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Electronics Australia

APRIL 1988

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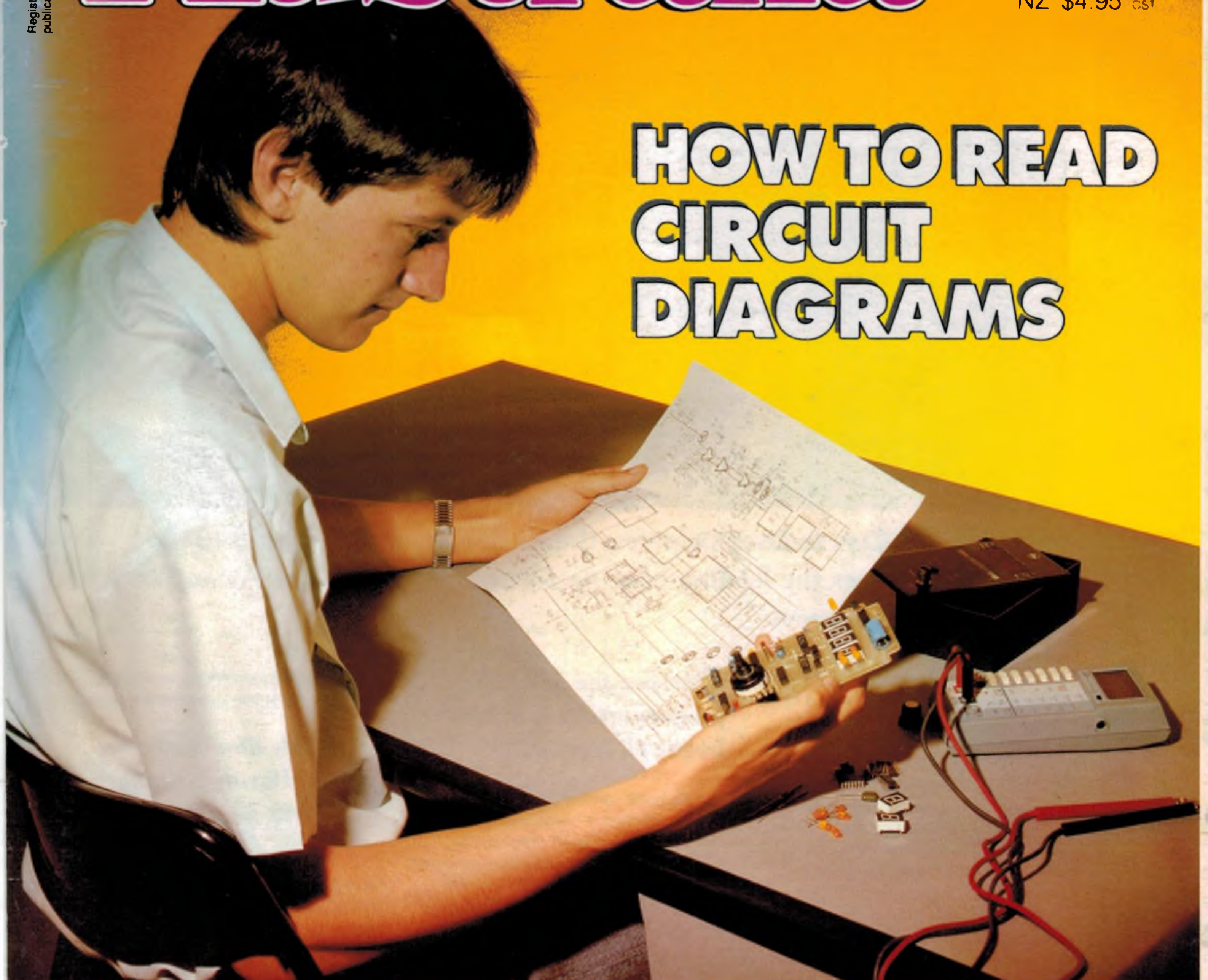
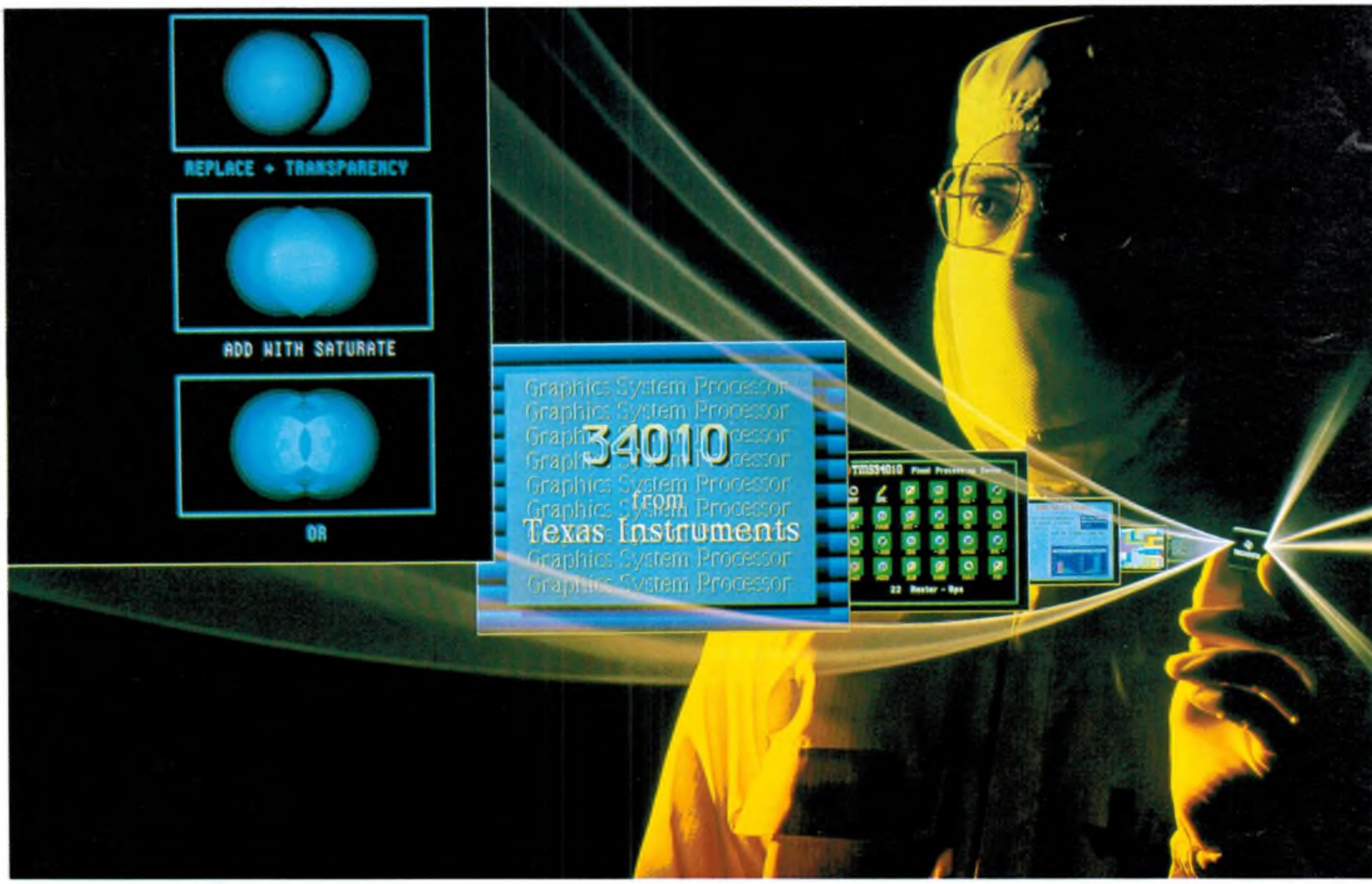


