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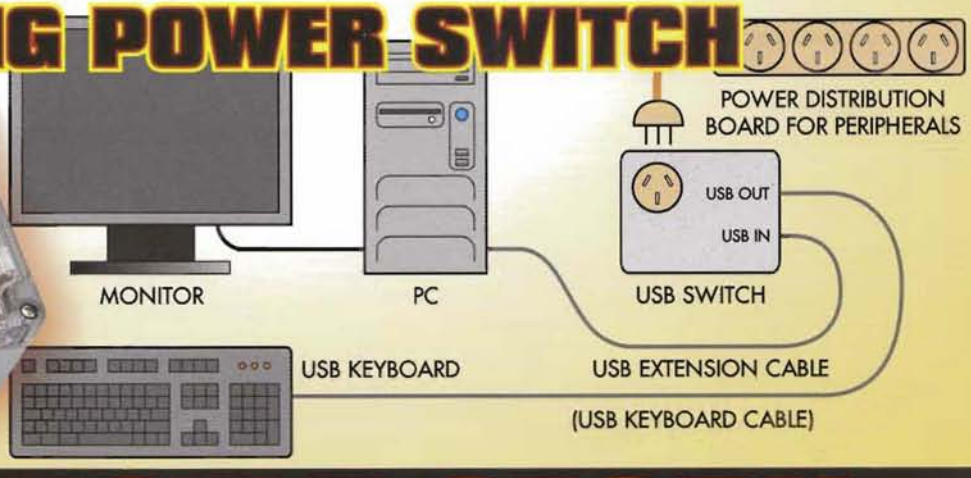


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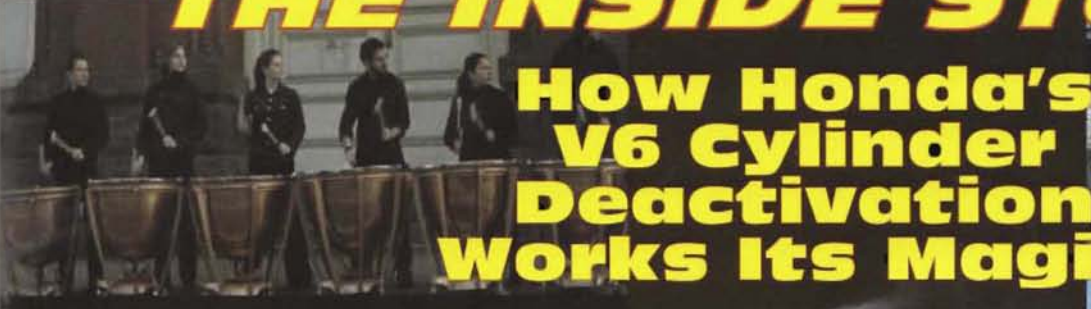
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Very Clever USB SENSING POWER SWITCH





THE INSIDE STORY:



How Honda's V6 Cylinder Deactivation Works Its Magic!



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Publisher's Letter

EVs & nuclear power – don't hold your breath



Before I sat down to write this editorial I reviewed all the Publishers' Letters I have written in the past three years and I have had to conclude that as far as electric vehicles and nuclear power stations are concerned, we have made no progress at all in that time. Practical mass-market electric vehicles are still as far away as ever and nuclear power, at least in Australia, is somewhere in the far future, if ever.

Why do I link the two together? First, let's look at electric vehicles. In the last three years, just one EV has come to market, the Tesla sports car, but the company's future, like all auto manufacturing in the USA, is under a very dark financial cloud. Less than 100 Tesla EVs have been delivered at the time of writing (early December) and no other EVs are on the immediate horizon from other manufacturers. Sure, there is lot of internet comment about EVs from China but until we see some production examples, it will be just talk.

On the other hand, as I wrote last month, hybrid EVs are likely to become much more commonplace. If you have a look at the projected fuel economy figures, such as 2.5l/100km from the planned VW diesel hybrid, these also raise doubts about the future viability of pure EVs. And the latest diesel engine developments further cloud the future. Consider the astonishing new Mercedes OMC651 diesel in the new C-class 250 CDI sedan. At just over 2 litres, it manages to produce 150kW and 500Nm for an overall 5l/100km economy. This is in a 1650kg sedan, much the same weight as typical big Aussie six sedans but with more than twice the fuel economy. Just imagine what will happen to hybrid fuel economy when they incorporate this technology.

The point about future hybrid EV fuel economy is that it makes the whole economics of EVs powered from the national grid a doubtful proposition. First, the fuel efficiency of hybrids will challenge the overall efficiency of our existing power stations and distribution system. There will be less justification for having large centralised power stations to provide the energy for personal vehicles.

Second, if a majority of vehicles were to be changed over to EVs and be powered from the grid, Australia would need to at least double its present generating capacity. But Australia is already heading for severe power shortages and that is without even thinking about EVs. The only way to massively increase our power generating capacity in the near future is by adopting nuclear power quite soon. That just isn't going to happen, unless there is a dramatic change by our politicians.

Finally, there is another reason why we are unlikely to see large numbers of EVs on our roads in the next 10-15 years. If it were to happen, both state and federal governments would have to find a substitute for all the fuel excises they load onto petrol and diesel. I think they are too happy with the status quo, in spite of all their posturing about climate change, carbon emissions and so on. They are not likely to encourage the sale of EVs in this country, for that reason alone. But in any case, there are not any viable EVs foreseeable at the moment.

The only factor to change this forecast is that petrol and diesel becomes a great deal more expensive than at the moment. What do you think?

Leo Simpson

MAILBAG



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Hydrogen still has potential as a fuel

I read with interest your short article on "Browns Gas" in "Ask SILICON CHIP" (September 2008 issue, pages 89-90) and hasten to add that I agree with the majority of your comments.

However, I would like to challenge your comment that the use of hydrogen as a fuel is never likely to come to anything. There is at least one quite promising research project being undertaken within Australia which involves producing hydrogen as a usable and practical fuel, although the approach is a little unconventional.

There is a reasonably well-known industrial process which uses waste "high grade" (ie, around 800°C) heat to convert methane (CH_4) to H_2 and CO in a catalytic process. The resultant blend of hydrogen and carbon monoxide is often referred to as Syngas. The principle is that the otherwise wasted heat energy is stored in the molecular structure of the gas so that the resultant gas has a higher (up to 30%) calorific content than the original.

CSIRO have a test plant running at their solar research facility in Newcastle where they use heat generated in a solar tower rather than using waste heat. Natural gas is pumped through a catalyst at the top of the solar tower and H_2 & CO comes out the other side (keep in mind that CO is combustible).

The initial reaction to this concept is that it is cheating. All they are doing is taking a non-renewable resource and modifying it! Thinking it through a bit further though, how hard is it to store solar energy and how much harder to store it in a medium that can be easily transported and used in multiple applications?

The point is that the energy content of the methane is less than the energy content of the synthesised hydrogen/carbon monoxide mixture. The difference is the heat that has been added. If that heat is from solar energy, it is effectively free. If it is from waste heat from industrial processes again it is effectively free because it would otherwise just be heating up the atmosphere. Thus, energy has been stored that is otherwise difficult to capture.

My understanding is that CSIRO now have significant Federal and state government funding for a pilot/research plant to be built in Queensland. Further details can be found at **http://www.det.csiro.au/science/r_h/nsec.htm**

While I accept that this is a long way from being developed into a commercial proposition, it does appear that there is enough happening out there to stop us writing off hydrogen as a fuel just yet.

Nick Fisher, VK2ZNF,
West Pennant Hills, NSW.

Sound levels on HDTV

Like your correspondent, I too have noticed a level difference between the SD and the HD feed for the same channel. But I strongly suspect that it is caused because the SD audio is an MPEG stereo feed while the HD audio feed is AC-3 5.1. I've also noticed that the SD feed has a more compressed audio range. I find that I need the volume higher on the HD channels to allow me to hear the voices clearly but the trouble with that is that the "background" music and sound effects are a lot louder.

I have found that by setting my set-top box to MPEG feed, the volume difference is reduced but the HD audio still appears to have a larger dynamic range.

The biggest issue I have is not the differences between the SD and HD feeds, it is the differences between the channels. I get my feed from the Como repeater in South Yarra, Melbourne, and channel 10 is always a lot louder than the other free-to-air channels.

It would be nice to get some mandated standards as to peak volumes and compression ratios that all the stations could agree on. Somehow I can't see that happening. This is just another reason to give up on free-to-air TV.

Laurens Meyer,
Richmond, Vic.

Smart meters unlikely to reduce consumption

Smart meters give you more control over your power costs in the same way as investing your own super funds gives you more control over your retirement income. If you've got the inclination and the understanding, you can get a great result. If you don't, it can be a financial disaster and most people don't.

Consumers want this to be a problem that the electricity suppliers look after for them. And that's why smart meters won't work, because most people will never look at them. They'll just pay whatever bill they get. As a result the problem won't be solved.

Experts, whatever field they are expert in, have a grossly inflated idea of how important it is in the overall scheme of things. They need to understand that things they think are hugely important to them just aren't so to everyone else in the world. That's something anyone who manages technology or any other highly technical area has to understand.

Gordon Drennan,
Burton, SA.

First integrated circuits were thermionic

I would like to offer a correction to the title of the article in the November 2008 issue of SILICON CHIP, "50 Years Of The Integrated Circuit". If the author Ross Tester had more completely

More on DIY electric vehicles

Thank you for the encouraging article on the DIY electric car scene (SILICON CHIP, December 2008). Just to let you know, my motor should give more than the stated average of 70kW. It's a 10.7-inch Elprom-EMS "Kostov" 144V DC motor with over 115kW, given the right conditions. Although series-wound DC motors don't marry well with regenerative braking systems without some fiddling and reverse field stuff, Sepex motors have no problem at all.

Some manufacturers and conversion companies are using AC motors and the trend is towards this, though for the average enthusiast with limited resources, DC motors work well, with plenty of torque. The controller is the limiting factor but we have some more elaborate ways to cool the MOSFETS and achieve better performance, keeping the operating temperature below the limit of the thermal safety cut-out. Lithium iron phosphate batteries are a major improvement and mass production will eventually bring their prices down. They are already successfully being used in buses in China.

Lithium iron phosphate and lithium polymer batteries could tip the scales on mass-production EVs, if only auto makers had the guts and vision to run with it. The polymers are roughly half the weight of the phosphates and one can achieve a much greater distance between charges, plus a likely doubling of the cycle life over deep-cycle lead acids, provided battery management is properly utilised.

Others are planning a rollout of A123 batteries in Australia and these are fast charging types (albeit requiring a hefty current which in turn requires a charging station – also in the planning stages). Mind you, I am happy to charge my battery pack for six hours off-peak or from the solar panels on the roof of my house and a 4kW inverter.

You mentioned heating of the interior. While some EV conversions use scrap bar heater elements, commercial ones are available for EVs (although I do like recycling junk). We've also been experimenting with water boilers (as used in cold climates to warm the engine bay). This, coupled with a typical heater element on an auxiliary system, can provide plenty of warmth.

As for LED tail lights, I have retrofitted some on my other Starion and will do so for the STAREV and may consider (when time permits) opening the tail light lens and stringing together a larger matrix, perhaps with suitable current-regulated PWM to avoid using limiting resistors altogether.

Your article hinted that the future for general mass-production EVs is still a ways off but our conversion business "Convert Ur Car" (0417 418 600) with Nathan Bolton is getting plenty of orders to convert older and newer cars such as the Toyota Echo. Oil prices go up and down and hybrids are overly complicated (for a reason) and personally, the satisfaction of not relying on a petrol station to fill up is highly rewarding.

Carmel Morris,
North Turramurra, NSW.

researched his topic he would have discovered that the first integrated circuits were not invented in 1958 but were in fact a German invention dating back to the mid 1920's by the well-known company Loewe. They were not based on silicon or germanium technology but were composed of several thermionic valves (tubes to the North Americans) integrated with various resistors and capacitors in a single package.

These devices were used in a variety of successful radios of the day and are now highly collectible as the first integrated circuits. For more information, I refer Ross to the book by Gerald F. J. Tyne titled "Saga of the Vacuum Tube" and an article published by "Electronics Australia" in the mid 1970s on the same topic.

For historical accuracy, Ross should have made clear he was only considering the previous 50 years of integrated circuits and not the complete history.

John Rickard,
Heathmont, Vic.





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Mailbag: continued

The grain of truth behind HHO

Thanks for weighing in on the HHO hydrogen scams. With the recent spike in gasoline costs, these products are once again in the spotlight in the USA. The HHO "wunder product" was presented to me in an online Volvo owners' forum that I participate in. On the surface, it made no sense and I said so. The thermodynamics of hydrogen as a fuel are straightforward and generating it using the car's alternator is absurd.

However, I some did follow up and was somewhat surprised to learn that there is a bona fide body of information about the use of small concentrations of hydrogen in a fuel stream as a combustion enhancer. This web page gives a good summary: **http://www.greencarcongress.com/005/11/hydrogenenhance.html**

I chased down some of the references and subsequent links and it tracks back to legitimate research, some of which has been around for quite a while. The Arvin/Meritor and MIT results are for real. Incorporating hydrogen into the fuel stream facilitates ultra lean burn conditions and reduces emissions, which seem to be the primary justification for the research.

If I understand it correctly, the hydrogen also is an octane enhancer and that would allow the use of very high compression engines and the realisation of their associated efficiencies.

The increase in fuel economy is (entirely?) a result of being able to use very high compression ratios, something the scammers conveniently overlook, of course, and is not present in the typical petrol/gasoline engine.

As it often turns out, the truth is being twisted to perpetrate false claims at the expense of the ignorant.

Peter Shulman,
Naperville, IL, USA.

Demand for electrolysis PWM supply

I read with interest your second rebuttal of the fallacy of producing hydrogen inside a car (SILICON CHIP, November 2008), to be later burnt in the engine in the name of efficiency or additional power. I note, however, that you have stated, "The popular internet process using stainless steel electrodes is much less inefficient". I believe you meant to state that this process is much less efficient, ie, more inefficient.

Working in a Jaycar retail store, I have numerous requests for PWM kits for the production of exactly what you detail and I attempt to gently advise the customer that what they are trying, while a healthy exercise, will just not give them what they want due to laws of physics and plain old science. Some of these people are not convinced that I know what I'm talking about (how could I, I just work here?) because I haven't read the same website they have but some have accepted that their project may not work but is good for a test.

Keep up the good work of proving or debunking marketing claims with science (like you did with the Enersonic Powersaver in May 2008) as it keeps me thinking of exactly why claims should be analysed in depth before being accepted as fact.

David Mudford,
Dunedin, NZ.

Comment: we congratulate you for attempting to advise customers in this way. Just for your information, we are planning to produce a PWM power supply with current regulation to suit "negative resistance" applications such as electrolysis, anodising and plating.

Low voltage connectors

I have used NEUTRIK "SPEAKON" speaker connectors for some years for low-voltage DC applications and they are probably the best product available. They are rated at 30A, screw terminated, fitted with an effective

cable strain relief, and twist-lock when mated, making them vibration proof. The polarity is marked on the connector bodies. The contacts are shielded to prevent short circuits and allow a double-ended lead to be used to connect a piece of equipment to its supply.

The part numbers are NL2FC for the lead-mounted plug and NL4MPST for the panel-mounted socket. I have learned the hard way not to use genuine imitations. If outdoor connectors are needed, the AMPHENOL C16 family of 4-pin connectors and accessories is an economical choice.

Ron Smith,
Rockhampton, Qld.

12V connector polarity

Referring to Ken Jobling's letter in the December 2008 issue, I would like to make a few comments. WICEN NSW used to use the same T-polarised connectors as a standard for many years going back to the 1970s. In NSW, the standard used was the "earth pin negative" system whereas, over the border in Victoria, they used the other "top of the T" for the negative system. This did cause problems for operators close to the state border, as both systems were equally logical.

The NSW Ambulance service also used to use the same sockets at that time, for plugging in ancillary equipment such as humidicribs and spotlights which were not polarity sensitive. The problem here was that, as there was no published standard polarity, the technicians who installed the sockets in the vehicles connected them in whichever way they felt like at the time, so there was no way of knowing which way a particular unit was installed.

About 10 or so years ago, we discovered the Anderson Powerpole, a hermaphroditic connector which comes in a number of different current ratings, the most appropriate of which were 30A and 75A for WICEN use. WICEN NSW has standardised on these since then. They can be put on both ends of a cable and it can be plugged in either way as everything can connect to everything else.

I and many other WICEN and non-WICEN amateurs have now standardised on these and use the standard configuration as published by the manufacturer. They are readily available through several sources including Jaycar Electronics & RS Components and are cheaper than the old "T" connectors. They are also a lot smaller and easier to terminate.

Eric van de Weyer, VK2VE,
Vaucluse, NSW.

More on DC connectors

Here is a link to some alternative 2-pin polarised sockets ($12 each) which D. J. of Tweeds Head (Mailbag, October 2008) should be using. A 2-pin polarised plug is also available.

These connectors were commonly used for DC applications for 12V, 32V and 50V. Once upon a time a 4-pin version was also available – people used them for trailer connectors. The link is: **http://12voltworld.com.au/product_info.php?products_id=201&osCsid=ba17bc004cbb322fb00dc1b56995500e**

These plugs and sockets are also available from automotive, trailer and electrical outlets as well. D. J.'s other alternative is to shop around at cheap $2 shops for 4-outlet cigarette sockets. Then his leads could have cigarette plugs on the ends and it would be easy to move equipment to the car.

Stephen Trembath,
Lyndhurst, Vic.

Supplier of splined shaft switches

I am currently building a dual-channel function generator based on the DSE discovery kit, which DSE no longer produce – shame really, it's a good kit.

I was looking for some splined rotary switches at all the usual outlets in Australia and NZ. I did not want the horrible black/white plastic ones and I wanted splined shafts with a metal body, as they are so much more reliable.

I did finally track down some suitable switches, from a company called Futurlec (**www.futurlec.com**). The switches were very reasonably priced and they arrived in only a few days. This might assist others who would want splined metal body switches.

Alex Scott,
New Plymouth, NZ.

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Mailbag: continued

Teletext playback does work without a TBC

In Mailbag (November 2008) Victor G. Barker said the JVC HR DVS1 S-VHS video recorder has a timebase corrector (TBC) and implied that is the reason why it can replay Teletext faultlessly. True, the HR DVS1 does have a TBC but it also allows you to turn it ON or OFF under the VHS MODE SET menu, so I duly put Mr Baker's theory to the test.

With the TBC ON the Teletext playback was perfect. With the TBC OFF the Teletext playback was perfect. So the TBC made no difference at all and is clearly not the reason why the HR DVS1 S-VHS recorder is able to record and replay Teletext perfectly.

Geoff Nicholls,
Hamburg, Germany.

Reworking portable tool battery packs

After acquiring a rather old battery operated hedge trimmer without a battery charger I was at a loss as to how I would charge the batteries safely. A stroke of good fortune was that the battery voltage was 18V, the same as the batteries in my Ozito drill. I also noted that this hedge trimmer battery pack only had two terminals whereas the Ozito packs had three.

As a result, I looked up the articles in the December 2006 issue of SILICON CHIP on "Bringing A Dead Cordless Drill Back To Life" and the "Cordless Power Tool Charger Controller", with the idea of modifying the hedge trimmer pack to use the Ozito charger. I also decided to investigate just how the Ozito charger operated and what (if any) protective circuitry was provided.

I discovered that over-temperature protection was provided (together with a timing circuit) to prevent overheating the batteries. This consisted of a thermal switch positioned in intimate contact with one of the battery cases in the tower section of the battery pack.

Carefully prising this away from its position, I found it to be a small metal case with two leads and labelled JRMA45. When I looked this up on the net I found it to be, as stated above, a thermally-controlled circuit breaker with a nominal operating (opening) temperature of 45°C.

I checked for the availability of this item in Australia without success but I did find an almost exact replacement from Master Instruments, Thermal Protector Model No. ER445A-06. I decided that if I incorporated one of these into my hedge trimmer battery pack and added the third, missing, contact (for which provision had been made), I could use the Ozito charger without fear.

It was then that I noticed in the article on rebuilding battery packs that the badly placed "thermistor", shown in one of the photographs, appeared to be more like a thermal switch, similar to some seen in small transformers. It seemed that this was probably more likely in simple charging circuits as the charging current would be switched off if the batteries overheated.

In any case I thought that you might be interested in revisiting this cordless tool battery business in the light of my findings. Maybe an even simpler (yet safe) charger could be developed than the one shown in December 2006, or a supplied "simple" charger easily modified to provide thermal protection. The website for Master Instruments is at **http://www.master-instruments.com.au/**

Colin Hiscock,
via email.

USB controlled lamp will flicker

I write with regards to the USB-Controlled Desk Lamp circuit that appeared in Circuit Notebook for October 2008. Although this circuit has merit, it has two basic faults. First, there is no hysteresis around the switching point. This will result in the lamp flickering badly at the onset of switch on.

Second, VR1 (100kΩ) is way too high and will result in some BC337s not saturating properly. Again flickering will occur. A value of around 20kΩ will give better results.

The text should also say that the LDR must be completely shielded from the lamp, as again flickering will occur

Comments on HDTV, Arduino and UV light boxes

What an interesting Mailbag featured in the December 2008 issue! T. J. writes on HDTV, calling it a joke. While I largely agree with this, he also comments that he has not seen any TV guides that feature HDTV programming. Firstly, this is not the case in (at least) metropolitan areas of NSW and usually TV guides will list down the bottom of each channel the variations seen on the HDTV version. This is another point in favour of his argument: HDTV is being wasted, as 90% of the programs on HDTV are exactly the same as on the SD channels.

R. L. comments about Arduino, saying that it is, perhaps, better than PICs, PICAXEs and BASIC stamps. I have already commented on this matter in APC magazine (June-July 2008), where an article was written, implying it to be some sort of revolutionary godsend.

I have used PICs now for some time and they are not only extremely cheap but more supported (see Microchip Technology's extensive library of application notes) and extremely powerful. They now boast 32-bit processors that are practically overtaking PCs (perhaps not). For a programming language, you can use either assembler for something simple and fast or Proton PICBASIC (**www.picbasic.org**) which isn't cheap but is very efficient and powerful.

R. L. also writes that he cannot find a comparison between PICs or PICAXEs and Arduino. All I can say is that he mustn't have looked very hard, as a simple Google search turned up many results. One such one is **http://letsmakerobots.com/node/80**

This outlines the pros and cons of both PICAXEs and Arduino. Final score? 6-3 in favour of the PICAXE! I will not comment on the BASIC STAMP, as these have largely stopped being used by the average hobbyist. However, it should be noted that their developer, Parallax, now sells an extremely powerful microcontroller called the Propeller, each with eight cores and the ability to output VGA graphics. These chips are probably more powerful than most of the micros I have mentioned previously. They are very cheap and yet relatively unknown. I urge readers to give them a go.

Sure, Arduino is a pretty neat takeoff of the AVR, just like the PICAXE and BASIC Stamp are takeoffs of the PIC. Arduino is proving to be extremely popular, however it is becoming so popular among the open source communities that the (often more powerful) opposition is often ruled out.

J. T. writes against the project of turning an old microwave oven into a UV light box. As SILICON CHIP replied, his comments do seem slightly alarmist! As written in the November 2007 UV light box article, escaping UV was not considered a problem, as the emitted radiation is mostly harmless and anything else is absorbed by the glass. And let's face it – UV light boxes are not the kind of thing that's going to be left on all day. You are probably going to be more in danger of getting your head jammed in the microwave door!

Speaking of PC board exposures though, I thought I should share my Kinsten exposure time for different materials:

Material	Exposure Time
Transparency	60-90s
LaserStar	70-100s
80gsm paper	290-320s

NB: these times are for ~30W of UV at a distance of 50mm. For non-UV lamps, exposure times should be multiplied by about five.

William Andrew,
Lane Cove, NSW.

when the lamp switches on if the light from the lamp is allowed to reach the LDR. As soon as the lamp turns on, the LDR will go to a low resistance which will switch off the lamp. The LDR will again go high, switching the lamp back on. The result will be more flickering.

Apart from this, the circuit should prove quite useful.

Jeff Monegal, CTOAN Electronics, North Maclean, Qld. SC

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Here's the drum on

Honda's 3.5 litre V6 with cylinder deactivation

By Leo Simpson

No doubt most readers will have seen the TV commercials for the current model Honda V6 Accord. The commercial shows a graphic demonstration of the engine's three modes whereby it can run on three, four or six cylinders. But while groups of musicians playing kettledrums might be spectacular, it does not give a clue as to how it's done.

If any normal 6-cylinder engine runs with one or two cylinders missing, it sounds and feels very sick indeed, with a major loss of smoothness and pulling power.

So how does the Honda Accord manage to run with one, two or even with three cylinders out – without loss of smoothness and power?

Not only does the engine manage to run smoothly in these three modes, the changes between modes while driving are imperceptible to the majority of drivers.

Honda is not the only car manufacturer to have an engine with variable cylinder modes. Chrysler has its Multi-Displacement System (MDS), Mercedes-Benz has its Active Cylinder Control and General Motors has Active Fuel Management.

But in contrast to Honda, these systems are less complex and apply to V8s rather than a V6.

The Honda V6 uses all six cylinders during start-up, heavy acceleration and when climbing steep hills. At high cruising speeds and when climbing modest inclines, the engine drops into 4-cylinder mode and finally, at light engine loads, it runs on just one bank of three cylinders. In 4-cylinder mode, it runs with one cylinder in each bank deactivated.

Honda uses its i-VTEC (intelligent Variable Valve Timing & Electronic Lift Control) to shut down the unwanted cylinders. It does this by closing the intake and exhaust valves. The pistons then continually compress and de-compress the air trapped in the cylinders and while this might seem like a power wasting process, it actually reduces the cylinder pumping losses compared to normal operation.

In fact, Honda claims that pumping losses can be reduced by up to 65%.

Honda's i-VTEC is another variant of the VTEC systems which have been used on its four and six-cylinder engines for quite a few years. VTEC enables large increases in volumetric efficiency of an engine and is an alternative to turbo-charging.



This under-bonnet photo belies the complexity of the engineering underneath those plastic cowls. In fact, it looks similar to the previous 3-litre engine which had a simpler VTEC system and no cylinder deactivation.

In effect, it enables the benefits of a modest camshaft profile for smooth low speed running and a high-lift high-duration camshaft profile for much higher outputs at high engine RPM. As a result, Honda's VTEC petrol engines are among the most powerful naturally aspirated (ie, not turbocharged) motors produced worldwide.

The Honda 3.5-litre V6 is a SOHC (single overhead cam) engine, meaning that it has two camshafts, one for each bank of three cylinders. Switching between the two cam lobes (on each camshaft) is controlled by the ECU which continually monitors engine oil pressure, engine temperature, vehicle speed, engine speed and throttle position.

At the switch point a solenoid is actuated to control a spool valve to operate a locking pin which locks the high RPM cam follower to the low rpm ones. From this point on, the poppet valves open and close according to the high-lift profile, which means that the engine's breathing is greatly improved.

The switch-over point is variable, between the minimum and maximum point, as determined by engine load. The switch back from high to low cam lobes is set to occur at a lower engine speed than the up-switch, to avoid surging if the engine is operating at or around the switch-over point. (Readers would know this as "hysteresis").

The SOHC version of VTEC applies variable valve lift, duration and timing only to the intake valves but in the 3.5-litre V6 it also controls valve deactivation via extra hydraulic controls. At this point, the story becomes more complicated.

First, consider that the cylinders in the V6 are numbered from 1 to 6, with the three cylinders on the rear bank being 1, 2 & 3 and those in the front bank numbered 4, 5 & 6. As already noted, cylinders 1, 2 & 3 are

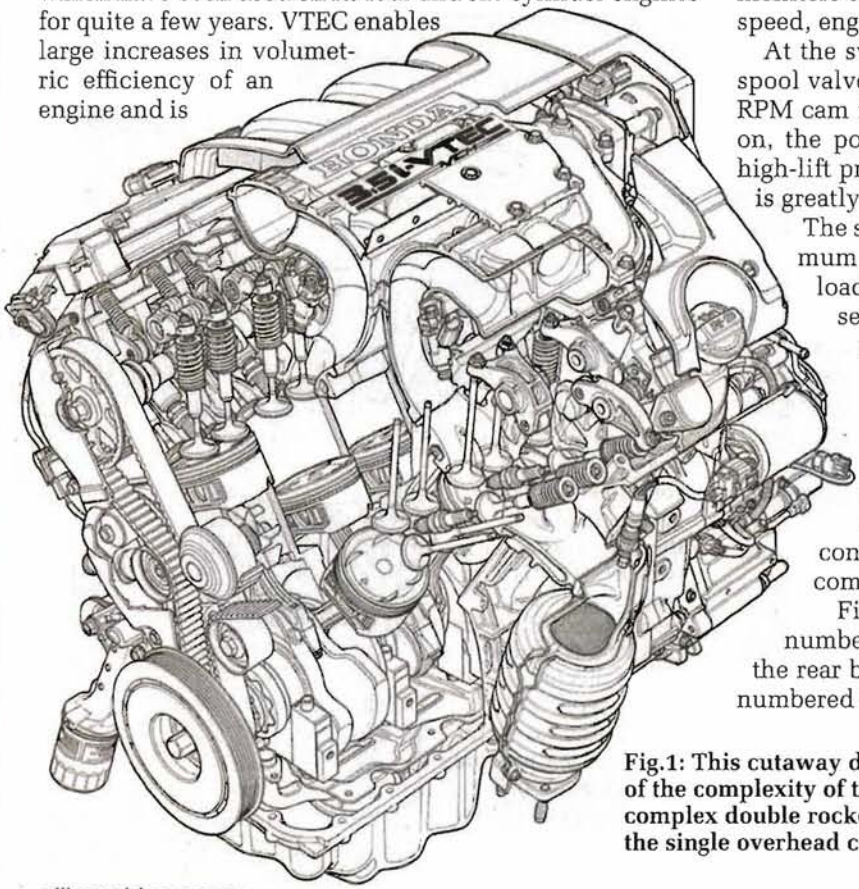
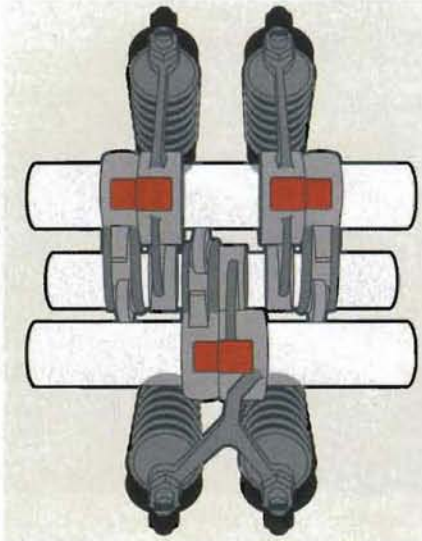


Fig.1: This cutaway diagram of the Honda engine gives some idea of the complexity of the design but it is difficult to make out the complex double rocker arm system which drives the valves from the single overhead camshaft (one for each bank).



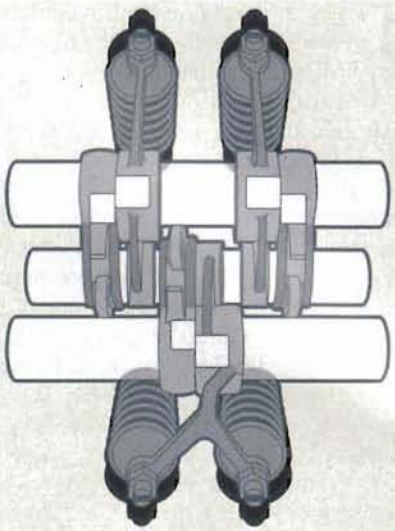


Fig.2 (left): this diagram shows how synchroniser pistons (red) lock primary and secondary arms are locked together so that the camshaft controls the four poppet valves for each cylinder. At right, Fig.3, the synchroniser pistons are unlocked and so the poppet valves are disabled, de-activating the cylinder.

deactivated in 3-cylinder mode while cylinders 3 & 4 are deactivated in 4-cylinder mode.

To enable these four cylinders to be deactivated, they have two types of rocker arm associated with the camshafts – primary and secondary. The primary rockers follow the camshafts while the secondary rocker arm compresses the valve springs.

Synchroniser pistons lock the rocker arms, enabling them to open or close the valves as required. By the way, there are four valves per cylinder, two inlet and two exhaust, making a total of 24 poppet valves.

Fig.2 shows how the primary and secondary rocker arms are locked together. When the ECU determines that a cylinder is to be deactivated, it reduces the hydraulic pressure to the primary rocket arm. This slides the synchroniser piston to the side, towards the secondary rocker arm, to disengage both the primary and secondary rocker arms, as shown in Fig.3.

As a result, the camshaft is effectively disconnected from the rocker arms and the inlet and exhaust valves are held in the closed position by the valve springs. Thus the cylinder is sealed and the piston moves up and down to compress and de-compress the trapped air, as depicted in Fig.4.

No fuel is injected at this time but the spark plugs continue to fire so that they do not cool down, minimising the possibility of plug misfire or fouling when normal cylinder operation is restored. When that happens, the relevant synchroniser pistons slides back into position to engage both the primary and secondary rocker arms and normal valve operation resumes.

It is interesting to consider the firing order of the engine in the three different modes. Normal firing order for the V6 is 1-4-2-5-3-6 and as already noted, the spark plugs are driven in the same order whether cylinders are deactivated or not. Hence, the firing order in 4-cylinder mode is 1-2-5-6 and in 3-cylinder mode, where one bank of cylinders is deactivated, the firing order is 4-5-6.

As you can imagine, the 3 and 4-cylinder modes lead give rougher engine operation than when in 6-cylinder, and the 4-cylinder mode is particularly rough, due to irregular firing order (ie, two firing strokes on the front back and two strokes on the rear bank). However, by restricting cylinder deactivation to higher speed and lower engine loads, this reduction in engine smoothness is minimised.

Active engine mounts

Where the engine potentially becomes very rough is at the point of cylinder deactivation, whether from six to four cylinders or for from four to three and back again. Honda's VCM (Active Control Mounts) counteracts this. The active control engine mounts are depicted in Fig.5a & 5b. In effect, each engine mount comprises a linear solenoid which drives a plunger to control hydraulic fluid inside the mount. Each solenoid is driven by an audio amplifier with a signal in anti-phase to the vibration at each mount.

The ACM system operates by using the crankshaft and

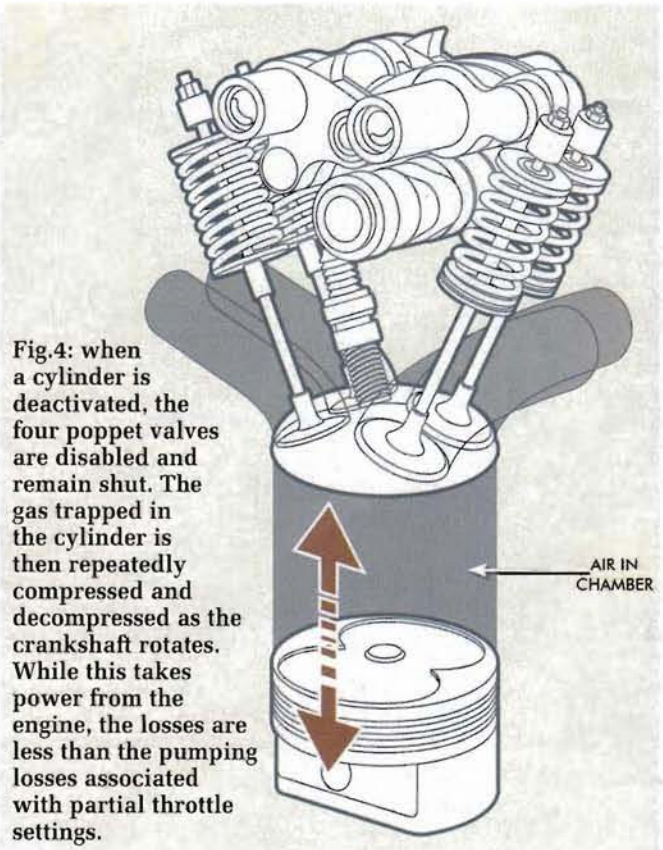


Fig.4: when a cylinder is deactivated, the four poppet valves are disabled and remain shut. The gas trapped in the cylinder is then repeatedly compressed and decompressed as the crankshaft rotates. While this takes power from the engine, the losses are less than the pumping losses associated with partial throttle settings.

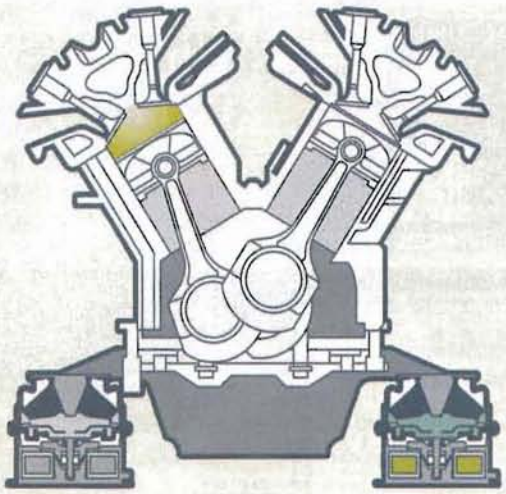


Fig.5a: Instead of conventional engine mounts the Honda 3.5l V6 has "active" mounts each involving large linear solenoid and an oil damper system.

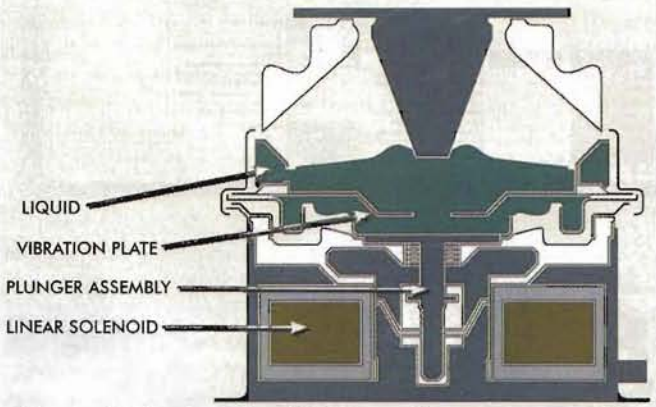


Fig.5b: the linear solenoid (it has a linear response to a drive signal) is driven with an audio signal to counteract unwanted engine vibration when in 3 or 4-cylinder modes or when changing from one mode to the next.

camshaft position sensors to estimate engine vibration when a cylinder is deactivated or reactivated and it feeds an appropriate signal to the solenoids to counteract that vibration.

At the same time, the transition between the cylinder modes is smoothed by adjusting the ignition timing, the drive-by-wire throttle position and by turning the torque converter lock-up on and off. As a result, the transition between three, four and six-cylinder operation is unnoticeable.

Noise cancellation

As a final measure to control the perceived noise of the engine, the Honda V6 Accord uses Active Noise Control (ANC) which SILICON CHIP readers would know as noise cancellation. ANC is similar to the Bose Active Noise Control system used in the current model Honda Legend.

In the case of Honda V6 Accord, the vehicle's sound system provides noise cancellation and it operates regardless of whether the radio or CD player is in use.

There are two microphones inside the cabin, one in the overhead console and one on the rear parcel shelf, to pick up low frequency engine and road noise. This noise signal

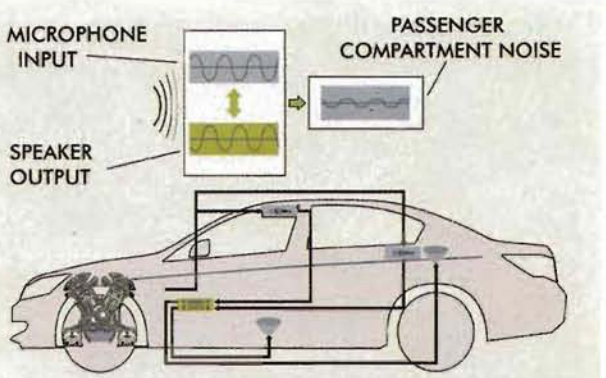


Fig.6: Honda's Active Noise Cancellation uses two microphones within the cabin. The low frequency engine and road noise signals they pick are processed and then fed through the car sound system to give a claimed cancellation figure of –10dB.

is reversed in phase and fed to the sound system amplifiers and loudspeakers to produce a claimed noise reduction of 10dB – a very significant result.

Conclusion

The 2008 Honda V6 with cylinder deactivation, active engine mounts and active noise control is a very complex package. It results in a car with a very powerful but economical engine and one with a very quiet ride.

Power output of the 3.5-litre V6 is 202kW (270 BHP) at 6200 RPM and 339Nm of torque at 5000 RPM, considerably higher than the 177kW and 287Nm of the 3-litre V6 it superseded. Even so, its fuel consumption is reduced with respect to the previous engine.

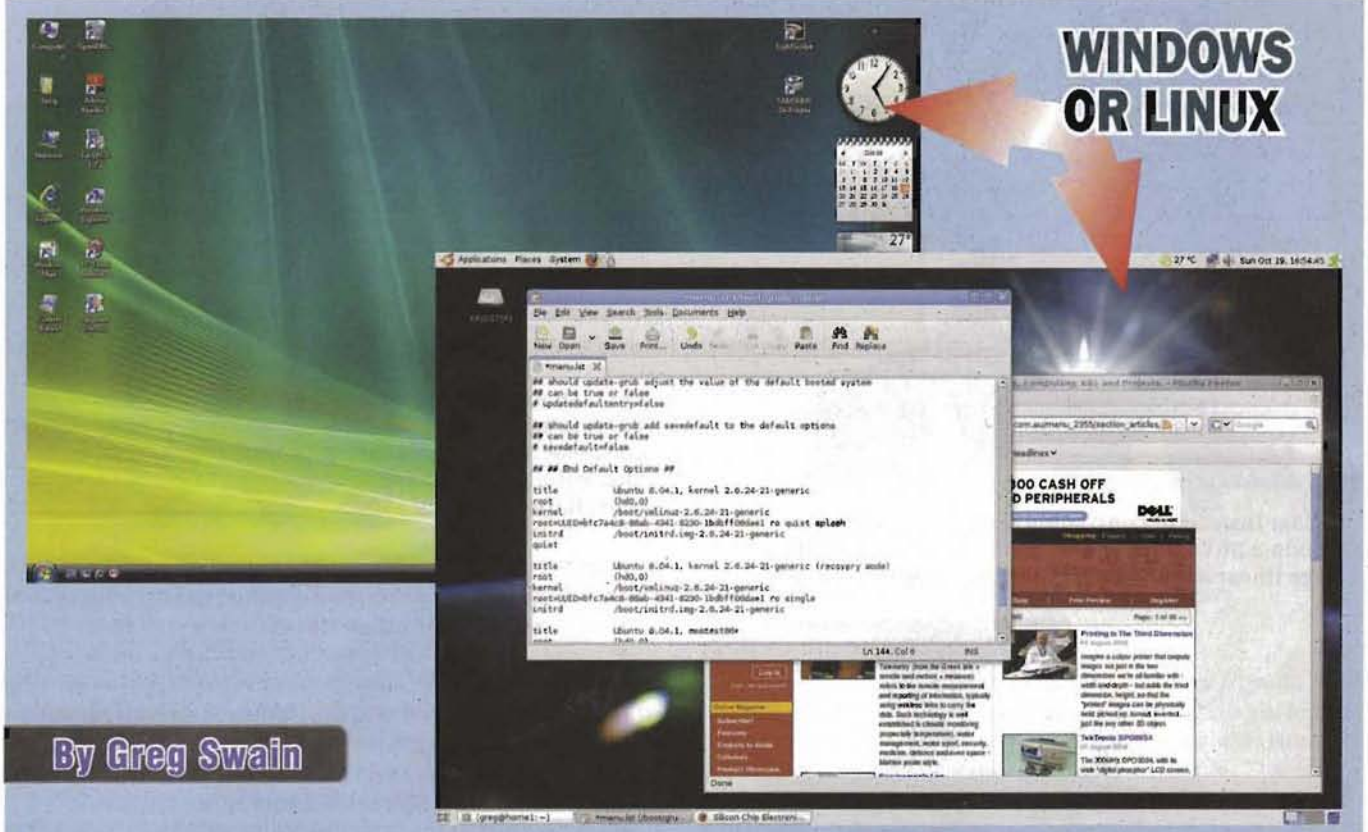
Which is all well and good but we should conclude on a sober note. While the new 3.5 litre V6 is clearly more efficient, it is installed in a body which is larger and considerably heavier than its predecessor: 1650kg compared with 1525kg (V6 luxury model in both cases). That's an increase of 125kg. The same thing happened when Honda previously changed models, with the weight for the V6 Luxury model increasing by 71kg. So in two successive models, Honda has increased the weight of its top Accord model by almost 200kg. Honda is not alone in this and most manufacturers continue to increase the weight of their cars with each model change.

So while engines continue to improve in power output and specific fuel consumption, due to increasingly complex technology, how much more would fuel economy improve if weight was not allowed to increase with each model change?

