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Advertising Index

AJ Distributors 58
Alienware _____________ 59
Analog Devices __________ 59
Antenna Components __________ 59
Dick Smith Electronics __________ 59
E. Water _____________ 59
Embedded Comms __________ 59
Flex Technology __________ 59
Halltech Electronics __________ 59
Hare & Forbes __________ 59
Intel PCIs ___________ 59
Jaycar ___________ 59
JED Microprocessors __________ 59
Keith Rippin ___________ 59
LED Sales __________ 59
Microcomms __________ 59
Ocean Controls __________ 59
Oztronics __________ 59
PCB EZ ___________ 59
Premier Batteries __________ 59
Quad Electronics __________ 59
RFS Radio __________ 59
RF Modules __________ 59
RMS Parts __________ 59
Sage Electronics __________ 59
Silicon Chip __________ 59
Silicon Chip Bookshop __________ 59
Silicon Chip Online __________ 59
Silicon Chip Order Form __________ 59
Small Battery Industries __________ 59
Sound Gather __________ 59
Speakerbits __________ 59
Sparta Controls __________ 59
Tech Repairs __________ 59
Telmark Australia __________ 59
Termed __________ 59
ToriGix __________ 59
Tracelectronics World __________ 59
Wiegand Electronics __________ 59
Wireless Ezcom Components __________ 59

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Silicon Chip
Silicon Chip
Silicon Chip
Silicon Chip
Silicon Chip
Silicon Chip
Silicon Chip
Silicon Chip
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Silicon Chip
Silicon Chip
Silicon Chip
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Silicon Chip
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Contents
Vol. 21, No. 12; December 2008

Features
12 The Chevrolet Volt Electric Car
18 Digital Cinema: Digitising The Movies
68 Review: Owon Digital Hand-Held Oscilloscope
78 The 2008 AEVA Electric Vehicle Field Day

Projects To Build
28 Versatile Car Scrolling Display, Pt.1
36 Test The Salt Content Of Your Swimming Pool
60 Build A Brownout Protector

Special Columns
40 Serviceman’s Log
53 Circuit Notebook
82 Vintage Radio

Departments
2 Publisher’s Letter
4 Mailbag
17 Book Review
39 Product Showcase
77 Order Form
87 Ask Silicon Chip
90 Notes & Errata
94 Market Centre

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Silicon Chip

12 The Chevrolet Volt Electric Car
The star of this year’s Sydney Motor Show, the Chevrolet Volt is a true electric vehicle. Here’s a look at the technology behind the vehicle – by Ross Tester

18 Digital Cinema: Digitising The Movies
There’s a revolution happening in the movie world, with the industry slowly moving away from film to digital. There are advantages for production, distribution and even copyright protection – by Barnie Smith

68 Review: Owon Digital Hand-Held Oscilloscope
We look at Owon’s affordable dual-channel digital oscilloscope that can also double as a digital multimeter. Its portability makes it ideal for field work – by Leo Simpson

78 The 2008 AEVA Electric Vehicle Field Day
An interesting display of DIY electric vehicle conversions – by Leo Simpson

 Projects To Build
28 Versatile Car Scrolling Display, Pt.1
Use it to monitor, display and log up to six sensors on a scrolling or static LED display. You program it via the USB port & it can also control two relay outputs in response to measured signals – by Mauro Grassi

36 Test The Salt Content Of Your Swimming Pool
Don’t shell out big bucks for a salt-water tester for your pool. Our low-tech solution is easy to set up and costs almost nothing – by Leo Simpson

60 Build A Brownout Protector
Low mains voltages (brownouts) are a fatal hazard to induction motors. This Brownout Protector is rated at 230V and is easy to build – by John Clarke

 Special Columns
40 Serviceman’s Log
Intermittents: No Money For Old Rope – by the TV Serviceman

53 Circuit Notebook
(1) Fuzz Box For Guitars; (2) Monitor For Pet Bed Heater; (3) One-Button Camera Timer; (4) VHF Aircraft Receiver With Squelch; (5) Toy Power Machine Is No Risk To Wallet; (6) Battery Monitor Has Low Current Drain

82 Vintage Radio
The Leak TL12 Plus Valve Amplifier – by Rodney Charnpens

Departments
2 Publisher’s Letter
4 Mailbag
17 Book Review
39 Product Showcase
77 Order Form
87 Ask Silicon Chip
90 Notes & Errata
94 Market Centre
Publisher's Letter

Electric vehicles might be a technological dead-end

This month we have two reports on electric vehicles. The first, on the General Motors' Chevy Volt, is a state-of-the-art electric vehicle which is slated to go into production in two years. The second, our report on the AEVA field day at Rose Hill in Sydney during October, shows developments at the do-it-yourself end of the electric vehicle scene.

Neither report really gives many clues as to what sorts of cars we will be driving in 10 years' time or further into the future. For a start, the majority of the cars we are driving right now will probably still be on the road in 10 years' time. Second, it is by no means certain that the prototype electric cars presently being touted by the major car manufacturers will go into production in their present form. In fact, it is by no means certain that General Motors in the USA will ever survive their current financial woes without substantial government assistance and restructuring. In any case, if it does go ahead, it appears as though the motor and batteries finally employed in the Chevy Volt could be quite different to the concept car seen at the Sydney Motor Show. We have also stated in a past issue that we thought the Chevy Volt was a "pretend electric" car in that it has fairly limited battery capacity and a small internal combustion engine to provide long range trip capacity. Given that GM has prior experience in producing the ill-fated EV-1, you would think they would take a better approach. Or is it because car dealers can see that electric cars will require little after-sales service and there won't be much money to be made from a pure electric vehicle?

What does seem certain is that more hybrid electric cars will be available in years to come. Toyota's Prius and the Lexus RX400h range of cars have already been big sales success and you can expect more of the same from Toyota, Honda and the other Japanese manufacturers. There is even a Commodore hybrid planned for release in a year or so.

However, it must be said that none of the existing hybrids from Toyota or Honda really push the envelope in getting the really high fuel economy that is poten-
tially available. Already, the Toyota Prius has been modified by DIY enthusiasts to get claimed economy down below 2.5/100km. How much better could it be if Toyota pushed the technology as far as it could? The good news is that diesel hybrids being developed and also seen at some of the European car manufacturers (eg, the Renault TwinDrive) are planned to do much better and will have an electric only range of 60km or more, comparable with the Chevy Volt.

But just because hybrid electric vehicles may seem more practical at the moment, this does not mean that particular technology will necessarily dominate in the long term. Other hybrid vehicles could take the spotlight. What do I mean by that? At present there is quite a lot of research into diesel hybrid vehicles with hydrogen storage systems – no electric motors would be involved. If that seems outlandish, consider that the vast majority of conventional vehicles, from the humble Bobcat right up to huge mining machines, use hydrogen storage systems. They run at very high hydraulic pressures (typically 21.000psi or 300 bar) and they use a hydraulic accumulator which is driven by a relatively small diesel engine working at more or less constant load.

Furthermore, a vehicle with a hydrogen storage system can provide very effective regenerative braking – much more effective than electric motor regeneration. Another big advantage of a diesel hybrid vehicle is that it does not have a large investment in batteries which have long-term consequences for the environment. In reality, such vehicles would not represent a drastic change from technology available right now.

So what sort of vehicle are you likely to be driving in 10 or 15 years' time? It might be a diesel hybrid.

Leo Simpson
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HDTV is a sick joke

I could not agree more that HD Television is being wasted in this country (Publisher's Letter, September 2008). I am sure that I am not the only one who is fed up with the unprofessionalism of our so-called “free-to-air” networks. I note that there is still no HD programming in any newspaper guides. The people who write the guides probably have never gone to the store, which is why, when you consider that the networks consistently change programs at the last minute, making guides useless anyway. The networks can’t consistently perform its mission, and demand that the networks achieve this. I am sure the networks can’t consistently provide this.

As one who has supposedly “shot himself in the foot” (Mailbag, September 2008, page 4), I would like to make a further comment. While I concur that Allan Hornsby has performed the maths correctly, 61 litres is the absolute minimum quantity of fuel required. To make the maths simple, I rounded the figure up to 100 litres; the additional 19 litres is my fault. Perhaps I should have been more explicit in my previous letter on the subject. It is highly unlikely that either a journey would be exactly 900km or that the fuel consumption be exactly 1/100km! The aim was to show how simple it was to use the “fuel consumption” figure. If either mpg or km/L values are used then the mathematical division process is required (900 divided by 11 approx.). If Allan fills up with exactly 11 litres for his journey, then I foresee him walking with “can in” to the nearest fuel outlet.

R.A. Hoppers Crossing, Vic.

Ceramic filters can be obtained from a junked TV

In response to the question about ceramic filters for the Jupiter receiver (Silicon Chip, August 2008) on page 100 of the October issue, F. A. is mistaken in that they are not described as “ceramic resonators”. A ceramic resonator can be a two or 3-doped device that is commonly found in the clock generator on many microprocessor-based circuits. A ceramic filter differs in the fact that it can be either a broadband filter which will trap all frequencies and pass only the wanted frequency or a notch filter which will do just the opposite. I am not sure in which country F. A. is based but if a ready source of these filters is from the sound IF section in a defunct VCR or TV which will be only 5 MHz (ANZ) or 6.8 MHz (South Africa/UK). Another supplier is Trade Tech New Zealand which has them. www.tradetechcom.au

A ceramic filter is the fact that it can be either a broadband or notch filter which will trap all frequencies and pass only the wanted frequency or a notch filter which will do just the opposite. I am not sure in which country F. A. is based but if a ready source of these filters is from the sound IF section in a defunct VCR or TV which will be only 5 MHz (ANZ) or 6.8 MHz (South Africa/UK). Another supplier is Trade Tech New Zealand which has them. www.tradetechcom.au

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By Fred Eady, Published 2007

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Practical Variable Speed Drives and Power Electronics

By Malcolm Barnes, 1st Ed, Feb 2003


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by Shawn Wright, Published 2008

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by Jack Dingwall

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By lan Hickman 4TH Edition

published 2003

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Mailbag—continued

Choosing good-quality automotive fuses

The Serviceman had an interesting article about AGI fuses earlier this year and hereby unfolds a little-known fact about automotive fuses.

Top of the line automotive electronics stock fuses which have the fuse material soldered to the end caps which are made of chrome plated brass. These are not cheap! Everyone who wants to sell fuses which are made of chrome-plated steel which are quite cheap and which quite often have the fuse material crimped between the end cap and the glass tube. If you happen to have low humidity these will not give much of a problem. However, I live in a climate where the ambient temperature drops below 0°C quite frequently in winter. What happens when the frost starts to thaw is that a thin film of water is deposited on the outside of the fuse (and anything else which exposes theroml) and thereby causes point temperature change and over time this breaks through the chrome coating on the end caps and produces rust. This eventually gives an intermittent contact and finally, as it becomes open circuit.

So next time you venture forth to buy automotive AGI fuses take a small magnet with you. If the fuses fail to stick to it you have the good quality ones which will last a very long time unless you overheat them. Thank clear of the others.

John Hardisty,
Burnie, Tas.

Silicon Chip

In June 2008, I was given a computer with 100L/hr (approximately 1kW) of water for free. Unfortunately, the computer only works when the fuse is removed. Unfortunately, of an R/C turbomotive fuse, I have to give the computer to a friend.

This project

Due to its low resistance at high light levels and so the LED light. You need to reverse this operation for night-time lighting.

We (the group that had built the system in June 2003) could operate it from 12V instead of the 240V mains. This drive a relay that can control the LED and load during dark.

Line input for voice recorder module

I have built the Enhanced Voice Recorder Module (December 2007) and plan to use it as a custom doorbell. It is possible to make a simple circuit to take a line-in input (eg. from computer MP3 player) in lieu of the condenser microphone (if S. F. via e-mail)

It’s quite easy to modify the Voice Recorder Module to accept an audio line-level input instead of the electret mic.

All that is needed is to remove the 100L/hr flow sensor, connect the input pins 20 and 21 of the HK828 chip, and connect the input to the line-level audio to pin 20, via another (or the same) 100nF coupling capacitor. It would also be a good idea to use a 5k24 integrator to control the coupling capacitor, to allow the analog signal to be filtered and prevent overloading the HK828.

Just connect the trim pot as a volume control, with its wiper connected to pin 20 of the IC via the 100nF capacitor.

Waterproof connectors needed for charger

I’m looking for some type of connector, to be mounted on the outside of the unit, which is somewhat waterproof or has a duct cover of some sort. I was thinking of some sort of banana plug but it’s not waterproof.

Would you know of any 2-way plug that can either be panel mounted or have a dust cover or similar? I would like to have a waterproof connector. I have the purpose of allowing the user to connect a charger to the unit which has an internal battery. I do not have any suggestions. (B. W., via email).

There are a few that can be used.

Before I start assembly of my Jaycar Lead Acid Battery Zapper/Tester kit (Silicon Chip, May 2006), I am curious if this device (with minor modifications) can also be used with 6V lead acid batteries.

To explain, I have a 1939 Craftsmen speedboat that I convert to 6V to make it easier to start. I also have an electric boat that is 24V. I can zap it with two 12V/6A batteries.

So there appear to be two options: modify the 6V setting on the Zapper or modify the 24V circuit and dedicate it to 6V.

Since I have 6V batteries for my 1925 Studebaker and my 1931 Model A Ford, modifying the 24V circuit would be preferable. (S. U., Saratoga Springs, NY, USA).

The zapper section of the Battery Zapper/Tester should be able to work satisfactorily with an 6V battery, without any changes. However, you would need to make a few minor changes to the test section, in order to check 6V batteries. As you suggest, this can be handled by tapping over the 24V positions of S2a and S2b.

I suggest that you try connecting a 22kΩ resistor in series with the 24V position of S2a, and connect the 24V current circuit between the two upper 22kΩ resistors in the voltage divider associated with S2b, rather than the existing connection between the two lower 22kΩ resistors.

This should effectively convert the 24V range into an 6V range, although you may need to change the voltage divider ratios, but you should have no need to zap them.

As a general rule, if your batteries are behaving normally and hold a good charge, there should be no need to zap them.

Power pack for Tempmaster

Could you suggest the possible specifications (output, etc) for a suitable power pack for the Tempmaster (Silicon Chip, June 2005)? The article does not make any mention of this. (J. B., via e-mail)

The current drain of the low voltage circuitry in the Tempmaster is very low indeed at less than 1mA. This means you can use a low-power plugpack, with a rating of 100mA or less.

AirNav RadarBox, November 2008: the contact email address given on page 16 should be jparncutt@bigpond.net.au

Controller, August 2007: a short circuit tracker is missing on the final version of the PC board file. The missing tracker should be running directly under the centre of diodes D5 and D6, connecting pin 1 of IC4 to the wide track running transversely just behind D5.

To fix this problem in existing boards, solder a short length of tinned copper wire in place of the missing track. A corrected version of the PC board file will be sent to board manufacturers.

Notes & Errata

December 2008

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I have a veteran motor car that has a magneto. The magneto is a bit unusual as the car has two spark plugs per cylinder, with one set of spark plugs over the inlet valves and the other set over the exhaust valves on the other side of the head (it is a "T" head configuration). The magneto is constructed so that the full secondary voltage (in theory, at least) can be directed to the "inlet" plugs for starting, after which the motor runs on both sets of plugs.

The car is a 1916 Stutz Bearcat, with a 4-cylinder 6.3-litre engine which is difficult to crank so the magneto has a difficult time!

The magneto is the major suspect for increasingly difficult starting and a miasma while idling. The magneto will be tested by a qualified person but the prognosis is not good. If the coils or condenser are suspect, then they must be repaired or re-wound, respectively. The problem is that magneto rewinders are a dying trade and there are very few people in this country that are qualified to do the work. Those who have so much work that there is something like a 6-month wait have the armature rewound.

I have successfully constructed the Universal High-Energy Ignition System Mk.2 kit. The preassembled assembly instructions for the ignition kit mentioned the use of magneto interrupter points as a sort of reluctor. I am interested to know if there has been a simpler kit design that could be adapted to use the magneto points as the interrupter and the magneto distributor in the normal way, with the high-tension provided by perhaps two coils and two circuits driven by the one interrupter? The use of an electronic (as against the electric) spark generator would obviate the need to switch to the inlet-only plugs for starting.

It is important that the magneto remains on the engine, as the engine should never be expected to be original. Also, if one can arrange a rebuild, I will eventually go back to the magneto-only operation (I. G. via email).

I have used the magneto signal for triggering by building the reluctor version of the Universal High-Energy Ignition. Alternatively, you can use the points as the trigger by building the points version. The trigger can be used to drive two high-energy ignition systems that can then drive separate coils and the poles of the distributor.

Alternatively, if the ignition coils do not draw any more than about 3A when saturated, it may be possible to connect two ignition coils in parallel and use the one Universal High-Energy ignition to drive both.

In my own case, I will be installing a UHF CB and UHF/VHF/HP sets in my new tourer. Many people doing outback touring (grey nomads) would have a CB and HP set. A kit that would combine multiple radio speaker outputs into one speaker would be ideal. You could use a mixer but there aren't many around these days, four inputs and then you have to have an amplifier and speaker, not very convenient.

A simple unit that mixes and has a small amplifier would be popular. I do know of one commercial unit available from overseas but it costs around $400 dollars. (L. W., via email).

- Presumably when these multiple radios are in use, only one is actively receiving signals of interest at any one time. Therefore it would be a simple matter to have one speaker switched to the relevant radio using a relay and a priority switching circuit.

- In effect, it would be similar to a VOX circuit. If you just want a 12V mixer, have a look at our 4-input mixer in the June 2007 issue. It could be combined with a small 12V power amplifier such as the Champ from the February 1994 issue.

LED light with photocell

I have constructed an anchor light for my host using the strip of 27 LEDs from a 12V trouble-light that plugs into a cigarette lighter socket. Now I want to add a photocell to switch it on dusk and off at dawn. When I wire in the cadmium sulphide photocell, it gives the opposite result and the light earthing needs to be incorporated into the mounting system.

I have two motors doing different jobs. One turns at about 6 RPM and the other 17 RPM. Both have good torque. Brian Wilson, Curtin, ACT.

LMS17 regulator circuit has a potential trap

A few years ago, while building an electronic device from a design in "Practical Electronics" magazine, I spotted a potential trap in the power supply circuit. This was a typical dual-rail circuit using LM317/337 regulators and in this case, used trimpots between the adjustment pins and the 0V rail to set the output voltages. It occurred to me that if it's trimpot went out of adjustment (i.e., happened), this would put excessive voltage onto the supply rail, killing some hard-to-get chips.

My solution at the time was to put the trimpots between the supply rails and the common rail, with fixed resistors in the original trimpot locations. So when I read the letter from Peter van Schalk in Mailbag, (August 2000), I dug out my May 2008 issue of SILICON
History of the AD8037
I was very glad to see Jim Rowe's RF Power Meter article in the Octo-
ber 2008 issue of Elektor relating to the Analog Devices AD8037 chip. A little history
about the development of that device series may be of inter-
est.
About 20 years ago, I was working with a team of engineers developing
medical ultrasound systems here in Sydney and we were using a TI TL441 log amp. Ultrasound signal
trends to be of wide dynamic range and you need a log amp to help
improve the signal-to-noise ratio for visual display.
The TL441 had been around for ages and used in medical radar systems — again a wide-range signal application — and eventually the chip was declared to be hermetically sealed and only custom built for military appli-
cations and we simply couldn't afford to buy them in the quantities we wanted.

We started developing our own log amp (not for medical use) for use in microcontroller
devices as to their range. They had
but not fast enough for medical ultrasound applications. My reason for seeking
them was for use in building a small PC board that I was designing for a
labouratory engineer (in the US) for $500+ per board.

The TL441 was for the arrival of the PICAXE microcontroller, a custom
chip already on the market. The TL441 had been around for years and used by
everyone because it was the only small microcontroller that
had a log amp, but the TL441 didn't have that feature.

However, once the PICAXE became
available, the TL441 was no longer needed and was eventually
made a small log amp by Texas Instruments.

I still like the TL441 and still use it today, especially when working with
PCs restricted to a limited supply voltage.

Musical Instrument Tuning Aid
Thank you for the article in the July 2008 issue of the Musical Instrument Tuning Aid. I plan to build one and use it for
my guitar. However, I'm trying to match it with different models available through
Sayac or Altronics (or S+, via email).

Either the opamp LM4560 does not work, or the Musical Instrument Tuning Aid.

15V DC power supply queries
I have a 30V-centred tapped 500mA
filter that I would like to use
with the 15V DC Power Supply (Microscope, April 2005), for a future
project. I know that the recommended
transformer is a 150mA unit which is
what I have at hand. However, I was wondering if there
are other models available through
Sayac or Altronics (or S+, via email).

With the extra cost associated with the different models, I
fear it may be more cost effective to use a CDI and
perhaps an opamp as a voltage
regulator.

Flexitimer tuning problem
I have built the Flexitimer MK4 and
found that when using the x10
bypass, it only seems to work from
0-6. However, once you select 7-9 in
the ON period, this will work fine but your OFF period goes out way
and make sure that there is no
connection to other PCBs?

We have just tested it on the seconds
but I assume it will be the same if you
work in minutes. How do you
work in minutes and seconds?

It's not easy to suggest the cause of
the Flexitimer's strange misbe-
vaviour. There should be no way that
programming the circuit will
change the OFF period, because
they are quite independent of each other
so the PIC's internal program is
controlled.

It's possible that there is a fault in
your timer's PC board or perhaps you
may have accidentally fitted one of
the diodes D1-D5 with the wrong
polarity. Failing this, perhaps your PIC
may not have been correctly programmed, in
which case you should be able to
design a circuit to monitor them for
programming it again.

How does a quartz watch work?
I have been reading Silicon Chip for seven years and find it very interesting and I have built some projects with
really good results. Quartz watches have been with us nearly 40 years now and a lot of people still don't know how
they work with that accuracy. So can you please pub-
lish an article on this subject? I am sure it will be very useful to many people. (T.P., Quakers Hill, NSW).

We described how crystal clocks work in the March 2008 issue, in an article entitled 1PPS Driver for Quartz Clocks. Quartz watches work
in exactly the same way.

Mixer for multiple radios
A lot of amateurs and other
people are installing multiple
radios. One bugbear is having a speaker for each radio.

I built the inverter from the Multi-
Spark Capacitor Discharge Ignition system to provide a 35V supply to
power a conventional CDI system. Needless to say, I blowed it up!

In a normal CDI, the SCR switches on and then stays on until the main
capacitor is fully discharged. When using the Multi-Spark inverter, the supply voltage holds the SCR on indefinitely and burns out the inverter.

If you can sense when the SCR is about to switch off the inverter and
charge the inverter after the OFF period
then you can switch off the inverter once the voltage is regulated via the 37V zener diodes (J. B., Farok, UK).

The inverter section of the Multi-
Spark CDI was not designed to be
used in this way. As you have found, it does not switch off as it is continu-
ously either charging or discharging the capacitor. The design allowed
for very high spark-repetition rates of up to 1kHz. To stop this inverter from
wasting extra circuitry and would depend on your CDI unit and how it triggers the SCR.

The best way to monitor the inverter is to monitor the SCR current in your
CDI and switch off the inverter while over there is no current flow. You would
need a low-value sense resistor in the cathode to ground connection for the SCR. This would need to
be supplied using an op amp (eg, an LM358). The op amp can then drive a
transistor similar to the CDI capacitor regulation transistor (Q3) to switch off the inverter.

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October 2008 89
Inverter-Driven Induction Motors

I refer to page 5 of the July 2008 issue, where you wrote: “In fact, using transistors for such simple common alternating current (induction motor) is never done, as far as we know.” I believe there is a most important application for inverters driving induction motors. My belief is based on logical reasoning on non-traditional power supplies, and I would indeed be most grateful if any reader can confirm or deny my assumptions.

I believe inverter-driven induction motors are used extensively as traction motors in railway locomotives, as an alternative to the DC traction motor which has been with us in very large numbers for over a century and is still preferred by many railways.

My reasoning is based on the observation that a locomotive wheel set needs not and should not be driven at a precise constant speed, as it would be if a synchronous motor were used. Since wheels wear, no two wheels are ever exactly the same size, so, even if there don’t seem to be round (thump, thump, thump), there will be a wheel size difference, which a wheel set will try to turn at different speeds, especially on curves.

Suppose the maximum efficiency of the inverter is 50%. Then, I surmise, the inverter frequency drops to a lower frequency to keep the wheel size and the inverter at all times limiting the current. I also suspect that some of these things are proprietary infor-

mation, especially the algorithms designed to reduce wheel slip.

Therefore, it is necessary to cut the motor somewhat slower and this is provided by the induction motor slip. Any comments please? I am right or wrong? (J. W., via email).

I. All modern electric locomotives use induction motors driven with a frequency that is variable-frequency, variable-volt inverter providing 3-phase drive, very similar in principle to that used in the Vector's 'motorbike featured in the May 2008 issue.

Of course, the inverter does not use simple transistors but large banks of IGBTs (insulated gate bipolar transistors) to provide high voltages and currents. Individuals wheel slip is not a major problem in a 2-axle or 3-axle bogie as the induction motors tend to be locked together in synchronism with the drive voltage, although there will be the normal slip factor of induction motors.

Wheel slip of the entire bogie is often controlled by a radar feedback system which ensures that axle speed cannot exceed an appropriate percentage of the average, or relative to the track speed. We have had articles on this subject in the past.

In fact, these days, all large AC motor drives are based on induction motors with variable-frequency, variable-voltage inverters. The Silicon Chip bookshop sells a number of books on electric motors and drives.

It seems counter intuitive that this is the case but the one-shot music alarm kind of sounds like the timer is only good for one time cycle between resets. Can the circuit be modified to be more suited for what I want to do? (M. L., via email). I am the author of description for your intended application, it sounds as if the Flextimer M4.3 should be checked and rechecked the board for faults but I cannot get the readout to zero via the offset pot VR3, as per your instructions.

It seems that the divider network to pin 3 of IC3a should be a 10kΩ resistor and not a 20kΩ resistor from pin 3 of 1C1 to VR3, because the readout does not go lower than 1.42V when VR3 is set full short. It also appears that the SPAN VR2 network may be at fault. Any ideas? (R. L., via email).

The span set-up for work provided you get 0.407V at the anode of REF1 and that all the component values for the resistors are correct. Note that VR1, VR2 and VR3 all have different values and each must be instanced (or repeat each circuit) in particular, VR3 must be the 20kΩ (code 203) unit. Also, you should ensure that Q6 and Q8 are correctly types D1 and D2 are oriented correctly.

Questions on the multi-message recorder

I was wondering about a HXC Design and Technology project which incorpo-

rates the Multi-Messa Voice Re-

coder. I was wondering of the size and type of amplified speaker. Will the device carry six different tracks of 30 seconds each? I would also like to have a button for each track and am unsure on how to do this. (M. W., via email).

It seems fairly simple and it’s a matter of “the larger the better” because larger speakers will be the more close to close to guarantee that if you are talking about the recent design as published in the December 2007 issue (HXC83) that you had written about there is not a small amplifier to drive the speaker. The total message length able to be stored in each channel is about 45 seconds, depending on the clock speed chosen. If you want to store six differ-
to the...
Mailbag: continued

Frost-free fridges are power hungry

With respect to David Robson’s request (Mailbag, October 2008) for the schematic for the Whirlpool Refrigerator Model WR1275S electronic control system, it is very hard to obtain. The details are considered secret by the manufacturer. That being the case, why use a refrigerator with a frost-free defrost system anyway? Such a refrigerator is inherently energy hungry; you use power to refrigerate and you use power again to defrost.

The defrost element is a glass-enclosed wire embedded element drawing something like 125 watts. This is a small heater that is designed when the refrigerator is supposed to be off or at least, when the compressor is not running. The compressor runs and then the defrost heater runs—a double whammy on power consumption.

Also, the electronics tend to be susceptible to power supply problems. A small heater of service calls to fix electronic controls in refrigerators. I would not personally run up a solar power inverter/generator system for my two bov’s worth—don’t use frost-free refrigerators on solar/inverter of the tracks. Intimate contact needs pressure, much more pressure than the weight of a piece of glass can supply. The rotating of the artwork while exposing—the ideal light source for this type of exposure is a point source, to alleviate this “umbra” effect even more. To use distributed source tubes is a compromise which most of us live with but that is ok. When while exposing just compounds this compromise even further.

If you have to use tubes for your exposure, hold the artwork under pressure and hold it still—please don’t rotate it!

The semi-transparent glass on the front of the microwave and the perfumed glass in a sample kit from microwaves—not light in the ultraviolet spectrum. You do make a point in the article about not looking (“staring”) at the tubes while in operation but you will notice that all commercial exposure boxes have masks that there is absolutely no light escape while the tubes are lit. Using the door interlock switch was a “nice touch” but doesn’t quite achieve the “no light escape” standard.

The remaining only one more question: Why publish such an article in the first place? Otherwise, congratulations on the quality of your presentation and on your longevity as the only surviving Australian magazine serving our electronics hobby industry.

Keep up the good work but please be a little more selective with what you publish. You do have a responsibility to mould those young minds out there, who use your magazine as part of their education, into the correct and safe practice of (hopefully) their chosen pursuit.

Jeff Thomas.

Falls Creek, NSW.

Comment: we take your point about staring but we did highlight the problem in the article. In fact, we feel it is often more effective to highlight what is right rather than point out obvious errors. Another example of this is our highlighting the hazard of a reader’s suggestion that 240V AC plugs and sockets be used for low-voltage DC, in the October 2008 issue (page 6). The rubber grommet was originally intended for the rigours of under-bonnet use so they should last for a very long time with occasional exposure to the low UV output of actinic tubes.

The same comment applies to your feedback about the UV output of microwave ovens. The UV output is low and is normally filtered by two layers of glass in the oven door. It should not be a problem. If people are worried, merely placing a layer of paper over the door would fix it.

Finally, we don’t accept your objection to using a turntable. All light bulbs are distributed light sources—the turntable will even that out. And if better clamping is required, it will make the turntable less obvious from the sharpness of the exposure.

The reason why we published the problematics of using the STP6N60E N-channel Mosfets or similar devices, rated at 200V 1A maximum (Q1, Q2) is to suggest a different part number (M. C., via email).

You can substitute the low-cost STP4NK30ZD or STP4N5K30ZD Mosfets.

The only situation where you can obtain them from Farnell—see www.farnellonline.com.au or phone 131 651. Their catalog numbers are 129-1984 and 129-1974 respectively.

HDTV sound level is louder than SD

I recently purchased an LCD HDTV and when I change from a standard plug-in AM/FM radio broadcast I notice that there is an increase in sound volume. I believe this is because of the different audio system used in HD broadcasting. I have the audio output of the TV going into my stereo system and I find that I am constantly reading for the stereo system remote control to adjust the sound down to the level that I am used to. This gets a bit annoying after awhile.

My question is has SILICON CHIP ever thought of publishing a project for a circuit that could be plugged in between the audio output of the TV and the input of the stereo system that would keep the audio at a preset level? This device could also be useful for those commercial systems that seem to be very loud also. (A. H., Hobart, Tas.).

Non-Water there should not be any change in sound levels when switching from SD to HDTV broadcasts and we would have to check the settings on your TV. Be that as it may, you could use a compressor to solve your problem but I am sure a lot of trouble given that a press of a button on the remote fixes it.

We published a stereo compressor in the June 2000 issue and while it is no longer available as a kit, all the components are still available. The key SSM2016P chip (two required) can be obtained from Farnell Electronic Components—www.farnellonline.com.au

Interval timer questions

I recently bought one of the new PIC- based Interval Timers (Slack, August 2008), I want the timer to run a water to air intercooler pump and fan for about a couple of minutes after being triggered by an RPM switch output from an aftermarket engine computer. However, a couple of paragraphs into the article, the Flextime microcontroller needs to be manually reset after each timing cycle.

I have purchased the Jaycar version of your Stereo FM Micromitter, featured in the December 2002 issue. Whilst I had no troubles with the construction, I have a question regarding the audio level on my stereo system, when compared to commercial FM stations.

I am driving the Micromitter with the audio line from my PIC and with the audio line level set to maximum and VR1 & VR2 set fully clockwise. However, there is still a significant difference in the audio level when I then switch the stereo system to a commercial FM station.

Is this just a feature of the Micro-
mitter that one just has to get used to or does it indicate a fault? TP1 is at 2.2V and VR3 was set to 1.61V. Is there a difference after the stereo indicator came on.

I am also powering it from a plug-
pack and the +5V rail is spot on. Otherwise I am very pleased with the performance. (L.C., Moggill, Vic.)

Most commercial FM stations apply considerable signal processing to compress the audio so that there is little dynamic range. This makes the signal effectively much louder—which is what the commercial stations want. However, this compression also helps when listening in a car as quiet passages are boosted in level.

You have suggested methods to verify this by tuning to the ABC FM stations when they are playing classical music. You will clearly hear the difference since these transmissions are not compressed—in other words, the quiet passages are quiet and the loud passages are loud.

The FM Micromitter does not compress the signal and this is why it appears to be lower in volume than commercial FM stations.

ASK SILICON CHIP

Got a technical problem? Can’t understand a piece of jargon or some technical principle? Drop us a line and we’ll answer your question. Write to: Ask Silicon Chip, PO Box 138, Collaroy Beach, NSW 2097 or send an email to siliconchip@siliconchip.com.au

FM Micromitter Does Not Have Volume Compression

The FM Micromitter is a frequency modulation system that works by mixing the audio signal with a high frequency carrier and then amplifying and filtering the output before it is transmitted by the antenna. The output of the FM system is not processed in any way and is therefore not compressed.

This is in contrast to most commercial FM stations which use techniques such as companding to compress the audio signal and make it louder. The FM Micromitter is designed to produce a signal that is loud and clear, just like a commercial FM station, but without the additional processing that is typically applied to commercial signals.

In this way, the FM Micromitter is different from commercial FM stations and is not designed to be used in situations where loudness enhancement is required. It is designed for use in locations where the signal needs to be loud and clear, but not necessarily at the same level as a commercial FM station.
This supply had its positive side earthed and it provided bias for the 68Q5 valves via a potentiometer. This DC voltage also fed the heaters of two 12AX7 valves in the early stages and it very effectively overcome any problems of hum leakage in the low-level sections of the amplifier. It was a nifty idea that wasn’t copied by many manufacturers.

Testing

Before going for the smoke test, carefully checked all the wiring, termi- nals and components and all looked to be in order — with one critical excep- tion. When I checked the wiring to the power plug, I found that there was no continuity between its earth pin and the chassis.

A quick check at the amplifier end showed that the earth lead was secure— attached and returned to the cover of the 3-pin mains plug. And that revealed the problem. As shown in the photos, the earth lead had been cut off.

Of course, it couldn’t be like that; since that would leave the chas- sis without an earth which would be dangerous. Cutting the end off the mains cable and replacing the plug quickly solved that problem.

So why had the earth lead been cut off? This was uncommon in the 1950s and 1960s when “earth loops” or “hum loops” were encountered in audio amplifier installations. Typi- cally, there would be a turntable, a record player (or cassette) tape recorder and an AM radio tuner all attached to the amplifier. These items would all have separate earths and circulating earth currents could find their way into the sensitive input stages via the shielded connecting cables.

As a result, these mains frequency signals would then be amplified and would appear as a loud hum.

One of the methods used to over- come this problem was to remove the mains earth connection on one or more pieces of equipment — a quite illegal and potentially dangerous practice. A far better method was to use 1:1 audio transformers. These isolated the signal earth from each piece of equipment and hence interrupted the earth or hum loop.

Getting back to the Leak ampli- fier, with the valves installed and the power turned on the voltages rose to about what would be expected. I then, checked the power consumption and it was 55W which again is about what had been expected.

The amplifier was also completely quiet with no hum or buzzing noises but when a finger was placed on the input a healthy “blunt” of hum was heard from the loudspeaker. The ampli- fier was shunting.

I don’t normally do any tests on the audio amplifiers in domestic radios using sound quality implantation. In this case, however, I decided to do some tests to see how well this ampli- fier would be judged as it would be expected.

I began by connecting my audio oscillator internally to the amplifier and an oscilloscope across the output terminals. Thus I could spot any performance problems. I then connected a good-quality 8-ohm loudspeaker and an oscilloscope across the output terminals. The response was substantially flat from around 20Hz to 12kHz. It dropped off after 12kHz but there was still substantial output of 6mV. As observed on the oscilloscope.

There were no signs of supersonic oscillation on the oscilloscope pattern, which indicated that the amplifier was stable. In addition, as the input signal was increased, the amplifier clipped symmetrically on the negative and positive excursions of the waveform.

I checked the loudness of the amplifier and checked the output level just before distortion became observ- able. I measured a signal output of 10W RMS, which is about what I expected. New output valves may vary more between output but there are probably many more hours of life left in the existing valves, so there was much work in reserve.

So, despite its age, the Leak TL/12 was still giving good performance.

Summary

This Leak amplifier is a good per- former and is reasonably priced. It is however, a very easy item to test since the early stages have been isolated for testing. However, some of the components on the board are a bit remote from their associated valve stage, which means that identifying a particular part can sometimes require a bit of care.

Fortunately, the parts are easy to get at and the component board is not mounted over the top of the valve sockets, as was the case in the “Pee Woo” receiver described in the September 2008 issue.

In summary, it is a great little amplifier and well worthwhile having in a system simply as a preamp since that it didn’t come complete with the preamp and its chassis cover.

I waited about six months until it became obvious that the problem wasn’t going to be a kit and ordered the PC board from RCS Radio and the parts from layar and built it that way. The transmitter worked as described and I was suitably impressed but I was still left confused as to why it wasn’t released as a kit.

I received my training as a TV repair- man as a young man but the landscape has changed, I assume “The Serviceman” was also trained in days of CRT TV’s. How did he learn how to repair LCD and plasma TV’s? Is there a book available?

There has been a silicon chip article for an “on-air” sign for ham ra- dio operators. If not you could develop the circuit for a 555 timer and a Mosfet in the output. This sign would be fixed outside the radio room and would flash when tuned on, thus indicating that you are on the radio.

My suggested “on-air” sign would be made out of red LEDs and would be about 25cm wide by 10cm high. The only thing advertised for this sign is the home-made box to house the sign.

Ross Fraser, New South Wales.

Comments: most TV servicemen would have done what is called “the home- made box to house the sign”.

The lamp would be a silicon chip. I can’t see why an earthed home-made box to house the sign."

Electric braking for a caravan

Regarding N. W.’s desire for an in- dicator of the amount of braking ef- fort being applied through his Brake Controller (Ask siliconchip.com.au, November 2008), a simple 12V Bezel Lamp connected to the brake lead from the controller and earth will provide all the indication he needs.

The lamp needs to be a filament type to integrate the PWM power signal supplied and the brightness is regulated according to the PWM. Anything over 75% braking effort will mean that he is too busy to look at it or not braking.

Position the lamp well down on the dashboard where it is not a distraction in everyday driving.

Brian Wilson, Cairns, ACT.

Don’t take short cuts on batteries

I wish to comment on Stan Swan’s well-intentioned but dangerous statement on page 21 of the article on 10W solar panels (November 2008). He states “The 10W CSS panel and regulator looks capable of being linked further to a larger capacity battery….”

