SILICON CHIP

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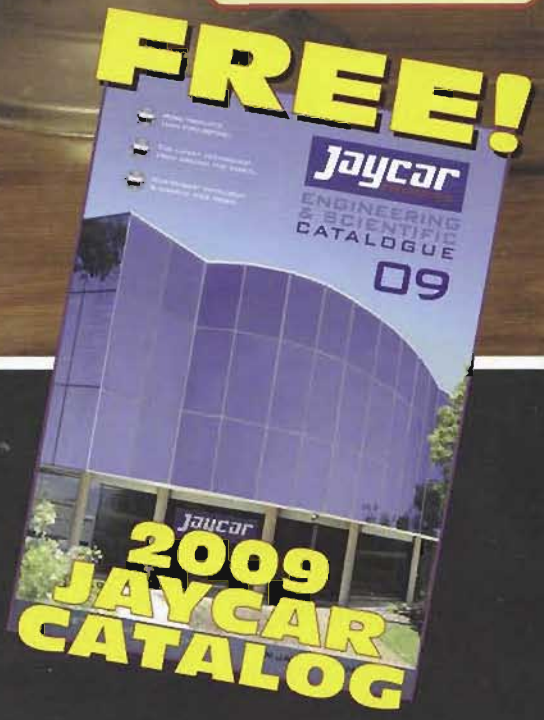
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PLUS:

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- Microcurrent Meter Adaptor
- Sharing A USB Printer Between Two PCs







Wireless Networking In Ubuntu & Puppy Linux

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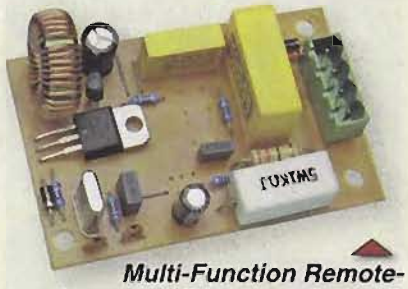
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Publisher's Letter

Everyday solvents can be dangerous



From time to time we all use solvents to clean electronic equipment. Maybe it is a case of just cleaning smudges and fingerprints off your computer's monitor. Possibly you need to clean solder flux off a freshly-assembled PC board or you need to degrease a metal chassis before it is painted. What solvent you use depends on the job and whether any residue can be tolerated.

Is it toxic? Is it inflammable? Can it be used safely without gloves or eye protection? Have you thought about this as you use solvents in your everyday work? If not, you really should. This topic was brought into sharp focus just the other week when our office photocopier had its annual contract service. This is a routine job which rolls around with monotonous regularity. We don't think about it; the technician arrives, does the job, presents the service form to be signed and that is the end of it.

But on this occasion, within five minutes of the technician arriving, my eyes started to sting and I noticed that I had a headache. I asked the technician if he was using a solvent. The answer was yes. What is it? He didn't know. When pressed, he said that it was simply Solvent B1? What is in it? Again, there was a blank. Then Ann Morris, our office manager reported that she too had stinging eyes as well as a sore throat. Clearly, there was a problem with this solvent.

Anyway, to cut to the chase, solvent B1 turned out to be quite toxic. It is also known as Sierra Lite. I downloaded two documents:

http://www.sierrachem.com.au/MSDS_Solvent_B1.doc
http://www.totalchemicals.com.au/MSDS/0811_B1_Solvent_MSDS_Total_Chemicals.pdf

Reading these should make your hair stand on end! This is a highly toxic solvent and classified as a dangerous chemical (Hazchem code 3Y; Poisons schedule 5). It should only be used with safety goggles, suitable breathing apparatus and gloves! Our service technician had been using it with no protection – just tip a bit on a rag and wipe over the photocopier drum and internal parts – no worries. There was no warning or any information about it on the container.

This stuff is also highly flammable and can be explosive and one must "take precautions against electricity discharges which may cause fire." And he was using it on a photocopier – which uses high electrostatic voltages!

The more I read through these documents, the more alarmed I became. I phoned the managing director of the service company to find out if he knew about this solvent B1, which his staff was routinely using. He didn't have a clue. To be blunt, the use of this solvent was putting his whole company operation at risk if anyone, a client or his staff, was injured. There are much safer solvents available for this job; isopropyl alcohol, for example, although even this is relatively toxic.

One thing it has highlighted for me is that any service person who comes into our premises, whether to service a printer, photocopier, the air-conditioner or anything else, will have to advise us about the solvents to be used, any potential hazards and so on, before they start the job.

I suggest you take the same approach. Do you use methylated spirits or Acetone (nail polish remover) regularly? What are their hazards? Check them out! What about paint thinners or floor degreasers? How about the various adhesives you might be using or perhaps heatsink compound? Some adhesives and heatsink compounds are very dangerous.

Even domestic cleaning agents can be quite dangerous, particularly if you are using them in confined spaces, as in a shower recess, for example. Be particularly careful with agents based on ammonia or bleach (chlorine hazard).

Don't be like our photocopier service technician. For your own health and welfare and that of others around you, be fully informed about all the chemicals you use. It could save your eyesight or even your life!

Leo Simpson

MAILBAG



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

Electric vehicles

I have been thinking about the Publisher's Letter in the December 2008 issue of SILICON CHIP, concerning electric vehicles. You may well be right ("electric vehicles might be a technological dead-end"), unless someone comes along with a much better battery type, possibly involving super capacitors.

There are two other vehicle types which use electric drive with an internal-combustion engine as the prime source of energy. The first is the conventionally-powered submarine. From day one, these vessels have had an IC engine, a battery and one or more electric motors. There have been tests with fuel cells and proposals to use a Stirling-cycle engine but the above configuration still dominates after over 100 years.

A primary factor here, of course, and not present to the same degree in other vehicle types, is a low noise level. Hydraulic systems may never cut it in that regard.

The second type is the railway locomotive. There the electric motors run directly from the generator driven by an IC engine, assuming the locomotive is autonomous, meaning it does not pick up energy from an overhead wire or a third rail.

Certainly hydraulic transmissions have been tried but never caught on. I believe there are two factors at work here:

(1) All-electric locomotives are, of course, very common. I cannot think how there could be an hydraulic equivalent. If autonomous (as just defined) hydraulic locomotives were introduced, there would be very little equipment commonality, apart from the prime mover and some control stuff, with conventional locomotive types.

(2) Apart from reason 1, railways are very conservative and reluctant to embrace new technology, sometimes ignoring performance and reliability improvements in deference to the maintenance headaches which arise, in their perception. Electric traction, like that of the submarine, has been around for over 100 years.

John Waller,
Plainfield, CT, USA

Comment: while it is true that diesel-hydraulic locomotives were never popular in North America they have been successful in other parts of the world, notably in Europe and Asia.

GPS needs three satellites for fix

I have just read page 22 of the January 2009 issue where Ross Tester has explained how GPS works. Towards the end of the article he states that "once the signal is received and position determined, it can keep accurate readings using only one satellite".

The way this is worded gives the impression to the reader that a single satellite is enough to maintain a position fix which is of course nonsense. It may be enough to keep accurate time but nothing else useful. If my understanding of GPS is wrong, then I'd love to hear the details, explaining how a single satellite is used obtain position information.

Ingmar Meins,
Russell, ACT.

Comment: we agree that the statement is wrong. In any case, once a complete fix is obtained, there should normally be plenty of satellites within view, unless the car is driving in an area with lots of tall buildings or in a forest.

DAB+ clarification

I would like to congratulate you on Alan Hughes' fine DAB+ article in the February edition but a few items need clarification.

The page 14 chart is erroneous and it does not clarify the Commercial and National Broadcasters, namely ABC and SBS. It should be amended as follows:

City	Commercial	National	Operator
Sydney	9A 9B	9C	TxA
Melbourne	9A 9B	9C	TxA
Brisbane	9A 9B	9C	TxA
Adelaide	9B	9C	TxA
Perth	9B	9C	TxA
Hobart			

Hobart is yet to be finalised.

In Sydney, DAB test transmissions have been broadcast from the TxA site at Willoughby since 2003 and they are still currently on air. For a shorter period in Melbourne, Broadcast Australia was conducting test transmissions from Mt. Dandenong but these ceased in December 2008.

When services commence with increased radiated power, broadcasters will have to comply with ACMA Technical Planning Guidelines (Federal Government) in the areas of co-channel interference, adjacent channel interference and masthead end overload. A strategy will have to be derived to minimise this impact.

I look forward to future articles in your Digital Radio series.

Name supplied but withheld at writer's request.

Good tip on Malware

In your January 2009 edition, the Serviceman dealt with a computer infected with the Antivirus 2008 malware. While I agree this is a nasty piece of work, the cure is much simpler than indicated.

There are a number of anti-spyware programs that will successfully remove it with minimal hassle. My favourite is Spybot Search and Destroy. This is a free package that can detect and delete AV2008 in all of its various

incarnations, as well as most of the other nasties that lurk on the net for the unwary.

I am responsible for the "care and feeding" of four computers used by our teenage children as well as some friends and I have yet to find a spyware/malware issue that this excellent program can't solve.

Richard Enright,
Moorebank, NSW.

GPS user operation not explained

The review of the Navman navigation unit in the January 2009 issue missed an important point. How do you enter the address you wish to go to? The matter of input was not reviewed and went on about a few "faults" that to me were insignificant.

I am not SatNav savvy and looked for this kind of basic info and it wasn't there!

Wayne Campbell,
Margaret River, WA.

Comment: all these SatNav devices have much the same method of inputting an address using on-screen prompts and an on-screen keyboard. Generally you only have to tap in the first three letters of a suburb or street name in order to get a choice of the likely names.

This is hard to depict in magazine pictures but easy once you see it demonstrated.

Electric cars not selling in Britain

Greenies talk big about electric cars. I'd buy one, they all say, but those evil multinational car/oil companies stop anyone from selling them.

Well, in Britain, where fuel costs much more than here and there is a huge overcrowded capital, there are electric cars from two companies on sale, one French, the other the Indian one an Adelaide company wanted to sell here. Between them they sell about 200 cars a year.

Gordon Drennan,
Burton, SA.

EVs & nuclear power

Concerning "EVs & Nuclear Power" in the Publisher's Letter (January 2009), one must agree with the opinions expressed in this article. While France gets 80% of its power through nuclear, our emissions per capita are higher than China's because of our insistence on coal-fired stations. A previous government was worried that if we started building nuclear plants, we might start a nuclear arms race in SE Asia. Now we find the proposed Indonesian reactor is situated in an earthquake-prone area.

A similar situation happened in Austria. A completed plant was mothballed after protests and later a neighbouring country built one on the border with Austria.

Other countries license EVs in the category of "quadricycle" but we do not have such a category. One shop in SA will have to send the Indian-built Riva car back because such lightweight vehicles would not survive our crash test requirements.

Any tinkerer can build an electric car. California even started to build parking stations with solar panels where EVs could park in the shade whilst being recharged before GM "killed the electric car". However, at present our power stations would not be able to cope with recharging EVs.

Dominic Wild,
Orange Grove, WA.

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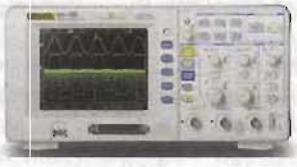
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Mailbag: continued

Digital radios will have varying features

Thank you for positive digital radio articles in SILICON CHIP magazine. Your articles outline all of the great DAB+ features that are possible but Commercial Radio Australia just wanted to clarify that like any product range, digital radio receivers will come in all shapes, sizes and price ranges and have different features. There will be entry-level receivers with simple scrolling text and others with pause and rewind, LCD screens, iPod docks and other features.

For example, while you mention a receiver that automatically switches between DAB+ and FM many times a second, although technically possible, there isn't currently such a receiver on the market. Obviously, as the digital market develops, these features could be possible in the future.

Also while Commercial Radio Australia's 5-state capital commercial radio members are all going digital, we don't have at this stage the exact number of radio stations that will be on-air at switch-on. The highly competitive industry players are still keeping new station information close to their chest. Austereo has announced the first Radar digital channel and others will announce their new initiatives closer to switch on.

More information is available at **www.digitalradioplus.com.au**

Joan Warner,
Chief Executive Officer,
Commercial Radio Australia,
Surry Hills, NSW.

Will DAB+ get to the rural areas?

I have read with interest the articles on digital radio. It is to be hoped that this is not going to be a repeat of the digital TV debacle. Minimal cost for viewers, oh yeah? – new antenna, masthead amplifier, new wiring and a set-top box and it stops working every time there is even moderate rain in the 120km between here and the transmitter.

I drove across to Perth from central NSW about 18 months ago. Apart from in the close vicinity of towns, the only available services on the car radio were the AM stations, and in long stretches not even those. In my area, as an example, the ABC tries to cover western plains NSW using FM stations. This is fine for those who live in the towns provided with transmitters but for those who live out of town or in towns without transmitters, you are likely to be out of luck.

Fortunately, there is still the old 2CR near Orange, which on AM still provides good coverage over most of western NSW but it does not have local programming, Classic FM, JJJ or RN.

Are we going to see a further deterioration in radio coverage as DAB+ is introduced? Although most Australians live in the major cities, they do not spend all their lives there and there are quite a few who live away from the cities. With the limited coverage that can be expected from DAB+, how is emergency coverage (as in the recent bushfires) to be provided?

Remember that people's lives may depend on being able to receive bulletins on small portable receivers, in an environment where there may be no power and no repeaters working.

John Denham,
Elong Elong, NSW.

In favour of hydrogen boosters

In regard to "hydrogen booster" devices for improving fuel economy, I would like to see SILICON CHIP do a test of the devices. I have read with much interest what has been said in previous issues.

I have one of these devices installed in my vehicle and I believe that it gives a small increase in economy. My vehicle, a 1995 Daihatsu Applause, is a small, efficient car. It has a kerb weight of 950kg and a 4-cylinder 1.6-litre engine which is supposed to produce up to 102 BHP.

Without the booster, I get between 11-13.5km/l, depending on how hard I drive. With the booster, I get 11.5-14.0km/l. The fuel I normally use is 95 RON E10 petrol/ethanol blend. I switched to high-performance three-electrode spark plugs before logging any fuel usage data.

A 1500W inverter needs a big battery bank

The item on deep-cycle batteries in a house system on page 97 of the February 2009 issue caught my attention. The point about battery discharge needs greatly expanding.

These house systems are always bound by the mighty dollar. In K. C.'s case, a 1500W inverter and 24V battery system have been selected. Taking battery voltage drops and efficiencies into account means that the average DC current required to supply 1500W is 75A. Since it is sinewave, then at the peak of the waveform it is most likely around the 100A mark. Then there is the surge capability of the inverter which is most likely 2500W, so the peak battery current is around 170A – a big ask for a 100Ah battery.

House loads may never reach this mark but powers in the 500W to 800W mark may be typical from time to time. Now in battery sizing there are a few simple rules that apply. The first K. C. has alluded to and that is the depth of regular discharges; 50% in his case. These must be better than average batteries because the recommended depth of regular discharge is only 30%. That makes his 100Ah batteries only capable of delivering 30Ah.

Second, the general rule of thumb is that if you have a 100Ah battery then the maximum regular average current drawn from and "sent into" it is Ah/10. Therefore, for a 100Ah battery, the maximum continuous load or charge current should only be 10A. This may be doubled for camping applications.

It all comes down to life expectancy of the battery. In large systems it is even less than this (usually around 0.7) to take into account the higher peak currents due to sinewave inverters and ripple in battery chargers.

Therefore, for a 1500W inverter on 24V, the minimum battery size should be 750Ah if the inverter is loaded to its maximum.

The third basic rule for battery integrity is charge them properly! Now K. C. has not indicated the specific type of lead-acid battery and they can vary from brand to brand. In a lot of cases, this information can be extremely difficult to obtain. Quite often even the battery seller doesn't know.

I have gel batteries that you can't take over 13.5V. These are standby batteries, designed to sit on float permanently and then deliver lots of current for a fairly short time. Then there are "Exide Energy Store" flooded cells that require nearly 16V for 90 minutes, depending on their depth of discharge and temperature. If you take 10% out, then it's only 15V for 30 minutes. If you take 30% out, then it's 15.6V for 90 minutes.

This charging process applies to many brands of lead-acid batteries. Generally, flooded type cells require an extended high-voltage period of charge maybe once per fortnight to once every month or two, depending on charging and usage. This is known as an "Equalisation Charge".

All lead-acid batteries may need an equalisation charge from time to time. Another thing that a lot of people don't realise is that it is extremely difficult to charge lead acid batteries properly if you still have the inverter connected and drawing current!

T. C. Thrum,
Para Hills West, SA.

When burning fuel in an internal combustion engine, not all of the energy stored in the fuel is turned into useful power. My understanding is that 20% is turned into useful power, 20% does not burn at all and the rest exits the cylinder as burning gas. Inputting a small amount, say, for example, two litres/minute of Browns gas is claimed to give a more effective burning process.

In short, more of the energy in the fuel is turned into useful power, therefore you use less fuel. It is also claimed to give you cleaner fumes out the exhaust pipe and less engine knock (what goes into your engine is claimed to be higher octane). The devices are claimed to be beneficial to any sort of IC engine and are said to do more for lower octane fuel.

High-output hydrogen booster units

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Mailbag: continued

Lesson learned on battery discharge

I just read the letter entitled "Deep-Cycle Batteries Must Not Be Heavily Discharged" in Ask Silicon Chip (February 2009). I have been through the same thing, ie, bought a 120Ah deep-cycle battery and started to deep-cycle it. A couple of months later I had a heavily sulphated battery with no capacity.

I got in touch with some guy from "energy matters" and he told me ideally I should not discharge below about 20% (80% is better). He also gave me some ideas about trying to restore my battery although he gave no guarantee that it could be restored. This is what I did.

First I added some Inox battery conditioner to the battery (two bottles @ $10.00) and started to charge and discharge the battery until I was getting as high a reading of specific gravity that I was able (maybe 10 times).

Then I emptied the battery of acid and filled it with distilled water. I started to charge and discharge with the water (perhaps 10 times). You can get an amazing amount of charge with just water even though you get no reading of specific gravity. I think the idea is to get the remaining sulphate on the plates to dissolve into the water.

Then I filled the battery with new battery acid and another dose of Inox battery conditioner. At that stage the battery would run a 65W car headlamp for 13 hours and still be holding reasonable voltage. That was good enough for me and that was about six months ago and so far so good. I don't discharge it below about 80% and I always make sure it is charged again the next day, either by solar or generator.

Tony Brazzale,
Lakes Entrance, Vic.

Comment: measuring specific gravity of battery acid in the cells is ultimately the best way of judging full charge but you cannot do this with many lead-acid batteries nowadays.

(15-30 litres a minute) are meant to be used in engines that have been modified to run insanely lean (eg, 19:1) and I do not know about these units. I do not wish to tinker with my car that much!

I will not dispute the fact that using electricity to convert water into Browns gas is something that will make you use more petrol but I believe that the benefit from the extra power you get from the fuel at the very least balances out this extra fuel usage. I believe that I am getting a small increase in economy based on my logged km/l figures.

I believe that it is true that some unscrupulous persons are trying to con people with hydrogen booster devices that do not work. They are also trying to scam us with poor-quality pirated movies, phoney vitamin pills, phoney medicines and electronic goods that have no warranty and that only last about a week.

Why would car companies not implement this if it works? Well, I do not know. I have read a lot of stuff on the internet, a lot of it being emotive claptrap. The basic remotely reasonable argument is that car companies are in bed with "big oil" and it is not in their interests to be more fuel-efficient as this will upset big oil and generally be a drawback to the profits of car companies.

Where car companies are trying to be fuel-efficient it is either where it is mandated by government or where it can be glamorous and with a big price tag (think expensive Toyota Prius – "everyone look at me, I'm saving the planet"!). A cheap device that could go into every car is not glamorous, nor can it have a premium slapped on it by car companies. If hydrogen booster technology is any good, car companies won't bother unless there is a profit to be had.

The unit I purchased was a "Fuels Plus 1", which I bought over the internet for $85. The unit is supposed to use 6A at 12V. When I ran a multimeter over it I found it was using 3A at 12V.

I may have made the mistake of using too thin gauge of wire to supply the current to the device. The device is supposed to produce 2-3 litres/minute. The device is straight across the battery, switched on or off by a relay, with no regulator or pulsing circuit. The unit holds two litres of water which is supposed to be good for 1500 litres of Browns gas.

I purchased it hoping for an increase of 1km/l in my fuel economy whereas I got half that. Even so, I believe that it has paid for itself. I guess it is not easy to squeeze extra mileage out of a lightweight car with a small engine.

Will SILICON CHIP obtain a few different models from reputable sources and do a test of the hydrogen booster?

Alex Rochford,
Devonport, Tas.

Comment: we do not think there is any point in doing such tests – we simply do not believe that boosters can work as claimed.

Such tests would also be very time consuming and would need to be done with a range of vehicles on a vehicle dynamometer. Road tests could not be relied upon, because you could not depend on drivers using exactly the same accelerator settings at particular points of a trip, for a number of comparisons.

The only way to do it is to put the car on a dynamometer and set it for a given power output at selected speeds with part throttle and then precisely measure brake specific fuel consumption (BSFC) with and without the booster operating.

Incidentally, we would be very surprised if your electrolyser produced 2-3 litres/minute at such a low power input.

Modern cars achieve almost complete combustion of the fuel. The only time that unburnt fuel would ever exit the engine is under heavy acceleration when the ECU is in "open loop" and the catalytic converter is unable to burn the residual.

By the way, your car is not efficient by modern standards. Plenty of current small cars with similarly-sized engines get much better fuel economy.

Rural AM stations' limited power radiation

On page 85 in column 2 of the November 2008 issue, Rodney Champness asks a question about the reasons why city AM stations were able to use 5kW radiated power, whereas rural ones were restricted to 2kW.

I asked that same question when I lived in "the bush" many years ago. I was told that advertisers in a town with one commercial station (the norm) did not want advertisers in the town down the road getting free plugs on their turf. Limiting the power naturally funnelled listeners onto the local station and it sounded better.

Of course the listener a bit further out from all such stations lost out. But then they supposedly had the ABC regional network, which did operate at higher powers. 2CR at Cumnock (Orange) radiated 50kW, while others were I think around 10kW.

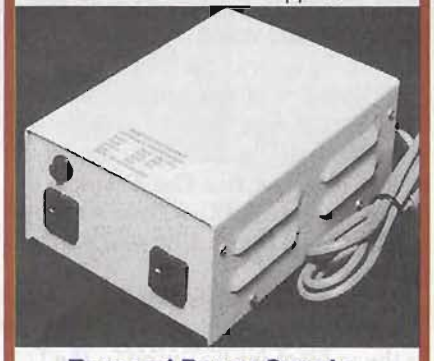
Bruce Bowman,
Ainslie, ACT.

Honda cylinder deactivation does work

I write in response to the article and reader feedback on the Honda cylinder deactivation system. While the power required to move a car at a set speed will be constant regardless of the number of cylinders, there can be efficiency gains by operating the engine on fewer cylinders. As mentioned in the article and the Editor's comments on readers' feedback, the reduction in "pumping losses" is responsible for this.

When a petrol engine is running at low throttle settings, it wastes a lot of energy by sucking the inlet air in through a small throttle opening. When the engine is running at higher loads, the throttle is more open, so there are fewer losses. By shutting down a number of cylinders, the remaining cylinders will be operating at higher load and so require a wider throttle opening; hence less losses.

There are other reasons that running fewer cylinders at higher loads can improve efficiency. For example, fuel

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injectors are more accurately able to meter fuel when they are running at higher loads, which means the engine can more accurately run at the most efficient air/fuel ratio.

Chris Lister,
Brisbane, Qld.

Good variety in February 2009 issue

I wanted to say how much I enjoyed the February 2009 edition of SILICON CHIP. It was nice to see a month without a single PIC or micro-based project (except the Car Display but that was more a PC software guide!) but still have interesting and relevant projects.

It reminded me of electronics in the late 1980s when I first got interested in the subject while living in the UK, where magazines such as Elektor and ETI were full of devices using discrete logic. I think a lot of electronics projects now just have a micro and it all happens in code. So people don't get the fun of debugging logic gates and building logic subsystems, or get a real grasp for how a circuit actually operates.

Don't get me wrong; I love a micro-based project but there is something about using logic gates and old school comparators to do the work. I think it is electronics as it used too be – everything open to view and explained. I learned a lot from studying such circuits and it certainly helped me when I finally did get involved with micro-based projects. Keep up the good work and the variety.

Bill Coghill,
Monterey, NSW.

Brilliant use of junk parts

In defence of SILICON CHIP and that controversial microwave oven UV light source project (October 2008), I thought it was a brilliant use of junk parts and would construct it if I ever start making PC boards at home.

I find this kind of article far more interesting than the usual "processor chip drives LED display" type of thing. As I consider myself reasonably literate, I would follow the article's instructions and use the recommended colour codes. I don't see a problem there.

As for its controversial wiring colour codes, let's be realistic here. It's never going to be worked on by anyone but the author and it is obvious by reading the labels and looking at what the green/yellow stripe wires are connected to, that they may be live.

It is not as if this device has been constructed to be sold or given to the public. I find it strange so many have complained about the unorthodox colour codes, when several times throughout the article it is clearly explained what the correct colours to be used are. I know common sense is no longer taught but if anyone can't follow written instructions and read labels, I really question the wisdom of them working on anything electrical to start with.

On incandescent bulbs, the $2 shops are the place to go for bulb hoarders. One shop was selling 30 packs of 60W bulbs for about $8. I walked out of there with more than a lifetime supply. Why it is necessary to actually ban the sale of incandescent bulbs is a mystery when people are already using CFLs where they are best used.

As an amusing exercise, I calculated that to have every incandescent lamp in my house on at the same time, less power would be used than required by one air-conditioner, yet there's no plan to ban air-conditioners.

Part of the problem is that politicians are technically ignorant. After all, our communications minister who will see to it that analog TV transmissions are also banned, when there is no technical reason to do so, had difficulty connecting a digital box to his television. (They'd probably turn off the analog system even faster if they knew it used AM for the picture transmission).

On a final note, it's quite ironic that any of my valve black & white television sets use less power than a plasma display. I wonder how far off linear power supplies and valve amplifiers are on the "to ban' list. Better build that class-A amplifier while you can!

John Hunter,
Hazelbrook, NSW.

Comment: you can still purchase a variety of incandescent lamps from lighting stores and IGA supermarkets. SC



Digital Radio

Part 3: Transmitters & Receivers



Last month, we discussed the details of the Advanced Audio Coding (AAC+) used in Digital Radio. This month we discuss how the AAC+ data is transmitted and received. The transmissions combine data with program content and the entire transmission is a multiplexed combination of the many programs.

By ALAN HUGHES

ONE OF THE MOST interesting features of Digital Radio transmission is that more than one station's program content is embedded into a single carrier frequency. In fact, up to nine different program digital streams can be combined into the one transmission. At the planned introduction* of digital broadcasting, there will be up to 71 radio stations (ABC, SBS and commercial) on 10 DAB+ transmitters.

Fig.1 depicts how the AAC+ encoded program and multiplexers combine data from a number of stations. Multiplexers can be thought of as rotary switches which continually cycle through the available data sources. So if they are switches, does this mean that bits of individual programs are missing, as the switch selects other program sources? No, that is the beauty of switching digital data packets – no program data is lost.

As well as the program digital streams, two other types of data are multiplexed into the transmission. The first, Program Associated Data, includes date & time, station identification & location, and pictures and text.

By contrast, Fast Information Channel inserts small blocks of data, often regardless of the program sources. Typical uses are emergency and traffic information, as well as paging and conditional access data.

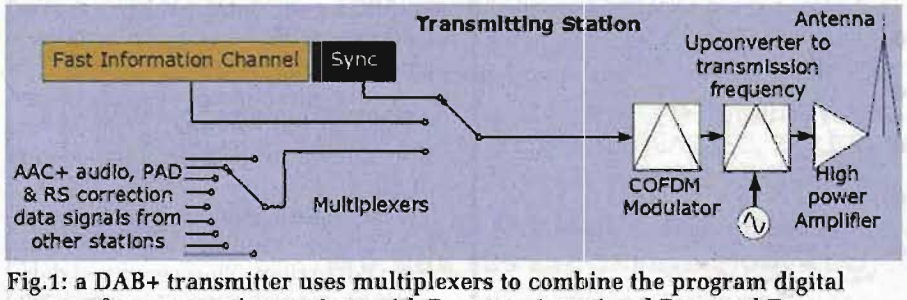


Fig.1: a DAB+ transmitter uses multiplexers to combine the program digital streams from up to nine stations with Program Associated Data and Fast Information Channel data.

Error detection

The effect of corrupted data becomes more drastic as compression is increased, so some error detection and correction will greatly improve the listening experience, particularly for car and portable reception. This takes several forms:

Cyclic Redundancy Check: this adds parity bits which are related to the data. This will enable the decoder to ignore corrupted data.

Reed-Solomon Error Correction: for every 110 bits, 10 bits are added which are mathematically related to the data. This will allow up to five bits in error to be corrected in the decoder.

DRM Error Correction: this uses the Cyclic Redundancy Check and Reed-Solomon error correction. Audio frames are divided into two. The first half, representing the loudest frequencies, has more error correction than the second half which is less significant. Huffman Codeword reordering is used for AAC.

Camouflage: the data is shuffled in a

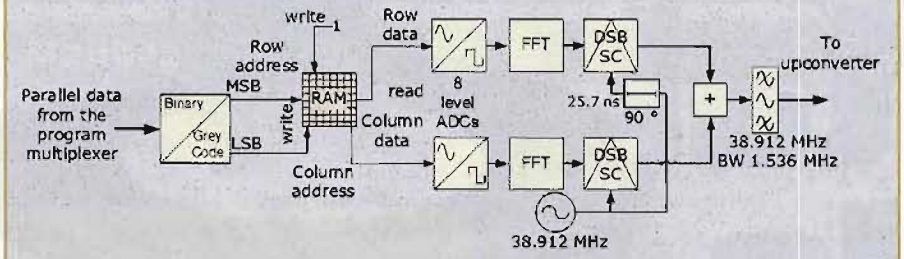


Fig.2: block diagram of a COFDM modulator. This results in quadrature amplitude modulation (QAM) of the transmitter signal.

predetermined order, prior to transmission, so that the effect of impulse noise is distributed, making the likelihood of complete correction greater. This makes reception more reliable until the noise is continuous.

COFDM multiple carriers

In the process of multiplexing, the single serial data stream is subjected to Coded Orthogonal Frequency Division Modulation (COFDM). This is similar to taking a serial signal and converting it to parallel. So for DAB+, each serial pulse becomes 1536 times longer in duration. This allows reflected signals to be ignored. It also enables Single Frequency Networks (multiple transmitters in the same coverage area on the same frequency) to be used.

Fig.2 shows the COFDM process while Fig.3 shows the resulting map of the modulation.

The data from the nine program sources is used to address a block of RAM (random access memory), one bit at a time. A 'one' is written into that location. For transmission, the memory is read so that the column value is obtained. This is fed into an analog-to-digital converter (DAC). It is used to vary the carrier level in a double sideband suppressed (DSB) carrier modulator. If the value is greater than 3.5, the carrier will be inverted to make the left side of the modulation graph in Fig.3. This is called the in-phase or "I" axis.

A second DAC is fed with the row data. It is identical to the "I" axis but its carrier is delayed by 90 °. This gives the Quadrature (Q) axis. Once the outputs of the two DSBSC modulators are added together, the result is quadrature amplitude modulation (QAM). This signal consists of a suppressed carrier and a set of sidebands. The frequency of the sidebands depends on the data being modulated. A Fast Fourier Transform is applied to this signal to generate the many carriers which are characteristic of COFDM.

The suppressed carrier is usually a standard intermediate frequency (IF) which is the same in every transmitter. To get to the allocated transmission frequency, a second modulator is used to increase the frequency. A high-powered linear amplifier increases the power to be applied to the transmitting antenna. In the DAB+ case, the antenna is vertically polarised.

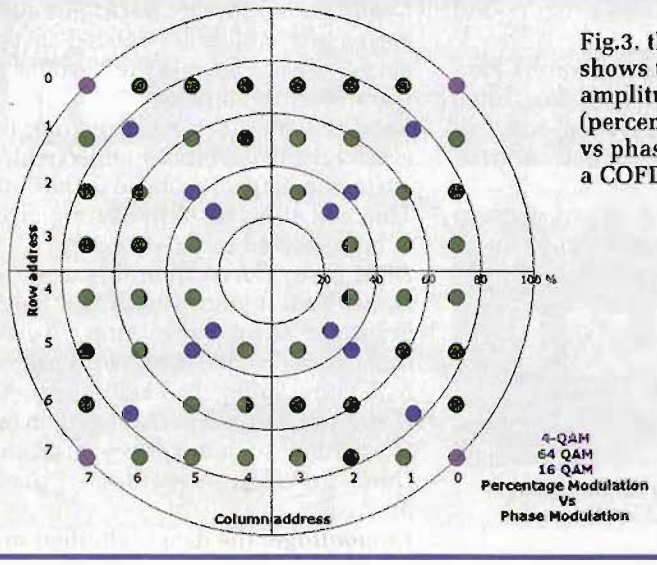


Fig.3. this diagram shows the quadrature amplitude modulation (percentage modulation) vs phase modulation for a COFDM.

Map characteristics

The modulation map of Fig.3 shows percentage modulation versus phase modulation. In 4-QAM, there are only four phases and so the amplitude is always at a maximum from the modulator, as shown by the pink spots on the graph. This mode gives the best immunity from noise.

64-QAM can transmit 16 times the data rate as 4-QAM. 64-QAM has nine amplitude levels over a range of 17dB. To get the same reliability of the reception, the radiated power needs to be increased by a factor of 50 times.

As a compromise, the data which has the most audible effect can be transmitted using 4-QAM and the more subtle information transmitted at 64-QAM. This is called "hierarchical" coding.

Digital radio receivers

Fig.4 shows the block diagram of a digital radio receiver. The blue section of the diagram is devoted to the RF and IF sections which more or less constitute a conventional radio tuner. The mauve or pale blue section is devoted to the COFDM demodulator which essential reverses the processes applied in the COFDM in the transmitter.

In operation, the microprocessor displays a list of available stations. The listener uses the station select switch to select the wanted program and the micro takes over from there. The antenna signal is filtered to only allow the channel you have selected to be amplified. The microprocessor will tell the tuning section which frequency band and what frequency is to be selected. The output of the tuning and IF amplifier section is digitised.

The signal leaves the hardware and with the exception of the audio amplifiers and loudspeakers, the rest is done by the microprocessor and some memory.

Audio directional control is performed in the Parametric Stereo section, shown in the pale green section of Fig.4.

The central pair of delays and attenuators is used to steer the sound from left to right. There is a fixed delay when the sound source is central. The outer pair of delays is used to produce

reverberation by feeding the steered signal back around the section. The duration of the delays and the amount of feedback will control the reverberation time. This adds to the "realism" of the sound.

The demodulation can be done using mathematics performed by a processor, however the control microprocessor will have to tell the demodulator which mode to operate in.

When the demodulator is operating in the COFDM mode, its output will be decoded by the AAC+ decoder back into AES digital audio. This is then converted to stereo analog sound and fed into speakers. An HDMI output could be used, particularly for 5.1 channel sound to be fed into a home-theatre amplifier.

The microprocessor can also decode and send text and images to the display screen. In addition, the processor will use the station list in the DAB+ or DRM signal to check the availability of other signals containing identical program and will switch to it if the DAB+ or DRM signal contains too many errors.

Fig.4 shows the DRM/FM/AM tuners in a separate block, for simplification of the diagram. The combined DAB+/DRM/FM/AM radio only needs the following modifications over a DAB+ only radio: additional firmware, extra tuning coils, plus varicaps and band-switching diodes. A ferrite rod or loop antenna is also required for the MF band (DRM & AM).

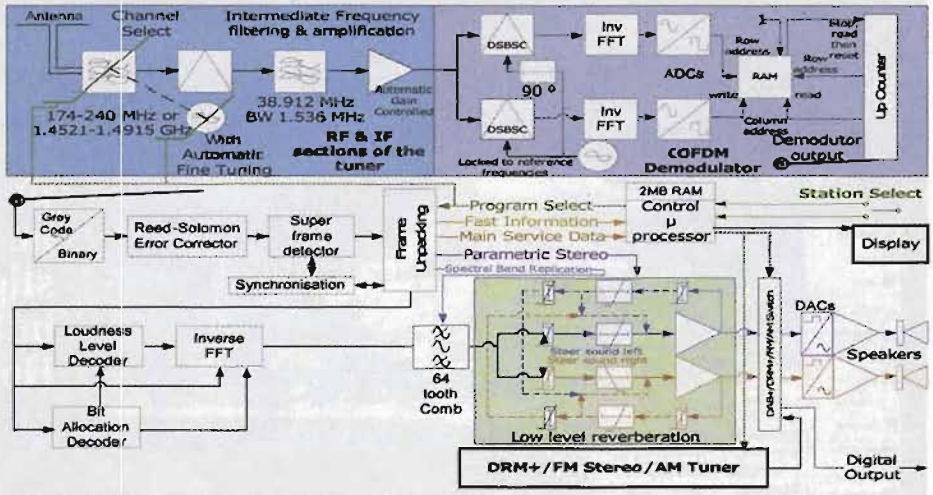


Fig.4. block diagram of a DAB+ receiver. The microprocessor controls all functions.

Radioscape® has a DAB+/DRM/FM/AM module available to radio manufacturers.

Next month, we will conclude with a discussion of the signal format, a comparison of DAB+ and DRM and suggested antennas. SC

STOP PRESS*

As we went to press on this issue, it was announced that industry-wide switch-on to DAB+ will be postponed to August 1st rather than May 1st 2009. May 1st will begin the widespread testing of new signals but the ABC will not begin test transmissions until June, with all its stations on air from July 1st.

Av-Comm DAB+ Digital Radio Receiver

ONLY $149.00 PLUS P&P



Av-Comm's Q4000 DAB+ receiver is the result of over 12 months product development and market research. Rather than releasing a non-compatible DAB receiver which could have been used during early on-air testing, the company chose to wait until the DAB+ standard was formalised.

Originally intended to combine the features of DAB+, FM with RDS and Internet radio, the results of Av-Comm's market research indicated that different demographics exist for DAB+ and Internet radio. The result is the Q4000 which is a basic VHF only DAB+ receiver.

The receiver also has a clock and alarm functions with snooze allowing it to be used as a bedside clock radio. Priced at $149 (plus P&P), the receiver represents an affordable entry point into the world of Digital Radio. The unit is capable of running from 6 AA internally-housed batteries but is supplied with a 9V regulated DC power supply.

For those technically minded, the important specs are:

(1) RF Input Frequency Range: 174.928-239.2MHz **(2) Sensitivity:** -100dBm **(3) Power supply** 9V DC,800mA **(4) DAB+ channels:** 5A/B/C/D, 6A,B,C,D, 7A,B,C,D, 8A,B,D,C, 9A,B,C,D, 10A,N,B,C,D, 11A,B,C,D, 12A,B,C,D, 13A,B,C,D,E,F.

Av-Comm Pty Ltd, 24/9 Powells Rd, Brookvale 2100, NSW, Australia
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Connecting Puppy Linux to the Internet via a network cable is a piece of cake. Wireless networking can be slightly more difficult but is still easy to do. Here's how.

By GREG SWAIN

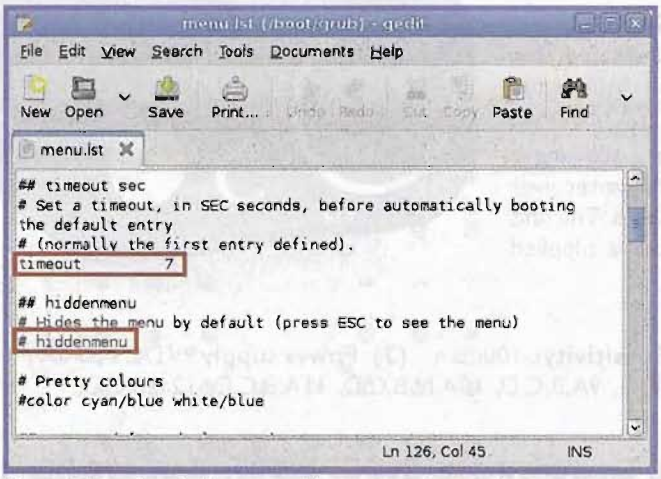
Wireless Networking With Ubuntu & Puppy Linux

LAST MONTH, we described how to resurrect an old laptop using Puppy Linux as the operating system. Puppy runs fast, even on old hardware, and is just the shot as an OS for machines that would otherwise finish up in landfill.

In the course of preparing that article, we decided to resurrect an old laptop that had once belonged to the daughter of one of the SILICON CHIP staff members. This 6-year old machine is a Compaq Presario M2000 running an AMD Sempron 3000 processor, 512MB of RAM and Windows XP.

Well, it used to run Windows XP but somehow this had become kaput. It was taking an age to load and had become so corrupted that it would take several minutes just for the fly-up menu to appear after the Start button was clicked.

Cleaning up the disk debris and running a registry checker did improve



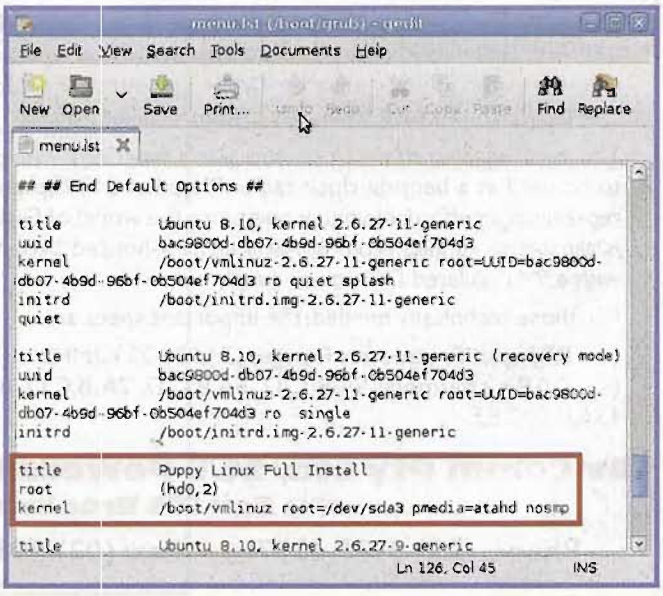


Fig.1 (above): set the menu timeout value and comment out the hiddenmenu line in Ubuntu's *boot/grub/menu.lst* file if setting up a dual-boot Ubuntu/Puppy system. Fig.2 (right): how the Puppy boot lines are added to *menu.lst*.

