SILICON CHIP

MARCH 2008
ISSN 1030-2662
03
9 771030 266001
PRINT POST APPROVED
- PP255003/01272
$8.50* INC GST NZ$9.90 INC GST

SPEED CONTROLLER WITH GRUNT!





HOW TO SOLDER AND WORK WITH SMDs





One for the Amateurs: DDS VFO



Great Products, Great Range, Great Prices from Jaycar Electronics

REVERSING SAFETY

Bluetooth Rear Vision Mirror LCD Monitor

This 7" TFT monitor can be connected to an in-car DVD player and also used with your Bluetooth phone for hands-free communication. You can even connect it to a reversing camera. The high reflectivity of the device allows you to use it as a regular rear vision mirror when not in use as a monitor.

- 2 composite video inputs
- Built-in caller ID
- Remote control included
- Works with our wired reversing cameras, available separately

Cat. QM-3763
$299.00







World Band AM/FM/SW PLL Radio Receiver

The amazing features of this great radio include phase-locked loop (PLL) for rock solid frequency stability, AM band, FM band (stereo), and three short-wave bands covering 1711kHz to 29999kHz. See website for full details.

- Local/DX switch
- I/F output
- Requires 4 x D Batteries

Cat. AR-1747
$99.00



Weather Station with Wireless Sensors and Computer Interface

The outdoor sensors will transmit up to 60 metres to the receiver which has full clock and calendar functions and shows wind direction, chill factor and speed. Also shows barometric pressure with 24 hour trend, rainfall, indoor and outdoor temperatures and other weather data. Connects to your computer for data storage and analysis. Mast length 500mm. See website for full details.

- Display unit 170mm tall



Cat. XC-0330
$249.00

PIR Controlled Mains Power Switch Kit

Ref Silicon Chip February 2008

This excellent kit uses a standard PIR to safely turn on 240VAC mains device(s) such as security systems, decorative lighting, fountain pumps or even commercial advertising etc. The 'on' period is adjustable. Kit supplied with case, screen printed PCB, and all electronic components.



Cat. KC-5455
$79.95

Adjustable Holesaws

An excellent cutter designed to cut plaster board and ceiling tiles. Features calibrated hole size adjustment. Two sizes available:
TD-2520: 62 to 177mm
TD-2522: 158 to 264mm
Note: Drill not included



Cat. TD-2520
$69.95

Cat. TD-2522
$79.95

Watch Foxtel All Over The House

Hassle-free sharing of audio and video signals all over the house without the inconvenience and cost of running wires. This powerful 5.8GHz sender will ensure crystal clear reception.

- Not ACA approved
- 5.8GHz operation
- Extra receivers available

Was $249.00

SAVE $50



Cat. AR-1840
$199.00

Remote Controlled Flying Fun

Mini M*A*S*H Helicopter

This tiny, infrared remote controlled helicopter is ready-to-fly and will zip around your home or office for up to 8 minutes on a single charge. It's fun to fly and is ideal for indoor use.

- Fast 20 minute charge
- Helicopter 135mm long
- Requires 6 x AA batteries
- Suitable for 8yrs+

Was $29.95



Cat. GT-3260
$19.95

SAVE $10

Other models also available

Mosquito Helicopter

- 170mm long
- Ages 8yrs+

Was $59.95

SAVE $10



Cat. GT-3262
$49.95

Mini Helicopter

- 170mm long
- Ages 8yrs+

Be quick! Limited quantities



Cat. GT-3215
$39.95

Mains Power Meter

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

Thousands Sold



Cat. MS-6115
$39.95

High End 12 Volt Jump Starter with Light

This rugged and powerful jump starter is fitted with a long lasting 17Ah battery, extra-long cables, work light, and battery test button. Includes charger. 380mm high.



Cat. MB-3596
$79.95

Portable 3.5" Digital LCD Television

Catch local digital TV broadcasts with this excellent hand held LCD colour digital TV. It has crystal clear reception and great audio quality. Supplied with rechargeable battery, plugpack, headphones, and AV lead included.

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

Was $299.00

SAVE $50



Cat. QM-3775
$249.00

Better. More Technical

Prices valid until 31-3-08

TELEPHONE• 1800 022 888 **INTERNET• www.jaycar.com.au**

Contents

SILICON CHIP

Vol.21, No.3; March 2008 www.siliconchip.com.au



How To Get Into Digital TV – Pages 9 & 14.

Features

9 How To Get Into Digital TV
Analog TV transmissions are on the way out. Here's a look at what you'll need to receive all the new digital transmissions on an analog TV – by Alan Hughes

14 Review: Tevion TEV8200 HD Set-Top Box
Got an analog TV set? You need an HD Set Top Box! – by Leo Simpson

22 How To Solder Surface Mount Devices
Here's how to solder SMD parts using simple tools – by Jim Rowe

46 PICAXE VSM: It's Time to Play; Pt.3
Using some of the 'virtual instrumentation' included with the software, from a simple voltmeter to an advanced I²C protocol debugger – by Clive Seager

72 The I²C Bus: A Quick Primer
Mystified by the I²C bus communications protocol? Read this – by Jim Rowe

82 Electric Flight
Battery-powered aircraft creates aviation history – by Ross Tester



12V-24V High-Current DC Motor Speed Controller – Page 30.

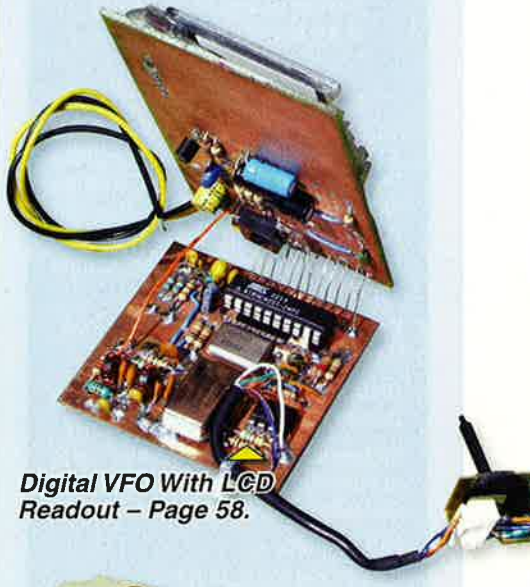
Projects To Build

30 12V-24V High-Current DC Motor Speed Controller, Pt.1
It's rated at up to 40A continuous, features automatic soft start & has good speed regulation under load – by Mauro Grassi

58 A Digital VFO with LCD Graphics Display
This digital VFO uses a recycled Nokia cellular phone LCD to display analog and digital frequency readouts – by Andrew Woodfield, ZL2PD

78 A Low-Cost PC-to-I²C Interface For Debugging
Tracking down bugs in I²C circuits can be tricky. This PC interface lets you take advantage of the free Philips/NXP "URD" debugging program – by Jim Rowe

91 One-Pulse-Per Second Driver For Quartz Clocks
Convert a low-cost quartz clock to GPS accuracy – by Jim Rowe



Digital VFO With LCD Readout – Page 58.

Special Columns

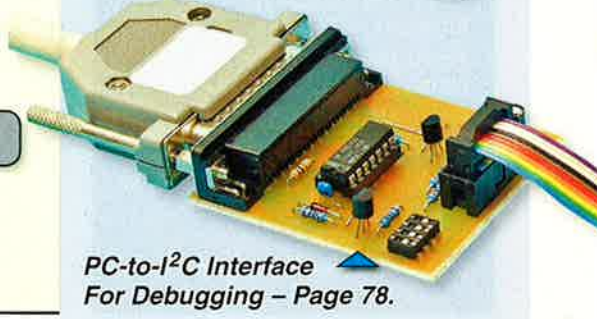
40 Serviceman's Log
Foxing out a Foxtel installation – by the TV Serviceman

67 Circuit Notebook
(1) TV Field-Strength Meter; (2) Alternator Controller For Charging Deep Cycle Batteries; (3) Emergency Light Uses 3W White LED; (4) PICAXE Light Box Countdown Timer; (5) Impedance Bridge Measures At Three Frequencies; (6) Simple Mosfet Tester; (7) PC Cooling-Fan Driver

84 Vintage Radio
The batteries used to power vintage radios – by Rodney Champness

Departments

2 Publisher's Letter
4 Mailbag
57 Order Form
96 Ask Silicon Chip
99 Notes & Errata
102 Market Centre



PC-to-I²C Interface For Debugging – Page 78.

SILICON CHIP
www.siliconchip.com.au

Publisher & Editor-in-Chief
Leo Simpson, B.Bus., FAICD

Production Manager
Greg Swain, B.Sc.(Hons.)

Technical Staff
John Clarke, B.E.(Elec.)
Ross Tester
Jim Rowe, B.A., B.Sc, VK2ZLO
Mauro Grassi, B.Sc.(Hons.)

Photography
Ross Tester

Reader Services
Ann Morris

Advertising Enquiries
Glyn Smith
Phone (02) 9939 3295
Mobile 0431 792 293
glyn@siliconchip.com.au

Regular Contributors
Brendan Akhurst
Rodney Champness, VK3UG
Mike Sheriff, B.Sc, VK2YFK
Stan Swan

SILICON CHIP is published 12 times a year by Silicon Chip Publications Pty Ltd. ACN 003 205 490. ABN 49 003 205 490 All material copyright ©. No part of this publication may be reproduced without the written consent of the publisher.

Printing: Hannanprint, Noble Park, Victoria.

Distribution: Network Distribution Company.

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

Editorial office:
Unit 1, 234 Harbord Rd,
Brookvale, NSW 2100.

Postal address: PO Box 139,
Collaroy Beach, NSW 2097.

Phone (02) 9939 3295.

Fax (02) 9939 2648.

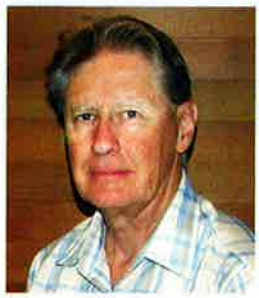
E-mail: silicon@siliconchip.com.au

ISSN 1030-2662

*Recommended and maximum price only.

Publisher's Letter

High-definition TV in limbo until the Olympics



This month, we highlight the end of analog television broadcasting (planned for December 2009) and outline what you can do to pick up the High-Definition TV broadcasts that are now available. In brief, if you want to keep watching "free-to-air" TV, you have three options. The first and most expensive is to purchase an HD TV, either LCD or plasma display. The second is to buy an HD personal video recorder (PVR) and hook that up to your analog TV set and third, the cheapest option, is to purchase an HD set top box (STB) and hook that up to your analog TV.

We would recommend one of the latter two options to most people because they will save a lot of money. Most people have two or more quite useable analog TV sets in their home and they should be capable of giving many more years of service. So there is no hurry to go and buy the latest HDTV. Remember that whatever HDTV set you buy now will be much cheaper in a year or two and that is particularly important to the majority of people who make most of these purchases on credit and then take years to pay them off. Better to save your dollars now and then buy a bigger and better HDTV set for cash in a few years' time.

People may wonder why they should buy a high-definition PVR or STB when they only have an analog set with a picture quality that is well below the state of the art. Why not just wait until the end of analog broadcasting and then get a PVR, STB or whatever? There are several reasons. The first is that the networks are now broadcasting some programs only in HD format and a standard definition STB will not pick them up. Second, an HD STB will provide a composite video output to allow an old analog TV to show the program, even though the picture quality will no better than if you watched a DVD through the same set.

In spite of the above, it has to be said that the current selection of HDTV programs is very limited and generally not worth watching. Most of the time, the programs on the HDTV channels are identical to the standard definition (SD) programs on the same networks. The only networks that bother to put out useful programs are the ABC and SBS. (By the way, all those people who reckon that they cannot pick up SBS will have no problems when they go over to digital reception – see next month's issue).

Many documentaries on SBS and ABC are magnificent on the big screen and they are even better in HDTV, with far more visual impact than on a small screen.

As far as commercial network programming is concerned, the quality of all digital programs, whether standard definition or high definition is generally woeful, unless you are interested in sport. Even then, while the video might be good, especially on a really big screen or projector, some of the commentary can be utterly banal. In fact, in my own home, the comment which applies to most commercial network programming is that it probably causes brain damage!

In truth, while some programs are very good, most digital TV air space is wasted and probably will remain so until the Beijing Olympics in August this year.

Leo Simpson

BitScope USB Mixed Signal Oscilloscope

Analog + Digital

Digital Storage Oscilloscope
✓ Dual Channel Digital Scope with industry standard probes or POD connected analog inputs. Fully opto-isolated.

Mixed Signal Oscilloscope
✓ Capture and display analog and logic signals together with sophisticated cross-triggers for precise analog/logic timing.

Multi-Band Spectrum Analyzer
✓ Display analog waveforms and their spectra simultaneously. Base-band or RF displays with variable bandwidth control.

Multi-Channel Logic Analyzer
✓ Eight logic/trigger channels with event capture to 25nS.

DSP Waveform Generator
✓ Built-in flash programmable DSP based function generator. Operates concurrently with waveform and logic capture.

Mixed Signal Data Recorder
✓ Record to disk anything BitScope can capture. Supports on-screen waveform replay and export.

User Programmable Tools and Drivers
✓ Use supplied drivers and interfaces to build custom test and measurement and data acquisition solutions.

Inventing the future requires a lot of test gear...
...or a BitScope



BS100U Mixed Signal Storage Scope & Analyzer

Innovations in modern electronics engineering are leading the new wave of inventions that promise clean and energy efficient technologies that will change the way we live.

It's a sophisticated world mixing digital logic, complex analog signals and high speed events. To make sense of it all you need to see exactly what's going on in real-time.

BS100U combines analog and digital capture and analysis in one cost effective test and measurement package to give you the tools you need to navigate this exciting new frontier.



Standard 1M/20pF BNC inputs

Smart POD Connector



Opto-isolated USB 2.0

12VDC with low power modes

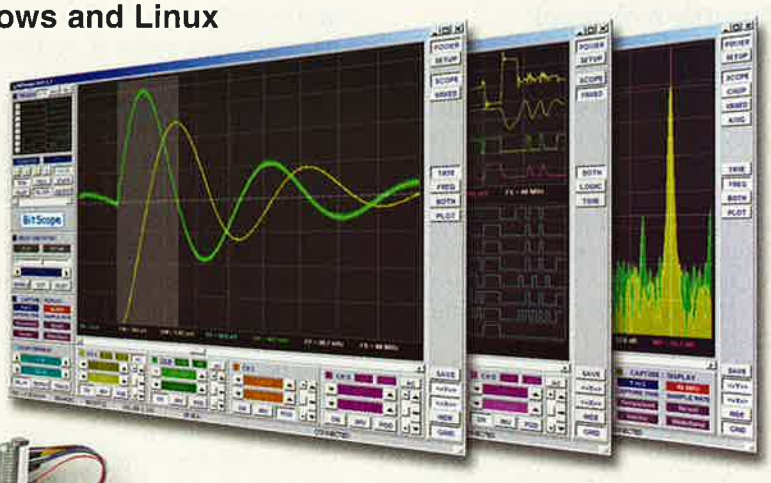
BitScope DSO Software for Windows and Linux

BS100U includes BitScope DSO the fast and intuitive multichannel test and measurement software for your PC or notebook.

Capture deep buffer one-shots, display waveforms and spectra real-time or capture mixed signal data to disk. Comprehensive integration means you can view analog and logic signals in many different ways all at the click of a button.

The software may also be used stand-alone to share data with colleagues, students or customers.

Waveforms may be exported as portable image files or live captures replayed on another PC as if a BS100U was locally connected.







3

BitScope Designs
Ph: (02) 9436 2955
Fax: (02) 9436 3764
www.bitscope.com

MAILBAG



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

Bigger battery for Prius not viable

That bigger battery in the Prius (Silicon Chip, February 2008) did not increase its "carbon economy". It just transferred the emissions from the car's tailpipe to the power plant's. And it has increased the mass of batteries that have to be replaced periodically, making the car's lifetime carbon footprint worse.

It has been suggested seriously, with numbers to prove it, that because of the limited life of the batteries, a hybrid like the Prius isn't any greener over its lifetime than the same car powered by a turbo diesel.

Gordon Drennan,
Burton, SA.

Keep those microcontroller projects coming

I have been a reader of Silicon Chip from day one. You are without a doubt a world-class publication, both by presentation and by quality of projects. Just as a whole generation of technical people enjoy the warm glow of valves, another generation cut their teeth on combinational logic. In your wisdom you have moved with the times and have introduced microcontroller projects. I believe you have built a lifeline for your publication by doing this.

By virtue of the kind of knowledge you share in your projects I for one have found a very satisfying career as a PIC programmer. I started out by attempting projects in Silicon Chip and Elektor magazine, undertook some more advanced study, including learning to program in 'C', and then went in search of a job that allowed me to apply these skills.

My point is that it all started from being able to access the basic knowledge in a structured and non-threatening way through Silicon Chip. For the sake of the future, please keep pushing microcontroller technology or what ever replaces it in your publication. You have shown the tenacity to survive in a very difficult market by having content and presentation that appeals to many. Long may it continue.

Mark Weir,
Tauranga, NZ.

Versatile 4-channel mixer fix

After building the Versatile 4-Channel Mixer project (Silicon Chip, June 2007) and not being able to get it working, I noticed in the "Notes and Errata" section of a recent issue that the published PC board design was incorrect in the region of CON1-CON4. The suggested fix was to reverse the metal contacts of these sockets.

This was no easy task as these sockets are obviously not meant to be taken apart! The stubborn little beggars bluntly refused to come out of the plastic mounting. However, two days and sore fingers and thumbs later, I managed to complete the task and install them on the board. My perseverance paid off, as the mixer is now working perfectly.

A couple of tips for people who also purchased the early version of the kit: I bought four completely new sockets and swapped the contacts over on them rather than attempting to alter the desoldered ones.

Secondly, two of the new ones had the number "3" on the under surface, while the other two had the number "4" on the bottom. Although they were identical, for some unknown reason the ones with number "4" on them were much more co-operative than those with the number "3".

George Green,
Wollongong, NSW.

Ultrasonic leak tester

On page 97 of the November 2007 issue, your correspondent is asking about an ultrasonic device to detect air leaks on vehicles with air brakes.

While such a device would probably have advantages, I have found that a very effective method for detecting air leaks on truck air brakes is to "paint on" soapy water, using a small paint brush to suspect areas (pipe joiners and connections etc).

Even when you can hear air leaks they can still be difficult to pinpoint but soapy water makes the job easier.

Peter Bell,
Glenorchy, Tas.

What is MPG?

Upon seeing the front cover of your latest issue (February 2008), I couldn't believe what I was seeing! Miles? Gallons? Who in Australia still uses the "old-fashioned" Imperial units? We don't! And how long has Australia been metric? One thing I do remember is that when I was going to tech some *thirty* years ago, we students would lose marks if our drawings did not use "metric".

I showed your magazine to my (elderly) mother who still does not fully understand decimal currency! She was as shocked as I was when she saw the references to miles and gallons. If you continue to publish magazines with "old-fashioned" measurements on the front cover, you will lose me, as a reader, forever!

T. Robinson,
Woodend, Vic.

Imperial units no longer used in Australia

I have browsed the February 2008 issue and am amazed that Silicon Chip would use units that are no longer applicable in Australia. Australian vehicles have metric speedometers. Fuel is purchased by the litre (or multiples

Serviceman should stop blaming himself

I always read the "Serviceman's Log" with much interest, as I can relate to many of the headaches he has to endure. In particular, the column in the December 2007 issue of SILICON CHIP piqued my interest, since I can comment first-hand on the mystery of diode D10, as follows.

The TinySwitch series of ICs are designed for off-line flyback power supplies. The flyback topology, although relatively inexpensive, suffers from very high voltage stresses on the main power switch. The stresses are not only the rectified and reflected voltages but also any additional voltage spikes caused by the transformer's leakage inductance. If unchecked, these spikes will destroy the 700V Mosfet located inside the IC.

To tame the voltage, an RCD (resistor-capacitor-diode) snubber is employed, as described in the IC's datasheets and application notes. Unfortunately, OEMs are always badgering power supply manufacturers to reduce costs. One of the ways to shave a few pennies off is to replace such an RCD snubber with a TranZorb, a surge protector based on a discrete avalanche diode.

Although this works and appears to be a reliable solution, the truth is that these diodes were never designed for repetitive avalanche duty and thus create junction hotspots. The diode may start leaking, causing the symptoms described, until it eventually fails completely.

I know this first-hand since the company I used to work for (a power supply manufacturer) got hit with a couple of product recalls for the same reason. The problem was that Power Integrations (the IC vendor) had actually suggested this very approach in their older application notes, now revised with the RCD clamp.

So please tell the poor Serviceman to stop blaming himself. It was not his fault but rather a poor design solution. If he can make the supply work with the RCD clamp, then leave it that way. Be sure to properly insulate all the exposed leads, as some pretty high voltages will be present.

Fernando Garcia,
Brownsville, Texas, USA.

thereof) and distance is measured in kilometres (the base unit being the metre). L/100km appears to be the standard unit for fuel economy.

I do realise there is something magical about the figure "100".

Ray Smith,
Hoppers Crossing, NSW.

Comment: you are the second to comment on the 100mpg headline but as you can see from the article, the Prius readout is in mpg and in any case, 100mpg sounds far more impressive than 2.825/100km (the actual equivalent to 100mpg). In fact, in the past we have had readers comment that such figures are meaningless to them.

Hydrogen for solar power

Why do all the comparisons of "direct" solar energy vs coal/hydroelectric conclude that solar is not suitable for base load power? As a direct to grid power source, this is true enough. However, using solar power to electrolyse water to gain hydrogen which can then be 'burnt' directly in a gas turbine is already a proven technology. The efficiency of the solar panels is not really an issue; more panels would make up the difference.

With all the land that is salt-affected and becoming useless for anything but sunlight collection, this could be an income stream for those farmers so affected. And if the panels were made to let through the light frequencies they cannot convert to electron release, would the land underneath the panels still be usable for grazing/crop production?

That is assuming that the alternative method of producing hydrogen using ceramic/direct hydrogen conversion proves not to be more efficient. See **http://www.unsw.edu.au/news/pad/articles/2004/aug/Solar_hydrogen.html**

Hydrogen could also be stored, piped and used for power generation inside the metropolitan areas as easily as natural gas is today. The benefits

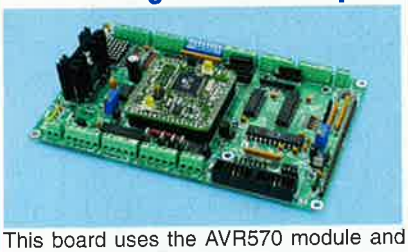
Atmel's AVR, from JED in Australia

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



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

AVR573 Single Board Computer



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

$330 PC-PROM Programmer

This programmer plugs into a PC printer port and reads, writes and edits any 28 or 32-pin PROM. Comes with plug-pack, cable and software.



Also available is a multi-PROM UV eraser with timer, and a 32/32 PLCC converter.

JED Microprocessors Pty Ltd
173 Boronia Rd, Boronia, Victoria, 3155
Ph. 03 9762 3588, Fax 03 9762 5499
www.jedmicro.com.au

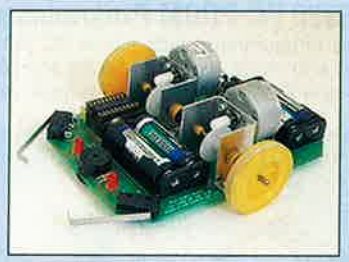
JOIN THE TECHNOLOGY AGE NOW
with
PICAXE



Developed as a teaching tool, the PICAXE is a low-cost "brain" for almost any project

Easy to use and understand, professionals & hobbyists can be productive within minutes.
Free software development system and low-cost in-circuit programming.
Variety of hardware, project boards and kits to suit your application.
Digital, analog, serial RS232, 1-Wire™, and I²C facilities.
PC connectivity.

Applications include:
Datalogging
Robotics
Measurement & instruments
Motor & lighting control
Farming & agriculture
Internet server
Wireless links
Colour sensing
Fun games



Distributed in Australia by
Microzed Computers Pty Limited
Phone 1300 735 420
Fax 1300 735 421
www.microzed.com.au

Mailbag: continued

of such a scheme are probably lower power transmission losses and less visual pollution, a more disbursed power generation system (greater disaster tolerance plus lower losses in power transmission) plus 'base load' generation becomes less of an issue. Schemes such as off-peak hot water would not be required to soak up the spinning reserve power generation as gas turbines are basically best used for full load/turned off systems.

And why are trees seen as the only way to recapture carbon from the atmosphere? Surely faster and denser growing plants such as sugar cane would make more sense. Grow the cane, process the cane and remove the sugar and bury the fibre pulp. The sugar can be used to make fuel for use in a co-generation system or be used as a source of hydrogen for fuel cells.

As seems to be so common these days, whenever something is proposed by a government department or some group or other, it seems that the proponents have a vested interest in their proposals.

Ron Powell,
Minchinbury, NSW.

Comment: some recent proposals for solar power involve the use of molten salt as the heat storage and transfer medium to run steam-powered generators. This would probably be more efficient and practical than any electrolysis scheme.

Comment on Atten oscilloscope review

I enjoyed reading the review of the ATTEN ADS7062C low-cost colour digital storage oscilloscope in the February 2008 issue supplied by our company for your evaluation. It was refreshing to see that the reviewer really knew how to drive a DSO.

There was one minor point however that could easily be missed. The oscilloscope is supplied with switched x1/x10 probes. It is possible to manually adjust the setting on the sensitivity to correct the readout on the screen for different probe attenuation settings. The scope actually operates from 2mV/div to 5V/div. This is displayed when set for use with an "x1" probe. It can even be set to work with a x100 probe.

In the case of the review, it must have been set for a x10 probe. In case any of your readers got the wrong impression or understood they could put in signals of 400V directly at 50V/div without a x10 probe, I just thought I had better point out the true scope performance. As mentioned several times in the article, it's the same as other more expensive scopes.

Charles Holtom,
Managing Director,
Trio Smartcal Pty Ltd.
www.triosmartcal.com.au

Valve radio of considerable interest

I found the article by Keith Walters on building a 3-valve radio (SILICON CHIP, January 2008) from everyday materials of considerable interest.

I have made valve shields using the tin-plate from tin cans. Just cut a suitable piece of tin-plate, wrap it around a piece of dowel a little smaller than the diameter of a valve and let it spring out to suit the valve size. Maybe you could solder the edge of the shield or leave it as is, and solder a wire from the shield to the chassis as Keith did.

Keith could have even used 6BL8 valves all the way through the set, as the 6BL8 or 6U8 make quite an acceptable audio output valve.

Rodney Champness,
Mooroopna, Vic.

Energy efficiency is just a marketing tool

I have been following some of the debate and articles on energy in your magazine. Our electricity usage equates to about $30 a month, up somewhat because of the equipment I use for my research. Our energy efficiency is achieved without double-glazing, we use quite a few incandescent lights and we have no insulation in either roof or walls. Instead, we employ principles of microclimate, ventilation, daylight, etc.

I am doubtful that efforts to promote energy efficiency in homes and workplaces will have any overall beneficial effect; just as energy efficiency

More on the Peter Seligman articles

After reading the Peter Seligman articles and the response by Dave Waplington (SILICON CHIP, February 2008) and Peter's subsequent comments, I need to add a couple of points.

First, it is likely that within the next 10 years we will see geo-sequestration of carbon dioxide commence in Australia and obviously, the CO_2 will be sourced from power stations, not moving vehicles. The argument that the electric vehicle just shifts the source of emissions may have to be revised, as it actually shifts the emissions to where they can be more easily contained.

Secondly, Peter Seligman says LPG and natural gas are similar and makes comparisons between LPG vehicles and natural gas power stations. Natural gas burnt in the power stations is mostly methane (CH4) whereas LPG is mainly a mixture of propane and butane (C_3H_8 & C_4H_{10}). These are derived from the condensate of the raw natural gas and comprise about 5% of its volume. Petrol is about equivalent to octane (C_8H_{18}) or higher, and usually also contains branched and cyclic hydrocarbons.

It is clear that the higher the molecular weight of the hydrocarbon fuel, the higher is the proportion of carbon, so that while CO_2 emissions from burning methane are about half those from petrol or diesel, those from LPG are only slightly better. A rough calculation I did when working on this subject at Mitsubishi indicated a CO_2 reduction of about 10-15%. This is not to be sneezed at but is not in the same league as natural gas.

It is possible to convert vehicles to run on natural gas but filling stations are scarce. I understand that there is only one here in Adelaide. About 20 years ago, the gas supply company SAGASCO (now taken over by Origin Energy) was experimenting with a small home compressor which could recharge a CNG vehicle tank from the gas mains. The compressors were made by Sulzer of Switzerland but SAGASCO didn't push the idea, perhaps because of the road tax problem.

They reported that their CNG vehicles such as Falcon utes and vans had reasonably good driveability but somewhat reduced power and range compared to LPG.

David Inkster,
Meadows, SA.

in transport will not turn the tide of increased consumption.

I was disappointed but not surprised to read of the debacle regarding incandescent lights in Australia. Here in NZ we have an equally stupid new law requiring double-glazing.

The reality is, I strongly suggest, that energy conservation will simply end up as a marketing tool. In other words, "more product" is the underlying philosophy, backed up by the iron hand of legislation.

Stephen Butcher,
Carterton, NZ.

Energy saving can be illusory

Following on from the topics on energy savings, there was a recent story on 'Today Tonight' covering the dangers of leaving devices on stand-by power. In particular, this story targeted TVs which when left on standby have a high risk of starting fires. In the story, a brief mention was made about a device called the "Power Genie" developed by Electronic System Integrators Pty Ltd and used to switch off devices at a single point – see **http://www.powergenie.com**.

I have looked at the site on the Power Genie with some interest and I am left wondering. They are selling this product on the idea that it turns devices off centrally, yet looking at its operation, it is constantly plugged into power and you have a controlling device to turn it on (ie, you have to leave it on standby to then operate by remote). So in effect, it's a product sold on reducing and saving power and also turning off devices on stand-by, yet this device itself seems to need to be on standby.

What is the benefit of such a device over, say, a power-board with a switch to turn off everything?'

Perhaps the true workings of this



Mailbag: continued

Electric vehicles not yet available

Recently I decided to sell my Toyota sedan and to make a serious attempt to import an electric vehicle. In Cape Town, this proved to be practically impossible and after several months, I gave up.

Even if it had been possible to import one, I wonder whether anyone would have been capable of servicing and repairing it. Instead, I imported a Bajaj Pickup from India, a successor of the original 1948 Vespa Ape, which is serviced and repaired locally. So far, fuel efficiency is 3l/100km. Compare this with 5.6-15l/100km for a typical sedan.

Not only that but it is very useful and great fun if one isn't deterred by a top speed of about 60km/h! So here is someone who aspired to an electric vehicle but the times did not yet favour it.

Thomas Scarborough,
Cape Town, South Africa.



Comment: it would certainly be economical but we like the protection of a real motor vehicle with lots of airbags and structural crash protection – which means that we might be able to have a major collision and still come through relatively unscathed.

device could be covered in an article in SILICON CHIP. This could then flow onto a project on something better which you could position anywhere and centrally turn a number of devices off (and where the device itself does not need to be controlled by another device to turn on).

I am beginning to find that this whole issue about saving energy and the environment is becoming a big 'con' on society, with everyone getting on the bandwagon and using it as either a political grab or as a means of sucking more hard-earned income from individual consumers. If the world governments *really* wanted to improve the environment, then the first point of the agenda is to release our reliance on oil and fossil fuels.

I was dumbfounded by a report which said that we should be taxed to force new 'green' technologies. **http://www.news.com.au/business/story/0,23636,22471121-462,00.html**

Flavio Spedalieri,
Frenchs Forest, NSW.

Comment: SILICON CHIP has produced two projects which are relevant: (1) the PowerUp in July 2003 and the USB Power Switch in the November 2004 issue. See also the Remote Controlled Mains Switch in this issue. It can be used in conjunction with a powerboard.

Efficiency question on Signature Series loudspeakers

There appears to be an error in the sensitivity of the Signature Series Kit Loudspeaker article. I have no doubt that these are efficient speakers and I know the tweeter is capable of the efficiency quoted, however the woofer is not.

The speakers are reported to have an efficiency of 92.5dB/1m/1W. This is not possible as the drivers only have an efficiency of 88dB/1m/2.83V (or ~87dB/1m/1W with a 6-ohm minimum impedance), so for the 260 series speakers with parallel drivers, the woofers will have a sensitivity of ~90dB/1m/1W or ~93dB/1m/2.83V.

Although the 2.83V measurement is more realistic for normal use, as almost all amplifiers are voltage controlled, quoting it as a 1W figure is still misrepresentation. Having said that, the realistic figure of 90dB/1m/1W is still very respectable and I commend you and Russell Storey on a very well-designed speaker. There would be very few commercial speakers that will come close to the level of the Signature Series.

Chris Lister,
Brisbane, Qld.

Russell Storey comments: the 260 Ribbon Speaker was measured using an LMS Speaker Analyser which is calibrated in true SPL dB (speaker pressure level). A B&K laboratory reference microphone pressure calibrator @ 94 SPL dB is used to calibrate the microphone and LMS Speaker Analyser measurement system before any measurement is made. A constant amplitude sinewave sweep set to 2.83V RMS across the speaker terminals is used as a reference point only. The microphone distance is set to one metre, centred on the tweeter axis. Up to 40 different readings are taken over a period of two hours and then averaged.

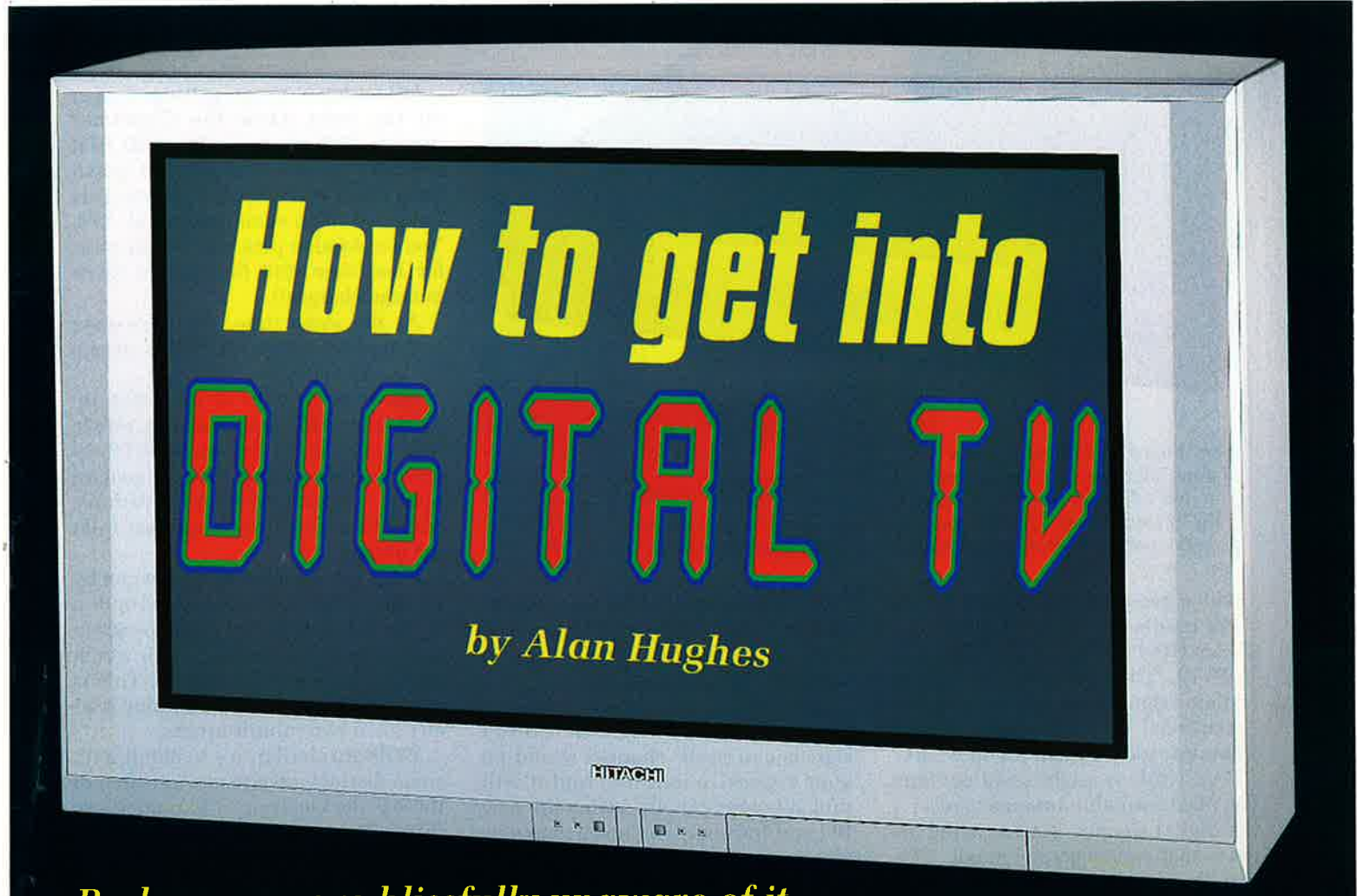
The 260 sensitivity is quoted at 92.5dB SPL under all of the above conditions and is an average over the 400Hz to 10kHz region.

Ambient temperature is the most important factor in measuring any loudspeaker system; this was set at 22°C. SPL dB of any transducer (speaker) can vary by as much as ±3dB to ±6dB in the ambient temperature range from 8-35°C. Other factors that change transducer measurement readings are humidity, barometric pressure and the effect they have on the microphone capsule, transducer motor (magnet) system, voice coil, compliance of the cone and spider materials and heating losses in component in the crossover.

Measuring any loudspeaker transducer or speaker system's response and specifications is like measuring a "sponge with a pair of metal callipers". Every time you measure the sponge diameter you will get a different set of readings.

Russell Storey,
Stones Sound Studio.
http://www.stonessoundstudio.com.au/

SC



How to get into DIGITAL TV

by Alan Hughes

Perhaps you are blissfully unaware of it – but the Australian Government plans to progressively switch off all analog TV transmitters, starting in less than two years time. And High Definition digital TV programs are now being shown on "free to air" commercial, ABC and SBS TV. Those programs are not available via Standard Definition digital tuners or set-top boxes. So what do you need to do?

You might have seen adverts on the Seven & Ten network stating that their new High Definition (HD) TV programs are now available. New Zealand is also converting, with HD Digital on air in all major population centres, ready for the start of the Beijing Olympics on 8th August 2008.

Perhaps you have been thinking that you will be able to get the new HD programs with your existing standard definition (SD) set-top box (STB) or SD digital tuner. Well, think again. It doesn't work that way.

If you want to see HD programs, you will need an HD tuner, even if your present display cannot show them in the needle-sharp focus of HD.

In Australia there are HD and SD receivers. SD programming will eventually die out with the advent of HD-only programming but an HD STB can produce an SD signal for analog receivers. So even if you decide to stay with your present analog TV set, it will still be possible to watch all the new high-definition free-to-air programs, provided that you have an HD STB.

The clock is definitely ticking on analog TV broadcasts. Senator Conroy, the Minister for Broadband, Communications and the Digital Economy, has set the switch-off date for metropolitan analog TV as December 2009, with all analog transmissions to cease by 2013.

So there is no escaping it, if you want free-to-air TV programs in the near future, you are going to have to "go digital" and realistically, that means "go HD".

But why wait? Why not enjoy all the advantages that HD TV has to offer, right now? The main advantages are more programs, much better picture and sound quality and no ghosting.

If you want to watch HD programs, you must obtain:

1) A wide screen TV which incorporates an HD tuner or
2) An HD Set Top Box (STB) which will receive digital signals and convert them into a form a conventional receiver can display or a standard



You'll need an HD set-top box if your TV doesn't have one built in. But don't despair: they won't cost an arm and a leg! This Tevion brand HD STB was on sale earlier this year for less than $100 (see the review in this issue). And we've seen them for $50 or less on eBay!

video recorder can record via its AV inputs or

3) An HD Personal Video Recorder (PVR). This device will receive digital signals and display on a conventional or wide-screen display (and/or record them if you wish).

And while it might seem obvious, you need a suitable antenna to receive the digital signals. Your existing antenna may not be good enough.

If you live in a home unit, your building's Master Antenna Television (MATV) system will need upgrading to pass the channels used by digital TV.

The cheapest and best way to do this is for all residents to obtain either a STB or PVR first. They may not receive all stations at this stage. Then get the body corporate/building owner to upgrade the MATV system to digital channels. The installation should be made according to Australian Standard AS1367: 2007.

The cheapest option is to install STBs near the antenna instead of retuning the channel amplifiers. One STB will be required for each digital channel. The STBs will be used to convert the digital signals back to standard definition analog.

However, this approach will prevent you seeing High Definition signals and multi-channel sound on your expensive new TV. And it will probably prevent you seeing the new HD and the supplementary channels already available. See **www.dba.org.au/index.asp?sectionID=26**

If you live in a free-standing home or dual-occupancy dwelling, you will need to check to see if you get reliable digital reception, particularly in the rain.

Check that the picture does not break up into little squares, the sound not go off and on or that the "no signal" sign appears.

If any of these things occur, then you require an antenna designed for digital reception (not "digital-ready") in your viewing area. The antenna cabling may also need replacing. We hope to have more to say on digital antennas next month.

HD set-top boxes are getting cheaper all the time. Over the Christmas period, Aldi stores had an HD STB available on special at just $99 (down from $119) while Coles supermarkets have had them even cheaper at $79. You could also pick one up on eBay for less than $50 (but watch those postage charges!).

At the same time, we have seen standard definition (SD) STBs on sale for as little as $35.

However, in view of the above remarks about HD programming, we see little point in buying an SD STB. In fact, we forecast that once the general public understands their limitations, SD STBs will shortly disappear from the market.

PVRs are also becoming cheaper by the day and they are a very good option if you want to record a HD program at a particular time while you watch another HD (or SD) program. This is easy with most PVRs since they usually have two inbuilt tuners.

PVRs are similar to a VCR but with some distinct advantages. The first of these is the Electronic Program Guide (EPG). This is where the broadcaster sends out via their transmissions the names of all programs to be shown for the coming week. You can then select the programs you wish to record by name. No more worrying about start and stop times, channel number etc.

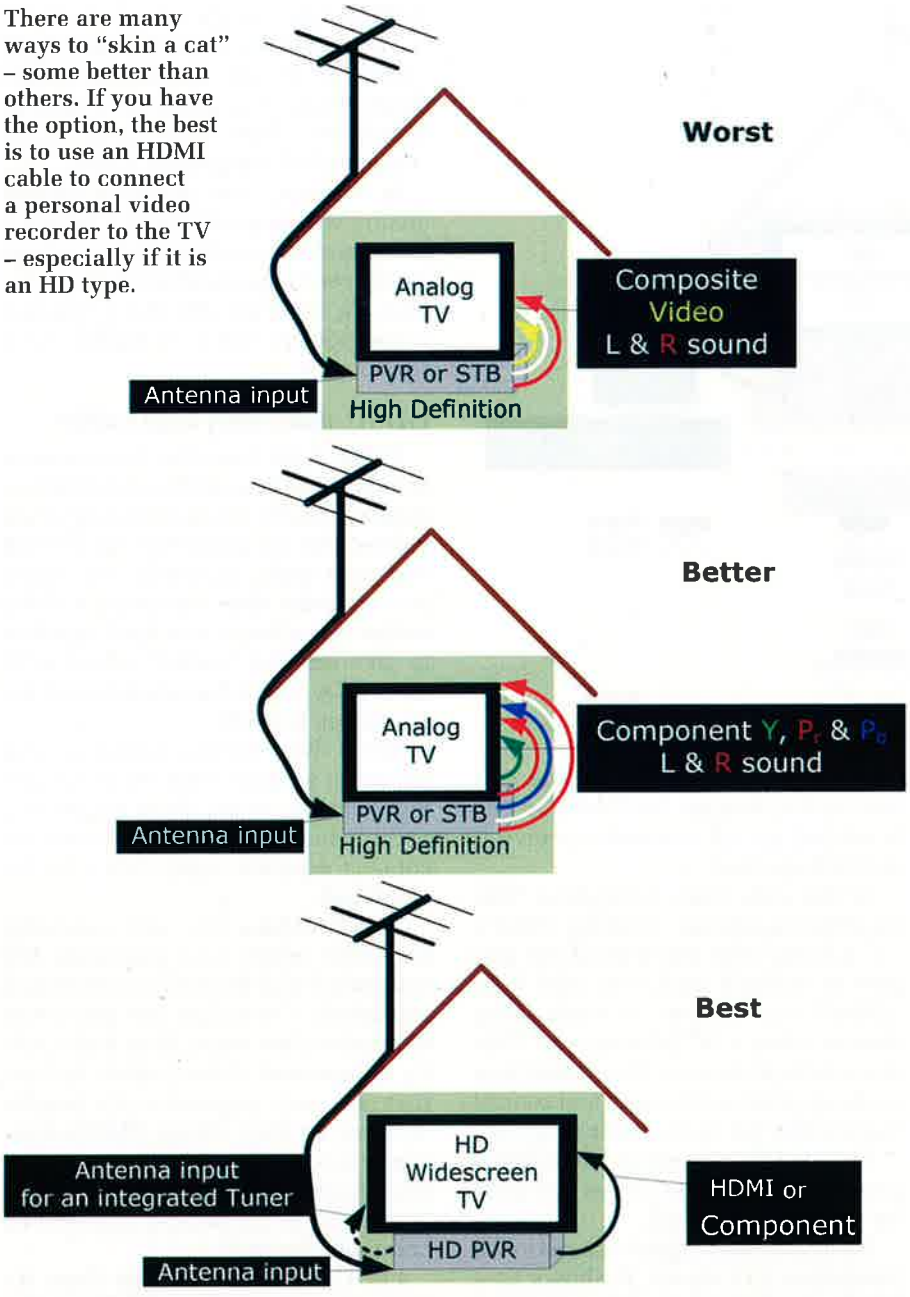
Another advantage is Time Slip recording, which enables you to pause the program you are watching, while the recording process continues. You can then start playing where you left off while the recording is being completed.

Since the recordings are made on a very large hard disk (typically 160GB or 250GB), there is no waiting for a tape to wind to the right place; it is just like playing a DVD.



Here's the rear view of the STB above. At left is the standard coax antenna input and loop output sockets. Alongside is the coaxial (digital audio) and S-video socket, followed by the Y, Pb and Pr component video sockets (labelled HD OUT). The next three sockets are component video (yellow) and L/R audio (white and red). Immediately alongside this is a D-socket for use with a VGA computer monitor. The next four sockets are the interesting ones: DVI out (for projectors, etc), the HDMI output we've discussed in the text; a USB socket for USB devices and finally, the optical, or TOSlink audio socket.

There are many ways to "skin a cat" – some better than others. If you have the option, the best is to use an HDMI cable to connect a personal video recorder to the TV – especially if it is an HD type.



Subtitling for the hard of hearing's data is also recorded along with the program so you can choose whether you display subtitles on playback or not.

HDMI or component video?

HD STBs and PVRs should be connected to your TV set or projector by HDMI or component video cables. HDMI stands for "high definition multimedia interface".

But which one should you use? HDMI or "component video"?

HDMI has the following advantages:

- It can carry the three colour signals and up to eight channels of sound on a single cable.
- It can tell the display what type of signals is being sent so that the display can automatically adjust.
- It can convey control commands for other devices. So for example, a single remote control can be used to control the PVR, etc.
- It can carry the High Definition Copy Protection (HDCP) signals. There is talk of only outputting Full Definition (1920 x 1080p) signals to the HDMI output only. This will particularly affect High Definition DVDs such as BlueRay and may actually be a drawback in the future, as far as most users are concerned, since HDCP is a copy prevention method.

PRIME ELECTRONICS
Est. 1987

FLUKE

115 Compact DMM



True RMS
AC/DC Volts 600V
AC/DC Amps 10A
Resistance
Continuity
Frequency
Capacitance
Diode Test
Analog Bar Graph
Backlight
Min/Max/Avg
Display Hold
Auto/Manual Range
Holster

List Price $245.00
Our Price $199.00

179/EDA2 Combo Kit



Kit Contains

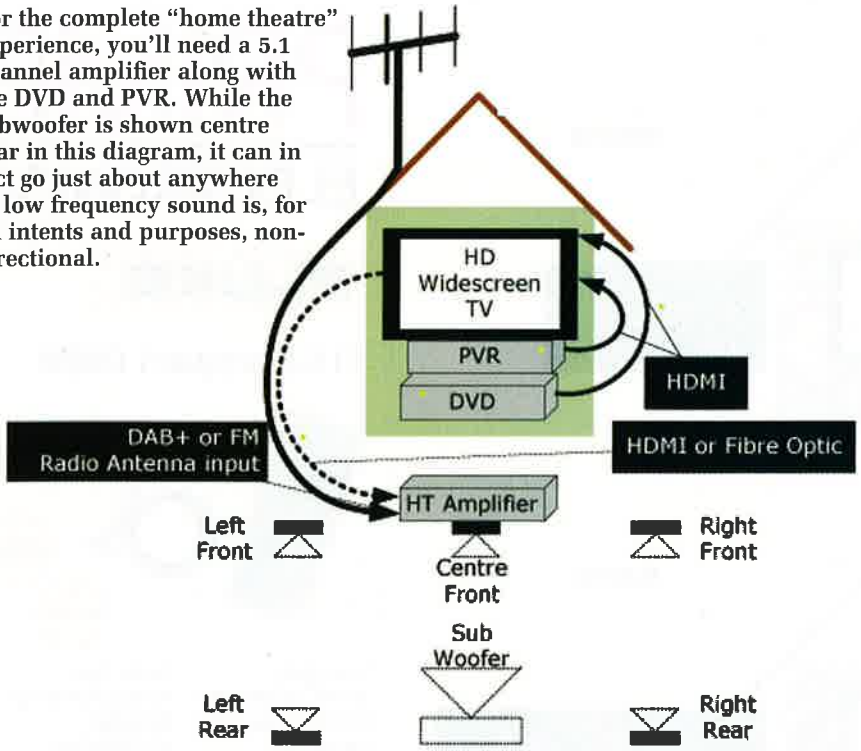
- Fluke 179 True RMS DMM
- TL224 SureGrip™ Silcone Test Lead Set
- TL910 Electronic Test Probe Set
- AC280 SureGrip™ Hook Clip Set
- TPAK Magnetic Hanger
- 80BK Intergrated DMM Temp Probe
- C35 Soft Meter Case

List Price $585.00
Our Price $499.00

Prices exclude GST

Call for a 2008 Fluke Catalogue

www.prime-electronics.com.au
Brisbane (07) 3252 7466
Sydney (02) 9704 9000



For the complete "home theatre" experience, you'll need a 5.1 channel amplifier along with the DVD and PVR. While the subwoofer is shown centre rear in this diagram, it can in fact go just about anywhere as low frequency sound is, for all intents and purposes, non-directional.

• The signals are not converted into analog. This is an advantage because the display will have to digitise component signals, so that the image can be stored for display. Thus digital to analog and an analog to digital conversions are eliminated.

• Finally, it allows the transfer of the xvYCC colour signals to the display. This gives a greater range of strong colours, if they are present on the disc.

But in spite of the above, there is presently no clear-cut advantage for HDMI over "component video". While HDMI is a digital format, it does not have error correction and therefore long cable runs can be more problematical, with possible signal dropouts, than the analog "component video" connection.

To explain, both HDMI and analog component video deliver signals as three discrete colour components, together with sync information which allows the TV or projector to produce the video display.

HDMI delivers these via three data channels in a format called TMDS (Transition Minimised Differential Signalling). The TMDS format basically involves a blue channel to which horizontal and vertical sync are added and separate green and red channels.

TMDS involves two schemes to minimise noise and interference. "Transition Minimised" refers to the conversion of the signal to Grey code, which only has one bit change at a time in the channel. So if interference is picked up, all channels receive it and it is ignored.

At the same time, it employs "Differential Signalling" whereby when a "1" is being sent one wire of the pair goes to +250mV while the other goes -250mV with respect to earth. They reverse when a "0" is being sent. This gives noise immunity. Error correction is also applied to the sound and control signals (but not to the colour signals).

The signals are sent as identifiable packets, so the same wires are used for picture and sound.

An HD colour signal consists of a luminance (Y) signal. It shows as a black, grey and white signal in sharp detail. The picture is then "coloured in", by using a Pr signal which colours it either red or aqua, or a Pb signal which colours it blue or yellow. The green and purple colours can be derived from the above three signals.

Component video is not much different, with the analog colour information also split three ways: luminance (the "Y" or green channel, representing the total brightness of the image); Red minus Luminance (the "Pr" or red channel); and Blue minus Luminance (the "Pb" or blue channel).

The horizontal and vertical sync pulses are delivered on the Y channel. The video display calculates the values of red, green and blue from the Y, Pb and Pr signals.

The sharpness of the image will be controlled by the resolution of the display but the accuracy of the colour should be a little better using HDMI compared to component video.

In essence, your ultimate picture quality will depend more on the resolution and video conversion processes inside your video monitor or projector than on whether you have selected a component video or HDMI cable connection.

HDMI uses only one cable

HDMI does have the convenience of only using one cable connection instead of three in the case of component video (plus an extra two for the left and right audio channels) but when you consider that component video cables are always moulded together to give one flat "cable", albeit with three RCA connectors at each end, the advantage is small.

Nor is there much advantage if you are using a video projector since you don't have to worry about connecting audio cables (although you do have to connect separate audio cables to the amplifier).

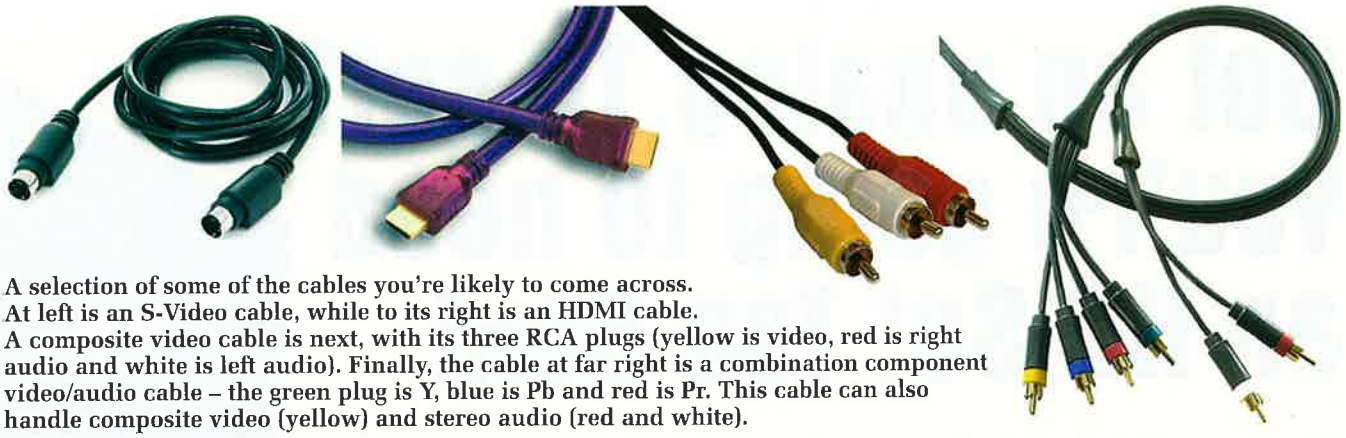
HDMI cables are not normally included when you purchase HD equipment and have to be purchased separately – and they are also more expensive than equivalent high quality component video cables. In fact, they are very expensive for lengths between 10-25m. Cheap HDMI cables can be a problem at lengths above 5m, with the most frequent symptom being "sparkles" in the picture followed by complete dropout.

For HDMI cables longer than 10-15m, you may need an HDMI repeater such as the one sold by Jaycar Electronics (Cat AC-1698 at $79.95). This is powered by a plugpack.

HDMI cables also present problems for installers. This is because you presently cannot buy HDMI cable and then fit it with connectors – you must buy the complete cable with connectors fitted at each end. This can make it very difficult to pull such a cable through wall cavities without damage.

Long component video leads can also be a problem, especially if they use cheap cable. The result is picture blurring.

For projectors, component connections are an alternative to the high cost of HDMI. However, blurring of



A selection of some of the cables you're likely to come across. At left is an S-Video cable, while to its right is an HDMI cable. A composite video cable is next, with its three RCA plugs (yellow is video, red is right audio and white is left audio). Finally, the cable at far right is a combination component video/audio cable – the green plug is Y, blue is Pb and red is Pr. This cable can also handle composite video (yellow) and stereo audio (red and white).

the vertical edges in the picture will occur if they are too long.

If you have insufficient HDMI inputs then you can use component inputs, but also feed the sound into the display as well.

The other option is to use a home theatre amplifier to do all switching, provided it can delay the sound for the delay in the display.

In practice, we think that the decision whether to use a component video or HDMI connection will depend on how many HDMI inputs your TV or projector has. At present, video projectors come with only one HDMI input and many HD TVs are the same. So if you have several HD video sources (eg, HD STB, PVR and DVD), you will probably end up using a mixture of component video and HDMI cables.

The most recent "upmarket" HDMI plasma and LCD HD sets may have two or three HDMI inputs so there is less of a problem with these models.

If you have one of these, it is best to feed all sources to the display, then take the sound from the display. This also has the advantage of avoiding problems with "lip sync" whereby the video is delayed with respect to the sound.

By the way, using S-video or composite video cables for HD connections is really a waste of time and money, unless you are using an analog TV set.

What about Surround Sound?

If you want to get the complete experience, then you also need a home theatre amplifier and all the necessary loudspeakers. If you purchase an HD STB or PVR, it will have a coax or optical output which can be fed to the Dolby decoder in your home theatre receiver.

However, consider that unless you frequently watch "action" movies, there is no real need for surround sound; your TV's inbuilt speakers will be quite adequate for the purpose.

Even if you do watch the occasional "action" movie, a good quality stereo pair of speakers and your existing system amplifier can still give a very satisfactory aural result.

In fact, if you have a limited budget, as most people do, then our advice is to buy the biggest HD set (or choose a HD video projector) and leave the decision about a surround system to a later date – if ever!

If you do decide to go for the full home theatre experience with multiple speakers, go for the best home theatre receiver you can afford. It will also solve any problems with switching of HD signal sources.

Most plasma and LCD TVs have stereo sound systems but many have relatively poor sound due to restricted speaker sizes.

HD programs are broadcast with the option of two sound systems. The first of these is MPEG2 which is stereo only. The second is AC-3 or Dolby Digital 5.1 which carries six channels: left, centre and right front, as well as left and right rear.

The 0.1 is the low frequency channel which is normally fed to an active subwoofer. Typically, when broadcast AC-3 has a greater dynamic range than MPEG2. SC

NEXT MONTH:
In part 2 of this feature, we'll look at some of the traps for young players in HDTV reception – for example, is your old analog TV antenna suitable for digital? The answer is . . . probably not!



Got an analog TV set? You're going to need an HD Set Top Box!



If you currently have an analog TV set or a digital projector and don't want to change it, you will need a high definition set top box to watch HD TV broadcasts – now and more importantly in the future.

By LEO SIMPSON

With that in mind, we purchased a Tevion TEV8200 HD STB from our local Aldi store. This is one of the cheapest HD STBs currently available and has all the features that you are likely to want.

With a recommended retail price of $119 (including GST) and occasionally available on special at $99, the Tevion HD STB is hard to go past. It is quite a bit larger than typical SD STBs and is quite heavy to boot.

Its front panel has six pushbuttons to control the various on-screen menus, to select channels and control volume. But after the initial setup, there is no need to ever use the front panel controls.

The rear panel is of more interest because the number of video output connections is impressive. In fact, the array of connectors on the rear panel is likely to be quite daunting for any non-technical user.

It has the standard male and female coax connectors for the antenna input fly lead and an output to VCR, TV or whatever. To connect an analog TV, there are RCA sockets for composite video and L & R stereo audio, S-video and component video.

Most analog TV sets will just use the composite video output (yellow socket) and the left/right stereo outputs (red & white). If your set only has a mono input, use the left audio (white) output.

In the (these days most unlikely) event that your analog set does not have audio/video (A/V) inputs, you will need an RF modulator to connect to the standard antenna input. Both Altronics and Jaycar Electronics have suitable RF modulators.

For connection to home theatre receivers, there are two digital outputs, one via a SPDIF coax (RCA) socket and one via a TOSLINK (optical) connector.

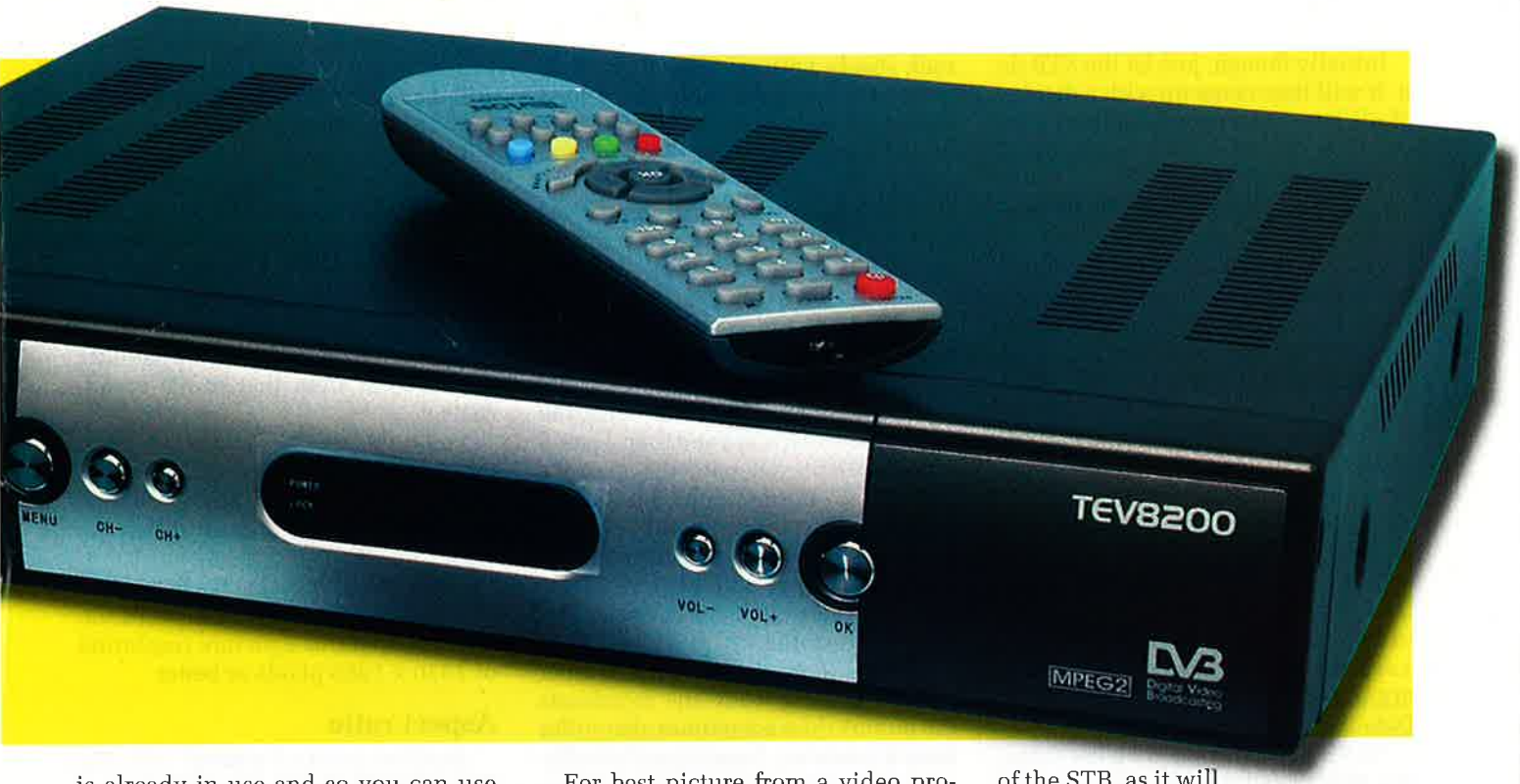
Having the two options is good since you may find that one of the digital inputs in your home theatre receiver



The TV Channel Manager screen shows the channels that are available together with a preview of the channel selected, in this case ABC HDTV. Note the availability of the D44 data signal channels.