This is not uncommon when using low capac- ity batteries but when ampere-hour capacities are in the hundreds or thousands of energy stored in capa- ble of producing horrifying results. Should one call in a parallel battery internally short or suddenly get a very low internal impedance, the current flow from the other battery discharging through the faulty cell can reach hundreds of amps, either burning out wiring or heating the faulty cell to explosion point.

Good practice in solar installa- tions is to correctly size the battery to maximum planned expansion at the time of installation, then increase generation sources and utilisation later. Never compromise on batter- ies, thinking that a defunct battery from a car will be OK. It cannot be anything else but defunct in a solar installation too. More could be said about the need to use deep-cycle versus high CCA type batteries, losses of efficiency as batteries age, etc but I think the message is clear.

Don Pech, Gledhow, WA.

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Don Pech, Gledhow, WA.
Capacitor C15 and resistor R23 in the plate circuit are included to give a small amount of top cut into the supersonic region.

V1’s output is applied via capacitor C4 to the grid of the first triode in V2. This valve is a twin triode 12AT7 and it functions here as a phase splitter.

Because there is no bypass capacitor across resistor R10, the cathode of the first triode tends to follow the voltage fluctuations on the grid due to the input signal. In addition, because the two triodes in V2 have their cathodes connected, the cathode of the second section is forced to follow the cathode voltage of the first section.

However, the grid of the second triode is effectively earthed as far as the signal is concerned by capacitor C9. This means that if the first triode has a positive-going signal applied to its grid, it will draw more plate current as the cathode tries to follow in a positive direction. As a result, the plate voltage will drop because of the increased voltage across R9 (due to the increased plate current).

This in turn means that a negative-going signal is fed via C8 & R21 to the grid V3 (EL84).

At the same time, the cathode in the second section of V3 also swings in a positive direction. However, if the grid voltage is maintained at its original level, so more negative bias is applied to this section.

In this situation, this valve section moves towards cut-off and the voltage on its plate rises. As a result, a positive-going signal is applied to the grid of V4 (via C16 & R18). This means that a push-pull signal is effectively applied to the two output stage grids.

Push-pull output stage

V3 and V4 (EL84s or 6BG6s) are connected into the circuit as push-pull amplifiers in the ultra-linear mode. Conventional PA amplifiers would have the screen biases valve and this is pin 7 of the output transformer whereas in the ultra-linear mode, they are wired to pins 3 & 5 respectively.

The EL84s (or 6BG6s) operate most of the time as push-pull class A amplifiers but operate in class AB1 at high volume.

One point to note is that, throughout the amplifier, the plate grid coupling capacitors have larger values than those found in valve radios. This is so that audio frequencies down to about 20Hz can be reproduced.

In domestic radios, the audio response rarely extends below around 150Hz. Basically, there was no point in extending the response lower than this because the modest speakers fitted to mantle receivers have very little buffering and do not work well below that frequency.

In fact, this was rather convenient as it meant that the designers and manufacturers could restrict the frequency response of the amplifier and eliminate any hum problems that might otherwise be present. This also kept the manufacturing costs down.

Power supply

The power supply is conventional and uses a 5V4G indirectly heated rectifier valve (V5). This produces the high-tension (HT) supply for the valve plates and screens.

The advantage of using an indirectly heated rectifier is that it begins operating at about the same time as the other valves. This means that the peak output voltage on the filter capacitors is almost the same as the working voltage and so lower rated capacitors can be used. Filtering and decoupling on the HT line is extensive, with R7, R15 & R22 doing the decoupling and C8, C9, C13 & C14 doing the filtering.

The 6.3V AC heater output from the mains transformer is centre-tapped, with the centre tap going to earth. This helps cancel out any induced hum from the heater to other valve elements.

Several years ago, I had cause to service a Geloso amplifier with similar output power to the Leak. It was a PA amplifier but had some interesting features in the power supply. There was a winding on the power supply that gave a voltage rail of 25V when rectified.
parts were removed and the audio input stage restored to its standard configuration.

Next, I decided to improve a chassis-mount can to house the fresh 32µF capacitors (C13 & C14). A small can of silicone was just the right size for this job.

Having consumed the mushrooms and cleaned the tin, I soldered two solder lugs to it at the open end, so that I could later bolt it down to the chassis. The can was then sprayed with matt black spray paint to match the rest of the amplifier. While the paint was drying, I checked all the resistors in the amplifier. A number of these were considerably out of tolerance and so were replaced.

These components are all mounted on a large tag strip and are quite easy to get at. However, for some strange reason, many of the components are not grouped close to the valve stage that they attach to.

Next, I cut a small section of perforated board to mount underneath the chassis, directly below where the capacitor can would sit. The new electrolytic capacitors were then installed inside the can and held in place with contact adhesive, foam plastic sheet and electrical insulation tape. That done, I mounted the new can, complete with the capacitors, onto the chassis and wired the components into circuit via the perforated board (see photo). The top of the chassis now looks almost the same as it did when the amplifier was new.

**Circuit details**

Fig.1 shows the circuit details of the Load TL/12 Plus. It's quite conventional and so most faults would be easy to find.

The first stage is an EF86 (V1), which is a low-noise audio pentode. It receives its signal via the "preamp" socket which is located on top of the chassis. R2 is included prevent RF signals from causing problems in the stage.

The cathode circuit and the plate circuit both deserve some comment. As shown in Fig.1, the feedback signal from the output transformer is applied to the cathode circuit by connecting it across a 1062 resistor and a 1kF capacitor. The latter tames the feedback signal to correct any phase problems.

Mazda had their striking "Taiki" concept car on display with its completely enclosed rear wheels. Like most concept cars, this one is very unlikely to see the light of a showroom but Mazda (like all concept car producers) maintain that many of the design elements in the Taiki will emerge in the next generation of street models.

When saving energy is right at the top of a designer's wish list, the Taiki's 0.25 drag coefficient cannot be ignored. But then again, neither can its shape. Nissan again featured their Mixim electric vehicle but this was not particularly news-worthy — it's been seen before.

Something that has not been seen before (at least in Australia) was taking pride of place on the GM-H stand: the Holden (or perhaps I should say Chevy) Volt. Will it be a Holden when it eventually reaches our shores?

Now here was something different, something worth a lot closer look.

**The Chevy Volt**

This is a vehicle based on a whole new design philosophy, one that has attracted a lot of comment in the media and on the web.

It is an EREV — an Extended Range Electric Vehicle — which marries several different genres.

First and foremost, the Volt is a true electric vehicle — the wheels are driven solely by an electric motor, powered by a bank of on-board batteries which are in turn charged overnight from the mains supply.

But it also contains a small, efficient, internal combustion engine (ICE), so does that make it a hybrid? No, because in a hybrid the ICE can also power the wheels.

In the Volt, it cannot: the ICE is solely responsible for charging the battery when it reaches its limit of about 60km. The ICE is where the EREV part comes in — the motor extends the range up to 400km.
You’ve probably picked up on that 60km basic electric range. GM’s research suggests that 75% of commuters (at least in the US) travel less than 40 miles (64km) each day, so they designed what amounts to a “town car” to precisely target this market. In this use, most of the time the ICE will never cut in but it takes away the so-called “range anxiety” which drivers of electric-only cars face: “what do I do when the battery runs out and I am stranded miles away from home/a power outlet/etc?”.

Another concept car

In truth, the Volt is also a concept car—a car that never was, nor will ever (probably) be.

The plan is to release a Chevrolet Volt in the USA in late (November 2010) and then in Australia sometime in 2012 but the odds are a million-to-one on that it won’t be this exact vehicle.

For a start, according to GM’s own press releases, they have yet to determine which battery manufacturer will get the nod. At the moment there are three manufacturers vying for what will be a very lucrative contract. But more on the battery shortly.

There’s also the engine: some reports suggest that the engine in the display model Chevy Volt is no more than an electric golf cart motor capable of moving it around “a bit.”

In conjunction with some major players and many minor ones, GM are still developing much of the “important” bits – like motors and batteries!

However, GM have said that the Volt chassis, look and running gear is probably very close to what will appear on US (and then world) roads.

The engine

We cannot tell you much about the electric engine because the final design hasn’t been chosen yet. However, GM are looking toward a motor with the equivalent of 150hp/110kW, 370Nm of instant torque (you gotta love electric acceleration!) and a top speed of – wait for it – 160km/h.

This seems to be a bit of an enigma: if you’re designing a town car with limited range for commuters, why give it freeway top speeds? Because they can?

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This seems to be a bit of an enigma: if you’re designing a town car with limited range for commuters, why give it freeway top speeds? Because they can?
A couple of snaps of the display model Volt at the Motor Show. Above, a cutaway showing part of the battery pack (ignore the black thing above it — that’s a large Plasma screen to extoll the Volt’s virtues!). At right is what will be the motor and control units (at the moment, the motor is from a golf cart!).

However, if other electric cars are any yardstick, with a top speed of 160km/h, idling along in city traffic should dramatically increase range but GM have made no comment on this.

The ICE-generator is highly efficient, having just one task — turn a generator. Therefore its power band and matching parameters can be maximised, unlike a normal petrol (or even diesel) engine which must be able to power a vehicle from rest to top speed under various loads and therefore is a compromise.

The motor appears to have already been chosen, with a model capable of running on either straight petrol or anything up to 85% ethanol blend. The fuel tank in the concept vehicle is tiny, appearing to be not much more than about 25 litres in capacity.

The battery and charging

Obviously, the battery is the most important part of any electric (or hybrid) vehicle. In the Volt, we know that (at least currently) the battery will be a T-shaped, 16kWh Lithium-ion type, consisting of more than 220 cells.

GM are very close-lipped about the actual make-up of the battery but reports we have seen suggest that they are working on a design with a 3-phase 220V AC motor(s) and some indication of battery voltage.

The batteries run along the centreline of the body and out towards the back wheels.

The batteries are not allowed to discharge below 30% — that’s when the ICE generator cuts in, or you start to charge it from the AC mains via its on-board, intelligent charger. GM claim that it will be possible to charge the battery in less than three hours “from a standard 110 or 230V household outlet”.

That’s a rather hefty charging current — about 16A or so by our calculation (16kWh x 70% / 3 hours = 3.73kW peak; 0.70 x 230 = 162.4A). And in the inefficiencies in both the charger and the actual charging (say 85% each) and that adds up to more than 22A.

We’re thinking that the vast majority of users will want to charge the Volt from charger off-peak power (or whatever it’s called in a few years) so they will need to have a special outlet installed anyway.

And, yes, we’ve checked: you are allowed to use off-peak power to charge a battery, even one in an electric vehicle!

Cost to charge

At current Sydney off-peak rates (5.83c/kWh) it’s going to cost the best part of a dollar to charge the Volt (16kWh x 5.83c).

West-case scenario (with Power-Saving Peak @ 30.25c/kWh) that would jump to around $8.40. Remember, this gives you about 60km of “all electric” driving.

GM’s costing is around $20,000 for a night-time charge and on their figures, that 75% “average 60km commute” would result in cost savings of about $4400 annually (Australian dollars). Obviously, without tests, this figure can neither be confirmed nor denied and just as obviously, doesn’t take into account any battery replacement costs.

Otherwise, you would expect operating costs of the Volt to be lower than a conventional petrol-powered car as service costs should be lower for a petrol engine that works only a small percentage of the time.

Incidentally, GM claim that the Volt will cost around 4c per kilometre to run electrically versus about 24c/km for an equivalent-sized petrol-powered vehicle.

The vehicle

The Volt is a front-wheel drive, four-passenger model that from the outside, simply looks like a modern car.

However, significant attention has been made to getting the body shape just right to achieve the lowest coefficient of drag — wind resistance — thus maximising range. This is a feature of most modern passenger car design, certainly not limited to the Volt.

GM also uses specially-developed, low-profile, low-rolling resistance tyres on 17-inch rims, again to minimise drag and therefore range.

Many of the design cues from the concept vehicle will endure in the production Volt, including the rounded front grille, athletic stance, rear design graphics, outside rearview mirrors and more. The Volt’s rounded and flush front fascia, tapered corners and grille are functional, enabling air to move easily around the car. At the rear, sharp edges and a carefully designed spoiler allow the air to flow off and away quickly. An aggressive rake on the windshield and rear screen help reduce turbulence and drag.

Inside, the Volt will offer the space, comfort, convenience and safety features that customers expect in a four-passenger sedan and it will deliver them in a variety of interior color, lighting and trim options unlike any offered before on a Chevrolet sedan.

Modern controls and attractive materials, two informational displays and a touch-sensitive “infotainment” centre with integrated shifter will distinguish the Volt’s interior from other vehicles on the market.

Some of Volt’s interior technological
features will include:
- Driver-configurable, liquid crystal display instrument panel.
- Standard seven-inch touch screen vehicle information display.
- Touch screen-style climate and "infotainment" controls.
- Optional navigation system with on-board hard drive for maps and music storage.
- Standard Bluetooth for cellular phone and USB/Bluetooth for music streaming.
- Driving the Volt will take some getting used to – there will be virtually no noise from the electric motor and even when the ICE generator fires up, its noise level will be way below conventional vehicles. Acceleration may also catch some drivers by surprise!

Green power?
A lot of argument about the "greenness" of the Chevy Volt has centred on its power source. The argument goes that by taking power from the grid to charge an electric car, one is simply transferring pollution from the exhaust pipe of the car to the exhaust stack of the power station.

GM is quick to point out that a lot of electricity generation in the USA (27% by some reports) is from coal-fired sources and even then, modern coal-fired power stations are much better in the pollution department than previously.

By taking large numbers of petrol-powered vehicles off the road and making them electric, they maintain there will be more incentive to make electric power generation cleaner and the atmosphere will also be cleaner from less vehicle pollution.

A good argument? Only time will tell...

How much?
The Chevy Volt initially had a target price of US$30,000. By GM's own admission, even now (two years before its release) the price has blown out to US$40,000 (almost AU$70,000 at time of writing but who knows!).

Whether this cuts out a significant portion of the market for GM is already causing a lot of discussion on the web, with many people raising serious concerns about the price increase (and remember, like-for-like US new car prices are on the whole significantly cheaper than ours).

Translate that to Australian dollars (which may be up, down or sideways by 2012) and you are paying a very high premium for an electric vehicle.

If it was me, I'd be with many of the web commenters: "I’d love one, but not at that price..."

Making a return appearance from previous years was this 1987 Toyota Camry station wagon. As the data sheet above shows, the Camry employs the standard 5-speed manual but no clutch is required. The large battery load means that it can only carry two people.

Oh, what a feeling: Toyota's stand had their Camry hybrids stacked like Matchbox toys!
Maximum measured fuel consumption for the Priss above in mixed petrol/electric mode is 2.5/0.10/0.0k. That's 122 MPG! Oops, did we mention MPG again? Silly us!

under the control of a microcontroller. In every case, the car had a throttle control potentiometer for speed control.

None appeared to make use of regeneration under braking and all used some variant of lead-acid or lithium-iron phosphate batteries. Some motors were wired in series mode (ie, with armature and field windings in series) while others were wired in shunt mode with the field windings run at constant voltage while the armature voltage was varied (using pulse-width modulation).

All on-road conversions need to pass inspection by the transport authority in the relevant state and these have comprehensive specifications which must be met before the vehicle can be passed. Electrical safety is most important, both from the aspect of avoiding electric shock as well as potential fire hazards if, for example, high voltage battery banks are shorted in an accident.

Each of the cars on display had varying approaches to safely securing the batteries and they all had heavy-duty contactors to disconnect batteries when not in use. Providing heating is a problem when there is no waste heat from an internal combustion motor available. The common approach seems to be to use a hair-dryer running from the main battery bank. In a similar vein, power brakes must still be available and

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There is upheaval in the movie industry. More feature films are being shot with digital cameras and successfully transferred to 35mm film release prints with advanced technology. Surprisingly, film is still hanging in as a capture medium, due mainly to the pressure from cinematographers who claim that everyone wants that 'film look', while few set out to achieve that 'video look' in the cinema. Coming up fast on the inside is the 'digital look', as increasing numbers of cinemas around the world begin to install digital projection into their bio-boxes. Barrie Smith takes a look into the popcorn and choc-top world of the digital cinema revolution.

vehicle conversions rather than an expo of the latest up-to-the-minute technology. And no doubt, all the owners would go about such a conversion quite differently if they were going to repeat the process – such is the value of on-the-job experience.

As far as we could tell, all the electric conversions on display used DC motors with wound fields and they ranged in power up to about 70kW. Such a power rating may not sound numerically impressive compared with typical petrol motors which can be up to 200kW or more.

But whereas the 200kW rating for a petrol motor is an absolute maximum rating which is rarely, if ever, likely to be delivered (or even available at the wheels), a 70kW motor is quite likely to be able to deliver three times the continuous power for short periods. As well, electric motors deliver close to their maximum torque at very low revs, so an apparently modestly-powered motor can give quite sparkling acceleration.

Most, if not all the electric conversions on display used one or another model of motor controller made by the US company Curtis. These essentially have a bank of power Mosfets operated in PWM (pulse width modulation) mode.

This 2002 Holden XC Combo van had the usual DC motor and Curtis controller and was powered with 14kWh's worth of Trojan wet cells. They occupy a fair amount of the cargo space, as shown in the photo below. It is used for daily commuting of about 35km each way and takes about 4.5 hours to recharge after each trip.

There was even a VW Beetle EV conversion. There are more batteries inside the (front) boot, as well as those on view in this photo.

While the batteries take up a lot of space in the Combo van, the all-up weight is not excessive at 1540kg. Best feature according to the owner is the electric power steering.
**The 2008 AEVA Electric Vehicle Field Day**

This year's field day for the Australian Electrical Vehicle Association, held at Annangrove in western Sydney during late October, had a range of interesting electric and hybrid electric vehicles on show.

Some were fully converted cars that are driven on a regular basis while others were "works in progress" which may be up to a year or more away from completion.

There was also a Toyota Prius which had been modified with extra battery capacity and an on-board charger.

At the outset it must be said that anyone who decides to convert any conventional vehicle to electric drive is taking on an ambitious project. Typically, the way they go about it has never been done before: to convert exactly that vehicle type or model, using that combination of motor, batteries, controller etc.

So the AEVA annual field day is very much a display of DIY electric vehicle conversion projects.

The AEVA field day at Annangrove was pretty basic in format – just a big open shed with lots of electric car enthusiasts poring over the cars. There was even an electric go-kart – with neck-snapping acceleration!

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**Decoding on who you ask, the cinema industry, as distinct from the production side, is under challenge – from metre-plus LCD and Plasma 16:9 home screens – or it’s not under challenge, thanks to a flood of successful block-busters.**

These are pulling millions of dollars from patrons happy to travel to a multiplex, sit in the dark with a crowd and enjoy the movie experience after paying $16 plus for each ticket.

The Australian figures are revealing: In its 10 week run Batman’s Dark Knight pulled $45 million while Mamma Mia! did $30 million in a similar period. Movies make money. Buckets of it.

The two thousand cinemas that constitute the Australian exhibition industry all have film projectors, mostly 35mm models that have served operators well for decades.

The principle of 35mm projection has remained basically unchanged since 1895, when the brothers Lumiere held their first public movie screening, at Paris’s Saloon Indian du Grand Café. Wise minds would say “Don’t mess with it. It works.”

That makes you wonder why there is a push to digital cinema. To find out, why I spoke to some industry players busy trundling digital projection gear into cinemas across the nation.

**Savings**

A man who could easily be described as the head of the push to digital cinema is Kodak’s Asia Pacific Digital Cinema manager David Sanderson. I asked him why we needed digital cinema.

Sanderson responded by saying it could be compared to most new technologies in that it “offers potentially big savings in certain parts of the industry.”

He tempered that by saying that in other parts “it probably doesn’t offer savings but the main drivers who are probably the studios and distributors out of the US would love to see it happen.”

He sees that there is definite pressure to get the US market converted quickly but adds that there is less pressure in other parts of the world. Europe, he feels, is probably a secondary area and probably the furthest away to US minds as far as conversion goes.

As of now it is estimated that 1200 cinemas, or about 1% of cinemas worldwide, are equipped with digital projectors.

Australia is also well back in the field with possibly 24 or 25 cinemas equipped with 2K standard digital projectors (see Info Box), virtually all in capital cities.

For example, the Greater Union chain is currently trialling digital projection in some of its major cinemas, including the “Gold Class” cinemas, including the “Gold Class” cinemas where there’s the added attraction of dinner and drinks served to your seat (such as shown in our photo opposite).

The situation here is that most film projectors that are still running side-by-side with digital are dedicated to 3D projection when it is scheduled. That situation would change dramatically when a serious roll-out of digital happened, Sanderson stressed.

What are the benefits for the audience? The Kodak man explained that the benefits are very straightforward for an audience.

For a start, you avoid today’s issues that we have today with film prints: where the film prints get scratched and dirty as they get cycled around the country.

With digital it’s very different. First of all, you get projection of a pristine image from day one to the last day.

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**December 2008**

35mm film projection has remained basically unchanged since 1895. As anyone who has been to a cinema knows, a lot can (and does) go wrong!
A portable hard drive, costing less than $100, compares to around $2000 for a 35mm movie film print. And the film print is easily damaged and is very heavy (some theatres have a fork lift to raise the spool to the projector!).
An easy way to bench test the Simple Voltage Switch is to temporarily wire a 10kΩ (or higher) pot across the power supply to provide a variable signal voltage. An adjustable 0-12V will be available at the centre terminal of the pot. Here, the blue wire connects this variable voltage to the signal input of the Simple Voltage Switch. Connect the +12V and earth terminals to the red and black wires respectively and you can easily test the operation of the device.

Using a multimeter, measure the voltage at the signal input (ie, connect the positive probe of the multimeter to the signal wire and the negative probe to earth) and measure the voltage at which the unit is activating the relay. For example, with the unit arranged to read rising voltages, you can gradually raise the input voltage the unit might turn on at 6.00V.

Now very slowly reduce the voltage to see at what point the relay turns off. You might find that the latter voltage is 5.7V, meaning that hysteresis (the difference between the switch-on and switch-off voltages) is 0.3V. Rotate VR2, the hysteresis pot, to make sure that the hysteresis changes. For example, with a switch-on voltage of 5.00V, the switch-off voltage might now be 4.96V; but a hysteresis of just 0.04V is making it too critical.

As you rotate VR2 clockwise, the hysteresis will increase. Note that changing the hysteresis will not change the trip point, allowing the two to be set individually.

Next, you can test VR1, which sets the trip point. As you turn VR1 clockwise, the trip voltage will increase. VR1 is a multi-turn trimpot, so that the trip point can be set very precisely. Note that you can keep turning this type of trimpot endlessly and never reach a clear "stop".

Installation

Fitting the unit to a car is straightforward. You will need to provide an ignition-switched +12V supply, earth (chassis) and the connection to the sensor signal you want to monitor. For example, if you are triggering the unit from the air-flow meter, you will need to use the workshop manual and a multimeter to find this wire. You will need to confirm that it has a voltage on it that rises with engine load and you will need to drive the car to do this.

The device to be switched by the relay will be connected to the Normally Open and Common relay contacts. Fig. 2 shows these connections.

Note that because a double-pole, double-throw (DPDT) relay has been used, another independent circuit can be switched simultaneously. This other circuit can even turn off the second device as the first is switched on.

If you want to simply monitor a voltage such as that from the oxygen sensor, you can delete the relay and mount the LED on the dashboard. In this way, the LED will come on when the fuel mixture is rich, flash when the mixture is oscillating in closed loop mode, and turn off when the mixture is lean.

Setting it up

There are two ways of setting up the Simple Voltage Switch:

(1) Measure the sensor voltage and then set up the unit on the bench to operate at this voltage. This will probably avoid any need for fine-tuning in the car.

(2) Do the complete set-up on the car itself.

If you are using an oxygen sensor to trip the unit, then the first way is better. For example, if you want the unit to trip when the sensor signal rises above 0.4V, then set it up on the bench to do this. When you subsequently install the unit in the car, you will only need to make a small adjustment to VR1.

However, if you want to turn on a device when monitoring the air-flow it's best to do it on the car, because the air-flow meter signal varies over a much wider range.

As you turn VR2 clockwise, the hysteresis pot to its minimum setting (ie, fully anticlockwise) and then adjust the trip point until the unit triggers when you want it. If the relay tends to chatter around the trip point, rotate VR2 clockwise to increase the hysteresis. When it is tripping at the correct voltage, check how long the device continues to operate as the voltage again drops (assuming the unit is set to trip on a rising voltage).

For example, if you are using the unit to trip an intercooler water spray on the basis of air-flow output, does the spray go off fairly quickly as the load again drops? In some applications, the hysteresis setting will be critical while in other applications it won't matter much at all.

In most cases, once the unit has been set up, it won't need to be altered.

The PC board fits into a standard 130 x 88 x 24mm jiffy box, so when the system is working correctly the board can be fitted into the box and installed under the dash or wherever it is convenient.

Footnote: A kit for this project is available from Jaycor Electronics, Cal. 025577.
**Christie DLP projector and associated server.**

"In the future it will all run through the one digital projector."

**Is there a difference?**

I asked Sanderson would an audience know the difference with digital.

He answered that generally the audience doesn't, unless they are attuned to looking for scratches or dirt on the print. He added that the quality of film and digital are very similar.

So, in fact if the audience doesn't notice the difference, it's a success.

**Roll-outs**

The matter of cost per installation opens up another can of worms.

According to Sanderson this figure can probably reach $100,000 "by the time you get the equipment and the screen and everything set up.

"For every screen you have to have a projector. Then you've got to have what's called a content player, a computer box that actually stores the movie on it that's going to play to that screen.

"And then you need automation interfaces — the devices that turn lights on and off, open the curtains and all that sort of thing. Added to this and constituting the master control is the TMS. You need one of these for the multiplex; it talks to each of the individual content players and projectors in each of the cinema halls."

If a cinema wants to run 3D movies then it may need to install a high gain screen for some processes. Some cinemas currently run 3D movies with a screen illumination of only 8 foot-lamberts.

One process, the ReallD 3D system needs a metallised screen because it's a polarised light system. There is also a Dolby 3D system which needs a high gain white screen, because of the filtering system used in the process.

See Info Box "Three Dee".

**VPF**

How will the cinema operators pay for digital?

Sanderson: "At the moment, if they are running 3D, they're having to do it out of their own pockets. This is countered by a premium price for 3D admission tickets."

Then there is the Virtual Print Fee (VPF) scheme requiring co-operation from the US film studios and a company like Kodak, who can support a roll out of digital cinema.

Once agreements are struck with a finance company then you can start to roll digital installs. A VPF pays off the equipment and does not go to the cinema. The cinema basically has to put up a small portion of the total cost to join in the scheme and as soon as they sign up the equipment goes into their cinemas and from day one they just show movies in digital.

The placement of the link and the orientation of diode D3 (both circled here) will depend on whether you want to activate the switch on a rising voltage or a falling voltage. As shown here, the unit is configured to trigger on a rising voltage, which is the most common requirement. To trigger on a falling voltage, reverse the orientation of diode D3 and move the link to the H/L position.

suggest that you start with the resistors and diodes and then progress to the larger components. Carefully check each component value before you install it and make sure that you insert the polarised components (diodes, IC, LED, transistor, voltage regulator and electrolytic capacitors) with the correct polarity.

**Testing it**

Test the kit at your workbench (or kitchen table) to make sure that it is working, as it should. Do not be tempted to install it straight into your car or other application before you know that it is definitely working properly.

You will need a 12V battery or DC power supply and a variable voltage, to simulate the sensor output that the unit will be monitoring. The easiest way to do this is as is shown in the photo on page 76 — it's just a matter of connecting a pot (eg. 10kΩ or more) across the supply, to give a 0-12V variable voltage at the wiper terminal.

Connect the DC supply and a potentiometer, as shown in the photo. Now rotate the potentiometer back to forth over its full range. At some point as you are rotating the potentiometer, the relay should click and LED1 should turn on and off. Rotating the potentiometer back the other way should again make the relay click and switch LED1 back off.

This view shows the fully-assembled PC board. Make sure that you install the polarised components the correct way around.

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**Figure 1:** The Simple Voltage Switch is connected to an ignition-switched +12V supply rail and to chassis, while the signal input is wired to the air-flow meter's output signal. One of the relay's normally open (NO) contacts is also connected to the ignition-switched +12V rail, while the adjacent common terminal is connected to an intercooler water spray pump. The other side of the pump is earthed. When the engine load exceeds a preset level, the water spray will be triggered into action.
The Simple Voltage Switch could be used to monitor the oxygen sensor signal, allowing devices to be turned on or off when the oxygen level is too low. The unit won't load down the signal, so it can still be used by the EUI.

Selected (either from IC1a or IC1b) drives transistor Q1 which in turn drives the relay. The diode across the relay coil (D2) is there to quench the reverse voltage that is generated by the collapsing magnetic field of the relay coil when it is switched off. Without the diode, the relay could generate very high positive voltages which could blow the diode.

Power for the circuit is obtained from a switched +12V ignition supply. Diode D4 gives reverse conduction protection, while the 100µF capacitor and zener diode ZD1 provide transient protection at the input of regulator REG1. The reference current is powered from the output of REG2 (+5V), while the remainder of the circuit is powered from the +11.4V rails which are derived before the regulator.

Construction

While the unit is simple to build, you need to know one thing about its eventual application. Will you be using it to detect a voltage that will be increasing (L/H) to the preset trip point or falling (H/L) to the preset trip point? The unit can be made to work either way but you need to know this before you assemble it. There will be no need to make changes when it is ultimately installed.

The low to high (L/H) voltage condition will be the most common, as in our example of switching an intercooler spray when the airflow signal rises above a particular point, say 4V. Below 4V, the spray is off and above 4V, the spray comes on. So ideally, you need to know which configuration you want before starting assembly. That way, you will know how to set the position of the pin on the board and the orientation of diode D3. On the other hand, if you do build and later decide to change the application, it is a simple matter of changing the diode setting and the orientation of D3.

For a rising voltage detection, the moveable link LK1 is placed in the "L/H" position, as shown in the component overlay diagram of Fig.2. Then diode D3 is oriented so that its cathode pin is closest to the top of the board. For the opposite condition, detection of a falling voltage, the link is moved to its "H/L" position and the diode's orientation is reversed. When assembling the PC board we

2K or 4K?

Digital High Definition TV has a vertical resolution of 1080 pixels, with a horizontal resolution of 1920 pixels. It's generally understood that no detail whose width is smaller than 1/90th the screen's width — a single pixel — can be seen. Digital movies are created by digitally scanning the original 35mm film and packaging the data into a DCP (Digital Cinema Package). For distribution purposes, the digital movie is distributed on a portable hard drive. There is compatibility between current 2K and 4K systems. Movie files created at 2K can be exhibited on 4K systems — 2K images are automatically up-converted to 4K data; a 2K projector can replay a 4K movie but limited to 2K quality on screen. The interchangeability between 2K and 4K means that studios need only distribute one movie file, whether it is 2K or 4K, and it can be played by any compliant projection system.

In a 2K scan film from digital, the number of pixels across the width of the scanned film frame is, at most, 4096 pixels. In a 4K scan, that upper limit is doubled, to 4096 pixels.

The difference between 2K and 4K projection?

In digital cinema, a 4K image with a 2.35:1 "scope" aspect ratio has 4096x1764 pixels. A 4K image with a 1.85:1 aspect ratio has 3996x2160 pixels.

By comparison, a 2K image with a 2.35:1 aspect ratio has 2048x856 pixels. A 2K image with a 1.85:1 aspect ratio has 1996x1080 pixels.

Kodak's David Sanderson made the point that future movie projection might be 8K on the screen — not 2K or 4K — but the audience would not see an increase in detail at all.

Digital Cinema Camera, shows the relative between a standard definition TV (grey), a 720pixel high definition screen, a 1080 pixel high definition screen, 2K cinema screen and 4K cinema screen.

This diagram, courtesy of Red Digital Cinema Cameras, shows the relative between a standard definition TV (grey), a 720pixel high definition screen, a 1080 pixel high definition screen, 2K cinema screen and 4K cinema screen.
Three Dee

The RealD 3-D system is based on the traditional method of 3D imaging, using linearly polarised glasses. The traditional method works by projecting two linearly polarised images onto the same screen, polarised at 45° and -45° from the horizontal, which are then filtered by linearly polarised glasses worn by the audience. 3D imaging requires two projectors, and often suffers from double-imaging if the head is tilted to the side, thereby cancelling the polarised effect. RealD however uses a single projector that alternately projects the right and left eye frames, and circularly polarises these frames clockwise for the right-eye and counterclockwise for the left eye, using an LCD screen in front of the projector lens. Circularly polarised glasses make sure each eye sees only its own picture, even if the head is tilted. A high frame rate of 72 fps per eye is used — each frame presented three times, driven by a backlash flywheel, as the source vision is usually 24 fps.

Some of the films in RealD: Chicken Little (2005), Monster House (2007). Globally, 500 screens ran the latter title in 3D.

Dolby 3D is based on INFITEC (Interference Filter Technology) technology, originating from a research project of DaimlerChrysler. INFITEC uses an extremely fine line-of-code circular/circular filter wheel. Light waves entering the eye are separated into three different wavelength bands by 3, 4, 7 types of receptors, related to the primary colours. Dolby 3D uses six very narrow bandwidth color bands — three for each eye. This allows the use of a single light source in a single-lens projector.

There are processes in the works to 3-Dise movies that were not originally shot in 3D. Dominic Casey has the very comment that while “there are some very clever people who are purporting to do old 2-D images, 3-Dise it, I’m waiting to see Casablanca in 3-D — and sit my wrists when that happens!”

The form of the RDR camera, it does not change the technique of making moving pictures, cinematography, the lighting, production design etc. It’s the technique and the culture, not the technology.

As David Sanderson stresses “It’s about the creative requirements of the guys that produce the movies and the creative people who have very, very high ideals of what they want. It’s not just a matter of saying here is the new thing, we’ll go with it. To change the way you actually make a movie is a very different set of criteria.”

Another matter is that Kodak does make the odd roll of motion picture negative and print film, sold to film companies and laboratories by the millions of metres. Film will be around for a while, even if Kodak pushes the digital barrow as strongly as they intend.

Another Approach

To get a totally different view of the technology I spoke to Dominic Casey, Communications Director of Atlab Image & Sound Technology (AIST). It’s in Sydney, a major player in the Australian industry who previously, as Atlab, had been the country’s main processor of motion picture negative and prints.

AIST’s digital cinema ‘product’ is vC2. This approach won because the company viewed the approach by the Hollywood majors as one body on a financial model that did not make sense, at least in the Australian environment.

The company began with vC2 some years ago as a method that provided quite low and digital projectors for cinemas to run pre-show advertising in the form of TV commercials transferred to film, or as slides and PowerPoint-like presentations.

Case: “We started out doing that and supplying the equipment through our cinema equipment division called Atlab Image and Sound Technology (AIST). We have now upgraded this to a level where the image quality is suitable for showing features in all but the largest of cinemas. It’s a slightly lower resolution than the 2K that Hollywood demand — it’s 1.3 or 1.4K, and we manufacture our own server that handles the files for that. This rolls out to the cinema operator for little more than $20,000. We claim that, for a suburban multi-screen cinema with a smaller screen, the quality is close to that previously experienced with film projection. We add that there is a ‘couple of hundred dollars’ available to us currently showing presentations in a process that has come to be called eCinema.

“The point about eCinema is that the Hollywood studios won’t allow their product to be shown in it but independent distributors can tap into live screen presentations of ballet and opera, organised by the Australian Film Commission that passed live in a handful of rural cinemas.”

It also means that the independ-ently-owned smaller cinemas as well as regional cinemas can now get art house and Australian-made films, supplied on portable hard drives that they couldn’t get before because there weren’t enough prints available.

In a typical installation the cinema is supplied with a server and a digital projector. AIST fits its own logic boards and software to supply the Panasonic LCD projectors.

At this pricing level it also means a high degree of control over the cinema equipment and is also fully compatible with digital cinema-quality theatre to run top movies. The only flaw in this idea is that a private cinema operator can’t buy the copyright and not obtain access to first-run films.

Case sees the whole approach as an exercise in diminishing returns and it means you can get 96% of the on screen quality for a quarter of the price.

In practical terms, Case is a realist and believes that watching audiences can split the difference between film and digital projection … “essentially most audiences we find haven’t a clue of what they’re watching, qual-ity-wise. Very few people can actually say digital is better or worse.”

More likely is a negative response when “some cowboy shows a DVD on a data projector and calls it digital cinema. We had a few of those and thought we had people come out of that screen: ‘If this is digital cinema, I don’t want to go to the cinema!’”

The cinema operators see it quite differently. Case explains that one of the attractions is that they can run movies (in digital form) that they wouldn’t get otherwise: “They can show quite a flexible programming. They’re not getting tie-ups from distributors. They’re putting a digital projector in alongside a film projector.”

“This means they can still be show-inverting input, pin 2, of IC6. Zener diode ZD2 and the 100nF capacitor are there to protect against transient voltages on the input signal IC6’s non-inverting input (pin 3) is connected to reference trimpot VR1, via a 10kΩ resistor. When pin 2 is below pin 3, IC6’s pin 3 output (pin 3) is high, to 0V. When pin 2 is below pin 3, pin 3 is high, at around ±10V.

Hydronix (positive feedback from pin 1 to pin 3) has been added to prevent the output from oscillating at the trigger voltage. This is provided via trimpot VR2 and diode D3.

This feedback controls the output to “pull-up” the voltage at pin 3 (operating higher than the reference voltage when IC6’s output goes high) in practice, this means that diode D3 is inserted with its anode towards pin 3 if you want the Simple Voltage Switch to trigger on a low to high (LVH) transition and with its cathode towards pin 3 if you want it to trigger on a low to high (LHV) transition.

Conversely, if D3 is installed the other way around (cathode to pin 3, anode to pin 3) will be pulled higher than the reference voltage if IC6’s output goes high.

In practice, this means that diode D3 is inserted with its anode towards pin 3 if you want the Simple Voltage Switch to trigger on a low to high (LVH) transition and with its cathode towards pin 3 if you want it to trigger on a low to high (LHV) transition.

Basically, the hysteresis is the difference between the switch-on and switch-off voltages. If it was set by using VR2. We need hysteresis in the circuit otherwise the relay would tend to switch on and off very quickly when...
Main Features
- Adjustable switching level between 0V and 16V at input
- DPDT Switch
- Configurable to switch on rising or falling voltage
- Adjustable hysteresis
- High input impedance – won’t load down sensors

This Simple Voltage Switch can be used anywhere you want a relay to switch when a voltage reaches a preset level. It has lots of applications in cars but can be used in any application where you have 12V DC available. Having switched the relay on, it will then switch off as the voltage being monitored drops below the preset level.

In CAR APPLICATIONS, many engine sensors have variable volt- age outputs and these can be used for relay switching. For example, if your car has an air-flow meter with a voltage output (most cars have), then you can use that as an engine load signal to switch things on and off. For example, do you want a warning when fuel usage is going through the roof, as it will be when the air-flow is high? If you use this project, it can turn on a light and/or sound a buzzer so you can ease off on the accelerator or slow down your gear, or both.