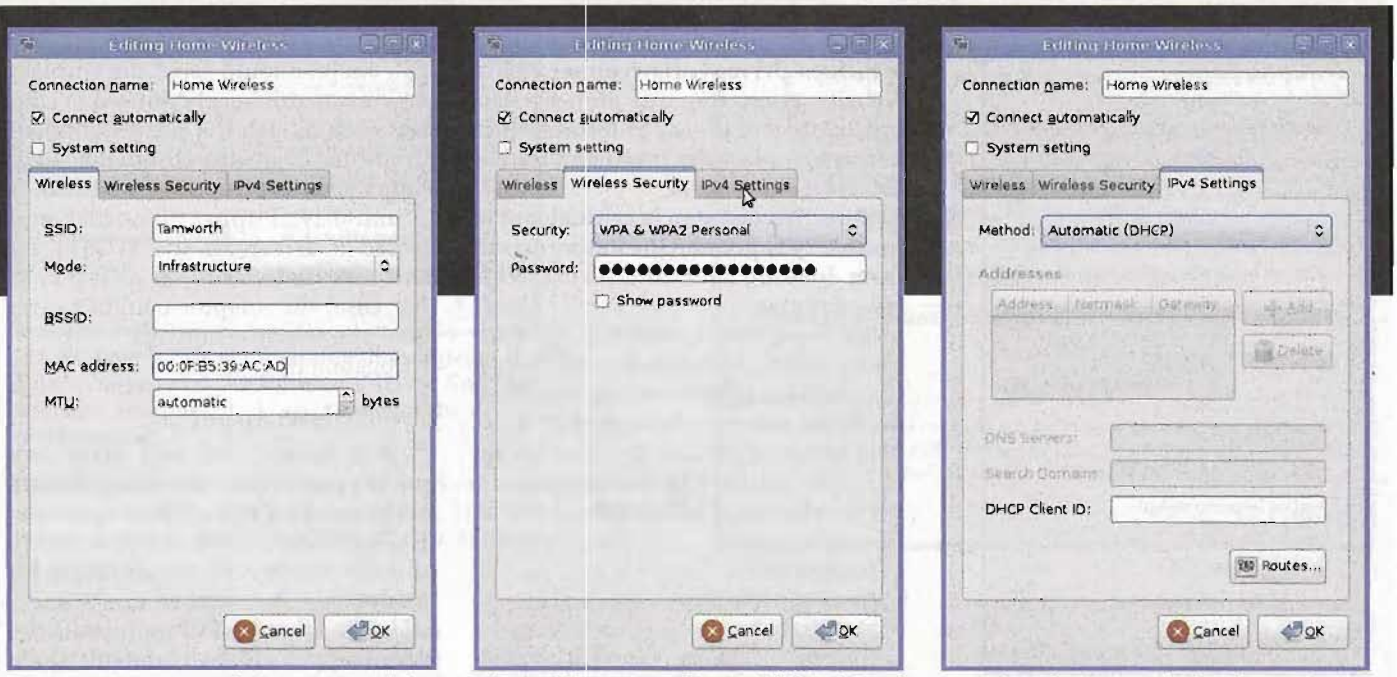


Fig.3: setting up a wireless networking profile in Ubuntu 8.1 (Intrepid Ibex) is a breeze using the Network Configuration wizard. These three dialog boxes show the basic set-up for a secure connection.

things somewhat but it was clearly beyond redemption. So why not ditch Windows altogether and install Linux? In fact, why stop at just one flavour of Linux?

To cut a long story short, we ended up installing both Ubuntu Linux and Puppy Linux as a dual-boot set-up. Ubuntu was installed first into one partition and then Puppy was installed into a second partition. Ubuntu's boot menu file (***/boot/menu.lst***) was then modified to add Puppy as one of the boot options.

How to you do that? Easy – Puppy recognises the Ubuntu install and tells you what lines to add to Ubuntu's ***/boot/menu.lst*** file. While you're at it, you also have to comment out the *hiddenmenu* line and change the *timeout* entry to suit – eg, seven seconds (Fig.1).



An external USB or PC Card wireless adaptor will be necessary if your laptop lacks a built-in adaptor.

Wireless networking

Getting wireless networking going in Ubuntu 8.1 (aka Intrepid Ibex) proved to be child's play. The laptop we were using didn't have a built-in wireless adaptor, so we tested it with four plug-in adaptors: (1) a Netgear WG511 Wireless PC Card; (2) a Netgear WG111T USB Adaptor; (3) a Netgear WG111v2 USB Adaptor; and (4) a Belkin Wireless G USB Adaptor. In each case, as soon as the device was plugged in, Ubuntu loaded the correct native driver and the device was ready to go.

It was then just a matter of setting up a wireless networking configuration and saving the profile. That's done by clicking *System -> Preferences -> Network Configuration* to bring up the Network Connections wizard – see Fig.3. You then add a wireless profile and enter in the necessary details such as the broadcast SSID, the mode and the security details (use WPA security if the driver supports it, otherwise use WEP).

You also need to enter the MAC address of the wireless adaptor if you are using MAC address filtering. This is always a good idea but note that if you do use MAC address filtering, you will have to create a separate profile for each wireless device you intend using.

And that's it. Once the network profile has been created, Ubuntu 8.1 automatically connects to the Internet. What could be easier? – you just plug the device in, set up the wireless network configuration details and it works.

However, based on personal experience, wireless networking with previous versions of Ubuntu is not

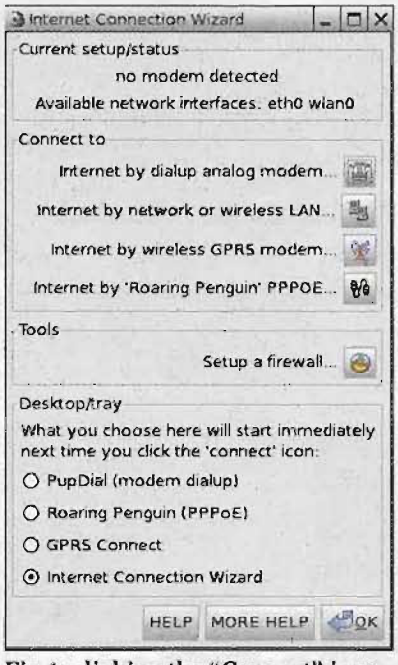


Fig.4: clicking the "Connect" icon on the Puppy desktop brings up the Internet Connection Wizard.

quite as simple. For example, none of the native drivers for the above-listed wireless adaptors worked with Ubuntu 8.04 (aka Hardy Heron) but they could all be made to work by using a utility called "Ndiswrapper" and the relevant Windows driver for each device.

As the name suggests, Ndiswrapper "wraps" the Windows driver so that it can be used under Linux. The procedure is relatively straightforward but we won't go into it in detail here because the latest 8.1 version of Ubuntu apparently doesn't need it – at least not for the adaptors we tested.

If you are forced to use Ndiswrapper with Ubuntu, then take a look at **https://help.ubuntu.com/community/WifiDocs/Driver/Ndiswrapper**. This website gives the full step-by-step procedure and is easy to follow – just be sure to blacklist the listed native drivers as instructed.

Note: this last step is critical and is necessary to prevent the native driver from loading and interfering with Ndiswrapper.

If it doesn't work, then it may be necessary to blacklist extra drivers – either that, or you've got the wrong Windows driver for your wireless adaptor. A list of drivers that you can try blacklisting is shown below (these entries go in ***/etc/modprobe.d/blacklist)***.

```
blacklist b43
blacklist b43legacy
blacklist ssb
blacklist rt2500usb
blacklist islsm_pci
blacklist islsm
blacklist islsm_usb
blacklist prism2_usb
blacklist rtl8187
blacklist r8187b
blacklist rt73usb
blacklist p54usb
blacklist ath_pci
blacklist ath_hal
```

Note that while Ndiswrapper works well in practice it's needed only if the native driver doesn't do the job.

Puppy wouldn't play ball

Getting the wireless networking going with Puppy also required some coaxing. With each of the three USB wireless adaptors, Puppy correctly loaded a native driver but things went pear-shaped from there. Although each USB adaptor could "see" the wireless network, it stubbornly refused to connect even though the correct wireless profile had been created and loaded in Puppy's networking set-up wizard.

Similarly, Puppy identified and loaded a driver for the WG511 PC card. But that was as far as it got. In that case, the adaptor couldn't even "see" the wireless network.

Doggone it!

Use Ndiswrapper

After some trial and error, we quickly got all four wireless adaptors working with Puppy. Once again, the trick is to use the Ndiswrapper utility plus the relevant Windows driver for the device.

Unlike Ubuntu, Puppy installs the Ndiswrapper utility by default along with a GUI, so it's easy to get going. Here's how it's done:

Step 1: obtain the Windows ***.inf*** and ***.sys*** driver files for the wireless network adaptor. These can either be obtained from the installation CD supplied with the device or downloaded from the manufacturer's website.

If necessary, install the driver software on a Windows machine to extract the ***.inf*** and ***.sys*** files from a ***.exe*** install file. That done, copy them onto a USB flash drive or, better still, into the ***/home*** folder in Puppy.

Step 2: run the Internet Connection Wizard by clicking the "Connect" icon on the desktop to bring up the dialog shown in Fig.4.

Step 3: click the "Internet By Network Or Wireless LAN" button to bring up the dialog box shown in Fig.5, then

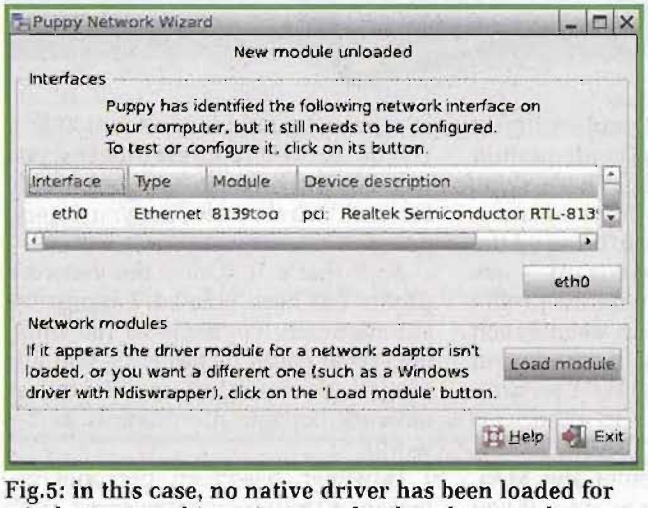


Fig.5: in this case, no native driver has been loaded for wireless networking – just one for the ethernet adaptor. Click the *Load module* button to proceed.

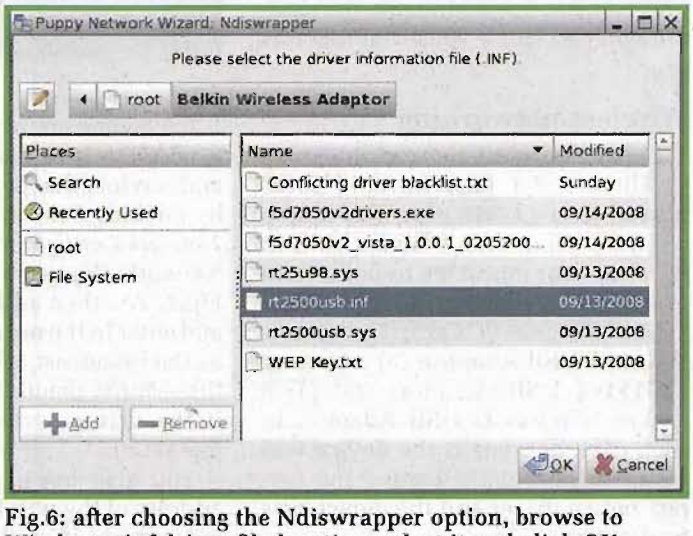


Fig.6: after choosing the Ndiswrapper option, browse to Windows *.inf* driver file location, select it and click OK.



Fig.7 (above): this is the dialog that appears if Ndiswrapper and the Windows driver find the wireless adaptor. Click *Save* to keep the driver configuration.

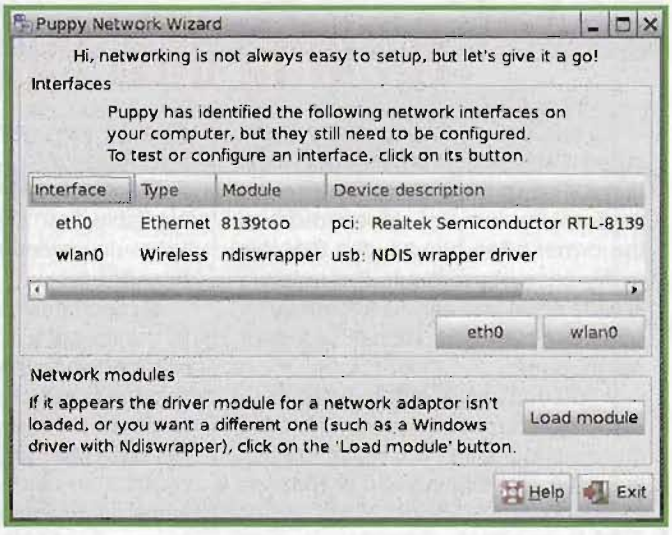


Fig.8 (right): once Ndiswrapper is working correctly, the wlan0 entry will appear in this dialog. You then click the wlan0 button to go to the dialog shown in Fig.9.

click "Load Module" and choose the "Ndiswrapper" button at the next dialog. **Be sure to unload and blacklist any existing native WLAN0 driver when prompted during this procedure (if one has been loaded).**

Alternatively, if no native driver has loaded, just click on the "None" button at this prompt.

Step 4: follow the prompts to install the Windows driver. Note that you must select the *.inf* file to install (Fig.6).

Step 5: having loaded the driver, the wizard will now bring up a dialog advising that it is trying to associate with an interface. If the driver finds the wireless interface and loads correctly (see Fig.7), then so far so good – proceed to Step 7.

Step 6: if it doesn't find the adaptor, unload the driver at the subsequent prompt, then reload Ndiswrapper and the Windows driver and try again. This step is apparently necessary to completely unload other drivers, to prevent them from conflicting with Ndiswrapper and the Windows driver.

In short, if a native driver has initially been loaded, you may have to go through the Ndiswrapper driver installation procedure twice to get it working. Based on my experience, simply installing Ndiswrapper and the driver once doesn't work.

Step 7: once the driver has associated with the wireless adaptor correctly, the dialog shown in Fig.8 will appear. This should now show the **wlan0** entry with the driver module listed as "ndiswrapper". If it does, click the **wlan0** button and then the **Wireless button** at the next dialog (Fig.9) to go to the dialog shown in Fig.10.

Step 8: click the "Scan" button. If it finds one or more wireless networks, you are in business. Select your network, then click the "New Profile" button to set-up a wireless networking profile as shown in Fig.10.

STEP 9: Once the profile is completed,

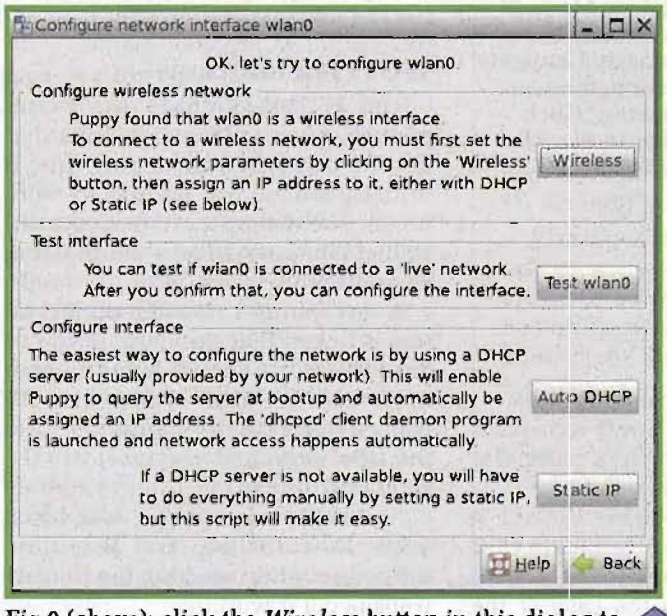


Fig.9 (above): click the *Wireless* button in this dialog to set up a wireless networking profile.



Fig.10 (right): to set up the profile, first click the *New Profile* button, then enter in the details as shown here. You then save the profile and click the *Use This Profile* button.

Locking Down A Wireless Network

It's surprising just how many unsecured wireless networks there are out there. Out of the box, most wireless modems/routers are unsecured and the owner often has no idea that this is the case. As a result, the network is wide open and can be accessed by other people in the vicinity (eg, your neighbours).

If you don't want others using your wireless Internet connection for free, there are four steps you should take to lock your wireless modem or wireless router down:

STEP 1: change the default user name and password that's used to log in to your wireless modem via your browser in order to set it up. The default user names are easy to discover on the net or even guess, so why make it easy for someone to gain access?

STEP 2: change the ESSID (ie, the name given to the wireless network) from the default, then disable "Broadcast ESSID". After all, there's no point in changing it from the default if you're then going to broadcast it to the world.

STEP 3: Enable MAC address filtering if available, then enter the MAC address for your wireless network adaptor into the set-up.

To explain, each wireless adaptor is assigned a unique identification number when it's manufactured. This number is in hexadecimal format and is referred to as the "MAC address". By enabling MAC filtering in your wireless router, you can limit access to those wireless adaptors that have the corresponding MAC addresses (you can enter more than one address).

To obtain the MAC address of your wireless network adaptor, just go to a terminal window and type ***ifconfig -a*** for a Linux system or ***ipconfig /all*** on a Windows system. This will be listed as the *Hwaddr* in Puppy or as the *Physical Address* in Windows.

Be sure to use the MAC address listed for your wireless adaptor, not for your ethernet adaptor.

Alternatively, if you are using an external adaptor, the MAC address will be on a label attached to the device.

STEP 4: Enable either WPA or WEP encryption (WPA = Wifi Protected Access; WEP = Wired Equivalent Privacy). Provided your network adaptor supports it, WPA is the one to go for since WEP is no longer regarded as being secure (although it's still better than nothing if you have no choice).

Note that the wireless router should be set up from your laptop or PC using a wired (ie, ethernet or USB) connection. Don't set it up using an unsecured wireless connection because it's wide open to anyone who may be snooping while you're doing so.

Note that it will also be necessary to enter the WPA (or WEP) key into the wireless networking profile on the laptop, otherwise you will not be able to access the wireless router. Depending on the operating system, you may have to enter the MAC address as well.

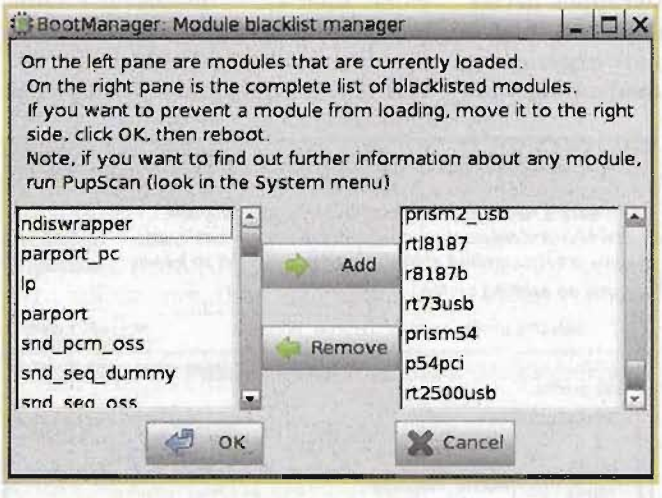


Fig.11: you can check which native drivers have been blacklisted by clicking Menu -> System -> BootManager Configure Bootup, then clicking "Click Here To Blacklist A Module".

click "Save" followed by "Use This Profile". If Puppy subsequently reports that it was able to find a live network, you then click the **Auto DHCP** button to obtain an IP address.

That's it – you will now be connected to the Internet. **Note, however, that Puppy does not automatically connect to a wireless network each time it starts up.** Instead, you have to reload the networking profile (select the profile, then click "Load", click "Use This Profile" and then "Auto DHCP" to reacquire an IP address.

Of course, there is a way to make it automatically connect to a particular network but let's not go there.

In practice, the Netgear WG511 & WG111T adaptors and the Belkin USB wireless daptor all work reliably using the Ndiswrapper. In the case of the WG511, the ***p54pci*** driver had to be blacklisted while for the Belkin device it was the ***rt2500usb*** driver.

No blacklisting was required for the WG111T, since no native driver was loaded in the first place. By the way, the ***athfmwdl.inf*** driver was the one that worked for my WG111T, not the ***netwg11t.inf*** driver which was also on the Netgear installation CD.

WG111v2 tantrums

The WG111v2 loads the Prism ***p54usb*** driver as its native driver but despite correctly blacklisting this, it initially stubbornly refused to work under Ndiswrapper. It fact, the installed Windows driver wouldn't even recognise the device.

A few minutes research on the Internet licked that problem. If you've got a WG111v2 and its serial number starts with WG72 or WG16, then it's really a WG111v1 device (despite what the label says) and you must use the WG111v1 driver.

So the incorrect driver was being used. Downloading and installing the correct v1 driver from the Netgear website got it working.

Troubleshooting

If Ndiswrapper doesn't work, try using a different Windows driver. Some wireless adaptors come in different



A USB wireless adaptor can be used if necessary but PC card adaptors (eg, the WG511) are less vulnerable to damage in laptops.

versions with different chipsets, so be careful if downloading drivers off the Internet. You must get the correct driver for your particular device otherwise it won't work (see the note about the Netgear WG111v2 above).

For this reason, try to use the driver that was supplied on the CD-ROM with the wireless adapter.

Note that you cannot use Windows Vista drivers with Ndiswrapper – it's limited to Windows XP and Windows 2000 drivers.

If you want to check which files have been installed under Ndiswrapper, take a look at the ***/etc/ndiswrapper*** folder. The install procedure should have copied both the Windows ***.inf*** and ***.sys*** files to a sub-folder. Delete the sub-folder if you want to get rid of them.

Blacklisting

If you want to check which driver modules have been blacklisted, click ***Menu -> System -> BootManager Configure Bootup***. This allows you to access the "Module Blacklist Manager" – see Fig.11. The loaded modules are listed at left, while the blacklisted modules are in the righthand pane.

To add a module to the blacklist, simply select it in the lefthand pane and click "Add". Conversely, to remove it from the blacklist, select it in the righthand pane and click "Remove".

Alternatively, you can directly handfettle the ***/etc/rc.d/modulesconfig*** file in a text editor. The blacklisted files go in the SKIPLIST section. Always be sure to leave a space between the last entry and the end quote mark.

Finally, if Ndiswrapper stubbornly refuses to work, try blacklisting the Broadcom drivers in the ***/etc/rc.d/modulesconfig*** file. Open this file in a text editor and add *bcm43xx b43 b43legacy ssb* to the end of the SKIPLIST section. Be sure to leave a space between the final entry and the end quote mark. **SC**

Useful Command Line Utilities

```
rxvt
# ifconfig -a
eth0      Link encap:Ethernet  HWaddr 00:FF:36:00:16:65
          BROADCAST MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)
          Interrupt:18 Base address:0x6000

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          UP LOOPBACK RUNNING  MTU:16436  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

wlan0     Link encap:Ethernet  HWaddr 00:0F:B5:39:AC:A0
          inet addr:192.168.0.67  Bcast:192.168.0.255  Mask:255.255.255.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:33 errors:0 dropped:0 overruns:0 frame:0
          TX packets:23 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:4733 (4.6 KiB)  TX bytes:2872 (2.8 KiB)

#
```

Fig.12: the *ifconfig -a* command can be used to discover the MAC address of any network adaptors attached to the machine. It will also display any IP addresses that have been assigned.

```
rxvt
# iwconfig
lo        no wireless extensions.

eth0      no wireless extensions.

wlan0     IEEE 802.11g  ESSID:"tamworth"
          Mode:Managed  Frequency:2.462 GHz  Access Point: 00:FE:FC:F3:4C:1F
          Bit Rate=11 Mb/s   Tx-Power:20 dBm   Sensitivity=-121 dBm
          RTS thr=2347 B   Fragment thr=2346 B
          Encryption key:EC29-F005-A177-FE62-5DAB-601F-8D   Security mode:restricted
          Power Management:off
          Link Quality:100/100  Signal level:-32 dBm  Noise level:-96 dBm
          Rx invalid nwid:0  Rx invalid crypt:0  Rx invalid frag:0
          Tx excessive retries:0  Invalid misc:0   Missed beacon:0

#
```

Fig.13: the *iwconfig* command gives information on the wireless set-up, including the broadcast ESSID if connected to a network.

Several useful Linux command-line utilities can be used to help you get your network (either wireless or cable) up and running. They are as follows: (1) ***ifconfig -a***, (2) ***iwconfig*** and (3) ***lsmod***.

Ifconfig -a is useful for discovering the MAC address of the wireless network adaptor and will also list its IP address if one has been picked up (the equivalent Windows command is ***ipconfig /all***). By contrast, ***iwconfig*** gives information on the wireless set-up. It shows the broadcast ID or ESSID (provided it's connected), the frequency, the bit rate and even the encryption key.

The third command, ***lsmod***, lists the driver modules that Puppy (or Ubuntu) has loaded. Among other things, this is useful for discovering which native driver is loading for your wireless adaptor (this driver must be blacklisted if you are using Ndiswrapper).

To run a command in Puppy, simply click the "Console" icon on the desktop to open a terminal window, then type the command and press Enter.

Multi-function, Intelligent Remote-Controlled Dimmer

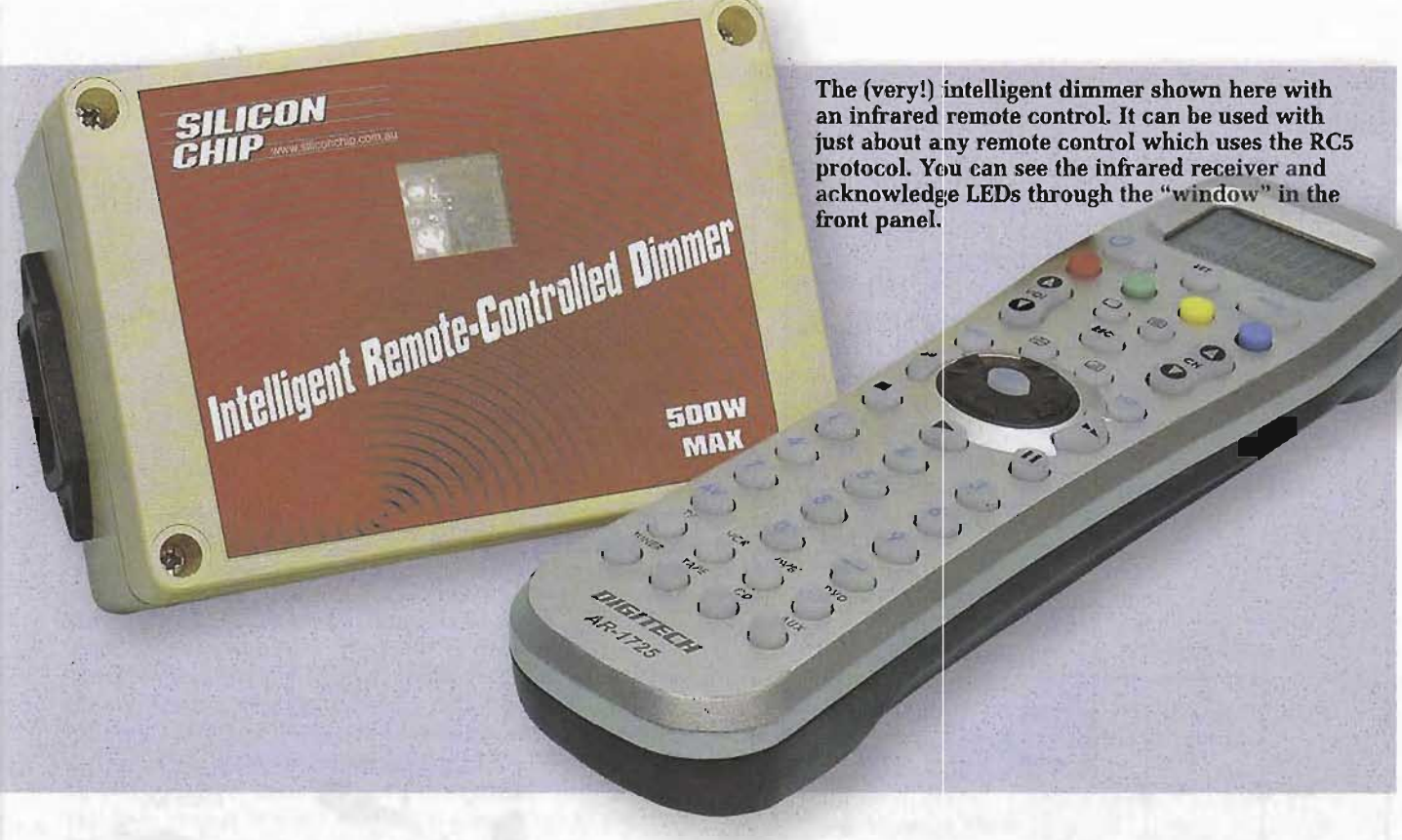
You probably think that a dimmer is a dimmer is a dimmer, right? This little beauty will definitely change your mind!



by Mauro Grassi

Main Features

- Five Modes of Operation:
  - (1) Dimmer with Time Out
  - (2) ON/OFF control only
  - (3) Sleep Mode – dims gradually to off over the timeout period
  - (4) Flash mode – functions as a strobe light
  - (5) Security mode – turns a light on and off randomly to simulate occupancy
- Use almost any RC5 remote controller– it learns the remote control codes
- Low standby power consumption (1.1W)
- Nine preset brightness levels with fine control in between
- Controls lamps up to 500W (eg, halogen spotlights)
- ON/OFF control for non-dimmable compact fluorescents
- Multi-Addressable: control up to nine dimmers independently
- Time Out Period: from 1 minute to 7 days (can be disabled)
- Save and restore your favourite brightness level and mode
- Remembers the last brightness level & mode if turned off using a series switch
- Customisable Triac triggering for finer control (advanced)
- Customisable dimming speed (advanced)



The (very!) intelligent dimmer shown here with an infrared remote control. It can be used with just about any remote control which uses the RC5 protocol. You can see the infrared receiver and acknowledge LEDs through the "window" in the front panel.

THIS REMOTE CONTROLLED DIMMER will work with incandescent and dimmable CFL (compact fluorescent) lights, as well as some 12V halogen lights. It can provide mood and home-theatre lighting or operate in SLEEP mode (eg, in an infant's room) to very gradually fade a lamp.

This dimmer also has intelligence – it can automatically turn off the light after a timeout period ranging from one minute to almost a week, ensuring the light is not left on if you forget to switch it off. It can also be used to control non-dimmable CFLs. In this mode, we simply turn the CFL ON and OFF (note: it may not be suitable with some non-dimmable CFLs which tend to flicker in the "OFF" state).

Want to individually dim more than one table lamp in a room? No problem. You could have up to nine of these dimmers in a room independently controllable with the same remote. In addition, you can also control two or more dimmers simultaneously!

You can use almost any RC5 remote control, because the light dimmer can be programmed to learn the command codes. Pretty neat, eh? You use the number keys to dim to a preset level or the VOL UP and VOL DOWN keys to dim up or down in fine increments. Button "0" dims down to off, while "9" dims up to fully on.

In addition, we have attempted to provide just about every possible remote control feature in this design. It is quite a simple circuit but the microcontroller's program provides all these features.

Circuit description

The circuit is based around a PIC18F1320 microcontroller which controls the Triac and responds to all the remote control commands. In addition, there is the infrared decoder IDR1, two RGB LEDs, an NPN transistor, two diodes, a zener diode, a 10MHz crystal and an inductor and a few resistors and capacitors.

The Triac is connected between the mains Active and the lamp via inductor L1. In conjunction with a 100nF 250VAC capacitor, this inductor provides suppression of electromagnetic interference caused by the rapid switching of the Triac.

The micro sends gate pulses to the Triac via NPN transistor Q1 and ultra-fast recovery diode D2. The diode protects the transistor from spikes generated when the Triac changes state from conducting to non-conducting and vice versa.

The micro controls the power level fed to the lamps by the Triac by varying the timing of the gate pulse during each half-cycle of the 230VAC mains waveform.

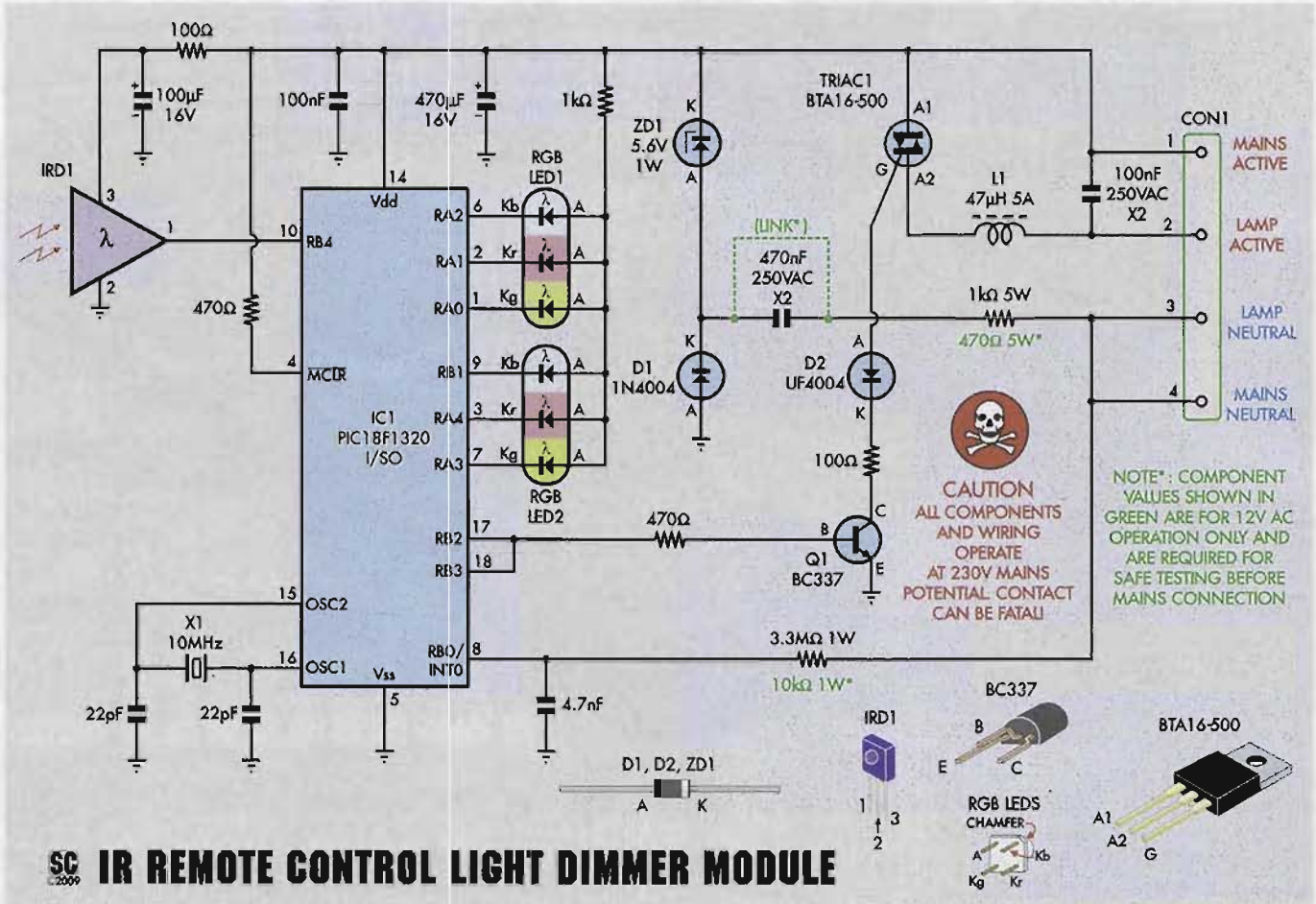
If the gate pulse is early in each half cycle, the power level will be high (ie, the lamp will be bright). Conversely, if the gate pulse comes late in each half-cycle, the power level will be low (ie, the lamp will be dim). This method of power control is referred to as "phase control".

WARNING!

This circuit is directly connected to the 230VAC mains. As such, all parts operate at mains potential (ie, at 230VAC) and contact with any part of the circuit could be FATAL. This includes both sides of the PC board.

DO NOT connect this device to the mains unless it is fully enclosed in the specified plastic case. DO NOT remove the lid of the case or touch any part of the circuit unless the power cord is unplugged from the mains socket.

This project is not for the inexperienced. DO NOT attempt to build it unless you know exactly what you are doing and are completely familiar with mains wiring practices and construction techniques.



SC 2009 IR REMOTE CONTROL LIGHT DIMMER MODULE

Fig.1: the circuit is based on a PIC18F1320-I/SO microcontroller, a Triac and an IR detector (IRD1). The two RGB LEDs give the user feedback on the operation and settings.

In order to know when in each half cycle to issue the gate trigger pulse, the microcontroller must be properly synchronised to the mains waveform at 50Hz. This is accomplished by a sync pulse taken directly from the neutral mains connection via a 3.3MΩ 1W resistor. The sync signal is filtered by a 4.7nF capacitor which forms a low-pass filter with the 3.3MΩ resistor and synchronisation occurs every half-cycle of the mains waveform, at a 100Hz rate.

Power supply

You may wonder how the micro can be synchronised to the mains waveform by connecting it to the Neutral side of the mains supply. Isn't this the low-voltage side of things?

Yes it is but the microcontroller is actually tied to the Active side of the mains supply. Power for the micro is derived from the mains via a 1kΩ 5W resistor and 470nF capacitor. The capacitor and resistor act as a current limiting impedance for the associated 5.6V zener diode, ZD1.

The supply circuit works as follows. First, for positive half-cycles of the 230VAC, current flows via ZD1, the 470nF capacitor and 1kΩ 5W resistor. At the same time, the 470µF 16V electrolytic capacitor is charged up. Then, for negative half cycles of the mains, current flows via D1, the 470nF capacitor and the 1kΩ resistor. The result is that the 470µF capacitor is charged to 5.6V - 0.6V = 5V DC.

The impedance of the 470nF capacitor at 50Hz is 6.77kΩ and in series with the 1kΩ resistor this gives a total impedance of 6.84kΩ. Hence the 5V supply can deliver up to 23mA. Apart from the current drain of the micro itself and IRD1, the circuit must supply the gate power to the Triac and drive the two RGB LEDs. These LEDs are connected with each of the six cathodes connected to a different I/O pin of the micro, IC1.

The common anodes of the two RGB LEDs are connected together and to the 5V rail via a single 1kΩ current limiting resistor. For this reason, only one LED (there are three within each RGB LED) is ever lit at any one time.

The LEDs are lit to acknowledge key presses, to prompt

Programming The PIC Micro

If you purchase this project as a kit, the PIC microcontroller will be pre-programmed. If not, you will need to program the PIC with the file 1010409A.hex before soldering it to the PC board.

To do this, refer to the "PIC Programmer SOIC Converter" published in the November 2007 issue (page 67) of SILICON CHIP. That simple project will allow you to interface the SMD PIC to a common PIC programmer with a ZIF socket. The PC board for this adaptor is available from RCS Radio.

Alternatively, SILICON CHIP can supply a programmed PIC for $A25 including postage.

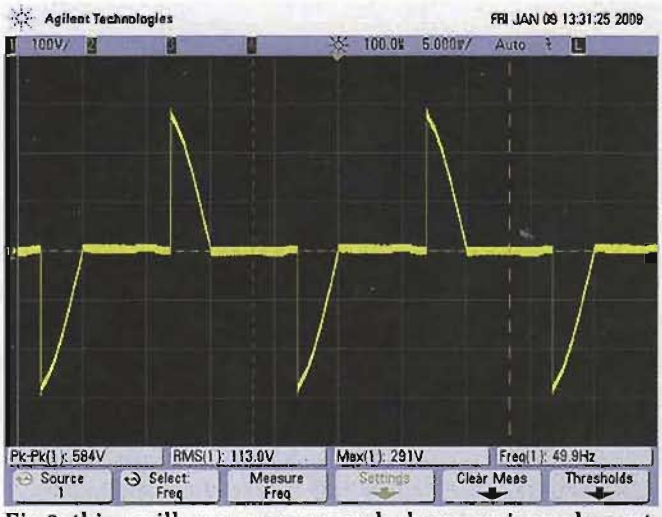


Fig.2: this oscilloscope screen grab shows an incandescent lamp being switched using phase control. The yellow trace shows the waveform at the A2 terminal of the Triac.

the user for input and to give feedback on current settings. We explain the user operation in detail below.

Signals from the IR remote control are amplified, filtered and decoded by the receiver module (IRD1). The 100Ω resistor and 100µF capacitor are used to decouple its 5V supply. The data output at pin 1 of IRD1 is connected to pin 10 of IC1 and configured as a digital input.

Construction

The Intelligent Dimmer is built on a single-sided PC board coded 10104091 and measuring 76 x 50mm. It is housed in a sturdy polycarbonate case (125 x 85 x 55mm) with a clear lid and neoprene lid-sealing gasket.

The component overlay diagrams for both sides of the PC board are shown in Fig.3. **Note that the circuit diagram and Fig.3 both show three components which must initially be installed to allow the dimmer to operate at 12VAC. This enables you to check its operation at a safe low voltage before changing these parts to allow it to operate at 230VAC.**

To build the 12VAC version, you simply install a wire link in place of the 470nF 250VAC capacitor, a 470Ω 5W resistor instead of the 1kΩ 5W unit and a 10kΩ 1W resistor instead of the 3.3MΩ 1W unit.

Check the PC board for any defects before starting the assembly. That done, the next job is to install the programmed PIC microcontroller on the copper side of the board. Note that the microcontroller is a SMD and must be the 18F1320-I/SO (in the SOIC 18-pin package). Make sure it is oriented correctly.

You will need a fine-tipped soldering iron to do the job. Position the IC over the pads and solder pins 17 & 18 first. Then solder pin 9, followed by the remaining pins.

Be careful not to get solder bridges between adjacent pins. If you do, a good way to remove them is to use solder wick (Jaycar NS-3026, Altronics T-1210).

Once the micro is in, flip the board over and install the parts on the component (top) side. Start by installing the four wire links, plus the link in place of the 470nF 250VAC capacitor. Follow these with the seven resistors. Start with the smallest and leave the 470Ω 5W wirewound resistor until last.

Install the diodes next. These are polarised so be sure to

Parts List – Intelligent Dimmer

1 PC board, code 10104091, 76 x 50mm
1 IP65 sealed ABS case with clear lid, 125 x 85 x 55mm (Jaycar HB-6246, Altronics H-0324)
1 flush-mount 3-pin mains socket (Jaycar PS-4094, Altronics P-8241)
1 IEC male chassis connector with mounting holes (Jaycar PP-4005, Altronics P-8320B)
1 10MHz crystal (X1)
1 47µH 5A inductor (Jaycar LF-1274, Altronics L-6617)
1 4-way "Dinkle" vertical socket (CON1) (Jaycar HM-3114, Altronics P-2534)
1 4-way "Dinkle" screw terminal plug (Jaycar HM-3124, Altronics P-2814)
1 10A IEC mains cord

Semiconductors

1 PIC18F1320-I/SO SOIC microcontroller (Farnell 9762027) programmed with 1010409A.hex (IC1)
1 IR receiver (Jaycar ZD-1952, Altronics Z-1611)
1 BTA16-500 isolated tab Triac (TRIAC1), Altronics Z-1710 – DO NOT substitute
1 BC337 NPN transistor (Q1)
2 RGB 5mm common anode LEDs (LEDs 1 & 2)
1 1N4004 diode (D1)
1 UF4004 ultrafast diode (D2)
1 1N4734 1W 5.6V zener diode (ZD1)

Capacitors

1 470µF 16V electrolytic
1 100µF 16V electrolytic
1 470nF (0.47µF) 250VAC X2 metallised polypropylene (Jaycar RG-5240, Altronics R-3132)
1 100nF (0.1µF) 250VAC X2 metallised polypropylene (Jaycar RG-5236, Altronics R-3122)
1 100nF MKT (code 104, 100n or 0.1)
1 4.7nF MKT (code 471, 4n7 or 0.0047)
2 22pF ceramic (code 22p)

Resistors (0.25W, 1% unless specified)

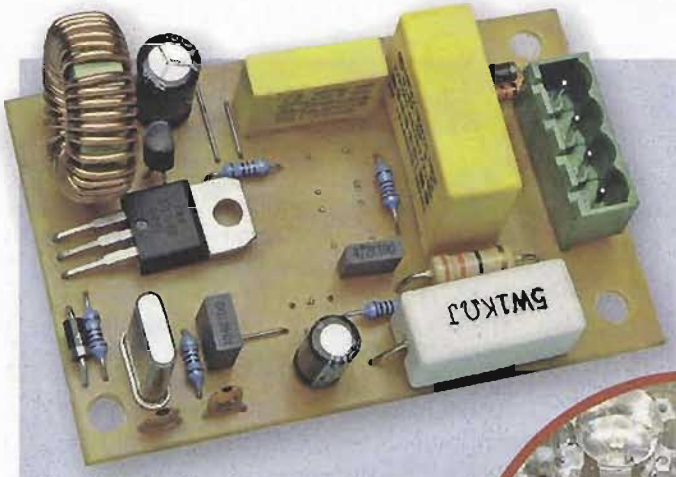
1 3.3MΩ 1W
1 10kΩ 1W*
1 1kΩ
1 1kΩ 5W wirewound
2 470Ω
1 470Ω 5W wirewound*
2 100Ω
(* 12V operation only)

Miscellaneous

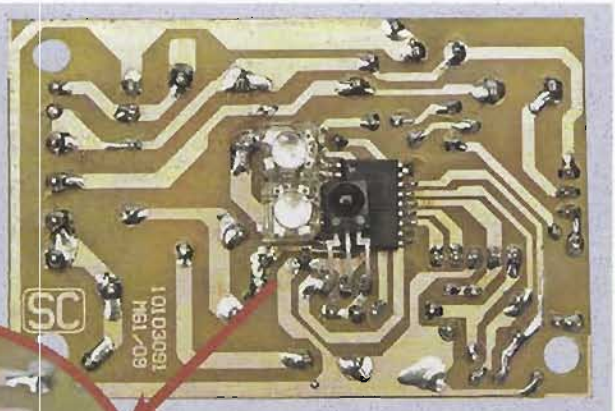
3 M3 x 25mm Nylon screws (to secure PC board)
2 M3 x 15mm Nylon screws (for IEC connector)
3 M3 x 12mm Nylon spacers
10 M3 Nylon nuts
1 100mm of 0.7mm-dia. tinned copper wire (for links)
1 200mm length 3-core mains flex (250V 10A rating)
1 4.8mm red spade connector
1 4.8mm blue spade connector
1 4.8mm yellow spade connector
3 100mm cable ties

Additional Parts Required For testing

1 12V AC 500mA or 1A plugpack
1 12V 300mA light globe (Jaycar SL-2656, Altronics S-4047)



The "normal" component side of the PC board carries most of the components . . .