NOTE: Honda Australia was not willing to release any of the finer technical details of the operation of this engine or its control systems for the preparation of this story. All photographs and diagrams are courtesy of Honda.

Reference:

Development of a 6-Cylinder Gasoline Engine with New Variable Cylinder Management Technology, Mikio Fujiwara, Kazuhide Kumagai, Makoto Segawa, Ryuji and Yuichi Tamura, (Honda R&D Co, Ltd). SAE Technical Paper Series, 2008 World Congress, Detroit, Michigan, USA.



By Greg Swain

Dual Booting With Two Hard Drives

Dual-boot set-up tutorials usually assume that you're installing the two operating systems into separate partitions on the same hard disk drive (HDD). But what if you want to use two hard drives – one for each OS – and keep both bootloaders intact?

DESPITE USING WINDOWS in the work environment, I have also been a long-time user of Linux (Ubuntu) at home. Ubuntu is an easy-to-use, stable operating system with a host of applications and is great for browsing the net (using Firefox) and for email and instant messaging.

A big advantage of Linux is that it's a very secure operating system. Certainly, you don't have the worries about viruses and other internet nasties that you do with Windows.

However, reality dictates that most people use Windows to run critical applications. This means that if you want to experiment with Ubuntu, a dual-boot system is the way to go.

Taking it easy

The most common path to a dual-boot Windows/Linux system is to install Windows first and then install Linux onto a second partition on the same hard drive. If you do that, the Linux installer automatically recognise the presence of the Windows installation and includes it in the Linux bootloader (or at least, that's what should happen).

After that, you simply press the Esc key when prompted as the system starts up to bring up the boot menu. This allows you to select which operating system to boot. If you don't do anything, the system automatically boots the default OS after a preset time.

Similarly, if you install Windows on one hard drive and then subsequently

install Linux on a second hard drive, Linux should again detect the Windows installation and automatically set up with a dual-boot system. The only proviso here is that the Windows disk must remain as the primary drive (or have boot priority in the BIOS).

Note that, in each case, the Windows bootloader is overwritten in the master boot record (MBR) by the Linux bootloader (known as "GRUB") when you install Linux. This means that if you later reformat the Linux partition (or remove the Linux drive), then you will no longer be able to boot Windows unless you reinstate the Windows bootloader.

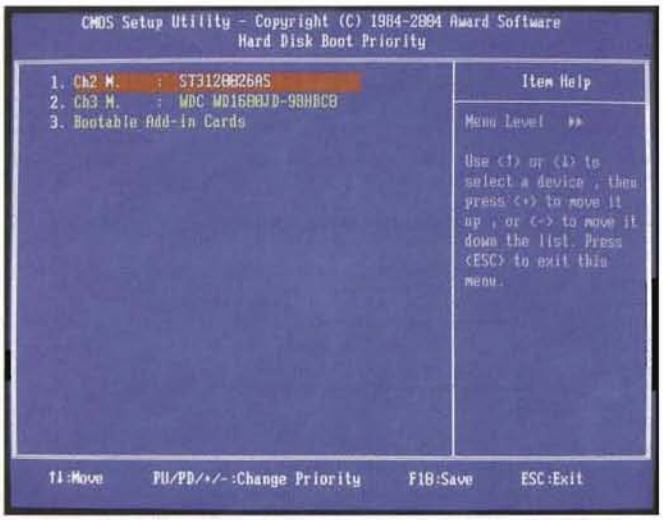


Fig.1: the hard disk boot priority (ie, if your PC has two or more hard disk drives) is set up in the system BIOS. The system will boot from the first drive in the list, provided it has a valid operating system.

Linux first?

What if you install Linux first and then install Windows? Unfortunately, you don't automatically get a dual-boot system, since the Windows installer will not recognise a Linux installation. Instead, it simply replaces the Linux bootloader in the MBR with its own and the system then only boots into Windows.

The way around this is to reinstate GRUB as the system bootloader. Just how this is done is covered in some excellent guides on dual-boot systems published on the APC magazine website at http://apcmag.com/howto_home.htm

The APC guides cover all sorts of dual-boot scenarios involving Vista, XP and Linux – eg, Vista and Linux, XP and Linux, and Vista and XP. It doesn't matter which system you install first; the APC guides have it covered.

We don't intend to repeat what's in those guides here. Instead, we will concentrate on one dual-boot scenario that's not in the APC guides and that's where Windows and Ubuntu Linux have been independently installed on separate hard disk drives (ie, with only one disk drive connected during each install).

Why separate HDDs?

There are several reasons why you might want to keep the two operating systems on separate disk drives. First, while a single-disk dual-boot Windows-Linux system works perfectly well, what if you want to later completely blow the Linux installation (including the GRUB bootloader) away?

As stated above, the answer is to reinstall the Windows bootloader in the MBR and while it's a straightforward procedure, you still have to do it (and risk something going wrong).

There's also a risk that you might foul up an existing Windows installation if you do the wrong thing when installing Linux. And that can be easy to do when it comes to altering partition sizes and formatting partitions for the Linux installation (even with two disk drives), particularly if you're inexperienced.

By far the safest route to a dual-boot system is to install each operating system onto its own hard disk drive, with only one disk connected during each install. That way, you can not possibly foul up an existing installation on the other (disconnected) drive when installing the second OS. It also means that the bootloader for each operating system is kept intact on its own drive.

The basic scenario

OK, so here's the basic scenario. First, you've installed Windows Vista (or Windows XP) on one hard drive and got it all working correctly. You've then disconnected that drive from your computer, plugged in a second hard drive and installed Ubuntu.

Finally, having done all that, the first drive has then been reconnected. The result is a machine with two hard disk drives, one with Windows installed and the other running Ubuntu.

Of course, it won't be a dual-boot arrangement but you can choose which OS you want to boot simply by changing the hard disk boot priority order in the system BIOS – see Fig.1. If you give the Windows disk priority, the system will boot into Windows. If you move the Linux disk to the head of the queue, the system will boot into Linux.

As indicated previously, the beauty of this scheme is that the bootloader of each operating system is left intact. That means that you can remove either disk and the operating system on the remaining disk will boot normally. It's also a very safe set-up that's easy to convert to dual-boot.

Dual booting

Unless you rarely use one OS, having to get into the system BIOS to change the disk boot priority is not the way to go. Instead, it's better to convert the system to dual-boot, so that you can choose which OS you want from a boot menu.

That's done by modifying the bootloader on one disk and giving that disk boot priority. In other words, you can

Changing Disk Drive Boot Priority

If your PC is less than about five years old, you can change the hard disk boot order in the system BIOS (see Fig.1). This should cater for both SATA and IDE drives (or a mixture of both) – it's just a matter of moving the desired boot drive to the head of the queue.

On older systems with IDE-only drives, it might not be possible to do this in the BIOS. Instead, you will have to change the boot priority using one of two methods:
(1) plugging one drive into the primary IDE port and the other into the secondary port; or
(2) where both drives are on the same IDE cable, by changing the master/slave jumpers on the drives (the master drive boots first).

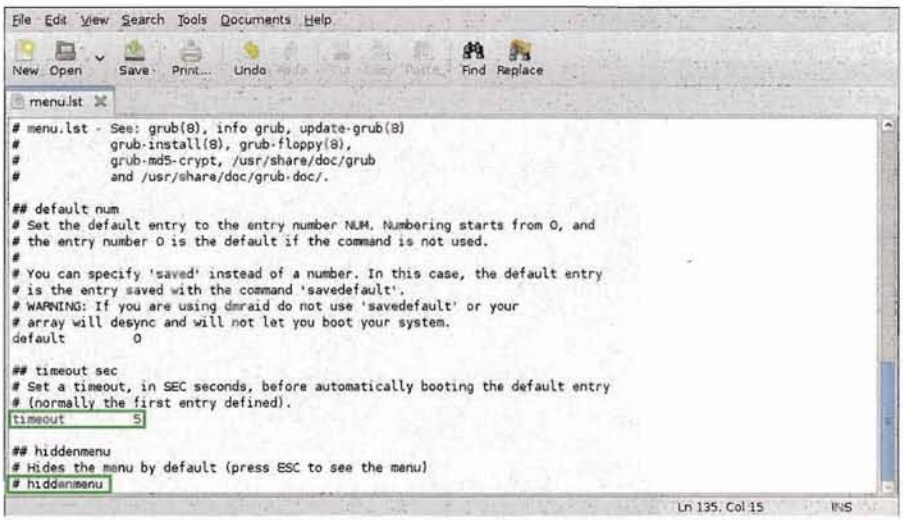


Fig.2: setting the timeout value and commenting out the "hiddenmenu" line in GRUB's menu.lst file.

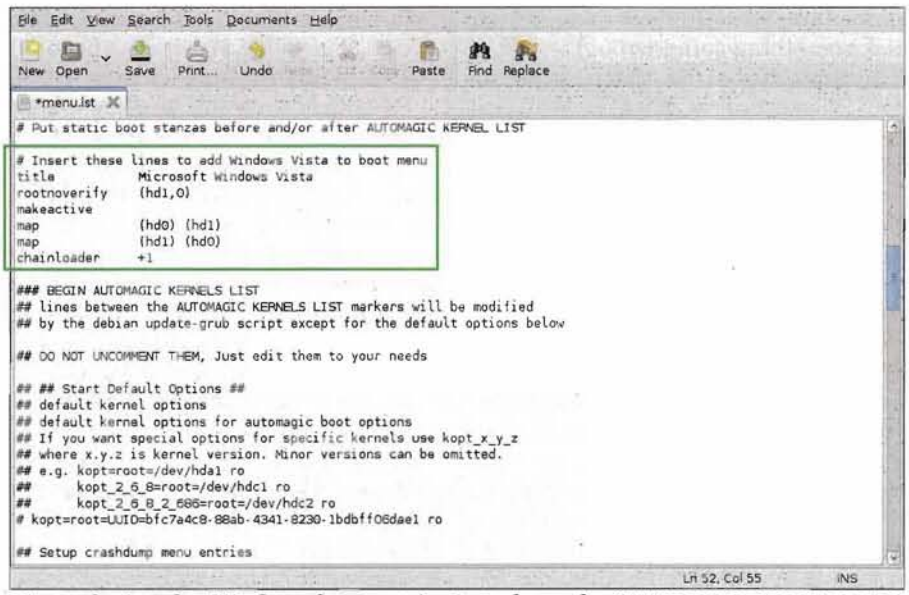


Fig.3: placing the Windows boot entries just above the "### BEGIN AUTOMAGIC KERNELS LIST" entry in GRUB's menu.lst file makes Windows the default. If you want Ubuntu to be the default, insert the Windows entries after the "### END DEBIAN AUTOMAGIC KERNELS LIST" line.

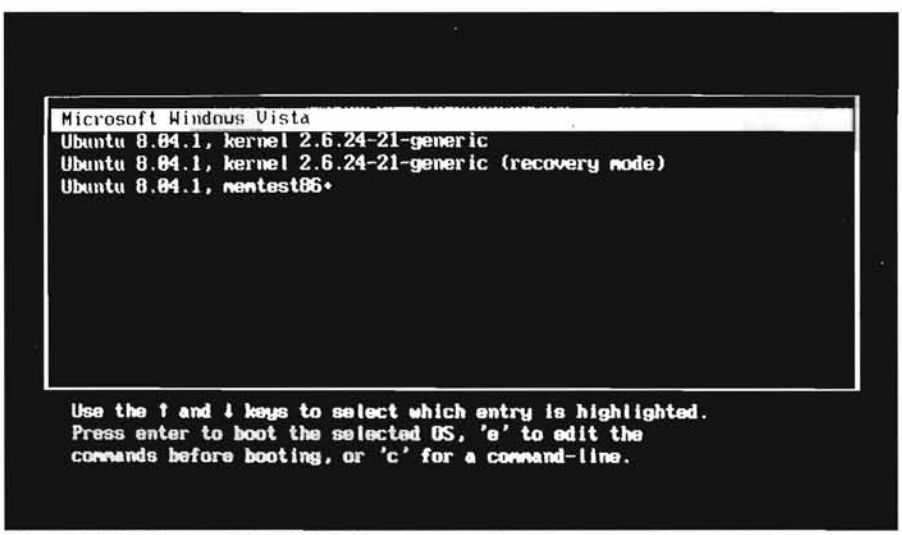


Fig.4: this is the resulting GRUB boot menu that appears at system start-up.

either modify the Windows bootloader and give the Windows disk boot priority in the system BIOS, or you can modify the Linux bootloader and give the Linux disk boot priority.

We'll look at both methods here but first, **be sure to back up any critical data that you might have on the two disks.** Both dual-boot methods are quite simple to implement but backing up is always a worthwhile precaution, as accidents can occur (you could drop a disk, for example).

Using the Linux bootloader

The easiest method is to modify the Linux bootloader (known as "GRUB") and this will work equally well for a Vista-Linux system or an XP-Linux system. All you have to do is edit the **/boot/grub/menu.lst** text file which GRUB uses to store the boot options.

Here's the step-by-step procedure:

STEP 1: go into the system BIOS and give boot priority to the Ubuntu hard disk (see Fig.1).

STEP 2: boot into Ubuntu and make a backup copy of the GRUB boot menu. Do this by copying the file **/boot/grub/menu.lst** to an external flash drive (or to some other location).

STEP 3: enter **sudo gedit/boot/grub/menu.lst** in a terminal window and type in the root password at the prompt. This will open the **menu.lst** text file in the **gedit** text editor.

STEP 4: scroll down the file and change the **timeout** line to a suitable value (see Fig.2). This value sets the boot menu display time (in seconds) during start-up. A value of 5 to 7 should be ideal (the default is 3).

STEP 5: comment out the **hiddenmenu** line by inserting a "#" character at the start of the line (see Fig.2). This ensures that the boot menu is shown at system start-up.

STEP 6: scroll down and locate the line "**### BEGIN AUTOMAGIC KERNELS LIST**". If you want Windows to be the default, then insert the following entries into **menu.lst** above this line, as shown in Fig.3:

```
title          Microsoft Windows Vista
rootnoverify   (hd1,0)
makeactive
map            (hd0) (hd1)
map            (hd1) (hd0)
chainloader    +1
```

This adds Windows Vista to the GRUB bootloader.

Alternatively, if you want Ubuntu to

be the default OS, then scroll down further and locate the "**### END DEBIAN AUTOMAGIC KERNELS LIST**" entry in **menu.lst.** Insert the Windows Vista boot entries after this line (ie, the first entry is the default operating system.

If you have XP instead of Vista installed, simply change the title line to "Microsoft Windows XP".

Note that you should keep the Windows boot entries out of the area between the begin and end **AUTOMAGIC KERNELS LIST** lines. If you don't do this, the Windows boot entries will be overwritten during the **update-grub** process each time the kernel is updated.

Keeping the Windows boot entries outside this area ensures that they remain static and won't be lost during kernel updates (not that it's really any great hardship to re-enter the necessary lines).

STEP 7: save the **menu.lst** file, exit Linux and reboot the machine.

That's it – you now have a fully-functioning dual-boot system. Each time the machine starts, the GRUB boot menu will appear and you will be able to choose between Windows and Ubuntu – see Fig.4.

Breaking up is easy to do

Divorcing the two systems couldn't be easier. As indicated previously, the bootloader on each disk is left intact, so if you remove one disk, the system will still boot into the OS on the remaining disk.

Of course, if you remove the Windows disk, the Windows entry will still appear on the GRUB boot menu when you boot Linux. That can be fixed by simply deleting the Windows boot entries from the **menu.lst** file.

Note also that if you change the disk boot priority in the BIOS and subsequently make the Windows disk number one, then the system will always boot into Windows. It will be as though the Linux disk doesn't exist. This means that you must assign boot priority to the Linux disk in the system BIOS if you want GRUB to bring up the dual-boot menu at system start-up.

Using the Windows Vista bootloader

If you're happy with the GRUB bootloader (and why not?), then you don't have to go any further. However, if you have Vista and Linux set-ups and want to dual-boot using the Windows bootloader, then that's also easy to do.

Adding the Linux boot entries to the Vista bootloader is best done using a program called EasyBCD from NeoSmart Technologies. This freeware program has an easy-to-use graphical interface that makes tweaking the Vista bootloader a breeze. **Note: EasyBCD is for use with Windows Vista only – it can not be used with Windows XP.**

OK, let's go through the procedure step-by step:

STEP 1: give the Ubuntu disk boot priority in the BIOS, then boot Ubuntu.

STEP 2: enter **sudo gedit/boot/grub/menu.lst** in a terminal window and type in the root password when prompted. This will open the **menu.lst** text file.

STEP 3: scroll down to the end of the file and locate the Linux boot entries between "**## ## End Default Options ##**" and "**### END DEBIAN AUTOMAGIC KERNELS LIST**". Copy these entries, paste them into a new text file and save the file to an external USB drive (eg, a flash drive).

STEP 4: exit Ubuntu, then modify the BIOS to give the Vista disk boot priority and start Windows.

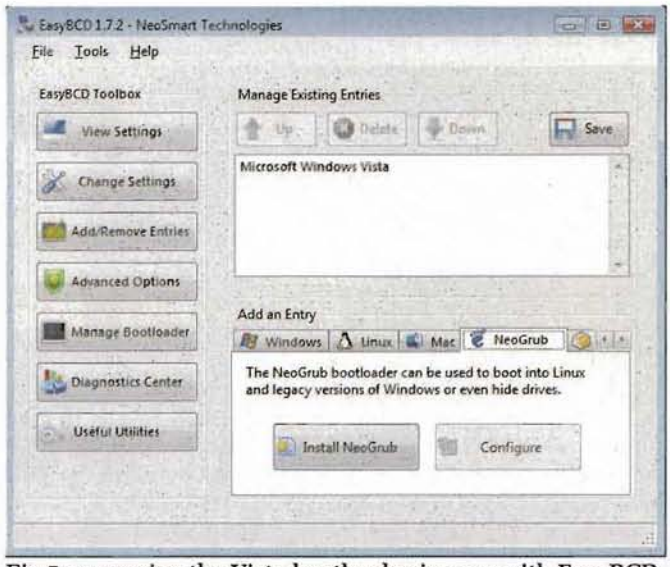


Fig.5: managing the Vista bootloader is easy with EasyBCD. Here's how to install NeoGrub, to dual-boot Linux.



Fig.6: clicking "Install NeoGrub" (Fig.5) adds the NeoGrub Bootloader under the existing Windows Vista entry.



Fig.7: you can also change various settings in EasyBCD including the default OS and the menu timeout (seconds).

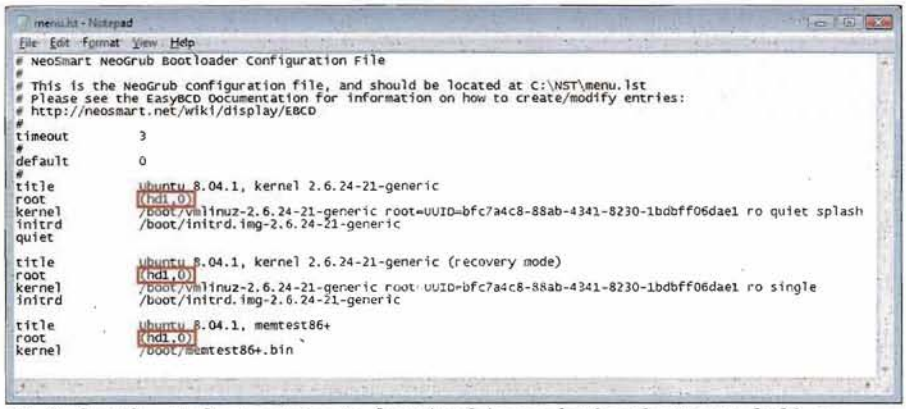


Fig.8: the Ubuntu boot entries in /boot/grub/menu.lst (on the Linux disk) are copied and pasted into the NeoGrub configuration file at C:\NST\menu.lst on the Windows disk. This enables the Vista bootloader to dual-boot Vista and Linux. Don't forget to change all (hd0,0) entries to (hd1,0).

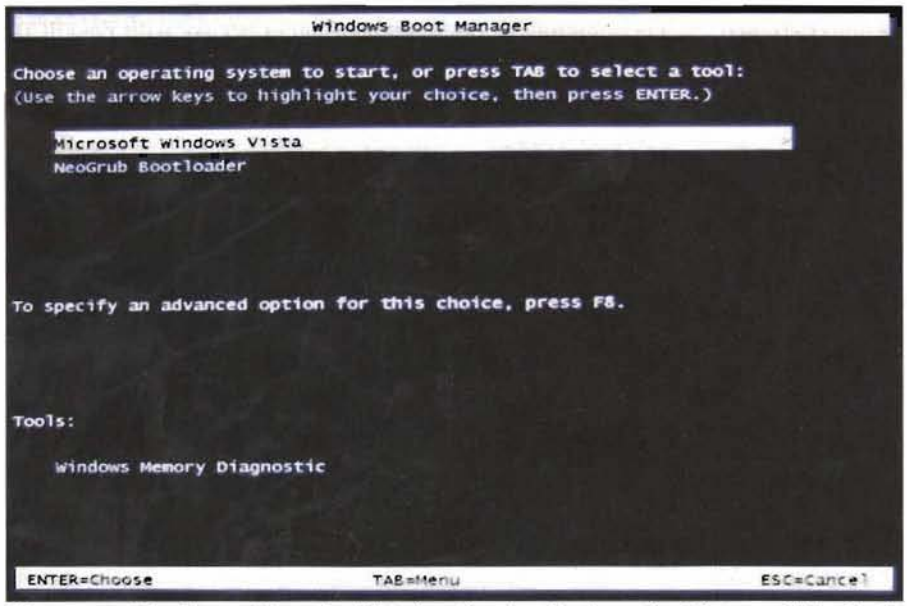


Fig.9: once it's all working, the Vista bootloader displays the Vista and NeoGrub boot options in the menu at system start-up.



Fig.10: selecting the NeoGrub Bootloader option from the menu brings up the Linux boot options. If no further action is taken, the default will load at the end of the timeout period set in C:\NST\menu.lst.

STEP 5: download and install EasyBCD. You can grab it here: **http://neosmart.net/dl.php?id=1**

STEP 6: launch the application and click on the **Add/Remove Entries** button to bring up the dialog shown in Fig.5.

STEP 7: click on the **NeoGrub** tab, then click the **Install NeoGrub** button. The "NeoGrub Bootloader" entry will be added beneath the existing "Microsoft Windows Vista" entry (Fig.6).

STEP 8: click **Configure**. This creates the NeoGrub **menu.lst** file in the **C:\NST** folder. This file is analogous to the **menu.lst** file in Ubuntu, except that it's initially almost empty.

STEP 9: open **C:\NST\menu.lst** in Notepad and paste in the Linux boot entries that you previously saved on your USB drive.

STEP 10: change all **(hd0,0)** entries in the **menu/lst** file to **(hd1,0)** – see Fig.8. This is necessary since Ubuntu in now on hard disk 1, partition 0 (as opposed to hard disk 0, partition 0 when the Linux drive has boot priority).

STEP 11: save the **C:\NST\menu.lst** file, exit Notepad and reboot the computer. You now have a working dual-boot system using the Vista bootloader.

When the machine restarts, it will display a boot menu with two options (see Fig.9):

(1) Microsoft Windows Vista; and
(2) NeoGrub Bootloader.

Selecting the latter will bring up the Linux boot options shown in Fig.10.

Kernel updates

One drawback of using the Vista bootloader is that the **C:\NST\menu.lst** file will not be automatically updated if you update the Linux kernel. This means that if you do update the kernel, then you will have to copy the updated boot entries from **/boot/grub/menu.lst** (on the Linux drive) to the **C:\NST\menu.lst file** on the Windows drive.

Don't forget to change the **(hd0,0)** entries to **(hd1,0)** each time you do this.

GRUB is more convenient

Using the GRUB bootloader is slightly more convenient if only because you don't have to edit **C:\NST\menu.lst** every time you do a kernel update. The GRUB bootloader is also slightly easier to set up but in the end, the choice is yours. **SC**



The state-of-the-art in GPS: Navman Platinum S300t

SatNav (GPS) units were one of the "hot" items at Christmas time. Most were the low-cost, low-featured variety. But we wanted to see what was offered in the top-of-the-range models and Navman came to the party with their just-released "Platinum" S300t. About the only thing it doesn't have is the kitchen sink. Oh, did I miss that?

My main reason for visiting the Sydney Motor Show back in October was to get as much information as possible on electric cars – and in particular, the Chevy Volt (see report in SILICON CHIP, December '08)

Apart from that, I found the show somewhat disappointing with quite a number of manufacturers choosing not to show (no pun intended!)

Sure, it was all glitz and glamour, lots of bright lights and agonisingly sparkling paintwork – but not much in the way of substance, especially for us and, therefore, readers of a technical electronics magazine.

So I started to look for other items of interest. Apart from a long, envious drool at the masterpiece of auto engineering that Enzo Ferrari kindly named after me (Testarossa, of course!) and staring gobsmacked at a magnificently restored Ford GT with an estimated auction price approaching $300,000 (you could buy them for less than $20,000 brand new!) there really wasn't much to hold my interest, at least.

As I was about to leave, I took another look through the press kit which organisers gave to members of the media. It was mostly one PR blurb after another, until I got to the Navman folder.

"What's this? A brand new GPS unit?". My excitement lasted only a few milliseconds when I realised that it wasn't a "real" GPS but unfortunately only a case (yes, a real GPS case!) with a weight inside it to simulate the works.

There was also an invitation to visit the Navman stand to see what all the fuss was about with their new Platinum range. I'm not sure the PR effort was all that successful, as mine was the first dummy GPS the people on the stand had seen (and this was day 3!).

Anyway, the most helpful Navman salesman took me through the features of this new model and that was enough to convince me that we should get hold of one for review.

by Ross Tester

Why look at SatNav?

Let's face it: SatNav (GPS) units are

the proverbial "dime a dozen". They're long past being a toy for the idle rich; in fact, GPS units are now inbuilt into many cars, ranging from the humble daily drive to some very up-market (read expensive!) marques.

For those who don't have one built in, the stuck-to-the-windscreen models are becoming ubiquitous. Just have a look at the number of cars being driven around these days with a GPS hanging off the glass.

Police tell us that the windscreen mount is a dead give-away for thieves because 99% of people place their GPS in the glovebox when they leave the vehicle. Even if the glovebox is locked, that's only a few moments work with a screwdriver.

The number of portable GPS units has just taken a monumental increase – with belt-tightening the order of the day last Christmas, large Plasma and LCD TVs took a hammering in the sales departments but retailers reported GPS units just about flying out the door.

Indeed, there were several GPS units being advertised at prices seemingly impossible even last Christmas – around $100 in some cases.

But these were/are, in the main, "old technology" with 3.5-inch screens and not much more than basic GPS functions (eg, where am I, show me how to get to "X"). We weren't really interested in these because they are so common and just about everyone understands how GPS works (if you don't, see the side box!)

But the Navman S300t Platinum GPS was anything but "basic" – and we thought our readers would like to see what a state-of-the-art GPS unit offers, albeit with a rather more significant pricetag than sub-$100!

In fact, the platinum range have recommended retail prices ranging from $429 up to $699 for the unit we played with. I don't think $699 is the most expensive GPS unit on the market these days but it would have to go close.

So for this amount of money, you'd want to get a lot more than basic GPS functions, right? You do!

We'll look at these in a bit more detail shortly but first, let's describe the unit itself.

The first thing you notice about the Platinum series is, unlike most GPS units, the complete absence of buttons on the front panel. That's because the myriad of controls have been migrated to the touch screen. That screen, by the way, now includes "glide touch" – you navigate around the map or menus by gliding your fingers over the screen. That's really neat.

Ignoring the absence of buttons, the S300t looks not too dissimilar to many of the other GPS units on the market these days (I'm sure Navman would argue with that!) but it's only after use that the differences become apparent.

With a 4.3-inch "widescreen" it measures 130 x 78mm and is just 13.5mm thick. Weight is 150g. It looks identical to the three other S-series (Platinum) models but it's the list of features that places the S300T at the top (at least currently) of Navman's evolutionary tree.

Released only last November, Navman claim the four models in the Platinum series – and the S300t in particular – represent the very latest in satellite navigation technology.

As well as providing a lot more "grunt" inside the case, importantly they have simplified the user interface to just three key areas: "go" for regular navigation instructions, "find" to search for specific places, areas or businesses and "explore" to search an area in greater detail or pull up information about points of interest (POI) online using TrueLocal.

Each in the range sport a 400MHz processor with either 1GB or 2GB of memory (the top two models have 2GB) and a micro-SD card slot.

Advanced features

In no particular order, just some of the features offered by the S300t are:

- **Live traffic updates** using the SUNA Traffic Message Channel (TMC). Updates are provided continually as road conditions are monitored, including accidents, incidents and traffic congestion. It will provide the location, how long the likely delay and even give you options to detour you around the location. A lifetime subscription to SUNA TMC is included.
- **Maps cover 100%** of the population of Australia – over 1.1 million kilometres of roads with shortcuts, fuel, parking, places to eat, tourist information and much more. The maps are powered by Navteq and



Reproduced not far off life size, the Navman S300t is shown here in its 3D mode with major buildings and landmarks as you would see them driving along – in this case, Sydney's Town Hall and Queen Victoria Building. Also on this screen is a traffic warning from the SUNA TMC, showing where the delay is and average speed. The S300t is remarkable for the lack of controls. In fact, there are two on the front – the blue stripe (bottom right) invokes the on-screen menu, which basically controls every function and setting. The pin (just visible top right) allows you to "fix" a current position so that you can return to it later. It's a very handy feature when you are, for example, looking for an address in an strange area. The only other control is the power switch on the top of the unit. Almost hidden here is the power connector on the underside.

you can zoom the maps for greater detail/greater area.

- **Tag location** – if you want to remember where you were, or a particular building/address, pressing a "pin" icon on the screen records that location exactly, enabling you to return (with GPS directions) at any time.
- **Bluetooth hands-free**, which enables you to go on line via Truelocal to do searches of over one million listings. You can also use the Navman as a hands-free car kit for mobile phones with Bluetooth.
- **FM Transmitter** – the S300t (along with the next model down, the S200) features an FM transmitter which operates through you car radio/stereo, so all voice and warning tones come through that. MP3 music files and even Bluetooth connected phone calls also operate in this way.
- **FM Radio Receiver** – the same two models also have an inbuilt receiver for FM radio stations which also operate through the transmitter to the car stereo.
- **Automatic day/night** screen switching
- **Lane guidance and junction views** – no longer will you be caught in the wrong lane to make a turn or heading.
- **3D landmarks** – if you're in a strange city, major buildings/landmarks (such as the Sydney Opera House or the MCG) appear in 3D that fit the dimensions of the map, making recognition that much easier.
- **Digital log book** – store distance expenses, etc
- **Efficiency mode** – it can give directions that avoid braking and keep speeds constant, reducing petrol consumption.
- **Explore** – hundreds of thousands of points of interest are programmed in but the Navman allows you to go much further by connecting to TrueLocal to look up more information, even dial them up or be guided directly there.
- **Warnings** – speed cameras, red light cameras, accident blackspots, railway crossing and school zones are all highlighted as you drive along. Speed zones also give you the warning for change of speed (unfortunately, not time related so it will still say 40km/h at midnight!)
- **Pedestrian mode** – swap to this mode and you'll get directions for travelling on foot, including blocked access, turn restrictions, etc.
- **Overseas maps** – Eastern and Western Europe, USA, New Zealand and Canada are already contained in the box (you do need to purchase an unlock key).
- **NavPix Downloads** – you can download geo-tagged images from Flickr (or from Navman website) and go!
- **Micro SD card slot** – with this you can view pictures or even videos or play MP3s (said to be great for the children on long trips – but isn't that where you'd want the GPS operating?)



In its "Explore" mode you can do just that – not just with the hundreds of thousands of POIs loaded but you can also connect to TrueLocal and use the huge database to find what you want. It will then direct you there or, with a bluetooth phone paired, you can then call up hands-free!

I'm sure there are more features that I didn't find out about in the short time I had to play with the Navman but you'd have to agree, this list is pretty extensive.

Digital map updates

The Navteq digital map data bears special mention. They claim to have the largest field team of geographic analysts in Australia who continually update the maps with both local knowledge and contacts. They collect data on new roads, one-way streets, turn restrictions, physical barriers, new housing developments and points of interest including banks/ATMs, petrol stations, restaurants, hotels and shopping centres.

In use

The basic operation of the Navman S300t is very easy to get going and use –eg, telling you where you are and how to get to where you want to go. The Australian female voice (Karen) was much more pleasant than that of my own GPS (sometimes I'd love to throttle Jane and occasionally [electronically] do!) You can also have an Aussie male, Lee.

But if you spend as much on a GPS as the Navman S300t, or even any of the platinum range, you're going to want to use a lot more than the basic SatNav functions – in other words, some of the myriad of features it comes packed with.

I have to say that some of the "premium safety alerts" – school zones, accident black spots, red light and speed cameras, etc – I found not only a nuisance (yes, they can be turned off!) but I also often found them inaccurate.

For example, it several times insisted I was coming to a school zone when there was none. Once it said there was a school zone 250m ahead when I was driving down a 150m dead-end street where there was definitely no school, or any school in the general direction. (There was a school perhaps 500m behind me – was this the one it was referring to?)

Another time it told me there was a school zone ahead in 300m, no 350, no 400m . . . all the way to 550m when it decided there was no school anyway. A few hundred metres later, I turned a corner and drove for 200m alongside a school that has been there since Adam and has school zones on three sides. . . and no school zone showed at all.

It also insisted there was a "safety camera" ahead, after I had passed it by it on a parallel road. Not only is that annoying, if you are in an unknown area your concentration is not what it should be when you're continually looking for revenue raisers (woops – forgive my cynicism showing through) – in this case non-existent ones.

I also found it was often inaccurate in its reported position – whether this was me not having learned enough about the unit I'm not convinced – but it sometimes told me I was tens, and sometimes hundreds of metres away from where I knew I was. Loss of GPS

How the Global Positioning System Works

Like many of today's technology breakthroughs, GPS was originally a military system. Initially four NAVSTAR satellites, the first launched in 1978, formed the backbone of the system. As satellites go, they aren't very big: about 1.5m wide and 5m long. In orbit (17,450km out), they weigh only 850kg.

Each satellite contains four extremely accurate atomic clocks (one second in three million years!). This time information and satellite identification is transmitted on two L-band carriers around 1.575GHz.

Today there are 32 of these satellites which provide coverage to every point on the planet. At least three satellites would normally be "visible" from anywhere; more important areas have up to twelve satellites available from which to obtain data.

Because the exact position of each satellite is known at any instant in time, a GPS receiver on the ground (or in the air, or at sea) can work out precisely how far away that satellite is by comparing the time-stamped transmitted signal to the time it actually received that signal.

Doing the same thing with the signal from a second satellite enables the GPS receiver to determine its position between the two. Adding a third signal enables a location to be established; ie, a three-dimensional "fix".

And adding a fourth signal (or more) enables errors to be virtually eliminated, giving even more accuracy.

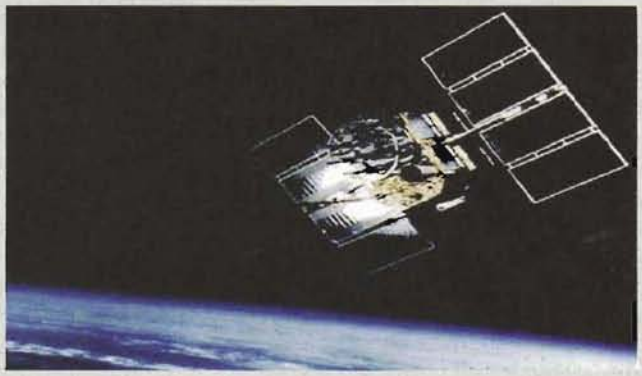
Design accuracy is within 30 metres of true position. Until 2000, accuracy for civilian and non-US-ally users was only 100m because of "selective availability" or SA errors, deliberately introduced into the system to make it more difficult for non-friendly armed forces to use.

But former US President Clinton ordered SA be removed on 1st May 2000, to allow all users access to the military-precision signal.

Achieved accuracy is usually better than 30m and often significantly better – most vehicle GPS systems can show exactly where a vehicle is on the road to within a few metres, an accuracy of at least 5m or even better. That's not too bad from 17,450km away!

The GPS system is fairly unaffected by weather; rain and cloud generally have little impact but wet foliage and even dense tree cover can cause problems.

During the "Desert Storm" war in the Middle East GPS was used extensively to obtain positions in completely featureless desert and often in blinding sandstorms. In fact, GPS has been credited with having a decisive role in the UN forces' success.



Most of today's GPS receivers require an initial "fix" from no more than three satellites to establish their position. Once the signal is received and position determined, it can keep accurate readings using only one satellite. Therefore it is ideal in very poor signal areas.

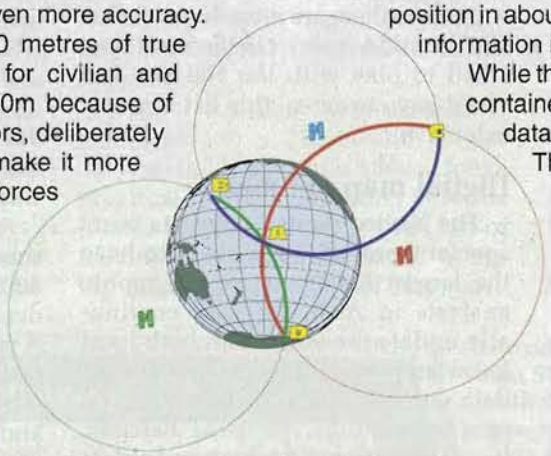
It can take almost a minute to receive and analyse enough signals to determine position from a "cold start". Once the receiver knows where it is, a "hot start" gives a position in about eight seconds. While operating, the information is updated about every 100ms.

While the majority of GPS units are fully self-contained, some have the ability to output data for recording, further analysis, etc. The output from the module is data in the form of NMEA-0183 sentences. NMEA stands for the National Marine Electronics Association and has become the standard for all GPS data output. An NMEA sentence contains an address field, a data field and a checksum.

Within the data field can be such information as latitude and longitude, north or south of equator, east or west of 0° meridian, speed over ground in knots, course over ground in degrees true, the date and time, and whether the data is vaild or not.

By the way, the reason that the exact positions of the GPS satellites is always known is that they themselves use signals from the other satellites to exactly determine their own position.

And positioning is not the only use for GPS: its highly accurate time signals are used in a huge variety of applications worldwide.



Basic Positioning (simplified to one plane only): if the GPS receiver (at point A) knows it is a certain time away from the red satellite, it must be somewhere on the red circle. Similarly, if it also knows it is a certain time away from the blue satellite, it can only be where the red and blue circles intersect (points A & C). If a third (green) satellite is added, it can only be at point A. Once it knows it is at point A, even if the GPS receiver temporarily loses data from one or two satellites it knows it cannot be at points B, C or D so it takes its data from one satellite and works with that data until another comes into view. In the real GPS world, all of the circles are actually spheres, so the system operates in all three dimensions and can therefore give height.

signal? I don't think so, given where I was at the time – with an open, clear sky view. And no, I was neither lost nor inebriated!

Most of the time, though, it was dead accurate, as you would expect. But the inconsistency disturbs me.

I never had the opportunity for it to re-plot my way around an accident, as the only accident I saw in the time I had it was just a few tens of metres from the SILICON CHIP office – and there was no way to go another route! However, that feature in itself would be one of the more handy to have if you are on the road a lot and/or have deadlines to meet.

And I didn't try the unit in its "pedestrian" mode, even though this is very easy to invoke. (Hey, why walk when you can drive?)

The display

I found the daytime display too "pastel" for my liking – I much preferred the night-time display, which automatically switches over if set that way.

You can adjust the brightness of the display in both day and night – even with the daytime display at 100% it was not the easiest to see in bright light and even worse in direct sunshine.

Conclusion

The Navman S300t has the most amazing array of highly desirable features I have ever seen in any Sat-Nav unit.

But personally, that's perhaps where I had the most difficulty with it.

Like most technology products these days, in the hands of a ten-year-old, I'm sure every one of those features would be understood and functioning very, very quickly.

Despite the assurances of Navman that they had simplified the user interface from previous models, despite me having used a GPS for a year or so, I found the learning curve a little steep. Maybe it is because I *have* used another brand of GPS and am very comfortable with it that I had to "unlearn" a lot to learn the Navman S300t.

Is that just me? Without wanting to sound boastful, as a person who lives "technical" 24/7, I believe I can come to grips with most "technical" products at least a little quicker than the average man-in-the-street.

So if you buy yourself a Navman S300t, you will be amazed at the range of features it offers – but be prepared to spend time getting to know it.

Or find yourself a friendly ten-year-old to explain it all to you!

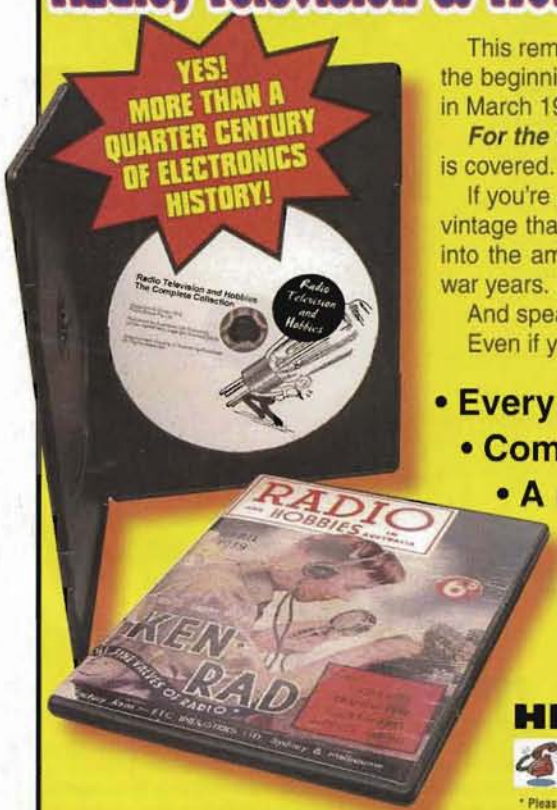
Where from, how much:

Navman GPS units are available from specialist retailers, department stores and dealers throughout the country, or online via **www.navman.com.au**

The model reviewed, the Navman Platinum S300t, has a recommended retail price of $699 but before Christmas we saw them retailing at up to $50 or so less than this. The entry-level Platinum model, the S100, has an RRP of $429, with others retailing for $499 (S150) and $599 (S200).

The main differences between the S100 and S300t are less memory (1GB), no Bluetooth (therefore no live local search either), FM transmitter, 3D Landmarks or 3D junction view, no MP3 or video player capability nor FM Radio receiver and the SUNA TMC is optional. The two others in the range have varying levels of these features. Otherwise, as we mentioned, they are identical in appearance. SC

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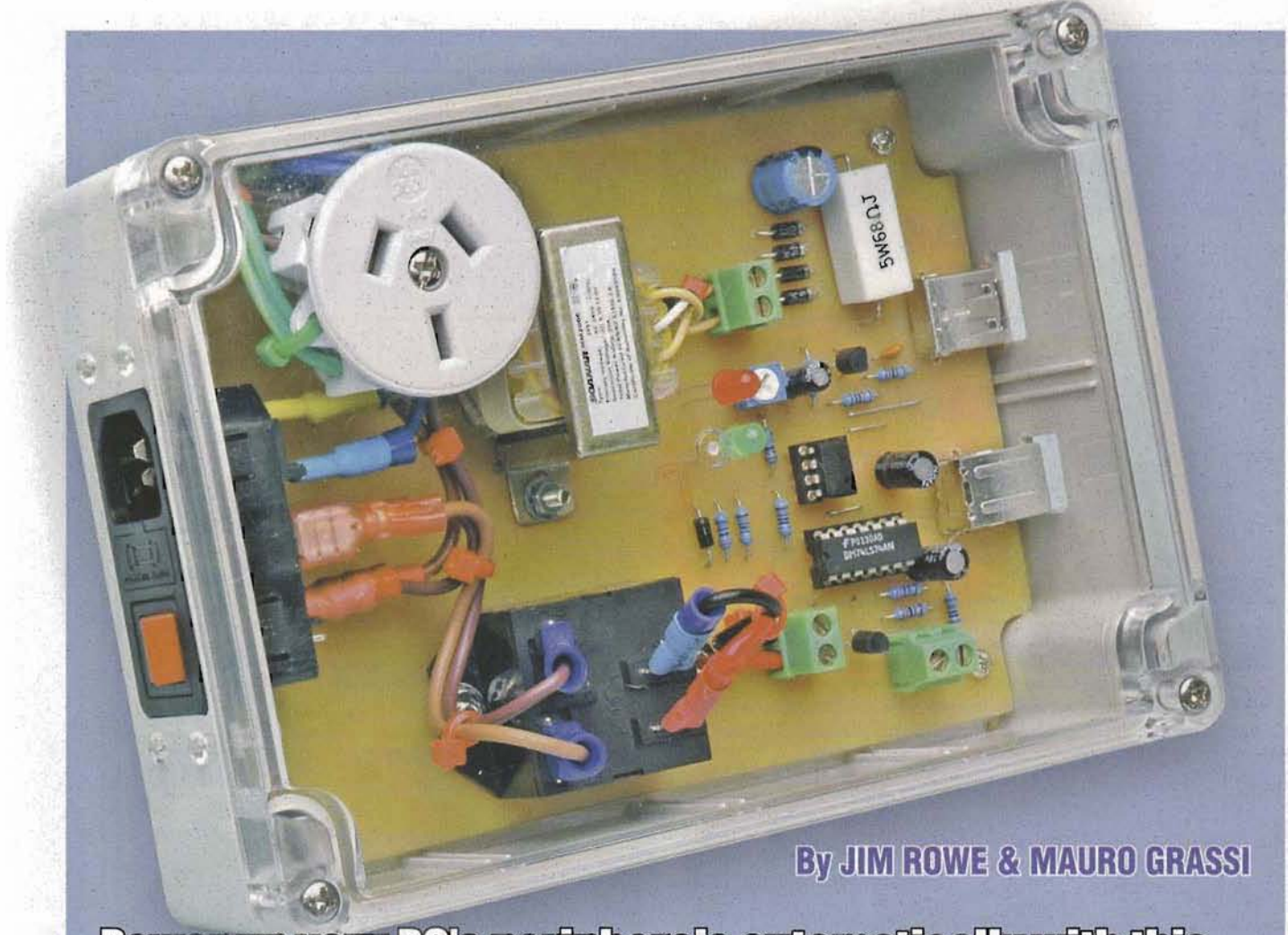
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By JIM ROWE & MAURO GRASSI

Power up your PC's peripherals automatically with this . . .