This screen is a program guide showing what is available over most parts of Sydney, including the D44 Datacast channels. The latter include weather, federal parliament, a TV buying channel, a Christian channel and so on.



is already in use and so you can use the alternative.

In case you were wondering, SPDIF stands for Sony/Philips Digital Interface. TOSLINK is a registered trademark of Toshiba Corporation and hence the origin of the name: TOShiba-LINK.

For connection to a PC, there is a DVI socket. For connection to a PC monitor, you can use the VGA RGB/HV D socket, together with the L & R audio outputs.

For connection to an LCD or DLP video projector, you can use the component video or HDMI digital outputs. Of course most good projectors will also take composite video, S-video or RGB/HV inputs but if you want high-definition pictures, you need to use the component video or HDMI signals.

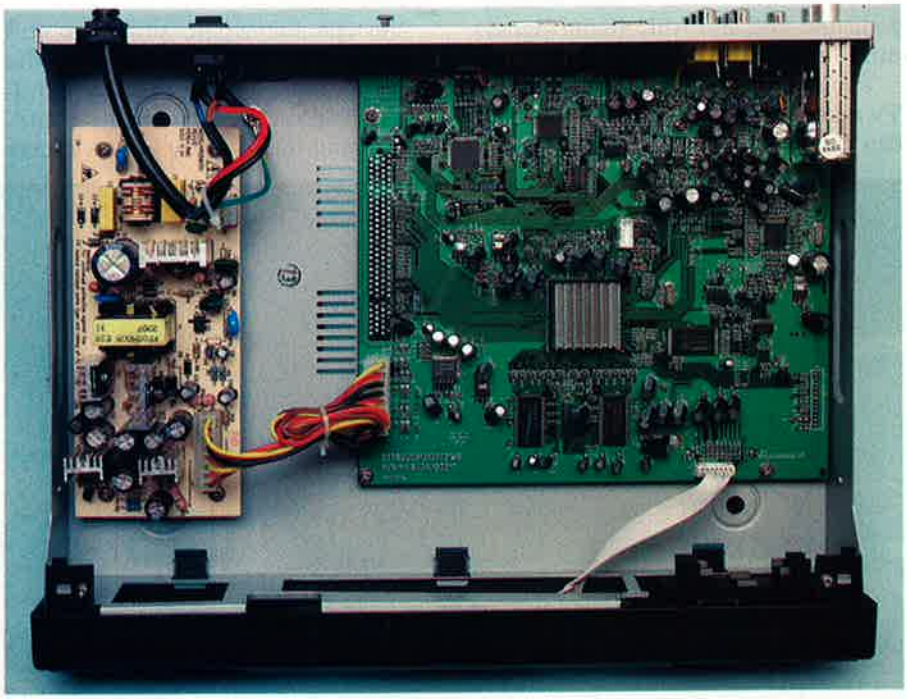
Setting up the Tevion TEV8200 is straightforward. First, you need to select the video output which you have connected to your TV, projector or whatever.

To do this, you press the FUNC button on the remote control twice within four seconds and this brings up a four-dash display on the STB's front panel readout. You then press one of the coloured buttons to select the output: RED for PAL (ie, analog TV); GREEN for VGA; YELLOW for Component Video and BLUE for DVI/HDMI mode. You can also use the Left/Right buttons to select the video resolution you want such as 1080i (interlace), 720p (progressive scan) and so on.

For best picture from a video projector, it is desirable to set the STB's output video resolution to the "native" video resolution of the projector, although most of the better projectors will do a pretty good job of scaling the signal to suit. Most HD projectors will also automatically recognise interlaced or progressive scan signals.

Once you have set the video output, you can ignore the front panel display of the STB, as it will display all the information you want via the video screen.

The next step is to get the STB to scan all the available channels. You can do this manually but it is far quicker and easier to just let the STB get on with it. Afterwards you can decide to get rid of channels you don't want, rename them, change their order or whatever.



Inside view of the Tevion TEV8200: note the large and complex PC boards and the large number SMDs and electrolytic capacitors. The electros look as though they might have been hit by a mini-tornado, don't they?

Initially though, just let the STB do it. It will then come up with a display of all the channels available in your location, together with their signal strength and quality.

It is here that an STB can demonstrate surprisingly good results. In my setup I have a 4-bay UHF antenna with direct line of sight to Sydney's North Head (Mosman/Manly) translator and it gives good reception of the existing analog stations (ABC, SBS, 7, 9 & 10).

The Tevion picked up the equivalent digital channels as you would expect, plus a brace of digital datacast channels (D44) which are available only in Sydney at the time of writing. I certainly did not expect to pick up the D44 channels – they must be coming in from the side of the UHF array. (For a signal coverage map, see **www.dba.org.au/uploads/images/NSW_Syd_Datacast_coverage_map.jpg**

As well, it also picked up the Prime and WIN digital and HD channels from Wollongong, about 85km to the south of my location on Sydney's northern beaches.

These latter channels do come and go at my location and it is possible that the intermittent reception was a case of summer-time tropospheric "ducting".

Suffice to say that there is no equivalent DX (ie, long distance) reception of UHF analog channels from Wollongong and SBS and ABC digital signals didn't make it either.

The really good point about digital TV reception is that, provided the STB can pick up the signal, the picture is rock steady with no sign of ghosting or noise. Even if you have pretty good analog TV reception, the transition to digital is a revelation, with the picture quality the same as obtained from a standard definition DVD, depending on your video signal connection and the quality of your monitor.

The Tevion STB has two further benefits when the signal strength momentarily dips, as it may do on the weaker signals. Instead of the annoying random pixellation of the picture, the whole picture freezes and then a panel may be displayed with the message "No signal". Furthermore, there are no loud zaps or cracks from the speakers as the sound drops out. Instead, the sound is muted, without any clicks. Nor are there any clicks when the sound is restored.

Having written that, I noted than when watching weak HD broadcasts the picture does sometimes also suffer from momentary freezing and pixellation. Still, it is not as severe as I have noted on other (SD) STBs.

For my checks I connected the Tevion to an older Panasonic 68cm analog TV (TC-68P22A) and a Panasonic AE700 LCD projector. On the analog TV, via the composite video connection, I had the satisfaction of seeing HD TV broadcasts without problems, although the picture quality was no better than noise-free PAL, as you would expect.

Via the Panasonic projector and the component video connection, the pictures are first class, even on standard definition. In fact, I must admit, after watching the very large pictures available via an HD LCD projector, I still have problems coming to grips with the excellent picture quality – it still seems too good to be true. For one who has experienced the limitations of black and white and then PAL colour TV reception, the results from digital TV are a revelation, as noted above.

In spite of that, it must be said that the picture quality from most of the supposed HD programs is apparently no different from that of SD broadcasts.

You only have to see the outstanding quality of the so-called "HD loops" broadcast by some of the commercial networks to see the dramatic difference with true HD.

I should also note that the Panasonic AE700 is not a "true HD" projector. True HD requires a picture resolution of 1920 x 1080 pixels or better.

Aspect ratio

Another point of interest with the Tevion is that you can select the picture aspect ratio to be shown on your TV set or display. You have three choices, 4:3, 16:9 or Panscan.

This is perhaps the biggest disadvantage of watching digital TV on an analog set with a 4:3 picture tube; no matter which aspect ratio setting you choose, the results are less than optimum.

If you choose 16:9, you will have black strips at top and bottom of the picture, just as you do, for example, with current analog broadcasts of ABC and SBS news programs. If you choose 4:3, you get a 4:3 picture, within a black rectangle – not very satisfying.



This is what usually happens during loss of signal. The picture freezes and you get a panel with the message, "No signal". Occasionally the picture becomes pixellated.



On changing channels, you get this electronic program guide for a few seconds. Lately, though, we have noticed increasing instances of "no information" .



The rear view of the Tevion TEV8200 shows a comprehensive array of video and digital output connectors. Note that DVI and HDMI connectors are included; essential if you are to get the best picture from LCD and DLP projectors.

And if you chose panscan, the whole screen area is filled but inevitably, you lose the sides of the broadcast picture. Oh, well...never mind.

As an aside, the commercial networks have yet to standardise their program and advertising content and the aspect ratio can vary between 16:9, 4:3, letter-box and so on. It is also very annoying for people with 4:3 sets when watching sports – the 16:9 format means that sport scores often cannot be seen.

Also on the negative side, sound quality appears to be only average and there is a fair amount of high frequency "frizzle" and a low level tone which is probably related to the switchmode power supply.

You have two choices for sound quality by the way, although the modes are limited: stereo (MPEG1/2) via the audio outputs or Dolby AC-3 via the SPDIF connection. Presumably, the AC-3 mode would be free of high-frequency frizzle but we did not test it. The remote control provides 20-level adjustment and muting.

Incidentally, all the screen shots of the Tevion STB shown in this article were taken with a 6-megapixel digital camera (Fuji Finepix S6500fd) from the Panasonic analog TV mentioned above.

One of the problems with taking these shots was the strobing effect between the TV scan rate and the camera's picture update, together with the inevitable Moire patterns evident because of the interference between the camera's CCD pixel structure and the vertical slot makeup of the TV screen (perhaps this might have been reduced if the shots were taken at maximum file size). A consequence of the strobing is a tendency to get a light band through the centre of the picture, in spite of using a slow shutter speed of 1/15 second. So while some of the various off-screen shots may look fairly poor, the actual picture quality was generally very good, as already noted.

Incidentally, all of these picture problems could have been avoided if I had taken the screen shots using the Panasonic projector, particularly if its "freeze frame" feature was used. But this would have defeated the purpose, as I wanted to show what is displayed on a typical analog TV set.

Interestingly, I found that the Aspect Ratio selection from the Tevion STB over-ruled the aspect ratio control on the Panasonic projector – not sure why that happens.

One aspect of digital TV that is not well-known is that digital radio services are available from ABC and SBS. Also available in rural areas is the Mytalk datacasting service. See **www.mytalk.com.au/NewDesign/Pages/Datacasting.asp**

Finally, the Tevion offers the ability to view subtitles via teletext and it has a selection of simple video games – perish the thought!

Inside the box

A look inside the box shows the Tevion HD STB is far more complex than typical standard definition STBs. It has a large main PC board which is packed with surface mount devices and a surprising number of electrolytic capacitors. I have to say that QC in assembly was a bit lacking: the electros are soldered in every-which-way but vertical!

The switchmode power supply board is also quite large, again with a number of electrolytic capacitors. Interestingly, while the Tevion is double-insulated, it is fitted with a three-core mains cord and moulded 3-pin plug.

Power consumption of the Tevion is listed as 20W. We measured power consumption at 14W, dropping to 12W on standby. Why the small drop? Surely, standby power should only be a watt or two? This means that the Tevion should be switched off at the power socket when not in use. All settings are saved in non-volatile memory when the power is off.

A USB socket on the rear panel is included for software upgrades and interestingly, the operating system is Linux. The main chip is an ATI Xilleon X210H.

Conclusion

If you don't intend purchasing an HD TV set in the near future, you should consider purchasing an HD STB such as this Tevion TEV8200.

For a relatively small outlay, you will get the immediate benefits of much better picture quality and a great range of TV programs.

Sure, it's not perfect and its standby power use is on the high side but the pictures outweigh the drawbacks.

And to save power, all you have to do is turn it (and anything else that goes to "standby" with a remote control) off at the power point. Our recent series of articles on power usage showed just how wasteful standby power is – and how much (power AND $$$) you can save with the simple step of turning things off! SC

benchmark

MARCH 2008

DICK SMITH ELECTRONICS

www.dse.com.au



$49.99

NEW

12V Auto Impact Wrench
Electrically loosen or tighten a tyre's wheel nuts without the strain and inconvenience of your standard socket wrench. Easy to operate, simply plug into the car's cigarette lighter socket, or connect directly to the car's battery. Supplied complete with a storage case, car battery adaptor lead, 4 wheel nut sockets, a hub-cap remover tool and a spare fuse. T 4885



$69.99

SAVE $30

DICK SMITH ELECTRONICS

Temperature Controlled Soldering Station
Quality soldering station, slim 48W soldering pencil, 1.6mm long-life plated tip and cleaning sponge. Adjustable 150°C - 450°C temperature with front panel metering. T2200



$1

DICK SMITH ELECTRONICS

SAVE 54¢

Screw Cap M205 Fuseholder
Low cost and popular panel mount M205 glass fuse holder with screw cap in the same style as P 7902. Rated at 10A max. P7918



$1

SAVE 78¢

Screw Cap 3AG Fuseholder
Our most popular and used panel mounting 3AG glass tube fuse holder. Rated at 10A. Required 13.5mm mounting hole. P7902



$2.50

SAVE $2.48¢

Fingerproof 3AG Fuseholder
3AG size tubular glass fuse holder with internal safety switch. Quality Bussman production model with flush face fitting. P7916



$2.50

SAVE $2.48¢

Fingerproof M205 Fuseholder
Safety Holder, Genuine fingerproof, type: M205 (20 x 5mm), panel mount: 10A Insulation, resistance: 10MOhm @500V, DC mounting hole: 13.5mm. P7914



Marushin Made in Japan Quality Single Pole Minature Push Button Switch Normally Closed
Rating: 125V AC 1A. Mounting: threaded bush. Overall size: 28.1 x 9.5mm. Clearance: 17.5mm. Cut out: 7.1mm. Model: MS-313. P7561

52¢

SAVE 68¢



Marushin Made in Japan Quality Single Pole Minature Push Button Switch Normally Open Rating: 125V AC 1A, Mounting:Threaded bush, Overall Size: 28.1x9.5mm, Clearance: 17.5mm, Cut Out: 7.1mm. P7560

52¢

SAVE 68¢



Miniature Toggle Switch
240V AC/2A Threaded Bush Popular model found in 101 and more different projects and uses. Grab a handful and save a bundle today. 40% off! P7654

$1.25

SAVE $1.04¢



Medium Size Toggle Switch
DPDT 125V AC/6A Solder tags. Another very popular sized model in this month's special at half the price. P7670

$1.25

SAVE $1.24¢

SAVE 49%! THIS MONTH ONLY



12-Core Rainbow Cable
Fantastic value – even lower costing than single core light duty hook up wire per metre! Uses 0.127mm wire strands for greater flexibility. W2045

$1/m

Promotion from 27/02/08 to 25/03/08

DICK SMITH ELECTRONICS

EASY TO INSTALL
NO WIRING



Home Automation – Timed Lighting and Appliance Kit
Automate lighting & appliances within minutes! Activate at the touch of a button, switch on bedside lamp and turn on the kettle at the same time. Simple and easy DIY installation. Easily expandable. L6026

$248

50% OFF
A LARGE RANGE OF KITS
we have a selection of kits which now can be purchased on line via www.dse.com.au
Stocks are strictly limited available for purchase only via the website



Spring-Loaded Nippers
These polished steel nippers have a high quality finish, are captive spring-loaded, and have comfortable coated handles for ease of use. Diagonal Nipper - 115mm. T3330

$1.96
SAVE $5



300mm Stainless Steel Ruler
Hardened stainless steel, non-reflective surface for easy reading, double sided metric/inch photographically etched blade, lifetime warranty against faulty materials. T6145

$4.99



Stainless Steel Pocket Workshop Pliers
Handy around the house or outdoors, unfolds into pliers, provides knife, screwdriver, file, bottle opener and other blades. Clips to your belt. T3309

$6.99
SAVE $6



Hobby Mini Vice
Sturdy and lightweight, this metal Vice fits easily to a workbench or table up to a thickness of approx 30mm. Made from aluminium alloy for strength and durability, its jaws are 60mm wide and open to a max of 50mm. T4747

$12.99
SAVE $4



DICK SMITH ELECTRONICS
13.8V DC 1.5 Amp Power Supply
Unregulated linear style DC power adaptor supplied with a 2.1mm plug (centre-tip positive). Ideal for portable TVs, radios etc. M9544

$19.98

$25,000 CONNECTED EQUIPMENT WARRANTY*



DICK SMITH ELECTRONICS
Surge Protector Twin Pack
Surge protection for a mains outlet and phone/fax connection. Powerful 1,675J mains surge rating plus noise filtering. Incl. phone patch cable. M7800P

$26.98
SAVE $26.88



DICK SMITH ELECTRONICS
Home USB Charger
Ideal for charging USB-powered devices when a computer is not available. Perfect for iPods and other MP3 players, PDAs, etc. High efficiency, international voltage operation, 5V 750mA output. M9942

$26.98



DICK SMITH ELECTRONICS
Lab Power Supply 13.8V DC 23A
This solidly built switch-mode power supply provides well regulated 13.8V DC output with a 23A current rating. Highly RF resistant, it is ideal for powering transmitters and other high-current loads in engineering and servicing applications. Q1755

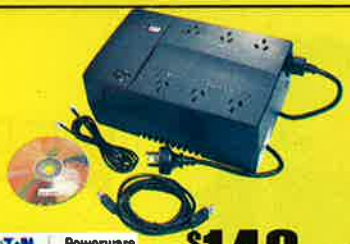
$99

SCOOP PURCHASE



HPM
Solar Rio Colour Flow Light
Incredible value for the enthusiast. Solar powered, with internal NiCd batteries and light sensing circuitry. Pull it apart for the great components, or put it to use in your garden in its intended lighting application. M7369

$4.99



EATON Powerware
700VA Uninterruptible Power Supply
Provides back-up mains power during a blackout, giving you time to shut down your PC. Internal rechargeable battery, surge protection for 6 mains outlets and a phone line. Includes USB cable and power management software. M7678

$149



DICK SMITH ELECTRONICS
Lab Power Supply 3-30V DC 20Amp
This efficient switch-mode power supply provides adjustable 3V to 30V DC output, 20A maximum continuous current, low ripple and noise output, and a compact case with an integral cooling fan. A fixed 13.8V output switch can be selected to over-ride the front panel voltage selection, allowing simple powering of high power car audio and radio transmitting equipment. Features large LED front-panel metering and heavy-duty banana sockets. Q1765

$199
SAVE $70

*Conditions apply. See in-store for details.

DICK SMITH ELECTRONICS



digitor

18V Rechargeable Cordless Drill

Quality 18V cordless drill with 17 torque settings, variable speed, 10mm keyless chuck, AC adaptor, NiCd battery pack, 4-6hr charging cradle with auto cut-off plus carry case. T4868

$29.88



DSE

40pc Hobby Rotary Tool Kit

This 130W high-speed mains-powered rotary tool is a multi purpose unit that is able to cut, drill, polish, grind, sand and engrave. Includes storage case, pencil grip extension shaft, collets, grinding, engraving, sanding, drilling and buffing attachments. Variable speed, approx 8,000 to 30,000prm. T4823

$29.88



DICK SMITH

Lab Power Supply 0-30V 2.5 Amp Digital Display

Laboratory grade linear style power supply with 0-30V adjustable output and an adjustable constant current setting from 0A to 2.5A at all selectable output voltages. Features separate voltage and current metering, overload protection and high/low current front panel terminals. Solidly built chassis, measures 150mm (W) x 235mm (D, inc knobs) x 145mm (H, inc feet). Q1770

$99 SAVE $50

UNBELIEVABLE PRICE



DICK SMITH

"Bit Shooter" Adjustable Bit Screwdriver

Changing the bit in your screwdriver is now even easier. Holds the 12 supplied screwdriver bits in 2 slip-in rotary holsters that allow simple selection and loading into the tip of the screwdriver via a pump action of the screwdriver handle. T6329

$3.91

DICK SMITH

101-Piece Bit Set with Carry Case

Ideal for the handyman or electronics enthusiast. An enormous collection of screwdriver bits, including Torx, Pozidrive, Tri-wing style security bits and a driver handle, all stored in a rugged carry case. T4513



$19.99 SAVE $10



DICK SMITH

64-Piece Super-Hard Bit Set

High-quality chrome finish Hex bits made from super-hard S2-grade alloy. Supplied with a quality locking/magnetic bit holder and carry case. T6345

$29.99 SAVE $10



DICK SMITH

7-Piece Precision Screwdriver Set A handy screwdriver set consisting of long, double-ended shafts and a quality handle with metal-threaded tightening mechanism that securely holds the screwdriver shaft. Covers Flat Head (1.5, 2.5 & 3mm), Phillips (00, 0, 1), Torx style (T6, T7, T8, T9), and Hex driver (1.5, 2mm). Includes handy storage case. T6331

$4.98 SAVE $5



DSE

8-Piece Security Torx Key Set Made from super-hard S2-grade steel alloy. Sizes include T5, T6, T7, T8, T9, T10, T15 and T20. The keys are labelled with their sizes, and supplied in a folding plastic retainer for easier storage and access. T3547

$9.60 SAVE $4



PRO-70K Butane Solderpro Kit

Cordless 70W butane soldering iron kit, soldering tip plus Hot knife, 'heat blower' & blow torch tips, solder, cleaning sponge, handy carry case. T1105

$49.98 SAVE $20



DICK SMITH

Lead-Free Solder Hobby Tube

A lead-free 1.0mm solder alloy containing flux for general electronics work. This solder is 99.3% tin and 0.7% copper. Recommended for use with iron-clad or nickel-clad soldering iron tips. 13 grams solder in handy dispenser tube. N1633

$1.89 SAVE $1

LIMIT OF 2 ROLLS PER CUSTOMER



DICK SMITH

Solder 0.8mm 100g Roll

General-purpose electronics-grade flux-cored 60/40 (tin/lead) solder suitable for most projects and repair work. 0.8mm size, 100g roll. N2628

$2.85 SAVE $3

LIMIT OF 2 ROLLS PER CUSTOMER



DICK SMITH

Lead-Free Solder

A lead-free 1.0mm solder alloy containing flux for general electronics work where earlier lead-based solders cannot be used. This solder is 99.3% tin and 0.7% copper. Recommended for use with iron-clad or nickel-clad soldering iron tips. 100g roll. N2630

$4.88 SAVE $4

Promotion from 27/02/08 to 25/03/08

DICK SMITH ELECTRONICS

NORMALLY $3.07/m
SAVE $1.49/m
THIS MONTH ONLY



Low Loss OFC Speaker Cable

Fig 8 OFC Speaker Cable High conductivity, very low loss Oxygen Free Copper cable with parallel fig 8 flex. Suitable for high/medium to high power installations – 168 conductors x 0.12mm. W2016

$1.58/m

NORMALLY $4.62/m
SAVE $2.32/m
THIS MONTH ONLY



Super Low Loss Fig. 8 OFC Speaker Cable

Super Low Loss OFC Fig 8 Speaker Cable High conductivity, heavy duty, super low loss, 315 strands x 0.12 OFC cable. Suitable for high to very high power installations in quality hi-fi/stereo speaker systems, this cable comes in an attractive translucent PVC sheath that is flexible despite its thickness. W2017

$2.30/m



Large Aluminium Framed Tool Case

Includes removable tool holder, 5 padded internal dividers, lockable latches with 2 keys, plus a strong carry handle. Approx. 456 x 326 x 148mm. Tools/accessories inpicture not supplied. T4856

$29.99
SAVE $20



High Quality Insulated Spacers

Insulated spacers complete with screws and spring washers. 8mm outside diameter, screws screw into brass inserts in the insulating material. Pack of 5pcs, 10mm long. Made in Japan. H1861

$3.86
SAVE $3



Efficient Powerfin Heatsink

Black anodised fan-type heatsink, supplied undrilled to suit TO-3 and other larger power transistors. Thermal Resistance: 1.0C/W Length: 225mm, Width: 105mm. H3426

$4.80
SAVE $5



Wonder Colour Cable Straps

Reuseable, hook and loop style fasteners, 165mm x 15mm, suitable for indoor use. 10-piece pack. H1949

$4.99
SAVE $3



Weller 200g Butane Gas

Highly filtered butane gas to power up your blowtorches and soldering irons. Supplied with a gas adaptor nozzle. 200g can. N1092

$6.99
SAVE $3



Economy Pencil Blowtorch

Great for heatshrink tubing, silver solder, gold, silver, brazing or glass work. Strong metal body, adjustable flame size, fits easily in your pocket and is powered by butane gas (not included). T1380

$6.99
SAVE $6



60W Hot Melt Glue Gun

A handy 60 watt mains-powered glue gun which features an adjustable wire stand and comes complete in a carry case and 6 glue sticks. T1418

$14.99
SAVE $4



Weller PSI-100K Butane Soldering Iron Kit

Pro grade butane tool with piezo self ignition, stainless steel body, complete with a range of high quality iron-plated tips and solid plastic case. T1398

$119
SAVE $20



Medium Breadboard Kit

This breadboard kit provides a fast way to prototype your circuit designs. 1260 terminal holes with quality plated contacts. It's mounted on an aluminium base-plate with non-slip feet and holes for binding posts. Complete with a good selection of jumper wires and binding posts. H4040

$26.99
SAVE $10



Silicon Chip Magazine

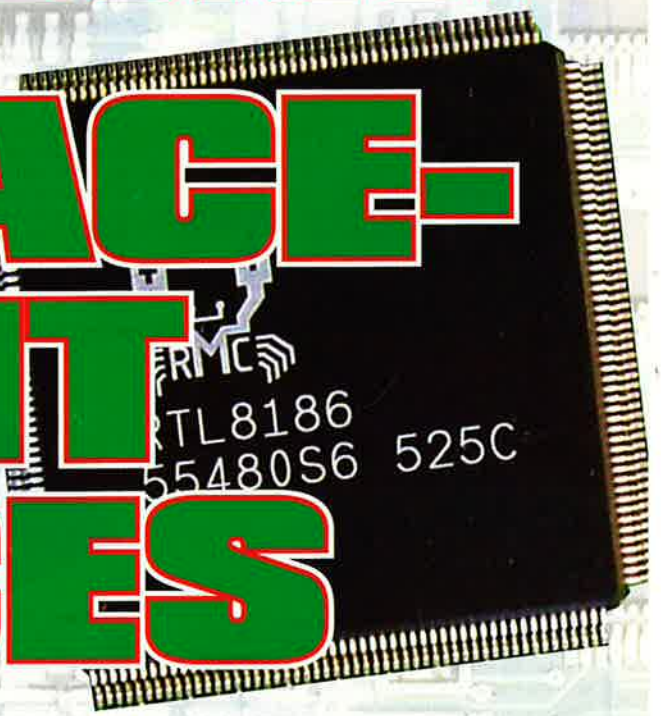
Save 50% off the cover price when you buy your copy each month from your local Dick Smith Electronics store. Limited stocks per month. Offer extended to April 2008 issue. May not be available at DSE Franschise or Reseller stores. B5020

$4.25

21

Terms and conditions: Offers start 27/02/08 and end 25/03/08 or while stocks last.
No rainchecks. No layby. Offers may not be available in some reseller or franchise stores.

How to solder SURFACE-MOUNT DEVICES



Many electronics enthusiasts hesitate to build projects involving surface-mount devices (SMDs) because they're daunted by the prospect of soldering such tiny parts to a PC board. But it can be done. Jim Rowe shows us how. . .

IT'S TRUE THAT SMDs are not really intended for manual assembly. They're designed for automated pick-and-place machines and reflow soldering ovens.

The problem is that more and more ICs and other components are becoming available ***only*** in SMD form. As technology marches on, it's becoming necessary for everyone to get used to working with SMDs.

You may already be familiar with the simpler SMDs like resistors, capacitors, diodes and transistors. Some of these are shown in Fig.1. Note that they're all shown twice actual size, for clarity.

We've used these in various projects published in the last few years, and shown how they can be soldered onto a PC board: use a soldering iron with a fine conical or 'flattened conical' tip and very fine (0.71mm OD) resin-cored wire solder.

Figs.2 & 3 show how this is done. The basic idea is to hold the chip or device in place while you tack-solder one or two of its leads to hold it in position. This then allows you to solder all of the leads to their pads in the usual way.

It needs to be done carefully and fairly quickly, so you don't damage

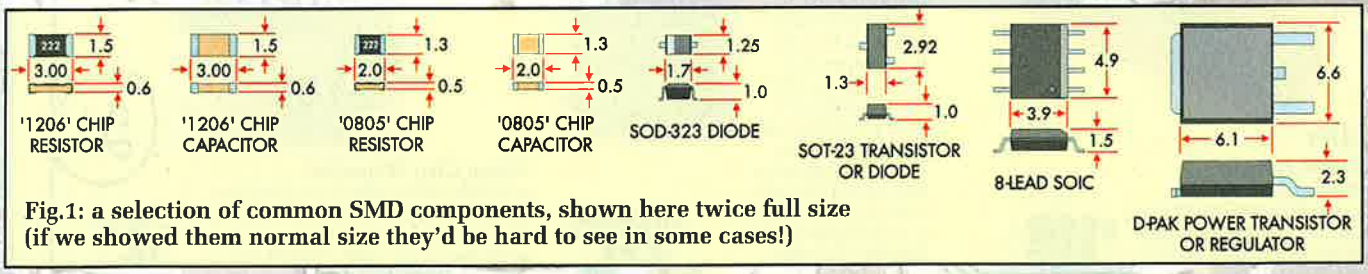


Fig.1: a selection of common SMD components, shown here twice full size (if we showed them normal size they'd be hard to see in some cases!)

either the SMD or the PC pads by overheating. You also need to make sure you don't apply too much solder, which can cause fine solder "bridges" to short between pads or tracks.

If you do get solder bridges, they can be removed by applying the end of some fine de-soldering braid to the top of the "bridge" and briefly applying the tip of your soldering iron to the top of the braid, so the end of the braid heats up to the solder's melting point and 'sucks up' the excess solder by capillary action.

OK, so what is the real problem with SMDs?

Um, it's the large SMDs with umpteen dozen closely spaced pins.

Fine-pitch ICs

More and more VLSI (very large-scale integration) devices now come in SMD packages like that shown opposite and those in Fig.4 – quad flat packs (QFPs) with anywhere between about 44 and 208 leads.

The lead pitch can be as fine as 0.4mm – less than 16% the pitch of 0.1"/2.54mm used in most familiar 'dual in line' IC packages.

The width of the leads can also be as fine as 0.18mm (that's right – only 180µm!), so the actual spaces between the leads can be as small as 0.22mm/220µm.

Now it *is* possible (just!) to solder a 44-lead MQFP device with 0.8mm pitch leads like that shown in Fig.4 using a fine-tipped soldering iron and the technique shown on the right in Fig.3.

That's providing you are extremely careful, have a very steady hand and don't mind having to use the soldering braid to remove the almost-inevitable solder bridges. If you can do this consistently, you are a champion!

The real problem arises when it



Close-up view of a 44-lead MQFP device with 0.8mm pitch (lead spacing), after being reflow soldered using a low cost snack oven.

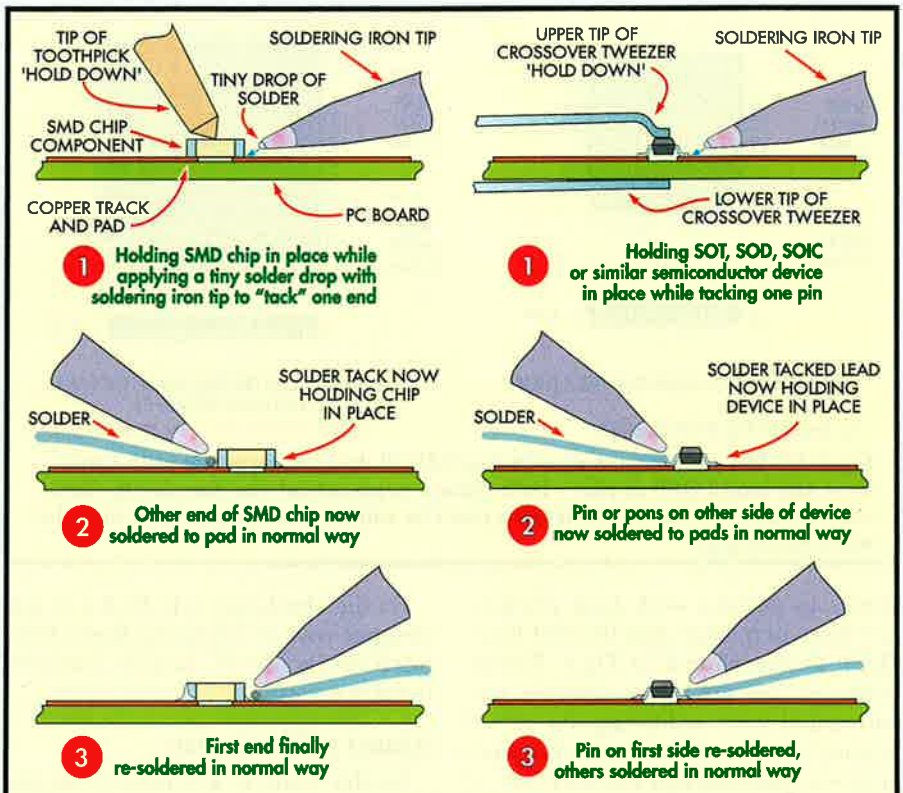


Fig.2: the basic steps involved in manually soldering smaller SMDs like those shown in Fig.1, using a fine-tipped soldering iron and very fine resin-cored wire solder. The steps for resistors and capacitors (left) are much the same as those for SOT, SOD and SOIC devices (right).

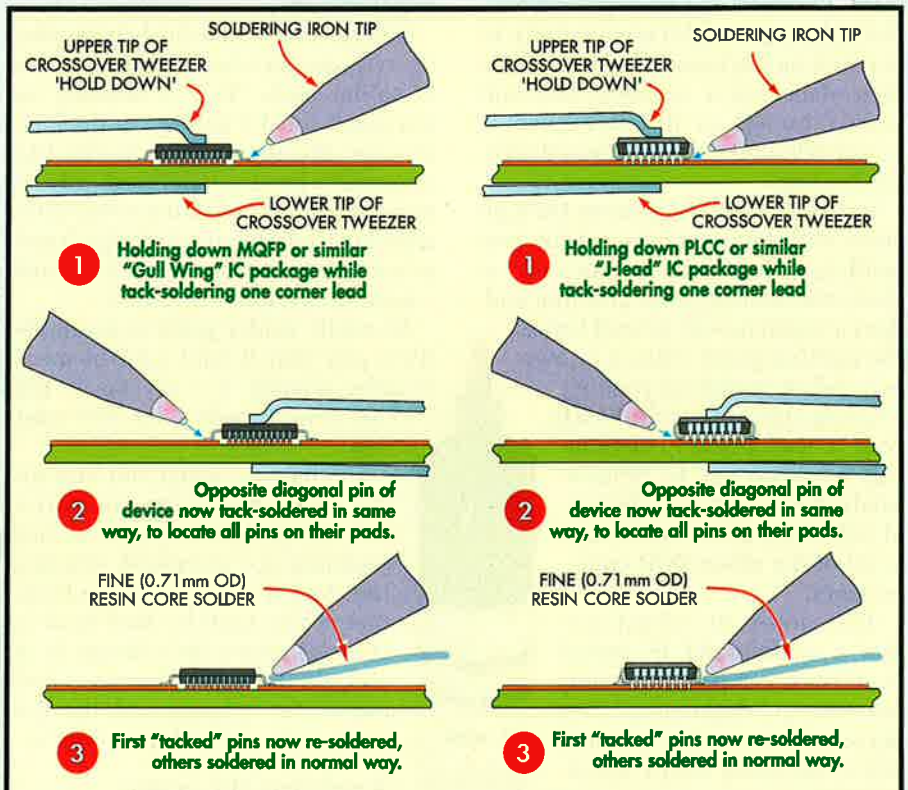


Fig.3: manual soldering of SMD ICs with lead pitches of 0.8mm or more can be done in the same way if you're VERY careful but be prepared for the accidental creation of solder bridges between leads – and having to remove them using solder wick. As you can see there's not much difference in approach between 'gull wing' and 'J-lead' devices.

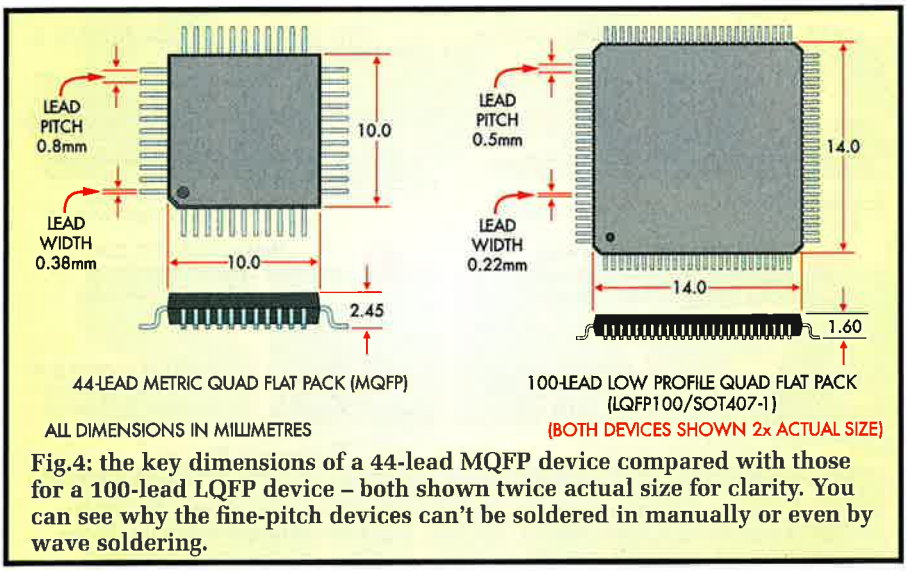


Fig.4: the key dimensions of a 44-lead MQFP device compared with those for a 100-lead LQFP device – both shown twice actual size for clarity. You can see why the fine-pitch devices can't be soldered in manually or even by wave soldering.

comes to devices with lead pitches of 0.4mm or 0.5mm, like the 100-lead LQFP device shown in Fig.4. These packages are not even suitable for automated wave soldering, let alone manual soldering. The leads and gaps between them are just too narrow.

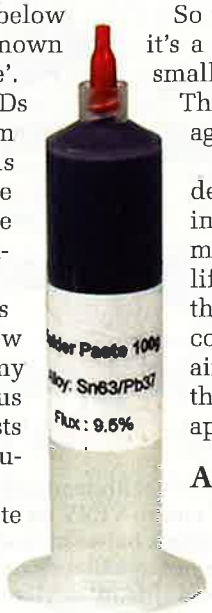
The only way to solder these devices is by reflow soldering. This process involves applying solder paste to all of the tiny pads on the board (using a laser-cut stencil and squeegee system), then placing the SMDs accurately in position on the board. The boards are then placed on a conveyor belt and passed through an 'IR reflow oven' at a controlled rate, using infrared radiant heating.

Inside the oven they move through areas with temperatures set for pre-heating, followed by a 'ramp up' to above the melting point of solder and then a 'ramp down' to well below the melting point. This is known as a 'reflow soldering profile'.

Using this approach, SMDs with a lead pitch of 0.4mm can be soldered to boards safely and with a high degree of reliability, at the same time as all of the other SMD components.

The main drawback is that a commercial IR reflow oven is very expensive (many thousands of dollars) and thus beyond the reach of enthusiasts and even many small manufacturers.

Getting laser-cut solder paste stencils made from your PC board CAD file is not cheap either.



So the challenge is to find a much cheaper way of soldering these fine-pitch SMDs into PC boards. Luckily, there is a way!

About solder paste

Solder paste is available from the better electronics stores. It consists of tiny spheres (<50µm in diameter) of tin-lead solder (63% tin, 37% lead), suspended in a water-soluble paste or gel of flux.

It's typically sold in fairly large plastic syringes, holding about 80 grams of solder paste. This is actually far too much for the average enthusiast, because the ingredients in the flux apparently have a shelf life of only six months after manufacture, even when stored in a refrigerator. Yet 80g of paste is enough to solder many hundreds – even thousands – of SMDs.

So while solder paste is available, it's a pity that it isn't sold in much smaller quantities – say 5g or 10g. This would mean a lot less wastage.

By the way, when you buy solder paste, make sure you store it in a refrigerator so you'll at least maintain its six-month working life. And if you store it in a fridge that is also used to store food (of course!), place the syringe in an air-tight container because both the solder spheres and the flux apparently give off toxic fumes.

Applying the paste

As mentioned earlier, large-scale manufacturers use laser-cut stencils and a squeegee system to apply just the right amount of solder paste to every pad on the PC board where an SMD lead or contact area is to be soldered.

This is shown in the upper two diagrams of Fig.5. This technique simply it isn't practical for small manufacturers or enthusiasts.

A much simpler approach involves applying a thin 'stripe' of paste along the pads for the SMD leads, as shown in the lowest diagram in Fig.5.

The stripe of paste is only a millimetre or so wide and can be applied using a fine brush, a very narrow roller applicator or a fine spatula with a 1mm wide tip.

You'd think that applying a continuous stripe of solder paste in this way would be 'asking for trouble' for it to

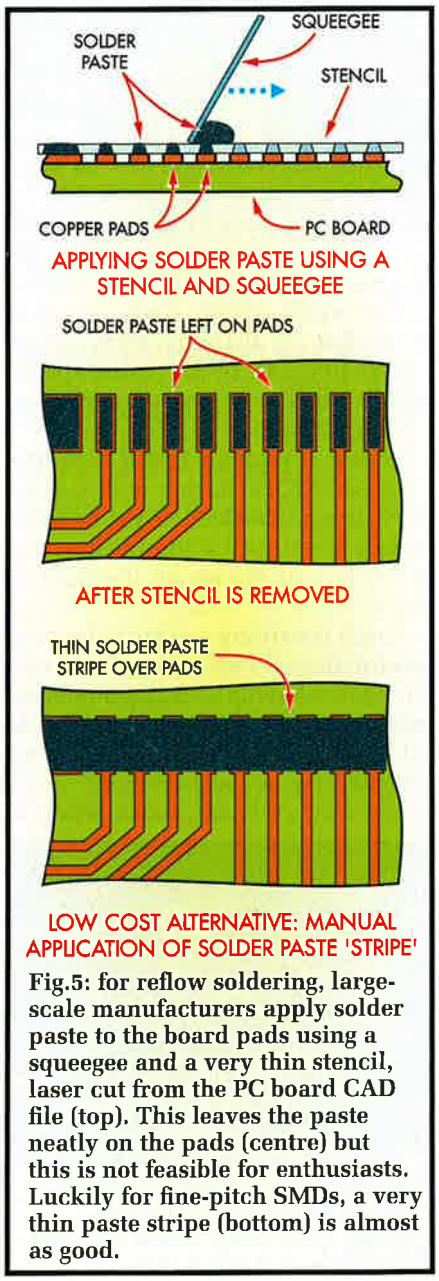
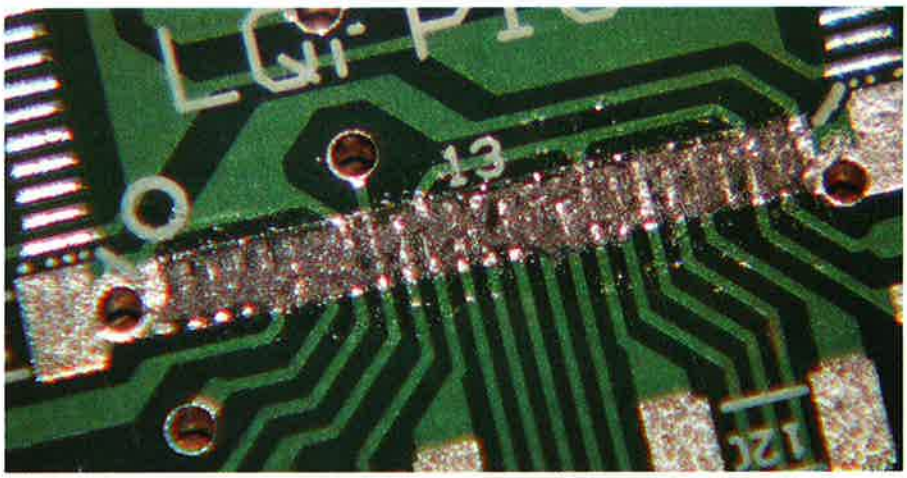
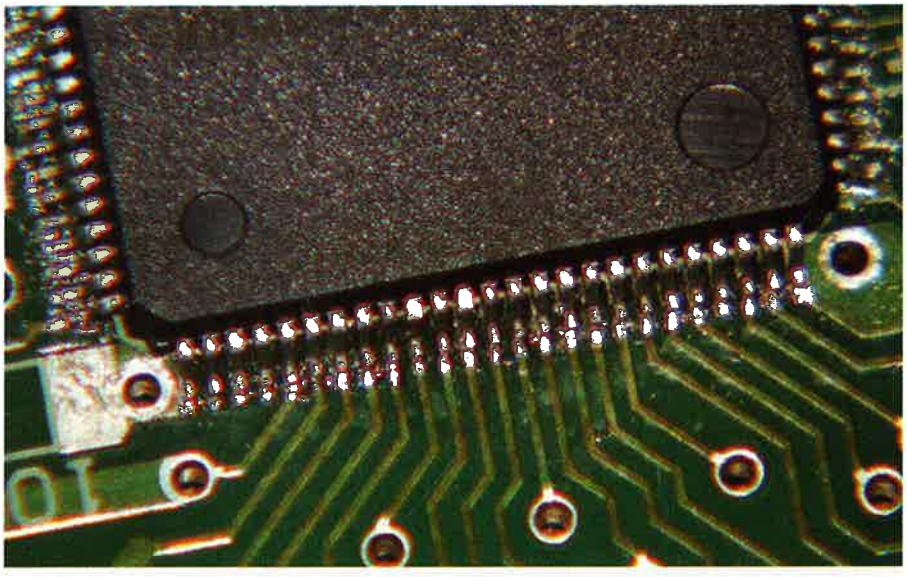


Fig.5: for reflow soldering, large-scale manufacturers apply solder paste to the board pads using a squeegee and a very thin stencil, laser cut from the PC board CAD file (top). This leaves the paste neatly on the pads (centre) but this is not feasible for enthusiasts. Luckily for fine-pitch SMDs, a very thin paste stripe (bottom) is almost as good.



Above: a closeup view showing a thin 'stripe' of solder paste applied manually to the pads for one side of a 100-lead LQFP device, with the tiny solder spheres just visible. This stripe is a tad uneven in thickness – a little too thick near the left end, and a little too thin towards the centre.
Below: closeup of the same board after the device had been reflow soldered using a snack oven. Despite the 0.5mm lead pitch, there were no solder bridges.



form bridges between pads, during the reflow soldering process.

However the secret of this approach is to make the paste stripe very THIN – only about 100µm wide or two solder spheres thick.

If it's no thicker than this, the result is that surface tension and capillary action causes the solder spheres to 'pull themselves together' into the gaps between each SMD lead and its board pad, when they melt during the reflow soldering.

Most of the solder spheres in the paste between the pads get sucked into the molten solder directly under each SMD lead, leaving very few to form bridges.

Not too thick, not too thin

If you make the paste stripe too thick, there WILL be enough spheres left in the gaps between pads to form bridges.

On the other hand, if you make the stripe too thin, there will be insufficient spheres to pull together and form a good bond between each SMD lead and its pad underneath.

So erring in this direction results in 'missing joints' after the reflow soldering process - not easy to repair!

So the most important thing about this manual approach to applying the solder paste is to take your time and care in making the stripe as even in width as you can.

It's easiest to do this with the board under a magnifier lamp or even a low-power stereo microscope with illumination.

I've also found that a very thin and narrow-tipped (about 1mm) spatula seems to make it easier to apply and even-up the paste stripe, although a very narrow 'applicator wheel' (I made one myself) was almost as good, and easier than a fine brush.

Whatever you use, the main ingredient is time and patience – applying solder paste is a bit like trying to spread microscopic caviar evenly on a sheet of glass.

In fact, since you have plenty of paste, do a few dry runs on a sheet of PCB copper laminate.

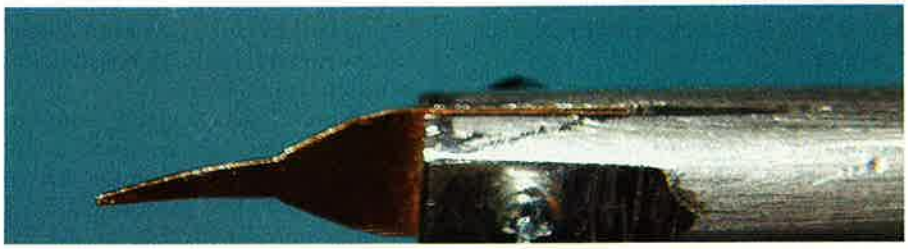
Placing the SMDs

Once the solder paste has been applied to the board, you can place your fine-pitch SMD(s) in position, with their leads over the board pads ready for the reflow soldering process.

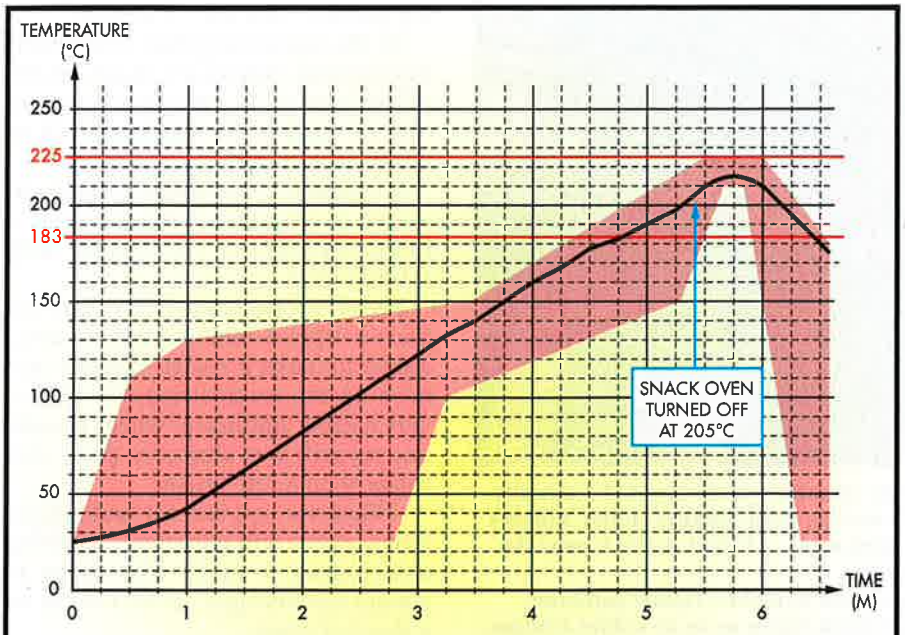
Large-scale manufacturers use a pick and place machine to place all of the components on the board in one pass – not just the fine-pitch SMDs but everything else as well. Then all parts can be soldered to the board in a single pass through the reflow oven. But that's not really feasible if you're placing all of the components manually.

Our method is to place the fine-pitch ICs on your board first, then do their reflow soldering. After the board cools down you can then inspect the results and if all is well you can proceed to solder in all of the rest of the components one by one, using the fine-tipped soldering iron approach illustrated in Figs.2 & 3.

You may be wondering how accu-



The business end of a 'mini spatula' made by the author for applying a stripe of solder paste on pads for fine pitch SMDs. It's shown here about 3x actual size.



NOTES: SHADED PINK AREA SHOWS RECOMMENDED TEMPERATURE PROFILE LIMITS
183°C = MELTING POINT OF TIN-LEAD SOLDER (60/40)
225°C = RECOMMENDED PEAK REFLOW PACKAGE TEMPERATURE
BLACK CURVE = MEASURED TEMP PLOT OF BOARD & ICS
ON 220 x 140mm x 4mm THICK ALUMINIUM PLATE, HEATED INSIDE KAMBROOK 650W KOT-150 SNACK OVEN ('BAKE' SETTING, USING BOTH ELEMENTS)

Fig.6: The shaded pink area shows the reflow soldering temperature profile limits recommended by SMD manufacturers. The solid black curve shows the measured temperature plot achieved by the author using a low cost snack oven on 'BAKE'.

rately you have to place the fine-pitch IC packages in position, before reflow soldering.

The answer is placed FAIRLY accurately but not fanatically so. The main thing is to make sure that every device lead is over its corresponding PC board pad, and closer to that pad than it is to any other pads nearby.

If you achieve that, when the solder spheres in the paste melt and coagulate during the reflow process, surface tension and capillary forces in the molten solder will automatically 'pull' all of the leads into position centrally over their pads.

So the idea is to carefully lower the IC package (orientated correctly, of course) into position using a 'vacuum pickup tool' or similar, and then nudge it gently into the correct position using a fine jeweller's screwdriver or 'pick tool'.

Again, it's easiest to do this under a magnifier lamp or stereo microscope, preferably one where you can rotate the board and IC until you're happy that all leads are over their pads on the board.

Once all of the fine-pitch SMDs have been placed carefully in this way, your board will be ready for reflow soldering. Be very careful not to bump or jar it, because the SMDs could easily be jolted out of position.

Reflow soldering

Now how do we do the actual reflow soldering? If you use an online search engine to track down info on reflow soldering, you'll find that quite a few have tried doing it with an electric frypan or skillet.

The basic idea is to place the PC board in the centre of the frypan, applying power until the solder paste clearly melts and flows under each SMD lead, then turn off the power and allow it all to cool down.

This can work – but there is a big risk of scorching the underside of the PC board; inevitably the underside of the board must be raised to a temperature considerably higher than the melting point of solder.

This board-overheating problem tends to be made worse because the heating element in the underside of most frypans is circular in shape. This produces uneven heating of the PC board, with a cooler region in the centre surrounded by a 'ring of heat'.

So depending on the location of your fine-pitch SMDs on the board, the reflow operation can easily result in a ring of scorching on the underside of the board. The result is a totally unusable board and the SMDs won't be able to be salvaged either.

Get an old frypan

If you decide to try the frypan approach, ***please don't use a frypan that is also used for cooking food***.

The fumes given off by solder paste during the reflow process are quite toxic and are likely to be absorbed by the frypan metalwork and/or Teflon coating. So the toxins may well be transferred into any food cooked in the frypan afterwards.

Buy a cheap frypan specifically for the job, and mark it clearly **'NOT TO BE USED FOR FOOD COOKING'**.

Because of the toxic fumes given off during reflow soldering, it's also very desirable to do it in a well-ventilated area – preferably outdoors. This applies regardless of whether you use a frypan or some other heating device.

Having read the references on the web about reflow soldering using a frypan, I decided to try it but with a slightly different approach.

I bought a cheap frypan, then did a few experiments with it. To try getting around the board scorching problem, I cut a 'heat spreader' plate from 4mm thick aluminium sheet, and placed this in the centre of the frypan with my test board sitting on it.

This did seem to make the heating fairly even but there was still a major problem.

Even with the frypan's thermostat set for maximum, the temperature on the top of the PC board never reached the melting point of solder (183°C), let alone the 215° level that is necessary to ensure good reflow.

Presumably the small air gap between the bottom of the frypan and my spreader plate added too much thermal resistance. So I removed the spreader plate and tried again, with the board placed directly on the bottom of the frypan.

This time the temperature on the top of the board did reach about 210°C and reflow took place, but when it all cooled down I discovered that the underside of the board had been scorched in a number of areas that had been directly over the circular heating element.

So reflow soldering with a frypan is just not worth the risk.

Using a snack oven

Another el-cheapo reflow technique that you'll come across on the web involves the use of a small electric 'snack' or toaster oven. Almost all of these use a pair of heating elements, one at the top of the oven compartment and the other at the bottom.

Whatever you're going to heat up in the oven goes on a tray supported by a wire mesh 'drawer' in the centre, which is linked to the oven door so it slides in or out when the door is closed or opened.

Often there's a switch which allows you to select either the top element ('GRILL') or the bottom element ('REHEAT') or both at the same time ('BAKE'). Each element draws about 325 watts, so the oven uses about 650W when both are used together. Since the reflow operation only involves drawing this power for five or six minutes at most, this isn't a problem.

The main advantage of using this kind of snack oven for reflow soldering is that the heating is done by infrared radiation, on the top of the board as well as from below, just like a 'proper' IR reflow oven. The main difference is that your board stays fixed in the oven during the whole process, rather than moving through different temperature regions on a conveyor belt.

This means that you have to arrange for the reflow temperature profile to be provided in some other way. This turns out to be easier than you would think.

I decided to try the snack oven approach for myself. So I bought a Kambrook KOT-150 snack oven which cost the magnificent sum of $29.95. This has no thermostat, just an electromechanical timer and the element selector switch. But the lack of a thermostat is not a problem and the timer didn't turn out to be all that necessary either.

My first test with the snack oven was to clamp a thermocouple temperature probe onto a test board, which was then placed in the small pressed tinplate tray that came with the oven. The tray was then placed on the oven's sliding mesh drawer and the oven door closed carefully so the thermocouple lead could exit through a small gap at the top of the door.

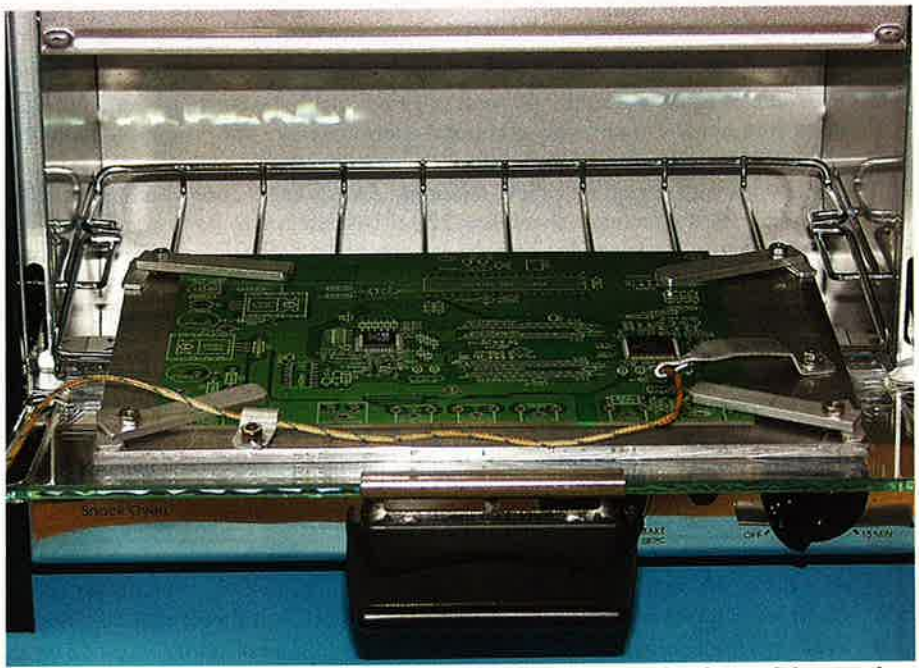


Here's the setup we used successfully for reflow soldering of fine-pitch SMDs. The board assembly is clamped on a 220 x 140mm plate of 4mm thick aluminium plate, with a thermocouple probe clamped to the board copper near the 100-lead device. Shortly after this shot was taken the snack oven was turned on, and then turned off again as soon as the digital thermometer reading hit 205°C.

The oven was set to BAKE (both elements on) and the timer knob set to apply power for about 10 minutes. I then proceeded to take temperature measurements every 15 seconds.

The resulting temperature characteristic turned out to be very close to the solid black curve in Fig.6, which also shows (shaded pink area) the reflow temperature profile limits for fine-pitch SMD IC packages recommended by larger chip manufacturers like NXP/Philips.

As you can see, the warm-up characteristic is nicely within the recommended limits. By turning off the power to the snack oven when the temperature on the top of the board just reached 205°C, the board temperature coasted up nicely to a peak at 215°



As soon as the temperature coasted down to about 165°C, the door of the snack oven was carefully swung down to allow the entry of more air to speed up the cooling. Both of the SMDs on this board had been reflow soldered very nicely, with no solder bridges between leads or pads. The board had not been damaged in any way, either, so I can recommend the snack oven approach.

and then began to coast down again. It dropped down below the 183°C solder melting point temperature about 6.5 minutes after switch-on, so after waiting about one more minute, I carefully opened the door and drawer to allow cooling to occur more rapidly.

When the test board had cooled right down, I took it out of the tray and checked underneath to see if there had been any scorching. There was none at all – even the silk screening on the underside of the board showed no discolouration.

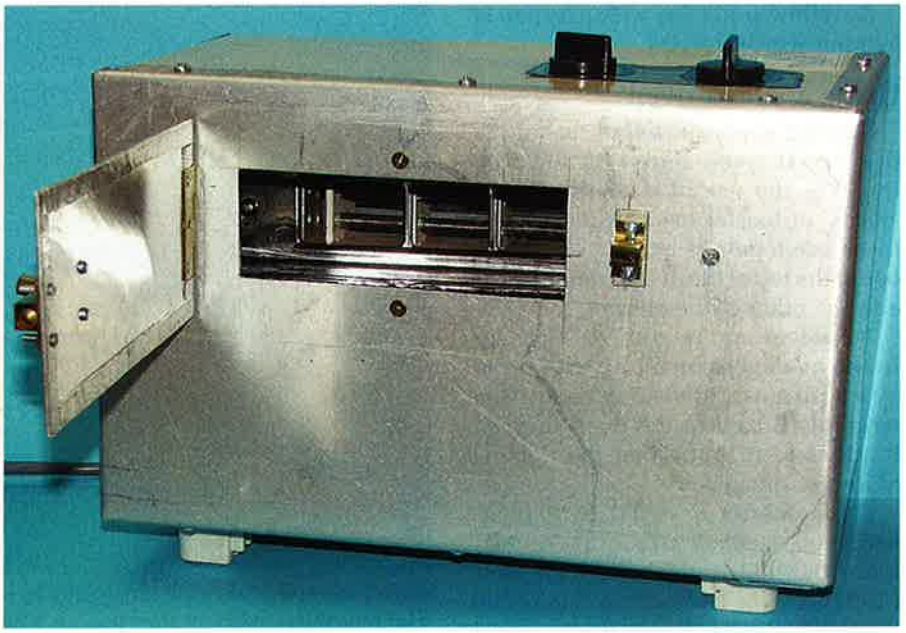
Trial run

Thus encouraged, I decided to carry out a reflow soldering test on another PC board. This was prepared with solder paste stripes around the pads for a fine-pitch IC and then an SMD device was carefully placed over these pads. Then I made my first mistake.

In an effort to make the process a little more controlled, I drilled four 3mm holes in the oven's tinplate tray, so the board could be fastened into it using four M3 machine screws and nuts. One of the screws was also used to attach the clamp for the thermocouple probe, to hold the probe securely in position with its bead in contact with the board's top copper close to the SMD chip.