Or you could use the throttle position sensor directly, to do the same thing. Or going back to the air-flow sensor, in a turbocharged engine, you could use the Simple Voltage Switch to control solenoids to close off the turbo waste from the boost pressure source whenever engine loads are low.

Or maybe you could use the unit to control a water spray onto the intercooler. We are sure that you will be able to think of plenty of nifty ideas.

This project was first presented in our “Performance Electronics for Cars” book published a few years ago and we are re-presenting it this issue to give it a wider exposure.

It is quite simple in presentation; just a PC board with a relay and a handful of other components. You should be able to assemble it in less than one hour.

Circuit description

Fig 1 shows the circuit of the Simple Voltage Switch. It relies on comparators, ICs, which compares the input voltage to a preset reference level. The input voltage (Vin) is divided by two 1MΩ resistors in series which effectively apply one half of the voltage to the input of their respective op-amps, which perform the actual switching. If Vin is greater than the comparator’s reference voltage then the output (pin 14) of that op-amp will go high, activating the relay.

The financial challenge for cinemas, especially independents, is that it’s not a matter of ‘either/or’, it’s a matter of ‘and/or’. Cinemas already have 35mm projectors installed.

Case: “They are usually paid for, amortised and they are churning on. If you’re putting in a new cinema you can’t afford just to put a digital projector in, you’ll be putting film in as well, so it’s an additional cost. The exhibitor gets nothing extra.”

Copyright

AIST itself handles the dubious to hard drive, so it becomes a subsidiary and complementary form of release. To illustrate this, Case recalls a typical film — The Queen — in 2007. This went out on about twelve 35mm film copies, which went into metropolitan centres, added to which were about forty digital copies. These were encoded into an MPEG format, compatible with ezC.

If film is supplied as a film master, AIST can make digital copies or transfer to film.

What do you do about copyright protection?

Case: “When digital release started people were more concerned with getting their film out there than they were with copyright protection. Hollywood was so conversant about the level of copyright protection because there is significant money to be made — and because if it’s a Hollywood product — it’s all about the first week’s returns.

With the sort of typical art house product, it tends to be a different audience. The audience is not disapp
tinted if it doesn’t get to see it on Day One and the distributors are just anxious to get the thing out there. You know the AIST copyright would not incur a big hemorrhage of revenue. But now we’ve got ezC established, we’re looking to some form of encryption.”

The company has dealt with “a couple of hundred cinemas around the country online — cinema in city centres. Most of these are independently-owned, although the Reading and the Dendy cinemas along with the Palace chain have a few digital installs.”

So cinemas have retained their 35mm projectors and will for some time. In Case’s view “The issue as far as the mainstream cinemas is concerned is the financial cost of going up to $200,000. It’s coming down but it’s not coming down that quickly.”

Acknowledgement:

Barrie Smith would like to thank David Sanderson and David Hill of Kodak and Dominic Case and Ben of AIST for their considerable help and assistance in preparing this story.

Anti-Piracy

It is no secret that Hollywood has been concerned about movie piracy for a long time. On the morning following the world premiere of Phil Noyce’s “The Ugly American” in Hanoi pirate DVD copies were on sale throughout the city, captured by an audience member and his/her camcorder. One trade association claims a camcorder copy of a movie can be the source of more than 90 percent of all illegal copies during initial release.

David Sanderson explains that every movie is 128-bit encrypted on the medium delivered to the cinema. If you intercepted an encrypted hard drive containing a movie and tried to play it, it won’t play.” Even if you set up a full digital cinema, you couldn’t play it. You need to have the KDM that is supplied with it. That KDM will only allow the movie to be played at a particular site, as in a multiplex, one particular multiplex between certain dates — and you try to do it any other time, it doesn’t work, that makes the distribution side very, very secure.

If you are going to take your video camera and set it up in the back row of the cinema and record the movie off the screen, then it’s very high risk, because both the image and the audio track will have watermarking on them. If needed, the movie’s distributor can go back and find out exactly which cinema it was actually shown in.

Even when the movie is burnt to a DVD, the forensic watermark can still be detected and the cinema that showed the movie can be pinpointed as well as the date and time of projection.

More info on watermarking: www.techweb.com/witn/198221447
The two scope inputs are on the lower right side of the meter, adjacent to the multimeter inputs.

The remaining connectors lie along the top edge, above the screen. On the left is the DC power/charger input, with the COM, USB and HOST sockets alongside (left to right).

oscilloscope since you will be using it in the field and will likely find it convenient to save some of your work. Using the supplied PC software, you can then view the images on your PC. It lets you connect to the oscilloscope in real time, as well as viewing previously stored waveforms.

As far as we can see, however, it does not let you export bitmap or GIF files (the version we tested was 6.6.01), although you can get around that by printing to files.

The PC software does allow you to export the waveform data to a spreadsheet such as Excel. A screen grab from Windows XP is shown in Fig.5.

Zooming functions
The Own HDS1022M-N oscilloscope has zooming functions. You set the width of the desired window by moving the cursors outwards from the centre of the screen. Then pressing the "Windowing" button adjusts the display to fit the selected area onto the entire display, as shown in Fig.6.

We must stress though that these functions don't enable you to see very fine detail, mainly because the resolution of the display as well as the memory depth (6kpts) are somewhat limited.

Conclusion
The Own HDS1022M-N is an affordable portable oscilloscope that is best suited for diagnosing video problems in the field, as well as for debugging most lower frequency circuits (up to 20MHz). It should be suitable for most audio work as well.

The user interface is easy to learn and logical, with on-screen cues helping you at key moments. It is also nice that the cue disappears after a few seconds of inactivity, making the display less cluttered. The display is big but of relatively low resolution and it is easy to read, even without backlighting.

The fact that it incorporates a DMM is a welcome addition. Both the scope and DMM inputs are rated at CAT II 400V maximum.

The unit is supplied with two x10 oscilloscope probes and two DMM leads, as well as an aluminium carry case. The charger and PC software as well as a small cable to connect a USB device are also included in the price.

The Own HDS1022M-N retails for $1149.00 (inc. GST).

For more details contact Own Electrical, Phone: 1300 792 976. Website: www.own.com.au.

siliconchip.com.au

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Promotion from 26/11/08 to 24/12/08

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**Oxygen Free Copper Speaker Cable**
Oxygen Free Copper (OFC) cable with ultra-flexible insulated PVC, shielding and stranded copper conductors on one side of the Fig.6 to add a security identification/ marking: Conductors: 3 x 0.12mm² OFC, cross-oriented 0.3mm². Price per metre. $20.00

**TV Overvoltage Surge Protector**
Protects entire connected equipment against induced overvoltage surges into the TV/video signal line from nearby high direct lightning strikes. Uses Genios Arrestor technology. "Y" type terminal. $20.00
right of the screen) comprising the main menu, as well as a horizontal row of options (appearing and disappearing from the bottom of the screen) showing the sub-menu options.

The settings are changed using the five buttons immediately below the screen.

There are two sets of three buttons for changing the vertical sensitivity of each channel, as well as a set of four arrow buttons having different functions depending on the context. The most common use for the horizontal pair of these is to change the timescale setting, while the vertical pair change the trigger level.

The menu defaults and button functions are well chosen. As with any menu-driven keyboard it can be easy to lose your way when the definitions change.

This oscilloscope shows the current definitions for the multiplexed buttons on the screen, which is helpful. Overall, the user interface is intuitive and should be easy to learn.

Quick measurements

This oscilloscope allows you to show up to two measurements, superimposed on the display in the top left corner, as shown in Fig.3.

You can choose the channel for each of the two measurements, as well as choosing what you want to measure. The choice of measurements is limited, though, just to the following:

- five: cycle RMS, mean, peak-peak, frequency and period.

Because you can choose the channel for each measurement, you can have one of these measurements applied to the same channel.

Keep in mind that two of the five measurements are really essentially the same; frequency is the reciprocal of period. You can, however, use the two cursors to measure other vital statistics of the signal. For example, you could use the cursors on a rising level of a waveform to measure its rise time (say between the 10% and 90% points).

The supported MATH functions include the four arithmetic operations. You can see the effect of adding, subtracting, multiplying and dividing the two signals as a third trace on the screen, in real time. Fig.4 shows the MATH functions in action.

Saving and transferring waveforms

The oscilloscope allows you to save up to four waveforms to its internal non-volatile memory. You can also use the small USB cable adapter to connect a USB flash disk and save to that. This is an essential feature for any portable oscillograph.

A centre-zero multimeter in both analog and digital formats! That's just one of the modes/ displays possible with the Owon!
Monitor, display and log up to six sensors and display up to 10 readings!

Multi-Purpose Car Scrolling Display

This project started out as a digital dashboard display but has grown and can be used in any measurement or data logging application where you have 9-12V DC available. It can monitor up to six signals and display up to 10 computed values in a scrolling or static readout on a 7 x 15 dot matrix LED display.

**What’s a Scrolling Display?** You really need a short video to show what this project does. The readout continually “scrolls” from left to right, displaying one, two and up to 10 computed values from up to six different signals. Each value is preceded by its description, such as battery voltage, temperature, duty cycle and so on. If you want to focus on one reading, pressing the sole pushbutton will make the display static.

Anyways, let’s just give a sample of what this project can do:

- Measure Engine Temperature – have a relay switch on above a preset temperature.
- Measure Fuel Injector Duty – have a relay switch if the duty cycle is too high or too low.
- Measure Engine RPM – have an in-car adaptor for use with 12V systems.

**Acquisition modes**

This oscilloscope supports up to three different acquisition modes. In standard mode, samples are acquired at equally spaced time intervals. If this is a good general-purpose mode but you may miss fast glitches, in the signal, which can be important if you are trying to diagnose faults. Alternatively, to capture fast glitches in the signal, you can use the peak detect mode, whereby the oscilloscope will take only the maximum and minimum points in each time interval and display these.

If the signal contains a high proportion of random noise, you can select the averaging mode. In this mode the oscilloscope averages out to 128 sweeps of the waveform, effectively cancelling out the noise component.

**Triggering**

For triggering, the oscilloscope has AC or DC coupling and LF and HF rejection. It also has an unusual feature allowing you to change the so-called SENSITIVITY. This is a multiplicative factor between 0.2 and 1.0 applied to the trigger. It refers to the proportion of the current vertical division setting under which the trigger will be ignored and makes the oscilloscope more or less sensitive to triggering. This is useful for adding another layer of filtering and reducing the effects of unwanted noise.

Edge and video triggering are available. In edge mode, triggering occurs when the signal contains a rising or falling edge passing through the trigger threshold, which is selectable. With video mode, both PAL and NTSC/SECAM are supported.

A third triggering option is ALTERNATING. In this mode, you can select edge or video triggering for each channel. Triggering will then alternate between the chosen triggering options for channels 1 and 2.

This is useful if you are viewing two substantially different signals simultaneously, such as two signals with markedly different frequencies, for example. The use of this mode is shown in Fig. 2.

**Menu system**

The Menu System is composed of a vertical on-screen column of options (appearing and disappearing on the screen).

![](siliconchip.com.au)

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**Specifications at a glance**

- **Input channels:** 2
- **Analog bandwidth:** DC to 20MHz (x10 probe)
- **Sampling rate:** 10MS/s
- **Vertical sensitivity:** 5mV/div
- **Vertical resolution:** 5.5mV/2
- **LCD panel:** 94mm CGA (320 x 200)
- **Size (including case):** 185x122x43 (mm)
- **Net weight:** 645g

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**Fig. 1:** A sinusoidal waveform (red trace) at around 150Hz and amplitude 15V peak to peak. The second channel (blue trace) shows a pulse train at around the same frequency. The timescale is set for 2.5ms per division on the vertical scale, stands at 5mV/div for the red trace and 25mV/div for the blue trace.

**Fig. 2:** Two signals, one a sinusoidal waveform and the other a digital signal are shown on the same display, showing the use of the ALT (alternating) triggering mode. The frequency of the sinusoidal waveform is much greater than that of the digital waveform (as much as a hundred times). With the capturing trigger mode, we are still able to capture the edge of the low frequency signal. Without the alternating trigger, it would be impossible to make sense of the blue trace.

**Fig. 3:** The measurements corresponding to the cycle RMS and frequency of the red trace can be seen in the top left corner of the screen. The measurement is applied to the sinusoidal waveform shown as the red trace. Note that the background colour of the measurement window corresponds to the colour of the trace on the screen. In this case, they are both red as they correspond to the red trace. You can choose two on-screen measurements from either channel (red or blue).
The Owon HDS1022M-N is a portable, dual-channel digital oscilloscope that can double as a digital multimeter. It comes in a rugged orange and grey multimeter style case and has two BNC sockets for the connection of oscilloscope probes. It can run from its internal batteries for about four hours or from an external power pack supply.

This is not the only compact portable digital oscilloscope available but it is probably one of the most compact and attractive packages ever offered, considering its range of features and performance.

The DMM is a practical add-on, allowing you to carry one less instrument in the field, as the Owl D5022M-N is primarily an oscilloscope. As a portable oscilloscope, it is well suited to most applications in the field, keeping in mind that its bandwidth is 20MHz when using a x1 probe (with a x1 probe, the bandwidth drops to 4MHz).

20MHz is enough bandwidth to diagnose faulty composite video signals, for example.

External connections

On the front panel, the Owon scope has four 4mm banana sockets for connecting the multimeter leads: COM (ground), V/D/C (to measure voltage, resistance or capacitance) and two other sockets, one for DC and AC currents up to 400mA and the other for up to 1A.

Above the DMM sockets is an array of pushbuttons which control the oscilloscope functions. They can be toggled between scope and DMM functions by the DMM/Osc button. The display simulates that of a centre-zero analog meter but also includes digital readout. You can use the automatic scaling mode or manually adjust the scale. You can also use a relative mode where you can set the ground reference to an arbitrary value.

The oscilloscope inputs are on the side and are standard BNC types but without probe sensing. You can select the probe type (x1, x10, x100 & x1000) with the front panel buttons and the vertical sensitivity is adjusted accordingly. The unit is supplied with two x10 probes.

Note that the multimeter and oscilloscope inputs are isolated from each other, meaning that you can have two different GND references. This helps to avoid unintended and possibly dangerous shorts, especially when switching back and forth between DMM and oscilloscope modes.

The display

The Owon HDS1022M-N has a 96mm (3.8-inch) colour LCD with QVGA (320x240) resolution. The screen can be used with or without backlighting and can be read in direct sunlight. The display can show 4996 colours and is a good size. You can see a typical screen grab in Fig. 1.

Persistence settings for the waveforms can be set from one second to five seconds and to infinite mode, a practical way to see quickly changing detail.

You can also change the display switch on at a preset RPM (perhaps to indicate when to change gear).

- Measure Throttle Position and Delta Throttle Position - if the accelerator pedal is pressed too abruptly, a relay can be made to switch on third ignition.
- Measure Speed - a relay switch if the speed is too high or too low.
- Measure Fuel Tank Level as a percentage of full tank - a relay switch on or off if the level is too high or too low.
- Measure Battery Voltage - a relay switch on or off if the voltage is too high or too low.
- Measure Air/Fuel Ratio - a relay switch on if the mixture is too rich or too lean.
- Measure Cabin Temperature - a relay on a fan if a relay is too high. Monitor almost any signal coming from the ECU.

So pick any six of the above possibilities and that is what this project could do in your car. But that is just for applications involving cars. In reality, this project can be used anywhere where a DC supply from 6-5V is available or you have a computer with a USB port. It accepts voltage, resistance, frequency or duty cycle inputs and has two digital outputs for switching on limit conditions. We will bet that you can think up lots more potential applications.

The project itself uses two PIC boards stacked with red Perspex on top. The top (display) board has a group of three 7x 5 dot matrix displays, a USB port and a single pushbutton. The main (lower) PIC board has the microcontroller and all the supporting circuitry for the connections and the optional output connections to relays or buzzers.

To build and test it up, you will need a laptop or desktop computer with a spare USB port. You will use a Windows-based software downloadable from www.siliconchip.com.au to set the measurement functions, calibrate the sensors and do data logging.

The LED display can be dimmed (either automatically by sensing the ambient light level or manually) and you can select the scrolling speed of the display, as well as the names of the measurements and their units. In static mode, the LED readout can display up to four digits. It can also be turned off using the front panel pushbutton.

The two output channels can drive external 12V relays directly and can be programmed to respond to maximum and minimum settings for any of the measured variables. Alternatively, the outputs could drive buzzers to give an audible indication that signals have exceeded their programmed limits.

You can choose different sounding buzzers to indicate maximum or minimum conditions, when using two different buzzers. Or you can use only one buzzer and the maximum and minimum limits are indicated by different sequences of beeps.

When you only need a visible indication of a limit condition, there are visible cues (a flashing display for a minimum condition and an inverted display for a maximum condition) on the LED display when in static mode.

So there are many uses for this display and it's really up to you as to how you set up.

User operation

User operation of the Car Scrolling Display has been kept deliberately simple. There is just one pushbutton on the front panel (S1), a momentary SPST switch. The firmware recognises a short press and a long press. A short press is anything less than about a second, a long press is anything more than that.

There are three display modes. You switch to the next display mode by holding S1 pressed for more than a second, i.e., by making a long press.

The first is the Scrolling Mode where only the selected readings are continuously displayed as a scrolling string. In this mode, pressing S1 for less than a second (i.e., a short press) will take you to the next reading, and that will then scroll continuously. After you have scrolled to the last
The unit is built on two PC boards - a main board and a display board. These are stacked together, along with a red Perspex panel for the dot matrix displays (assembly details next month). Note that the boards shown are prototypes and the final versions are slightly different.

reading, making a short press will turn the display off. The sequence can then be repeated.

The second display mode is the Static Mode. In this mode, the selected reading is displayed without scrolling. You can make a short press to go to the next reading. Again, making a short press after the last reading turns the display off. The sequence then repeats again.

The third and last display mode is the All Scrolling Mode. In this mode, all readings are displayed as a scrolling string. The string then repeats continuously. Pressing S1 while in this mode takes you to the first display mode again and the whole sequence repeats from there.

In both scrolling modes, the name of the variable, the value and the unit are displayed as a scrolling string. In Static Mode, up to four digits are displayed at once.

In Static Mode, a maximum condition is indicated by the display flashing every second or so between normal and reverse modes, i.e., all the normally lit dots become unlit, and vice versa - Fig.5. This is a very dramatic mode to indicate a problem condition. A minimum condition, on the other hand, is indicated by a flashing reading. As indicated, these visual cues are only available in Static Mode.

Note that the Battery Voltage is always displayed first. For each of the displayed variables, you select the variable number and the value index to display. You also set the order in which they are displayed.

Remember that you can change all settings and perform the required calibration using a laptop and a USB cable.

Electrical signals in cars

To get a good understanding of the signals used in cars, you will need to refer to the Stacci Cdr publication "Performance Electronics for Cars". This has a range of useful electronic projects for cars and also explains how to interpret the signals from your car's ECU.

All modern cars have an ECU (Electronic Control Unit) that manages the ignition timing and fuel injection. Almost all electrical sensors in your car produce a voltage or vary their DC resistance, depending on the quantity being measured, or produce a digital signal (varying the frequency or duty cycle) to indicate the reading.

Different sensors have different voltage ranges. For example, a narrowband air/fuel sensor may have an output in the 0-1V range, whereas a tachometer sensor output may be a square wave at 5V with the frequency of the signal proportional to the engine’s RPM.

By contrast, a fuel injector signal is digital (12V amplitude), with the positive period (i.e., the time the signal is at a high level) normally proportional to the time the injectors are firing. Alternatively, it may be inverted, with the negative period indicating the firing of the injectors. Since all calibration is done in software, either negative or positive duty cycles can be monitored.

This project will accept all of these types of signals and with software calibration via the USB port, it is easy to adapt to a wide range of different sensors.

How it works

The block diagram of Fig.1 shows the main features of the circuit. As you can see, a microcontroller is the heart of the project and it drives the dot matrix displays, manages the USB connection and drives the two outputs.

Probes into the Active and Neutral terminals of a mains outlet. Measure the mains voltage, then remove the probes from the mains outlet and switch on the Brownout Protector. Wait for the relay to switch on, then measure the DC voltage between TP1 and TP GND (or the mounting screw of the 3-terminal regulator). Next, adjust trimpot VR1 for a reading of the mains voltage divided by 100. As previously suggested, if the mains voltage is 230VAC, test point TP1 to 2.3V. Finally, adjust trimpot VR2 to set test point TP2 to 2.00V.

Further testing can be done if you have access to a Variac. This will be convenient for those with mains voltage that is too high for the expected readings. The Variac can be used to reduce the mains voltage to check that the brownout detection operates at the required voltage.

If you do not have access to a Variac, then you can adjust VR1 so that the TP1 voltage drops just below the TP2 voltage. When it does, check that the relay switches off and that the brownout LED lights. Return VR1 to its correct position after this test and secure the lid with the four screws.

That completes the setting up. The Brownout Protector can now be used as is or you can mount it on a wall adjacent to the appliance. The case can be secured to the wall using four screws which are accessed via internal channels adjacent to the lid mounting screws.
The PC board is secured to the bottom of the case using self-tapping screws that go into integral standoffs. The IEC socket is attached by first clipping it to an aluminium mounting plate (see Fig.5), then fitting it inside the case and securing the plate using four Nylon screws and metal nuts (see photos).

Note also that the cutout in the box should be just enough to provide clearance for the flange of the IEC socket.

Once the IEC connector has been secured in place, you can install the PC board. To do this, you will need to first slide the edge of the PC board under the IEC connector. The PC board is secured using for M3 x 6mm screws into the integral threaded mounting bushes on the base of the box.

The BROWNOUT PROTECTOR

A 16V zener diode (ZD1) clamps the input voltage in case of transient. This is necessary to protect both the input supply bypass capacitor (47μF, 25V) and the terminal low-dropout regulator REG1 (a LM2940-5). The entire circuit runs from the +5V rail output by REG1. This supply rail is bypassed by a 47μF 16V capacitor and the 100μF electrolytic capacitors near the microcontroller and the other logic ICs.

The “bushes” located under the board allow the connection of wire into the flange of the IEC socket, that the cutout sets to CON2. The IEC socket is fed to CON2, wire wiring using for the IEC connector.

The IEC socket is pulled up by a 10kΩ resistor and is fed to the CCP3 (Capture/Compare) input (pin 17) of IC1 via a low-pass filter composed of a 1kΩ resistor and a 10nF capacitor. This low-pass filter removes potentially noisy signal transitions.

The frequency and duty cycle of the input signal is measured by capturing the value of an internal timer output from the microcontroller’s system clock (12MHz). It counts how many system clock ticks occur when the signal is low and when the signal is high.

The counter is 24 bits wide. For example, when applying a 40% duty cycle rectangular wave at 100kHz, we will obtain the following counter values:

\[ CGa = 48,000 \text{ and } CGb = 72,000. \]

In other words, the internal timer running at 12MHz counts up to 48,000 in the time that the signal is high and up to 72,000 in the time the signal is low.

From these two values, the firmware calculates the frequency and duty cycle as follows:

\[ \text{Freq } = \frac{12,000,000}{CGa + CGb + \text{CON3}} \]

\[ \text{Positive Duty Cycle } = \frac{100CGa}{CGa + CGb + \text{CON3}} \]

The four voltage/resistance inputs are connected to the 6-way connector CON3.

Each analog input passes through a voltage divider consisting of 22kΩ and 10kΩ resistors and bypassed by a 100nF capacitor. Each resulting voltage is then digitised by the microcontroller using the onboard ADC (analog-to-digital converter) which has 10 bits of resolution and whose full range is from 0-V.

The division factor from the 22kΩ and 10kΩ resistors is 3.2 which means that the analog inputs have a full range of 0-16V, suitable for most applications in a car or any vehicle with a 12V battery.

Any voltages above 16V will not be correctly read (i.e. readings will plateau), because the input protection diodes on the ADC inputs of IC1 will begin to conduct. The high series input impedance will ensure that the input
the relay mounting screws should be 4mm in diameter. Check also that the main PCB board is cut and shaped to size so that it fits into the box.

Insert the resistors first, taking care to place each in its correct position. Use the resistor colour code table when selecting each value. You can also use your digital multimeter to check each resistor before installing it.

Next, install PC glands for test points TP1, TP2 & TP GND. That done, install the 1N4004 diodes (D1-D6), the 1N4148 diode (D7) and zener diode ZD1, taking care with their orientation. IC1 can be mounted next (watch its orientation), followed by the capacitors. Note that the electrolytic types must be oriented as shown.

The 3-terminal regulator (REG1) is mounted on the PCB-board with a small finned heatsink. It leads need to be bent to fit into the holes provided and then it is secured on the heatsink with an M3 x 10mm screw and nut and its leads soldered.

Next, install trim pots VR1 & VR2, transistors Q1 & Q2, LEDs 1 & 2 and the two 2-way screw terminals CON1 & CON2. The transistor and LEDs sit a few millimetres above the PCB board.

The relay is secured using M4 screws and nuts while the transformer is attached using M3 screws and nuts. The transformer must be earthed and this is achieved using a short green/yellow earth wire with crimped eyelet. This is attached to one of the transformer mounting feet with two washers, above and below the eyelet – see Fig.3. Note that the enamel must be scrapped from the transformer foot to ensure good contact.

The IEC fused male socket 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 socket cannot be mounted directly to it. Instead, the IEC socket is firstly mounted on a 1mm thick metal plate and this plate is then secured to the inside of the box using four Nylon screws and metal nuts. As a result, the flange of the IEC socket is mounted flush with the surface of the box, giving a neat finish.

Diagrams for the metal plate, the box cut-out and the socket cut-out in the box lid are shown in Figs.4-6. Note that the end of the box for the IEC cut-out is best located at the same end as the

<table>
<thead>
<tr>
<th>No.</th>
<th>Value</th>
<th>4-Band Code (%)</th>
<th>5-Band Code (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10kΩ</td>
<td>brown black orange brown</td>
<td>brown black black brown</td>
</tr>
<tr>
<td>2</td>
<td>1kΩ</td>
<td>brown black orange brown</td>
<td>brown black red brown</td>
</tr>
<tr>
<td>3</td>
<td>2.2kΩ</td>
<td>red black brown</td>
<td>red black brown</td>
</tr>
<tr>
<td>4</td>
<td>560Ω</td>
<td>green blue black brown</td>
<td>green blue black black brown</td>
</tr>
<tr>
<td>5</td>
<td>470Ω</td>
<td>yellow violet black brown</td>
<td>yellow violet black brown</td>
</tr>
</tbody>
</table>

is 32 conversion. dividing itself processes these that you lose in advance you know in advance that your sensor has a nominal output much lower than 16V. This involves changing the 22kΩ resistor on the corresponding analog input.

The following equation is used
be clearly seen through the transparent lid so the overall assembly is very straightforward. The complete wiring diagram is shown in Fig.2.

Begin construction by checking the PC board for any defects such as shorted or broken tracks. That done, check that the hole sizes are correct. The holes for the four corner mounting covers for BRG1 and for the transformer mounting points need to be 3mm in diameter, while the holes for the GPO and GPC connector and relay output contacts are secured using cable ties.

Provided that the mains voltage remains below the brownout threshold, the relay will remain off. In fact, the relay remains off at any voltage below the threshold, including voltages down to 0VAC.

A power-on delay is included so that the relay only switches on about five seconds after power is applied. This delay is due to the values of the 10kΩ and 100Ω filter components that monitor the average voltage from the rectifier. These are sufficiently large so that it takes time for the 100Ω capacitor to charge up to above the voltage provided at TP2. This delay is also important to allow for the inevitable momentary drop in mains voltage which is caused by the high surge currents every time an induction motor starts up. Normally, these high currents only last a second or two, depending on the appliance, and we want to be sure that they do not cause the Brownout Protector to erroneously switch off the power.

Construction

The Brownout Protector is housed in a weatherproof ABS enclosure (171 x 131 x 56mm) with a transparent lid and neoprene lid-sealing gasket. The box is designed to meet the IP65 dust and moisture ingress standard, although this standard is compromised somewhat by the addition of the GPO and IEC socket.

All the parts, except the GPO and IEC connector, are assembled onto a PC board coded 10112081 and measuring 152 x 188mm. This board has corner cut-outs at one end to allow it to sit on the base of the box.

The GPO mains input socket with on/off switch and integral fuse is mounted in the rear of the case and a 3-pin AC socket is mounted on the transparent lid. The two LEDs on the PC board can be seen through the transparent lid. A complete wiring diagram is shown in Fig.2.

To get an approximate value for the resistor, \( R = \frac{20000}{100000} \) for the channel with the maximum voltage range required (±5V) and \( R \) will be the new resistor value (ie. to replace the existing 22kΩ resistor). The resulting sensitivity will be approximately the value of V in mV (millivolts); eg. if \( V = 6 \), then the sensitivity will be about 6mV and the resistor value will be 34kΩ.

Since all calibration is done in software, you only need to replace the 22kΩ resistor corresponding to your analog channel to improve the accuracy for that channel. The software does not need to be changed, as the result will be correct for your new divider when you perform the next calibration.

Oxygen sensor loading

Although the ADC inputs of IC1 have a high input impedance, the load on the analog inputs will be the sum of the 2kΩ (or your replaced value) resistor and the 10kΩ resistor, ie. 32kΩ (or 10,000 + R).

While this loading is high enough to result in very small current draw from most sensors in your car, you should be aware that typical narrowband oxygen sensors do not tolerate more than about 10mA current load. Since the ECU will have its own current load, we should aim to draw no more than about 1mA extra from such a sensor.

This means that if you wish to connect an oxygen sensor to this project, you should omit or remove the 10kΩ resistor to ground on the corresponding analog input. The result will be that the loading will then be the series impedance of the 2kΩ resistor and the high input impedance of IC1's ADC input.

The resulting extra current should be less than 1mA since the ADC inputs have a typical leakage current of just 500μA. Note that there will also be negligible transient loading due the 100nF capacitor.

Additional input channels

There are two additional analog channels used. One is used to measure the battery voltage at pin 1 of CON1. It has its own 56kΩ and 10kΩ voltage divider and 100nF bypass capacitor.

The other analog channel is used to monitor a voltage divider on the display board consisting of a light dependent resistor (LDR1) and an 2kΩ resistor. The analog signal is at pin 13 of CON6 and is used to measure the ambient light level, to vary the brightness of the LED display.

CON4 is used to connect the two Rasps and is used for the limit conditions. Each digital output from the microcontroller is applied to the base of an
NPB BC373 transistor (Q16 or Q17) via a 1kΩ resistor. Each transistor is configured as a switch, to drive the coil of the relay or a 12V buzzer. Diodes D2 & D3 clip any back-EMF spikes generated when the relays switch off, while the 220Ω/50V capacitor is used for bypassing.

The microcontroller (IC1) runs from a 20MHz crystal and the circuit was tested on 15.8V with the relay energised (on) and 17.45VDC with the relay off, a variation of more than +10%.

By contrast, the variation in the "averaged" voltage across C2 was 3.6V with the relay on and 3.75V with the relay off, a variation of just over 4%. This is important because in the worst case, the brownout detector needs to respond to an actual variation in mains voltage from 216V (the normal minimum mains voltage) to 200V (the switching threshold). This is a variation of only 7.5% and we don’t want the circuit being confused by variations in the supply waveform.

Trimpot VR1 is included so that the sample voltage fed to op amp IC1a is exactly 1/100th of the mains AC voltage value. To give an example, if the mains voltage is 230VAC, trimpot VR1 is adjusted so the DC voltage at the output of IC1a, at TP1, is exactly 2.3V. This is part of the calibration procedure and just why we do this will become clear in a little while.

The voltage at TP1 is fed to the non-inverting input (pin 5) of op amp IC1b which is connected as a comparator.

A nominal 3.9V reference is provided by zener diode (ZD1) which is fed via a 560Ω resistor from the +12V supply. Trimpot VR2 sets the switching threshold for IC1b and its wiper is connected to IC1b’s pin 6 inverting input. Pin 6 is set to about 2.0V (representing a brownout threshold detection point of 200VAC).

So with a normal mains voltage, pin 5 will be at 2.3V (representing a 230VAC mains voltage). This voltage is higher than the 2V at pin 6 and so the output of IC1b will be high (close to 12V). This switches on transistor QT1 which powers the relay (R1/Y1). The relay’s contacts supply power to the appliance connected to the GPO.

When IC1b’s output is high, diode D7 will be reverse biased and so the 10kΩ resistor at pin 5 does not affect circuit operation.

However, when the mains voltage drops to just below 200VAC, the voltage at pin 5 will go below the 2V threshold set at pin 6 and so pin 7 of IC1b will go low. This will switch off transistor QT1 and the relay, to disconnect power from the appliance.

Diode D6 queues the back-emf from the relay when its magnetic field collapses, protecting Q1 from damage. Simultaneously, transistor Q2 switches on to light the brownout indicator, LED2, via a series 2.3kΩ current-limiting resistor.

Hysteresis

When IC1b’s output is low, D7 conducts and pulls pin 5 even lower than 2V due to the voltage divider action of the 100kΩ and 10kΩ resistors.

For example, if the voltage at TP1 is at slightly less than 2V, the output of IC1b will very close to 0V and so the divider action caused by the 10kΩ resistor connecting to 2V and the 100kΩ resistor connecting to 0.1V will give a voltage at pin 5 of (2.00 - 0.5V) x 0.1/1.1 = 0.18V. This is a drop in voltage of 140mV. So instead of pin 5 now being at 2V, the action of the 100kΩ resistor, diode D7 and the 10kΩ resistor reduces the voltage by about 140mV, i.e. to 1.86V.

Before IC1b’s output can go high again, the mains voltage would have to rise by the extra voltage to make up this 140mV difference. This requires some increase in mains voltage of 14VAC. In practice, though, because the average voltage at TP1 is higher when the relay is off compared to when it is on, the extra voltage required from the mains for the relay to switch back on again is 10V.

This voltage difference effect is called “hysteresis” and is included to prevent the relay from rapidly switching on and off at the brownout threshold.
Note that since the year 2000, the electricity suppliers are obliged to follow Australian Standard AS3008 where mains voltage should be 230VAC with tolerances of ±10% and ±6%. That means the voltage could drop to 216V at the lower tolerance limit. Our circuit sets the switching threshold to 200VAC to avoid mains tripping during normal supply conditions.

A heavy-duty relay does the switching. While ever the mains voltage is normal, the relay contacts are closed and power is available to the load (motor). If the mains voltage drops below 200VAC for more than five seconds the relay contacts open to protect the motor. The relay contacts are rated for current carrying up to 65A – ideal for switching power to a motor which is pulling heavy starting currents.

**Circuit details**

The full circuit is shown in Fig.1. It comprises just a few low-cost components. These include a dual op amp (IC1), a couple of transistors, a 12V regulator and the heavy-duty relay. Power for the circuit is derived from the mains via a 12.6VAC step-down transformer, T1. This drives a full-wave rectifier using diodes D4-D5 and a further diode, D6, before filtering with a 470µF capacitor (C1). The resultant nominal 17V DC is applied to the 12V 7812 3-terminal regulator (IC6), IC6-G provides the 12V supply for IC1 and the 12V relay.

**Brownout protection**

To detect a brownout condition, the circuit needs to monitor the AC voltage from the transformer secondary winding, but in practice, we don’t do this directly but instead monitor the rectified DC waveform at the anode of diode D5. This is filtered using a 100KΩ resistor and a 100µF capacitor (C2) which is shunted by 10kΩ resistor, trim pot VR1 and 910F capacitor (C3) from an averaging filter to give a lower voltage (VP x 0.636 x 150KΩ/15kΩ = 3.6V).

OK, so why go to all this trouble rather than just monitoring the DC voltage across capacitor C2? After all, if the mains voltage varies, the voltage across C1 will vary in proportion, will it not?

The reason for using the averaging filter method is twofold. First, the actual AC waveform of the mains supply is usually “flat-topped” due to the loading effect of gas discharge lighting (eg, fluorescent) and the capacitor-input power supplies used in all computers and most electronic equipment. Using the peak of the waveform to represent the actual mains voltage is not sufficiently accurate because the degree of “flat-topping” varies during the day, depending on whether it is peak or off-peak period.

Second, when the relay switches on and off, it causes a considerable variation in the voltage across C1. For example, across C1 we measured be at around 4.3V when a USB cable is connected and at 0V otherwise.

This pin is configured as a digital input (bit 3 of PORT D) which allows the firmware to detect when a USB cable is connected or disconnected.

Schottky diode D4 allows the circuit to be powered directly from the USB port and connects directly to the +5V rail. In the worst case, the Vin line will be at +4.75V (5V ±5% is what the USB standard specifies) and so the +5V rail can be as low as +4.3V when powered directly from the USB port.

D4 also protects against reverse polarity and prevents current flow into the USB port when the circuit is powered from a 12V battery or power supply.

Because the +5V rail can be substantially lower than +5V when powered from the USB port, you must perform any calibration with the full 12V input from the car battery. The actual voltage of the +5V rail will affect the ADC readings from the analog channels because it is the primary reference for the ADC conversion. This will be explained in the calibration instructions, next month.

**Display circuit**

Microcontroller IC1 controls the display via 27-pin connector CON6, which plugs into CON7 on the display board — see Fig.4. Fifteen of these lines control RC127 FPN transistors to drive the columns of the LED display. The display consists of three 7 x 5 dot matrix LED display (scrolling or static display).

Static display of up to 4 digits (floating point)

Selectable scrolling speed

On screen limit warnings for each variable in the static display mode.

Software calibration using polynomial interpolation.

Persistent settings stored in non-volatile memory.

Easily load and store previous settings to file on your computer.

Easily load and store different calibration point files on your computer.

All settings changeable using the USB port and PC host program.

Data logging via the USB port; selectable variable update frequency from 0.1Hz can collect 1000s of samples to a PC’s hard drive.

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**Main Features & Specifications**

- Can be powered from 9-12V DC or from a USB port (5V).
- Two Frequency/Duty Cycle Inputs with frequency up to 10kHz.
- Positive Duty Cycle Range: 0-100%.
- Four Voltage/Resistance Inputs Plus Battery Voltage (the latter has its own channel).
- Voltage Range: 0-16V (greater or smaller ranges possible by changing one resistor).
- Sensitivity with 16V scale: approx. 16mV.
- Best Sensitivity: approx. 5mV (aires changing one resistor and recalibrating using the supplied PC software).
- Two output channels to drive external relays or buzzers.
- Up to 10 displayed variables.
- Averaging or direct acquisition mode for each variable.
- Screen dimming on ambient light with adjustable sensitivity and selectable minimum brightness.
- 7 x 15 dot matrix LED display (scrolling or static display).
- Static display of up to 4 digits (floating point).
- Selectable scrolling speed.
- On screen limit warnings for each variable in the static display mode.
- Software calibration using polynomial interpolation.
- Persistent settings stored in non-volatile memory.
- Easily load and store previous settings to file on your computer.
- Easy load and store different calibration point files on your computer.
- All settings changeable using the USB port and PC host program.
- Data logging via the USB port; selectable variable update frequency from 0.1Hz can collect 1000s of samples to a PC’s hard drive.