USB-Sensing Mains Power Switch

Do you have to manually switch your PC's peripherals on (and later off again) each time you boot your PC? If so, this project will make life a lot easier. It monitors your PC's USB port and automatically turns all that other gear on and off as required.

MANY EARLY PCs had an IEC-type 240V outlet socket on the back of the box that was switched by the PC's own on/off switch. This allowed you to automatically switch power to the computer's monitor, printer and other peripherals when the PC itself was switched on or off.

All you had to do was plug a power distribution board into this outlet and then plug the peripherals into this board. The power switch on the front of the PC then controlled everything – all very neat and convenient.

Unfortunately, this handy switched power outlet disappeared when the PC manufacturers changed over to software-controlled power supplies. So with most newer PCs, you're now forced to use a power distribution board with its own master power

switch, if you want to control all your peripherals with a single switch.

Of course, that means you have to remember to manually switch on the peripherals when you switch on your PC and vice versa. And that can be a real nuisance. If you forget to turn the peripherals on, the computer won't recognise the monitor or any USB peripherals when it boots and may have to be restarted.

Apart from that, having to manually switch everything on and off at the wall socket can be a real nuisance. Not only that, it can also be impractical if the wall socket is inaccessible because it's hidden behind a desk or some other piece of furniture.

That's where this USB Sensing Power Switch comes in. It connects to one of your PC's USB ports and when it detects activity on that port, it automatically switches mains power through to a socket on its front panel. By connecting a powerboard to this socket, you can automatically switch all your peripherals (including your monitor) on when the PC itself is switched on and then off again when the PC is powered down.

This not only relieves you of having to manually switch gear on and off but also means that the wall socket can be left on.

Life ain't easy

At first glance, the circuitry required to do the job should be quite simple – just monitor the USB port's +5V line and use it to turn a transistor on when the PC is switched on. This transistor could then turn on a relay to switch the mains power through to the outlet socket each time the PC was switched on.

Unfortunately, it's not that easy in practice, unless you use a laptop (more on this later). The reason is very simple – most desktop PCs maintain +5V standby power on their USB ports even when they are powered down. And that would mean that our USB Sensing Power Switch would never switch off if we simply sensed the +5V USB rail.

In fact, the only way to "kill" the +5V standby power on the USB ports is to switch the PC off at the wall socket (or at the back of the computer itself), hardly the most convenient solution.

So why do desktop PCs do this? Well, there are a couple of reasons. First, by maintaining power to the USB ports, it allows the computer to be booted simply by double-clicking a USB mouse or by typing a password into a USB keyboard. This is set up in the PC's BIOS (eg, "Power On By Mouse" or "Power On By Keyboard") and is a very convenient way of starting the machine if the computer is tucked away under a desk.

Second, it allows you to recharge the batteries in a range of devices via a USB port, even when the computer is off. These devices include MP3 players, iPods, some GPS units and cordless keyboard/mouse receiving stations.

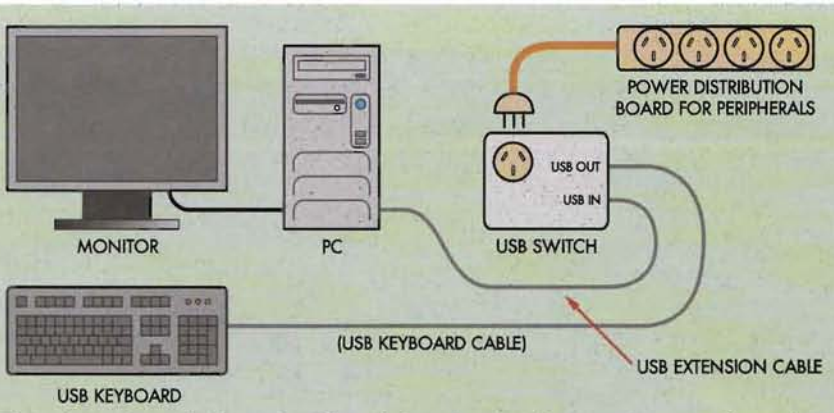


Fig.1: how the unit is used. All peripherals plus the monitor are plugged into the power distribution board. Note that a USB keyboard or mouse must be connected to the USB Switch if you are using a desktop PC.

Laptops are different

By contrast, laptop computers do shut down the standby power to their USB ports when they are powered down. Presumably, this is done to conserve the battery. Our tests on a number of laptops indicate that powering them via a mains adaptor makes no difference either – the USB ports are still powered down when the machine is switched off.

For laptops then, simply monitoring the +5V USB line is valid and our circuit has an option to do just this. That means that laptops are easy to cater for. A few desktop machines also have a jumper option on the motherboard to disable USB standby power. However, most don't so we need to use some other method to determine when the machine is switched on.

Monitoring a data line

The answer for desktop machines is to monitor the D- data line of the USB port instead. To do this, however, we must have a USB device plugged into the USB port that the PC recognises, typically a mouse or keyboard.



The USB input and output sockets are accessed via cutouts in one end of the case. The connection to the PC is via a standard type A to type B cable.

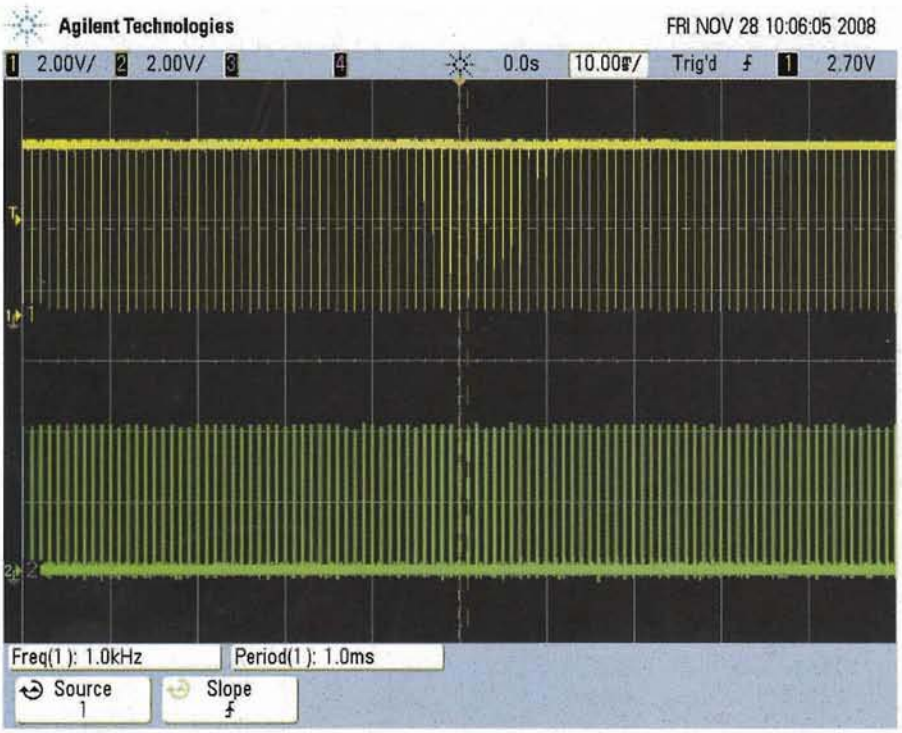


Fig.2: this scope grab shows the polling signals with a full-speed USB device connected to the USB Sensing Power Switch. The green trace is the signal on the D- line of the USB port while the yellow trace is the signal at the collector of transistor Q1. The polling frequency is 1kHz, as specified in the USB standard.

The reason for this is that when a recognised device is plugged in, the USB host (ie, in the PC) regularly "polls" that USB port for activity. This polling signal takes place at a 1kHz rate (ie, 1ms frames) for low-speed and full-speed devices and has an amplitude of 3.3V.

By contrast, high-speed USB devices use a differential 8kHz polling signal that has an amplitude of just 0.3V. This type of device can not be used with this project – only low-speed and full-speed devices can be used.

Fig.2 shows the USB polling signal with a full-speed USB device connected. This signal appears shortly after the machine is switched on. What happens then depends on whether you have USB mouse (and/or keyboard) support enabled in the system BIOS. If it isn't enabled, then the polling signal almost immediately ceases again and stays off during the boot period until well into the Windows splash screen, at which point Windows loads its own driver.

When that happens, the polling signal reappears and remains on until the machine is powered down again. However, the polling gap during boot-up can typically be 30-40 seconds long or more, depending on how long it takes Windows to load its driver.

Alternatively, if USB mouse (or keyboard) support is enabled in the BIOS, the polling signal remains present as the machine boots and only briefly ceases towards the end of the splash screen as the Windows driver takes over. So, in this case, the polling signal is almost continuous from switch on.

By detecting the polling signal on the D- line, we can thus reliably detect when a desktop PC has been switched on. But what about the gap in the polling signal that occurs during boot-up, particularly if USB mouse/keyboard support is not enabled in the BIOS? Unless precautions are taken, the peripheral devices would power up shortly after the PC was switched on, only to almost immediately switch off again when the polling signal ceased.

They would then remain off until the Windows driver loaded for the particular device that was plugged into the USB port. For a plug and play monitor, that could be a real problem – if it isn't turned on, Windows can not recognise it and so loads a default low-resolution desktop.

Fortunately, this problem is easily solved by designing a circuit that remains on by default after the polling signal is detected and by then using a timer to turn it off a set period after the polling signal ceases. In the case of the USB Sensing Power Switch, this delay period can be set anywhere between 33s and 67s but can easily be extended if your computer is slow to boot.

Note that using the delay circuit also means that the peripherals remain powered up for a brief period after the computer is turned off. So if the delay period is 40s, for example, the peripherals will remain on for 40s after shut down.

Loop through sensing

Fig.1 shows how the unit is used with a desktop computer. Basically, it uses "loop through" sensing via two USB ports (one for USB in and one for USB out).

As already mentioned, you must have a USB mouse or keyboard (or some other low-speed or full-speed USB device) plugged in. You can not use a high-speed device and that includes most USB flash drives and disk drives (the USB device itself will work but the USB Sensing Power Switch won't).

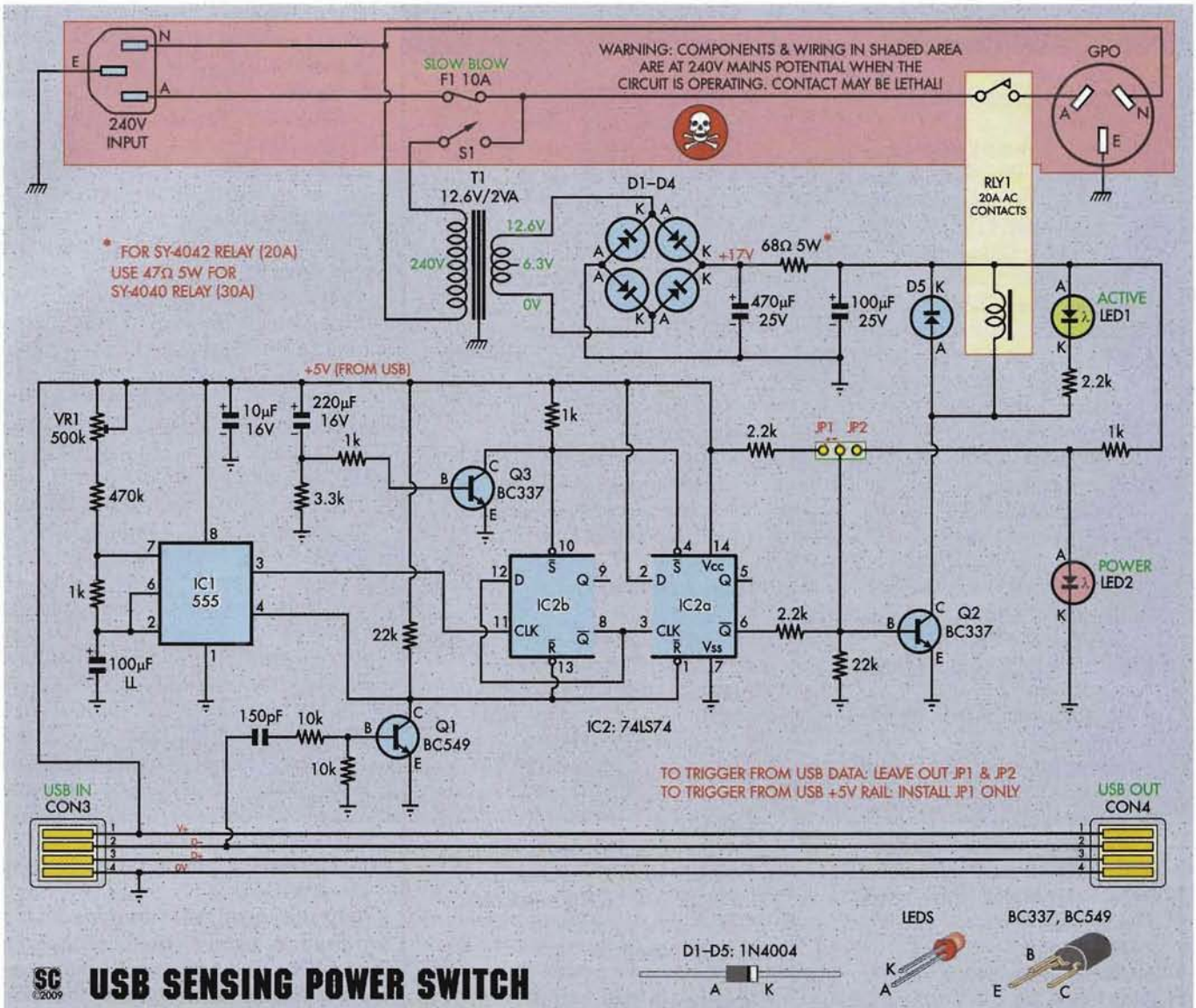
Alternatively, for a laptop, all you need to do is connect the unit to a USB port on the computer and configure it to monitor the +5V rail. In this case, you don't have to have a peripheral connected to the USB Out socket but you can if you wish. What's more, you can connect any type of USB device you want, including high-speed devices – they will all function normally.

By the way, which ever method you use to monitor the USB port, this unit will also power down your peripherals if the PC goes into hibernation. It will then automatically turn them back on again when the machine comes out of hibernation.

Earlier unit

Before going further, we should mention that this unit supersedes the USB-Controlled Power Switch described in November 2004. That earlier unit was built into a modified power board and used an optocoupler to provide isolation and a Triac to switch the mains power.

However, some readers have found that the Triac fails under certain circumstances. Because of the confined space inside the powerboard, the total loading on the unit was specified as



USB SENSING POWER SWITCH

Fig.3: the circuit can be triggered either from the +5V USB line (JP1 in) or from the D- data line (JP1 out) using transistor Q1 and dual D-type flipflop IC2. When triggering occurs, Q2 turns on and this turns on relay RLY1 to switch mains power through to the GPO. Q3 and its associated parts form the reset circuit for IC2, while 555 timer IC1 switches the unit off after a preset time if no data is detected on the D- line.

700W maximum and it's possible that this rating was being exceeded in some cases.

By contrast, this new project uses a relay with 20A AC contacts to switch the mains, which means that the outlet is rated at a full 2300W. The relay also completely eliminates the problem of Triac failure. In addition, because it is built into its own enclosure, this new unit is easier to build than the earlier version, since you don't have to doctor a powerboard.

Finally, the earlier unit monitored the +5V USB line only. It's suitable for use with laptops but is limited to those desktop machines in which the USB standby power can be disabled or where the PC itself is switched off at the wall.

How it works

OK, let's see how the unit works. Fig.3 shows the circuit details and as you can see, there's not a lot to it.

The first thing to note is that the electronic switching circuitry must be electrically isolated from the mains, so there's no risk of 240V AC getting back into the computer via its USB port. That's done by using a transformer in the power supply plus a relay to switch the mains through to the GPO.

As shown, a pair of standard USB sockets, CON3 and CON4, allow the unit to be connected between the PC and an external peripheral using standard USB cables. All of the USB connections go "straight through", so the added circuitry is essentially "transparent" as far as USB communication is concerned.

Let's start by considering the simplest configuration, in which the unit is used to monitor the USB 5V (V+) rail (ie, it's being used with a laptop). In this case, jumper JP1 is installed and IC1, IC2a, IC2b and transistors Q1 & Q3 are effectively bypassed and have no role in the circuit's operation.

When the laptop is powered up, +5V DC appears on pin 1 of each of its USB ports. We simply "steal" a couple of milliamps from this convenient

Parts List

1 PC board, code 10101091, 151 x 109mm
1 IP65 ABS sealed polycarbonate enclosure with clear lid, 171 x 121 x 55mm (Jaycar HB-6248 or equivalent)
1 2851 12.6V 150mA (2VA) mains transformer
1 chassis-mount 12V coil SPST relay with 20A contacts (Jaycar SY-4042)
2 PC-mount 2-way terminal blocks (CON1,CON2)
1 PC-mount Type B USB connector (CON3)
1 PC-mount Type A USB connector (CON4)
1 snap-fit fused male IEC connector with switch
1 M205 10A slow-blow fuse
1 10A flush-mounting mains outlet socket with side wire entry
1 300mm length of 10A brown mains wire
1 150mm length of 10A blue mains wire
1 150mm length of 10A green/yellow mains wire
12 Nylon cable ties
4 M3 x 6mm machine screws
2 M3 x 10mm machine screws
2 M4 x 10mm machine screws, pan head
2 M3 hex nuts
3 M3 star lockwashers
2 M4 hex nuts
2 M4 star lockwashers
2 M4 flat washers
4 M3 x 10mm Nylon screws, pan head
8 M3 hex Nylon nuts
2 6.4mm insulated spade connectors for 1mm² wire
7 4.8mm insulated spade connectors for 1mm² wire
1 4.8mm insulated piggyback spade connector for 1mm² wire
1 5.3mm ID eyelet terminal for 1mm² wire
1 72 x 38 x 1mm sheet steel or aluminium (for IEC connector mounting plate)
1 3-pin header
1 jumper link
1 500kΩ miniature horizontal mount trimpot (VR1)
1 14-pin machined IC socket
1 8-pin machined IC socket

Semiconductors
1 555 timer (IC1)
1 74LS74 dual D-type flipflop (IC2)
1 BC549 NPN transistor (Q1)
2 BC337 NPN transistor (Q2,Q3)
1 5mm green LED (LED1)
1 5mm red LED (LED2)
5 1N4004 1A diodes (D1-D5)

Capacitors
1 470µF 25V PC electrolytic
1 220µF 16V PC electrolytic
2 100µF 25V LL PC electrolytic
1 10µF 16V electrolytic
1 150pF ceramic

Resistors (0.25W, 1%)
1 470kΩ
2 22kΩ
2 10kΩ
1 3.3kΩ
3 2.2kΩ
2 1kΩ
1 68Ω 5W

source of 5V DC and use this to turn on transistor Q2 via a 2.2kΩ resistor and jumper JP1.

Q2 in turn switches on relay RLY1. As a result, RLY1 closes its contacts (which are in the Active line) and so power is switched through from the mains input socket to the GPO (general purpose outlet). In addition, Q2 turns on LED1 (green) to indicate that the relay is on.

Conversely, if the laptop is turned off, the +5V DC disappears from USB pin 1 and this removes the forward bias on Q2 (its base is pulled down to ground via the 22kΩ resistor). Q2 therefore stops conducting, turning off the relay (and LED1) and in turn switching off the power to the GPO. Simple.

Monitoring the D- line

Now let's consider the more complicated case, where we monitor the "D-" data line (ie, the unit is to be used with a desktop machine). In this case, JP1 is left open so that the unit can not be triggered by the +5V USB line. Instead, IC1, IC2a, IC2b and transistors Q1 & Q3 now come into play and transistor Q2 is driven from the Q-bar output of D-type flipflop IC2a.

It works like this: normally, when the PC is off, the pin 6 Q-bar output of D-type flipflop IC2a is low and transistor Q2 and the relay are off. However, if the PC is turned on, transistor Q1 is rapidly pulsed on and off by the polling signal that appears on the D- line. Q1 inverts this polling signal and applies a train of brief low-going pulses to the reset pins (13 & 1) of IC2b & IC2a.

As a result, IC2b & IC2a are reset, thus forcing their Q outputs low and their Q-bar outputs high. This turns on transistor Q2 via a 2.2kΩ resistor at pin 6 of IC2a and activates the relay which now remains on.

IC1 is a 555 timer which is wired to operate in astable mode. It is also reset each time Q1 is briefly pulsed on by the timing signal (ie, pin 4 is pulled low). This sends pins 3 & 7 of IC1 low and discharges the 100µF timing capacitor on pins 2 & 6 via the 1kΩ resistor.

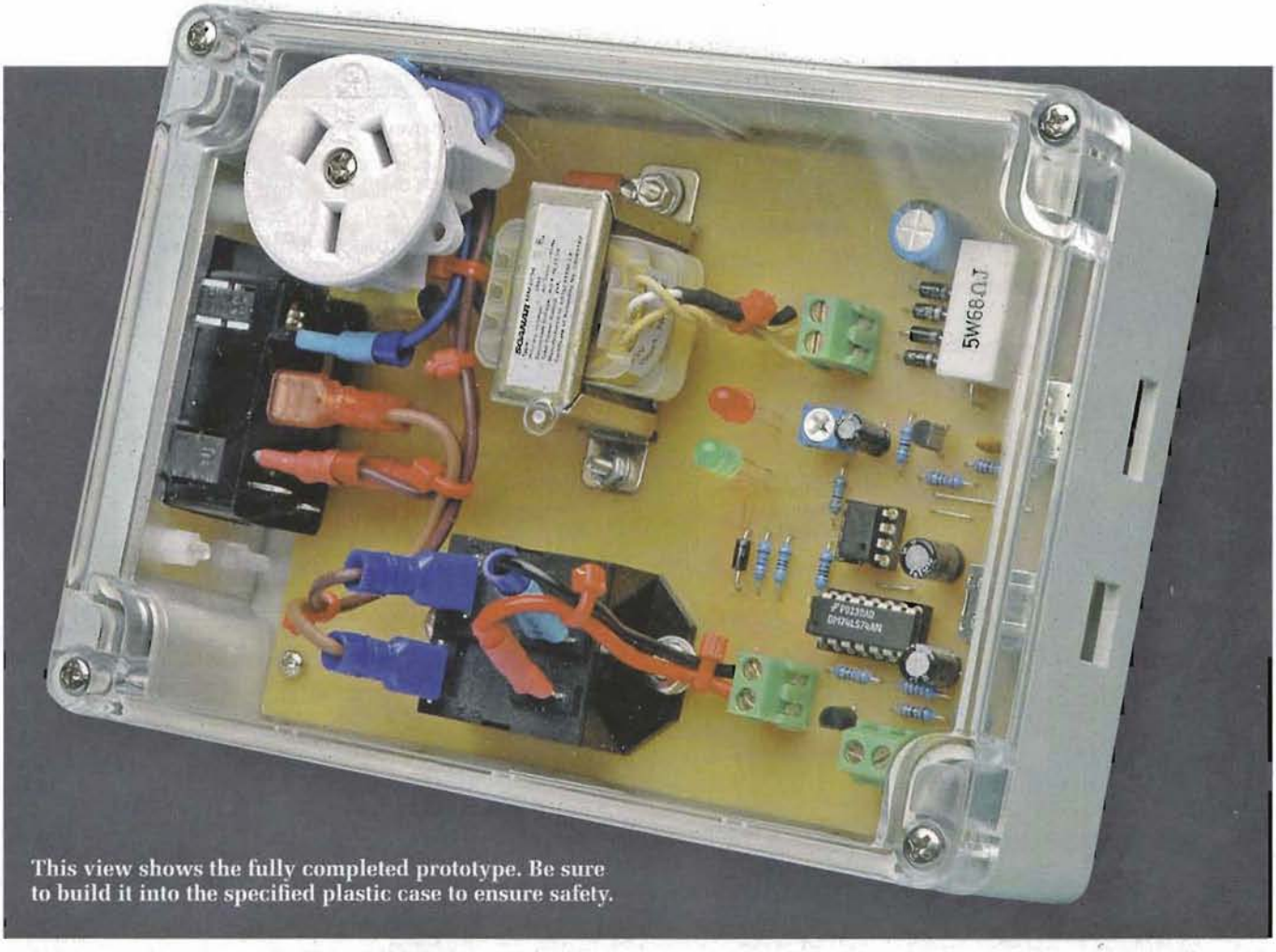
After the first brief reset pulse, Q1 turns off for a period of 1ms and so pin 3 of IC1 switches high for 1ms and clocks IC2b. Because IC2b's Q-bar output is connected to its D input, its outputs immediately toggle, with Q now going high and its Q-bar output switching low (ie, a rising-edge clock signal transfers the logic state on its D input through to its Q output). This has no effect on IC2a though, since the flipflops only respond to high-going clock pulses.

At the end of this 1ms period, Q1 is pulsed on again by the polling signal and IC1, IC2b & IC2a are again reset. As a result, both Q2 and the relay remain on while ever polling pulses are present.

No polling signal

Now let's see what happens if the polling signal ceases. When that happens, IC1's pin 3 output immediately switches high and clocks IC2b, sending its Q-bar output low. At the same time, IC1's 100µF timing capacitor begins charging towards the supply rail via trimpot VR1 and the 470kΩ and 1kΩ resistors.

The timing period for IC1 can be set anywhere from 33-67s, depending on the setting of VR1. If another polling pulse occurs within this timing period, then the circuit is reset and the relay remains on. However, if no polling pulse is detected (ie, the PC has been powered down), the timing capacitor continues to charge until it reaches 2/3Vcc. At this point, pin 3 switches low and the 100µF timing capacitor



This view shows the fully completed prototype. Be sure to build it into the specified plastic case to ensure safety.

quickly discharges into pin 7 via the 1kΩ resistor.

When the voltage on the timing capacitor discharges to 1/3Vcc, pin 3 switches high again and the 100µF capacitor begins recharging. This high-going output from IC1 clocks IC2b again, sending its Q-bar output (pin 8) high. This in turn clocks IC2a and switches its Q-bar output low.

As a result, both Q2 and the relay switch off, as does LED1.

Further clock pulses from IC1 now have no further effect on IC2a. That's because its D input (pin 2) is tied high and any further clock pulses simply transfer this logic high to its Q output and so Q-bar remains low.

In effect, IC1 functions as a missing pulse detector. If the polling signal is absent for longer than its timing period, it applies two clock pulses to IC2b – one almost immediately and the other at the end of the timing period.

IC2b simply prevents this first clock pulse from reaching IC2a and turning off the relay prematurely.

Transistor Q3 and its associated parts form a power-on reset circuit for IC2b & IC2a. This might seem rather complicated for a reset circuit but is necessary to give a long time constant (about 0.7s). This prevents the USB reset pulse which appears on the D- line almost immediately after power is applied from falsely triggering the unit (ie, before the computer is turned on).

Note that we originally used a simple RC reset network here but were forced to use the more complicated circuit when we discovered this problem. This accounts for some of the differences between the unit shown in the photos and the final version.

Power supply

All the circuitry involving IC1, IC2, Q1 & Q3 is powered directly from a +5V rail which is derived from the USB port. By contrast, the relay circuit (including transistor Q2 and LED1) is powered from a 12V rail.

This 12V rail is derived from a simple power supply based on mains transformer T1. Its 12.6V AC secondary is rectified using bridge rectifier D1-D4, the output of which is then filtered by a 470µF electrolytic capacitor.

This supply provides about 17V DC, so a 68Ω 5W dropping resistor is used to reduce the effective relay voltage to around 12V when it's energised. The specified relay draws about 75mA.

Note that it is also possible to use a similar relay (Jaycar SY-4040) with contacts capable of switching 30A

What Happens During Hibernation?

ONE FEATURE of this device is that it will power down the peripherals plugged into it if the computer goes into hibernation. That's because all data activity ceases on the USB data line during hibernation and because laptop machines power down their USB ports.

This allows you to save power while the computer hibernates which is worthwhile over long periods. The peripherals will automatically start up again when the machine comes out of hibernation.

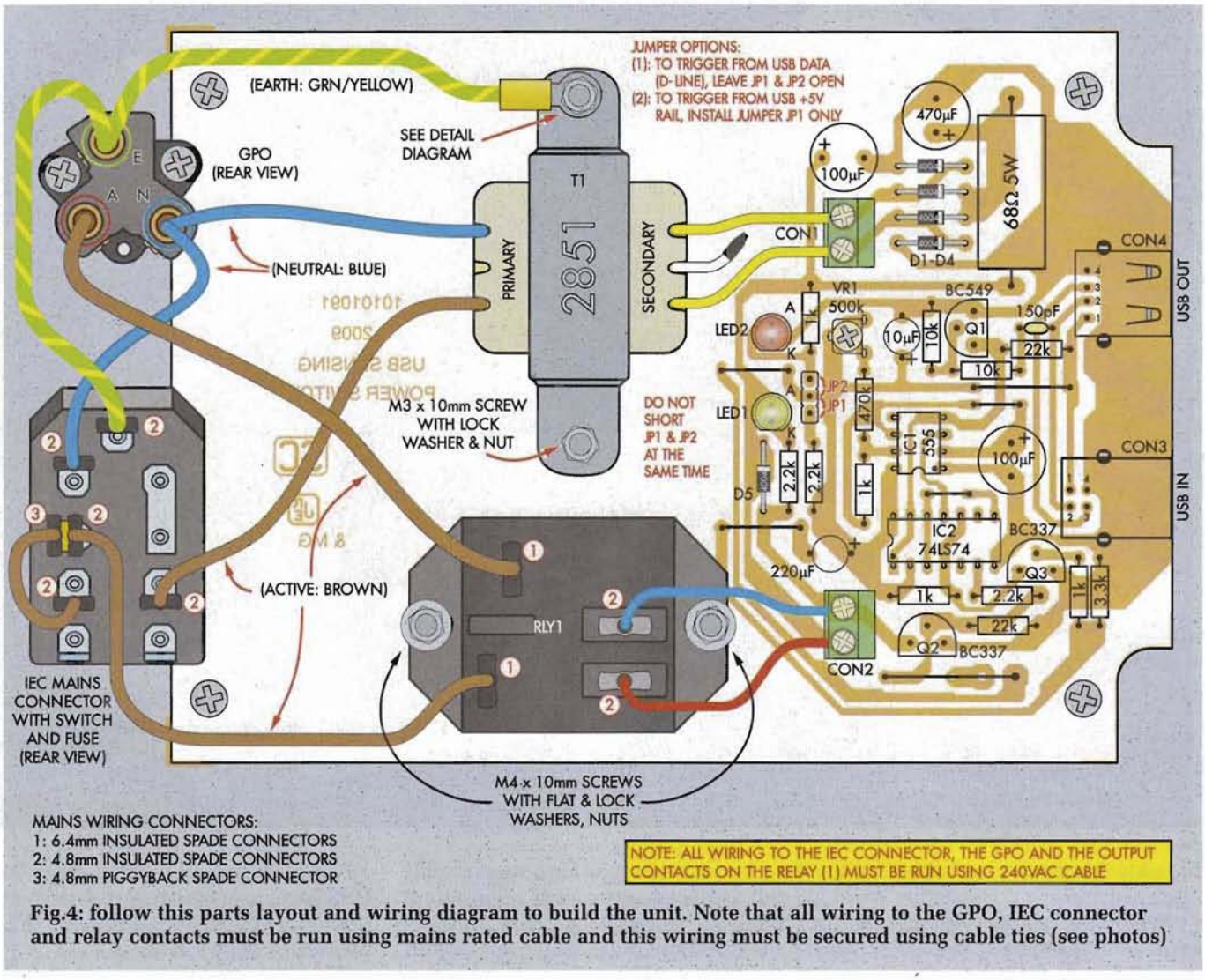


Fig.4: follow this parts layout and wiring diagram to build the unit. Note that all wiring to the GPO, IEC connector and relay contacts must be run using mains rated cable and this wiring must be secured using cable ties (see photos)

AC. However this relay needs 100mA of energising current, so if it's used the dropping resistor value must be reduced to 47Ω. There is no real advantage in using the higher rated relay however, as the IEC mains input connector is only rated for 10A.

In any case, it's very unlikely that the current drain of the peripherals connected to your PC will total 10A – which corresponds to 2300W. So the 20A relay we're using is already overkill.

Diode D5 is connected across the relay coil to protect transistor Q2 from the back-EMF voltage that's generated by the relay's coil when it switches off. LED1 (green) indicates when the relay is on and mains power is present at the GPO, while LED2 (red) indicates when mains power is applied to the unit.

Finally, switch S1 (which is integral with the IEC socket) allows you to manually turn off the mains power. This is handy if you want to boot the computer but you don't want to power up certain peripherals, such as a printer or external disk drive.

Construction

All of the parts used in the project are housed in a sturdy polycarbonate enclosure (171 x 121 x 55mm) with a clear lid and a neoprene lid-sealing gasket. **Note that you must use the specified plastic case for safety reasons – do not use a metal case.**

As shown in the photos, the IEC mains input connector (with inbuilt switch S1 and fuse F1) mounts on one end of the enclosure, while the 3-pin GPO socket mounts in the lid. Everything else is mounted on a PC board coded 10101091. This board measures 151 x 109mm and has corner cut-outs at one end to allow it to sit on the base of the box.

Fig.4 shows the parts layout and wiring. All the low-voltage circuitry is mounted at the righthand end of the board and there are square cutouts in the end of the case to provide access to the USB connectors. The indicator LEDs are viewed through the transparent lid of the enclosure.

Two-way terminal blocks CON1 and CON2 are used to terminate the connections from the secondary winding of T1 and the coil of RLY1, respectively. By contrast, one of T1's

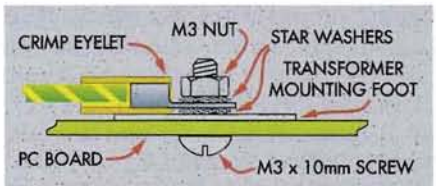


Fig.5: an M3 x 10mm screw & nut, two M3 star washers and a crimp eyelet are used to secure the earth wire to the transformer frame.

primary leads and the relay contacts are connected to the mains wiring via insulated spade connectors.

Begin the assembly by installing the six wire links on the PC board, then install the resistors. Table 1 shows the resistor colour codes but you should also check each one using a digital multimeter before soldering it to the board. The 68Ω 5W resistor should be mounted with its square-section ceramic body spaced up about 3mm from the board, so that the air can circulate beneath it (you can use a cardboard spacer to do this).

Diodes D1-D5 can go in next, followed by the three transistors (Q1-Q3). Be sure to use the correct transistor at each location. Q1 must be a BC549, while Q2 & Q3 are BC337s. Note that the transistors and diodes are all polarised, so be sure to install them with the correct orientation.

Follow these parts with the two ICs. We used good-quality machined IC sockets on the prototype but you can solder these devices directly to the PC board if you wish. Be sure to orientate these devices as shown on Fig.4 (the dot or notch on each device is at the pin 1 end).

The electrolytic capacitors are next on the list, again taking care with their orientation. Once they are in, install the 150pF capacitor and the two LEDs (flat side as shown). You can either mount the LEDs close to the board or leave their leads reasonably long so that they will later sit close to lid of the case for improved visibility.

The 3-pin header can now be soldered in place, followed by screw terminal connectors CON1 & CON2 and the two USB connectors (CON3 & CON4). Be sure to install CON1 & CON2 with their entry holes



Inside the completed prototype – note how the mains wiring is firmly secured using cable ties, as are the leads to the transformer secondary and relay coil. Note also that the PC board used in this prototype version differs in several respects from the final version shown in Fig.4.

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	470kΩ	yellow violet yellow brown	yellow violet black orange brown
❑	2	22kΩ	red red orange brown	red red black red brown
❑	2	10kΩ	brown black orange brown	brown black black red brown
❑	1	3.3kΩ	orange orange red brown	orange orange black brown brown
❑	3	2.2kΩ	red red red brown	red red black brown brown
❑	2	1kΩ	brown black red brown	brown black black brown brown
❑	1	68Ω 5W	not applicable	not applicable

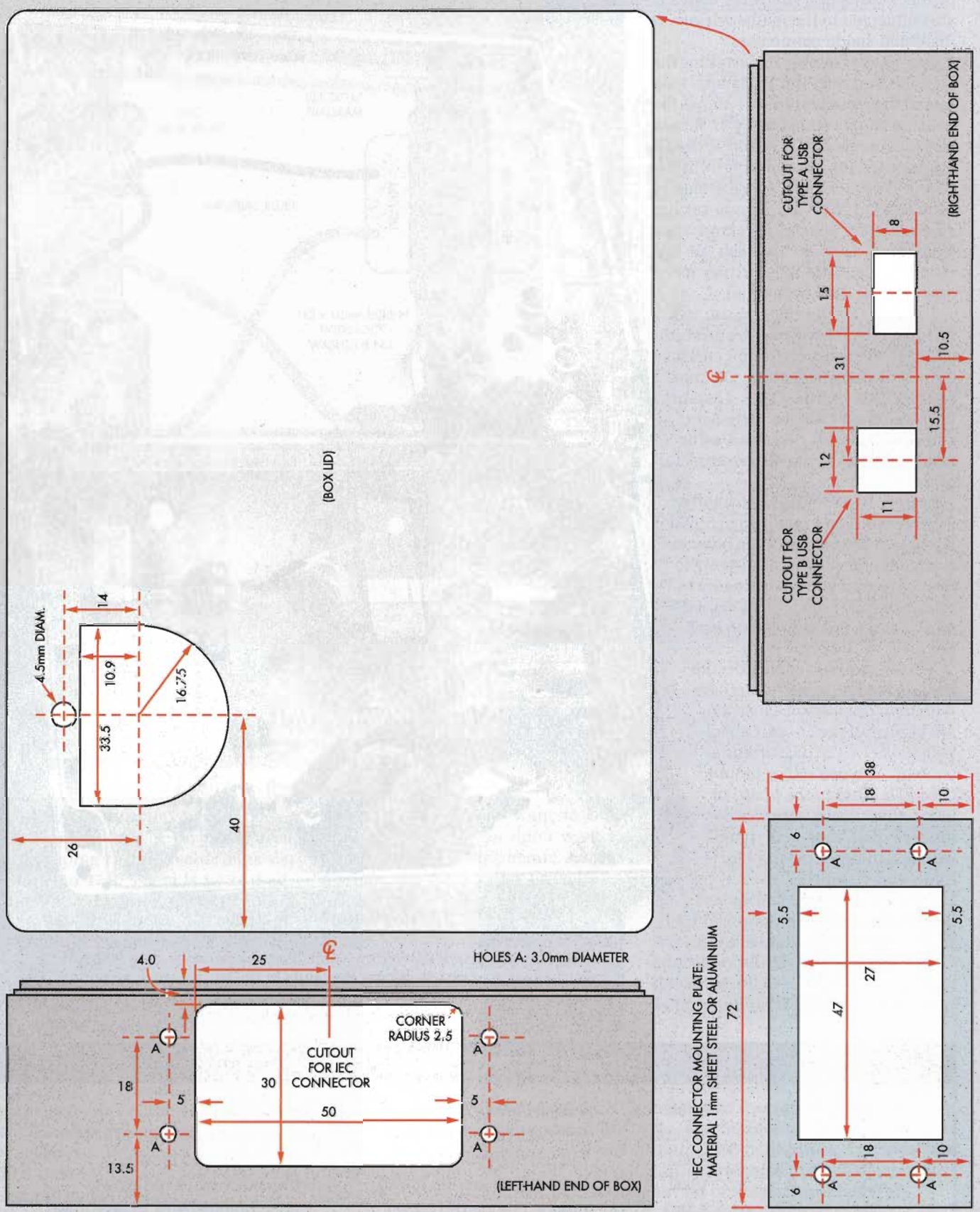
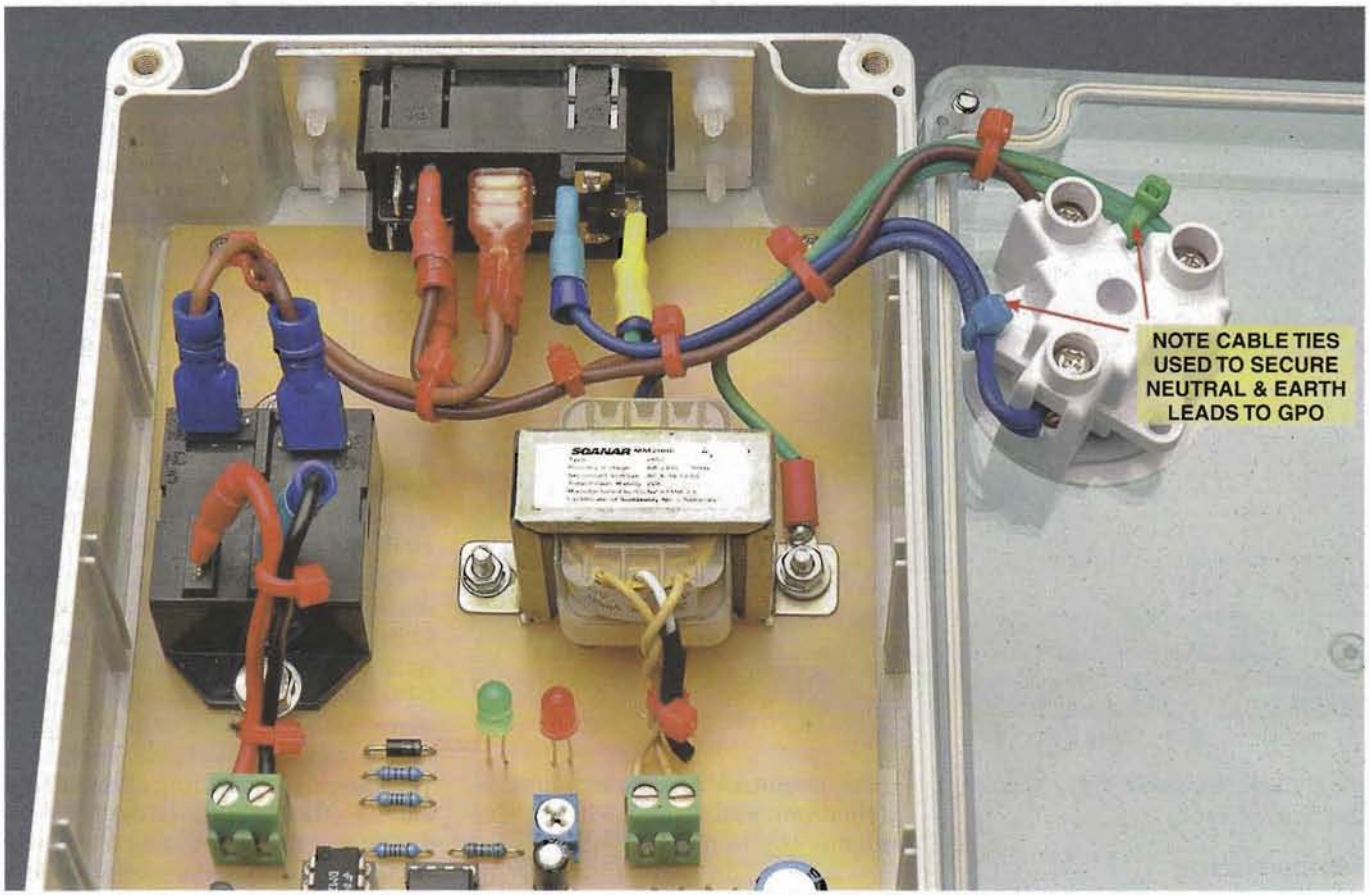


Fig.6: this diagram shows the cutout and drilling details for the GPO socket in the case lid, the access holes for the USB connectors (righthand end), the IEC connector (lefthand end) and the metal mounting plate for the IEC connector. A large cutout can be made by drilling a series of small holes around the inside perimeter, then knocking out the centre piece and carefully filing the job to a smooth finish.