The board and tray were carefully placed on the oven's mesh drawer and the oven door gently closed so they slid smoothly inside. Then power was applied to the oven again, measuring the top-of-board temperature every 15 seconds as before. All went well, with exactly the same temperature profile as before. But just as the temperature reached about 200°C (just before I would turn off the power) there was a 'PING' sound – apparently the tinplate tray had been under stress as a result of the board being bolted inside and the stress was relieved suddenly when the temperature reached 200°.

Having turned off the power as soon as the temperature reached 205°, I waited impatiently while the



It's not elegant but it works: an SMD chip baking oven, made by the author by converting a discarded blower heater. The reflector part of the heater was flattened and bent into a small rectangular oven shape, then re-attached to the front of the blower heater element (just visible through the opened front door).

Ten Tips for successful DIY reflow soldering of SMDs

1. Store your solder paste in a sealed container in the fridge, to prolong its useful life.
2. Take care to apply the solder paste in a 'stripe' along the centre of the SMD lead pads on the PC board, with the stripe no more than about 1.5mm wide and (most important) very thin – no more than about 100µm, or two solder spheres. As even in thickness as you can make it, also – no lumps or voids...
3. Use a small snack oven for reflow soldering. Clamp the PC board on the top of a flat heat diffusion/support plate made from 4mm thick aluminium sheet, say 220 x 140mm in size (to fit comfortably in the snack oven). Also monitor the temperature on the top of the board near one of the SMDs, using a thermocouple probe connected to a digital thermometer.
4. Place the SMD chip(s) in position on the board carefully, with all leads as near as possible to their corresponding board pad. You don't have to be fanatical about this though: the chips will auto-locate during reflow, providing each lead is closer to its own correct pad than to the pads on either side.
5. Place the board and its support plate on the oven's slide-out drawer very carefully, so as not to bump or jolt the SMDs from their positions. Then carefully close the oven door so they slide smoothly into the oven – again without jarring.
6. Use both the upper and lower heating elements of the oven for reflow solder heating. This is usually achieved by selecting the BAKE setting. Using both elements gives more even heating, closer to that in a proper IR reflow oven.
7. Switch on the oven, monitoring the temperature on the top of board using the thermocouple probe and digital thermometer. The temperature should rise fairly smoothly, reaching the melting point of tin/lead solder (183°C) in just under five minutes. Take care not to bump or jar the oven after this.
8. As soon as the temperature reaches about 205°C, turn off the oven power without bumping anything. The temperature will continue rising, to reach a peak at around 215-220°C. It should then begin falling again.
9. Wait until the temperature drops below the melting point of solder – say down to about 165°C. Then it should be safe to open the oven door so the drawer and its contents slides out, to speed up further cooling.
10. When the board has cooled down to around room temperature, remove it from the support plate and check the solder joints on all SMD leads with an illuminated magnifier or stereo microscope. If there are any solder bridges, these can be cut away using the tip of a hobby knife or 'sucked' off using desoldering braid and a fine-tipped soldering iron.

temperature peaked again and crept downwards once more. Once it had dropped to about 165° I carefully opened the door, so the drawer and tray slid outwards.

Then I examined the SMD chip with a magnifying glass, only to discover that stress relief 'ping' at 200° had caused the SMD chip to be jolted out of position. The reflow soldering had actually occurred quite nicely but with the chip and its leads in the wrong position. Bother!

However, the overall result still confirmed that the snack oven was quite suitable for reflow soldering. So I decided to make a much sturdier PC board support plate, to replace the flimsy tinplate tray.

The new plate was a 220 x 140mm rectangle of 4mm-thick aluminium plate and had a 3mm hole drilled near each corner, for the board hold-down clamp screws.

The holes were countersunk underneath so countersink-head screws could be used to hold down the board, without producing bumps underneath the plate. This was to make sure that the plate and board could be slid smoothly around on the oven's mesh drawer.

Another board was prepared with solder paste and a fine-pitch SMD chip placed carefully in position. Then the board was clamped to the top of the new support plate, the thermocouple probe fitted and the complete assembly placed inside the oven.

This time everything went really well. There were no 'pings', the solder reflowed nicely and when it all cooled down again a board inspection showed that the SMD chip had settled itself in the correct position and was nicely soldered. And there were no solder bridges!

So we are able to report that reflow soldering of fine-pitch SMD chips can be done successfully using a low-cost snack oven like the Kambrook KOT-150 shown in the pictures.

Listed on the page opposite are the ten important 'rules of thumb' when it comes to using a snack oven for successful reflow soldering of fine-pitch SMD chips. If you follow these rules carefully, success is almost guaranteed.

Finally, what about using a "fan-forced" snack oven? ***Not*** a good idea! That fan could easily blow the SMDs out of position. SC

Footnote: About MSL rating

If you're going to be using reflow soldering for SMDs in plastic packages, you should know a bit about the way these devices are rated in terms of MSL or 'moisture sensitivity level'.

Basically, it has been discovered that SMDs in plastic packages have a tendency to absorb moisture when they're stored in typical 'shop floor' or workshop conditions for any significant period of time. The degree of moisture absorption depends on a variety of factors — including the size of the device package, the number of leads and the relative humidity level in the storage environment.

The problem is that when SMDs are heated up during reflow soldering, this absorbed moisture tends to turn into steam, and build up sufficient pressure to cause cracking and other damage inside the package. It can easily damage the chip inside and/or its bonding wires, even if no cracks are visible on the outside of the package.

To minimise the risk of this kind of damage during reflow soldering, chip manufacturers nowadays bake most plastic-package SMDs (especially those in fine-pitch packages) for many hours at 125°C in a very dry and inert atmosphere, to drive out any moisture. Then they are sealed in hermetic packaging ('dry packs'), and the idea is that they should be left in this packaging until just before they're subjected to reflow soldering.

Now because this last-minute unpacking isn't practical even for big manufacturers and in any case isn't really necessary for some devices, semiconductor industry standards bodies like JEDEC (formerly the Joint Electron Device Engineering Council) have established a system whereby each device is given a rating to show how long it can be safely left out of its hermetic packaging in a typical 30°C/60%RH workshop or factory environment, before reflow soldering. There are eight of these MSL rating levels, ranging from MSL 1 for packages which are deemed impervious to moisture up to MSL 6 for packages which are very sensitive to moisture and must be reflow soldered within no more than six hours after being removed from their dry packs.

You'll find this MSL rating printed on the dry packs of most SMD devices in plastic packages and certainly for those in fine-pitch packages (which are almost always rated at MSL 2 or higher). Table 2 shows the significance of the various MSL levels.

So what do you do if you want to reflow solder an SMD with an MSL level of 2 or higher, if you know has been out of its hermetic packaging for longer than its rated safe time? Or if it hasn't been out for that long, but subjected to very high relative humidity?

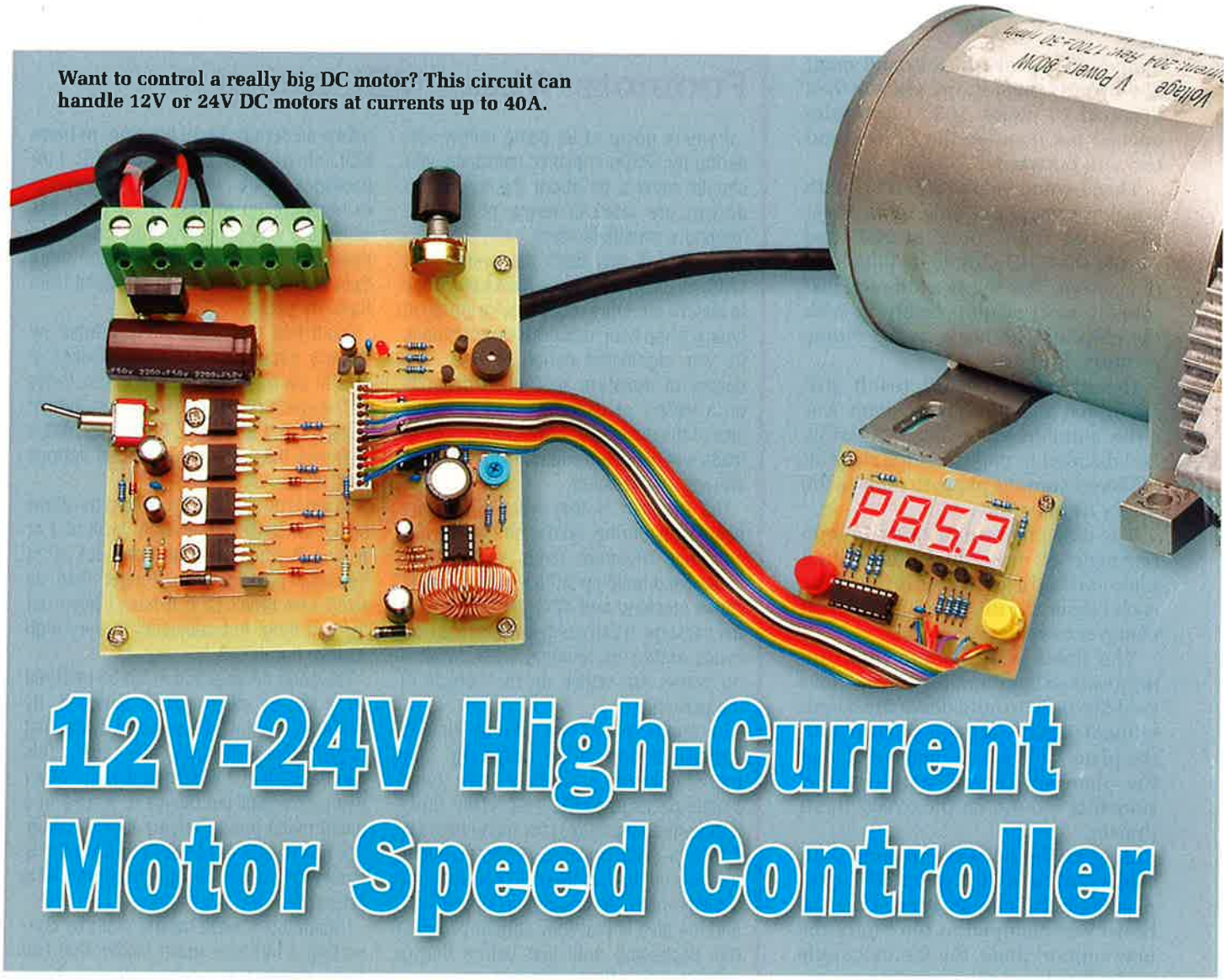
The good news is that it can be restored so it can be safely reflow soldered, by baking for about 24 hours at a controlled temperature of between 115-125°C. This can be done in a small fan driven hot-air oven, provided the device is placed in a small metal box to ensure even heating. The box should also have some small vents to allow the escape of any moisture that is released during the baking.

I made up a small baking oven by converting a fan-type room heater that had been dumped at council cleanup time. The fan motor, fan and heating element were all in perfect working order, as was its thermostat switch.

So all I had to do was remove these components and convert the heater case into a recirculating-air oven. Then the 'works' were re-installed and the thermostat tweaked to cycle the oven temperature around 118°C, which produced a rough but quite serviceable DIY baking oven for plastic package SMDs.

JEDEC MOISTURE SENSITIVITY LEVEL (MSL) RATINGS

MSL rating	Safe exposure time at <= 30°C/60%RH before reflow soldering
1	Unlimited (non moisture sensitive)
2	1 year
2a	4 weeks
3	1 week (168 hours)
4	72 hours
5	48 hours
5a	24 hours
6	6 hours (extremely moisture sensitive)



Want to control a really big DC motor? This circuit can handle 12V or 24V DC motors at currents up to 40A.

12V-24V High-Current Motor Speed Controller

This 12V or 24V high-current DC Motor Speed Controller is rated at up to 40A (continuous) and is suitable for heavy-duty motor applications. All control tasks are monitored by a microcontroller and as a result, the list of features is extensive.

THIS COMPLETELY NEW speed controller is based on a PIC16F88 microcontroller. This micro provides all the fancy features such as battery monitoring, soft-start and speed regulation. It also monitors the speed setting potentiometer and drives a 4-digit display board which includes two pushbuttons.

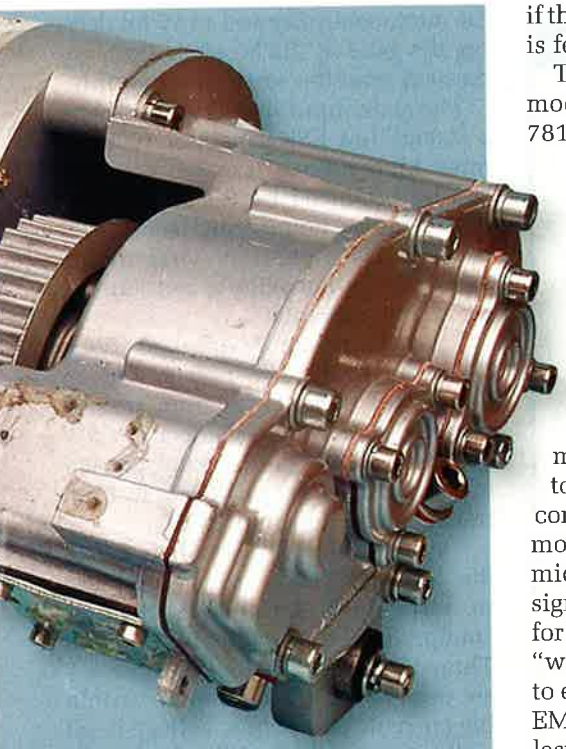
The 4-digit display board is optional but we strongly recommend that you build it, even if you only use it for the initial set-up. It unlocks the full features of the speed controller and allows all settings to be adjusted. The microcontroller will detect whether the display board is connected and if not, the speed controller will support only the basic functions. In this simple mode, it will function as a simple speed regulated controller with automatic soft-start and with the speed being directly controlled by a pot (VR1). All the other settings will be the initial defaults or as last set (with the display board connected).

When connected, the 4-digit display allows you to monitor the speed and the input voltage (useful when running from a battery). It also enables you to navigate through the various menus to adjust the settings.

The circuit can run from 12V or 24V batteries and can drive motors (or resistive loads) up to 40A. Furthermore, this is our first DC speed controller (except for out train controllers) incorporating speed regulation under load. In other words, a given motor speed is maintained, regardless of whether the motor is driving a heavy load or not.

Monitoring the back-EMF

In speed controllers which do not have good speed regulation (ie, the vast majority of designs), the more a motor is loaded, the more it slows down. In order to provide speed regulation, the



Pt.1: By MAURO GRASSI

circuit must monitor the back-EMF of the motor, since this parameter is directly proportional to its speed.

As a result, our new speed controller monitors the back-EMF of the motor. "Back-EMF" is the voltage generated by any motor to oppose the current through the windings. EMF stands for "electromotive force" and is an obsolete term for voltage. Back-EMF is directly proportional to the motor speed and so by monitoring this parameter, we have a means of controlling and maintaining the motor speed.

In practice, the main control loop of the microcontroller tries to match the speed of the motor (back-EMF) to the speed set by the pot or recalled from a preset memory. If the measured speed is lower than the set speed, the duty cycle of the pulse width modulation (PWM) signal used to drive the power Mosfets that control the motor is gradually increased. In other words, if the speed tends to drop, more power is fed to the motor and vice versa.

The frequency of the pulse width modulation can be set from 488Hz to 7812Hz. This is a useful feature since different motors will have different frequency responses, as well as different resonant frequencies. This is important to reduce the audible buzzing from the pulse width modulation, as these frequencies are well within the range of hearing.

By now you're probably wondering how the microcontroller monitors the back-EMF of the motor, considering that the motor is continuously driven with pulse-width modulated DC. The answer is that the micro periodically turns off the PWM signal to the motor for just enough time for the back-EMF to stabilise. This "window" needs to be wide enough to ensure that we are measuring back-EMF and not the spike generated by the last PWM pulse. On the other hand, we don't want the window so wide that the maximum power to the motor is significantly reduced or that the motor noticeably slows.

The compromise value is that the motor is monitored for 200µs every 7.4ms (ie, about 135 times a second), as shown in the scope diagrams in this article. As a result, the fact that we do monitor the back-EMF around 135 times a second means that the power applied to the motor is slightly less than the theoretical maximum, although this effect is negligible.

A low-battery alarm is also incorporated to warn when the battery level drops below a preset value. This is especially useful for applications like electric wheelchairs.

There are also eight memory speed settings. All settings are persistent, meaning they are retained in non-volatile memory.

Soft start

When the motor is switched off, perhaps by an external switch in series with one of its terminals, the voltage at the drain of the Mosfets will be 0V (this is due to the voltage divider used to scale the back-EMF voltage to within the operating range of the microcontroller). The microcontroller converts this analog value to a digital value using an on-board ADC (analog-to-digital converter).

The firmware detects this 0V condition and sets the duty cycle of the PWM to 0%. This ensures that when the motor is switched in, its speed will increase gradually from the stationary state to the desired speed setting.

Turn-on currents for motors can be very high and it is desirable to reduce these surge currents as much as possible. That is why the automatic soft-start feature has been incorporated into the firmware. It will ensure that the motor is brought up to the set speed gradually.

Fast switch-off feature

Another feature that has been incorporated into the firmware is the so-called "Fast-off" feature. This means that the duty cycle of the PW modulation is set to 0% (turning off the motor) whenever the selected speed setting of the pot goes to 0%. Rather than decreasing the speed gradually, setting the pot to its lowest setting turns the motor off immediately.

This design also incorporates our extensive experience with previous speed controllers featured in SILICON CHIP. As a result, it uses four high-current Mosfets to do the switching (pulse width modulation), uses very wide tracks on the PC board and heavy-duty (40A) terminal blocks to carry the heavy currents.

User interface

Two pushbuttons on the display board are used to navigate through the menus, while the pot is used both to vary the speed and to vary certain settings.

Main Featu

- Good speed regulation u load
- Automatic soft-start and fast switch-off
- Eight memory settings
- 4-digit 7-segment display
- Variable frequency for pulse width modulation (PWM)
- Battery level meter
- Low-battery alarm
- Persistent settings & defaults
- Rated up to 40A continuous current
- 12-24V DC input voltage

Parts List

3081,

erminal

IC socket

DT toggle switch (S1)
1 50A 5AG fuse (F1) (Jaycar SF1976)
1 60A 5AG fuseholder (Jaycar SZ2065)
1 12-way pin header (Altronics P-5502)
1 200mm length 16-way rainbow cable
1 PC-mount mini piezo beeper (Jaycar AB3459 or equivalent)
1 220µH inductor (L1) Jaycar LF1276 or equivalent)
1 10kΩ 16mm PC-mount linear single-gang pot (VR1)
1 500Ω horizontal trimpot (VR2)

Semiconductors
1 PIC16F88-I/P microcontroller programmed with 0910308A.hex (IC1)
1 MC34063 switchmode DC-DC converter (IC2)
1 BC327 PNP transistor (Q1)
3 BC337 NPN transistors (Q2-Q4)
4 IRF1405 N-channel Mosfets (Q5-Q8) (Jaycar ZT2468)
1 1N4004 diode (D1)
1 1N5819 Schottky diode (D2)
2 MBR20100CT 20A diodes (Jaycar ZR1039) OR
1 40EPF06PBF 40A ultra-fast diode (Farnell 910-1560) (D3)
5 1N4745 16V 1W zener diodes (ZD1-ZD5)
2 1N5364BG 33V 5W zener diodes (ZD6-ZD7) (Farnell 955-8217)
1 3mm red LED (LED1)

Capacitors
1 2200µF 50V low-ESR electrolytic (Altronics R-6207)
1 470µF 16V electrolytic
1 100µF 63V electrolytic
1 100µF 25V electrolytic
1 10µF 25V electrolytic
3 4.7µF 16V electrolytic
1 220nF 100V MKT polyester
1 100nF 100V MKT polyester
3 100nF monolithic
1 470pF ceramic

Resistors (0.25W, 1%)

2 33kΩ	1 100Ω
2 4.7kΩ	1 56Ω
1 3.6kΩ	1 22Ω 1W
6 1kΩ	4 15Ω
2 470Ω	3 1Ω

Display Board
1 PC board, code 09103082, 73mm x 58mm
1 SPST PC-mount momentary-contact switch, yellow (Jaycar SP0722; Altronics S-1097) (S2)
1 SPST PC-mount momentary-contact switch, red (Jaycar SP0720; Altronics S-1095) (S3)
1 16-pin DIP IC socket (optional)
1 100nF monolithic capacitor

Semiconductors
1 74HC595 shift register (IC3)
4 BC337 NPN transistors (Q9-Q12)
4 7-segment common cathode red LED displays (Jaycar ZD1855; Altronics Z-0190)

Resistors (0.25W, 1%)
4 470Ω
8 39Ω

The two pushbuttons are sensitive to two types of presses, short and long. A short press is of the order of half a second or less while a long press is one around one second.

To change a setting, a long press is usually needed. This prevents unwanted changes to the settings, which are stored in EEPROM and thus recalled at the next switch on.

Because of the capabilities offered by the PIC microcontroller, we have been able to incorporate a large number of features into the firmware, as described in the separate panel later in this article.

Circuit description

The circuit for the speed controller is shown in Fig.1. As noted previously, it can work with 12V or 24V batteries but has been optimised for operation at 24V. Within the circuit itself, there are two separate voltage rails: +5V for the microcontroller and +16V for driving the gates of the Mosfets. Both are derived from the +24V input supply.

The main input supply is filtered by a 2200µF low ESR capacitor, to minimise high-voltage transients which can be produced by the inductance of the battery connecting leads. This capacitor is absolutely vital to the proper operation of the speed controller at high currents.

S1 is the power switch and diode D1 protects the low-power part of the circuit (IC1 & IC2) from reverse polarity. A 22Ω 1W resistor, a 33V 5W zener diode (ZD7) and a 100µF capacitor also protect the MC34063 IC from transients on the supply rail.

The filtered supply is then fed to the MC34063 (IC2) which operates in a standard step-down converter configuration to provide the +5V rail. Three 1Ω resistors between pins 6 & 7 are used to set the maximum switching current. The output voltage is set by the voltage divider associated with trimpot VR2.

Only about 200mA is ever drawn from this supply and most of this is used to drive the display.

IC1 is the heart of the circuit and is the popular PIC16F88 microcontroller which incorporates a number of peripheral functions. Of these, the timers, hardware PWM (pulse width modulation) and three ADC inputs are used.

The three ADC inputs used are at pins 1, 2 & 18. As these need to be within the 0-5V range, voltage dividers consisting of 33kΩ and 4.7kΩ resistors are used to scale both the input voltage rail (which could be as high as 29V) and the back-EMF from the motor, to be fed to the ADC inputs at pins 1 & 18. The ADCs convert the monitored voltages to 10-bit values.

The +16V rail is used as the gate drive supply for the Mosfets and is derived from the 24V supply via a 1kΩ resistor and a 16V 1W zener diode (ZD1). Bypassing of this rail is particularly important and is accomplished using 100µF and 100nF capacitors near ZD1 and adjacent to the transistors Q1 & Q2.

If the battery supply is to be 12V, the 1kΩ resistor feeding ZD1 should be reduced to 100Ω. In this case, the supply will actually be between 12V and 14V (depending on the actual battery voltage); still enough to provide adequate gate drive for the Mosfets and

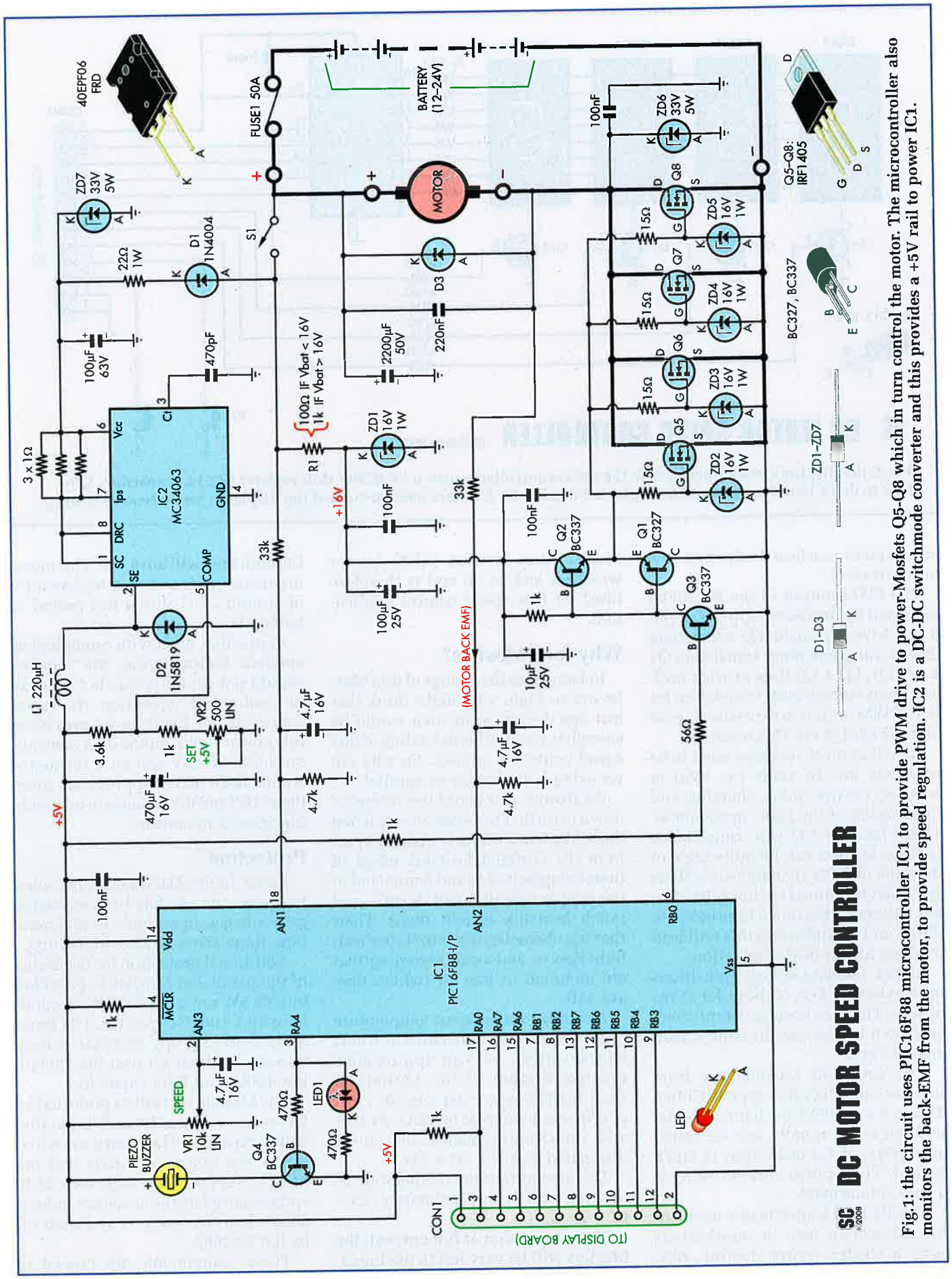


Fig.1: the circuit uses PIC16F88 microcontroller IC1 to provide PWM drive to power-Mosfets Q5-Q8 which in turn control the motor. The microcontroller also monitors the back-EMF from the motor, to provide speed regulation. IC2 is a DC-DC switchmode converter and this provides a +5V rail to power IC1.

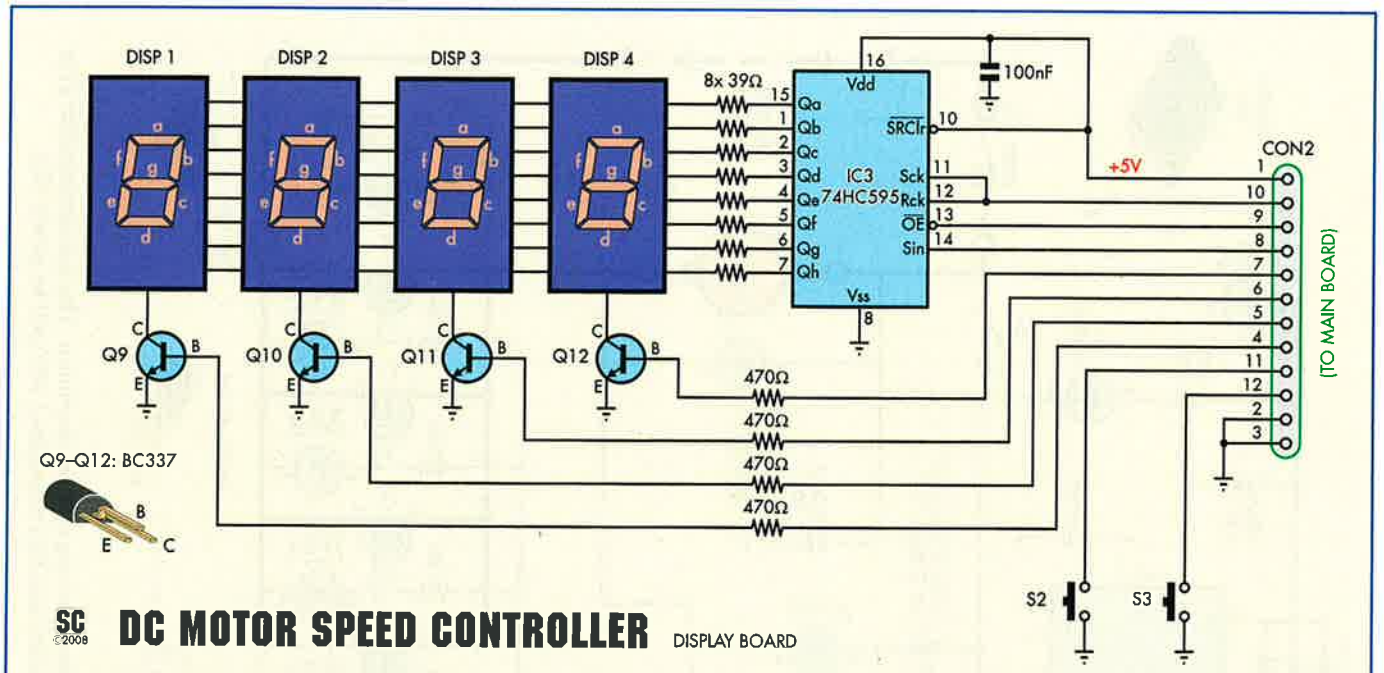


Fig.2: the display circuit interfaces to the microcontroller & uses a 74HC595 shift register (IC3) & transistors Q9-Q12 to drive four 7-segment LED displays. Switches S2 & S3 are used to control the display & for software set-up.

ensure minimum heat dissipation (low on-resistance).

The PWM output of the PIC16F88 (adjusted by firmware) appears at pin 6 and drives transistor Q3 which then drives complementary transistors Q1 & Q2. Q1, Q2 & Q3 thus provide buffering and voltage level translation for IC1's PWM output to drive the gates of Mosfets Q5-Q8 via 15Ω resistors.

Note that these resistors need to be relatively low in value (ie, 15Ω) in order to ensure quick charging and discharging of the gate capacitances. That's because the gate capacitance of these Mosfets can be quite high, of the order of 5000-10,000pF each. If the gate charging time is too long, the Mosfets will spend too much time between the on and off states and this will lead to much higher heat dissipation.

In fact, the gate voltage transitions need to be very fast, of the order of 1µs or less. This has been accomplished, as shown by the oscilloscope screen grab of Fig.4.

The specified Mosfets are from International Rectifier, type IRF1405. This is a 55V 169A N-channel Hexfet with an exceptionally low on-resistance (Rds) of 5.3 milliohms (5.3mΩ) typical. Their pulse current rating is a stupendous 680A.

The IRF1405 is specifically intended for automotive use, in applications such as electric power steering, anti-lock braking systems (ABS), power windows and so on and is therefore ideal for this speed control application.

Why four Mosfets?

In fact, since the ratings of this Mosfet are so high, you might think that just one device on its own would be enough to handle the 40A rating of this speed controller project. So why are we using four Mosfets in parallel?

As always, real world use brings us down to earth. For a start, we are using these Mosfets without heatsinks, apart from the vestigial heatsink effect of their being bolted to and connected to the copper side of the PC board – not much heatsink benefit there. Their thermal characteristic is 62°C per watt (junction to ambient), assuming that are mounted in free air (which they are not).

Assuming an ambient temperature of 25°C and an on-resistance of 10mΩ (conservative), we can approximate the temperature of the Mosfets at their highest operating current (10A per Mosfet for a total of 40A). At 10A and 10mΩ on-resistance, the power dissipated is: $10^2 \times .01 = 1W$

This means that the temperature of the case will be approximately: $25 + 62 \times 1 = 87°C$

This means that at full current, the Mosfets will be very hot to the touch.

Careful: they will burn you. Our measurements produced a top temperature of around 77°C after a test period of half an hour.

In practice, even with much higher ambient temperatures, the Mosfets should not get quite this hot because in "real world" operation, the speed control is not likely to be providing full power to the motor on a continuous basis. At 24V and 40A, the motor would have 960W applied (ie, more than 1HP) and this equates to relatively high power operation.

Protection

Zener diodes ZD2-ZD5 are included to protect the Mosfets from excessive gate voltages. In normal circuit operation, these zener diodes do nothing.

Additional protection for the drains of the paralleled Mosfets is provided by 33V 5W zener diode ZD6, in parallel with a 100nF capacitor. The zener is there to clip any residual voltage transients which get past the 2200µF low-ESR input filter capacitor.

The Mosfets are further protected by fast-recovery diode D3 and its parallel 220nF capacitor. These parts are wired across the motor terminals and are used to suppress the high back-EMF spikes caused by the armature inductance when the motor is switched off by the Mosfets.

These components are crucial to

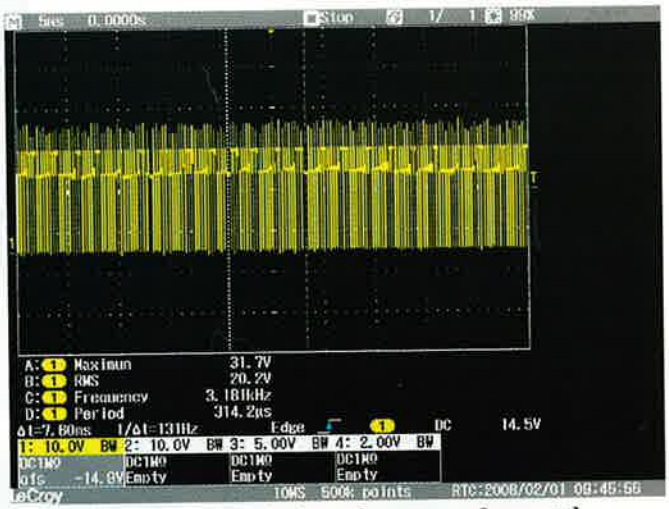


Fig.3: the yellow trace is the voltage waveform at the drain of the Mosfets, when a motor is connected. There are narrow spikes up to 31.7V when the Mosfets switch off due to the inductance of the armature. The small windows where the Mosfets are switched off to sense the back-EMF of the motor can also be seen. The two vertical cursors show that the period between such intervals is of the order of 7.6ms. In other words, the speed of the motor is monitored at 131Hz.

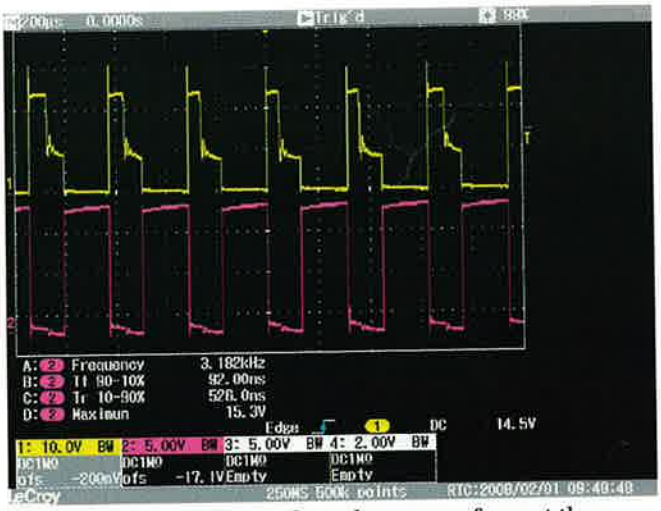


Fig.4: the yellow trace is the voltage waveform at the drain of the Mosfets, while the purple trace is the gate drive. The gate drive goes as high as 15.3V. The rise time of the gates is 526ns while the fall time is 92ns. When switching the Mosfets on and off, it is necessary that the transition be fast, ideally under 1µs, otherwise the Mosfets will dissipate more heat than is necessary. To ensure fast switching of the Mosfets their gate capacitance needs to be charged and discharged very quickly.

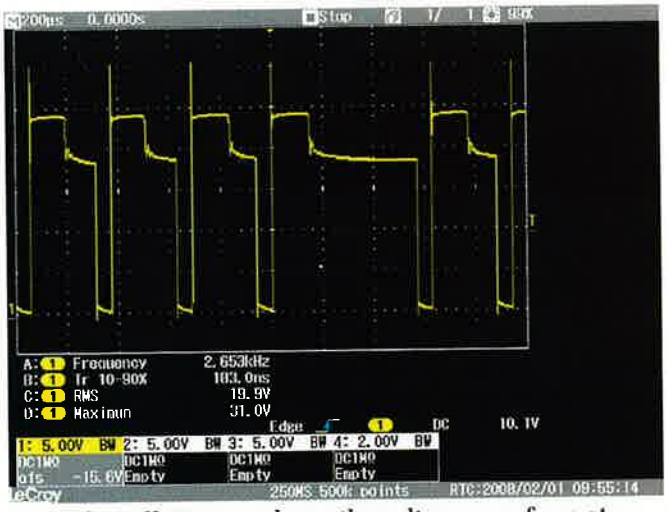


Fig.5: the yellow trace shows the voltage waveform at the drain of the Mosfets when a motor is connected. The irregular waveform corresponds to the back-EMF monitoring. The Mosfets are then off and the voltage is then directly proportional to the speed of the motor. The window is narrow enough so that the motor's deceleration is negligible. Turning off the Mosfets to monitor the back-EMF is asynchronous to the PWM driving the Mosfets.

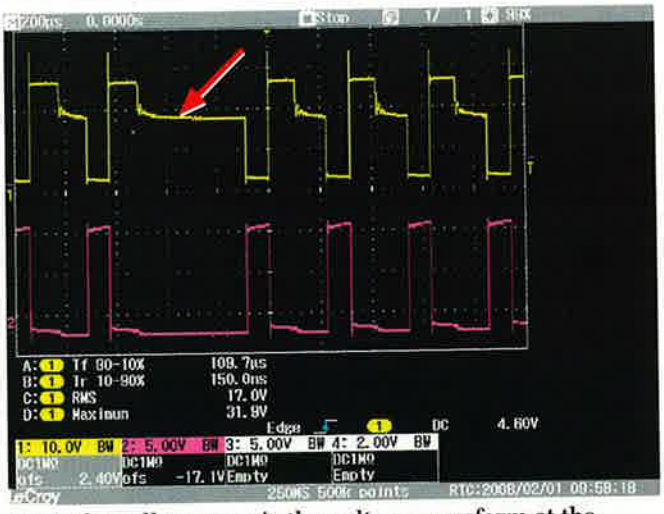


Fig.6: the yellow trace is the voltage waveform at the drain of the Mosfets and the purple trace is the waveform at the gate of the Mosfets when a motor is connected. Again, the irregular yellow waveform (arrowed) corresponds to the period when the Mosfets are switched off to sense the back-EMF and hence the speed of the motor. You can see from the purple trace that the gate drive during this time is 0V.

the operation of the speed controller. Without them, the high voltages generated can and probably would destroy the Mosfets.

Other protection measures

As already mentioned, diode D1 provides reverse polarity protection for microcontroller IC1 and the switchmode supply (IC2). Zener diode ZD1 is self-protecting in the case of reverse supply connection. However, if the supply is reversed, there will be a heavy conduction path via fast recovery diode D3 and the internal substrate diodes in the four power Mosfets. If you are lucky, the 50A fuse will blow before the Mosfets are damaged but there is no guarantee of this. **SO DON'T REVERSE THE BATTERY CONNECTIONS!**

In a similar vein, if the outputs are shorted while power is applied, high current will flow through the Mosfets. Again, if you are lucky, the 50A fuse will blow before the Mosfets go up in smoke. In reality, the 50A fuse is there to stop a fire! **SO DON'T SHORT THE OUTPUTS TO THE MOTOR.**

If the motor is under heavy load and becomes stalled, high currents will flow in its armature. Depending on the motor's rating, this may or may not

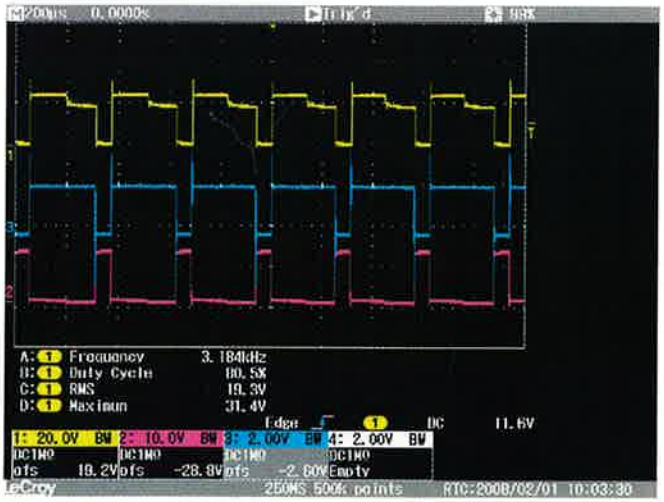
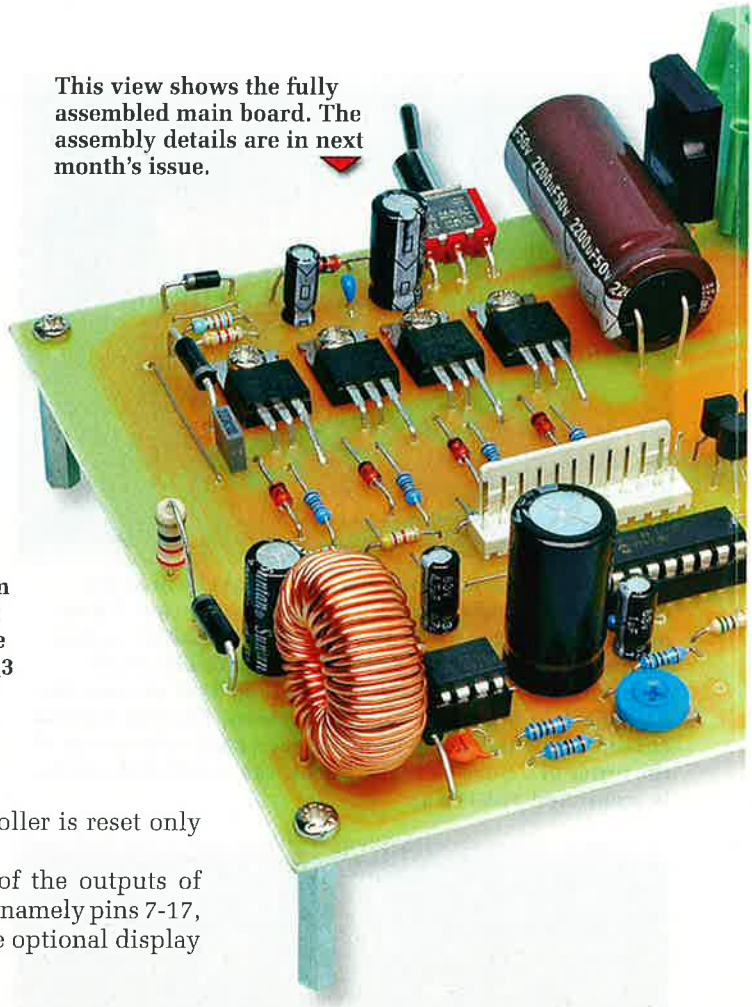


Fig.7: the yellow trace shows the voltage waveform at the drain of the Mosfets, the purple trace shows the voltage waveform at the gates and the cyan trace shows the voltage waveform at the PWM output of the microcontroller. Note that transistors Q1-Q3 provide voltage translation by stepping up the 5V output from the microcontroller to 12-16V. This higher voltage is needed to ensure that the Mosfets are fully turned on.



This view shows the fully assembled main board. The assembly details are in next month's issue.

blow the fuse. If the fuse does not blow during stall conditions of the motor, the Mosfets should survive although they may get very hot.

Warning buzzer

If the circuit is overloaded, the battery voltage should drop to the point where the warning buzzer will sound.

LED1 and its 470Ω current limiting resistor are switched by a high level on the output of pin 3 of the microcontroller. This is configured as a simple digital output. It also turns on Q4 and the piezo beeper. This output is controlled by the firmware and can be disabled.

A 1kΩ pull-up resistor is used on pin 4 (reset) of the PIC16F88-I/P. This ties the reset pin high which means that the microcontroller is reset only at power-on.

Finally, the rest of the outputs of the microcontroller, namely pins 7-17, are used to drive the optional display board.

Display board

Fig.2 shows the optional display board circuit. It connects to the main board via 12-pin header CON1 and a ribbon cable.

The display board consists of two pushbuttons, four 7-segment displays which are multiplexed by the firmware, four transistors and some resistors, as well as a 74HC595 shift register (IC3).

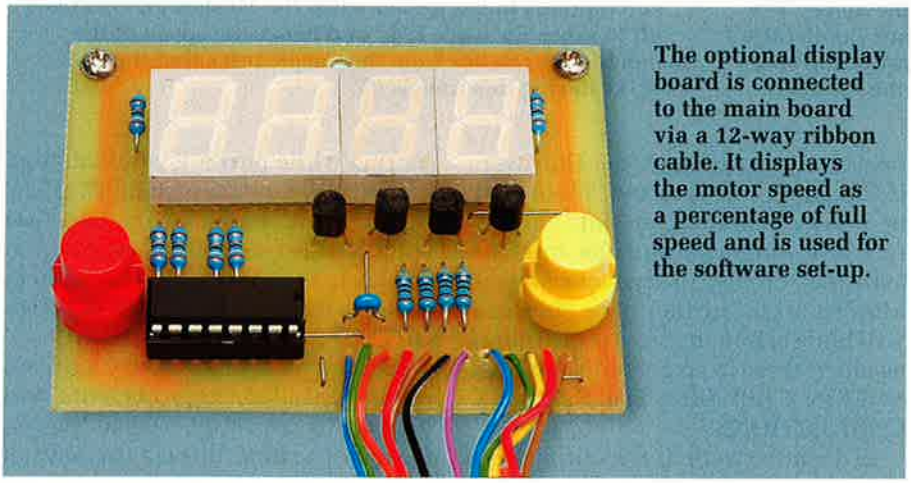
Pins 1 & 2 of 12-way connector CON2 supply +5V to the display board. Pin 3 is connected to a digital input of the microcontroller and is pulled high by a 1kΩ resistor on the main board. Conversely, it is pulled low by the display board. This is used by the microcontroller to detect whether the display board is connected or not.

Pins 4-7 of CON1 are used to drive the transistors Q9-Q12 on the display board. These transistors switch the 7-segment display cathodes.

Pins 8-10 of CON1 are respectively the CLK, DATA and OUTPUT ENABLE lines and these go to the 74HC595 shift register (IC3). The microcontroller drives these lines to load a new 8-bit value into the shift register. The outputs of the shift register are connected across the four 7-segment displays and drive the anodes.

Finally, pins 11 & 12 are connected to pushbuttons switches S2 & S3 on the display board. They are also connected to digital inputs on the microcontroller (which have internal pull-ups enabled) and these inputs are used to monitor the pushbuttons.

Next month, we will cover the construction and troubleshooting of the speed controller. In the meantime, take a look at the "Software Features & Set-up" panel on the facing page.



The optional display board is connected to the main board via a 12-way ribbon cable. It displays the motor speed as a percentage of full speed and is used for the software set-up.

DC Motor Speed Controller: Software Features & Set-up



THE STRUCTURE of the firmware for the DC Motor Speed Controller is shown overleaf in Fig.8. The transitions between the various menus are made using the switches on the display board and are indicated with labelled arrows.

There are four possible switch presses, either Short or Long and either the Left (L) or Right (R). Thus, for example, "Short R" refers to a short press of the right pushbutton.

Main menu

The Main menu is as shown in Menu 1. It consists of the letter 'P' (for "percentage") and three digits with a decimal point indicating the range 00.0% to 99.9%. The percentage value indicates the fraction of full speed the motor is currently running at.

In this mode, the motor's speed can be adjusted by varying the pot. The letter 'P' will flash while the motor's speed increases or decreases to the new setting. When the current speed reaches the speed set by the pot, the letter 'P' will stop flashing and there will be a short beep (if enabled).

Since there is a small periodic window when the pulse width modulation is turned off by the firmware in order to read the back-EMF, at full speed the reading will not indicate 99.9% but will achieve its maximum at around 98% or so.

Monitoring the input voltage

From the Main menu, press "Short R" once and you will be taken to the display shown in Menu 2. It consists of a 'b' (for "battery") followed by three digits with a decimal point indicating a level from 00.0V to 99.9V, to monitor the battery. For good voltage accuracy, it is important that the +5V supply rail be precisely set using trimpot VR2.

In practice, with the supply rail to the microcontroller set at 5V, the level will not register any higher than around 40.1V. This is because the voltage divider used to derive the voltage reading consists of 33kΩ and 4.7Ω resistors. The relatively high series resistance of 37.7kΩ was chosen to avoid damaging the input of IC1 if the input voltage goes any higher than around 40V.

To go back to the Main menu, either press "Short L" or press "Long R". If you press "Long L", you will set the low-battery alarm level to 91.6% of the current voltage input level (and then return to the Main menu). This is a shorthand way to set the low-battery alarm level when you know that the batteries are fully charged.

For a typical 12V battery, they are fully charged at around 13.8V (with charger connected) and should not be discharged beyond 11V.

Press "Short R" to go to the low-battery alarm level menu.

Setting the low-battery alarm

From the Main menu, press "Short R" twice. You will be taken to the low-battery alarm level menu as shown in Menu 3.

It consists of an 'A' (for "alarm") followed by three digits which indicate a level between 00.0V and 41.6V. This will show the current setting of the low-battery alarm or rather, the voltage level below which the alarm will sound (if enabled).

Whenever the input voltage is below this level, the display will flash (with increasing frequency as the voltage drops) while if the alarm sound is enabled, there will be a flash from LED1 and a beep.

To set the low-battery alarm level

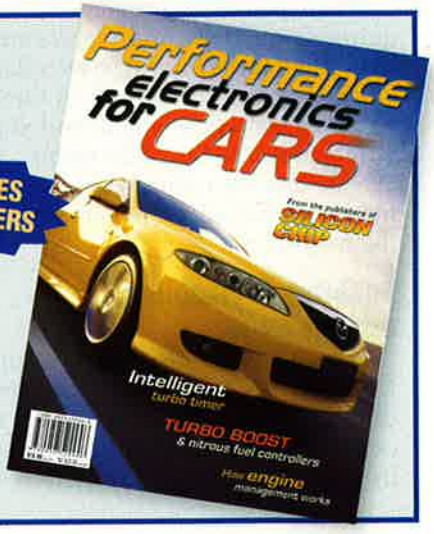
. . . *continued next page*

Looking for real performance?

NOT A REPRINT – Completely *NEW* projects – the result of two years research & development

- Learn how engine management systems work
- Build projects to control nitrous, fuel injection and turbo boost systems
- Switch devices on and off on the basis of signal frequency, temperature and voltage
- Build test instruments to check fuel injector duty cycle, fuel mixture and brake and coolant temperatures

160 PAGES 23 CHAPTERS



Mail order prices: Aust. $A22.50 (incl. GST & P&P); Overseas $A26.00 via airmail.

Order by phoning (02) 9939 3295 & quoting your credit card number; or fax the details to (02) 9939 2648; or mail your order with cheque or credit card details to Silicon Chip Publications, PO Box 139, Collaroy, NSW 2097.

press "Long L". The 'A' will start flashing and then the low-battery alarm level can be modified by adjusting the pot setting. To turn the alarm off completely, simply set the level to 00.0V.

When you have reached the required level, simply press any button and the level will be recorded (and stored in EEPROM). Then there will be a beep (if enabled) and you will be taken to the Main menu.

Note that the motor will be turned off automatically when setting the low-battery alarm level.

Setting the PWM frequency

From the Main menu, press "Short R" three times. You will be taken to the frequency menu as shown in Menu 4.

This consists of an 'F' (for "frequency") followed by three digits with a decimal point indicating a level between 0.48kHz and 7.81kHz. This is the current PWM frequency. As the frequency increases, the resolution of the PWM setting decreases.

At 0.48kHz (actually 488Hz) the resolution is 10 bits. This decreases to six bits at 7812Hz. Thus, the resolution is at worst six bits or 64 levels and at best 10 bits or 1024 levels.

While in this menu, press "Long L" and you will be able to set the frequency. The 'F' will start flashing and then the frequency will be modified according to the pot setting.

When you have reached the required frequency, simply press any button and the level will be recorded and stored in EEPROM. Then there will be a beep (if enabled) and you will be taken to the Main menu.

Note that the motor will be automatically turned off when setting the frequency.

Enabling & disabling audible cues

From the Main menu, press "Long L". You will be taken to the settings menu as shown in Menu 8. It consists of 'A' (for alarm) followed by either '0' or '1' (0 = disable, 1 = enable) and a 'b' (for beep) followed again by either '0' or '1' (0 = disable, 1 = enable). In this menu, pressing "Short L" will toggle the alarm setting (enable/disable) and pressing "Short R" will toggle the beep setting (enable/disable).

When the alarm setting is disabled, there will be no beeping when the input voltage falls below the alarm level. There will still be a warning flashing on the display, however. To disable the latter, simply set the alarm level to 00.0V. When the beep setting is disabled, audible beeps emitted by the firmware at certain points (as when setting certain values or when the desired speed is reached) will be blocked.

If you do not want any beeping from the piezo buzzer, simply set 'A' to 0 and 'b' to 0. In this menu, pressing "Long L" will take you to the Reset Menu, as explained below. Pressing "Long R" will take you back to the Main menu.

Reset menu

From the Main menu, press "Long L" twice. You will be taken to the Reset Menu as shown in Menu 9.

It consists of the letters 'CL' (for "clear") followed by two digits and a decimal point of the form X.X.

The X.X represents the current version of the firmware, which for this release stands at 3.0. It is possible that future releases of the firmware will add new features or refinements to critical sections of the code.

While in this menu, press "Short L", "Short R" or "Long R" to go back to the Main menu.

Note, however, that pressing "Long L" will reset all settings to the default values and the speed controller will lock until power is turned off. When a power-on reset next occurs, the default values for the frequency, low-battery level alarm and audible beeps will be restored.

This feature is useful for initialising the firmware variables and for making sure that you begin from a known state. Most of the time, it will not be used.

Memory speed mode

From the Main menu, press "Short L" to enter memory mode. The display will be as shown in Menu 6.

It consists of the letter 'C' (for "constant") followed by a digit from 1-8 (indicating one of the eight available memories), in turn followed by two dashes.

Now adjusting the pot will select one of the eight memories. When the pot becomes stable for a short period, the speed of the motor will be set according to the current value of that memory.

The display will change as shown in Menu 7. This display still consists of the letter 'C' followed by the number of the memory but it will then have a decimal point followed by two digits representing the speed percentage from 00% to 99% (the first two letters will flash until the set speed is reached).

Adjusting the pot will now change the selected memory and the speed setting will be recalled from one of the eight stored memory speed settings (after a short beep, if enabled).

To go back to normal mode, where the motor speed is controlled directly by the pot, simply press any key, long or short.

Setting the memory

To set one of the eight memory speed values you press "Long R" from the Main menu. The display will change as shown in Menu 5. It consists of the letter 'C' (for "constant") followed by a digit from 1-8 (indicating one of eight memory settings) and two dashes.

Now adjusting the pot will select one of the eight memory settings to store the current value of the speed of the motor.

When the pot becomes stable for a short period, the speed of the motor will be stored at that particular memory. This can be recalled later by entering memory mode, as explained in the previous section.

There will be a short beep (if enabled), indicating that the value has been stored and you will be taken back to the Main menu. SC

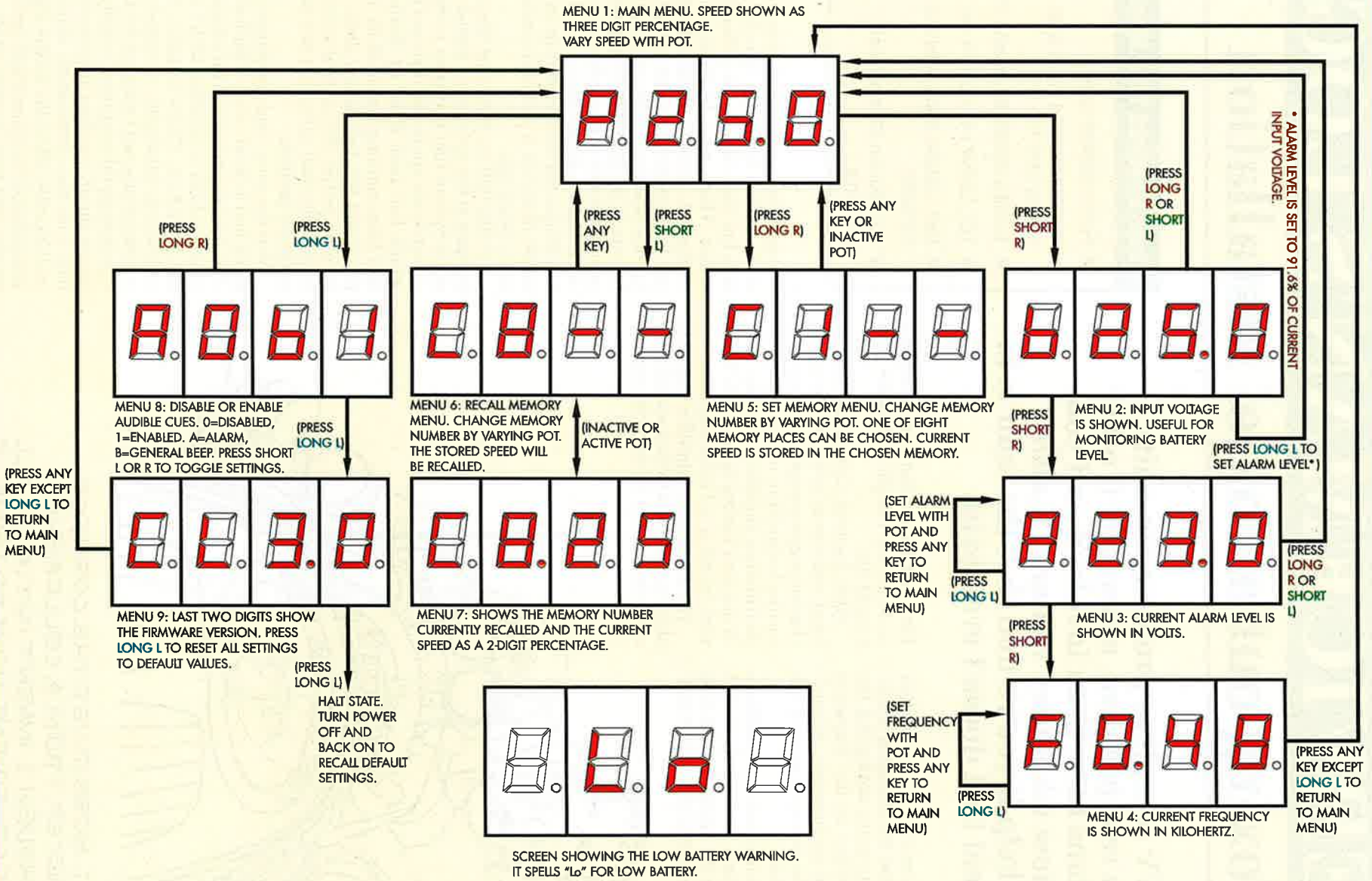


Fig.8: this diagram shows the structure of the firmware for the DC Motor Speed Controller. The transitions between the various menus are made using the switches on the display board and are indicated with labelled arrows.

SERVICEMAN'S LOG

Foxing out a Foxtel installation

Fixing TV reception problems in units can be a real problem, especially if other technicians have been involved and you don't know what they've done. It also doesn't help if you're told that the fault is in equipment that doesn't even exist.

Items Covered This Month

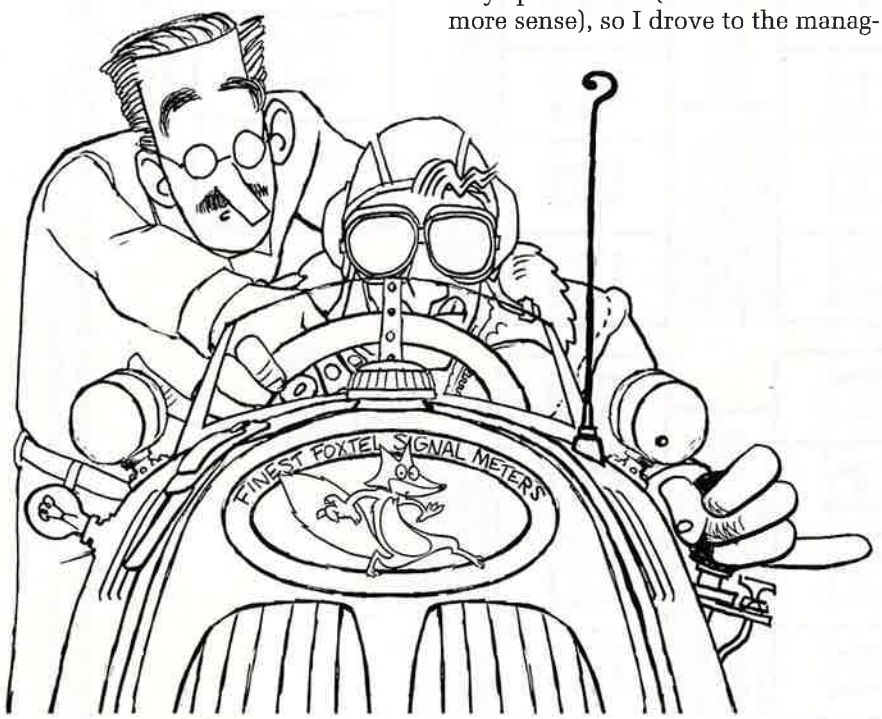
- Foxtel satellite system
- TCL TFW76BO3 76cm wide-screen CRT TV
- Toshiba 42WP48A plasma TV
- TCL L32M61A7 LCD TV set
- Dell Latitude D600 notebook computer
- Ford Falcon XE electrical problems

I recently received a handwritten work order from the managing agents of a block of 12 units, stating that the antenna amplifier in the basement needed urgent replacement. According to the order, it was ruining all the Foxtel reception.

Now I had never been to this address before and knew nothing about it. I tried phoning the agents but the man in charge wasn't available. In the end, I decided that as I had been contracted to do the job, I might as well see what I could do.

When I arrived, I discovered that the block was a security building to which I had no access except to the basement. Inside, I could find no sign at all of a distribution amplifier, nor any trace of one ever having being there. There was, however, a Foxtel amplifier.