. . . however there are four, including the microcontroller, mounted on the copper side (see enlargement at left).

get their orientation correct. The zener diode and the 1N4004 go in the top righthand corner, while the UF4004 (D2) goes near the Triac.

Now solder in the BC337 NPN transistor (Q1). It can only go in one way. That done, bend the leads of the Triac down by 90° about 9mm from its body, then install it so that it sits horizontally on the PC board (metal tab down) as shown in Fig.3 and the photos. **Do not substitute for the Triac – check its part number carefully.**

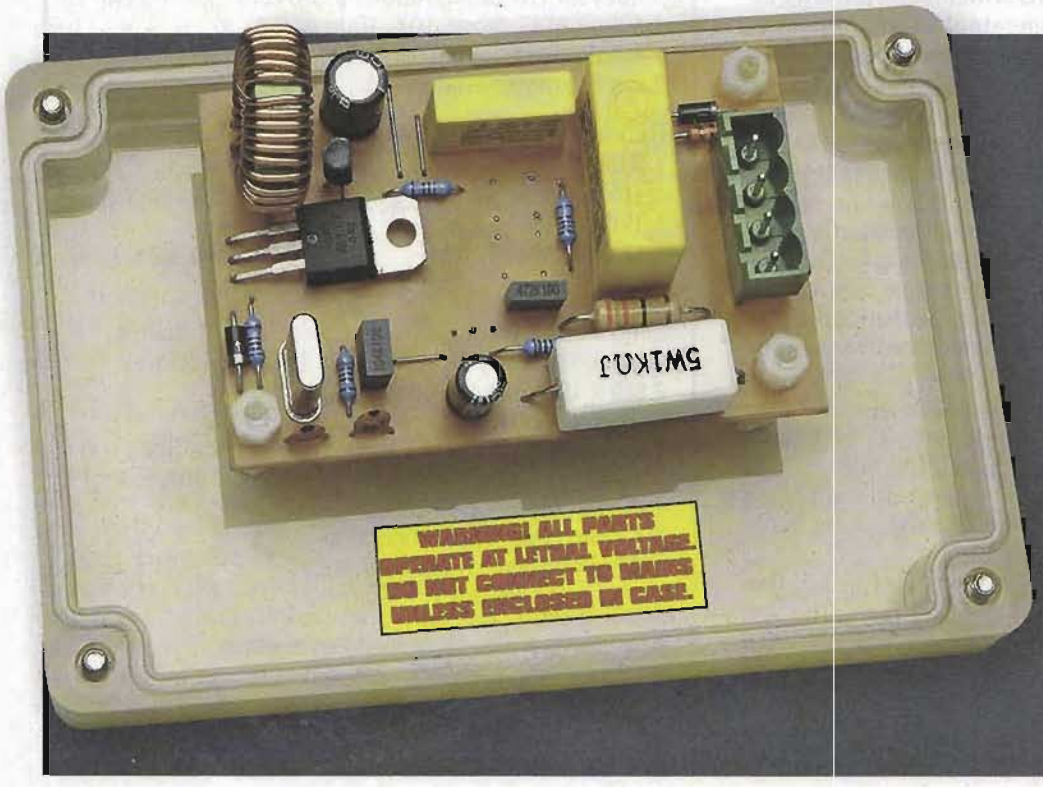
The capacitors can now go in. The two larger electrolytic capacitors must be oriented correctly.

The 47µH inductor is next on the list – it sits vertically on the PC board. Make sure that the enamel coating on the leads is stripped away on the tips prior to soldering. Follow with the 4-way socket (CON1) and the 10MHz crystal.

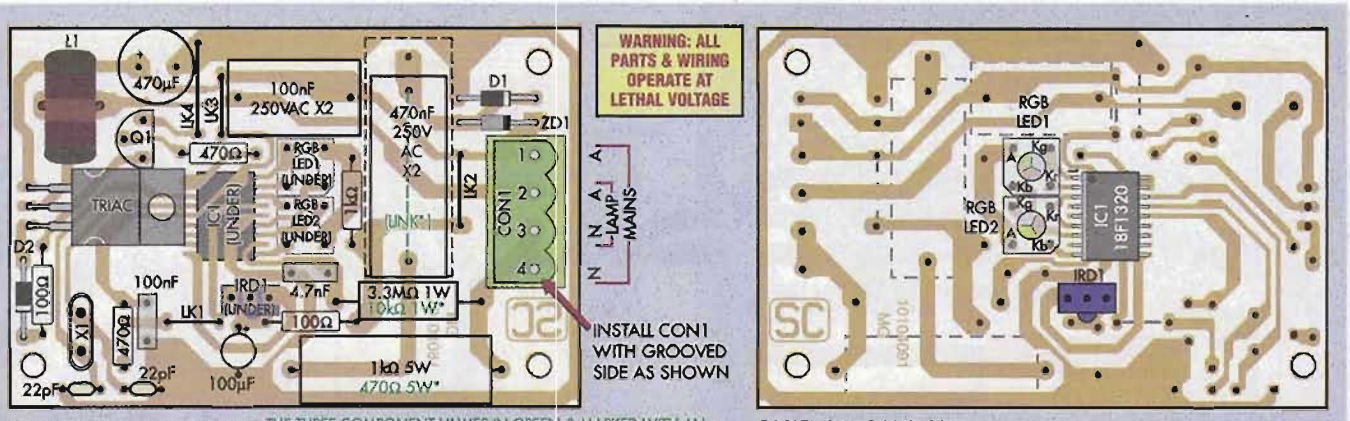
Note particularly the orientation of CON1 – it must be installed exactly as shown, with its grooved side towards the righthand edge of the PC board.

Now flip the PC board over to the copper side again. There are three more components to be fitted to this side: the two RGB LEDs and the infrared receiver module IRD1.

Start with the two RGB LEDs. These go in with a very specific orientation so refer to the component overlay before proceeding. Be careful not to use too much heat when you solder in the LEDs because excessive heat can easily destroy them (or the fine connecting leads inside the RGB LED). We recommend using a temperature-controlled soldering station set to no more than around 300°C. The RGB LEDs sit about 5mm from the PC board and you will need to also



Another view of the completed top side of the PC board, this time mounted on the case lid (note: mains version shown). Be sure to attach the warning label to the inside of the lid, as shown.



Note: components marked in blue must be installed first to build the low-voltage (12V AC) version for testing (see text). After testing, these parts are removed and the alternate parts installed for mains operation.

Fig.3: the component overlay for both sides of the PC board. Remember that the low-voltage version (blue components) MUST be built first and the module then tested using a 12V AC plugpack. Only if the low-voltage version passes testing should you proceed to install the three components needed for mains operation (marked with an asterisk – see text).

be careful that you don't melt their plastic housing as you solder the leads to the copper side.

Finally, solder in the infrared receiver module (IRD1). Its mounted with its leads bent down by 90° about 10mm from its body. Make sure its domed lens faces upwards, as shown in the close-up photo.

Testing on low voltage

Your dimmer is now ready for its low-voltage operation tests. First, connect a 12V light bulb (Jaycar SL-2656, Altronics S-4047) between the LAMP ACTIVE and LAMP NEUTRAL connections on the 4-way screw terminal block CON1 (ie, between pins 2 & 3). That done, apply 12VAC from a plugpack supply to pins 1 & 4 of CON1. You can then use your remote control to run through the various dimmer modes and functions (see features panel).

Note that the low voltage version may show signs of flickering at high-brightness settings because the synchronisation with the zero crossings of the mains will be offset by the AC plugpack. This problem should not occur with mains operation.

Converting to mains operation

Having successfully tested the circuit with a 12V AC plugpack and light bulb, you can now disconnect power and install the three components for mains operation:

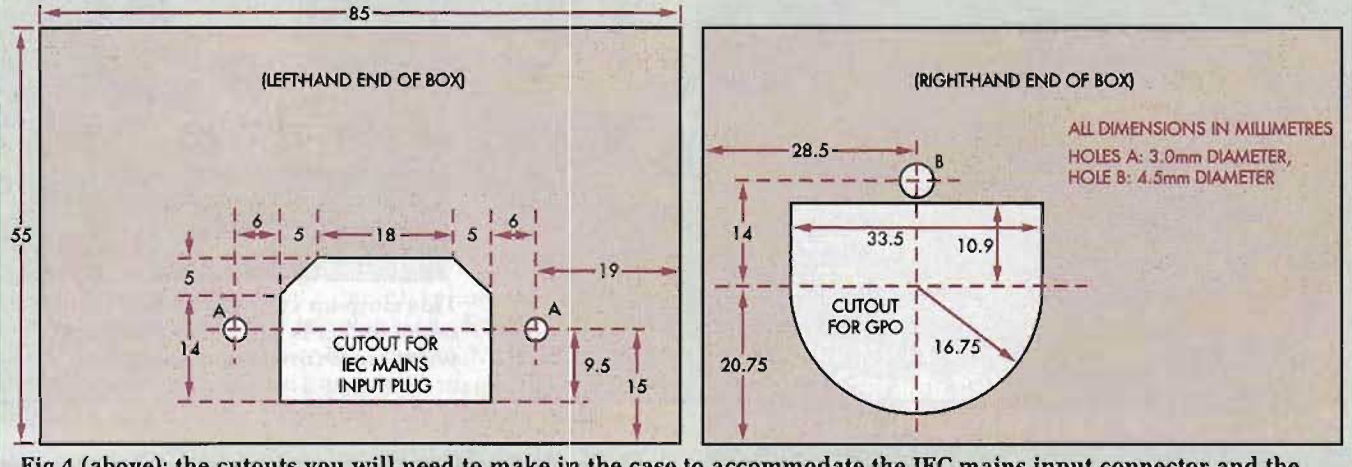


Fig.4 (above): the cutouts you will need to make in the case to accommodate the IEC mains input connector and the 230V mains outlet on the opposite end.

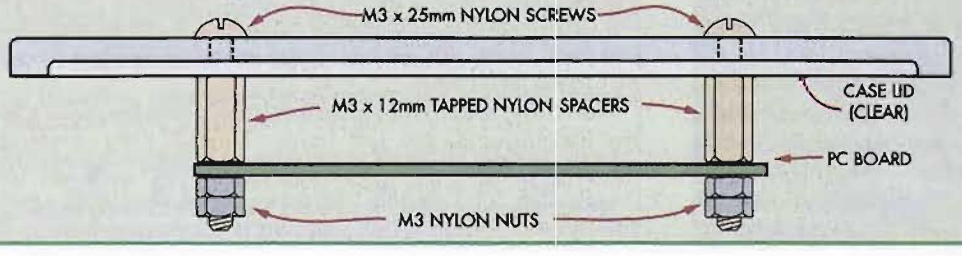


Fig.5 (left) shows how the PC board "hangs" from the case lid on M3 x 12mm tapped Nylon spacers. Be sure to use Nylon screws and nuts to secure the assembly

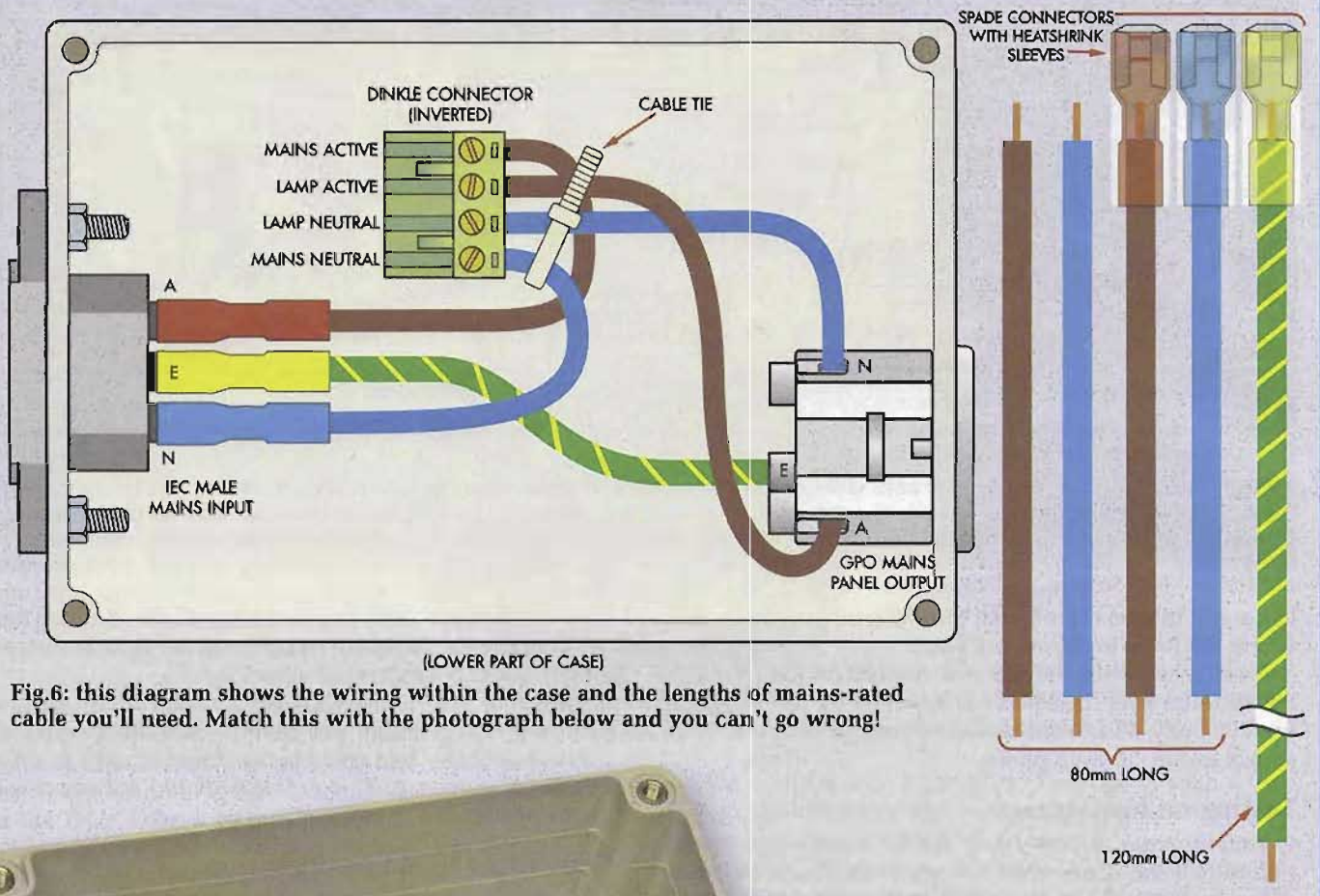
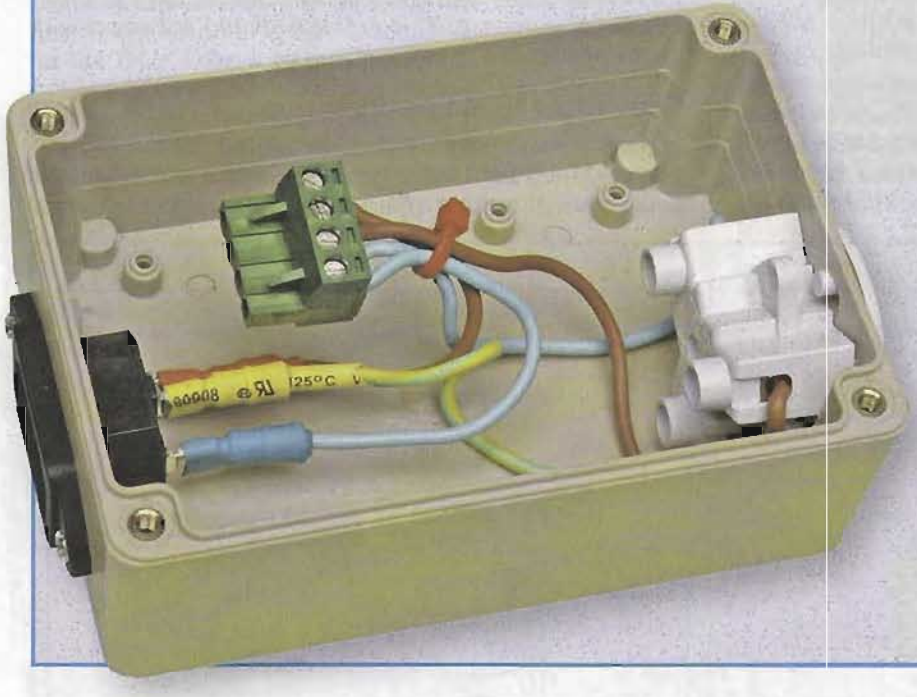
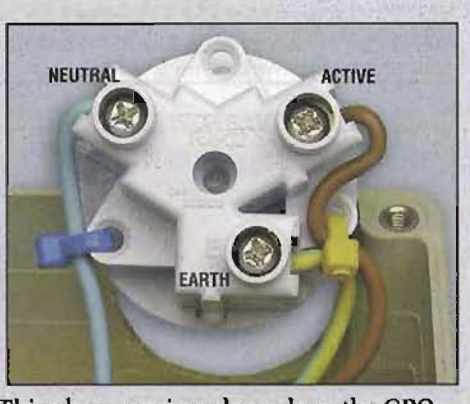


Fig.6: this diagram shows the wiring within the case and the lengths of mains-rated cable you'll need. Match this with the photograph below and you can't go wrong!





This close-up view shows how the GPO outlet socket is wired. Note how the wires are secured using cable ties.

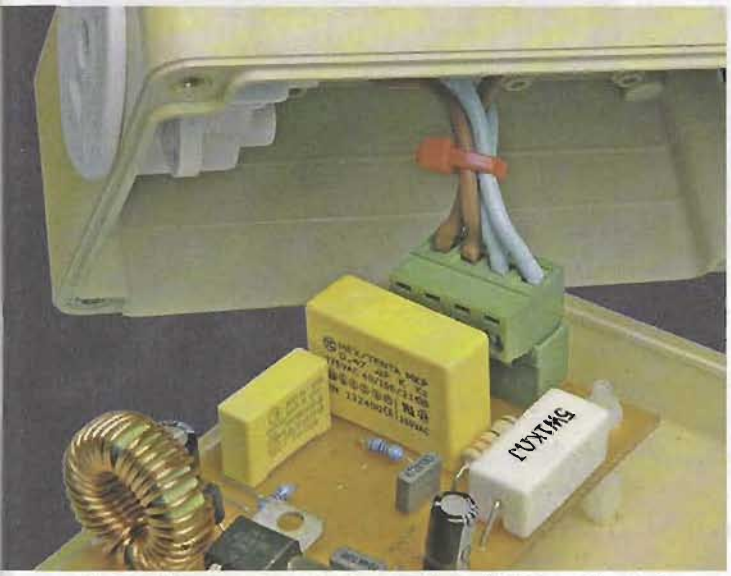
the 470nF 250VAC X2 capacitor (ie, remove the link), the 3.3MΩ 1W resistor and the 1kΩ 5W resistor.

Having done that, the case can then be prepared to accept the hardware. We used an IP65 sealed ABS case with clear lid and with dimensions of 125 x 85 x 55mm.

You will need to make two cut-outs in the sides to fit the male chassis-mount IEC socket and the 3-pin GPO outlet socket. The template is shown in Fig.4. The IEC socket is attached using two Nylon M3 x 12mm screws and four nuts. The second nut at each location locks the first in place, to ensure that the IEC socket cannot possibly come loose.

Important: do NOT use metal screws to secure the IEC socket (or PC board). Because all the circuitry inside the case will be at 230VAC potential we don't want any exposed metalwork on the case, so Nylon screws must be used. For the same reason, you must house this project in the specified plastic case. DO NOT use a metal case.

You now need to make the internal connections between the IEC input socket, the 4-way "Dinkle" plug connector for the PC board and the 3-pin GPO socket. Use 250VAC 3-core flex for this job. Strip the outer sheath to reveal the three coloured wires – brown is for Active, blue is for



The Dinkle connector is plugged into CON1 as shown here. Make sure that its mains Active lead is adjacent to zener diode ZD1 on the PC board, with the Neutral wires towards the 1kΩ 5W resistor.

the Neutral and green/yellow is for the Earth connection. **Be sure to wire the Dinkle connector plug exactly as shown in Fig.6 and the photo below it.**

A ratchet-driven crimping tool is needed to crimp the ends of three wires connecting to the male IEC socket with the 4.8mm spade lugs. Don't rely on squeezing with plier-type (automotive) crimpers, as these will not give safe, reliable connections. The connections are shown in Fig.6.

If you are unable to obtain fully-insulated 4.8mm connectors, then use non-insulated connectors but be sure to fully insulate them using 6mm-diameter heatshrink tubing after the leads have been crimped.

Use cable ties to secure the mains wiring as shown in the photos. **Note particularly how the Active, Neutral and Earth leads are secured to the GPO outlet socket. In each case, the terminals are marked "L" (for Active or Live), "N" for Neutral and "E" for Earth.** Check the wiring carefully, to ensure that each mains wire is run to its correct terminal on both the outlet socket and the IEC input connector.

Drilling the lid

The next step is to drill the mounting holes in the lid for the PC board. Fig.8 shows the mounting hole locations and can be used as a drilling template. The front-panel label can then be attached. Cover the label with clear film and cut out the window before fitting it. It can be affixed to the lid using a thin smear of neutral-cure silicone sealant as

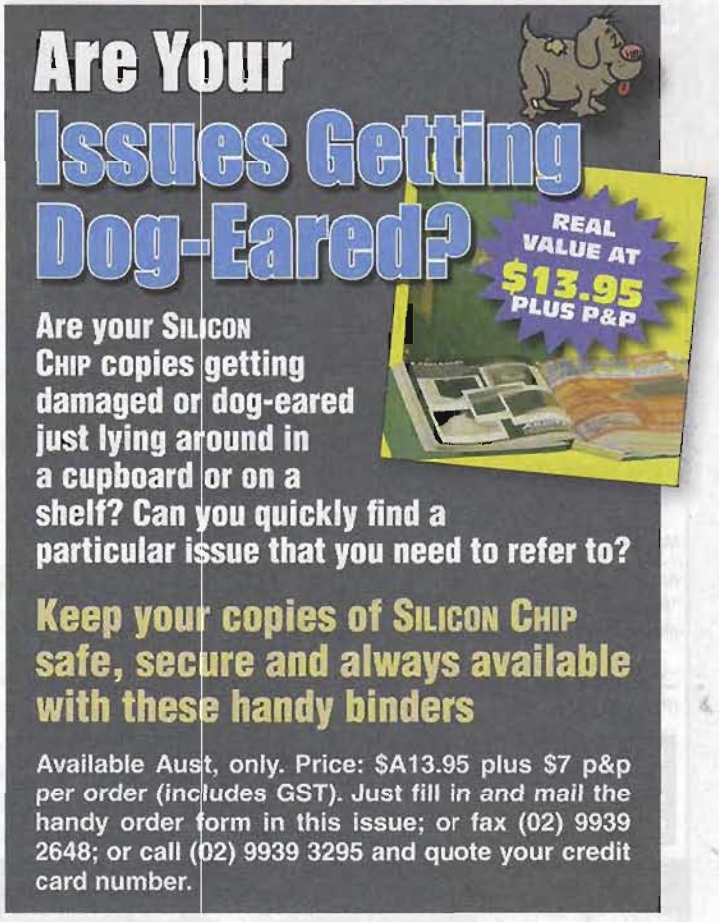
Important Points To Check

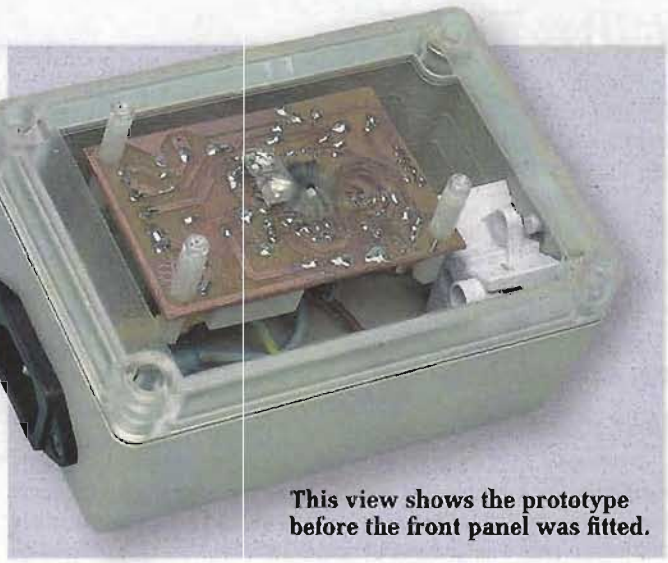
(1) Be sure to use the specified ABS plastic case & note that Nylon screws must be used to secure the IEC connector and to secure the PC board to the lid (via tapped Nylon spacers).

(2) Use mains-rated cable for all connections to the IEC mains socket and to the flush-mount 3-pin mains outlet socket.

(3) Use insulated spade connectors to terminate the leads to the IEC connector. A ratchet-driven crimping tool is necessary to fit these spade connectors and ensure safe, reliable connections.







This view shows the prototype before the front panel was fitted.

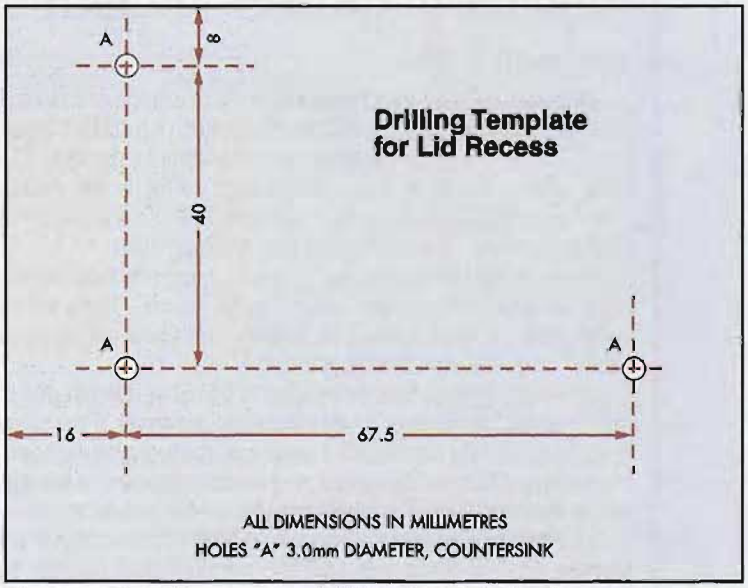


Fig.8: use this diagram as a drilling template for the case lid (it fits in the recess in the top of the lid).

WARNING! ALL PARTS OPERATE AT LETHAL VOLTAGE. DO NOT CONNECT TO MAINS UNLESS ENCLOSED IN CASE.

Fig.8: this warning label should be affixed inside the case, eg, to the lid.

the adhesive. Finally, cut out the three PC board mounting holes using a sharp knife.

To improve the presentation in the magazine, we sprayed the outside of the case with a cream gloss plastic paint but this step is unnecessary for the home constructor. This was done before the label was attached and after first removing the wiring and the two sockets and masking off the holes so that no paint could get inside. The lid was left on but the top recess was masked off to leave a clear window for the LEDs and IR receiver.

If you do elect to paint the case, use plastic paint and make sure that no paint gets inside as this could compromise its insulation properties.

Mounting the PC board

The PC board is mounted on the clear lid of the case using three M3 x 25mm Nylon screws, three M3 x 12mm Nylon spacers and six nuts – see Fig.5. **Note again that you must use Nylon screws and standoffs to ensure safety.**

Once the board has been mounted, the Dinkle connector can be plugged into CON1. **As shown in one of the photos, it should go in with its screw terminals towards the 470nF 250VAC capacitor and with the "Mains Active" wire adjacent to zener diode ZD1. Check this carefully, then attach the lid to the case.**

Getting it going

The next step is to use your multimeter (set to a low ohms range) to check between the earth pin of the IEC connector and the earth pin of the flush-mounting mains output socket. You should get a reading of zero ohms here (this checks the integrity of the earth connection).

Before applying power, refer to the warning panel earlier in the article. All the circuitry operates at 230VAC and you must NOT connect this device to a mains wall socket unless it is fully enclosed in its plastic case (ie, with the lid on). If it's plugged in, the circuit could still be live even if the mains switch is off at the wall – ie, if Active and Neutral have been transposed at the wall socket. You have been warned!

Provided the lid is fastened down, you can now plug



Fig.9: this full-size artwork for the front panel can also be downloaded from our website.

in a lamp and apply mains power to the unit via the IEC socket. If you are using a Digitech remote control from Jaycar (Cat. AR-1726), just set it to VCR code 917 and it should just work. Check the panel on the following pages for information on using other remote controls.

Reducing standby power

Although the standby power is relatively low at about 1W, you may wish to eliminate this by switching power off altogether when the dimmer is not in use. The best way to do this is with an in-line switch in the mains cord to the IEC socket. Suitable inline switches can be obtained from Jaycar (PS-4075) or Altronics (P-8237).

When you turn power off using the switch, the brightness setting level will be restored when you apply power next time.

OVERLEAF: Dimmer features – and how to use them!

Dimmer Features – And How To Use Them!

The remote control

We tested the Intelligent Light Dimmer with a range of universal infrared remote controls, including the Digitech AR-1726 (Jaycar Cat. AR-1726). Set the Digitech remote control to the VCR-917 code (this is the code for a Philips VCR). This is the default (pre-programmed) code in the PIC micro (IC1), so if you use the Digitech remote, you don't have to do anything else!

However, the dimmer can be operated using any RC5 remote control, because the control codes can be "learnt". There are 20 codes that the light dimmer recognises and these are listed in Table 1, together with their function.

If the light dimmer senses infrared activity but it is not one of the 20 codes recognised, it will be ignored. However, if the same unrecognised code is pressed 10 times consecutively, the light dimmer will enter the remote control programming menu that lets you define the remote control codes for each of the 20 functions.

Once this menu is entered (you will see the LEDs flash to indicate that the menu is being entered). You will then be prompted, by flashing LED codes, to define each of the 20 remote control codes used to operate the light dimmer. The LED codes for each command are shown in the **LED Code** column in Table 1.

So, for example, when you see the LED code for "1" (a single flash from the top green LED), you should press the key on your RC5 remote that you want to define for the function that "1" has (in this case, it functions both to enter settings and to set the brightness to 11% of full brightness).

After all 20 remote control codes have been successfully defined, they will be stored in EEPROM, so this only needs to be done once.

User operation

As noted above, up to 20 keys can be programmed with separate functions. For example, the number keys are used to dim to preset levels, while the VOL UP and DOWN buttons can dim up and down in fine increments. The Channel UP and DOWN keys are used to change the operating mode (five modes), the MENU button lets you enter one of the 10 menus and the INFO button lets you see the current

Button Name	Function(s)	LED Code	Recommended Key Definitions for the Digitech AR-1726 remote (defaults)
OK/ADDRESS	In normal operation, this button is used to set the address (OK/ADDRESS + number). If inside a menu, it can be used to exit the menu.	BBLUE x 2	Press 'OK'
TOGGLE	If light is on, dims it to off. If the light is off, dims it up to full brightness. If inside a menu, this is used to toggle the sign of the number being entered.	BBLUE x 1 + TBLUE x 2 (dimming up) or TBLUE x 1 + BBLUE x 2 (dimming down)	Press 'MUTE'
MODE UP	Go up to the next mode. The modes are, in order: Normal, ZV, Sleep, Flashing and Security.	BBLUE x 1 + TBLUE x 1	Press 'Channel Up'
MODE DOWN	Go down to the previous mode. The modes are, in order: Normal, ZV, Sleep, Flashing and Security.	TBLUE x 1 + BBLUE x 1	Press 'Channel Down'
INFO	In normal operation, this button is used to get information about the current settings. Press INFO + number to get the appropriate setting according to Table 3.	BGREEN x 1 + TBLUE x 1	Press 'STOP'
MENU	In normal operation, this button is used to enter a menu to change a setting. Press MENU + number to enter the appropriate menu according to Table 2.	BGREEN x 1 + TRED x 1	Press 'MENU'
UP	Dim up finely by 4%	BGREEN x 1	Press 'Volume Up'
DOWN	Dim down finely by 4%.	BRED x 1	Press 'Volume Down'
PLAY	Recall your favourite brightness level and operating mode (you must have previously saved those by using the RECORD button).	BGREEN x 2	Press 'Play'
RECORD	Press to save the current brightness and operating mode. You will then be able to recall these settings at any time by pressing PLAY.	BRED x 2	Press 'Record'
0	Dim to off.	TRED x 1	Press '0'
1	Dim to 11% of full brightness.	TGREEN x 1	Press '1'
2	Dim to 22% of full brightness.	TGREEN x 2	Press '2'
3	Dim to 33% of full brightness.	TGREEN x 3	Press '3'
4	Dim to 44% of full brightness.	TGREEN x 1 + BBLUE x 1	Press '4'
5	Dim to 55% of full brightness.	BBLUE x 1	Press '5'
6	Dim to 66% of full brightness.	BBLUE x 1 + TGREEN x 1	Press '6'
7	Dim to 77% of full brightness.	BBLUE x 1 + TGREEN x 2	Press '7'
8	Dim to 88% of full brightness.	BBLUE x 1 + TGREEN x 3	Press '8'
9	Dim to full brightness.	TGREEN x 1 + BBLUE x 2	Press '9'

Table 1: a suggested remote control code definition sequence using an RC5 remote control. This assumes you are using the Digitech AR-1726 universal remote control (although other universal remotes should be similar and may be used). Note that TGREEN denotes the top green LED, TRED the top red LED while BBLUE denotes the bottom blue LED, etc.

MENU Number	MENU Function
0	Reset and restore all default settings
1	Time Out Period (Minutes)
2	Flash Modulus
3	Quiescent Level
4	Address (0=Broadcast)
5	Limiting Phase 0 (Positive Half Cycle)
6	Limiting Phase 1 (Negative Half Cycle)
7	Offset Phase 0 (Positive Half Cycle)
8	Offset Phase 1 (Negative Half Cycle)
9	Dimming Delay

Table 2: the menu options. In each case, you press the MENU button followed by the appropriate number to choose that menu. Entering a menu is indicated by a specific sequence on the two RGB LEDs. You can then use other keys to set up the property (see text). In all cases, you press OK/ADDRESS to exit the menu.

INFO Number	INFO Function
0	Firmware Version (HLL=version H.LL)
1	Time Out Period (Minutes)
2	Flash Modulus
3	Mains Frequency (0.1 Hz)
4	Address (0=Broadcast)
5	Limiting Phase 0 (Positive Half Cycle)
6	Limiting Phase 1 (Negative Half Cycle)
7	Offset Phase 0 (Positive Half Cycle)
8	Offset Phase 1 (Negative Half Cycle)
9	Dimming Delay

Table 3: the information options. In each case, you press the INFO button followed by the appropriate number to choose that option. The information is then displayed using the two RGB LEDs and can represent decimal numbers by different sequences of blinks (see text).

settings and so on. Each time you press a recognised command, the two RGB LEDs will flash to acknowledge the command which will then be executed.

When a set dimming level has been reached, there will be an additional acknowledgment LED code of the operating mode.

So, for example, if you press "3", the LED code for "3" will be shown and then the dimmer will perform the command that it corresponds to. In this case, it will dim the light up or down in brightness so that it is at 33% of full brightness. When that level is reached, the light dimmer will issue the LED code for the current operating mode.

Number codes

The red blink indicates zero. One, two and three green blinks indicate, respectively, 1, 2, and 3. A blue blink indicates 5. Fig.10 shows all the number codes, along with the codes for plus and minus. Numbers like 128 or -2400 can also be shown. These multi-digit numbers have their digits codes shown in order from left to right.

When a number is displayed, the sign is displayed first. For example, the code to display 128 is (POSITIVE + 1 green blink + 2 green blinks + 1 blue blink + 3 green blinks). To display -2400 however, the code is (NEGATIVE + 2 green blinks + 1 green blink + 1 blue blink + 1 red blink + 1 red blink).

Once you use the light dimmer, you will quickly become used to the LED codes.

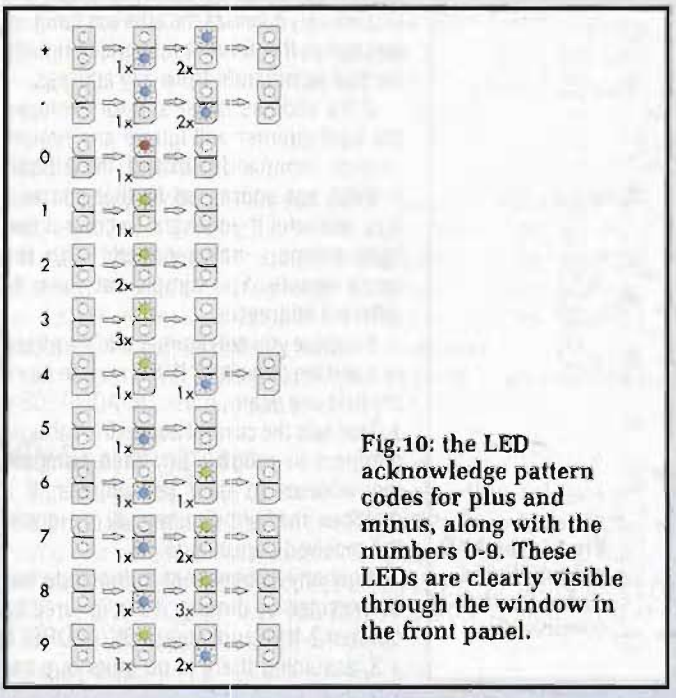


Fig.10: the LED acknowledge pattern codes for plus and minus, along with the numbers 0-9. These LEDs are clearly visible through the window in the front panel.

Operating modes

There are five operating modes. In order, they are: (1) Normal, (2) ZV, (3) Sleep, (4) Flashing and (5) Security. You use the Channel UP and Channel DOWN buttons to change the mode.

(1) Normal mode

Normal mode is the default. In this mode, the light can be dimmed over the full range. If the timeout is not disabled, the light automatically dims to off if no remote control activity has been detected for that period of time.

The dimming speed can be changed as well (see below). In this mode, you can dim the light up or down using the VOL UP & VOL DOWN and the number keys. You can also use the TOGGLE key to dim up to full brightness or dim down to off. Pressing any of the number buttons will dim the light to the preset level of that button. For example, pressing 4 will dim to about half brightness (actually 44%). Pressing 0 will dim to off and so on.

continued next page

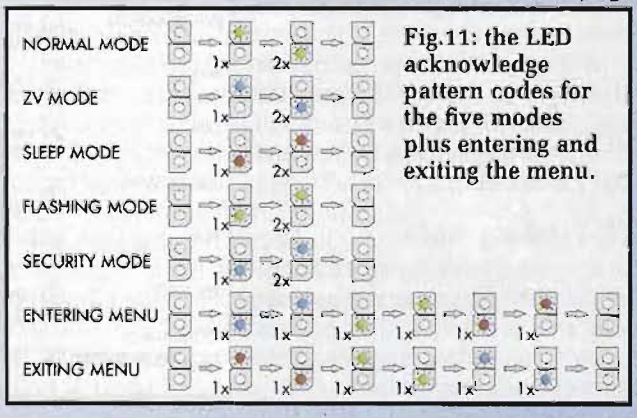


Fig.11: the LED acknowledge pattern codes for the five modes plus entering and exiting the menu.

Timeout Period Digit Code (minutes)	Timeout Period	Power Consumption of a 100W light for the timeout period
30	Half an Hour	0.05 kWh
60	1 Hour	0.10 kWh
120	2 Hours	0.20 kWh
180	3 Hours	0.30 kWh
240	4 Hours	0.40 kWh
360	6 Hours	0.60 kWh
720	Half a Day	1.20 kWh
1440	A Day	2.40 kWh
9999	Almost a week	16.67kWh
0000	Disabled	–

Table 4: a selection of timeout period codes (in minutes) and what the timeout period will be. The 4-digit code in the left column must be entered when prompted in the timeout period menu to set the appropriate timeout period. To disable the timeout period function, enter a code of '0000'. To enable it, enter the appropriate number of minutes. The maximum timeout period is 9999 minutes, or almost a week. The longer the timeout period, the less chance that it will trigger when the light is in use, but the less power conservation protection offered.

If you want to change the rate at which the lamp dims, you enter the menu mode, press the 9 button and then enter the dimming delay (0 to 9999) and press OK.

(2) ZV mode

In ZV (zero voltage) mode, the light is only ON or OFF. This may be used for non-dimmable CFLs. You use the same dimming controls as for Normal mode, except that you only need to use 0 (fully off) or 1 (fully on). The TOGGLE key still retains its former action.

(3) Sleep mode

Sleep Mode functions the same as Normal Mode except that the light is gradually dimmed to off for the duration of the timeout period (when there is no IR activity).

This is useful, for example, for setting a baby to sleep. You could set the timeout period to 30 minutes, set the dimmer to sleep mode and then set the initial brightness.

While the timeout period can be anything from 1 minute to 1 week, the sleep mode function will only work with timeout periods between 1 minute and 255 minutes (4.25 hours).

(4) Flashing mode

In Flashing mode, the light will flash with a 25% duty cycle at a user set frequency (see below). This mode is useful for a shop front display or some form of beacon application.

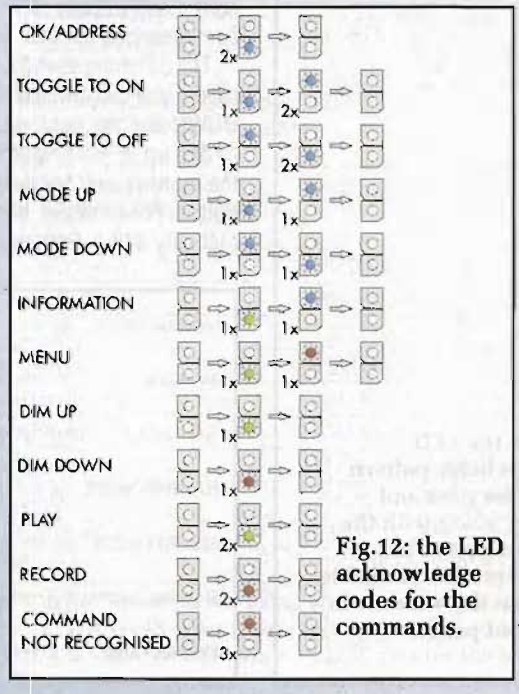


Fig.12: the LED acknowledge codes for the commands.