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This view inside the prototype unit shows how the mains wiring is installed and secured. It's a good idea to fit two Nylon nuts to each Nylon screw that's used to secure the IEC connector bracket, to firmly lock it into place.

facing towards the transformer and relay.

The board assembly can now be completed by installing transformer T1 and the relay. First, transformer T1 is mounted using two M3 x 10mm long screws with lockwashers and nuts. Note that the screw fitted to the transformer's "rear" foot is fitted with an additional lockwasher, because this screw is also later used to attach the crimp eyelet of a mains (safety) earthing lead for the transformer frame.

Note also that the enamel must be scraped off the transformer foot to ensure a good contact.

Once the transformer has been mounted on the board, the white "centre tap" secondary wire can be cut short and fitted with a short length of heatshrink sleeving. The two yellow secondary leads go to CON1. Keep these two leads short and secure them together using a couple of cable ties.

Relay RLY1 is mounted using two M4 x 10mm machine screws with flat washers, lockwashers and M4 nuts. Short leads fitted with 4.8mm insulated spade connectors at one end are then used to connect its coil terminals to CON2. Once again, secure these leads together with cable ties, as shown in the photos.

Preparing the enclosure

Once the board assembly has been completed, it can be placed aside while you cut the various holes in the enclosure and its lid. The size and locations of all of these holes are shown in Fig.6.

In summary, there are two small rectangular cutouts at one end of the case for access to USB connectors CON3 and CON4, plus a single large rectangular cutout at the other end for the IEC mains input connector. In addition, there are two holes in the lid to mount the GPO socket.

The IEC fused male connector and switch is a snap-in type intended for use with a mounting plate thickness of about 1mm. Unfortunately, the specified IP65 box has a wall thickness of 3mm, so the IEC connector cannot be mounted directly to it. Instead, it is fitted to a 1mm-thick metal plate and this plate is secured to the inside of the box using four M3 x 10mm Nylon screws and eight Nylon nuts.

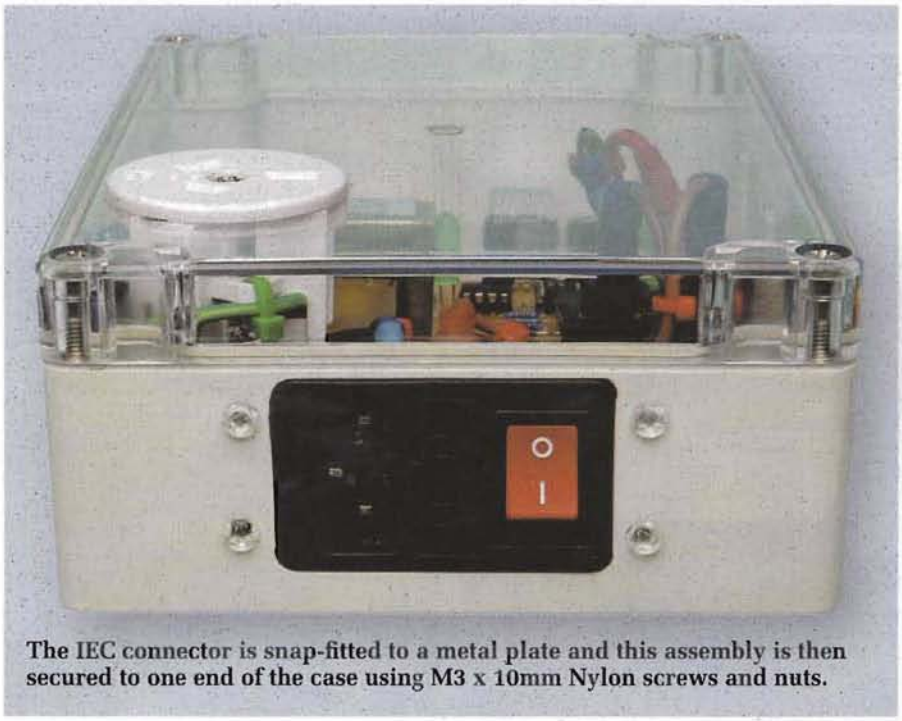
As a result of this arrangement, the flange of the IEC socket is mounted flush with the surface of the box, giving a neat finish.

As well as the box cut-outs, Fig.6 also shows the dimensions of the metal plate for the IEC connector. It should be made from 1mm thick sheet steel or aluminium.

Having made the plate, the next step is to snap the IEC connector into it and then attach this assembly inside the enclosure using the four M3 x 10mm Nylon screws and nuts. It also a good idea to then install an additional Nylon nut on each mounting screw. These will firmly lock the first nuts into position and ensure that the assembly can not possibly come loose.

That done, mount the PC board assembly inside the enclosure and secure it using four M3 x 6mm machine screws. These screws go into the integral threaded mounting bushes on the base of the box.

The GPO outlet can now be fitted to the lid. That's done by first unscrewing the centre screw holding the front plate to the rear moulding and then screwing the outlet back together with



The IEC connector is snap-fitted to a metal plate and this assembly is then secured to one end of the case using M3 x 10mm Nylon screws and nuts.

the enclosure lid sandwiched between the two sections.

Mains wiring

The final assembly step is to install the mains wiring. This involves all wiring to the IEC input connector, the relay contacts and the GPO socket, plus the primary winding of T1.

Note that all this wiring must use 250VAC 10A rated wire. Brown wires are used for the Active connections, blue for Neutral and green/yellow for the Earth wiring – see Fig.4. Fig.5 shows how the Earth lead is attached to the transformer mounting foot via a 5.3mm ID crimp eyelet terminal.

All leads to the IEC connector and to the relay are terminated using insulated spade connectors. **You must use a ratchet-driven crimp connector to fit these. Do not use a cheap automotive-style crimp tool, as this will not give reliable connections.** The Earth wire terminations, in particular, must be well made in the interests of safety.

Fig.4 shows what type of spade connector to fit to each wire. Use 4.8mm spade connectors to the IEC connector as indicated. These spade connectors should all be fully insulated.

If you are unable to obtain fully insulated 4.8mm connectors, then use non-insulated connectors but be sure to fully insulate each one using 6mm-diameter heatshrink tubing after its lead is crimped in place.

Note that the connector at the terminal marked "3" on the IEC connector is a piggyback type. Again, it should be fully insulated using heatshrink tubing. Note also that some IEC connectors may have 6.4mm lugs and will require 6.4mm spade connectors.

As shown in the photos, all this mains wiring must be neatly installed and secured using eight cable ties. This is necessary to make it impossible for any leads to come loose and make contact with the low-voltage components on the PC board.

Note that the Neutral and Earth wires are also tied to the GPO socket using the holes in its moulding as anchor points (see photo).

Additional cable ties are used to secure the leads to CON1 & CON2. Again, the idea is to ensure they cannot come loose and contact mains voltages.

Initial checks

Before doing anything else, use your multimeter (set to a low ohms range) to check between the earth pin of the IEC connector and the earth outlet of the GPO. You should get a reading of zero ohms here (this checks the integrity of the earth connection). Similarly, you should get a reading of zero ohms between the earth pin of the IEC connector and the transformer frame.

Having verified the earth connection, fit the 10A fuse to the fuseholder in the IEC socket. Note that this fuse should be a slow-blow type.

Testing

It's now time to test the unit. Here's the step-by-step procedure:

(1) Rotate trimpot VR1 fully anticlockwise (this sets the timing period to minimum).

(2) If you are using a laptop, install jumper JP1 to trigger off the +5V USB rail. If you are using a desktop machine, leave JP1 out so that the unit triggers off the D- line.

(3) Attach the lid to the case. This is important – **we strongly advise against**


into MICROS OR PICS?

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Using The USB Sensing Power Switch

DESKTOP COMPUTER: trigger from the D- data line. Leave all jumpers out, connect the device to the computer via a standard USB cable and plug a USB mouse or keyboard into the USB Out socket (see Fig.1). Set trimpot VR1 so that the green LED (LED1) stays on continuously while the computer boots. Enabling USB mouse or USB keyboard support (depending on which device you have plugged into the USB Out port) will allow you to set VR1 to minimum (ie, to give the minimum delay period).

LAPTOP COMPUTER: trigger from the USB +5V line. Install jumper JP1 and connect the device to the computer via a standard USB cable. Use of the USB Out socket is optional and you can plug in any device you wish. Note that plugging in a USB mouse or keyboard will introduce a switch-off delay (as set by VR1), unless you leave out IC2.

connecting this unit to mains power without the lid in place, to eliminate the risk of electric shock.

(4) Connect the unit to a mains power outlet, then switch on the mains outlet and switch on the IEC connector's switch (S1). The red LED should light to indicate that the power is on but nothing else should happen – ie, the relay and LED1 (green) should remain off.

(6) Connect the unit to your computer using a standard USB type-A to type-B cable. If you are using a desktop computer, then connect your USB mouse or keyboard to the USB Out socket (CON4) as well.

(7) Power up the computer. After a brief delay (no more than several seconds), you should hear a click as the relay operates and the green LED should light to indicate that mains power has been switched through to the GPO.

(8) If you have a desktop computer, check the green LED as the computer boots. If it goes out and then comes back on again towards the end of the Windows splash screen, then the delay period is too short.

To adjust the delay, **first unplug the mains cord from the IEC connector, then open the lid and adjust trimpot VR1 slightly clockwise. Be sure to replace the lid before testing the unit again.** Repeat this procedure if necessary, so that the green LED remains on while the computer boots.

(9) Power down the computer. If you are using a laptop, the green LED should go out as soon as the machine shuts down. You should also hear a click as the relay switches off.

Alternatively, if you are using a desktop machine, the green LED and relay should remain on for the delay period after the computer switches off. This period will be somewhere between about 33s and 67s, depending on the setting of VR1.

Note: if your desktop computer is very slow to boot and 67s isn't long enough, increase the value of the 470kΩ resistor in series with VR1. Alternatively, enable USB mouse or USB keyboard support in the system BIOS, depending on which device you have plugged into CON4.

If this all checks out, your USB-Sensing Power Switch is working and can be put into service. All you have to do is plug a power distribution board into the GPO on the top of the enclosure and then plug your peripherals into this distribution board.

Don't forget to connect a USB mouse or keyboard to the unit if you are triggering the unit from the D- line of the USB port.

That's it. Your peripherals will now be automatically turned on and off with the computer. SC

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 plate to ensure safety.

(2) Use mains-rated cable for all connections to the IEC socket, the GPO and the relay contacts. Secure this wiring using cable ties – see photos.

(3) Use fully-insulated spade connectors to terminate the leads to the IEC connector and to the relay contacts. A ratchet-driven crimping tool is necessary to fit the spade connectors.

(4) Do not touch any part of the 230VAC wiring while this device is plugged into the mains. Also, *DO NOT* attempt to build this device unless you know what you are doing and are familiar with high-voltage wiring.

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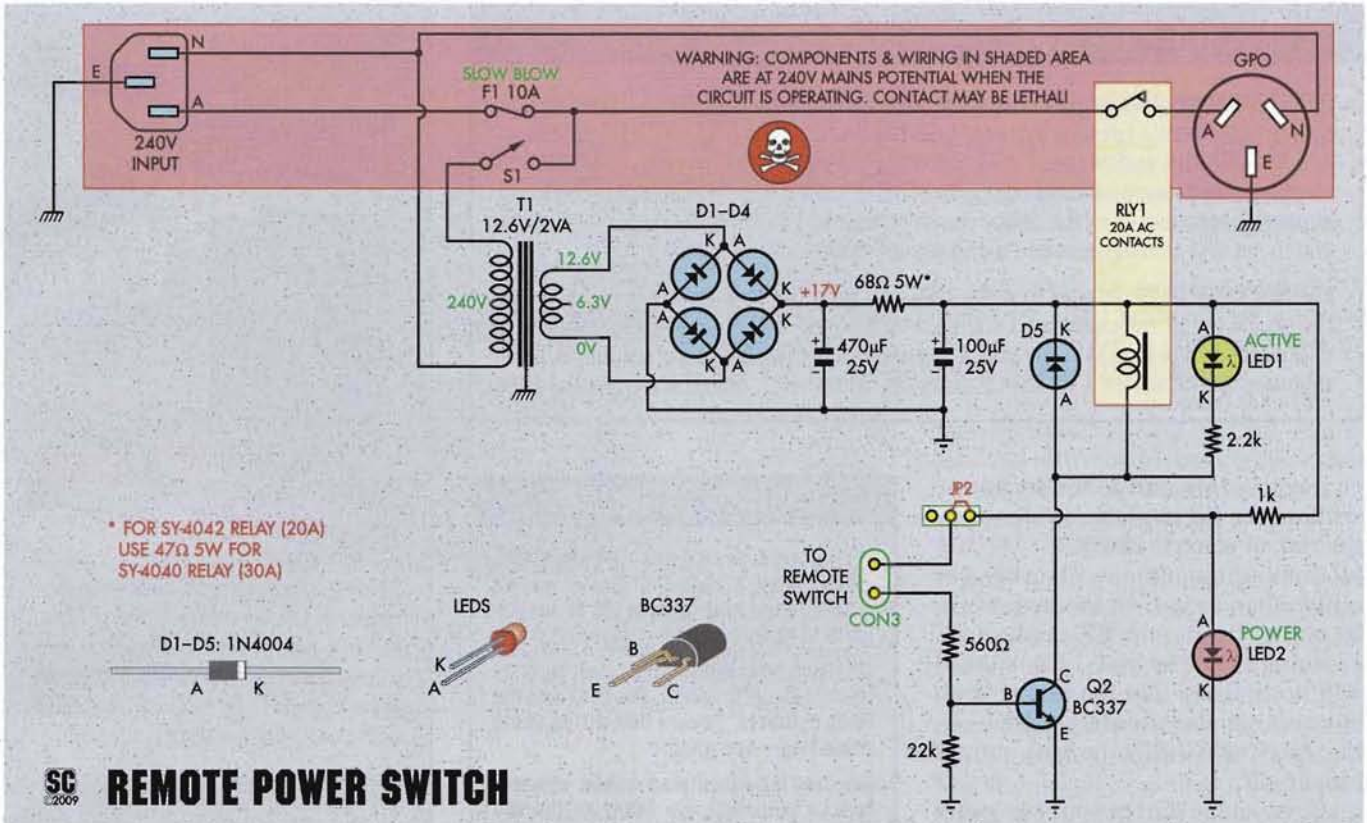


Fig.1: the circuit is triggered by closing the contacts of a remote switch. When that happens, transistor Q2 turns on and activates the relay which then switches power through to the GPO. LED1 indicates when the relay is on.

Remote Mains Relay Mk.2

The PC board used for the USB Sensing Power Switch can also be used to build a remote mains relay. This can be used for switching mains power to lights or appliances using a remote switch (or relay) linked by low-voltage wiring. It can also be used for controlling security lights from the relay contacts on a PIR sensor.

By JIM ROWE

THERE ARE many devices with relay outputs that are unable to safely switch mains voltages. Often, the relay contacts will not be rated for 240VAC mains or, even worse, there are exposed tracks on the PC board which were never designed to carry mains voltages and currents.

This Remote Mains Relay Mk.2 neatly solves that problem. It can be activated using a switch, relay contacts or even a switching semiconductor such as an open-collector transistor.

Because the remote switch is in the low-voltage section of the circuit, it is completely safe. In addition, the switch leads only carry a couple of milliamps, so light-duty cable can be used to connect the switch.

Fig.1 shows the modified circuit for the Remote Mains Relay. As shown, the ICs, transistors and USB sockets used in the USB Sensing Power Switch are deleted. Instead, jumper JP2 is installed and the +2V supply that appears across power indicator LED2 (red) is fed to a remote switch via connector CON3.

The remote switch is used to turn transistor Q2 on or off, simply by switching its base current on or off (via a 560Ω resistor). When the switch closes, Q2 turns on. This then turns on relay RLY1 which closes its contacts and switches power through to the mains socket (GPO).

Building it

This device must be installed in exactly the same type of polycarbonate box used for the USB Sensing Power Switch. The mains wiring to the IEC

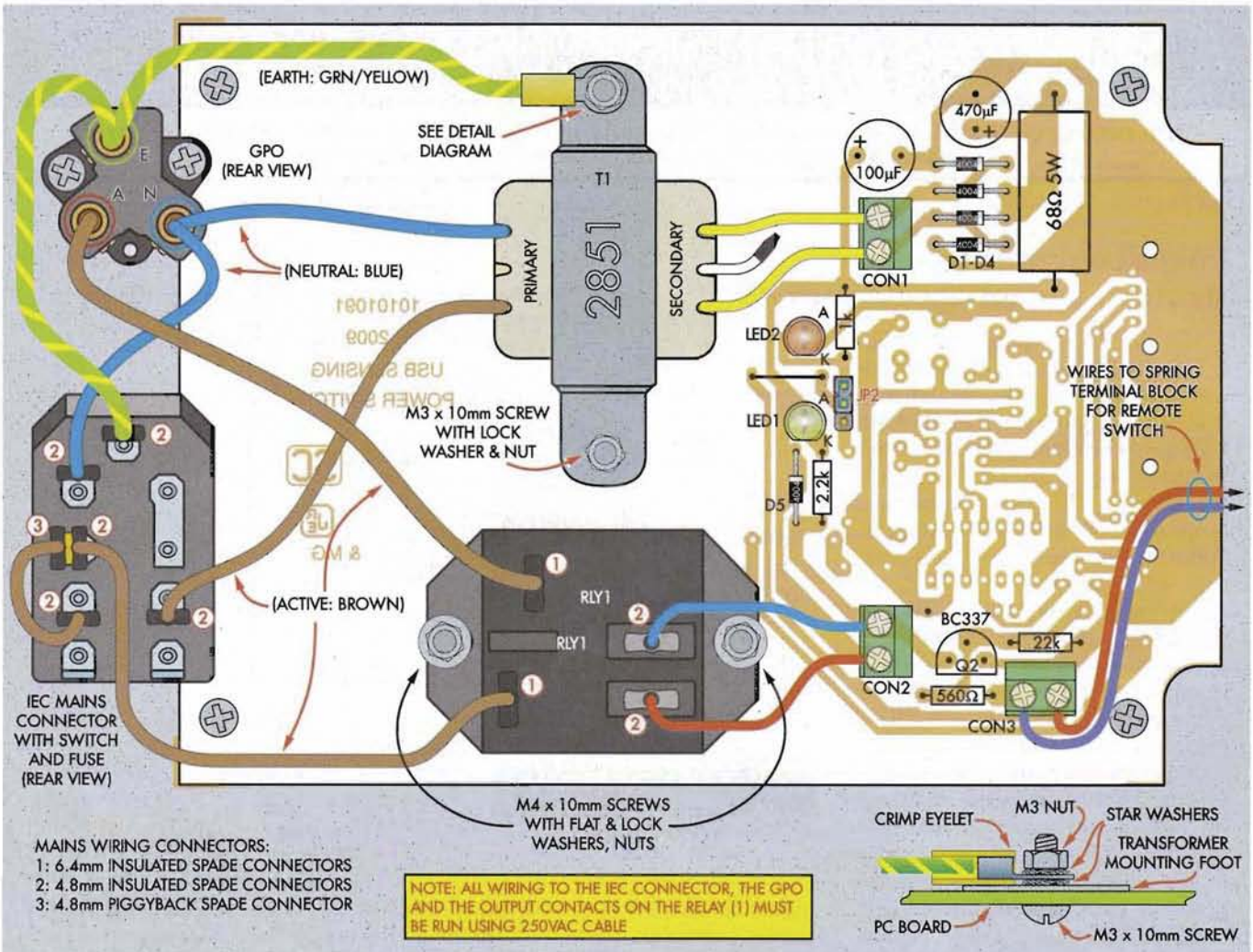


Fig.2: install the parts on the PC board and complete the wiring as shown here. The device is built into the same case as the USB Sensing Power Switch. Secure all the mains wiring with cable ties as shown in the previous article.

connector, transformer and relay must also be installed (and secured using cable ties) in exactly the same manner – see previous article.

Apart from that, it's just a matter of installing the parts on the PC board as shown in Fig.2. You also have to run a couple of leads from CON3 to the remote switch. These leads can be connected to the rear of a small 2-way spring (speaker) terminal block (eg, Jaycar PT-3000) which is fastened to the righthand end of the box using M3 x 10mm Nylon screws and nuts.

The remote switch or relay contacts can then be connected to the spring terminal block using a suitable length of light-duty figure-8 speaker cable, or similar – see Fig.3.

Finally, note that this design supercedes the Remote Mains Relay described in May 2006. That project was exclusive to Dick Smith Electronics and is no longer available. SC

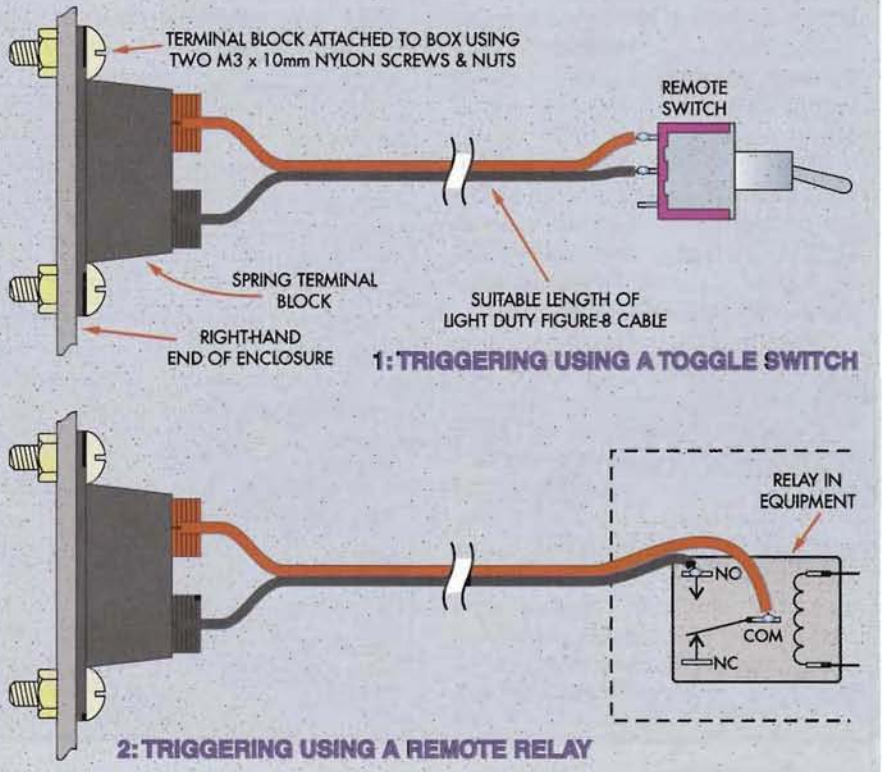


Fig.3: the unit can be triggered using a remote toggle switch, the contacts of a remote relay (eg, in a PIR sensor), or a semiconductor switch.

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.

Fuel Economiser uses strain gauge on accelerator

This project helps a driver to avoid excess fuel consumption by monitoring pressure on the accelerator. It uses a pressure sensor made from a piece of conductive foam (as used to store ICs) and mounted between two sheets of PC board. The sensor is mounted on the accelerator pedal and its resistance drops when pressure is applied to it.

The pressure sensor is teamed up with a PICAXE-08M. The PICAXE determines whether excess pressure is applied to the pedal and provides a warning if it does. It will allow gentle acceleration to your peak speed. Two stages of high acceleration (as determined by the software) can be detected and a different tone is produced for each.

The PICAXE-08M senses pedal pressure via the ADC pin 6. This looks for a change of the resistance of the pressure sensor. A 5kΩ pot, VR1, provides a sensitivity adjustment. The PICAXE runs through tests at 100ms cycles and if the value of W0 (the reading derived from the transducer) exceeds your threshold, it triggers a piezo speaker to sound an alert.

The circuit uses a 78L05 regulator and diode D1 is included for polarity protection. The piezo speaker should be a fairly quiet unit, not rated at 105dB/1m which would scare the daylights out of the driver.

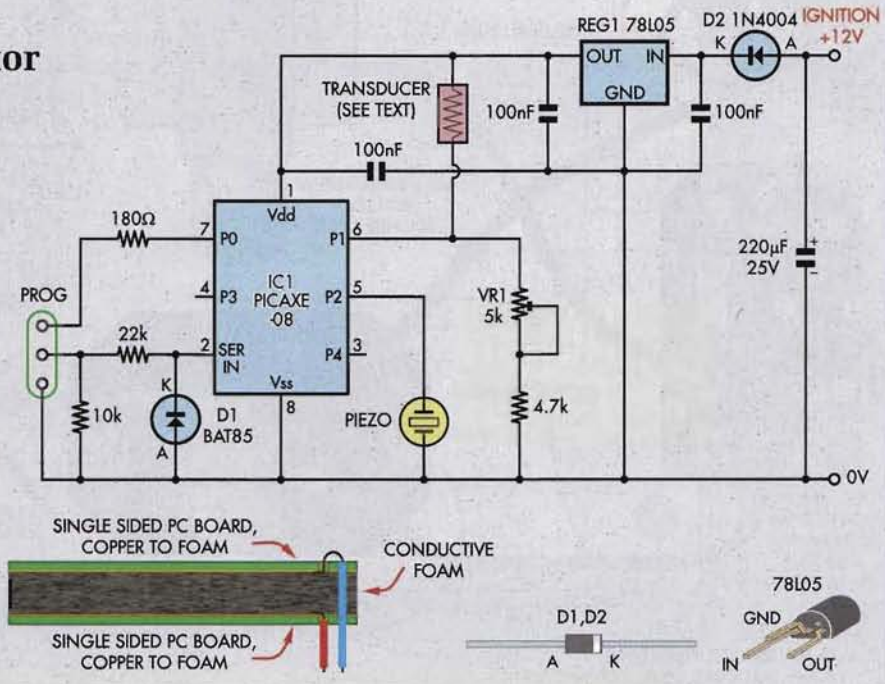
When making the sensor, remember that the assembly must be slightly compressible and must resume its shape when pressure is removed, so you cannot simply use nuts and bolts.

The wires are soldered to the two pieces of PC board with the copper sides facing the foam. The sensor assembly was held together with some heatshrink sleeving intended for making battery packs (Jaycar Cat. WH-5880). It is thick, wide and designed for making your own battery packs. Lying flat, it is almost 50mm wide and slightly elastic.

The sensor size will depend on the size of the accelerator pedal and more importantly, it must also be sized so that two bands of the heatshrink sleeving can slide on over the top, to hold it in place.

These pressure sensors can be expected to vary in resistance and pressure/resistance characteristics.

Brett Cupitt,
Ashfield, NSW. ($50)



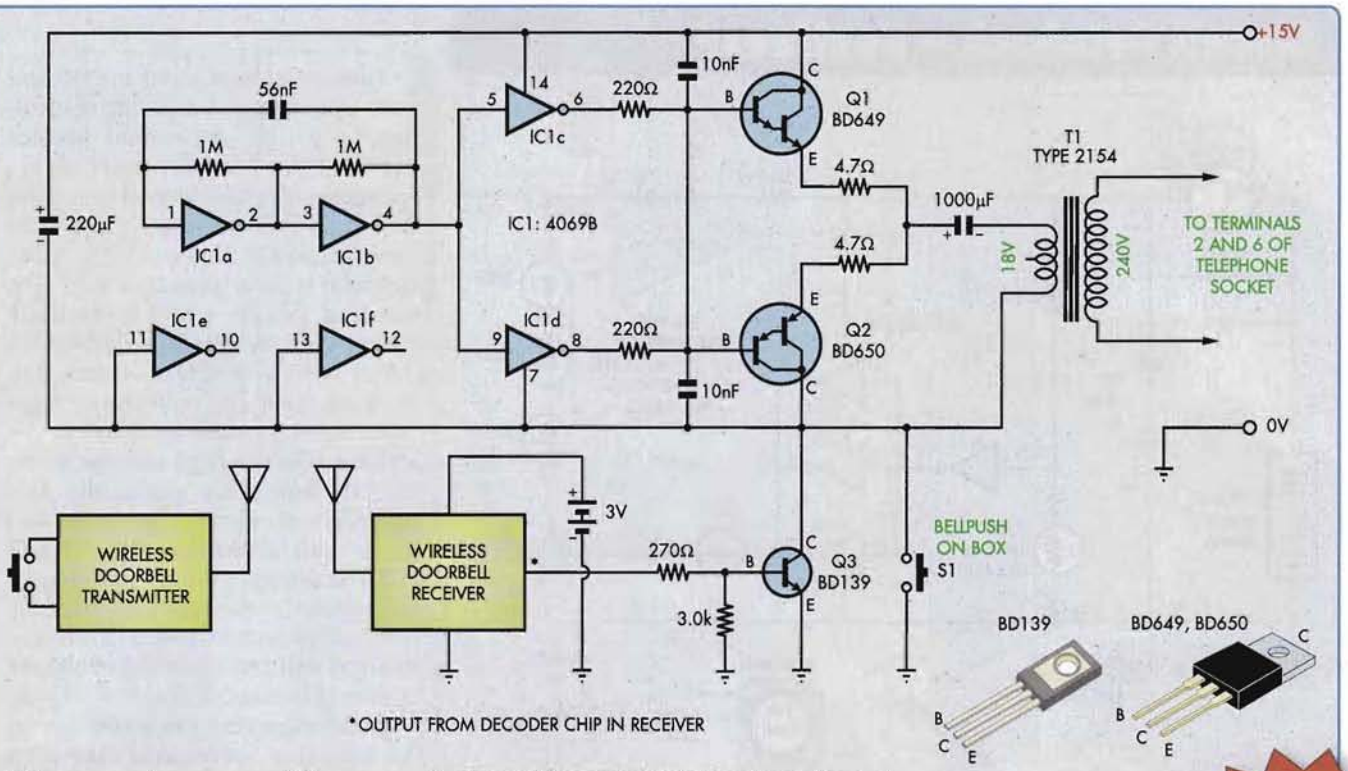
Fuel Economiser Software Listing

```
;Fuel Economiser V1.1 October 2008
;Copyright Brett Cupitt
;======================

start:
readadc10 1,w0          ;get transducer reading
debug w0                ;remove this line after testing
if w0>325 then alert2:  ;goto alert if transducer pressure exceeded
if w0>300 then alert1:  ;ditto
pause 100               ;wait 100ms
goto start:             ;do it again

alert1:
sound 2,(7,7)           ;low level alert
goto start:

alert2:
sound 2,(75,100)        ;higher level alert
goto start:
```



Phone ringer with remote control

This telephone ringer was designed for an amateur play in a theatre restaurant. It required remote control of the ringing and the phone had to be an 800-type bell telephone.

The ringer circuit is based on a 4069 hex inverter (IC1). IC1a & IC1b are connected to oscillate at 25Hz. The signal drives inverters IC1c & IC1d which then drive complementary emitter follower transistors Q1 & Q2. The output signal from the commoned emitters is fed via a 1000µF coupling capacitor to the primary of transformer T1 which has a step-up ratio of 1:13.3 (ie, 18V to 240V).

This gives about 36V AC which is adequate to drive the ringer on a type 800 phone with mechanical ringer (the normal ring voltage from the phone line is about 75V AC). Depending on the gate thresholds, the value of the feedback capacitor in the oscillator will need to be between 33nF and 56nF.

The remote control is based on a cordless doorbell, normally priced at $8-12 from a bargain shop. The bell receiver circuit board was removed from its case and the two wires to the speaker cut at the circuit board end. The oscillator circuit which warbles the speaker also has to be removed. This is on a separate small PC board which is easily unsoldered.

These receivers use a 2272-L4 remote control decoder chip. When operated, pin 17 of the chip goes high, ie, to +3V. This output is used on transistor Q3 which pulls the negative line of the ringer circuit low, to allow it to operate.

Julian James is this month's winner of a Peak Atlas Test Instrument

The ringer operates the bells on a Telstra 800 type bell phone and it also works with a British Telecom 746 phone. The latter was used in the amateur production as it has an authentic ringing sound. These phones have their bell gongs mounted offset so they can be turned to alter the distance between the gong and the striker. It might be worth "tuning" the phone to suit the ringer circuit.

The circuit will, of course, ring an electronic phone such as the Telstra Tele 200 type.

Ten AA cells were used to power the main ringer and two 2 AA cells for the receiver circuit.

Julian James,
Coledale, NSW.

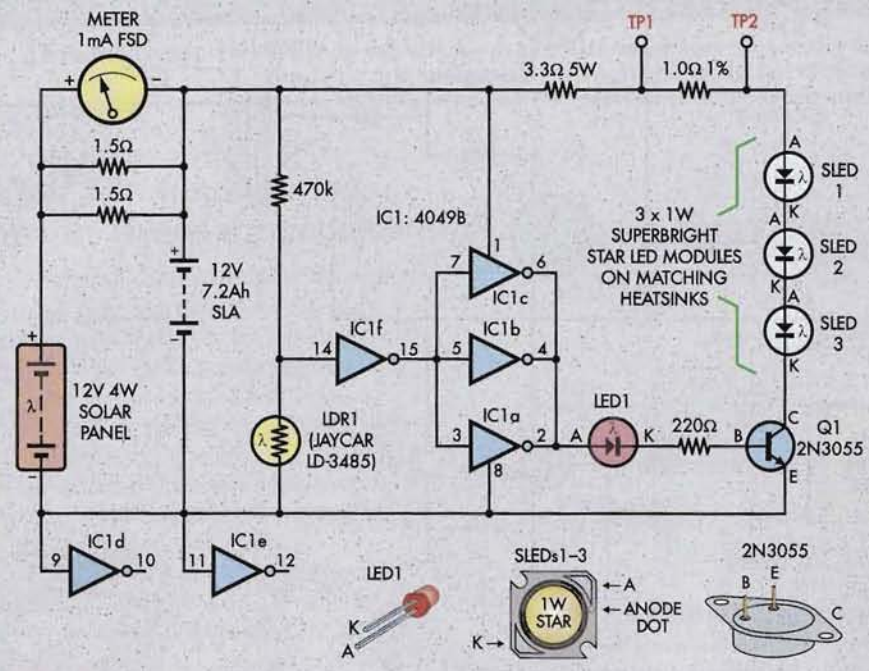
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So now you have even more reasons to send that brilliant circuit in. Send it to SILICON CHIP and you could be a winner.

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



Solar powered backyard lighting system

This solar powered lighting system will provide enough light (around 75 lumens) to illuminate the average backyard. It will switch on at dusk and back off at dawn.

The 12V lead-acid motorbike battery is charged by the 4W solar cell with charging current being monitored by the 300mA meter movement (Jaycar MU-48, Cat. QP-5010). The optimum orientation of the solar cell is set by peaking the meter.

During daylight, the three 1W Star LED modules are off, being controlled by a light dependent resistor (LDR) at pin 14 of IC1. As dusk approaches, the LDR's resistance rises to a high value, allowing pin 14 to go high. Pin 5 then pulls the three inverter inputs (pins 3, 5 & 7) low, causing pins 2, 4 & 6 to go high. These then provide base current via LED1 to transistor Q1, causing it to turn on hard (its collector voltage should drop to around 30mV).

This effectively places the string of 1W Star LEDs across the 12V supply with current being limited to around 280mA by the 1Ω and 3.3Ω resistors. The 1Ω 1% resistor is included to allow easy monitoring of the LED current. Using Ohms law, 280mA will give a reading of 280mV across this resistor.

Make sure that the LEDs are on an adequate heatsink as they each dissipate 1W. The controller can be built into a Jiffy box with a translucent lid, to allow the LDR to operate. The 1W LEDs can be mounted where convenient.

All the components are available from Jaycar Electronics.

Phillip Storey,
Watsons Bay, NSW. ($40)

Crystal-controlled short-wave converter

This converter covers all major shortwave broadcasting bands from 75-21 metres, and is designed to be connected to older analog-tuned AM car radios as a tunable IF stage. Digitally tuned sets are not very useful, as the tuning steps are too coarse for this purpose.

The RF coils are recycled 10.7MHz IF transformers with the integral fixed capacitor in the base removed. This is easily accomplished by clipping the leads to the capacitor.

L3 is a 455kHz IF transformer which is modified in a similar manner. The crystals can be recycled from old computer equipment and any frequency close to the stated values will work, with the frequency coverage altering to suit. Most crystals marked 15MHz or higher will generally oscillate at one-third of the marked frequency. For example, a 25.5MHz crystal will oscillate at 8.5MHz. An old colour TV chassis will provide a 4.4MHz crystal and its first harmonic at 8.8MHz will also make it suitable.

The circuit works as a mixer stage with transistor Q1 oscillating at the frequency of the crystal selected by switch S1. It beats with the incoming signal from the antenna and the mixer's output frequency is coupled to the antenna input of the AM radio.

Setting up

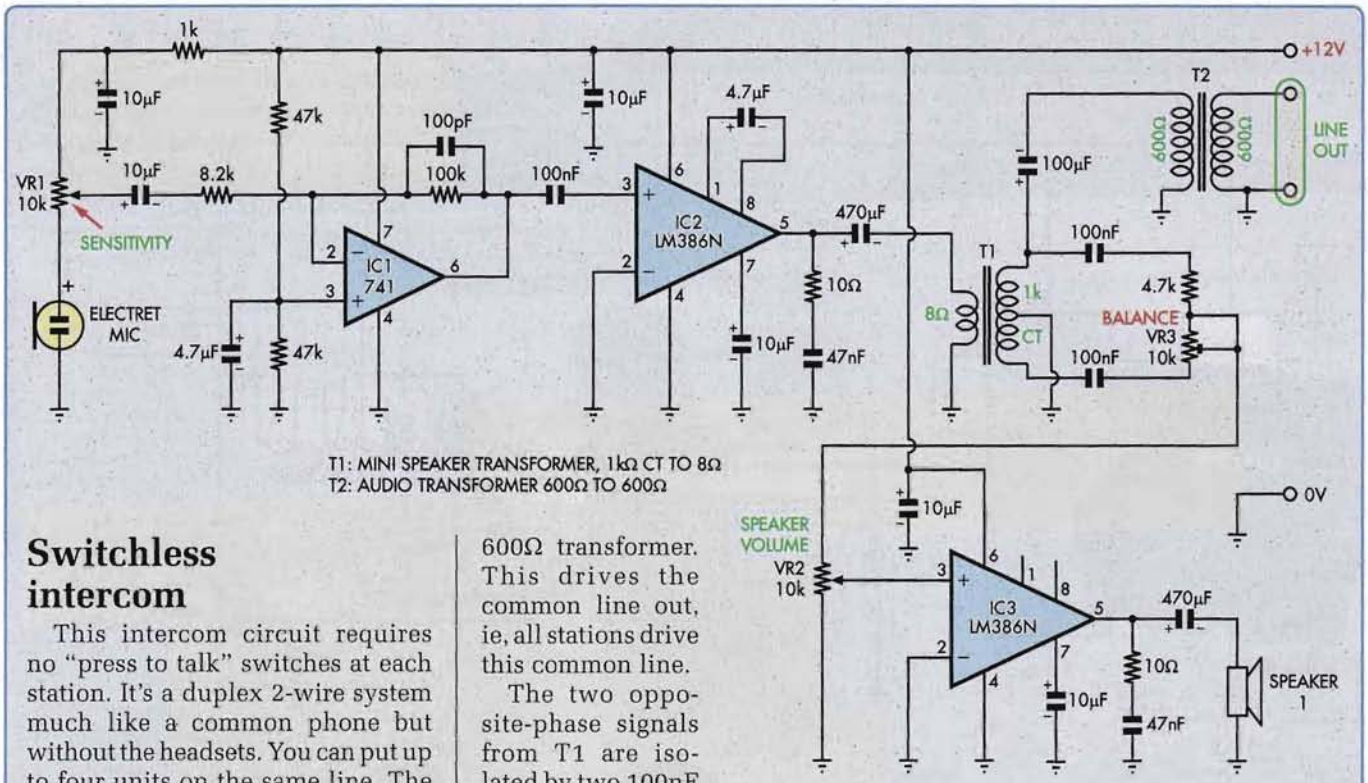
To set up the circuit, connect the converter's output directly into the antenna socket of the car radio. The radio should be tuned to about 1400kHz. Adjust the car radio's antenna trimmer for a peak in noise.

Select the 11.5MHz crystal with switch S1 and with the tuning gang (VC1/VC2) fully open (ie, minimum capacitance), adjust L1/L2 for maximum noise. By tuning the car radio and peaking the signal with VC1/VC2, the 21-metre band will be covered. Tuning VC1/VC2 lower will result in another peak corresponding to the 31-metre band.

Other bands are covered similarly, by switching in the other crystals and peaking the RF stage to the high or low side of the IF. The three crystals effectively cover six bands, each about 1MHz wide.

An on/off switch was not included in the prototype, with the power for the converter being supplied from the radio. If desired, switching may be arranged and a bypass switch added to allow normal AM broadcast reception.

Dayle Edwards,
Taylorville, NZ. ($50)



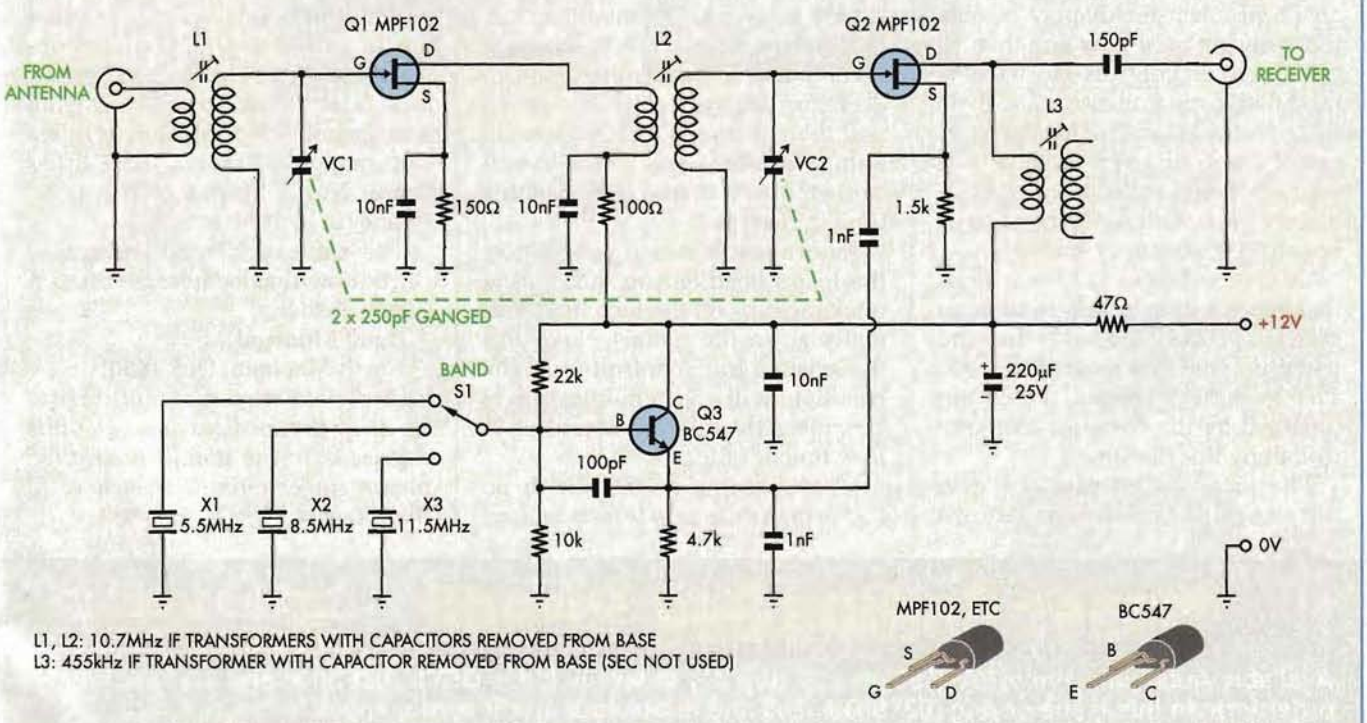
Switchless intercom

This intercom circuit requires no "press to talk" switches at each station. It's a duplex 2-wire system much like a common phone but without the headsets. You can put up to four units on the same line. The intercoms are all the same so only one will be described here.