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**Figure 1:** The circuit monitors the rectified DC voltage at the output of bridge rectifier D1-D4. This voltage is fed via VR1 to voltage follower IC1A which in turn drives comparator stage IC1B. IC1B then drives transistor Q1 to control RUV1.

**Figure 3:** In-range measurements appear on the display and out-of-range measurements alternate between normal and reversed mode (top right) when above maximum or flash on and off when below minimum.
These days, many inground swimming pools use a salt-water chlorinator to keep the water clean and safe from nasty microbes. The chlorinator electrolyses the salt content of the water to produce sodium hypochlorite which then acts like normal "pool chlorine" to sanitise the water. Not having large amounts of chlorine in the water makes it much more pleasant and you don't come out of the water smelling of chlorine. Nor will your eyes sting or your swimming togs become bleached.

However, for a salt-water chlorinator, there must be a minimum concentration of salt in the water for it to work correctly. Just how much is needed depends on the brand and model of chlorinator but typically it is around 3000 to 4000 ppm (parts per million). If the salt concentration goes below the specified level, you must add some salt to the pool. On the other hand, you should not add too much as that is simply wasteful and it might lead to accelerated corrosion of some of the pool hardware.

So how do you measure salt water concentration? Most people don't even bother. They just take a sample of their pool water to the pool shop and ask them to test it (at the same time getting several other important pool chemistry factors checked). If it is below the specified level, this is the perfect opportunity for the pool shop to sell you some bags of salt.

The Pool Salt Meter at our local pool shop. Obviously, it does more than check dissolved salt levels — it also checks total dissolved solids. But it also costs more than $300 and, according to our friendly pool shop owner, "...costs a fortune to repair, too." We wonder why!

A couple of shots of the measuring cup to show not only its size but also its construction. The two black circles (next to the green circles) are the carbon electrodes which make contact with the pool water, to give a reading in parts per million on the meter at left.

Add too much salt to your swimming pool and it might lead to accelerated corrosion of some of the pool hardware. However, for a salt-water chlorinator, there must be a minimum concentration of salt in the water for it to work correctly. Just how much is needed depends on the brand and model of chlorinator but typically it is around 3000 to 4000 ppm (parts per million). If the salt concentration goes below the specified level, you must add some salt to the pool. On the other hand, you should not add too much as that is simply wasteful and it might lead to accelerated corrosion of some of the pool hardware.

So how do you measure salt water concentration? Most people don't even bother. They just take a sample of their pool water to the pool shop and ask them to test it (at the same time getting several other important pool chemistry factors checked). If it is below the specified level, this is the perfect opportunity for the pool shop to sell you some bags of salt.
Brownout Protector

Protects AC motors against low AC mains voltage

What is a "brownout"? This rather graphically describes what happens to your lights when the AC mains voltage drops dramatically - they get very dim. But apart from dim lights, brownouts are a fatal hazard to induction motors, as used in air conditioners, pumps, dishwashers and a lot of other appliances.

YEARS AGO, BROWNOTS were quite rare and generally confined to rural districts where the power lines had very long runs. A falling tree or an electrocuted possum might cause the mains voltage to drop to a level and lights would go dim. This has always been a hazard for the induction motors used in pumps and refrigerators.

Nowadays, though, because the electricity grid is running much closer to total capacity, brownouts can be experienced much more commonly in the cities and suburbs. Our own office in the Sydney suburb of Brookvale have had brownouts on a number of occasions in the last year or so. On such occasions, we have made sure that the air conditioner, fridges, compressors and other machinery in the building were turned off until full AC mains supply was restored. Had we not done so, all the motors in that equipment were liable to burnout.

So how many motors in your home are at risk right now if a brownout was to occur? The list can be quite long: fridge, freezer, washing machine, dishwasher, air conditioner, pool pump, spa pump and perhaps one or two garage door openers; typical of many homes. All this equipment could attempt to turn on during a brownout and the motor(s) would probably burn out.

Maybe your insurance policy covers motor burnouts but you would need to read the fine print. The insurance company might also look askance at your claim if there was more than one motor burnout or if the appliances were more than a few years old.

Why do motors burn out?

When induction motors are starting up they draw very heavy current for a second or two and when they are up to speed, the current drops back to reasonable levels. However, if the AC mains voltage is low, the induction motor may not develop enough torque to come up to full speed. In all of the appliances listed above, the motor starts with a heavy load so it is at particular risk if those starting currents do not reduce quickly. Those motors with a starting winding (switched out by a centrifugal switch) are at particular risk because those windings are only intended for very intermittent use.

By the way, some motors do have thermal cut-outs but these cannot be regarded as a panacea - they are more correctly regarded as fire preventive.

So why not make your own salt motor? Such a device is not likely to be very complex, is it? That's what we thought too.

So we visited a local pool shop and asked the friendly manager if we could have a look at his salt meter. And we took some photos to show what it looked like. It was an analog meter with scale calibrations in ppm and TDS (total dissolved solids). But notwithstanding those obscure labels, our impression was that it was simply an ohmmeter connected to a measuring cup.

Measuring cup

The measuring cup was interesting. As the pictures show, it was a small cylindrical container with two holes at a certain level up the sides. In the base of the cup were two carbon electrodes which evidently make connection to the solution.

In use, the cup is first flushed with fresh water and then, holding your fingers over the holes in the sides of the cup, you fill it up with your pool water. You then unblock the holes and the water flows out so that it is at a precise level in the cup. You then take the reading by pressing the button on the meter. That's all there is to it.

Hmm. So is this really necessary? Since virtually every reader of SILICON CHIP magazine has a multimeter or two or three, whether a digital (DMM) or good old-fashioned analog type and since they all have "Ohms" scales, no other equipment is necessary.

In other words, if you want to measure salt content of your pool, you don't need a $300 salt solution meter or whatever else it might be called.

Standard salt solution.

What you do need is a salt solution of known concentration. To be more
precise, how do you make up a solution with 3000 ppm salt? In fact, making up such a solution is dead easy. All you need is a measuring jug which will hold one litre of water and a set of measuring spoons. You then need to measure out 3 grams of salt. Pool salt or table salt will do—they are both pretty much the same thing, no matter how they are labelled.

Half a teaspoon of salt is 3 grams. Add that to the water and stir thoroughly until all the salt is dissolved. Voila! You now have one litre of salt solution which is exactly 3000 ppm. Handily a high-tech exercise, is it?

Want a 4000 ppm salt solution? Just add 4 grams to one litre of water instead of 3. But believe me or not, we have seen internet retail outlets which sell such a standard 3000 ppm salt solution for $10.95 for a 230ml bottle! So now that we have a standard salt solution, how do we measure salt content in a swimming pool? It is just a matter of comparing the resistivity of the standard salt solution with the resistivity of the pool water.

The more salt in the water, the lower will be its resistivity. So the next step is to make a container with a couple of electrodes connected to both sides. You could use almost any cylindrical plastic container but we chose to use a 200mm length of thin plastic stormwater pipe fitted with a standard end cap.

We drilled 2.5mm holes in opposite sides of the resulting container about 140mm from the bottom. We then attached a solder lug to each of the holes, using a screw, nut and lockwasher.

The solder lugs were connected to a length of figure-8 cable with a pair of 3mm banana plugs at the other ends. The banana plugs were connected to a digital multimeter and it was switched to measure “Ohms”.

A dollop of silicone sealant should be applied to the screw heads (on the outside only) to make them water-tight. While you’re about it, you might like to put a smear of silicone on the inside bottom of the 90mm tube as you slide the cap on—again, to make it water-tight. We didn’t and the results are obvious in our photograph.

So that is the test set-up.

Checking it out
To check it out, first fill the container with fresh water to a mark at say, 20mm from the top. Note the ohms measurement. Typically our reading was 5000 ohms or thereabouts. It will vary depending on how much chlorine is in your tap water.

Tip out the fresh water and note that the resistance reading now becomes very high, typically 40 megohms or more. Then fill the test container with the 3000 ppm salt solution and note the resistance reading.

Typically, we measured around 1800 ohms or 1.8kΩ. This will vary depending on the temperature of the solution but we can assume for the purpose of this exercise that the solution water temperature is fairly close to that of the pool.

Then fill the test container with water from your pool. If the salt concentration is more than 3000 ppm, the resistance reading will be lower than the one above (or whatever your previous measurement was). Conversely, if the salt concentration is less than 3000 ppm, the resistance will be higher than 1.8kΩ.

You can then decide whether or not you need to add salt to your pool. Incidentally, you should not need to add salt to your pool more than once or twice a year. Evaporation from your pool will not reduce the salt concentration; it will increase it.

There are three different ways in which salt can be lost from your pool.

The first is when swimmers splash water out of the pool and you subsequently have to top it up with fresh water.

The second is when back-washing the pool filter, although our experience is that this doesn’t make a huge amount of difference as the water is filtered and not up more than 1.8kΩ. Evaporation from your pool will not reduce the salt concentration; it will increase it.

The third way—fortunately rare because it usually throws virtually all your pool chemistry out of whack—is when you get a lot of rain and a lot of water is lost out of the overflow.

Of course, if your pool leaks more than average (most do leak a little!) and you often have to add water to top up your level, your salt level will also drop.

So there it is. While we have not described how to make a salt concentration meter reading in ppm (because we don’t believe it’s necessary to actually know the figure), we have described a method of comparing the resistivity of pool water to a standard salt solution.
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The increasing popularity of home-theatre systems has had one good effect from my point of view: a steady flow of home-theatre amplifiers to fix. Now that VCRs are all but gone, I need all the extra work I can get.

We have had a number of audio repairs come into the workshop recently, all of which have been irritatingly difficult.

The first was an Onkyo surround sound home-theatre system, model TXSR502, which was intermittently switching off. Unfortunately, the word “interrrupt” often has different meanings for the customer and the repairer. To the former, it means that things obviously can’t be much wrong and therefore it will be cheap to repair an item that is actually working most of the time.

To the repairer, however, it means quite the opposite. For starters, it is often difficult to get the fault to occur in order so that the symptoms can be observed. An intermittent fault can also make it difficult to judge whether or not the fault has been really fixed, so that the set doesn’t come back under warranty.

Finally, tracking down an intermittent fault can be a time-consuming task and that adds to the expense. In addition, the unit has to be soak-tested for longer.

Unfortunately, the difference between these two positions usually has to be resolved into an estimate before you can start the job. And if guesswork is to be eliminated, you literally have to repair the set first, otherwise you could be hopelessly out.

Of course, you can always reduce an estimate but rarely are you able to increase it.

Fortunately, experience has shown that, after many years, the Onkyo TXSR502 can develop dry joints, especially in the pre-power-amp driver stages. In fact, I had quickly concluded that the fault was probably due to the protection circuits switching the relays off, so this fitted in well with the known pattern of faults with this model.

As it happened, the board had quite a few dry joints so I was fairly confident that reworking the solder across the PCB board would fix the fault. Eventually, after I had finally completed the task, I reassembled the set and put it aside to soak test.

Initially, all seemed well but my coffee fix had only just kicked in when, some 15 minutes later, I noticed that the same fault had started again. The speaker relays were clicking on and off and the set was locked onto the “Video 1” input and wouldn’t change.

Being an Onkyo agent it has its privileges and I was able to borrow another TXSR502 from another service agent. I then swapped the front display board and found that the fault transferred from one set to the other.

OK, so the fault was on the display board, even though there was hardly anything on it apart from its microprocessor. This microprocessor (75702, PD7508032GE-030) is an 8-pin high-density square surface-mount device. It’s too expensive to replace it, so I ordered a new one plus the duo-crystal X7501. They arrived fairly promptly and took a long time to install but I was relieved to think that this would almost certainly fix the fault.

Well, it didn’t.

So what was there left that could cause this problem? I turned my attention to the 26 tactile switches but they all looked perfect, as did the three operation switches on board U03 which plugged into 3-pin socket JL7501.

The keys form a matrix which feeds the microprocessor on four lines: K9-K3 (pins 19-22). There should be ±5V on these lines but in fact there was only 2V, so 3V was disappearing down the gunk somewhere.

I checked the impedance of the switch lines and noticed that K9 (pin 19) was slightly lower than the other. As a result, I disconnected it and the unit immediately worked properly but it stopped again when this pin was reconnected.

Next, I unplugged the Operation Switch Board (U03) but that made no difference. I then reassembled the socket and scrubbed it with PCB board cleaner and a toothbrush. That finally fixed the problem and it worked for weeks before it was returned to the client who no doubt thought he was paying an inflated price for what he considered a straightforward job.

I can’t honestly put my hand on my heart and say that I knew exactly what caused the problem. However, I surmise it to be either a solder dag or just dirt that produced a high resistance of winning are considered. There are 216 possible combinations of the three output pairs and five of these, marked with asterisks, are winners.

Since the pin 3 output of each counter can occur but has no LED connected, this is a no score condition. So the chances of winning are 5 in 216 or 431:1 against. Not good. If my work is good, then three blues as a special prize, it will come up once in every 216 games, on average.

In a real poker machine, the odds are a great deal worse, since it has many symbols in each row and “N” rows rather than three. To the logical mind, poker has no appeal at all.

A. J. Lowe,
Bardon, Qld. ($60)

Battery monitor has low current drain

This circuit makes use of an ultrabright LED to produce a low battery-warning indicator which pulls very little current.

As shown, it uses a 9V battery and the LED only lights if the supply voltage drops below 7.6V. At that point, the battery is on its last legs so the operating current of the LED will have little effect on its remaining life.

When the voltage is above about 7.5V, the 7.5V zener diode (ZD1) will conduct to turn on transistor Q1. This in turn shunts current away from the LED. Conversely, when the voltage drops below 7.6V, the zener diode and the transistor will stop conducting and the LED will light.

Total current drain from a fresh 9V battery will be of the order of 0.1mA, dropping very slightly as the LED comes on.

Steven Graham,
Chirstchurch, NZ. ($30)

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Editor’s note: this circuit would normally be wired in after the equipment’s power switch.

Contribute And Choose Your Prize

As you can see, we pay good money for each of the “Circuit Notebook” items published in each issue of SILICON CHIP. But now there are four more reasons to send in your circuit ideas.

Each month, the best contribution will receive an upgrade to the Editor’s note: this circuit would normally be wired in after the equipment’s power switch.
Toy poker machine is no risk to wallet

This poker machine circuit can be built to help the young (and not so young) understand the folly of the real thing. It demonstrates the very high probability of winning regardless of the "win" conditions.

Six inverters in ICA, ICB, IC2, IC3, IC4, are paired to provide three independent clock oscillators which run at different speeds. These clocks drive three 4017 decade counters, ICA, IC2, IC3 & IC4. Each decade counter uses six of its outputs and they are set back to zero each time they reach a count of 6. Five of the outputs drive five LEDs - red, green, yellow, blue and white - which flash at different rates, depending on the clock oscillators.

Each counter is provided with a stop switch so that the counts can be stopped at will, randomly. The aim is to get a winning set: three green, three reds, etc.

By adding five 5-input AND gates (IC5 & IC6), a piezo buzzer can be made to sound if a winning combination occurs. The outputs of the five AND gates are ORed by the five diodes to drive transistor Q1 and the buzzer.

The folly of the poker machine becomes apparent when the odds of winning are so low that it is impossible to stop the machine from producing a winning set. This is due to the high probability of winning set occurring, regardless of the stop switch position.

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December 2008
Anyway, I removed the chassis and then released the PC boards from their frames. That done, I carefully examined the copper side of each board under a magnifying lamp but the soldering could not be faulted. I then checked the component side for any obvious faults but again everything looked OK.

Next, I used my ohmmeter to check for continuity from the mains plug pins to the power supply in case of invisible hairline fractures. And it was here that I had my first clue. I was tracing the line between the neutral pin to the bridge rectifier and it soon became apparent that it was intermittently going open circuit. Step by step I eliminated until I got to the power switch.

The power switch is a double-pole double-throw (DPDT) type and when I removed and checked it, I could see that it was intermittent on one side only. Having found the problem, I put it back in the set, shorted the bad side and left it on test while I waited for the owner to get in contact.

Unfortunately, I still hadn’t heard from her a fortnight later, so I’m not sure how long I have to wait.

One good turn...

I guess that you could call this story “One Good Turn Deserves Another”.

It involves a guy in South Africa who discovered that his neighbour had fallen on hard times. Apparently, the neighbour’s electricity had been cut off and that meant, among other things, that the wife had to do all the washing (including nappies) by hand – this for a whole mess of kids.

Being the kind-hearted type, he agreed to let his neighbour use an extension lead to connect their houses together so she could use the washing machine. That was fine for awhile but then our hero went out to do the week’s shopping. When he returned, he was surprised to hear this propeller-like whirr from his fusebox. On examining it, he found the electricity meter spinning so fast that the gauge was about to take off.

Of course, he went straight around to his neighbour to find out whether the next and longest job to do with it. He didn’t have to ask because as he was going around the back, there were at least another half dozen extension leads feeding from his house to all the other neighbouring ones. Talk about

VHF aircraft receiver with squelch

This VHF receiver offers very good performance with few components and covers the whole commercial air band from just above 100MHz to 140MHz with sensitivity of just a few microvolts. It has a noise squelch circuit, for pleasant noise-free listening a very pleasant experience.

The antenna is coupled via a 100pF capacitor to the base of transistor Q1; a grounded base buffer stage. It isolates the antenna from the following stage involving Q2 which acts as a super-regenerative detector. The detector is self-locked at around 20kHz via the combination of the 1kΩ resistor and 1nF capacitor associated with inductor RFC2.

Bandpass filter

The recovered audio modulation from inductor RFC2 is fed via emitter-follower stage Q3 to op amp stage IC1 which acts as a narrow bandpass filter. It rejects the high frequency content of the input signal and any voice modulation. Its output is rectified by diodes D1 & D2 and filtered by a 1μF capacitor. This becomes the squelch control voltage for Q4 which turns on to reverse-bias diode D3. This prevents signal from the emitter of Q3 from being coupled through D3 to the input of the audio stage, IC2.

Hence, when signal is present, the receiver “quiets” on receipt of a carrier and squelch voltage to Q4 falls, turning it off. Thus the collector voltage of Q4 rises and forward bias D3 to allow the audio signal through to the volume control, VR3. Potentiometer VR2 acts as the squelch control.

Winding inductor L1

Inductor L1 is wound on a 3mm former with four turns of 1mm enamelled copper wire. RFC1 & RFC2 are standard 10pH moulded choke coils which connect IC1 in the PM section of a standard plastic dielectric tuning capacitor. This gives enough range to tune from 100MHz to 140MHz. All the capacitors in the RF section should be disk ceramics.

Potentiometer VR1 adjusts the bias on the detector Q2 and maximum sensitivity is at the point where the bias is stable at the earthy end of the adjustment. At this point, about 1.5–2V will appear across the 1μF capacitor with the squelch control set fully open. This setting will remain fairly constant over the complete tuning range. When plugged in correctly, the squelch will “split” on background noise.

Dayle Edwards, Taylorville, NZ. ($60)
One-button camera timer

This project is a one-button time-lapse camera timer initially developed for a Canon 400D digital SLR camera but it should work with other cameras as well. You can use a different timer switch for the Canon 400D but that costs at least $35—a lot of money for what is just a wire on the end of a cable.

This circuit adds a nifty timer to the cable in the form of a PIC12F675 microcontroller for about the same price or less if you build it from recycled parts.

Once programed, it can be used to take photographs at intervals from one to 65,535 seconds (ie, 18 hours 12 minutes). It features a single button to control all functions, audible feedback via a piezo LED, and a simple LED status light. The output pin from the timer can be used to turn on or off another device.

The PIC microcontroller is a 27000 FET (Q2) which connects the tip of 2.5mm audio plug to ground. This provides a particular impulse to the camera’s remote shutter function. The switch is normally open and activates the shutter half-press function but that is not used by this project.

An astable multivibrator comprising transistors Q1 & Q2 and associated components drives the piezo transducer. Since the circuit takes its signal from the collectors of Q1 & Q2 it gives a healthy output in spite of the low supply voltage of only 3V.

The PIC microcontroller supplies power to the multivibrator via pin 3 to turn it on and off and also sets the time (high or low) by using pin 5 to the RC network controlling the pitch.

The Vbias is indicated by LED1 & LED2 which can be single LEDs or a 3-bit bi-colour LED package. The unit powers up in the "set" mode which is indicated by red LED1. You then select the time-lapse interval (in seconds) by pressing the button.

The first press emits a low beep, indicating zero, that is, that you need to press the button until the next digit you want. Digits are entered as you would write them on paper, so 120 seconds would be entered as 1, then 2, then 0.

To enter each digit, all you have to do is wait for one second or more. You will then hear a high/low beep. If you overshoot the digit, you just keep pressing until you hear the low beep indicating zero and start over.

Once the time-lapse interval has been entered, you switch into the "shoot" mode by holding the button down for one second or more until you hear a high beep. LED1 will extinguish and LED2 will briefly flash every time a shot is taken. Shooting begins as soon as you release the button.

This has a useful side-effect in that if you want to start your shooting at a particular time, you just keep holding the button down while looking at your watch. It will give you "ticking" beeps at one-second intervals so you can release the button to start shooting at a particular instant.

The last time-lapse interval set is remembered. To use the previously set interval, just press and hold the button after power up and "shoot" mode will be started using that interval.

To temporarily suspend shooting, tap the button for less than one second. You can resume shooting using the existing interval by holding the button down for more than one second.

The software will be available for download from www.siliconchip.com.au

To program the PIC12F675 you will need to purchase a programmer such as the Microchip PICKIT2 and obtain a Compiler such as the free version of CompileC.

Andrew Armstrong, Dural, NSW.
The pulses on P46 were too narrow to be visible on the borrowed CRO which had a bandwidth of just 20MHz. However, following IC1a and IC1b which constitute a Schmitt trigger, the widened pulses were visible as long as the trigger level was adjusted.

IC2a is a bistable flipflop which has two modes of operation. The first is the Reset-Set (R-S) mode and the second the JK or clocked mode. The important thing I noticed here was that when the trigger pulses were present, the flipflop wasn’t clocking and so the sweep waveform didn’t start.

So it seemed that the IC was faulty. Fortunately, the circuits for this part of the two timescale circuits are identical and I could compare them, rather like the two channels of a stereo audio amplifier. There was another MC105E131 on the PC board, so I swapped it over.

When I did that, the A timescale then worked, producing a nicely triggered waveform. A replacement IC then got the B timescale working again.

Flickering trace

There was just one final fault to fix. When the scope was switched on from cold, an out-of-focus trace resulted which I fixed for a while before settling down. To fix this, I initially replaced two more high-voltage ceramic capacitors (C28 & C30) on the Power Blanking Unit board and this appeared to do the trick but the problem was back the next day.

It was then that I noticed a tiny spark on the PC board which was generating the out-of-focus trace. This spark was caused by tracking of the -1200V across the surface where a cable had been clipped to two neon lamps which had perished.

In fact, there were two of these pairs of neon and both supports had perished. I removed the neon, scraped away the remains of the supports and cleaned the probe points. The board worked for two neon lamps which had perished.

At the next switch-on, the trace came up in focus and there was no flicker. So the old CRO was restored to full working order, although I have to admit that the diagnosis and repair of the timescale faults was spread out over about a year.

I guess servicemen in business don’t have that luxury.

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

Fuzz box for guitars

This fuzz box uses low-cost discrete components rather than op amps. It’s designed for use only with an amplified guitar signal.

While it may appear to be a conventional differential op amp amplifier configuration with Q5 as the long tail for the two input transistors (Q1 & Q2), it actually uses positive rather than negative feedback. It clips symmetrically and the loading of the following amplifier or mixer has no effect on its clipping symmetry.

Q4 is connected as a grounded base stage with base bias provided by three diodes: D2, D3 & D4. Q3 drives the emitter of Q4 and the positive feedback signal to the base of Q2 comes via the 4.7kΩ resistor from the collector of Q4. The three diodes also set the bias for Q5 which sets the operating point for the input pair. Trimpots VR1 & VR2 are used to set symmetry and to zero the DC output voltage.

Craig Kendrick, Selens, Philadelphia, USA. (£45)

The monitor for pet bed heater

This monitor for a pet bed heater works by monitoring the supply and alarming when a defect is present on the bed or causing the heater to become unplugged. The microphone closed NC pushbutton is not pressed, current flows through it to the heater element so that it works normally. Conversely, when the button is pressed, the circuit functions as a normally closed NC. Passing through diode D1, LED1, the 1kΩ limiting resistor and the heater resistance. As a consequence, LED1 lights to show that the heater is connected to the 12V AC supply.

Geoff Coppa

Elanora, Qld. (£30)

Editor’s note: a permanent LED monitor could have been arranged by omitting the pushbutton and simply wiring the 12V LED circuit in parallel with the heater element, if that could be conveniently done.
At this price you should buy two!

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Menu controls. Finished in matt olive

RC Mini M4*S'H Helicopter

This is our smallest ready-to-fly remote
control helicopter designed to suit
the needs of younger pilots. It is ideal
for indoor flying with its soft
silex covered rotors.

20 minutes charge time

for 9" flying time

Helicopter: 150mm long

Suitable for kids.

Retro Music Centre

This Commodore-type unit of 30's 50's. The
player includes a turntable, AM/FM stations.
A powerful amplifier and a CD player is equipped in a classic wood
finish with two front speakers and
a CD player with a translucent
lid. Also has a programmable
function. Requires
2 x AA batteries

91/2" L x 7" W x 3.3" D

Dimensions: 300 x 230 x 180mm

Start to fly back up to your L1 CD

$99.99

USB Turntable

The handy turntable is a great
addition to the
lounge or study or any place
where you want to listen to vinyl records or
make back-up copies in a convenient
digital form.

The turntable plays 7" single
45's albums and even 7" 45's.

33 1/3/45/78 rpm

$99.99

Radio Control Apache Attack Chopper

The Apache is a radio control helicopter
with 3 channels"a tail rotor, " coaxial rotor and swash
head with four control pods.

Around 20 minutes flying time

Requires 6 x AA batteries

$99.99

Wireless Weather Station

A useful device for the office or
house. Incorporates a high
temperature-moisture gauge,
wind vane, weather station play,
humidity, wind speed, direction,
and barometric pressure.

Temperature

Humidity

Wind Speed

Barometric Pressure

94mm x 94mm x 105mm

$49.99

LED Tactical

This amazing digital LED tactical
torch is ideal for use in the home
or office. It has a powerful
LED light source, capable of
illuminating an area of up to 100m
on a single AAA battery.

Size: 160(W) x 35(H) x 21mm

$19.99

Now and Future

Rachel (08) 3191667

Hi-Fi sound

Connect to TV,

Moveable

$199.99

Duality Optical

USB Input/Output

This is a luxury optical USB
input/output device. It has
an optical mouse and a
USB hub. It is suitable for
all computers, whether
on a desk or in a
portable
format.

Size: 170(W) x 22(W) x 22(W)

$54.99

EcoSafe Lead-Free Soldering Station

EcoSafe Lead-Free Soldering Station

Designed for both lead-free and ordinary
printed circuit boards. The face has a built-in
temperature control and is equipped with two
fused power input and temperature
controllers with a digital LCD display.

High powered 220W heater

Easy temperature adjustment

Fast temperature response

Quick temperature recovery

$165.00

Due mid December '08

Free Call: 1800 022 888 for orders!
Heavy Capable of investment. Was available from the CD, DVD remote 2.4GHz & Hardy. What was the SIGHT) neh used in the special package? This is a good looking, no nonsense stereo amplifier that is rated at a generous 100 watts RMS per channel and will form the heart of an impressive stereo system.

- Suitable for use in "Back to Back" situations.
- Input: 120V AC, 60Hz, 60W x 2
- Output: 100W RMS per channel
- Frequency Response: 20Hz - 20kHz
- Input impedance: 47k ohms
- Input sensitivity: 500mV
- Power consumption: 60W

This simple, low-cost 100WTH channel soundbar system is a great addition to any home, office, or other location. Whether it's for the bedroom, kitchen, or living room, it will provide clear, well-balanced sound from any source. With its clean, minimalist design, it will complement any modern decor. So why wait? Take advantage of this amazing deal today!

Radio Controlled Mini Monster Truck

This little truck has remote control from your TV remote or other device. It's suitable for children aged 8+)

- USB power
- Works with batteries or rechargeable pack
- Easy to use and control
- Great for outdoor play

Analog Projection Clock

This clock is perfect for any home or office. It's equipped with a built-in projection feature, allowing you to display the time on your favorite wall. The clock is also designed with a stylish and modern aesthetic, making it a great addition to any space. With its digital display and automatic time correction, this clock is a must-have for anyone looking for a reliable and stylish timepiece.

Advantage Digital Distance Calculator

Waterproof and shock-resistant, this distance calculator is perfect for any project or application requiring precise measurements. The calculator features a simple user interface and can be used in a variety of settings, such as construction, engineering, and outdoor activities. With its durable and reliable design, this distance calculator is sure to meet all your measurement needs.

Rechargeable 3 in 1 Massager

This massager includes three different modes: automatic massage, manual mode, and timer-controlled mode. It's perfect for anyone looking to relieve muscle tension and improve overall health and well-being. With its compact and portable design, it's easy to take with you on the go for pain relief on the spot.

Advanced Digital Distance Calculator

This simple but effective distance calculator is perfect for any project or application requiring precise measurements. The calculator features a simple user interface and can be used in a variety of settings, such as construction, engineering, and outdoor activities. With its durable and reliable design, this distance calculator is sure to meet all your measurement needs.

Hands-Free Bluetooth FM Transmitter

Plug in your iPod or Bluetooth and listen through your car's FM radio. Just set it up, you can use the hands-free feature to make and receive calls while driving or while somewhere else. Note: iPod not included.

USB to DVI Adaptor

Convert the additional to use DVI. This adaptor allows you to connect with graphics without having to add any graphics card. Just connect it to any USB 2.0 port.

USB RJ45 Extension Adaptor

Connect any USB device to your computer from up to 50 metres away. Ideal for those who need to connect with graphics without having to add any graphics card. Simply connect it to any USB 2.0 port.

USB DVD Maker

Connect your device to your computer from up to 50 metres away. Ideal for those who need to connect with graphics without having to add any graphics card.

Adaptor for Nokia® Mobile Phones

This adapter is perfect for those who enjoy talking on the phone while working or doing other activities. It's easy to use and can be connected to your device via USB. Now you can stay connected and focused on your work, even while you're on the go. So why wait? Get your Nokia® Mobile Phone Adaptor today!
Great Christmas At Jaycar

Rack Mount Dual MP3 Controller
The convenience of MP3 with the flexibility of full pitch, cue and track controls will add musical flexibility to your DJ or home studio setup. It accepts two SD cards of up to 1GB capacity and gives a huge array of control over every track on each card. The soft LCD display indicates function very Hayes.

- Supports USB Tag
- 128x32 Pixel display
- Probes for 3.5mm line in
- Power supply included
- Dimensions: 190(W) x 230(H) x 70(D)mm

Secure $299.95 (was $44.55)

Portable Combo 30W PA Amp with USB
This speaker's a live tool as well as sounding great in a studio or practice space. With an integrated digital output and USB port, it's easy to connect MP3, digital music and unlike other units it will allow you to plug in a memory card. Ideal for a DJ or live player.

- Supports miniSD card
- Supports USB 2.0 card
- CD player
- 2 channels
- Dimensions: 320(W) x 200(H) x 70(D)mm
- Weight: 6.5kg

Secure $348.95 (was $139.95)

200 WRMS 12' Party Speaker
This speaker meets the needs of the DJ or home karaoke enthusiast. It's portable and packs a full power punch. Ideal for a DJ or live player.

- RMS: 200W
- Frequency response: 80(Hz) - 20kHz
- Dimensions: 290(W) x 120(H) x 280(D)mm
- Weight: 10.5kg

Secure $229.95 (was $199.95)

I-Mix Club USB DJ MIDI Controller
Mix, and access any of your iPod tracks directly from your PC. The I-Mix USB gives you the control you need when going from a traditional voice to a DJ party. It sends MIDI data from the controller to the DJ software, allowing you to manipulate the music in an exciting and dynamic way. It's the ultimate tool for the party DJ.

- 2 outputs
- 380 buttons
- 30 foot cable
- ループ：5.1mm audio input per channel

Secure $399.95 (was $359.95)

Home Theatre Powerboard
Surround sound and home theater is more affordable than ever. This controller is perfect for your home theater and is simple to set up and easy to use. It's a powerful tool for the home theater enthusiast.

- Supports surround sound
- 5.1 audio input per channel
- Dimensions: 165(W) x 40(H) x 260(D)mm
- Weight: 3.7kg

Secure $109.95 (was $99.95)

4 Way AV Component Distribution Amplifier
This 4 channel distribution amplifier is used to spread your audio and video signals to four rooms in your house. It can be used to distribute audio and video signals to each room. The four channel amplifiers can be used to distribute audio and video signals to each room.

- 4 outputs
- Dimensions: 200(W) x 200(H) x 70(D)mm
- Weight: 4.5kg

Secure $599.95 (was $359.95)

Spotlight Radio with Speaker
This is the ultimate tool for the party DJ. It's portable and packs a full power punch. Ideal for a DJ or live player.

- 100W RMS
- Frequency response: 80(Hz) - 20kHz
- Dimensions: 240(W) x 240(H) x 200(D)mm
- Weight: 10.5kg

Secure $549.95 (was $449.95)

Upgrading Your Car Audio This Summer!

At Jaycar

VenM Car Speakers
This new improved range of full range car speakers features updated Kevlar cones and silk dome tweeters for improved high end responses. 3-way stereo models from 3" to 6.5" will provide you with a great sound with Crystal clear treble, deep bass and improved output at a price that won't break the bank. Pick 3"-4" Two Way or 5"-6.5" Two Way.
- Dome handling 250W RMS
- Paper cones 125W RMS
- Sold each
- Dimensions: 3.5x8cm
- Frequency response: 80Hz - 20kHz

Secure $44.95 (was $39.95)

5"x2 Way Kit
- Dome handling 150W RMS
- Paper cones 70W RMS
- Sold each
- Dimensions: 12.5x5cm
- Frequency response: 80Hz - 20kHz

Secure $44.95 (was $39.95)

6"x4"4 Way Kit
- Dome handling 150W RMS
- Paper cones 70W RMS
- Sold each
- Dimensions: 15cm x 10cm
- Frequency response: 80Hz - 20kHz

Secure $44.95 (was $39.95)

VenM Low Profile Subwoofer
This is the ultimate tool for the party DJ. It's portable and packs a full power punch. Ideal for a DJ or live player.

- 12" 3000W RMS
- Frequency response: 20Hz - 20kHz

Secure $199.95 (was $159.95)

In-Dash Multimedia Player
This unit will play CDs, DVDs, WMA, MP3, MP4, and GMF radio. The built in "12" screen doubles as a control panel when listening to MP3s etc. It also has an auxiliary audio input for external MP3 or tape player etc. This player can be installed into various domestic and car applications and is suitable for a home entertainment system or a car audio system.

Secure $399.95 (was $369.95)

Curly Musical Instrument Lead
Light output approximately 1200 lumens at 12V

Secure $199.95 (was $149.95)

UPGRADE YOUR CAR AUDIO THIS SUMMER!

For more information on these and other products, visit us on the web at www.jaycar.com.au or contact us on 1800 022 888 for orders.
GREEN POWER - ALTERNATIVE ENERGY PROCTS

Powertech Monocrystalline Solar Panels
The new super compact 500W units are made of a high-efficiency silicon monocrystalline solar cells and are ultra-thin and light in weight. They have the highest power to weight ratio and have some serious advantages: large panels, high power output, great reliability, and very low maintenance costs. These panels are ideal for off-grid living, small solar systems, and remote applications. They are made of high-quality materials and are designed to last for many years. They are also lightweight and easy to transport, making them ideal for remote locations and mobile applications. The panels are available in a range of sizes and are suitable for a variety of applications, from small, off-grid systems to large-scale installations.

New to the SLA Battery Range
The newest and nicest 12V batteries in the range, with the highest quality, will have all the same features and specifications as the existing 12V units. These batteries are high-performance units that can be used for a variety of applications, including caravans, boats, and off-grid living. They are designed to be long-lasting and efficient, providing reliable power for years to come. The batteries are also available in a range of capacities, allowing you to choose the right size for your needs. These batteries are ideal for people who want to live a more sustainable lifestyle and reduce their carbon footprint.

Solar Panel "Y" Leads
These new "Y" leads are designed for connecting two outputs of solar power in parallel or connecting multiple panels in an off-grid or semi-off-grid system. They are easy to use and are designed to work with any type of solar panel. The "Y" leads are made of high-quality materials and are designed to be durable and long-lasting. They are also easy to install and are compatible with a wide range of systems and applications. These "Y" leads are ideal for people who want to expand their solar system and increase their power output.

Rolling Code Infrared
Keyless Entry System Kit
This rolling code infrared keyless entry system features two easy-to-install wireless remote controls that can be programmed to up to 16 separate key fobs. The remote features include "sleep" mode for maximum battery life, and are compatible with most brands of garage doors and locks. The system is designed to be simple to install and is ideal for people who want to secure their property and prevent unauthorized access. The system is also compatible with most types of remote controls and can be easily programmed to work with a variety of devices.

Low Cost Programmable
Interval Timer Kit
This low cost programmable interval timer kit is designed for use in a variety of applications, including watering plants, controlling electrical devices, and timing events. The timer is easy to use and is programmable for a wide range of times. It is suitable for short-term applications and can be used for up to 48 switch-on periods. The kit includes a complete selection of electronic components and is ideal for hobbyists and enthusiasts. The kit is easy to assemble and is suitable for people who want to build their own projects.

Power Supply Kit for Ultra-LE MK2 200W Amplifier Kit
This power supply kit is designed for use with the MK2 200W amplifier kit. It includes all the necessary components for a complete power supply system and is suitable for a wide range of applications. The kit is easy to build and is designed to be compatible with most types of electronic devices. It is suitable for both hobbyists and professionals and includes all the necessary components for a complete power supply system.

SAFETY FIRST

The key to preventing photographic piracy is to ensure that your images are protected against unauthorized use. This can be achieved by taking appropriate measures such as using watermarks, restrictions, and encryption. It is also important to ensure that your images are not easily distributed or shared, as this can increase the risk of unauthorized use. By taking these steps, you can help protect your images and prevent photographic piracy.
Powertech Monocrystalline Solar Panels

The new super compact 300W sits are ideal for technical applications and are made from the very best materials and components. Heat sink construction is designed to keep the panel cool, even under high ambient conditions. The panel is mounted, compact, and lightweight design, are larger in size than previous models. These panels are lightweight, aesthetically pleasing, and effective.

<table>
<thead>
<tr>
<th>Cell Type</th>
<th>Power</th>
<th>Voltage</th>
<th>Current</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monocrystalline</td>
<td>300W</td>
<td>12VDC</td>
<td>25A</td>
<td>15%</td>
</tr>
</tbody>
</table>

Wind Generators

The new super compact 300W sits are ideal for technical applications and are made from the very best materials and components. Heat sink construction is designed to keep the panel cool, even under high ambient conditions. The panel is mounted, compact, and lightweight design, are larger in size than previous models. These panels are lightweight, aesthetically pleasing, and effective.