The distribution amplifier was probably up in the roof (which would make more sense), so I drove to the managing agent and obtained the key. Back at the units, I finally got into the roof area but there was no amplifier there either. There was, however, ample evidence to show that there used to be one because there was an empty box for one and there were cable fittings for one to be installed. Fortunately, I managed to talk to a long-time resident of the block who was pretty cluey and he told me that there used to be an amplifier there but it had been removed many years ago.



~I BORROWED THE CORRECT METER FROM A COLLEAGUE ALTHOUGH I WASN'T *INITIALLY* ALL *THAT* CONFIDENT HOW TO DRIVE IT

He also told me that what was now in place at the units was a Foxtel Satellite System that had been installed privately except for the dish and LNB which had been fitted by Foxtel. It had been running successfully for a few years but had failed about two months earlier and several previous technicians had called but had failed to fix the problem.

Now the story I had previously been given had a certain ring of truth about it, as it is not uncommon for a distribution amplifier to interfere with Foxtel transmissions. That's because most technicians invariably run free-to-air transmissions and Foxtel on the same line through this amplifier. A faulty DC power supply can thus introduce hum bars into the distribution amplifier and severely affect the Foxtel signal, sometimes to the extent that it prevents the decoder from working at all.

However, in this instance, there was no distribution amplifier and unfortunately, I am not all that familiar with the Foxtel satellite system. For starters, I don't know the satellite channel plan or what sort of levels to expect, nor do I have the correct signal level measuring equipment.

Fortunately, I managed to borrow the correct meter from a colleague although I wasn't initially all that confident as to how to drive it. However, having familiarised myself with the gear, I checked the signal level output from the Foxtel amplifier to be 75dB, which is not enough for a 12-outlet building. As a result, I picked up a new Foxtel satellite amplifier (identical to the original unit) from my wholesaler, along with a generic spare and an 18V power supply.

I connected the brand new Foxtel amplifier, only to find it was DOA (dead on arrival) – faulty straight out of the box! I then fitted the new generic amplifier and set its output for 100dB. That done, I went to one customer's unit and measured 70dB at his outlet which is perfect for Foxtel. But there was still no Foxtel.

Foxtel use horizontal and vertical polarisation in their systems, controlled by the power supply, ie, 12V = vertical and 18V = horizontal. The question was, which one was being used? I tried the 18V power supply I had with me but no go, so I went back to my friendly wholesaler and picked up a 12V power supply. It made no difference so I left the original 18V power supply in place.

Foxtel also uses two local oscillator frequencies – 11.3GHz and 10.7GHz – to match the appropriate LNB, so that was the next thing to look at. I managed to get the locked Foxtel security code (set-up menu 0611) to get into the service menu and changed the local oscillator from 11.3GHz to 10.7GHz.

At last – perfect pictures! It was then just a matter of going around to all the other Foxtel owners and readjusting their menus in the same way.

When the job was completed (all in the same day), I had time to reflect on what had probably happened. When the original fault occurred, there was a lot of miscommunication as to what the problem was and too many different technicians got involved.

The cause was actually the Foxtel amplifier but a previous technician had changed the LNB on the dish for one with a different local oscillator frequency and didn't replace the original when he found it made it worse – probably because he was told to just change it and didn't have time to check the result.

TCL widescreen TV

Tim O'Brian (not his real name) has a TCL TFW76BO3 76cm widescreen CRT TV which is about 18 months old. Unfortunately, it was now cutting off after just a few minutes of operation.

TCL (Thomson China Ltd) is the largest manufacturer of TV sets in the world and also makes sets for many other brands such as NEC, etc. TCL is their own brand name and the sets are sold with a 3-year warranty. And so, as the local service agent, off I went to Tim's address at unit 23/123 Mary St to do an in-home warranty repair.

I was not familiar with Mary St, which turned out to be a very long street with a lot of home units. Anyway, I soon found number 123 but I couldn't find unit 23 (the units were very poorly labelled). I phoned Tim on the mobile and spoke to his mother, whose English was not too good, and explained my predicament.

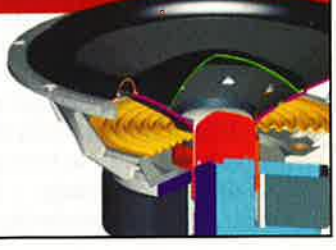
Unfortunately, our communications weren't the best so I asked her to come outside and look out for me or at least describe some kind of landmark. Even so, I still couldn't find her or the unit, so I queried the street address and nearest cross street.

She kept telling me "unit 23/123 Mary St" but the nearest cross street she nominated was nowhere to be seen. In the end, I got back into the car and cruised up and down until I reached the cross street but I still couldn't find 123.

It took a long time, interspersed with

Ozitronics
Tel: (03) 9896 1823 Fax: (03) 9011 6220
Email: sales2008@ozitronics.com
Introducing the MT System
A series of C programmable chips based on the latest generation of 8051, Atmel AVR or ARM core flash microcontrollers.

• Onboard 16-bit run-time interpreter for fast program development
• Multiple, selectable program storage
• Lots of sample programs
• Free IDE includes text editor, compiler, simulator, test terminal & serial downloader (no programmer required)
• Demoboards available for quick and easy project development
Prices & documentation available on website:
www.ozitronics.com


TRUE AUDIOPHILE SPEAKERS
Danish Engineered Speaker Drivers for Astonishing Sound Reproduction with Clarity & Outstanding Performance
Tymphany & DST bring together Peerless & Scan-Speak the worlds most respected and trusted high-end loud speaker brands for the past 80 years. Visit: www.d-s-t.com.au
Find Specs / details online:
www.d-s-t.com.au
Peerless vline
vifa innovation lives on
SCANSPEAK

Available from:
Wagner Electronics
138 Liverpool Road,
Ashfield, NSW, 2131
Phone: 02-9798-9233
Fax: 02-9798-0017
Email: sales@wagner.net.au
Web: www.wagner.net.au



some fairly terse phone calls, to work out what was happening. It turned out that the street address was actually 1-3 (1 to 3) and its entrance was in the cross street. Once that had been sorted out, I had to negotiate the full-security lift which required a card to operate it before I was finally let into Tim's place on the third floor.

When I saw the set, I knew that this was just going to be "one of those days". It was, of course, situated in an entertainment centre in the corner with pitiful access. What's more, the set weighed more than I do – which is a lot these days!

On the plus side, the fault just might have been due to another symptom I hadn't been told about, namely retrace lines on the screen.

My first step was to remove the back and swing it around while dodging both the baby and the dog who were trying to eat my tools. I then carefully readjusted the flyback transformer screen control until there were no more lines and waited 15 minutes to see if the set switched off. It didn't and I then managed to put the back on the TV and replace it in the entertainment cabinet without leaving either the baby or the dog inside.

After completing the necessary paperwork, I left, confident that the repair had been completed satisfactorily. But of course, that wasn't to be the end of it. A few days later, Tim phoned back and said that while it was now taking longer, the set was still cutting out. Drat!

There was nothing for it but to go back to "123".

This time, I went armed with a new flyback transformer and a video output IC (TDA6107AJF/N1) which isn't even shown on the circuit diagram (it just shows discrete transistors). Fortunately, I didn't get lost this time and even better, the baby and dog were in other rooms.

Anyway, I removed the chassis, replaced both items and checked and resoldered a few possible dry joints. That done, I adjusted both the horizontal and vertical focus pots and the screen controls very slowly and deliberately.

After an hour or so, I was finally finished and was demonstrating the set when it went off all by itself. I was ropeable and completely bamboozled by the whole turn of events.

Now I couldn't even switch the set back on and prior to it going off, I couldn't change the stations with the remote control. Fortunately, yours truly had caused the problem and there was a simple solution. I had brought along a spare service remote control to help with the adjustments and it was in an open carrier bag into which I had just put my University multimeter. The heavy multimeter was pressing against the remote control's pushbuttons, causing the random results I was experiencing!

Aaaarghh!! After a job like that, you need a stiff drink and a lie down!

Toshiba plasma TV

I was recently called to a Toshiba 42WP48A plasma set that had been in heavy-duty use at a club. The barman had phoned to say it was dead and asked if I could fix it straight away because of the sport. I asked him if there was any clue beforehand that the set was about to fail and he replied that there was absolutely nothing.

Apparently it had been working one minute and was "dead" the next.

When I called, I could see that there was no power and so the set had to go to the workshop. Back at the ranch, I took the back off and a few quick measurements showed that the power supply – a Sanken PKG-4000 PDC20360 – was dead.

I have seen a few of these power supplies before and have sometimes found the white wirewound resistors to be faulty for no apparent reason. There is no circuit for the power supply as it is considered unrepairable. The PC board is mounted on a sheet of aluminium using over 30 screws and 12 plastic mounting clips to hold it in place.

In this case, R26 (10Ω 5W) was open circuit so I replaced it. However, when I switched the set on, it was still dead.

It was then that I noticed that IC1 and R32 (1.5Ω) had blown so badly that I couldn't read what the device type numbers were. The IC was obviously part of the standby power supply, judging by the size of the chopper transformer – probably one of those 8-pin Mosfet and control ICs.

That was as far as I was allowed to go. The club then told me the set had actually been killed during a thunderstorm (great – now they tell me!) Anyway, a new power supply was ordered and the $900 repair charged to the insurance company.

If the service manual had shown more detail on the power supply, the repair would have cost much less than that.

TCL warranty job

I had a brand new TCL L32M61A7 LCD TV come in under warranty with intermittent no sound when hot.

I thought that this would be a straightforward repair. However, after fooling around for some time with vibration tests, I finally nailed the problem by applying freezer to the main microprocessor.

This large-scale surface-mount IC is not designed to be replaced and so a new main board had to be ordered to fix the problem.

Dell notebook

I was recently asked to repair a friend's Dell Latitude D600 notebook. His problem was that the computer would not run from the battery, nor would it even charge the battery.

A quick check of the BIOS indicated that there was provision for two bat-

teries but only one was installed. After checking to see that the machine's existing 11.1V Li-Ion battery wasn't on the factory recall list, I decided to get a new one on eBay. I also ordered a new 7.2V CMOS backup battery for good measure.

When these new batteries were installed, not a lot had changed. The computer continued to run correctly from the PA-12 +19.5V AC adaptor but not from either the new battery or the old battery. The BIOS (which I upgraded to ver. A16 from A8) still reported two batteries and that one was charging but the old battery always measured 0V while substituting the new one gave an indication of 74% charged. Neither value changed at any time.

Obviously there was something fishy about the battery charging system within the computer but was it a hardware problem or a software problem?

The main battery has a 9-pin connector. Pins 1 & 2 are the +11.1V rail, while pins 6, 8 & 9 are the negative rail. Pins 3, 4 & 5 measured +5V and pin 7 measured +3.26V.

I downloaded the service manual from the web and stripped the notebook right down to just the motherboard to see if I could find anything wrong. I then examined and measured the voltages around the power supply very carefully but I couldn't find any clues. There were no blown fuses, burnt resistors or even hot components – all looked perfect. Most of the charging is controlled via surface-mounted switching ICs.

I didn't have the user's guide but I did discover the 5-green LED charge gauge which confirmed that there was no charge in either battery, despite what the BIOS displayed. I then trawled the web but could find nothing, so I went to the Dell website and asked for help via email, quoting my service tag number.

I really wasn't expecting very much but I was subsequently very pleasantly surprised when a gorgeous chick phoned me up and told me they would send a technician round the very next day to change the motherboard.

I was still very cynical, expecting some monstrous catch, but lo and behold, a technician did rock up the next day and replaced the motherboard under warranty – all done in a tenth of the time it took me to dismantle the notebook in the first place. Not only that, it was all free and under warranty.

The new battery still would not work even though the BIOS said it was 74% charged. However, the original completely discharged battery now did work and really started to charge, continuing to do so until it was at 100%. Furthermore, it ran the notebook quite satisfactorily.

My friend was delighted and both of us were mightily impressed with Dell's customer service. They have really put the meaning back into those oft-misused words.

So why does the BIOS indicate two batteries? Well, there's provision to install a second main battery in the space that's normally reserved for a floppy disk drive. As for the new battery, I sent it back for a refund.

Falcon electrical problems

Finally, here is an interesting story concerning some strange electrical faults in an old XE Ford Falcon. It was sent in by R. S. of Hoppers Crossing, Victoria and I'll let him tell it in his own words:

An acquaintance's youngest son, Brett, requested my assistance to solve some electrical problems that he was experiencing with his aging XE Falcon sedan (late 1984 model). This vehicle had originally been purchased new by his late grandfather, so its service history was well known.

The were several symptoms that concerned Brett. First of all, the speedometer tended to react to the flashing of the turn indicator, which was very strange indeed. In addition, the righthand indicator lamp was permanently illuminated, unless the indicator switch was set to activate the righthand blinkers. And when the righthand blinkers were activated, the indicator lamp turned off when the front and rear globes illuminated.

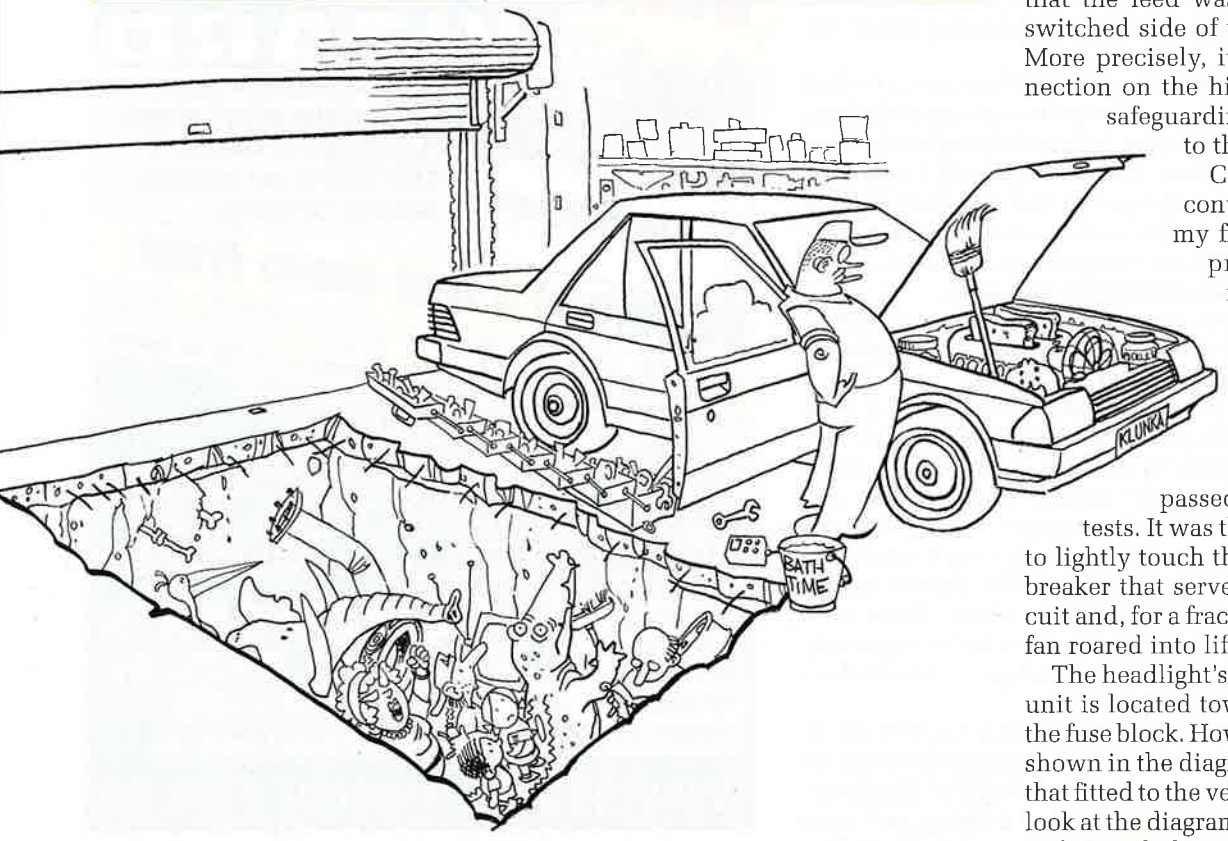
Another strange fault was that the temperature gauge swung from the low end of the scale to the high end in a most alarming manner. This was so bad that Brett had disconnected the sender wire in the engine bay to prevent possible damage to the gauge.

Another problem was that the air-conditioning (a/c) fan was intermittent, as was the a/c compressor clutch which only worked if the fan worked. This problem had been apparent for some time but had not previously been investigated. It was open to conjecture as to whether it was related to the other problems.

Due to rain, it was great day to work indoors and so I suggested that we meet at his parent's house, where the garage/workshop has a pit – useful should it be necessary to work underneath the vehicle. In my opinion, a pit is more of a requirement than an ensuite when designing and building a house!

Anyway, we examined the circuit diagram in the workshop manual and soon determined that the vehicle was





~A PIT IS MORE A REQUIREMENT THAN AN ENSUITE WHEN DESIGNING & BUILDING A HOUSE...

a base Falcon which had been fitted with air-conditioning on the production line. At this stage, I was favouring an earthing problem as the common cause of all the symptoms. As a result, I tracked down a common earth point on the diagram for all the dashboard wiring.

According to the manual, it was located on the lefthand side of the vehicle. This was eventually found after removing the glovebox and a kick panel and appeared to be in good order. Furthermore, a quick check with a DMM found just a millivolt or so across the connection when everything was powered up.

Brett then advised me that turning on the headlights (either low or high beam but not the parking lights) would cause the fan to operate. This really was strange. He had also noticed that there was a single clicking sound just before the fan began to rotate.

Brett also advised me that "hitting" the car reasonably firmly in the vicinity of the click would also activate the fan. And that in turn led us to a plug-in 30A relay. This relay is used to control the fan and I suspected that it might have an intermittent fault.

The relay was pulled from its socket and its coil resistance checked. This turned out to be about 87Ω which is normal. The relay was then checked by connecting it to a 12V DC supply and this showed that the relay was operating correctly.

In addition, its normally open (NO) contacts had almost no resistance when closed.

My next step was to bridge the matching NO connections in the socket and this showed that the fan was in perfect working order on the full speed setting. However, it did not function on the low or medium-speed settings and I suspected a faulty high-wattage series resistor as one was indicated on the diagram. I wasn't too concerned about this at this stage, though – finding and testing the resistor could wait until the intermittent electrical problem had been solved.

I went back to the circuit diagram and traced the wiring to the relay coil. This led me to a separate diagram relating to the a/c control which showed that the feed was directly from the switched side of the ignition switch. More precisely, it came from a connection on the high side of the fuse safeguarding the supply lead to the fan.

Checking the coil control voltage gave me my first real clue to the problem. It ranged from 3V to a maximum of 10V. No wonder the relay wasn't operating correctly!

Next, I reinserted the relay as it had passed all the necessary tests. It was then that I happened to lightly touch the thermal overload breaker that serves the headlight circuit and, for a fraction of a second, the fan roared into life.

The headlight's thermal interrupter unit is located towards the bottom of the fuse block. However, the fuse block shown in the diagram was different to that fitted to the vehicle. I took another look at the diagrams we had discarded and found that the more upmarket models (Fairmont, etc) were fitted with the fuse block I was looking at in this vehicle.

This also showed that the control signal for the relay came from the low side of a 20A fuse labelled 'acc', just to the left of the thermal overload breaker. Touching this fuse very lightly immediately brought the fan to life.

I felt around the back of the fuse block and moved the connecting wire, to see if it was loose. It wasn't loose but the slightest movement caused the fan to run so I removed the fuse and found that it was intermittently going open circuit.

Carefully dismantling this 3AG fuse showed that the soldered connection between the fuse element and the end cap was the problem. I replaced the fuse with a new one and no amount of wiggling, tapping, banging or activation of the headlight switch would cause the fan relay to switch off. What's more, with the engine running, the a/c compressor clutch now worked reliably as well.

I was also surprised to find that the low and medium-speed fan settings also now worked. So by replacing just one fuse, I had fixed the intermittent

fan and a/c operation problems and the lower fan speed problems as well.

Indicator problems

That left the righthand indicator lamp problem. It was still lighting when the control was in the middle of its travel (ie, neither the right nor left indicator selected).

So was there a problem with the control switch unit? There are three connector blocks associated with the electrical controls on the steering column, so I disconnected them all. Re-connecting the ignition/power circuit then caused the fault to reappear. That meant that the indicator selector, the high/low beam circuit, the horn circuit and their switches were OK.

There was nothing for it now but to remove the instrument module. That done, I probed the flying socket for voltage on the connection serving the repeater light. This showed that the connection was at 0V with the indicators in the off position, which is correct.

Moving the indicator to the righthand position then showed a pulsing 0-12V DC voltage at this point, at the frequency of the flash rate (about one pulse per second). Again this was correct and Brett advised that he had also checked this but double-checking never hurts.

That meant that the problem with the indicator lamp was in the instrument cluster itself. Undoing six screws gave us access to the circuit board which was now closely inspected. We didn't have a circuit diagram for the board, so I began to trace the now-tarnished copper tracks from the plug pins to the repeater globe, then through the globe and on towards the base of the temperature gauge. As mentioned, this gauge had been indicating a problem, so it was somehow connected to the fault.

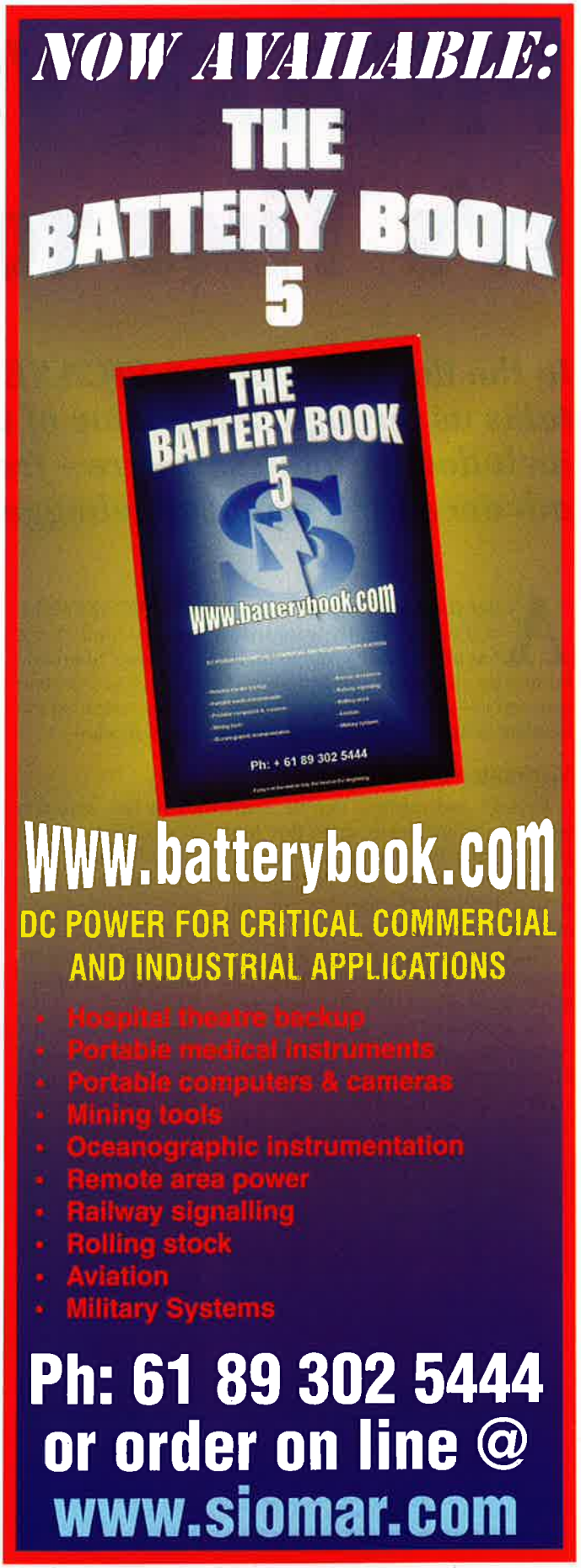
I went back to the plug and observed that a nearby copper track had been very hot in the recent past. To get a better view, I undid the three screws that secured the economy gauge to the circuit board (this economy gauge is simply a mechanical vacuum gauge sensing the air pressure in the inlet manifold). Once this gauge was out, I could now see that this track had become detached from the board surface due to the excess localised heat.

A closer examination revealed four or five small black marks (about the diameter of a pin), which had been hidden behind the vacuum gauge mounting point. What had caused these? The answer came when I looked at the back of the vacuum gauge mounting.

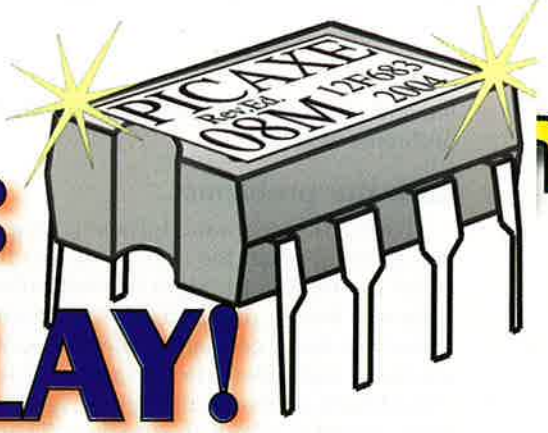
This showed that two flat-headed screws had vibrated loose and were now capable of touching two adjacent copper tracks on the PC board. These screws were both threaded into the brass block of the vacuum gauge, thereby forming a complete current path between the two tracks and shorting them out

The fix was simple. First the two screws were retightened and, for insurance, sealed in position with a drop of nail polish (a beautiful shade of pink). The floating track was then removed and the break bridged using a short length of tinned copper wire.

And that fixed all the remaining problems. The indicator lamp now operated correctly and both the speedo and temperature gauge remained steady, with no tendency to flick in sympathy with the indicator signal. After that, it was just a matter of reassembling the instrument panel and the old Ford was ready for the road once more. SC



PICAXE VSM: It's Time to PLAY!



In the third part of our PICAXE VSM tutorials Clive Seager talks us through using some of the 'virtual instrumentation' included with the software – from a simple voltmeter to an advanced I^2C protocol debugger!

After you have designed a circuit using PICAXE VSM, you will naturally want to test it! Fortunately VSM has a wide range of 'virtual instruments' available for testing purposes. This article assumes you have worked through the tutorials in parts 1 and 2 of this series, so are familiar with drawing circuits in the VSM software.

Voltmeter and Ammeter

Voltage and current can be measured in two separate ways. As an example, open the 'high command.dsn' sample file from the */samples/picaxe/commands* folder. You will then need to use the 'File>Save As' menu to save with a different filename so you can experiment and save modifications to it.

Fig.1 shows the circuit with a traditional voltmeter connected across the LED. When run, the voltmeter will show the voltage when the LED switches on and off.

An ammeter can be added by deleting the wire between the resistor and PICAXE pin. Right click and select Place>Virtual Instrument>DC Ammeter. Once dropped, right click on the ammeter symbol and edit the properties 'Display Range' from amps to milliamps. Then draw the two wires back in as shown in Fig.2.

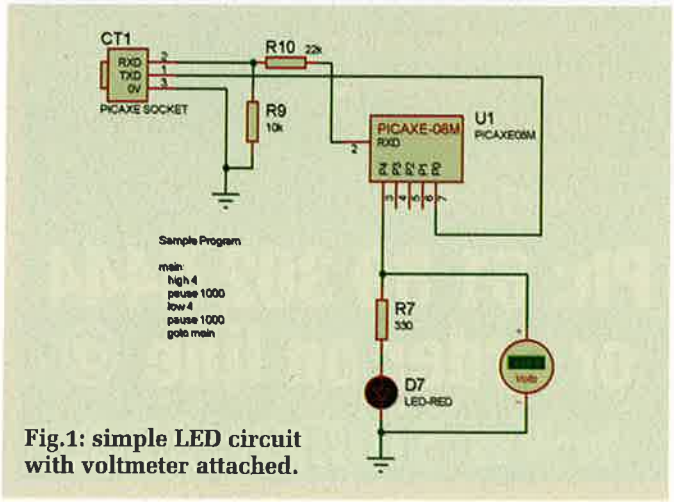


Fig.1: simple LED circuit with voltmeter attached.

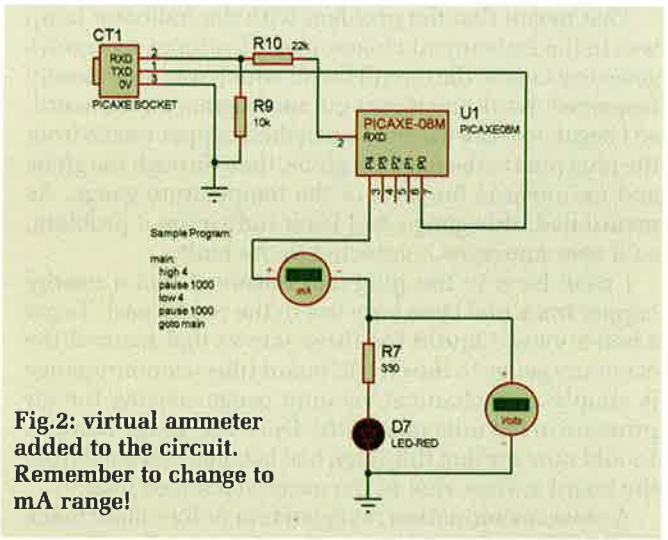


Fig.2: virtual ammeter added to the circuit. Remember to change to mA range!

When run you will now have a display of both current and voltage. If you change any of the other component properties – eg, (changing the 'Forward Voltage' of the LED from 2V to 2.5V or the resistor from 330Ω to 270Ω) you will see corresponding changes in the current.

The second, slightly simpler way of measuring voltage and current is to just add probes onto any component pin or wire. To do this, right click, select place and then either the voltage or current probes (see Fig.3). Once the simulation is run, the probes will show the current or voltage at the probe position.

Oscilloscope

On occasions you may wish to trace the voltage or a signal over a period of time. This is when the virtual oscilloscope is of use

Open the 'infrain.command dsn' sample file and re-save with a different filename. This uses a 'simulated' IR LED and IR receiver (eg, equivalent to the TSOP4840). Two

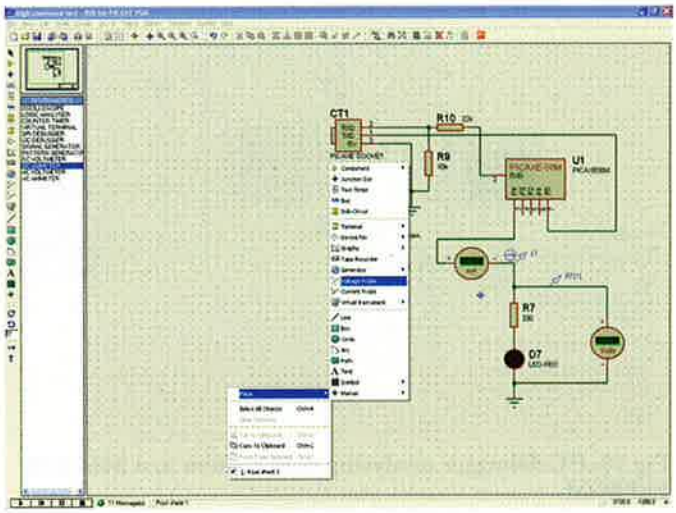


Fig.3: right-click the mouse to add voltage and current probes.

channels of the oscilloscope are connected across the LED output and the receiver output.

When run, the oscilloscope display panel will appear on screen, showing the trace from the two channels. As can be seen from Fig.5 the top LED trace clearly shows the modulating signal, while the receiver trace shows the demodulated inverted output! The virtual oscilloscope includes all controls that you would expect to find on a real device, and so the position, timebase etc can all be adjusted as you require.

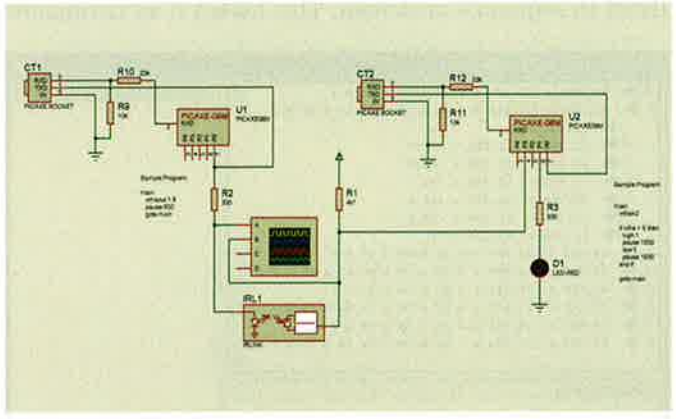


Fig.4: two PICAXE chips communicating via a simulated infrared link.

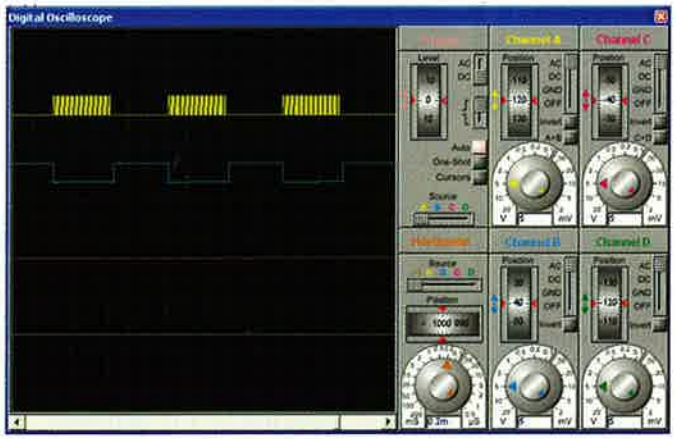


Fig.5: virtual oscilloscope trace.

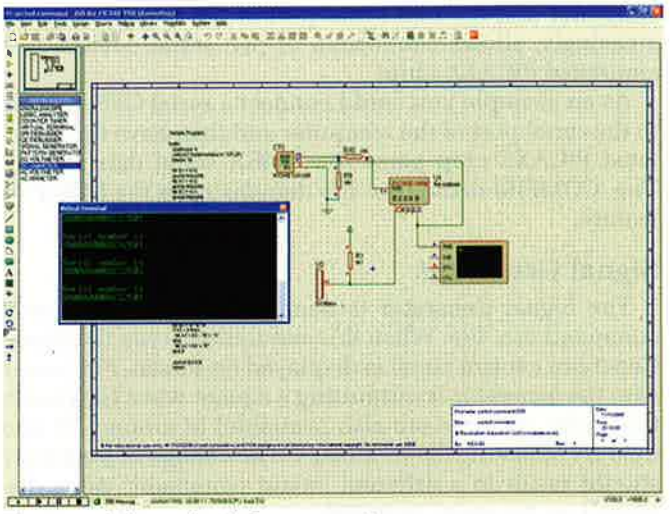


Fig:6: serial terminal demonstration.

Serial Terminal

This time take a look at the 'sertxd command.dsn' sample file. This demonstrates the 'Virtual Terminal' which acts as an RS232 serial terminal for testing programs with serial data. When run, the serial data output from the PICAXE chip is displayed on screen within the terminal window.

As with all serial systems, you do need to set the baud rate and polarity of the terminal to match the PICAXE settings (4800,n,8,1 [inverted polarity] in this case). This is carried out by right-clicking on the terminal symbol and selecting 'Edit Properties'.

COMPIM

While we are talking about serial communication it is also worth mentioning the COMPIM (COM Physical Interface Model). This 'symbol' acts as a link between the

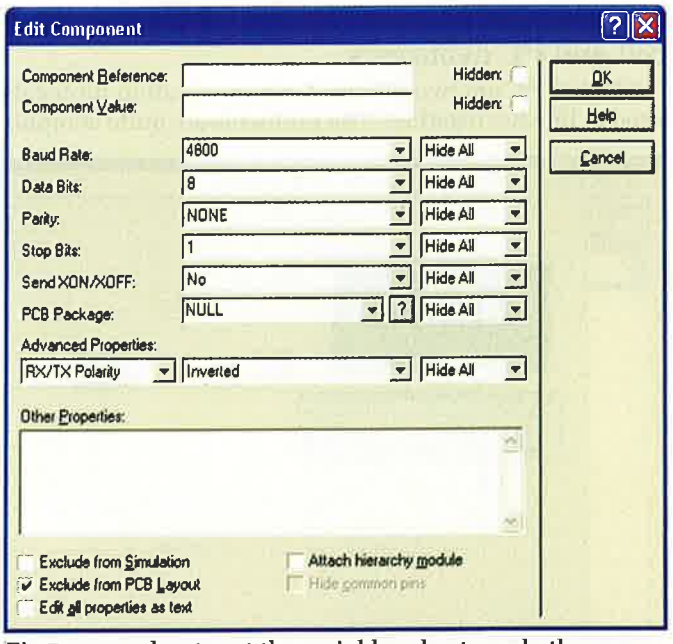


Fig.7: remember to set the serial baud rate and other parameters, or you will see corrupt characters on screen!

simulator and the real serial port of the computer. This, amazingly, allows connection of real serial devices to a simulated PICAXE chip!

As an example you could connect a serial GPS module to the serial port of the computer and then have the simulated PICAXE chip parse the NMEA serial data stream! The 'COMPIM demo.dsn' file demonstrates the COMPIM feature.

Signal Generator

The Signal Generator is demonstrated via the 'count command.dsn' file. When this simulation is run the Signal Generator control panel is displayed on screen. First make sure the generator is outputting a square wave (sawtooth, triangular and sine are also available) of around 5V and then try adjusting the frequency. The change in frequency should result in a different 'count command' value displayed on the serial terminal.

An alternate, simpler, way of applying test signals to a wire is to just drop a generator probe onto the wire (as

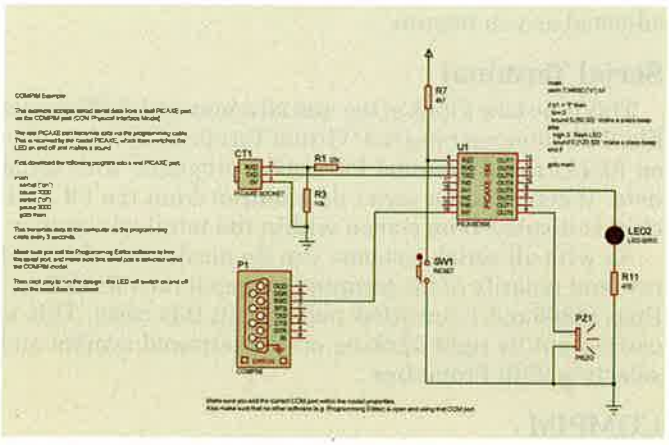


Fig.8: demonstration of the COMPIM feature.

with the voltage and current probes). This is carried out by right-clicking and selecting Place>Generator.

SPI and I²C debuggers

SPI and I²C are two different communication protocols used to link ICs together. The protocols are quite complex

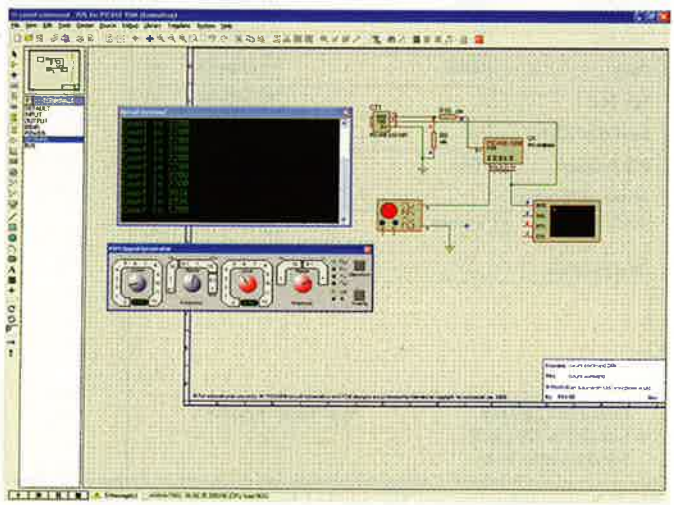


Fig.9: virtual signal generator.

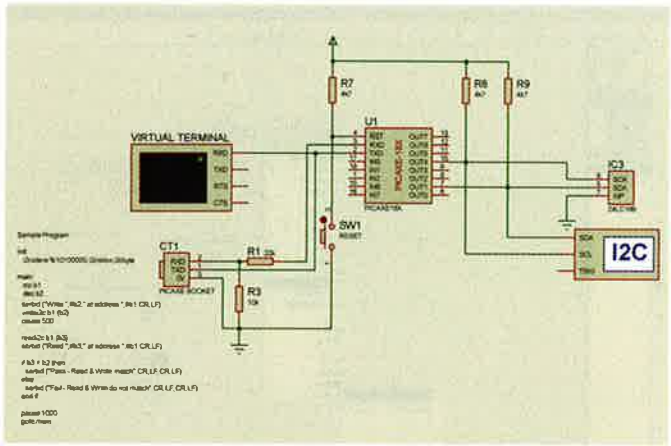


Fig.10: I²C debugger analysing data written to a 24LC16B EEPROM

but fortunately the technicalities of the protocols are taken care of automatically in the PICAXE system, via use, as an example, of the writei2c and readi2c commands.

Those interested in studying these protocols further may be interested in the function of the I²C and spi debugger instruments. For instance, the writei2c command.dsn' file demonstrates how the 'I²C debugger' instrument is connected to the I²C bus.

When the simulation is run the details of each I²C transaction – start signal (S), address (AO), data pulses, ack pulses (A), nack pulses (N), stop signals (P) etc – are clearly listed in sequence on screen. This makes it an invaluable

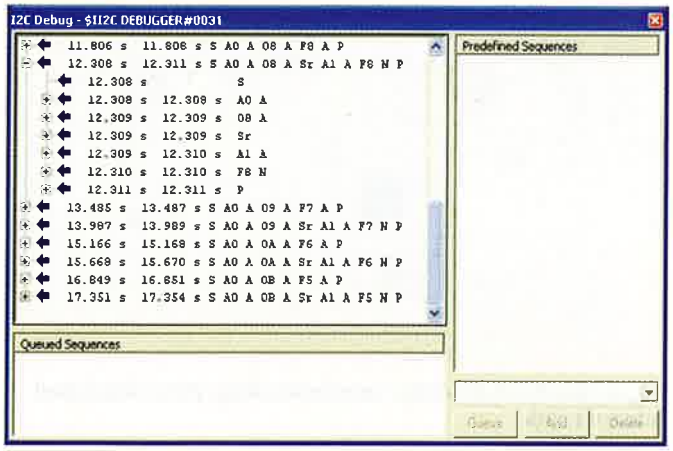


Fig.11: I²C debugger trace. This shows the time, and type, of all activity on the I²C bus

learning tool for those interested in understanding these protocols.

Summary

The software also contains a few other instruments such as a logic analyser – have a play with them! Using 'virtual simulated' instruments will never be quite the same experience as twiddling dials on real-life bench-top models but using these simulations is still a worthwhile process.

PICAXE VSM incorporates an impressive array of virtual instruments – and you certainly wouldn't be able to buy a new oscilloscope, signal generator or I²C debugger for anything like the price of a VSM licence! SC

MARCH PRE - CATALOGUE

Jaycar

SALE NOW ON!

Kits for Kids

Motorcycle Construction Kit



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

Cat. KJ-8900
$12.95

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

301 Piece Solar Construction Kit

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



Cat. KJ-8905
$29.95

- Tools included
- Motor and solar panel included
- Requires 1 x AA battery
- 10yrs+

153 Experiments in Electricity and Magnetism Kit



Learn all the basic principles behind electricity. 153 different experiments require only a 9V battery or no power at all.

Cat. KJ-8835
$39.95

- Ages 9+.
- 9V battery: SB-2423

DVR Camera Kit

The DVR is fitted with a 250GB hard drive, can accommodate up to 4 cameras with power derived from the DVR and will allow you to record and view up to 4 cameras simultaneously. Package includes the DVR with 1 dome and 1 outdoor IR camera with bracket, mounting hardware, power supply, 14m of cable, software, USB interface lead and user manual. Additional cameras sold separately.

Was $949

SAVE $250



Cat. QV-3085
$699

250GB HDD INCLUDED

Weather Station with Wireless Sensors, Computer Interface & TV Out

Set up your own weather channel or connect to your computer for storage and analysis. The indoor receiver measures the indoor temperature, humidity, atmospheric pressure and receives weather data from the outdoor thermometer-transmitter sensor, wind sensor, and rain gauge. The receiver unit has USB interface output allowing data to be uploaded to a PC or laptop and a AV output so you can view the weather data on your TV.

Was $299

SAVE $100



Cat. XC-0332
$199

2.4GHz Baby Monitor with LCD Screen & IR Colour Camera

This popular 2.4GHz wireless surveillance system has a specially designed indoor Hi-res colour CMOS camera and hand-held LCD monitor, that enables you to monitor your home, children or elderly residents even when it gets dark. You can link the monitor to a VCR to record what the camera captures or link it to a TV that has the 'Picture-in-Picture' feature to keep an eye on the baby while you watch your favourite TV show.

- 2.4 inch colour TFT-LCD screen
- Can work with up to 4 cameras
- 10 IR LED illuminator
- Hi-Res colour CMOS camera
- 4 channel selection
- Low power consumption
- 2 x PSU included
- Monitor measures 65(L) x110(H)x 23(W)mm

Cat. QC-3258
$199



NEW

USB Digital TV Stick

Watch high definition digital TV on your desktop or laptop PC for the same cost as a standard definition set-top box. Simple to set up and use, just connect the USB stick, plug in the antenna, install the software and away you go.



NEW

- Supports worldwide free-to-air DTV
- Software with time shifting and scheduled recording
- Compatible with Windows XP, ME and Vista
- Windows only - not suitable for Mac
- Antenna, cable and software included

Cat. XC-4859
$99

Mains Adaptor 12VAC 2A Unregulated

Mains Adaptor 12VAC 2A Unregulated, 7 plugs included.

- Approval number: N17582



NEW

Cat. MP-3057
$29.95

200W PA Combo Amp/Speaker

A PA system in a box. 3 channels with balanced and unbalanced inputs, RCA inputs for an auxiliary source. The ideal small PA for schools, sports organisations, churches, weddings, conferences or solo acts.

NEW

- 12" speaker
- 2 channel equaliser
- Line level RCA inputs
- Tough moulded enclosure
- Balanced and unbalanced line outs
- 200WRMS power output
- Dimensions: 600(H) x 410(W) x 325(D)mm



Cat. CS-2517
$399

Rear view

Reversing Camera Kit with Wireless Camera

Prevent Driveway Accidents

This wireless video system simply splices into the car's reversing light cable. It is automatically activated when you select reverse and gives you a clear view behind your vehicle. The camera is waterproof and can be mounted outside the vehicle.

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



Cat. QC-3725
$249

49

38 Channel 1.5W UHF Pocket Transceiver

This high-quality light-weight UHF transceiver is ideal for use in many professional and leisure activities.
- 1.5W output
- Up to 8km range
- Hi/lo power setting



Cat. QC-1049 **$59**

Dynamo Powered Splash Proof Radio with LED Torch

Compact, portable, splash proof. 90 seconds winding gives 20 minutes operation. Has provision for battery operation if desired.

Was $34.95



Cat. AR-1775 **$28.95**

SAVE $6

Dynamo Wind up LED Torch

Great gift idea for campers or hikers. Just one minute of winding will give you 30 minutes of light. Approximately 130mm long.

Was $19.95



SAVE $5

Cat. ST-3337 **$14.95**

RC Solar Pond Pump

Uses latest solar technology, requires no wiring, can be used a night and no running costs. Turns on/off via remote control.
- Squirts 50mm high
- 2 bright LEDs
- 350mm (Dia.)

Was $69.95

SAVE $15



Cat. YH-5452 **$54.95**

Mini Digital Camera Keyring

Always have a camera with you!
- 100k pixels
- Takes up to 80 photos (20 Hi-Res)
- Use as a web cam
- Includes easy-to-use software & cable

Was $19.95

SAVE $5



Cat. QC-3190 **$14.95**

Wireless Weather Stations

Be Your Own Weatherman

Anyone with a interest in the weather will love this station. It has an unbeatable range of features, it is great value, and best of all has no need for messy wiring. The system measures and displays inside and outside temperature, air pressure, rainfall, humidity, wind speed, direction, and chill factor.
- Requires 7 x AA batteries
- Indoor display unit 140(W) x 170(H) x 40(D)mm

Cat. XC-0293 **$149**



Weather Station with Wireless Sensors and Doorbell

Easy to install - no wires, no fuss. Displays full clock and calendar functions, humidity, temperature readings, barometric changes as well as an audio and visual indication when the doorbell is pressed. Can be desk or wall mounted.
- Indoor display 225(W) x 260(H) x 27(D)mm

Was $99.95

SAVE $20



Cat. XC-0336 **$79.95**

Children's Weather Station

Observe, learn and forecast the weather. This fully functional weather station is designed especially for children.
- Shows wind direction
- Measures wind speed in kph & mph
- Indicates relative humidity
- Measures temperature in Fahrenheit & Celsius degrees
- Measures rainfall in inches & centimetres
- No batteries required

Suitable for children 8yrs+ Was $49.95

SAVE $10



Cat. XC-0308 **$39.95**

Professional Grade Outdoor Garden Lighting

Quality Die Cast low voltage outdoor garden lighting range. Each fitting is die cast, powder coated and moisture sealed with neoprene gaskets. The spectacular range can be powered by 12 volt halogen lamps or a professional 24V for large installations where voltage drops would normally be a problem.

10% OFF EACH

Garden Flood Light
- Size (length including spike) 310mm.
- Dia. at globe 75mm.

Cat. SL-2770 Was $14.95 Now $13.45



Focal Spotlight/Highlighter
- Length: 320mm approx
- Dia at globe: 65mm.

Cat. SL-2772 Was $14.95 Now $13.45



General Purpose Spotlight / Highlighter
- Size 100(H) x 96(dia) mm excluding bracket and spike.

Cat. SL-2774 Was $14.95 Now $13.45

Wall Mount Step Light

This light will mount on a wall, and is ideal for lighting a path, or steps.
- Size 100(dia) x 50(D)mm.

Cat. SL-2778 Was $9.95 Now $8.95



Pathway Illuminator

A stylish contemporary design used to reveal a pathway at night.
- Size 170(H)mm excluding spike which is 160(L)mm
- Dia 60mm.

Cat. SL-2780 Was $16.95 Now $15.25



Flushmount Illumination

This lamp is designed to be embedded into a path or walkway. It can actually be walked on.
- Size 100(H) x 96(Dia)mm.

Cat. SL-2776 Was $14.95 Now $13.45



Pagoda Light
- Size 300(H)mm excluding spike
- Dia 140mm.

Cat. SL-2784 Was $19.95 Now $17.95

MORE INFO AVAILABLE ONLINE

Mini Head Torch 3 Super Bright LEDs

Excellent for outdoor activities.
- Requires 2 x AAA batteries
- Weatherproof and digitally controlled
- Brightness levels 100% & 50%
- 3 super bright LEDs
- Flashing mode for emergencies.

Was $19.95

SAVE $5



Cat. ST-3288 **$14.95**

Mini Head Torch with 6 Super Bright LEDs also available

Was $19.95

Cat. ST-3282 **$14.95**

SAVE $5

Jumbo Display Indoor/Outdoor Thermometer with Memory

This thermometer has one LCD that shows both the inside and outside temperatures simultaneously. It will record the minimum and maximum temperatures that are reached. The outside temperature sensor is waterproof and is on 3 metres of very thin cable, which helps when putting through a window seal. Has a tilting bail for standing as well as a screw hole for wall mounting.



- Reads both °F/° C, selectable with switch
- Measuring range: -39.9°C to 49.9°C
- -39.8°F to 122°F
- Size: 110(H) x 100(W) x 22(D)mm
- Operates with AAA battery (supplied)

Was $35

SAVE $7

Cat. QM-7205 **$28**

7 LED Diving Torch

This torch is waterproof to 30m, and is very light and small. It features 7 high brightness Japanese made white LEDs. There is a rubber hand grip and rubber head which incorporates the rotary on/off switch, as well as a lanyard.

Was $19.95



SAVE $5

Cat. ST-3076 **$14.95**

LED Safety Band

Traffic and other hazards can see you coming from afar.
- Four red LEDs
- Adjustable 30mm wide Velcro band
- Flashing or steady lighting mode
- Visible up to around 300m

Was $9.95



SAVE $5

Cat. ST-3026 **$4.95**

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

Speakers

Wide range of speakers available for a multitude of home or car audio projects



HOME AUDIO

6" Polycone Woofer

- Nom impedance: 8 ohms
- Power handling: 30WRMS

Was $24.95

SAVE $5

Cat. CW-2108 **$19.95**

8" (200mm) Paper Cone Woofer

- Nom impedance 8 ohms
- Power handling 30WRMS

Was $24.95

SAVE $5

Cat. CW-2110 **$19.95**

10" (250mm) Paper Cone Woofer

- Nom impedance 8 ohms
- Power Handling 40WRMS

Was $29.95

SAVE $5

Cat. CW-2119 **$24.95**

6.5" Driver

Is capable of astounding bass extension. It will deliver incredibly deep bass that matches bigger sized woofers in a good enclosure design. Suitable for Hi-Fi or home theatre applications.

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



Cat. CW-2154 **$89.95**

CAR AUDIO

NEW

4" Kevlar/Dome Tweeter Coaxial Car Speakers

New and improved! These Kevlar® cones are now paired with soft dome tweeters that provide cleaner and crisp sounds while maintaining natural and smooth balance. The 12dB octave crossover are now integrated into the speaker.

- Nominal impedance: 4 ohms
- Power handling capacity: 40WRMS
- Dimensions: A 102 B 90 C 47



Cat. CS-2370 **$79.95**

7" TFT Touch Screen VGA Monitor

Not only will you be amazed at the high resolution and audio clarity of this unit, but the added feature of touch screen capabilities enables use with a laptop/PCs, games consoles and endless other VGA operate devices.

Was $499



Cat. QM-3749 **$449**

SAVE $50

Economy Car Alarm

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

- Includes
- Electronic black box controller
- Shock sensor
- Ignition cut-out relay
- Wiring looms



Was $89

Cat. LA-9000 **$79**

SAVE $10

MP3 Player Cassette Adaptor

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

- Built-in 3.7V 250mAh battery
- Supports SD, mini SD and MMC cards



SAVE $20

Cat. AR-1764 **$49.95**

Was $69.95

DIY Kits

Ref: High Performance Electronic Projects for Cars - Silicon Chip Publications.

Speedo Corrector MkII



When you modify your gearbox, diff ratio or change to a large circumference tyre, it may result in an inaccurate speedometer. This kit alters the speedometer signal up or down from 0% to 99% of the original signal. With this improved model, the input setup selection can be automatically selected and it also features an LED indicator to show when the input signal is being received. Kit supplied with PC with overlay and all electronic components with clear English instructions.

Cat. KC-5435 **$49.95**

Economy Adjustable Temperature Switch



If you don't need the display, or the huge operational range of the High Range Adjustable Temperature Switch with LCD, then this unit is a great alternative. It has an adjustable switching temperature up to 245°C, and it can be configured to trigger with rising or falling temperature. It has adjustable hysteresis (the difference between on/off temp) which is a great feature many other units do not possess. It can be used to operate cooling fans on a radiator or amplifier, over-temp warning lights or alarms, and much more. The small temperature sensor reacts quickly to temp changes. Kit supplied with PCB, NTC Thermistor, & all electronic components.

Cat. KC-5381 **$29.95**

Auto Savings

2 Farad Capacitor with Coloured LED Display
Cat. RU-6751
Was $149.00 Now $129.00
Save $20.00

1 Farad Capacitor with coloured LED Display
Cat. RU-6752
Was $99.95 Now $89.95
Save $10.00



RU-6752

Digital Tachometer
Cat. QM-1448
Was $69.95 Now $59.95
Save $10.00

Alcohol Breath Tester Key Chain
Cat. QM-7293
Was $39.95 Now $29.95
Save $10.00



QM-1448

iPod® Car Charger
Cat. MB-3650
Was $19.95 Now $14.95
Save $5.00

Auto Current Tester
Cat. QP-2251
Was $29.95 Now $24.95 Save $5.00

Car Voltage Meter/In-Out Thermometer/Clock
Cat. XC-0116
Was $39.95 Now $29.95 Save $10.00

Car Voltage Meter with Clock & Stopwatch
Cat. XC-0118
Was $34.95 Now $24.95
Save $10.00



XC-0118

LED Globes for Vehicles

Ideal replacements for your vehicles incandescent lamps. • 12 volt

Note: Only suitable for show or off road use.

19 x White for car stop/tail lamp	ZD-0311
19 x Red for car stop/tail lamp	ZD-0316
19 x Yellow for car indicators	ZD-0317
19 x White for car indicators	ZD-0319
19 x Red for car tail (bayonette) lamp	ZD-0318

Cat. ZD-0311 **$19.95**

Cat. ZD-0319 **$19.95**

Cat. ZD-0316 **$14.95**

Cat. ZD-0318 **$9.95**

Cat. ZD-0317 **$14.95**



120A Auto Circuit Breakers

These circuit breakers feature a 3 digit LED voltage display so you can keep an eye on the battery's condition, a status LED which will illuminate only when there is a complete connection. High quality screw down connections.

SZ-6002
Accepts: 1 x 0 gauge in
1 x 0 gauge out.
Power Handling: 120 Amps
Dimensions: 45(H) x 100(W) x 45(D)mm



Was $39.95

Cat. SZ-6002 **$34.95**

$5 OFF

SZ-6004
Accepts: 1 x 4 gauge in
2 x 8 gauge out
Power Handling: 2 x 60 Amps
Dimensions: 45(H) x100(W) x 70(D)mm



Was $44.95

Cat. SZ-6004 **$39.95**

$5 OFF

Dome & Ribbon Tweeters - Home Audio

NEW

Dome Tweeters

These tweeters offer great versatility and cater for just about any application. They feature ferrofluid injection cooling which increases power handling and greatly reduces failure to high thermal transients. Three models available

- CT-2005 19mm Shielded Dome Tweeter
- CT-2007 25mm Titanium Dome Tweeter
- CT-2009 25mm High Performance Dome Tweeter



Cat. CT-2005 **$19.95**

Cat. CT-2007 **$24.95**

Cat. CT-2009 **$34.95**

Response Ribbon Tweeter

Ribbon tweeters are renowned for their smooth, natural response. Fast transient response, neodymium magnet, Kapton voice coil.

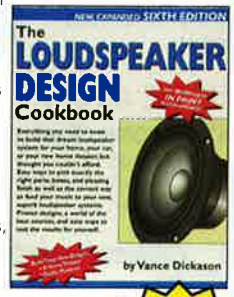
- Nominal impedance: 6 ohms
- Power handling: 10 WRMS
- Sensitivity: 92 dB 283mV @ 1m
- Recommended crossover frequency: >2500Hz

Cat. CT-2032 **$49.95**



Loudspeaker Design Cookbook Sixth Edition

The sixth edition of this world famous loudspeaker design "Bible" as used by manufacturers and amateurs alike! Totally updated and revised chapters, significantly more chapter footnote references and explanatory graphs. Includes new tutorials on woofer design, curvilinear vents, a brand new chapter on transmission line enclosures, CAD software, in car sound and 2 fully documented speaker designs. Will teach you all you need to know to design, construct and test loudspeakers for your home stereo, home theatre and car.



SAVE $20

- 233 pages
- Softcover

Was $69.95

Cat. BA-1409 **$49.95**

Speaker Surround Kits

8" Speaker Surround Kit CF-2791 $19.95
- 2 x 8 inch rubber surrounds
- 10ml bottle of special glue

10" Speaker Surround Kit CF-2792 $29.95
- 2 x 10 inch rubber surrounds
- 10ml bottle of special glue

12" Speaker Surround Kit CF-2793 $39.95
- 2 x 12 inch rubber surrounds
- 10ml bottle of special glue

FROM **$19.95**



Universal Crossover PC Boards

Build Your Own Crossovers

These 2 and 3 way crossover printed circuit boards have been designed as a versatile method of building your own customised crossover that will suit just about any speaker system. They can be used on 4 or 8 ohm speakers, and even with a combination of both. They can be wired to give a max. of 12dB per octave, or by leaving some components out, they could be 6dB or a combination of both. Full instructions on how to select the various components for different crossover frequencies are included, as well as an attenuation table for tweeters.



2 Way CX-2605 **$13.95**

3 Way CX-2606 **$17.50**

2 x 100 WRMS Stereo Amplifier with Remote Control

This is a good looking, no-nonsense stereo amplifier that is rated at a generous 100 watts RMS per channel and will form the heart of an impressive stereo system.



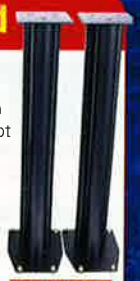
- Inputs for Mic, Tape, Tuner, AV1, AV2, CD, Phono
- Approx 420mm wide

Cat. AA-0470 **$199**

Speaker Stand

These speaker stands are made of tough, steel construction, featuring three strong tubular supports and can be filled with dry sand and/or lead shot with a suitable sealant applied to the base to prevent leakage. Produce a cleaner, more lively sound from your existing speakers.

- Dimensions:
- Base Plate - 280(D) x 210(W)mm
- Speaker Plate - 210(D) x 170(W)mm
- Height: 400mm
- Black in colour • Sold as a pair



Cat. CW-2845 **$99**

Build Your Own Speakers

Essential for multi driver speaker systems

2 WAY SPEAKER CROSSOVERS

3500Hz/6dB	Cat. CX-2614	$10.50
3500Hz/12dB	Cat. CX-2612	$16.95
5000Hz/6dB	Cat. CX-2613	$10.50

3 WAY SPEAKER CROSSOVERS

800-5000Hz 6dB	Cat. CX-2615	$16.50
700-53500Hz 12dB	Cat. CX-2618	$34.95
1200-5000Hz 12dB	Cat. CX-2621	$57.50

Accessories to finish off your Speakers

SPEAKER EQUIPMENT FITTINGS

Speaker Cabinet Spikes Cat. HS-8002 $10.95
- Pack of 4 for 1 speaker box only

Strap Handle Cat. HS-8022 $4.95
- Rubber strap is reinforced with steel
- Total length 255mm x 27mm

Cabinet Handle Cat. HS-8010 $9.95
- Dimensions 165(W) x 210(L)mm

Metal Cabinet Handles
- Recessed handle, rubber grip & spring return

Silver Cat. HS-8015 $13.95ea

Black Cat. HS-8016 $13.95ea

Flared Speaker Box Cat. CX-2688 $4.95
- Flared to minimise air turbulence

Angled Sub-woofer Cat. CX-2685 $14.95
- Angled at 30° to use in confined spaces

Grey Speaker Carpet Cat. CF-2757 $19.95
- Size 1m x 1.4m x 2mm

Black Speaker Carpet Cat. CF-2755 $34.75
- Size 1m x 1.8m x 3mm

Spray-on Contact Adhesive Cat. NA-1504 $14.95
- 400g • Great for laying speaker carpet in/on speaker cabinets

Grille Cloth 1.5 x 1m Cat. CF-2752 $17.50
- Protects expensive drivers
- Allows all sound to get through

Speaker Sealant 2m Cat. CF-2762 $5.45
- Gets airtight seals between drivers and cabinets

Passive Direct Injection Box

One of the most useful and versatile audio tools available, this DI Box is indispensable in providing easy interfacing and connection between a variety of audio equipment in numerous applications.



Cat. AA-0402 **$19.95**

- Perfect for all live sound, permanent installations - club, church and practice PA systems, monitor systems, home and project recording studios, karaoke and DJ sound systems.
- Rugged, roadworthy, all-steel construction will give years of continuous reliability.