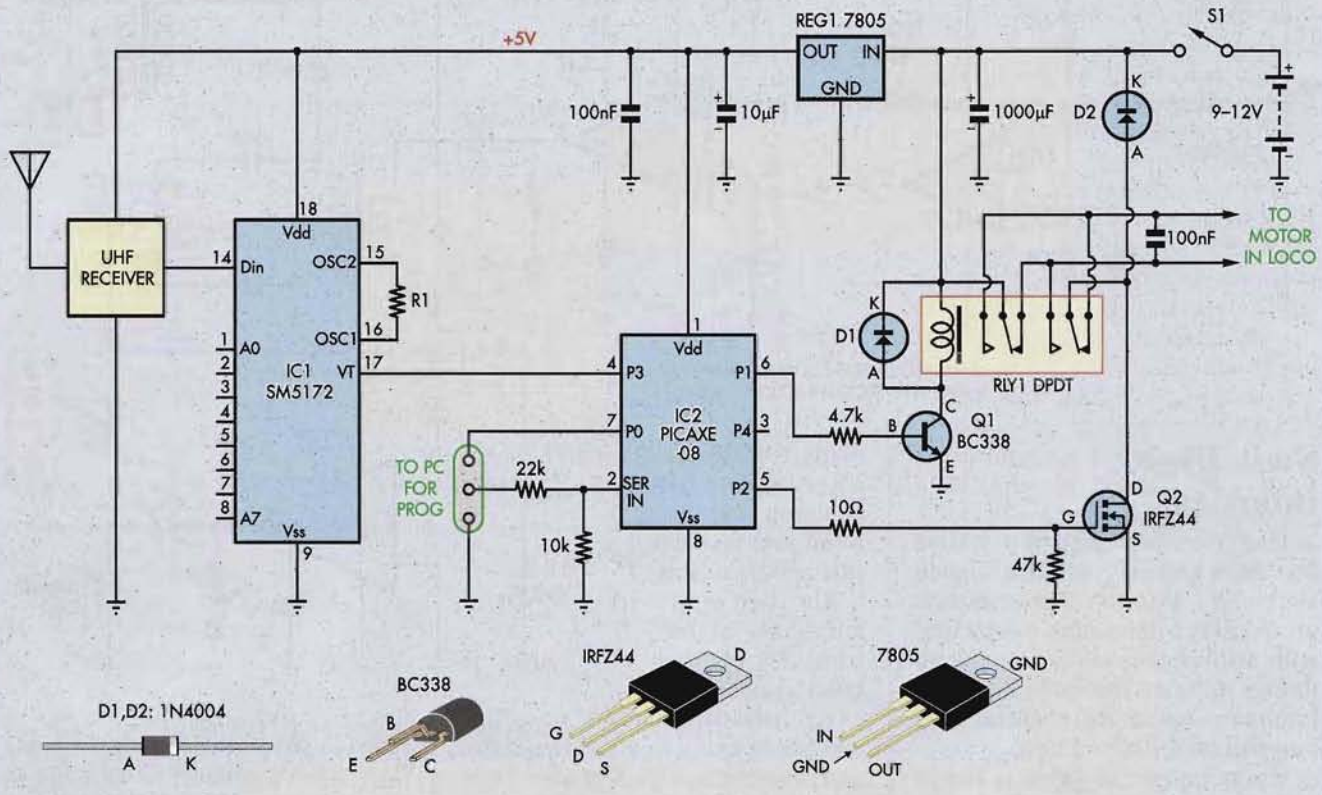
The microphone signal is fed to inverting preamplifier stage IC1. This feeds an LM386 amplifier (IC2) which drives transformer T1. T1 functions as a phase splitter and one side drives T2, a 600Ω to 600Ω transformer. This drives the common line out, ie, all stations drive this common line.

The two opposite-phase signals from T1 are isolated by two 100nF capacitors, with one phase going to a 4.7kΩ resistor and the other to VR3, a 10kΩ trimpot providing a balance null adjustment. The reason for this is to cancel out the input signal from the electret microphone while allowing signals from other stations to be fed via T2, through the null network, to 10kΩ (log) potentiometer VR3 which acts as a volume control. IC3 is another LM386 audio amplifier and this drives the loudspeaker.

Craig Kendrick Sellen, Philadelphia, USA. ($45)



L1, L2: 10.7MHz IF TRANSFORMERS WITH CAPACITORS REMOVED FROM BASE
L3: 455kHz IF TRANSFORMER WITH CAPACITOR REMOVED FROM BASE (SEC NOT USED)



Model railway track cleaner

One of the problems faced by model railroaders is the dreaded dirty track in a tunnel and on inaccessible parts of the layout. This is also a problem for display layouts that only get used now and then.

This circuit controls a loco that is modified to run from batteries. To do this, you will need to disconnect its motor from the track pickups and connect them instead to a 9-12V battery pack which will need to be installed in an empty wagon.

Under this wagon is a foam block that has a piece of fine sandpaper glued to it. The foam holds the sand paper pressed down onto the track. The loco runs around the layout powered by the batteries and controlled by this circuit.

The loco has no problem with dirty track because it has its own onboard battery pack, so it happily runs around cleaning the rails.

A single-channel UHF radio system from Oatley Electronics controls the circuit.

Pressing the transmit button and holding it will cause the loco to slowly accelerate in one direction. Release the button when the train is travelling at the required speed. Pressing and releasing the button will then cause the train to come to a stop. Another press and hold will cause the train to start again but this time in reverse.

As an added bonus, if you connect the loco's headlight to the unused track pickups on the loco (that normally go to the motor), then turn the existing train controller on, the headlight will give an indication of how clean the rails are according to how much it flickers.

When shining brightly with no flickering as the loco travels around the layout, the track should have been thoroughly cleaned.

Resistor R1 is set depending on the decoder chip used but is typically 220kΩ. The encoder/decoder chips used will determine this value.

Unfortunately, Oatley Electronics has discontinued the single channel Tx/Rx pairs but CTOAN Electronics can still supply them in limited quantities for $25, payable by bank transfer or money order only. Orders can sent to CTOAN, 163 Clifton Drive, North Maclean, Qld 4280. Phone (07) 3297 5421.

The software (TrackCleaner.bas) can be downloaded from the SILICON CHIP website.

Geoff Monegal,
North Maclean, Qld. ($50)

Editor's note: readers may also like to try using the cordless doorbell units suggested in the remote controlled phone ringer circuit, elsewhere in these pages.



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Mark the date down now: Sunday, February 8

It doesn't seem like 12 months ago that we were telling you about the (then) upcoming Wyong Amateur Radio Field day . . . but it must have been!

Organised by the Central Coast Amateur Radio Club, Australia's largest Amateur Field Day is on the "must visit" list of just about every amateur radio operator and anyone else interested in electronics.

It's held at the Wyong Racecourse, about an hour north of Sydney, with plenty of on-site parking and Wyong Station within easy walking distance. If your want more information, or if you get lost, there is an operator and a "talk-in" available on the Central Coast 2m repeater (146.725MHz)

The main attractions will be the stalls from major amateur and electronics retailers (there's always plenty of bargains!), flea market stalls (there's always plenty of bargains!), displays by special interest groups, seminars and amateur radio fox hunts.

An amateur radio station will be operating and you can even sit for your amateur radio operator's licence if you've boned up on the theory! (Exam bookings should be made in advance with Brian Kelly, VK2WBK on 0418 659 043)



Amateurs' ladies are not forgotten, with displays by the Central Coast Potters Society and the NSW Embroiders Guild.

Admission is $10 per person with under 17s free. Free tea and coffee is provided and there are also several food stalls on site. The trader/flea market area opens at 9.30am and tea/coffee/chat area opens at 7.30am.

Contact:
Central Coast Amateur Radio Club
PO Box 238 Gosford NSW 2250
Tel: (02) 4340 2500 (Field Day)
Website: www.ccarc.org.au

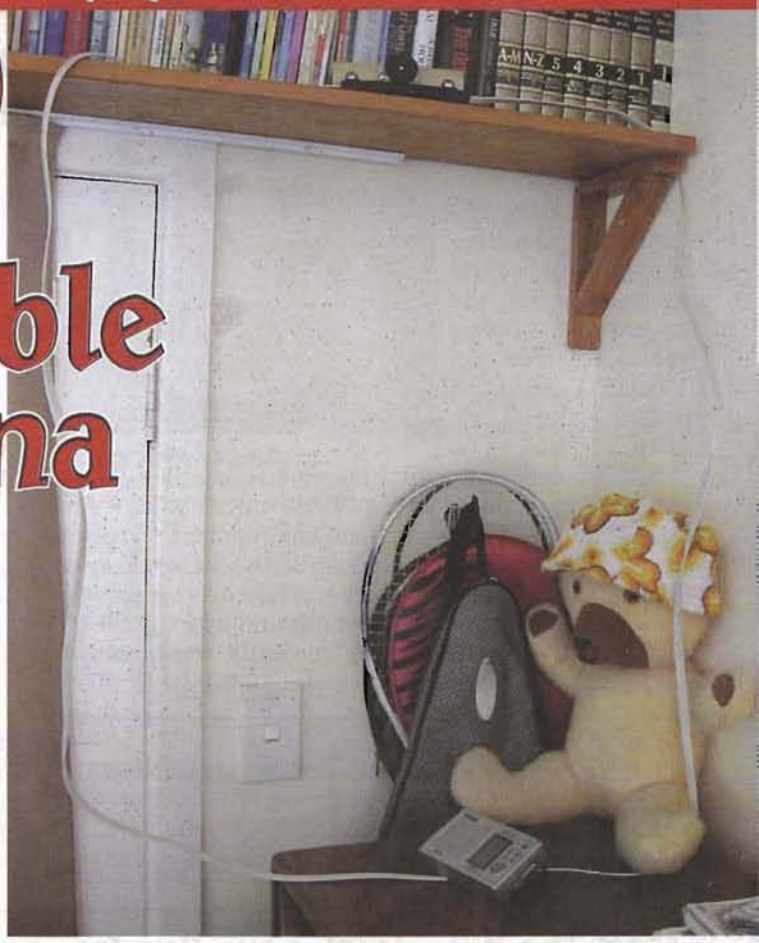
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A "learn-by-doing" Saturday Arvo project

AM (MW) broadcast band portable loop antenna



Lamenting the passing of local AM radio? Desert island or outback mining camp based? Unable to clamber up on the roof for a long wire aerial anymore? Here's a simple medium wave tunable loop that, even indoors, will bring signals out of thin air!

Way back in 1965, country music star Connie Smith sang about a "tiny blue transistor radio". The "trannie" was then the height of desirable consumer hi-tech. The ability to take pocket music and news with you was near-revolutionary in an era when almost everything electronic was wired to the mains.

These early portable radios were AM (Amplitude Modulation) only, covering the 520kHz –1650kHz medium wave (MW) broadcast band, with a significant part of their appeal due to the inbuilt radio-signal-concentrating ferrite rod antenna. Mains powered MW radios prior to this era had used bulky wire loops or lengthy external aerials, neither of which suited portability.

Ferrites are iron-based magnetic materials and an aerial coil wound around such a rod could be brought to resonance via a variable tuning capacitor within the radio circuitry itself. They're convenient and very compact and usefully offer good broadside directivity, arising from response to the magnetic component of the radio signal.

However, their efficiency is much less than a traditional antenna, a fact now often forgotten. Although ferrite rods are further hindered by an upper frequency limit of just a few MHz, almost all portable radios made in the last 50 years have used them for MW reception.

Tuning a signal

But how does a ferrite rod antenna coil pick up a signal of a specific frequency? In truth, it doesn't – it picks up a great range of frequencies at the same time. It must be made resonant at a particular frequency so that it allows signals at that frequency to pass through, while rejecting all others.

And how is it made resonant? By adding capacitance in parallel with the coil.

And if either the coil or the capacitor is made variable, the frequency of the signal which passes through can also be made variable.

It's more usual to have a variable capacitor than a variable inductor, though variable inductors are available (or at least they were once!).

Coil/capacitor electrical resonance is related to frequency by a well-known formula:

$$f = \frac{1}{2\pi\sqrt{LC}}$$

f = frequency in Hertz
C = capacitance in *Farads*
L = inductance in *Henries*

For a signal to cause LC resonance at 1MHz (which, incidentally, is right in the middle of the MW broadcast band), a capacitor of 100pF could be used with a coil of 250µH inductance.

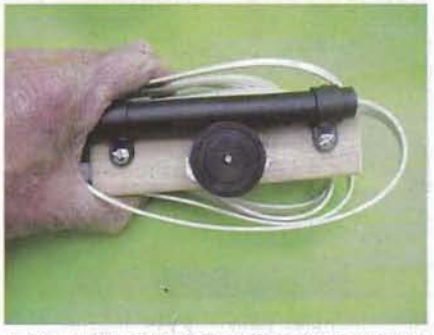
Neither the L nor C values are very high – we're talking picofarads 10^{-12} of a Farad) and microhenries (10^{-6} of a Henry) and even stray capacitance or a few extra turns of wire can significantly shift the resonant frequency.

Tuning capacitors traditionally used to complete the LC resonance were a mechanical marvel, typically presenting capacitance values of between 10 to 415pF or 30 to 300pF as the interleaving air-spaced insulated plates meshed. The drive for compactness again produced superior "dielectric" insulating layers-plastics have hence long been used instead

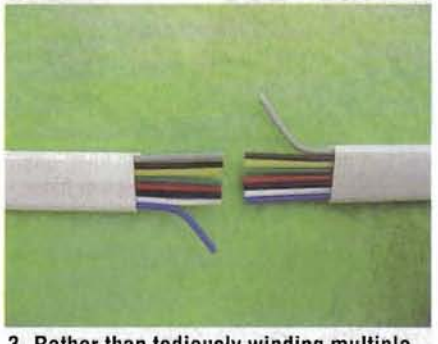
by Stan Swan



1. Medium Wave (MW) AM broadcast band loop antenna. Built using cheap 4-pair (8 wire) telephone "ribbon" cable (Jaycar WB-1625), and (optionally) housed in cheap garden 13mm irrigation plastic hose. The more rigid self-supporting version is better suited to serious use, as it can better null offending local noise or stations and even DF (direction find) when rotated towards remote signals.



2. The compact version allows easy storage – suitable for portable and traveling needs. Three metres of cheap 8-wire cable will resonate nicely over most of the upper 500kHz -1.7MHz MW Broadcast Band with a common 60-160pF miniature variable tuning capacitor (eg, Jaycar RV-5728). However you should use longer lengths for stations at lower MW frequencies OR add a second capacitor in parallel to the variable.



3. Rather than tediously winding multiple strands of wire around a frame, the approach here is to simply connect the cables offset wire ends (eg, white to blue, black to white, red to black and so on), thus making an 8-wire loop! Classic gray computer ribbon cable could also be used BUT the coloured wires of the phone cable used here make for much easier assembly and less confusion.

of air between the plates. It's now in fact hard to locate larger value variable tuning capacitors, with the limited C range (60-160pF) Jaycar RV-5728 almost the only available offering.

But back to the L side of things. During the golden age of AM radio pre WW2, aerial coils were mostly air wound on hollow formers, and Wheeler's Formula was developed to estimate this inductance for a given number of wire turns on a coil of known radius and length.

$$L = \frac{N^2R^2}{9R + 10H}$$

L = inductance in microhenries
N = number of turns of wire
R = radius of coil in inches
H = height of coil in inches

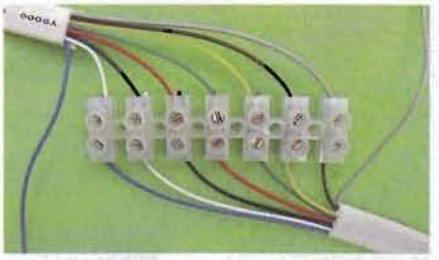
Yes – it's shown using inches but this classic formula essentially says that larger coils need fewer wire turns (or vice versa) for the same inductance. Thus hoop- sized coils of diameter around ½ m can be wound to resonate in the MW band with just a few dozen turns of wire – even hula hoops have been persuaded to act as coil supports!

Mmm – interesting but why do you need such a large coil? Although classic radio theory, the reasons still appeal. Naturally, larger antenna coils capture more of the passing radio signal but they also show desirable orientation effects, allowing beaming onto weak stations or interference reduction. Being magnetic devices – they're coils after all – they respond to the magnetic component of the electromagnetic (EM) radio wave, rather than the electrical portion picked up by a long wire antenna. Hence, as many interference sources are electrical in nature, this magnetic response can give some useful immunity to locally produced electrical noise.

Aha! Keen minds may already hence see where this is leading, and they'd join the legions of those who've long appreciated that a large tuned loop antenna could enhance MW radio performance. For almost a century, insulated magnet wire has been lovingly wound onto wooden supports and web sites still abound showing ambitious loop constructional details.

Aside from radio DX hobbyists (DX means distance) chasing rare stations, sports fanatics trying to hear a distant game or perhaps listeners after weak 1.7MHz "X" (extended) band ethnic or school stations, serious MW reception needs arise in remote mountainous and ocean regions where urban radio signals are elusive.

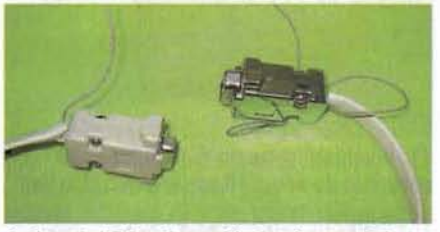
Daytime lower frequency radio signals tend to just follow the earth's surface, being little influenced by the sort of terrain or vegetation that blocks VHF or microwave signals. At night, ionospheric reflection



4. If your soldering is not up to it, the wire ends can even be joined by cheap screw terminal connectors (eg, Jaycar HM-3194). This will give design versatility, especially if you want to shorten the loop to cover higher frequencies.



5. When trimmed with a scalpel these terminals will also just fit (perhaps end to end) inside the 13mm plastic pipe.



6. A serial D9 pair could also be used, but these are tricky to solder & more costly.



7. Just basic household tools will do – the compact version can be mounted on a short piece of trellis offcut.



8. Cut off three metres and remove about four finger widths of the outer insulation.



9. Avoid nicking (& thus weakening) the 8 inner wires- carefully bend back the outer insulation as you cut.



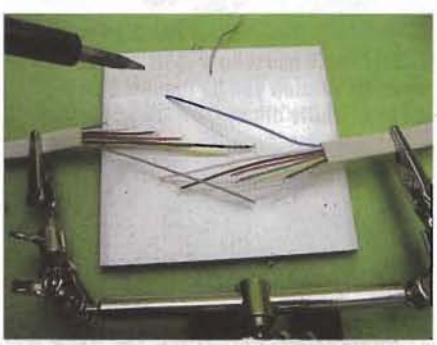
10. A scalpel will often do this most cleanly – side cutters are usually too savage.



11. If soldering the pairs then "stagger" each join by about 10mm to avoid shorting.



12. Use both fine pliers & side cutters to reveal the copper wire.



13. A "third hand" or "helping hand" will greatly assist in holding the wires steady during soldering. The soldering doesn't have to be especially neat but avoid shorts or weakened joints.

can boost MW ranges to thousands of kilometres – east coast Australian (and even west coast USA) MW stations are often received after dark in NZ with a decent communications receiver and external antenna – and vice versa. You could be based on a desert island or outback mining camp and still follow global events on MW radio, with remote tropical thunder storm static crashes or interfering stations perhaps the limiting reception factors.

The ability to tune into MW news and weather forecasts in the wilds can be extremely convenient and maybe even life saving. It's easy for city dwellers to assume cell phone, internet, FM and TV coverage is near universal but when just a few hours away in the outdoors the plight of much of the "out of touch" world soon becomes apparent.

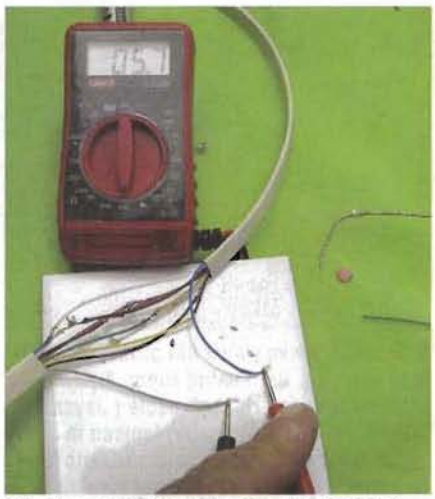
This was brought home to me recently when camping with a sports-mad group at an isolated NZ beach, as radio coverage of the Saturday evening big football match was thwarted by no one having an AM radio with them.

Predictably cell phones and FM radios abounded but the site's remoteness precluded VHF/UHF reception. Cell phone and MP3 Li-Ion batteries will go flat after a few days usage as well, and often are unique to the device, preventing swap-outs with common AA cells.

In fact the portable entertainment takeover by MP3 players and cell phones with inbuilt FM radios, has meant that classic AM medium wave (MW) broadcast band radio receivers have become elusive. A quick poll around a typical home often reveals the only non-mains-operated AM portable set will be in the car, where its ability to bring in stations when well out of town is essential.

The few pocket AM radios still on sale usually have pathetic sensitivity and audio but decent compact AM sets are still cheaply available for those who look hard enough. Jaycar's AR1741 AM/FM/SW traveler clock radio (~$20) even offers digital frequency displays and excellent audio. For purists however, classic analog tuning still appeals due to lower circuit noise and reduced battery drain.

Several cheap SONY analog portables (especially the deceptively simple SRF-59 based around a CXA1129N proprietary phasing IC) can run for weeks on just a single AA, yet have AM performance equal to professional communications receivers. Every survival kit and offshore coastal boat should have one, if only to navigate (when all else fails) by ferrite rod direction finding (DF).



14. After soldering (or connector joining), use a DMM on resistance to check the wires are not shorted or broken. About 5Ω resistance is normal.



15. Rather than forcefully pushing the wires into the protective irrigation hose, it's probably easier to slit a short length with scissors. The hose saddles will hold it shut again afterwards,



16. Hot melt glue can be used to keep any wire joins apart. Don't use too much here or later re-soldering may be difficult!



17. Further hot-melt glue can be used at the tube ends to secure the cable.



18. Only low value (typically 60-160pF) "poly-vari-cons" (plastic insulated variable tuning capacitors) are now usually available. Mounting for these can neatly be done with aluminium sliced from a drink can.



19. Punch a hole through the thin aluminium, trim with scissors & fold the wings to suit the mount. Even use two such brackets if the first seems too flimsy.



20. It looks quite professional. Discard the two topside screws, as if screwed down too far these will usually hit the plates inside the tuning capacitor and stop them moving!



SILICON CHIP has run loop antenna articles in the past (June 1989, March 2005 and October 2007) but with remote, emergency and educational needs in mind the quest developed to design a simpler, cheap, easily made and portable version that could enhance (just by inductive coupling) the performance of any MW radio placed nearby.

We've recently had a hard-hitting earthquake awareness TV program over here in the Kiwi shaky isles, reminding that (after drinking water) "what's going on" communication needs are paramount. With radio reception needs heightened, robust compact windup approaches were further preferred over classic fragile "timber and threaded wire" loops.

After assorted trials and number crunching, eight paralleled offset conductors were found most suitable – in spite of their inter-wire capacitance. The resulting loop was made from a 3m length of cheap 8-wire phone cable (eg, Jaycar WB-1625), supported and (optionally for the show-off version) able to be housed in budget plastic garden irrigation hose.

Conclusion

The weak signal enhancing performance (especially on classic "deaf" AM radios) of the design was found to be absolutely **outstanding** – MW signals just leapt off the bench! Electronics students were astounded at the resonance effect and cynics found it hard to credit that just "energy out of thin air" was at work.

As this loop can be built much more cheaply (and faster) than traditional laboriously wound and mounted designs, the eight-wire approach may suit tight budgets, educational resonance demonstrations, remote weather forecast/news needs and travelers unable to erect a long wire outdoors.

Aside from listening to remote tear-jerker tunes, it may even save your bacon, especially if the news, weather forecasts and footy scores are found to be against you!

21. Before fastening the capacitor to the mount, adjust the two small trimmers to a minimum (ie, plates NOT overlapping) – this determines the upper frequency. If you want lower MW frequencies then adjust them to FULLY overlap (more capacitance). These tuning capacitors have two sets of moving plates within and they can be paralleled by joining the two side terminals. For most users, however, just the LH side and the centre terminal (as shown) will do – this accesses the larger variable range.



22. Finished. The portable design easily folds up for storage or travel.



23. Clothes pegs fastened to a curtain make a neat holding system. The loop doesn't need to be perfectly formed either, although its directional pickup will naturally not be as good.



25. Simply tune the variable capacitor for maximum band signal- it can be quite sharp (consistent with a high "Q" factor). Signal enhancement on some stations is so strong that intermodulation may develop in the receiver, indicating nearby stations on frequencies where they don't actually transmit.

For more information, including a demonstration on the performance of the loop antenna, visit Stan Swan's "Inscrutables" page at www.instructables.com/id/Medium_Wave_AM_broadcast_band_resonant_loop_antenn/ SC

SERVICEMAN'S LOG

Headphone Problems In An LCD TV

There are some jobs that I would rather forget about. But for the sake of my soul, one has to learn to be humble by reminding oneself of one's failings. And if I don't do it, there's always an OAP who will.

Items Covered This Month

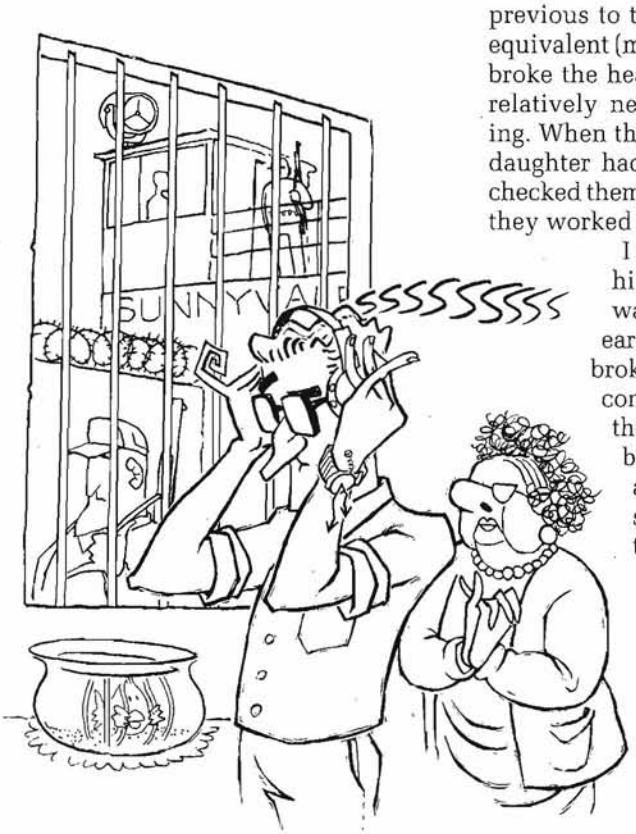
- Sony KV-PG21P10 BG-2T
- Toshiba 42WP56A (LG 42V7 chassis)
- NEC NLT-17W LCD TV
- Antivirus 2008 malware

A while ago, a rival service centre passed on a job as they were super busy and one television technician down. Besides which, it was for a brand they were not an agent for and the fault was an easy one for me. It would be money for old rope.

The set was a deluxe European-designed 66cm LCD TV made by Samsung. It was located at an old folk's home and the symptom was no sound out of the headphones.

Well, how hard could that be? So off I trotted and found Mrs Belmont's room in the home. She was an intelligent person and could manage her affairs pretty well, though she did find it hard to see. The reason for the headphones was not because of her hearing but more not to interfere with her neighbours in adjoining rooms.

The headphones were Sony infrared cordless types (model MDR-IF) and when I checked them out, all I could get was hiss. Mrs Belmont had been there at the home for some time and previous to this, she had the Philips equivalent (model no HC-30) until she broke the headset. The Sony set was relatively new and had been working. When they stopped working, her daughter had taken them home and checked them out on her TV and found they worked fine.



THE SYMPTOM WAS NO SOUND OUT OF THE HEADPHONE...

I wished I had known this history beforehand, as it was sounding more like the earphone socket had been broken but I had nothing to confirm her story. I thought the easiest answer would be to take her headset away and return with some earpieces to check the TV out the next day. I was quite prepared to waive the additional service call fee.

Back at the workshop, I checked out the Sony headset which was working faultlessly in stereo. I also checked the batteries just in case. I grabbed some 3.5mm stereo jack earpieces and also some speakers and returned as promised the next afternoon.

When I plugged the earpieces in, both worked! Not very loudly, I must confess but at a reasonable volume. However, when I connected her Sony headphones, I again got nothing but hiss. I did notice that if I connected via the RCA sockets on the transmitter, I could get one channel to work slightly if I unplugged the other, which was rather bizarre.

Time to think laterally – what about the lighting conditions in the room? I turned off all the lights, especially any low-powered neon globes and looked around for special ones – in particular, infrared. There were quite a few possible sources of infrared light – remote controls and fire and security systems all might use interfering light.

As a result, I corralled all the remotes and removed their batteries. I put the transmitter right up close to the receiver but nothing made any difference at all. In the end, I decided it was time to upgrade to wireless headphones, so I ordered some in.

Fortunately, I also know the agents for this particular brand of TV as they are not far away, so I gave them a buzz to see if they had any clues. Though the set was way out of warranty, they wanted me to bring it in so they could check it out. Next morning we had it on their workbench with the Sony headphones.

We soon established that there was a slight problem with the set as it wasn't giving much output compared to similar models in stock. The head-

phones were otherwise working quite satisfactorily with all the other sets.

We next removed the stand and laid the set face down on sponges and proceeded to swap the set over board by board with brand new working stock. Now the set belonging to Mrs Belmont was a Series 1 (of 3) before this model was phased out and as luck would have it, the company had temporarily run out of stock of Series 1 boards. There is no separate headphone amplifier. The headphones get their amplification through the main 10W power amplifier.

We proceeded to upgrade the whole set, including the headphone socket, to a Series 2 model. This provided additional features to the set, such as HDMI sockets and the like.

Changing the main video control board made the most difference, increasing the audio output just enough to make the headphones work, although they were still far too hissy.

Unfortunately, the tuner board could not be changed as they only had an incompatible Series 3 in stock. However, there is a well known capacitor (C466) which causes lines on high-definition reception. This is one of those "fish oil" 100µF 16V surface mounted types, so we replaced this to be on the safe side.

This set has two SCART sockets on the rear and on SCART 2, there is constant audio output not controlled by the remote. When we connected the headphones to this, the sound was yet again a little better. The final workaround was to use the new wireless headphones on SCART 2. We now had enough volume to give breathtaking quality audio. After a little iron-work to alter the new SCART sockets, the back was replaced.

I redelivered the set to Mrs Belmont, and tried to explain that, though we had been unable to find an actual fault per se, we had had great success with the new arrangement. And in deference to her OAP status, I only charged her for one service call, including half an hour labour. However that did not stop her from giving me the benefit of what she thought of my technical ability or lack of it. After all, it was a very simple fault!

A beautifully clean Sony

Small TV repairs are not really viable these days unless the fault is really simple because they are just about giving them away with cornflakes. Anyway, a beautifully clean 21-inch Sony flat-screen set was brought in with intermittent width. I figured it was just going to be a dry joint in the east-west circuit and quoted accordingly. I was given the go-ahead provided I didn't exceed this estimate. If I was wrong, it was going to be a bit of a challenge.

The set was a Sony KV-PG21P10 using a BG-2T chassis which isn't all that dissimilar to the BG-1S chassis. Examining the motherboard with a maggy lamp didn't reveal any obvious dry joints but I resoldered all the likely candidates anyway. Of course it made no difference and now I was in trouble.

Measuring the B+ rail showed that it was varying wildly with the beam current (and hence width), so the fault had to be with the feedback control circuit to the switchmode power supply. The B+ is supposed to be +135V.

Fortunately, I just happened to have a few scrapped chasses that are very similar to this model, so I started by replacing IC802 (SE135N) which is the error control IC. That was a strike 2. Next, I went for the optocoupler (PH600 PC123F2). Strike 3!

Now they reckon strike 3 and you're out! So I was now supposed to abandon this set for economic reasons. Well of course, I couldn't – I just had to know!

Next, I changed the two electros in the control circuit (C610 & C606). Still no difference. Well then, it had to be the main control IC (IC601, STR-F6707A), didn't it? I fitted a second-hand one, convinced that this had to fix the fault. When it still made no difference, I even ordered a new one, so

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THIS SIGN WAS ALSO NOW EMBEDDED IN THE DESKTOP...

convinced was I that it was the culprit. Only when that too made no difference did I realise what a complete fool I was. To compound this, I then measured every component around the IC but then I struck paydirt – on checking the continuity of D606, I found it to be open-circuit.

Replacing the diode finally fixed the problem. It all just goes to prove that there is no fool like an old fool, albeit maybe slightly wiser!

Toshiba plasma set

One of the most common problems you can get with LG-built plasma sets is failure of the "y-sus" board. I dislike repairing these, mainly because of the logistics. This is a 42-inch widescreen TV and is often mounted on a wall. It requires two people to remove it, the back is held on with 50 screws and you need a lot of room to work on it while it is resting dangerously face down on a piece of soft foam.

In this particular instance, I was working on a Toshiba 42WP56A which is an LG 42V7 chassis. Capacitor C63, a 100µF 63V electro, had spilt its guts, probably due to the failure of transistor Q9. Fuse FS2 was also open. However, you are not supposed to repair this. Because the damage might have spread to both the "z-sus" and "control" boards, you are supposed to replace all three boards as a "y-sus" kit, part no 6871VSNB03E. If you purchase these directly from an LG spare parts agency they are quite reasonably priced and the new ones are modified to be more reliable. If you purchase them as spare parts from whatever brand the set is made under, you can pay more than double. Sometimes you have to though, as the control module is programmed for that particular brand and model.

After fitting the kit, the set began working but the picture was terrible. There were vertical lines and lots of digital noise. We checked the voltages against those listed on the back of the display. All the flat ribbon cables and clamps were triple checked carefully but it made no difference. In the end, it turned out that the new control module was faulty and we had to reuse the old module to restore perfect pictures!

Faulty NEC LCD TV set

I was called out to examine an NEC NLT-17W LCD TV. The set's owner, Mrs O'Connor, complained that each time she switched it on, the word "Component" briefly appeared on the screen and then the set would close down. This particular set was a few years old and was outside its 3-year warranty period. They are now pretty cheap to replace and I recently saw a 19-inch LCD TV with a DVD player for less that $400.

However, Mrs O'Connor had paid nearly $1300 (ouch!) for her set some years ago and so was anxious to get it fixed. I took it back to the workshop, removed the cover and had a good look around inside it. My initial thought was that it had something to do with the main control module, with possibly the display driver being faulty, as the backlights came on momentarily before the set closed down.

However, after closely inspecting the backlight inverter board, I noticed a slight discolouration on one of the insulating plastic shields stuck on the inverter transformers. When I removed this shield, it was obvious that the centre surface-mounted transformer (T5 – TR51301N DK334A) was overheating, with the resulting hot spot causing the faint discolouration.

The part was not available separately but a new inverter board fixed the problem.

An act of imprudence

A customer came in whingeing about his battle with XP Antivirus 2008. This malware normally comes in as a cleverly disguised attachment to an email purporting to be from a reputable courier company. The email normally states something along the lines that they have been unable to deliver the package and asks the recipient to open an attachment for instructions.

And of course, that's exactly what he did. And like thousands of others, he was suddenly immersed in a world of pain from this act of imprudence. The malware that was now injected into his computer had, in one fell swoop, punched a hole in his firewall, disabled all his anti-spyware and anti-virus programs and replaced the display settings with a version of its own.

The computer now booted with a big red sign shouting to all the world that it was infected. This sign was also now embedded in the on-screen desktop and could not be removed. And his screensaver had been replaced by one that mimicked the "blue screen of death".

But that wasn't the end of it. The malware was now suggesting that he pay money in order to solve the problem.

This particular piece of malware goes under the name of XP Antivirus 2008 and is basically a rogue anti-sypware program that looks just like the real thing. Basically it gives fake alerts to scare you into purchasing the program. It is difficult to remove and can re-install itself even after it appears to have been removed.

I won't bore you with the details of the cure but is was basically a case of "googling" on an uninfected computer and following the advice of several reputable websites (you have to be careful here). The infected machine should be disconnected from the in-

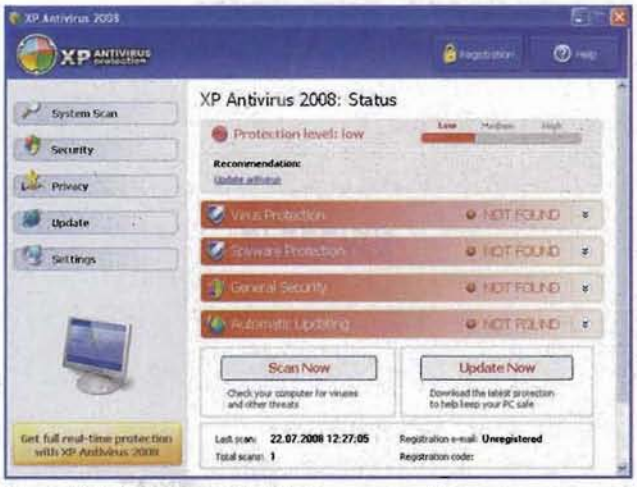


Fig.1: XP Antivirus 2008 is a rogue anti-spyware program that gives false alerts.

ternet during this procedure.

Suffice to say, fixing it took quite some time (you have to hand-fettle the registry) and the client was billed accordingly. He was also instructed to upgrade his anti-virus and anti-spyware software and instructed to never, ever open such attachments.

May those who peddle this sort of stuff rot in hell.

The old toaster wrangler

Finally, here's a funny story from a friend of mine. This friend works in an office and in the kitchen area, they have a microwave oven and a toaster plugged into a powerboard which is then plugged into a power point on the wall. They also have a sales rep who is only in the office two or three days a week.

The only problem was that when ever the sales rep came in and used the toaster, he turned off the power to the microwave which meant that its clock had to be reset. And there was another oddity – there were also lots of crumbs left on the bench around the toaster.

Several requests to the sales rep not to do this failed to solve the problem and eventually it really got to one of the guys who worked in the office. Now this particular guy is normally very relaxed and laid back but having to continually reset the clock in the microwave nearly gave him apoplexy.

And then one day he caught the perpetrator redhanded. Apparently the sales rep didn't realise that you could eject the toast before the cycle was complete by pressing a little button at the top of the toaster. And so he came up with a rather novel way of getting his toast out.

What he was doing was watching his toast through the slots as it cooked. And when it was dark enough, he simply switched off the power at the wall, grasped hold of the toaster in his hairy mitt and turned it upside down to let the toast fall out! Basically, he was relying on gravity eject rather than spring eject.

That also explained why he left so many crumbs behind when ever he used the toaster and so both puzzles were solved in one hit. There's now a large sign next to the power point giving instructions on proper toaster usage.

Some mothers do 'ave 'em! SC

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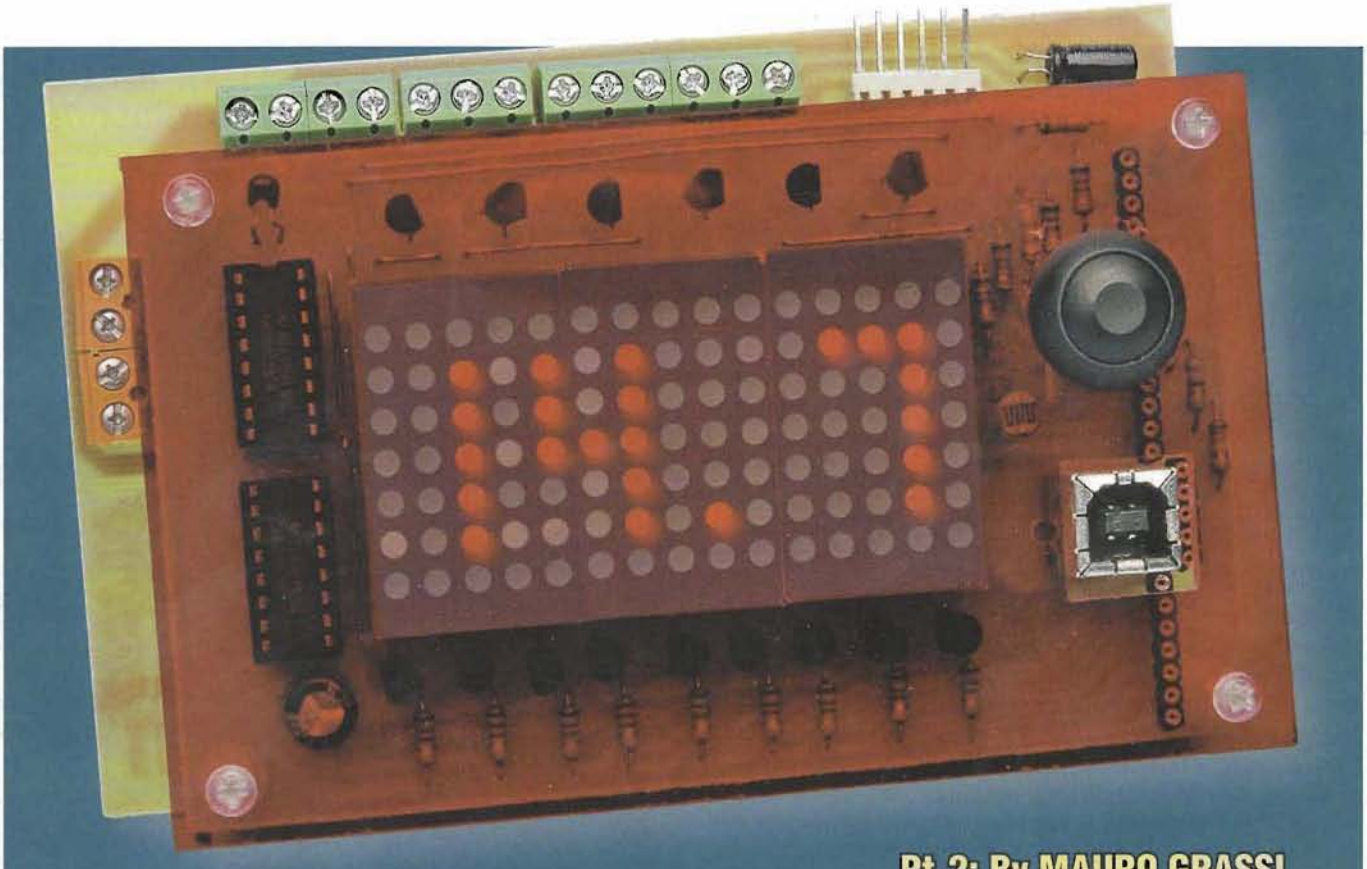
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Pt.2: By MAURO GRASSI

Multi-Purpose Car Scrolling Display

Construction & software installation

In this month's article, we guide you through the construction of the Car Scrolling Display. We also show you how to install the software driver that's used to communicate with the display via a USB port on a Windows PC.

ALL THE PARTS for the Car Scrolling Display are installed on two PC boards – a main board coded 05101091 (134 x 86mm) and a display board coded 05101092 (124 x 75mm). These two boards are stacked together with a red Perspex window and are secured using Nylon spacers, washers and screws. Note that there is no wiring between the two boards. The display board simply plugs into the main board via connector CON6.

Note also that the display board is smaller than the main board. That's been done so that when the two boards are stacked together, the screw terminal blocks on the main board are exposed for easy access.

Main board assembly

Fig.6 shows the assembly details for the main board. Begin by checking the board for cracks in the tracks or any shorts between adjacent tracks. This is easier to do before installing the parts and can save you trouble later.

Once you are convinced that the PC board is OK, start the assembly by soldering in the 10 wire links. You must do this first, as two of these links (LK5 & LK6) are underneath the 40-pin IC socket.