(5) Security mode

This mode will randomly turn the light on and off at full brilliance, for a period between five minutes and two hours. This simulates someone entering a room and turning a light on then later turning it off, making it perfect for giving a home an "occupied" appearance even though no-one is at home.

Both the on time and the off time are random; ie, they are not the same. They could be anywhere between (and including) five minutes and two hours.

Menus and Information

There are a number of menus that let you change the default behaviour of the light dimmer. To enter menu X (where X is in the range 0-9), you press MENU + X whereas to get information on a setting you enter INFO + X. The complete list of menus and information options is given in Tables 2 & 3.

Timeout period

The timeout period can be set anywhere between 1 minute and 9999 minutes. Setting it to 0 disables the timeout function. To view the current timeout period, go to INFO+1 whereas to set the timeout period go to MENU+1.

For example, to set the timeout period to 2 hours, press MENU + 1 (then wait to enter the menu, which is acknowledged by a LED sequence – see Fig.11). Then you would type 1 + 2 + 0 + OK/ADDRESS (OK/ADDRESS is used to exit the menu).

To now view the current timeout period type INFO + 1. You should see the LED code for +120. Table 4 shows some typical timeout periods.

Mains Frequency

Pressing INFO + 3 gives the current mains frequency in units of 0.1Hz. For example, a reading of 495 indicates 49.5Hz.

Multi addressable

Setting the light dimmer's address is easy. Simply press MENU + 4. To view the address type INFO + 4. The address can be set anywhere between 1 and 9. Setting it to 0 (broadcast) disables the address function and makes the dimmer respond to remote control commands from any address.

If the address is set to 4 for example, the light dimmer will ignore any remote control commands (except INFO commands) not addressed to that address. This is useful if you want to control two light dimmers independently with the same remote. You simply set them to different addresses.

Suppose you set dimmer one's address to 1 and the other to 2. If you want to make the first one listen, press OK/ADDRESS + 1. That sets the current address for all light dimmers in range. They then compare that address to their set address. If it matches, the light dimmer will not ignore the received commands.

Now any subsequent commands will be executed by dimmer 1 but ignored by dimmer 2. If you now press OK/ADDRESS + 3, assuming there is no other dimmer

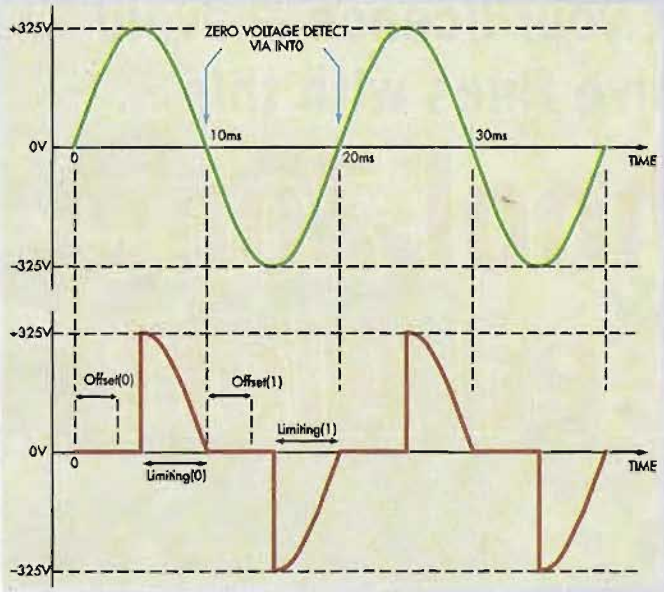


Fig.13: this explains the meaning of the four advanced settings. The offset can be a positive or a negative number, while the limiting value is a single unsigned 8-bit number.

nearby, both will ignore any subsequent commands!

You can also disable the selective addressing by setting the dimmer's address to 0. Press MENU + 4 to enter the ADDRESS menu. Then press 0 + OK/ADDRESS to set the address to 0 and make it listen to any address.

Speed of dimming

The default value for the dimming delay is 10. This gives a period of around five seconds to dim from one extreme to another.

You can vary the speed of dimming by entering MENU + 9. Then enter the number. Possible values range from 0 (fastest) to 9999 (extremely slow).

To set the speed of dimming to take roughly 10 seconds from one extreme to another, enter the sequence MENU + 9, then wait to enter the menu, then enter 2 + 0 + OK/ADDRESS to set the dimming delay to 20. At any time, you can press INFO + 9 to see the set value. The dimming delay will be echoed back to you as a number in LED code.

Speed of flashing

In Flashing mode, the frequency of flashing can be varied by entering MENU + 2. Wait to enter the menu and then you can enter a number. The higher the number, the slower will be the flashing. A value of X gives a flashing frequency of approximately 5/(X+1) Hz. So for example, a value of 19 will give a 0.25Hz flashing frequency (or a flash roughly every four seconds).

The default flashing value is 10 giving a flashing rate of 0.45Hz (roughly one flash every two seconds).

Minimum brightness

You can set the minimum lamp brightness which will apply at all times unless the dimmer is switched off by an in-line switch.

You can set the quiescent level by pressing MENU + 3. You will then be able to set the quiescent level with the usual dimming buttons (VOL UP and VOL DOWN and the number keys). Once you are happy with the set level, press OK/ADDRESS to exit the menu.

Note that if you are using the light dimmer in the ZV mode or flashing mode, the quiescent current level will be ignored.

Save and recall options

At any time, you can use the RECORD button to store the current brightness and operating mode to non-volatile memory (EEPROM).

When you next press the PLAY button, these settings are restored. This can be used to set your favourite brightness level to be recalled at any time in one touch.

Advanced settings

The firmware of this light dimmer allows fine tuning of the Triac response, in terms of four parameters that can be set by the user: two limiting values and two offset values (two each for each of the two half cycles of the mains waveform).

Note that you will not normally need to set these values as the defaults should be suitable for most incandescent lamps, dimmable CFLs and halogen lamps. In the event that you are driving, say, a desk halogen lamp, where the 12V power is supplied by a transformer (plugpack), the load will not strictly be resistive, as the transformer would present an inductive load.

In this case, this light dimmer allows you to set these four parameters to control the triggering of the Triac and to customise the dimmer response.

The limiting values "limiting0" and "limiting1" are 8-bit numbers ranging from 0x00 to 0xFF (hexadecimal). The default values are 0xFF or 255.

The brightness level is guaranteed to always be less than or equal to the "limiting0" value in the positive half-cycle of the mains waveform and less than or equal to the "limiting1" value in the negative half-cycle of the mains waveform.

A brightness level of N corresponds to the limiting value: V = 28 x N where N is a digit from 0-9. As a percentage, the equation becomes: V = 2.55 x P, where P is the percentage of full brightness. So, for example, a brightness level of 5 corresponds to the value 140 (or roughly 55% brightness).

Suppose we want to limit the positive half-cycle brightness to around 55% of full brightness. Then we would enter MENU + 5 (then wait to enter the menu). Then we would type 1 + 4 + 0 + OK/ADDRESS. This would set the limiting value for the positive half cycle to around 55%.

This gives you very fine control of the Triac response.

An example: driving a 12V halogen desk lamp

Why would you ever need to change the default values? Suppose you are controlling a desk lamp with a 12V halogen bulb. The 12V is derived from a transformer in a plugpack and hence presents an inductive load to the light dimmer.

The inductive load changes the phase relationship and we found that by choosing values of limiting0 = 0xFF and limiting1 = 0xE0, we could prevent the desk lamp from flickering when set to the maximum brightness level.

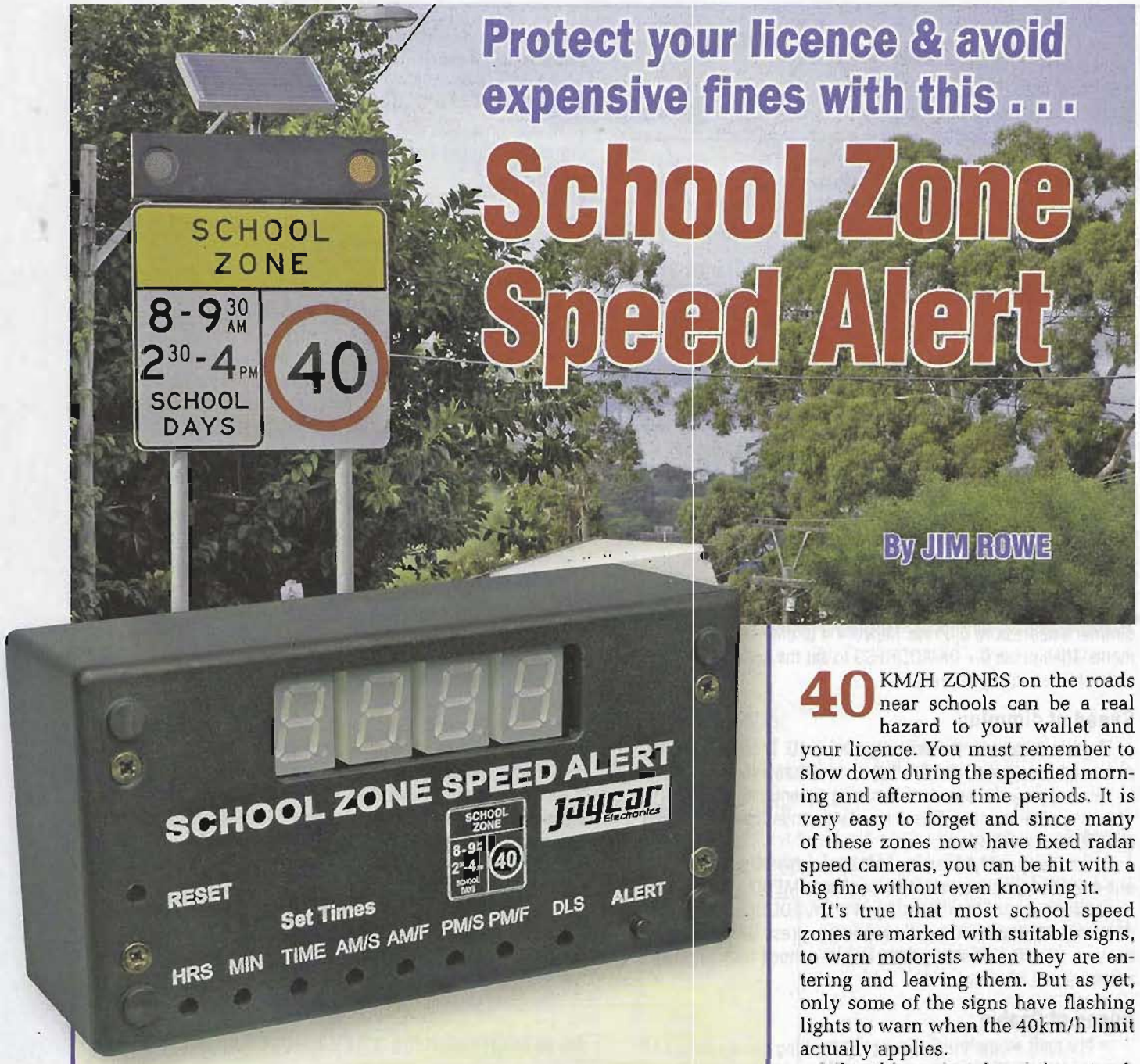
The flickering occurs because the Triac triggering is occurring before the zero crossing of the mains rather than after.

The offset setting is a signed 16-bit number (the default value is 0) which you can also set (it can range between -32768 to 32767). The unit is 800ns. So an offset of 1500 indicates a time offset of 1.2ms for example. Note that a half cycle of the mains (at 100Hz) equates to a 10ms period, or in other words a full offset of 12500. SC

Protect your licence & avoid expensive fines with this . . .

School Zone Speed Alert

By JIM ROWE



Have you been booked for driving through a school zone at well above the 40km/h limit? It's easy to do and can be a very expensive mistake. Here's a project to help you stay out of trouble. It keeps track of the time and flashes a warning LED during the morning or afternoon 40km/h time periods.

40KM/H ZONES on the roads near schools can be a real hazard to your wallet and your licence. You must remember to slow down during the specified morning and afternoon time periods. It is very easy to forget and since many of these zones now have fixed radar speed cameras, you can be hit with a big fine without even knowing it.

It's true that most school speed zones are marked with suitable signs, to warn motorists when they are entering and leaving them. But as yet, only some of the signs have flashing lights to warn when the 40km/h limit actually applies.

What this project does is keep track of the time and it flashes a warning LED when the 40km/h speed limit applies in school zones. The project itself is housed in a small jiffy box and is intended to go inside your glove box. However, the warning LED is connected to the main box using a short length of figure-8 cable and can be mounted in a small hole in the lower part of your dashboard or in a small bracket mounted just below the dash.

It should be inconspicuous but able to attract your attention when it's flashing. The LED flashes brightly enough to attract your attention in daylight

but not so bright as to dazzle you and disturb your driving.

What it does

You can think of the project as a special kind of alarm clock. It keeps the time but it has four "alarm time" settings, two for the start and finish of the morning 40km/h period and the other two for the start and finish of the afternoon speed limit period. The LED flashes not just at the start of the 40km/h speed periods but all through their duration.

The heart of the project is a PIC-16F628A-I/P microcontroller. The program inside the PIC is already provided with the start and finish times of the morning and afternoon 40km/h zone times common throughout Australia: from 08:00 to 09:30 in the morning and from 14:30 (2:30PM) to 16:00 (4:00PM) in the afternoon.

Each of these "alarm time" settings can be changed if you wish but in most cases this won't be necessary.

All you'll normally have to do is set the current time and whether or not it is "normal" or daylight saving time. There's also a button to enable or disable the warning LED, so you can turn it off for weekends and school holidays. These settings are easily changed, as we will explain later.

How it works

Fig.1 shows the circuit. It consists of the PIC micro, four 7-segment LED displays, 10 pushbuttons, one LED and little else. All the real work is done by the firmware program inside the PIC micro.

Indeed, most of the circuitry is there simply to allow you to set the clock's time and functions, using the pushbuttons and the 7-segment displays. At other times the displays are turned off, to save energy.

The four 7-segment displays are driven by the PIC micro in multiplexed fashion, with the segments driven from port pins RB0-RB6 via switching transistors Q1-Q7, while the digits are driven from RA0-RA3 via transistors Q8-Q11. Switches S1-S9 are also scanned by the PIC in multiplex fashion, again using RB0-RB6 as output lines and RB7 and RA4 as input lines.

The remaining switch (S10) is provided as a Reset button, to allow the PIC firmware to be returned to its original "factory settings" if it should

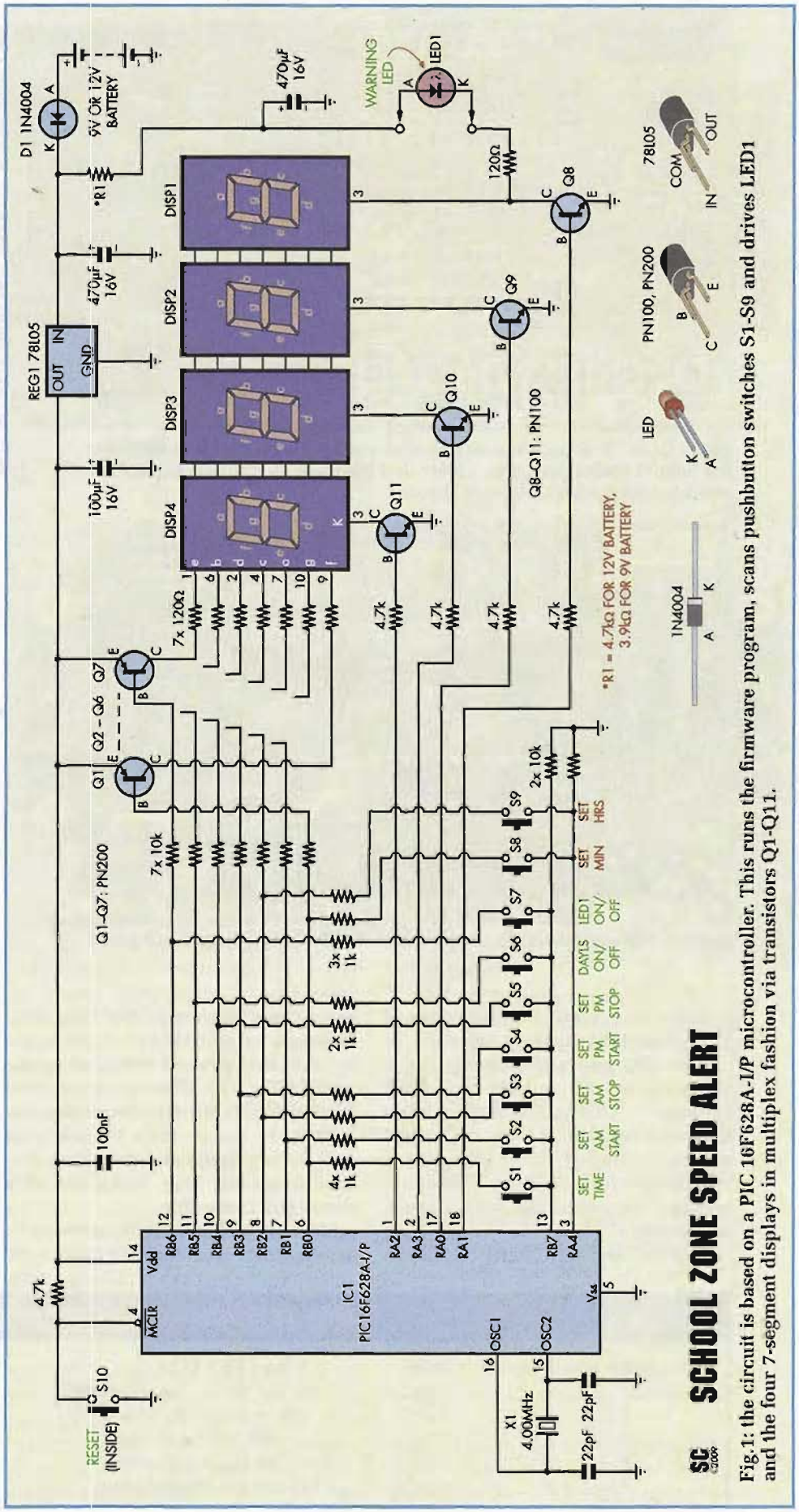


Fig.1: the circuit is based on a PIC 16F628A-I/P microcontroller. This runs the firmware program, scans pushbutton switches S1-S9 and drives LED1 and the four 7-segment displays in multiplex fashion via transistors Q1-Q11.

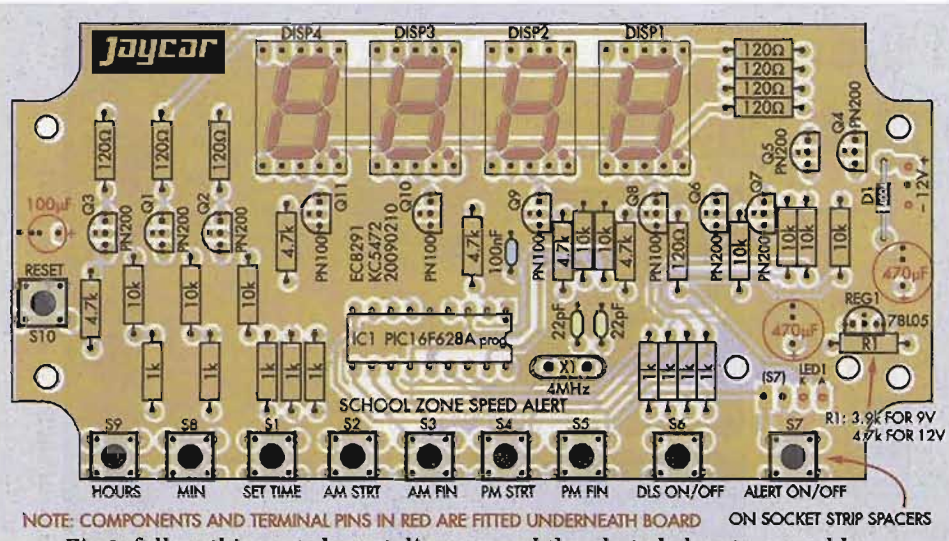
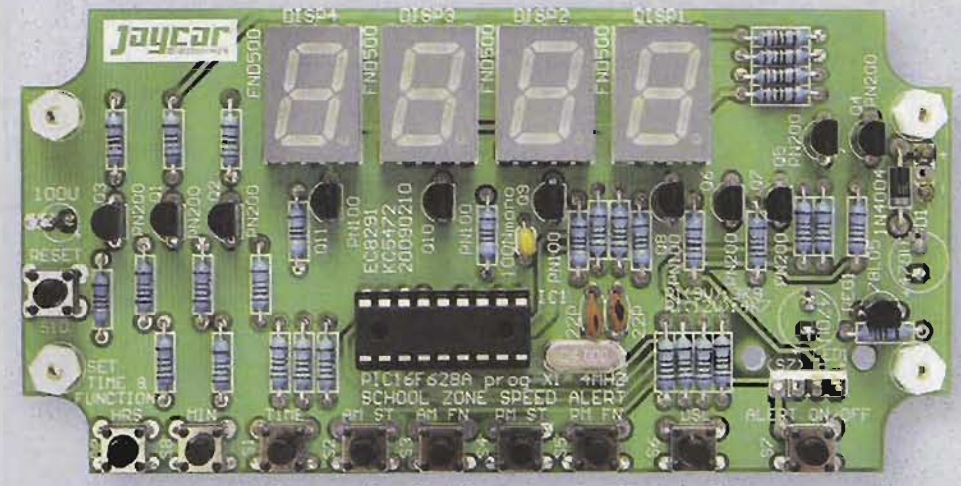


Fig.2: follow this parts layout diagram and the photo below to assemble the School Zone Speed Alert. Note that the three electrolytic capacitors are mounted on the back of the PC board.



Here's a view of the completed PC board assembly. Switch S7 is mounted on socket strip spacers so that its button protrudes through the front panel.

ever become "confused" (or rather, if you yourself become confused).

The PIC has a 4MHz oscillator using crystal X1 and the two 22pF capacitors. This is necessary so that the clock keeps good time – you don't want it drifting too much otherwise it will not perform its duty correctly – warning you when the school speed zones apply!

The PIC and all its associated circuitry runs from a regulated 5V supply line derived from the battery input via a 78L05 low-power 3-terminal regulator (REG1). This allows the project to be powered from a 9V alkaline battery inside the box or from the vehicle's 12V battery **(note: an internal 9V battery won't last long, so the vehicle's battery is preferable).**

The only change that needs to be made when you decide to use a 9V battery instead of the 12V car battery is the value of resistor R1, ie, the charging resistor for the warning LED flashing circuit. That's because LED1 is the only part of the circuit that operates directly from the battery input voltage, via polarity protection diode D1.

The flashing circuitry for LED1 works as follows. Resistor R1 allows the 470µF capacitor connected to the anode of LED1 to charge up to the nominal battery voltage, which takes a few hundred milliseconds. LED1 does not draw current during this time because it is controlled by switching transistor Q8 and this is normally kept off by the PIC.

When the LED is to be flashed (to warn the driver that they are now in a 40km/h time zone), the PIC turns on Q8 for about 100ms. This allows LED1 to conduct through the 120Ω current-limiting resistor, emitting a bright pulse of light and discharging the 470µF capacitor in the process.

The PIC then turns off Q8 to switch off LED1, keeping it off for at least 900ms to allow the capacitor to recharge, ready for the next flash. This charging and discharging sequence only happens during the 40km/h zone times, with LED1 flashing brightly once per second. It's a simple arrangement but one that gives bright flashing despite a relatively low average current drain.

Because switching transistor Q8 is shared by both DISP1 and LED1, this results in LED1 flashing unavoidably whenever you are changing the clock's settings or functions, ie, whenever DISP1 is operating. **So you'll soon notice that LED1 flashes whenever settings are being made or changed.** This might be a bit confusing until you get used to it.

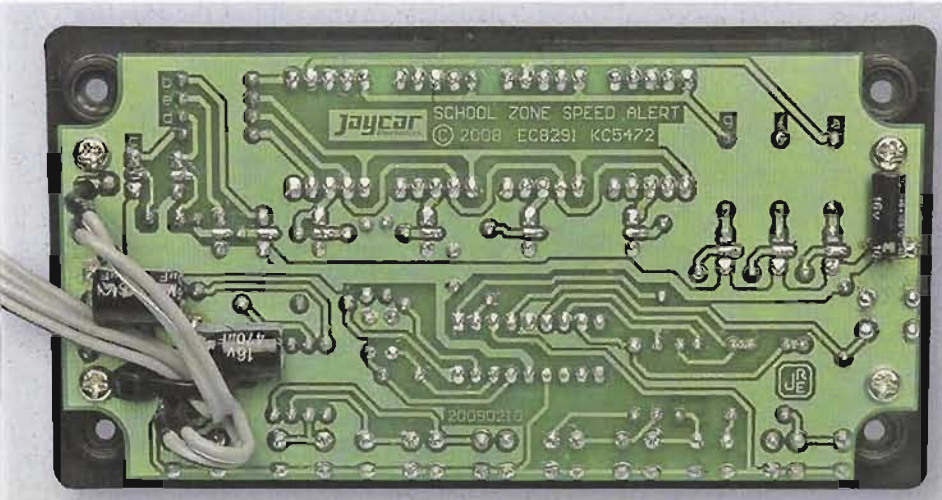
Note that the 7-segment displays DISP1-DISP4 do not operate when LED1 is flashing during a 40km/h zone time.

Construction

As you can see from the photos, all

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	9	10kΩ	brown black orange brown	brown black black red brown
❑	6	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	1	3.9kΩ	orange white red brown	orange white black brown brown
❑	9	1kΩ	brown black red brown	brown black black brown brown
❑	8	120Ω	brown red brown brown	brown red black black brown



This view shows how the three electrolytic capacitors are mounted. The leads to the warning LED and the battery are secured by looping them through a cable tie that goes through two holes in the PC board.

of the circuitry and components used in the project (apart from LED1 and the battery) are mounted on a small PC board. This fits inside a standard UB3 size utility box measuring 130 x 68 x 44mm. If you wish to power the unit from a 9V alkaline battery, this can be fitted inside the same box and under the PC board.

The PC board is coded EC8291 and measures 123 x 61mm. It is double-sided with plated-through holes, to avoid the need for any wire links and to also make assembly as straightforward as possible.

Fig.2 shows the parts layout on the PC board. To build the unit, just follow this diagram, along with the silk-screening on the board itself, and you shouldn't have any problems.

You can begin assembly by fitting the resistors, followed by the 18-pin socket for IC1 and the four PC board terminal pins (two for the battery input and two for the wires from LED1). These pins are all fitted on the rear of the board, by the way.

Note that there are pads and holes for two further pins next to those for LED1.

We've provided the extra pin locations to give you the option of having pushbutton S7 mounted away from the board if you wish, rather than (or as well as) having it mounted directly on the board. This is because most of the time S7 is the only switch that needs to be accessed, to enable the warning LED for school day driving or disable it for weekend/holiday driving.

Alternatively, you may prefer to have S7 mounted remotely, perhaps near LED1, so it can be accessed without needing to open the glove box to reach the main unit.

The next step is to fit the 10 pushbutton switches, with reset switch S10 at the lefthand end of the board and all of the others (except S7, if you prefer to have it connected remotely) in a line along the front. All of the switches except S7 mount directly onto the board, so that when the board is mounted behind the box lid/front panel, their actuators do not protrude through the matching access holes – preventing accidental "operation" inside the glove box.

These switches are accessed via a ballpoint pen, toothpick or similar stylus, which isn't a problem since they're only accessed very occasionally. **But since S7 will need to be accessed more often, it's mounted on four small socket-pin standoffs**, so that its actuator protrudes through the hole in the front panel for easy fingertip use.

Solder S7's terminals to the pins after mounting it, to prevent it from coming loose.

Once the switches are in, install the two 22pF disc ceramic capacitors (to the right of IC1) and the 100nF multilayer monolithic (just above pin 1 of the IC socket). Then you can fit the three electrolytic capacitors but note that all three of these are polarised, so they need to be orientated as shown in Fig.2. Note that all three electrolytic capacitors are mounted on the underside of the PC board, with their leads soldered to the pads on the top of the board. This is because they are a little too tall to fit in the 9mm space between the PC board and the lid, when the two

Parts List

1 UB3 jiffy box, 130 x 68 x 44mm
1 PC board, code EC8291, 123 x 61mm
10 SPST micro tactile pushbutton switches, vertical PC-mount, 6mm actuator (S1-S10)
1 4MHz quartz crystal, HC-49US case (X1)
1 18-pin IC socket
4 M3 x 9mm tapped spacers
4 M3 x 6mm machine screws, countersunk head
4 M3 x 6mm machine screws, pan head
4 1mm diameter PC board pins
1 4-pin SIL socket strip (to provide the standoffs for S7)
2 1m lengths of figure-8 cable
1 3AG in-line fuseholder
1 3AG 500mA fuse
1 cable tie
1 100mm length 2.5mm-dia. heatshrink tubing

Semiconductors
1 PIC16F628A-I/P microcontroller, programmed (IC1)
1 78L05 +5V regulator (REG1)
7 PN200 PNP transistors (Q1-Q7)
4 PN100 NPN transistors (Q8-Q11)
1 1N4004 diode (D1)
4 FND500 7-segment common cathode LED displays (DISP1-DISP4)
1 5mm high-intensity LED (LED1)

Capacitors
2 470µF 16V electrolytic
1 100µF 16V electrolytic
1 100nF monolithic ceramic
2 22pF NPO disc ceramic

Resistors (0.25W 1%)
9 10kΩ 9 1kΩ
5 4.7kΩ 8 120Ω
1 3.9kΩ (9V) or 4.7kΩ (12V) for R1

Where To Buy A Kit

The development of this project has been sponsored by Jaycar Electronics who own the copyright of the design and firmware. Kits (Cat. KC-5472) will only be available from Jaycar and its dealers.

Specifications

Flashes a high-brightness LED approximately once per second during the 40km/h school zone periods (normally 08.00-09:30 and 14:30-16:00).

User settings: current time, normal & daylight saving time modes, and ability to disable the warning LED (eg, at weekends and school holidays, etc). The starting and finishing times can also be changed.

Timekeeping accuracy: close to the frequency accuracy of the quartz crystal oscillator; ie, within about 40 parts per million or better than about one second in seven hours.

Current drain: (1) in silent running mode – less than 4mA; (2) in setting mode – about 50mA average; (3) in warning mode (LED1 flashing) – about 5mA average.

are assembled together.

The capacitors can either be mounted verically as shown on Fig.3 or horizontally (ie, with their leads bent through 90°) as shown in the photos. In the latter case, secure them in place using silicone adhesive, to prevent them from vibrating and coming adrift.

After the electrolytics are in place, fit the four 7-segment LED displays. These go in the upper centre of the board. Make sure that you orientate each one so that its small circular decimal point LED is at lower right – otherwise the display won't function correctly.

Next, fit protection diode D1, regulator REG1 and all the discrete driver transistors (Q1-Q11). Orientate all these parts as shown in the overlay diagram and also take care to place the four NPN (PN100) transistors in the positions shown for Q8-Q11, below the 7-segment displays. The PNP (PN200) transistors are used for Q1-Q7.

Now fit crystal X1. A crystal in an HC-49US low-profile case fits on the top of the board. **It must be installed slightly proud of the board, to avoid the possibility of its case shorting to an adjacent pad.**

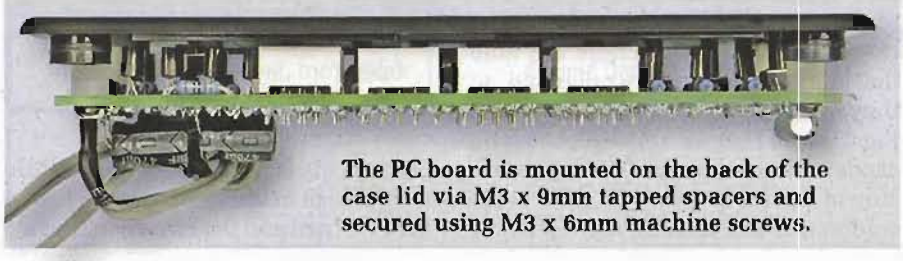
Alternatively, if the crystal is in the taller HC-49U case, it must be fitted on the underside of the board like the electrolytic capacitors. **In this case, use a thin insulating plastic or cardboard washer to act as a spacer to again make sure that the crystal's metal case can't short any of the PC board's tracks or pads.**

The final step in the board assembly is to plug the pre-programmed PIC micro (IC1) into its socket, taking care both to orientate it correctly and also to plug it in without straining or bending any of the pins. Once this is done you can attach the board assembly to the rear of the box lid, using four M3 x 9mm tapped spacers and M3 machine screws. Countersink head screws are used to attach the spacers to the lid while pan-head screws are used to attach the PC board to the spacers.

If you live in a dusty environment, you may wish to apply an optional 70 x 23mm rectangle of thin clear plastic film (like photocopier film or laminator pouch material) to the underside of the lid behind the display window (to keep out dust). The film can be held in place using glue around the edges.

Having mounted the board, connect the remote warning LED using a length of figure-8 cable – see Fig.3. A second length of figure-8 cable is then used to connect the board to a 9V or 12V power supply. Fit some short lengths of 2.5mm-diameter heatshrink sleeving over the terminations on the PC board, to prevent the leads from vibrating a breaking the solder connections.

Note that you will need to drill an exit hole in the side of the case for these cables.



The PC board is mounted on the back of the case lid via M3 x 9mm tapped spacers and secured using M3 x 6mm machine screws.

Setting up

To test and set up the unit, first connect a 9V or 12V battery, depending on the value chosen for R1. It should now be running, even though you shouldn't see anything on either the displays or LED1 at this stage.

Are you currently in daylight saving or not? If you are, you need to press switch S6 with a ballpoint pen or toothpick; hold it down for about one second. The displays should flash the message "dSon" once and LED1 should also flash briefly. If you are not currently in daylight saving, you don't need to do this operation until daylight saving does begin.

Next, set the current time. This is done by first pressing S1, again holding it down for a second or so. This causes the displays to flash the unit's current time setting about once per second. As noted above, LED1 will also flash briefly along with DISP1.

The initial reading on the displays should be 0001 or 0002, depending on how long the unit has been connected to the battery and running. When first powered up (or reset), it resets to midnight, or 00:00.

The idea now is to use switch S9 to increment the hours digits to their current time value, and then S8 to increment the minutes digits to their current time value. In both cases, you simply hold the switch down and the PIC will increment the reading at a rate of about once per second. This makes it easy to get to the current time values and simply release the switch when they are reached.

When you have the current time on the displays, press S1 again and hold it down for about a second. The displays will flash the message "SEt", to show that the time has been set. The displays and LED1 then turn off.

Enabling LED1

The final step is to decide whether you want to enable or disable the operation of warning LED1 – which will depend on whether it is currently a school day or not. If it's not a school day and you therefore don't want to enable LED1, there's no need to do anything more because **when the School Zone Speed Alert is powered up (or reset), LED1 is disabled by default.**

If it is a school day and you do wish

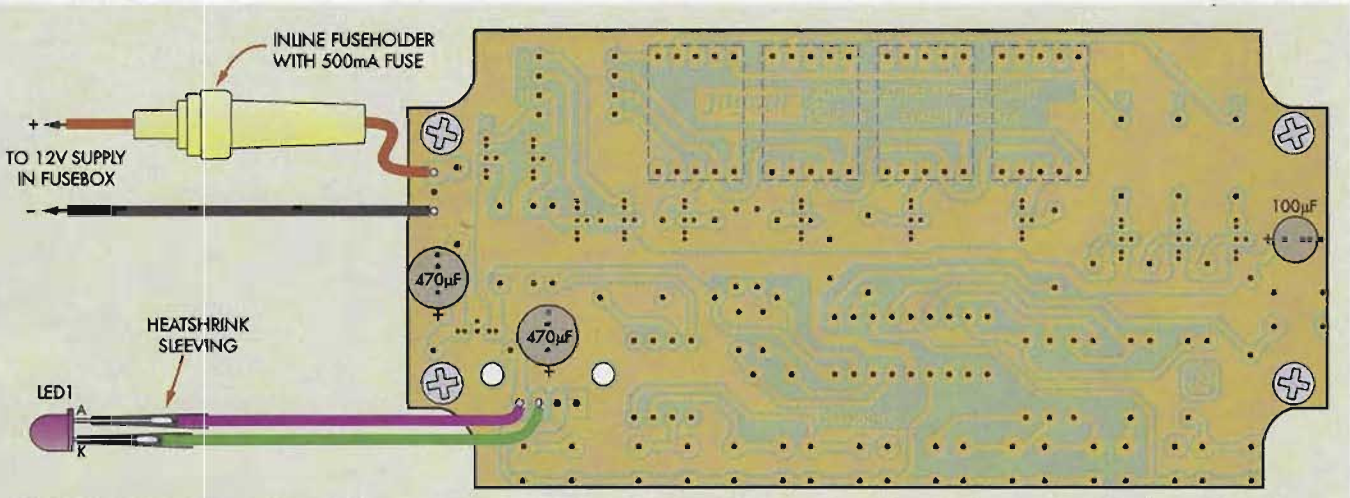


Fig.3: the School Zone Speed Alert is connected to a permanent 12V supply at the fusebox in the vehicle's cabin. Note the 500mA inline fuse in series with the positive lead.

to enable LED1, simply press switch S7 and hold it down for a second or so. It should flash twice briefly, to indicate that it has been enabled.

In most cases, this is all you need to do to set up your School Speed Alert. Normally, there is no need to worry about switches S2-S5, because these are only needed if the school crossing time zones in your area are different from the unit's default time settings of 08:00 - 09:30 for the mornings and 14:30 - 16:00 for the afternoons.

Only if you are in an area where the times are different from these, will you need to change the two start and finish time settings using switches S2-S5. These are used in a very similar way to the current time settings switch (S1) and as before, in conjunction with the hours incrementing switch S9 and the minutes incrementing switch S8.

You simply press and hold down the appropriate setting button until the current setting is shown on the displays, then change the setting hours and minutes using S9 and S8. Then you press the initial setting button once again, holding it down until the displays flash "SEt" and go dark again.

Installation

Once set up, the unit can be connected to the vehicle's 12V supply. Use figure-8 cable to do this and make the connection to a permanent 12V source in the fusebox inside the cabin. **Be sure to include a 500mA inline fuse in series with the positive lead (at the fusebox end) and take care with the polarity of LED1 – see Fig.3.** SC

Using The School Zone Speed Alert

The School Crossing Alert is intended to be placed in your car's glovebox but with the warning LED (LED1) fitted in a recess in the dashboard or on a small bracket below it, so its flashing can attract your attention.

There's normally nothing to do in terms of operating the unit, apart from enabling the warning LED for driving on school days and disabling it for weekends and school holidays. Both operations are done simply by opening up the glove box and pressing switch S7, holding it down for a second or so. The LED will flash twice briefly when it has been toggled into "warning enabled" mode but it remains off when it has been toggled into disabled mode.

Daylight saving

The only other operation that needs to be done from time to time is to toggle the unit into daylight saving mode when daylight saving begins, or back into "normal time" at the end of daylight saving. Both operations are done using switch S6, pressing it and holding it down for a second or so. The displays will flash "dSon" when you toggle into daylight saving mode, or "dSoF" when you're returning to normal time.

The firmware inside the PIC has been programmed to keep time with much the same accuracy as a normal quartz clock or watch. As a result, you shouldn't need to correct its current time setting very often – once every couple of months, at most.

Because the timekeeping accuracy of the unit does depend on the frequency accuracy of the 4.00MHz crystal though, some units may need the time to be corrected more frequently. This is done in exactly the same way as you originally set the time, using switch S1, switches S9 and S8 and then S1 again to save the new setting.

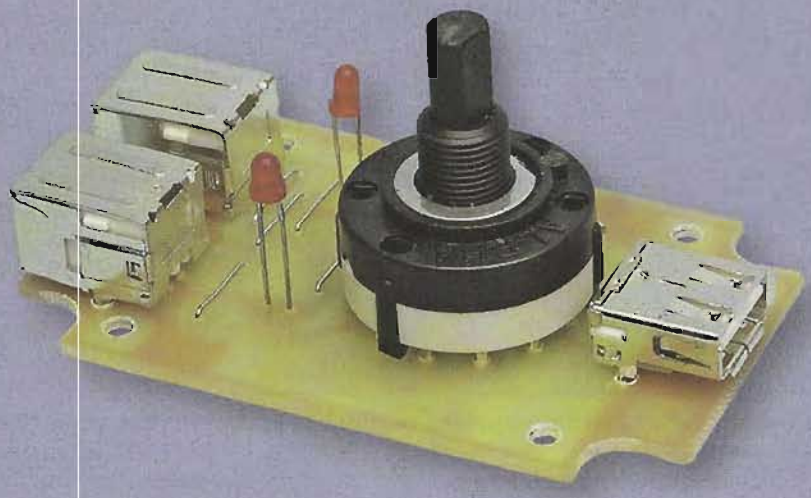
Trimming the crystal

If your unit turns out to have a crystal whose frequency error is sufficient to require more frequent resetting, there is another option. This involves replacing the 22pF NPO ceramic capacitor nearest IC2 on the PC board, with a 6.2-30pF trimmer capacitor such as the Jaycar RV-5716 (green). This trimmer should be fitted on the rear of the board, to allow it to be adjusted more easily.

The trimmer will then allow you to set the crystal frequency closer to 4.000MHz, to bring the timekeeping into line. It will be easiest to find the right setting for the trimmer by using a frequency counter to monitor the frequency at pin 15 of the PIC.

If you don't have access to a frequency counter, you will have to set the trimmer by trial and error. Run the unit for a few hours, then check the current time setting. If it's slow, reduce the trimmer's setting slightly and try again. Conversely, if it's fast, increase the trimmer's setting.

Share a USB printer or other USB device between two PCs





Manual 2-Way USB Device Switch

This simple device allows two computers to share a single USB printer or some other USB device, such as an external flash drive, memory card reader or scanner. A rotary switch selects the PC that you wish to use with the USB device, while two LEDs indicate the selected PC.

By JIM ROWE & GREG SWAIN

THE MOST COMMON way to share a USB printer between two PCs is to use one machine as a print server. However, that's not always convenient because it means that the server PC must always be on if you want to print something.

That can be a real nuisance if you just want to quickly fire up the other machine and print something out. It also means that the two PCs must be networked together, either via a hub/router or directly via an ethernet crossover cable.

Another way is to use a dedicated USB print server. However, as before, this must be connected to an ethernet network, along with the PCs. Such devices also need their own power supply, generally cost well over $100 and are overkill if you just want to share a single USB printer between two computers for occasional printing in a home set-up.

That's where this simple device comes in. It's basically a 2-way switch box that lets you manually switch your USB printer from one PC to the other, as required. The switching is performed using a rotary switch, while two LEDs on the front panel indicate which PC has been connected to the printer.

This method has several advantages. First, you don't need to network your two computers. Second, you can print from either machine with the other turned off. And third, the device doesn't need a power supply.

It's also cheap to build and easy to set up – just run standard USB Type A to Type B cables from your PCs to the USB Switch and connect a third cable from the switch to the printer. That's it.