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<td>25A</td>
<td>15%</td>
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</tbody>
</table>

Solar Panel Y Leads

These are excellent cases and you can general purpose, enough to handle the very popular low range. This excellent keyless entry system can be removed to protecl your valuable components. Heat sink construction is designed to keep the panel cool, even under high ambient conditions. The panel is mounted, compact, and lightweight design, are larger in size than previous models. These panels are lightweight, aesthetically pleasing, and effective.

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<td>25A</td>
<td>15%</td>
</tr>
</tbody>
</table>

Rechargeable 35W HD Spotlight

If you need reliable light 10W. This is a practical solution with durable properties. It has been designed to last the test of time and is much more durable. Boat, 12V battery, is a practical solution for any other high-power applications. It features a tough yet lightweight construction that is built to last. The built-in rechargeable battery gives over 50% more running time and is rechargeable for long periods. Suitable for a range of applications, it is a practical solution for any other high-power applications.

<table>
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<th>Efficiency</th>
</tr>
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<tr>
<td>35W</td>
<td>12VDC</td>
<td>2.5A</td>
<td>10%</td>
</tr>
</tbody>
</table>

Mains Power On The Go! Modified Sine Wave Inverters

This excellent keyless entry system can be removed to protecl your valuable components. Heat sink construction is designed to keep the panel cool, even under high ambient conditions. The panel is mounted, compact, and lightweight design, are larger in size than previous models. These panels are lightweight, aesthetically pleasing, and effective.

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<td>10%</td>
</tr>
</tbody>
</table>

3 Channel UHF Pocket CB Radio

A versatile transceiver with a minimum input of 1W and 25W power saving modes. All 3G legal standards are included with this model. This versatile transceiver with a minimum input of 1W and 25W power saving modes. All 3G legal standards are included with this model.
Great Christmas

At Jaycar

4-in-1 Retro Music Centre with USB/SD

Report to SD card or via USB with this retro all-in-one music centre. It plays everything, AM/FM radio, turntable, cassette player and MP3. You can save tracks to an SD card or to a PC as WAV or MP3 files.

- **LED display**
- **3.0" LCD, 64x80 pixel compatible**
- **2 x 40mm speakers**
- **2 x 280mAh batteries**
- **Dimensions**: 390x195x116mm

**$299**

World Band AM/FM/SW PLL Radio Receiver

This is a unique radio set that is sure to find its place on your Xmas list. It has all the features you’d expect in a radio receiver, plus a large display and easy to read controls. It’s perfect for anyone who loves to stay connected.

- **Size**: 150x200x30mm
- **Display**: 2" LCD
- **Batteries**: 4 x AAA

**$109**

New Battery Charger with LCD

Recharge up to 4 x 9V/AA or 4 x 1.2V AAA NiMH batteries simultaneously. LCD display shows charge status and includes a timer to ensure the batteries are fully charged. Ideal for use with flashguns, cameras and other devices that require frequent recharging.

- **Price**: $99

Computor Connect Wireless with Wireless Sensors

The outdoor sensors will allow you to control your lights from anywhere in the house using the computer. The system includes wireless sensors that can be installed anywhere in the house and the lights can be turned on or off by simply clicking the sensor. The system is simple to install and use and provides complete control of your lighting system.

- **Size**: 100x50x20mm
- **Battery**: 4 x AAA

**$199**

Portable Combo 30W PA Amp with USB

This portable PA system is perfect for any event or occasion. It features a 30W amplifier, USB port for music playback, and a microphone input. It’s ideal for use in small rooms, parties or even outdoor events.

- **Power supply**: 12V DC
- **Output**: 30W

**$438**

Rack Mount Dual MP3 Controller

The combination of MP3 with the flexibility of full pitch, cue and track control will add a whole new dimension to your DJ or home studio setup. It accepts two SD cards up to 32GB in size and also includes a built-in tracklist generator and a range of additional features to make your DJing experience even more enjoyable.

- **Supports**: D3 Tag
- **UPC**: 50604202123
- **Declared**: 50604202124
- **USB**: 50604202125
- **Dimensions**: 230x30x30mm

**$438**

In-Dash Multimedia Player

This versatile player can be installed in any car or truck. It supports a wide range of multimedia formats, including MP3, WMA, JPEG, and more. It also includes a Bluetooth connection for hands-free calling.

- **Display**: 3.5" touch screen
- **Power supply**: 12V DC

**$189**

**UNINTERRUPPTIBLE POWER SUPPLIES**

Pre-Charged Rechargeable Batteries

Ideal for use with DJ equipment, this fully charged battery pack provides extra power when needed. The Battery pack is designed to work with DJ equipment and provides a backup power source when needed.

- **Price**: $99

4 Way AV Component Distribution Amplifier

This distribution amplifier offers a clean and powerful signal to your home theatre, allowing you to enjoy the best sound quality. The unit is designed to distribute up to 4 AV signals, providing a versatile solution for any home entertainment system.

- **Price**: $149

Spending Guide for your Christmas Shopping

- **Home Theatre Powerbank**
- **Jaycar Home Theatre Powerbank**

**$109**

Curly Musical Instrument Lead

This lead provides a high-quality connection for your musical instrument, ensuring the best possible sound quality. It features a durable and flexible design, making it perfect for use with a variety of instruments.

- **Price**: $29.95

**GREAT CHRISTMAS AT JAYCAR**

**LOCATIONS**

- **548 Mount St, South Yarra, VIC 3141**
- **348 Pittwater Rd, Dee Why, NSW 2099**
- **253A Hollywood Rd, Coogee, NSW 2034**
- **201a Great Western Hwy, Leppington, NSW 2170**
- **177-179 Williams St, Granville, NSW 2142**
- **446-458 Epping Rd, Epping, NSW 2121**
- **10-12 Napier Pl, Cronulla, NSW 2230**
- **428-430 Kogarah Rd, Kogarah, NSW 2217**
- **251-253 Randwick Rd, Randwick, NSW 2031**
- **265-267 Bayswater Rd, Bayswater, NSW 2040**
- **33-35 Cookes Rd, Burwood, NSW 2134**
- **250-252A Kent St, Lismore, NSW 2480**
- **10-12 Napier Pl, Wheelers Hill, VIC 3150**
- **446-458 Epping Rd, Epping, NSW 2121**
- **10-12 Napier Pl, Cronulla, NSW 2230**

**GET IN TOUCH**

- **Jaycar Customer Service**
  - **Phone**: 13 79 45
  - **Email**: sales@jaycar.com
  - **Website**: www.jaycar.com.au

**NEW AT JAYCAR**

- **Compact Computer Connect Wireless with Wireless Sensors**
  - **Size**: 100x50x20mm
  - **Battery**: 4 x AAA

**$199**

- **Uninterruptible Power Supply with Battery**
  - **Size**: 100x50x20mm
  - **Battery**: 4 x AAA

**$99**

- **Portable Combo 30W PA Amp with USB**
  - **Power supply**: 12V DC
  - **Output**: 30W

**$438**

- **Rack Mount Dual MP3 Controller**
  - **Supports**: D3 Tag
  - **UPC**: 50604202123
  - **Declared**: 50604202124
  - **USB**: 50604202125
  - **Dimensions**: 230x30x30mm

**$438**
Low Cost DMM
This deal features a digital multimeter perfect for the home handyman or young experimenter and will give great value for money. It includes a basic 10A AC current range as well as voltage and transistor testing functions. Also compact, it's easy to use and very durable.

Price: $19.95

Radio Control Apache Attack Chopper
Torques up quantities of children, this 3-channel radio control with thruster, reversing and trampolines. Includes a 3-channel radio control with helicopter and 2-channel radio control.

Price: $59.95

Wireless Weather Station
I noticed that a crack ceramic cable in the upper front panel. With the phase switch to Auto mode, the trace disappeared but it was not being triggered so that the square wave calibration signal was not visible on the screen.

Normally, you would adjust the trigger level to make the waveform stationary. However, when I did this, the trace disappeared altogether. Another fault had developed. It looked as though the trace was being blanked as soon as it was being triggered.

In order to test this theory, I borrowed another CRO and looked at the blanking signal which is generated on the Trip Switch Unit (X7A-1500-00), exiting the circuit on P87, pin 4. This showed that the trace was indeed being blanked. To confirm this, I looked at the CRO signal at pin 35, pin 4. This is the waveform which sweeps the spot across the screen at a uniform rate.

However, the waveform was just unstable. In other words, rather than the trace being blanked, it wasn't being triggered at all, even though the trigger adjustment was correct.

To backtrace a little, the Trip Switch Unit is on a PCB board measuring about 250 x 100mm. This includes the trigger, oscilloscope, and sweep circuits for both the A and B timescales.

There are 12 high-speed ECL logic ICs on the board, plus dozens of transistors and diodes. The fault just had to be on this board somewhere. I counted 33 electrolytic capacitors and after my success with a bulk replacement of these in the power supply, I decided to do the same on the Trip Switch Unit.

Anyway, I replaced all 33 capacitors and then reconnected the multimeter of plots (20 or threequarters) to the board. I then powered it up and found that the fault was still there which was frustrating but not really surprising. Still, it had eliminated one potential source of problems.

Triggering for the A timescale is from the A Trip Switch Unit and enters the timescale board via P46. Unfortunately, the pulses on P46 were too narrow to be visible on the borrowed CRO which had a bandwidth of just 20MHz. However, following IC1 and IC1b which form a Schmitt trigger, the wide pulses were visible as long as the trigger level was adjusted.

IC2a is a bistable flipflop which has two modes of operation. The first is the Reset-Set (R-S) mode and the second is the J-K mode. The important thing I noticed here was that when the trigger pulses were present, the flipflop wasn't clocking and so the sweep never started.

So it seemed that the IC was faulty. Fortunately, for the circuits for this part of the two timescale circuits are identical and I could compare them, rather like the two channels of a stereo audio amplifier. There was another MC10H131 on the PC board, so I swapped it over.

When I did that, the A timescale then worked, producing a nicely triggered waveform. A replacement IC then got the B timescale working again.

Flickering trace

There was just one final fault to fix. When the scope was switched on from cold, an out-of-focus trace resulted which worked for a while before settling down. To fix this, I initially replaced two more high-voltage ceramic capacitors (C38 & C39) on the Power Blanking Unit board and this appeared to do the trick but the problem was back the next day.

It was then that I noticed a tiny spark on the PCB which was generated in trying to solve the trace that flickered. This spark was caused by tracking of the -1200V across the surface where a cable passed over two neon lamps which had perished.

In fact, there were two of these pairs of neon and both supports had perished. I removed the neon, scraped away the remains of the supports and cleaned the board with a brush. A cost of clear varnish or the damaged area gave some assurance that it wouldn't happen again.

At the next switch-on, the trace came up in focus and there was no flicker. So the old CRO was restored to full working order, although I have to admit that the diagnosis and repair of the original parts was spread out over about a year.

I guess a serviceman in business doesn't have that luxury.

Fuzz box for guitars

This fuzz box uses low-cost discrete components rather than op amps. It's designed for use only with an amplified guitar signal.

While it may appear to be a conventional differential op amp amplifier configuration with Q5 as the long tail for the two input transistors Q1 & Q2, it actually uses positive rather than negative feedback. It clips symmetrically and the loading of the following amplifier or mixer has no effect on its clipping symmetry.

Q4 is connected as a grounded base stage with base bias provided by three diodes: D2, D3 & D4. Q3 drives the emitter of Q4 and the positive feedback signal to the base of Q4 comes via the 4.7kΩ resistor from the collector of Q4. The three diodes also set the bias for Q5 which sets the operating point for the input pair.

Monitor for pet bed heater

This monitor for a pet bed heater was designed to give a long signal during the heating on the bed and causing the heater to become unphased. A normally closed NC pushbutton is not pressed, current flows through it to the heater element so that it works normally. Conversely, when the button is pressed, the circuit functions as a current limiter.

Editor's note: a permanent LED monitor could have been arranged by omitting the pushbutton and simply wiring the D1/LED1 circuit in parallel with the heater element, if that could be conveniently done.

Available Aust. only. Price: $A13.55 plus $7.88 per order (includes GST). Just fill in and mail the handy order form in this issue; or fax (02) 9939 2648; or call (02) 9939 3295 and quote your credit card number.
One-button camera timer

This project is a one-button time-lapse camera timer initially developed for a Canon 400D digital SLR camera but it should work with other cameras and without the switch for the Canon 400D but that costs at least $35 – a lot of money for what is just a wire to the end of a cable.

This circuit adds a nifty timer to the cable in the form of a PIC12F875 microcontroller for about the same price or less if you build it from recycled parts.

Once programmed, it can be used to take photographs at intervals from one to 65,535 seconds (ie. 18 hours 12 minutes). It features a single button to control all functions, audible feedback via a piezo LED. The output of pin 2 of IC1 switches a 2N7000 FET (Q3) which connects the tip of a 2.5mm audio plug to ground in a particular mode of the camera’s remote shutter function. The sleeve would normally activate the camera’s shutter half-press function but that is not used by this project.

An astable multivibrator comprising transistors Q1 & Q2 and associated components drives the piezo transducer. Since the piezo takes its signal from the collectors of Q1 & Q2 it gives a healthy output in spite of the low supply voltage of only 3V. The PIC microcontroller supplies power to the multivibrator via pin 3 to turn it on and off and also sets the tone (high or low) by using pin 5 to switch an RC301 resistor into the RC network controlling the pitch.

(Visa) Indication is provided by LED1 & LED2 which can be single LEDs or a 3-lead bi-colour LED. The package powers up in “set” mode which is indicated by red LED1. You then select the time-lapse interval (in seconds) by pressing the button.

The first press emits a low beep, indicating zero, then subsequent presses emit high beeps which you count until you reach the next digit you want. Digits are entered as you would write them on paper, so 120 seconds would be entered as 1, then 2, then 0.

To enter each digit, all you have to do is wait for one second or more. If you overshoot the digit, you just keep pressing until you hear the low beep indicating zero and start over.

Once the time-lapse interval has been entered, you switch into “shoot” mode by holding the button down for one second or more until you hear a high beep. LED1 will extinguish and LED2 will briefly flash every time a shoot is taken. Shooting begins as soon as you release the button.

This has a useful side-effect in that if you want to start your shooting at a particular time, you just keep holding the button down while looking at your watch. It will give you “ticking” beeps at one-second intervals so you can release the button to start shooting at a particular instant.

The last time-lapse interval set is remembered. To use the previously set interval, just press and hold the button after power up and “shoot” mode will be started using that interval.

To temporarily suspend shooting, tap the button for less than one second. You can resume shooting using the existing interval by holding the button down for more than one second.

The software will be available for download from www.siliconchip.com.au.

To program the PIC12F875 you will need to purchase a programmer such as the Microchip PICKIT 2 and obtain a compiler such as the free version of MikroC.

Andrew Armstrong, Dural, NSW.

Circuit Notebook – Continued

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Anyway, I removed the chassis and then released the PCB boards from their frames. That done, I carefully examined the copper side of each board under a magnifying lamp but the soldering could not be faulted. I then checked the component side for any obvious faults but again everything looked OK.

Next, I used my ohmmeter to check for continuity from the mains plug pins to the power supply in case of invisible hairline fractures. And it was here that I had my first clue. I was tracing the line between the neutral pin to the bridge rectifier and it soon became apparent that it was intermittently going open circuit. Step by step I eliminated until I got to the power switch.

The power switch is a double-pole double-throw (DPDT) type and when I removed and checked it, I could see that it was intermittent on one side only. Having found the problem, I put it back in the set, shorted the bad side and left it on test while I waited for the owner to get in contact.

Unfortunately, I still hadn’t heard from her a fortnight later, so I’m not sure how long I have to wait.

One good turn...

I guess that you could call this story “One Good Turn Deserves Another”. It involves a guy in South Africa who discovered that his neighbour had fallen on hard times. Apparently, the neighbour’s electricity had been cut off and that meant, among other things, that the wife had to do all the washing (including nappies) by hand – this for a whole mess of kids.

Being the kind-hearted type, he agreed to let his neighbour use an extension lead to connect their houses together so she could use the washing machine. That was fine for awhile and then our hero went out to do the week’s shopping. When he returned, he was surprised to hear this propeller-like noise coming from his fusebox. On examining it, he found the electricity meter spinning so fast that the gauge was about to take off.

Of course, he went straight around to his neighbour to find out whether he had anything to do with it. He didn’t have to ask because as he was going around the back, there were at least another half dozen extension leads leading from his house to all the other neighbouring ones. Talk about freeze to see if it would start up again. It didn’t but when I tapped the chassis with the butt-end of a screwdriver, I could hear it trying to start.

That was all though. When the set was dead, there was no red power LED which meant that there was no standby voltage.

Despite the fact that there were lots of other jobs in the workshop, I decided to give this set some priority. By tracking down this intermittent fault, I could at least quote for it when (and if) its owner phoned and get it out of the way.

By now, I’d concluded that the fault wasn’t heat-related. Instead, it was more likely due to a bad connection or a dry solder joint somewhere near the power input stage of the power supply.

I tried the name, address and telephone number the mystery man had given me but none was correct. I then checked the telephone book and throughpages.com.au but again no luck.

Great – someone had dumped a set on me with no fault given and no contact information.

Well, at least I didn’t have to wait too long for the answer to one of my questions because about one hour later, the set suddenly died. However, the day was over so I just jammed the set inside the door and left.

The next day was a hot one and the set cooked out after a much shorter time period than the previous day. This indicated that the fault was heat-sensitive, so I hit various 3-pin IC regulators and other devices with a freezer to see if it would start up again. It didn’t but when I tapped the chassis with the butt-end of a screwdriver, I could hear it trying to start.

That was all though. When the set was dead, there was no red power LED which meant that there was no standby voltage.

Despite the fact that there were lots of other jobs in the workshop, I decided to give this set some priority. By tracking down this intermittent fault, I could at least quote for it when (and if) its owner phoned and get it out of the way.

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VHF aircraft receiver with squelch

This VHF receiver offers very good performance with few components and covers the whole commercial air band from just above 100MHz to 140MHz with sensitivity of just a few microvolts. It has a noise squelch circuit, for pleasant noise-free listening, a very pleasurable experience.

The antenna is coupled via a 10pF capacitor to the base of transistor Q1; a grounded base buffer stage. It isolates the antenna from the following stage involving Q2 which acts as a super-regenerative detector. The detector is self-squelched at around 20kHz via the combination of the 1kΩ resistor and 1nF capacitor associated with inductor RFC2.

Bandpass filter

The recovered audio modulation from inductor RFC2 is fed via emitter-follower stage Q3 to an amp stage IC3 which acts as a narrow bandpass filter. It rejects the high qhimp content of the input signal and any voice modulation. Its output is rectified by diodes D1 & D2 and filtered by a 1pF capacitor. This becomes the squelch control voltage for Q4 which turns on to reverse-bias diode D3. This prevents signal from the emitter of Q3 from being coupled through D3 to the input of the audio stage, IC2.

Hence, when signal is present, the receiver “quiets” on receipt of a carrier and squelch voltage to Q4 falls, turning it off. Thus the collector voltage of Q4 rises and forward biases D3 to allow the audio signal through to the volume control, VR3. Potentiometer VR2 acts as the squelch control.

Winding inductor L1

Inductor L1 is wound on a 3mm former with four turns of 1mm enamelled copper wire. RFC1 & RFC2 are standard 10pF moulded chokes which connect IC1 to the PM section of a standard plastic dielectric tuning capacitor. This gives enough range to tune from 100MHz to 140MHz. All the capacitors in the RF section should be disk ceramics.

Potentiometer VR1 adjusts the bias on the detector (Q4) and maximum sensitivity is at the point where the hiss is stable at the sandy end of the adjustment. At this point, about 1.5–2V will appear across the 1pF capacitor with the squelch control set fully open. This setting will remain fairly constant over the complete tuning range. When I told you right, the squelch will “split” on background noise.

Dayle Edwards, Taylorville, NZ. (S60)
Toy poker machine is no risk to wallet

This poker machine circuit can be built to help the young (and not so young) understand the folly of the real thing. It demonstrates the very high probability of failing regardless of the "win" conditions.

Six inverters in IC1, a 4049, are paired to provide three independent clock oscillators which run at different speeds. These clocks drive three 4017 decade counters, IC2, IC3 & IC4. Each decade counter uses six of its outputs and they are set back to zero each time they reach a count of 6. Five of the outputs drive five LEDs - red, green, yellow, blue and white - they flash at different rates, depending on the clock oscillators.

Each counter is provided with a stop switch so that the counts can be stepped at will, randomly. The aim is to get a winning set: three greens, three reds, etc.

By adding five switchable AND gates (IC5 & IC6), a piezo buzzer can be made to sound if a winning combination occurs. The outputs of the five AND gates are ORed by the five diodes to drive transistor Q1 and the buzzer.

The folly of the poker machine becomes apparent when the odds

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December 2008

41
We have had a number of audio repairs come into the workshop recently, all of which have been irritatingly difficult.

The first was an Onkyo surround sound home-theatre system, model TXSR502, which was intermittently switching off. Unfortunately, the word “intermittent” often has different meanings for the customer and the repairer. To the former, it means that there obviously can’t be much wrong and therefore it will be cheap to repair an item that is actually working most of the time.

To the repairer, however, it means quite the opposite. For starters, it is often difficult to get the fault to occur in order so that the symptoms can be observed. An intermittent fault can also make it difficult to judge whether or not the fault has been really fixed, so that the set doesn’t come back under warranty.

Finally, tracking down an intermittent fault can be a time-consuming task and that adds to the expense. In addition, the unit has to be soaked-tested for longer.

Unfortunately, the difference between these two positions usually has to be resolved into an estimate before you can start the job. And if guesswork is to be eliminated, you literally have to repair the set first, otherwise you could be hopelessly out.

Of course, you can always reduce an estimate but rarely are you able to increase it.

Fortunately, experience has shown that, after many years, the Onkyo TXSR502 can develop dry joints, especially in the pre-power amplifier driver stages. In fact, I had quickly concluded that the fault was probably due to the protection circuits switching the relays off, so this fitted in well with the known pattern of faults with this model.

As it happened, the board had quite a few dry joints so I was fairly confident that reworking the solder across the PCB would fix the fault. Eventually, after I had finally completed the job, I redid the set and put it aside to soak test.

Initially, all seemed well but my coffee fix had only just kicked in when, some 15 minutes later, I noticed that the same fault had started again. The speaker relays were clicking on and off and the set was locked onto the “Video 1” input and wouldn’t change.

Being an Onkyo agent it just had to be one of the two microprocessors the set uses. The main one, Q7502 on the display board, feeds the DSP (digital signal processor) which then feeds the protection circuits. I could measure the voltage changing on the output ports and could also see the data lines varying between the processors.

Being an Onkyo agent it has its privileges and I was able to borrow another TXSR502 from another service agent. I then swapped the front displays, played and found that the fault transferred from one set to the other.

OK so the fault was on the display board, even though there was hardly anything on it apart from its microprocessor. This microprocessor (Q7502, P17PBF0232GE-F030) is an 80-pin high-density square surface-mount integrated circuit. It’s too difficult to replace cheap as chips so I ordered a new one plus the duo-crystal X7501. They arrived fairly promptly and took a long time to install but I was relieved to think that this would almost certainly fix the fault.

Well, didn’t it! So what was there left that could cause this problem? I turned my attention to the 26 tactile switches but they all looked perfect, as did the 3 operation switches on board U303 which plugged into 3-pin socket LS7501.

The keys form a matrix which feeds the microprocessor on four lines: K0-K3 (pins 19-22). There should be +5V on these lines but in fact there was only 2V, so 3V was disappearing down the ganger somewhere.

I checked the impedance of the switch lines and noticed that K0 (pin 19) was slightly lower than the other. As a result, I disconnected it and the unit immediately worked properly but it stopped again when this pin was reconnected.

Next, I unplugged the Operation Switch Board (U03) but that made no difference. I then reconnected the socket and scrubbed it with PCB cleaner and a toothbrush. That finally fixed the problem and it worked for week before it was returned to the client who no doubt thought he was paying an inflated price for what he considered a straightforward job.

I couldn’t honestly put my hand on my heart and say that I know exactly what caused the problem. However, I surmise it to be either a solder dog or just dirt that produced a high resistance of winning are considered. There are 216 possible combinations of the three counter outputs and five of these, represented by the winners, are winners. Since the pin 3 output of each counter can occur but has no LED connected, this is a no-score condition. So the chances of winning are in 216 or 431:1 against. Not good, but if you’re a pedestrian, say, 3 blues as a special prize, it will come up once in every 216 games, on average.

In a real poker machine, the odds are a great deal worse, since it has many symbols in each row and “N” rows rather than three. To the logical mind, pokies have no appeal at all.

A. J. Lowe, Bardon, Qld. ($600)

Battery monitor has low current drain

This circuit makes use of an ultra-bright red LED to produce a low battery-warning indicator which pulls very little current.

As shown, it uses a 9V battery and the LED only lights if the supply voltage drops below 7.6V. At this point, the battery is in its last legs so the operating current of the LED will have little effect on its remaining life.

When the voltage is above about +7.6V, the 7.5V zener diode (ZD1) will conduct to turn on transistor Q1. This in turn shunts current away from the LED. Conversely, when the voltage drops below 7.6V, the zener diode and the transistor will stop conducting and the LED will light.

Total current drain from a fresh 9V battery will be of the order of 0.1mA, dropping very slightly as the LED comes on.

Steven Graham, Christchurch, NZ. ($80)
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precise, how do you make up a solution with 3000 ppm salt? In fact, making up such a solution is dead easy. All you need is a measuring jug which will hold one litre of water and a set of measuring spoons. Then you need to measure out 3 grams of salt. Pool salt or table salt will do—they are both pretty much the same thing, no matter how they are labelled.

Half a teaspoon of salt is 3 grams. Add that to the water and stir thoroughly until all the salt is dissolved. Viola! You now have one litre of salt solution which is exactly 3000 ppm. Handly a high-tech exercise, is it?

Want a 4000 ppm salt solution? Add 4 grams to one litre of water instead of 3. Believe it or not, we have seen internet retail outlets which sell such a standard 3000 ppm salt solution for $10.95 for a 230ml bottle! So now that we have a standard salt solution, how do we measure salt content in a swimming pool? It is just a matter of comparing the resistivity of the standard salt solution with the resistivity of the pool water.

The more salt in the water, the lower will be its resistivity.

So the next step is to make a container with a couple of electrodes connected to both sides. You could use almost any cylindrical plastic container but we chose to use a 200mm length of 3mm plastic stormwater pipe fitted with a standard end cap.

We drilled 2.5mm holes in opposite sides of the resulting container about 140mm from the bottom.

We then attached a solder lug to each of the holes, using a screw, nut and lockwasher.

The solder lugs were connected to a length of figure-8 cable with a pair of 3mm banana plugs at the other ends. The banana plugs were connected to a digital multimeter and it was switched to measure "Ohms".

A dopl of silicone sealant should be applied to the screw heads (on the outside only) to make them water-tight. While you’re about it, you might like to put a smear of silicone on the inside bottom of the 90mm tube as you slide the cap on—again, to make it watertight. We didn’t and the results are obvious in our photograph.

So that is the test set-up.

Checking it out

To check it out, first fill the container with fresh water to a mark at, say, 20mm from the top. Note the ohms measurement. Typically, our reading was 5000 ohms or thereabouts. It will vary depending on how much chlorine is in your tap water.

Tip out the fresh water and note that the resistance reading now becomes very high, typically 40 megohms or more. Then fill the test container with the 3000 ppm salt solution and note the resistance reading.

Typically, we measured around 1800 ohms or 1.8kΩ. This will vary depending on the temperature of the solution but we can assume for the purpose of this exercise that the solution water temperature is fairly close to that of the pool.

Then fill the test container with water from your pool. If the salt concentration is more than 3000 ppm, the resistance reading will be lower than the one you got for whatever your previous measurement was. Conversely, if the salt concentration is less than 3000 ppm, the resistance will be higher than 1.8kΩ.

You can then decide whether or not you need to add salt to your pool. Incidentally, you should not need to add salt to your pool more than once or twice a year. Evaporation from your pool will not reduce the salt concentration; it will increase it.

There are three different ways in which salt can be lost from your pool.

The first is when swimmers splash water out of the pool and you subsequently have to top it up with fresh water.

The second is when back-washing the pool filter, although our experience is that this doesn’t make a huge amount of difference.

The third way—fortunately rare because it usually throws virtually all your pool chemistry out of whack—is when you get a lot of rain and a lot of water is lost out of the overflow. Generally, your pool water loses more than average (most do leak a little!) and you often have to add water to top up the level, your salt level will also drop.

So there it is. While we have not described how to make a salt concentration meter reading in ppm (because we don’t believe it’s necessary to actually know the figure), we have described a method of comparing the resistivity of pool water to a standard salt solution.

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**Brownout Protector**

By JOHN CLARKE

**Protector**

Protects AC motors against low AC mains voltage

What is a "brownout"? This rather graphically describes what happens to your lights when the AC mains voltage drops dramatically - they get very dim. But apart from dim lights, brownouts are a fatal hazard to induction motors, as used in air conditioners, pumps, dishwashers and a lot of other appliances.

YEARS AGO, BROWNOUTS were quite rare and generally confined to rural districts where the power lines had very long runs. A falling tree or an electrocuted possum might cause the mains voltage to drop to very low level and lights would go dim. This has always been a hazard for the induction motors used in pumps and refrigerators. Nowadays, though, because the electricity grid is running much closer to total capacity, brownouts can be experienced much more commonly in the cities and suburbs. Our own offices in the Sydney suburb of Brookvale have had brownouts on a number of occasions in the last year or so. On such occasions, we have made sure that the air conditioner, fridges, compressors and other machinery in the building were turned off until full AC mains supply was restored. Had we not done so, all the motors in that equipment were liable to burnout.

So how many motors in your home are at risk right now if a brownout was to occur? The list can be quite long: fridge, freezer, washing machine, dishwasher, air conditioner, pool pump, spa pump and perhaps one or two garage door openers; typical of many homes. All this equipment could attempt to turn on during a brownout and the motor(s) would probably burn out.

Maybe your insurance policy covers motor burnouts but you would need to read the fine print. The insurance company might also look askance at your claim if there was more than one motor burnout or if the appliances were more than a few years old.

**Why do motors burn out?**

When induction motors are starting up they draw very heavy current for a second or two and when they are up to speed, the current drops back to reasonable levels. However, if the AC mains voltage is low, the induction motor may not develop enough torque to come up to full speed. In all of the appliances listed above, the motor starts with a heavy load so it is at particular risk if those starting currents do not reduce quickly. Those motors with a starting winding (switched out by a centrifugal switch) are at particular risk because those windings are only intended for very intermittent use.

By the way, some motors do have thermal cut-outs but these cannot be regarded as a panacea - they are more correctly regarded as fire preventive measures.

So why not make your own salt motor? Such a device is not likely to be very complex, is it? That's what we thought too.

So we visited a local pool shop and asked the friendly manager if we could have a look at his salt meter. And we took some photos to show what it looked like. It was an analog meter with scale calibrations in ppm and TDS (total dissolved solids). But notwithstanding those obscure labels, our impression was that it was simply an ohmmeter connected to a measuring cup.

**Measuring cup**

The measuring cup was interesting. As the pictures show, it was a small cylindrical container with two holes at a certain level up the sides. In the base of the cup were two carbon electrodes which evidently make connection to the solution.

In use, the cup is first flushed with fresh water and then, holding your finger over the holes in the sides of the cup, you fill it up with your pool water. You then unblock the holes and the water flows out so that it is at a precise level in the cup. You then take the reading by pressing the button on the meter. That's all there is to it.

Hmm. So is this really necessary? Since virtually every reader of SILICON CHIP magazine has a multimeter or two or three, whether a digital (DMM) or good old-fashioned analog type and since they all have "Ohms" scales, no other equipment is necessary.

In other words, if you want to measure salt content of your pool, you don't need a $300 salt solution meter or whatever else it might be called.

**Standard salt solution.**

What you do need is a salt solution of known concentration. To be more precise, you

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**Specifications**

- Adjustable threshold voltage
- Switching up to 2200W
- Power indicator
- Brownout indication
- Rugged sealed enclosure

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**Main Features**

- Standby power consumption: 5W with relay on
- Maximum Control Power: 2200W
- Brownout threshold voltage: typically set to 220V
- Switch on delay: 5 seconds

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**By the way!**

It's not really that hard, is it? We don't think so! (This is the warning label on the meter at left).
The Pool Salt Meter at our local pool shop. Obviously it does more than check dissolved salt levels – it also checks total dissolved solids. But it also costs more than $300 and, according to our friendly pool shop owner, "...costs a fortune to repair, too." We wonder why!

A couple of shots of the measuring cup to show not only its size but also its construction. The two black circles (not to the green circles) are the carbon electrodes which make contact with the pool water, to give a reading in parts per million on the meter at left.

Test the SALT CONTENT

Do you have a swimming pool with a salt-water chlorinator? Then you will know that you have to periodically add salt to the water to make sure that the chlorination process works properly. So how do you measure salt content in your swimming pool?

By LEO SIMPSON

These days, many in-ground swimming pools use a salt-water chlorinator to keep the water clean and safe from nasty microbes. The chlorinator electrolyses the salt content of the water to produce sodium hypochlorite which then acts like normal "pool chlorine" to sanitise the water. Not having large amounts of chlorine in the water makes it much more pleasant and you don’t come out of the water smelling of chlorine. Nor will your eyes sting or your swimming togs become bleached.

However, for a salt-water chlorinator, there must be a minimum concentration of salt in the water for it to work correctly. Just how much is needed depends on the brand and model of chlorinator but typically it is around 3000 to 4000 ppm (parts per million). If the salt concentration goes below the specified level, you must add some salt to the pool.

On the other hand, you should not add too much as that is simply wasteful and it might lead to accelerated corrosion of some of the pool hardware.

So how do you measure salt water concentration? Most people don’t even bother. They just take a sample of their pool water to the pool shop and ask them to test it (at the same time getting several other important pool chemistry factors checked). If it is below the specified level, this is the perfect opportunity for the pool shop to sell some bags of salt.

rather than protecting the motor from any damage.

So these you have the reasoning behind our Brownout Protector. If you have a couple brownouts every year, you need protection for your appliances. You cannot rely on the possibility that you will be at home or awake when a brownout occurs and that you will be able to turn off all of the at-risk appliances before they are damaged. And unless the appliances are all in a single location (unlikely), you need one Brownout Protector for each appliance you wish to protect.

Features

The Silicon Chip Brownout Protector provides constant protection for any single-phase induction motor, disconnecting power when the AC mains voltage drops below a preset level and then reconnecting it when the voltage returns to normal. The cost of this protection is far less than the likely cost of repair and replacement of a typical small induction motor. It may be used with induction motors rated up to 2.3kW (10A).

Above: the Brownout Protector is housed in a rugged ABS plastic case with a clear lid. It can be used with induction motors rated up to 2.3kW and you will probably need one for each appliance you wish to protect.

Power is applied to the unit via a switched IEC connector attached to one end of the case. Note that this connector and its internal mounting plate must be secured using Nylon screws to ensure safety.
Note that since the year 2000, the electricity suppliers are obliged to follow Australian Standard AS3008 where mains voltage should be 230VAC with tolerance of ±10% and ±6%. That means the voltage could drop to 216V at the lower tolerance limit. Our circuit sets the switching threshold to 200VAC to avoid mains tripping during normal supply conditions.

A heavy-duty relay does the switching. While ever the mains voltage is normal, the relay contacts are closed and power is available to the load (motor). If the mains voltage drops below 200V for more than several seconds the relay contacts open to protect the motor. The relay contacts are rated for inrush currents up to 65A – ideal for switching power to a motor which is pulling heavy starting currents.

**Circuit details**

The full circuit is shown in Fig. 1. It comprises just a few low-cost components. These include a dual op amp IC1, a couple of transistors, a 12V regulator and the heavy-duty relay.

Power for the circuit is derived from the mains via a 12.6VAC step-down transformer, T1. This drives a full-wave rectifier using diodes D1-D4 and a further diode, D5, before filtering with a 470µF capacitor (C1). The resultant nominal 17V DC is applied to the 12V 7812 3-terminal regulator (IC2). IC1 provides the 12V supply for IC1 and the 12V relay.

**Brownout detection**

To detect a brownout condition, the circuit needs to monitor the AC voltage from the transformer secondary winding. In practice, we don’t do this directly but instead monitor the rectified DC waveform at the anode of diode D5. This is filtered using a 1000µF resistor and by a 100µF capacitor (C2) which is shunted by 10kΩ resistor, trim pot VR1 and a 100ΩF capacitor (C3) from an averaging filter to give a lower voltage (VP x 0.636 x 150kΩ/10kΩ = 3.6V).

So, why go to all this trouble rather than just monitoring the DC voltage across capacitor C7? After all, if the mains voltage varies, the voltage across C1 will vary in proportion, will it not?

The reason for using the averaging filter method is twofold. First, the actual AC waveform of the mains supply is usually “flat-topped” due to the loading effects of gas discharge lighting (eg, luminaires) and the capacitor-input power supplies used in all computers and most electronic equipment. Using the peak of the waveform to represent the actual mains voltage is not sufficiently accurate because the degree of “flat-topping” varies during the day, depending on whether it is peak or off-peak period.

Second, when the relay switches on and off, it causes a considerable variation in the voltage across C1. For example, across C1 we measured be at around 4.3V when a USB cable is connected and at 0V otherwise.

This pin is configured as a digital input (pin 3 of PORT D) which allows the firmware to detect when a USB cable is connected or disconnected.

Schottky diode D4 allows the circuit to be powered directly from the USB port and connects directly to the +5V rail. In the worst case, the VOUT line will be at ±4.75V (5V ±5% is what the USB standard specifies) and so the +5V rail can be as low as ±4.3V when powered directly from the USB port. D4 also protects against reverse polarity and prevents current flow into the USB port when the circuit is powered from a 12V battery or power supply.

Because the +5V rail can be substantially lower than +5V when powered from the USB port, you MUST perform any calibration with the full 12V input from the car battery. The actual voltage of the +5V rail will affect the ADC readings from the analog channels because it is the reference polarity for the ADC conversion. This will be explained in the calibration instructions, next month.

**Display circuit**

Microcontroller IC1 controls the display via 7-pin connector CON6, which plugs into CON7 on the display board — see Fig. 4. Fifteen of these lines control IC1 pin 8C327 FPN transistors to drive the columns of the LED display.

The display contains a triple 7-bit dot matrix LED module, a 74HC595 shift register (IC2) and a ULN2003 Darlington array (IC3). The 74HC595 is multiplexed, meaning that only one column is lit at any time. The brightness of the display is varied by changing the duty cycle of the column driving signals. The display refresh frequency is around 1500Hz.

IC2 is an 8-bit shift register and the seven least significant bits (Q0-Q6) are used to select one of the seven rows of LED segments. It is implemented to select any of up to four outputs for each register to go to tri-state. This effectively blanks the display. This is done by the microcontroller driving the +5V rail, and when the shift register is being loaded. The time that the display is disabled is so short that it is imperceptible.

The display connects with the shift register and is also controlled by a simple digital output from the microcontroller.

The seven bits from the shift register are used as inputs to the ULN2003, the Darlington array (IC3). The ULN2003 can sink up to 500mA in total between its seven outputs.