These links should be installed

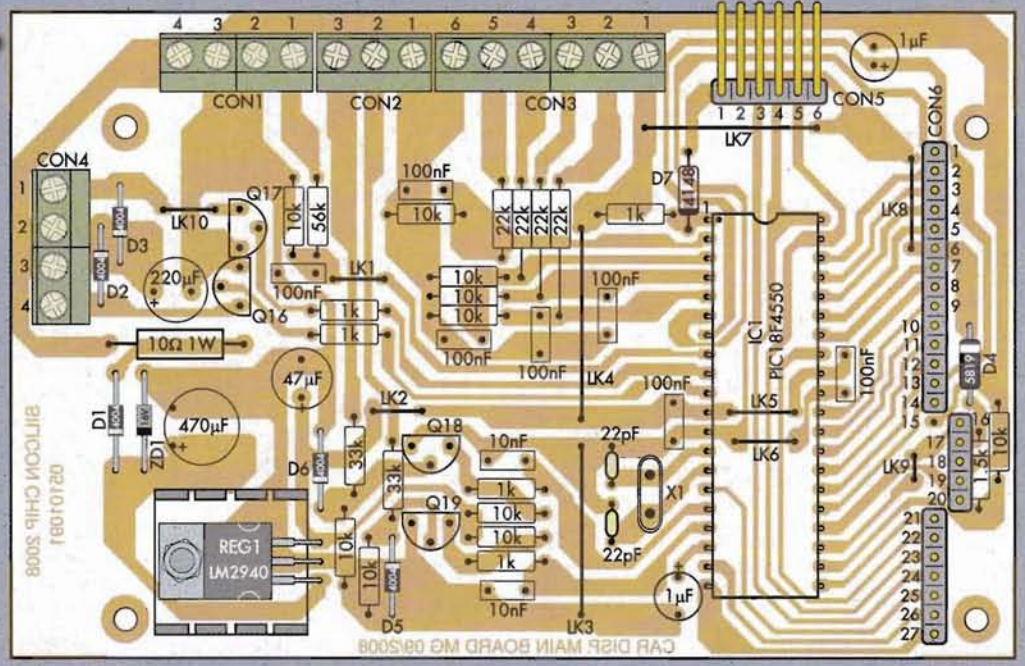
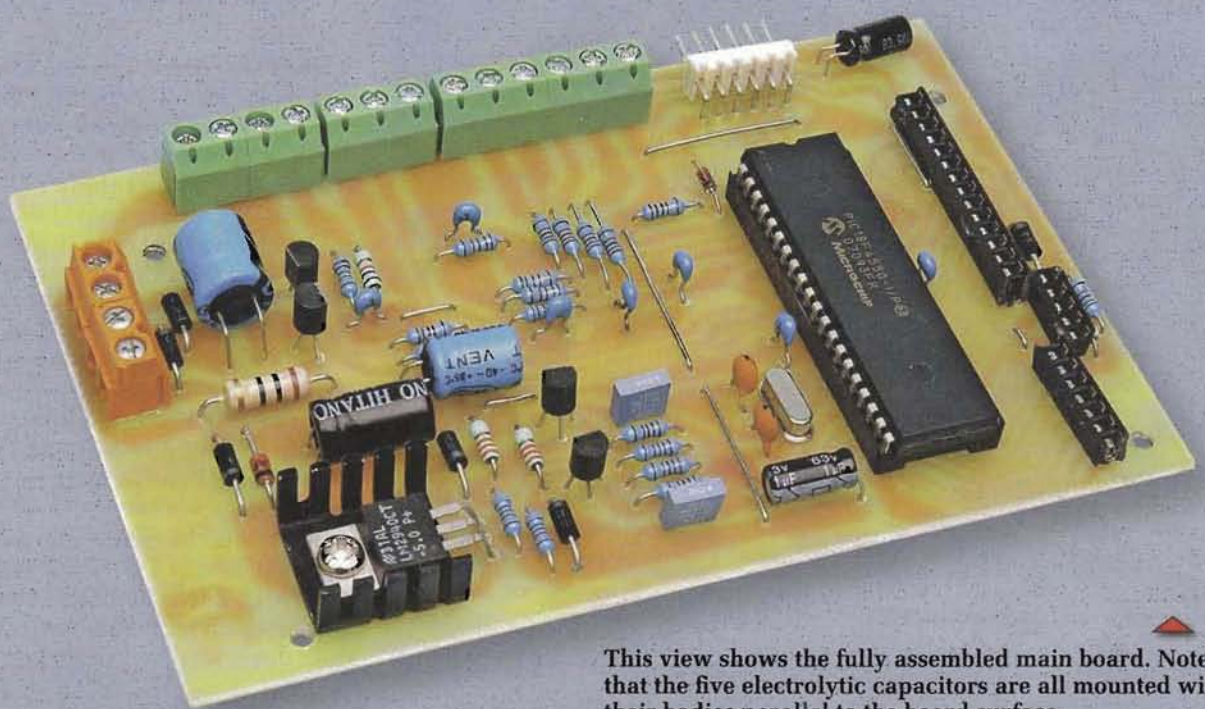


Fig.6: follow this parts layout diagram to build the main PC board. Take care to ensure that all polarised parts go in correctly and don't install the PIC microcontroller in its socket until after the power supply has been checked – see text.



This view shows the fully assembled main board. Note that the five electrolytic capacitors are all mounted with their bodies parallel to the board surface.

using tinned copper wire. You can straighten this link wire by first clamping one end in a vise and then pulling on the other end with pliers to stretch the wire slightly. After that, it's simply a matter of cutting the links to length and using pliers to bend their leads down at right angles so that they fit the PC board.

There are 24 resistors on the main PC board and they can be soldered in next. You must make sure that the correct value is used at each location. The colour code table shows how to decipher the values but it is also prudent to check each one with a multimeter before it is soldered in place. Note that the 10Ω resistor must be rated at 1W.

Once the resistors are in, the diodes can be installed. There are eight diodes in total, of four different types.

Begin by installing 16V zener diode ZD1. Refer to the component overlay for its location and orientation! Remember that the cathode of a diode is normally indicated by a stripe.

The signal diode (D7, a 1N4148) is used for ICSP (In Circuit Serial Programming) and is installed near CON6 (the ICSP header). You only really need it if you intend to program the microcontroller (IC1) in circuit, otherwise it can be left out.

Diodes D5 & D6 are next on the list. Note that these were shown as 1N5819

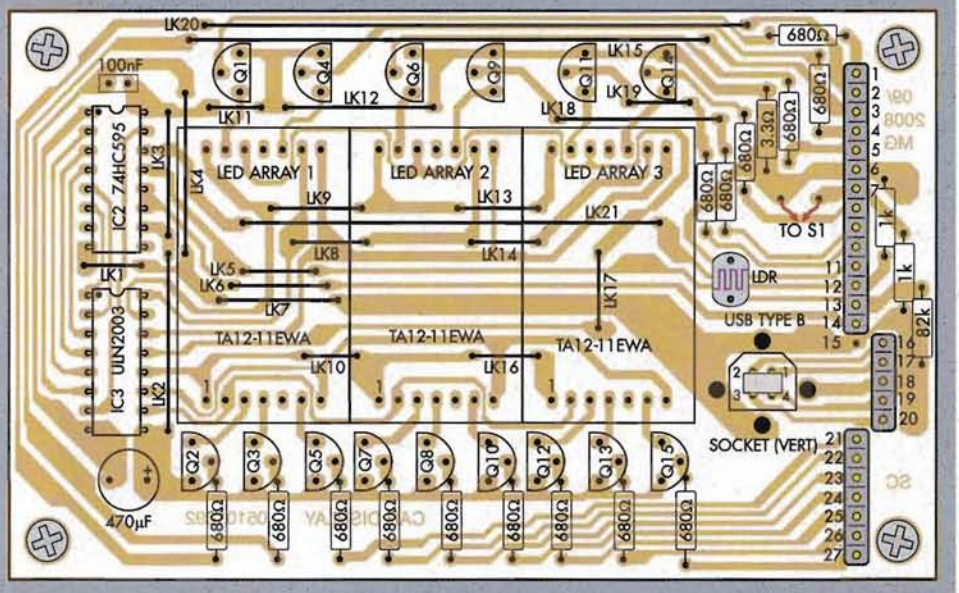
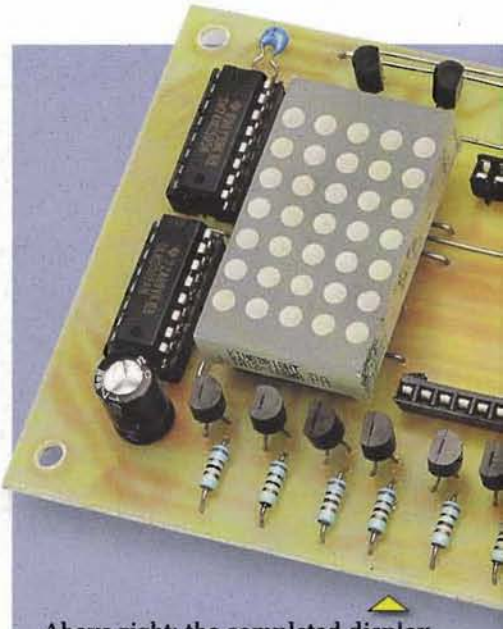
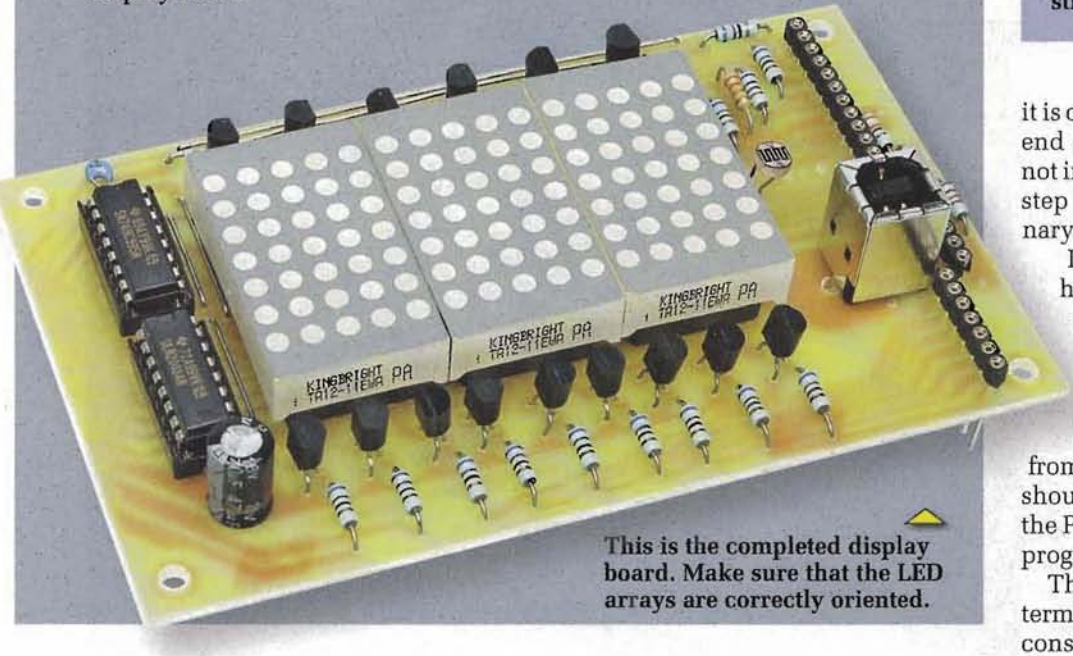


Fig.7: here's how to install the parts on the display board.



Above right: the completed display board with two of the LED arrays removed to show their 7-pin socket strips.



This is the completed display board. Make sure that the LED arrays are correctly oriented.

Schottky types on the circuit diagram (Fig.3) last month but in practice, 1N4004 diodes will do and that's what are now specified in the parts list. Be sure to install them with the correct orientation.

By contrast, diode D4 must be a 1N5819 Schottky type (as originally specified). This can now be installed, followed by the five remaining diodes which are all 1N4004s.

The four transistors can now all go in. These are all BC337 NPN types and each must be correctly oriented, as shown in Fig.6.

Now for the capacitors. The ceramic and the 100nF monolithic capacitors are not polarised and can go in either way around. However, the electrolytic capacitors are polarised, so be sure to install them as indicated on the overlay.

Note particularly that all the electrolytic capacitors must have their leads bent by 90° so that their bodies lie horizontally on the PC board – see photo. Do not mount them vertically; if you do, they will later interfere with the bottom of the display board when the boards are stacked together.

Once you've installed the capacitors, you are ready to install the connectors and the IC socket. Install the 40-pin IC socket first, making sure that it is oriented correctly with its notched end as indicated. Note that the IC is not installed in the socket just yet. That step comes later, after some preliminary checks of the supply rail.

Install the right-angled 6-pin ICSP header (CON5) only if you intend to program the microcontroller. Note that you will need to cut away the plastic locating guide on this connector if you intend to use the PicKit2 programmer from Microchip. In addition, CON5 should be mounted about 2mm above the PC board in order to fit the PicKit2 programmer.

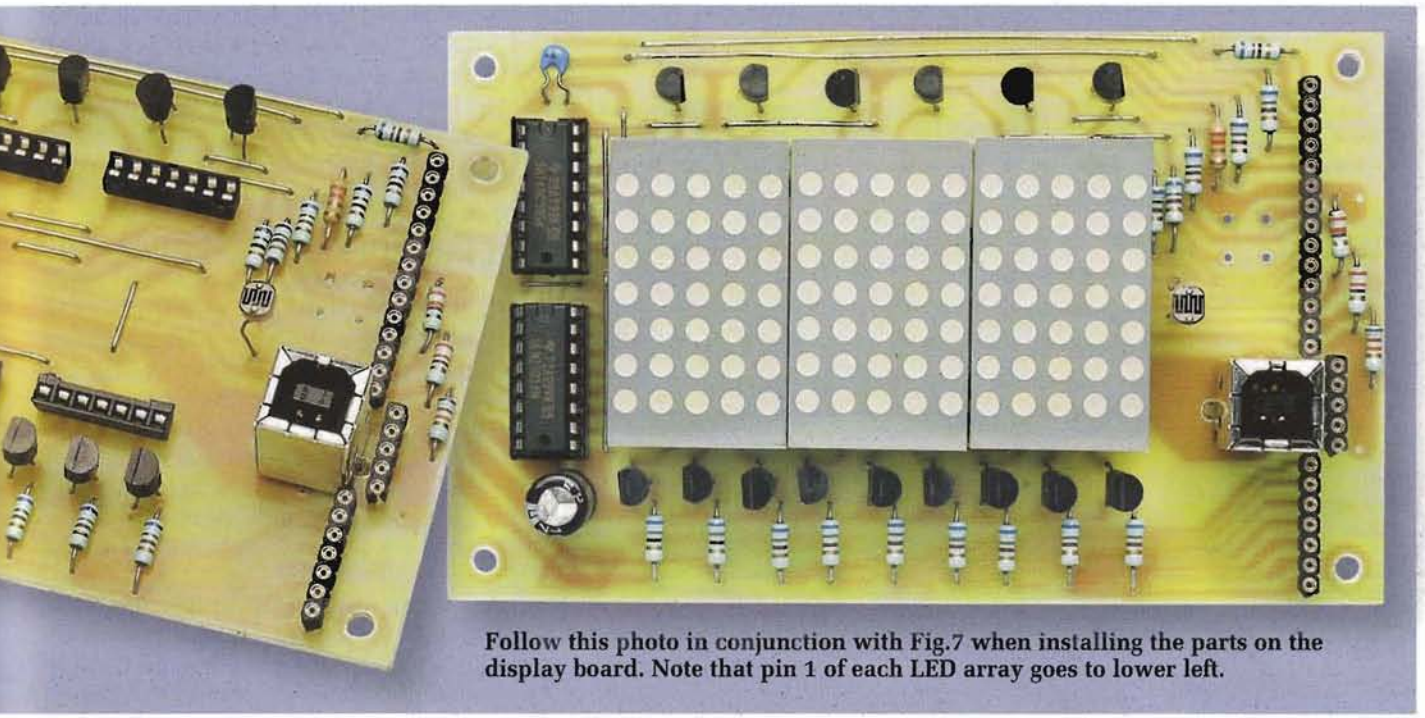
The rest of the connectors are screw terminal blocks CON1-CON4. These consist of 2-terminal and 3-terminal blocks which are combined by sliding their dovetailed ends together.

As shown, CON1 & CON4 are each made by sliding two 2-terminal connectors together, while CON3 consists of two 3-terminal connectors. CON2 is a single 3-terminal connector.

Making up CON6

CON6, a 27-way connector, is made by first cutting a 40-pin IC socket into two 20-pin sockets. You can use a small fine-toothed hacksaw to do this job.

As shown on Fig.6, CON6 is split into three parts. The first is a 14-pin connector, the second is a 5-pin connector and the last is a 7-pin connec-



Follow this photo in conjunction with Fig.7 when installing the parts on the display board. Note that pin 1 of each LED array goes to lower left.

tor (note: pin 15 is not used). You make these by first cutting one 20-pin connector into 14-pin and 5-pin connectors. The 7-pin connector is then cut from the remaining 20-pin connector.

Regulator REG1 can go in next. As shown, this device is mounted horizontally with its leads bent down by 90°, to go through their matching PC board holes. In addition, the regulator must be fitted with a small U-shaped heatsink and this is sandwiched between the regulator's tab and the PC board.

Secure this assembly to the PC board using an M3 x 10mm screw, lockwasher and nut before soldering the regulator's leads. If you solder the leads first, the soldered joints may crack as the mounting screw is tightened down.

Note that we specified an LM2940CT-5 low drop-out regulator in the schematic (Fig.3) published last month. However, you can also use a common (and much cheaper) 7805 regulator in its place, if you wish.

The only drawback here is that using the 7805 means that you will have to power the circuit from a 12V supply. By contrast, the LM2940CT-5 will work with supply voltages down to as low as 9V.

The LM2940CT-5 also contains in-built reverse polarity protection but we don't use it in this circuit. That's because reverse polarity protection is provided by diode D1.

Construction of the main PC board can now be completed by installing the 20MHz crystal. It's non-polarised and so can go in either way around.

Display board assembly

Fig.7 shows the parts layout on the display board. Begin the assembly by installing the 21 wire links (LK1-LK21). Some of these links are quite long and run close together, so it's important that they be straight before they are installed (stretch the link wire to straighten it).

The resistors can go in next. Note that the 3.3Ω resistor must be rated at 0.5W, while the others are all rated at 0.25W.

Now solder in the two 16-pin IC sockets. These must be oriented with their notched ends as shown on Fig.7.

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	82kΩ	grey red orange brown	grey red black red brown
❑	1	56kΩ	green blue orange brown	green blue black red brown
❑	4	22kΩ	red red orange brown	red red black red brown
❑	2	33kΩ	orange orange orange brown	orange orange black red brown
❑	10	10kΩ	brown black orange brown	brown black black red brown
❑	6	1.5kΩ	brown green red brown	brown green black brown brown
❑	15	680Ω	blue grey brown brown	blue grey black black brown
❑	2	330Ω	orange orange brown brown	orange orange black black brown
❑	1	10Ω	brown black black brown	brown black black gold brown
❑	1	3.3Ω	orange orange gold brown	orange orange black silver brown

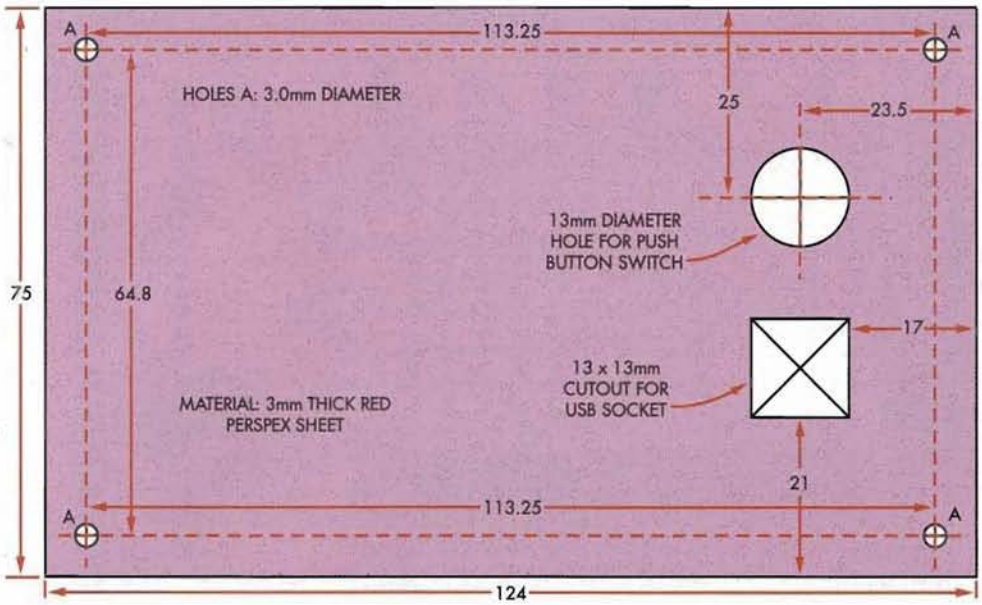


Fig.8: follow this drilling and cutting diagram to make the front panel. It's made from 3mm-thick red Perspex measuring 124 x 75mm.

Note that although these sockets are optional, we do recommend them. They make it much easier to replace the ICs, if necessary.

The next step is to install six 7-pin socket strips to accept the dot-matrix LED arrays. These are made by cutting three 14-pin IC sockets in half and then cleaning up the edges using a small file. That done, the sockets strips can be soldered in place.

These sockets are used simply to space the LED arrays off the board, so that they later sit close to the red Perspex front panel. They also make it easier to replace a module in the unlikely event that it fails.

You can now install the two ICs in their sockets, making sure they are correctly oriented. Don't get these two ICs mixed up – IC2 is the 74HC595 shift register, while IC3 is the ULN2003 Darlington array.

The three LED modules can also be installed in their sockets, each with pin 1 at bottom left. Pin 1 of each module is indicated by a digit on the side.

Once this is done, you can solder in the 15 BC327 transistors. Be sure to orient them as shown and push them down onto the board as far as they will comfortably go before soldering their leads.

Next, solder the two capacitors in place. The 100nF monolithic type is not polarised but the 470µF electrolytic is so take care when installing it.

The three pin connector strips that make up CON7 can now be installed. These are made from a 32-way strip that's cut into three pieces of 14, 7 & 5 pins. As shown in the photo, these are installed from the component side of the PC board.

Now install the USB type B socket. It sits vertically on the PC board and only fits one way around. Its two tabs can be bent flat against the underside of the board to secure it in position before soldering. Solder its four pins and both tabs to the PC board.

The last thing to do is to solder in the LDR. This should be installed about 10mm above the PC board, so that it later sits just below the front panel.

That completes the assembly of the two PC boards. The next step is to make the front panel.

Preparing the front panel

The front panel is made from a single piece of red Perspex measuring 124 x 75mm (ie, the same dimensions as the display board). Fig.8 shows the cutting and drilling details. There are four 3mm-diameter holes for securing it to the display board plus a larger (13mm) hole for pushbutton switch S1.

In addition, you need to make a square cut-out to provide access to the USB socket.

Once you've cut and drilled the panel, fit the pushbutton switch in place and wire it back to the display board using two 60mm lengths of hook-up wire. The front panel is then fitted with four M3 x 12mm tapped Nylon spacers plus four Nylon washers which are secured using M3 x 25mm Nylon screws – see Fig.9.

The display board can now be fitted in position over the Nylon screws. Another four Nylon washers are then fitted, after which another four M3 x 12mm Nylon spacers are wound on.

Preliminary tests

Before attaching the main board, it's a good idea to carry out a power supply check, to confirm that the +5V supply rail is correct. **Note that this should be done with microcontroller IC1 out of its socket.**

First, connect a 12V battery to the power input terminals of CON1 (pin 4 is the +12V input, pins 2 & 3 are ground). Apply power and check the voltage at pin 1 of CON3. If it's close to +5V, then everything is in order.

Note that this voltage can normally range from 4.9-5.1V. A voltage above

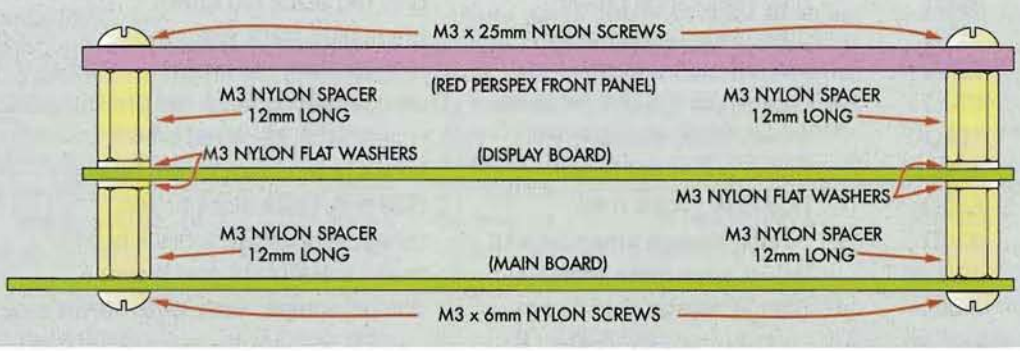
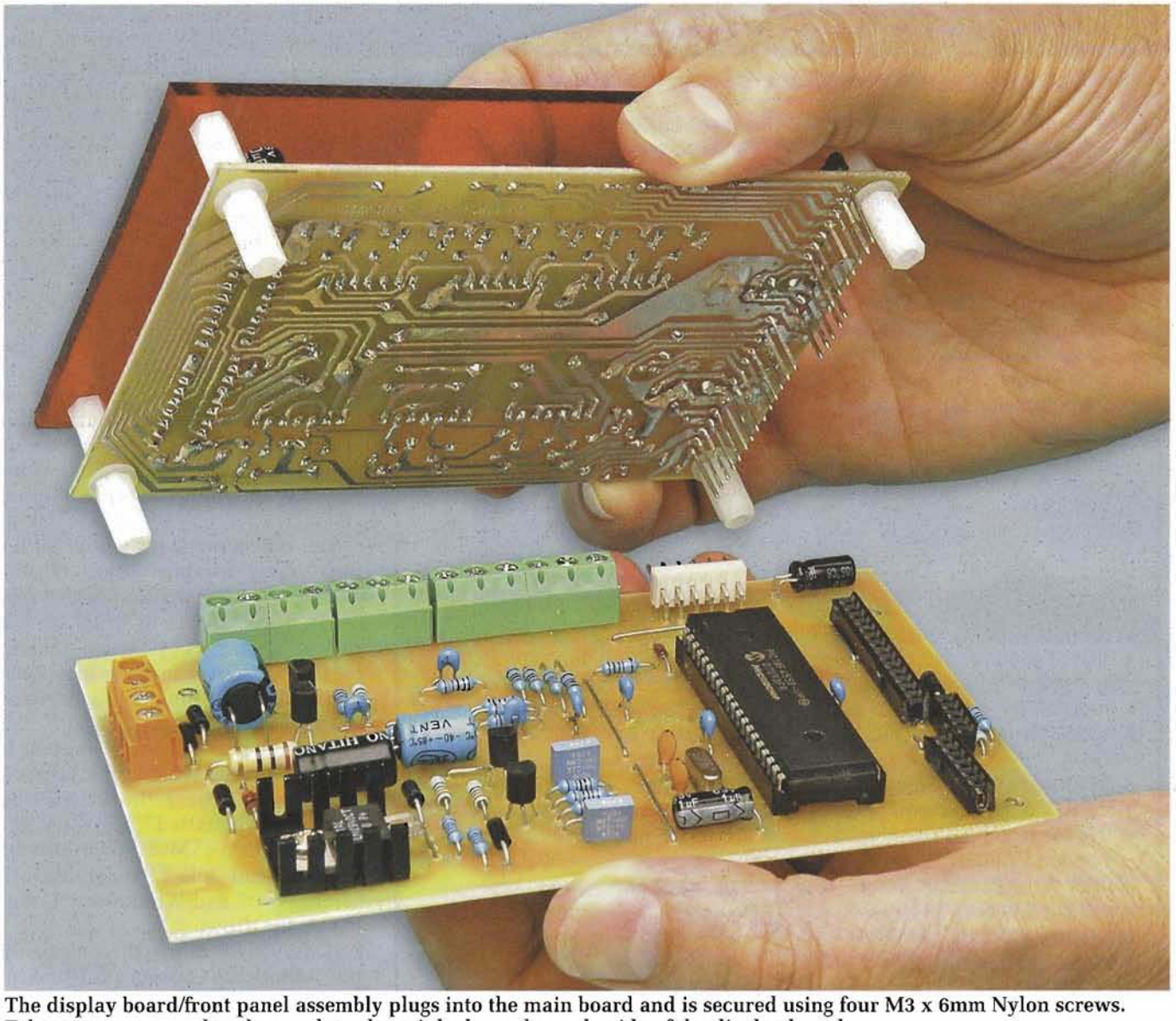


Fig.9: the two PC boards and the front panel are secured together using M3 x 12mm tapped Nylon spacers, M3 Nylon washers and M3 Nylon screws.



The display board/front panel assembly plugs into the main board and is secured using four M3 x 6mm Nylon screws. Take care to ensure that the regulator heatsink clears the underside of the display board.

6V or lower than 4.5V indicates that there is a problem and you should disconnect power immediately.

Assuming that the +5V rail measures OK, you can now disconnect power and install IC1 in its socket. Note that this IC must be programmed with the firmware hex file. If you are building this project from a kit, it will be supplied preprogrammed.

Final assembly

Having checked that the +5V rail is OK, it's time to complete the assembly. This simply involves plugging the display board into the main board and then securing the assembly using four M3 x 6mm Nylon screws.

Switch on

Once the assembly has been com-

The Software Features In Brief

In next month's article, we explain the software features in detail. In the meantime, here's a quick summary.

First, the software calibration allows you to read almost any sensor with a varying voltage, resistance, frequency or duty cycle output. Calibration involves entering a few calibration points. The software then computes a polynomial which passes through these points and that's stored in non-volatile memory.

You can therefore use this project as a "speedo corrector", by calibrating the variable to read the correct speed (note: car speedos often intentionally read high). You can measure the output of a resistance-based sensor directly (without a voltage divider). We've held the calibration instructions over to next month's article, as they were too long to include here!

Once calibrated, you can name the variables and enter the units, as well as minimum and maximum values. You can choose which to display and in what order, as well as the number of digits after the decimal point. You can select optional averaging on each variable and the speed of scrolling and the brightness of the display.

Each of the six variables has an accumulator (for running totals) as well as delta values (showing the difference in the readings). There are also two programmable outputs (for a relay or buzzer) that can switch on limit conditions.

You can do real-time data logging of the variables via the USB port (with selectable sampling frequency) and the data can be exported to a spreadsheet to create graphs.

Other features include protection for the battery supplying power (if used in a car) and fine tuning options for greater accuracy! All will be explained, next month.

Parts List

Main Board

1 PC board, code 05101091, 134 x 86mm
2 40-pin IC sockets
4 2-way screw terminal blocks, 5mm spacing (Jaycar HM-3173, Altronics P-2032A)
3 3-way screw terminal blocks, 5mm spacing (Jaycar HM-3172, Altronics P-2033A)
1 TO-220 mini heatsink, 6073B type (Jaycar HH-8502, Altronics H-0630)
1 6-way 2.54mm right-angle locking header (Jaycar HM-3426; Altronics P-5516) – optional for ICSP
1 20MHz crystal (X1)

Semiconductors

1 LM2940CT-5 regulator (REG1) (or use a 7805 – see text)
1 PIC18F4550/I-P microcontroller (programmed with 0510109A.hex (IC1)
4 BC337 NPN transistors (Q16-Q19)
5 1N4004 diodes (D1-D3, D5-D6)
1 1N5819 Schottky diode (D4)
1 1N4148 diode (D7) – only needed for ICSP
1 16V 1W zener diode (ZD1)

Capacitors

1 470µF 25V electrolytic
1 220µF 50V electrolytic
1 47µF 16V electrolytic
2 1µF 16V electrolytic
7 100nF monolithic (code 104 or 100n)
2 10nF MKT (code 103 or 10n)
2 22pF ceramic

Resistors (0.25W, 1%)

1 56kΩ	10 10kΩ
4 22kΩ	6 1.5kΩ
2 33kΩ	1 10Ω 1W

Display Board

1 PC board, code 05101092, 124 x 75mm
3 Kingbright TA12-11EWA dot matrix LED modules, red (Tenrod Cat. TA12-11EWA, Farnell Cat. 1168665)
3 14-pin IC sockets (cut into six 7-pin sockets to mount the displays)
2 16-pin IC sockets
1 SPST dome pushbutton switch (Jaycar SP-0657, Altronics S-1084)
1 32-way IC socket strip (Jaycar PI-6470, Altronics W-0420)
1 LDR (Jaycar RD-3480, Altronics Z-1619)
1 vertical USB Type B socket (Farnell 107-6666)

Semiconductors

1 74HC595 shift register (IC2)
1 ULN2003 line driver (IC3)
15 BC327 PNP transistors (Q1-Q15)

Capacitors

1 470µF 16V electrolytic
1 100nF monolithic

Resistors (0.25W, 1%)

1 82kΩ	2 330Ω
15 690Ω	1 3.3Ω 0.5W

Miscellaneous

4 M3 x 25mm Nylon screws (Jaycar HP-0142)
8 M3 x 12mm tapped Nylon spacers
8 Nylon flat washers (Jaycar HP-0148)
4 M3 x 6mm Nylon screws
1 1m length of tinned copper wire for links
1 200mm length medium-duty hook-up wire

pleted, apply power (ie, via CON1). You should now see a message scroll past on the LED display modules. Among other things, this default welcome message should show the firmware version.

If you see this, then everything is working correctly and you can proceed to the next section which explains how to install the software driver on your PC. If not, you should refer to the troubleshooting panel.

Driver installation

The USB device interface for the Car Scrolling Display uses the generic Microchip driver for Windows. Before communicating with the display using the PC host program, you will need to install this driver. This section explains how to install the driver in Windows XP, although other versions of Windows will be similar.

The first step is to download the Microchip installer (MCHPFSUSB_Setup_v1.3.exe) from the SILICON CHIP website and run it. Note that you should use version 1.3 as older or newer versions may not be compatible. The installer program will typically put the driver in the C:\MCHPFUSB\Pc\MCHPUSB Driver\Release folder.

Next, connect the Car Scrolling Display to your computer using a USB cable. Windows will recognise the device as a "Display" and then the "Found New Hardware" Window will appear as shown in Fig.10. Select the "No, not this time" option and click "Next".

You will now be presented with a new dialog window. Select "Install from a list or specific location" and click "Next" again to bring up the dialog shown in Fig.11. Select "Search for the best driver in these locations" and enable the "Include this location in the search" box.

Now click the "Browse" button. In the "Locate File" window that appears, navigate to where the MCHPUSB files were installed (normally C:\MCHPFUSB\Pc\MCHPUSB Driver\Release) and select "mchpusb.inf". Click "Next" and Windows will then install the driver.

If the driver is installed correctly, the "Microchip Custom USB Device" entry should now be visible if you go into Device Manager (Control Panel ->System -> Hardware tab -> Device Manager button) – see Fig.12 (provided the device is connected).

Using the host software

Once the driver has been installed successfully, you control the Car Scrolling Display using the PC host program **cardisplay.exe**. This program allows you to change all settings and to do data logging. It is also used for calibration.

Once you've connected the Car Scrolling Display's inputs to the sensors you are interested in monitoring, you can then use a laptop in your car to perform the calibration (you only have to do this once) or change any other system settings (such as the display brightness, etc).

You can also use a laptop in your car to do real time data logging of



Fig.10: this is the dialog that appears the first time the USB clock is connected to the PC. Select the option shown and click the "Next" button.

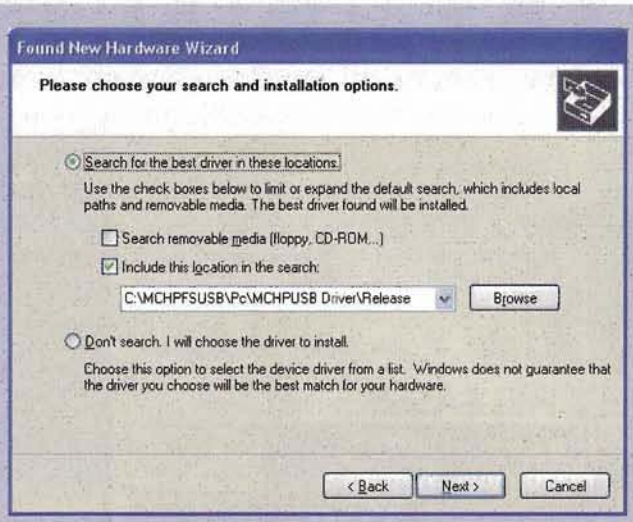


Fig.11: selecting "Install from a list or specific location" brings up this dialog. Select the options shown and click the "Next" button. Windows then installs the driver.



Fig.12: this entry will appear in Device Manager if the driver is installed correctly.

Troubleshooting

If the unit doesn't work correctly, the following troubleshooting tips should help resolve the problem.

Symptom: nothing is shown on the display or some columns or rows are blanked out.
What To Check: there are a number of possibilities here. One is that CON6 and CON7, which connect the main PC board to the display PC board, are not making good contact. Try reconnecting the two boards to see if that clears the fault.

Another possibility is that the Kingbright LED array modules have been installed with the incorrect orientation. If one column is blanked while the rest of the display seems to be working, then check its driver transistor – it may be faulty or it could be the wrong type (they should all be BC327 PNP types).

Symptom: the supply rail is not close to +5V.
What To Check: if the supply rail is 0V instead of +5V, check zener diode ZD1, reverse polarity protection diode D1 and regulator REG1. Check particularly that the diodes are all correctly oriented.

If the supply rail is noticeably higher than +5V, there is either a problem with the regulator or a short between the 12V and 5V rails. Alternatively, a component connected to one of these rails may have failed (eg, diode D2 or D3).

Symptom: the display seems to be working correctly but does not work when powered solely from the USB port.
What To Check: either Schottky diode D4 is incorrectly oriented or the USB port (or hub) is not supplying power.

the signals. Of course, you will need someone else to do the driving while you do this!

To install the PC host program, you first have to download the compressed file "cardisplay.zip" from the SILICON CHIP website (**www.siliconchip.com.au**). You'll find it the downloads section under January 2009.

Extract the files in the zipped archive to a folder on your hard drive. There should be at least two files:
(1) **cardisplay.exe** – this is the executable command line program; and
(2) **cardisplay.map** – this file is used internally by the host program. It must be in the same folder as **cardisplay.exe** for the program to recognise it.

Note that the map file is produced by the C compiler of the firmware. It contains memory mapping information for the firmware produced by the linker. When and if the firmware is updated, the map file will also change and this new file must be copied to the folder containing **cardisplay.exe** in order for it to work correctly.

So installing the PC host program is easy – just copy the **cardisplay.exe** and **cardisplay.map** files to your chosen folder. Once that's done, you simply go to a command prompt to run the program using your chosen command line option. We'll have more to say about this next month. SC

Vintage Radio



By RODNEY CHAMPNESS, VK3UG

The American Philco 52-545 5-Valve AC/DC Mantel Receiver



Manufactured in the US in the early 1950s, the Philco 52-545 is a 5-valve broadcast-band superhet. It's a transformerless AC/DC that runs directly off 115V AC and so a care must be exercised when working on it.

IN BOTH AUSTRALIA and New Zealand during the valve radio era, it was standard practice to use a mains transformer to convert the 240V AC mains to other AC voltages, as required. By using a transformer, the lethal mains voltage was isolated from the receiver's metal chassis and this made it safer for both users and servicemen.

However, there were some exceptions to this convention as there were areas with DC mains and areas that relied on 32V DC house lighting plants. Many AC/DC sets were made for use in country areas and these often had one side of the mains directly connected to the chassis!

This meant that, depending on which way around the mains was wired, the chassis could operate at 240V AC with respect to earth. For the unwary, they could be a real death trap and were always dangerous to work on.

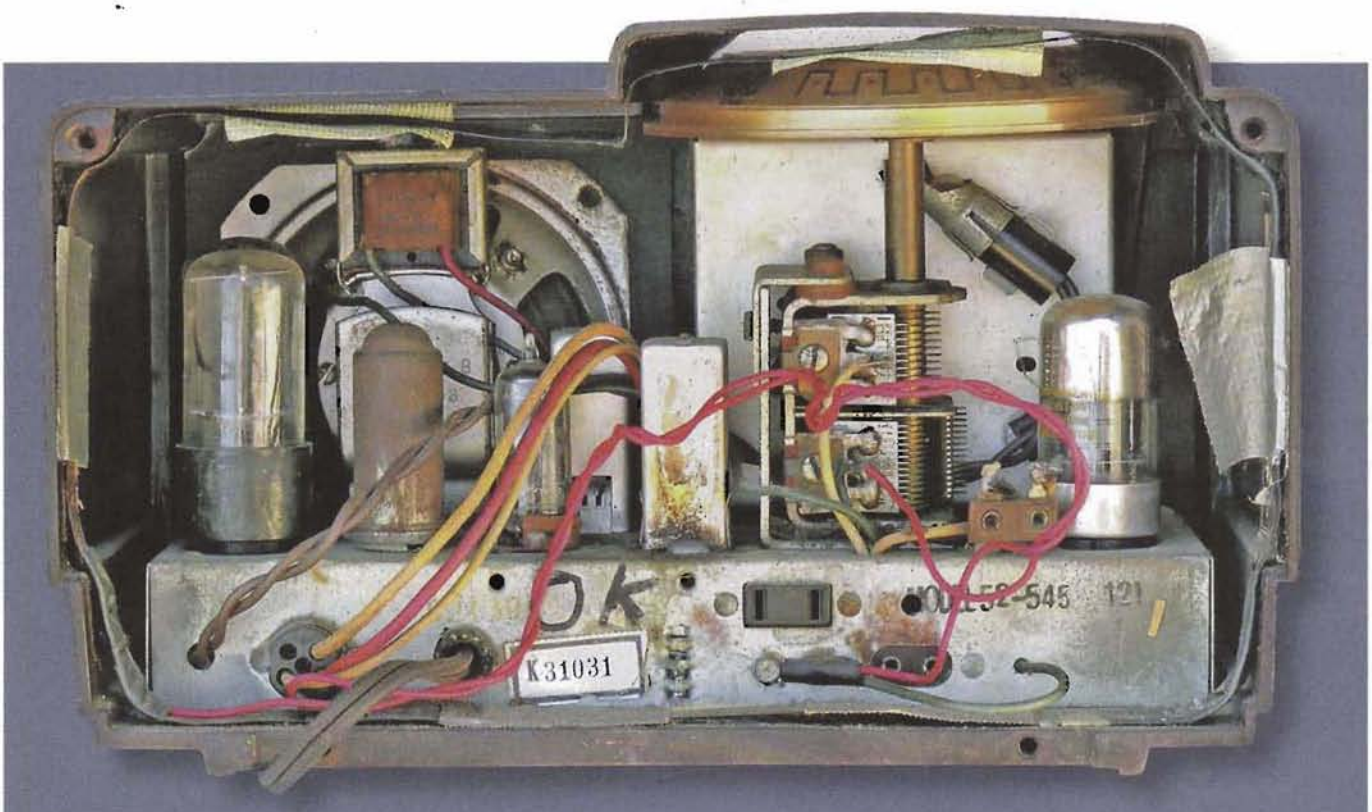
Because of this, AC/DC receivers were always totally fully enclosed in a cabinet (ie, with closed backs) and the controls were often fully insulated from the chassis. That wasn't always the case though. Many AC/DC sets had metal-shafted controls which were attached to the chassis and if a knob came off, users could get a nasty if not fatal shock from the bare control shaft!

To overcome this problem, some sets did not earth one side of the mains so that the chassis itself could be earthed. In these sets, all items that would normally have been earthed to the chassis were instead connected to a bus bar (often a thick solid-core tinned copper wire). This bus was then earthed as far as RF was concerned using a large high-voltage paper or mica capacitor wired between it and the chassis.

In addition, the antenna coil primary winding was often completely isolated from the mains, with one end going directly to the antenna and the other going directly to an outside earth.

No standards

The techniques used by the manufacturers to isolate both users and servicemen from electric shock from AC/DC sets were generally quite satisfactory – at least, for normal use. However, it seems that there was little uniformity in the methods used to ensure that the unwary (or careless) were protected against electric shock



This view from the back shows the unit prior to restoration. Note the antenna loop around the inside of the cabinet and the unusual mounting arrangement for the tuning gang.

or worse, electrocution. In those days, if a fault developed, people often took the backs off sets to see which valves lit up and would wriggle various components, etc, with the set turned on. And if the chassis was at 240V AC, a severe shock or even electrocution was likely.

Some servicemen were also rather "gung-ho" in their attitude to these potentially dangerous sets and suffered the same consequences. The use of a 1:1 mains isolation transformer made servicing these sets much safer but many servicemen lacked such a basic device.

In my time as an impoverished serviceman, I always checked before I started servicing an AC/DC set to see which side of the mains was attached to the chassis before I plugged the set into the power point. I often altered the mains plug wiring so that the Neutral (which is virtually at earth potential) was attached to the chassis instead of the Active (Neutral and Earth are connected together at the switchboard).

Of course, even this will not be safe if Active and Neutral have been transposed at the mains outlet, so you always had to be extremely careful. **The moral of the story with AC/DC sets is if you don't know what you're doing then don't! Leave them strictly alone and you'll live to see another day.**

US & European sets

In the US, AC/DC sets were extremely common as they tended in later years to be the "cheap and cheerful sets". However, this was not always the case. Many valves were designed to have heater voltages much higher than 6.3V and this meant that a number of such valves could be connected in series string across the mains (115-120V in the US). The heater current was usually 0.15A but some valves had heater currents as low as 50mA.

Of course, if a person touched the 115V mains in the US, he or she was less likely to be electrocuted than a person who touched our more lethal 240V mains in similar circumstances. However, that should not be taken as a suggestion that touching 115V mains can not result in death. It's still all too easy to receive a fatal shock.

In Europe, 230V AC/DC receivers were common. If you look carefully at many European receivers with mains transformers, it will be apparent that the mains wiring is often not that well protected against accidental contact when the chassis is being handled, as can happen at times when it is being serviced. This means that such sets should always be switched off at the power point before moving them to gain access to a particular section during servicing.

By contrast, Australian AC-operated receivers are generally much better laid out to protect users and servicemen against shock but never take that for granted.

In short, when servicing AC/DC sets or even imported sets with a transformer, it's a good idea to always use a 1:1 isolation transformer. If that's not possible, make sure that the chassis or the common bus bar is connected to the Neutral side of the mains. In addition, after applying power, always use your multimeter to confirm that there is no voltage between the chassis and mains earth.

Finally, use an Earth Leakage Detector (ELD) on the mains just to be doubly sure that all is safe. I always use an ELD as standard practice and in some cases an isolation transformer as well.