WAS MODERN TV REALLY INVENTED IN JAPAN?

Great projects: SIMPLE FM TUNER, 300W INVERTER, BENCH AMP, CURRENT TRACER PROBE

Graphics Solutions



From PC displays to laser printers, the flexibility of TI's TMS34010 processor delivers the leading-edge performance you need today and to stay out in front tomorrow.

In TI's TMS34010 Graphics System Processor, you have a new and better approach:
The first high-performance, 32-bit CMOS microprocessor optimized for graphics applications.

The 34010 can execute all functions needed by graphics operating environments; hard wired coprocessors can only execute a small part.

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"Because the 34010 is programmable, it is in a league all its own".

Jim Richards, president of VMI, is talking graphics performance. You can programme the 34010 processor to perform any graphics function you want, unlike hard-wired coprocessors.This means you can readily customize your system to outperform your competition.

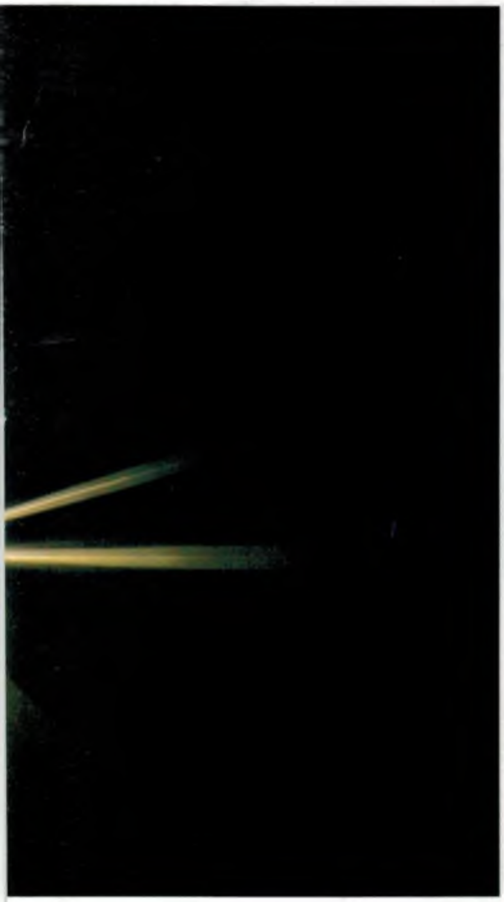
But there's an even more important aspect to consider.The 34010 will help keep your system ahead of competition because it is compatible with existing graphics hardware standards- CGA™,EGA™, and PGC™ - and supports graphics software standards such as CGI™, DGIS™,and MS-Windows™.