Note that there are no current-limiting resistors to the displays. Instead, we rely on the beta limiting of the transistors via the 600Ω base drive resistors. We found that even small value limiting resistors markedly decreased the perceived brightness of the LED display.

However, we have included a 3.3Ω current-limiting resistor on the supply rail to the display board. This causes the display to draw substantial currents (up to around 200mA peak) thereby affecting the +5V rail, which is used as the positive reference to the ADC system, the firmware also turns off the display when digitising the analog inputs. This happens too quickly to be perceptible.

An additional digital input on IC1 is used for pushbutton switch S1. It will be high when S1 is pressed and low otherwise. The signal is fed via CON6 at pin 7 and the switch is de-bounced by the software.

The USB type B socket is on the display board and the four connections are fed to the main board via CON6. The socket is used to connect the board to a computer via the USB standard.
The voltage at TP1 is fed to the non-inverting input (pin 5) of op amp IC1a which is connected as a comparator. A nominal 3.9V reference is provided by zener diode (ZD1) which is fed via a 560Ω resistor from the +12V supply. Trigger VR2 sets the switching threshold for IC1b and its wiper is connected to IC1b's pin 6 inverting input. Pin 6 is set to about 2.00V (representing a brownout threshold detection point of 200VAC).

So with a normal mains voltage, pin 5 will be at 2.3V (representing a 230VAC mains voltage). This voltage is higher than the 2V at pin 6 and so the output of ICb will be high (close to 12V). This switches on transistor Q1 which powers the relay (R714). The relay's contacts supply power to the appliance connected to the GPO.

When ICb's output is high, diode D7 will be reverse biased and so the 100kΩ resistor at pin 5 does not affect circuit operation. However, when the mains voltage drops to below 200VAC, the voltage at pin 5 will go below the 2V threshold set at pin 6 and so pin 7 of ICb will go low. This will switch off transistor Q1 and the relay, to disconnect power from the appliance.

Diode D6 quenches the back-emf from the relay when its magnetic field collapses, protecting Q1 from damage. Simultaneously, transistor Q2 switches on, providing the brownout indicator, LED2, via a series 2.3kΩ current-limiting resistor.

**Hysteresis**

When IC1b's output is low, D7 conducts and pulls pin 5 even lower than 2V due to the voltage divider action of the 100kΩ and 10kΩ resistors. For example, if the voltage at TP1 is at slightly less than 2V, the output of ICb will very close to 0V. The snub of D1 will be about 0.5V and so the divider action caused by the 10kΩ resistor connecting to 0V and the 100kΩ resistor connecting to 0.5V will give a voltage at pin 5 of (2.00 - 0.5) x 10kΩ / (10kΩ + 100kΩ) or 0.15V. This is a drop in voltage of 140mV. So instead of pin 5 now being at 2V, the action of the 100kΩ resistor, diode D7 and the 10kΩ resistor reduces the voltage by about 140mV, i.e., to 1.86V.

Before IC1b's output can go high again, the mains voltage would have to rise by the extra 140mV to make up this 140mV difference. This requires an increase in mains voltage of 14VAC. In practice though, because the average voltage at TP1 is higher when the relay is off compared to when it is on, the extra voltage required from the mains for the relay to switch back on again is 10V.

This voltage difference effect is called "hysteresis" and is included to prevent the relay from rapidly switching on and off at the brownout threshold.
Provided that the mains voltage remains below the brownout threshold, the relay will remain off. In fact, the relay remains off at any voltage below the threshold, including voltages down to OAC.

A power-on delay is included so that the relay only switches on about five seconds after power is applied. This delay is due to the values of the 100kΩ and 100μF filter components that monitor the average voltage from the rectifier. These are sufficiently large so that it takes time to charge up the 100μF capacitor to charge the voltage provided at TP2. This delay is also important to allow for the inevitable momentary drop in mains voltage which is caused by the high surge currents every time an induction motor starts up. Normally, these high currents only last a second or two, depending on the appliance, and we want to be sure that they do not cause the Brownout Protector to erroneously switch off the power.

Construction

The Brownout Protector is housed in a weatherproof ABS enclosure (171 x 121 x 56mm) with a transparent lid and neoprene lid-sealing gasket. The box is designed to meet the IP65 dust and moisture ingress standard, although this standard is compromised somewhat by the addition of the GPO and IEC socket.

All of the parts, except the GPO and IEC connector, are assembled onto a PC board coded 10112081 and measuring 152 x 108mm. This board has corner cut-outs at one end to allow it to sit on the base of the box.

The IEC mains input socket is positioned on the back of the board and is 3-pin. The socket is mounted on the transparent lid. The two LEDs on the PC board can be clearly seen through the transparent lid so the overall assembly is very straightforward. The complete wiring diagram is shown in Fig.2.

Begin construction by checking the PC board for any defects such as shorted or broken tracks. That done, check that the hole sizes are correct. The holes for the four corner mounting screws are 3mm in diameter, the holes for the transformer mounting points need to be 3mm in diameter, while the holes for the relay mounting points need to be 5mm in diameter. The transformer and relay mounting points need to be 3mm in diameter, while the holes for the relay mounting points need to be 5mm in diameter.

To get an approximate value for the resistor, R = 2000Ω - 10,000Ω where V is the maximum voltage range required (>5V) and R will be the new resistor value (ie. to replace the existing 22kΩ resistor). The resulting sensitivity will be approximately the value of V in mV (millivolts); eg. if V = 6, then the sensitivity will be about 6mV and the resistor value will be 3kΩ.

Since all calibration is done in software, you only need to replace the 22kΩ resistor corresponding to your Analog channel to improve the accuracy for that channel. The software does not need to be changed, as the values will be correct for your new divider when you perform the next calibration.

Oxygen sensor loading

Although the ADC inputs of IC1 have a high input impedance, the load on the analog inputs will be the sum of the 22kΩ (or your replaced value) resistor and the 10kΩ resistor, ie. 32kΩ (or 10,000 + R).

While this loading is high enough to result in very small current draw from most sensors in your car, you should be aware that typical narrowband oxygen sensors do not tolerate more than about 10mA current load. Since the ECU will have its own current load, we should aim to draw no more than about 1mA extra from such a sensor.

This means that if you wish to connect an oxygen sensor to this project, you should omit or remove the 10kΩ resistor to ground on the corresponding analog input. The result will be that the loading will then be the series impedance of the 22kΩ resistor and the high input impedance of IC1's ADC input.

The resulting extra current should be less than 1mA since the ADC inputs have a typical leakage current of just 500μA. Note that there will also be negligible transient loading due the 100μF capacitor.

Additional input channels

There are two additional analog channels used. One is used to measure the battery voltage at pin 1 of CON1. It has its own 56kΩ and 10kΩ voltage divider and 100μF bypass capacitor. The other analog channel is used to monitor a voltage divider on the display board consisting of a light dependent resistor (LDR1) and an R2kΩ resistor. The analog signal is at pin 13 of CON6 and is used to measure the ambient light level, to vary the brightness of the LED display.

CON4 is used to connect the relays and the buzzers used for the limit conditions.

Each digital output from the microcontroller is applied to the base of an
the relay mounting screws should be 4mm in diameter. Check also that the main PCB board is cut and shaped to size so that it fits into the box.

Inset the resistors first, taking care to place each in its correct position. Use the resistor colour code table when selecting each value. You can also use your digital multimeter to check each resistor before installing it.

Next, install PC stakes for test points TP1, TP2 & TP GND. This done, install the IN4004 diodes (D1-D6), the IN4148 diode (D7) and zener diode ZD1, taking care with their orientation. IC1 can be mounted next (watch its orientation), followed by the capacitors. Note that the electrolytic types must be oriented as shown.

The 3-terminal regulator (REG1) is mounted on the PCB board with a small finned heatsink. Leads need to be bent to fit into the holes provided and then it is secured on the heatsink with an M3 x 10mm screw and nut and its leads soldered.

Next, install trim pots VR1 & VR2, transistors Q1 & Q2, LEDs 1 & 2 and the two 2-way screw terminals CON1 & CON2. The transistors and LEDs sit a few millimetres above the PCB board.

The relay is secured using M4 screws and nuts while the transformer is attached using M3 screws and nuts. The transformer must be earthed and this is achieved using a short green/yellow earth wire with crimped eyelet. This is attached to one of the transformer mounting feet with two star washers, above and below the eyelet – see Fig.3. Note that the enamel must be scraped from the transformer foot to ensure good contact.

The IEC fused male socket and switch is a snap-in type intended for use with a mounting plate thickness of about 1mm. Unfortunately, the specified IP08 box has a wall thickness of 3mm so the socket cannot be mounted directly to it. Instead, the IEC socket is first mounted on a 1mm thick metal plate and this plate is then secured to the inside of the box using four Nylon screws and metal nuts. As a result, the flange of the IEC socket is mounted flush with the surface of the box, giving a neat finish.

Diagrams for the metal plate, the box cut-out and the socket cut-out in the box lid are shown in Figs 4-6. Note that the end of the box for the IEC cut-out is best located at the same end as the

<table>
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<th>Table 1: Resistor Colour Codes</th>
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<td>No.</td>
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<tr>
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</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>3</td>
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The PC board is secured to the bottom of the case using self-tapping screws that go into integral standoffs. The IEC socket is attached by first clipping it to an aluminium mounting plate (see Fig.5), then fitting it inside the case and securing the plate using four Nylon screws and metal nuts (see photos).

Two sets of mounting bushes located on the base of the box (see photo). Note also that the cutout in the box should be just enough to provide clearance for the flange of the IEC socket. Once the IEC connector has been secured in place, you can install the PC board. To do this, you will need to first slide the edge of the PC board under the IEC connector. The PC board is secured using for M3 x 6mm screws into the integral threaded mounting bushes on the base of the box.

Wiring

All wiring must use 250VAC 10A rated wire except for the relay coil wires to CON2. Brown wires are used for the Active and the blue for the Neutral. The green/yellow-striped wire is for the Earth wiring and must not be used for any other wiring.

Note that the mains wires terminate at the IEC socket and on the relay will need to use insulated crimp 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.

Note that the crimp connections to the relay will need to be bent over slightly so that the lid can fit without fouling. All wiring must also be secured with cable ties to prevent a loose wire moving and making contact with the low-voltage components on the PC board. We did this with nine cable ties, as can be seen in the photographs.

The two Neutral wires are also tied to the 3-pin socket using the holes on its moulding.

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

When you are testing and making adjustments, the Brownout Protector will need to be operated with the lid open. You must take care not to touch any of the connections in the 250VAC section when it is plugged into a wall socket, even though they are insulated by the crimp connectors (it is wise to be careful). This includes the wiring to the GPO, IEC connector, transformer primary and relay contacts.

First, set your multimeter to read up to 250VAC and insert its insulated probe into the display brightness and the number of lit pixels.

A 16V zener diode (ZD1) clamps the input voltage in case of transients. This is necessary to protect both the input supply bypass capacitor (470µF, 25V) and the 3-terminal low-dropout regulator REG1 (LM2940-5). The entire circuit runs from the +5V rail output by REG1. This supply rail is bypassed by a 47µF 16V capacitor and the 100nF monolithic capacitors near the microcontroller and other logic ICs.

CON2 (4-way) accepts the two identical frequency/duty cycle inputs. Considering pin 2 of CON2, for example, the signal is applied to the base of PNP BC337 transistor Q19 through a 33kΩ resistor. The 10kΩ resistor to ground sets the switching threshold to around +2.6V. That is, the transistor switches on when the signal input is above +2.6V and switches off for voltages below that.

Diode D5 clips any negative voltage excursions of the signal to the base of the transistor to around -0.6V. The collector output of the transistor is pulled up by a 10kΩ resistor and fed to the CCP1 (Capture/Compare) input (pin 17) of IC1 via a low-pass filter composed of a 1kΩ resistor and a 10nF capacitor. This low-pass filter removes potentially noisy signal transients.

The frequency and duty cycle of the input signal is measured by capturing the value of an internal timer run from the microcontroller’s system clock (12MHz). It counts how many system clock ticks occur when the signal is low and when the signal is high.

The counter is 24 bits wide. For example, when applying a 40% duty cycle rectangular wave at 100kHz, we will obtain the following counter values: $C_{low} = 48,000$ and $C_{high} = 72,000$.

In other words, the internal timer running at 12MHz counts up to 48,000 in the time that the signal is high and up to 72,000 in the time the signal is low.

From these two values, the firmware calculates the frequency and duty cycle as follows:

$$F_{req} = \frac{12,000,000 (C_{low} + C_{high})}{V_{out}}$$

Positive Duty Cycle = $100(C_{low} + C_{high}) / V_{out}$

Voltage/resistance inputs

The four voltage/resistance inputs are connected to the 6-way connector CON3.

Each analog input passes through a voltage divider consisting of 22kΩ and 10kΩ resistors and bypassed by a 100nF capacitor. Each resulting voltage is then digitized by the microcontroller using the onboard ADC (analog-to-digital converter) which has 10 bits of resolution and whose full range is from 0-5V.

The division factor from the 22kΩ and 10kΩ resistors is 3.2 which means that the analog inputs have a full range of 0-16V, suitable for most applications in a car or any vehicle with a 12V battery.

Any voltages above 16V will not be correctly read (i.e., readings will plateau), because the input protection diodes on the ADC inputs of IC1 will begin to conduct. The high current input impedance will ensure that the input

Fig.3 shows the circuit of the main board while Fig.4 shows the circuitry of the display board. In Fig.3, IC1 is the PIC16F8450 microcontroller and there are four multi-way terminal blocks. CON1 (4-way) provides the connections to the battery or DC supply. The 12V input from the car’s battery is passed through a 10Ω 1W resistor and a reverse polarity protection diode (D1). The 1Ω resistor will normally drop around 2V since the circuit typically draws around 200mA, depending on

Fig.2: these diagrams illustrate some of the readouts that can be scrolled across the three 7-segment multi displays. The battery and ambient light functions are built in, while all other functions are set up by the user via a PC program.
The unit is built on two PC boards—main board and a display board. These are stacked together, along with a red Perspex panel for the dot matrix displays (assembly details next month). Note that the boards shown are prototypes and the final versions are slightly different.

The second display mode is the Static Mode. In this mode, the selected reading is displayed without scrolling. You can make a short press to go to the next reading. Again, making a short press after the last reading turns the display off. The sequence then repeats again.

The third and last display mode is the All Scrolling Mode. In this mode, all readings are displayed as a scrolling string. The string then repeats continuously. Pressing S1 while in this mode takes you to the first display mode again and the whole sequence repeats from there.

In both scrolling modes, the name of the variable, the value and the unit are displayed as a scrolling string. In Static Mode, up to four digits are displayed at once.

In Static Mode, a maximum condition is indicated by the display flashing every second or so between normal and reverse modes, i.e., all the normally lit digits become unlit, and vice versa—Fig. 5. This is a very dramatic mode to indicate a problem condition. A minimum condition, on the other hand, is indicated by a flashing reading. As indicated, these visual cues are only available in Static Mode.

Note that the Battery Voltage is always displayed first. For each of the displayed variables, you select the variable number and the value index to display. You also set the order in which they are displayed.

Remember that you can change all settings and perform the required calibration using a laptop and a USB cable.

Electrical signals in cars

To get a good understanding of the signals used in cars, you will need to refer to the Stacci Out publication “Performance Electronics for Cars”. This has a range of useful electronic projects for cars and also explains how to intercept the signals from your car's ECU.

All modern cars have an ECU (Electronic Control Unit) that manages the ignition timing and fuel injection. Almost all electrical sensors in your car produce a voltage or vary their DC resistance, depending on the quantity being measured, or produce a digital signal (varying the frequency or duty cycle) to indicate the reading.

Different sensors have different voltage ranges. For example, a narrowband air/fuel sensor may have an output in the 0-1V range, whereas a tachometer sensor output may be a square wave at 5V with the frequency of the signal proportional to the engine's RPM.

By contrast, a fuel injector signal is digital (12V amplitude), with the positive period (i.e., the time the signal is at a high level) normally proportional to the time the injectors are firing. Alternatively, it may be inverted, with the negative period indicating the firing of the injectors. Since all calibration is done in software, either negative or positive duty cycles can be monitored.

This project will accept all of these types of signals and with software calibration via the USB port, it is easy to adapt to a wide range of different sensors.

How it works

The block diagram of Fig. 1 shows the main features of the circuit. As you can see, a microcontroller is the heart of the project and it drives the dot matrix displays, manages the USB connection and drives the two outputs.

Further testing can be done if you have access to a Variac. This can be used to reduce the mains voltage to check that the brownout detection operates at the required voltage.

If you do not have access to a Variac, then you can adjust VR1 so that the TP1 voltage dips just below the TP2 voltage. When it does, check that the relay switches off and that the brownout LED lights. Return VR1 to its correct position after this test and secure the lid with the four screws.

That completes the setting up. The Brownout Protector can now be used as is or you can mount it on a wall adjacent to the appliance. The case can be secured to the wall using four screws which are accessed via internal channels adjacent to the lid mounting screws.

Fig. 4: The cutout and drilling diagram for the GPO socket in the case lid. The 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.

Fig. 5: the cutout and drilling diagram for the IEC connector at the end of the box.

Fig. 6: Follow this diagram to make the mounting plate for the IEC connector.
Owens HDS1022M-N
Dual Channel Hand-held Oscilloscope

Review by Mauro Grassi

The Owon HDS1022M-N is a portable, dual-channel digital oscilloscope that can double as a digital multimeter. It comes in a rugged orange and gray multimeter style case and has two BNC sockets for the connection of oscilloscope probes. It can run from its internal batteries for about four hours or from an external plugpack supply.

This is not the only compact portable digital oscilloscope available but it is probably one of the most compact and attractive packages ever offered, considering its range of features and performance.

The DMM is a practical add-on, allowing you to carry one less instrument in the field, keeping in mind that its bandwidth is 20MHz when using a x10 probe (with a x1 probe, the bandwidth drops to 4MHz). 20MHz is enough bandwidth to diagnose faulty composite video signals, for example.

External connections

On the front panel, the Owon scope has four 4mm banana sockets for connecting the multimeter leads: COM (ground), V/DC (to measure voltage, resistance or capacitance) and two other sockets, one for DC and AC currents up to 400mA and the other for up to 16A.

Above the DMM sockets is an array of pushbuttons which control the oscilloscope functions. It can be toggled between scope and DMM functions by the DMM/OSC button. The display simulates that of a centre-zero analog meter but also includes digital readout. You can use the automatic scaling mode or manually adjust the scale. You can also use a relative mode where you can set the ground reference to an arbitrary value.

The oscilloscope inputs are on the side and are standard BNC types but without probe sensing. You can select the probe types (x1, x10, x100 & x1000) with the front panel buttons and the vertical sensitivity is adjusted accordingly. The unit is supplied with two x10 probes.

Note that the multimeter and oscilloscope inputs are isolated from each other, meaning that you can have two different GND references. This helps to avoid unintended and possibly dangerous shorts, especially when switching back and forth between DMM and oscilloscope modes.

The display

The Owon HDS1022M-N has a 96mm (3.8-inch) colour LCD with QVGA (320x240) resolution. The screen can be used with or without backlighting and can be read in direct sunlight. The display can show 4096 colours and is a good size. You can see a typical screen grab in Fig.1.

Persistence settings for the waveforms can be set from one second to five seconds and to infinite mode, a practical way to see quickly changing detail.

You can also change the display switch on at a preset RPM (perhaps to indicate when to change gear).

- Measure Throttle Position and Delta Throttle Position - if the accelerator pedal is pressed too abruptly, a relay can be made to switch on or off.
- Measure Speed - have a relay switch if the speed is too high or too low.
- Measure Fuel Tank Level as a percentage of full tank - have a relay switch on or off if the level is too high or too low.
- Measure Battery Voltage - have a relay switch on if the voltage is too high or too low.
- Measure Air/Fuel Ratio - have a relay switch on if the mixture is too rich or too lean.
- Measure Cabin Temperature - switch on a fan via a relay if it is too high.
- Measure almost any signal coming from the ECU.

So pick any six of the above possibilities and that is what this project could do in your car. But that is just for applications involving cars. In reality, this project can be used anywhere where a DC supply of 6-12V is available, or you have a computer with a USB port. It accepts voltage, resistance, frequency or duty cycle inputs and has two digital outputs for switching on limit conditions. We will bet that you can think up lots more potential applications.

The project itself uses two PC boards stacked with red Perspex on top. The top (display) board has a group of three 5 x 5 dot matrix displays, a USB port and a single pushbutton. The main (lower) PC board has the microcontroller and all the supporting circuitry for the connections and the optional output connections to relays or buzzers.

To build and set it up, you will need a laptop or desktop computer with a spare USB port. You will use Windows-based software (downloadable from www.siliconchip.com.au) to set the measurement functions, calibrate the sensors and do data logging.

The LED display can be dimmed (either automatically by sensing the ambient light level or manually) and you can select the scrolling speed of the display, as well as the naming of the measurements and their units. In static mode, the LED readout can display up to four digits. It can also be turned off using the front panel pushbutton.

The two output channels can drive external 12V relays directly and can be programmed to respond to maximum and minimum settings for any of the measured variables. Alternatively, the outputs could drive buzzers to give an audible indication that signals have exceeded their programmed limits. You can choose different sounding buzzers to indicate maximum or minimum conditions, when using two different buzzers. Or you can use only one buzzer and the maximum and minimum limits are indicated by different sequences of beeps.

When you only need a visible indication of a limit condition, there are visible cues (a flashing display for a minimum condition and an inverted display for a maximum condition) on the LED display when in static mode.

So there are many uses for this display and it's really up to you as to how you set it up.

User operation

User operation of the Car Scrolling Display has been kept deliberately simple. There is just one pushbutton on the front panel (S1) as a momentary SPST switch. The firmware recognises a short press and a long press. A short press is anything less than about a second, while a long press is anything more than that.

There are three display modes. You switch to the next display mode by holding S1 pressed for more than a second, i.e., by making a long press. The first is the Scrolling Mode where only the selected reading is continuously displayed as a scrolling string. In this mode, pressing S1 for less than a second (i.e., a short press) will take you to the next reading, and that will then scroll continuously.

After you have scrolled to the last...
Monitor, display and log up to six sensors and display up to 10 readings!

Multi-Purpose Car Scrolling Display

This project started out as a digital dashboard display but has grown and can be used in any measurement or data logging application where you have 9-12V DC available. It can monitor up to six signals and display up to 10 computed values in a scrolling or static readout on a 7 x 15 dot matrix LED display.

So what’s a scrolling display? You really need a short video to show what this project does. The readout continually “scrolls” from left to right, displaying one, two and up to 10 computed values from up to six different signals. Each value is preceded by its description, such as battery voltage, temperature, duty cycle and so on. If you want to focus on one reading, pressing the sole pushbutton will make the display static. Anyway, let’s just give a sample of what this project can do:

- Measure Engine Temperature – have a relay switch on above a preset temperature.
- Measure Fuel Injector Duty – have a relay switch if the duty cycle is too high or too low.
- Measure Engine RPM – have a relay mode to use XY where channel 1 will correspond to the X (horizontal) coordinate while channel 2 will correspond to the Y (vertical) coordinate. The result will be a Lissajous figure.

Quick setup
As with most oscilloscopes, this one has an “AUTOSET” feature. When you press the AUTOSET button, the oscilloscope will display the waveforms, choosing the settings for the time base and vertical scale (among others) that gives the optimal display. This makes it easy to get a signal on the screen. From there, you can manually adjust those settings as needed.

Incorrect settings for the trigger level and trigger offset can give a poor, unstable display. With this oscilloscope you can always zero both of these (zero corresponds to the centre of the display) by pressing the V and R keys (normally used in DMM mode to select Voltage and Resistance measurements).

Portable use
The internal 350mAH 7.4V Lithium ion battery will provide enough power for around four hours’ use when fully charged. Turning off the screen back-lighting will improve the battery endurance substantially.

However, you can use the plugpack to power the oscilloscope and charge the battery, when you have access to mains power. It takes about the same time again to fully charge the battery. It would also be useful to have an in-car adaptor for use with 12V systems.

Acquisition modes
This oscilloscope supports up to three different acquisition modes. In standard mode, samples are acquired at equally spaced time intervals. This is a good general-purpose mode but you may miss fast glitches in the signal, which can be important if you are trying to diagnose faults.

Alternatively, to better capture fast glitches in the signal, you can use the peak detect mode, whereby the oscilloscope will only take the maximum and minimum points in each time interval and display those.

If the signal contains a high proportion of random noise, you can select the averaging mode. In this mode the oscilloscope averages out to 128 sweeps of the waveform, effectively cancelling out the noise component.

Triggering
For triggering, the oscilloscope has AC or DC coupling and LF and HF rejection. It also has an unusual feature allowing you to change the so-called SENSITIVITY. This is a multiplicative factor between 0.2 and 1.0 applied to the trigger. It refers to the proportion of the current vertical division setting under which the trigger will be ignored and makes the oscilloscope more or less sensitive to triggering. This is useful for adding another layer of filtering and reducing the effects of unwanted noise.

Edge and video triggering are available. In edge mode, triggering occurs when the signal contains a rising or falling edge passing through the trigger threshold, which is selectable. With video mode, both PAL and NTSC/SECAM are supported.

A third triggering option is ALTERNATING. In this mode, you can select edge or video triggering for each channel. Triggering will then alternate between the chosen triggering options for channels 1 and 2.

This is useful if you are viewing two substantially different signals simultaneously, such as two signals with markedly different frequencies, for example. The use of this mode is shown in Fig. 2.

Menu system
The Menu system is composed of a vertical on-screen column of options (appearing and disappearing on the
right of the screen) comprising the main menu, as well as a horizontal row of options (appearing and disappearing from the bottom of the screen) showing the sub-menu options.

The settings are changed using the five buttons immediately below the screen.

There are two sets of three buttons for changing the vertical sensitivity of each channel, as well as a set of four arrow buttons having different functions depending on the context. The most common use for the horizontal pair of these is to change the timebase setting, while the vertical pair change the trigger level.

The menu defaults and button functions are well chosen. As with any menu-defined keyboard it can be easy to lose your way when the definitions change.

This oscilloscope shows the current definitions for the multiplied buttons on the screen, which is helpful. Overall, the user interface is intuitive and should be easy to learn.

Quick measurements
This oscilloscope allows you to show up to two measurements, superimposed on the display in the top left corner, as shown in Fig.3.

You can choose the channel for each of the two measurements, as well as choosing which you want to measure. The choice of

Fig.4: the red trace is a sinusoidal waveform at around 150kHz while the blue trace is a pulse train at similar frequency. The green waveform is the result of the MAT505 fences that subtracts the value of the blue trace from the red trace in real time. The timebase stands at 50ns/div. Note that the vertical scales for the two input channels differ and are shown in the bottom left corner of the screen to be 10V/div for the red trace and 5V/div for the blue trace.

limited, though, just the following five: cycle RMS, mean, peak-peak, frequency and period.

Because you can choose the channel for each measurement, you can have two of these measurements applied to the same channel.

Keep in mind that two of the five measurements are really essentially the same; frequency is the reciprocal of period. You can, however, use the two cursors to measure other vital statistics of the signal. For example, you could use the cursors on a rising level of a waveform to measure its rise time (say between the 10% and 90% points).

The supported MAT505 functions include the four arithmetic operations. You can use the effect of adding, subtracting, multiplying and dividing the two signals as a third trace on the screen, in real time. Fig.4 shows the MAT505 functions in action.

Saving and transferring waveforms
The oscilloscope allows you to save up to four waveforms to its internal non-volatile memory. You can also use the small USB cable adaptor to connect a USB flash disk and save to that. This is an essential feature for any portable oscil...
The two scope inputs are on the lower right side of the meter, adjacent to the multimeter inputs.

The remaining connectors lie along the top edge, above the screen. On the left is the DC power/charger input, with the COM, USB and HOST sockets alongside (left to right).

locope since you will be using it in the field and will likely find it convenient to save some of your work.

Using the supplied PC software, you can then view the images on your PC. It lets you connect to the oscilloscope in real time, as well as viewing previously stored waveforms.

As far as we can see, however, it does not let you export bitmap or GIF files (the version we tested was 6.6.0.1), although you can get around that by printing to files.

The PC software does allow you to export the waveform data to a spreadsheet such as Excel. A screen grab from Windows XP is shown in Fig.5.

Zooming functions
The Owon HDS1022M-N oscilloscope has zooming functions. You set the width of the desired window by moving the cursors outwards from the centre of the screen. Then pressing the "Windowing" button adjusts the display to fill the selected area onto the entire display, as shown in Fig.6. We must stress though that these functions don't enable you to see very fine detail, mainly because the resolution of the display as well as the memory depth (6kpts) are somewhat limited.

Conclusion
The Owon HDS1022M-N is an affordable portable oscilloscope that is best suited for diagnosing video problems in the field, as well as for debugging most lower frequency circuits (up to 20MHz). It should be suitable for most audio work as well.

The user interface is easy to learn and logical, with on-screen cues helping you at key moments. It is also nice that the cage disappears after a few seconds of inactivity, making the display less cluttered. The display is big but of relatively low resolution and it is easy to read, even without backlighting.

The fact that it incorporates a DMM is a welcome addition. Both the scope and DMM inputs are rated at CAT II 400V maximum.

The unit is supplied with two x10 oscilloscope probes and two DMM leads, as well as an aluminium carry case. The charger and PC software as well as a small cable to connect a USB device are also included in the price.

The Owon HDS1022M-N retails for $1149.00 (inc. GST). For more details contact Owon Australia, Phone: 1300 792 976. Website: www.own.com.au.

siliconchip.com.au
Simple Voltage Switch
For Car Sensors

This Simple Voltage Switch can be used anywhere you want a relay to switch when a voltage reaches a preset level. It has lots of applications in cars but can be used in any application where you have 12V DC available. Having switched the relay on, it will then switch off as the voltage being monitored drops below the preset level.

Main Features

* Adjustable switching level between 0V and 16V at input
* DPDT relay
* Configurable to switch on rising or falling voltage
* Adjustable hysteresis
* High input impedance – won’t load down sensors

In CAR APPLICATIONS, many engine sensors have variable voltage outputs and these can be used for relay switching. For example, if your car has an air-flow meter with a voltage output (most cars have), then you can use that as an engine load signal to switch things on and off.

For example, do you want a warning when fuel usage is going through the roof, as it will be when the air-flow is high? If you use this project, it can turn on a light and/or sound a buzzer so you can ease off on the accelerator or change down one gear, or both.

Or you could use the throttle position sensor directly, to do the same thing. Or going back to the air-flow sensor, in a turbocharged engine, you could use the Simple Voltage Switch to boost solenoids to close off the turbo waste from the boost pressure source whenever engine loads are low.

Or maybe you could use the unit to control a water spray onto the intercooler. We are sure that you will be able to think of plenty of nifty ideas.

This project was first presented in our "Performance Electronics for Cars" book published a few years ago and we are re-presenting it this issue to give it a wider exposure.

It is quite simple in presentation; just print out the relay and a handful of other components. You should be able to assemble it in less than one hour.

Circuit description

Fig. 1 shows the circuit of the Simple Voltage Switch. It relies on comparators IC1a, which compares the input voltage to a preset reference level. The input voltage (Vin) is divided via two 1MΩ resistors in series which effectively apply one half of the voltage to the

ing their mainstream films, their blockbusters in the evenings of high attendance days like Thursday, Friday and weekends. Then, earlier in the weeks, or afternoons, they can run art house movies and attract a whole new audience.

There is also reduced pressure on film prints wanted by the distributor who may need to ship it out to Orange or Goldsands.

Copyright

AIST itself handles the dubbing to hard drive, so it becomes a subsidiary and complementary form of release. To illustrate this, Case recalls a typical film — The Queen — in 2007. This went out on about twelve 35mm film copies, which went into metropolitan centres, added to which were about forty digital copies. These were encoded into an MPEG format, compatible with ezC.

If a film is supplied as a film master, AIST can make digital copies or transfer to film:

What do you do about copyright protection?

Case: “When digital release started people were more concerned with getting their film out there than they were with copyright protection. Hollywood is always a little worried about the level of copyright protection because there is significant money to be made and also because it’s a Hollywood product — it’s all about the first week’s returns.

With the sort of typical art house product, it tends to be a different audience. The audience is not disappointment included in it if you can’t get to see it on Day One and the distributors are just anxious to get the thing out there. You know AIST copyright would not incur a huge blackmail of revenue. But now we’ve got ezC established, we’re looking to some form of encryption.

The company has dealt with a couple of hundred cinemas around the country and certain cities and venues. Most of these are independently-owned, although the Reading and the Dendy cinemas along with the Palace chain have a few digital installs.

So cinemas have retained their 35mm projectors and will for some time. In Case’s view “The issue as far as the mainstream cinemas concerned is the high cost of digital project and ancillary equipment. If you’re putting in a new cinema you can’t afford just to put a digital projector in, you’ll be putting film in as well, so it’s an additional cost. The exhibitor gets nothing extra.”

The financial challenge for cinemas, especially independents, is that it’s not a matter of ‘either/or,’ it’s a matter of ‘plus’.

Cinemas already have 35mm projectors installed.

Case: “They are usually paid for, amortised and they are churning on.

Or maybe you could use the video camera and set it up in the back row of the cinema and record the movie off the screen, then it’s very high risk, because both the image and the audio track could have watermarking on them. If needed, the movie’s distributor can go back and find out exactly which cinema it was actually shown in.

Even when the movie is burnt to a DVD, the forensic watermark can still be detected and the cinema that showed the movie can be pinpointed as well as the date and time of projection.

More info on watermarking: www.techweb.com/winn/199221647

Acknowledgement:

Barrie Smith would like to thank David Sanderson and David Hill of Kodak and Dominic Case and Ben of AIST for their considerable help and assistance in preparing this story.

Anti-Piracy

It is no secret that Hollywood has been concerned about movie piracy for a long time. On the morning following the world premiere of Phil Noyce’s “The Ugly American” in Hanoi pirate DVD copies were on sale throughout the city, captured by an audience member and his/her camcorder. One trade association claims a camcorder copy of a movie can be the source of more than 90 percent of all illegal copies during initial release.

David Sanderson explains that every movie is 128-bit encrypted on the medium delivered to the cinema. If you intercepted an encrypted hard drive containing a movie and tried to play it, it won’t play. Only if you set up a full digital cinema, you couldn’t play it. You need to have the KDM that is supplied with it. That KDM will only allow the movie to be played at a particular site, as in a multiplex, one particular multiplex between certain dates — and you try to do this at any other time, it doesn’t work, that makes the distribution side very, very secure.

Or maybe you are going to take your video camera and set it up in the back row of the cinema and record the movie off the screen, then it’s very high risk, because both the image and the audio track could have watermarking on them. If needed, the movie’s distributor can go back and find out exactly which cinema it was actually shown in.

Even when the movie is burnt to a DVD, the forensic watermark can still be detected and the cinema that showed the movie can be pinpointed as well as the date and time of projection.

More info on watermarking: www.techweb.com/winn/199221647
The RealD 3-D system is based on the traditional method of 3D imaging, using linearly polarised glasses. The traditional method works by projecting two linearly polarised images onto the same screen, polarised at +45° and -45° from the horizontal, which are then filtered by linearly polarised glasses worn by the audience. 3D imaging requires two projectors, and often suffers from double-imaging if the head is tilted to the side, thereby cancelling the polarised effect.

RealD however uses a single projector that alternately projects the right and left eye frames, and circularly polarises these frames clockwise for the right-eye and counter-clockwise for the left eye, using an LCD screen in front of the projector lens. Circularly polarised glasses make sure each eye sees only its own picture, even if the head is tilted. A high frame rate of 72 fps is used — each frame presents three times in succession to the observer, to produce the sense of depth, as the source vision is usually a few hundred milliseconds.

Some of the films in RealD: Chicken Little (2005), Monster House (2006), and Sex and the City (2008). Globally, 1000 screens ran the latter title in 3D.

Dolby 3D is based on INFITEC (Interference Filter Technology) technology, originating from a research project of Daimler Chrysler. INFITEC uses an extremely fine-thick holographic film for circularly polarising light. Light waves entering the eye are separated into three different bands by means of different types of polarising filters, related to the primary colours. Dolby 3D uses six very narrow bandwidth colour bands — three for each eye. This allows the display of one light source in a single lens projector.

There are processes in the works to 2D-3D movies that were not originally shot in 3D. Dolby has the very comment that while "there are some very clever people who are using processing and filtering and 3D蜕变 3D; it's a very interesting thing to see Casablanca in 3D — and I'm thrilled when that happens!" But Dolby also believes that film-making for a single screen cinema with a smaller screen, the quality is close to that previously experienced with film projection. He adds that there's a "couple of hundred successful films" currently showing presentations in a process that has come to be called eCinema.

"The problem is that the audience in a Hollywood studio won't allow their product to be shown in a 2D manner. Independent distributors and the like have begun to show live screen presentations of ballet and opera, organised by the Australian Film Commission. And as we've seen live in a handful of rural cinemas.

It also means that the independently owned smaller cinemas as well as regional cinemas can now get art house and Australian-made films, supplied on portable hard drives that they couldn't get before because there weren't enough prints available. In a typical installation, the cinema is supplied with a server and a digital projector. AIST fits its own logic boards and software to supply the Panasonic LCD projectors.

At this pricing level it also means a change in the cinema quality, making DV by using hard drives that supply the film, which means that the cinema operator can actually control the film and the screen any way it wants. The 3D cinema requires that the cinematographer be changed as well. The "ultimate" is that the cinematographer..."
The Simple Voltage Switch could be used to monitor the oxygen sensor signal, allowing devices to be turned on or off when the air is too lean. The unit won't load down the signal, so it can still be used by the ECU.

The input voltage is close to the preset threshold.

IC7b is an inverter and it provides a signal which is the opposite polarity to IC6a's output. It compares IC6a's output with the +5V set on its non-inverting input. When IC6a's output goes high, IC7b's output goes low. When IC6a's output goes low, IC7b's output goes high.

Link LK1 provides the option of driving the relay with a falling (NL) input voltage or a rising (LH) input voltage, respectively. The output selected (either from IC6a or IC7b) drives transistor Q1 which in turn drives the relay.

The diode across the relay coil (D2) is there to quench the reverse voltage that is generated by the collapsing magnetic field of the relay coil when it is switched off. Without the diode, the relay could generate very high positive voltages which could blow the buffer transistor.

Power for the circuit is obtained from the switched +12V ignition supply. Diode D1 gives reverse connection protection, while the 100Ω resistor, 100Ω capacitor and zener diode ZD1 provide transient protection at the input of regulator REG1.

The reference current is powered from the output of REG1 (+8V), while the remainder of the circuit is powered from the +11.4V rails which are derived before the regulator.

### Construction

While the unit is simple to build, you need to know one thing about its eventual application. Will you be using it to detect a voltage that will be increasing (L/H) to the preset trigger point or falling (NL) to the preset trigger point? The unit can be made to work either way but you know this before you assemble it. There will be no need to make changes when it is ultimately installed.

The low to high (L/H) voltage condition will be the most common, as in our example of switching an intercooler spray when the air-flow signal rises above a particular point, say 4V. Below 4V, the spray is off and above 4V, the spray comes on.