The Philco 52-545

One such transformerless set is the US Philco 52-545. The unit featured here is owned by a friend and is a typical 115V AC/DC receiver from the

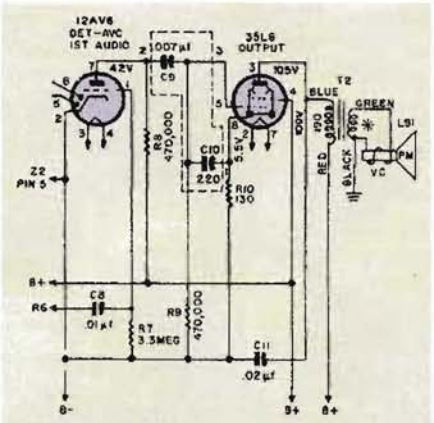


Fig.1: a 12AV6 is used as a detector and first audio stage, while a 35L6-GT is used as the audio output stage.

early 1950s. It is a standard 5-valve superhet.

One unusual feature of this set is the way the dial-drive is arranged. As shown in the photos, the tuning gang is mounted on its back with its control shaft pointing upwards. A large knob is mounted onto this extended shaft and it is calibrated in much the same way as many handspan dials are. The tuning is smooth and effective, so it works well despite the rather unusual arrangement.

The chassis itself is housed in a brown bakelite cabinet which also has a clock built into it. Unfortunately though, the clock is of little use in Australia as it is designed for 60Hz mains operation and quickly loses time when used on our 50Hz mains.

This model has no external antenna connections, although investigations show that earlier models did have such a feature in the past. Instead, this unit uses a tuned-loop antenna winding around the rear edge of the cabinet. A twisted pair of wires to the tuning gang connects the loop to the set.

Valve line-up

The relatively rare 7A8 octode is used as the converter valve. Its oscillator coil is unusual in that it has no adjustable core. I suspect that adjustment at the low-frequency end of the tuning range was deemed unnecessary, as the dial calibrations are rather vague anyway.

The 455kHz signal from the converter is applied through a double-tuned IF transformer to a 12BA6 IF amplifier stage, the output of which is then fed to a second IF transformer. The resulting 455kHz signal is then detected using the diode section of a 12AV6 (see Fig.1) to derive the audio plus simple AGC. The triode section of the 12AV6 then amplifies this audio before feeding it to a 35L6GT audio output stage.

Finally, the 35L6GT drives the speaker via a speaker transformer (T2).

Power supply

Because it is an AC/DC mains receiver, the Philco's power supply is quite different to that used in sets using a mains transformer. Fig.2 shows the circuit.

In AC/DC receivers, the heaters are wired in series across the mains. However, because the total voltage drop across the filaments is less than the mains voltage, several methods are employed to drop the excess voltage and regulate the current flowing in the heater string. Note also that the heater currents must all be the same unless equalising resistors are used across those valves which have lower heater current requirements.

As mentioned above, valves with 0.15A heaters were commonly used in AC/DC sets. In this receiver, there is a 35Z5 rectifier, a 35L6GT, a 12BA6, a 12AV6 and a 7A8. This line-up gives heater voltage drops of 32 + 35 + 12.6 + 12.6 + 6.3 = 98.5V, respectively.

Applying 115V AC to a string of valves with a total heater voltage rating of 98.5V would not be conducive to them having a long life. As a result, in this set, a thermistor is used in series with the heaters to reduce the applied voltage.

Philco called this thermistor a "tube saver". When the receiver is first turned on, nearly 100V is dropped across the thermistor, which has a cold resistance of around 800Ω. As it warms up, this resistance gradually drops so that progressively more voltage is applied across the valve heaters.

In all, it takes about 40 seconds for the set to warm up and start operating.

Note that the warm-up characteristics of valves wired in series are not uniform. This means that in the absence of a component such as the "Tube Saver", some valves may have perhaps 30V across their heaters for a short time instead of their rated 12.6V. And that's hardly conducive to a long valve life.

Note also that although a thermistor has been used here, other components are also be used by different manufacturers, eg, a resistor, a barretor or, more rarely, a capacitor.

As Fig.2 shows, in the Philco 52-545, one side of the mains is connected to the negative bus (not to the chassis as is common) via a switch in the clock. The other side of the mains is connected to the rectifier's heater, while the rectifier's plate is connected to a tap on its heater.

The high-tension DC output from pin 8 of the rectifier goes to a filter network consisting of several electrolytic capacitors and resistors. From there, around 108V DC is fed to the plate of the 35L6GT audio output valve.

In the case of the negative bus, a parallel network consisting of a 0.27μF

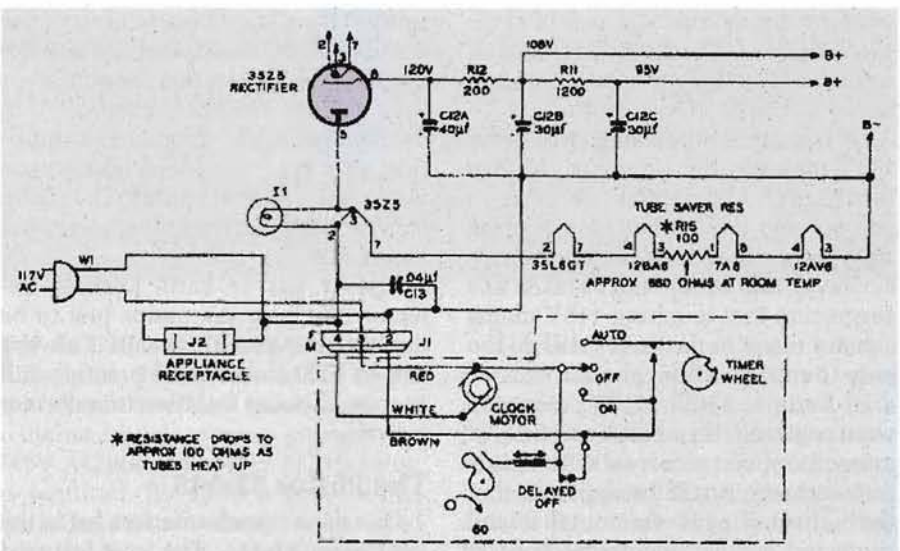
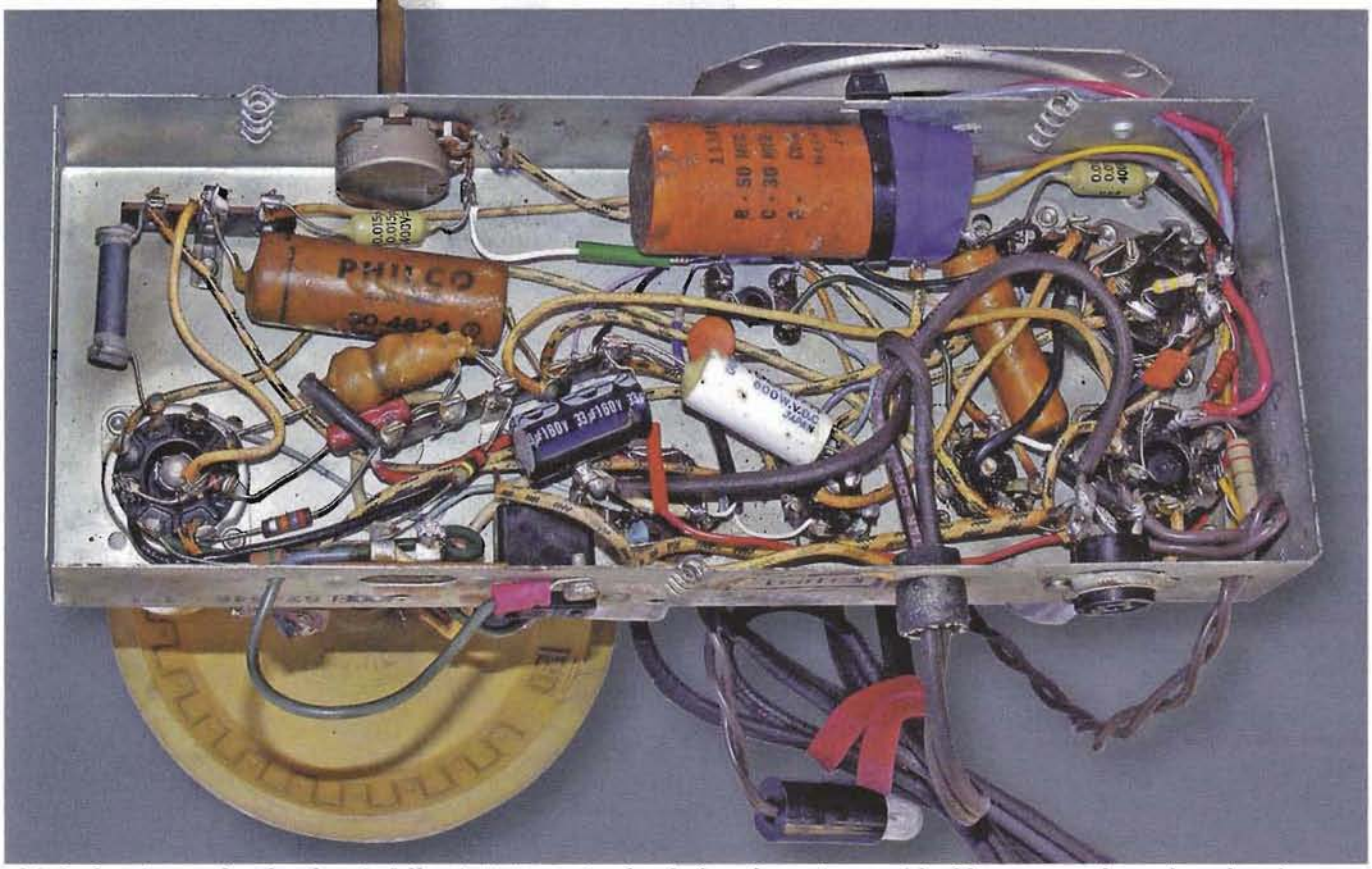


Fig.2: the Philco 52-545's power supply circuit. This is an AC/DC set with the valve heaters wired in series with a thermistor directly across the mains.



This is the view under the chassis following restoration but before the mains cord had been properly anchored to the rear panel. The untidy nature of the original wiring makes it difficult to access some of the parts.

(270nF) capacitor and a 150kΩ resistor connects to the chassis. This network acts as an RF bypass and means that the chassis can give you a "tickle" under some circumstances but not enough to electrocute you.

However, always be careful servicing these transformerless receivers – a fault can render them lethal and they are inherently dangerous in any case.

Restoration

Usually, I am fortunate enough to have access to the relevant circuit diagram of each set that I restore. In this case, I wasn't quite so lucky.

I trawlled the internet but found only part of the circuit on one site. This was then used in conjunction with an older circuit I had in a book of Beitman's, so that I was eventually able to work out all the important parts of the circuit.

This was necessary to determine whether or not any drastic modifications had been done to the set. Fortunately, there did not appear to be any major changes but as the restoration progressed, I became aware of several silly modifications that had drastically reduced the set's performance.

During restoration, one of the first things I do is to visually check both sides of the chassis. This allows me to assess the quality of the workmanship, both at manufacture and during any subsequent servicing or restoration.

In this case, it was obvious that the set had been serviced. As a result, quite a bit of tidying up was necessary as someone in the past had used some quite heavy wire to replace older wiring. This new wiring had been run point-to-point, without much thought about access to the components underneath it.

The solder joints were also rather questionable, with large blobs on many connections and several pigtail ends nearly shorting to nearby terminals.

Next, I tested the electrolytic capacitors and found them all to be slightly low in value but not low enough to warrant replacement. During these tests, however, I noticed that the low level audio leads were unshielded and ran close to the heater line. As a result, hum was being induced from the heater line into the low-level audio circuit.

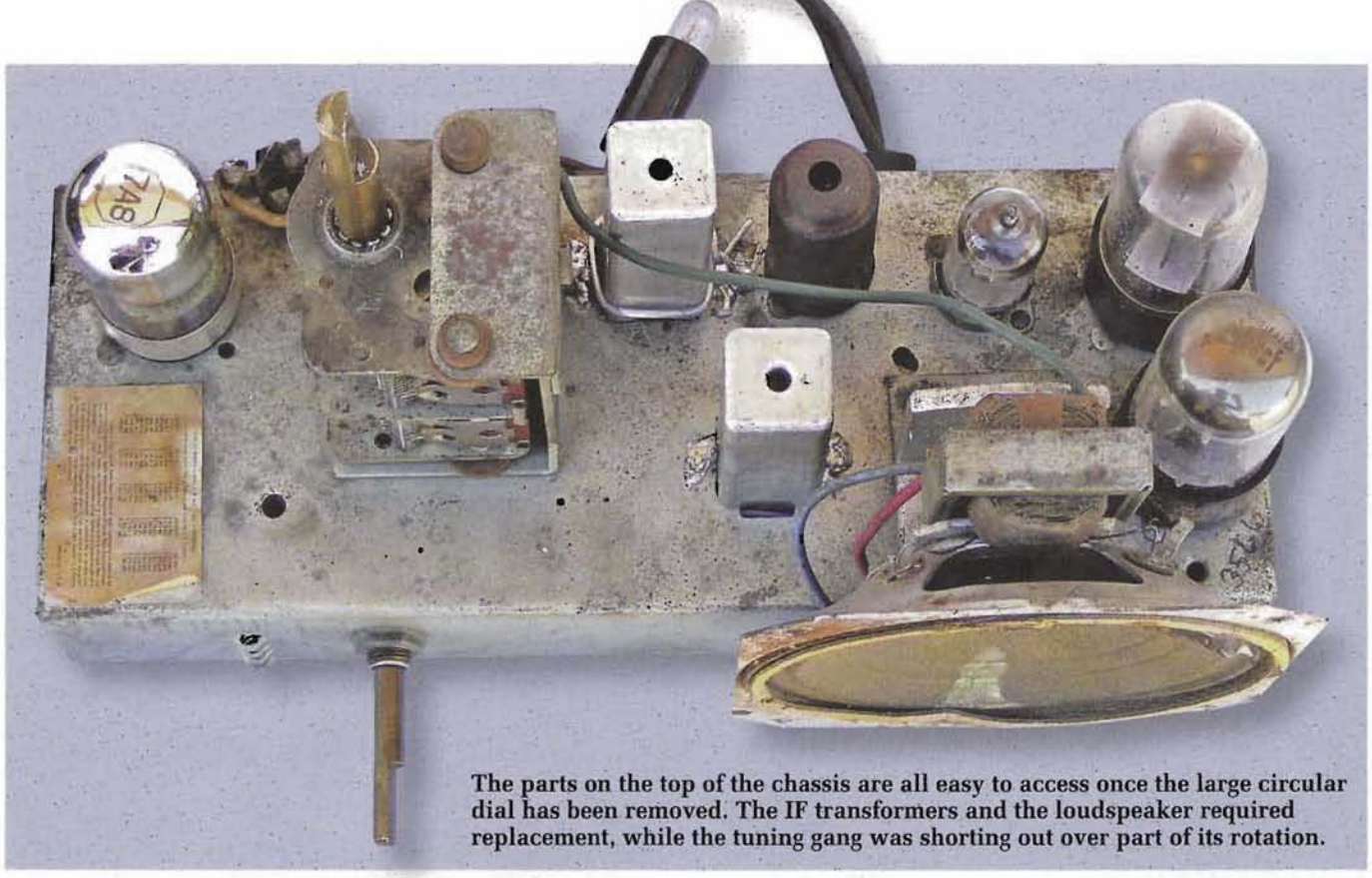
This problem was later cured by using shielded leads and by rerouting them away from the heater line.

Next, I set about replacing the heavy non-original wiring with something more appropriate. The original wiring that remained was mostly fabric-covered and was in good order. I then checked the resistors and replaced several that were well out of tolerance. Unfortunately, this wasn't an easy job as the component leads were all wound around the tie points to make them easy to solder during manufacture.

The paper capacitors were next on the list. Most were quite leaky electrically and so were replaced but some were in quite good condition and were left in circuit.

That done, I checked the wiring as best I could without an original circuit and found a couple of anomalies. First, the "cold" end of the loop antenna was connected to the chassis instead of to the AGC line. This meant that AGC could not be applied to the converter and under some conditions, quite high AC voltages were applied to its input grid.

The 7A8 also proved to be down in performance (I wonder why). I correct-



The parts on the top of the chassis are all easy to access once the large circular dial has been removed. The IF transformers and the loudspeaker required replacement, while the tuning gang was shorting out over part of its rotation.

ed this wiring but it's not easy finding your way around this chassis due to the untidy layout of the wiring.

Getting it going

To test the set, I connected it to 115VAC via an isolating transformer and switched on. I then carefully monitored the voltages as the set warmed up and they were normal. However, the only thing I got out of the set was a loud crackle that varied as the volume control was adjusted.

Because the volume control is located prior to the 12AV6 audio amplifier stage, it was obvious that the fault was located in an earlier stage of the receiver.

To diagnose the problem, I first removed the 12BA6 IF amplifier valve but the crackling remained. I then quickly replaced the 12BA6 in its socket, since removing a valve also interrupts power to all the remaining valve heaters.

My next suspect was the second IF transformer which couples the signal from the 12BA6 through to the detector. As a result, I disconnected the plate and HT leads from the transformer and earthed the screen of the 12BA6 to the negative bus with a clip lead so that the valve would not draw current. When power was reapplied, the crackle had gone and the audio stage was functioning normally.

So it appeared that the IF transformer was at fault. To test it, I turned the set off and checked its windings with a multimeter. The secondary was OK but the resistance of the primary constantly varied.

I removed and dismantled the transformer and found several dry joints inside, on its terminals. I resoldered these and then refitted the unit, fully expecting this to put an end to the crackling.

Well, it didn't and I was forced to the conclusion that there was leakage between the primary and secondary windings of the transformer. Fortunately, I had a similar-sized IF transformer out of an old AWA receiver in my junkbox, so I fitted that in place of the original. It ended up fitting well (after a little hole filing) and I wired it up in the conventional manner (the original circuit was peculiar to say the least).

That done, I turned the set on again and all was quiet except for a slight amount of hiss from the speaker.

Next, I connected my signal generator to the front end of the set – ie, earth lead to the negative bus and the active signal lead via a mica capacitor to the grid of the 7A8. By setting the generator to give a high output on around 455kHz, I was able to force a signal through the set and after adjusting the replacement IF transformer, the set was starting to look like it might be a "goer".

No oscillator

However, something was still not quite right, as the oscillator in the 7A8 was refusing to operate. This is fairly easy to check. First, you place another receiver (preferably a portable) alongside the set under test and tune it to around 1200kHz. You then tune the set under test from the low-frequency end of the dial towards the high-frequency end.

When this is done, a "swish" should be heard as the set under test is tuned to through 745kHz. If nothing is heard, then it is likely that the oscillator is faulty, as in this set.

Having established that the oscillator wasn't working, I first checked the oscillator coil and found that the two windings had continuity. The coil is unusual in that, as mentioned previously, it has no adjustment core (near enough is good enough, as the dial calibrations are rather vague).

At this stage, I thought that the valve must have succumbed to the drastic abuse it had suffered due to a previous

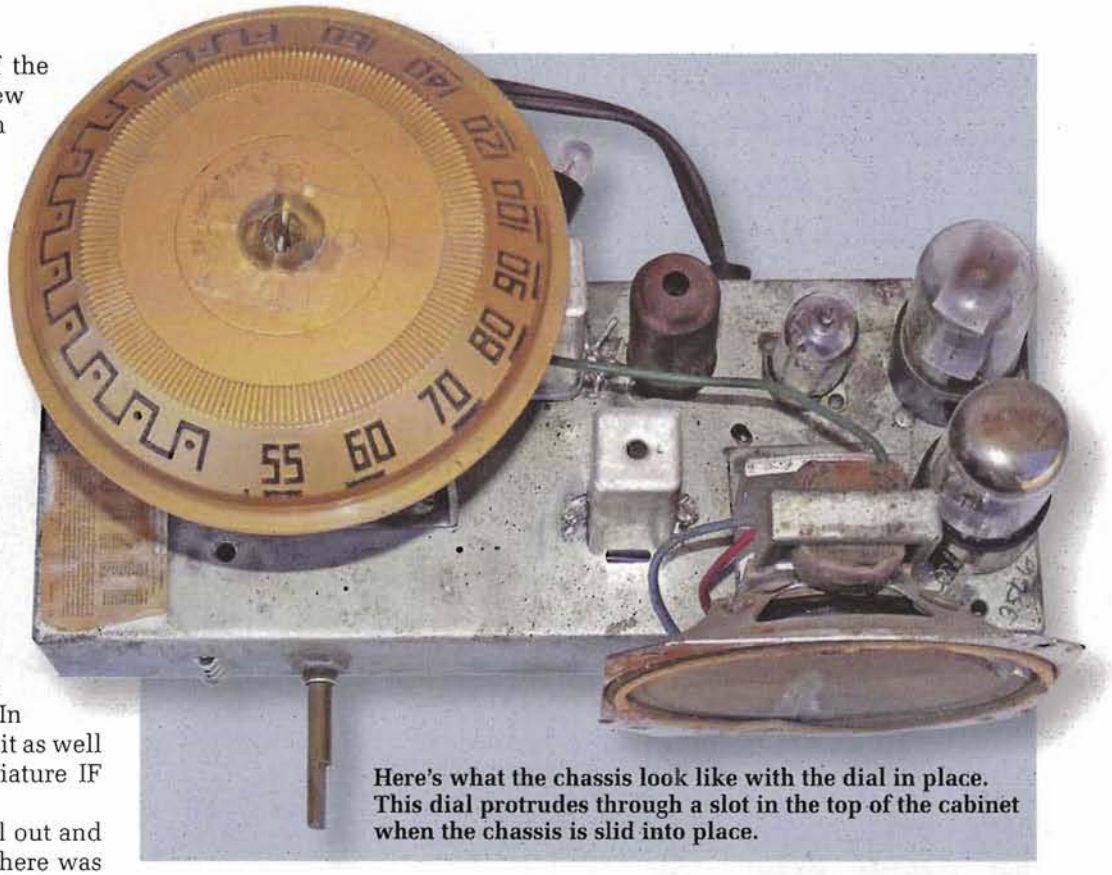
owner's incorrect wiring of the loop antenna. However, a new valve didn't solve the problem so I looked more closely at the tuning gang and found that the oscillator section was shorting over part of its rotation.

Because it was an outside leaf that was shorting it was easily bent out a little and that solved the problem. The oscillator then worked with both 7A8 valves, although the new valve worked better. Even so, the set's performance was still woeful, due to it being badly out of alignment.

Unfortunately, I couldn't adjust the tuning of the first IF transformer as one core had had its slug mangled. In the end, I decided to remove it as well and fit the other AWA miniature IF transformer that I had.

When I pulled the original out and dismantled it, I found that there was no hope of adjusting the mangled core. By contrast, the second core could be adjusted but a previous owner had wound it right out. It probably could have been made to work with a lot of mucking about but it looked like too much work so I just fitted the AWA transformer.

That did the trick. When I turned the set back on again, I found that it was now working reasonably well. After a final touch up of the tuning cores, the IF stage was again working like new.



Here's what the chassis look like with the dial in place. This dial protrudes through a slot in the top of the cabinet when the chassis is slid into place.

Still below par

Despite my work on the IF section, the set's performance was still below par. The trimmer on the antenna loop had been adjusted for minimum capacitance but it still needed to be less at the high-frequency end of the dial. This indicated that the twisted pair of wires from the loop to the tuning gang had too much capacitance between them and this was preventing the antenna loop from tuning properly.

My first attempt at fixing this problem involved replacing this twisted pair with some air-spaced 300-ohm TV ribbon cable. My reasoning was that this would reduce the capacitance across the tuned circuit sufficiently to deliver a peak at the high-frequency end of the dial. However, while this did reduce the capacitance, the trimmer still could not be adjusted correctly.

It was beginning to look as though there were too many turns on the antenna loop, so I decided to check it. I unwound all the tape around the two points where the wires emerged from the loop and this revealed that there were in fact two windings wired in series. One was the tuned winding while the other was a link winding for an external antenna and earth, so someone had obviously been fiddling.

I disconnected the two windings and connected the winding with the highest resistance (about 2.5Ω) to the tuned circuit. The set was now starting to perform like it should. There were more stations evident at the low-frequency end of the dial and the antenna trimmer could now be peaked at the high-frequency end.

There was just one final problem with the set – the speaker has been damaged at some time in the past. It had been repaired but still sounded terrible and so it was replaced.

Summary

Although this restoration took some time, the result is a set that is quite a reasonable performer. As an AC/DC receiver, it is much safer than many and would make a worthwhile addition to any vintage radio collection. SC



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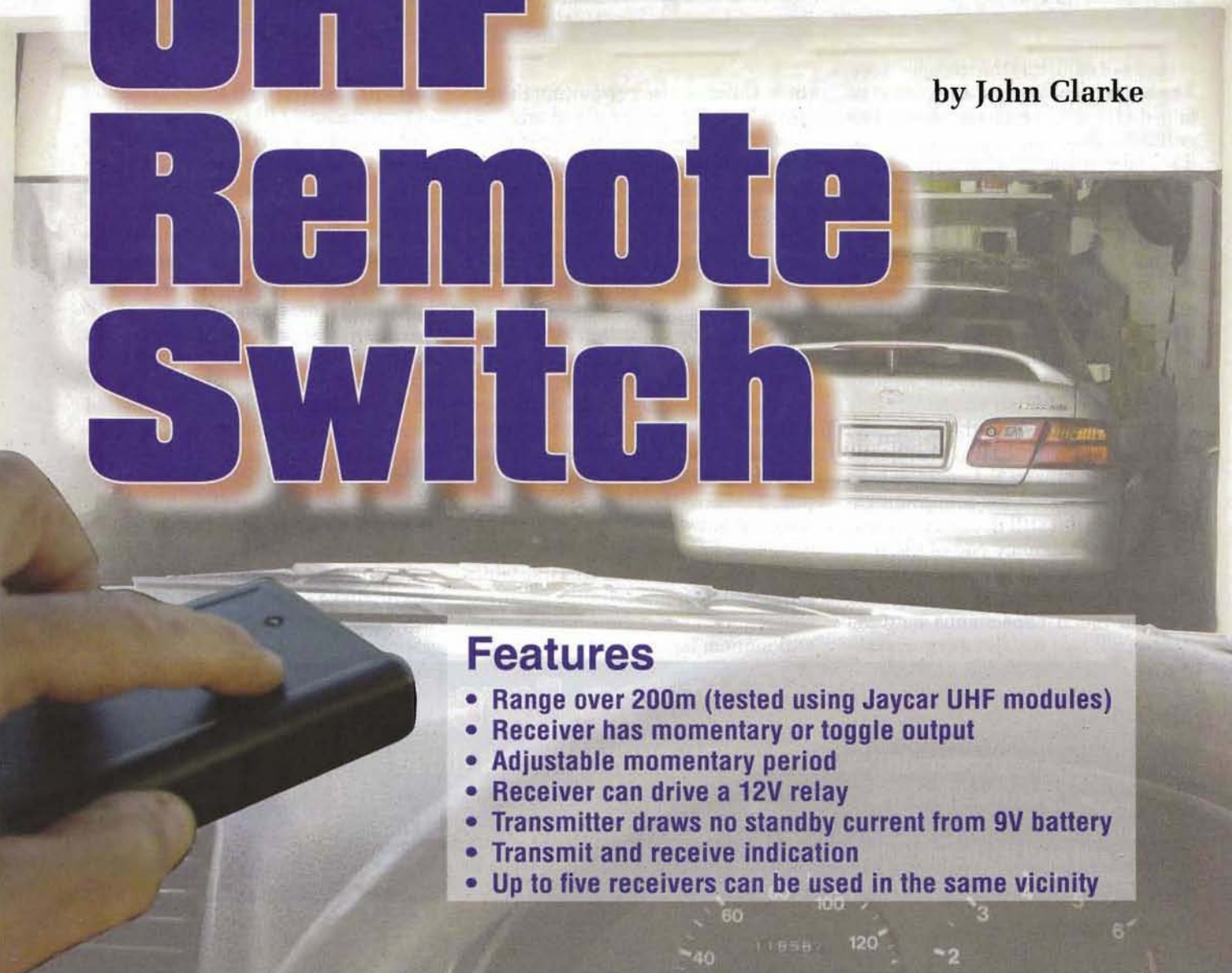
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Ideal for remote control of practically anything you like and with a range of more than 200m, this wireless transmitter and receiver pair use pre-built UHF modules that make it easy to construct and use.

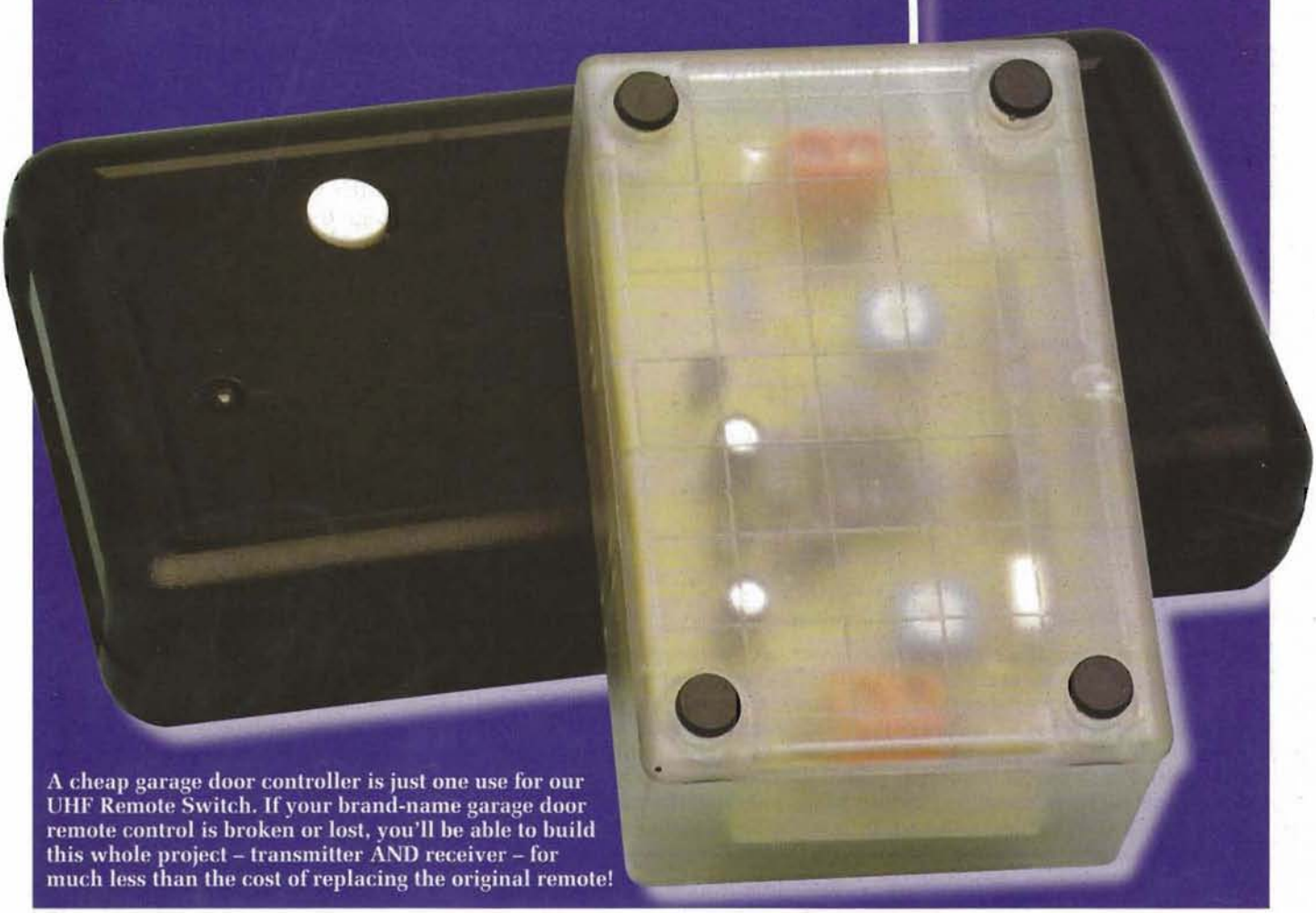
433MHz UHF Remote Switch

by John Clarke



Features

- Range over 200m (tested using Jaycar UHF modules)
- Receiver has momentary or toggle output
- Adjustable momentary period
- Receiver can drive a 12V relay
- Transmitter draws no standby current from 9V battery
- Transmit and receive indication
- Up to five receivers can be used in the same vicinity



A cheap garage door controller is just one use for our UHF Remote Switch. If your brand-name garage door remote control is broken or lost, you'll be able to build this whole project – transmitter AND receiver – for much less than the cost of replacing the original remote!

There are quite a few 433MHz transmitter and receiver modules around these days. Relatively inexpensive, they are ideal for remote control applications as well as their more usual tasks, wireless data links. While the majority offer only fairly short range (tens of metres), some can work over a 200m+ range.

Even tens of metres range is a considerable improvement over infrared transmitter and receiver pairs that not only have limited range (<10m) and usually don't work well in sunlight but more importantly, have strictly line-of-sight reception. A wall, a filing cabinet, even a vase of flowers can stop infrared dead – just like your TV/video infrared remote control.

On the other hand, UHF modules can operate where there is no line-of-sight between the transmitter and receiver. They'll even work through (most!) walls, although walls with interior aluminised insulation or similar will cause them grief.

Commonly known as 433MHz data transceivers, they operate on the 433.050MHz to 434.790MHz band, at a level of 25mW. Classified as Low Interference Potential Devices (LIPD), they are widely used for sending wireless data in industrial, medical and for scientific purposes.

However, these days you are more likely to find them in wireless consumer applications such as door openers, doorbells and weather stations.

We have used these devices in the past for various wireless applications, including the Water Tank Level Meter featured in SILICON CHIP between November 2007 and January 2008.

Both Jaycar and Altronics sell a version of the transmitter and receiver pair. The best part about them is that they are pre-assembled and aligned – you don't even need a multimeter to get them going!

As LIPD devices, they have no legal protection against interference from other LIPD devices on the same or similar frequencies. The trade-off is that they are one of the few radio frequency transmitters that can be used without a licence.

ASK

The 433MHz modules send data by a method known as Amplitude Shift Keying or ASK. This simply means that to send data, the transmitter sends bursts of 433MHz signal. When the transmitter is sending the 433MHz signal, the data is a '1' and when the transmitter is off and not sending 433MHz signal the data is a '0'. The receiver responds to the transmitted signal by producing a high output when the data sent is a '1' and a low output when the data sent is a '0'.

It may seem easy to use the UHF transmitter/receiver modules just to do simple switching,

SECURITY NOTE

While this UHF Remote Switch has protection against unauthorised access via its "identity" settings, there is little to prevent someone with a similar transmitter stepping through these identities if the basic operation is known. Therefore it should not be placed in locations where security could be compromised – eg, used on a garage door opener where the garage gives access to the rest of the home.

How not to use the UHF transmitter and receiver modules

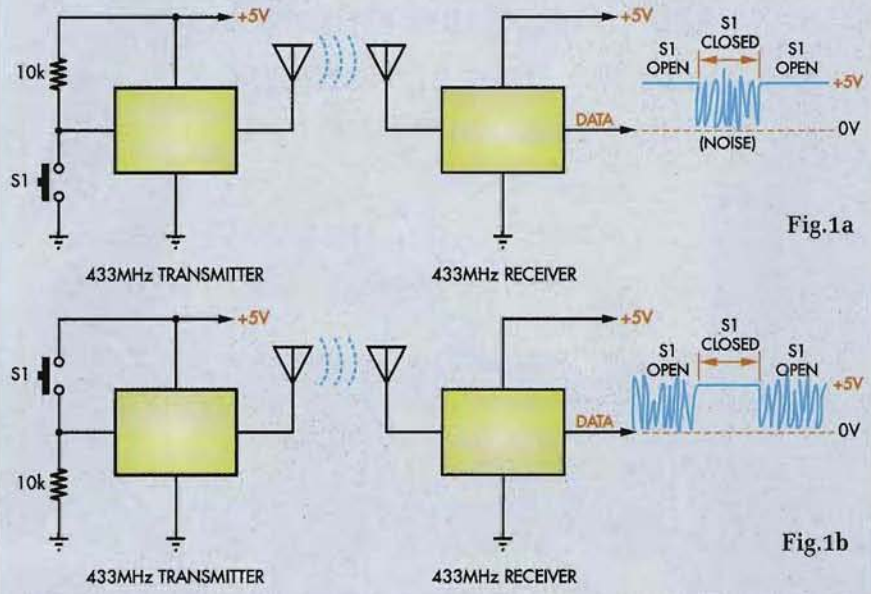


Fig.1a

Fig.1b

The two alternative arrangements for connecting a switch (S1) to activate the transmitter are shown in Fig.1a and 1b. With S1 open, the transmitter will be sending 433MHz signal to the receiver and the receiver output will be set constantly high. When S1 is closed, the transmitter will be off and the receiver will pickup random noise shown as a series of irregular high and low signal. Fig.1b has S1 connected so that the transmitter only sends 433MHz signal when closed to produce a high output at the receiver. When S1 is open the transmitter is off and the receiver outputs random noise.

by simply connecting them as shown in Fig.1a. This is where the transmitter is set to continuously send a signal with the data input held at 5V. The receiver then responds by outputting a high. It follows that the data output from the receiver would go low when the transmitter ceases transmitting its signal.

The alternative arrangement with the transmitter off with S1 open is shown in Fig.1b. In this case the output from the receiver would go high when S1 is closed.

However, neither of these arrangements will work. The reason is that the data rate must be a minimum of 300 bits per second and a maximum of 10k bits per second. So for slow speed use where the switch remains open or closed for longer that the minimum rate, there are problems.

The first problem is that with no signal sent by the transmitter, the receiver outputs a continuous stream of noise. This is seen as random high and low signal at the receiver output.

The reason for this effect is that the receiver has automatic gain control (AGC). In the absence of 433MHz signal the receiver increases its amplification (or gain) until it begins to receive signal. If there is no 433MHz signal, the gain will become so high that the receiver just detects noise. This noise is then what is applied to the receiver output.

When there is a 433MHz signal transmitted, the receiver gain is reduced so that the signal is received correctly without detecting the background noise. The AGC action is designed to work if the 433MHz signal is modulated (switched on and off) at the correct 300Hz to 10kHz range.

The second problem is that the receiver will respond to any 433MHz signal that occurs in its range. So if your next-door neighbour's garage door is being activated using a 433MHz remote control, then the receiver will also provide an output. So some form of encoding is needed so that the receiver will only work in conjunction with its transmitter and not from another transmitted signal.

As a consequence, UHF modules cannot be used without some form of signal conditioning. For transmission, the signal needs to be processed so that a signal with the correct bit rate is sent to the transmitter module. For reception, the signal needs to be processed to ignore the noise from the receiver module in the absence of signal and to only respond to a valid transmission.

The complexity of the signal conditioning means that a microcontroller is almost a prerequisite and we chose an 8-pin PIC12F675-I/P device for both the transmitter and receiver.

Using the microcontroller also allows extra features such as the



Inside the two cases – the receiver in its utility box at left with a long-wire antenna (all of 170mm!) and the transmitter with its coil antenna, fitted into a remote control case. The battery compartment is on the other side of the case.

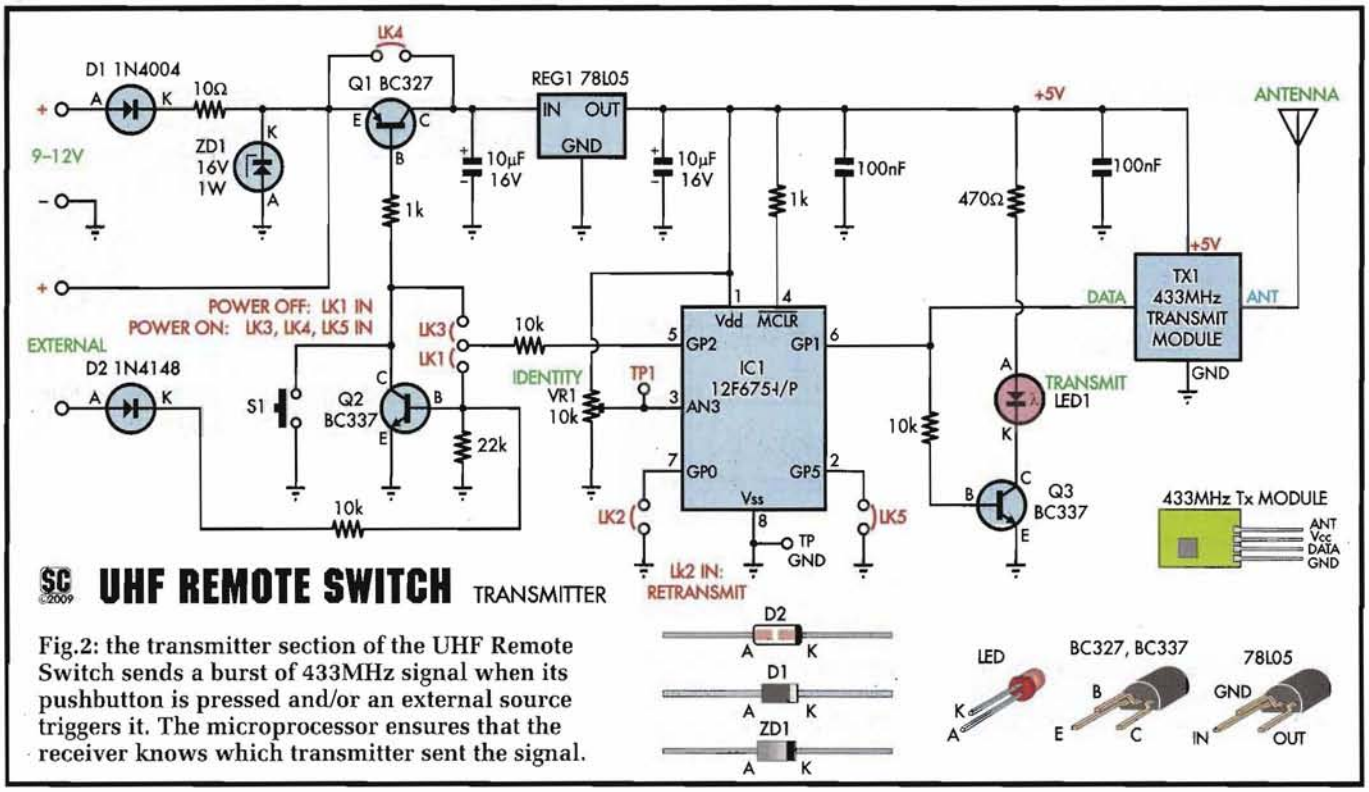


Fig.2: the transmitter section of the UHF Remote Switch sends a burst of 433MHz signal when its pushbutton is pressed and/or an external source triggers it. The microprocessor ensures that the receiver knows which transmitter sent the signal.

ability to have momentary or toggle output, an adjustable momentary delay and you can also have up to five different transmitter and receiver pairs working in the same vicinity without interfering with one another.

Presentation

Both the transmitter and receiver are quite flexible in their presentation. We elected to fit the transmitter into a handheld remote control case which also houses the 9V battery in a separate battery compartment. A pushbutton switch is used to start transmission of signal.

However, the transmitter could be housed in a smaller plastic case or even in no case at all, ie, just as a PC board, depending on the application (eg, behind the dashboard of your car with just the pushbutton seen on the dash).

Similarly, the receiver may be housed in a small plastic case or perhaps inside a garage door remote controller case. Even if the case was metal, which would normally stop the signal, the antenna wire could emerge through a suitable hole.

The receiver PC board has input terminals for power and two output terminals that can drive a 100mA load such as a relay coil. The relay contacts can drive low voltage items as motors and lamps. A LED indicates when the output is on. This receiver includes link options for momentary or toggle output and an adjustable momentary delay adjustment.

Both transmitter and receiver include an identity control that sets one of five possible identities. The identity of the transmitter and the receiver must be the same for the receiver to respond to the transmitter.

Transmitter circuit

Fig.2 shows the transmitter circuit. As previously stated, it is based on a PIC microcontroller (IC1) and a 433MHz transmitter module. The PIC12F675-I/P microcontroller includes an internal oscillator and up to five general-purpose input/outputs (GPIO). Four of these GPIOs can be used as analog-to-digital inputs.

The circuit is designed to run from a power supply between 7V and 12V with very low power drain, suiting battery use. Normally, we would assume a 9V battery would be used but it could be wired into a vehicle's 12V supply. Absolutely no power is drawn when the transmitter is in its standby state – that is, when the transmit switch has not been pressed.

When the transmit switch is pressed the power drawn is less than 20mA and this is only for a short period while the switch is held closed and the unit is transmitting.

Power is applied to the circuit via diode D1 and a 10Ω resistor to the emitter of transistor Q1. The diode provides reverse polarity protection (essential when used with a 9V battery) while the 10Ω resistor in conjunction with the 16V zener diode (ZD1) protects against transient voltages. Transient voltages are not likely when used with a battery supply but the protection is included should the circuit be powered from an automotive 12V supply.



One form of transmitter mounting is inside a handheld case, complete with a 9V battery as shown here.