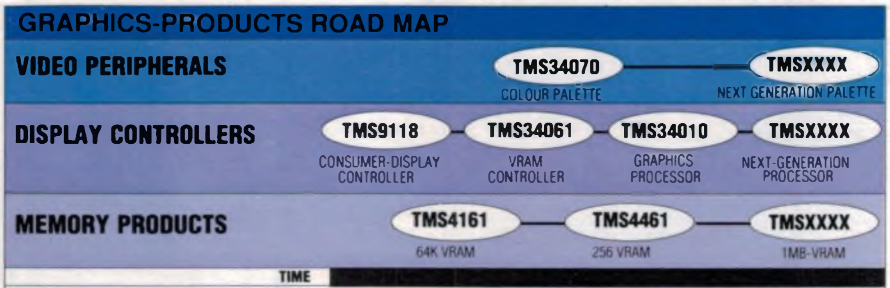
Standards like Windows and DGIS run faster on TI's TMS 34010

The 34010 is also among the fastest microprocessors available. It handles six million instructions per second with a "draw rate" of up to an amazing 50 million pixels per second. Thus, it can boost total system performance.

Because of the support of MS-Windows and DGIS alone, many major applications software packages can already run on 34010-based systems.

From TI.





Road map to tomorrow's graphics systems: Next generation additions to TI's innovative graphics-products family will allow you to build on your present designs to develop even higher-performance systems.

"You would think TI designed the 34010 with our technology in mind"

Luis Villalobos, Conographic president, refers to the power of the 34010 to process font outlines for desk-top publishing. Resolution up to 64K x 64K means no hardware limits for laser printers and other hard-copy devices.

Host independence and the flexibility of a device programmable in "C" language make TI's 34010 the cost / performance leader for PC displays, laser printers, desk-top publishing, workstations, terminals, plotters, FAX, image processing, digital copiers, mass storage, robot vision, and communications.

TI's total systems solution

In implementing your design, you'll want to consider other building blocks T I has developed. Included are the single-chip TMS34070 66-MHz Colour Palette that supports simultaneous display of 16 out of 4,096 colours and the TMS70C42 Microcontroller that handles all serial interface duties.

Also included are high-speed video random-access memories (TMS4161 and TMS4461), plus linear small and large-area CCD image sensors.

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You can trigger one module with another, time-correlate measurements between modules, and even view state, timing and analog on the same screen. The HP 16500 A is a fully programmable part of HP DesignCentre... a CAE development environment that unites engineers from IC design/verification to PCB design and test.

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HEWLETT PACKARD

E115620A

Coming next month in Electronics Australia

Two-chip FM radio

You've seen plenty of really simple AM radios, but simple FM radios have been conspicuous by their absence. Here's a new project to change all that: it uses only two ICs and is very easy to build. But it works really well!

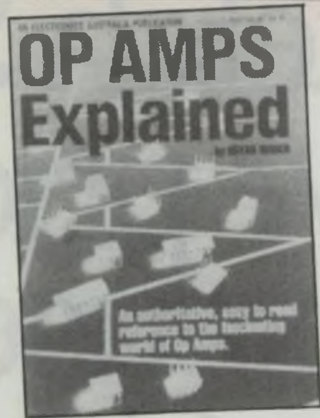
Simple tester for power transistors

Conventional transistor testers don't really check power transistors properly — in fact they can be quite misleading. Here's a simple, low cost power transistor tester that does the job properly. Great for selecting and matching pairs . . .

Low cost 50MHz frequency counter

Most people don't need to measure frequencies above about 50MHz, so a 500MHz or 1GHz counter can be expensive overkill. Here's a much cheaper and easier to build 50MHz design. It's compact, too.

**Note: although these articles have been prepared for publication, circumstances may change the final content of the issue.*



Look inside almost any piece of modern electronic equipment (even things that are normally "digital") and you're likely to find op amps amplifying, filtering, shaping, clipping, detecting level changes or otherwise processing signals.

Without op amps, we'd still be in the electronic dark ages. And without sound basic understanding of the way they work and the way they're used, you probably won't get very far in today's world of electronics.

This book can be your guide and reference. It is authoritative, but at the same time very accessible and easy to read. The author has really boiled down the concepts of op-amp operation to make them understandable.

Recommended to all interested in linear electronics, operational amplifiers and their applications whether at hobby level or as a serious University or College student.

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Volume 50, No.4

Electronics Australia

April 1988

AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE — ESTABLISHED IN 1922

Is this the real inventor of TV?

Kenjiro Takayanagi is almost unknown outside Japan, but he was developing fully electronic TV when inventors like Baird were playing with spinning discs. His story is fascinating - see page 26.

Projects, projects...

This month we've again got four great construction projects for you: a low cost bench amplifier/-signal tracer, a really easy to build FM stereo tuner (using pre-aligned modules), an improved version of the popular 300W inverter, and a simple digital current sensing probe for PCB troubleshooting.