Five Way Speaker Switch

Allows up to five pairs of stereo speakers to be connected to any Hi-Fi system. Each pair of speakers cay be individually turned on or off in any combination. Also features a separate headphone socket.



Cat. AC-1643 **$29.95**

Kits

Theremin Synthesiser Kit

The Theremin is a weird musical instrument that was invented early last century but is still used today. The Beach Boys classic hit "Good Vibrations" featured a Theremin. By moving your hand between the antenna and the metal plate, you create strange sound effects like in those scary movies. Kit includes a machined, silk screened, and pre-drilled case, circuit board, all electronic components and clear English instructions.



Cat. KC-5295 **$59.95**

Three Stage FM Transmitter

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

- Requires 9V battery



Cat. KJ-8750 **$19.95**

FOR INFORMATION AND ORDERING

TELEPHONE> 1800 022 888 INTERNET> www.jaycar.com.au

8-Zone 2-Partition Alarm Panel

8 protection zones and 2 zones for panic and duress alarms. Designed for home and office protection, the system gives local alarm warnings. Supplied with one alarm control panel and one master control keypad. Programmable user codes, delays and alarm duration.

Specifications:

- Operating voltage: 16.5VDC
- Entry delay: 15 - 90 seconds
- Exit delay: 60 seconds
- Alarm duration: 3 - 5 minutes or unlimited
- Alarm outputs: 12VDC, 2.5A
- Dimensions: Control panel - 168(W) x 168(H) x 78(D)mm
- Keypad - 117(W) x 117(H) x 27(D) mm
- Suitable backup battery: 12V, 7.2Ah available separately - SB-2486
- Suitable 17VAC plugpack: MP-3022

Cat. LA-5361 **$199**

NEW



Due Mid March

Security Accessories to Enhance your Alarm System

AV-Gad Brako Glass Breakage Sensor Detects shock signal and glass breaking for a false alarm-free glass break detector	Cat. LA-5550	$59.00
Eyespy 11 PIR with Auto Temp Compensation Increased performance in warm temperatures and reduced false alarms in cold temperatures	Cat. LA-5532	$49.95
Plastic Siren Cover Rust proof and protects an external siren speaker from tampering. Has pre-drilled holes for strobe mounting and an internal speaker bracket.	Cat. LA-5112	$19.95
12 Volt Photoelectric Smoke Detector This unit is ideal for permanent wiring in boats, caravans or motorhomes etc. Fitted with N.O & N.C. contacts to trigger an external alarm.	Cat. LA-5045	$19.95
Dual Infra-Red & Microwave Motion Detector This dual technology sensor provides the highest detection reliability by combining both IR and microwave motion detectors in one compact and attractive unit.	Cat. LA-5039	$79.95
NO & NC Reed Switch and Magnet You have both types of contacts on the one unit. Normally open (NO) and normally closed (NC) per pair.	Cat. LA-5070	$6.25
Flush Mount Piezo Siren Modern day replacement for the traditional top hat screamer. Mounts flush in the ceiling making it less noticeable. Output: 108dB @ 1m 47mmdia.	Cat. LA-5257	$12.95

Professional Surveillance Cameras - CCD Only

- **For reliable, quality installations • Fit either C or CS mount lens**
- **Feature Auto-Iris output for an Auto-Iris lens, which adjusts to widely changing lighting conditions**
- **Top and bottom mounting threads for fitting on a standard mounting bracket or indoor/outdoor enclosure**
- **Use specified regulated 12VDC plugpacks: MP-3011 - $17.95 or MP-3032 - $24.95**
- **Connections: 2.1mmID/5.5mmOD DC power socket, RCA audio socket and BNC video socket**

MORE INFO AVAILABLE ONLINE

Full range of professional surveillance DVRs 4, 8 & 16 channel with 250GB HDD From $499

B&W CCD Camera - Pro Style



Cat. QC-3310 **$69**

SAMSUNG

High Resolution Colour with Auto-Iris



Cat. QC-3307 **$249**

SONY

Day/Night Camera with Sony Super HAD CCD Sensor



Cat. QC-3301 **$249**

SONY

Pro Style - Hi-Res ExView HAD Colour CCD Camera



Cat. QC-3299 **$290**

SONY

Quick Reference

Cat.	Type	Sensor Brand	Resolution Pixels (H x V)	Horizontal TV Lines	Min Lux	Shutter Speed (sec)	S/N Ratio	Current Draw	Weight	Dimensions (mm)	Recommended Retail Price	Recommended Power Supply
QC-3310	B&W	Samsung	500 x 582	380	0.05	1/100,000	>48dB	120mA	630g	118 x 62 x 50	$69.00	Cat. MP-3011
QC-3309	Colour	Sony HAD	500 x 582	350	0.3	1/100,000	>48dB	180mA	630g	118 x 62 x 50	$149.00	Cat. MP-3011
QC-3307	Colour	Sony HR SuperHAD	752 x 582	520	0.25	1/100,000	>48dB	160mA	290g	118 x 62 x 50	$249.00	Cat. MP-3011
QC-3810	Colour	Panasonic HR	753 x 582	480	1	1/100,000	>48dB	100mA	250g	117 x 60 x 50	$199.00	Cat. MP-3011
QC-3300	Colour	Sony SuperHAD	500 x 582	380	0.1	1/110,000	>48dB	250mA / 3W	610g	130 x 60 x 51	$199.00	Cat. MP-3032
QC-3301	Colour	Sony HR SuperHAD	752 x 582	470	0.2	1/110,000	>48dB	290mA / 3.5W	610g	130 x 60 x 51	$249.00	Cat. MP-3032
QC-3298	Colour	Sony ExView HAD	500 x 582	380	0.05	1/110,000	>48dB	295mA / 5W	610g	130 x 60 x 51	$249.00	Cat. MP-3032
QC-3299	Colour	Sony ExView HAD HR	752 x 582	470	0.07	1/110,000	>48dB	295mA / 5W	610g	130 x 60 x 51	$299.00	Cat. MP-3032

Security

Installing Home Security Systems Book



Installing home security can be a daunting task but this guide will almost certainly save you time and frustration. It clearly explains how to plan positioning of motion detectors for maximum efficiency, how to identify potential entry points for thieves, using sensors and switches plus basic cabling and installation. If you're looking to purchase and install an alarm for the first time, this guide is essential reading. A4 8 pages.

Cat. BI-8205 **$2.00**

Large Alarm Sticker

Cat. LA-5102 **$2.25**



Oval Alarm Window Sticker

Cat. LA-5104 **$2.95**



2.4GHz Transmitter for Video Cameras



This compact transmitter simply plugs in-line with an ordinary security camera and turns it into a wireless unit which can broadcast on one of four standard channels. The transmitter operates with all cameras that have a BNC signal socket and uses the camera's existing power supply, eliminating additional wiring.

- Power jumper lead and fixed antenna included
- Measures 35(W) x 40(H) x 60(D)mm

Cat. QC-3594 **$69.95**

Commercial Grade Door Entry Beam



Ideal for use in retail and commercial environments. It has an effective range of 2 - 8 metres, so it is suitable for most entry points. Includes mains plugpack.

- Optional counter also available

Cat. LA-5193 **$89.95**

Active Matrix TFT Security Monitors



These rugged high performance TFT monitors are purpose-built for demanding security applications and feature a toughened screen to prevent damage. The monitors will accept VGA, S-Video, or composite video input and have Interlaced to Progressive scan.

- Up to 1280 line resolution
- Accepts VESA 100 mounting
- Don't confuse with cheaper non-protected LCD screens!!

Cat. QM-3419 **$549**

19" model also available
QM-3420

Cat. QM-3420 **$649**

VoIP

VoIP or Voice over Internet Protocol is a method for taking analogue signals and turning them into digital data that can be transmitted over the Internet. Perhaps the biggest incentives of VoIP for the home users are price and flexibility. With VoIP, you can make a call from anywhere you have broadband connectivity and by using some of the free VoIP software available you can bypass the phone company all together. Both phones compatible with Skype, MSN, Yahoo Messenger, Xten, Dialpad, MediaRing, and Net2Phone.

USB Wireless Phone

- Also use as handset for MSN and Yahoo Messenger's voice service
- Plugs into computer USB port
- Echo eliminating technology
- 30m range



Cat. XC-4958
$129.95



USB VoIP Phone with LCD & Hands Free

- Plugs straight to a spare USB port on your computer
- Mobile phone design and crystal clear sound quality
- Hands Free Function



Cat. XC-4966
$49.95

Memories on Show - 12" Electronic Photo Frame

Display your digital photos or videos with an MP3 file for background music if you like. The files can be loaded via a compatible memory card or via a USB cable (available separately) .You can control the display for individual images, a slide show or thumbnails with the remote or with the built-in keys. A huge 12.1" screen size for maximum impact.

- Supports SM, SD, XD, MS & MMC Cards
- PSU supplied

Cat. QM-3774
$349.95



VGA to VIDEO Converter

Use your TV as a computer monitor. Great for watching DVD movies, PC gaming, presentations, educational applications or Internet viewing on TV.

- No software required

Was $99.95



SAVE $10

Cat. XC-4870
$89.95

3.5" HDD Enclosure with PC Button Back-Up

This tough aluminium enclosure provides 480Mbps USB2.0 high speed data transfer with hot swappable, plug and play.

- Suits most 3.5" IDE hard drives.
- One button backup software for PCs included.
- Hard drive not included

Was $59.95



SAVE $20

Cat. XC-4660
$39.95

NAS Device with Built-in BitTorrent Client



Everything you would expect from a modern network attached storage device and more! Includes a built-in BitTorrent client that can be used to download and share files over the BitTorrent network without the need to have your computer turned on.

- Hard drive not included

Cat. XC-4677
$149

Multi-Network Cable Tester with Pin out Indicator

This multi-network cable tester is designed to quickly test UTP/STP/Coaxial/Modular network cables by manually or automatically scanning the wires for continuity, incorrect wiring and polarisation. It will sequence each connection and indicate the connections via two 9-way LED bar graphs. Cables can be checked before or after installation by using the Remote Terminator (included). This ingenious cable tester also allows ground- testing of shielded twisted/pair cables.

- Main Unit: 104 x 62 x 26mm (LxWxD)
- Active Terminator: 100 x 30 x 25mm (LxWxD)
- Requires 1 x 9V battery
- Note: Not suitable for Live circuits

Was $39.95



SAVE $10

Cat. XC-5076
$29.95

Wireless Networking

More homes and offices are being networked without wires. Here's the affordable way to be part of the trend.

Book

This book covers both the MAC and PC environments and will help you set up your wireless network like the Pros. It includes hints on network security and how to prevent outside attack.

- Soft cover
- 560 pages



Cat. BP-7100
$49.95

Router

This router allows communication with up to four wireless and networked computers. It includes support for WAN, web based and remote management, auto detection and configuration of ISP, built in firewall, and more!

- Static and dynamic routing
- VPN pass through

Was $129.95



SAVE $50

Cat. YN-8086
$79.95

A range of wireless networking cards to suit all computers and provisions.

Common specifications:

- IEEE 802.11g wireless network compatible. Interoperation with IEEE 802.11b 11Mbps networks
- 64 / 128 Bit WEP encryption
- 54Mbps high speed transfer rate
- 40 - 100m indoor range
- 100 - 300m outdoor range
- Low power consumption
- Plug and Play compatible
- Compatible with Win98SE/2000/ME/XP

USB 2.0 Wireless Network Adaptor

Was $49.95



SAVE $10

Cat. YN-8067
$39.95

PCMCIA Wireless Network Adaptor

Was $49.95



SAVE $10

Cat. YN-8068
$39.95

PCI Wireless Network Adaptor

Was $49.95



SAVE $15

Cat. YN-8066
$34.95

Pro Computer Tool Kit

The ideal kit for the computer service professional. Includes

- 3 solder aid tools
- Chrome vanadium screwdrivers
- Crimping tool
- Shifting spanner and much more!

See our website or catalogue for full listing

Was $78.95



SAVE $20

Cat. TD-2041
$58.95

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

200 Watt Wind Turbine Generators

These units are quite massive and ruggedly built. They will generate 200 watts at wind speeds as low as 8 metres per second. They will deliver useful power at a gentle 3 metre/sec breeze or give up to 300W at higher wind velocities.
There are two units available: one for 12V systems and another for 24V systems. The 12V unit has a 16V output and the 24V models has a 28V output which will charge an appropriate battery bank.
Specifications:

- Rated Power: 200 watts
- Max Power: 300 watts
- Output Voltage: 12V model: 16V
  24V model: 28V
- Output Current at Rated Power:
  12V model: 16.66A
  24V model: 8.33A
- Turbine Start Speed: 3m/s
- Max Wind Speed: 40m/s
- Rotor Dia: 2.1 metres
- No of Blades: 3
- Recommended Minimum Tower Height: 4.5 metres
- Shipping box dimensions:
  Box 1: 74 x 44 x 26cm (weight 50kg)
  Box 2: 154 x 24 x 13cm (weight 30kg)
- Total shipping weight: 80kg

Cat. MG-4510 **$499**
Cat. MG-4512 **$499**



Powertech Polycrystalline Solar Panels

Great value! Wide variety of sizes!
On electrical specifications alone, these quality polycrystalline panels not only stand up to the name brand solar panels but also feature good efficiency and panel size to power rating ratios. They also feature tempered glass protection for harsh environments, and integrated waterproof junction boxes with cable glands that are amongst the best we've ever seen.

10% OFF EACH



Voltage	Power	Cat	Was	Now
12V	5W	ZM-9071	$99.95	$89.95
12V	10W	ZM-9073	$149	$134.10
12V	20W	ZM-9074	$239	$215.10
12V	65W	ZM-9076	$549	$494.10
12V	80W	ZM-9078	$699	$629.10
12V	120W	ZM-9079	$1050	$945

Dual Stage Lead-Acid Battery Float Chargers

Fully automatic switchmode battery chargers that will efficiently charge high capacity sealed and unsealed lead acid batteries then properly maintain them. Just connect and forget.
Specifications:

Cat.	MB-3610	MB-3612	MB-3614
• Max. Current:	6A / 3A +/- 5%	12A / 6A +/- 5%	6A / 3A +/- 5%
• Wattage:	85W	160W	160W
• Equaliser Charge:	14.4V +/- 0.1V	14.4V +/- 0.1V	28.8V +/-0.2V
• Floating Charge	13.8V +/- 0.1V	13.8V +/- 0.1V	27.6V +/-0.2V
• Dimensions WxHxD:	168 x 72 x 45mm	162 x 96 x 48mm	168 x 96 x 48mm
• Weight:	650g	850g	850g
• AC input:	110/220VAC switchable 47 63Hz		
• Efficiency:	>85%		



Cat. MB-3610 **$79.95**
Cat. MB-3612 **$99.95**
Cat. MB-3614 **$99.95**

5 Volt 3400mAh Li-ion Battery Pack

Take this back-up battery pack with you and charge your digital devices when you are away from home or office. Suitable for many devices including iPod®, PSP® and mobile phones. The pack is charged via USB and includes 7 output adaptor plugs to suit the most popular digital devices.



Cat. MB-3300 **$69.95**

NOTE: iPod® and phone not included

Solar Power System with Lights

Everything you need to get a basic solar setup off the ground. All the components needed are included in the kit: 5 watt solar panel encapsulated in tempered glass, 7Ah SLA battery and 2 x 12V 5W energy saving fluorescent lights. The battery is housed in a sturdy metal enclosure with DC sockets for all the connections, so it's straightforward to set up and use.



Cat. MP-4551 **$179**

Lithium Iron Batteries

Lithium Iron (Li Fe) batteries pack 5 - 6 six times the capacity of ordinary alkaline cells and give a 40-60% cost saving when comparing energy delivered to price paid.

- SB-2364 1500mAh AAA twin pack
- SB-2366 1200mAh AA twin pack
- Ten year storage life
- 4 x battery pack also available

Note: These are not rechargeable



Cat. SB-2364 **$7.95**
Cat. SB-2366 **$7.95**

Eclipse Lithium 9V 1200mAh Batteries

Essential for smoke detectors, wireless alarms, garage remotes etc. Very dependable. For the sake of your family fit your smoke detector with Lithium batteries.
Note: These are not rechargeable



2 Pack SB-2396 **$22.95**

Wind Powered Generator Experimenters Kit

Learn all about this green energy source, and the mechanics of wind generators. It is supplied in kit form, so you get to assemble the whole thing before you start learning about how it works.



Cat. KJ-6696 **$49.95**

12 Volt Battery Charging Regulators for Solar Panels

Maintain your battery system in peak condition with one of our solar charge controllers. They are available with a range of features to suit various installations.

12V 5A



Cat. AA-0348 **$29.95**

12V 1.5A



Cat. AA-0258 **$22.95**

12V 6A



Cat. MP-3128 **$39.95**

12V 20A



Cat. MP-3126 **$74.95**

20A 12V with LCD



Cat. MP-3129 **$139.95**

Kits

PIC Based Water Tank Level Meter Kit

Ref Silicon Chip November 2007

This PIC-based unit uses a pressure sensor to monitor water level and will display tank level via an RGB LED at the press of a button. The kit can be expanded to include and optional wireless remote display panel that can monitor up to ten separate tanks (KC-5461) or you can add a wireless remote controlled mains power switch (KC-5462) to control remote water pumps. Kit includes electronic components, case, screen printed PCB and pressure sensor.



Cat. KC-5460 **$99.95**

UHF Remote Controlled Mains Switch

Ref Silicon Chip February 2008

Commercial remote control mains switches are available but these are generally limited to a range of less than 20m. This UHF system will operate up to 200m and is perfect for remote power control systems etc. The switch can be activated using the included hand held controller or our KC-5461 water tank level sensor base station. Kit supplied with case, screen printed PCB, RF modules and all electronic components.



Cat. KC-5462 **$99.95**

Telemetry Base Station for Water Tank Level Meter

Ref Silicon Chip January 2008

This Base Station is intended for use with the telemetry version of the KC-5460 water tank level meter. It has an inbuilt 433MHz wireless receiver and can handle data transmissions from up to 10 level meters and display the results on a 2-line 32-character LCD module. Kit includes electronic components, case, screen printed PCB and RF module.



Cat. KC-5461 **$79.95**

Save on Digital Multimeters

Computer Connect Auto Range DMM

With the ability to analyse and store information on your home or notebook computer, this meter is ideally suited to laboratory or fieldwork. The software features data logging, with information displayed on a graph or simple list. When recording, you have the option of recording continuously or in preset time gaps. Min/max/avg information can also be displayed. The information can be exported to spreadsheet programs such as Excel for further analysis.

- 3.7 Digit
- Diode Test
- 10 Amp AC & DC current
- Data Hold
- Software included

Was $39.95

SAVE $10



Cat. QM-1538 **$29.95**

Sensational Value DMM

Excellent budget digital multimeter packed with features.

- 3.5 Digit
- 12.5mm high LCD
- Transistor test
- Diode test
- 10 Amp current
- Plug-in leads



Cat. QM-1500 **$7.95**

AC/DC Current Clamp Meter

Ideal for car stereo installations and electrical trades people.

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

Was $139.95

SAVE $40



Cat. QM-1562 **$99.95**

QM-1564 Mini AC/DC Current Clamp Meter with Non-contact Voltage Sensor available separately **Was $99.95 Now $79.95 Save $20.00**



SAVE $50

QM-1290



SAVE $40

QM-1462



SAVE $15

QM-1539



SAVE $20

QM-1541

Description	Cat.	Safety Category	Display	Features	Was	Now
Protek 506	QM-1290	Cat III 600V	4000 Count	20A Current, TrueRMS, RS232	$198.00	$148.00
USB Computer Connect	QM-1462	Cat IV 600V	4000 Count	20A Current, USB Interface	$139.95	$99.95
IP67 Harsh Environment	QM-1541	Cat IV 600V	4000 Count	Large Display, IP67	$99.95	$79.95
Cat III DMM	QM-1539	Cat III 600V	4000 Count	Large Display	$59.95	$44.95

See our website or ask in-store for full specifications

YOUR LOCAL JAYCAR STORE
Australia Freecall Orders: Ph 1800 022 888

NEW SOUTH WALES

Albury	Ph (02) 6021 6788
Alexandria	Ph (02) 9699 4699
Bankstown	Ph (02) 9709 2822
Blacktown	Ph (02) 9678 9669
Bondi Junction	Ph (02) 9369 3299
Brookvale	Ph (02) 9905 4130
Campbelltown	Ph (02) 4620 7155
Erina	Ph (02) 4365 3483
Gore Hill	Ph (02) 9439 4799
Hornsby	Ph (02) 9476 6221
Newcastle	Ph (02) 4965 3799
Parramatta	Ph (02) 9683 3377
Penrith	Ph (02) 4721 8337
Rydalmere	Ph (02) 8831 3151
Silverwater	Ph (02) 9741 8557
Sydney City	Ph (02) 9267 1614
Taren Point	Ph (02) 9531 7033
Tweed Heads	Ph (07) 5524 6566
Wollongong	Ph (02) 4226 7089

VICTORIA

Coburg	Ph (03) 9384 1811
Frankston	Ph (03) 9781 4100
Geelong	Ph (03) 5221 5800
Melbourne	Ph (03) 9663 2030
Ringwood	Ph (03) 9870 9053
Springvale	Ph (03) 9547 1022
Sunshine	Ph (03) 9310 8066
Thomastown	Ph (03) 9465 3333

QUEENSLAND

Aspley	Ph (07) 3863 0099
Cairns	Ph (07) 4041 6747
Ipswich	Ph (07) 3282 5800
Maroochydore	Ph (07) 5479 3511
Mermaid Beach	Ph (07) 5526 6722
Townsville	Ph (07) 4772 5022
Underwood	Ph (07) 3841 4888
Woolloongabba	Ph (07) 3393 0777

AUSTRALIAN CAPITAL TERRITORY

Belconnen	Ph (02) 6253 5700
Fyshwick	Ph (02) 6239 1801

TASMANIA

Hobart	Ph (03) 6272 9955

SOUTH AUSTRALIA

Adelaide	Ph (08) 8231 7355
Clovelly Park	Ph (08) 8276 6901
Gepps Cross	Ph (08) 8262 3200

WESTERN AUSTRALIA

Maddington	Ph (08) 9493 4300
Northbridge	Ph (08) 9328 8252

NORTHERN TERRITORY

Darwin	Ph (08) 8948 4043

NEW ZEALAND

Christchurch	Ph (03) 379 1662
Dunedin	Ph (03) 471 7934
Glenfield	Ph (09) 444 4628
Hamilton	Ph (07) 846 0177
Manukau	Ph (09) 263 6241
Newmarket	Ph (09) 377 6421
Palmerston Nth	Ph (06) 353 8246
Wellington	Ph (04) 801 9005
Freecall Orders	Ph 0800 452 9227

Jaycar Electronics

SILICON CHIP
www.siliconchip.com.au

Order Form/Tax Invoice

Silicon Chip Publications Pty Ltd
ABN 49 003 205 490

YOUR DETAILS

Your Name_____
(PLEASE PRINT)

Organisation (if applicable)_____

Address_____

_____

Postcode_____ **Daytime Phone No. (** **)**_____

Email address (if applicable)_____

Method of Payment:

❑ Cheque/Money Order ❑ Visa Card ❑ Master Card

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

Card expiry date: |_|_| |_|_|

Signature_____

PRICE GUIDE: SUBSCRIPTIONS

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

Please state month to start.

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

PRICE GUIDE: OTHER PRODUCTS

(all prices include GST on Aust. orders)

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

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

*BINDERS: BUY 5 or more and get them postage free. (Available in Aust. only): $A13.95 each plus $7 p&p per order.

*ELECTRONICS PROJECTS FOR CARS, VOL.2: Aust. $A14.95; Overseas $A18.00. (Prices include p&p & GST where applicable).

*PERFORMANCE ELECTRONICS FOR CARS: Aust. $A22.50; Overseas $A26.00. (Prices include p&p & GST where applicable).

SUBSCRIBERS QUALIFY FOR 10% DISCOUNT ON ALL SILICON CHIP PRODUCTS*

* except subscriptions/renewals

Qty	Item Description	Item Price	P&P if extra	Total Price
Total			$A	

BUY 10 OR MORE BACK ISSUES & GET A 10% DISCOUNT

Subscribe to SILICON CHIP on-line at: www.siliconchip.com.au
Both printed and on-line versions available

TO PLACE YOUR ORDER

Phone (02) 9939 3295
9am-5pm Mon-Fri
Please have your credit card details ready

OR

Fax this form to (02) 9939 2648
with your credit card details
24 hours 7 days a week

OR

Mail this form, with your cheque/money order, to:
Silicon Chip Publications Pty Ltd
PO Box 139, Collaroy, NSW
Australia 2097

← 49

A Digital VFO with Graphics Display

This DDS VFO uses a widely available recycled Nokia cellular phone LCD to display analog and digital frequency readouts, text, and VFO status messages

For several years, I've wanted to build my own DDS (Direct Digital Synthesis) VFO (Variable Frequency Oscillator).

Analog Devices makes one of the most popular ranges of DDS chips which digitally generate precise sine waves covering frequencies from practically "DC to daylight"; well, up to many hundreds of MHz.

Some time ago I managed to obtain several samples but, for some time afterwards, that was as far as things went. I was just too busy with work and family to devote any time to the project.

In addition, I couldn't locate a suitable design to build. Practically all existing designs use one of the PIC microprocessor family. Others use several PIC microprocessors; yet others use a further large bunch of ICs to interface displays and keypad functions. With my microprocessor development tools all focused on the 8051 family – and being fundamentally of a contrary nature – I was determined to use an 8051 chip in my DDS VFO rather than mess about gearing up for another microprocessor, and keep the chip count minimal.

Underlying this was a feeling that if I wrote my own software, I could customise it to suit my precise requirements and be better placed to develop one or two other DDS-based projects I have in mind. Of course, that naively assumes I'll find the time to complete those new designs.

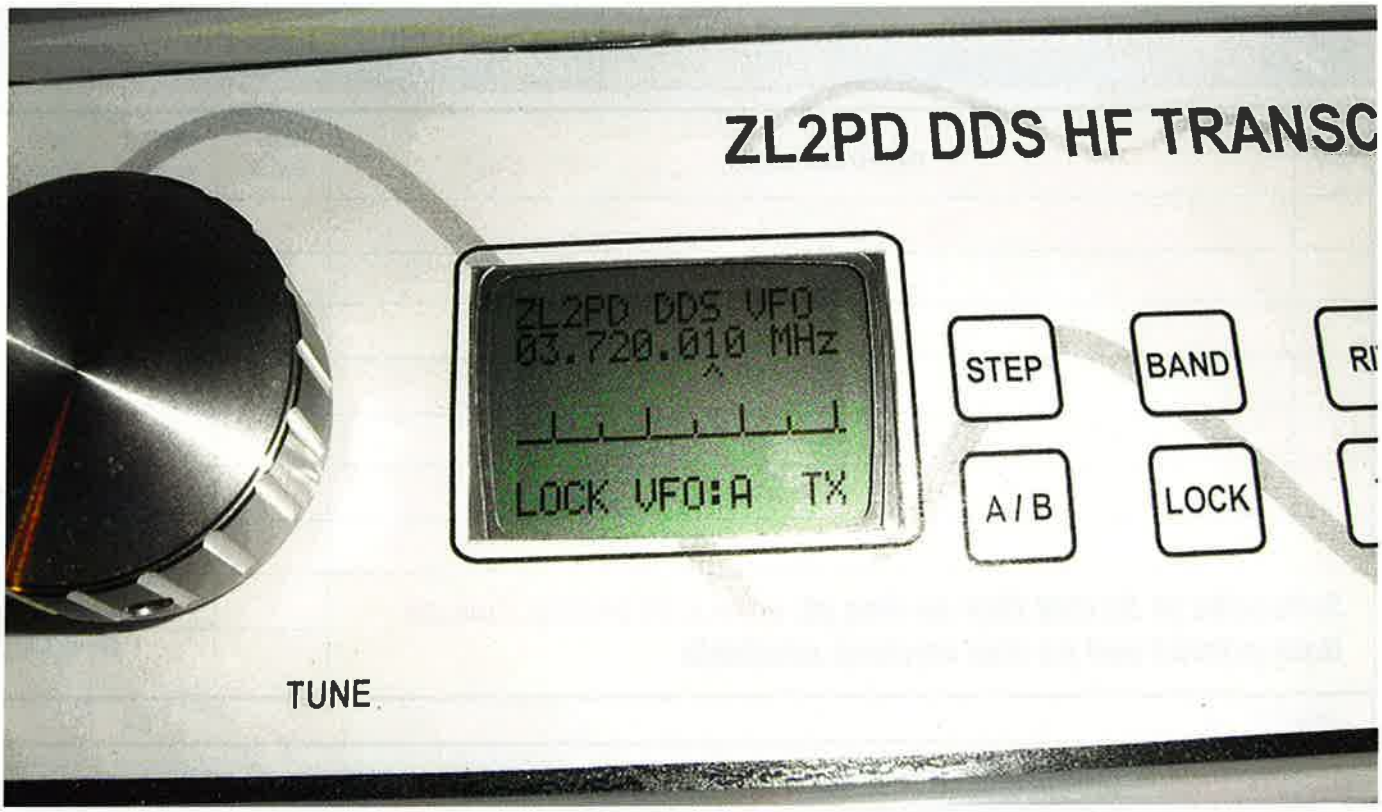


Fig.1: the promise of things to come? The DDS VFO with its cellular phone "readout" mounted inside an HF transceiver the author is currently working on . . .

n LCD

by Andrew Woodfield
ZL2PD

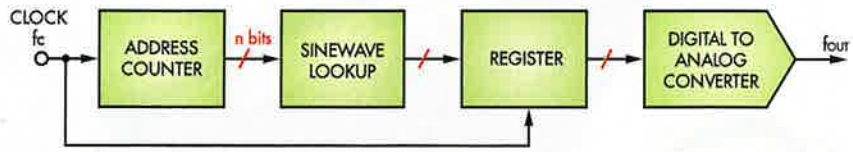


Fig.3: basic Direct Digital Synthesis system.

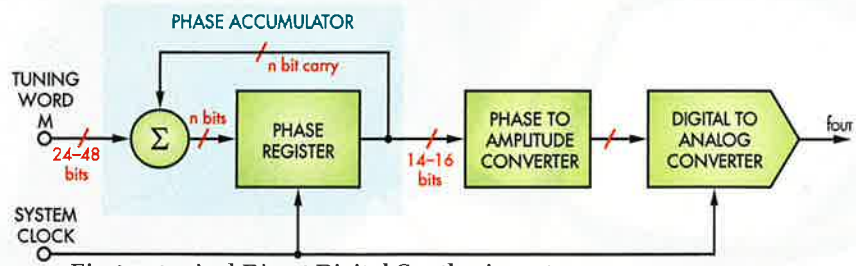


Fig.4: a typical Direct Digital Synthesis system.

Operator interface

Let's not forget the operator interface.

Practically all existing designs use a standard 2 line x 20 character alphanumeric display. An earlier popular design used high current seven segment LED displays. The size of both of these displays and the limited information presented to the operator didn't seem ideal to me.

They certainly weren't well suited for the small HF transceiver I've also been building.

This led to another delay while I looked for alternative displays and a series of experiments with some small cheap, graphical LCD modules.

These monochrome LCDs were used in many older cellular phones, as well as in some current low cost entry-level models.

I built several small projects using one of the most commonly used graphical LCDs, the Nokia 3310 LCD module. This LCD turned out to be very useful – It offers a 84 x 48 pixel display with a visible area of about 35mm x 25 mm.

DDS Oscillators

Direct digital synthesis (DDS) is a digital method to generate waveforms, usually sine waves.

In contrast to the more common phase locked loop (PLL) approach which uses a voltage controlled oscillator, digital dividers and a phase detector to generate frequencies in defined steps, data stored in an internal DDS chip table is passed to a digital to analog (D/A) converter at a specific clock rate. If the table contains values equivalent to the amplitude of a sine wave, then a sinewave at a frequency related to the clock rate will be produced.

One such basic DDS is illustrated in Fig.3.

By changing the clock speed, a wide range of sinewave frequencies can be generated. If the clock is fast enough, frequencies can readily be generated across wide ranges, and at sub-Hz increments.

The completely digital nature of the DDS oscillator and its ability to generate very fine frequency increments are the main advantages over PLLs.

In practice, a DDS device uses the arrangement shown in Fig.4. The tuning word, which is usually 32 or 48 bits wide, is used to modify a phase accumulator. This outputs a 14-16 bit word for onward signal generation.

With this approach and with a 32-bit tuning word, it is possible to generate more than 4 billion specific frequencies.

For more information on DDS chips, the introductory documents on the



Fig.2: the readout, from a Nokia cellular phone, is capable of displaying simple graphics . . .

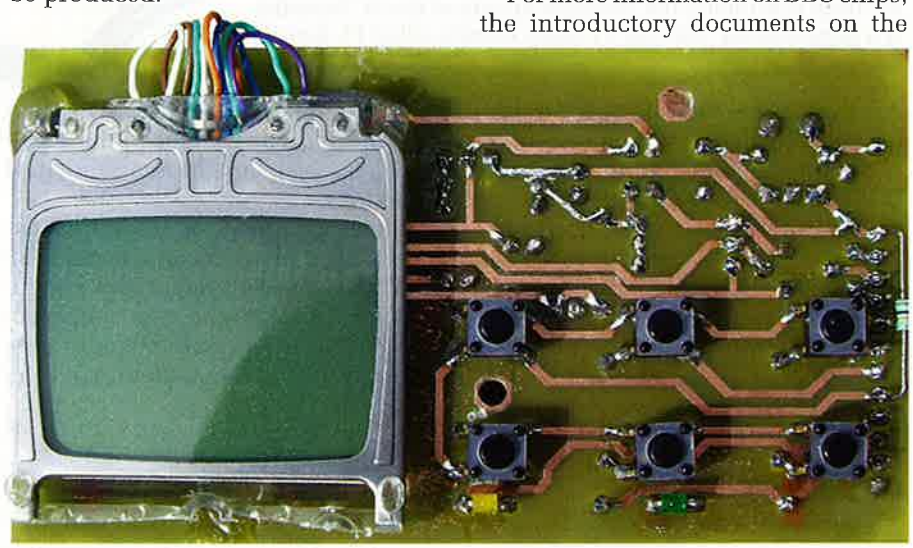


Fig.5: and here it's shown mounted on the back of the PC board, along with the six control switches. There are minor differences to the correct layout shown in Fig.8.

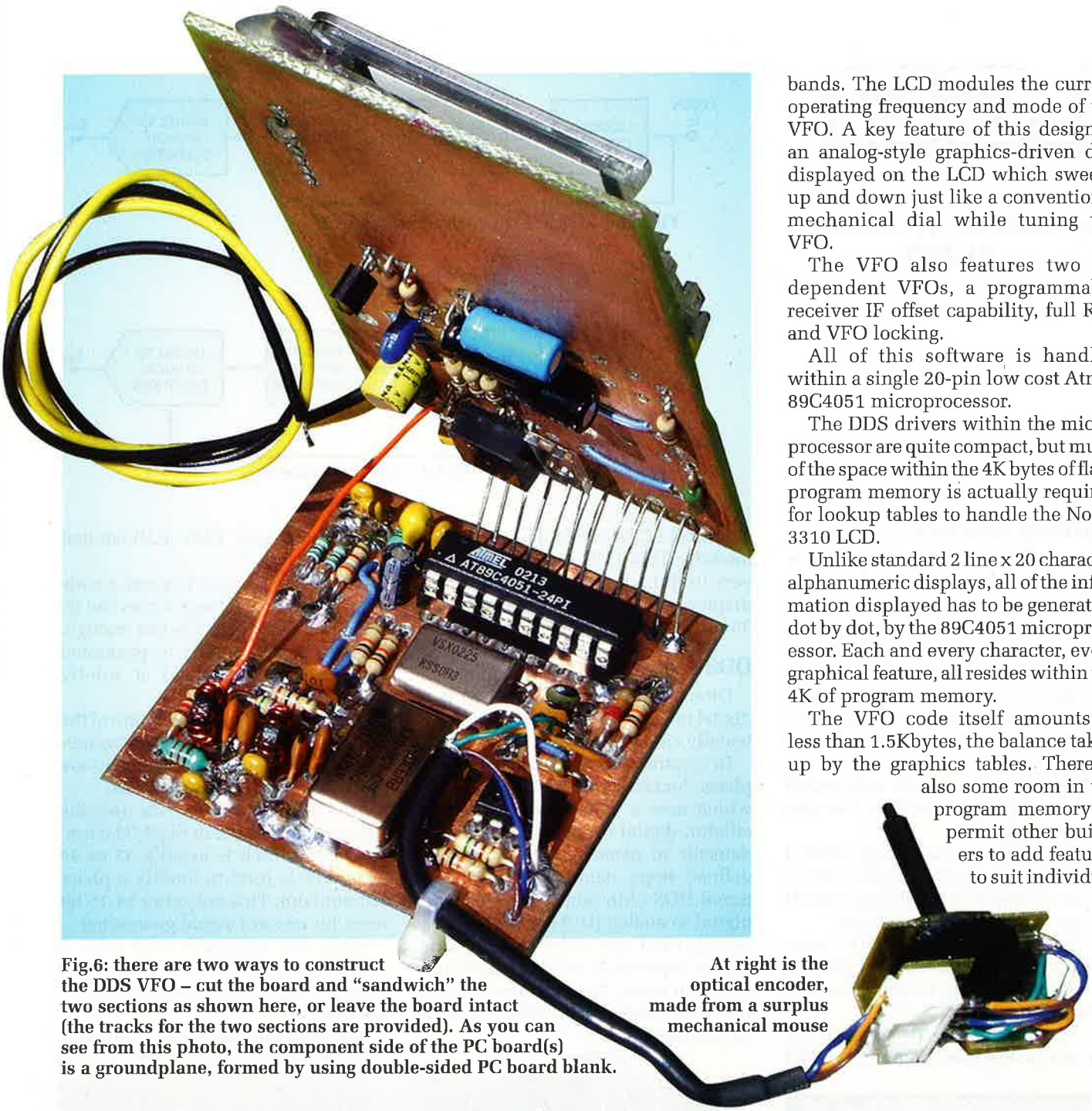


Fig.6: there are two ways to construct the DDS VFO – cut the board and "sandwich" the two sections as shown here, or leave the board intact (the tracks for the two sections are provided). As you can see from this photo, the component side of the PC board(s) is a groundplane, formed by using double-sided PC board blank.

At right is the optical encoder, made from a surplus mechanical mouse

Analog Devices website at www.analog.com are highly recommended.

The most significant problems with DDS oscillators are noise and spurious emissions. These can be minimised by using D/A converters with relatively long digital words. Many DDS devices are limited to 10-bit words but newer devices more often use 12-bit or 14-bit words.

This DDS VFO uses an Analog Devices AD9850 chip which uses a 10-bit D/A. This delivers a spurious emission level of -50dB.

Frequencies are selected using 32 bits of a 40 bit tuning word, allowing better than 0.03Hz frequency steps with the 80MHz DDS clock used in this design. The balance of the 40 bit word is used for phase and control functions.

Since this level of resolution exceeds most requirements, many DDS VFO designs use a larger step size. In this VFO design, the user can select 10Hz, 100Hz or 1kHz steps to give three tuning rates – slow, medium and fast.

Functionality

The DDS VFO covers all amateur radio bands between 160m and 10m in 10Hz, 100Hz or 1kHz increments, and will happily tune outside of these bands. The LCD modules the current operating frequency and mode of the VFO. A key feature of this design is an analog-style graphics-driven dial displayed on the LCD which sweeps up and down just like a conventional mechanical dial while tuning the VFO.

The VFO also features two independent VFOs, a programmable receiver IF offset capability, full RIT, and VFO locking.

All of this software is handled within a single 20-pin low cost Atmel 89C4051 microprocessor.

The DDS drivers within the microprocessor are quite compact, but much of the space within the 4K bytes of flash program memory is actually required for lookup tables to handle the Nokia 3310 LCD.

Unlike standard 2 line x 20 character alphanumeric displays, all of the information displayed has to be generated, dot by dot, by the 89C4051 microprocessor. Each and every character, every graphical feature, all resides within the 4K of program memory.

The VFO code itself amounts to less than 1.5Kbytes, the balance taken up by the graphics tables. There is also some room in the program memory to permit other builders to add features to suit individual requirements.

The code uses no special features of the AT89C4051 and so it may be used with almost any 8051-type processor possessing adequate memory.

One option might be the addition of country-specific frequencies, for example, not currently supported by the present VFO software. To that end, the fully commented source code is available from my website, as well as the Intel hex file for direct programming of blank microprocessors.

The Design

In contrast to other designs, this DDS VFO design is almost minimal-

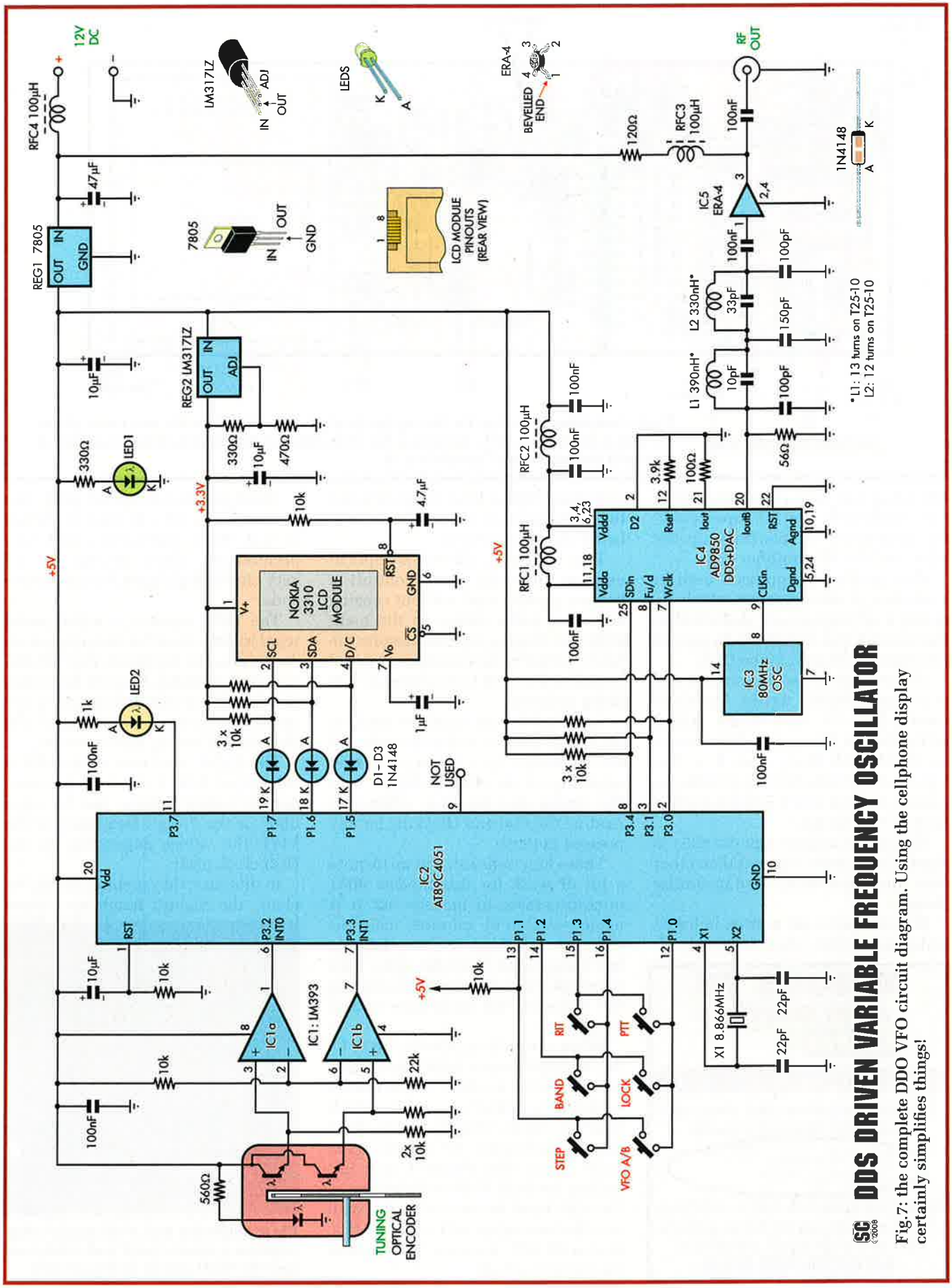


Fig.7: the complete DDO VFO circuit diagram. Using the cellphone display certainly simplifies things!

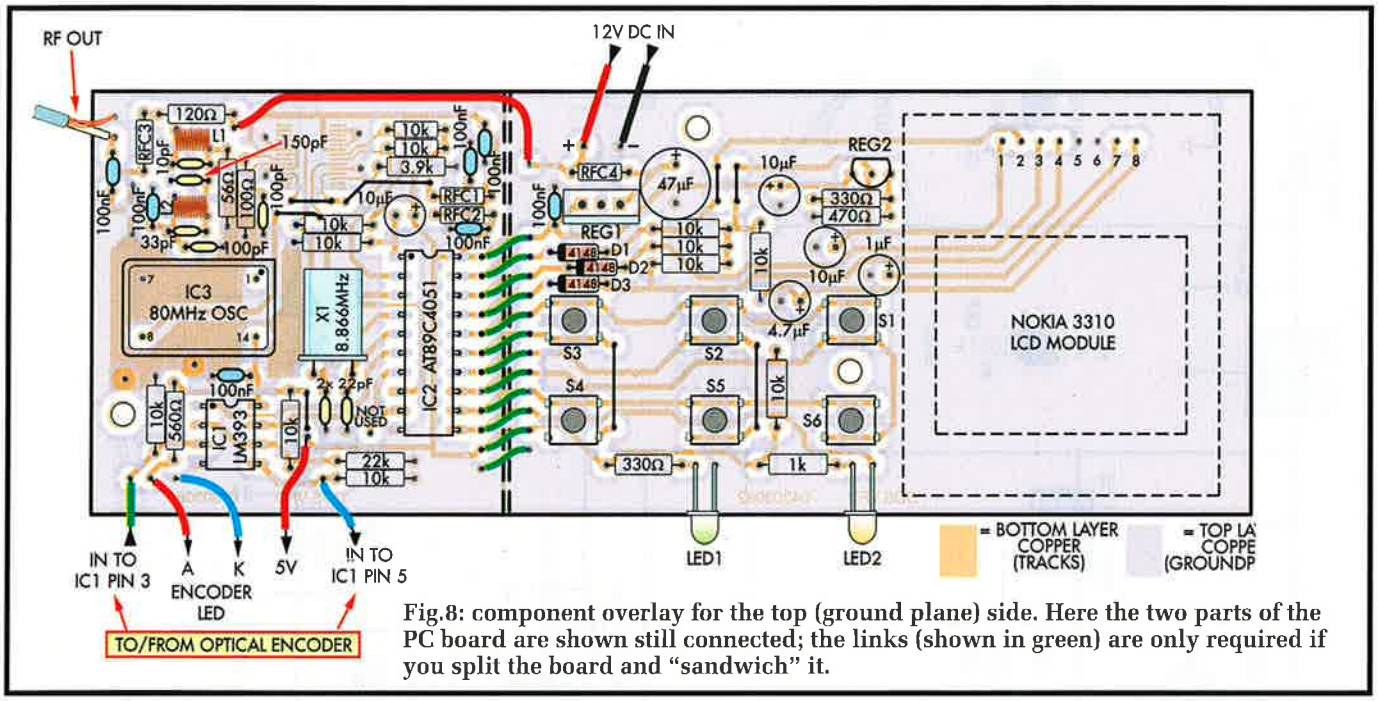


Fig.8: component overlay for the top (ground plane) side. Here the two parts of the PC board are shown still connected; the links (shown in green) are only required if you split the board and "sandwich" it.

ist, using just four chips (excluding the regulators): the microprocessor, the optical encoder interface chip, the DDS, and the RF amplifier chip.

This avoids the approach used in a number of other designs which requires a microprocessor dedicated to the encoder and display and a second processor dedicated to the DDS.

The microprocessor is also operated at a very leisurely 8MHz. I actually used a PAL TV colour-burst crystal of 8.866MHz but any crystal from 8 to 12MHz will likely work fine. The top speed for this micro is 24MHz, so clearly nothing much is being pushed hard in this design.

This might suggest that the 8051 is significantly more efficient than other 8-bit microprocessors used in similar designs.

My software is all written in hand-coded assembler, often far more efficient than higher level languages and the code possibly also makes a little better use of interrupts.

This approach allows the optical encoder (the main tuning control) to be very rapidly read without causing any measurable delays in the main DDS and display routines despite the fairly intensive data transfers required by the Nokia 3310 LCD whenever it is being updated.

Interrupt-driven routines tend to be a little more complex to write but are necessary here to handle rapid updating of the digital display and the analog dial graphics, while also reading the dial and checking for any pressed buttons.

These functions can add up to quite a lot of work for this modest 8051 microprocessor to manage but it is made possible by minimal mainline software functions and a relatively fast background interrupt cycle. This interrupt cycle is focused on reading the encoder, the most time-critical function.

When power is applied to the VFO, the microprocessor begins by initializing the LCD module. These feature a brief animated set of graphics which illustrate some of the flexibility of the display and makes use of some spare ROM space. The 89C4051 then initialises the DDS VFO to the bottom of the 80m band in receive mode, with an offset assuming an IF of 8.467MHz, and with RIT (receiver incremental tuning) turned off.

These parameters are all set by the software, and are very easy to change to suit other applications and user preferences. These settings are all very clearly highlighted in the source code.

The DDS requires a 40-bit serial word transfer from the microprocessor. As the encoder is rotated, the DDS frequency is updated, the new frequency displayed and the dial graphics dynamically changed according to the direction of tuning knob rotation.

The 40-bit word sent to the DDS is calculated from a series of predetermined lookup values, one for each digit in the 7-digit frequency of the VFO, the values depending on the DDS clock used.

In this case, they assume an 80MHz clock, the highest frequency crystal

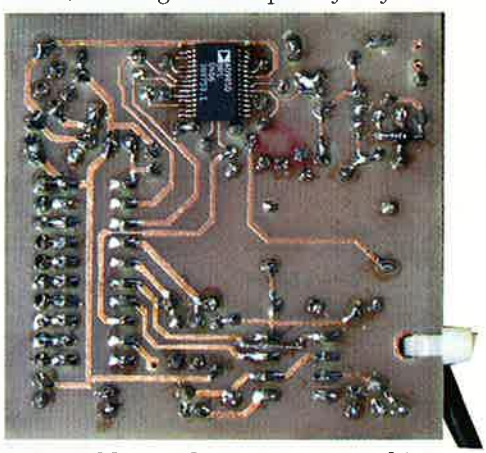


Fig.9: soldering that SMD-mount chip requires a steady hand and a fine iron (see the SMD article in this issue!)

A NOTE TO SILICON CHIP SUBSCRIBERS

Your magazine address sheet shows when your current subscription expires.

SUB 20049 Expiry Sept 07
Claude Kidlehopper
2/10 Coconut Street
NEWPORT NSW 2106

Check it out to see how many you still have. If your magazine has not turned up by the first week of the month, contact us at silchip@siliconchip.com.au

oscillator I could buy locally.

The DDS output is filtered using a 5th order elliptical low pass filter with a cutoff frequency of about 35MHz. The output from the filter is then amplified with a ERA-4 surface mount MMIC. This gives a output level of about 1V peak-to-peak or +13dBm into 50Ω from the VFO, ideal for diode mixers. Since the DDS output level follows a sinx/x envelope, the output reduces to 0.8V peak-to-peak by 30MHz. This 2dB rolloff is of little concern in transceiver applications but should be borne in mind if this software is used for signal generator applications.

The 80MHz DDS oscillator is the reference for the VFO's output frequency. By contrast, the microprocessor crystal is a nominal 8MHz crystal and, as noted earlier, its exact frequency is not critical. Since output frequency accuracy and stability depends on the 80MHz DDS oscillator (and few of these have any external frequency adjustments available), any users requiring absolute output frequency accuracy can make the simple frequency alignment adjustments within the software.

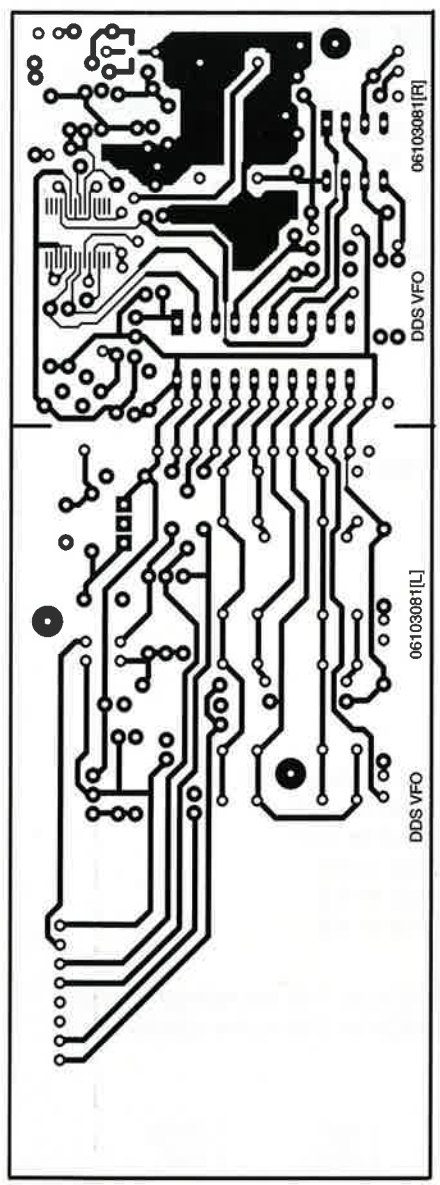
I found my VFO was accurate to a few hundred Hertz and quite adequate for my uses.

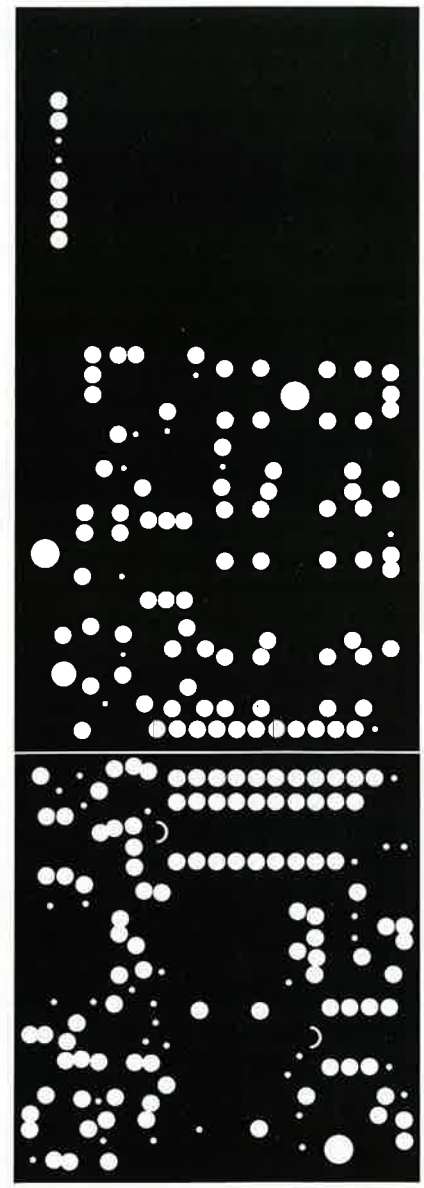
The Nokia 3310 LCD module requires a 3.3V supply. While some 8051 chips will operate on the same 3V supply, the 80MHz oscillator demands a 5V supply. The decision was therefore made to run both a 5V (for micro and oscillator) and a 3.3V rail for the LCD. It's a slight additional complexity but makes the design easier to convert to other types of 8051 chips should this prove desirable.

The interface between the AT89C4051 and the display, necessary due to the different supply rails on these parts, is handled with three cheap isolating diodes. If you are able to purchase some 3.3V clock oscillators (a standard part but one I couldn't buy locally), you can easily modify the entire VFO for single supply rail operation.

The microprocessor interface for the LCD module uses fewer control lines than suggested in many references. Most suggest the need for five lines, including a reset line from the microprocessor. Careful reading of the datasheet revealed that the chip select (CS) line can be permanently tied to ground at the cost of a little more current.

The VFO's MMIC amplifier is fairly





Figs.10 & 11: here's the full size artwork for both sides of the PC board with the top (ground plane) at right. We imagine most constructors will not bother etching a second layer (if they can!) but will simply remove the top-side copper around the holes with a small twist drill (eg, 5mm). It's tedious but easy enough to do holding the drill in your fingers, putting the tip in the hole and twisting. The smaller holes in the ground plane are for the components which solder to both sides of the board – these should not be opened out.

greedy, drawing around 65mA, so the modest constant 5mA consumed by the always-on LCD turned out to be of little concern. The datasheet also suggested the possibility of using a resistor-capacitor reset arrangement (10kΩ and 4.7μF), and that saved a further I/O pin. As a result, there is an additional delay of a hundred milliseconds or so at power-up, just to be sure the display has reset but this is of little importance in overall operation.

The main dial knob uses connects to an optical encoder. This is interfaced to the microprocessor with an LM393 comparator to ensure clean rising and falling quadrature signals. The use of an optical encoder delivers improved long term reliability and allows users to set up the mechanics of the dial knob to suit individual taste.

Construction

The VFO can be built either as a single PC board measuring about 150 x 50 x 15mm (wxhxd) or in a sandwiched two-PC board configuration measuring 100 x 50 x 25mm (wxhxd). Those wanting a smaller version can convert the current layout to use SMD

Parts List – DDS VFO

1 double-sided PC board, 150 x 50mm, coded 06103081 (see text)
1 digital display ex Nokia 3310 cellular phone (see text)
1 surplus mechanical (ball-type) mouse for optical encoder parts (containing 1 LED and 2 phototransistors – see text)
1 8.866MHz crystal (X1)
6 PC mounting SPST pushbutton switches

Semiconductors
1 LM393 (IC1)
1 AT89C4051 microcontroller (IC2)
1 80MHz oscillator (IC3)
1 AD9850 (IC4)
1 ERA4 (IC5)
1 7805 5V positive voltage regulator (REG1)
1 LM317LZ voltage regulator (REG2)
3 1N4148 silicon signal diodes (D1-3)
1 yellow LED
1 green LED

Capacitors
1 10µF 16V PC electrolytic
3 10µF 10V PC electrolytic
1 4.7µF 10V PC electrolytic
1 1µF 10V PC electrolytic
7 100nF polyester (code 0.1, 100n or 104)
1 150pF polyester (code 150p or 151)
2 100pF polyester or ceramic (code 100p or 101)
1 33pF ceramic (code 33p or 33)
2 22pF ceramic (code 22p or 22)
1 10pF ceramic (code 10p or 10)

Inductors
1 390nH (L1) (13T 33SWG ENCU on T25-10 toroidal former)
1 330nH (L2) (12T 33SWG ENCU on T25-10 toroidal former)
4 100µH (RFC1-4)

Resistors (all 0.25W, 1%)

1 22kΩ	12 10kΩ	1 3.9kΩ	1 1kΩ	1 560Ω
1 470Ω	2 330Ω	1 120Ω	1 100Ω	1 56Ω

parts and reduce the dimensions by about 40%. While the present design uses a double sided PC board, the top side of the board is left unetched, forming a continuous copper ground. This allows the PC board to be etched in typical home workshops with ease as if it was a single sided PC board. That's the method I used for the version pictured.

While I've used standard components as far as possible, construction is not for the faint-hearted. The DDS chip, for example, is a 28 pin SMD device with very close pin spacing. The display connections are also challenging. Time and care allows both to be soldered into place but it does require a good soldering iron with a fine tip, steady hands, patience and good eyesight.

I'd suggest building the keyboard/display PC board first. Install the jumpers first, the resistors, then the buttons, and finally mount the display. The Nokia 3310 display is supplied mounted on a plastic keypad frame assembly complete with speaker.

Prise out the speaker – it's just pressed into a rubber ring – and trim the surplus plastic away with a sharp knife, being careful not to disturb the plastic around the display itself. This is essential to maintain slight compression on the metallic springs which press onto the conductive tracks on the LCD glass.

The display is then wired to the pads on the PC board. I was tempted to lay the PC board out to permit the display to be directly mounted on it but the current method offers a little more flexibility. However, it does require some delicate soldering of wire jumpers between the spring metal connections on the rear of the display and the PC board.

I kept everything in place with a few dabs of hot glue and the display assembly was mounted a few millimetres off the PC board with three further strategic dabs of hot glue. This sounds crude – but it's unseen and the glue forms a very rigid arrangement which can be easily adjusted with a little heat from a soldering iron.

The display is extremely light, and the resulting mounting is very robust. There is also space beneath the LCD for the addition of backlighting, perhaps using some diffused LEDs, if desired, although the current PC board layout does not allow for component wiring.

By the way, don't be tempted to remove the white plastic material from the rear of the LCD. This improves display contrast and aids backlighting. I tried some green LEDs for backlighting and they worked very well, so I may add these to the final transceiver.

An extra pullup resistor (10kΩ) can be seen in Fig.5 mounted next to the inter-PC board wiring on the top side of the keyboard/display PC board. This was caused by a minor change in pin connections when going from my Veroboard and wirewrap prototype to the final PC board version. This resis-

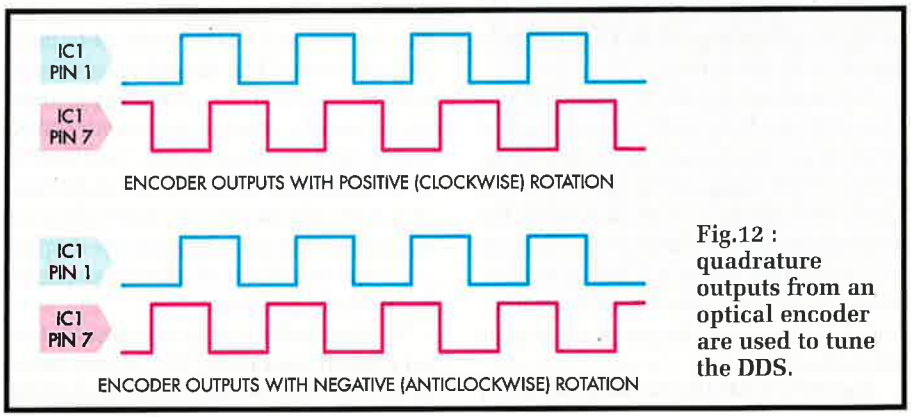


Fig.12 : quadrature outputs from an optical encoder are used to tune the DDS.

siliconchip.com.au

tor has now been added to the PC board layout shown in Figure 8 and 9.

Constructing the DDS/microprocessor PC board can start with the installation of the resistors and capacitors. Then proceed to add the jumpers and the various through-PC board connections if your board does not have plated-through holes. Mount the microprocessor socket (I strongly recommend using a "machine screw" IC socket for non-plated through PC boards), the LM393, crystal oscillator and crystal.

The LM393 does not need a socket. Complete the board by soldering in the DDS chip and the ERA-4 MMIC.

The optical encoder should be added next. Although you can use a commercial model, I made my optical encoder from parts salvaged from an old PC mechanical-type mouse. It's not a difficult task – there are enough bits inside an old mouse for two such encoders.