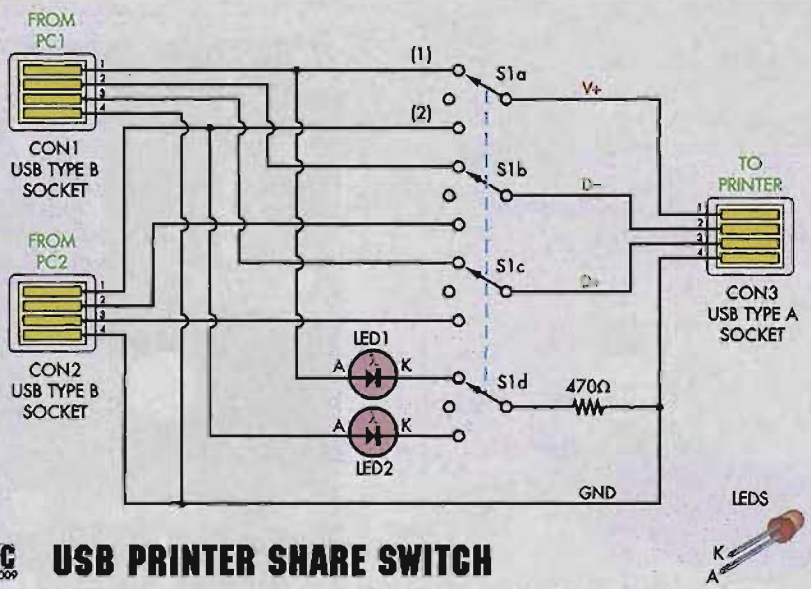
Other devices

This device is not simply confined to switching a USB printer – it can also be used to switch other USB devices, such as USB flash drives, memory



Parts List

1 PC board, code 07104091, 77 x 46mm
1 UB5 plastic utility box, 83 x 54 x 31mm
1 front panel label, 48 x 77mm
2 Type B USB sockets, PC-mount (CON1, CON2)
1 Type A USB socket, PC-mount (CON3)
1 PC-mount 4-pole, 3-position rotary switch
1 knob to suit
4 M3 x 15mm tapped spacers
4 M3 x 6mm machine screws
4 M3 x 6mm countersink-head machine screws
2 3mm red LED (LEDs1&2)
1 470Ω resistor



SC 2009 USB PRINTER SHARE SWITCH

Fig.1: the circuit uses switch poles S1a-S1c to select either USB socket CON1 or CON2 and connect its pins through to CON3. The fourth pole (S1d) selects either LED1 or LED2, to indicate which PC has been selected.

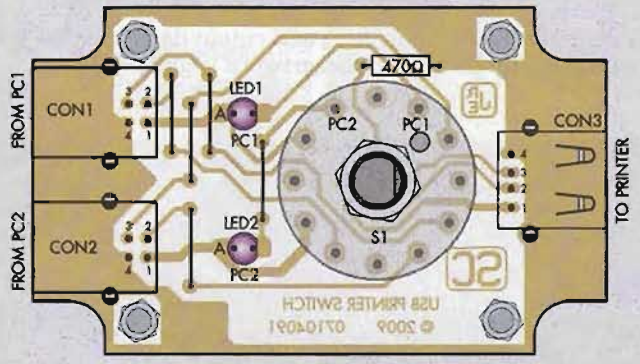


Fig.2: install the parts on the PC board as shown here. Note particularly the orientation of switch S1. It's mounted so that the flat side of its shaft faces CON3 when the switch is in the centre position.

card readers, USB digital picture frames and scanners. However, if you are switching a USB flash drive, you must always be sure to go through the "Safely Remove Hardware" procedure before switching over, otherwise you could lose data.

Circuit details

Let's take a look now at the circuit – see Fig.1.

There's not much to it. At the left, we have two USB Type B sockets to accept the signals from the two PCs (PC1 & PC2). These are the upstream ports and their V+, D- and D+ (data) lines are connected to switches S1a-S1c respectively, while their GND terminals (pin 4) are commoned and fed through to pin 4 of USB Ty pe A socket CON3.

Basically S1 is wired as a 4-pole 3-position switch. However, the centre position is unused. That's been done to ensure a clean break when switching between positions 1 & 2 of each pole, so that either a break-before-make or a make-before-break switch can be used.

In operation, S1a-S1c simply select between USB sockets CON1 and CON2. In position (1), the outputs from CON1 are selected and fed through to the downstream USB output socket (CON3). Conversely, in position 2, CON2's outputs are selected and fed through to CON3.

Switch pole S1d selects between LED1 and LED2, to indicate which input socket (and thus which PC) is selected. These two LEDs connect to the V+ (+5V) lines from CON1 & CON2 respectively, while the associated 470Ω resistor to ground provides current limiting (to about 10mA).

As a result, LED1 lights when S1 selects position 1 (CON1), while LED2 lights for position 2 (CON2).

CON3 is a USB Type A socket. This is connected to the USB device (eg, a printer) via a standard USB Type A to Type B cable.

Construction

All the parts for the USB Switch are mounted on a small PC board coded 07104091 and measuring 77 x 46mm. This assembly fits inside a standard UB5-size plastic utility box, with rec-

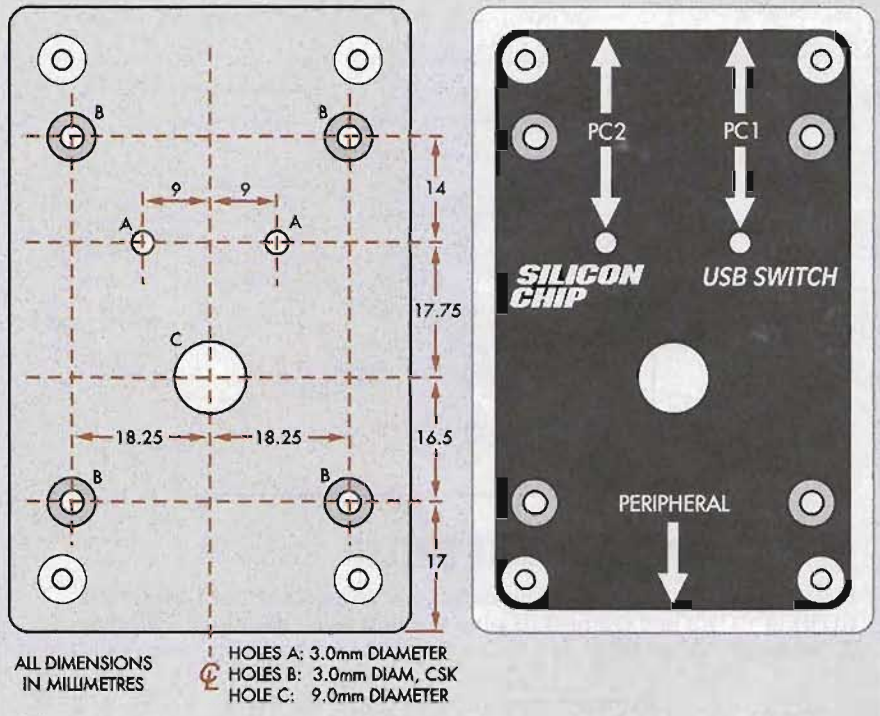
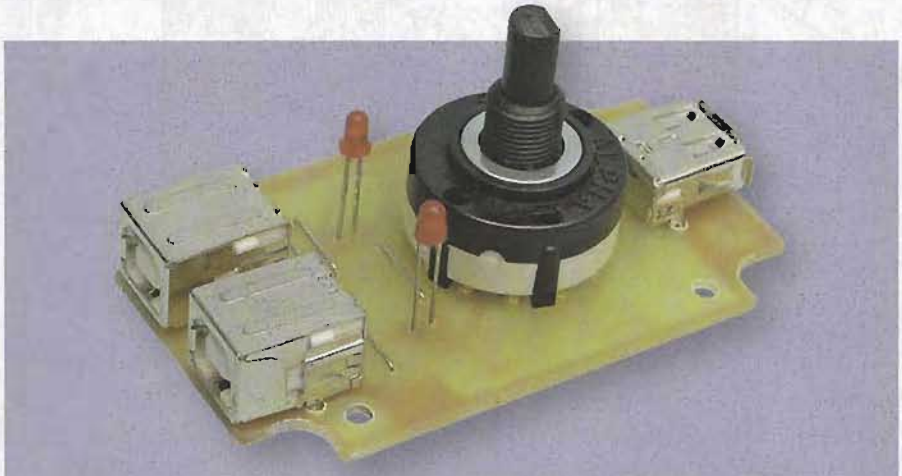
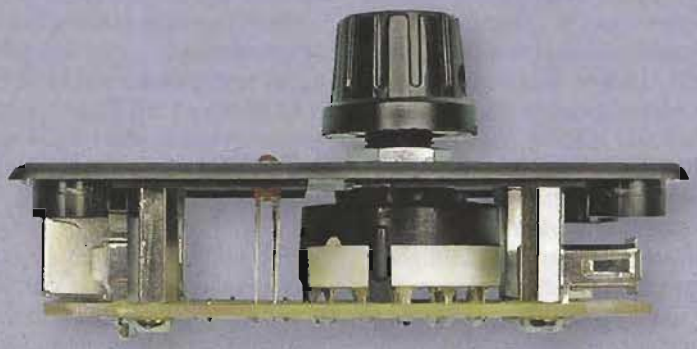


Fig.3: this diagram shows the drilling and cutout details for the lid (left), together with the full-size front-panel artwork (right).



This is the fully-assembled PC board. Be sure to install the rotary switch with the flat side of its shaft towards CON3 (at right) when the switch is in the centre position. The LED leads are soldered after the board has been attached to the lid (see text).



The PC board is attached to the lid of the case using four M3 x 15mm tapped spacers and M3 x 6mm machine screws.

tangular cutouts at either end to access the USB sockets.

Fig.2 shows the parts layout on the PC board. Begin the assembly by installing the five wire links and the 470Ω resistor. The three USB sockets can then be installed. Make sure these sit flush against the PC board before soldering their pins and don't forget to solder the large tabs on either side of each socket.

Switch S1 is next. First, cut its shaft to 10mm, then install it on the board so that the flat side of the shaft faces CON3 when the switch is in the centre position. Be sure to push the switch all the way down so that it sits flush against the board before soldering its pins.

Once the switch is in, fit an M3 x 15mm tapped spacer to each corner mounting position. Secure these using M3 x 6mm screws. The board assembly is then complete except for the two LEDs, which we'll come to shortly.

Final assembly

Fig.3 shows the drilling details for the case lid. Four 3mm mounting holes are required for the PC board, two 3mm holes for the LEDs and a single 9mm hole for the switch shaft.

Fig.3 also shows the full-size artwork for the front-panel label. This can either be photocopied or downloaded from the SILICON CHIP website and printed out. Protect it by covering it with clear contac film, then attach it to the lid using a thin smear of silicone sealant as the adhesive. Wait until the silicone dries before cutting out the holes using a sharp hobby knife.

The PC board can now be attached to the lid. First, slip the two LEDs into position (check their orientation), then secure the board to the lid using four M3 x 6mm countersink-head screws. That done, fit the switch nut, then push the LEDs through their front-panel holes and solder their leads.

The final step is to make the cutouts in the ends of the case for the USB sockets. You will need two 12 x 10mm cutouts for the type B sockets and a 17 x 9mm cutout for the type A socket. These can be made by first marking out their positions, then drilling a series of holes around the inside perimeters, knocking out the centre pieces and filing them to a neat finish.

That's it – your USB Switch is now complete. Attach the lid to the case, fit the knob and it's ready to go. SC

SERVICEMAN'S LOG

Is it worth fixing an older plasma set?

Despite the big "R" or even "D" word we hear on the media every night, new plasma and LCD sets still seem to be getting cheaper. Most of this is caused by the never-ending supply of better, newer or more technology for the dollar. Unfortunately this problem is spiralling down to my level because the question is always, is it worth fixing?

Items Covered This Month

- Samsung LA32R51B TV
- Teac PLH4220SD TV
- Tivoli Audio Music System
- TCL PDP-4200BK TV (LG PDP42V72462 chassis)
- Logitech Z-10 loudspeakers

If you bought a plasma set over two years ago for about $2000, you could now buy a better one for only $1000 and if you tried to sell it, you would probably only get $500 – that's if you managed to sell it at all. If it breaks down, most times it can only be repaired to board level. Such boards are supplied (if you are lucky) at an inflated two-year-old price and on many occasions this can take the projected repair price over the $500 threshold.

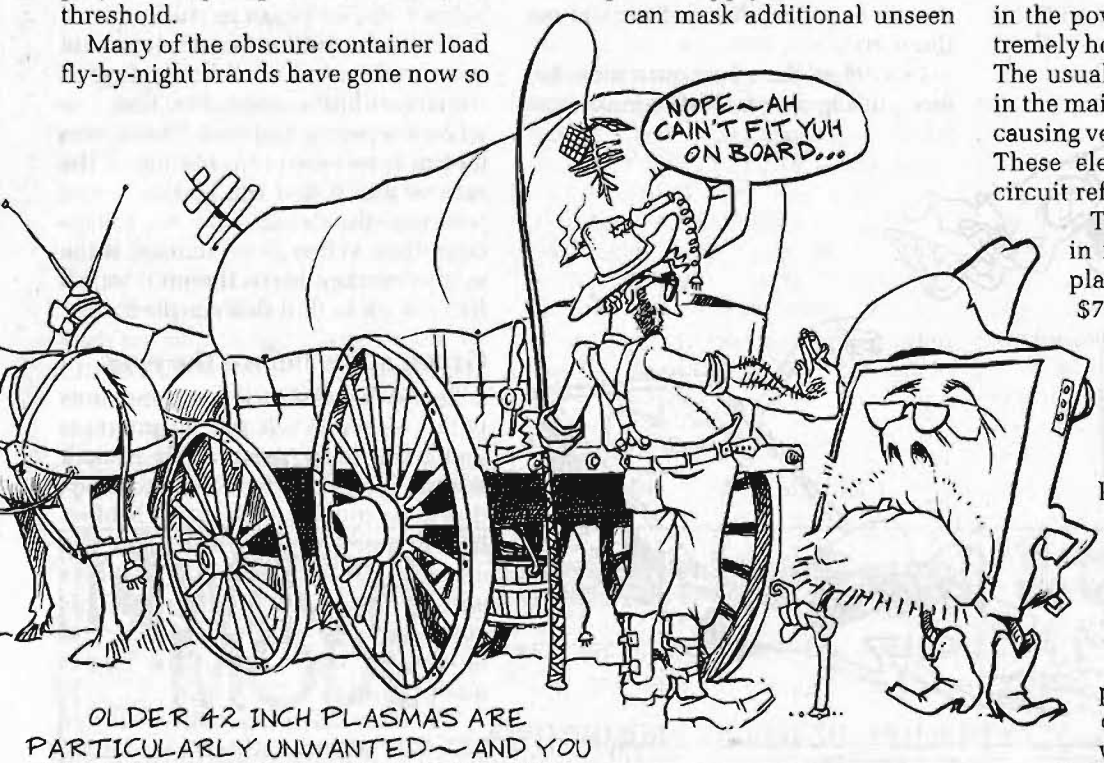
Many of the obscure container load fly-by-night brands have gone now so customers are often extremely anxious to find a way out of their predicament. Some are even attempting fraudulent insurance claims and are pressurising us to present quotes that are misleading in the hope of a replacement claim.

If a set is dead after a storm I am blatantly asked to inflate the prices even higher in order to write the sets off. The problem can be worse because if a set's power supply is knocked out it can mask additional unseen problems the set might have endured. As the stakes are so much higher now in terms of cost, you can easily get the scenario that after the quote for a new power supply has been accepted and it has been fitted, you might find that the cost of replacing other faulty boards can easily cost the same again or more.

For example, recently I attended to a Samsung LA32R51B which had died. The two main electros (82µF 450V) in the power supply had become extremely hot and destroyed themselves. The usual reason for this is a failure in the mains voltage-doubling circuit, causing very high voltage across them. These electros do not even have a circuit reference.

The set cost almost $4000 in 2005 and a much better replacement now sells for about $750. The new power supply I quoted for cost $470 all up. However, the client wasn't happy about this price and insisted I increase it just in case the insurance company elected to have the set repaired rather than replaced. Well of course, I point blank refused to do this so he left rather unhappy. His problem.

This is becoming such a problem that many service companies do not want the work. Older 42-inch plasmas are particularly unwanted because they require two people to



OLDER 42 INCH PLASMAS ARE PARTICULARLY UNWANTED~AND YOU DEFINITELY NEED A BIGGER WAGON TO PUT THEM IN...

pick them up. And you definitely need a bigger wagon to put them in.

If the set was removed from a wall bracket you can bet that the original desk stand has been tossed out which adds more headaches when you are servicing the set.

Resurrection of a Teac

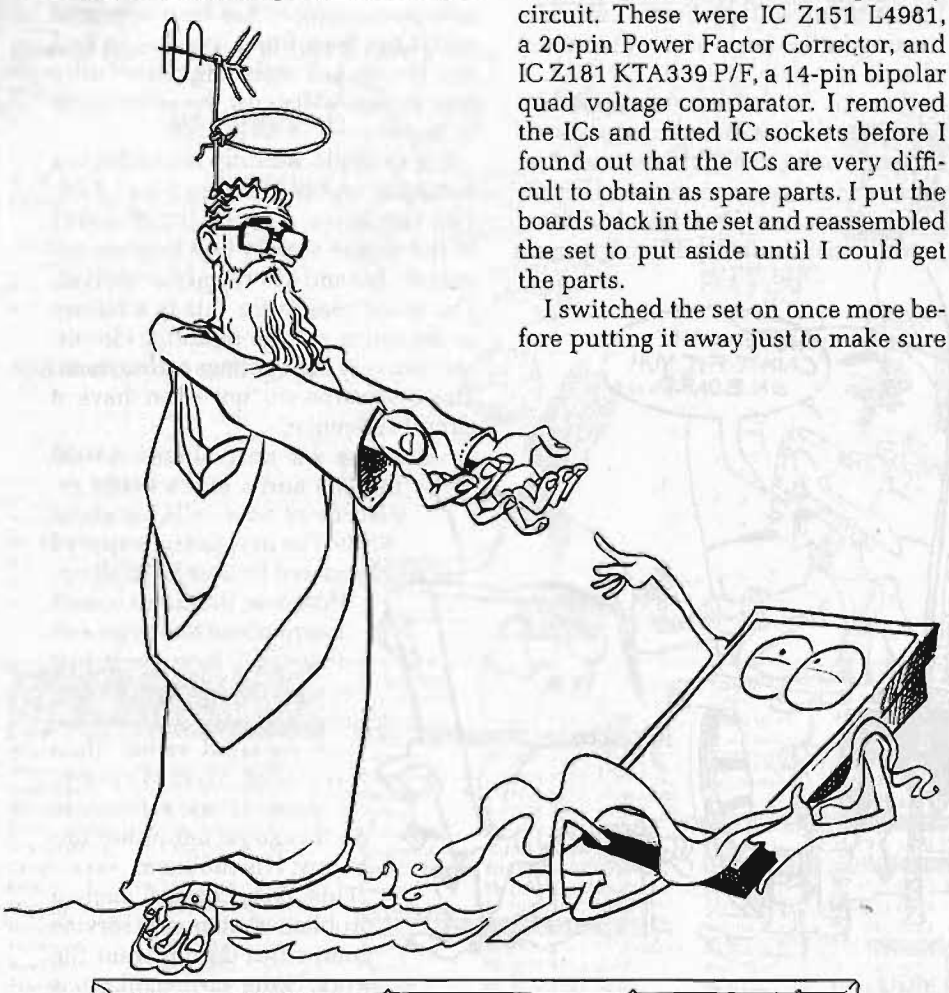
Recently, I was given a dead 2005 Teac PLH4220SD. The set had already been to at least one rival service company who correctly diagnosed that the power supply had failed (in a storm) and that a replacement was expensive and not available for at least a month. They did not know if there was anything else that might be wrong and they were certainly not keen to store a 5-year old plasma, which was technologically nearly worthless, for six weeks or so.

So the client bought a new one and gave me the old one. I discovered that it was basically an LG PDP42V72413 Series 7 with a Sankei power supply unit. I examined the board very carefully outside the set but could find nothing wrong. There were no obviously failed parts that needed replacing. At switch-on you could hear the relays click on and off and the red Standby LED changed colour to blue.

The remote was working and there was a 5V standby voltage available. I shorted the relay contacts which allowed the primary circuits to be energised but nothing was coming out of the secondary power rails. I unplugged and then later replaced the Y sus and Z sus boards on the off-chance that a feedback pulse was switching the set off.

As a last resort, I decided to replace the two control ICs in the primary circuit. These were IC Z151 L4981, a 20-pin Power Factor Corrector, and IC Z181 KTA339 P/F, a 14-pin bipolar quad voltage comparator. I removed the ICs and fitted IC sockets before I found out that the ICs are very difficult to obtain as spare parts. I put the boards back in the set and reassembled the set to put aside until I could get the parts.

I switched the set on once more before putting it away just to make sure and blow me down if the set didn't fire up and it has worked perfectly ever since! Explain that one!



RESURRECTION OF A TEAC (EXPLAINED)

Deluxe radio

Tivoli Audio makes beautiful high-quality radios. The Music System is one of their flagship models which also has a CD player built in, all for a modest $1200.

A colleague of mine is a service agent and he told me about one that came in under warranty. It was stuck in standby mode. He removed the front panel to find the wafer thin PC board behind it was not installed properly because one of the two locking screws wasn't centred properly. It was plugged into a socket similar to a PC RAM socket.

Thinking this would be an easy fix, he removed and refitted it correctly and reassembled the front panel and tested it again. Unfortunately, that made no difference. Being an agent meant that he had other units in stock that had been repaired and checked, so he started swapping the boards over, beginning with the front panel. He then tried the back panel, the speaker and power harness. In fact, just about everything.

Access to some of this is pretty difficult, especially with the CD player in the way, so he unplugged it and lo and behold, the set began to work.

He then examined the CD player and could not fault it until he unplugged the snooze button assembly. That was when the penny dropped. The snooze button is recessed into the top of the cabinet and it had jammed in the on position, thus confusing the microcontroller. When he unjammed it the system worked perfectly but it took a lot of work to find this simple cause.

Green spots before the eyes

One of the most common complaints with plasma TVs is that of intermittent green snow, particularly in dark scenes. Being intermittent makes diagnosis much harder and it is often heat related. Almost all of these sets are models that have LG displays and boards in varying degrees. This covers a wide range of brands and models, as LG is one of the largest manufacturers.

The other day I was called out to a TCL PDP-4200BK which uses an LG PDP42V72462 chassis (series 7). This set was mounted on a wall bracket

with the cables disappearing into a wall cavity to ancillary equipment. I was fortunate enough to actually see the problem and the client was able to help me remove the set so it was face down on some blankets on a sideboard just below.

I removed the 50,000 screws that held the back on, blessing my electric screwdriver and happy that they weren't Torx head screws like Philips use. Once the back was off, I propped the set up a little so I could see the reflection of the screen on a mirror tile I had secreted underneath. I then powered the set up and selected a channel.

Unfortunately, in the process of moving the set, I noticed that the picture was now intermittently snowy too. I soon found out that the cause of this was the coaxial antenna wall socket but I couldn't do anything about it until I had completed the repair I was working on because access to the socket was so poor.

Fortunately, this fault is well known and so I went straight to VR1 (V Setup) on the Y sus board. I marked its current position with an indelible Texta pen before giving it a small twist. This was enough to fix the green spots completely but I had been caught before with the intermittent nature of this fault. The client and I loosely refitted the back and propped the set up against the wall so they could watch it again.

Apart from the intermittent snow problem the antenna lead was giving, the picture was otherwise blemish free. I told the client to watch it overnight and if it was still fine the next day, I would reinstall it properly and fix the antenna connection. Back at work the next day I got a telephone call from the wife of my client telling me I hadn't fixed the set – it was exactly as before and I had better bring some replacement boards.

Fortunately when I returned and spoke to the husband he could discern the difference between the two faults and confirmed that the green dots had indeed gone but there was still an intermittent snow problem.

Between us, we reassembled the set and reinstalled it onto the wall bracket. Once this was done, I now only had limited space to reach the antenna wall socket. It was an HPM type and the cover had been painted onto the wall. After a lot of very hard work, I managed to remove the whole assembly and disassemble it. I then rewired it properly and firmly and reinstalled it after tightening up the centre and outer parts of the coaxial socket.

Once this was done we had a consistently good picture on all channels.

Had this not worked, I would then have checked all the voltages next to the corresponding values written on the panel for Va and Vs. I would also check VR4 and VR3. Finally, I would have had to resort to replacing the "Y sus kit".

The Y sus kit consists of the Y sus board, the Z sus board and the Control board, and is usually only replaced when the Y or Z sus board blows up. The reason all three are replaced is that LG have modified all of them to make them more reliable, because sometimes a fault on one of them can cause the whole lot to self-destruct.

This is fine for the Series 7 of LG sets but not for the other brands which use a different control module with different plugs and sockets. If you are wondering whether to replace these modules you must make a note of the part numbers. The current ones are:
(1) Y-sus: 6871QYH036D
(2) Z-sus: 6871QZH041B
(3) Control: 6871QCH053G

The different control modules are denoted by their last letter. They are priced from $250.00. For most other brands, these boards sell for much, much more.

Bedroom indulgence

One of the shortcomings of flat panel TVs is the lack of quality sound. Some sets have no audio output sockets except for an earplug connection. Others only have optical. Where possible, it is nice to be able to connect the set to a surround-sound theatre amplifier but these can cost from $500 upwards. A simple solution is to use computer amplified speakers which start from only a few dollars.

I just got a new Samsung LCD set for the bedroom and decided to indulge myself by getting some decent computer speakers. Mrs Serviceman only agreed providing:
(1) They were cheap
(2) She could have a new dress
(3) They looked good
(4) She could have a new dress, and
(5) They were small.

There are such a lot of different designs and prices out there these days that it is difficult to make a decision, so in the meantime I continued to use some old JBL speakers. The big problem with speakers is that you really need to try them out before making a decision. I note that Apple in the US offers such a service of try before buying. The only trouble is that then you are locked into their products.

In the end, I was taken by a pair of Logitech Z-10s and the clincher was the special price; Officeworks had them for nearly half price. I was also very taken by the Edifier M3200 Salt

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and Pepper speakers, the Altec Lansing FX3022 Expressionist Bass with built in subs or even the FX2020AA Expressionist Classic, not to mention La Cie 130811.

I was pretty lucky because Officeworks sold out very fast and I got one of the last pairs. I unboxed the whole thing very carefully and was impressed by their beautiful black piano finish and also by how heavy they were. However, I was somewhat disappointed after connecting them to the 3.5mm earphone jack socket because there was no sound at all.

I eventually found and read the tiny multi-lingual pamphlet which gave instructions on operating the speakers. Most of the instructions referred to connecting the speakers via a USB lead to a PC but I was not using this feature.

After a lot of messing around, it occurred to me that there might actually be something wrong with these brand new speakers, so to confirm this, I connected them to my computer and loaded the appropriate software.

The speakers broke out into fantastic sound! Not only that but the display on the right speaker showed the CD title and all its details, plus an analog clock. They had all the bells and whistles. All the touch controls – volume, bass, treble, balance, etc – worked well too. Wonderful.

I unplugged them and moved them next door to the LCD TV and plugged them in again. Again there was nothing; absolutely nothing. The JBL speakers worked fine and I swapped the leads over. Next, I tried what I thought was a pretty long shot. My PC is located near a conventional Sony CRT TV which also has a 3.5mm stereo jack socket for headphones. It was only a small matter of disconnecting the PC to the Logitech speakers and plugging in this other TV. The sound worked. Wow!

OK, to sum up: the new Logitech speakers worked with the PC and the old Sony TV but not with the new Samsung LCD. The old JBL speakers

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~(1) THEY WERE CHEAP
~(2) SHE COULD HAVE A NEW DRESS...

worked with everything, so why wouldn't the Logitech speakers work with the Samsung?

I looked and looked and touched all the controls until the penny dropped. The touch control panel of the Logitech has a graphical display of the controls of 10 different size bars that go from minimum to maximum. When you plug in the speakers and power them up and touch the volume up button, all the bars are displayed, denoting full volume.

Where muggins stuffed up

Where muggins stuffed up was that these bars were OUTLINED. When I kept my finger on the touch control for a long time, the bars gradually became SOLID until about half-way through when you heard the sound.

When connected to the PC, the volume level is controlled by the PC as well and so the sound is instantly at its default level. When I unplugged them and connected them to the LCD, the volume level defaulted to zero, which to a newcomer looks like full volume but isn't. When I connected them to the old Sony TV, I had not unplugged the power so they were still at the PC default and so also worked normally.

The instruction book was a waste of paper and it is a pity that the volume control took such a long time to respond to a finger touch. Anyway, they are performing well now, though I admit it would have been nicer if they had provision for a subwoofer. They were very good value for money, though.

On an unrelated subject, I would have liked to connect these new speakers to my old Apple Powermac G4 but I discovered that they use a very special mini-digital 2.5mm recessed stereo jack designed only for Griffin iFire 400 Powerwave amplifiers for Apple Pro Speakers. And guess what – there are no adapters available!

Very inconvenient and very iSad! SC

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By DAVID L. JONES

The µCurrent

. . . a precision current adaptor for multimeters



You might not be aware of it but your digital multimeter is unable to make accurate current measurements in low-voltage circuits because of its "burden voltage". This precision current adaptor solves that problem and greatly improves the measurement accuracy, as well.

DON'T MOST multimeters already have current measurement ranges? Well, of course they do. But most multimeters, be they a no-name $10 hardware store throwaway model or a $1000 highly-accurate brand-name meter, all suffer from two rather annoying issues with their current measurement ranges – burden voltage and reduced accuracy.

The biggest problem with current measurement ranges is burden voltage. This is the voltage that the internal current shunt resistor drops as the circuit's current passes through it.

The burden voltage is typically specified in millivolts per Amps (mV/A). The value will change for different current ranges, so you might have 1mV/A, 1mV/mA and 1mV/µA for example.

Normally, you may not give burden voltage a second thought, as like many, you probably think it's fairly insignificant in most applications. In fact, most people would be hard-pressed to tell you what the burden voltage of their particular multimeter actually is. It's usually buried away in the user manual, if it's mentioned at all. Next time you borrow a colleague's meter, ask them what the burden voltage is, and watch their reaction!

At small displayed currents, the burden voltage is usually not an issue but at larger displayed currents (relative to full-scale) the burden voltage can be very high, even in the order of several volts! This can often force you to use a higher current range (with a lower-value shunt resistor), with subsequent loss of resolution and (often) accuracy.

You may in fact have encountered this many times, with your circuit either not working or "playing up" on too low a current range. That's the burden voltage at work, starving your circuit of the voltage it needs to function correctly. You usually have no option but to reluctantly switch to a higher current range to lessen the effect.

The problem can also be highlighted with the many 4½-digit or "10000 count" meters on the market. In theory, they allow you to get an extra digit of resolution over a 3½-digit meter. But you may now find yourself trying to measure, for example, 990.0µA on the 1mA range with a burden voltage of just under 1V. Can your circuit really handle a 1V drop?

The burden voltage of a multimeter is determined primarily by the shunt resistor used for measurement. However, on the higher current ranges (mA & A) it also includes the protection fuse resistance and, to a much lesser extent, any switch and test lead contact resistance. Some manufacturers will specify it as a total or just the shunt resistor, or in many cases not mention it at all!

Some meters will specify it as a maximum voltage drop only. For example, "300mV max". In this case, to get the mV/A value, you simply divide that voltage by the full-scale range current.

Current measurements with low supply rails

The recent trend toward low-voltage microcontrollers and other silicon devices (some operating from as low as 1V or less!) has really highlighted the need for considering the burden voltage when measuring currents. 3.3V supplies have been widely used for a long time now and the trend is heading lower.

A common task these days is to measure the accurate "sleep" and operating current of a microcontroller. Indeed, with the lower supply voltages of today's battery-powered circuits, accurately measuring the supply current has become more critical.

So the industry has changed but digital multimeters haven't really kept up with the pace when it comes to ac-



Table 1: Burden Voltages For Typical Multimeters

Multimeter Model	Approx Cost($)	Burden Voltage (mA range)	Burden Voltage (µA range)
Meterman 5XP (3.5-digit)	$65	1V max	300mV max
JayTech QM-1340 (4.5-digit)	$99	5mV/mA	0.11mV/µA
Meterman 30XR	$120	4.6mV/mA	1mV/µA
Protek 506	$175	1mV/mA	1mV/µA
Meterman 37XR (10,000 count)	$250	10mV/mA	1mV/µA
B&K 390A (4000 count)	$380	2V max	500mV max
Fluke 77 series III (3.5-digit)	$400	6 mV/mA	N/A
Fluke 77 series IV (6000 count)	$425	2mV/mA	N/A
Fluke 79 series III (3.5-digit)	$375	11mV/mA	N/A
Fluke 177/179 Series IV (6000 count)	$430	2mV/mA	N/A
Fluke 27	$900	5.6mV/mA	0.5mV/µA
Fluke 80 series V (4.5-digit)	$720	1.8mV/mA	0.1mV/µA
Agilent U1251A (4.5-digit)	$680	1mV/mA	0.1mV/µA
Extech MM570 (500,000 count)	$680	3.3mV/mA	0.15mV/µA
Fluke 289 (50,000 count)	$950	1.8mV/mA	0.1mV/µA
Gossen MetraHit E-XTRA (60,000 count)	$1700	300mV max	150mV max
Fluke 8808A (5.5-digit)	$1100	1mV/mA	1mV max
Fluke 8846A (6.5-digit)	$2100	500mV max	15mV max
Keithley 197A Microvolt (5.5-digit)	N/A	300mV max	300mV max

curate current measurement. You may think that multimeters are getting more "accurate" for less cost but that's only part of the story.

Let's look at how the supply voltage can impact your current measurement or vice-versa, as the case may be:

Let's say you want to measure the supply current of a chip or circuit taking 200mA using a 4000-count meter on the 400mA range. This is a fairly common scenario and one you would think would be pretty easy for any multimeter to handle. But maybe not . . .

A typical high-end "accurate" multimeter will have a "low" 1mV/mA burden voltage (about as low as it gets), so this means the meter will drop 200mV across its shunt resistor at 200mA. This represents an almost tolerable 4% (200mV/5V x 100) of a 5V supply voltage.

This may not be a big deal if your supply voltage is spot on 5V, as your chip will get 4.8V and still be within spec. But what if it's only 4.8V? Your chip or circuit will now be getting only 4.6V which may well be below its operating specifications.

This already shows the limitation of the current range on a typical multimeter. But that's without even considering how the circuit current can differ when you lower the rail by 0.2V.

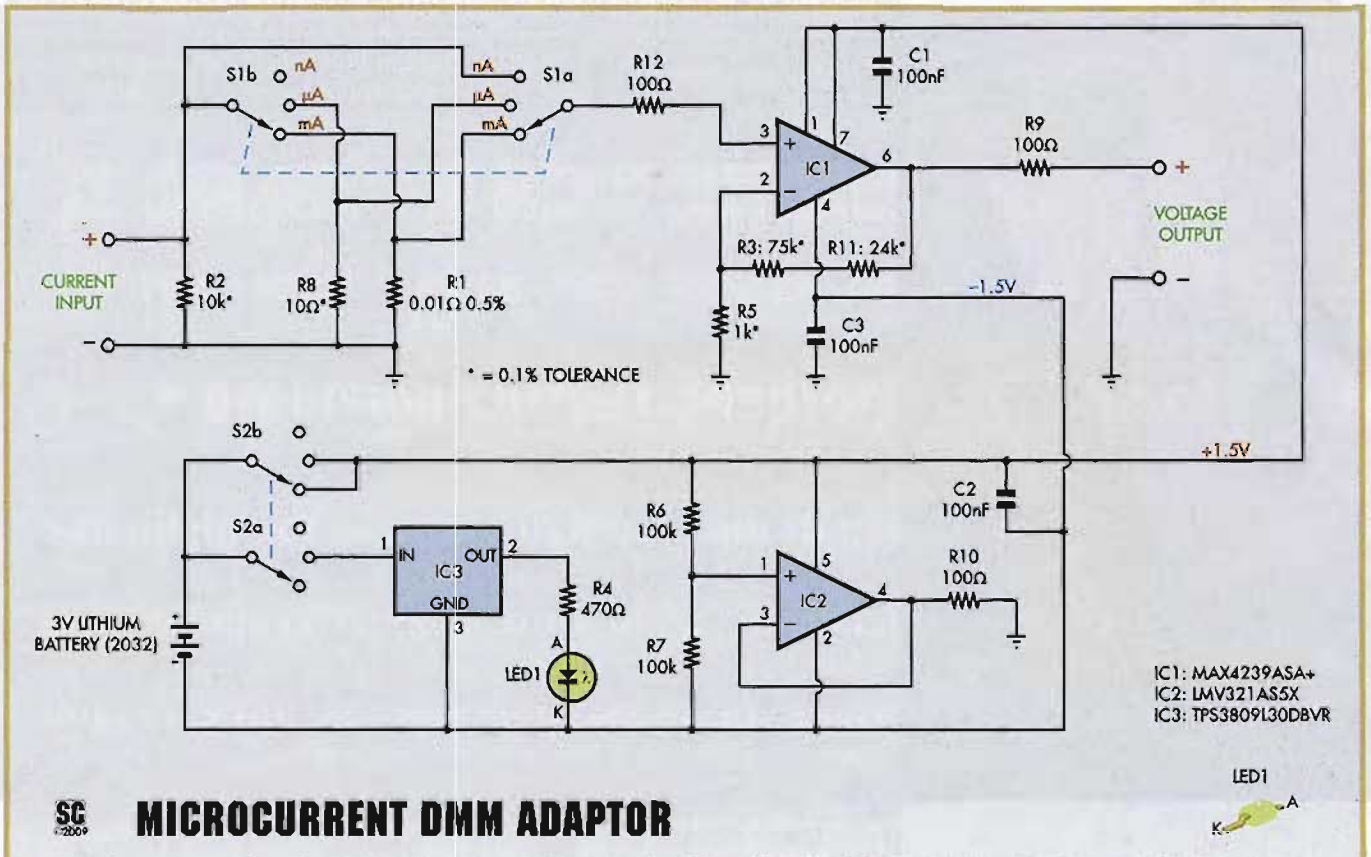
Let's now say you need to do the same thing on a modern circuit or chip with, say, a 1.2V power supply, ie, the voltage from a single NiMH cell. That same 200mV burden voltage is now a whopping 17% (200mV/1.2V x 100) of the supply voltage. Your circuit may now fail to function correctly and this is clearly not acceptable, not to mention inaccurate.

Think this is only a problem with "cheap" meters? Well, think again. The Fluke 87-V, probably the most popular high-performance meter available, has a burden voltage of 1.8mV/mA (which is still pretty good). So the above numbers are even worse – a 360mV drop for a 200mA current.

Sure, you can switch up a current range, using the 10A jack, with its burden voltage of say 10mV/A, giving you a very nice drop of only 2mV. But your display is now showing 0.200 or 0.20 instead of 200.0 – you've just lost a valuable digit or two of resolution. The higher 10A current range is likely to be much less accurate than the mA range too!

Let's now take a look at the quoted burden voltage of some typical multimeters – see Table 1. As shown, things can improve a bit with the more expensive meters, particularly on the µA ranges. But an expensive precision meter is by no means a guarantee of a low burden voltage. Even many top-of-the-line bench meters can have unacceptable burden voltages for many applications.

It should be noted that while some meters will have a fixed burden voltage for all mA ranges, others like the Meterman 30XR have individual



MICROCURRENT DMM ADAPTOR

Fig.1: the circuit is based on IC1, a Maxim MAX4239 ultra-low offset/drift, low-noise precision amplifier. IC3 is a voltage monitor while voltage follower stage IC2 provides a virtual ground reference for the circuit.

specifications for each range; ie, 2mA range = 100mV/mA, 20mA = 13mV/mA and 200mA = 4.6mV/mA.

Some popular and highly regarded meters like the Meterman 37XR and Fluke 79 are particularly bad on their mA range, an order of magnitude worse than some cheaper meters – so beware. Taking the above example again, the Meterman 37XR would drop a whopping 2V (10mV x 200) on its mA range for 200mA. This will not be much good when your supply voltage is only 3.3V, 5V or even 12V.

And the 37XR is a relatively expensive 10000-count meter that is supposed to be capable of measuring 999.9mA on its 1A range – which it will try to do. But that would be a gigantic 10V drop which the meter itself cannot even handle, so it's limited to a nominal 400mA with a 4V drop on that range. Crazy huh?

By now you should understand that burden voltage can be a real hidden problem lurking in your meter. What is your meter rated at?

Accuracy

And the second problem we mentioned? That would be one of accuracy or lack of it. Most multimeters have a much poorer accuracy specification for current than for the DC voltage ranges or the "Basic DC Accuracy" as it's called.

The Meterman 37XR, for example, is quite an accurate meter at ±0.1% (+5 counts) on DC volts and is sold and marketed as such. But its current accuracy is a not so impressive ±0.5% (+10 counts) on DC current and ±1.5% for the 10A range.

An even better example is the Fluke 27, with ±0.1% (+1 count) DC volts accuracy and ±0.75% (+2 counts) mA/µA DC current accuracy. Other multimeters are very similar, with a factor of five or more between the DC volts and DC current accuracy being quite typical.

This issue applies to the AC voltage vs AC current ranges as well. Some meters can actually have very poor AC current accuracy and/or reduced AC frequency response compared to their AC millivolt range.

Take the Fluke 27 again as an example. Its ACV accuracy is ±0.5% (+3 counts) to 2kHz but the AC current range is considerably worse at ±1.5% (+2 counts) to 1kHz.

µCurrent adaptor is the solution

You guessed it, the project presented here presents a neat solution to these issues. The "µCurrent" (pronounced "micro current") is a simple yet accurate professional grade precision amplified current adapter for multimeters. It provides up to a 100-fold reduction in burden voltage for a given current range!

An additional feature is a nanoamp (nA) current range. This gives any cheap 3.5-digit multimeter the ability to resolve 0.1nA (100pA). On a 4.5-digit multimeter it will resolve 0.01nA (10pA). And this comes with an excellent accuracy of <0.2%.

In most cases, µCurrent is also able to improve your meter's current range accuracy by using your meter's more accurate mV DC voltage range to display the DC or AC current. (Yes, yes, we know that AC current is a tautology but what else can you call it?)

For AC, the frequency response extends up to 10kHz although the

circuit's THD (total harmonic distortion) increases substantially above 2kHz. This is still a very respectable AC response range, surpassing that of many digital multimeters on current and voltage ranges.

Typical accuracy of the μCurrent itself is better than 0.2% on the μA and nA ranges, and 0.5% or better on the mA range. Unfortunately, it is not easy to obtain a 0.1% precision shunt resistor for the mA range, as the 10-milliohm value is too low.

The burden voltage of the μCurrent is a fixed 10μV/μA and 10μV/nA on the lower ranges. It varies on the mA range due to the switch resistance but 70μV/mA is a nominal upper figure. These figures are unmatched by almost any meter on the market.

So, for example, at a full scale of say 1000μA, that's a maximum burden voltage of only 10mV. So measuring the current rail of a 1.2V logic supply with full-scale resolution would give you a worst case drop of around 0.8%, a fairly insignificant figure.

The output voltage in mV is directly proportional to the input current, so you can simply read the current value from your multimeter's mV DC range.

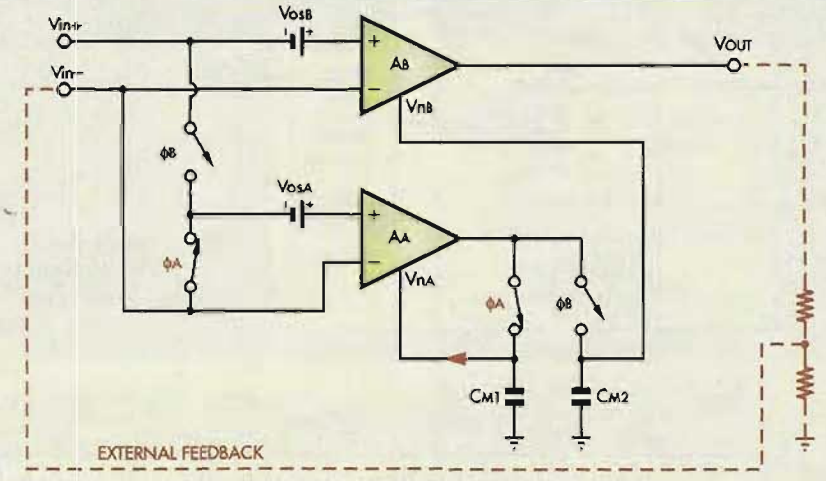
The μCurrent thus effectively eliminates burden voltage by making it insignificant in all but the most extreme applications.