Spotlight on Components

As part of this month's feature on components, there's an intriguing look at the evolution of a specialised IC - from discrete parts to final monolithic chip. See page 120

ON THE COVER

For a lot of newcomers to electronics, circuit diagrams are a real stumbling block (see our story on page 92). But they're really no problem to EA staff member Mark Cheeseman, shown here checking one of his circuits (Photo by Peter Beattie)

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Letters to the editor

Amplifier earthing

The Forum article on "Should hi-fi amplifiers be earthed or not?" in *Electronics Australia* February 1988 makes a number of interesting points, especially with regard to electrical safety and classes of insulation. However I do believe there is a need to further clarify some aspects of the article and the reported advice obtained from Mr Ron Profit of SAA.

The electrical safety of equipment in Australia and many other major countries is based on three classes of insulation, all of which are deemed to give equal protection against shock. A brief description of each is as follows:

1. Class I

Protection against electric shock is afforded by basic insulation plus the connection of accessible conductive parts to the protective earth.

Basic insulation is generally single layer.

2. Class II

Protection against electric shock is afforded by double insulation or reinforced insulation or by other equivalent systems, there being no provision for protective earthing.

Double insulation consists of basic insulation plus supplementary insulation. Reinforced insulation, which may be single or multilayer, is a system considered to have the equivalent mechanical and electrical strength as double insulation. Other systems include the use of protective impedances and the like.

3. Class III

Protect against electric shock is afforded by supply at safety extra low voltage (SELV), which in AS 3000 is specified as 32V AC or 115V DC.

SELV parts able to be touched must be isolated from higher voltages by the equivalent of Class II insulation.

Tests and dimensional and material requirements for these Classes of insulation are contained in the Australian Standards AS 3100, AS 3300 and AS 3250. For example, the 3750V test mentioned in your article is only one of the tests specified for Class II insulation. Likewise the concept of single layer reinforced insulation was certainly introduced "some time back" as it has been permitted by AS 3100 (AS C100) for more than 30 years!

As pointed out in your article, AS 3100, AS 3300 and AS 3250 requires that Class II equipment be marked with a "double square" symbol and be not provided with an earthing conductor in the main cord or with the means of connecting such an earthing conductor. The prohibition on the deliberate introduction of an earthing conductor that is not required for electrical safety purposes to Class II equipment is part of the package of requirements that equate the safety levels afforded by Classes I and II.

However there is no prohibition in Australian Standards to the use of Class I for amplifiers. Likewise there is no prohibition on the treatment as Class I i.e., having accessible metal connected to the mains earthing conductor, of an amplifier constructed as Class II but not marked with the "double square" symbol.

As the options available to manufacturers and purchasers of audio systems are clearly covered in the applicable standards there seems to be no need for action by SAA and State Regulatory Authorities as suggested in your article. If your aim is to have amplifiers manufactured with a mains earth connection, perhaps you should encourage manufacturers and suppliers to provide them as current Australian Standards do allow for such equipment.

Peter N. Walsh,
Group Manager Electrotechnology,
Standards Association of Australia.

Comment: Thank you for your letter, which raises a number of additional points. I'll try to discuss these shortly in Forum.

American midget death trap?

Further to your February 1988 article, *Restoring a Vintage American Midget Radio*, I'm afraid very reluctantly I have to knock it a bit, much as I hate doing so, as it dealt with nice nostalgic valve goodies.

Firstly, "hot chassis" sets are death machines. Also Australian Standard 3100 "Definitions and General Requirements for Electrical Materials and Equipment", Clauses 2.29 and 5.1 define the neutral as live, (it's too easy to swap the wires in the plug) and requires these parts to be guarded respectively. So the only hope of some sort of compliance would be if the set were screwed into a case, and all metal made finger proof. (But try to get an approval?)

Secondly, half-wave rectified mains appliances are prohibited, if the DC so generated exceeds 5mA continuously. This is to prevent corrosion of the installation's earth.

Thirdly, the 25A7GT rectifier valve is rated at 117V AC maximum. Here it cops 240V AC max! Good for selling valves perhaps.

As it was basically a 115V mains voltage set originally, I would regard it as a more legitimate restoration if it were made up again as a 115 volt radio, rather than attempt to convert it by a questionable series resistor system to 240 volts. The 240/115 transformer, is as it was 40 years ago a perfectly legitimate conversion system.

Brian M. Byrne,
Indooroopilly, Qld.

Comment: Your criticism is no doubt valid, Brian. We published the story because it was an interesting one, and gave an insight into the way some old valve sets worked. Many of them did have a live chassis, and quite a few did use the crude series-resistor system to drop excess voltage when operating an essentially 115V circuit from 240V. There are probably very few such sets still around in Australia, but your warnings about the dangers and problems obviously won't go astray.

More phone details?

Re the article "Telephone Toyland", in your September 1987 issue. This was a good start into explaining telephone communications, but how about a follow-up!

For example, the operation of the 800 series Colorfone could be explained in more detail, as no doubt could other types of phones, auto dialers, etc.

You have opened the subject up. Now let's pursue it further.

Brian Plummer,
Hastings, NZ.

Comment: Thanks for the suggestion, Brian. What do other readers think?

Editorial Viewpoint

A wealth of good reading!

Hello again. This month we've got a lot of interesting things for you, whether you're a newcomer to electronics, a seasoned professional or anywhere in between.

One fascinating story is about Kenjiro Takayanagi, the still almost unknown Japanese inventor who visualised and virtually invented modern electronic television back in 1924-25. He may not have been *the* inventor, perhaps, but he certainly seems to deserve as much credit as John Logie Baird, the man usually credited with its invention. Frankly I found this one a real eye-opener, and I think you will too.