It is possible to monitor the two output pins of the LM393 interface to confirm correct quadrature waveforms using an oscilloscope (See Fig.12) while rotating the encoder.

If you test without the microprocessor installed, which is best, you will need to add temporary pullup resistors on each open-collector comparator output. Any value from 4.7kΩ to 100kΩ works fine for testing. Remove these once encoder testing is complete. Fig.12 shows the ideal waveforms. Actual outputs have less perfect shapes, with variable width and timing but still do the job.

The LCD module and pushbuttons are mounted on the solder side of the PC board. This allows the board to be mounted at the ideal distance from the front panel for display visibility and for the buttons to be depressed through a Lexan or similar flexible keypad/panel.

Since my workshop facilities doesn't run to Lexan production facilities, I made a workable flexible front panel from transparent plastic stick-on film from the local stationery shop and a laser-printed paper panel overlay.

Unfortunately, my panel layout is too long to be printed here but it can be downloaded from my website (see references) or from **www.siliconchip.com.au.**

The film is layered over the paper on both sides and provides protection for the display while allowing the

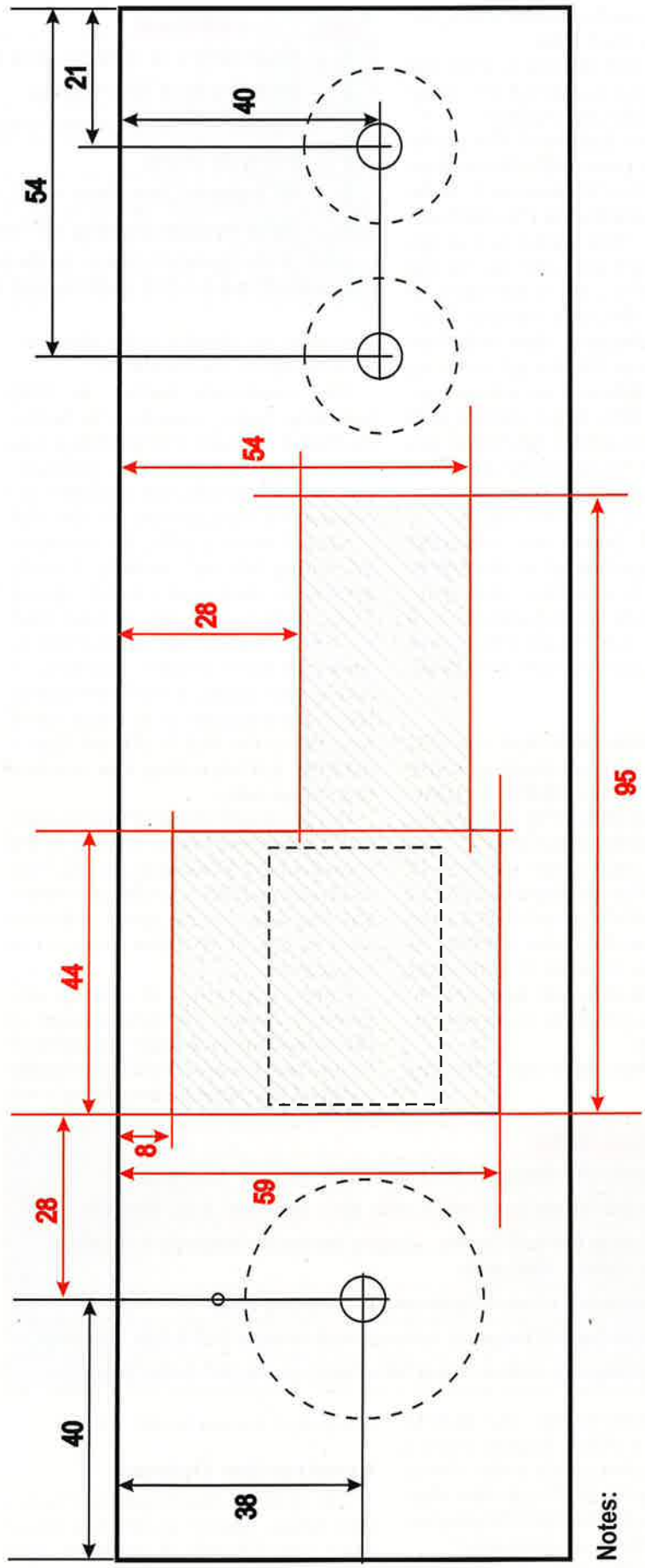


Fig.13 : same-sized diagram of the front panel of the transceiver on P58 showing where the VFO mounts.

buttons to be easily pressed under the appropriate keypad label.

This panel will obviously wear out much faster than Lexan but it's cheap and easy to make and replace.

There are two indicator LEDs on the PC board. The green LED shows when DC is applied to the board and can be used as a power indicator (Top left hand corner of the front panel in Fig.10). The yellow LED was used during the software development to measure the time taken by the main software loop. It still does, changing state each time through the loop, flickering in varying degrees of brightness as buttons are pressed, the VFO is tuned, and the LCD updated. I located this LED at top dead centre over the main tuning knob. Yes, I confess, it's purely for there for show, so just omit it if you don't like it.

The two PC boards are connected together using a total of 12 short wire links. There is a further short wire jumper which is run between the two boards for the +12V supply. This goes to the 120Ω resistor to power the MMIC.

Operation

With an 80MHz DDS clock, the VFO will operate with minimal spurious outputs up to about 30MHz. In transmit mode, the DDS VFO outputs the frequency displayed on the LCD.

In receive mode, the receiver IF offset is added to the displayed output frequency until the actual DDS output frequency exceeds about 30MHz. At that point, the IF offset is subtracted from the nominal output frequency to keep spurious products to an acceptable minimum.

The VFO keys have the following functions:

VFO KEY FUNCTIONS:	
Step	Selects VFO frequency increment (10Hz, 100Hz or 1kHz steps)
Band	Selects desired band (160m, 80m, 60m, 40m, 30m, 20m, 15m, 12m, 10m)
RIT	Changes dial to RIT control allowing the receiver frequency to be offset by ±5kHz in 10Hz steps
VFO A/B	Selects one of two independent VFO frequency banks
Lock	Locks the VFO frequency to the currently selected DDS output frequency
Tx	Removes the receiver IF and RIT offsets from the VFO output frequency

As mentioned earlier, the LCD is addressed as a 6-line display, each 8 pixels high and 84 pixels wide. This is determined by the LCD controller chip bonded inside the Nokia 3310 display, a Philips PCD8544 or equivalent.

The DDS VFO software therefore addresses the display using this line-based mode as shown above.

LINE	FUNCTION
1	Reserved for a 14 character string of text including the user's callsign
2	Digital display of VFO frequency
3	Used by the VFO cursor which indicates the step size currently in use
4	Analog dial display
5	RIT frequency (Only shown in RIT mode)
6	Status messages including VFO lock, VFO A/B selection, and Tx mode

Line 1 is the top-most LCD line. Incidentally, lines in the software are actually numbered from 0 to 5 to match the LCD controller's addressing scheme.

Also mentioned earlier, the VFO has three tuning speeds, selected by the Step key. Some consideration was given to adding variable rate tuning to this VFO. This method is used on some commercial transceivers. As the dial is rotated more quickly, for example, the tuning rate will initially directly match the increased rotation speed. Then, if the tuning rate is sustained, the VFO frequency increment will be automatically increased, resulting in accelerated tuning, with the frequency being incremented at a much faster rate. When the dial is slowed, this is detected and the tuning rate switches to a slower rate.

Having used it in one of the commercial transceivers I own, I've not found it particularly pleasant to use. Call me old-fashioned but I prefer the standard fast/slow tuning speed selection used in one of my older commercial transceivers.

I did try a variety of variable rate methods during the development of this design but none really proved to offer any benefits over the scheme finally adopted. So, variable rate tuning is not a standard feature in this VFO.

Construction Options

The split PC board layouts used in this design readily permit the use of other keypads and displays. In such cases, only the DDS/microprocessor board need be built. The relevant port lines are all available on the edge of this PC board.

With minor changes in software, those standard two-line x 16 character alphanumeric LCD modules may be used, as may many different keypad arrangements and keypads. In most such cases, the software will readily fit in the smaller AT89C2051 (2K flash ROM) microprocessor which is 100% pin-compatible with the DDS/microprocessor board layout shown here.

If there is sufficient interest, I will make schematics, connection details and software available on my website for this alternate version.

Future Development

Now that this design is complete, I want to find some time to build an RF signal generator using the more powerful AD9854 or AD9912 DDS chips. These DDS devices have higher quality quadrature outputs and are ideal for use with software-based receivers.

Interestingly, a simple signal generator actually requires much less code than a ham-band transceiver VFO. But to compensate for this, I'd like to use one of the more complex full-colour cellular phone LCD modules.

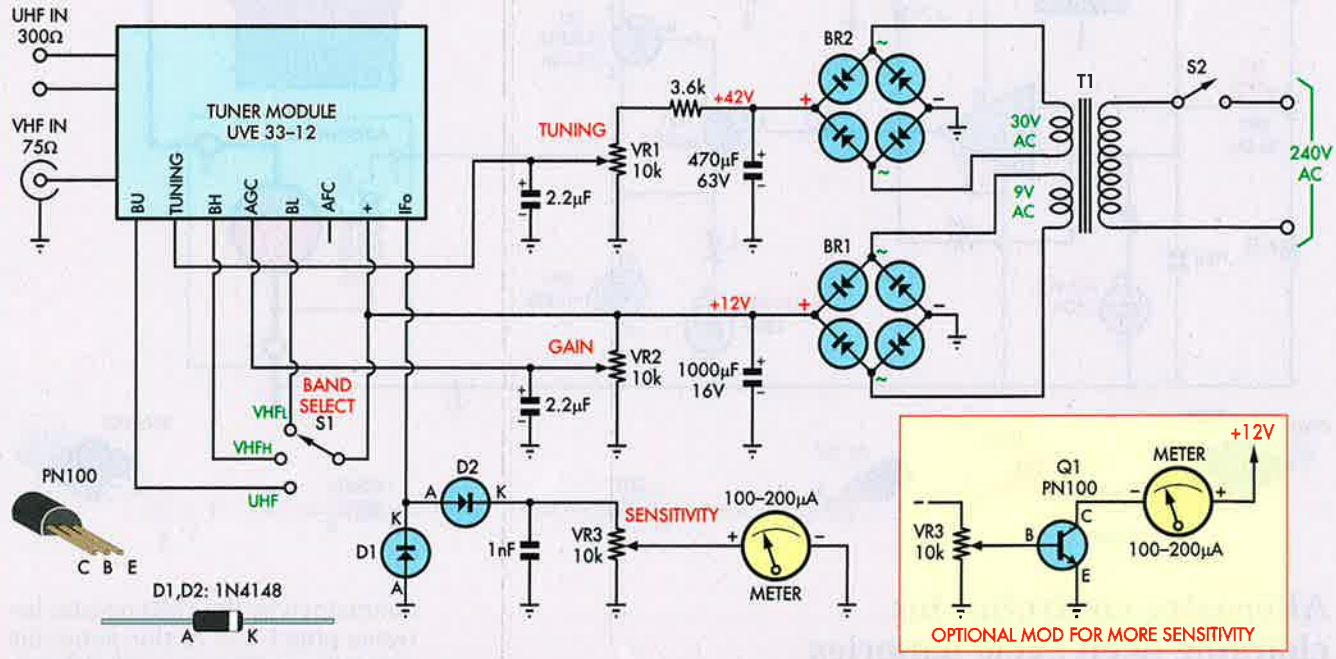
All I have to do is persuade my wife to let me borrow her new cellphone for a few minutes... SC

References

1. The ZL2PD website can be found at www.geocities.com/zl2pd/ This contains all of the source code, assembled hex files, full size schematics and PCB artwork for free downloading
2. Analog Devices, 'A Technical Tutorial on Digital Signal Synthesis', 1999 (See www.analog.com)
3. Two websites offering Nokia 3310 LCD displays at time of writing include www.jelu.se and gsmserver.com, although I have no experience with either source.

CIRCUIT NOTEBOOK

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



TV field strength meter

This TV field strength meter is based on a tuner module salvaged from an old Sharp TV although the circuit can be adapted to most VHF/UHF tuner modules used in TVs and VCRs. The pin assignments are usually stamped on the cover of the tuner module or may be found on the bottom of the PC board.

The Sharp tuner is an older model digital tuner, with a 75-ohm input for VHF and a 300-ohm input for UHF. Modern tuners now have a single 75-ohm input for the VHF & UHF bands. Old VCRs can be picked up cheaply at flea markets and at kerbside rubbish collection times.

The IF (intermediate frequency) pin produces a 45MHz signal (in the USA) and the IF output level varies with the incoming signal level. In fact, the frequency of the IF signal doesn't matter as it's simply rectified by diodes D1 & D2. Trimpot VR3 provides a sensitivity adjustment for the meter.

The circuit is powered by a transformer with 8V and 30V AC secondary windings. The 8V AC is rectified by bridge BR1 and filtered to provide the nominal 12V DC rail for the tuner module while the 30V AC is rectified by bridge BR2 and fed to potentiometer VR1 is to provide a tuning voltage range of 0-30V DC. Potentiometer VR1 is connected to the AGC input to serve as a gain control.

If you need more gain to obtain reasonable deflection of the meter, transistor Q1 can be added, as shown.

As presented, the circuit will give a useful indication of TV signal strength and can be used as an aid for best antenna orientation.

Henry Bowman,
Parsons, Tennessee. ($50)

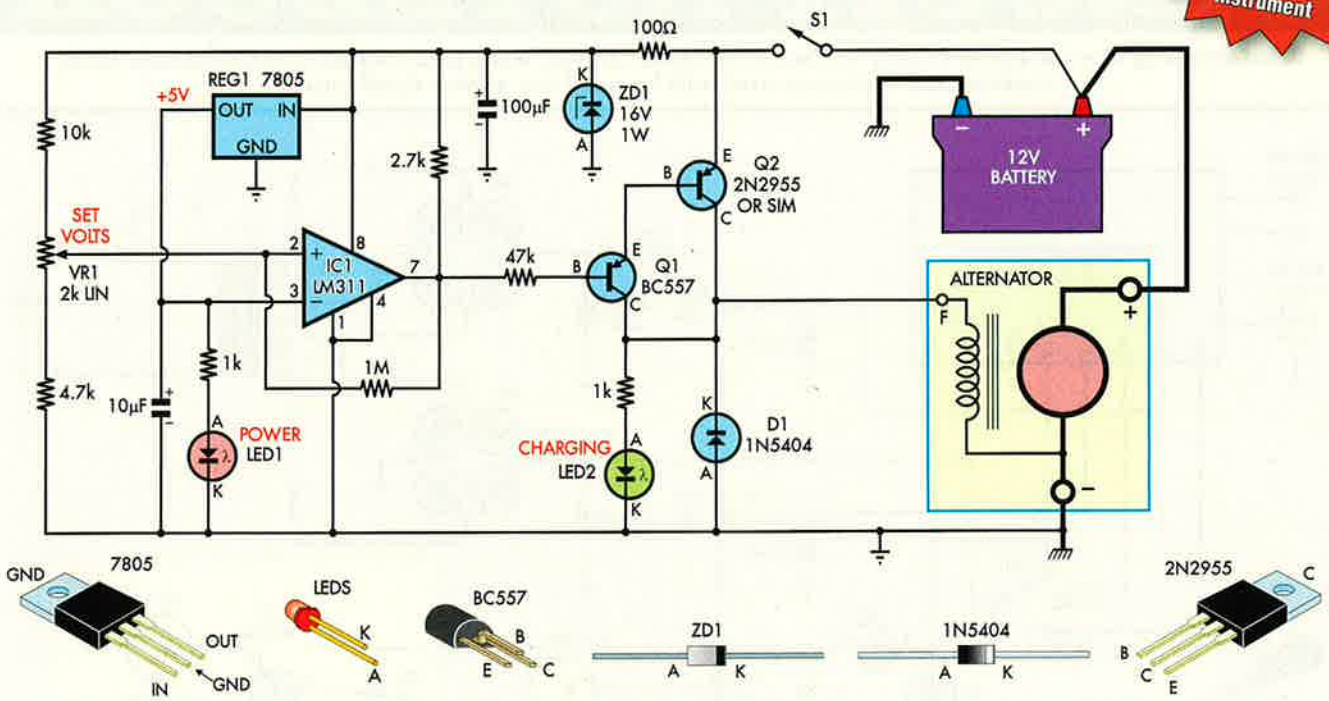
Contribute And Choose Your Prize

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



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

D. Edwards is this month's winner of a Peak Atlas Test Instrument



Alternator controller for charging deep cycle batteries

This controller is used for charging a bank of deep-cycle lead acid batteries from a 12V alternator driven by a Lister diesel motor. It provides three modes of charging: a hefty initial bulk charge, a pulse width modulated float charge to settle the voltage level and, when required, an adjustable high-voltage equalising charge. This latter mode is also useful to reactivate the sulphated batteries.

The heart of the circuit is an LM311 comparator (IC1) and its reference voltage at pin 3 is provided by a 78L05 voltage regulator. The battery voltage is monitored during charging by a resistive divider which includes trimpot VR1. Its wiper is connected to the non-inverting input (pin 2) of the LM311. If the battery is below the set reference voltage level, the alternator field current is supplied by transistors Q1 & Q2, setting the alternator at its maximum charge current.

When the set level is attained, nominally 13.8V to 14.2V, the circuit will switch to PWM mode, pulsing current into the battery bank at whatever rate is required to keep equilibrium. This pulse width modulation (PWM) is a function of the hysteresis of the comparator, as determined by the 1MΩ resistor between pins 3 & 7. At this point, the generating system can be shut down, as the best diesel efficiency can only be achieved if the engine is running almost fully loaded.

The battery bank should be equalised several times a year. This is achieved by setting the cut-out voltage much higher than normal, usually around 15V and charging the batteries to this level. This will cause gassing in the cells which helps to mix the electrolyte which otherwise tends to settle into layers of varying acidic density. Any load connected to the battery bank should be disconnected during this procedure.

D. Edwards,
Taylorville, NZ.

Emergency light uses 3W white LED

This simple emergency light is based on one 3-watt white power LED. 12V AC is applied to a bridge rectifier and a 100µF filter capacitor to feed an LM317 voltage regulator. This is arranged to deliver 7.5V DC via diode D1 to charge a 6V 4Ah SLA battery. Diode D1 limits the maximum battery voltage to 6.9V and also prevents reverse current flow from the battery.

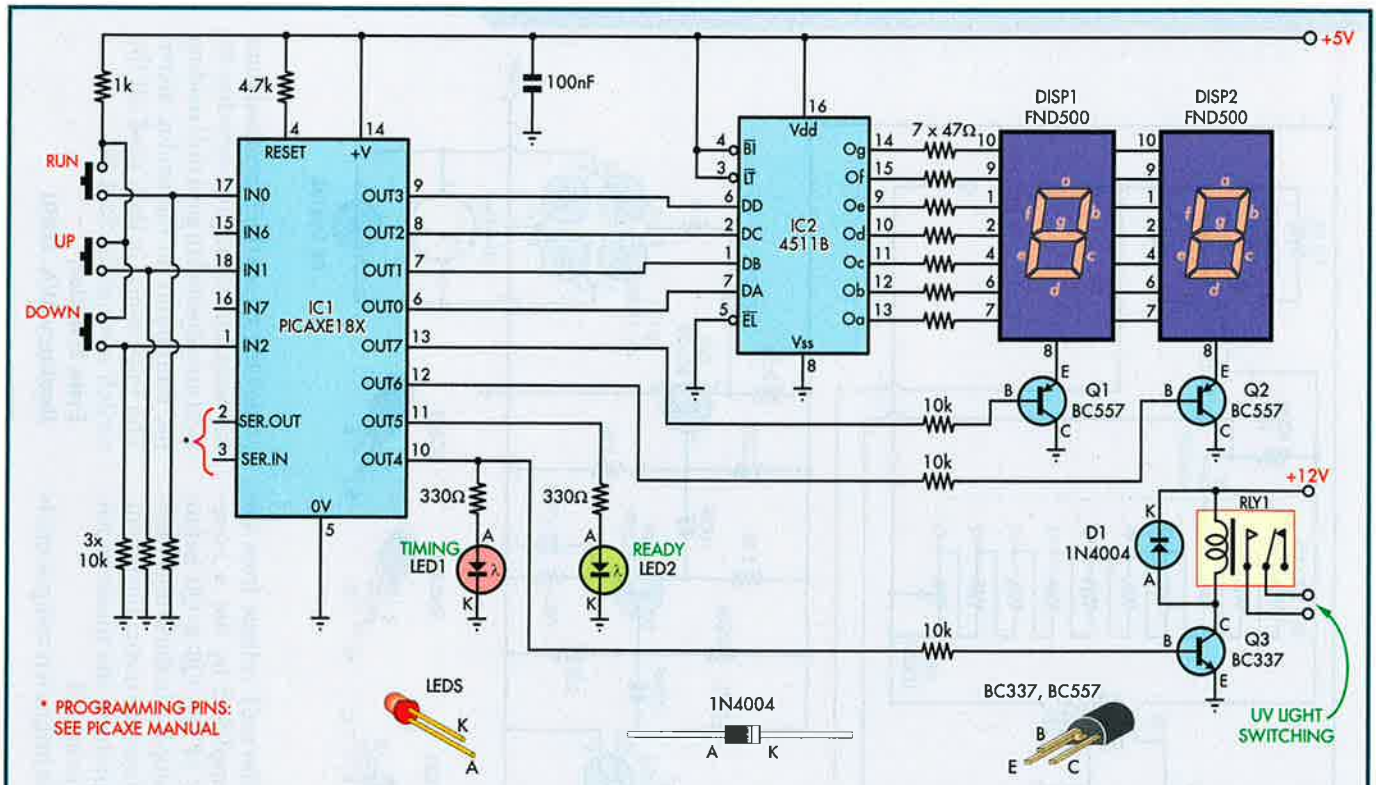
555 timer IC1 functions as an optical comparator and switch. LDR1 is the light-sensing element. When light intensity is high, LDR1's resistance is low and as a result, the high level output from pin 3 will turn on transistor Q1 and disable the LM317 driving LED1 (in reality, it reduces the output of the LM317 to 1.25V).

When the light intensity is low, LDR1's resistance is high, the 555's output switches low and the LM317 is enabled to drive LED1.

(Editor's note: this circuit has no provision to prevent over-discharge of the SLA battery if it is left to run for an extended period. Discharging an SLA battery below 1.8V per cell (ie, 5.4V for a 6V SLA battery) will destroy it.

T. K. Hareendran,
Kerala, India. ($35)

siliconchip.com.au



PICAXE light box countdown timer

This PICAXE countdown timer uses two 7-segment displays to provide a maximum light box exposure time of 99 seconds. Three pushbutton switches are used to set the time (Up/Down) and to start the exposure (Run).

A default time of 30 seconds is loaded the first time the software is run and after that the micro (IC1) stores the last time that was used, ready for the next run. The last used setting is saved when the power is turned off.

Four outputs from the PICAXE drive a 4511 BCD to 7-segment decoder (IC2). This drives the two 7-segment displays together with transistors Q1 & Q2 which drive the display's common cathodes.

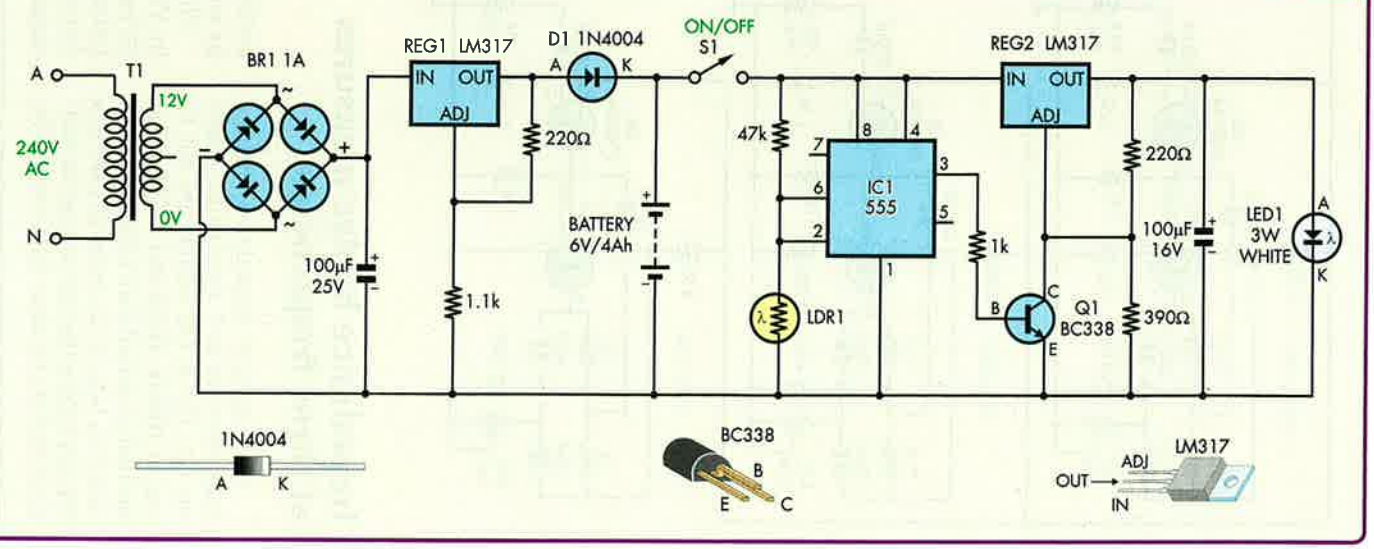
The timing is controlled by 'for next loops' and the 'pause' command. The timer counts down from the selected time in seconds, to zero.

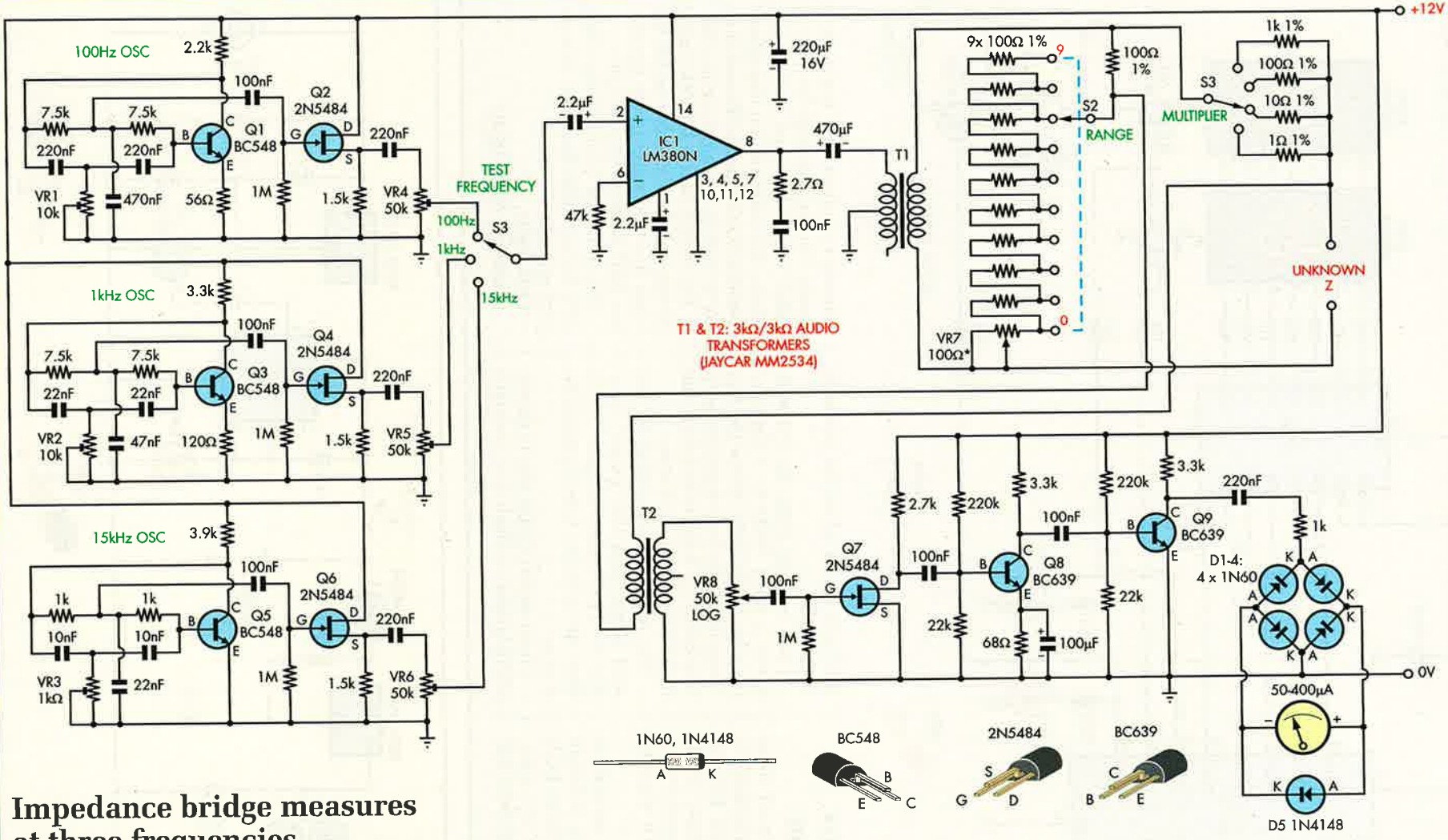
There are two LEDs. Pin 11 drives LED2 (green) to flash at a 1-second interval to indicate that the timer is ready. Pin 10 goes high to turn on LED1 when the timer is counting down. The same output also drives transistor Q3 to operate the power relay to switch the lamps on an off.

The details of the 240VAC mains wiring can be the same as for the Light Box Controller in the November 2007 issue of SILICON CHIP.

The software (Countdown1.bas) will be available from the SILICON CHIP website.

Cliff Wylie,
Leumeah, NSW. ($50)





Impedance bridge measures at three frequencies

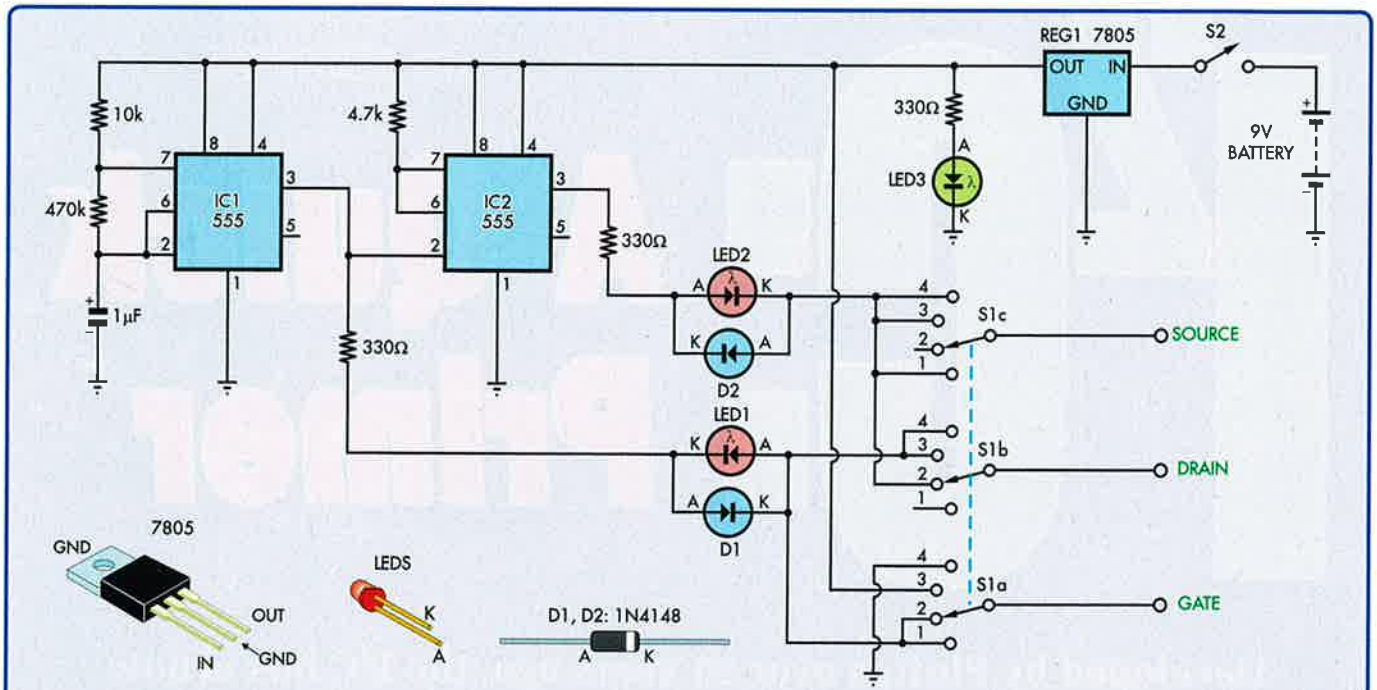
This simple impedance bridge uses three twin-T oscillators based on Q1, Q3 & Q5 which are set to run at 100Hz, 1kHz and 15kHz. The oscillator outputs are taken from the resistive legs of the twin-Ts via FETs Q2, Q4 & Q6 which act as high impedance buffers (source followers). The oscillator frequencies can be trimmed by trimpots VR1, VR2 & VR3.

The oscillator amplitudes are set by VR4, VR5 & VR6 and fed to switch S3 before being amplified by IC1, an LM380 amplifier. This drives transformer T1 which drives the switch ranges for the bridge circuit.

Finally, the null voltage from the bridge is amplified by the AC-coupled stages of Q7, Q8 & Q9 before being AC-coupled to the bridge rectifier (D1-D4) and the meter movement. Diode D5 protects the meter movement from overload.

In use, the unknown component is connected across the Z terminals and the range and multiplier switches S2 & S3 are adjusted to get a null reading (ie, minimum) on the analog meter. The impedance is then read off the switch settings for S2 & S3.

Fritz Winkler,
Bunbury, WA. ($60)



Simple Mosfet tester

This simple tester checks both N-channel and P-channel Mosfets. It checks for shorts between gate, drain and source and also distinguishes between N and P-channel Mosfets.

IC1 is configured as an astable multivibrator to run at about 2Hz, as determined by the components at pins 2, 6 & 7. IC2, another 555 timer, is used simply as an inverter. Hence the two pin 3 outputs of IC1 & IC2 are in anti-phase.

These two pin 3 outputs are fed out via 330Ω resistors and LEDs 1 & 2, paralleled with diodes D1 & D2. From there, the anti-phase signals are connected to the Mosfet under test via a 3-pole 4-position rotary switch. The three switch wipers are connected to terminals labelled "gate", "drain" and "source".

The switch settings correspond to the following tests: **Test 1** checks for a short between the gate and source. If a short exists, alternating current paths are provided via LED1 and LED2 (ie, the LEDs alternately turn on and off). **Test 2** checks for a short between the gate and drain. If there is no short, no LEDs will light.

Test 3 provides a positive bias to the gate, while the drain and source are connected to the LEDs. If the Mosfet is N-channel, both LED1 and LED2 will blink. If the Mosfet is P-channel, only LED2 will blink.

Test 4 provides a negative bias to the gate, while the drain and source are connected to the LEDs. If the Mosfet is P-channel, both LED1 and LED2 will blink. If the Mosfet is N-channel, only LED1 will blink.

If the Mosfet's drain and source are shorted, both LED1 & LED2 will flash in tests 3 and 4, for both N-channel and P-channel Mosfets.

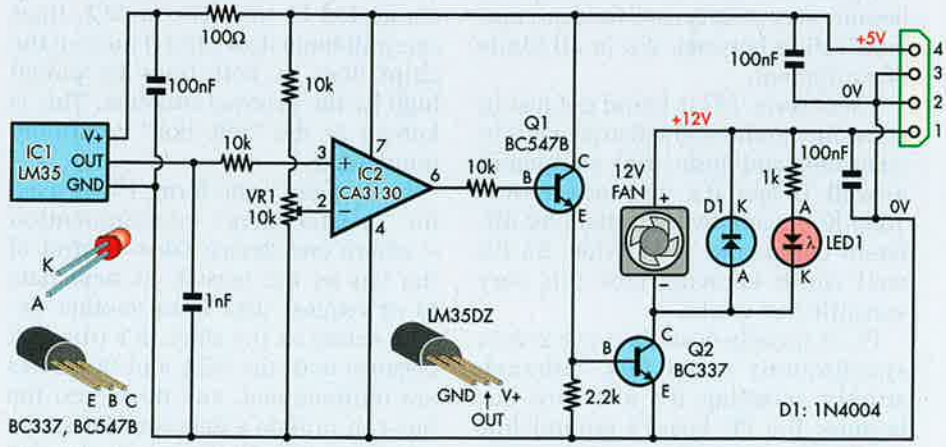
Henry Bowman,
Parsons, Tennessee. ($45)

PC cooling fan driver

This circuit can be used to control a fan in a computer or equipment cabinet. It's based on an LM35 analog temperature sensor which has an output voltage that's directly proportional to temperature in °C. Its output signal is fed to a CA3130 op amp (IC2) which is connected as a comparator.

IC2 switches on the fan via transistors Q1 & Q2 when the air temperature is above that set by VR1. LED1 lights whenever the fan is running.

Power for the circuit comes from the +5V and +12V rails in a PC and can be derived from a spare 4-pin supply connector (use a Y-adaptor if necessary). The red wire is +5V, yellow is +12V and the two black wires are the common/ground leads.



T. K. Hareendran,
Kerala, India. ($35)

I²C: A Quick Primer

By JIM ROWE

Developed by Philips over 25 years ago, the I²C bus is now a well-established standard for low to medium-speed data communication between ICs. However, its basic operation still isn't well understood, except by people in the chip design business. Here's a quick primer to bring you up to speed.

BACK ABOUT 1980, when digital ICs were really starting to be used in consumer gear such as car radios, stereo systems and TV sets, Philips developed a low-cost interfacing technique for allowing the various ICs in a system to exchange data at a low to medium speed. They called it the "Inter-Integrated Circuit" or "I-squared-C" (I²C) bus and it rapidly became very widely used for data communication between ICs in all kinds of equipment.

These days, I²C is found not just in consumer audio and video gear but in computer and industrial equipment as well. In fact, it's now used in over 1000 ICs, made by more than 50 different companies worldwide. So it's well worth knowing how this very versatile bus works.

I²C is usually described as a 2-wire synchronous serial bus, although strictly speaking it's a 3-wire bus because the PC board's ground line is also an essential part of the communications link. The two nominal wires or "lines" are the data or SDA line and the clock or SCL line. Both of these lines are regarded as bidirectional and to allow this they are both used in wired-OR or "open drain/open collector" mode.

This means that both lines are connected to the PC board's positive supply rail only via pull-up resistors and can only be pulled down to logic low (or ground potential) by the circuitry inside the chips connected to the bus lines. So strictly speaking, any chip connected to the SDA or SCL lines can pull them down but if none of the chips does so, both lines are pulled high by the external resistors. This is known as the "idle bus" condition, incidentally.

In its most basic form, I²C is used for "master-slave" communication – where one device takes control of the bus as the master, to send data to or request data from another device acting as the slave. It's true that because both the SDA and SCL lines are bidirectional, any device on the bus can initiate a data transfer as the master and similarly, any device can play the role of the slave.

So the I²C bus can operate as a multi-master bus and in fact its official specification provides for bus contention and resolution situations, where two devices try to take control of the bus at the same time. However, in most common applications, there is a single master device (usually a microcontroller) and the rest of the devices are used as slaves. These slave devices may be digital tuning chips, controlled-gain amplifier or filter chips, video switching or processing chips, EEPROM memories and LCD panels, etc.

Fig.1 shows the basic master-slave I²C interface circuit. As shown, there are really three lines between the master and slave chips: SCL, SDA and ground. The external pull-up resistors (Rp) provide the only connections between the SCL and SDA lines and the positive supply rail (+V).

In operation, the SDA line can be pulled down to ground by either the master or slave devices, via the open-drain Mosfets connected internally to their SDA pins. Similarly, both chips can monitor the logic levels on the SDA line, via the Schmitt trigger inverters which are also connected to their SDA pins.

The circuitry connected to the SCL

siliconchip.com.au

pin inside each chip can be identical to that connected to the SDA pins. However, if only one device is to act as the master, it only needs an open-drain Mosfet connected to the SCL pin (as shown in Fig.1) because it will always be providing the SCL clock pulses. Conversely, when other devices are only being used as slaves, they only need the Schmitt trigger inverter to "receive" the SCL clock pulses.

The next thing to note is that although Fig.1 only shows a master device with a single slave device, the I²C bus can be used to connect one or more masters to many slave devices – as many as 112 different devices in fact. These slave devices are simply connected to the SCL and SDA lines in "daisy chain" fashion, as shown in Fig.2.

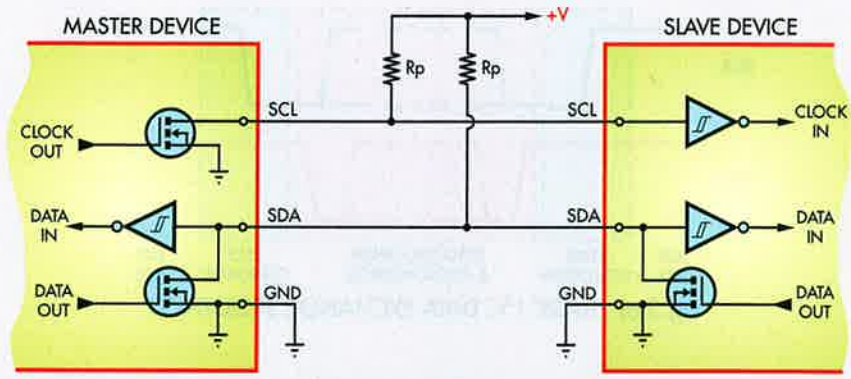


FIG.1: BASIC MASTER-SLAVE I²C INTERFACE

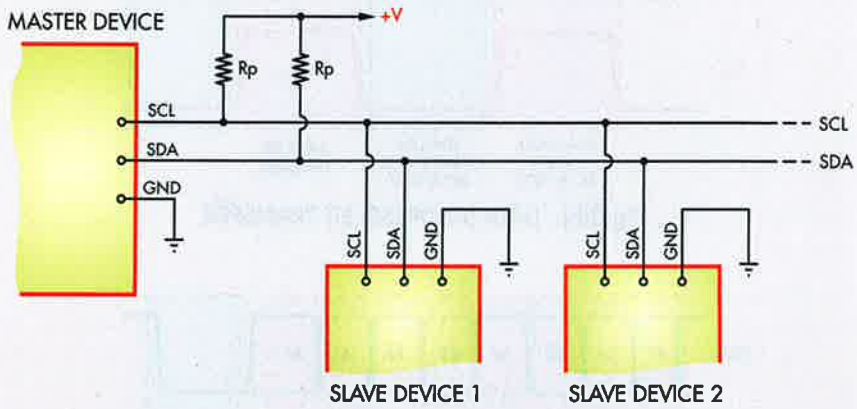


FIG.2: I²C BUS WITH ONE MASTER, MANY SLAVES

Starting and stopping

Before an I²C data transfer operation or sequence can take place, the master device must check to make sure that the bus is idle; ie, both the SCL and SDA lines must be at logic high. If so, it then takes control of the bus by pulling down the SDA line while leaving the SCL line high.

This is described as setting up a "Start condition" and announces to all other devices on the bus that a data transfer is about to take place. The Start condition can be seen on the left in the SCL and SDA waveforms shown in Fig.3(a).

We'll look at the actual data transfer operations in more detail shortly. For the moment, let's look at the way the master device signals the end of a data transfer sequence, by setting up a "Stop condition".

As shown on the right of Fig.3(a), this is simply the reverse of the Start condition. The master device releases control of the SCL line first, so that it goes high, then it releases the SDA line so this also goes high (ie, after the SCL line goes high). Both lines are then high, thus returning the bus to the idle condition.

So this is the basic format of an I²C data transfer sequence: Start condition, the data transfer itself and then the Stop condition – all under the control of the master device.

Now let's look more closely at the fine details.

Data transfer

The master device controls all data transfer on the I²C bus, as this is the device that toggles the SCL line to produce clock pulses – one positive pulse for each data bit, as shown in Fig.3(b). The data bits themselves are conveyed on the SDA line, which must be stable when the SCL line is high. All logic level changes on the SDA line must occur between clock pulses, when the SCL line is low.

Basically, all data is sent over the I²C bus this way, as serial eight-bit bytes with the most significant bit (MSB) first. This is shown in Fig.3(c), which also shows the next important thing you need to know about I²C operation: after each data byte is sent, the receiving device *must* "Acknowledge" that it has been received.

This is normally done by the receiver pulling down the SDA line while the master device provides a ninth clock pulse on the SCL line. Which device pulls down the SDA line to acknowledge reception depends on the direction of data transfer: if the master is sending data to a slave, the slave device must acknowledge. On the other hand, if a slave is sending data to the master, the master itself must acknowledge.

In other words not only is acknowledging mandatory after each byte but it is the receiving device which must do the acknowledging. As noted above, the acknowledge is usually done by pulling the SDA line low during the ninth clock pulse, known as "ACK", but there are some situations where the receiving device acknowledges by leaving the SDA line high. This is known as "ACK-bar" and we'll look at it more closely soon.

Addressing

By now you're probably wondering how the I²C master device can selectively communicate with one particular slave device when there may be a number of slaves on the bus. That's easy: the first data byte sent out by the master after it grabs the bus and sets up the Start condition is an address byte, specifying which slave device

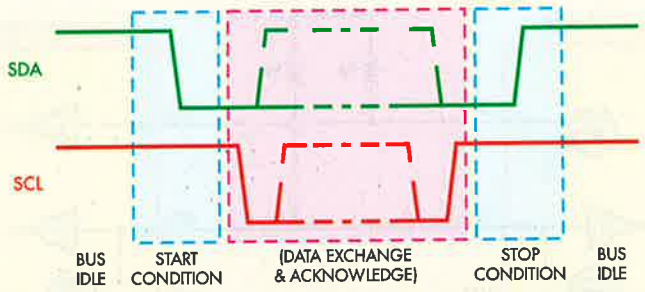


Fig.3(a): BASIC I²C DATA EXCHANGE SEQUENCE

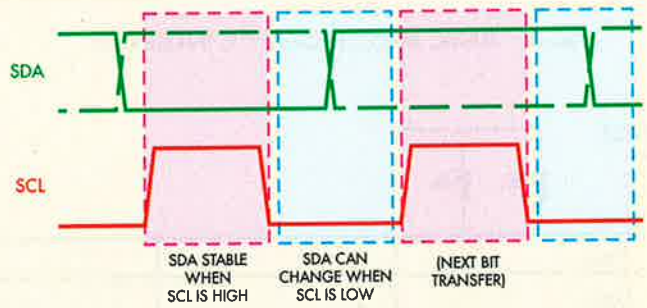


Fig.3(b): DATA (ADDRESS) BIT TRANSFER

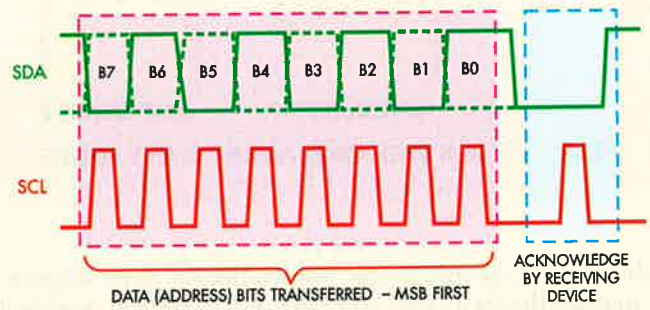


Fig.3(c): DATA (ADDRESS) BYTE TRANSFER WITH ACKNOWLEDGE

it wants to communicate with. It also specifies whether it wants to write data to the device or read back data from it. Basically, the first seven bits of this first byte form the actual slave address, while the eighth bit specifies a read (1) or a write (0) operation.

This addressing scheme is part of the I²C bus specification and devices designed to communicate via the I²C bus are given unique addresses (licensed to the chip maker by NXP, the current name for Philips Semiconductors). In some cases the address is built right inside the chip and can't be changed, while in others it can be set to one of a number of addresses in a range allocated to that device, by tying one or more of its other pins to logic high or low.

The latter arrangement is especially useful for devices like EEPROMs and other memories, where you might want to have a number of them on the same bus. Each device can be given its own unique address to prevent confusion.

Because the I²C address code uses seven bits, this means that in theory you should be able to have a maximum of 128 (2^7) devices connected to the same bus. However, as part of the I²C specification, 16 of the possible address codes are reserved for either special or future purposes, so in practice you can only have a maximum of 112 different chips on the same bus. That's still more than enough to handle the vast majority of situations.

By the way, since the read/write bit effectively forms the eighth bit of the address byte, it's quite valid to regard each device as having two addresses on the I²C bus – one address for writing data to it and the other for reading from it. For example, a device might have an effective write address of say 42h (01000010 binary) and a read address of 43h (01000011). This is really the same device address, with only the final read/write bit changing in value.

By the way, the current I²C specification also provides for 10-bit extended device addressing as an alternative to the 7-bit addressing scheme. However 10-bit device addressing is apparently not used much yet.

Single byte transfers

To make basic I²C operation a little clearer, let's now take a look at Fig.4(a). This shows the sequence of operations involved in a master device taking control of the bus, addressing a particular slave device and then writing a single byte of data to that device.

As you can see, the sequence begins with the master setting up the Start condition (S) and then sending the 7-bit address of the slave it wants to receive the data. It then follows with zero in the eighth bit (R/W-bar) position to indicate that it wants to "write" or send the data.

If that particular slave device is present on the bus and ready to accept the data, it must then respond by pulling the SDA line low (A) before the master sends out the ninth (acknowledge) clock pulse. None of the devices on the bus with other addresses will respond.

Following this acknowledgement, the master then sends out the eight bits of the data byte itself, after which the slave device must respond again with an acknowledge bit. Once the master detects this second acknowledge, it sets the Stop condition (P) to signify the end of the transfer and release the bus lines.

Reading a single data byte from a slave device is very similar. Fig.4(b) shows the details. Here the master device again sets up the Start condition (S) and sends out the 7-bit address for the slave device it wants to read the byte from. Now comes the first difference, because in this case it sends out a '1' for the eighth R/W-bar bit, to indicate that it wants to read back a data byte from the slave.

If the addressed slave is present and ready to send back the data byte, it then

siliconchip.com.au

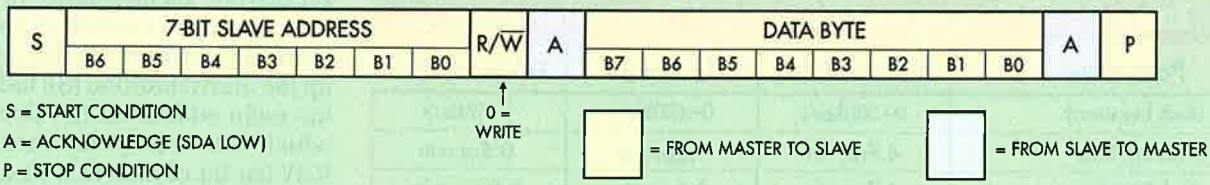


Fig.4(a): MASTER WRITING A SINGLE DATA BYTE TO A SLAVE DEVICE

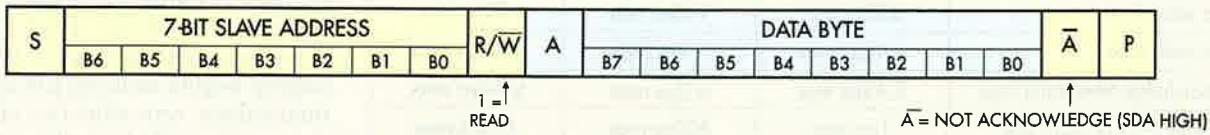


Fig.4(b): MASTER READING A SINGLE DATA BYTE FROM A SLAVE DEVICE

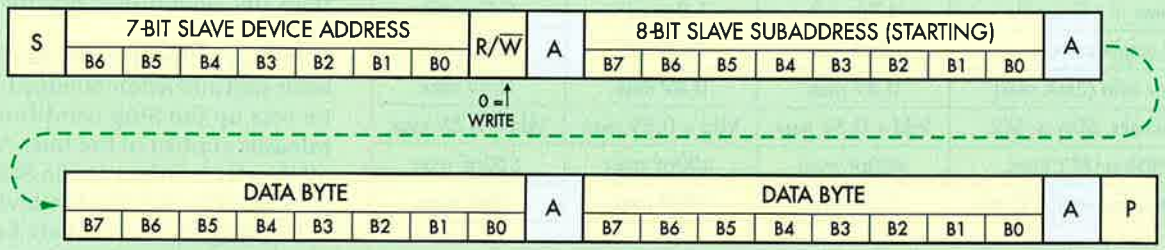


Fig.4(c): MASTER WRITING MULTIPLE DATA BYTES TO SLAVE DEVICE SUBADDRESSES (IN SEQUENCE)

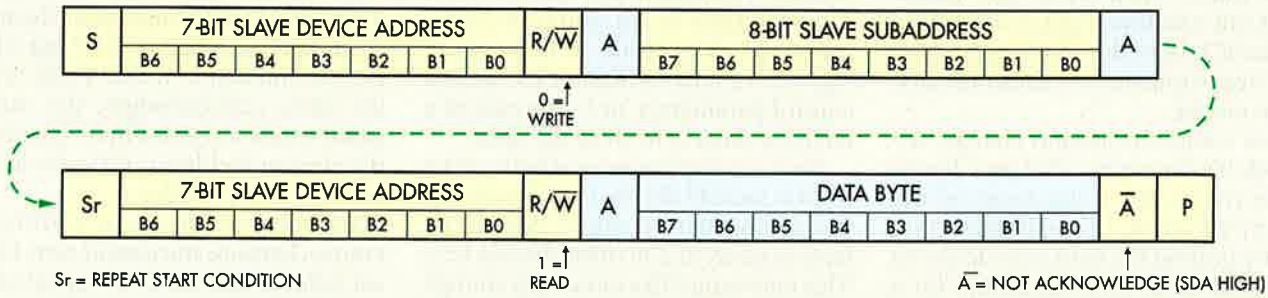


Fig.4(d): MASTER READING A SINGLE DATA BYTE FROM A SLAVE DEVICE SUBADDRESS

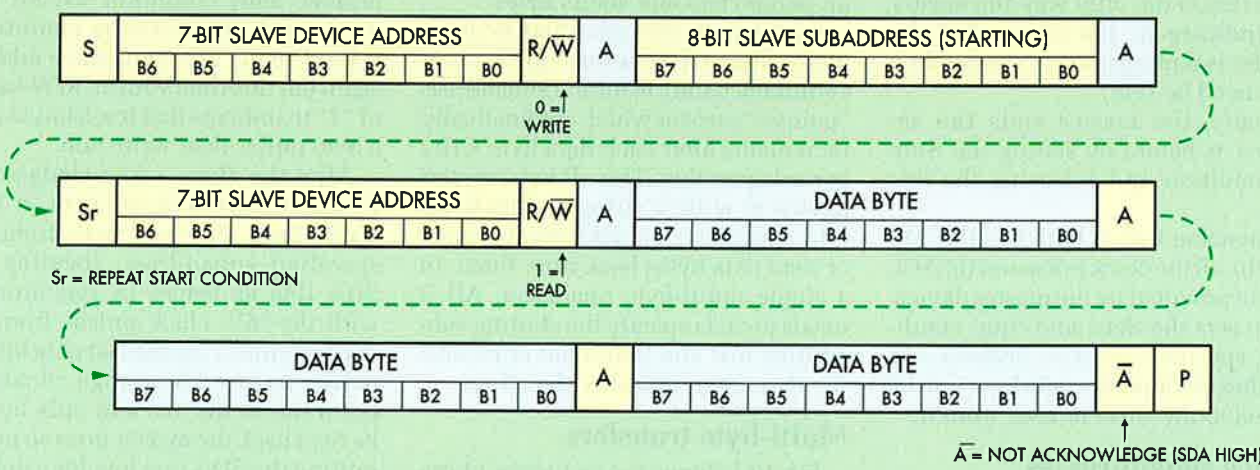


Fig.4(e): MASTER READING MULTIPLE DATA BYTES FROM SLAVE DEVICE SUBADDRESSES (IN SEQUENCE)

Table 1: I²C Timing and Electrical Characteristics

Parameter	Standard-mode	Fast-mode	Fast-mode Plus
SCL clock frequency	0–100kb/s	0–400kb/s	0–1Mb/s
SCL clock low time	4.7µs min	1.3µs min	0.5µs min
SCL clock high time	4.0µs min	0.6µs min	0.26µs min
Setup time, S or Sr condition	4.7µs min	0.6µs min	0.26µs min
Hold time, S or Sr condition	4.0µs min	0.6µs min	0.26µs min
Data setup time	250ns min	100ns min	50ns min
Data valid time	3.45µs max	0.9µs max	0.45µs max
Acknowledge data valid time	3.45µs max	0.9µs max	0.45µs max
Rise time, SCL or SDA sigs	1µs max	300ns max	120ns max
Fall time, SCL or SDA sigs	300ns max	300ns max	120ns max
Setup time, stop (P) condition	4.0µs min	0.6µs min	0.26µs min
Bus free time, P – S cond's	4.7µs min	1.3µs min	0.5µs min
Low level output current	3mA min	3mA min	20mA min
Output low volts (3mA sink)	0.4V max	0.4V max	0.4V max
High level volts, SDA or SCL	Vdd + 0.5V max	Vdd + 0.5V max	Vdd + 0.5V max
Shunt C, SDA or SCL lines	400pF max	400pF max	550pF max
Capacitance for each I/O pin	10pF max	10pF max	10pF max

acknowledges the request by pulling the SDA line low (A) for the ninth clock pulse. Then when the master sends out a further eight clock pulses on the SCL line, the slave toggles the SDA line to transmit the data bits back to the master.

Now comes the second change. Although it's the master that now has to acknowledge that it has received the data byte from the slave, it doesn't do this by pulling the SDA line down on the ninth clock pulse as before for a normal acknowledge (A). Instead, it leaves it high for a not-acknowledge (A-bar). Can you guess why? It's because this is the only way the master can indicate to the slave that the transfer is ending and no further data bytes need be sent.

Finally, the master ends the sequence as before by setting the Stop (P) condition and releasing the bus lines.

Remember that in both Fig.4(a) and Fig.4(b), all the clock pulses on the SCL line are provided by the master device. It also sets the Start and Stop conditions, specifies the slave address and specifies whether the data byte is to be written to the slave or read from it.

Device subaddresses

Although each device connected to an I²C bus has a single main address, the I²C specification does allow it to have multiple secondary or subaddresses. This can be very useful where a device such as an audio or video processor chip needs to have many registers or latches to store its various control parameters, or in the case of a memory device, to store the data.

Since a complete second byte can be used to specify the device subaddress, this means that a complex device can have as many as 256 subaddresses (2^8). This may sound like more than enough but some very complex video processing chips do need over 180 different subaddress registers to store their setup parameters and status bytes.

Fortunately, devices which do have multiple subaddresses usually have an additional handy feature: a subaddress "pointer" register which automatically increments after each data byte write or read operation. This allows a master device to write a string of data bytes into successive subaddress registers, or read data bytes back from them, in a single multi-byte operation. All it needs to do is specify the starting subaddress first and then send or receive the data bytes one after the other.

Multi-byte transfers

Fig.4(c) shows the sequence of operations involved for a master device to write a number of data bytes into successive subaddresses in a slave device. As you can see, the sequence begins as before with the master setting up the Start condition (S), followed by the main address of the slave device which is to receive the data, plus an R/W-bar bit of zero to indicate a data write.

When the addressed slave device acknowledges (A), the master then sends a second byte specifying the starting subaddress. Then, after the slave acknowledges again, the master simply begins sending the data bytes themselves, one after the other. The slave acknowledges the receipt of each data byte and saves them in consecutive subaddress registers, starting with the subaddress specified by the master.

Finally, after the last data byte has been sent and acknowledged, the master sets up the Stop condition (P) and releases control of the bus. As before, all the clock pulses on the SCL line are generated by the master device.

Reading back a data byte from a single slave device subaddress is similar but with a couple of noteworthy differences – see Fig.4(d).

As before, the master sets up the Start condition (S) and sends the main slave address plus an R/W-bar bit of zero to indicate a write. Then, when the slave acknowledges, the master again sends a second byte specifying the slave subaddress and waits for the slave to acknowledge.

But now things take a different course, because the master now has to set what is known as a "repeat start" condition (Sr), to signal that it is still controlling the bus (note: a repeat start condition is virtually the same as a normal Start condition except that it does not follow a Stop condition). It then sends the main slave address again but this time with an R/W-bar bit of "1" to indicate that it wishes to read a byte rather than write one.

After the slave acknowledges this repeated slave address byte, it then sends back the data byte from the specified subaddress, toggling the SDA line as before in synchronism with the SCL clock pulses from the master. Following the last data bit, the master must acknowledge, of course, but if this is the one and only byte to be read back the master does so not by pulling the SDA line low for a normal acknowledge but by leaving it high for a NACK (A-bar). This is to indicate to

siliconchip.com.au

the slave that there are no more bytes to be read back.

Finally it sets up the Stop condition (P) as before, to release control of the bus.

The sequence of events when the master device wants to read back a number of data bytes from consecutive slave subaddresses is very similar. This is shown in Fig.4(e).

Here the master sets the Start condition (S) and sends the slave device address first as before, followed by an R/W-bar bit of zero for writing. Then, when the slave acknowledges, it sends the starting subaddress and waits for the slave to acknowledge again. It then sets a repeat start (Sr) condition and again sends the slave device address, followed by an R/W-bar bit of one to indicate that data will now be read from the slave rather than written to it. After acknowledging (A), the slave then sends back the first byte of data from the specified starting subaddress.

When the master acknowledges that it has received this first data byte by pulling the SDA line down (A), the slave continues to increment its internal subaddress pointer and send back data bytes from consecutive subaddresses. This continues until the master acknowledges the last byte it wishes to receive in the current transfer, by leaving the SDA line high during the ninth clock pulse (ie, A-bar) rather than by pulling it down as for the earlier bytes. This again signals the slave that no more bytes are to be sent back.

Finally, as before, the last step is for the master to set up the Stop condition (P) and release control of the bus.

Other bus events

We have now looked at virtually all of the events that take place on a basic "single master/multiple slaves" I²C interface bus. As most common applications are of this type, you shouldn't have much trouble with them if you've kept up so far.

There are also other kinds of I²C bus events like "clock synchronisation", "arbitration" and "clock stretching" but these mainly come into the picture with more complex multi-master systems – like 10-bit addressing. For the most part, you won't need to worry about them, so I'm not going to try explaining them here.

If you do need to find out more about them, they're covered quite well in NXP's I²C Bus Specification and User Manual, which can be downloaded from the NXP website (**www.nxp.com/acrobat_download/usermanuals/UM10204-3.pdf**).

I²C bus speeds

When Philips first developed the I²C bus, it was only intended for low-speed operation – up to 100kb/s (kilobits per second). However, over the years, the I²C specification has been revised and expanded and nowadays there are a total of four different allowable bus speed modes.