So ideally, you need to know which configuration you want before starting assembly. That way, you will know how to set the position of the link on the board and the orientation of diode D3. On the other hand, if you do build and later decide to change the application, it is a simple matter of changing the link setting and the orientation of D3.

For a rising voltage detection, the moveable link LK1 is placed in the "L/H" position, as shown in the component overlay diagram of Fig. 2. Then diode D3 is oriented so that its cathode band is closest to the top of the board. For the opposite condition, detection of a falling voltage, the link is moved to its "H/L" position and the diode's orientation is reversed. When assembling the PCB board we

VPP is similar to a surcharge on the rental cost per movie, with the distributor or the US studio financing the roll-out. This would be a massive saving when the latter can distribute digital films to the cinemas when compared to the cost of distributing rolls of film per cinema.

This is happening in the US and Europe at the moment but has been stalled for the last 12 months, mainly because of the lack of finance.

### Release

Will digital cinema help the smaller film producer with a title on limited release?

Sanderson: "I think the answer is yes, because they can go through the post production phase which is probably lower in cost in digital, particularly if they get it out to a lot of cinemas, then taking digital copies is a lower cost."

A block-buster, such as a Batman or Bond movie, can face a simultaneous release to possibly 2000 or so screens Australia-wide. With a 35mm print cost likely to be around $3000 per copy, you don't need a PhD in maths to see that a digital release of a movie on portable hard drives at less than $100 a pop would have the movie people salivating at the thought.

The only counter to this is that, for a while a come, film distributors will need to have dual inventories of film and digital release media. In the long term though (probably within five to ten years), the benefits will be substantial.

Satellite distribution would seem to ignite another fire in the movie industry's eyes and remove all media costs. David Sanderson feels this is some way ahead and, to illustrate the situation, recalls talking to a very large company in India, who own a fibre optic network that encircles the country.

He explains that, while the Indian company can distribute the movies via that system it still takes them something like twelve hours to push a movie out through the network. A two hour movie, even in compressed form, can reach 250GB.

### Opportunities

Digital presentation also delivers many opportunities to the canny cinema operator in the form of television presentations. Both globally and in Australia, live presentations of sport and opera are already in train.

The only attraction that film may still maintain is the culture of film. "Talk to any major cinematographer and you will hear they still want to shoot with film because of the creative benefits it affords them (real or perceived)."

So the choice of camera technology is striding ahead, particularly in

### 2K or 4K?

Digital High Definition TV has a vertical resolution of 1080 pixels, with a horizontal resolution of 1920 pixels. It's generally understood that no detail whose width is limited to 1/1920 the screen's width — a single pixel — can be seen.

Digital movies are created by digitizing the original 35mm film and packaging the data into a DCP (Digital Cinema Package) for distribution. Most commonly, the digital movie is distributed on a portable hard drive. There is compatibility between current 2K and 4K systems. Movie files created at 2K can be exhibited on 4K systems — 2K images are automatically up-converted to 4K data; a 2K projector can replay a 4K movie but limited to 2K quality on-screen.

The interchangeability between 2K and 4K means that a studio need only distribute one movie file, whether it is 2K or 4K, and it can be played by any compliant projection system.

In a 2K scan from film to digital, the number of pixels across the width of the scanned film frame is at most, 2048 pixels. In a 4K scan, that upper limit is doubled, to 4096 pixels.

The difference between 4K and 2K projection?

In digital cinema, a 4K image with a 2.39:1 ("scope") aspect ratio has 4096x1716 pixels. A 4K image with a 1.85:1 aspect ratio has 3996x2160 pixels.

By comparison, a 2K image with a 2.39:1 aspect ratio has 2048x908 pixels. A 4K image with a 1.85:1 aspect ratio has 2048x1081 pixels.

Kodak's David Sanderson made the point that future movie production might be 8K on the screen — and not 2K or 4K — but the audience would not see anything of that at all.
If a cinema wants to run 3D movies then it may need to install a high gain screen for some processes. Some cinemas currently run 3D movies with a thin screen illumination of only 8 foot-lamberts.

One process, the RealD 3D system, needs a metallised screen because it's a polarised light system. There is also a Dolby 3D system which needs a high gain white screen, because of the filtering system used in the process. See Info Box "Three Dee".

VFP

How will the cinema operators pay for digital?

Sanderson: "At the moment, if they are running 3D, they're having to do it out of their own pockets. This is countered by a premium price for 3D admission tickets."

Then there is the Virtual Print Fee (VPF) scheme requiring co-operation from the US film studios and a company like Kodak, who can support a roll out of digital cinemas.

Once agreements are struck with a finance company then you can start to roll digital installs. A VPF pays off the equipment and does not go to the cinema. The cinemas basically have to put up a small portion of the total cost to join in the scheme and as soon as they sign up the equipment goes into their cinemas and from day one they just show movies in digital.

Testing it

Test the kit at your workbench (or kitchen table) to make sure that it is working, as it should. Do not be tempted to install it straight into your car or other application before you know that it is definitely working properly.

You will need a 12V battery or DC power supply and a variable voltage, to simulate the sensor output that the unit will be monitoring. The easiest way to do this is as is shown in the photo on page 79 – it's just a matter of connecting a pot (e.g. 10kΩ or more) across the supply, to give 0-12V variable voltage at the wiper terminal.

Connect the DC supply and a potentiometer, as shown in the photo. Now rotate the potentiometer back to forth over its full range. At some point as you are rotating the potentiometer, the relay should click and LED1 should turn on or off. Rotating the potentiometer back the other way should again make the relay click and switch LED1 back.

This view shows the fully-assembled PC board. Make sure that you install the polarised components the correct way around.

The placement of the link and the orientation of diode D3 (both circled here) will depend on whether you want to activate the switch on a rising voltage or a falling voltage. As shown here, the unit is configured to trigger on a rising voltage, which is the most common requirement. To trigger on a falling voltage, reverse the orientation of diode D3 and move the link to the H/L position.

The cinema already has a high quality system the existing set up will work well.

Unless the cinema plans to run 3D movies there is no need to change the screen itself. The standard screen illumination is 14 to 16 foot-lamberts and digital installs are designed to run at this level.

With a new digital installation it may not be necessary to upgrade the audio set up. If the cinema already has a high quality system the existing set up will work well.

So, in fact if the audience doesn't notice the difference, it's a success.

Roll-outs

The matter of cost per installation opens up another can of worms.

According to Sanderson this figure can probably reach $100,000 “by the time you get the equipment and the screen and everything set up.

"For every screen you have to have a projector. Then you’ve got to have what’s called a content player, a computer box that actually stores the movie on it that's going to play to that screen.

“And then you need automation interfaces — the devices that turn lights on and off, open the curtains and all that sort of thing. Added to this and constituting the master control is the TMS. You need one of these for the multiplex; it talks to each of the individual content players and projectors in each of the cinema halls."

"In the future it will all run through the one digital projector.”

Is there a difference?

I asked Sanderson would an audience know the difference with digital.

He answered that generally the audience doesn't, unless they are attuned to looking for scratches or dirt on the print. He added that the quality of film and digital are very similar.

So, if the audience doesn't notice the difference, it's a success.
Using a multimeter, measure the voltage at the signal input [ie, connect the positive probe of the multimeter to the signal wire and the negative probe to earth] and measure the voltage at which the unit is activating the relay. For example, with the unit arranged to read rising voltages, as you gradually raise the input voltage the unit will trip at 5.0V.

Now very slowly reduce the voltage to see at what point the relay turns off. You might find that the latter voltage is 5.2V, meaning that the hysteresis (the difference between the switch-on and switch-off voltages) is 0.3V. Rotate VR2, the hysteresis pot, to make sure that the hysteresis changes. For example, with a switch-on voltage of 5.0V the switch-off voltage might now be only 4.96V; but a hysteresis of just 0.04V is making it too critical. As you rotate VR2 clockwise, the hysteresis will increase. Note that changing the hysteresis will not change the trip point, allowing the two to be set individually.

Next, you can test VR1, which sets the trip point. As you turn VR1 clockwise, the trip voltage will increase. VR1 is a multi-turn trimpot, so that the trip point can be set very precisely. Note that you can keep on turning this type of trimpot endlessly and never reach a clear "stop".

Installation

Fitting the unit to a car is straightforward. You will need to provide an ignition-switched +12V supply, earth (chassis) and the connection to the sensor signal you want to monitor. For example, if you are triggering the unit from the air-flow meter, you'll need to use the workshop manual and a multimeter to find this wire. You will need to confirm that it has a voltage on it that rises with engine load and you will need to drive the car to do this.

The device to be switched by the relay will be connected to the Normally Open and Common relay contacts. Fig. 2 shows these connections.

Note that because a double-pole, double-throw (DPDT) relay has been used, another independent circuit can be switched simultaneously. This other circuit can even turn off the second device as the first is switched on.

If you want to simply monitor a voltage such as that from the oxygen sensor, you can delete the relay and mount the LED on the dashboard. In this way, the LED will come on when the fuel mixture is rich, when the mixture is oscillating in closed loop mode, and turn off when the mixture is lean.

Setting it up

There are two ways of setting up the Simple Voltage Switch:

(1) Measure the sensor voltage and then set up the unit on the bench to operate at this voltage. This will probably avoid any need for fine-tuning in the car.

(2) Do the complete set-up on the car itself.

If you are using an oxygen sensor to trip the unit, then the first way is better. For example, if you want the unit to
trip when the sensor signal rises above 0.45V, then set it up on the bench to do this. When you subsequently install the unit in the car, you will only need to make a small adjustment to VR1.

However, if you want to turn on a device when monitoring the air-flow, it's best to do it on the car, because the air-flow meter signal varies over a much wider range. Start by lining up, set the hysteresis pot to its minimum setting [ie, fully anticlockwise] and then adjust the trip point until the unit triggers when you want it to. If the relay tends to chatter around the trip point, rotate VR2 clockwise to increase the hysteresis. When it is tripping at the correct voltage, check how long the device continues to operate as the voltage again drops (assuming the unit is set to trip on a rising voltage).

For example, if you are using the unit to trip an intercooler water spray on the basis of air-flow output, does the spray go off fairly quickly as the load again drops? In some applications, the hysteresis setting will be critical while in other applications it won't matter much at all.

In most cases, once the unit has been set up, it won't need to be altered.

The PC board fits into a standard 130 x 68 x 42mm jiffy box, so when the system is working correctly the board can be fitted into the box and installed under the dash or wherever it is convenient.

Footnote: A kit for this project is available from Jaycar Electronics, Cal. W2577.

A handful of projectionists could move between screens and keep an eye on where things are from one screen to another. But, Sanderson stresses, "you know you need to have someone there in case something does happen, and that will still apply with digital."

Digital also means the whole show — say a movie plus ads plus trailers for coming movies, can all be run as a single program.

Sanderson: "It's all moving in that direction very quickly. At the moment you'll tend to get the ads possibly run from a separate digital system to the main movie and the trailers could be today running on 35 mm film.
other benefit for the audience is going to be that more cinemas will be able to show a new movie on day one, thanks to the lower cost per title. Country cinemas can then enjoy simultaneous release with the capitals.

And for the cinema operator? Automation is the key to the cinema’s main benefits. When a cinema multiplex is fully digitised, a Theatre Management System (TMS) is installed — virtually, a computer that runs the show.

The movie on a hard drive is loaded into a server and then the TMS works with the ticketing system that the cinemas use today to program what shows run on what screens.

At that point, the TMS takes over and sends the movie data to the appropriate projector/screen and starts the movie at the right time. In fact, it runs the whole show — dims the lights, opens the curtains etc.

The Key

The movie can be delivered in any of three different methods to cinemas: via remote management on a Virtual Private Network (VPN), by satellite transmission or by physical media (hard disk drive).

Also sent to the cinemas is the Key Delivery Message (KDM), most likely in the form of a USB flash drive or sent via a phone line and a modem. This is provided by a film’s distributor or its laboratory.

The KDM is the more than an anti-piracy device. It’s the content key that unlocks the encryption on the movie and therefore unlocks the movies for the correct dates on which the cinema is allowed to play it and what day it has to finish. If a theatre wants to screen a movie outside of the parameters the KDM allows, they would need to obtain a new KDM from the distributor.

There’s even more to this locking process, as explained in the Info Box ‘Anti-Piracy’.

Out of Focus

Today’s metro multiplexes are operated by minimal staff. You’ve probably found that the standard of film projection at your local multiplex confirms this, with delayed projection, the movie often out of focus or out of rack for five minutes or more, with sound frequently at painful levels until the projectionist corrects matters.

Digital projection can only improve this situation and allow a multiplex with ten or more screens to be operated simultaneously.

Atlab Image and Sound Technology are pushing ahead with their own approach to digital cinema and see little demand for 4K projection.
The 2008 AEVA Electric Vehicle Field Day

This year’s field day for the Australian Electrical Vehicle Association, held at Annangrove in western Sydney during late October, had a range of interesting electric and hybrid electric vehicles on show.

Some were fully converted cars that are driven on a regular basis while others were “works in progress” which may be up to a year or more away from completion.

There was also a Toyota Prius which had been modified with extra battery capacity and an on-board charger.

At the outset it must be said that anyone who decides to convert any conventional vehicle to electric drive is taking on an ambitious project. Typically, the way they go about it has never been done before: to convert exactly that vehicle type or model, using that combination of motor, batteries, controller etc.

So the AEVA annual field day is very much a display of DIY electric vehicle technology.

The AEVA field day at Annangrove was pretty basic in format – just a big open shed with lots of electric car enthusiasts poring over the cars. There was even an electric go-kart – with neck-snapping acceleration!

by Leo Simpson

The 2008 AEVA Electric Vehicle Field Day

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epending on who you ask, the cinema industry, as distinct from the production side, is under challenge – from metre-plus LCD and Plasma 16:9 home screens – or it’s not under challenge, thanks to a flood of successful block-busters.

These are pulling millions of dollars from patrons happy to travel to a multiplex, sit in the dark with a crowd and enjoy the movie experience after paying $16 plus for each ticket.

The Australian figures are revealing. In its 10-week run Batman’s Dark Knight pulled $45 million while Mamma Mia! did $30 million in a similar period. Movies make money. Buckets of it.

The two thousand cinemas that constitute the Australian exhibition industry all have film projectors, mostly 35mm models that have served operators well for decades.

The principle of 35mm projection has remained basically unchanged since 1885, when the brothers Lumiere held their first public movie screening, at Paris’s Salon Indien du Grand Café. Wise minds would say “Don’t mess with it. It works.”

That makes you wonder why there is a push to digital cinema. To find out, why I spoke to some industry players busy trundling digital projection gear into cinemas across the nation.

Savings

A man who could easily be described as the head of the push to digital cinema (is Kodak’s Asia Pacific Digital Cinema manager David Sanderson. I asked him why we needed digital cinema.

Sanderson responded by saying it could be compared to most new technologies in that it “offers potentially big savings in certain parts of the industry.”

He tempered that by saying that in other parts “it probably doesn’t offer savings but the main drivers who are probably the studios and distributors out of the US would love to see it happen.”

He sees that there is definite pressure to get the US market converted quickly but adds that there is less pressure in other parts of the world. Europe, he feels, is probably a secondary area and probably the furthest away to US minds as far as conversion goes.

As of now it is estimated that 1200 cinemas, or about 1% of cinemas worldwide, are equipped with digital projectors.

Australia is also well back in the field with possibly 24 or 25 cinemas equipped with 2K standard digital projectors (see Info Box), virtually all in capital cities.

For example, The Greater Union chain is currently trialling digital projection in some of its major cinemas, including the “Gold Class” cinemas, which have the added attraction of dinner and drinks served to your seat (such as shown in our photo opposite).

The situation here is that most film projectors that are still running side-by-side with digital are dedicated to 3D projection when it is scheduled. That situation would change dramatically when a serious roll-out of digital happens, Sanderson stressed.

What are the benefits for the audience? The Kodak man explained that the benefits are very straightforward for an audience.

For a start, you avoid today’s issues that we have today with film prints, where the film prints get scratched and dirty as they get cycled around the country.

With digital it’s very different. First of all, you get projection of a pristine image from day one to the last day.

35mm film projection has remained basically unchanged since 1885. As anyone who has been to a cinema knows, a lot can (and does) go wrong!

Barco DP2000 projector using a 3 cm DLP chip is a 4K machine with 6.5 kW lamps and ability to cover a 30m-wide screen. AIST is currently testing this model and Barco’s DP2000 at the Greater Union George Street Sydney cinemas.
There is upheaval in the movie industry. More feature films are being shot with digital cameras and successfully transferred to 35mm film release prints with advanced technology. Surprisingly, film is still hanging in as a capture medium, due mainly to the pressure from cinematographers who claim that everyone wants that ‘film look’, while few set out to achieve that ‘video look’ in the cinema. Coming up fast on the inside is the ‘digital look’, as increasing numbers of cinemas around the world begin to install digital projection into their bio-boxes. Barrie Smith takes a look into the popcorn and choc-top world of the digital cinema revolution.

vehicle conversions rather than an expo of the latest up-to-the-minute technology. And no doubt, all the owners would go about such a conversion quite differently if they were going to repeat the process – such is the value of on-the-job experience.

As far as we could tell, all the electric conversions on display used DC motors with wound fields and they ranged in power up to about 70kW. Such a power rating may not sound numerically impressive compared with typical petrol motors which can be up to 200kW or more. But whereas the 200kW rating for a petrol motor is an absolute maximum rating which is rarely, if ever, likely to be delivered (or even available at the wheels), a 70kW motor is quite likely to be able to deliver three times the continuous power for short periods. As well, electric motors deliver close to their maximum torque at very low revs, so an apparently modestly-powered motor can give quite sparkling acceleration.

Most, if not all the electric conversions on display used one or another model of motor controller made by the US company Curtis. These essentially have a bank of power Mosfets operated in PWM (pulse width modulation) mode...
Extra batteries added to this Toyota Prius give it an estimated electric-only drive range of 40km. The 28V battery pack is in the same voltage range as the existing battery and is disconnected by a big contactor (visible at one side of the boot) for charging via the 240VAC socket on the rear bumper. We liked the solid mounting for the batteries – you would not want them coming adrift in accident.

under the control of a microcontroller. In every case, the car had a throttle control potentiometer for speed control. None appeared to make use of regeneration under braking, and all used some variant of lead-acid or lithium-iron phosphate batteries. Some motors were wired in series mode (ie, with armature and field windings in series) while others were wired in shunt mode with the field windings run at constant voltage while the armature voltage was varied (using pulse-width modulation).

All on-road conversions need to pass inspection by the transport authority in the relevant state and these have comprehensive specifications which must be met before the vehicle can be passed. Electrical safety is most important, both from the aspect of avoiding electric shock as well as potential fire hazards if, for example, high voltage battery banks are shorted in an accident.

Each of the cars on display had varying approaches to safely securing the batteries and they all had heavy-duty contactors to disconnect batteries when not in use. Providing heating is a problem when there is no waste heat from an internal combustion motor available. The common approach seems to be to use a hair-dryer running from the main battery bank. In a similar vein, power brakes must still be available and

Maximum measured fuel consumption for the Prius above in mixed petrol/electric mode is 2.5/10km. That's 132 MPG! Oops, did we mention MPG again? Silly us!

This DATSUM 1208 EV conversion had a large array of batteries underneath the fibreglass canopy. Note the extra lead-acid battery in the engine compartment, necessary to run headlights and all the accessories. All EV conversions need a separate 12V battery or a step-down DC-DC converter, for this reason.

**BOOK REVIEW**

**TV Across Australia – One For The Grey Nomads**


WE OFTEN RECEIVE requests from people wanting to know details of TV transmitters: channel number, polarisation, location of transmitter and so on. This is vital information if you are setting up a new antenna but it is even more important if you are one of the growing band of "grey nomads" out touring Australia. Each time they come to a stop they need the details of the local TV transmitter so they can point their antennas in the right direction.

This information is available for every radio and TV transmitter in the country on the ACMA website. However that site is labyrinthine and the transmitter info is difficult to find. The link is http://www.acma.gov.au/WEB/STANDARD/pc-P_C9150

There you will find a series of pdf files available for download, including three for TV stations. The most useful one that lists transmitters by locality is http://www.acma.gov.au/webwrt/asset/main/lib1000059r-y-8.pdf

However, it runs to 132 pages and it would not be much use to someone in a remote caravan park somewhere in woop woop, especially if they did not have a laptop computer and an internet connection. That is why this book is a much more convenient solution.

It is divided into four sections, the first of which is the location guide. There are more than 1000 transmitter locations throughout Australia and in each case there is a reference to one of the 28 maps in section 2. The maps are very useful because not only do they show the transmitter location you are looking for in particular, you can also see others in that location. So say you are in the Kalgoorlie area in Western Australia. Map 20 will show that there is a transmitter at Kalgoorlie as well as others relatively close by at Coolgardie, Kambalda, Broads Dam and Ora Banda.

In a pinch, one of those other locations might give you useful reception.

Having identified the potential transmitter locations, you can refer to the alphabetical listing which gives the details for each transmitter, over 4000 of them, in town or area (eg, BSR, ABC etc), channel number etc. In each case, you can see whether the transmitter is digital or analog, the VHF or UHF band, the polarity (Vertical or Horizontal), transmitter power, transmission pattern (unidirectional or directional) and the latitude and longitude.

The transmitting pattern is most important because if it is directional, most of the transmitter power will be aimed at the main population areas. This can be a problem if you are not in those areas. You will also need to know if the transmission is digital or analog and we would assume that anyone touring Australia would also have a set-top box, if they don't have a digital TV set onboard.

If you are about to install an antenna, there is also a suggested Clipsal antenna for every location. By the way, the publication is sponsored by Clipsal. Finally, the fourth section is a comprehensive appendix of information about antennas, radio frequencies, signal propagation etc. There is also a catalog of Clipsal antennas, antenna installation methods, splitters and modulators. Also listed is a range of equipment by Kingray.

All in all, anyone interested in doing an antenna installation or planning an extended tour around Australia, this is a most useful book. It is available from the Silicon CHIP bookshop at $49.95 plus $7 packing and postage (L.D.S)
Preliminary Specifications

General
Vehicle Type: 5-door, front-wheel-drive sedan.
Category: Extended-Range Electric Vehicle (E-REV).
E-REV Competitors: None.
Chassis: Independent MacPherson struts front, compound crank twist axle rear, four-wheel disc brakes, full regenerative brakes to maximise energy capture, electric power-assist steering.
Seating Capacity: Four.

Performance
Top Speed: 160km/h
EV Range, City (km): 64 km

Dimensions
Wheelbase: 2685mm
Length: 4404mm
Width: 1798mm
Height: 1430mm
Cargo Volume: 301L

Battery System
Type: Lithium-ion.
Energy (kWh): 16

Electric Drive Unit
Power (kW / hp): 111 / 150
Torque (Nm / lb-ft): 370 / 273

Exterior
Tyre and Wheel Size: Specially developed low rolling-resistance tyres on 17-inch aluminium wheels.

Features will include:
- Driver-configurable, liquid crystal instrument display.
- Standard seven-inch touch screen vehicle information display.
- Touch screen-style climate and “infotainment” controls.
- Optional navigation system with onboard hard drive for maps and music storage.
- Standard Bluetooth for cellular phone and USB/Bluetooth for music streaming.

Driving the Volt will take some getting used to — there will be virtually no noise from the electric motor and even when the ICE generator fires up, its noise level will be way below conventional vehicles. Acceleration may also catch some drivers by surprise!

Green power?
A lot of argument about the “greenness” of the Chevy Volt has centred on its power source. The argument goes that by taking power from the grid to charge an electric car, one is simply transferring pollution from the exhaust pipe of the car to the exhaust stack of the power station.

GM is quick to point out that a lot of electricity generation in the USA (27% by some reports) is from coal-fired sources and even then, modern coal-fired power stations are much better in the pollution department than previously.

By taking large numbers of petrol-powered vehicles off the road and making them electric, they maintain there will be more incentive to make electric power generation cleaner and the atmosphere will also be cleaner from less vehicle pollution.

A good argument? Only time will tell!

How much?
The Chevy Volt initially had a target price of $US30,000. By GM’s own admission, even now (two years before its release) that price has blown out to $US40,000 (almost AU$70,000 at time of writing but who knows?). Whether this cuts out a significant portion of the market for GM is already causing a lot of discussion on the web, with many people raising serious concerns about the price increase (and remember, like-for-like US new car prices are on the whole significantly cheaper than ours).

Translate that to Australian dollars (which may be up, down or sideways by 2012) and you are paying a very high premium for an electric vehicle.

If it was me, I’d be with many of the web commenters: “I’d love one, but not at that price…”

This Mitsubishi Triton EV conversion was perhaps the most impressive on display with a whopping DC motor. However, the rear seat section was chuck-a-block with batteries, leaving little capacity to carry extra load. Again note the 12V battery in the engine compartment for lighting and accessories.

Oh, what a feeling: Toyota’s stand had their Camry hybrids stacked like Matchbox toys!

Making a return appearance from previous years was this 1987 Toyota Camry station wagon. As the data sheet above shows, the Camry employs the standard 5-speed box but no clutch is required. The large battery load means that it can only carry two people.
We look at the circuits of early 1930s receivers we see that triodes were used to amplify the audio signals, with 1:3 to 1:5 audio step-up transformers between each stage. The triode output stage was then coupled to an output transformer which in turn fed the loudspeaker.

In cheaper receivers, the limited output from the triode output stage often led to a high-frequency 'hiss' when a tone was played through the horn speaker. These speakers looked beautiful but the audio quality left a lot to be desired.

Certainly until well into the 1930s, the audio reproduction that was obtained could hardly be called 'high fidelity' (or 'hi-fi'). Even in 1935, "Modern Radio Servicing" by Alfred Ghinardi quoted high fidelity as the reproduction of the frequency range from 50 to 7500 cycles at 5% distortion. That's truly dreadful by today's standards.

A typical "high fidelity" amplifier of the 1930s still used triodes in all amplifying stages plus an output transformer. The output transformer matched the high impedance of the triode push-pull output stage to a level suitable for the speaker(s). In addition, some amplifiers also included a push-pull audio driver transformer to act as a phase splitter and driver to the triode output stages.

Even when tetrode and pentode output valves became common, the high end quality audio was still obtained from triodes. Negative feedback also became common during the 1930s. This feedback reduced a proportion of the output from the secondary of the audio output transformer and feeding it back in anti-phase to an earlier stage in the amplifier.

This negative feedback reduced the gain of the amplifier at all frequencies but more so at the frequencies that had the greatest amplification. This smoothed out the gain across the audio band and reduced distortion. It did, however, mean that such amplifiers

If, however, other electric cars are any yardstick, with a top speed of 160km/h, idling along in city traffic should dramatically increase range but GM have made no comment on this.

The ICE generator is highly efficient, having just one task – turn a generator. Therefore its power band and operating parameters can be maximised, unlike a normal petrol or even diesel engine which must be able to power a vehicle from rest to top speed under various loads and therefore is a compromise.

The motor appears to have already been chosen, with a model capable of running on either straight petrol or anything up to 85% ethanol blend. The fuel tank in the concept vehicle is tiny, appearing to be not much more than about 25 litres in capacity.

The battery and charging

Obviously, the battery is the most important part of any electric (or even hybrid) vehicle. In that, we know that (at least currently) the battery will be a T-shaped, 16kWh Lithium-ion type, consisting of more than 220 cells.

GM are very close-lipped about the actual make-up of the battery but reports we have seen suggest that they are working on a design with a 3:phase 220V AC motor with some indication of battery voltage.

The batteries run along the centre-line of the body and out towards the back wheels.

The batteries are not allowed to discharge below 30% – that's when the ICE generator cuts in, or you start to charge it from the AC mains via its on-board, intelligent charger. GM claim that it will be possible to charge the battery in less than three hours “from a standard 110 or 230V household outlet”.

That's a rather hefty charging current – about 16A or so by our calculation (16kWh x 70% / 3 hours x 3.7kW per hour x 220V / 18.2A). Add in the inefficiencies in both the charger and the actual charging (say 85% each) and that adds up to more than 22A.

We're thinking that the vast majority of users will want to charge the Volt from (charger off-peak power (or whatever it's called in a few years) so they will need to have a special outlet installed anywhere.

And yes, we've checked: you are allowed to use off-peak power to charge a battery, even one in an electric vehicle!

Cost to charge

At current Sydney off-peak rates (5.8c/kWh) it's going to cost the best part of a dollar to charge the Volt (16kWh x 5.8c). West-case scenario (with Power Savings Peak @ 30.25c/kWh) that would jump to around $4.80. Remember, this gives you about 60km of "all electric" driving.

GM's costing is around $32.00 for a night-time charge and on their figures, that 73% "average 60km commute" would result in cost savings of about $4400 annually (Australian dollars). Obviously, without tests, this figure can neither be confirmed nor denied and just as obviously, doesn’t take into account any battery replacement costs.

Otherwise, you would expect operating costs of the Volt to be lower than a conventional petrol-powered car as service costs should be lower for a petrol engine that works only a small percentage of the time.

Incidentally, GM claim that the Volt will cost around 4c per kilometre to run electrically versus about 24c/km for an equivalent-sized petrol-powered vehicle.

The vehicle

The Volt is a front-wheel drive, four-passenger model that from the outside, simply looks like a modern car.

However, significant attention has been made to getting the body shape just right to achieve the lowest coefficient of drag – wind resistance – thus maximising range. This is a feature of most modern passenger car design, certainly not limited to the Volt.

Also uses specially-developed, low-profile, low-rolling resistance tyres on 17-inch rims, again to minimise drag and therefore range.

Many of the design cues from the concept vehicle will endure in the production Volt, including the rounded front grille, athletic stance, rear design graphics, outside rearview mirrors and more. The Volt's rounded and flush front fascia, tapered corners and grille are functional, enabling air to move easily around the car. At the rear, sharp edges and a carefully designed spoiler allow the air to flow off and away quickly. An aggressive rake on the windscreen and rear screen help reduce turbulence and drag.

Inside, the Volt will offer the space, comfort, convenience and safety features that customers expect in a fourpassenger sedan and it will deliver them in a variety of interior color, lighting and trim options unlike any offered before on a Chevrolet sedan.

Modern controls and attractive materials, two informational displays and a touch-sensitive "infotainment" centre with integrated shifter will distinguish the Volt's interior from other vehicles on the market.

Some of Volt's interior technological...
You’ve probably picked up on that 60km basic electric range. GM’s research suggests that 75% of commuters (at least in the US) travel less than 40 miles (64km) each day, so they designed what amounts to a “town car” to precisely target this market.

In this use, most of the time the ICE will never cut in but it takes away the so-called “range anxiety” which drivers of electric-only cars face: “what do I do when the battery runs out and I am stranded miles away from home/a power outlet/etc?”.

Another concept car
In truth, the Volt is also a concept car – a car that never was, nor will ever (probably) be.

The plan is to release a Chevrolet Volt in the USA in late (November 2010 and then in Australia sometime in 2012 but the odds are a million-to-one on that it won’t be this exact vehicle.

For a start, according to GM’s own press releases, they have yet to determine which battery manufacturer will get the nod. At the moment there are three manufacturers vying for what will be a very lucrative contract. But more on the battery shortly.

There’s also the engine: some reports suggest that the engine in the display model Chevy Volt is no more than an electric golf cart motor capable of moving it around “a bit.”

In conjunction with some major players and many minor ones, GM are still developing much of the “important” bits – like motors and batteries!

However, GM have said that the Volt chassis, look and running gear is probably very close to what will appear on US (and then world) roads.

The engine

We cannot tell you much about the electric engine because the final design hasn’t been chosen yet. However, GM are looking toward a motor with the equivalent of 150hp/110kw. 370Nm of instant torque (you gotta love electric acceleration!) and a top speed of – wait for it – 160km/h.

This seems to be a bit of an enigma: if you’re designing a town car with limited range for commuters, why give it freeway top speeds? Because they can?

usually required an extra stage to make up for the lost gain due to negative feedback. Even so, the advantages of negative feedback made it well worth having.

As time went by, manufacturers became increasingly keen to use tetrodes and pentodes in the output stages of audio amplifiers, as they had higher gain than triodes and were more efficient. However, the audio quality of early amplifiers using these valves was not as good as those using triodes.

Subsequently, in the 1950s and 1960s, a modified audio output stage was developed that had high gain and efficiency but also relatively low distortion levels. This amplifier circuit configuration was called “ultra-linear” and it used tetrodes or pentodes in a semi-triode type circuit.

In the ultra-linear circuit, the valve screens were connected to taps part way along the audio output transformer. This became a very popular method of obtaining good-quality audio output while relying on the added efficiency of tetrode and pentode valves. In fact, the Leak amplifier featured here uses an ultra-linear output stage.

The weak link
The audio output transformers were (and still are) the weak link in valve amplifiers, particularly when it comes to producing high-quality audio over an extended frequency range. In fact, good-quality transformers are specially wound to ensure a good frequency response and to reduce spurious resonances.

By the 1960s, valve hi-fi amplifiers had come a long way and the Leak amplifier described in this article was one of the best. After that, transistor and FET amplifiers quickly outstripped valve amplifiers in audio quality, total audio output, distortion figures and total efficiency.

Of course, some audiophiles will disagree with me and tell me that valve amplifiers have qualities that make them better than solid-state equivalents. That of course is a personal view but not one with which I concur.

The Leak TL/12 Plus amplifier
The Leak amplifier featured here was given to me some time ago. Unfortunately, though, it didn’t come with its preamplifier or the perforated metal cover which fits over the top of the chassis.

This particular unit had been pulled out of the PA system in a local church after many years of faithful service. It is not a particularly powerful amplifier but is typical of the high-end 10-12W amplifiers that were developed in the early 1960s.

When I first got the amplifier, it was immediately obvious that a few rather odd alterations had been done to it. It was certainly not the standard of work you would expect on a high-quality...
piece of equipment. For example, the main supply electrolytic capacitors had been replaced but instead of being fitted into a can above the chassis, had been attached to the underside of the chassis with silicone sealant. However, since the repair, they had subsequently parted company with the chassis, so that they were just floating on their leads.

They looked terrible and would have still looked terrible even if the silicone had held fast.

Other electrolytic capacitors looked as though they had just been “thrown in” too, in various other parts of the amplifier. In fact, it looked like all the electrolytic and paper capacitors had been replaced.

My first step was to replace all the high-voltage electrolytic capacitors with more suitable values and voltage ratings. At the same time, I made sure that these were installed in a much more professional fashion.

It’s worth noting that the ones I removed didn’t suit the amplifier, although they were still working OK. For example, C13 and C14 (the main supply filter capacitors) were both 100µF capacitors instead of 32µF, as specified on the circuit. In particular, C14 should not have been increased to 100µF as the peak charging current through rectifier valve V5 would have exceeded its rating and shortened the life of the valve.

In addition, someone had modified the input circuit, probably to cater for a transistor preamplifier. The additional replacement capacitors had been secured with silicone sealant but this had since parted company with the chassis.

parts were removed and the audio input stage restored to its standard configuration.

Next, I decided to improvise a chassis-mount can to house the fresh 32µF capacitors (C13 & C14). A small can of mushrooms was just the right size for this job.

Having consumed the mushrooms and cleaned the tin, I soldered two solder lugs to it at the open end, so that I could later bolt it down to the chassis. The can was then sprayed with matt black spray paint to match the rest of the amplifier.

While the paint was drying, I checked all the resistors in the amplifier. A number of these were considerably out of tolerance and so were replaced. These components are all mounted on a large tag strip and are quite easy to get at. However, for some strange reason, many of the components are not grouped close to the valve stage that they attach to.

Next, I cut a small section of perforated board to mount underneath the chassis, directly below where the capacitor can would sit. The new electrolytic capacitors were then installed inside the can and held in place with contact adhesive, foam plastic sheet and electrical insulation tape. That done, I mounted the new can, complete with the capacitors, onto the chassis and wired the components into circuit via the perforated board (see photo).

The top of the chassis now looks almost the same it did when the amplifier was new.

Circuit details

Fig.1 shows the circuit details of the Leak TL12 Plus. It’s quite conventional and so most faults would be easy to find.

The first stage is an ER100 (V1), which is a low-noise audio pentode. It receives its signal via the “preamp” socket which is located on top of the chassis. R2 is included prevent RF signals from causing problems in the stage.

The cathode circuit and the plate circuit both deserve some comment. As shown in Fig.1, the feedback signal from the output transformer is applied to the cathode circuit by connecting it across a 106Ω resistor and a 0.1Ω capacitor. The latter tames the feedback signal to correct any phase problems.

Mazda had their striking “Taiki” concept car on display with its completely-enclosed rear wheels. Like most concept cars, this one is very unlikely to see the light of a showroom but Mazda (like all concept car producers) maintain that many of the design elements in the Taiki will emerge in the next generation of street models. When saving energy is right at the top of a designer’s wish list, the Taiki’s 0.25 drag coefficient cannot be ignored. But then again, neither can its shape.

Nissan again featured their Mixim electric vehicle but this was not particularly newsworthy—it’s been seen before.

Something that has not been seen before (at least in Australia) was taking pride of place on the GM-H stand: the Holden (or perhaps I should say Chevy) Volt. Will it be a Holden when it eventually reaches our shores?

Now here was something different, something worth a lot closer look.

The Chevy Volt

This is a vehicle based on a whole new design philosophy, one that has attracted a lot of comment in the media and on the web. It is an ERIV – an Extended Range Electric Vehicle which marries several different genres.

First and foremost, the Volt is a true electric vehicle—the wheels are driven solely by an electric motor, powered by a bank of on-board batteries which are in turn charged overnight from the mains supply.

But it also contains a small, efficient, internal combustion engine (ICE), so does that make it a hybrid? No, because in a hybrid the ICE can also power the wheels.

In the Volt, it cannot: the ICE is solely responsible for charging the battery when it reaches its limit of about 60km. The ICE is where the ERIV part comes in—the motor extends the range up to 406km.
An “electric” concept car due here in 2012: the Chevrolet

The Sydney International Motor Show has come and gone, under a glare of spotlights and almost continual buffeting of paintwork and glass. Of course, the Ferraris and Lamborghinis earned lots of “ohs” and “ahs” from the admiring crowds (and probably thoughts of “when I win Lotto . . .”).

But it was the more everyday, perhaps even prosaic vehicles which attracted the most attention. Maybe it was the economic climate. There was plenty for the rev-heads but this year the themes seemed to be a definite shade of light about 550nm in wavelength (OK, green for the uninformed).

Many manufacturers featured small, efficient diesels (remember not too long ago when “diesel” was a dirty word?). Hybrids also seemed to be the order of the day, with several manufacturers offering their particular variants. The Toyota stand had them stacked up the wall and sitting at 45-degree angles, as well as rotating in front of you. Toyota’s Hybrid Synergy Drive (Oh What a Feeling!) was everywhere, even in the flashing LED and LCD signs (printed signs, such as featured on the Ford display next door, are so passé). But there was little to differentiate the new Camry’s propulsion system from the new Prius propulsion system. It’s a hybrid. Honda had their Insight, which was no different to last year’s Honda Insight (or the year before, if you believed the planners). “But there’s a new one coming soon,” he said. How soon? “Umm – next year?”