Bringing us right up to the present, another story takes a look at the impressive "Megachip" project which Philips and Siemens hope will bring them to the forefront of submicron IC technology. There's also an in-depth look at digital audio tape (DAT), from our US contributor Ken Pohlmann.

This month we're also launching a new column, by well-known writer Frank Linton-Simpkins. Many of you will already be familiar with Frank's writing, with its unique blend of erudition, good humour and shrewd insight. Many's the time his pieces have reduced me to fits of laughter, and I feel sure you'll find them just as enjoyable.

When it comes to construction projects, we have an easy to build little bench amplifier which is designed to work as a signal tracer as well. There's also an upgraded version of the very popular 300W power inverter, and a novel low-cost current tracer probe for troubleshooting on digital PCBs.

We haven't forgotten the newcomer, of course. There's a very easy to build FM stereo tuner, using a set of pre-aligned modules. There's also a special article on how to read circuit diagrams — something we haven't explained for quite a while (sorry about that!).

We also have the first instalments of TWO more new "understanding" series. One is on VCRs and how they work, written specially for us by David Botto (who wrote our popular *Colour TV* series). The other is on basic radio theory, written again specially for us by Bryan Maher (author of our equally popular *Op-Amps Explained* series and book). Both of these series are original, by the way — neither has been published before, either here or anywhere else.

If you're a professional, you'll also find some interesting articles on developments in electronic components — including the story of how a locally manufactured hazard warning lamp has been continuously improved by taking advantage of evolving *Australian* semiconductor technology.

Plus all of our usual features, of course. We've spent a month putting it all together for you, and I feel sure you'll find plenty there to keep *you* busy for at least a few days!

Jim Rowe

What's New In
Entertainment Electronics

Dali releases "flagship" model speaker system

Danish American Loudspeaker Industries (Dali) has released its new top-of-the-range loudspeaker system, the Model 40. This is a large seven-driver system offering excellent bass reproduction, claimed elimination of phase modulation and "hangover", and wide dispersion of highs in the horizontal plane.

The Dali-40 provides a 25mm metal dome tweeter, two 113mm midrange drivers and four 200mm very long stroke bass drivers. It has a nominal impedance of 4 ohms, a sensitivity of 89dB/1W/1m and is suitable for use with amplifiers delivering from 50W to 500W per channel. Rated frequency response is 25 — 20,000Hz within 2dB.

Each pair of bass drivers is mounted back-to-back in a totally separate enclosure, with the external speaker of each pair working as a conventional bass reflex system, and the internal speakers in a bandpass bass reflex system. The bass drivers themselves have four-layer voice coils with aluminium rings in the magnet system, to absorb eddy currents.

The two midrange speakers are positioned above and below the dome tweeter, and use cones made from TPX material with Norsorex suspension. TPX material has lower density than polypropylene, but provides double the stiffness and much better damping. Norsorex is a new material which blends the properties of foam rubber and oil.

The Dali-40 system is housed in a very heavy braced cabinet which uses solid wood, anodised aluminium extrusions and glass, with very low vibration. Each cabinet is finished in genuine rosewood veneer, measures 1240 x 480 x 380mm and weighs 68kg. Quoted price (RRP) of the system (two enclosures) is $7990.

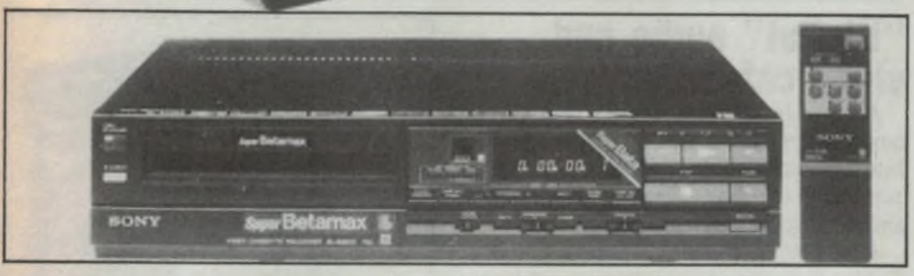
Further information on the Dali range of speaker systems is available from Scan Audio, 52 Crown Street, Richmond 3121.

Even bigger Bose

Based on the same technology as the company's award winning Acoustimass Hi-Fi speaker system, Bose has just released a revolutionary new professional bass system called the Acoustic Wave Cannon.

The Cannon is a 12 foot (3.8 metre) long black tube containing one 12" loudspeaker placed about three quarters the way along the length of the tube. It's aimed basically at the cinema and installed sound system market and was recently seen being used at the Sydney Bicentennial BHP Steel Outdoor Movie Season at the Sydney Opera House. Rumour has it that a domestic Hi-Fi version of the cannon may well be seen on the Australian market towards the beginning of 1989.