The original 0-100kb/s mode is now known as "Standard Mode", while the other three modes are designated "Fast Mode" (0-400kb/s), "Fast Mode Plus" (0-1Mb/s) and "High Speed Mode" (0-3.4Mb/s).

Table 1 shows the most important electrical characteristics of the three speed modes in common use.

If devices are to be used on an I²C bus running in one of the higher speed modes, they must be given SDA and SCL driver and buffer stages capable of working at those higher speeds. On the other hand, a device which does have higher speed drivers and buffers can always be used on an I²C bus operating in Standard Mode. In fact, this backwards compatibility is part of the I²C specification.

Debugging & troubleshooting

Debugging and troubleshooting of I²C bus circuits can often be done by monitoring bus activity using a dual-trace oscilloscope, with one trace watching the SCL line and the other the SDA line. If the scope is arranged to trigger on a negative-going edge on the SDA line, it will trigger for each Start condition.

However, for tracking down more subtle problems, it may be necessary to use an I²C debugging program running on a PC, linked into the bus via a suitable hardware interface adaptor. This type of program usually allows you to do things like reading data from slave device subaddress registers, or writing data into them to program device operation "on the run".

There are various I²C debugging programs currently available, many of them designed to work with their own USB-I²C hardware interface. These combined software and hardware packages can be fairly pricey though – up to hundreds of dollars in some cases.

Fortunately, for quite a few years now, Philips/NXP has made available a freeware debugging program of their own, called "URD" – short for "Universal Register Debugger". The current version of this is v3.12, which can run on any version of Windows up to Windows XP. It comes as a self-installing file called URD312.EXE and when it installs, it also unpacks two PDF files.

These PDF files provide a User Manual for the program (URDUser.pdf) and a reference manual (URDLang.pdf) for its programming language, which seems to be derived from Microsoft's Visual Basic for Applications.

Hardware interface

URD v3.12 is compatible with a very simple hardware interface which connects to one of the PC's parallel printer ports and comes with a driver for this type of interface. Elsewhere in this issue, you'll find a simple LPT/I²C interface of this type described, so you can build one up yourself to use with the URD program. Together they make a much cheaper alternative to commercial I²C debugging packages. SC

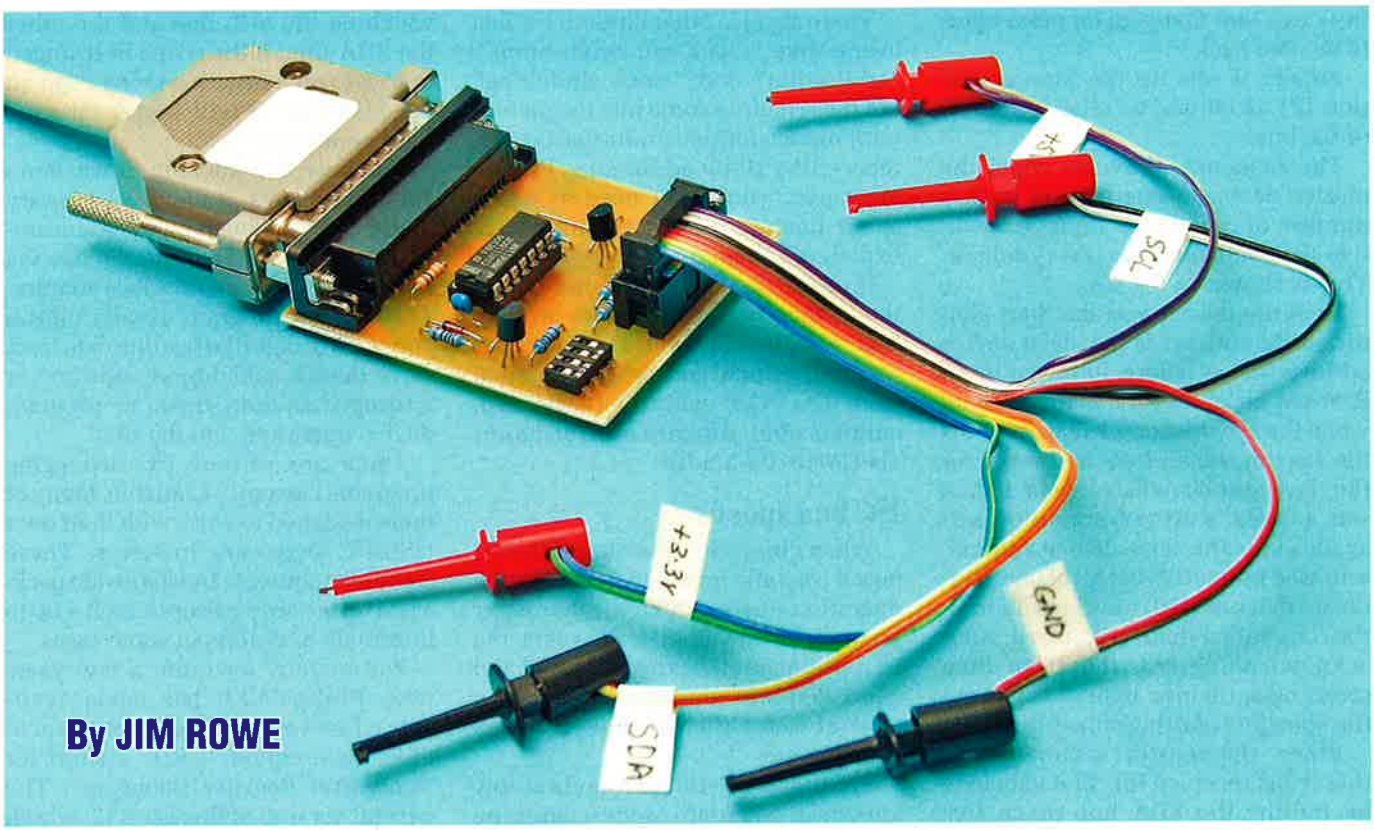


Issues Getting Dog-Eared?

Keep your copies of SILICON CHIP safe with these handy binders



Available Aust. only. Price: $A13.95 plus $7 p&p 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.



By JIM ROWE

A low-cost LPT-to-I²C interface for debugging

Tracking down problems in circuits which are programmed via an I²C bus can be tricky and time-consuming, unless you take advantage of a debugging program running on a PC. Here's a low-cost, easy-to-build printer port to I²C interface designed to work with the Philips/NXP debugging program URD312.exe.

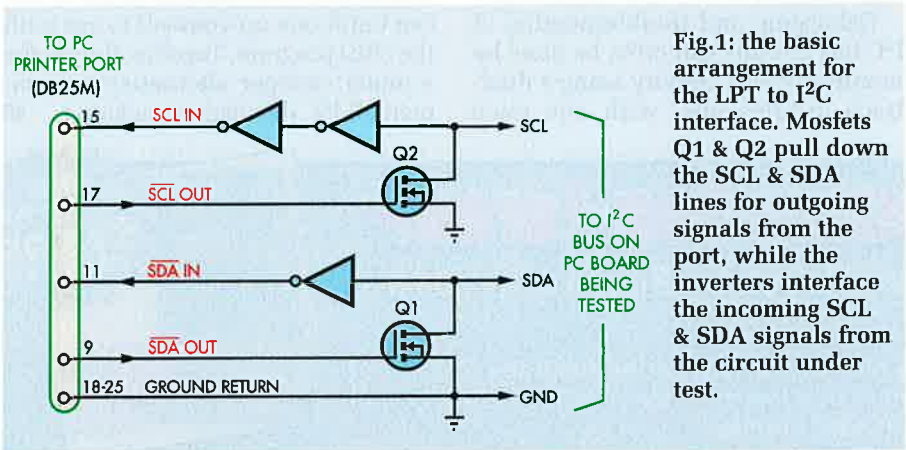


Fig.1: the basic arrangement for the LPT to I²C interface. Mosfets Q1 & Q2 pull down the SCL & SDA lines for outgoing signals from the port, while the inverters interface the incoming SCL & SDA signals from the circuit under test.

JUST RECENTLY, I was trying to finish a project which uses a couple of video-processing ICs that are programmed via the I²C bus. However, I struck trouble with one chip. For some reason, it wasn't responding correctly to the set-up data I was sending to it from the project's microcontroller, even after I had been through my control program umpteen times searching for bugs (or programming errors).

Even when I wrote a test program and captured the I²C bus activity with my digital scope, I still couldn't track down the source of the trouble.

Fortunately, before tearing out the last few strands of my hair, I decided to seek help from the support people at NXP (formerly Philips Semiconductors) – not only because the chip concerned happened to be one of theirs but because it was Philips that developed I²C in the first place. After all, if anyone should be expert at solving I²C problems, it should be NXP.

As it turned out, they were very helpful. An NXP support engineer promptly sent me an email suggesting several things to try. Then, when that didn't fix things, he suggested I try analysing the problem using a debugging program running on a PC. Not only that but he also sent me a copy of the latest version of their free I²C debugging program (called "URD"), which they developed quite a few years ago. The current version turned out to be v3.12, which comes as a self-installing package called URD312.exe (more on this later).

Along with the program, he also sent a device data register set-up file for the video processing chip I was working with, so the URD program could communicate with it sooner. And last but by no means least, he sent me a PDF file with the circuit of the original PC printer port/I²C interface card that the URD program was designed to work with, so I could build one up for the troubleshooting.

That's pretty good support from the other side of the world, don't you think?

As it happened, the original interface used a 74LS05 chip that I didn't have, so I decided to update the circuit to use devices that are readily available nowadays. And that's the project described here – it uses a 4011B quad NAND gate, a couple of Mosfets and not much else.

How it works

Like the original NXP/Philips interface, this unit is designed to allow the URD program to communicate with an I²C bus on a development board via the PC's parallel printer port (LPT). The basic arrangement of the circuit is shown in Fig.1.

In operation, the URD program sends out the SCL pulses in inverted form via pin 17 of the printer port (originally used for the SEL-bar line). So the interface uses this printer port line to control Mosfet Q2, which is used to pull down the SCL line of the I²C bus.

Conversely, the URD program monitors the I²C bus SCL pulses via pin 15 of the printer port, which was originally used for monitoring the printer's Error-bar line. As a result, the interface feeds back the SCL line status to pin 15 via a pair of inverters which function as a non-inverting buffer.

Similarly, the URD program sends out data to the SDA line (in inverted form) via pin 9 of the printer port, originally used to send parallel data bit 7 to the printer. The interface uses this printer port line to control Mosfet Q1, which is used to pull down the SDA line of the I²C bus.

Finally, the URD program receives data from the SDA line (again in inverted form) via pin 11 of the printer port, which was originally used for monitoring the printer's Busy/Ready-bar line. So, in the interface, we feed

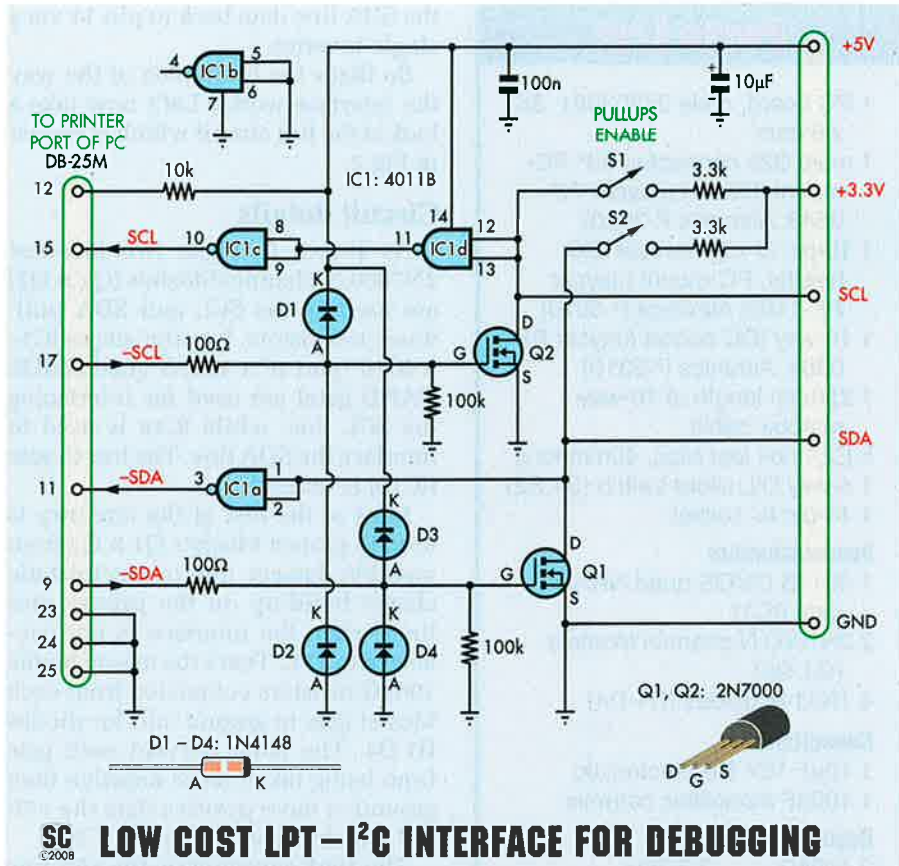


Fig.2: the complete circuit for the LPT to I²C interface. It's based on Mosfets Q1 & Q2, a 4011B quad NAND gate (IC1a, IC1c & IC1d) and just a few other parts. Diodes D1-D4 are there to protect the Mosfets.

SC ©2008 LOW COST LPT–I²C INTERFACE FOR DEBUGGING



Parts List

1 PC board, code 04203081, 55 x 61mm
1 male D25 connector, 90° PC-mount (CON1) (Jaycar PP-0843; Altronics P-3220)
1 10-pin (5 x 2) vertical IDC header, PC-mount (Jaycar PP-1100; Altronics P-5010)
1 10-way IDC socket (Jaycar PS-0984; Altronics P-5310)
1 250mm length of 10-way rainbow cable
5 EZ-hook test clips, 40mm long
1 4-way DIL slider switch (S1,S2)
1 14-pin IC socket

Semiconductors

1 4011B CMOS quad NAND gate (IC1)
2 2N7000 N-channel Mosfets (Q1,Q2)
4 1N4148 diodes (D1-D4)

Capacitors

1 10µF 16V RB electrolytic
1 100nF monolithic ceramic

Resistors (0.25W 1%)

2 100kΩ
1 10kΩ
2 3.3kΩ
2 100Ω

the SDA line data back to pin 11 via a single inverter.

So that's the basic idea of the way the interface works. Let's now take a look at the full circuit which is shown in Fig.2.

Circuit details

As shown in Fig.2, two low-cost 2N7000 N-channel Mosfets (Q1 & Q2) are used as the SCL and SDA pull-down transistors. Inverter stages IC1c & IC1d (part of a 4011B quad CMOS NAND gate) are used for interfacing the SCL line, while IC1a is used to interface the SDA line. The fourth gate (IC1b) is unused.

Most of the rest of the circuitry is used to protect Mosfets Q1 & Q2 from possible damage due to electrostatic charge build-up on the printer port lines when the interface is not connected to a PC. That's the reason for the 100kΩ resistors connected from each Mosfet gate to ground and for diodes D1-D4. The latter prevent each gate from being taken more negative than ground or more positive than the +5V rail which is used to power IC1.

The 10µF capacitor on the +5V line provides supply line filtering, while the 10kΩ resistor ensures that pin 12 of the printer port is pulled high. This is a requirement of the URD program which expects to find a logic high on this pin of the printer port (originally used for monitoring the "Out of paper" line).

Switches S1 & S2 can be used to switch in two 3.3kΩ pull-up resistors on the SCL & SDA lines respectively. This is necessary if the I^2C bus lines on the PC board being tested don't already have pull-up resistors.

Note that the interface line marked "+3.3V" must be connected to the +3.3V line supplying power to the I^2C chips on the board being tested, so the interface pull-ups can function correctly.

As indicated, the interface pull-ups aren't needed if the board being tested is already provided with pull-ups of its own. In that case, S1 and S2 are simply left open (and the interface's +3.3V lead doesn't need to be connected to anything).

Building it

Building the interface is very straightforward, as all the parts are mounted on a small PC board coded 04203081 and measuring 55 x 61mm. These parts include the male D25 connec-

From the publishers of SILICON CHIP
Our most ambitious title yet:
PERFORMANCE ELECTRONICS FOR CARS
NOT A REPRINT: More than 160 pages of new and exciting projects never published before – all designed to get top performance from your car.
FASCINATING ARTICLES: 7 chapters explaining your car – engine management, car electronics systems, etc
ADVANCED PROJECTS: You'll build controllers for turbo boost, nitrous, fuel injection and much more!
We explain the why as well as the how to!
Available direct from the Publisher ($22.50 inc postage):
Silicon Chip Publications, PO Box 139, Collaroy NSW 2097. Ph (02) 9939 3295; Fax (02) 9939 2648;
email silchip@siliconchip.com.au or via our website: www.siliconchip.com.au



tor used to mate with the PC printer port.

Fig.3 shows the parts layout. Install the single wire link first, then install the resistors, the four diodes and the two capacitors. Be sure to orientate the diodes and the 10µF electrolytic capacitor exactly as shown.

Follow these parts with the two Mosfets (Q1 & Q2) and the IC, again taking care to ensure they go in the right way around. The assembly can then be completed by fitting the D25 connector (CON1), the IDC header (CON2) and the 4-way DIP switch.

Take care when installing CON2 – the slot in its body goes towards the bottom edge of the PC board.

Note that switches S1 & S2 are part of a 4-way DIP switch, with the other two switches not used. If you happen to have a 2-way DIP switch, this could be used simply by fitting it in the two righthand positions (nearer the 3.3kΩ resistors).

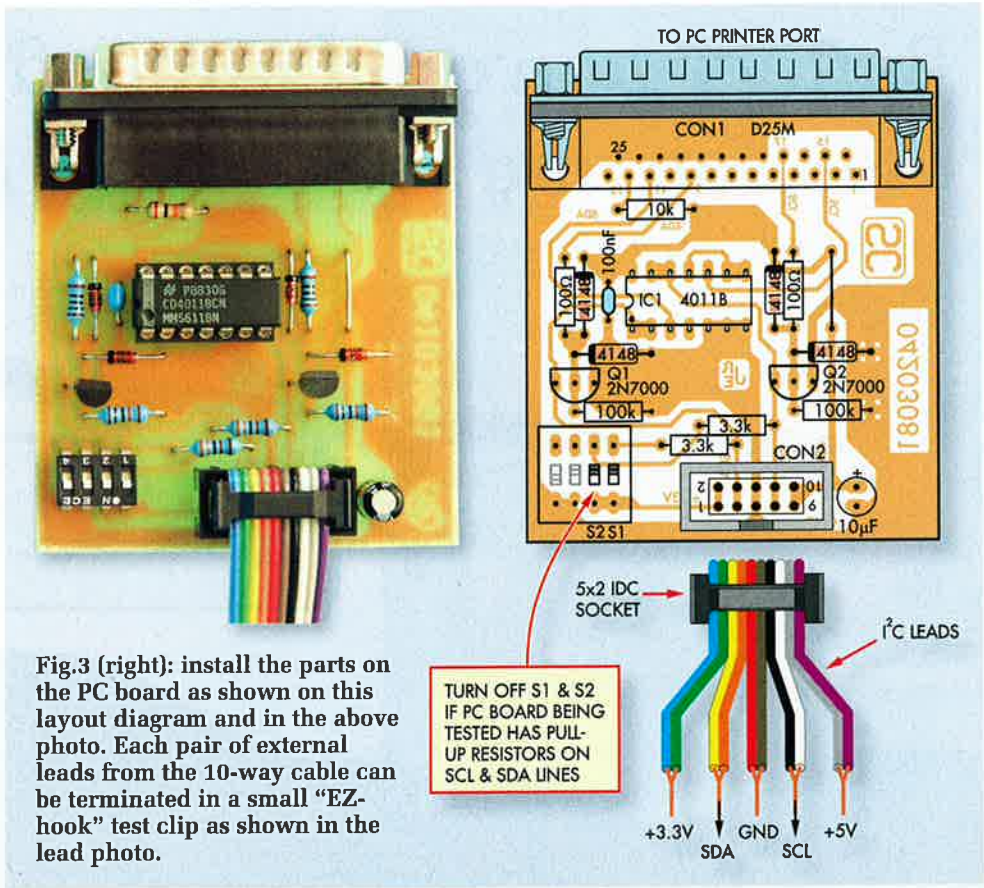


Fig.3 (right): install the parts on the PC board as shown on this layout diagram and in the above photo. Each pair of external leads from the 10-way cable can be terminated in a small "EZ-hook" test clip as shown in the lead photo.

The 10-way IDC header (CON2) provides the interface to the I²C circuit under test. This allows you to make up a test lead cable from a 250mm length of ribbon cable which is fitted with a 10-way IDC socket at one end to mate with the header. Each pair of wires in the cable can then be terminated in a small "EZ-hook" test clip to make the connections to the PC board being tested.

Putting it to use

There's not a great deal involved in using the interface, apart from connecting the I²C leads from CON2 to the appropriate points on the PC board you're debugging. This means connecting the SCL and SDA leads to the same lines on the board to be tested, the ground lead to the board's ground and the +5V lead to a suitable supply rail on the board.

If you're going to be using the pull-up resistors on the interface, you'll also need to connect the +3.3V lead to the positive rail of the chips connected to the I²C bus – and close interface switches S1 and S2, of course.

On the other side of the interface, all that's needed is to plug CON1 into a printer port connector on a suitable PC, either directly or via a short D25M-D25F extension cable if necessary. After that, it's simply a matter of running the URD program and using it to check and/or modify the contents of the I²C subaddress registers inside the chips on the board you're working on.

Obtaining the URD program

To make it easier for you to get the NXP/Philips URD312 debugging program, we are posting a copy of URD312.EXE on the SILICON CHIP website (**www.siliconchip.com.au**). If you download this and execute it, you'll find that it will install on most PCs running Win98, WinMe, Win2000 and WinXP. When it installs, it also loads the driver it needs for communicating with the interface via the printer port.

I had no difficulty installing and running the URD program on a machine running Win98 but it did have a problem talking to the printer port when I installed it on a machine running WinXP/SP2. I still haven't sorted out that particular problem at the time of writing this article but it may be part of the tighter security enforced by WinXP when the SP2 patches are applied. **SC**

Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	2	100kΩ	brown black yellow brown	brown black black orange brown
❑	1	10kΩ	brown black orange brown	brown black black red brown
❑	2	3.3kΩ	orange orange red brown	orange orange black brown brown
❑	2	100Ω	brown black brown brown	brown black black black brown

Battery-powered aircraft creates aviation and technology history



"Powered" Flight!

Two days before Christmas, a light aircraft took off from the Aspres sur Brec airfield near Gap in the French High Alps and flew for more than 50km without using a drop of petrol or avgas.

It was the first flight of a fixed-wing, piloted plane powered only by battery and electric motor. The plane, named the "Electra", was a single-seater Souricette wood-and-fabric aircraft, built from a kit and modified for the purpose. It was fitted with a British-made 25hp electric motor (of the type used in golf carts) and 48kg of lithium-polymer batteries.

With test pilot Christian Vandamme at the controls, it flew a course through The Alps for 48 minutes.

While electric-powered flight has been achieved before, it was either with ultralights, powered hang gliders or pilotless drones. In fact, SILICON CHIP featured such a flight more than fifteen years ago – in the October 1991 issue.

And US inventor Paul MacCready, who developed the first man-powered plane, the Gossamer Albatross, has also pioneered electric-motor-powered microlights and ultralights, including a flight over the English Channel in 1981.

However, a fixed-wing, conventional plane (one with an airworthiness certificate) flying with only battery power has until now been a dream.

A group founded to promote electric/green flight, the French "APAME" group, (rough translation Association for Promotion of Electric Aircraft), was behind the project, in collaboration with ACV Aero Services, Pegase, Capenergies and Onera.

President of APAME, Anne Levrand, said that the flight showed that non-polluting, quiet, light aviation was within reach. "Fuel cost per hour of the Electravia was around one Euro, compared with about 60 Euro for an equivalent petrol-driven aircraft," she said. "The motor and batteries will cost between ten and fifteen thousand Euro, roughly the same as current small petrol engines."

However, this comparison has started fierce debate amongst green and aviation groups, who maintain that when you take the cost and environmental impact of the batteries into account (especially the lithium) and then look at factors such as performance, petrol still wins hands-down.

The debate highlights one of the major hurdles in electric-powered anything – but most importantly aircraft – the weight and weight-to-power ratio of the batteries. Typically, batteries produce just 2% of the energy of the same mass of petrol.

by ROSS TESTER

Some technical data:

Aircraft:
- "ELECTRA" registration no F-WMDJ :
- One-seater
- Kit construction, in wood and fabrics
- Wing span : 9m
- Length : 7m
- Weight of the aircraft without batteries: 134kg
- Maximum weight for take off : 265kg
- Cruise speed : 90km/h
- Special ground-adjustable propeller from ARPLAST

Electrical:
- Motor: 18kW disk brush type
- Batteries: Lithium - Polymer
- Total weight of batteries: 47kg
- Quick charge: 45 minutes

And while huge reseach budgets in the battery field are currently producing exciting results (see the feature in the next issue of SILICON CHIP), they are still a long way behind the internal combustion engine.

Moreover, with current and even foreseeable technology, battery power can only result in propeller-driven aircraft with all their current disadvantages over jet aircraft.

But this flight demonstrates that electric flight is possible.

The Times of London reported that Sonex, a leading US manufacturer of kit aircraft, is about to fly a 50hp electric plane that can carry two people at 220km/h for up to an hour before recharge.

This puts the aircraft right into the recreational pilot market where modest-performing, light sport aircraft are in demand.

The Times also reported that NASA and Boeing are currently researching hydrogen-fed fuel cells which will drive high performance and high power electric motors, capable of powering much larger aircraft for much longer flights. SC

Earlier successes...

Electric Ultralight Trike



On August 25th 2007, the ultralight trike called "Electron Libre" (it means "free electron"!), powered by a 20hp electric brush motor and supported by APAME and ACV Aéro Service, performed a 22 minute flight in calm atmosphere conditions from Aspres sur Buëch airfield (Alpen). New powerful LIPO batteries allow such a performance. Of course the trike is almost noiseless. Flight with electric motor is now possible and affordable by all.

TENROD

Small Colour TFT LCDs


Door Camera

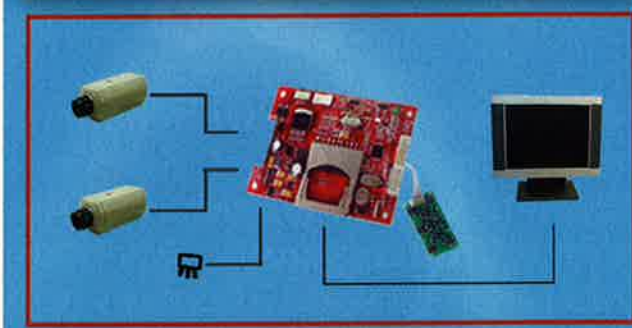

3.5" Small TFT LCD


4.0" Small TFT LCD


5.6" Small TFT LCD

- Full Colour TFT LCD
- NTSC & PAL Compatible
- With Picture Quality Control
- DV 12V Operation
- Simple Wire Harness Connection

Digital Video Recorder Module



Video & Still Image Recording On Motion Detect

- 2 Video Ch Input
- NTSC & PAL
- Alarm output
- Trigger input
- SD card
- On Board Flash
- JPG & AVI file format
- Real time clock
- Date & time stamp
- PIP, OSD
- With keyboard
- RCA connections
- DC input (9V to 12V)
- Kit available

Quality System Endorsed Company

www.tenrod.com.au
sales@tenrod.com.au
NSW: Unit 1, 24 Vore Street Silverwater NSW 2128
tel: (02) 9748 0655 fax: (02) 9748 0258
VIC: tel: (03) 9886 7800 fax: (03) 9886 7799
QLD: tel: (07) 3879 2133 fax: (07) 3879 2188

Vintage Radio



By RODNEY CHAMPNESS, VK3UG

The batteries used to power vintage radios

This view shows an assortment of old Eveready 1.5V cells and batteries, together with a 3V battery at far right. A Burgess 4.5V battery is also shown.



Many valve radios were battery-powered but a lot of the battery types used are now obsolete and no longer available. However, with a little ingenuity, sets that would otherwise be static displays only can be restored to full working order.

WHEN WE STOP to think about it, our civilisation would almost grind to a halt without batteries. Without them, there would be no iPods, no mobile phones, no handheld remote controls, no torches, no hearing aids, no battery-powered radios, no cordless mice or keyboards and no cordless telephones, to name just some of the equipment we now take for granted. Even worse, we would have to hand-crank our cars to start them if we didn't have batteries to do the job for us!

Batteries were used to power many early valve radio receivers, particularly in areas where mains power was unavailable. These batteries consisted of both primary (non-rechargeable) and secondary (rechargeable) types. A primary battery is one that uses up its chemicals in an irreversible reaction and is disposed of after use (ie, after it has gone "flat"). By contrast, secondary batteries can be recharged because the chemical reactions that take place inside them are reversible.

Primary cells

Many types of primary cells had been developed by the early 20th century. These included the Fuller bichromate cell, Edison cell, Grenet Bichromate cell, Bunsen cell, Daniell cell, Gravity cell, Daniell gravity cell, Grove cell, Poggendorff cell, silver chloride cell, air depolarised cells and last but not least, Leclanche cells. Many of these cells were a variation on a theme and all were an attempt to provide electrical energy in an economical and convenient way.

Because quite corrosive chemical solutions were used in many of these cells, considerable care was necessary when handling them. In fact, none of these cells were convenient to use in radios in their original format. However, the Leclanche cell was eventually modified to give us the now familiar "dry cell". This is now the most common primary cell used in portable radios.

Typically, a Leclanche dry cell has a positive carbon pole contained in a porous container filled with manganese dioxide which acts as a depolariser (the depolariser is used to remove the hydrogen gas that is developed on the carbon pole). This assembly stands in a container of ammonium chloride paste which also includes a negative zinc pole. It produces an output voltage of nominally 1.5V.

One of the accompanying photos shows three glass-encased cells. The front one is an early Leclanche cell. However, we are more familiar with the normal torch cell in the same photograph, which is basically a refined version of the Leclanche cell and is much easier to use.

Secondary cells

By contrast with primary cells, secondary cells are a more recent development which occurred around



Dry batteries designed to power valve radio sets came in all shapes and sizes. The units shown here are now all obsolete.

1800. However, practical cells did not become available until about 1880.

As stated above, secondary cells are rechargeable and include lead-acid car batteries and the nickel-cadmium (nicad) and nickel-metal hydride (NiMH) cells now used in many electronic devices. Because they are rechargeable, they can significantly reduce long-term battery costs in many applications. Early secondary cells include Plante cells, Faure cells and alkaline cells, with quite a few variations on a theme.

During the early 20th century, secondary cells were classified according to their construction as follows: lead sulphuric acid cells, lead-zinc cells, lead-copper cells and alkaline zincate cells. The lead-acid cell is now the main secondary cell used in the automotive industry, while NiFe cells (nickel and iron electrodes) and, more recently, nickel cadmium cells are the main alkaline-based electrolyte secondary cells commonly in use.

Maintenance

Rather than being discarded, early primary cells were refurbished. The elements that were used up in the chemical reactions were replaced, after which the cell was again ready for use. However, this was a messy and quite often expensive exercise. Furthermore, the chemicals could be quite corrosive, so care was essential.

Almost without exception, primary cells now are thrown away when they become exhausted. Chinese "D" cells may cost from 25 cents upwards while high-quality alkaline cells may cost in the region of $2.00 each but will give superior service.

It's also interesting to note that some attempts were made to recharge primary cells back in the 1950s and early 1960s. During that era, a number of portable radio manufacturers installed a "re-activation" circuit into their radios. When the portable was connected to the mains, the set would work directly off the mains and the supply circuitry would also be used to "recharge" the installed dry batteries.

In practice, various protocols had to be followed to recharge the batteries and the number of recharges the batteries could successfully take was decidedly vague. Usually, the instructions were not to use the batteries in the set to the point of being completely discharged before plugging the set into the mains again. Even four to five semi-successful "recharges" was considered good value, as the batteries were quite expensive.

HMV recommended that the batteries in their sets be "re-activated" for six hours for every hour of operation. They believed that a set was typically used for around two hours a day, so an overnight charge would be the most convenient way of doing this.

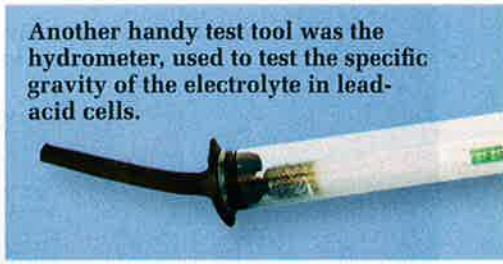
However, HMV also inferred that the batteries must be reactivated as soon as possible after any discharge, otherwise recharging would not be successful. Apparently, using the batteries on successive days without reactivation would make later attempts futile.

I have no idea as to whether this idea would work with today's dry cells, including alkaline types. However,


High-discharge testers like this unit were used for checking lead-acid cells. The battery is shown for size comparison.



An assortment of transistor radio batteries. These are mainly 9V types, the main exception being the 2510 at right which had 2 x 7.5V outputs.



Another handy test tool was the hydrometer, used to test the specific gravity of the electrolyte in lead-acid cells.

the instructions on many of these batteries indicate that it should not be attempted. Perhaps this is because people may endeavour to recharge the cells at too high a rate which could cause them to explode. You have been warned!

During in the 1960s and 1970s, Astor and AWA also made some portable-cum-car radio transistorised receivers that used rechargeable nicad AA cells. These sets were rather advanced for their time and they were fairly expensive.

Secondary cell problems

A disadvantage of early lead-acid secondary batteries was that it was necessary to keep an eye on the charging procedure. This involved using hydrometer to check the charge condition of each unsealed lead-acid cell. A high-discharge cell tester was also commonly used with car batteries.

During this procedure, it was very important not to smoke or create any sparks. This was to prevent the hydrogen gas given off during charging from exploding. It's a warning that's still valid today.

Early valve radios

Early valve radios commonly used the 201 or the later 201A triode valves. These required filament voltages of 5A at 1A and 5V at 0.25A respectively.

In practice, these valves were commonly run from a 6V lead-acid battery with a rheostat in series with the filaments to reduce the applied voltage to 5V.

By contrast, the high-tension (HT) voltage for the 201 & 201A varied from around 22.5V to about 135V, depending on the valve's function in the circuit. The HT current drain was usually less than 25mA for the entire receiver.

In the early days, miniature lead-acid batteries were sometimes made up to supply the HT requirements of such receivers. Just imagine a bank of 60 cells supplying 120V to a receiver, then imagine having to check the electrolyte in each of these cells each time they had to be charged! That would really have been fun!

I have only ever seen one example of these miniature batteries so I suspect that they weren't all that popular.

An alternative involved using a bank of dry cells to provide the necessary HT voltage and current for the receiver. For a 135V HT rail, this involved connecting 90 cells in series.

It's worth noting here that dry cell manufacturers standardised on the size of the cells used in their batteries at an early stage. For the HT batteries, they used A-size cells which are smaller than C-size cells. We don't see them around these days but one is shown in the lead photo, standing alongside the cyclindrical No.6 cell.

Dry cell deficiencies

Unfortunately, early dry cells did have some deficiencies. First, the insulation used between the cells in a battery was commonly cardboard and in a moist environment this became slightly conductive. As a result, the batteries would discharge and go flat over a period of several months, a problem that was particularly evident in hot, humid areas.

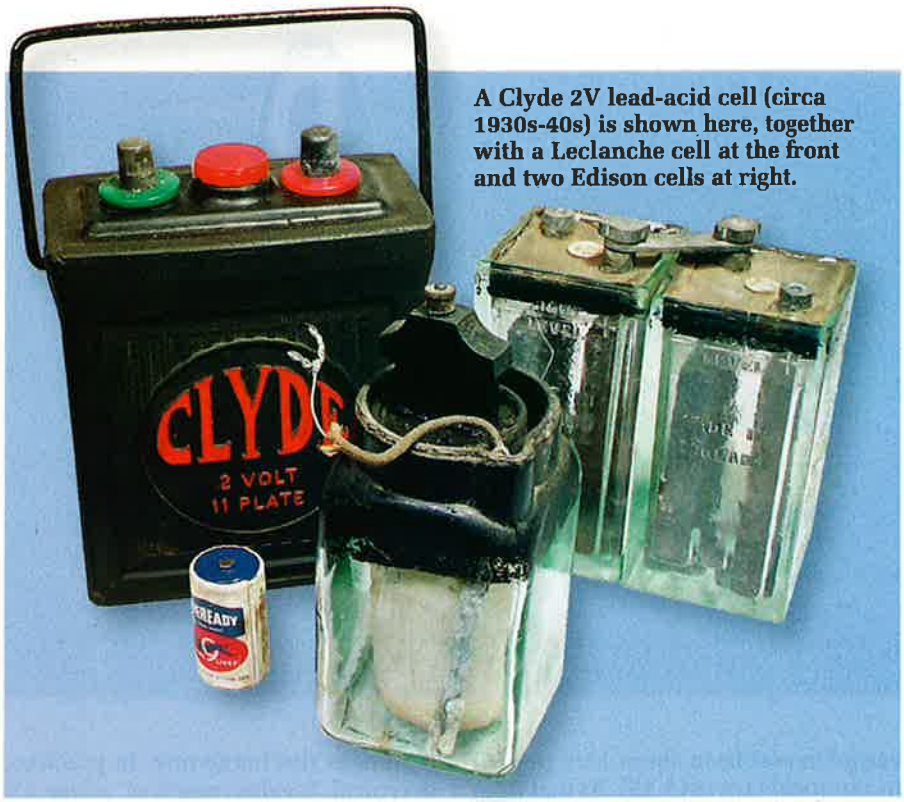
In addition, some early dry cells had a "breather" vent and the moisture in the paste-type electrolyte evaporated over a period of several months. As a result, early dry cells had a rather limited shelf life.

The earliest Traeger pedal radios (for the Flying Doctor Service) were commonly used in tropical areas and in an endeavour to overcome the discharge



Eveready made a wide range of dry batteries for valve radios, the larger "B" units shown here delivering 45V. Diamond also made a range of dry batteries.





A Clyde 2V lead-acid cell (circa 1930s-40s) is shown here, together with a Leclanche cell at the front and two Edison cells at right.

problems in dry cells, only 9V of HT was used from two 4.5V batteries.

The Australian army also initially had problems with dry batteries in their transceivers in the tropics during WWII. However, they were able to reduce the problems by completely sealing the batteries in wax. Of course, cost was not of prime concern in that instance.

Dry batteries have changed enormously over the years and today's batteries are considerably better than those used during the early valve radio era. In particular, the layer type method of construction was a major advance in packaging and was coupled with good insulation techniques and economy of manufacture. The subminiature overseas-made HT batteries, the Australian 490P & 482 types and transistor receiver batteries such as the 2761, 2362, 2510, 2364, 216 and 286, etc, all used this very efficient construction method.

When Australian manufacture of transistor radios ceased, most of the "specials" for the Australian receivers quickly became hard to get and in some cases disappeared from the market. The 276P "evolved" and became a lower grade battery. The layer construction was dispensed with and six "C" cells in a holder were incorporated in its place. This was a backward step, as the contacts in the holder didn't always make good contact and the electrical capacity of the battery was reduced.



A collection of Stanmor dry batteries. There was nothing fancy about the packaging used for these units.

By contrast, large low-voltage dry batteries did not depart from the original concept of wiring multiple A, C, D, E & F cells in parallel (I've never found any reference to a "B" cell). An advantage here was that insulation was not a problem with such low voltages. We are all familiar with the "C" and "D" cell sizes and the "A" was basically a little brother to the "C" cell. Batteries such as the X250 and 745 1.5V types used the "F" cell.

Towards the end of the valve era, portable receivers often used a combined low-tension (LT) and HT battery in the one case. Apparently, the HT sections were of layer construction while the LT sections were built using "D", "E" or "F" cells.

One such battery was the 759 which supplied 1.5V and 90V. This was suitable for household sets but was too big for portables. Another battery pack for use in rural areas was made by Eveready and contained one X250 1.5V battery and two 470 22.5/45V batteries. Although they were not all in the same case, they were all supplied together in the same delivery carton.

Of course, using an "all in one" meant that if one section failed, the whole battery had to be replaced.

Lead-acid batteries were predominantly used for supplying valve heaters and for powering vibrator HT power supplies. In practice, 2V cells varied from 25Ah capacity to 130Ah, while 6V batteries varied between 60Ah and 160Ah in capacity. In 1937, these



Diamond made a large variety of dry batteries for valve radios, including 45V "B" batteries and 4.5V and 1.5V "A" batteries.

varied in cost from about 17/6 ($1.75) to about £5/11/6 ($11.15). At that time the average weekly wage was about £4/10/- ($9.00), so they were quite expensive.

The use of 2V lead-acid cells declined quite rapidly when 1.4V filament valves were introduced, replacing those with 2V filaments. However, 6V (and occasionally 4V) lead-acid batteries remained in use with vibrator-powered receivers until around the mid 1950s.

Battery life

Most radio batteries were rated for a 20-hour discharge rate. In practice, a typical 5-valve receiver using 2V valves draws 720mA. This meant that a fully-charged 25Ah cell would need recharging after about 35 hours, whereas a 130Ah cell would operate for about 180 hours.

Similarly, vibrator-powered radios with efficient power supplies typically drew around 1A from a 6V battery. That makes the maths simple – a 60Ah battery would last around 60 hours and a 160Ah battery would last around 160 hours.

As with lead-acid batteries, dry battery life depends on the battery capacity, the current drawn and the amount of time that current is drawn during each listening session. In practice, the battery life in transistor receivers varies from around 30 hours for a 9V 216 battery to about 300 hours for a 276P battery and up to 1000 hours for a 286 (as quoted by Kriesler for one of their sets).

In typical valve portable receivers, the life of a 1.5V 745 battery allied with a pair of 45V 482 batteries was usually somewhere around 300 hours. The Australian "miniature" portables used two 950 cells to provide the filament current and a 467 67.5V battery to supply the HT current. In operation, the two 950 cells would last around 30-40 hours, while the 467 HT battery would probably last up to twice as long.

By the way, if a restorer aimed to power the filaments of such a set from "D" cells, a pair of alkaline cells would give up to 150 hours before dropping to the cut-off voltage of 1V.

The much larger dry battery packs designed for household receivers would have lasted much longer than the 745/482 combination. In fact, some combinations may have had an operational life of around 1000 hours or more. However, I have no means of being entirely sure of these figures (or the other figures quoted above), as I haven't actually put this to the test.

Battery receiver power

Providing battery power for early portable transistor receivers is not



Valve radio batteries were typically quite large and were not cheap.

an impossible task. For example, 216 batteries are still used in many transistor receivers and myriads of other electronic devices. They can often be used in transistor receivers where much larger batteries were originally specified.

Of course, the life of the 216 will be noticeably less than the battery it is replacing. The 276P was a commonly used battery but is rarely seen these days. However, WES Components in Ashfield NSW have 276 batteries with adaptors to convert them to the 276P type.

Alternatively, you can often use several AAA, AA, C or D cells in multiple cell battery holders if a 216 or a 276 battery is not appropriate.

Battery-powered console, table and mantel radios that used 2V accumulators and three 45B dry batteries in series are a different story, as suitable batteries are no longer made. However, such sets can be operated from a mains power supply that's been designed to deliver the necessary DC rails at the required current.

Another way of powering such sets is via DC-to-DC inverters. These are typically designed to work from a 6V or 12V lead-acid battery. This method is closer to the original method of supplying power, as the receiver is independent of the mains.

Valve portable receivers

Valve portable receivers provide a much greater challenge. Certainly, a mains type power supply will do the job but this means that the set can no longer be used as a portable.

A cumbersome method of supplying the HT voltage is to string together the requisite number of 216 batteries. Ten 9V batteries in series to supply 90V does look a bit odd though! Similarly, alkaline D cells can supply the filament voltage quite easily.

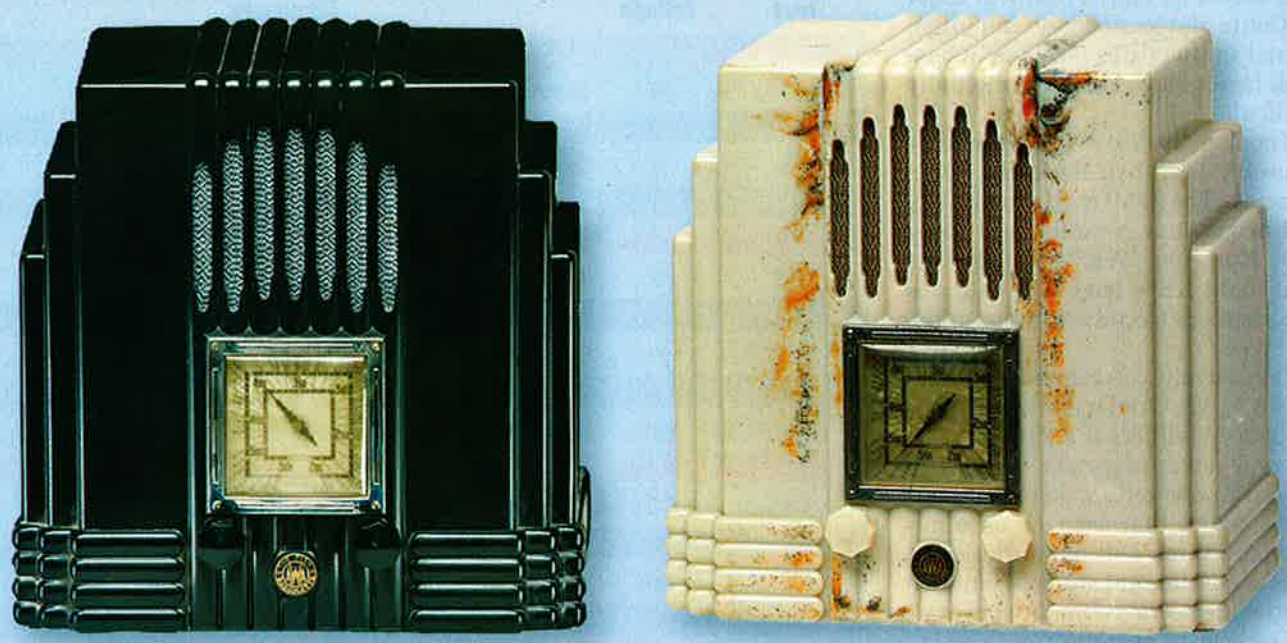
A better method of supplying the HT rail is to use a DC-to-DC inverter that will fit inside the receiver. However, this can be quite a challenge with the small miniature receivers of the late 1940s, although the full-sized portables shouldn't pose too many problems. The filament supply can still be supplied by heavy-duty alkaline cells, with the inverter supplying just the HT requirements of the receiver.

Supplying bias to battery sets is comparatively easy as no current is usually drawn from these supplies. Sometimes, the original batteries in 30-50 year old receivers still supply nearly the correct bias voltage (they will not supply any current though). Basically, it's just a matter of using suitable small batteries to do the job (AAA or 216-size batteries may suit individual receivers).

Typical Eveready Battery Types For Valve & Transistor Radios

Type	Voltage	Comments
Bias Batteries		
794	9V	Tapped bias battery
714	4.5V	Battery to suit "baby" pedal radio
W95	9V	Bias battery tapped at -1.5, -3, -6 & -9V
761	4.5V	Bias battery tapped at -1.5, -3 & -4.5V; uses 3 'D' cells, 100 x 35 x 87mm
Low-Tension Batteries		
X250	1.5V	30 x 'F' cells; companion to the older and larger 470
745	1.5V	8 x 'F' cells, 270 x 34 x 97mm
739	9V	Battery for series-wired portable set filaments; uses 6 x 'F' cells
717	7.5V	Filament battery; 5 x 'C' cells
–	1.5V	Large battery; same size as the 45V 770
High-Tension Batteries		
467	67.5V	45 layer type cells; 72 x 34 x 90mm
482	45V	Layer type construction; 90 x 43 x 138mm
470	45V	Large 45V battery, newer type; 126 x 100 x 148mm
770	45V	Large 45V battery, 22 times the volume of the 467
Transistor-Radio Batteries		
286	9V	2 x 276P batteries in parallel, 62 x 50 x 180mm
276P	9V	62 x 50 x 90mm
733	9V	57 x 52 x 90mm
2362	9V	33 x 25 x 76mm plus terminals
2364	9V	
216	9V	Miniature transistor battery
2761	9V	
2582	2 x 6V	
2510	2 x 7.5V	
2512	2 x 9V	
General Purpose Batteries		
742	1.5V	4 x 'F' cells
509	6V	4 x 'F' cells
X-71	1.5V	1 x 'F' cell
703	4.5V	Bias and general purpose battery
–	3V	2 x 'E' cells cycle battery
A	1.5V	Small general-purpose cell
C	1.5V	Small general-purpose cell
D	1.5V	Medium general-purpose cell
E	1.5V	Medium general-purpose cell
F	1.5V	Medium general-purpose cell
6	1.5V	Large telephone & general purpose cell; 17-30Ah capacity, depending on use
Composite Batteries		
759	1.5V & 90V	

Photo Gallery: AWA Empire State Radiolette



PERHAPS THE MOST FAMOUS RADIO made by AWA, the "Empire State" Radiolette was first produced in 1934. It was housed in a bakelite case and came in a variety of colours including black, brown, marbled white and dark green. A black Model 28 (1934) and a marble Model 32 (1936) are shown here. Both are 5-valve superhet receivers and the valve line-up was as follows: 6D6 RF amp, 6A7 converter, 6B7 IF/AF amplifier/detector, 42 audio output and 80 rectifier. Photo supplied by the Historical Radio Society of Australia Inc (HRSA), PO Box 2283, Mt Waverley, Vic 3149. www.hrsa.net.au



An assortment for bias batteries from Eveready, Diamond and Impex. Note the multiple output terminals on each battery, to enable the correct bias voltage to be selected.

A mains power supply or a DC-to-DC inverter supply can also be used to power non-portable battery-operated valve radios. This should be relatively straightforward, as space is not usually a problem in such sets.

In practice, a mains supply can either be designed specifically for particular receiver or designed to supply a range of voltages to suit many different receivers from the 1920s to the 1960s. The same goes for DC-to-DC inverters. Most portables use 1.5V, 7.5V or 9V on the filaments, while the HT requirement is usually either 67.5V or 90V.

Obtaining a battery eliminator

So where do you obtain a suitable mains-powered battery eliminator to run a vintage radio? Well, I currently have a suitable design on the drawing board to be published later in the year. This unit will supply filament voltages of 1.4, 2, 3, 4, 5 & 6V at 1A or so and 7.5-9V at 50mA. It will also supply HT voltages ranging from 22.5V to 135V and there will be a good selection of bias voltages as well.

Suitable DC-to-DC inverters were rather thin on the ground until Tony Maher of the Historical Radio Society of Australia (HRSA) designed a number units in 2001. His first item was designed to replace a 467 battery. It fits into the same space as the battery and is powered by four nicad or NiMH cells.

He has since added a 2V supply for sets using 2V valves and is about to publish a 90V version of his 467 battery-sized supply in *Radio Waves* (the HRSA in-house magazine). SC

Simple add-on board mates with the GPS Frequency Reference

1pps Driver For Quartz Clocks



By JIM ROWE

This simple add-on module for the GPS-Based Frequency Reference is designed to drive the escapement coil of a low-cost quartz clock movement. It uses the 1Hz GPS pulses available at the rear of the Frequency Reference so that the clock can display local time with GPS-based accuracy.

IF YOU BUILT the GPS-Based Frequency Reference described in the March-May 2007 issues, you'll know that it provides a continuous readout of "Universal Time Coordinated" (UTC) on its LCD. This time is derived directly from the GPS satellite system and is therefore very accurate.

In practice, it's not all that difficult to mentally convert UTC into local time. In most cases, you simply add or subtract a certain number of hours, depending on the nominal longitude of your local time zone and, of course, your time of year. For example to convert UTC into Eastern Australian Standard Time, you simply add 10 hours, or 11 hours during the summer months when we're on "Summer Time" (daylight saving). So 05:15:00 UTC becomes 15:15:00 (3:15pm) EAST, or in summer 16:15:00 (4:15pm).

That's all well and good but most people would find a direct readout of their local time a little more useful. And that's where this project comes in. It uses the 1pps (one pulse per second) output from the GPS system to drive a quartz wall clock. All you have to do is set the display for local time at the start, after which the clock will be accurately controlled via the GPS seconds pulses.

It turns out to be very easy to interface the GPS Frequency Reference to a standard 'analog' quartz clock movement. First, you have to remove the existing circuitry from the clock (usually just a chip and a crystal on a tiny PC board) and bring out the connections to the clock's escapement coil. That done, the coil can be pulsed instead by the little driver module described here. This driver module is small enough to fit inside the clock (next to the movement) and gets its power from the GPS Frequency Reference, along with the 1Hz (1pps) pulses.

How it works

If you remove the back from a standard 'analog' quartz clock movement and take a look inside, you'll find a small PC board with a single IC chip and a tiny quartz crystal (usually 32.768kHz). This drives a simple stepper motor coupled to a multi-stage reduction geartrain.

Inside the IC there's an oscillator stage which uses the crystal to generate the 32.768kHz 'clock' pulses plus a counter chain which divides these pulses down to 1Hz (one per second). These 1Hz pulses are then used to drive the movement's stepper motor so that it gives an increment of rotation every second. The geartrain then steps down these increments in the motor spindle's rotation to drive the spindles for the clock's second, minute and hour hands.

The stepper motor is basically the interface between the electronic and mechanical sections of the clock movement. And that makes the motor quite

ANTRIM TRANSFORMERS
manufactured in Australia by
Harbuch Electronics Pty Ltd
harbuch@optusnet.com.au
Toroidal – Conventional Transformers
Power – Audio – Valve – 'Specials'
Medical – Isolated – Stepup/down
Encased Power Supplies



Encased Power Supply
www.harbuch.com.au
Harbuch Electronics Pty Ltd
9/40 Leighton Pl, HORNSBY 2077
Ph (02) 9476 5854 Fax (02) 9476 3231

Want a real speed controller kit?



If you need to control 12 or 24 volt DC motors and want a speed controller that will easily handle 30 amps, then this is the kit for you.

This controller allows you to vary the speed of DC motors from 0 to 100%. It is also ideal for controlling loads such as incandescent/halogen lamps and heating elements.

This kit makes a great controller for use on small electric vehicle projects, such as electrically assisted bikes and go-carts. We have tested it to over 30 amps without problems—it barely gets warm! *Item code: SPEEDCON.*

We also have solar maximiser kits, Luxeon LEDs, and lots of interesting products and publications.

Go to shop.ata.org.au or call us on (03)9639 1500.

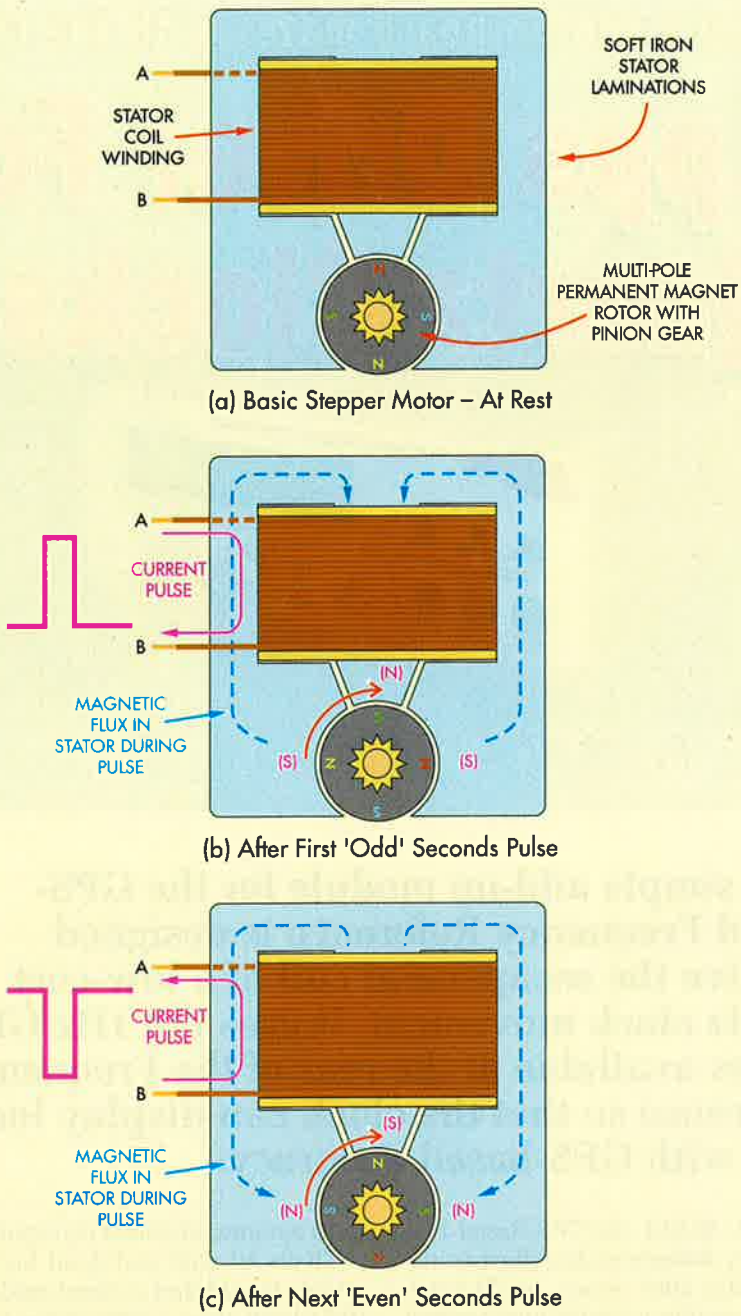


Fig.1: a clock stepper motor uses a multi-pole permanent magnet rotor which rotates inside a circular gap in a soft-iron stator. It's made to step in the same direction by reversing the polarity of the current pulse at each step.

interesting, especially as it's surprisingly simple in construction.

In most cases, the motor is similar to the arrangement shown in Fig.1. As can be seen, it has a multi-pole permanent magnet rotor which is free to rotate inside a circular gap in a soft-iron stator. The latter has two pole pieces which are driven by a single coil.

The trick is to get this very simple motor to rotate in 1-second steps, all in the same direction. That's done by applying the pulses to the stator coil with alternate polarity, as shown in the diagram.

Basically, 'odd' pulses are applied with one polarity, while 'even' pulses are applied with the opposite polarity. As a result, the rotor clicks around through an angle equivalent to the distance between its permanent magnet poles each second – see Fig.1. The geartrain steps down these 1-second jumps to drive the clock hands!

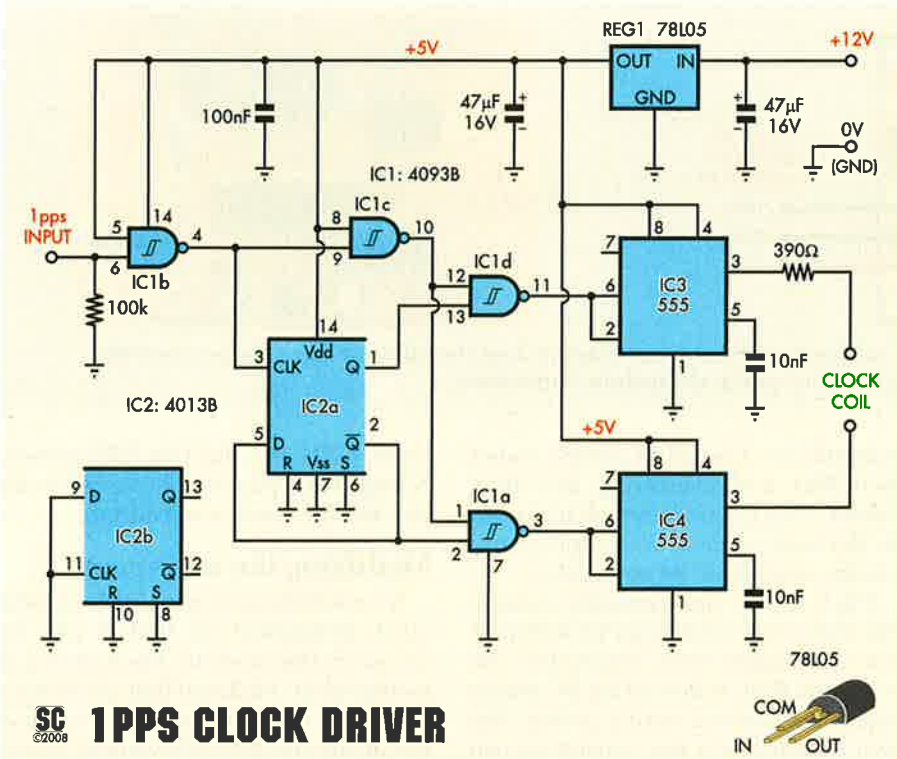


Fig.2: the circuit uses NAND gates IC1a-IC1d and D-type flipflop IC2a to separate the incoming 1Hz pulses into alternating "odd" and "even" pulse streams. These pulse streams then drive IC3 & IC4 which in turn drive the clock coil.

This means that using the 1Hz pulses from the GPS Frequency Reference to drive such a clock movement is quite easy. All we have to do is provide a simple driver circuit which accepts the 1Hz GPS pulses and in turn applies brief current pulses to the stepper motor coil in the same alternate-polarity manner as the normal clock electronics. And that's exactly what we do in this project.

Circuit details

Refer now to Fig.2 for the complete circuit details. It can basically be divided into two logical sections.

The first section comprises the NAND gates of IC1 and flipflop IC2a. This section separates the stream of 1Hz pulses coming from the GPS Frequency Reference into two streams of alternating 'odd' and 'even' pulses.

The second section comprises 555 timers IC3 & IC4. These drive the stepper motor coil using the two separated pulse streams.

In greater detail, the incoming 1Hz pulses are first fed through IC1b which is connected as an inverting input buffer. Note that pin 6 of IC1b is tied to ground via a 100kΩ resistor to prevent it from 'floating high' if the input cable is disconnected from the Frequency Reference.

IC1b's output appears at pin 4 and is fed in two directions – to pin 9 of IC1c and to the clock input (pin 3) of IC2a. IC1c simply re-inverts the signal and its pin 10 output is then fed to pin 12 of IC1d and to pin 1 of IC1a.

IC2a is one half of a 4013B dual D-type flipflop (the second flipflop in the IC is not used here). As shown, its Q-bar output is connected back to the D input, so the flipflop is configured in toggle mode. As a result, its Q and Q-bar outputs (pins 1 & 2 respectively) toggle back and forth in complementary fashion, in response to the incoming pulses.

IC2a's Q output is fed to pin 13 of IC1d, while its Q-bar output goes to pin 2 of IC1a. As a result, IC1d and IC1a separate the 1Hz pulses into two alternating streams, each controlled by the toggling outputs of IC2a. The 'odd' 1Hz pulses (inverted) emerge from pin 11 of IC1d, while the 'even' pulses (also inverted) emerge from pin 3 of IC1a.

These two separated pulse streams are then used to trigger 555 timers IC3 & IC4 which are used here simply as inverting drivers. As you can see, the clock's stepper motor coil is connected between their two pin 3 outputs via a 390Ω current limiting resistor.