Ryan Lexus had their up-market hybrids alongside their new LF-Xh concept car (which has a V6 engine plus an electric motor driving all four wheels). While Toyota’s Prius has claimed the prized top-of-the-range position when it comes to hybrids, Lexus has sold more than 2000 of their up-market hybrids in the past two-and-a-bit years.

Capacitor C15 and resistor R23 in the plate circuit are included to give a small amount of top cut into the supercooled region. V1’s output is applied via capacitor C4 to the grid of the first triode in V2. This valve is a twin triode 12AT7 and it functions here as a phase splitter. Because there is no bypass capacitor across resistor R10, the cathode of the first triode tends to follow the voltage fluctuations on the grid due to the input signal. In addition, because the two triodes in V2 have their cathodes connected, the cathode of the second section is forced to follow the cathode voltage of the first section.

However, the grid of the second triode is effectively earthed as far as the signal is concerned by capacitor C9. This means that if the first triode has a positive-going signal applied to its grid, it will draw more plate current as the cathode tries to follow in a positive direction. As a result, the plate voltage will drop because of the increased voltage across R9 (due to the increased plate current).

This, in turn means that a negative-going signal is fed via G8 & R21 to the grid V3 (EL84).

At the same time, the cathode in the second section of V2 also swings in a positive direction. However, the grid voltage is maintained at its original level, so more negative bias is applied to this section.

In this situation, the valve section moves towards cut-off and so the voltage on its plate rises. As a result, a positive-going signal is applied to the grid of V4 (via C16 & R18). This means that a push-pull signal is effectively applied to the two output stage grids.

Push-pull output stage

V3 and V4 (EL84s or 6BQ5s) are connected into the circuit as push-pull amplifiers in the ultra-linear mode. Conventional PA amplifiers would have the screen bias voltage applied to pin 7 of the output transformer whereas in the ultra-linear mode, they are wired to pins 3 & 5 respectively.

Note that the output transformer has tappings on its secondary for 4, 8 and 16-ohm headphones or systems. The negative feedback line is taken from the 16-ohm terminal of the output transformer and applied via R12 and C7 to the cathode circuit of V1, as mentioned previously.

The EL84s (or 6BQ5s) operate most of the time as push-pull class A amplifiers but operate in class AB1 at high volume.

One point to note is that, throughout the amplifier, the plate grid coupling capacitors have larger values than those found in valve radios. This is so that audio frequencies down to about 20Hz can be reproduced.

In domestic radios, the audio response rarely extends below around 150Hz. Basically, there was no point in extending the response lower than this because the modest speakers fitted to mantle receivers have very little buffing and do not work well below that frequency.

In fact, this was rather convenient as it meant that the designers and manufacturers could restrict the frequency response of the amplifier and eliminate any hum problems that might otherwise be present. This also kept the manufacturing costs down.

Power supply

The power supply is conventional and uses a 5V4G indirectly heated rectifier valve (V5). This produces the high-tension (HT) supply for the valve plates and screens.

The advantage of using an indirectly heated rectifier is that it begins operating at about the same time as the other valves. This means that the peak output voltage on the filter capacitors is almost the same as the working voltage and so lower rated capacitors can be used. Filtering and decoupling on the HT line is extensive, with R7, R15 & R22 doing the decoupling and C5, C6, C13 & C14 doing the filtering.

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The 6.3V AC heater output from the mains transformer is centre-tapped, with the centre tap going to earth. This helps cancel out any induced hum from the heaters into other valve elements.

Several years ago, I had cause to service a Geloso amplifier with similar output power to the Leak. It was a PA amplifier but had some interesting features in the power supply. There was a winding on the power supply that gave a voltage rail of 25V when rectified.
I waited about six months until it became obvious that there was not going to be a kit and ordered the PCB board from RCS Radio and the parts from Laser and built it that way. The transmitter worked as described and I was suitably impressed but I was left confused as to why it wasn’t released as a kit.

I received my training as a TV repairman on CRT TVs, as further SLAs or even a car battery could be paralleled for greater energy storage. I am just this kind of abuse of installation procedures that leads to solar getting a bad name for inef-fective delivery of power and worse still, creating the scenario where wiring is burnt out, fires started and even batteries exploding.

One of the major problems I faced when installing solar systems was to get people to recognise the need to correctly size a battery bank. When batteries (or cells) are new, they have reasonably consistent internal impedance. Over time, with repeated charging, plate gases alter and cell impedance will change. The bulk of changing current will go to the paralleled battery with the lowest impedance, resulting in the lost- ing more water by hydration. Actual capacit-

Don’t take short cuts on batteries

I wish to comment on Stan Swan’s well-intentioned but dangerous statement on page 21 of the article on 10W solar panels (November 2000). He states: “The 10W PCB panel and regulator looks capable of being linked further to a larger capacity battery…” Should one cell in a paralleled battery internally short or suddenly get a very low internal impedance, the current flow from the other batteries discharging through the faulty cell can reach hundreds of amps, either burning out wiring or heating the faulty cell to explosion point.

Good practice in solar installations is to correctly size the battery to maximum planned expansion at the time of installation, then increase generation sources and utilisation later. Never compromise on batters, thinking that a defunct battery from a car will be OK. It cannot be anything else but defunct in a solar installation too. More could be said about the need to use deep-cycle versus highCCA type batteries, loss of efficiency as batteries age, etc but I think the message is clear.

An under-away view of the restored amplifier. A small piece of perforated board was used to terminate the leads from the new electrolytic capacitors fitted into the replacement can.

This supply had its positive side earthed and it provided bias for the 6BQ5 valves via a potentiometer. This DC voltage also fed the heaters of two 12AX7 valves in the early stages and it very effectively overcame any problems of hum leakage in the lower level sections of the amplifier. It was a nifty idea that wasn’t copied by many manufacturers.

Testing

Before going for the smoke test, carefully check all the wiring, terminals and components and all looked to be in order — with one critical excep-

This Leak amplifier is a good perform-er and is reasonably priced, but the easy to use 1:1 audio transformers. These isolated the signal on each piece of equipment and hence interrupted the earth or hum loop.

Getting back to the Leak ampli-
fier, with the valves installed and the power turned on the voltages rose to about what was expected. I then checked the power consumption and it was 55W which again is about what was expected.

The amplifier was also completely quiet with no hum or buzzing noises but when a finger was placed on the input a healthy “blurt” of hum was heard from the loudspeaker. The amplifi-
er was-attacking.

I don’t normally do any tests on the audio amplifiers in domestic radios using sound quality implanters. In this case, however, I decided to do some tests to see how well this amplifi-
er would sound. This would not spoil any performance problems.

I began by connecting my audio oscil-
scope internally short or suddenly get a very low internal impedance, the current flow from the other batteries discharging through the faulty cell can reach hundreds of amps, either burning out wiring or heating the faulty cell to explosion point.

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Position the lamp well down on the dashboard where it is not a distraction in everyday driving.

Brian Wilson, Curtin, ACT.

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Frost-free fridges are power hungry

With respect to David Robson's request (Mailbag, October 2006) for the schematic for the Whirlpool Refrigerator Model WR1273S electronic defrost control, that problem is very hard to obtain. The details are considered secret by the manufacturer. That being the case, your question, why use a refrigerator with a frost-free defrost system anyway? Such a refrigerator is inherently expensive and hungry; you use power to refrigerate and you use power again to defrost.

The defrost element is a glass-enclosed wire wound element drawing something like 125 watts. This element is attached in parallel with the refrigerator's compressor. If the refrigerator is supposed to be off or at least, when the compressor is not running. The compressor runs and then the defrost heater runs—a double whammy on power consumption.

Also the electronics tend to be susceptible to power supply problems. That is, a lot of service calls to fix electronic controls in refrigerators. I would not personally run a refrigerator on a solar power inverter/generator system. For my two boat's worth—don't use frost-free refrigerators on solar/inverter of the tracks. Intimate contact needs pressure, much more pressure than the weight of a piece of glass can supply. The rotating of the artwork, while exposing— the ideal light source for this type of exposure is a point source, to alleviate this "umbra" effect even more. To use distributed source tubes is a compromise which most of us live with but the problem remains while exposing just compounds this compromise even further.

If you have to use tubes for your exposure, hold the artwork under pressure and hold it still—please don't rotate it! The semi-transparent glass on the front of the microwave and the perforated glass at the back of the microwave from microwaves—not light in the ultraviolet spectrum. You do make a point in the article about not looking ("staring") at the tubes while in operation but you will notice that all commercial exposure boxes have a cover that is absolutely no light escape while the tubes are alight. Using the door interlock switch was a "nice touch" but doesn't quite achieve the "no light escape" standard.

The remaining only one more question. Why publish such an article in the first place? Otherwise, congratulations on the quality of your presentation and on your longevity as the only surviving Australian magazine serving our electronics hobby industry.

Keep up the good work but please be a little more selective with what you publish. You do have a responsibility to mould those young minds out there, who use your magazine as part of their education, into the correct and safe practice of (hopefully) their chosen pursuit.

Jeff Thomas.

Falls Creek, NSW.

Comment: we take your point about staring but we did highlight the problem in the article. In fact, we feel it is often more effective to highlight what can go wrong rather than just say "don't do it". Another example of this is our highlighting the hazard of a reader's suggestion that 240V plug and sockets be used for low-voltage DC in the October 2006 issue (page 6).

The rubbergood is normally intended for the rigours of under-bonnet use so they should last for a very long time with occasional exposure to the low UV output of actinic tubes.

The same comment applies to your feature on the use of home-made transistors. Formerly, the UV output is low and is normally filtered by two layers of glass in the oven door. It should not be a problem. If people are worried, merely placing a layer of paper over the door would fix it.

Finally, we don't accept your objection to using a turntable. All light bulbs are distributed light sources—the turntable will even that out. And if better clamping is required, it will be used during the exposure from the sharpness of the exposure.

The reason why we published the previous article is that we know microwave oven users and that the reason for the feature was not a subjective opinion about the usefulness of the devices. If you are not interested in the microwave oven industry, you will find the the article very useful.

Bill Spedding.

Wellington, NSW.

Self-contained FM reception

I have an old AM radio valve. I don't have an AM radio. Adding FM reception to an AM radio is one of those projects that should be used to add FM reception to the amplifier stage with a separate tuner (G. K. T. , email). It is a problem isn't it? Old valve radios look great but they don't get FM. At present the only remedy is to modify a small AM/FM radio and feed the FM output to the amplifier stage in the radio. There is no kit to do the job.

If you want to listen to CDs, etc on your radio, why not consider building the Little Jim AM Radio Transmitter described in the January 2006 issue.

Mosfets for TENS unit

I am trying to build the Pocket TENS Unit featured in the January 2006 issue. I am having trouble locating the STP6N60E N-channel Mosfets or similar devices, rated at 200V 1A minimum (Q1, Q2). It is also very difficult to suggest a different part number (M. C., via email). You can substitute the low-cost STP4NK030Z or STP4NK050D Mosfets. You can obtain them from Farnell—see www.farnellonline.com or phone 1300 361 005. Their catalogue numbers are 129-1984 and 129-1974 respectively.

HDTV sound level is louder than SD

I recently purchased an LCD HDTV and when I change from a standard pal to HDTV broadcast I notice that there is an increase in sound volume. I believe this is because of the different audio system used in HD broadcasting. I have the audio output of the TV going into my stereo system and I find that I am constantly readjusting for the stereo system remote control to adjust the sound down a little. This gets a bit annoying after awhile.

My question is has SILICON CHIP ever thought of publishing a project for a circuit that could be plugged in between the audio output of the TV and the input of the stereo system that would keep the audio at a preset level? This device could also be useful for those commercials that seem to be very loud also (B. A., Hobart, Tas.).

No, there should not be any change in sound levels when switching from SD to HDTV broadcasts and we would not have the time to check the settings on your TV. Be that as it may, you could use a compressor to solve your problem but I must say it is a bit of trouble given that a press of a button on the remote fixes it.

We published a stereo compressor in the June 2000 issue and while it is no longer available as a kit, all the components are still available. The key SS1210U8P chip (two required) can be obtained from Farnell Electronic Components—www.farnellonline.com.au

Interval timer questions

I recently bought one of the new PIC-based interval timers (Preface, Practical Electronics, August 2006). I want to try the timer out on a water to air intercooler pump and fan for a couple of minutes after being triggered by an RPM switch output from an aftermarket engine computer.

However, a question arising from the article, the flexi-time microcontroller needs to be manually reset after each timing cycle.

Congratulations on reaching 21 years

Firstly, I would like to offer congratulations to SILICON CHIP magazine for turning 21 years old. I have been a long-term subscriber and have enjoyed the magazine for most of those years. It is a good magazine for most of those years. Technicians, engineers, electronics enthusiasts and ham radio operators alike are lucky to have such a quality publication to enjoy each month.

I have a few questions. My first question is regarding the "Little Jim" AM transmitter as described in January 2006. However, there is still a significant difference in the audio level when I then switch the stereo system to a commercial FM station.

Is this just a feature of the Micro- mitter that one just has to get used to or does it indicate a fault? TPI is at 2.2V and VR3 was set to 1/8. It is possible that the stereo indicator came on.

I am also powering it from a plug- pack and the +5V rail is spot on. Otherwise I am very pleased with the performance. (L. C., Moggill, Vic.)

Most commercial FM stations apply considerable signal processing to compress the audio so that there is a lot of dynamic compression. This makes the signal effectively much louder — which is what the commercial stations want. However, this compression also helps when listening in a car as quiet passages are boosted in level. To verify this, you should IPOD to verify this by tuning to the ABC FM stations when they are playing classical music. You will clearly hear the difference since these transmissions are not compressed—in other words, the quiet passages are quiet and the loud passages are loud.

The FM Micromitter does not compress the signal and this is why it appears to be lower in volume than commercial FM stations.

FM Micromitter Does Not Have Volume Compression

I purchased the Jaycar version of your Stereo FM Micromitter, featured in the December 2002 issue. Whilst I had no troubles with the components and ICs, I had a question regarding the audio level on my stereo system, when compared to commercial FM stations.

I am driving the Micromitter with the audio line from my PC with and without the line level set to maximum and VR1 & VR2 set full clockwise. However, there is still a significant difference in the audio level when I then switch the stereo system to a commercial FM station.

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FM Micromitter Does Not Have Volume Compression
Inverter-Driven Induction Motors

I refer to page 5 of the July 2008 issue, where you wrote: “In fact, using transistors for such simple commutation (induction motors) is never done, as far as we know”. I believe there is a more important application for inverters driving induction motors. My belief is based on logical reasoning drawing on non-electrical knowledge: if you would indeed be most grateful if any reader can confirm or deny my assumption.

I believe inverter-driven induction motors are used extensively as traction motors in railway locomotives, as an alternative to the DC traction motor which has been with us in various forms for over a century and is still preferred by many railways. My reasoning is based on the observation that a locomotive wheel set need not and should not be driven at a precise constant speed, as would be a synchronous motor. Wheels on a railway do not spin at a precise constant speed, but vary with the terrain, speed, and other factors. A locomotive wheel set try to turn at different speeds, especially on curves.

Suppose the maximum frequency of the inverter is 50Hz then, I surmise, the inverter frequency drops to a lower less than 50Hz. The use of the inverter with the inverter at all times limiting the current. I also suspect that some of these things are proprietary information.

It seems counter intuitive that this is the case but the one-shot motor is also known as the inverter driven induction motor. To the inverter motor some slack and this is provided by the inverter motor slip. Any comments please? I aim right or wrong? (J. W., via email).

All modern electric locomotives use induction motors driven with a variable-frequency, variable-voltage inverter providing 3-phase drive, very similar in principle to that used in the Vectris motorbike featured in the May 2008 issue.

Of course, the inverter does not use simple transistors but large banks of IGBTs (insulated gate bipolar transistors) to provide the high voltages and currents. Individuals wheel slip is not a major problem in a 2-axle or 3-axle bogie as the induction motors tend to be locked together in synchronism with the drive voltage, although there will be the normal slip factor of induction motors.

Wheel slip of the entire bogie is often controlled with a radar feedback system that ensures axle speed cannot exceed an appropriate speed relative to the wheelset. This wheelset will try to turn at different speeds, especially on curves.

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Of course, the inverter does not use simple transistors but large banks of IGBTs (insulated gate bipolar transistors) to provide the high voltages and currents. Individuals wheel slip is not a major problem in a 2-axle or 3-axle bogie as the induction motors tend to be locked together in synchronism with the drive voltage, although there will be the normal slip factor of induction motors.

Wheel slip of the entire bogie is often controlled with a radar feedback system that ensures axle speed cannot exceed an appropriate speed relative to the wheelset. This wheelset will try to turn at different speeds, especially on curves.

Suppose the maximum frequency of the inverter is 50Hz then, I surmise, the inverter frequency drops to a lower less than 50Hz. The use of the inverter with the inverter at all times limiting the current. I also suspect that some of these things are proprietary information.

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History of the AD8307
I was very glad to see Jim Rowe’s RF Power Meter article in the Octo-
ber issue 2008 of 50Wire. I was interested in the Analog Devices AD8307 chip. A little history
of that device series may be of interest.
About 20 years ago, I was working with a team of engineers developing medical ultrasound systems here in Sydney and we were using a TI TL441 log amp. Ultrasonic signal levels tend to be of wide dynamic range and you need a log amp to help with improved dynamic range for visual display. The TL441 had been around for ages and used in military radar systems again a wide-range signal application and eventually the chip went fully hermetic and then custom sealed for military only applications and we simply couldn’t afford to buy them in the quantities we needed.

We started developing our own log chips to drive our own devices as to their range. They had
but not fast enough for medical ultrasound. My reason for needing to put it on a fairly accurate and
heat sink to help it cope with the dissipations. I would divide a little over 3W.

Use an extruded aluminium heat sink.

Musical Instrument Tuning Aid
Thank you for the article in the July 2008 on the Musical Instrument Tuning Aid. I plan to build one and use it for tuning everything from guitars to banjos. I even have a homemade Marimba. I have used a commercially available tuner (Korg) for this purpose and found it to be very good.

However, as a way of getting back into electronics and then ‘off’ of many years, I thought I’d have a go at one of your projects. For the input I would need a signal conditioner. With differential ‘microphone’ which won’t be exorbitantly expensive. Could you suggest a couple of suitable models available through Jaycar or Altronics (S., via email).

Either the Jaycar AM-4990 dynamic microphone ($14.95) or the Altronics C-035 ($43.00) microphone would be quite suitable for our medical Ultrasonic Tuning Aid.

15V DC power supply
I have a 30V centre-tapped 50mA transformer that I would like to use with the ±15V DC Power Supply (Davies, August 1989) for a future project. I know that the recommended transformer is a 150mA unit which is what I have tested with in minutes of order. Kits. Could the 500mA transformer be used instead of the 150mA unit and if so, whether any changes be necessary to the on-board components?

Would the extra current cause any incompatibilities in the build? The normal voltage regulators, as the instruction detail talks about the possible used for heating or other purposes for higher voltages? (D., via email).

A 500mA transformer can be used if it has the same 30V centre tapping. Using the higher current rated transformers does not necessarily mean you have to use a different transformer. However, I would need a suitable transformer. You may find the Musical Instrument Tuning Aid.

Flexitimer tuning problem
I have built the Flexitimer Mk4 and found that when using the ±10 feature, it only seems to work from 0-6. However, once you select 7-9 in the ON period, this will work fine but your OFF period goes for ever.

I have only tested it on the seconds selection but I am assuming it will be the ±10 B socket anyway. Do you think it is likely to be the problem? (S., via email).

It’s not easy to suggest the cause of your Flexitimer’s strange misbehaviour. There should be no way that programming the OFF period of 0-6 will change the OFF period, because they are quite independent of each other as the PCB’s internal program is concerned.

It’s possible that there is a fault in your timer’s PC board or perhaps you may have accidentally fitted one of the diodes D1-D5 with the wrong polarity. Failing this, your PIC may not have been correctly programmed, in which case you should be able to send it back for them to program it again.

How does a quartz watch work?
I have been reading SILICON CHIP for seven years and find it very interesting and I have built some projects with good results.

Quartz watches have been with us nearly 40 years now and a lot of people still don’t know how they work with that accuracy. So can you please pub-
lish an article on this subject? I am sure it will be very useful to many people. (T. Quakers Hill, NSW).

We described how crystal clocks work in the March 2008 issue, in an article entitled 1PPS Driver for Quartz Clocks. Quartz watches work in exactly the same way.

Mixer for multiple radios
A lot of amateurs and others are installing multiple radio sets these days. One bugbear is having a speaker for each radio.

Dec 2008
In my own case, I will be installing a UHF CB and UHF/VHF and HF sets in my new tourer. Many people doing outback touring (grey nomads) would have a CB and HF set. A kit that would combine multiple radio speaker outputs into one speaker would be ideal. You could use a mixer but there aren’t many around anyway, four outputs and then you have to have an amplifier and speaker; not very convenient. A simple unit that mixes and has a small amplifier would be popular. I do know of one commercial unit available from overseas but it costs around $400 dollars. (L. W., via email).

P. Presumably when these multiple radios are in use, only one is actively receiving signals of interest at any one time. Therefore it would be a simple matter to have one speaker switched to the relevant radio using a relay and a priority switching circuit.

In effect, it would be similar to a VOX circuit. If you just want a 12V mixer, have a look at our 4-input mixer in the June 2007 issue. It could be combined with a small 12V power amplifier such as the Chump from the February 1994 issue.

LED light with photocell

I have constructed an anchor light for my host using the strip of 27 LEDs from a 12V trouble-light that plugs into a cigarette lighter socket. Now I want to add a photocell to switch it on dusk and off at dawn. When I wire in the cadmium sulphide photocell, it gives the opposite result and the light earths to be incorporated into the mountings system.

I have two motors doing different jobs. One turns at about 6 RPM and the other calls 17 RPM. Both have good torque. Brian Wilson, Curtin, ACT.

LMS17 regulator circuit has a potential trap

A few years ago, while building an electronic device from a design in "Practical Electronics" magazine, I spotted a potential trap in the power supply circuit. This was a typical dual-rail circuit using LMS17/337 regulators and in this case, used trimpots between the adjustment pins and the 0V rail to set the output voltages. It occurred to me if that trim pot went open-circuit, this would put excessive voltage on the supply rail, killing some hard-to-get chips.

My solution at the time was to put the trim pots between the supply rails and the common rail, with fixed resistors in the original trim pot locations. So when I read the letter from Peter van Schaik in Mailbag, (August 2008), I dug out my May 2008 issue of Silicon

Ignition System For A Stutz Bearcat

I have a veteran motor car that has a magneto. The magneto is a bit unusual as the car has two spark plugs per cylinder, with one set of spark plugs over the inlet valves and the other set over the exhaust valves on the other side of the head (it is a "T" head configuration). The magneto is constructed so that the full secondary voltage (in theory, at least) can be directed to the "inlet" plugs for starting, after which the motor runs on both sets of plugs.

The car is a 1916 Stutz Bearcat, with a 4-cylinder 6.3-litre engine which is difficult to crank so the magneto has a difficult time!

The magneto is the major suspect for increasingly difficult starting and a misfire while idling. The magneto will be tested by a qualified person but the prognosis is not good. If the coils or condenser are suspect, then they must be repaired and rewound, respectively. The problem is that magneto rewinders are a dying trade and there are very few people in this country that are qualified to do the work. Those who are have so much work that there is something like a 6-month wait to have the armature rewound.

I have successfully constructed the Universal High-Energy Ignition System Mk.2 kit. The preamble to the assembly instructions for the ignition kit mentioned the use of magneto interpoles/points as a sort of reluctor.

I am interested to know if there has been a simpler kit design that could be adapted to use the magneto points as the interrupter and the magneto distributor in the normal way, with the high-tension provided by perhaps two coils and two circuits driven by the one interrupter? The use of an electric (as against the electric) spark generator would obviate the need to switch to the inlet-only plugs for starting.

It is important that the magneto remains on the engine, as the engine should be returned to the original. Also, I can arrange a rebuild, I will eventually go back to the magneto-only operation (I. G., via email).

I am using the magneto signal for triggering by building the reductor version of the Universal High-Energy Ignition. Alternatively, you can use the points as the trigger by building the points version. The trigger can be used to drive two high-energy ignition systems that can then drive separate coils and the points.

Those having a magneto-only cars might be able to use the concept for another application, for example to trigger a single relay or to use one Universal High-Energy ignition to drive both.

Timer recording is also a bit complicated with this option.

The best solution is with a PVR but you need to be aware that some of the more basic models (Digicrystal/Supertv/WinTel) do not allow the menu selection of teletext during playback, but it is usually in the (annoying) video stream sent to the TV and can be selected in the normal way on the TV.
Choosing good-quality automotive fuses

The Serviceman had an interesting article about AGC fuses earlier this year and hereby unfolds a little known fact about automotive fuses.

Top of the line automotive electronics stocks fuses which have the fuse material soldered to the end caps which are made of chrome plated brass. These are not cheap! Everyone wants to sell you fuses which are made of chrome plated steel which are quite cheap and which quite often have the fuse material crimped between the end cap and the glass tube. If you happen to be buying fuses with low humidity these will not give you much of a problem. However, I live in a climate where the ambient temperature drops below 0°C quite frequently in winter.

What happens when the frost starts to thaw is that a thin film of water is deposited on the outside of the fuse (and anything else which exhibits thermal properties) causing the point temperature change and over time this breaks through the chrome coating on the end caps and produces rust. This eventually gives an intermittent contact and finally fails, as it becomes open circuit.

So next time you venture forth to buy automotive AGC fuses take a small magnet with you. If the fuses fail to stick to it you have the good quality ones which will last a very long time unless you overheat them. Steer clear of the others. John Hardisty, Burnie, Tas.

How to Zap 8V Batteries

Before I start assembly of my Jaycar Load Acid Battery Zapper/Tester kit (Silicon Chip, May 2006), I am curious if this device (with minor modifications) can also be used with 8V lead acid batteries.

To explain, I have a 1939 Craftsman speedboat that I converted to 8V to make it easier to start. I also have an electric boat that is 24V. I can zap it with two independent 12V batteries.

So there appear to be two options: modify the 8V setting on the zapper or modify the 24V circuit and dedicate it to 8V. Since I also have 6V batteries for my 1925 Studebaker and my 1931 Model A Ford, modifying the 24V circuit would be preferable. (S. U., Saratoga Springs, NY, USA).

The zapper section of the Battery Zapper/Tester should be able to work satisfactorily with an 8V battery, without any changes. However, you would need to make a few minor changes to the condition test section, in order to check 8V batteries. If you are unsure of what you are doing by taking over the 24V positions of S2a and S2b.

I suggest that you try connecting a 22kΩ resistor in series with the 24V position of S2a, and connect the 8V battery to the battery leads. I have the two upper 220Ω resistors in the voltage divider associated with 5V, rather than the existing connection between the two lower 220Ω resistors.

This should effectively convert the 24V range into an 8V range, although you may need to change the voltmeter (the vacuum tube) to 110Ω and the one below it to 330Ω. As a way, as a general rule, if your batteries are behaving normally and hold a good charge, there should be no need to zap them.

Mailbag continued

AirNav Radarbox, November 2008:

The contact email address given on page 16 should be parncut81@gmail.com.

Controller, August 2007: A short copper track is missing on the final version of the PCB board file. The missing track should be running directly under the centre of diode D5, connecting pin 1 of IC4 to the wide track running transversely just behind D5.

To fix this problem in existing boards, solder a short length of tinned copper wire in place of the missing track. A corrected version of the PCB board file will be sent to board manufacturers.

Notes & Errata

(1) The Jaycar PS-0789 and PS-0787 are now available.

(2) A BNC or F connector could be used (panel-mount BNC or F socket with a BNC plug).

(2) Banana sockets such as the insulated PS-0429 from Jaycar. This has the disadvantage that the polarity could be adjusted incorrectly when plugging into the plug (ie, not polarized).

(3) 4 pin DIN panel socket and panel mount (Jaycar P0439 and P00060). The back of the socket can be sealed using neutral-cure silicone sealant after the wires have been soldered on.

(4) 5 pin 777-rated multi-pole connectors, eg: Jaycar PP-1006 and PS-1007.

Just a quick note to say I've been reading the world's most popular book. I've just finished the 4th edition, by lan Hickman. It's been a fantastic read, and I've learned so much from it.

The book is titled "Microcontroller Projects in C for the 8051" and it's written by Dogan Ibrahim. It's a comprehensive guide to microcontroller programming, with a focus on the 8051 family of processors. The book is packed with practical examples, exercises, and real-world applications.

I've found it to be an excellent resource for anyone looking to get started with microcontrollers, whether you're a beginner or an experienced programmer.

The book is available in both hardcover and paperback formats. It's published by Pearson Education and has been a bestseller for years.

I highly recommend this book to anyone interested in microcontroller programming. It's a valuable resource that will help you build your skills and achieve success in this exciting field.

Thanks for reading, and happy programming!

Sincerely, [Your Name]
mailbag

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HDTV is a sick joke

I could not agree more that HD Television is being wasted in this country (Publisher’s Letter, September 2008). I am sure that I am not the only one who is fed up with the unprofessionalism of our so-called “free-to-air” networks. I note that there is still no HD programming in any newspaper guides. The people who print the guides probably have no great regard for time, when you consider that the networks consistently change programs at the last minute, making guides useless anyway. The networks can’t even get their own EPGs right half the time, so what chance do we have?

The Government does not appear to give a toss about this appalling situation. It will continue unless people get off their butts and demand change. If not, HDTV will go nowhere as the networks will simply continue to milk the consumer of every last ounce of money and time that they need to. The Government is going to cop a beating if they don’t wake up. When they switch the analogue system off we will be left with a substandard service and they are the ones that will pay the price of voter anger.

Tony Joyce.

Macquarie Fields, NSW.

Return shot on fuel consumption conversion

As one who has supposedly “shotted himself in the foot” (Mailbag, September 2008, page 4), I would like to make a further comment.

While I concur that Allan Hornsby has performed the maths correctly, 61 litres is the absolute minimum quantity of fuel required. To make the maths simple, I rounded the figure up to 100 litres; the additional 19 litres is my modesty.

Perhaps I should have been more explicit in my previous letter on the subject. It is highly unlikely that either a journey would be exactly 900km or that the fuel consumption be exactly 5.1/100km! The aim was to show how simple it was to use the “fuel consumption” figure. If either mpg or km/L values are used then the more difficult division process is required (900 divided by 11 [approx]). If Allan fills up with exactly 81 litres for his journey, then I foresee him walking with “can in” to the nearest fuel outlet.

Ralph Hoppers Crossing, Vic.

Ceramic filters can be obtained from a junked TV

In response to the question about ceramic filters for the Jupiter meter (Silicon Chip, August 2008) on page 100 of the October issue, F. A. is mistaken in that they are not described as “ceramic resonators”. A ceramic resonator can be a two or 3-doped log device and it is commonly found in the clock generator on many microprocessor-based circuits.

A ceramic filter differs in the fact that it can be either a narrowband filter which will trap all frequencies and pass only the wanted frequency or a notch filter which will do just the opposite. I am not sure in which country F. A. is based but a ready source of these filters is from the sound IF section in a defunct VCR or TV which will be easier 5.5MHz (1MHz) or 6.0MHz (South Africa/UK). Another supplier is Trade Tech New Zealand which has them http://www.tradetech.co.nz/results.html?search_type=1&know_search=1&q=cerm5.

Chris Ibrahim, Hamilton, NZ.

Power use can be greatly reduced

You make a good case for the “Smart Power” charges increase power bills by up to 45% (Publisher’s Letter, September 2008). In Victoria, no such proposal has been made (as yet) but I’ll be on the lookout when it does change.
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Publisher's Letter

Electric vehicles might be a technological dead-end

This month we have two reports on electric vehicles. The first, on the General Motors' Chevy Volt, is a state-of-the-art electric vehicle which is slated to go into production in two years or so. The second, our report on the AEVA fold day at Rose Hill in Sydney during October, shows developments at the do-it-yourself end of the electric vehicle scene.

Neither report really gives many clues as to what sorts of cars we will be driving in 10 years' time or further into the future. For a start, the majority of the cars we are driving right now will probably still be on the road in 10 years' time. Second, it is by no means certain that the prototype electric cars presently being touted by the major car manufacturers will go into production in their present form. In fact, it is by no means certain that General Motors in the USA will even survive their current financial woes without substantial government assistance and restructuring.

In any case, if it does go ahead, it appears as though the motor and batteries finally employed in the Chevy Volt could be quite different to the concept car seen at the Sydney Motor Show. We have also stated in a past issue that we thought the Chevy Volt was a "pretend electric" car in that it has fairly limited battery capacity and a small internal combustion engine to provide long range trip capacity. Given that GM has prior experience in producing the ill-fated EV1, you would think they would take a better approach. Or is it because car dealers can see that electric cars will require little after-sales service and therefore won't be much money to be made from a pure electric vehicle?

What does seem certain is that more hybrid electric cars will be available in years to come. Toyota's Prius and the Lexus RX400h range of cars have already been a big sales success and you can expect more of the same from Toyota, Honda and the other Japanese manufacturers. There is even a Commodore hybrid planned for release in a year or so.

However, it must be said that none of the existing hybrids from Toyota or Honda really push the envelope in getting the really high fuel economy that is poten
tially available. Already, the Toyota Prius has been modified by DIY enthusiasts to get claimed economy down below 2.5/100km. How much better could it be if Toyota pushed the technology as far as it could? The good news is that diesel hybrids being developed by some of the European car manufacturers (eg, the VW TwinDrive) are planned to do much better and will have an electric only range of 50km or more, comparable with the Chevy Volt.

But just because hybrid electric vehicles might seem more practical at the moment, this does not mean that particular technology will necessarily dominate in the long term. Other hybrid vehicles could take the spotlight. What do I mean by that? At present there is quite a lot of research into diesel hybrid vehicles with hydrogenic transmissions -- no electric motors would be involved. If that seems outlandish, consider the vast majority of existing vehicles, from the humble Bobcat right up to huge mining machines, use hydrolic transmissions. They run at very high hydraulic pressures (typically 21,000kPa or 3000 psi) and they use a hydraulic accumulator which is driven by a relatively small diesel engine working at more or less constant load.

Furthermore, a vehicle with a hydraulic transmission can provide very effective regenerative braking -- much more effective than electric motor regeneration. Another big advantage of a diesel hybrid vehicle is that it does not have a large investment in batteries which have long-term consequences for the environment. In reality, such vehicles would not represent a drastic change from technology available right now.

So what sort of vehicle are you likely to be driving in 10 or 15 years' time? It might be a diesel hydrolstic.

Leo Simpson
Contents

Vol. 21, No. 12; December 2008
www.siliconchip.com.au

12 The Chevrolet Volt Electric Car
The star of this year's Sydney Motor Show, the Chevrolet Volt is a true electric vehicle. Here's a look at the technology behind the vehicle — by Ross Tester

18 Digital Cinema: Digitising The Movies
There's a revolution happening in the movie world, with the industry slowly moving away from film to digital. There are advantages for production, distribution and even copyright protection — by Barnie Smith

68 Review: Owon Digital Hand-Held Oscilloscope
We look at Owon's affordable dual-channel digital oscilloscope that can also double as a digital multimeter. Its portability makes it ideal for field work — by Barry Smith

78 The 2008 AEVA Electric Vehicle Field Day
An interesting display of DIY electric vehicle conversions — by Leo Simpson

Projects To Build

28 Versatile Car Scrolling Display, Pt1
Use it to monitor, display and log up to six sensors on a scrolling or static LED display. You program it via the USB port & it can also control two relay outputs in response to measured signals — by Mauro Grassi

36 Test The Salt Content Of Your Swimming Pool
Don't shell out big bucks for a salt-water tester for your pool. Our low-tech solution is easy to set up and costs almost nothing — by Leo Simpson

60 Build A Brownout Protector
Low mains voltages (brownouts) are a fatal hazard to induction motors. This Brownout Protector is rated at 2300W and is easy to build — by John Clarke

72 Simple Voltage Switch For Car Sensors
Use it to monitor a car sensor and turn things on and off... boost solenoids, fans, water injection, intercooler sprays, etc — design by John Clarke

Special Columns

40 Serviceman's Log
Intermittents: No Money For Old Rope — by the TV Serviceman

53 Circuit Notebook
(1) Fuzz Box For Guitars; (2) Monitor For Pet Bed Heater; (3) One-Button Camera Timer; (4) VHF Aircraft Receiver With Squelch; (5) Toy Power Machine Is No Risk To Wallet; (6) Battery Monitor Has Low Current Drain

82 Vintage Radio
The Leak TL12 Plus Valve Amplifier — by Rodney Champsness

Departments

2 Publisher's Letter
77 Order Form

4 Mailbag
87 Ask Silicon Chip

17 Book Review
90 Notes & Errata

39 Product Showcase
94 Market Centre

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**NEW!**

**REMOTE CONTROL UGO HELICOPTER**
This stylish, wind-resistant helicopter with its 6-axis feedback mechanism. Not a real helicopter, it is made of plastic and is a full-feet model. A real wind will blow the blades. The helicopter can be operated using 8 minutes of flying time. It can fly 40 meters above the ground.

**NEW!**

**USB OPTICAL MOUSE WITH NUMBER KEYPAD**
Not suitable for children under 12 years of age. Please read instructions before use. The mouse is connected to your computer via a USB port and provides precise positioning. The mouse is easy to use for children and adults.

**NEW!**

**INFRARED DIGITAL PEN & NOTETAKER**
Clip this handy little tool to your shirt. All pens can be both writing devices and everything you write will be copied electronically and stored in your computer. A perfect pen for engineers, scientists, architects and inventors. Online easily find and type in the works that you have written down. The pen even includes a Note Manager software so you can write and organise your notes, sharing and reading notes for students or the office.

**NEW!**

**REMOTE CONTROL OFF-ROAD VEHICLES**
Can't be controlled by the price tag, these all-terrain dirt bikes are incredible. The 130cc electric off-road services has a compact electric motor and rod. It is constructed around a lightweight metal frame and features front and rear shocks. Lightweight aluminium brake pads for reliable stopping power. The 10-speed gear system includes 3-speed forward, 1 reverse gear and a 2-speed reverse gear. It has 3 Sealed Bearing system for maximum durability. An easy start button and remote control are included. The remote control is a wireless technology with a two-channel radio. Just point the remote to the subject and press the two buttons (left and right). The remote can be powered by 3 AAA batteries.

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**NEW!**

**REMOTE COMMAND Station**
If you own a full - size desk, the Desk Hanger with Drawer, Keyboard and Mouse will fit in a drawer. The Desk Hanger is a must for every home or office. It will help you to keep your desk tidy. The Desk Hanger is easily attached to the wall or any flat surface. It is fully adjustable and will fit any size desk. The Desk Hanger is made of durable plastic and will last for years. It is ideal for use in the kitchen, office, or study.

**NEW!**

**REMOTE CONTROL WING**
This item has been designed specifically for the amateur scientist who wants to study the flight of birds or insects. The wing is made of lightweight aluminium and is easy to hold. It is simple to use and requires no special equipment. The wing can be powered by a rechargeable battery. It is strongly recommended to use this toy on natural grass for the kids to have fun on your next holiday party.

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