New 8mm camcorders, Super-Betamax VCR from Sony



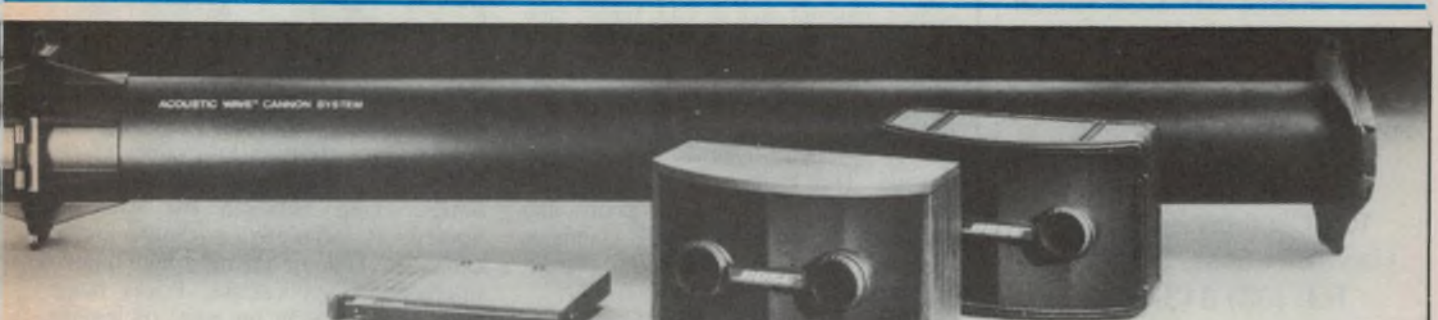
To launch its 1988 marketing thrust, Sony has released three new Handycam 8mm camcorders and a Super-Betamax VCR for the Australian market.

Taking its place at the top of the Sony camcorder lineup is the new CCD-V90 Handycam "Pro", offering a greatly improved CCD image sensor with 495,000 pixels of gross resolution. As well as offering what is claimed to be the clearest and sharpest picture yet provided in a home video camera, the V90 also offers a variable speed electronic shutter with speeds up to 1/2000th second, optional manual override on all auto adjustments, five speed playback and edit search facilities.

Second new addition to the Handycam range is the CCD-V50, an improved version of the popular V30 unit offering digital memory and superimpose facilities. This allows the user to store a high-contrast image, such as a title, and superimpose it (in a choice of eight colours) at any desired point over live material. The V50 has a 6x power zoom, and its CCD sensor offers a resolution of 291,000 pixels for excellent picture detail. Suggested retail price is $3125.

The third new Handycam is the CCD-AU200, a limited edition unit which Sony describes as its "gift to the nation" to mark the Australian Bicentenary. The AU200 is a limited edition model, packaged in green and gold livery and offering aim-and-shoot convenience with all normal features including auto focus, white balance and exposure. Recommended retail price for the AU200 is an attractive $1988, which should bring it within the range of many more people.

Perhaps to emphasise its continuing committment to the Betamax system, Sony also released the new SL-S2000 Super Betamax home VCR. This features a new "super" mechanism, colour switch and sharpness control, "long-life" video heads, real-time counter, cordless remote control and BetaScan picture searching at nine-times normal speed.



JVC releases S-VHS in Japan

JVC has announced in Japan Super-VHS (S-VHS), an improved domestic half-inch video system having high resolution and picture quality said to be comparable to that of 1" broadcast use recorders.

JVC's Super-VHS system allows more than 400 lines of horizontal resolution compared to around 230 lines which you would currently experience using your home video recorder.

S-VHS video decks will be equipped with recording functions for both conventional VHS and S-VHS systems, to enable users to select either mode. A conventional VHS cassette can be used on a S-VHS VCR when recording in the conventional VHS mode, ensuring compatibility.

JVC is hoping to release the first PAL S-VHS model onto the Australian market in late 1988.

To produce the improved resolution, the S-VHS system records the video signal at a much higher frequency than it does in the standard VHS mode.

IR remote control preamp kit

Dick Smith Electronics has released an Infrared Remote Control Preamplifier kit. This uses an existing amplifier or receiver and adds full remote control operation from up to six metres away. At the press of a button it can turn your system on or off, operate the volume or tone controls, or switch between your record player, tape deck, or compact disc player.

An array of coloured LEDs provides a simple visual indication of which mode is in operation — a professional feature that eliminates guess work.

The kit comprises two parts: the small hand-held transmitter and the main receiver/preamplifier unit. Full instructions are supplied to connect the main unit to your amplifier.

Available from Dick Smith Electronics stores, the DSE Infrared Remote Control Preamplifier kit (K-4003) costs only $259.

"Digital" audio and video cables

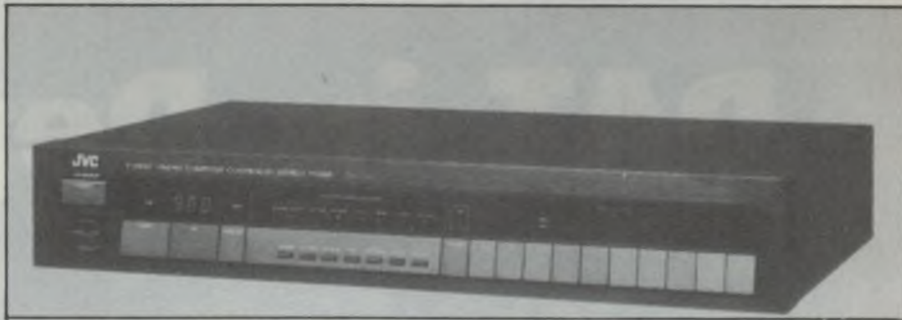
Audio Investments has released a new range of SAEC Digital Audio Interconnect Cables. The new range comprises two lines, digital audio cables and a range of video interconnect cable.