During the gaps between the pulses, both IC3 and IC4 are in their 'off' state, with their pin 3 outputs both switched low. As a result no current flows through the stepper motor coil. However, each time a pulse arrives at IC1b's pin 6 input, either pin 11 of

Parts List

1 PC board, code 04103081, 46 x 38mm
5 PC board terminal pins

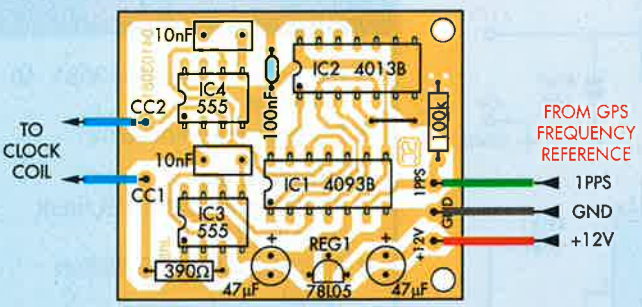
Semiconductors
1 4093B quad CMOS Schmitt NAND (IC1)
1 4013B dual CMOS flipflop (IC2)
2 555 timers (IC3,IC4)
1 78L05 low-power 5V regulator (REG1)

Capacitors
2 47µF 16V RB electrolytic
1 100nF monolithic ceramic (code 104 or 100n)
2 10nF monolithic ceramic (code 103 or 10n)

Resistors (0.25W, 1%)
1 100kΩ
1 390Ω

Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	100kΩ	brown black yellow brown	brown black black orange brown
❑	1	390Ω	orange white brown brown	orange white black black brown



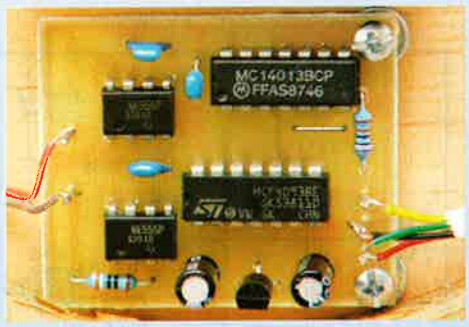


Fig.3: install the parts on the PC board as shown in this layout diagram and the photo at right. Take care with component orientation when installing the ICs and the electrolytic capacitors.

IC1d or pin 3 of IC1a will pulse low, depending on the current state of flipflop IC2a.

This causes either IC3 or IC4 to trigger, pulsing its output pin to the +5V level for the duration of the pulse (about 100ms) and hence driving a pulse of current through the stepper motor coil in one direction or the other. The next pulse (about 900ms later) then triggers the other 555 output driver, resulting in a current pulse through the coil in the opposite direction.

Power for the circuit can be derived from any 12V DC source, including the 12V DC rail used to power the GPS Frequency Reference. This is applied to a low-power regulator (REG1) which delivers a +5V rail to power the circuit.

The two 47µF capacitors and the 100nF capacitor provide supply decoupling and filtering.

Building the module

All of the driver module circuitry is mounted on a small PC board coded 04103081 and measuring just 46 x 38mm. This is small enough to mount in the back of most wall-type quartz clocks, alongside the movement.

Fig.3 shows the assembly details. No particular order need be followed but we suggest that you install the wire link first, followed by PC stakes at the five external wiring points. The two resistors and the capacitors can then go in. Take care to ensure that the two 47µF electrolytics are orientated correctly.

That done, you can install regulator REG1 and then complete the assembly by soldering in the four ICs. Be sure to orientate the ICs as shown on Fig.3 (ie, with pin 1 at lower left) and be careful not to get IC1 (4093B) and IC2 (4013B) mixed up.

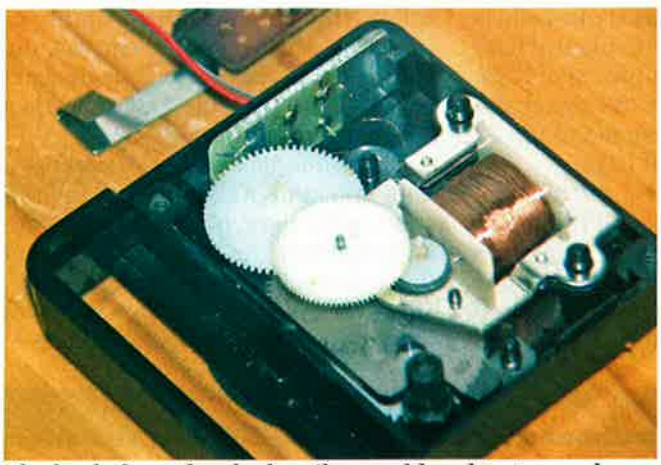
The two terminal pins on the left marked CC1 and CC2 are used to terminate the leads from the clock's stepper motor coil (see below). In addition, you have to make three connections to the GPS Frequency Reference – ie, +12V, GND and the 1Hz GPS pulses. A length of 2-pair telephone cable can be used for these connections.

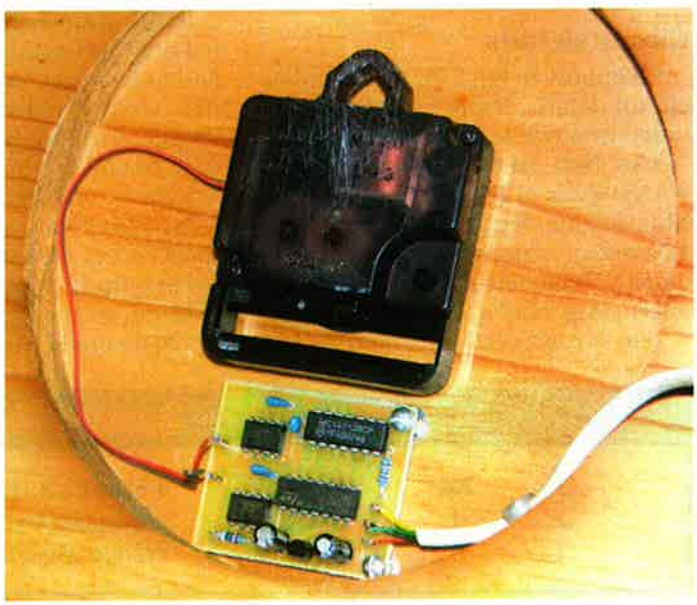
Modifying the movement

It's not difficult to modify the quartz clock movement so that it can be driven by this module. The first step is to remove the back and then the clock's PC board. The latter usually fits into a slot at one end of the movement's case. If the battery contacts are attached directly to the PC board, these can be removed as well.

As you are removing the PC board, you'll find that there are two fine wires from the stepper motor coil soldered to it. These two wires must be carefully desoldered from the board, after which the board can be discarded.

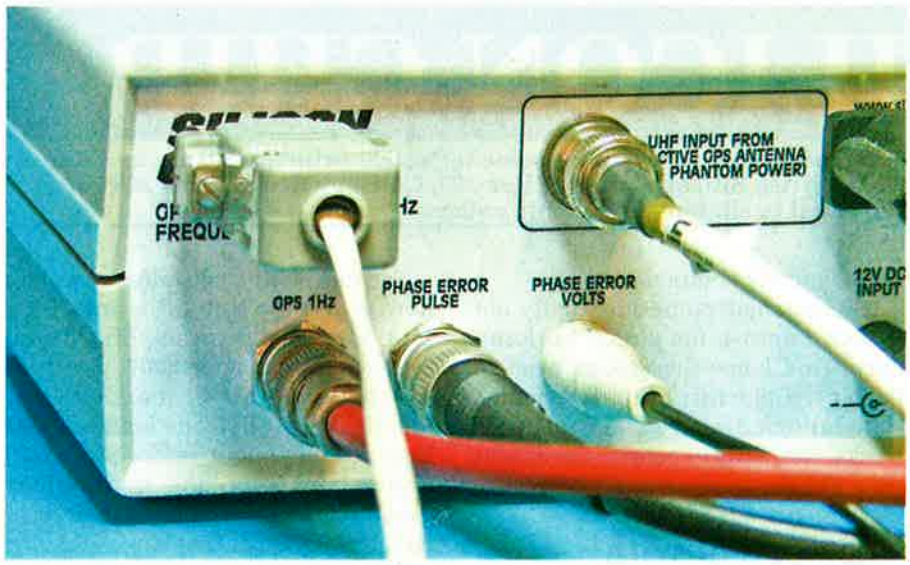
The next step is to connect a short length of light-duty 2-core cable (eg, a 200mm length of rainbow cable) between the coil wires and the CC1 & CC2 terminals on the driver board. This should be done in such a way that neither the joints nor the coil wires





The leads from the clock coil are soldered to two pads on a piece of scrap PC board as shown in the above photo (see text). These pads also terminate the leads from the driver board. The photo at right shows the completed driver module mounted in the back of the clock case.

siliconchip.com.au



The driver board can be connected to the GPS Frequency Reference via a length of 2-pair telephone cable fitted with a DB-9 plug. This can plug into a matching DB-9 socket mounted on the rear panel, just above the "GPS 1Hz" output socket.

will be strained if the lead wires are accidentally pulled.

The way to do this is as follows. First, cut a small rectangle from an old PC board, making it exactly the same size as the clock PC board (so that it will slide into same case slot). That done, cut a 3mm hole into the side of the movement case near the board slot, then bring the ends of the lead wires in through the hole and solder them to two pads on the new "termination board". Finally, solder the coil wires to these same pads and refit the back to the clock movement.

The driver module itself can be mounted next to the clock module. In our case, the module was attached to the wooden dial 'plate' using a pair of 6G x 9mm self-tapping screws, with an M3 nut and flat washer under each to act as spacers.

GPS reference connections

As mentioned above, a length of 2-pair telephone extension cable is used to connect the driver module to the GPS Frequency Reference. To do this, we suggest fitting an extra DB-9 socket on the rear panel of the GPS Frequency Reference, just above the holes for the GPS 1Hz and phase error pulse outputs – see photo at left.

That done, use three short lengths of hook-up wire to make the connections inside the unit to three of the pins on this added socket. One lead goes from the socket to the main board ground, another to the +12V line and the third wire to the rear of the "GPS 1Hz" output socket.

Now fit a matching DB-9 plug to the end of the cable from the clock driver module. Be sure to connect the leads to the correct pins on this plug, to mate with those on the new DB-9 socket.

It's now just a matter of testing it out. Connect the DB-9 plug to the socket, apply power and check that the clock immediately starts ticking. Its second hand should step in time with the flashes from the "GPS 1Hz" LED on the GPS Frequency Reference.

All that remains when you get to this stage is to set the clock movement to the current local time. If you want the second hand to read correctly as well, the easiest way to do this is to first unplug the clock connection from the rear of the GPS Frequency Reference when the seconds hand is in the 12 o'clock position.

That done, set the minutes and hours hands manually for the start of the next minute and then, as soon as the UTC seconds display on the Frequency Reference's LCD reaches "59", plug the connection back in again to restart the clock.

If you time this reconnection correctly, the clock will now display local time accurately (to the second) – and will continue to do so as long as GPS 1Hz pulses keep arriving. SC

"I'll GO THE RIGOL ... UNBEATBLE FOR PRICE AND PERFORMANCE"





Rigol DS5062MA 60MHz
- 60MHz Bandwidth, 2 Ch
- 1GS/s Real Time Sampling
- 4k Memory Per Channel
- Advanced Triggering
- Built-in USB
- 3 Year Warranty

ONLY $799 ex GST



Rigol DS5102MA 100MHz
- 100MHz Bandwidth, 2 Ch
- 1GS/s Real Time Sampling
- 4k Memory Per Channel
- Advanced Triggering
- Built-in USB
- 3 Year Warranty

ONLY $1,099 ex GST



Rigol DS1202CA 200MHz
- 200MHz Bandwidth, 2 Ch
- 2GS/s Real Time Sampling
- 10k Memory Per Channel
- Advanced Triggering
- Built-in USB
- 3 Year Warranty

ONLY $2,036 ex GST



Rigol DS1302CA 300MHz
- 300MHz Bandwidth, 2 Ch
- 2GS/s Real Time Sampling
- 10k Memory Per Channel
- Advanced Triggering
- Built-in USB
- 3 Year Warranty

ONLY $2,620 ex GST

Sydney Tel 02 9519 3933 Fax 02 9550 1378
Melbourne Tel 03 9889 0427 Fax 03 9889 0715
Brisbane Tel 07 3275 2183 Fax 07 3275 2196
Adelaide Tel 08 8363 5733 Fax 08 83635799
Perth Tel 08 9361 4200 Fax 08 9361 4300
email testinst@emona.com.au
web www.emona.com.au

EMONA

ASK SILICON CHIP

Got a technical problem? Can't understand a piece of jargon or some technical principle? Drop us a line and we'll answer your question. Write to: Ask Silicon Chip, PO Box 139, Collaroy Beach, NSW 2097 or send an email to silchip@siliconchip.com.au

Query on PC board layout

Looking at the power supply PC board for the Studio Series Preamplifier (SILICON CHIP, October 2005), why do the tracks from REG1 & REG2 go to the external terminals first and then back to D5 and D7? Why don't D5 and D7 connect directly to REG1 & REG2, as shown in Fig.10 on page 31? (J. E., Silverwater, NSW).

● This is an interesting question, J. E., and it highlights the fact that many aspects of the topology of our PC board designs never get a mention in the articles – we simply don't have the space.

In this case, notice that diodes D5 & D7 are in parallel with the 100Ω sense resistors for the adjustable regulators and it is the connections of the 100Ω resistors which are important, not the diodes. By connecting the 100Ω resistors to the output terminals in the way depicted, any small voltage loss in the copper tracks from the OUT pins of the regulators to the external connectors is automatically compensated for.

This is a small point, admittedly, but it does improve the circuit performance. And since the diodes need to be in parallel with the 100Ω resistors, they are connected to the same PC tracks. Normally of course, the diodes do nothing.

Puzzlement with kit assembly

I recently bought a kit for the 20W Class-A Amplifier from Altronics in Auburn and have so far put everything together quite easily. However, there are a couple of anomalies which I hope you might throw some light on.

First, the power amplifier circuit shows a 150nF 250VAC capacitor and this is also printed on the amplifier boards (near the inductor). The one supplied with the kit is marked 150nF but 100VAC Vishay. Is this a problem? The hole centres suit the (smaller?) supplied cap, so I've installed it, assuming it will be OK. Can you please advise?

Second, could you please explain how to use the tiny little links LK1, 2, 3 & 4 on the preamplifier board (SILICON CHIP, August 2007, page 20)? All four supplied in the kit appear identical. I've not encountered this type of component before and don't understand from the instructions exactly how they're meant to fit or in fact, exactly what they do.

The instructions mention the headers have pins but those supplied do not, just a little sliding socket which can be pushed out. Is LK2 on top while LK1 is underneath? Similarly, is LK3 on top and LK4 below? Your help would be greatly appreciated, as I don't understand the instructions. On page 18 of the August edition, links are mentioned and the photo on page 21 shows what looks like a gold pin sticking up from underneath. (K. P., via email).

● The 100VAC capacitor is fine. You install the four 2-pin headers as shown on the PC board. Then, the link itself is the little top sliding section – this shorts the two pins of the header together.

Ignition System For A 1939 Packard

I bought a High-Energy Ignition kit (SILICON CHIP, December 2005 & January 2006) for use in a 1939 Packard which is running a 6V negative-earth system. Can you tell me if it is suitable for this and if so, is there anything special I need to do to make it run?

I built the kit but have had problems with the engine cutting out after about 10 minutes. This has happened three times, coincidentally cutting out after running around 10 minutes each time. I have LK1 in the normal position, LK2 in the 0.5ms position and LK3 in normal. I have also tried it in the point's position.

Are there any bench and in-car tests I can perform which will help verify that the circuitry is OK? (S. L., via email).

● This ignition system was not specifically designed for 6V but it should work with minor circuit changes. In particular, the 100Ω 5W resistor for the base of transistor Q1 should be 47Ω 5W instead. Insufficient base current for Q1 when using the 100Ω resistor (at 6V) may be the cause of the cutting out. We also recommend using a 47Ω 5W resistor for the points' resistor.

One possible problem could be that the collector is arcing across to the case. Check that Q1's collector (the metal tab) is isolated correctly, using the washer and bush. Check that there are no sharp protrusions that may puncture the washer. The hole in the box must be chamfered so there are no sharp edges that can cause an arc-over.

Defective brownout protection

A while back I built the Appliance Energy Meter (SILICON CHIP, July & August 2004). I built it with the added brownout protection but the device doesn't seem to restore to normal function once battery operation has been activated. I have just disconnected the battery and it seems a waste not to use the relay. (A. R., via email).

● Make sure the 9V battery is an alkaline type and is fresh. Standard 9V batteries do not seem to be able to supply the necessary current.

Better transistors for the class-A amplifier

For the 20W Class-A Amplifier, is it possible to use MJL1302A & MJL3281A transistors instead of the specified MJL21193 & MJL21194 de-

Electronic Tacho For A Motorbike

I went to a Jaycar store with the intent of purchasing your electronic tachometer. The salespeople allowed me to read the directions/information that accompanies this kit but it was not obvious if I could use the tachometer because the salespeople and the article were vague about how the tacho picks up the signal from the coil.

I want to use it with a Suzuki DR650 motorbike. As far as I know it has electronic ignition because everything does these days. It has no engine management system and I doubt that it has electrical connections for adding a tacho.

Any help would be appreciated. I don't want to pay about $60 and not be able to use it. (R. B., via email).

● The tachometer detects rpm signal either from the ignition coil or from the ignition pickup sensor. In cars, the sensor is usually a reluctor, Hall Effect device, optical pick-up or points. With a motorcycle, things are different and often the ignition is a very basic Capacitor Discharge Ignition (CDI) that comprises a high voltage magneto coil and a magneto pickup. The high voltage is used to charge a capacitor which is ultimately dumped into the coil by a signal from the magneto pickup. A small electronic circuit comprising the capacitor and an SCR is used to dump the capacitor's charge.

The tachometer can generally be used if it connects to the magneto pickup. Although the tachometer has been used on these CDI motorcycle ignition systems we cannot guarantee that it will work with all motorcycles. The tachometer will not operate on the coil side because of the short firing pulse from CDI ignitions.

Note that most motorcycles already include a tachometer as standard equipment.

vices? I presume the transistors I have are genuine On Semiconductor as they have a circle printed with "ON". (N. J., via email).

● Yes, these are ideal substitutes.

Offset problem in Studio 350 amplifier

I have constructed two Studio 350 amplifier modules (SILICON CHIP, January/February 2004) from kits supplied by Altronics. For each kit, adjusting VR1 never brings the output to 0V; rather it adjusts between 120mV to 10mV from one extreme to another. Curiously, one kit stays positive with respect to ground (+120mV to +10mV over VR1's range) and the other stays negative (-10mV to -120mV). With VR1 in its centre, the offset is about +35mV in both cases. VR2 adjusts the idle current just fine.

I have not yet tried removing the 470Ω set-up resistors and applying a signal, as I am not particularly keen on using something that hasn't passed its tests. I have checked all the voltages against those printed on the schematic in the article and they're all within about 20%, although some only barely.

The power rails measure 72.5V rather than exactly 70V and I have not yet hooked up both amplifier modules at the same time. I am considering swapping the 2SA1084 transistors from the long-tailed pair in case they're poorly matched enough to cause this issue. (M. J., via email).

● This is a question of input transistor matching. Try swapping in some different input transistors to see if you can get a better match. However, if you can get the output offset down to 10mV that really is good enough – far better than most amplifiers. It is really only important if you are driving a transformer-coupled loudspeaker such as an electrostatic.

Short circuit in NiMH charger

I recently built the NiMH Charger from the September 2007 issue. It made all the settings/adjustments OK with the trimpots but when I connect batteries (2 x AA) for charging, the voltage regulator (LM317), trimpot VR6 and IC1 all overheat and fail. The DC power supply is rated for 22V @ 3A.

My previous Nicad charger projects from SILICON CHIP are still going strong.

OCEAN CONTROLS

Helping to put you in Control

Controllers

We have a selection of Controllers for managing your processes.



N322 Electronic Thermostat
Budget priced ON-OFF temperature controllers. Models for Thermistor, PT100 RTD and J Thermocouples. The NTC model is provided with a 2m waterproof NTC Thermistor to get you up and running immediately. **From $89+GST**



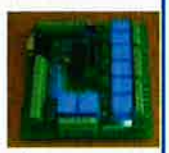
N1100 PID Process Controller
Popular controller features a universal Input accepts: Thermocouples , RTD, 4-20mA, 50mV and 0-5Vdc. Outputs include Relay, 4-20mA and pulse for SSR **From $175+GST**



USB I/O Controller
The KTA-220 allows PC's to control real world applications. It features 8 relay outputs, 4 Isolated Inputs, 2 Analog inputs and a PWM output. Multiple modules can be connected to a single PC. **$135 +GST**



Serial I/O Controller
KTA-108 is a Serial Port Controlled I/O module. It features 8 relay outputs, 4 Isolated Inputs **$112.50+GST**



Pixel Controller Card
Using the PICAXE 28X microntroller. It features 8 relays, 8 digital Inputs, 4 analog inputs. Programmed in Basic **$129.50+GST**



Solid State Relays
High quality SSR's with 4-32VDC, 80-280VAC, 4-20mA and potentiometer inputs. DIN Rail and Panel Mount Heatsinks for SSR's also available.

Contact Ocean Controls
Ph: 03 9782 5882
www.oceancontrols.com.au

Comparing Rechargeable & Non-Rechargeable Cells

I have a question regarding conventional (non-rechargeable) batteries versus rechargeable batteries. Just taking standard "over the counter" cells as an example (AAA, AA, C & D), rechargeable cells always come with a mAh rating, whereas conventional batteries (heavy duty, alkaline, etc) do not. I know rechargeable cells are 1.2V and conventional batteries are 1.5V. But what I'm not clear on is which type of battery would produce the highest short-term peak current?

Obviously, if the internal resistances were identical, then 1.5V would "push" more current into a given load than 1.2V but is it that simple? Are the internal resistances similar in each type of battery?

Why don't conventional batteries have an mAh rating and why do some toys say not to use rechargeable batteries? In my case I am looking at modifying a launch controller for model rocketry clustering. Launch controllers in rocketry are used to supply current to a Nichrome wire igniter-head, which in turn ignites the rocket motor. When clustering (ie, igniting more than one rocket motor simultaneously), it is essential that the controller provides a high current for a short period (1-3 seconds), otherwise the situation could arise where one or more motors may not ignite before lift-off occurs, which could lead to serious damage to both the rocket and the pocket, to say nothing of the potential hazard to spectators!

This leads to my final question: for a given number of cells (most controllers hold four AA cells), would the best solution be alkalines, rechargeables or the "newer" non-rechargeable Lithium cells? Any assistance would be greatly appreciated.

- Non-rechargeable cells and batteries do not have their capacity stated because it really depends on how you use them.

If used for a short time each day, they will provide more capacity than if used continuously. The current draw also changes the available capacity.

Rechargeable cells state the capacity because this information is needed to be able to recharge them and their capacity is fairly consistent over a wide range of applications.

Some toys cannot be used with rechargeable cells because they are voltage sensitive and may not work well with the lower voltage available from rechargeables. Rechargeables can also damage toys with motors because high current delivered to a stalled motor can burn it out. In general, rechargeables can deliver higher currents than non-rechargeable cells.

The current available from a cell depends on the chemistry and the manufacturer. Generally, Nicad cells can deliver the most current but these days NiMH cells can deliver high currents as well.

In general, if you have any device which can accept rechargeable cells and you use it a lot, then rechargeables are the better proposition.

Circuit board/components checked OK. Any assistance would be appreciated. (R. R., via email).

- It appears there is a problem with the LM317. To destroy the adjustment trimpot and IC1 would suggest that there is a high current flow in the adjust terminal or the output is somehow shorting to the drain of the Mosfet. Check that the Mosfet is isolated from the box and that the regulator tab is not shorting to the case with the securing screw.

Digital instrument display for fire truck

I want to use the Digital Instrument Display (SILICON CHIP, August & September 2003) to convert the analog temperature display on the engine of a fire brigade truck belonging to a volunteer brigade, so that I can provide a remote idiot light at the rear of the appliance to shut down the engine in the event of an over-temperature condition. The problem is that the vehicle is 24V.

Could you please advise on the mods required to run the display from 24V? (J. C., Mt. Dandenong, Vic).

- Change zener diode ZD1 to 30V rating and the 100µF capacitor at the input to REG1 to 35V. Change the 1kΩ resistor at the collector of Q6 to a 2.2kΩ 0.5W resistor and make sure C1 and C2 are 35V.

Serial I/O controller kit is a slave

I am really keen to build the Serial I/O Controller kit but there's one question that has been plaguing my mind for months now. Is there any way to interface this card with a computer and have the card control functions of software on the computer?

What I am trying to achieve is finding a method of utilising this card to run batch files on my computer to do automated tasks should a condition change on the card's inputs. Is this possible? If so, what modifications would I have to make. (J. H., via email).

- The Serial I/O Controller published in the November 2005 issue is a slave device. This means that it sits and waits for commands from the host PC. Once it receives a command, it executes it, and optionally sends data back to the PC. It does not initiate data transfers with the PC.

The set of commands that are available are explained on page 78 of the November 2005 issue. For the application that you have in mind, a simple C program could be written that will run on the host PC. It would continuously monitor some condition, by periodically sending commands to the Serial I/O Controller, and it would analyse the received data. It would then take action, such as executing another program, if some condition is met.

In other words, the application you have in mind can be implemented but you will have to:

(1) Write a C program (or equivalent in some other high level language) to poll the Serial I/O Controller periodically and analyse its output;

(2) This program must run on the host PC and must be always running - the host PC will have to be on for a start.

(3) This program will preferably be loaded automatically by the OS

(operating system) and work in the background.

As you can see, it can be done, yet the solution is not ideal, mainly because polling is an inefficient way to implement your application.

Laptop recording & software

I was interested in the article on PC recording (SILICON CHIP, November 2007) as I am about to buy a new laptop computer for audiovisual work. You mention the audio testing software "Rightmark Analyser" but how would I test a new computer before purchase, to see if it is suitable?

What are the preferred specs for a laptop? Few of them appear to be media-orientated with AV sockets fitted. My old Pentium 400 had a separate Pinnacle sound card in one of the motherboard slots – this had a full set of RCA in/out connectors on the rear metal bracket.

I have spoken to four different computer suppliers and they say that any late model should do but can't be sure. They're a bit vague, refer me to someone else or don't reply. Even a consultant who specialises in recording has not replied. Yet I've seen concerts being recorded straight into laptop computers.

Enquiries to the PC user group for technical specs are for members only. So maybe I should join then investigate this recording aspect. (P. S., Albert Park, Vic).

● Any salesman will tell you that *any* laptop will do the job but like anything else (cars, stereo systems, washing machines), some are better than others. Some laptops have sound quality which is atrocious (hum and noise, poor frequency response etc) while others are exemplary – it all depends on the manufacturer and the model.

Generally, cheap laptops have cheap and dirty sound circuitry but a high price is not always a guarantee of high quality. However, there are a number of ways of making sure you get a good one:

(1) Take a copy of the analyser program with you and ask to test it before you buy it. Most places will allow this and if they don't then try (2) below.

(2) Make sure you get a "money back guarantee if returned within X days" deal and simply purchase the laptop. Take it home and analyse it. If it's no good, take it back and demand one that works properly or you want a refund.

(3) In the unlikely event that both of the above are not possible, then get a high-quality music sampler CD that you know intimately and a set of high-quality headphones – the best you can get, even if you just borrow them. Play the CD and listen to it on a known system of high quality. Then try it on the laptop in question.

If you have good ears, then it should be readily apparent if the laptop is not up to spec – if you don't, then the whole matter is rather moot anyway. Chances are that if the manufacturer has gone to the trouble of designing a good audio playback stage in the laptop, then the recording section will also be good.

As to what constitutes good specifications, just compare its performance with that of high-quality amplifiers: 20-20kHz within ±1 or 2dB; less than 0.1% distortion; -70dB hum and noise or better. There is no need to go overboard on specifications. The main thing is that the finished result *sounds good*. A poor quality laptop will soon reveal itself in this regard because results will simply not be pleasing to the ear, even when everything else is done correctly. SC

Notes & Errata

PIR Sensor Triggered Mains Switch, February 2008: the O11 output mentioned in the text on pages 58 and 59 and on the circuit should be the O10 output.

Multi-Message Voice Recorder, December 2007: the resistor from pin 7 of the HK828 should be 47kΩ and the parts list should show nine 47kΩ resistors and only one 10kΩ.

UHF Remote Mains Switch Transmitter, February 2008: Transistor Q1 is a BC327 (PNP) as listed in the parts list. The circuit labelling is incorrect. In addition, the parts list should have 5 10kΩ resistors not 4.

Electricity Saving Box, November 2007: the formula published in Fig.6 (page 26) should read: $\theta' = \tan^{-1} (\omega (L - \omega^2CL^2 - CR^2))/R = 59.98°$ which leads to $\cos(\theta') = 0.5$.

WARNING!

SILICON CHIP magazine regularly describes projects which employ a mains power supply or produce high voltage. All such projects should be considered dangerous or even lethal if not used safely.

Readers are warned that high voltage wiring should be carried out according to the instructions in the articles. When working on these projects use extreme care to ensure that you do not accidentally come into contact with mains AC voltages or high voltage DC. If you are not confident about working with projects employing mains voltages or other high voltages, you are advised not to attempt work on them. Silicon Chip Publications Pty Ltd disclaims any liability for damages should anyone be killed or injured while working on a project or circuit described in any issue of SILICON CHIP magazine. Devices or circuits described in SILICON CHIP may be covered by patents. SILICON CHIP disclaims any liability for the infringement of such patents by the manufacturing or selling of any such equipment. SILICON CHIP also disclaims any liability for projects which are used in such a way as to infringe relevant government regulations and by-laws.

Advertisers are warned that they are responsible for the content of all advertisements and that they must conform to the Trade Practices Act 1974 or as subsequently amended and to any governmental regulations which are applicable.

SILICON CHIP REFERENCE

GREAT BOOKS FOR



SELF ON AUDIO
by Douglas Self **2nd Edition 2006**

The very latest from the renowned audio design guru. A collection of 35 classic magazine articles offering a dependable methodology for designing audio power amplifiers in a way that improves performance at every point without significantly increasing cost. Includes compressors/limiters, hybrid bipolar/FET amps, electronic switching and more. 474 pages in paperback.

$83



AUDIO POWER AMPLIFIER DESIGN HANDBOOK by Douglas Self 4th Edition 2006

Reduced in price from previous edition! From one of the world's most respected audio authorities. New 4th edition is more comprehensive than ever – now with new chapters on Class D amplifiers and DC servos. Now even bigger – 465 pages in paperback. ***See the review in September 2006 issue.***

$87



Practical Variable Speed Drives and Power Electronics
by Malcolm Barnes. 1st Ed, Feb 2003.

An essential reference for engineers and anyone who wishes to design or use variable speed drives for induction motors. As reviewed in SILICON CHIP September 2003. 288 pages.

$94

AUDIO ELECTRONICS
By John Linsley Hood. Second edition 1999.

For anyone involved in designing, adapting and using analog and digital audio equipment. Covers tape recording, tuners and receivers, preamplifiers, voltage amplifiers, audio power amplifiers, compact disc technology & digital audio, test & measurement, loudspeaker crossover systems, power supplies and noise reduction systems. 375 pages in soft cover.



$101



Microcontroller Projects in C for the 8051 by Dogan Ibrahim. Published 2000.

Through graded projects introduces the fundamentals of microelectronics, the 8051 family, programming in C and the use of a C compiler. Provides an interesting, enjoyable and easily mastered alternative to more theoretical textbooks. 178 pages in paperback.

$81



ANALOG ELECTRONICS
By Ian Hickman. 2nd edition 1999.

Essential reading for electronics designers and students alike. It will answer questions about core analog theory and design principles as well as offering practical design ideas. Many of the circuits taken from Ian Hickman's magazine articles. 294 pages in soft cover.

$100



Power Supply Cookbook
by Marty Brown. 2nd edition 2001.

An easy-to-follow, step-by-step text for a wide variety of power supplies. All described in simple language. Anyone with a basic knowledge of electronics can create a very complicated power supply design. 265 pages in paperback.

$109

Op Amps for Everyone
Edited by Ron Mancini Published 2003

Compiled by Texas Instruments, this is the closest thing to a "bible" on op amps. This is an engineer's reference with lots of theory, plenty of maths and right up-to-the-minute with modern devices. Not cheap but worth every cent. 478 pages, soft covers.



$137



SWITCHING POWER SUPP. A to Z
by Sanjaya Maniktala. Published 2006.

Theoretical and practical aspects of controlling and measuring electromagnetic interference in switching power supplies. Includes flow-charts for building DC-DC converters and their magnetic components under typical wide-input supply conditions. 503 pages in hard cover. **CD-ROM included.**

$106

NEW NEW NEW NEW NEW



RF CIRCUIT DESIGN
by Chris Bowick, Second Edition, 2007.

A new edition of the classic RF circuit design book. RF circuit design is now more important that ever in the wireless world in which we live. In most of the wireless devices that we use there is an RF component – this book tells how to design and integrate in a very practical fashion. 256 pages in paperback.

$67

DVD PLAYERS AND DRIVES
by K.F. Ibrahim. Published 2003.

A guide to DVD technology and applications, with particular focus on design issues and pitfalls, maintenance and repair. Ideal for engineers, technicians, students of consumer electronics and sales and installation staff. As reviewed in Silicon Chip February 2004. 319 pages in paperback.



$85

PRACTICAL RF HANDBOOK
by Ian Hickman **NEW 4TH EDITION 2006**

The latest guide to RF design for engineers, technicians, students and enthusiasts. Covers key topics in RF: analog design principles, transmission lines, couplers, transformers, amplifiers, oscillators, modulation, transmitters and receivers, propagation & antennas. 279 pages in paperback.



$80



ANALOG TECHNIQUES WITH DIGITAL INTERFACING
by T H Wilmshurst – Published 2001.

Covers all the analog electronics needed in a wide range of higher education programs: first degrees in electronic engineering, experimental science course, MSc electronics and electronics units for HNDs. Supported by numerous worked examples and experimental exercises. 312 pages paperback.

$88



PIC IN PRACTICE by D W Smith.
New 2nd Edition - published 2006

Based on popular short courses on the PIC, for professionals, students and teachers. Can be used at a variety of levels. An ideal introduction to the world of microcontrollers. 255 pages in paperback.

$60

ELECTRIC MOTORS AND DRIVES
By Austin Hughes - Third edition 2006

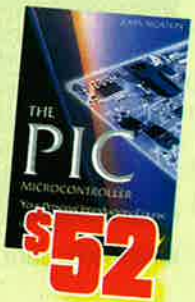
Brand new edition of this amazingly popular book. Intended for non-specialist users of electric motors and drives, filling the gap between academic texts and general "handbooks". Explores all of the widely-used modern types of motor and drive including conventional & brushless DC, induction motors, steppers, servos, synchronous and reluctance. 384 pages, soft cover



$55

PIC MICROCONTROLLER – PERSONAL INTRODUCTORY COURSE
By John Morton NEW: 3rd edition 2005.

A unique and practical guide to getting up and running with the PIC. It assumes no knowledge of microcontrollers – ideal introduction for students, teachers, technicians and electronics enthusiasts. Revised 3rd edition focuses entirely on re-programmable flash PICs such as 16F54, 16F84 12F508 and 12F675. 226 pages in paperback.



$52

BOOKSHOP
ENQUIRING MINDS!

10% OFF! WANT TO SAVE 10%? SILICON CHIP SUBSCRIBERS AUTOMATICALLY QUALIFY FOR A 10% DISCOUNT ON ALL BOOK PURCHASES!

NEW NEW NEW NEW



ROBOT BUILDER'S COOKBOOK
By Owen Bishop Published 2007

Introducing, through hands-on project work, the mechanics, electronics and programming involved in practical robot design and construction. The use of the PIC microcontroller throughout provides a painless introduction to programming. It's a book for first-time robot builders, advanced robot builders and those studying at higher education levels in this fascinating field. Has companion website to download programs. 374 pages in paperback

$63

AC MACHINES By Jim Lowe Published 2006

Applicable to Australian trades-level courses including NE10 AC Machines, NE12 Synchronous Machines and the AC part of NE30 Electric Motor Control and Protection. Brings together up-to-date aspects of the field, covering polyphase induction motors, single-phase motors, synchronous machines and polyphase motor starting. 160 pages in paperback.



NEW NEW NEW NEW

$66

NEW NEW NEW NEW



HANDS-ON ZIGBEE
By Fred Eady, Published 2007

We asked our Zigbee guru, Telelink's Jack Chomley, to comment on this book and he said "wow! This one is right up to date". A lot of it is pretty in-depth but, according to Jack, if you want to learn all about Zigbee you'd go a long way to find a better reference than this one. 336 pages in paperpback.

$96.50

NEWNES GUIDE TO TELEVISION AND VIDEO TECHNOLOGY
By KF Ibrahim 4th Edition (Published 2007)

It's back! This very popular book now in a new edition provides a full and comprehensive coverage of video and television technology including the latest developments - HDTV and DVD. It starts with fundamentals so is ideal for students but covers in-depth technologies such as blu ray, DLP, Digital TV, etc so is also perfect for engineers. The new edition has a number of useful appendices covering a wide variety of subjects. 600+ pages in paperback



NEW NEW NEW NEW

$60.50

THE PRACTICAL GUIDE TO SATELLITE TV
By Garry Cratt – 6th Edition 2007

We've had other satellite TV books in the past but they have all had a lot of useless (to this part of the world) overseas stuff. This one is written in Australia, for Australian conditions by one of Australia's foremost satellite TV experts. If there is anything you wanted to know about setting up a satellite TV system, (including what you can't do!) it's sure to be covered in this 176-page paperback book



NEW NEW NEW NEW

$49

RADIO, TV AND HOBBIES April 1939 to March 1965
– Every article to enjoy once again on DVD-ROM!

$62

This remarkable archival collection spans nearly three decades of Australia's own "Radio and Hobbies"/"Radio TV and Hobbies". Every article has been scanned into PDF format – ready to read at your leisure on your computer (obviously, a computer DVD-ROM reader is required along with Acrobat Reader 6 or later). For history buffs, it's worth its weight in gold. For vintage radio enthusiasts, what could be better? For anyone interested in electronics, this is one which you ***MUST*** have in your collection!

AMATEUR SCIENTIST TWIN CD SET – NOW NEW V3.0: Includes bonus science software library



$62

Many thousands of copies now sold. Two incredible CDs containing over 1000 classic projects, sourced from Scientific American over the past 73 years – and covering every field of science. This new "Dr Shawn" edition is the latest version – it's said to be even more user friendly with much more information and data. Runs with any browser (on Win2000 or later). Recommended by the National Science Teachers Association (USA).

NOTE: ALL PRICES ARE PLUS P&P – SEE BELOW.

ORDER HERE

☐ AC MACHINES	$66.00
☐ AMATEUR SCIENTIST CD	$62.00
☐ ANALOG CIRCUIT TECHNIQUES W/DIGITAL INT.	$88.00
☐ ANALOG ELECTRONICS	$100.00
☐ AUDIO ELECTRONICS	$101.00
☐ AUDIO POWER AMPLIFIER DESIGN	$87.00
☐ DVD PLAYERS AND DRIVES	$85.00
☐ ELECTRIC MOTORS AND DRIVES	$55.00
☐ HANDS-ON ZIGBEE	$96.50
☐ INTERFACING WITH C	$68.00
☐ M'CONTROLLER PROJECTS IN C FOR 8051	$81.00
☐ NEWNES GUIDE TO TELEVISION AND VIDEO TECHNOLOGY	$60.50
☐ OP AMPS FOR EVERYONE	$137.00
☐ PIC IN PRACTICE	$60.00
☐ PIC MICROCONTROLLER - PERSONAL INTRO COURSE	$52.00
☐ POWER SUPPLY COOKBOOK	$109.00
☐ PRACTICAL GUIDE TO SATELLITE TV (6th edition)	$49.00
☐ PRACTICAL RF HANDBOOK	$80.00
☐ PRACT. VARIABLE SPEED DRIVES/POWER ELECT.	$94.00
☐ RADIO, TV AND HOBBIES ON DVD-ROM	$62.00
☐ RF CIRCUIT DESIGN	$67.00
☐ ROBOT BUILDER'S COOKBOOK	$63.00
☐ SELF ON AUDIO (2nd_ edition)	$83.00
☐ SWITCHING POWER SUPPLIES A-Z (inc CD-ROM)	$106.00
☐ VIDEO SCRAMBLING/DESCRAMBLING	$95.00

TAX INVOICE – SILICON CHIP PUBLICATIONS ABN 49 003 205 490

Your Name _____

PLEASE PRINT

Address _____

_____ Postcode _____

Daytime Phone No. (_____) _____

Email _____ @ _____
STD

Payment details:

☐ Cheque/Money Order enclosed ***OR***

Charge my credit card – ☐ Visa Card ☐ MasterCard

No: ☐☐☐☐ ☐☐☐☐ ☐☐☐☐ ☐☐☐☐

Signature _____ Card expiry date ☐☐ ☐☐

BOOK TOTAL: $..... PLUS P&P: $..... ORDER TOTAL$ AU$.....

101

P&P Australia: $7.00 ***PER ORDER***
NZ: $A12 per book
Elsewhere: $A18 per book

POST TO: SILICON CHIP Publications, PO Box 139, Collaroy NSW, Australia 2097.
OR CALL (02) 9939 3295 & quote your credit card details; or FAX TO (02) 9939 2648

*ALL TITLES SUBJECT TO AVAILABILITY. PRICES VALID FOR MONTH OF MAGAZINE ISSUE ONLY. ALL PRICES INCLUDE GST

MARKET CENTRE

Cash in your surplus gear. Advertise it here in Silicon Chip.

CLASSIFIED ADVERTISING RATES

Advertising rates for these pages: Classified ads: $29.50 (incl. GST) for up to 20 words plus 85 cents for each additional word. Display ads: $54.50 (incl. GST) per column centimetre (max. 10cm). Closing date: 5 weeks prior to month of sale.

To book your classified ad, email the text to **silicon@siliconchip.com.au** and include your credit card details, or fax (02) 9939 2648, or post to Silicon Chip Classifieds, PO Box 139, Collaroy, NSW, Australia 2097.

Enclosed is my cheque/money order for $_____ or please debit my

❑ Visa Card ❑ Master Card

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

Signature_____ Card expiry date____/____

Name _____

Street _____

Suburb/town _____ Postcode_____

Phone:_____ Fax:_____ Email:_____

MW MEAN WELL ON-LINE IN-STOCK



Computronics Corporation Ltd
6 Sarich Way, Technology Park, BENTLEY, WA, 6102
Ph. : 08 9470 1177, Fax: 08 9470 2844
www.computronics.com.au/meanwell

Serial to TCP/IP Converters from TRUSYS



BF430 $75.00 BF450 $85.00

NO STATIC IP REQUIRED!

Universal serial device servers allow your industrial serial devices to be monitored from your network with PPPoE & DDNS protocols. They support firmware upgrade, web management and event alarm triggering using email and SMS for real-time system management.

Applications:
- Factory automation
- Access control and security
- Time recording system
- Hospital automation
- PLC instrument control

For more information, call, fax, email or visit our website!

TRUSYS
Tel: 0428 282 222 Fax: 03 5264 1275
Email: sales@trusys.com.au
www.trusys.com.au

FOR SALE

MicroByte Electronics: PIC Micros – Development Board – Development tools & Components. Phone: (03) 9378 4288. **info@microbyte.com.au**; **www.microbyte.com.au**

PCBs MADE, ONE OR MANY. Any format, hobbyists welcome. Sesame Electronics Phone (02) 9593 1025. **sesame@sesame.com.au** **www.sesame.com.au**

RCS RADIO/DESIGN is at 41 Arlewis St, Chester Hill 2162, NSW Australia and has all the published PC boards from SC, EA, ETI, HE, AEM & others. Ph (02) 9738 0330. **sales@rcsradio.com.au** **www.rcsradio.com.au**

12V Batteries, <6mths use. 5, 7, 9A/h, $1 per A/h. Ongoing availability. Pickup only, Highbury, SA. **petria@adam.com.au**

LEDs! I NOW HAVE good stocks of Nichia superbright oval LEDs, as well as 5mm Agilent (HP) LEDs. These are fantastic, bright brand-name quality LEDs at Chinese LED prices! Also Osram surface mount range and other NOS standard and superbright brand name LEDs from just a few cents each. Also Cree X-Lamps, 5 and 10 watt power LEDs, LED drivers, kits and all sorts of other stuff. **www.ledsales.com.au**

KIT ASSEMBLY

KEITH RIPPON KIT ASSEMBLY & REPAIR:
* Australia & New Zealand
* Small production runs.
Phone Keith 0409 662 794.
keith.rippon@gmail.com

WANTED

CUSTOMERS: Truscotts Electronic World – large range of semiconductors

Circuit & Design Ideas Wanted

Do you have a good circuit idea? If so, sketch it out, write a brief description of its operation & send it to us. Provided your idea is workable & original, we'll publish it in Circuit Notebook & you'll make some money. We pay up to $100 for a good circuit idea or you could win some test gear. *Silicon Chip Publications, PO Box 139, Collaroy, NSW 2097.*

ELNEC IC PROGRAMMERS

High quality
Realistic prices
Free software updates
Large range of adaptors
Windows 95/98/Me/NT/2k/XP



CLEVERSCOPE USB OSCILLOSCOPES

2 x 100MSa/s 10bit inputs + trigger
100MHz bandwidth
8 x digital inputs
4M samples/input
Sig-gen + spectrum analyser
Windows 98/Me/NT/2k/XP



IMAGECRAFT C COMPILERS

ANSI C compilers, Windows IDE
AVR, TMS430, ARM7/ARM9
68HC08, 68HC11, 68HC12

GRANTRONICS PTY LTD

www.grantronics.com.au

Satellite TV Reception



International satellite TV reception in your home is now affordable. Send for your free info pack containing equipment catalog, satellite lists, etc or call for appointment to view. We can display all satellites from 76.5° to 180°.

AV-COMM P/L, 24/9 Powells Rd, Brookvale, NSW 2100.
Tel: 02 9939 4377 or 9939 4378.
Fax: 9939 4376; www.avcomm.com.au

SPLat CONTROLS You get results faster with the world's easiest controllers!

- 12 I/O: 400mA outputs, protected inputs
- LCD, 5 buttons, 4 LEDs
- No soldering required
- Easy to program, excellent tutorials
- Powerful, versatile



best value!

MS120OEM216
$149 1-off

Developer's Kit S193 includes programming cable & software
Made in Australia - enthusiastic users world-wide
splat-sc.com

Best Home Weather Station . . . EVER!



- More frequent updates – every 2.5 seconds!
- More alarm settings – over 70 parameters!
- More highs, lows and graphs – over 80 in all!

With the Vantage Pro2 Weather Station you get incredibly detailed information on:
Wind – direction and strength
Rainfall – current, recent patterns etc.
Temperature – current, wind chill, etc.
Barometric pressure – current and trends
Humidity & dewpoint – current and 24 hrs
And your own local forecast. You'll be more accurate than the weather bureau!
Available in wired or wireless models (wireless transmission up to 300m!)

ECOWATCH
Unit 5, 17 Southfork Dve Kilsyth, Vic 3137
Tel: (03) 9761 7040 Fax (03) 9761 7050
www.davisinstruments.com.au

Do you have wireless problems? Telelink has wireless solutions!



If you want the right 'wireless' ingredients for a successful project recipe, **THINK Telelink!** Don't want to be confused by wireless gobbledegook and confusing buzz words? **TALK to Telelink!** We will give you honest advice so that you can make the right purchase decision for your OEM low power wireless requirements. Browse our website for more information about our products. If you have any questions speak with a Telelink Communications representative.

At Telelink we sell solutions, not problems!

01010101 TeleLink Telelink Communications

www.telelink.com.au
e-mail Jack Chomley – jack@telelink.com.au
or call (07) 4934 0413 or 0428 188 551

VIDEO - AUDIO - PC

distribution amps - splitters
digital standards converters - tbc's
switchers - cables - adaptors
genlockers - scan converters
bulk vga cable - wallplates



DVS5c & DVS5s High Performance Video / S-Video and Audio Splitters



MD12 Media Distribution Amplifier

QUEST Quest AV



VGA Splitter VGS2



HQ VGA Cables



AWP1 A-V Wallplate

Come to the specialists... QUESTRONIX

Quest Electronics Pty Limited abn 83 003 501 282 t/a Questronix
Products, Specials & Pricelist at www.questronix.com.au
fax (02) 4341 2795 phone (02) 4343 1970
email: questav@questronix.com.au

Dontronics

www.dontronics.com has 300 selected hardware and software products available from over 40 world wide manufacturers, and authors.

Olimex Development Boards & Tools: ARM, AVR, MAXQ, MSP430 and PIC.

Atmel Programmers And Compilers: STK500, Codevision C, Bascom AVR, FED AVIDICY Pro, MikroElektronika Basic and Pascal, Flash File support, and boot loaders.

PICmicro Programmers And Compilers: microEngineering Labs USB programmers, adapters, and Basic Compilers, DIY (Kitsrus) USB programmers, MikroElektronika Basic, Pascal, DSpic Pascal Compilers, CCS C, FED C, Hi-Tech C, MikroElektronika C, disassembler and hex tools.

CAN: Lawicell CANUSB, CAN232

FTDI: USB Family of IC 's. FT232RL, FT2452RL, also BL and others.

4DSystems LCD/Graphics: Add VGA monitor, or OLED LCD to your micro. Simple Serial I/F.

Heaps And Heaps Of USB Products: TTL, RS-232, RS-485, modules, cables, analyzers, CRO's.

Popular Easysync USB To RS-232 Cable: Works when the others fail. Only one recommended by CBUS. Money back guarantee.

www.dontronics-shop.com

and passive components for industry, hobbyist and amateur projects including Drew Diamond. 27 The Mall, South Croydon, Melbourne. (03) 9723 3860. **electronicworld@optusnet.com.au**

WANTED: EARLY HIFIs, AMPLIFIERS, Speakers, Turntables, Valves, Books, Quad, Leak, Pye, Lowther, Ortofon, SME, Western Electric, Altec, Marantz, McIntosh, Tannoy, Goodmans, Wharfedale, radio and wireless. Collector/ Hobbyist will pay cash. (07) 5471 1062. **johnmurt@highprofile.com.au**

Do You Eat, Breathe and Sleep TECHNOLOGY?

Opportunities for full-time and part-time positions all over Australia & New Zealand

Jaycar Electronics is a rapidly growing, Australian owned, international retailer with more than 39 stores in Australia and New Zealand. Our aggressive expansion programme has resulted in the need for dedicated individuals to join our team to assist us in achieving our goals.

We pride ourselves on the technical knowledge of our staff. Do you think that the following statements describe you? Please put a tick in the boxes that do:

- ☐ Knowledge of electronics, particularly at component level.
- ☐ Assemble projects or kits yourself for car, computer, audio, etc.
- ☐ Have empathy with others who have the same interest as you.
- ☐ May have worked in some retail already (not obligatory).
- ☐ Have energy, enthusiasm and a personality that enjoys helping people.
- ☐ Appreciates an opportunity for future advancement.
- ☐ Have an eye for detail.

Why not do something you love and get paid for it? Please write or email us with your details, along with your C.V. and any qualifications you may have. We pay a competitive salary, sales commissions and have great benefits like a liberal staff purchase policy.

Send to:
Retail Operations Manager - Jaycar Electronics Pty Ltd
P.O. Box 6424 Silverwater NSW 1811
Email: jobs@jaycar.com.au

Jaycar Electronics is an equal opportunity employer and actively promotes staff from within the organisation.

Jaycar Electronics

RFMA RF Modules Australia

Low Power Wireless Connectivity Specialists

BIM1-151.300-10
VHF FM Transceiver
In Stock NOW!
Range: 5km+
Power: 100mW
Data rate 10kbps
Also: 151.275 & 151.6MHz



Applications:
Rural
Utilities
Industrial
Commercial
Government
Meter Reading

BiM2A-433-64
UHF FM Transceiver
In Stock NOW!
Range: 500m+
Upto: 25mW
Data rate 64kbps
33mm x 23mm x 4mm



RADIOMETRIX: Low Power, Licence Exempt Radio Modules

RF Modules Australia. P.O. Box 1957 Launceston, TAS., 7250.
Ph: 03-6331-6789. Email: sales@rfmodules.com.au. Web: rfmodules.com.au

20 years experience! SPEAKERBITS

HI-FI SPEAKER REPAIRS

YOUR EXPERT SPEAKER REPAIR SPECIALISTS

Specialising in UK, US and Danish brands. Speakerbits are your vintage, rare and collectable speaker repair experts. Foam surrounds, voice coils, complete recone kits and more. Original OEM parts for Scan-Speak, Dynaudio, Tannoy, JBL, ElectroVoice and others!

tel: 03 9647 7000 www.speakerbits.com

DOWNLOAD OUR CATALOG AT
www.iinet.net.au/~worcom

WORLDWIDE ELECTRONIC COMPONENTS
PO Box 631, Hillarys, WA 6923
Ph: (08) 9307 7305 Fax: (08) 9307 7309
Email: worcom@iinet.net.au

Printed Circuit Board Manufacture
48-Hour service * High quality * Low prices
1 offs to any quantity
Artwork design if required
Call for obligation free quote...
INSTANT PCBs, POBox 448, Avalon 2107
Ph (02)9974 1189 Fax (02)9974 5491

RETAIL MANAGER: PERTH STORE

Altronics is a dynamic national company involved in retailing and wholesaling a wide range of electronic equipment to the trade and enthusiast markets.

We are searching for a motivated manager to join our Perth team. The successful applicant will have several years experience in retail, preferably with management experience and a background in the electronics industry.

Excellent communication and customer service skills are essential. This is a hands-on position which involves serving customers, processing orders, merchandise control and supervision of our retail team. A generous salary and bonus scheme will be provided.

To register your interest, forward your resume to Dean Stephens via email at: dean.stephens@altronics.com.au

ALTRONICS 174 Roe St. Perth WA 6000.
Ph: 1300 797 007 Fax: 1300 789 777 Internet: www.altronics.com.au

Advertising Index

555 Electronics 43
Alternative Technology Assoc 92
Altronics ..... loose insert
Alvin Electronics 13
Amateur Scientist CDs ..... IBC
Av-Comm 103
BitScope Designs 3
Computronics 102
Dick Smith Electronics 18-21
Dontronics 103
Ecowatch 103
Emona Instruments 95
Grantronics 103
Harbuch Electronics 92
High Profile Communications 103
Instant PCBs 104
Jaycar IFC,49-56,104
JED Microprocessors 5
Keith Rippon 102
LED Sales 102
Microgram Computers ..... OBC
Microzed Computers 6
Microbyte Electronics 102
Ocean Controls 97
Ozitronics 41
Prime Electronics 11
Quest Electronics 103
RCS Radio 102
RF Modules 104
Sesame Electronics 102
Silicon Chip Binders 77,92,104
Silicon Chip Bookshop 100-101
SC Perf. Elect. For Cars 37,80
Silicon Chip Subscriptions 57
Siomar 45
Soundlabs Group 79
Speakerbits 104
Splat Controls 103
Telelink 103
Tenrod Australia 83
Truscotts Electronic World 102
Trusys 102
Vaf Research 7
Wagner Electronics 41
Worldwide Elect. Components .. 104

PC Boards

Printed circuit boards for SILICON CHIP designs can be obtained from RCS Radio Pty Ltd. Phone (02) 9738 0330. Fax (02) 9738 0334.

NEW! V3 SUPER SCIENCE FAIR EDITION!

THE AMATEUR SCIENTIST

Two incredible CDs with over 1000 classic projects from the pages of Scientific American, covering every field of science...

NEW UPDATED VERSION ALSO INCLUDES BONUS SCIENCE SOFTWARE LIBRARY!

Arguably THE most IMPORTANT collection of scientific projects ever put together!
This is version 3, Super Science Fair Edition from the pages of Scientific American.
As well as specific project material, the CDs contain hints and tips by experienced amateur scientists, details on building science apparatus, a large database of chemicals and so much more.





ONLY $62.00

PLUS $7 Pack and Post within Australia

NZ P&P: $AU12.00, Elsewhere: $AU18.00

"A must for every science student, science teacher, science lab . . . or simply for those with an enquiring mind . . ."

Just a tiny selection of the incredible range of projects:

• Build a seismograph to study earthquakes • Make soap bubbles that last for months • Monitor the health of local streams • Preserve biological specimens • Build a carbon dioxide laser • Grow bacteria cultures safely at home • Build a ripple tank to study wave phenomena • Discover how plants grow in low gravity • Do strange experiments with sound • Use a hot wire to study the crystal structure of steel • Extract and purify DNA in your kitchen •Create a laser hologram • Study variable stars like a pro • Investigate vortexes in water • Cultivate slime moulds • Study the flight efficiency of soaring birds • How to make an Electret • Construct fluid lenses • Raise butterflies as experimental animals • Study the physics of spinning tops • Build an apparatus for studying chaotic systems • Detect metals in air, liquids, or solids • Photograph an ant's brain and nervous system • Use magnets to make fluids into solids • Measure the metabolism of an insect . . . • and many, many more (a thousand more, in fact!)

See the V2 review in SILICON CHIP, October 2004. . . or read on line at siliconchip.com.au

HERE'S HOW TO ORDER YOUR COPY:

BY PHONE:* (02) 9939 3295 9-4 Mon-Fri

BY FAX:# (02) 9939 2648 24 Hours 7 Days

BY EMAIL:# silchip@siliconchip.com.au 24 Hours 7 Days

BY MAIL:# PO Box 139, Collaroy NSW 2097

BY INTERNET:^ siliconchip.com.au 24 Hours 7 Days

* Please have your credit card handy! # Don't forget to include your name, address, phone no and credit card details. ^ You will be prompted for required information

There's also a handy order form inside this issue (see SILICON CHIP Bookshop pages).

Exclusive in Australia to: SILICON CHIP www.siliconchip.com.au

For all those innovative, unique, interesting, hard to find products

Express Cards

Cat. No.	Description	Price
2405-7	ExpressCard to Serial	$139
2402-7	ExpressCard to Gigabit LAN	$119
2401-7	ExpressCard to eSATA – 2 Port	$119
2403-7	ExpressCard to Firewire (1394A)	$129
2404-7	ExpressCard to Firewire & USB Combo	$139
2457-7	PCIe to ExpressCard Adapter	$109
2408-7	USB to ExpressCard Adapter	$129
2407-7	ExpressCard into PCMCIA Slot Adapter	$79



USB Converters

Cat. No.	Description	Price
2729-7	USB to Parallel – DB25	$59
2685-7	USB to Parallel - Centronics	$35
2920-7	USB to Serial (RS232) 1 Port	$59
2929-7	USB to Serial (RS232) 8 Port	$459
2853-7	USB to RS422/485 1 Port	$249
2907-7	USB to RS422/485 4 Port	$560
23025-7	USB to 5.1 Sound Adapter	$45



Network Switches

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



Optical Audio Equipment

Cat. No.	Description	Price
23000-7	3 Port Switch – Toslink	$39
23001-7	3 Port Switch – Mini Plug	$39
23002-7	4 Input, 2 Output Switch - Toslink	$118
23006-7	Toslink to S/PDIF Converter	$52
23005-7	S/PDIF to Toslink Converter	$52
23007-7	Optical Extender to 25m	$52



What's New?

Cat. No.	Description	Price
9287-7	Cordless Pen Mouse	$129
9521-7	Cordless Pen Mouse with Laser Pointer	$149
9526-7	**Remote Control - Voice Activated & Programmable!**	**$389**
1008265-7	Wireless VGA Adapter (802.11g based)	$549
17115-7	**LGA775 Motherboard with ISA Slots**	**$649**
15156-7	USB to VGA Adapter	$179
	Temperature Logging	
18211-7	Standalone Temperature Logger – Software & Reader	$175
18210-7	Temp Logger Tag Only - 8000 Readings	$69
18212-7	Temp & Humidity Logger Tag Only – 4000 Readings	$199
17085-7	USB Temperature Sensor	$169
17090-7	USB Temperature & Humidity Sensor	$319
	eSATA	
2459-7	PCI Express (PCIe) 1 Port eSATA Card	$50
2462-7	PCI 2 Port eSATA Card	$94
6988-7	SATA 2.5" HD to eSATA & USB Combo Enclosure	$65
6913-7	SATA 3.5" HD to eSATA & USB Combo Enclosure	$85
1008319-7	SATA to eSATA Backplane – 2 Port	$18
1008241-7	eSATA Cable 1m	$14.50
	Digital Microscopes	
3626-7	USB Microscope Basic	$239
3685-7	USB Microscope with Microtouch	$269
3686-7	USB Microscope with Microtouch Trigger	$295
3687-7	USB Microscope PLUS with Measurement	$359
3688-7	USB Microscope with Microtouch & Measure	$499
	PCI Express	
2450-7	Gigabit LAN	$89
2452-7	Firewire B & USB Combo	$239
2453-7	SATA II – 2 Port	$99
2456-7	2456 Serial & Parallel Combo	$129



Not sure what product you need? Call us today for friendly advice!

1800 625 777 www.mgram.com.au ask@mgram.com.au

Point of Sale

Cat. No.	Description	Price
	POS Bundles	
9514-7	Basic Point Of Sale Bundle	$799
9510-7	Premium Point Of Sale Bundle	$999
	Barcode Scanners	
9493BLK-7	USB Barcode Scanner - CCD	$189
1008149-7	USB Barcode Scanner - Laser	$359
1008178-7	Bluetooth Cordless Barcode Scanner - CCD	$599
	Assorted Hardware	
8264-7	Magnetic Card Reader Track 1, 2 & 3 – PS/2	$139
5839BLK-7	Thermal Receipt Printer - Parallel	$569
9512BLK-7	Cash Drawer – RJ12 (Connects to receipt printer)	$179
5551-7	Mini Label Printer – 54mm Wide	$239
5751-7	Zebra LP2844 Label Printer – 104mm Wide	$659
9338-7	Cheque Reader – PS/2	$718



Gadgets

Cat. No.	Description	Price
3655-7	USB EPROM Programmer	$499
1168-7	Car PC 12v – 1Ghz 512Mb 80Gb WinXP	$1659
3527-7	USB 2.0 Analog TV Tuner & Video Capture	$119
3102-7	VGA to Video Converter with VGA Pass-through	$149
2726-7	PCMCIA 2 Port Serial Adapter	$269
2737-7	PCMCIA to Parallel Adapter	$269
6741-7	IDE to Compact Flash Adapter – Front Access	$99
2874-7	Independent RAID Server – Dual IDE HD with Hot Swap	$569
2959-7	Independent RAID Server – Dual SATA HD with Hot Swap	$599
1248-7	Windows CE Based Terminal with Wyse Emulation	$699
1171-7	7" Touchscreen LCD – 12v DC	$470
1173-7	8" Touchscreen LCD – 12v DC	$579
15141-7	USB Macro Stick – 16 Key Programmable	$199
6885-7	USB to PCMCIA for Wireless Broadband Cards 32-bit	$299



MicroGram Computers

Unique IT Solutions

Reseller enquiries welcome

1800 625 777
ask@mgram.com.au
www.mgram.com.au

All prices subject to change without notice. For current pricing visit our website. Pictures are indicative only.

SHORE AD/MGRM1207