How it works

A current adapter is basically just a shunt resistor with an amplifier. But there are a few extra neat features to the μCurrent design to make it as professional and handy as possible, as we'll see. The full circuit is shown in Fig.1.

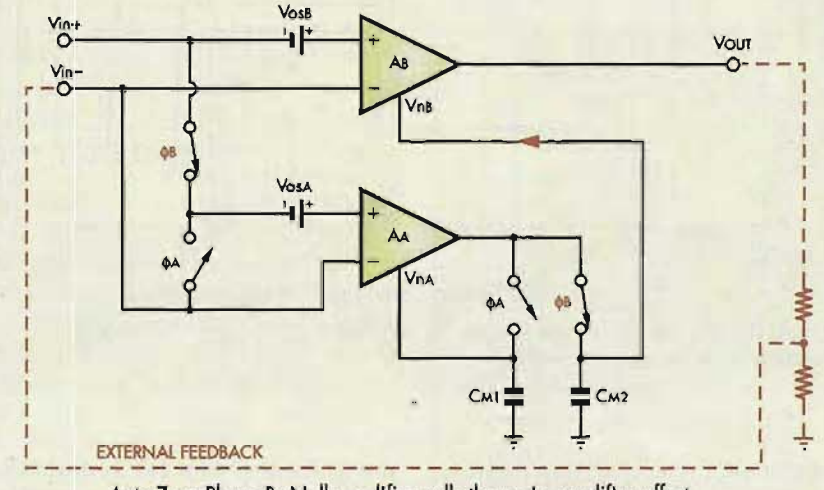
The heart of the design is IC1, a Maxim MAX4239. This is a special "ultra-low offset/drift, low noise precision amplifier". As the name suggests, it's a pretty high-spec device. The key figure in this application is its near-zero offset voltage. It's not just "low offset" like many precision op amps; this one has almost no practical offset voltage at all. It is typically 0.1μV, with a maximum figure of 2.5μV over the entire temperature range.

This class of op amps is known as an "auto-zero" (or "chopper") amplifier. Maxim is a bit hush-hush on the actual internal workings of their particular device, saying only that "these characteristics are achieved through a patented auto-zeroing technique that samples and cancels the input offset and noise of the amplifier. The pseudo-random clock frequency varies from 10kHz to 15kHz, reducing intermodulation distortion present in chopper-stabilized amplifiers".



Auto-Zero Phase A: Null amplifier nulls its own offset

Fig.2(a): how a basic auto-zero amplifier works. In the first phase, the main amplifier (A_B) is offset with the voltage stored on capacitor C_{M2}. The nulling amplifier (A_A) measures its own offset voltage and stores it on capacitor C_{M1}.



Auto-Zero Phase B: Null amplifier nulls the main amplifier offset

Fig.2(b): in the second phase, the nulling amplifier (A_A) measures the input difference voltage on A_B and stores this value on capacitor C_{M2}, ready for the next cycle.

However, we can get a good idea of how a basic auto-zero amplifier works by referring to Fig.2.

An auto-zero amplifier is basically the combination of a normal op amp (A_B) with a "nulling" op amp (A_A) that continually corrects for the DC offset voltage of the main amplifier. The device is driven by an internal clock that drives a 2-phase offset process.

In the first phase, in Fig.2(a), the main amplifier (A_B) is offset with the voltage stored on capacitor C_{M2}. The nulling amplifier (A_A) measures its own offset voltage and stores it on capacitor C_{M1}.

In the second phase, in Fig.2(b), the nulling amplifier (A_A) measures the input difference voltage on A_B and stores this value on capacitor C_{M2}, ready for the next cycle. This process continually eliminates the offset voltage of the main amplifier.

A side benefit of this is that it also eliminates typical op amp 1/f noise, as the low frequency is treated as a slowly varying input offset voltage and hence gets cancelled out.

The pseudo-random clock used in the MAX4239 also helps to reduce the effects of intermodulation distortion as

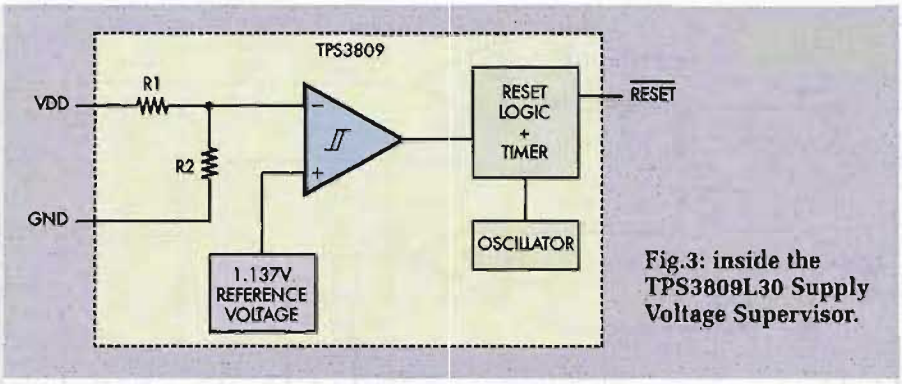


Fig.3: inside the TPS3809L30 Supply Voltage Supervisor.

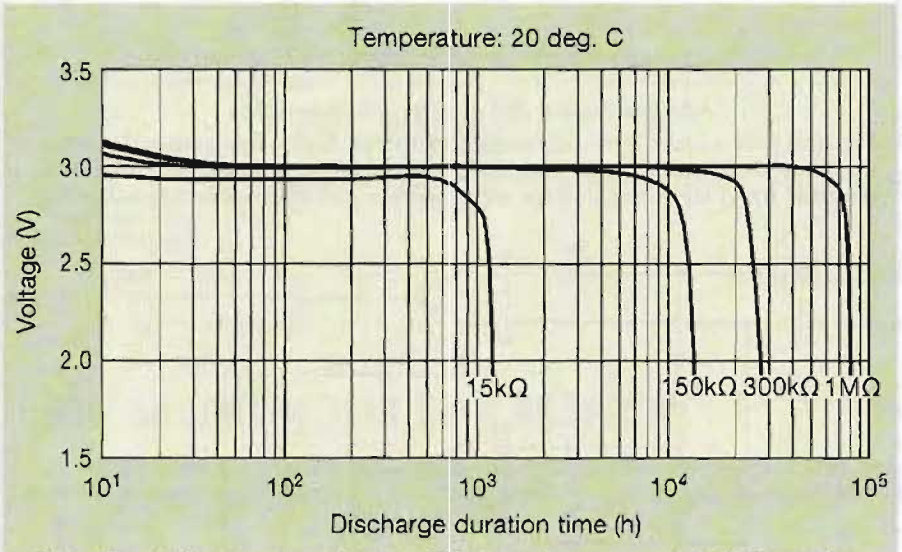


Fig.4: the discharge curves for the 3V lithium battery specified (CR2032), using a number of different loads.

AC signals approach half the chopping frequency (10-15KHz).

This remarkable DC performance allows the µCurrent to have insignificant output offset error. As a result, it will display 0V output for a zero current input.

It is also quite a low power device, drawing around 600µA with a supply voltage specified down to 2.7V. This makes it ideal for operation from a single 3V lithium battery.

The MAX4239 also has a companion device, the MAX4238. The only difference is that the MAX4239 is a high bandwidth "decompensated" version of the MAX4238. The MAX4239 requires a minimum gain of 10 which we have in this circuit, so it's better to use the higher bandwidth device.

If you want to use the MAX4238 then that is possible without any circuit changes, only the bandwidth and other AC performance measurements will differ.

A fixed gain of 100 is defined by precision resistors R5 and R3+R11. These are 0.1% resistors with negligible temperature drift.

The 100Ω resistor R9 at the output of IC1 ensures stability. This value will be low enough to ensure error-free operation with multimeters having greater than 100kΩ input impedance. If for some reason your meter is lower than this, than you'll have to lower the value of R9 appropriately.

Current ranges

There are three current ranges that are defined by the shunt resistor on each range, together with the gain of IC1.

R2 (10kΩ 0.1%) is the shunt resistor for the nA range and is permanently connected across the input terminals. It gives a burden voltage of 10µV/nA (1nA x 10kΩ). The other shunt resistors R1 and R8 are disconnected in the nA range. R2 is permanently connected, ie, not switched, to ensure that the input is not left open-circuit.

R8 (10Ω 0.1%) is switched in parallel with R2 in the µA range by S1b which gives a burden voltage of 10µV/µA (1µA x 10Ω). R2 contributes a small error of less than 0.1% in this case. It can be ignored.

R1 (10mΩ 0.5%) is switched in parallel with R2 in the mA range by S1b which gives a (resistor) burden voltage of 10µV/mA (1mA x 10mΩ). Because R1 is such a low value, the solder joints and the copper tracks of the PC board can contribute large errors, so a special purpose-designed "shunt" resistor is used. This is a 4-terminal device that includes the 10mΩ resistor and two "sense" terminals connected directly across the resistor on the substrate. This eliminates any errors caused by solder joint or copper track resistance.

However, because the 10mΩ shunt resistor is such a small value compared with the resistance of the range switch, the switch itself will dominate the actual total burden voltage. The switch contact resistance is rated at 70mΩ maximum, so the actual burden voltage on the mA range will vary from unit to unit and will change with time, but can be taken as a nominal 70µV/mA.

The maximum current in the mA range is a nominal 300mA, as this is the contact rating of the switch. But in practice it can be higher than this.

You will notice that the virtual ground is connected to the sense side of R1. This means that the sense currents for R2 and R8 also flow through this terminal but these currents are negligible and so they have virtually no effect.

The switch contacts of S1a select which shunt resistor voltage gets fed through to op amp IC1.

Power supply

Any current adapter must be able to handle both positive and negative inputs and so a dual-polarity power supply is required. In a battery-powered device, this can be achieved in one of three ways.

The first way is by using two or more series batteries to a middle "0V" tap. This method is convenient but takes more space, there are more batteries to replace and you can get uneven current drain from the batteries, thus making true low-battery detection more difficult.

The second way is by using a single

Specifications

Three current ranges:
(1) ±0-300mA (70µV/mA burden voltage typical)
(2) ±0-1000µA (10µV/uA burden voltage)
(3) ±0-1000nA (10µV/nA burden voltage)

Output Voltage Units: 1mV/mA; 1mV/µA & 1mV/nA

Resolution (nA range): 100pA (3.5-digit meter), 10pA (4.5-digit meter)

Accuracy (typical): <0.2% on µA and nA ranges, <0.5% on mA range

Output Offset Voltage: negligible on 4.5-digit meter

Bandwidth: 2kHz nominal (±0.1dB)

Temperature Drift: insignificant over normal ambient range

Noise: < -90dBV

THD: < -60dB

Battery: CR2032 lithium coin cell

Battery Life: >200 hours (LED OFF); >50 hours (LED ON)

Connection: 4mm banana, screw terminal inputs, standard 19mm spacing

Parts List

1 µCurrent double-sided screen-printed PC board, 79 x 50mm
1 UB5 plastic utility box, 83 x 53 x 28mm
1 CR2032 3V lithium cell
1 1060TR CR2032 SMD battery holder
2 miniature 3-position PC-mount slide switches, C&K JS203011AQN
1 4mm black banana jack
1 4mm red banana jack
1 4mm black binding post
1 4mm red binding post

Semiconductors
1 MAX4239ASA+ SO8 op amp (IC1)
1 LMV321AS5X SOT23-5 op amp (IC2)
1 TPS3809L30DBVR SOT23 voltage monitor (IC3)
1 LTST-C230GKT 1206 reverse green LED

Capacitors
3 100nF 0805 capacitors

Resistors
2 100kΩ 1% 0805
1 75kΩ 0.1% 0805
1 24kΩ 0.1% 0805
1 10kΩ 0.1% 0805
1 1kΩ 0.1% 0805
1 470Ω 1% 0805
3 100Ω 1% 0805
1 10Ω 0.1% 0805
1 LVK12R010DER 10mΩ 0.5% 1206 (current sense)

Where To Buy Kits & Parts

Blank PC boards, kits and fully-built units are available from the author's website at: **www.alternatezone.com/electronics/ucurrent**

battery supply and generating a negative supply using a switched capacitor inverter. This is convenient for low current applications but it generates noise and requires filtering. Also, using a 3V lithium battery means a total power supply voltage from 5.4V to over 6V. But our MAX4239 can only handle a maximum 5.5V supply voltage, so extra diodes would be required.

The third method involves a "virtual ground" split supply circuit and this is the technique used in the µCurrent circuit. In effect, the two 100kΩ resistors comprise a voltage divider and this is buffered by op amp IC2 which is connected as a unity gain voltage follower to provide a low impedance output. However, the output impedance is increased by the series 100Ω resistor which has been included to ensure output stability.

The output from the 100Ω resistor (R10) is now the "virtual ground" reference for the rest of the circuit. This ensures that IC1 has a ±1.5V supply from the battery and the input current shunt resistors can now sense current in either direction.

IC2 is an LMV321 general-purpose, low-power, low-voltage op amp (essentially a low-voltage version of the venerable LM351). The total current drain for this portion of the circuit is about 145µA.

Low battery detection

To ensure that what you read on your multimeter is accurate, it is important to know if the battery voltage is low and thus possibly affecting the measurement. IC3, a Texas Instruments TPS3809L30 Supply Voltage Supervisor, does this job accurately in a single chip. It contains a precision resistor divider, a voltage reference and an output circuit with timer (Fig.3).

If the input voltage on the V_{DD} pin drops below 2.64V then the Reset-bar output will go low. In our application, Reset-bar will be high and thus the BATT LED will be on if the battery voltage is above 2.64V. Conveniently, this is about the "end point" for a 3V lithium coin cell. The discharge diagram for the lithium battery, using a number of different loads, is shown in Fig.4.

By using the same type of 2-pole 3-position switch used for the current range selection, we are able to get a very handy "battery check" mode between the ON and OFF modes, to switch in IC3 to light the LED. You can keep using the µCurrent in this mode with the LED ON if desired but it does use more battery power.

The in-built timer will take about 0.2s to light the LED, so it's possible to move the power switch through the BATT CHECK mode and not have the LED light if you are quick enough.

Output voltage range

The MAX4239 is capable of swinging its output fairly close to the supply rails. Given that the power supply will be at least ±1.35V for a working battery, this means that the output voltage can approach this figure within a few millivolts.

Normally though, the µCurrent will be used with your multimeter's mV range which will be typically up to a maximum of 999.99mV for a 10000-count meter. So there is some headroom left if you want to push it higher for any reason.

Output units

The output units are scaled by the shunt resistors and gain of IC1 to be precisely 1mV per range unit. So the

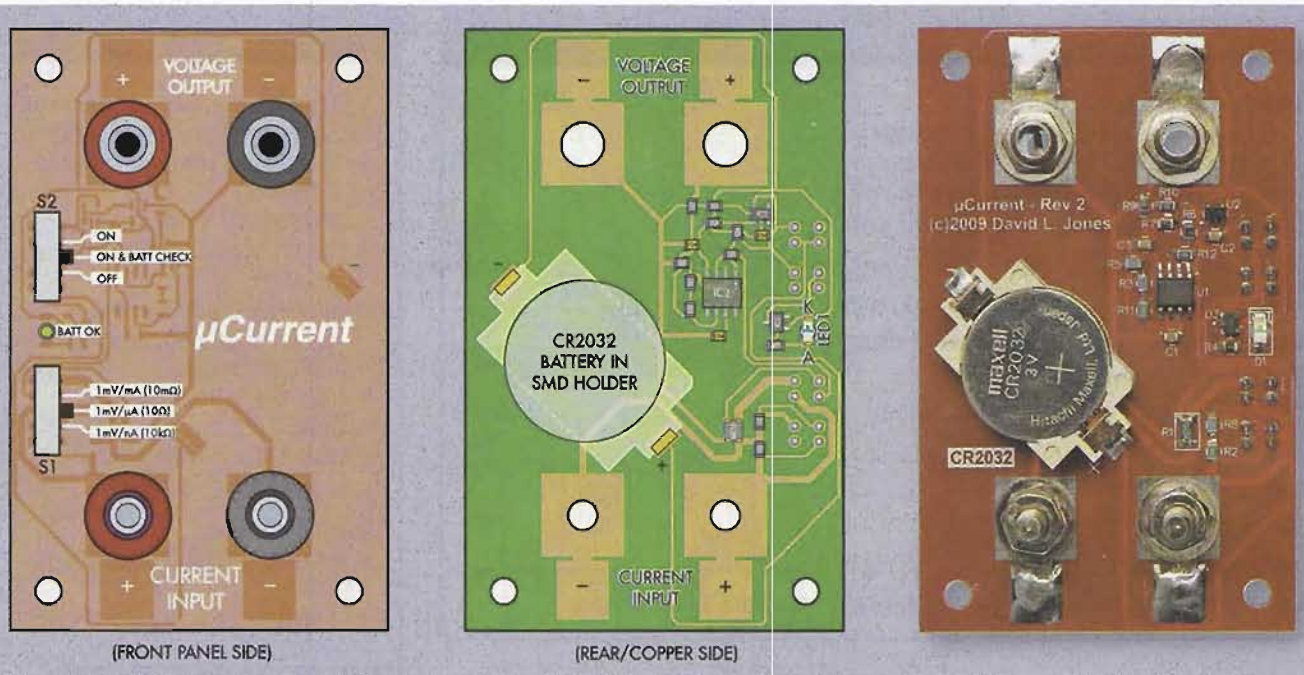


Fig.5: install the parts on the PC board as shown here. You will need a soldering iron with a small chisel-point tip to solder the SMD devices to the board, along with a pair of fine-pointed tweeters and some fine solder.



The top of the PC board forms the front panel and is attached to a UB5-size utility case.

output will be 1mV per mA, 1mV per µA or 1mV per nA.

This makes it easy and logical to directly read on your multimeter's mV range. So if you read 100mV on your meter, that equates to 100mA, 100µA, or 100nA, depending on the range you have selected.

AC performance

The AC performance is shown in the accompanying screen shots (Figs.6 & 7) as measured with an Audio Precision analyser with a 1V output level on the µA range. There is little performance difference between the ranges.

The nominal bandwidth is 2kHz, as the THD starts to increase exponentially after this. This figure is quite sufficient as most meters have a response 1kHz on AC current ranges.

Overloads

Fuses have been omitted from the design to ensure as low a total burden voltage as possible. **Therefore you must be careful to ensure that the input is not connected directly across a supply voltage capable of providing a current that exceeds the selected range. Failure to take care here can result in a blown shunt resistor.**

Connectors

The connectors are standard 4mm banana plugs, with standard 19mm spacing. This allows the use of various types of adapters if required. The screw-terminal type connectors are used for the current input, which is convenient for connecting to existing wiring without test leads. The top screw part can be completely removed to enable some short "shrouded" banana plug test leads to fit.

Construction

Apart from the connectors and miniature slide switches, the entire design uses surface-mount components. This was done in order to give a professional look and to reduce cost and size by using a standard UB5 utility box. The double-sided PC board is used as the lid and front panel of the box. Its red solder mask on the topside provides a very elegant and durable appearance. The shield plane on the top layer is connected to V_{GND}.

All the SMDs are relatively large 0805, SO and SOT packages, so soldering is pretty easy using a basic iron. Refer to the March 2008 issue of SILICON CHIP for a detailed article on how to solder surface-mount components, if you are new to this.

There are a few things that make SMD hand-soldering much easier: a small chisel point tip (not conical), fine multi-core solder (0.56mm or better) and a pair of fine-pointed tweezers.

Start with the three IC packages, making sure each one is mounted with the correct polarity. Follow these with the resistors and capacitors, taking care not to damage the precision resistors with excess heat.

Applying a small amount of solder to one pad first makes it easy to "reflow" the component into place while you solder the other end.

Next, solder in the LED. This is a special "bottom emitter" LED which is effectively soldered in upside down,

with the light coming through a hole in the board. Be sure to match the polarity to the silkscreen.

Next, solder the battery holder into place, ensuring the correct polarity. Apply the iron and then solder to the topside of the flat pin instead of the pad for this part. The solder should then reflow easily to the pad underneath.

Now turn the board over and install the two miniature slide switches, again ensuring correct orientation. If you have the vertical switches, then the side with the metal indent should face to the outside edge of the board. Side mount switches should have the switch lever towards the middle of the board. Ensure that the switches are flush with the board and straight, then tack one pin down first. Check that everything is OK before soldering the rest.

Finally, install the banana connectors. Unscrew them completely first, removing all nuts, washers and solder tags. Install them on the topside with just the plastic spacers touching the topside of the PC board.

Next, put the solder tag on the bottom side and solder it only to the smaller adjacent solder pad, then place the washer and screws on top and tighten. Feel free to add a thread-locker and/or glue if desired.

Testing

Testing is fairly straightforward. You will need a power supply, some suitable resistors and your multimeter.

Insert the battery and switch to BATT CHECK mode. The LED should light within 0.2s. Switch to ON mode and the LED should turn off.

Measure the DC voltage from the negative output connector (V_{GND}) to first one then the other side of the battery in order to check the split supply system. You should get approximately ±1.5V and both values should match closely.

Next, connect the Voltage Output terminal to your multimeter and set the multimeter to its mV DC range. With nothing connected, you should get a reading of zero on all three current ranges.

The next step is to select a resistor for each range to give you a decent current level, eg, around half the meter's full scale. For example, for a 5V supply, use a 47Ω 1W resistor (106mA), a 47kΩ resistor (106µA) and five 10MΩ resistors in series (100nA).

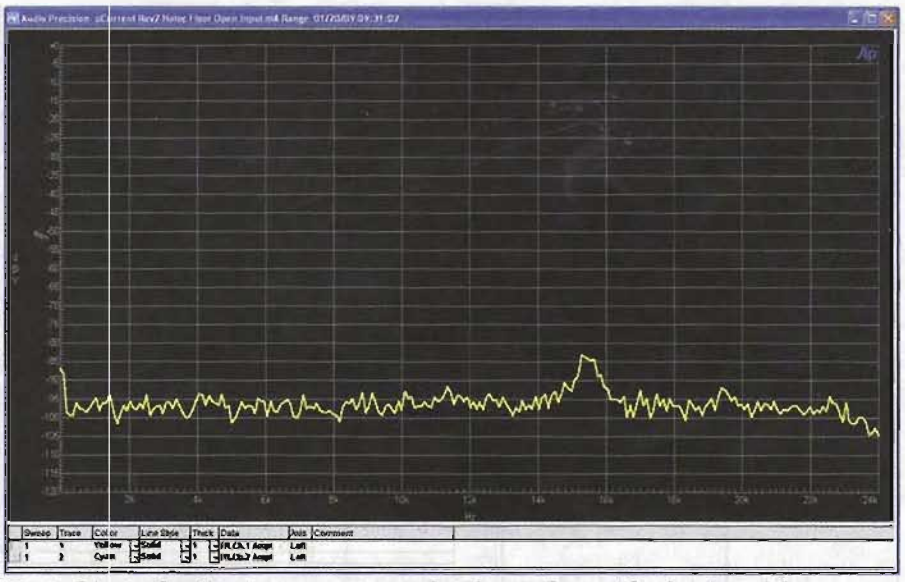


Fig.6: this Audio Precision spectrum plot shows the residual noise of the µCurrent Adaptor circuit.

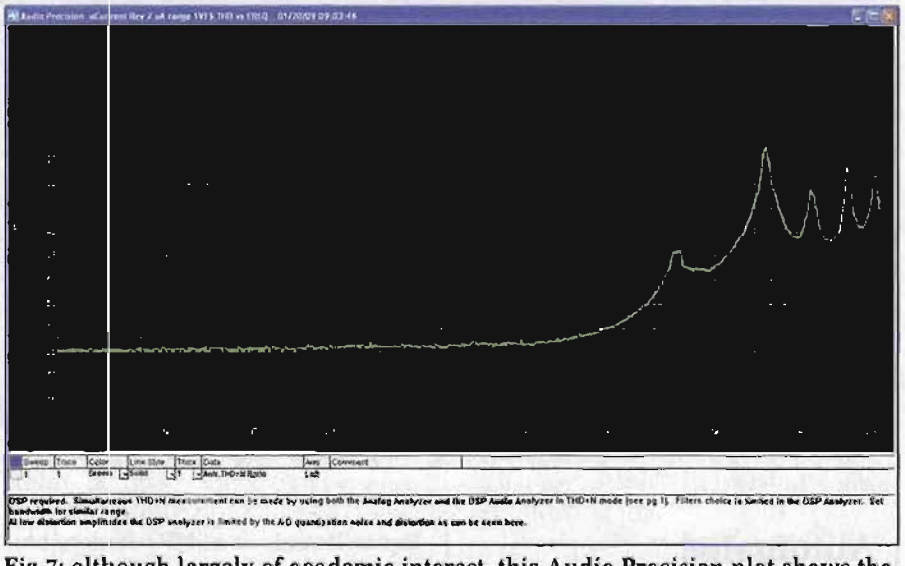


Fig.7: although largely of academic interest, this Audio Precision plot shows the THD vs frequency of the µCurrent Adaptor at a signal level of 1V.

That done, connect the test resistor in series with the supply and the Current Input terminals. Ensure that you have the correct range selected before switching on your supply voltage – you don't want to blow any shunt resistors!

Your meter should read approximately 106mV (mA), 106mV (µA) and 100mV (nA) for the values mentioned. You can double-check your values by measuring the actual resistor values and supply voltage and calculating the current if desired.

If these currents match, then your µCurrent is ready for operation, as the calibration is inherent within the precision 0.1% components used. The output value should not differ between BATT CHECK and ON modes.

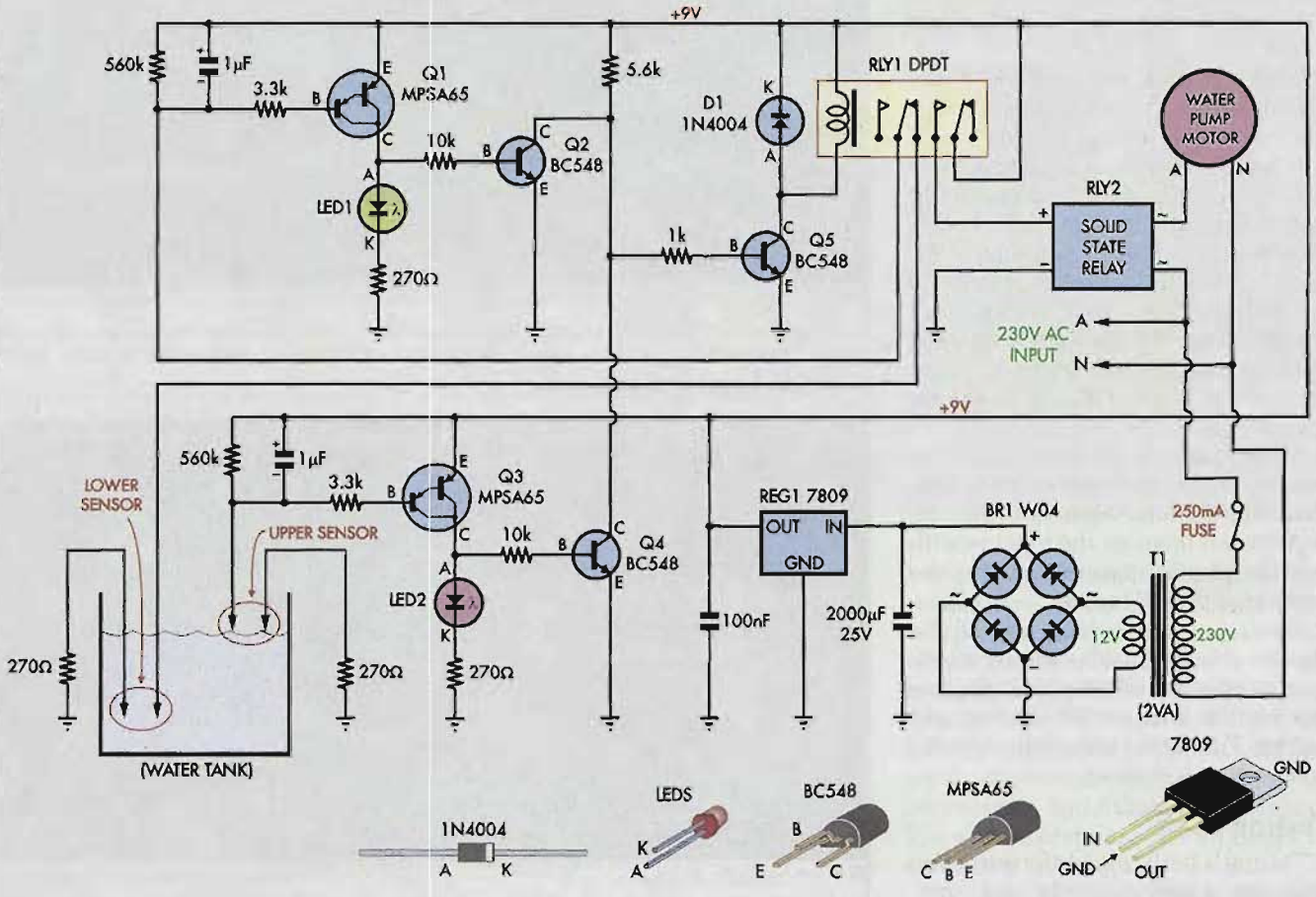
It might be handy to check the battery current also. It should be around 0.7mA with the LED off and around 3mA with the LED on. Don't forget to switch off when you are finished measuring.

The last step simply involves screwing the PC board onto the box. With typical infrequent use, the battery should last many years.

That's all there is to it. You now have a precision current measurement tool ready for those more demanding applications. We hope this article has got you thinking about the impact burden voltage can potentially have on current measurements. SC

CIRCUIT NOTEBOOK

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



Automated water tank filler

This circuit has been very useful in filling a header tank for a reticulated water supply on a farm. Eight troughs are supplied in different paddocks where a lack of water would have serious consequences for the stock.

In the past, the tank had been filled daily by a time clock which was not successful. During hot weather, the stock would empty the tank on a regular basis and then be without water for several hours or the tank would overflow and flood the area if the weather was wet and the cattle did not drink much.

The circuit described has been used to maintain the level of water in the header tank within prescribed limits. It controls a 3HP submersible bore pump which has a high starting current, necessitating a solid-state relay sufficient to take the starting load.

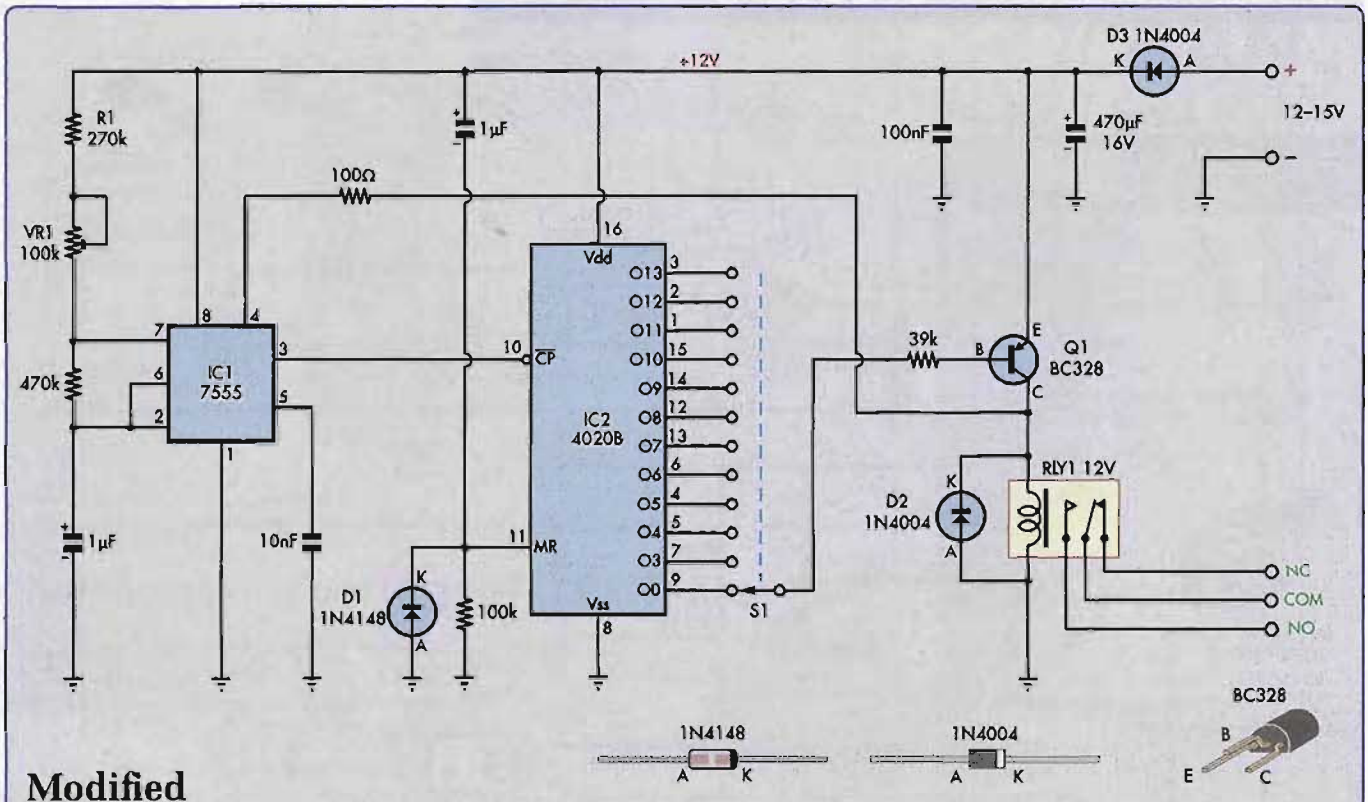
Two Darlington transistors, Q1 & Q3, in conjunction with Q2 & Q4, are connected to the upper and lower water sensors in the tank. Q2 & Q4 have a common 5.6kΩ load resistor and function as a NOR gate. The output of the NOR gate drives Q5 which activates relay RLY1.

Initially, when the water level is low, both sensors will be open-circuit, the NOR gate output will be high and the relay will be turned on. This causes the normally closed (NC) contacts of the relay to open and disconnect the lower sensor. However, the upper sensor will still be open circuit and the NOR gate output will be high, keeping the relay closed. The normally open (NO) contact of the relay will be closed to operate the solid-state relay RLY2 to run the pump.

This state continues until the water reaches the top sensor which will then drop the output from the NOR gate to 0V. The disables relay RLY1 and the pump is stopped.

In practice the upper level sensor is just below the overflow from the tank and the lower sensor about half way up the tank. The sensor contacts are simply two stainless steel screws about 25mm apart and screwed through the poly tank walls. The wiring junctions on the side of the tank are protected by neutral-cure silicone sealant.

Geoff Hitchman,
Cape Bridgewater, Vic. ($45)



Modified Flexitimer

The Flexitimer originally published in the March 1991 issue of "Electronics Australia" is still a very popular timer and is available from Jaycar (Cat. KA-1732). However, it does have the drawback that when the timer is off there is a constant load on the power supply due to the relay. This is undesirable when operating from a battery.

This modified Flexitimer circuit is arranged so that the relay is energised during the timer's on period and is de-energised when the timer period has elapsed.

The original Flexitimer has the relay driven directly from transistor Q1 so that the relay is off initially and is energised and the end of the time period. The relay's closing contacts (normally open) could then be used to connect power in an external circuit or the opening contact (normally closed) could disable an active circuit. The oscillator (IC1) is allowed to run because the relay coil (unenergised) holds the reset input at pin 4 of IC1 at 12V.

The modified circuit shown here operates similarly except that the relay is now connected between the 0V supply rail and the collector of a PNP transistor that has its emitter connected to the +12V rail. This effectively reverses the action of the relay. So when the Flexitimer is timing out, the selected Q output of IC2 will be low (0V) and this low allows current flow from the emitter to the base of Q1, switching it on. The collector of Q1 holds the pin 4 (reset) of IC1 at +12V, allowing the oscillator to run.

At the end of the timing period, the selected Q output of IC2 goes high, switching off Q1 and pulling the reset of IC1 low via the now unenergised relay coil. Diode D2 prevents the voltage at the collector of Q1 from going more than -0.6V when it is turned off, while a 100Ω resistor to IC1's reset input (pin 4) limits current flowing from the input.

The standby power drawn by the circuit is now only due to the current drawn by IC1 and IC2, plus the resistance of R1 and VR1. Preferably IC1 should be a 7555 or LMC555CN (a CMOS 555) to minimise standby current.

John Clarke,
Silicon Chip.

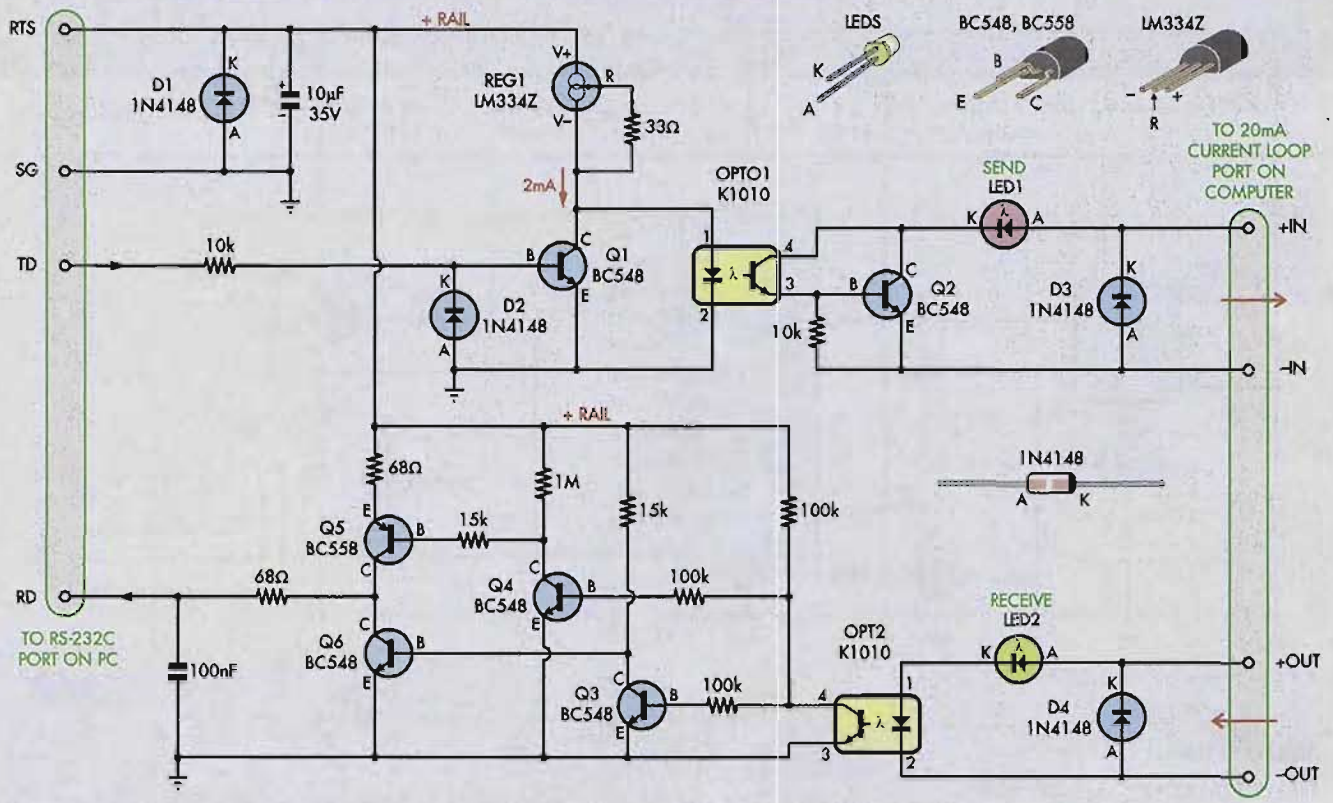
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RS232C to current loop converter

I was recently reunited with my 2650 Mini Computer ("Electronics Australia", May 1978) which was intended to be used with a Teletype ASR33 teleprinter via a 20mA current loop serial interface. The teleprinter provided the 2650 with a keyboard input and a printer output (before the days of CRT video monitors).

Having donated my teleprinter to the local museum, I decided to build an RS232C-to-current-loop converter so that I could use a PC as the terminal. The circuit consists of a send channel fed by TD (Transmit Data) and a receive channel, feeding RD (Receive Data). The optocouplers in each channel electrically isolate the two current loops from each other and isolate the two computers from each other as well.

The current loop side is relatively easy, as the computer supplies all the current for both the send and receive loops. The RS232C side of the converter is powered by the RTS signal line, which is normally high if the terminal emulator is configured for no hardware handshaking. The major design consideration in this circuit is that RS232C signals are relatively high impedance, so not much current is available from RTS. In addition, the maximum voltage on RTS may be anywhere between +5V and +25V.

To overcome this variability, the send optocoupler LED is driven by an LM334Z constant current source with a 33Ω bias resistor to set the current to 2mA. The LM334Z has a dropout voltage of only about 1V, leaving sufficient voltage to drive the optocoupler's LED even if the RTS signal only swings to +5V.

In RS232C, logic 0 is a positive voltage while a logic 0 in the current loop is represented by no current flowing. This inversion is implemented by using Q1 to shunt the send optocoupler LED (OPTO2) when the TD signal is high (logic 0).

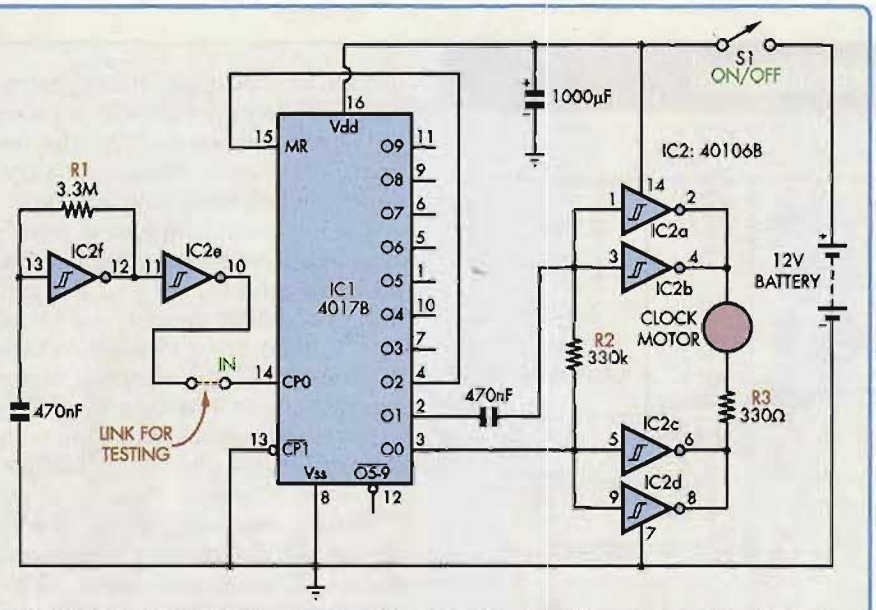
The constant current source ensures that the same current is drawn from RTS regardless of whether the send optocoupler LED is on or off, thereby preventing the send channel of the circuit from influencing the RTS voltage available for the receive channel of the circuit. It also makes the send circuit immune to the variations in the voltage available from the RTS line due to the different currents drawn by the receive circuit for 0 and 1 signals.

The circuit feeding the RD line uses transistors Q3-Q6 in a push-pull output stage designed to present an impedance to RD as close as possible to the impedance of RTS, while at the same time drawing minimal current from RTS.