1707-PRO (Super Digital Audio Cable) is designed for interconnect from source material such as CD, tuner, tape and digital sources to pre-amp. The 1707-PRO series utilise a process called Ohno Continuous Casting (OCC) which involves the hardening of extremely pure copper wire from the centre to the outside. This forms what is claimed to be a single crystal free of grains and bubbles, offering what SAEC claims as "virtually flawless transmission characteristics".

CD-1702 (Digital Audio Cable) utilises a coaxial design, high purity copper

with 24 carat gold plated, non-magnetic phono plugs ensuring low values of capacitance, inductance, and resistance. SAEC claim although the cable is classed as primarily a digital audio cable, it is suitable for most high quality interconnect applications. Prices range from $129 to $159 for pairs of lengths from 0.8mm to 1.6m, including tax.

Computer-controlled FM/AM Tuner



The new T-X900(L)B from JVC is a good example of the integration of computer technology with traditional audio technology.

When a station is tuned, the computer takes over to optimise a whole series of tuning parameters, including sensitivity, IF bandwidth, QSC (Quieting Slope Control), and even your choice of two antennas.

A total of 10 FM and 10 AM (or MW/LW) stations can be memorised for one-touch recall. And when a station is entered into the computer memory, tuning parameters are memorised also. In addition, stations can be automatically entered into the memory, and when an optional program timer is used, a different station can be recalled each time the tuner comes on.

Other features of the unusual tuner include a dB-Reference signal strength meter, a record-level calibrator and user-changeable station sheet.

Disctronics launches first PAL commercial CDV

In a project that gives Australian-based global CD manufacturer Disctronics the lead in Compact Disc Video software production, the company has presented Russian music company, Melodiya, at the MIDEM conference with its first CDV for commercial release. This is the first PAL commercial release in the world on the new CDV format and launches Disctronics as the only alternative to PDO in PAL and NTSC mastering and pressing.

Russian female rock vocalists, The Bazykina Twins, are dazzlingly displayed in the video portion of the CDV singing their hit song "Moscow Nights" which was originally produced as a clip for Soviet television and features a broad range of scenic visuals and spectacular effects. The CDV project was realised through the work of Melodiya, Soviet TV and German Avksentjev, Director of the Soviskusstvo Department of Mezhdunarodnaya Kniga, Russia's foreign trade organisation.

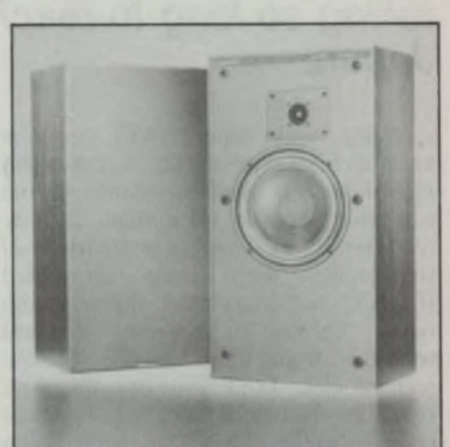
Mr Avksentjev describes the CDV project as, "the most important step in presenting our contemporary music to the rest of the world through the audio and visual excellence of Compact Disc Video. We have taken advantage of the state-of-the-art technology that our friends at Disctronics offer to break through with a whole range of music."

The successful production of the first commercial samples of CDV also shows Disctronics capabilities in the emerging CDV market. The raw materials — video footage and audio masters — were sent to Disctronics' Southwater UK plant one week before release. The edit was completed in London on the Friday and the mastering engineers at Southwater worked closely with Philips engineers in the critical mastering process which was completed on the following Monday. The CDVs were pressed on Tuesday and the first commercial samples were received in Cannes at MIDEM on Wednesday for showing at the trade fair on Thursday morning.

Two-way compact loudspeakers

Boston Acoustics has announced the A70 Series II two-way acoustic suspension speaker. The new A70 is a complete redesign of the original, incorporating completely new drivers, crossover and cabinet, and offering greater sonic accuracy and lower distortion than the original. The cabinet is finished in a wood grain vinyl, and the suggested retail price is $1499.

The Boston-built 8" woofer uses a copolymer diaphragm and a newly designed magnet that substantially reduces distortion. The tweeter is the Boston Acoustics CFT5 1" ferrofluid cooled dome tweeter, the same unit used in the most expensive Boston Acoustics speaker system.



Frequency response is 45-20,000Hz ±3dB. Impedance is 8 ohms and recommended amplifier power is 15 to 75 watts. Sensitivity is 90dB/W/m. The A70 Series II measures 23" H x 12 1/2" W x 8 7/8" D (584 x 318 x 225mm).

Further details from Falk Electrosound, 28 King Street, Rockdale, 2216.

New Ortofon MC 3000 moving coil cartridge

In the development of its new MC 3000 moving coil cartridge, Ortofon sought to introduce new technology while at the same time retaining the acknowledged advantages of its low impedance moving coil principle.