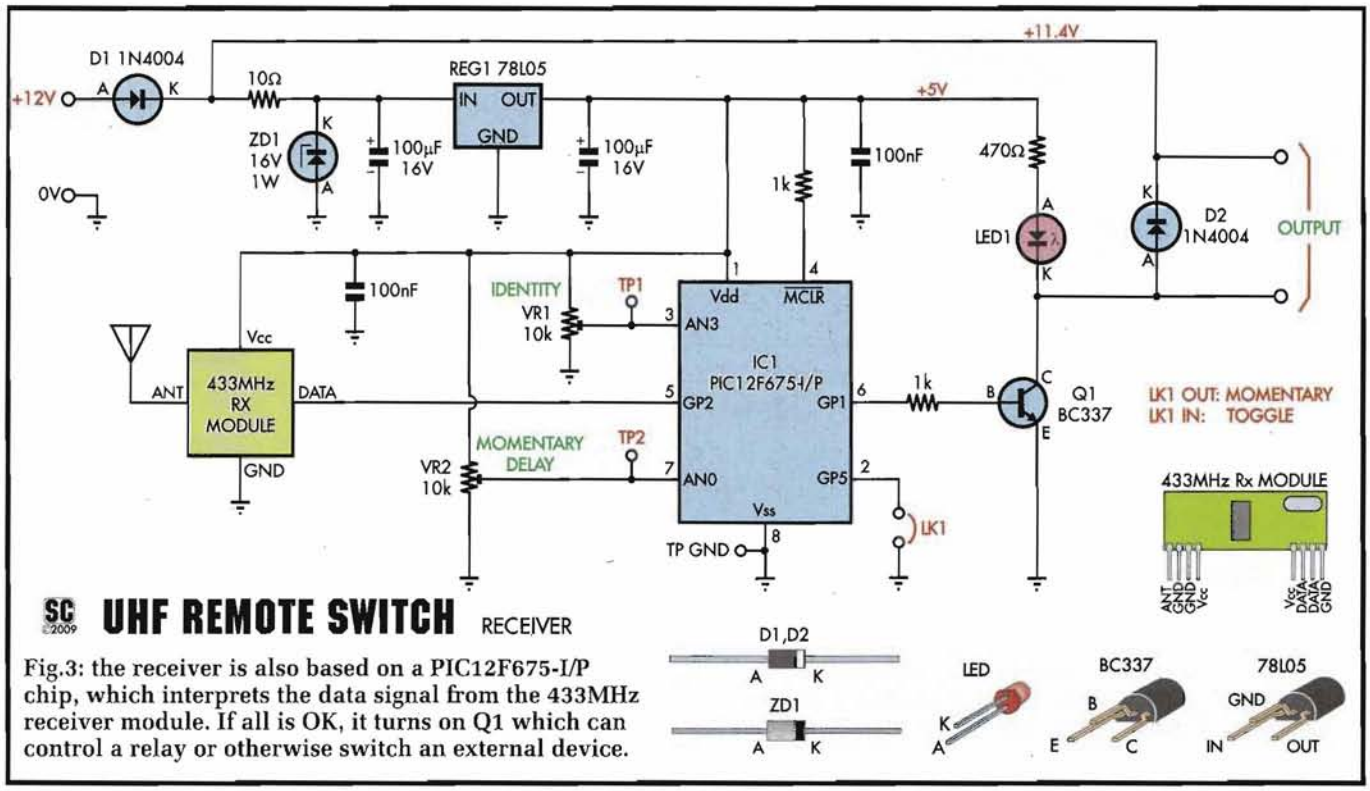


Fig.3: the receiver is also based on a PIC12F675-I/P chip, which interprets the data signal from the 433MHz receiver module. If all is OK, it turns on Q1 which can control a relay or otherwise switch an external device.

Pressing switch S1 connects the base of transistor Q1 to ground via the 1kΩ resistor. This allows current to flow from the emitter to base and so the transistor switches on. Power is then connected to the input of regulator REG1. REG1 supplies 5V to IC1 and the UHF transmitter TX1.

Pressing S1 is not the only way to trigger the transmitter – other methods are available to suit many different applications. For example, connecting the two "External" inputs together will turn transistor Q2 on, having the same effect as if switch S1 is closed.

A further alternative is to apply a voltage (as low as 1.8V) to the anode of D2 to trigger Q2. The input current at 1.8V is 60µA.

With power now connected to IC1, the program begins to run and the GP2 output at pin 5 goes to 5V. This high output drives the base of transistor Q2 via the 10kΩ resistor and link LK1, so the transistor switches on. Power to the circuit is now maintained even if the switch is released.

IC1 now reads the voltage applied to its AN3 input from trimpot VR1, connected across the 5V supply. Voltage from this trimpot is divided up into five equal divisions where each division represents its own identity:

0-1V = identity 1,
1-2V = identity 2,
2-3V = identity 3,
3-4V = identity 4 and
4-5V = identity 5.

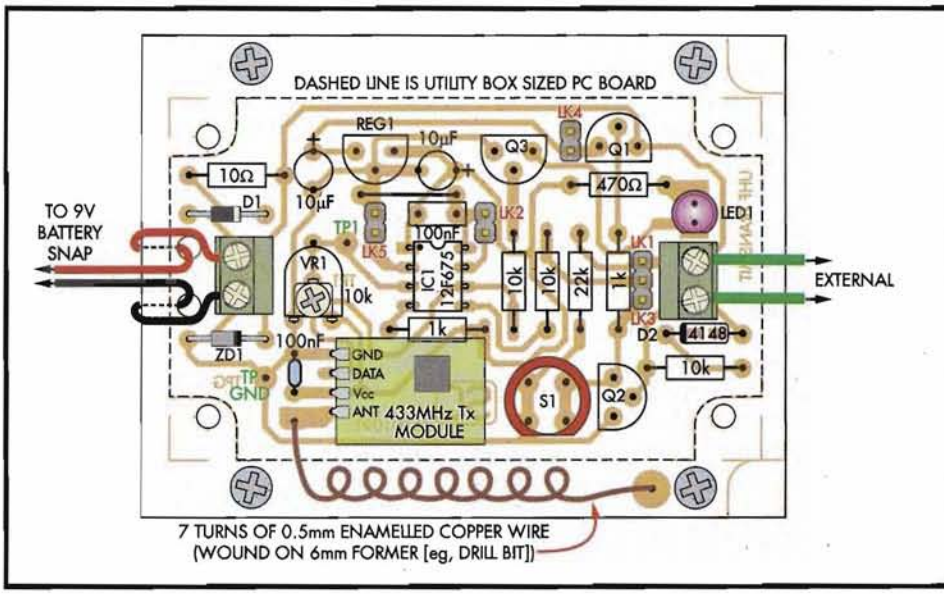
The identity is sent as part of the code in the transmission. As noted previously, the receiver must be set to the same identity as the transmitter before it will respond to the signal.

For Identity 1 the sent code has the value of 8. Identity 2 has the code 16, Identity 3 is 32 and 64 and 128 for Identities 4 and 5. The microprocessor looks for these values in the signal and matches them with values it has stored as part of the program.

Signal from IC1's GP1 output drives both the DATA input of the UHF transmitter and the base of transistor Q3 via a 10kΩ resistor. Q3 powers the LED via a 470Ω resistor and this LED flashes as signal is sent to the transmitter module.

Initially, GP1 is set high for 50ms. This sends a burst of 433MHz signal from the transmitter and sets up the UHF receiver so that it is ready to receive data without producing noise. GP1 then goes low for 1ms before going high again for 16ms.

The 16ms allows the receiver to lock



onto the data rate of the transmitter. The data rate between the transmitter and receiver needs to be locked because we are using the internal oscillators of the microcontrollers rather than crystal oscillators. The 2% accuracy of the oscillators can affect whether the data is received correctly.

After the 16ms burst of 433MHz is a 1ms low. This is followed by an 8-bit encode value, an 8-bit on/off signal and an 8-bit stop value. The receiver must receive all bits correctly before it will act upon the signal. The 8-bit on/off signal has the value 120 and the stop bit value is 240.

When transmission is completed, output GP2 goes low (to 0V), switching off Q2. If switch S1 is also open then power is removed from the circuit, as Q1 would also be switched off.

Setting the links

As an alternative to having power switched on only during transmission of the signal, you can have power permanently connected to IC1 and the transmitter module. This may be required if you power the unit from an existing 5V supply or if you want to use the 5V supply from REG1 to power another circuit that requires permanent power.

A change of jumper links is all that is required to make the changes. Swap the link for LK1 to LK3 and fit links to both LK4 and LK5. If using an existing 5V supply, REG1 is not necessary and can be omitted: simply connect +5V to what was REG1's "out" position.

Link LK5 signals to the IC1 microcontroller that the power arrangement is different and transmission is not required when power is connected. The transmission in this case is initiated by a closure of S1 or a signal at the external input. This is detected by IC1 as a low-going level at the GP2 input.

Link LK2 is used to set repeat transmission at a nominal 200ms rate. The idea of this option is to allow the receiver to provide an output while ever the transmission is being sent and to cease the output when the signal stops.

Receiver circuit

The receiver circuit, shown in Fig.3, also uses a PIC12F675-I/P microcontroller which works in conjunction with the 433MHz receiver module controller.

The circuit is powered from a 12V supply. It's much the same as the transmitter: diode D1 protects from reverse polarity connection while the 10Ω resistor and zener diode ZD1 prevent any transient voltages from reaching the 5V regulator, REG1.

This supplies power to both the microcontroller IC1 and the 433MHz wireless receiver module. Overall current consumption is around 7mA with the LED off and 14mA with the LED on. More current is required from the supply if a relay is connected to the output.

REG1 includes two 100µF bypass capacitors, one at its input and the other at its output. Both IC1 and the 433MHz module have their supply decoupled by a 100nF capacitor close to the supply pins for each.

IC1 has two analog inputs (AN0 and AN3) to monitor the voltage set by VR1 and VR2. The voltages at each input are converted to a digital value within IC1. VR1 sets the identity and this is adjusted to match the identity of the transmitter. VR2 sets the timeout period of the output when it is set for momentary action.

Data from the UHF receiver module is monitored by the GP2 input of IC1. When it receives a signal it compares the values embedded in the code with the identity value set by VR1 and for the correct on/off and stop bit codes. If the values are correct it sends its GP1 output high, which turns on transistor Q1.

With Q1's collector now low, LED1 is connected virtually across the 5V supply (via its 470Ω current-limiting resistor), so the LED lights.

Q1's collector is connected to one of the output terminals. This can be used as an output itself for any device capable of being switched by a low (<1V) level or it can drive a 12V relay connected across the output terminals. Diode D2 protects Q1 from the voltage spike likely when the relay switches off.

The output can be either momentary or toggled, as selected using link LK1.

When LK1 is out, operation is momentary and Q1 is initially turned on only when it receives a valid transmission from the transmitter. It stays turned on for a period set by trimpot VR2.

Timeout periods can be set from 0.2s through to about 50s. If the transmitter is set to retransmit then Q1 can be held on for as long as the transmitter switch is held. The timeout needs

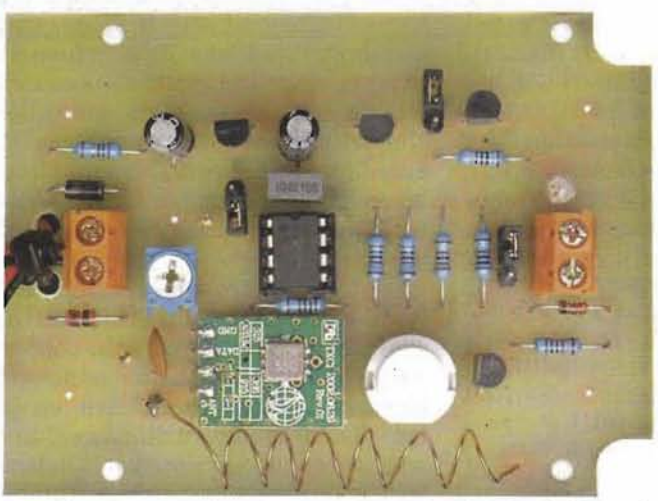
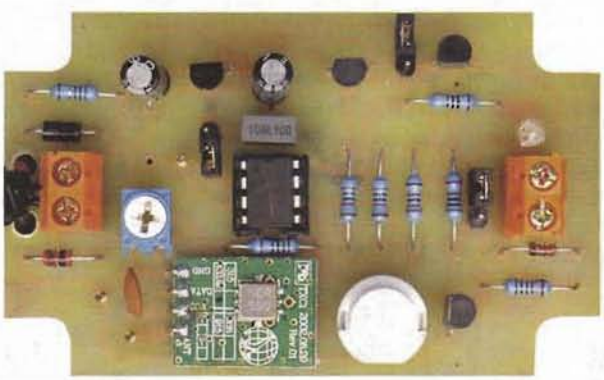


Fig.4 (opposite) is the component overlay for the full-sized transmitter PC board, which matches the photo above.



Here's the mini version, intended for mounting in a utility box. It doesn't have the spiral wire antenna; instead a 170mm length of hookup wire is soldered to the antenna pin (lower left of the green UHF module).

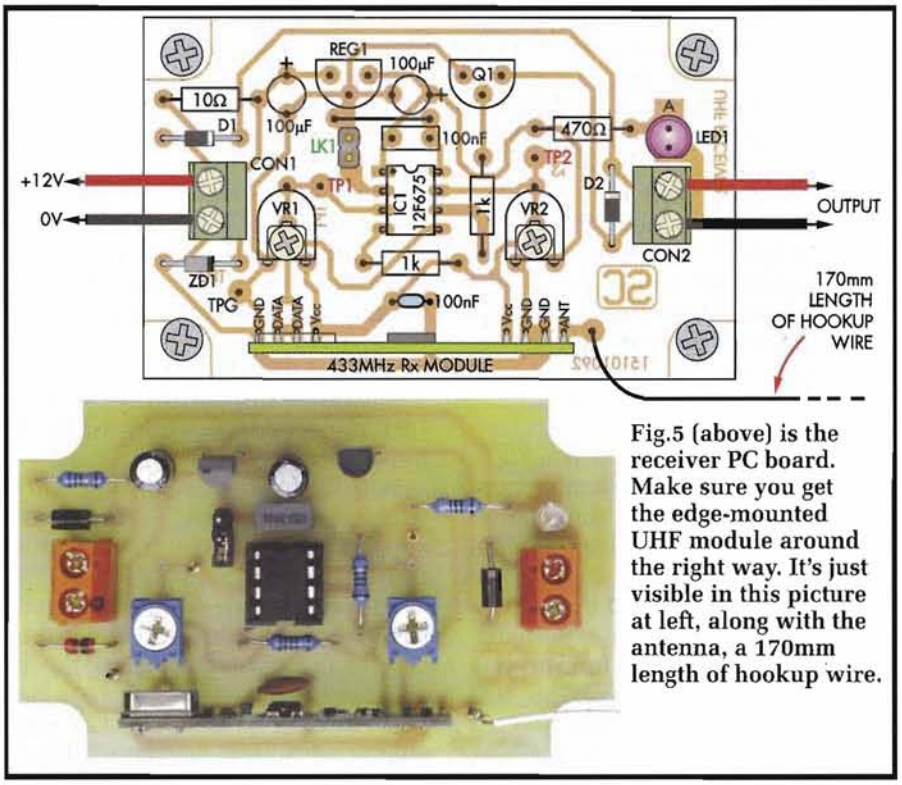


Fig.5 (above) is the receiver PC board. Make sure you get the edge-mounted UHF module around the right way. It's just visible in this picture at left, along with the antenna, a 170mm length of hookup wire.

to be set long enough that Q1 does not momentarily switch off between each retransmission of signal from the transmitter. Q1 switches off when the transmitter switch is released and after the timeout period.

Construction

We'll start with the transmitter which, as we mentioned before, is designed to fit into either a small remote control case measuring 135 x 70 x 24mm or into a 83 x 54 x 31mm utility box.

The PC board, coded 15101091 measures 85 x 63mm. An alternative outline, measuring 79 x 48mm for the utility box version, is also shown.

Fig.4 shows the parts layout. Begin by checking the PC board for shorted tracks or breaks in the copper. Also, check the hole sizes. The corner mounting holes should be 3mm in diameter, as should the two holes to anchor the battery snap leads.

Now work can begin with the assembly. Install the link and resistors first. The table overleaf shows the resistor colour codes but it is a good idea to also check each value using a digital multimeter before soldering it onto the PC board.

Next, install the PC stakes for the test points and antenna connection, followed by the jumper header pins.

Capacitors can now be installed, making sure the electrolytic capacitors are oriented as shown on the overlay. The ceramic capacitor is located near to the transmitter module

When soldering in diodes D1and D2 and zener diode ZD1, take care to orient them as shown. Likewise the 8-pin IC socket – it is oriented with its notch as shown on the overlay. Q1 (BC327), Q2 and Q3 (BC337) and REG1 (78L05) also must be installed the right way around – and in the right positions (the transistors all look the same!).

LED1, as well as being the right way around, must sit up higher than the transistors so that it can be seen through its hole in the case. The top of the LED should be 15mm above the PC board.



This shot gives a better idea of how the 433MHz UHF receiver module is mounted. Note the capacitor in front of the chip on the module – it is the 100nF ceramic disk.

The last components to mount before the UHF transmitter module are trimpot VR1, the two-way screw terminals and switch S1. Note that the switch must be installed with its flat side toward the edge of the PC board.

The UHF transmitter module is mounted horizontally on the PC board and its leads will have to be bent over at 90° before inserting into the PC board holes. Make sure the transmitter is oriented correctly before bending the leads. The pin-outs for the module are screen printed on its PC board.

As you can see from the photos and diagrams, the transmitter antenna is a small coil, made by winding seven turns of 0.5mm enamelled copper wire around a 6mm (1/4") drill bit.

Each end of the wire should be stripped of its insulation and soldered to the antenna PC stake at one end and the PC board pad at the other. If you have cut down the PC board to suit the smaller (utility) case, then an alternative antenna can be made using a 170mm length of insulated hookup wire attached to the antenna PC stake.

The 9V battery leads pass through one of the battery compartment holes in the hand-held remote case before being looped through the holes in the PC board and into the screw terminals. A cable tie secures the wires in position. The PC board is secured to the case with four M3 screws that screw into the integral support bushes of the case.

Receiver

All receiver components mount on a second PC board, coded 15101092 and measuring 79 x 48mm. It can be housed in a plastic utility box that measures 83 x 54 x 31mm (the same size as the alternative transmitter case). The PC board doesn't have any mounting holes – it is designed to clip into the horizontal slots in the side guides of the box.

Fig.5 shows the parts layout. Again, begin by checking the PC board for shorted tracks or breaks in the copper and before soldering any components in, check that the PC board clips neatly into the box as shown. It may require a little filing to narrow the PC board for a good fit without bowing out the side of the box.

Construction is similar to the trans-

Parts List – UHF Remote Switch

TRANSMITTER
1 PC board coded 15101091, 85 x 63mm
1 remote control case 135 x 70 x 24mm (Jaycar HB-5610, Altronics H 0290* or equivalent)
1 433MHz wireless transmitter module (TX1) (Jaycar ZW-3100, Altronics Z 6900 or equivalent)
2 2-way PC mount screw terminals with 5.04mm pin spacing (CON1,CON2)
1 DIP8 IC socket
1 9V battery
1 9V battery snap connector
1 SPST PC board mount snap action switch (S1)
3 2-way pin header with 2.54mm pin spacings
1 3-way pin header with 2.54mm pin spacings
4 jumper plugs
1 100mm cable tie
4 M3 x 6mm screws
2 PC stakes
1 170mm length of 0.5mm enamelled copper wire
1 20mm length of 0.7mm tinned copper wire

Semiconductors
1 PIC12F675-I/P microcontroller programmed with 1510109A.hex (IC1)
1 78L05 low power 5V regulator (REG1)
1 BC327 PNP transistor (Q1)
2 BC337 NPN transistors (Q2,Q3)
1 1N4004 1A diode (D1)
1 1N4148 switching diode (D2)
1 16V 1W zener diode (ZD1)
1 3mm green LED (LED1)

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

Resistors (0.25W, 1%)
1 22kΩ 3 10kΩ 2 1kΩ 1 470Ω 1 10Ω
1 10kΩ horizontal trimpots (VR1)

RECEIVER
1 PC board coded 15101092, 79 x 48mm
1 plastic utility box 83 x 54 x 31mm
1 433MHz wireless receiver module (RC1) (Jaycar ZW-3102, Altronics Z 6905 or equivalent)
2 2-way PC mount screw terminals with 5.04mm pin spacing (CON1,CON2)
1 DIP8 IC socket
1 2-way pin header with 2.54mm pin spacings
1 jumper plug
4 PC stakes
1 170mm length of light duty hookup wire
1 20mm length of 0.7mm tinned copper wire

Semiconductors
1 PIC12F675-I/P microcontroller programmed with 1510109B.hex (IC1)
1 78L05 low power 5V regulator (REG1)
1 BC337 NPN transistor (Q1)
2 1N4004 1A diodes (D1,D2)
1 16V 1W zener diode (ZD1)
1 3mm green LED (LED1)

Capacitors
2 100µF 16VWPC electrolytic
1 100nF MKT polyester (code 104 or 100n)
1 100nF ceramic (code 104 or 100n)

Resistors (0.25W, 1%)
2 1kΩ 1 470Ω 1 10Ω
2 10kΩ horizontal trimpots (Code 103) (VR1,VR2)

(* Altronics case is narrower and longer – 182 x 65 x 28mm; the PC board may need to be shaped)

mitter: install the link, resistors (use the colour code table and/or digital multimeter to confirm values), capacitors, PC stakes, jumper header pins, IC socket and finally the semiconductors. Once again, make sure any polarised components (eg, electrolytic capacitors and semiconductors) are soldered in the right way around.

As with the transmitter, the LED should be mounted so its top is 15mm above the PC board surface

Trimpots VR1 and VR2 can be installed along with the two-way screw terminals. Unlike the transmitter, the UHF receiver module is mounted vertically on the PC board – make sure the receiver is oriented correctly. The pin-outs for the module are screen printed on its PC board.

The receiver antenna is simply a 170mm length of insulated hookup wire, with a 2mm bared end soldered to the antenna PC stake.

With the exception of the ICs, which will be placed after testing, that completes assembly. Before moving on to the testing stage, thoroughly check both transmitter and receiver boards

RESISTOR COLOUR CODES

	No.	Value	4-Band Code (1%)	5-Band Code (1%)
☐	1	22kΩ	red red orange brown	red red black red brown
☐	3	10kΩ	brown black orange brown	brown black black red brown
☐	4	1kΩ	brown black red brown	brown black black brown brown
☐	2	470Ω	yellow violet brown brown	yellow violet black black brown
☐	2	10Ω	brown black black brown	brown black black gold brown

for component misplacement (or polarity) and bad or missing solder joints.

If you are satisfied that all is well, move on!

Testing

Set your multimeter to a low DC voltage (6-10V or thereabouts) and connect the 9V battery to the transmitter. Connect the probes to pin 1 and pin 8 of the IC socket.

Press S1 and check that the multimeter reads somewhere between 4.75V and 5.25V. If there is no voltage, check the battery, battery connections and also that Q1 and Q2 are indeed in the right way around and in the right places.

Check the receiver in a similar way (except there is no S1 to press!). Again, the voltage across pins 1 and 8 of the IC socket should be between 4.75V and 5.25V when 12V DC is connected to the power input terminals.

If the voltages in both these checks are incorrect, disconnect power and trace through the circuit until you find the error or problem.

Kit suppliers tell us that 90% of problems in project construction are poor soldering while the other 20% are incorrect component placement or polarity.

If the voltages are correct, switch off power and insert the microcontrollers for both transmitter and receiver into their sockets – dare we say it – the right way around!

First, the transmitter PC board: insert jumper LK1 and adjust VR1 fully anticlockwise. Reapply power and check that the transmitter flashes its transmit LED when S1 is pressed. So far so good.

Now apply power to the receiver and press S1 on the transmitter again. The receiver LED should light for around 200ms (ie, a brief flash). Note that the receiver will not work if it is too close to the transmitter (the transmitter is overloading the receiver). You need to have the transmitter and receiver apart by about 1m before it will work reliably. Close up operation is possible if the receiver antenna is disconnected.

You can test the momentary delay by rotating VR2 to mid setting. The LED should light for around 5 seconds. Note that the delay values from VR2 are not linear with respect to rotation so you can select closer spaced delays at the lower periods.

Values that can be selected are approximately 200ms, 400ms, 600ms, 800ms, 1s, 1.2s, 1.4s, 1.6s, 1.8s, 2.0s, 2.2s, 2.4s, 3s, 4s, 5s, 6s, 8s, 10s, 12s, 15s, 18s, 21s, 25s, 27s, 30s, 32s, 35s, 38s, 41s, 44s and 50s. These values are spaced about 156mV apart as measured at TP2.

The two lowest 156mV settings will only give the 200ms period because trimpots are not very easy to set much below 200mV at the fully anticlockwise end. The upper end adjustment may not access the 41 and 44s position depending on the trimpot linearity.

If you want the output to toggle where the output alternates between on or off for each transmission, insert the jumper plug for LK1. The momentary delay has no effect for this setting.

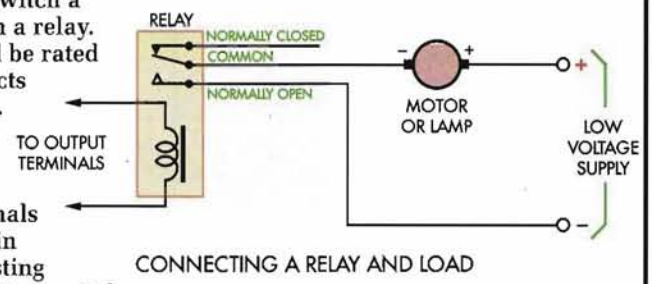


Fig.6: here's how to switch a low voltage load with a relay. The relay coil should be rated at 12V and the contacts rated to suit the load. If using as a garage door opener controller, the NO and common relay terminals would be connected in parallel with the existing (low voltage) pushbutton switch.

Identity

If you are using more than one UHF transmitter and receiver pair, or if you receive a valid signal from a neighbour's transmitter, then you may wish to have a separate identity. This will prevent another transmitter from operating the receiver.

Remember, however, that each transmitter and receiver pair must have the same identity in order to work together. There are five possible identities, selected using trimpot VR1 in both the transmitter and receiver.

The easiest selections are Identity 1 where VR1 is set fully anticlockwise, Identity 3 where VR1 is to set mid-position and Identity 5 where VR1 is set fully clockwise. Positioning of VR1 for Identity 2 is mid way between fully anticlockwise and mid setting while Identity 4 is between mid setting and fully clockwise.

Further options for the transmitter include 'retransmit' using link LK5. This sets the transmitter to continue repeating a transmission while S1 is closed or while the external trigger is applied. This will keep the receiver output activated provided that the momentary delay is sufficient to prevent LED1 dropping out between transmissions. The setting is ideal if you want the receiver to 'follow' the closure of S1.

Finally, the transmitter includes supply options where the circuit can be continuously powered. To do this swap the jumper LK1 into LK3. Also insert LK4 and LK5. Note that for this arrangement, transistor Q1 and its 1kΩ base resistor are not required and can be left off the PC board.

Connecting a relay

A 12V relay can be driven via the output terminals of the receiver, provided the receiver is powered by a 12V supply with a 100mA or higher current capability. The contacts can be used to drive a load as shown in Fig.6.

For general 12V-24V use, with loads up to about 3A for a motor and 10A for a lamp, a standard 12V horn relay could be used. These are available from Jaycar – SY-4068 for a single pole changeover (SPDT) version or SY-4070 for the double pole (DPDT) version. Altronics sell a similar SPDT horn relay, S-4335A. These relays are rated at 30A.

Higher rated relays are also available, such as the 60A-rated Altronics S-4339 and the similar Jaycar SY-4074.

If using as a garage door controller, most openers have a "local" low-voltage pushbutton switch. The relay contacts would simply wire in parallel with this switch and the receiver set to "momentary" mode.

Note that the relay is not recommended to drive mains appliances unless you are proficient with using mains wiring.

A mains-rated relay is obviously required. The contacts of the relay must be rated for the load and, of course, any 240V wiring must be adequately isolated. Switching motors will require a higher rated contact than the stated running current because start-up currents are much higher. SC

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Fixing the horn on a Falcon ute

My father owns a 1978 Ford Falcon utility and I have a question relating to the vehicle's horn. The horn must've worked at some stage early on in the vehicle's life but it now doesn't work and hasn't worked for 30 years or so. I wonder now whether the horn may not have even been connected up from new or could it be possible for the horn to stop working due to constant use?

My father also drives trucks for a living and he had the horn in one of his trucks disconnected because it would sound without even being activated. Is there an easy answer to these questions? (K. C., Wangaratta, Vic).

● Horns are electromechanical devices that have an electromagnet and electrical contacts. Normally, the contacts are closed and when power is applied to the horn from the horn switch in the cabin of the truck, the magnet bends a sheet of steel towards it.

This also causes the contacts in the horn to open and so the magnet power is released and the steel returns to its normal position. This restores power to the magnet and the process starts again. The movement of the steel sheet is what creates the sound.

They can usually be repaired by cleaning and adjusting the contacts. Sometimes it is the horn switch in the truck cabin that is at fault, where it does not make contact when pressed or it is too sensitive and sounds the horn when not required.

If you're not confident about doing it yourself, the horn and wiring can be easily fixed by an auto electrician. In any case, replacement horns are readily available from auto accessory stores.

FM transmitter for drive-in cinema

I am helping a small country shire re-open their drive-in cinema which is equipped with an old version of your Minimitter made in 1992. It is hopeless at staying on frequency which is more than compounded now with most car radios using precise frequency tuning, ie, exactly on the spot.

I am looking at replacing it with your 2002 design and would like to know if this version is stable enough to be reliably picked up with modern car radios. We are running an AM transmitter which is spot-on but the AM end of most car radios leaves a lot to be desired in terms of response – not that these old Australian-made Raycophone projectors go much past 7kHz in terms of the top end. But they still spit out a good screen image over a 100m throw onto an 18m screen and they are still running carbons. (L. M., Darlington, NSW).

● The December 2002 design is crystal-locked so there should be no drift problem.

Request for a USB-powered mixer

I would like to ask if you'd do a USB-powered basic mixer project for computer users. To give some background, I have five computers and only one set of speakers. Several months ago I built a $20 basic passive mixer from a jiffy box, some RCA sockets and a handful of resistors. This delightful device takes four stereo inputs and feeds my amplified speakers.

Naturally, there's a drop in signal level and some hum but the result has been great. I can now have my media PC playing tunes while still hearing game sounds from my games PC and I can hear other "beeps" and "boops" as the other machines do things.

What would be nice though would be something that boosts the signals so I don't need to drive my amplifier so high, plus some mixer features like adjustable volume for each source (not

How To Remove Colour From A Video Signal

Is there a simple way of turning a colour picture from a standard 75-ohm 1V p-p video output from a miniature colour security camera into a black and white picture when viewed on a standard TV monitor? Is it possible to simply filter out the colour burst signal using an RC filter of some sort?

I need a black and white picture but B&W cameras are becoming scarce. It is therefore easier and cheaper to purchase a colour camera. The problem is, the camera has no means of turning off the colour.

What I need is some sort of circuit to stop the chrominance on the video line between the camera and the TV monitor. (C. B., via email).

● There are several ways of removing the colour. The simplest method is to remove the colour burst by connecting a 1nF capacitor across the 75-ohm signal and earth wires of the video lead but this is very crude and it restricts the picture bandwidth as well.

Second, you could try to use a 4.43MHz trap filter comprising a 10µH inductor in parallel with a 130pF capacitor. This trap connects in series with the video lead in the signal wire.

Alternatively, a ferrite suppression bead with several turns of insulated signal lead through it may be sufficient to attenuate the 4.43MHz colour burst frequency. Note that the filter should be built into a small metal box and terminated with 75-ohm connectors for the input and output.

Getting Rid Of PWM Whine

I have assembled and fitted the 24V Motor Speed Controller (SILICON CHIP, June 1997) to a 12V 2A twin-motor electric golf bag buggy. The speed controller works fine but the motors are emitting a high-frequency whine when the speed is reduced.

I fitted a 1000µF electrolytic capacitor across the load and this eliminated the whine. The only problem is that the capacitor overheats.

Is there a filtering circuit that can be fitted to stop this whine? (C. F., via email).

● The PWM switching frequency should be altered to reduce the whine. Try using a 220nF capacitor on pin 5 of the TL494 instead of 68nF.

The 10kΩ resistor at pin 6 can also be adjusted to get the frequency correct for your motors. Use the 10kΩ resistor in series with a 100kΩ trimpot (wired as a variable resistor) – ie, lift the 10kΩ resistor from the ground track and insert one leg of the trimpot into this ground connection instead. Then connect the trimpot wiper to the free end of the 10kΩ resistor. Adjust the trimpot for best results.

The 1000µF capacitor across the motors should be disconnected as it is likely to blow up. In essence, by connecting the capacitor is this way, you are subjecting it to very high ripple currents as it attempts to filter out the PWM voltage. It would also heavily stress the Mosfets as they attempt to deliver high peak currents through the capacitor.

for individual channels though) and best of all, draw power from a USB port, as most computer set-ups already have too many plugpacks littering the place!

I noticed you had a USB-powered microphone preamp in the July 2008 issue which inspired me to write. I may eventually hack one up myself but I figured your greater expertise might save me from blowing something up along the way. For example, I don't understand how much power each amplifier segment would draw and thus whether USB is practical. And it might be a project of interest to other readers as well. (S. R., via email).

● It is an intriguing idea but essentially it would be a USB version of our Versatile 4-Input Mixer which was featured in the June 2007 issue. Effectively, you would need to take the MAX232 section of the July 2008 circuit and use it to power the mixer, with attendant changes to the op amp biasing, etc.

However, we do think that would be a lot of trouble to go to, just to eliminate the 12V plugpack. And while plugpacks do seem to multiply, we don't think there would be enough interest in the project, given that we already have an existing project for that purpose.

By the way, if you already have a 12V peripheral such as a printer, you may be able to use it to also power the June 2007 project. Just make sure that the polarity of the printer supply rail is the same as the mixer.

Using the USB port to obtain 9V DC

I purchased the 3V-to-9V DC Converter (SILICON CHIP, March 2004). I would like to use a laptop USB port to power a 9V 80mA load and as the kit design is for a 3V input, I was wondering if the kit needs to be changed in any way so that it can be fed with the USB port's 5V? (G. D., via email).

● The 4.7V ZD1 zener diode in the converter should either be changed to 5.6V or removed altogether for your 5V input application. Apart from that, the circuit should not require any other modifications.

The maximum input to pin 3 of the TL499A is 10V, so the nominal 5V from a USB port will be OK.

Query on Power Tool Charger Controller

I am contemplating building the Power Tool Charger Controller (SILICON CHIP, December 2006) and am wondering if it is possible to modify the circuit so the Mosfet (or a substitute) is in the positive charging rail.

My reasoning is that it would then be possible to use the negative supply rail to connect one side of the thermistor, with the other running through the existing "spare" connection on my battery. This would allow a simpler 3-wire connection between the controller and the charging unit.

Indeed, the whole unit could be built into the case of the existing "cheapie" charger, making the project altogether more elegant. I don't understand Mosfets sufficiently to attempt this without advice. (B. D., Wellington, NZ).

● While it would be possible to redesign the circuit to have a Mosfet switch power from the positive charging supply, this was not done because it would have added too much complexity. The way we approached the design was much simpler. In addition, using the same common wire for the thermistor and charging current could cause incorrect end of charge detection because of the voltage drops in the charging wiring.

The Mosfet in the positive line would either need to be a P-channel type with gate voltage protection added or an N-channel type with a "high side driver" for the gate.

DC fault in class-A module

I have a problem with the 20W Class-A Amplifier. The left module's heatsink gets very hot after half an hour of operation. Voltage across the test resistor is OK at 1.68V when switched on but then drops to nearly nothing. The heating-up switches the speakers off (just as well) and Q12 (MJ21193) gets hot.

What has gone wrong with this beautiful amplifier? (A. H., Oatlands, NSW).

● You evidently have a fault in the amplifier whereby there is substantial DC across the speakers. You need to measure the DC voltages throughout the faulty channel and compare them with those in the good channel.

It sounds as though one of the transistors in the early stages has become faulty. You should be able to identify the culprit by measuring the base-emitter voltage of each transistor. They should all be in the range of about 0.65-0.75V.

Parking sensor using proximity effect

I have been looking on eBay and saw a parking sensor using "EPS" rather

than ultrasonics. It seems to use a fixed frequency oscillator into a radiating wire antenna mounted behind the plastic bumper. Proximity to an object disturbs the field and triggers an alarm; basically, a metal detector. Any thoughts on such a project? (R. M., via email).

- You could build a project based on proximity effect by adapting some of the circuitry from our Theremin published in the July & August 2006 issue. However, it would not be so easy to calibrate the system to give a distance response, as do the conventional ultrasonic parking sensors. It is doubtful whether it would have the same range as ultrasonics, as well.

Finally, there is not much point producing an original parking sensor project now that they are available so cheaply from Jaycar, auto accessory stores and eBay.

MC3334P ignition IC is obsolete

I was thinking of building an ignition system for a 1992 Honda Civic. The High Energy Ignition from the June 1998 issue would be fine and is preferable but I cannot source the MC3334P IC. Is it still available in Australia? (C. D., Newcastle, NSW).

- The MC3334P is now obsolete. We have produced a new ignition system which has the same functions, in the December 2005 and January 2006 issues.

Making your own scope probes

I am looking to make a 50:1 probe for an oscilloscope to look at 0-600V variable speed motor drives at work. These are mains powered and sometimes they can't be bonded to earth.

Due to chassis signal returns and VSD input filtering, they will trip out an ELCB (earth leakage circuit breaker). Also, I don't wish to lose too much of the interesting transient voltages or "modified sinewave" details.

Could you help me with an idea of the workings of CRO probes? (P. W., via email).

- We featured an article on scope probes in the June 1989 issue and followed it up with a simple 10:1 probe in the August 1989 issue. This will give you the necessary background to design a probe for yourself.

We would suggest that you either build or buy a 100:1 high-voltage probe (not 50:1). Trio-Smartcal would be able to help you with a suitable product (phone 1300 853 4-7).

However, if you need to have the equipment isolated from earth, that means you really need two probes to enable a differential signal to be viewed. Most scopes will enable this by using the subtraction mode with two input channels for signals which are non-critical.

Critical signal conditions, which yours may be, require either an active differential probe interface or a scope with differential inputs (very rare these days).

Switching problem with speed controller

I have a problem with the motor speed control from the June 1997 issue. The problem is that the positive rail runs right through to the motor, leaving all the works on the negative side but the thing I wish to control is grounded to negative (no option) as in a vehicle chassis. Is there any way this can be modified to have the control on the positive side? (T. L., via email).

- There is no solution with that particular speed controller. In fact, all our DC speed controllers have the same problem. Unless you can isolate the motor from the car's chassis, there is no solution.

In fact, it would be unusual to have a motor with one side tied to the frame/chassis. Are you sure it cannot be isolated?

Transconductance amplifier wanted

Our equipment company got this question from a customer recently: "could I have a quote for an AC current source that would convert an input AC voltage (generated by a signal generator) into an output AC current proportional to the input voltage? Some 5A AC amplitude would do, with about 10V output voltage."

Would any of your audio amplifiers

Shortcut Leads To Clock Death

I cannot believe how stupid I have been. I have had the Mesmeriser clock (SILICON CHIP, June 2005) running for about six months now and LOVE it! However, the LEDs seem to be the weakness (blue ones). I needed to order more after using up the 10 extras supplied to replace ones in the Jaycar kit that were defective. When one more LED failed about a month after commissioning, I just left it. The stop/start process just seemed to be too much trouble for one LED.

Recently, I decided to fix it and instead of shutting everything down and reprogramming it, I had a brain fade and decided it wouldn't hurt to replace one LED with power on. I removed the offending LED without incident but as I started to clean the PC board holes ready for the replacement, I failed to notice the feed cable perilously close to the stem of the soldering iron.

It melted the insulation and shorted the AC feed to the LED-mounting hole on the board (LED13). The soldering iron arced slightly at its tip, the clock lights went out and the circuit board died whilst making a noise like a dying bird – like a weak chirping noise.

It will be a problem to fault-find because the supply side seems OK at first glance – any ideas about where to start? Most likely chip to try replacing first perhaps?

Please feel free to publish this as a reminder to your readership that no matter how small and trivial the task may look, the shortcut is inevitably more expensive than doing it the right way. (K. D., via email).

- Oh, dear! Or in the words of the sergeant in "It Ain't Half Hot, Mum": Oh dear, how sad, never mind!

Where to start? Pull all ICs out of their sockets. Power up and check the supply rails. Then check the Darlington transistor associated with the shorted lines. Then put the ULN2003A ICs back in and power up. If any LEDs are alight, it probably indicates a fault in the associated IC. If you get through all that, try putting U3 back in (after turning off power!).

How To Test Battery Condition

To test dry cell batteries it is necessary to put a resistor in series with the voltmeter. Could you tell me what size resistors are needed for common size batteries? Is there a formula to work this out? (A. F., via email).

● Placing a resistor in series with a voltmeter does not do anything except add a voltage drop for the multimeter measurement. This would normally be a very small voltage reduction because most meters are high impedance when measuring voltage.

However, a resistor can be placed across the battery to provide a load, so that the battery condition can be more readily checked when in use in a typical appliance. Typically, a 50mA load current should be adequate and this would require a 30-ohm resistance for 1.5V cells and 180Ω for a 9V battery.

The voltage measured from the battery or cell with the load applied will give some idea of its condition. A non-rechargeable battery can usually be considered "flat" when the cell voltage drops to below 1.2V. For rechargeable NiMH and Nicad batteries, the equivalent "flat" voltage is 1.1V per cell.

You can apply more or less load to the cell or battery, depending on whether you want to test under the same conditions as the appliance in which it is used.

be suitable for this at 50Hz? He really needs a transconductance amplifier, however these are very expensive and are used in calibration labs, etc.

I was thinking that the source will be a function generator of known output voltage and impedance, fed into an amplifier whose input impedance could be set with a resistor, plus the gain can be set with a pot. Plus it will feed a known load (a coil of about 2Ω), so that a crude but "calibratable" transconductance amplifier could be made.

So the question is: have any of your amplifiers with an output power in excess of 50W got the ability to drive a 2-ohm load? Do you think this is feasible at all? (C. H., via email).

● We are not sure that your customer understands the topic. Any voltage amplifier will convert "an input AC voltage (generated by a signal generator) into output AC current proportional to the input voltage" (sic), provided that the load is resistive. There would not be any need to modify the output impedance of the amplifier.

In theory, any voltage amplifier can be converted to a current (transconductance) amplifier by re-arranging the feedback network and yes, most of our amplifier designs could probably be converted. However, we have not done any work along these lines.

Most of our amplifiers could drive 2-ohm loads, provided they were derated so that the maximum output current was no more than the maximum current into a 4-ohm load (we are skirting around the topic of SOAR curves here). Our SC480 design from the Jan-Feb 2003 issues could probably do the job. So there is no need to have a transconductance amplifier.

Audio oscillator & millivoltmeter

Has SILICON CHIP ever published a high quality audio millivoltmeter & audio sine/square oscillator? (K. C., via email).

● We have published two high-quality AC millivoltmeters. The first was in August & September 1998 and the second was in October & November 1998.

We also published two high-quality sine/square oscillators. The first was in January & February 1990, while the second was in February & March 1999. We can supply the back issues for $9.50 each, including postage. SC

Notes & Errata

How Oxygen Sensors Work/Wideband Air-Fuel Mixture Display Unit, November 2008: reference to the narrowband Bosch sensor as an LSU11 is incorrect. It should be an LSM11. Bosch part numbers for the LSM11 are 0 258 104 002 (250cm cable) and 0 258 104 004 (65cm cable).

Brownout Protector, December 2008: the wiring diagram (Fig.2) on page 64 shows a number of 6.4mm spade connectors on the IEC mains connector. Most IEC connectors have 4.8mm terminals, so be sure to use the correct fully insulated 4.8mm spade connectors with this type.

WARNING!

SILICON CHIP magazine regularly describes projects which employ a mains power supply or produce high voltage. All such projects should be considered dangerous or even lethal if not used safely.

Readers are warned that high voltage wiring should be carried out according to the instructions in the articles. When working on these projects use extreme care to ensure that you do not accidentally come into contact with mains AC voltages or high voltage DC. If you are not confident about working with projects employing mains voltages or other high voltages, you are advised not to attempt work on them. Silicon Chip Publications Pty Ltd disclaims any liability for damages should anyone be killed or injured while working on a project or circuit described in any issue of SILICON CHIP magazine. Devices or circuits described in SILICON CHIP may be covered by patents. SILICON CHIP disclaims any liability for the infringement of such patents by the manufacturing or selling of any such equipment. SILICON CHIP also disclaims any liability for projects which are used in such a way as to infringe relevant government regulations and by-laws.

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