Since there is a brief period during signal transitions when both output transistors will be on, a low pass filter (68Ω & 100nF) is included to prevent any transients from reaching the RD line. The 68Ω emitter load resistor for Q5, together with the 10µF capacitor between RTS and ground, minimises the impact of switching transients on the positive supply.

Diode D1 acts as a crowbar to prevent negative voltages being applied to the RS232C side of the interface in case RTS goes negative.

The optocouplers used are Cosmo K1010. Most other types of optocoupler will work in the receive channel but the send channel has a relatively low input current so a type with a current transfer ratio (CTR) greater than around 50% is recommended; the 4N3x family should work but the 4N2x family may not.



Simple counter uses crystal clock as a readout

This circuit uses a cheap quartz clock as the counter display. The circuit will count to 43,200 (60 seconds × 60 minutes × 12 hours). With this capacity, it would be capable of counting total attendance at most major public events.

In fact, the total count may be increased to nearly 200,000, with a small loss of accuracy (this is explained later).

IC1, a 4017 decade counter, continually cycles through its Q0 & Q1 outputs so that these reverse every time that a clock pulse is fed to pin 14. The paralleled inverters of IC2 buffer these complementary pulses. IC2c & IC2d are driven directly by pin 3 of IC1, while IC2a & IC2b are driven via a 470nF capacitor. This is combined with a 330Ω resistor R2 to form a differentiating network.

The resultant waveform across the clock coil is an alternating pulse waveform with a peak value of 4V, ie, the pulses are +4V, -4V and so on. The 330Ω resistor (R3)limits the coil current.

IC2f is an oscillator buffered by IC2e. This provides a pulse source for testing clock operation. It could also provide a "fast clock" function of the circuit.

The count may be multiplied by moving the connection at pin 4 (Q2) of IC1 to another output. If it is moved, for example, to pin 10 (Q4), the circuit will count to 86,400, with a 50% chance that a single count will be dropped (the final count on the clock face, in this case, needs to be multiplied by two).

T. Scarborough is this month's winner of a Peak Atlas Test Instrument

If the connection to pin 4 is moved to pin 11 (Q9), the circuit will count to 194,400, with a proportionate loss of accuracy (multiply by 4.5).

The signal applied to the clock input (pin14 of IC1) must not exceed Vdd (positive) or be less than Vss (0V). In addition, filtering may be required for a turnstile counter switch to eliminate contact bounce. Use a 1kΩ pullup resistor between pins 14 & 16 of IC1 if a switch is used to activate the counter. A 100µF electrolytic capacitor can be connected across the switch for contact debouncing.

Rev Thomas Scarborough,
Fresnaye, Capetown,
South Africa.

The circuit does not generate negative voltages on RD, so it is not entirely RS232C-compliant but most modern computer serial ports will interpret voltages below +3V on RD as logic 1. By the same token, the circuit interprets any voltage below 0.6V on TD as a logic 1, so it will cope with RS232C ports that are non-compliant in the same way.

Andrew Partridge,
Toowoomba, Qld. ($60)

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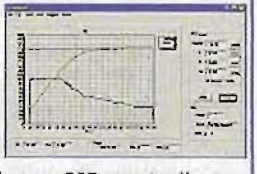
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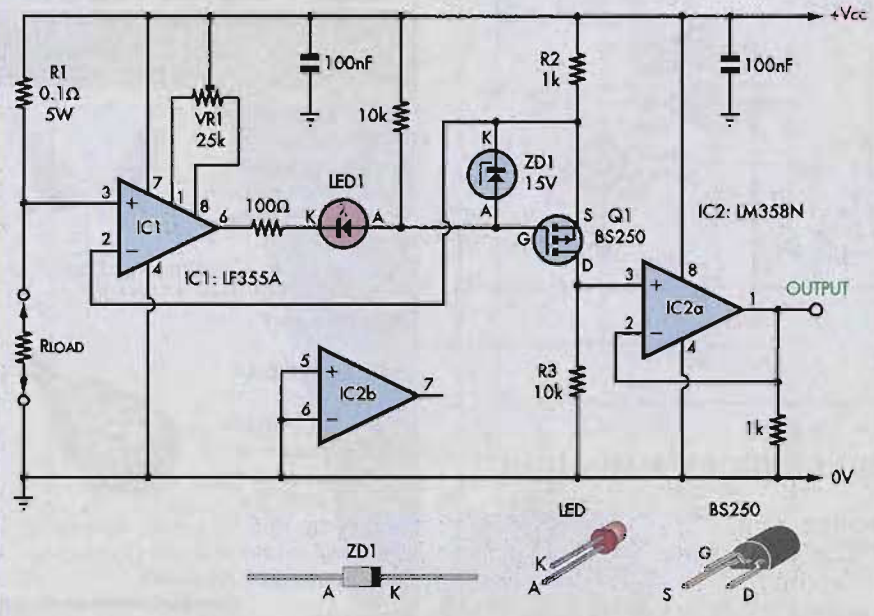
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High side current monitor

This circuit is designed to allow a microcontroller with an ADC (analog-to-digital converter) to sense current flow, although it could be useful in other applications, including analog circuits.

The most common method involves passing the current through a shunt (resistor) and measuring the voltage drop across it. This resistor can be either on the high side (V_{CC}) or the low side (ground) of the load. Sometimes a high-side monitor is desirable to avoid causing a shift in ground potential as seen by the load. The challenge in this case is that the voltage developed is relative to the positive power supply but that ADCs are usually ground-referenced.

Low-side sensing is simpler but high-side sensing only requires a few extra components. The LF355A op amp is used in this circuit because it can sense all the way up to its positive supply voltage and because JFET inputs result in less error due to input leakage current. The LF355A data sheet contains a similar circuit that uses a JFET and fewer components but a Mosfet should be superior due to a lower gate leakage.

It works as follows: op amp IC1 drives the gate of P-channel Mosfet Q1 via a 100Ω resistor and LED1. The 100Ω resistor is required because Q1 has substantial gate capacitance and the circuit might be unstable without it. If using a larger Mosfet with more gate capacitance, you might need to increase the value of the resistor and the associated 10kΩ resistor in proportion. Virtually any P-channel Mosfet with an on-threshold above 4V is suitable.

LED1 is necessary because the on-threshold of Q1 may be so small that IC1 can't pull its gate sufficiently close to V_{CC} to turn it off. You may need to experiment a little to determine whether a red, yellow or green LED best matches your Mosfet, as the LED forward voltage can vary, depending on the colour and type.

The key point is that most standard LEDs have a forward voltage in the range of 1.8-2.5V and IC1 can drive its output to within 2-3V of V_{CC}. If LED1 has a forward voltage of around 2V, this means IC1 can drive Q1's gate to within 1V of V_{CC} in the worst case and this is enough to turn off just about any discrete P-channel Mosfet.

To adjust the amplification, change the ratio of the Mosfet's source and drain resistors (1kΩ & 10kΩ). Make sure that the 0.1Ω shunt resistor can handle the heat that will be generated at the maximum load current.

Op amp IC2a is connected as unity gain voltage follower to buffer the Mosfet's output so that the input bias current of the ADC can't affect the result. The output of IC2a then drives the ADC or other circuitry.

The circuit should operate starting at around 8V. This limitation is primarily due to IC1. If operating close to this limit, ensure Q1 has a low on-threshold. The circuit as shown can operate up to a V_{CC} of 36V, beyond which IC1 and IC2 could be damaged.

The major sources of inaccuracy will be the matching of resistors R1, R2 and R3 (use 1% resistors or better) and the offset voltage and bias currents of IC1 and IC2. IC1 has provision for the connection of a trimpot (R7) to cancel out its offset voltage. Adjust R7 to get the output as close to 0 as possible with no load. You can compensate for amplification errors with a scale factor in the microcontroller if necessary.

Editor's note: the LF355A in this circuit only has a typical specification for the input common mode voltage range that is 0.1V above the positive supply.

The minimum specification input common mode voltage range is ±11V for a ±15V supply. You may need to select a particular LF355A that works in the circuit. 0.1% resistors are required for R1, R2 and R3 for 60dB accuracy.

Nicholas Vinen,
Randwick, NSW. ($40)



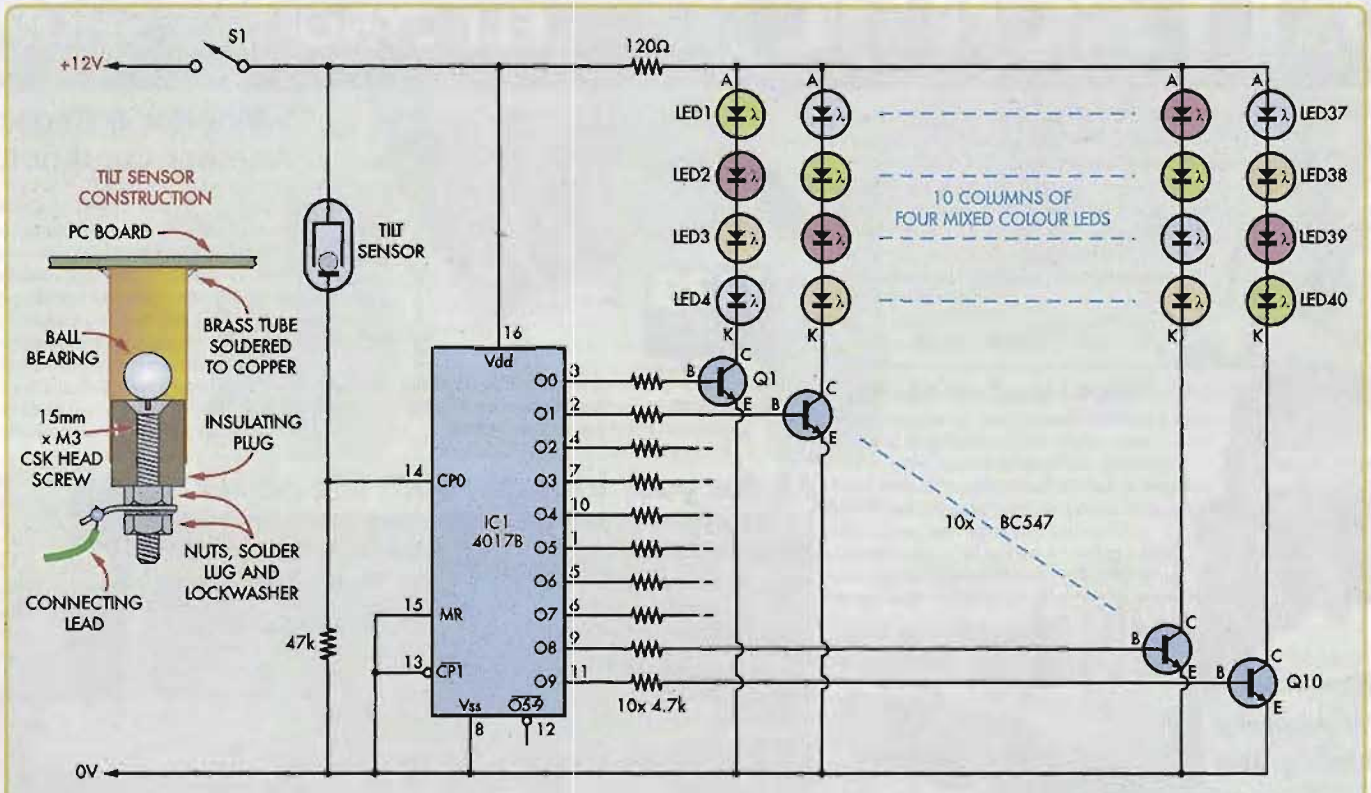
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Electronic kaleidoscope

This toy was made to suit young children. A mixture of 40 red, green and yellow 3mm LEDs is set in an 8 x 5 grid, at 0.6-inch spacing (to suit Veroboard), in the top of an instrument style case, measuring about 190 x 135 x 45mm.

The LEDs are driven in mixed groups of four by the 10 outputs of a 4017 decade counter. The LEDs are wired in random fashion, with one group of four making a close cluster, another zigzagging across the space and so on.

The 4017 counter is clocked by a tilt sensor. This comprises a ball bearing loose in a vertical brass tube 8mm diameter and about 20mm long. The top end of the tube is soldered to the Veroboard, to provide one contact. At the lower end is an insulating plug through which passes a countersunk head screw. This is the second contact.

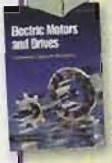
As the toy is tilted, the ball rolls about and bridges the screw and the brass tube so it is subject to lots of contact bounce which provides lots of random clocking for the counter. Although only four LEDs are lit at any time, it generally looks as if nearly all are lit, due to persistence of vision.

The tilt sensor hangs down from the inside of the top of the box. For children who can't hold the box to rock it, one rubber foot is fitted in the centre of the bottom. Then as the box rests on a table it can be easily rocked to and fro, making the LEDs flash – a merry garden of lights.

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

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By MAURO GRASSI

Tektronix MSO2024 Mixed Signal Oscilloscope

A 200MHz, 1GS/s 4/16-channel mixed-signal oscilloscope

The Tektronix MS2024 is a compact mixed-signal oscilloscope that is suitable for a wide range of applications or educational use. It has four analog and 16 digital inputs, a sampling rate of 1Gs/s and an operating bandwidth up to 200MHz. It is very easy to use and does not take up a lot of valuable bench space.

THE 4-CHANNEL MSO2024 is the top of the Tek2000 range. Its ability to accept up to 16 digital inputs for debugging of logic applications makes it particularly attractive, especially since it is such a compact unit. The operating bandwidth of this model is 200MHz and this will be more than adequate for most applications, including audio, video and general assorted use.

The high sampling rate 1GS/s (Gigasamples per second), allows a timebase speed of up to 2ns/div. And although some oscilloscopes share the sampling rate among the available channels, the MSO2024 achieves 1GS/s on all four channels at all times.

When you first pick up this scope, it gives two impressions. First, it is quite wide but not very deep at 140mm and therefore it won't take up a lot of bench space which tends to be at a premium in most labs and workshops. The second impression is the wide aspect ratio screen. The display is a 7-inch WQVGA (Wide Quarter VGA). A wide QVGA screen must have the same vertical resolution as a QVGA screen but its aspect ratio will be different to the standard 4:3.

In this case, the display has a resolution of 480 x 234 pixels giving an aspect ratio close to 2:1. This allows you to get a good display showing several cycles of typical signals, something that's not possible on a screen of lesser width. The LCD also has a simulated phosphor response, meaning the intensity of the pixels varies according to the time they are on.

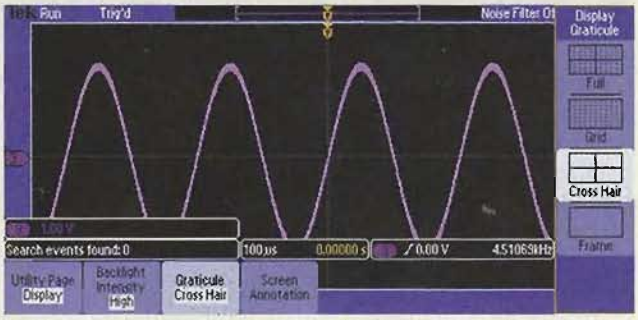


Fig.1: a screen grab showing a typical menu. You can see what the soft buttons running vertically down the side of the screen do as their function is clearly indicated adjacent to them on the screen. This sub menu gives the options for displaying the background grid. The intensity of the grid can also be changed using one of the general-purpose knobs. The other knob then lets you change the intensity of the traces on the screen.

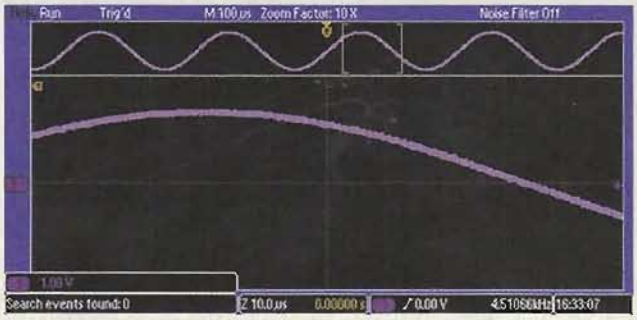


Fig.2: this shot shows the Wave Inspector feature applied to a sinewave. You can see that the display has been split and the top window shows you the entire recorded wave train. The bigger, bottom window then shows the zoomed-in part bracketed out in the top window. In each case, you can pan across the record and zoom in on it using two concentric knobs. The pan knob has a jogging action.

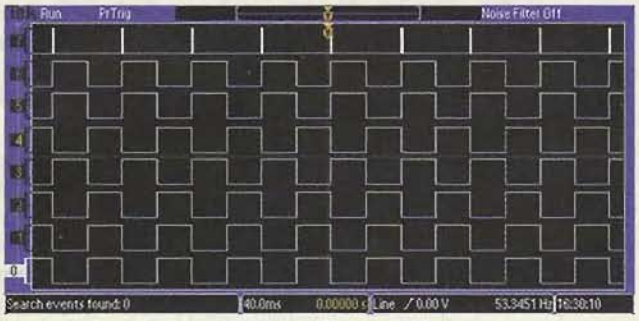


Fig.3: this is not just a DSO (Digital Storage Oscilloscope), it's actually an MSO (a Mixed Signal Oscilloscope) as this screen demonstrates. In this shot, eight digital channels are recording the activity on the driving pins of a static LCD display. The square driving signals on the segments can be seen (some are in phase and some are out of phase with the backplane drive). You can select three different sizes for the digital traces and even move them around.

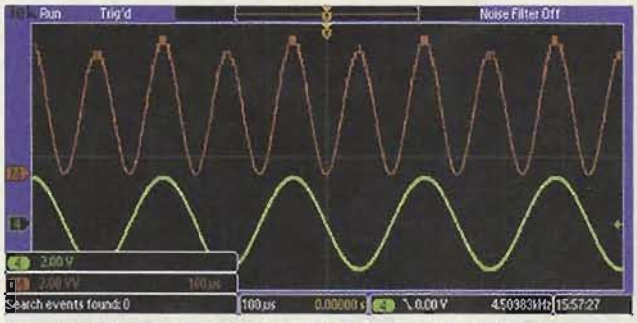


Fig.4: a sinewave (green trace) at around 4.5kHz is shown while above it is the result of the MATHs function (red trace) which shows the square of the sinewave. The MATHs trace is computed in real time but we found the response of the oscilloscope was sluggish with the record length set to 1Mpts. We therefore changed it to 125kpts to speed up the response, especially of the MATHs trace rendering. You can also perform the FFT using the MATHs features.

Apart from that, you can vary the persistence of the dots for periods ranging from 400ms up to around 10 seconds and then to infinite persistence. This would be useful to see fine or quickly changing details of the waveform.

User interface

The oscilloscope has dedicated vertical sensitivity and offset knobs for each of the four analog channels. This makes it considerably easier to use than if the controls were "doubled" up. Below the sensitivity knobs are the four associated BNC sockets which are probe sensing as well as being able to work with active probes. However, the four 10:1 probes supplied with the scope do not have the plugs to enable auto sensing.

To explain further, with probe-sensing inputs, the scope automatically changes the vertical sensitivity displayed on the screen. So if you select a sensitivity of 1V/div and then plug in a 10:1 probe, the displayed sensitivity will take the probe attenuation into account and change to 10V/div.

There is an extra BNC connector for the auxiliary trigger input and a rectangular connector for the 16 digital channels. Around the screen itself is an array of "soft buttons" whose function changes according to the displayed menus. These are easy to use because their functions are indicated next to or above them on the screen, according to which menu you are in. A screen grab of a typical menu is shown in Fig.1.

There are two general-purpose knobs with digital clicking action referred to as "a" and "b". According to which menu you are in, you use these to vary settings. Again, their function is clearly indicated on the display.

The other knobs relate to (1) the trigger level (pushing this knob sets the trigger to 50%), (2) the timebase and (3) the pan and zoom controls. The latter are two concentric knobs. The larger of the two has a jogging action, allowing you to pan the waveform, while the smaller one allows you to zoom in on the waveform by as much as 10,000 times!

Replay & review waveforms

The pan and zoom features are part of the so-called "Wave Inspector" module. A small window appears in the

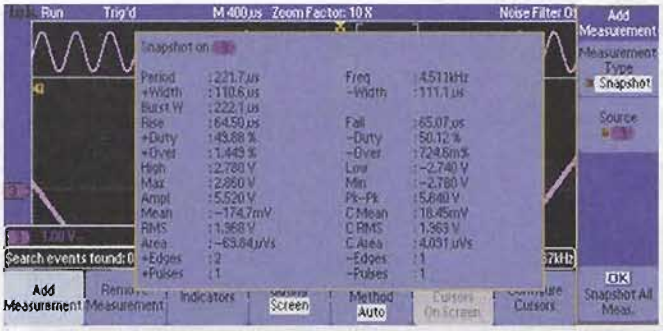


Fig.5: the list of possible measurements is extensive. One of the nicer features is that you can take a snapshot of all the measurements at the touch of a button. This shot shows the result of applying the snapshot to a sinewave and we can see that the frequency is around 4.5kHz, the DC offset is around -175mV and the RMS amplitude is close to 2V. Remember that some of these measurements are "equivalent"; for example, frequency is the reciprocal of period.

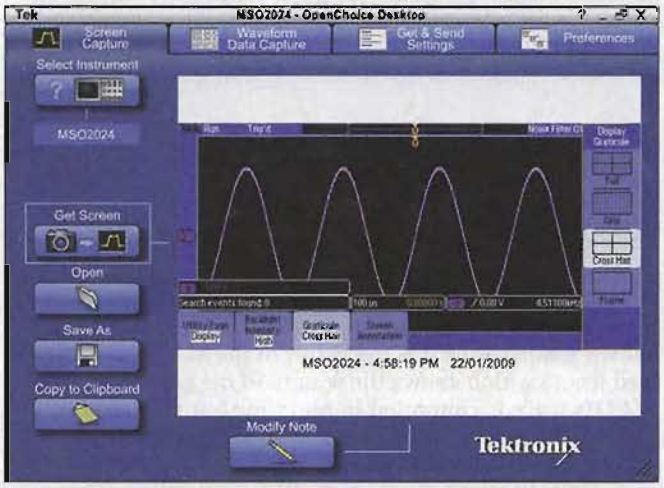


Fig.6: a screen grab of the OpenChoice PC software. This shows a screen grab on the PC, as captured from the oscilloscope. The PC is connected to the oscilloscope via a USB cable, using the USB device port on the back of the MSO2024.

top of the screen showing the entire captured wavetrain. You can then use the pan control knob to move forwards or backwards in time from the trigger point. But you can do even more than that. You can mark points in the record and move between them at the touch of a button, and even search the record.

The criterion for a search match is similar to the trigger options. You can, for example, search for a rising edge, a particular positive pulse width and so on. The difference is that it is applied to the captured wavetrain rather than the real-time signal. There is one further advantage: once the wave train has been captured, you can experiment with different searches!

You may then mark the relevant points where the search found the trigger and go back to it or scroll back and forth between saved markers. A screen grab showing the Wave Inspector is shown in Fig.2.

Capturing fast glitches

This oscilloscope has another feature by the odd name of "FilterVu". This allows you to capture glitches in your signal while still filtering out unwanted noise. The way it works is that two waveforms are displayed superimposed. One is a filtered waveform (with reduced noise components) while the other captures any glitches.

This is similar to the "peak-detect" feature in some other oscilloscopes and can help in seeing fast glitches in a signal that may be the difference between reliable operation of a circuit and intermittent failures.

Trigger options

Triggering is an integral part of the operation of any oscilloscope, as in normal acquisition mode, the oscilloscope will only display a waveform once the trigger condition is met. Choosing the appropriate trigger can mean the difference between capturing detail relevant to you or not. So how does the MSO2024 measure up in terms of triggering options?

As commonly found in current oscilloscopes, the trigger can be AC or DC-coupled or low or high-pass filtered to reduce spurious noise. You can select a hold-off period from the last trigger point during which the triggering is effectively disarmed. The hold-off prevents spurious triggering due to level transitions and other artefacts in the signal.

The standard triggering modes of the MSO2024 include the usual edge and pulse-width triggering modes as well as standard video triggering (NTSC, PAL, SECAM). Runt triggering allows you trigger when a signal rises above a preset threshold voltage but fails to clear the voltage threshold subsequently. For edge triggering, you can select a rising or falling level and select the threshold voltage. For pulse width triggering, you can choose the polarity of the pulse (positive or negative), its minimum amplitude and width.

Since this is a mixed-signal oscilloscope, you can also trigger on the logic conditions from one or more of the 16 digital channels. For example, you can choose to trigger when one digital input is high while another is low.

Digital inputs

We should mention that the 16 digital channels are synchronised to the analog waveforms. You can also select the voltage threshold for the digital channels. For example, you can define a high level to be anything above 2.5V and a low level to be below that.

The digital threshold voltage can be set arbitrarily or chosen from a list of known logic families like TTL or 3.3V CMOS. The MSO2024 comes with an adaptor that plugs into the front of the oscilloscope to connect the 16 digital inputs and they can easily be attached to the leads of most ICs. The screen grab of Fig.3 shows some digital waveforms on the screen.

Optional modules

You can purchase additional modules to enhance the features of the oscilloscope. For example, there are modules to decode serial protocols like I^2C, RS232/485, LIN, CAN and SPI, as well as HD TV formats. The serial protocols will be especially useful for debugging embedded systems, as these typically use a number of serial protocols.

The MSO2024 also includes, for the serial protocols, an event table. This is a log of the relevant decoded data in

Specifications At A Glance

Analog channels:	4
Digital channels:	16
Analog Bandwidth:	DC to 200MHz
Sampling Rate:	1GS/s
Memory Depth:	1Mpts
Vertical Sensitivity:	2mV/div – 5V/div (x1 probe)
Vertical Resolution:	8 bits
LCD display:	7-inch widescreen QVGA LCD (480 x 234 pixels)
Net Weight:	4.08kg

chronological order. The optional modules come as small "cards" that plug into ports on the front panel.

Note that for the modules not installed in your oscilloscope, there is a 30-day free trial, activated when you first use it.

Making measurements

All the usual measurements you would expect can be made, like RMS, frequency and peak-to-peak voltage. In fact, the range of measurements is quite comprehensive, including rise and fall times, burst width, cycle RMS and mean, overshoot, etc.

One nice feature is that you can take a "snapshot" of the waveform in which case all measurements are applied to it. This gives you a very easy way of taking the vital statistics of a waveform and is shown in Fig.5.

MATHs features

The MATHs features of this oscilloscope allow you to add, subtract and multiply two waveforms and display the result as a separate (red) trace. You can also perform the FFT (Fast Fourier Transform) on an input channel, which effectively separates the signal into its frequency components.

In Fig.4 we show the result of using the MATHs function to compute, in real time, the square of a sinewave. Maths waveforms can be created from real-time channel data or from previously stored reference waveforms: there are two of these and they are stored in non-volatile memory.

The oscilloscope's response is slow at times. We found it especially slow when displaying the MATH trace with the full 1Mpts record length but this improved once we lowered the record length to 125kpts.

By the way, updating the firmware is quite easy. You simply download the file from the Tektronix website, copy it to a USB flash drive and insert the drive into the oscilloscope's host USB port on the front panel. The oscilloscope then recognises the files and starts the update process.

USB ports & software

The MSO2024 has a USB host port on the front panel for connecting a USB flash drive. You can then use the supplied software to save screen grabs and oscilloscope settings (you may subsequently restore the settings).

There is also a USB device port on the back of the oscilloscope. This allows you to connect it to a PC and by using the supplied data logging software, NI LabView's SignalExpress, you can remotely control the oscilloscope and acquire screen grabs directly. Remember that the LAN port is not standard, though.

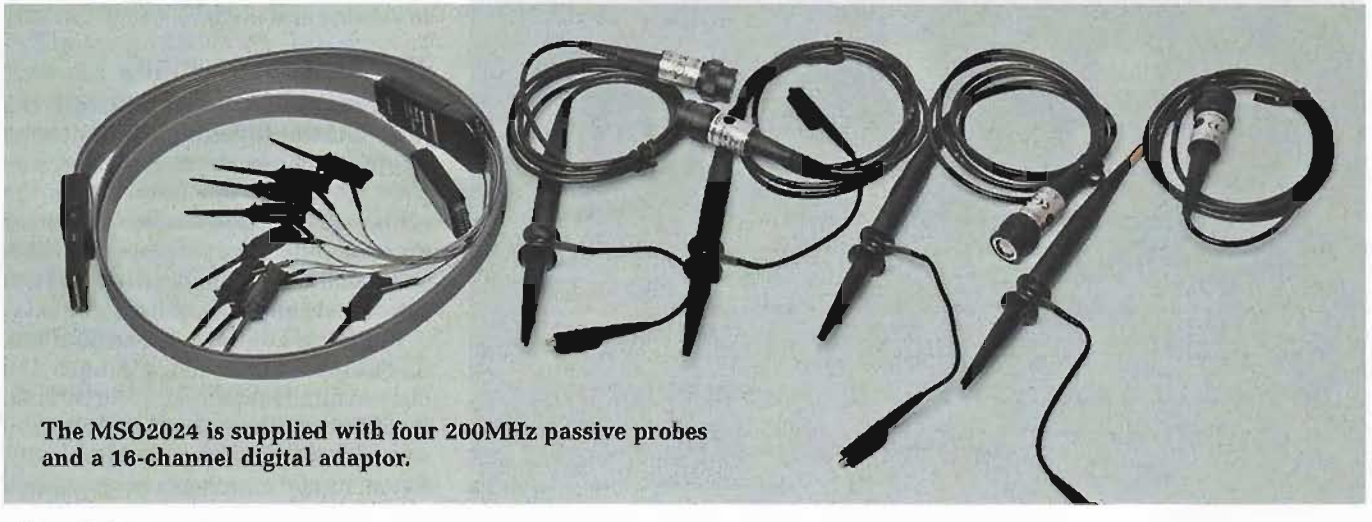
Available options are Ethernet and GPIB ports, as well as a module that plugs in at the back of the oscilloscope and provides VGA and LAN connections.

Conclusion

The MSO2024 is an affordable scope with many features found in more expensive models. In particular, the measurement options are comprehensive, the Wave Inspector that allows you to pan and zoom the stored waveform is the same as used on higher end models.

The firmware is among the best we have seen. The menus are intuitive to use and the logic of the interface is easy to learn. The ability to make automatic and custom measurements and to search, zoom in on and play back waveforms makes this oscilloscope a desirable debugging tool.

The MSO2024 is supplied with four 200MHz passive probes, a 16-channel digital adaptor, manuals NI LabView SignalExpress and Open Choice PC software and a 3-year warranty.The price is $A9760.00 (ex. GST). The VGA and LAN interface is priced at $A749.00 (ex. GST). It can be purchased from Tekmark Australia, Suite 302, 18 Orion Rd, Lane Cove, NSW 2066. Phone: (02) 9911 3888 or visit: **www.tekmark.net.au** **SC**



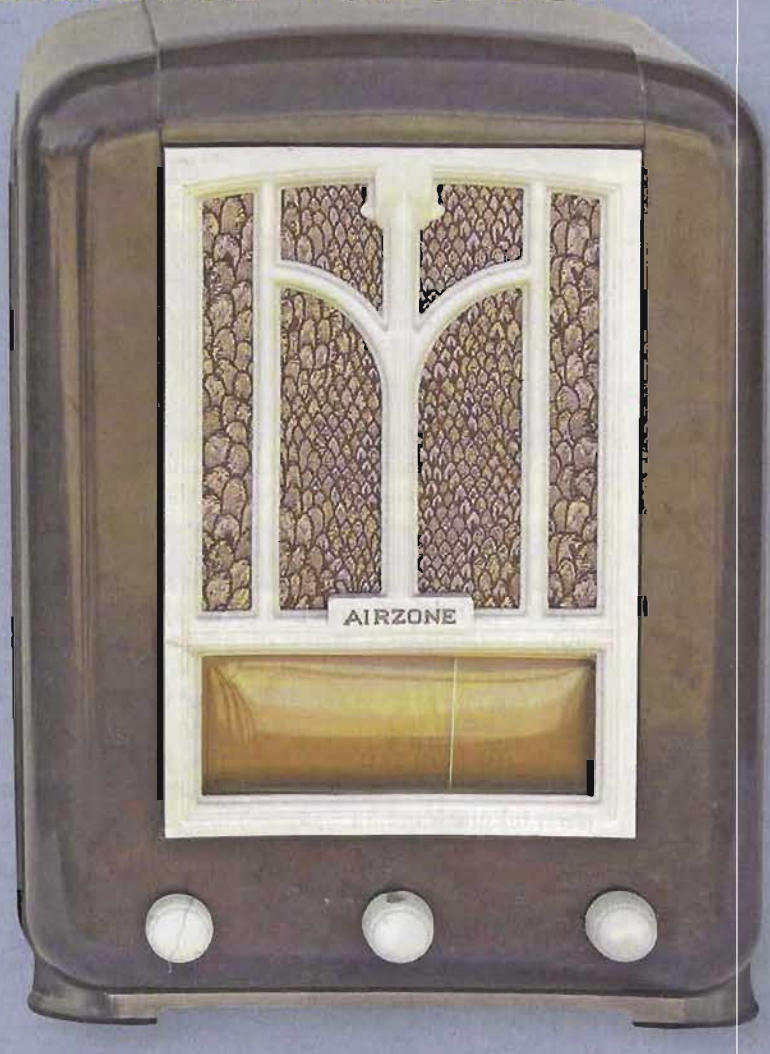
The MSO2024 is supplied with four 200MHz passive probes and a 16-channel digital adaptor.

Vintage Radio



By RODNEY CHAMPNESS, VK3UG

The Airzone 520/550 5-valve mantel receiver



Manufactured in the mid-1930s, the Airzone 520/550 is an early 5-valve superhet that was capable of good performance. It was housed in a distinctive bakelite cabinet and is usually easy to restore to working order.

BY THE MID-1930s, many manufacturers were building well-designed superheterodyne receivers. This was made possible by the development of new components. In particular, valves specifically designed for the task of frequency conversion had become common and these considerably improved the circuitry around the converter/mixer stages.

Airzone, like many other manufacturers, was quick to embrace this step forward in valve design, as they made it easy to design receivers with greatly improved performance. Airzone was established in Sydney in 1931 and quickly established itself as a manufacturer of good-quality domestic receivers.

The company's 520/550 5-valve superhet receiver was released in the mid 1930s and built on that well-earned reputation. It is a well-made set with distinctive styling and is easy to service and align.

The Airzone 520/550

Airzone's method of identifying their sets was different from that used by other manufacturers. Basically, they gave the chassis one number and the cabinet that housed it another number and combined the two together. This enabled them to quickly identify both the chassis and the cabinet.

In the case of the Airzone 520/550, the number indicated a model 520 chassis fitted into a model 550 cabinet. By contrast, other manufacturers gave sets with slight cabinet variations different model numbers, even though

"Airzone" A.C. Operated Broadcast Mantel Model 550

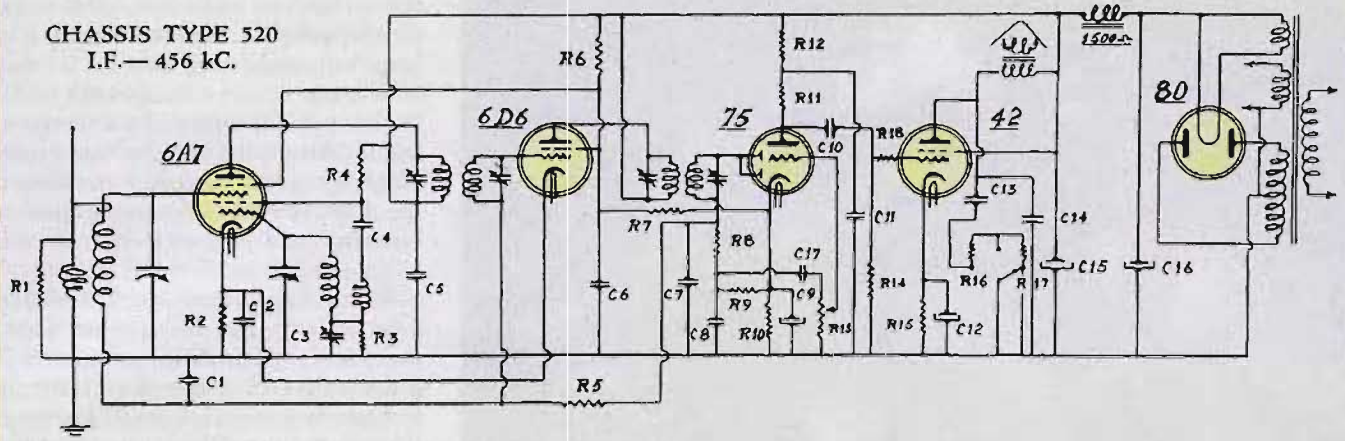


Fig.1: the Airzone Model 520/550 is a typical 5-valve superhet from the mid-1930s. The 6A7 functions as a frequency converter and is followed by a 6D6 IF amplifier, a 75 detector/audio preamplifier and a 42 audio output stage.

they used the same chassis. This meant that a string of sets with different model numbers could, in fact, be electrically identical.

As shown in the photos, an attractive, tall, brown bakelite cabinet was used to house the Airzone 520/550. This featured an ivory-coloured escutcheon around the dial and speaker cloth. However, the speaker cloth in this particular receiver looks as though it has been replaced so I cannot be sure what the original looked like.

The controls along the lower edge of the cabinet are white bakelite and from left to right they are for volume, tuning and tone. As was typical of the mid to late 1930s, the power was switched on and off at the wall socket.

For a mantel receiver, the 520/550 is quite tall and would also have needed quite a wide mantelpiece to safely support it. In fact, it could have just as easily been called a "table" set rather than a "mantel" set.

The layout inside the set is straightforward, with the chassis sitting on the bottom of the cabinet. However, as shown in the photos, the speaker, speaker transformer and filter capacitors are all fitted to an elevated bracket assembly that's attached to the chassis, with the parts sitting just behind the loudspeaker. As a result, the set cannot be rested upside down for service and instead must be laid on its side.

A look at the circuit

The circuit of the 520 chassis is typical of better designs from the pre-octal valve and pre iron-dust core era. It is purely a broadcast-band receiver, which simplifies any work needed underneath the chassis. Fig.1 shows the circuit details.

The antenna input circuit is typical of the era, with some top coupling between the antenna and the tuned winding. However, resonating the primary winding to a frequency below the broadcast band was not a feature of this set, nor was it used in sets from other manufacturers at that time. Resistor R1 is there to even the response across the broadcast band.

The first valve in the line-up is a 6A7. This is the frequency converter and it converts the incoming broadcast signal to several frequencies, one of which is the 456kHz intermediate frequency (IF). This is fed to an IF amplifier stage based on a 6D6.

The oscillator tuning circuit in the converter stage is a little different to most others, as there is no high tension (HT) voltage on the feedback winding. Note that this circuit uses variable padder C3 to adjust the low-frequency end of the tuning instead of the iron-dust or ferrite cores used in later sets.

The IF transformers are air-cored and the IF stage is aligned to 456kHz using the trimmers across the transformer windings. The IF signal is amplified by the 6D6 and passed through a second IF transformer to the detector and AGC diodes in a 75 valve.

Simple AGC is used so that even with just noise being received, a small, negative amount of AGC control voltage is developed across resistors R8 & R9. In particular, the top of R8 is always negative with respect to the bottom of R9 which connects to the cathode of the 75.

Note that the DC return for the detector and AGC diodes goes to the cathode of the 75. When there is no input signal, this means that the AGC line will be positive due to the voltage drop across R10, which is around 1.3V.

Normally, this would be an indication of either a design fault or a component failure. However, that's not the case here because both the 6A7 and 6D6 have cathode bias, with the valve cathodes resting at around +3V with reference to the chassis. This results in a bias of -1.7V between the signal grids and the cathodes of these two stages.

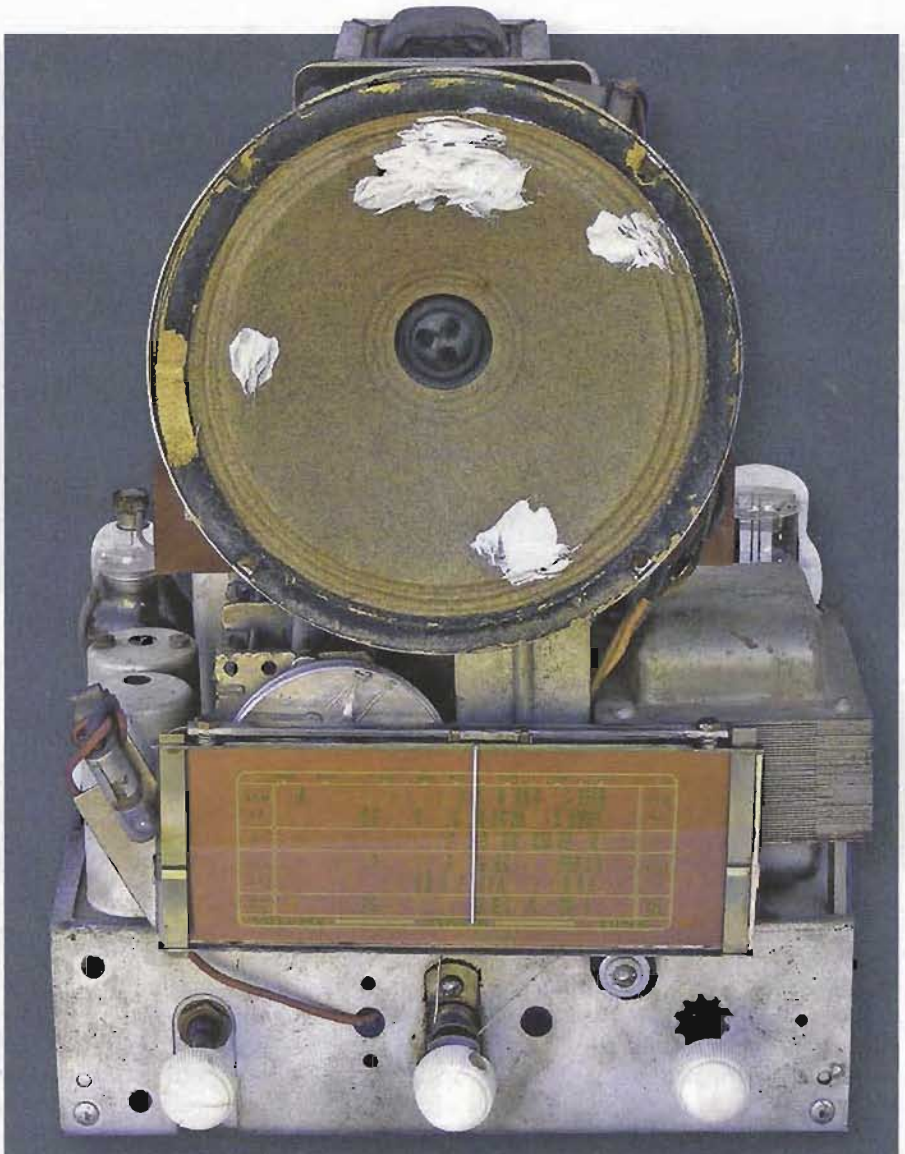
When a strong signal is received, the positive voltage on the AGC line quickly goes negative to the tune of several volts, so the operation of the AGC system is quite normal.

Detected audio

The detected audio signal from the 75 has any 456kHz signal filtered out by a network consisting of C7, R8 & C8. The filtered audio signal is then applied to the triode section of the 75 valve for amplification.

Any 100Hz hum on the HT line to the 75 is filtered out using R12 & C11. The amplified audio is then applied to a 42 output stage where it is further amplified and fed to the loudspeaker via a transformer. In addition, a switched tone control system is wired between the 42's plate and chassis.

The power supply is standard for the



Several holes in the loudspeaker had been patched by a previous restorer using a white silicone compound. It does the job but looks awful.

era, with an 80 acting as a full-wave rectifier. This in turn feeds an 8µF filter capacitor (C16) and the field coil of the dynamic loudspeaker. The HT output from the field coil is then further filtered by another 8µF capacitor (C15). This filtered output forms the HT line for the remainder of the receiver.

Restoration

The chassis is easy to remove – just remove the three control knobs, undo four screws which pass through the bottom of the cabinet and release the two clamps that secure the speaker against the front of the cabinet. The latter, by the way, ensure that the speaker is held hard against the front of the cabinet so that it has a reasonable baffle to ensures good sound quality.

Having removed these parts, it's then just a matter of sliding the chassis out of the cabinet. In this case, the cabinet was still in good order, with a good shine present on the bakelite. As a result, it required no work other than a quick clean-up with some soapy water.

This set had actually been restored at some time in the past, before it was loaned to me. As a result, I did not expect it to require much work.

A glance under the chassis reveals that some of the wiring goes to small round tagstrips. In general, the parts are well-spaced and so short-circuits are unlikely. However, it is necessary to move some components aside to get at others near the bottom of the chassis.

The paper and electrolytic capacitors had all been replaced by the previous restorer, as had a number of resistors. In addition, the loudspeaker had been repaired using several "blobs" of a white silicone compound to fill in the holes. It doesn't look too good but it does do the job. An equivalent black compound would have looked much better but a replacement speaker is really the way to go if one can ever be found.

As a safety precaution, a fuse had been added to the mains input. However, this is of doubtful value as it is a 3A unit and is therefore unlikely to blow before real damage has been done to the set. This set draws about 55W (approximately 0.25A), so a better rating for the fuse is 0.5A. This would then protect the set in the case of a severe fault.

Cleaning up

The set had been in storage for quite some time, so the first job was to give the chassis a good dust out. That done, the valves were removed and the chassis cleaned using a kerosene-soaked kitchen scourer. This produced a good result although it would be necessary to completely dismantle the set to return it to pristine condition, a job that's not to be undertaken lightly.

Two of the valves needed re-gluing to their bases. This was done using Tarzan's Grip, after which the valve pins were cleaned using Inox spray. The valves were then refitted in their sockets.

Next, all the moving parts associated with the dial mechanism and tuning gang were lubricated with light machine oil. The bearings on the tuning gang are hard to get at so I used a small hypodermic syringe partially filled with oil to do the job.

Electronic work

Having cleaned the set up, it was time to restore the chassis to working order. First, the top cap lead to the 6A7 had perished, so this was replaced with a short length of hook-up wire. I then looked at the two 8µF electrolytic capacitors on the HT line and found that both were encased in black, heat-shrink tubing.

The previous restorer had obviously replaced these but had used radial lead capacitors instead of the original axial lead units. As a result, he had converted the replacement units to axial

types by soldering a length of wire onto the negative terminal and extending it down the side of each capacitor. He had then fitted them with heatshrink to hold the leads in place.

This worked but it was impossible to read the capacitor values and ratings. I peeled back the heatshrink and found that they were both 10µF 450V units. These are quite adequate for the job, so they were left in place and the heatshrink refitted (I always like to check the voltage ratings of filter capacitors).

The power cord had also been replaced by the previous restorer but the installation was rather crude and not up to current safety standards. The earth had been soldered to the chassis and the cord had been tied in a knot to secure it which is now illegal. These problems were corrected by fitting a cable clamp and securely bolting the earth lead to the chassis via a crimp lug.

Switching on

Before plugging a restored set into the power socket, it's always wise to make a few basic checks. In this case, a quick check with a multimeter revealed no shorts between the HT line and the chassis or from mains to chassis.

The mains wiring was also carefully checked. That done, the set was powered up and the HT line monitored as the set warmed up. During this time, it's also a good idea to observe the valves for any signs of distress, such as violet glows or sparks.

Following switch-on, the HT voltage across C16 rose to 400V and then quickly settled back to 350V as the valves warmed up. The voltage across C15 settled down to around 250V, so the HT voltages were all quite normal.

Next, I connected an antenna and found that stations could be tuned in. However, the dial pointer could not be tuned all the way to the low-frequency end of the dial and the tuning capacitor was not completely closing at this end.

There is very little space between the slide-rule dial scale, the dial drum and the tuning gang so it was difficult to see exactly what the problem was. After some experimenting, I found that I could manually assist the system so that the gang fully closed but that didn't really solve the problem.



The top of the chassis is tightly packed with various parts. The valves are easy to access but the tuning gang and dial assembly can only be accessed by removing the speaker bracket assembly.

With the gang closed, the pointer was repositioned so that it sat right at the low-frequency end of the dial scale. It now correctly moves between each end of the dial scale but the tuning gang still doesn't quite close at the low-frequency end unless manually assisted. This problem was left for the owner to solve, as he is a fitter and turner by trade.

I also found that the set would intermittently stop operating at around 600kHz. This is almost certainly due to the stator and rotor plates of the tuning gang shorting together at this particular spot.

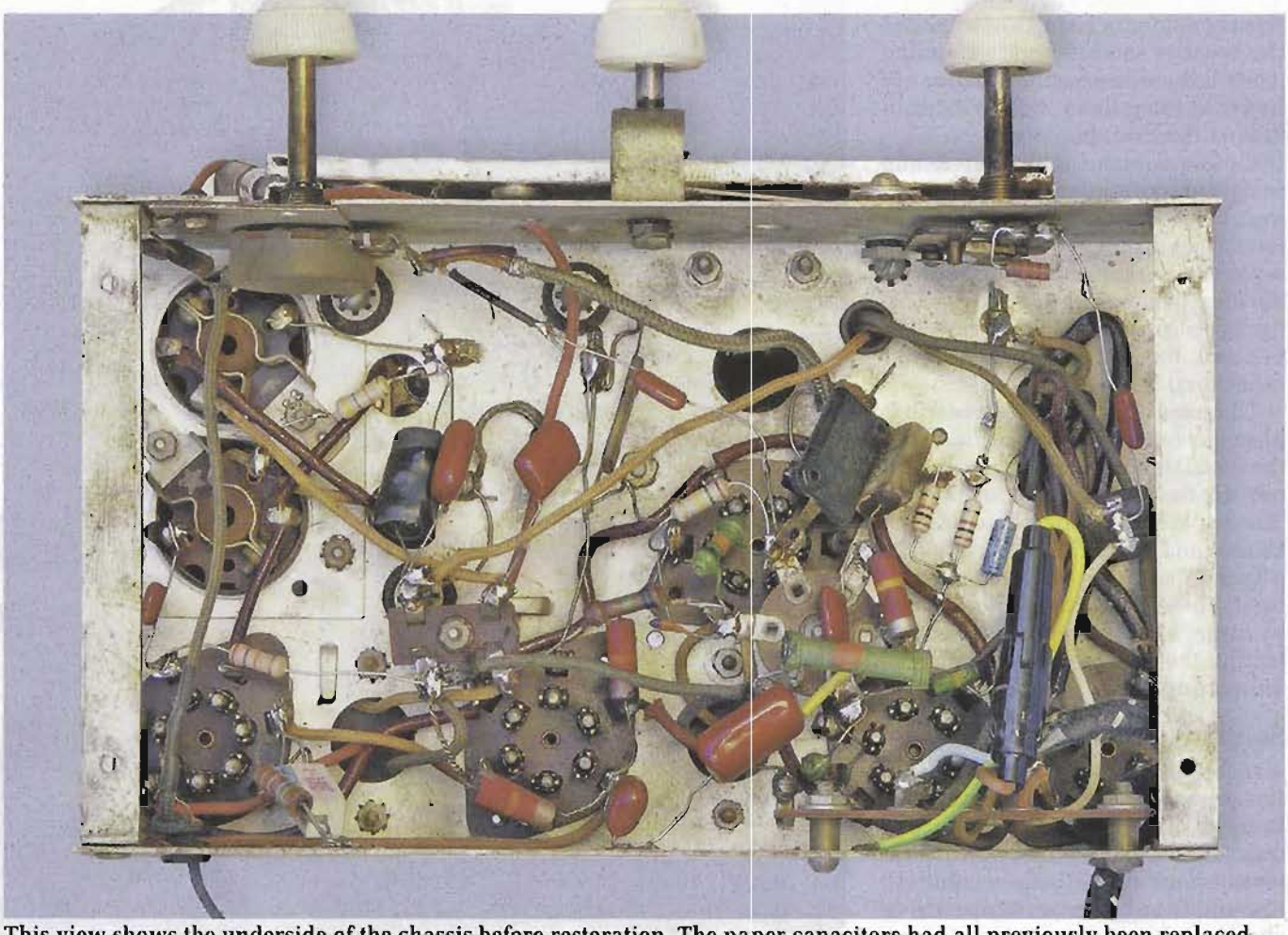
Unfortunately, the gang is extremely difficult to get at, being underneath the speaker assembly and behind the valves. Even with a headset and a torch, I made no headway with this problem, despite bending the plates slightly in an effort to clear the fault.

Once again, I'll leave the owner to remove the speaker assembly and fix this particular problem.

Alignment

I had expected the alignment to be spot-on but in practice, it was slightly out. To correct this, I first connected a signal generator via a low-value capacitor to the antenna lead and tuned the receiver to the low-frequency end of the dial. I then tuned the generator across the expected intermediate frequency (IF) and it was nominally at 456kHz.

Next, I disconnected the antenna from the set and set the generator to



This view shows the underside of the chassis before restoration. The paper capacitors had all previously been replaced, along with the mains cord. The latter required further work, including the installation of a proper cord clamp to secure it and securely bolting the earth wire to chassis via a crimp eyelet.

a low level so that little AGC action would occur in the receiver. I then tuned the IF transformers by ear and was able to noticeably improve the performance. **You have to be careful doing this though, as two of the trimmers are connected to the HT line!**

The front-end tuned circuits were next on the list. First, I tuned the set to the low-frequency end of the dial and manually assisted the dial-drive system so that the gang completely closed. The antenna was then reconnected and the output of the signal generator attached to the insulated antenna wire via a crocodile clip.

Next, I tuned the generator over the 500-600kHz range and found that the set was not tuning down to 530kHz. To correct this, I set the generator on the low frequency side of the lowest frequency the set would tune, then adjusted the oscillator padder for maximum response. This step was then repeated, after which the set would then tune down to 530kHz.

That done, I tuned to the other end of the dial and found that the set would only go to about 1500kHz. So, using much the same technique as used at the low-frequency end, I "walked" the oscillator higher in frequency by adjusting its trimmer so it would tune to 1629kHz (a local Italian station).

In fact, the dial scale indicates that the set should tune to somewhere between 1600kHz and 1650kHz but I don't have any information on the manufacturer's exact specification.

Next, I went back to the low-frequency end of the dial and readjusted the padder before repeating the procedure at the high-frequency end. The dial has a frequency scale as well as station indications, which makes tuning and alignment just that much easier to accomplish.

Finally, aligning the antenna circuit is easy – just tune the receiver to a weak station at around 1400kHz and adjust the antenna trimmer for best performance.

At the end of these adjustments, the set turned in a very good performance. In fact, it is amongst the best of the era.

Summary

The Airzone 520/550 is a well-made set with good performance and good looks. It is somewhat less complicated than many similar sets of the era but Airzone certainly got the best out of the circuit.

My only areas of criticism are the difficulties in accessing the tuning gang and the lack of clearance between the dial drum, gang and slide-rule dial (hence the trouble I had with the system jamming at the low-frequency end of the dial). Even so, these problems can be sorted out if someone is prepared to spend a few hours on the set.

In summary, this is a radio from one of the lesser-known manufacturers and is well worth having in your collection. **SC**

Half Duplex with HopeRF "TTL" HM-TR UHF data transceivers

By STAN SWAN

Our introductory second-generation UHF data transceiver article in October 2008 showed that using a PICAXE to drive HopeRF's HM-TR 433MHz programmable data transceivers works well. In subsequent months, these well-priced units have become very popular!

FOR THOSE WHO have just come in, these Chinese-made UHF FSK data transceivers, selling locally for ~$25 (via MicroZed, the Australian PICAXE distributors) offer tempting programmable features in a 6-pin SIP "one-stop" package. They have been found well-suited to more professional 433MHz ISM applications.

Thanks to a quality-fitted antenna socket, even the supplied "rubber ducky" antenna allows line-of-sight (LOS) ranges of up to 1km, with performance in demanding conditions superior to cheap classic individual 433.92MHz transmitter/receiver offerings – many of which unfortunately have insensitive receivers.

Conditions in crowded Asian cities apparently favour the 433MHz UHF band for the likes of slow wireless utility data from water and electrical meters. Microwave level 2.4GHz data links do not have the necessary punch-through for numerous obstacles and so quickly suffer attenuation.

We focused on the more versatile RS232 versions in the initial SILICON CHIP article but this month the "bare-bones" TTL transceiver types will be considered. These TTL versions offer very low (µA level) supply current "sleep" benefits and may also be slightly cheaper, as a MAX232 IC is not fitted to them.

However, even before "on-air" data transceiver use, initial set-up configuration of these HM-TR/TTL units requires logic level conversion and inversion.

Although still referred to as TTL (Transistor Transistor Logic), modern low-power consumption circuitry is now largely CMOS-based and operates in the logic range of 0V to +5V, with increasingly +3.3V or even lower values emerging.

Classic RS-232 signals use negative voltages (as great as -15V) to represent a logic high, with logic lows covering a range to perhaps +15V. However, many laptops, especially when battery operated, have much lower serial voltages.

In contrast, TTL assigns 0 to ~1V as logic low and signals ~2-5V as a high. True RS232 signal levels are thus far too great for TTL electronics and the

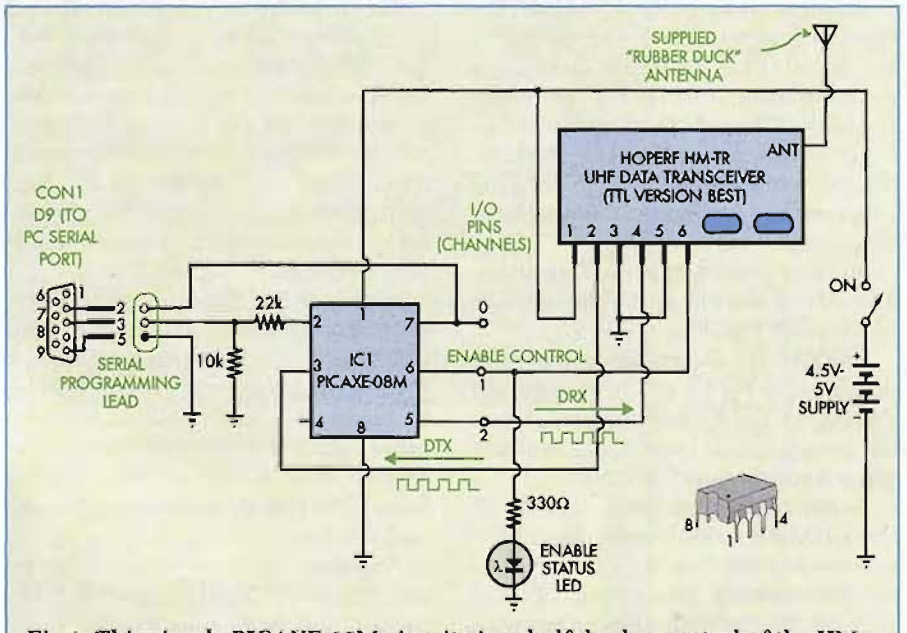
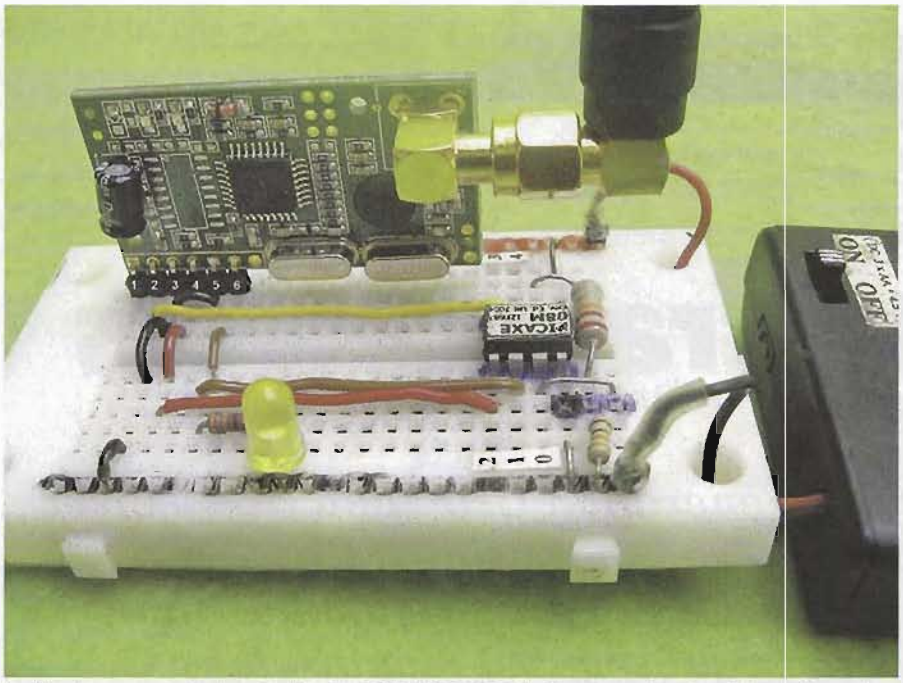


Fig.1: This simple PICAXE-08M circuit gives half duplex control of the HM-TR 433MHz data transceiver and has very low hibernation current.



Solderless prototyping (with the PICAXE-08M in its now standard breadboard layout) suits HM-TR evaluation. Add-on transducers, such as a DS18B20 or LDR, can easily be monitored as well. Two identical set-ups are needed for half-duplex operation.

"high" negative RS232 voltage can't be handled at all.

Consequently, TTL serial data requires logic level conversions when presented to an RS232 interface and lows and highs also must be inverted, meaning logic 1 becomes 0 and vice versa.

RS232-TTL level converting circuits abound, with TI/Maxim's purpose-built MAX232 16-pin dual driver/receiver IC long recognised as the standard approach (see Fig.2). However, this high-performance IC can be an overkill for pedestrian needs such as ours, especially since we're only occasionally dealing with a handful of settings at 9600 bps.

As only half the MAX232 is needed for the HM-TR/TTL set-up, Maxim's 8-pin DS275 line-powered RS232 transceiver IC may appeal instead. This derives power from the data line itself and provides a lower cost and extremely low-power serial port interface.

Of course, such specialised ICs are often just the thing that your stockist will be fresh out of when you want one!

Rest easy: numerous discrete conversion "poor man's" workarounds have evolved, typically using NPN/PNP transistors or 2N7000 N-FETs. The simple 2 x NPN discrete approach suggested by a fellow Kiwi has shown itself to be very effective and should appeal to those on skinflint budgets (see Fig.3).

Inverting the logic sign can be easily handled during later PICAXE HopeRF TTL communications with **T2400** "true" style signals (which idle high), rather than **N2400** "inverted" serial. PICAXE serial code will then be in the form **SEROUT 2,T2400,b0**.

Because set-up of the TTL HM-TR's may be just an infrequent need, it's suggested that a simple dedicated programming breadboard be used. Final RF PC board circuitry can have a 6-pin in-line socket fitted for the HM-TR, allowing the data transceiver to be lifted out and configured externally on this breadboard as needed.

Such a versatile approach additionally allows use of new software that's on HopeRF's menu.

The HM-TR setup program (recently upgraded to Ver 1.1 and now featuring English as the default language), can be downloaded from their website **www.hoperf.com/rf_fsk.asp**

Aside from occasional reports of these HM-TR modules resetting themselves (perhaps due to power supply removal during data handling) and thus needing reprogramming anyway, numerous "cut and try" transceiver set-up tweaks are available.

Transmitter (TX) frequency deviation and receiver (RX) bandwidths may especially be worth investigating – narrow TX and wide RX bandwidths have shown merit. Power level attenuations (PA) however may be academic, as at only 5mW the maximum TX output is hardly going to burn holes in the ether!

Although data can be fed at a standard PICAXE 2400 bps, reducing the "on air" data transmission rates may also improve communications under noisy conditions. The modules transparently handle any speed conversions but buffering issues (just 32 bytes) may arise in some configurations. EXPERIMENT!

Application

Naturally these TTL units could be just used as a convenient "one stop" package for either simple data transmission or reception but their unified capabilities are better suited for something more demanding than such simplex work!

Two transceiver units set up identically can enter into a half duplex relationship, much in the classic two-way radio, one-at-a-time style of "Hello 1 this is 2, can you hear me, over".

Abundant scope exists for considerable half-duplex tinkering of course, just as in the radio analogy where issues such as band watching, time scheduling, power supply drain, interference and simultaneous use of the channel may arise.

The introductory example shown here, using a popular high-level PICAXE-08M microcontroller, involves sending a simple transmitter beacon, composed of the usual SEROUT ASCII "U" (10101010) wake-up and a qualifier ("ttl"). When the PICAXE controlled receiver awakens and receives this, an acknowledgement is sent in return.

At this point, the units swap roles, with the original transmitter (and PICAXE) then hibernating at µA level currents. It's quite entertaining to watch the units talking to each other "ping pong" style like this but serious data (such as temperatures from a DS18B20) could instead be sent and verified.

As the educational PICAXEs have a non-timed-out **SERIN** command, the units could hang up awaiting serial data. A simple pre-data alert has been instigated with the **PULSIN** command,

as this pulse-measuring command usefully does time out.

In the code example shown, the duration is of trivial interest, as it's the complete absence of any pulse that's being used to cycle the beacon loop. Only when something is detected does the program move to SERIN data reception.

Naturally, the approach is not foolproof as it stands, since 433MHz channel noise may be interpreted as a data signal.

Scope may exist to define the PULSIN variables exactly for the nature of the data. Both units by chance may just fall into SERIN at the same moment, perhaps if one is moving, thus uselessly awaiting signals from each other as well.

Discharging a supply capacitor resistor combination, so that a PICAXE reset eventually occurs, may help break out of this. A 1µF capacitor and 1MΩ resistor have a time constant (CR) of 1s, so after five time constants (5s) the capacitor will be virtually discharged – this is explored in a case study.

As well as such explorations, readers are encouraged to modify the example with suitable **SLEEP** and **PAUSE** commands, in a quest to perhaps minimise supply current drain.

The exact approach depends on the application, as a battery-powered receiver could be hibernating for many hours, while a mains-powered transmitter (with no battery concerns and drawing ~30mA) could be sending beacons frequently.

Low duty cycles are typical with wireless telemetry in fact, as temperatures, humidity data or water levels may only change slowly. Perhaps data may even be stored in non-volatile memory for "store and forward" bulk sending when convenient.

In such a case, receiver batteries may last years (approximating shelf life) or a simple solar panel energiser could be used. SC

Resources, code and case studies are hosted at **www.picaxe.orconhosting.net.nz/hoperf.htm**

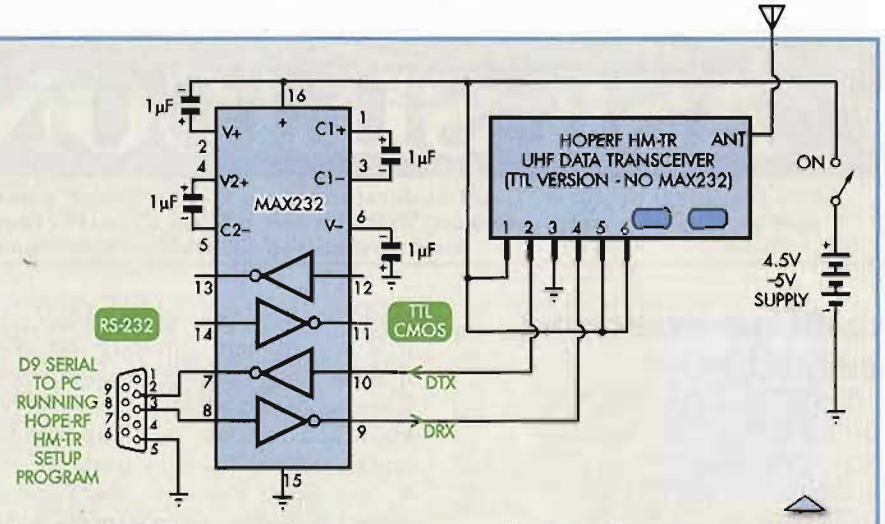
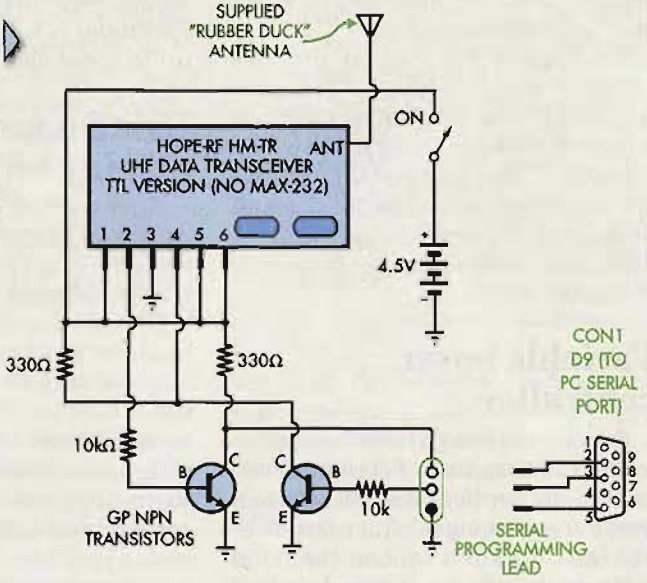
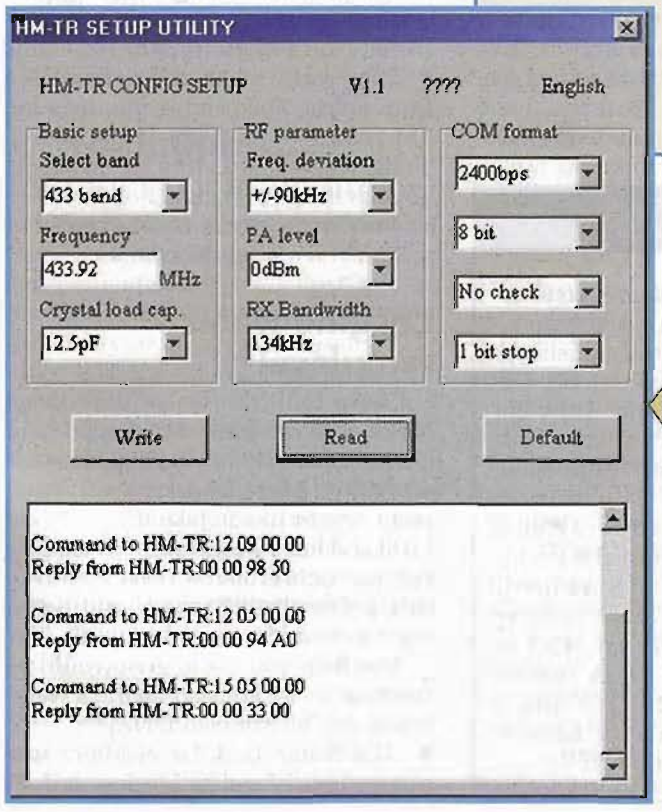


Fig.2: initial TTL transceiver set-up requires logic level conversion, readily handled by a standard MAX232. The normal PICAXE 3-wire programming lead can be used.

Fig.3: TTL-RS232 level conversion/ inversion can also be simply achieved with two NPN transistors such as BC547s. Resistor values are not critical, with typical PICAXE "junk box" values just used here. Refer to the resource website for a breadboard layout.





HopeRF's upgraded set-up utility now has English default and a progress panel. Serial at 2400,8,N,1 with narrow TX deviation and wide RX bandwidth was used but experimentation is encouraged! Slower "on air" data rates may give greater range.

ASK SILICON CHIP

Got a technical problem? Can't understand a piece of jargon or some technical principle? Drop us a line and we'll answer your question. Write to: Ask Silicon Chip, PO Box 139, Collaroy Beach, NSW 2097 or send an email to silicon@siliconchip.com.au

dsPIC programming capability

Is the "Low-Cost Programmer For dsPICs & PICs" that appeared in the May 2008 issue capable of programming PIC16C745 OTP chips? (J. B., Ballarat, Vic).

● No, the dsPIC Programmer does not support the PIC16C745. The main reason is that WinPIC (the PC freeware program used with the dsPIC programmer) does not support it.

We suggest you look at the PIC-18F2550 which is pin-for-pin compatible with the 16C745, as a suitable replacement. It has USB 2.0 rather than 1.1 and is flash-based (not OTP). It also has more memory and better specs all round, as it is a newer design. And the dsPIC programmer can program most of the 18F series.

Variable boost controller

I purchased the Variable Boost Controller (SILICON CHIP, February 2007) to fit to my car but I did not realise it needs to see a signal from the ECU. My ECU does not control the boost solenoid in my car. I was hoping I could hook this kit up with +12V and it would operate correctly but after making it and reading the paperwork, it seems I am mistaken. Please let me know how to hook this kit up without an ECU signal. (C. W., via email).

● The input signal to the Variable Boost Controller can be from the pulse width modulated signal that controls the boost control solenoid. The Variable Boost Controller intercepts the signal. Note that the Variable Boost Controller is suited to electronic controllers, not electromechanical.

Using a fuel mixture display on a motorbike

After reading your November 2008 edition of SILICON CHIP am I able to do the following with the Wideband Fuel Display Mixture Kit?

(a) Use it as a standalone unit to tune the carburettor on a motorbike? I would add an extension pipe into the exhaust and drill a narrow-band oxygen sensor into it.

(b) Use my car's battery and earthing point to provide power and earth or could I use a battery? And what type? Is this possible?

I have seen some standalone kits for $500 which is way too expensive for a DIY'er like myself. (J. N., via email).

● You can use a narrow-band oxygen sensor secured to an add-on tailpipe to monitor the exhaust for stoichiometric mixture measurements. A heated sensor would be required because the tailpipe gases are not sufficiently hot enough to bring the sensor up to operating temperature.

You can power the heater for the sensor from the bike supply or a separate battery but note that the sensor's heater may draw 3-4A of current. The oxygen sensor ground would connect to the display ground whether or not you use separate power supplies for the sensor and display.

We are developing a wideband sensor controller that will be better for tuning because it will work over a wider range of air/fuel mixture and be far more accurate.

Where to buy rare earth magnets

Where can I buy rare earth magnets? (A. B., North Mackay, Qld).

● Rare earth magnets are available from Jaycar The catalog numbers are LM-1652, LM-1622, LM-1618 and LM-1620. Your closest store to Mackay is Townsville (177 Ingham Rd West End) or you can buy them via mail order or online at **www.jaycar.com.au**

Logging water tank level

I have built the Water Tank Level Meter with the telemetry display unit (SILICON CHIP, November 2007 to January 2008). The unit works very well and I would like to take it to the next level and have it log onto a PC via a serial interface. Is there an easy way to do this or does the PIC require additional code to provide a serial output?

Any help you could give would be fantastic as we are keen to track water usage. (B. T., Auckland. NZ).

● The Water Tank Level Meter was not designed for data logging. It does

Quiescent Current Setting Problem

I have just completed two 120W LD amplifier modules (SILICON CHIP, August & September 2008). However, even with the 47Ω resistor in Q7's emitter I cannot get anywhere near 7-10mV across any of the 0.1Ω emitter resistors; mine all read around 2.5mV, with 30mV across the speaker terminals.

The rail voltage is ±55.8V and the voltage across the diodes (Q10 & Q11 base) is OK at 2.28V. All other circuit voltages read fine as per the article and the modules seem to work OK and both modules are exactly the same.

Are there any updates to this project? (M. H., Windsor, Canada).

● The low quiescent current is possibly due to one of the transistors Q12-Q15 having a higher than normal base-emitter voltage. Although since the quiescent current in both amplifiers is the same, it is probable that with the batch of transistors you are using, all devices exhibit a slightly higher than normal B-E voltage compared to the ones we used.

You could try a lower emitter resistor value for Q7, say, 43Ω or 39Ω for a 14mA or 15mA current flow through DQ12-DQ15 and a dissipation of 767mW or 846mW respectively, in Q7 and Q9.

Problem With USB Sensing

I was reading the article on the USB-Sensing Power Switch (SILICON CHIP, January 2009) and I have a query. With most desktop systems, the system will boot if it receives a valid data stream through either a serial port (modem) or a USB port (a broadband modem).

Those machines that connect to ADSL modems through a network port do not have this problem unless the "wake up" option is turned on in the mainboard's BIOS. Personally, I prefer to switch off my system at the wall to prevent a USB startup when I am out!

I have received a great many calls regarding systems which start themselves up and in each case I have found that a valid data stream into a USB port has caused the system to boot. I also check the mainboard's BIOS settings to locate an option to prevent this but as yet, I have not been able to locate this. For those people who do turn off at the wall, it is a good idea and it stops those under or over-voltage issues and switches the modem off as well.

This prevents inadvertent boot-ups and unauthorised access to the system from the Internet. So many people still have no firewall or anti-virus protection and this leaves their system wide open to abuse, especially if the system boots itself and remains online during unattended periods.

What do you think about this or have you not confronted this problem yet? (D. S., Maryborough, Qld).

● We have not confronted this problem. Presumably the problem you describe arises when using a modem connected directly to a computer using a USB cable. Most such modems would also provide an Ethernet connection. In that case, simply replace the USB connection with an Ethernet one.

As you say, there is an option to disable wake up on LAN (when using Ethernet) but also because of the way NAT works on routers, this problem cannot occur when using a router. Most routers have firewalls too and the option to enable MAC address filtering.

Is this a problem with computers in the shut down ("OFF") state waking up or computers in some other power-saving state? Does the modem have a firewall? The answer is to enable it.

Another option is to turn off the modem rather than the computer or have the modem controlled by the USB Power Sensing Switch. In that case, when you shut down your computer, the modem will lose power within the timeout period, preventing a wake-up event (unless it occurs within that time window).

Most modern operating systems like Windows have firewalls too, which are by default enabled, so apart from it being a nuisance that the computers are waking up, security should, in principle, not be compromised.

not have a separate output to just send data periodically. However, the serial output sent to the UHF transmitter could be logged if required. This signal includes the tank number and identity codes, as well as the water level.

UPS solution for momentary blackouts

I live in North Queensland and we have a lot of lightning which often causes momentary power fluctuations, enough to cause computers to shut down. My computer is set to automatically start up again in the event of a power failure.

The problem I experience often is that the computer will not start up correctly or it hangs part way through start up. This requires a power down and restart and then all is OK.

How about a small project to overcome this problem; something that will not allow the computer to restart for maybe a five or 10-second delay after a power outage? I use a power filter but a UPS is over the top for my requirements. (G. A., Tolga, Qld).

● One possibility would be to build the Brownout Protector (SILICON CHIP, December 2008) which will switch off the load after a short delay. However, a power outage causing a computer shut-down is not good as data will be lost and the computer may not shut-down correctly.

A UPS is really the best answer and would not cost much more than the Brownout Protector. Have a look at Jaycar's 650VA unit (Cat. MP-5200).

PC board wanted for STK086 module

Recently I picked up a couple of STK086 amplifier modules. I have noted your comments previously in answer to another question about the poor performance of these modules compared to the SC480, etc.

Even so, they are an option for a quick amplifier, particularly for the older person who has trouble soldering small components these days. I wanted to ask if in your archives you have projects using these and if there is a PC board design for a basic unit as per the data sheet? (P. E., via email).

● We have not produced any designs based on the STK086. However, we did produce a number of designs based on the National Semiconductor LM3786/3886 series devices back in 1995. We also featured designs on the National Semiconductor LM1875 20W chip and the Philips TDA1562Q bridge amplifier. All of these give better performance than the STK086.

Zener diode connection confusion

I have bought the Jacob's Ladder kit (SILICON CHIP, April 2007). I noticed in the construction process (I have not added the coil yet) that diode ZD1 is shown incorrectly on the circuit board. The 'A' and 'K' seem to be at the wrong ends. It caught me out and maybe it might catch others out.

I think that anyone writing in with problems with the kit might benefit by being informed of this in case they use the 'A' and 'K' to position their diodes. (D. R., via email).

● The A & K markings on the zener diode are correct. This is a point that tricks many people.

Consider that a zener diode is con-

Measuring Light Pollution From The Moon

With quite simple equipment (see links below) a few amateurs may have succeeded in observing North American street light reflected from the Moon's surface. The idea may be worth considering by SILICON CHIP.

Simple equipment and powerful PC processing of signals make an interesting mix. I suspect York Optical in Melbourne have the optical BP filters (or would import and stock ones from Edmund Scientific, if a project was published). Programs to process the audio in the PC and to get correct observing times still need a little research. (T. L., Wellington, NZ).

http://www.bluehaze.com.au/modlight/modlightrx.htm
http://www.mgte.com/laser/proof%20of%20civilization-1.pdf

● This is an intriguing concept but one with which it would be very difficult to get reliable results. We cannot see how you could get a reliable reflected 120Hz signal anywhere in America since the lighting systems will be spread over three phases and so the strongest signal should be at 360Hz.

The first step in doing any such test would be to see if the whole instrumentation set-up was completely free of 120Hz and 360Hz residual signals. This would be very difficult since the computer set-up shown would be run from mains power or a 60Hz inverter.

Second, it would be necessary to ensure that there was no sky pickup of light pollution from nearby cities. That implies a very remote, dark location with very good "seeing" and no clouds in the sky.

Finally, as suggested in the article, the best time to do such a test would be during an eclipse!

In Australia (and we presume NZ), most street and building lighting is via high-pressure mercury or fluorescent lamps. There certainly is high and low-pressure sodium discharge lighting being used but it is a fairly small component. Therefore, using the narrow-band sodium optical filter would make the test impractical in the Antipodes.

In any case, we already know that cities cause considerable light pollution which is wastefully radiated in the sky. You only have to note how bright it is on a cloudy night!

nected so that it has reverse current flow, from cathode (K) to anode (A) when its voltage rating is exceeded. If you reverse the connection of the zener diode it will function like a normal diode with a voltage drop of about 0.7V. Thus you will get no supply to the 555 timer IC and the 10Ω resistor will burn out.

Running a drill from a PC supply

In December 1998 there was an article on converting old PC power supplies into handy 13V supplies. I constructed a few of these and have found them handy for all sorts of uses. I recently tried running a cordless drill/screwdriver from one of these supplies but it just shuts down immediately on switching on the drill.

It's a shame that we throw out these drills when the Nicads invariably fail after a couple of years and new rechargeable sub-C cells cost twice what a new drill does. The supply will run a load of 8A at 13.3V which should be plenty for the drill. (T. C., via email).

● It probably does not like the commutated load presented by the brush motor. Try a big electro, say 10,000µF 25V, at the output of the supply.

SC480 power supply change

I'm building the power supply for the SC480 50W amplifier. I require a ±12V supply rather than the ±15V one provided. I wish to know how to do this. Can I use a 12V zener diode rather than the 15V one? (A. P., via email).

● A 1W zener diode such as a 15V type can accept a maximum of 66.6mA for 1W dissipation. Generally you would run the zener at 33mA or less so that it doesn't run too hot. Similarly, a 12V 1W zener can be run at 83mA maximum for 1W dissipation but generally it would be run at 40mA or less.

For the 40V SC480 supply, the 12V zener alternative would draw (40V - 12V)/1.1kΩ or 25mA. The parallel 2.2kΩ resistors would dissipate about 343mW each. This is OK.

Check that the 12V supply is maintained when connected to the circuit that is powered from this. You can alter the two 2.2kΩ 1W resistor values for more current if the supply is not maintained at 12V under load. Two 1.8kΩ 1W resistors would allow a maximum of 31mA through the zener diode.

Power supply for external DVD drive

I have an external DVD burner with a switchmode power supply with outputs of 12V DC at 2A and 5V DC at 2A. I have had to replace this power supply twice.

Have you described a circuit which can be used to power an external DVD burner? A normal transformer power supply may be more reliable. Would such a power supply also be suitable for use with an external hard drive? (R. M., via email).

● While a normal transformer power supply with linear regulators may be more reliable, we have not produced such a design. Such a design would also be much larger, dissipate a lot more heat from its linear regulators and probably be quite a bit more expensive. We don't think it is worth doing as a project.

TV logo blanker wanted

Is there any possibility of producing a circuit for blanking out the extremely annoying banners at the bottom of TV screens. It would need to have a couple of controls to move the blanking pattern (preferably, just a black box) around the screen and perhaps to change the size of it. A small RF generator to allow connection via the antenna (eg, channel 34 or whatever) would be excellent. (C. R., Tuebingen, Germany).

● We have discussed this topic in the past. Such a project would require a video field store so that the logo blanking signal could be properly mixed with the program video signal. You could not simply couple a blanker signal in via an RF modulator.

In fact, it is extremely difficult to get rid of these semi-transparent logos

Adjusting Sensors For A Pump Controller

I just built the Pump Controller for a solar hot water system and am having a problem with the sensors not performing as described. When I apply an increase in temperature to sensor 2, I get the desired results but not from sensor 1. All the components check out OK.

As I understand it, sensor1 is installed on the roof panels and sensor2 on the water tank. (N. K., Oak Ridge, Tennessee).

● We presume you mean the Pump Controller For Solar Hot Water Systems which was published in Circuit Notebook of the March 2002 issue.

Both sensor 1 and sensor 2 are LM335Z temperature sensors and so both should provide the same reading at the same temperature. With higher temperature on a sensor, the voltage should rise between its + and - terminals. If not, make sure the - terminal is at ground and the + terminal is connected to the (nominal) 12V supply via the 8.2kΩ resistor.

Each trimpot should be set about midway. Winding trimpot VR1 or VR2 fully clockwise or fully anticlockwise will cause the corresponding sensor to operate incorrectly.

Typically, each sensor should have 2.98V between its + and - terminals at 25°C. Adjust VR1 and VR2 so that each sensor reading is correct.

used by all the TV networks these days. Even the networks have problems doing this, as evidenced by the smudged logo effect seen on some SBS news items where they have evidently been sourced from other networks.

12V to 24VAC inverter required

I'm interested in installing an irrigation system with solenoid valves for my fruit trees and vegie patch near my water tank. The problem is that there is no power there and irrigation systems require 24VAC.

Have you published a 12VDC to 24V AC inverter so people can install an irrigation system from a basic standalone solar powered system remote from their house? (S. L., via email).

● We have not produced such a project and we think there would be relatively little demand for it. One way would be to use a standard low-power 12VDC - 240VAC inverter in conjunction with a step-down transformer to obtain 24VAC. Jaycar or Altronics should be able to supply you with everything you need.

Alternatively, have a look at the solar-powered fountain driver in the Circuit Notebook pages of the March 2009 issue. SC

Notes & Errata

Theremin MK2, March 2009: two 470µF capacitors are used in the circuit. The 25V capacitor on the parts layout diagram is the one just above REG1.

In addition, the 100kΩ resistor shown connected from the base of Q4 to 9V on both the circuit and layout diagrams is incorrect. It should be 330kΩ. This resistor is located between the two top earth terminals of transformers T3 and T4.

Finally, the parts list should show 10 100nF MKT capacitors (not 8).

Time Delay Photoflash Trigger, February 2009: on page 72, the paragraph on step 17, referring to setting links LK1-LK4 should be ignored. This paragraph referred to an earlier version of the circuit.

GPS Synchronised Clock, March 2009: the circuit for experimenting with the GPS module (Fig.4) should include a 4.7kΩ resistor in series between pin 12 of the MAX232 IC and pin 3 of the GPS module. In addition, there should be a 10kΩ resistor from pin 3 of the GPS module to ground. Without these modifications the EM-408 GPS module may be damaged by excessive voltage on pin 3 (serial data input).

Also, the set-up cable for connecting the clock controller to a PC had the tip and ring of the phono plug swapped compared to the standard download cable used by Revolution Education. The PC board and cable shown in Fig.3 will work correctly as described but the cable is not suitable for programming PICAXEs.

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.

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