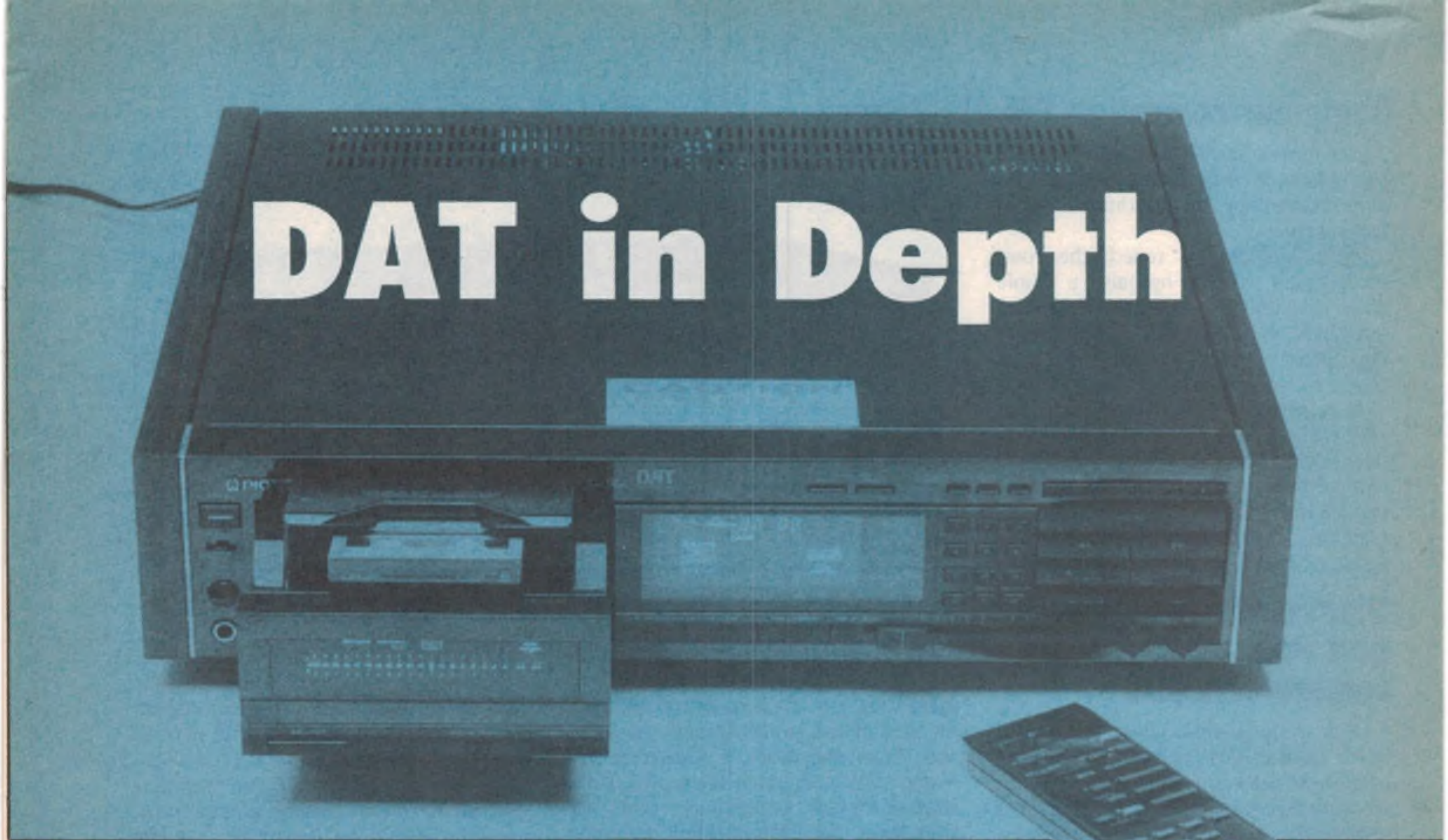
The ceramic cartridge shell material is as hard as ruby or sapphire and nearly as hard as diamond, which means that the shell of the MC 3000 is virtually immune to vibration and resonances.

The new diamond stylus, Ortofon Replicant Stylus 100, has an exceptionally slim profile which ensures a wide contact area on the groove wall.

Finally, the newly constructed magnetic circuit and the use of new materials in the moving system has allowed for an increase in the output voltage of the cartridge, e.g., 0.1mV, double that of the existing MC 2000.

In order to match the higher output of the MC 3000, Ortofon has also developed a new transformer: the T 3000. This unit has no switches or contact — it uses a toroidal mu-metal core and a pure silver wire coil system.

Further details on the Ortofon 3000 are available from Scan Audio, 52 Crown Street, Richmond 3121.



DAT in Depth

Digital audio tape (DAT) is not only high technology, but also highly controversial. Here's a rundown on both the technical details of DAT, and the reasons why it's taking so long to reach the markets outside Japan.

by KEN C. POHLMANN*

**Director of Music Engineering, University of Miami, Florida*

Digital audio tape (DAT) recorders are the first mass-market digital audio tape recorders made available to the consumer. Similar to a video cassette recorder, DAT employs a rotary head (technically the system is called R-DAT, or rotary-head digital audio tape). Because it borrows technical solutions from video head and tape technologies, DAT provides the wide recording bandwidth needed for pulse code modulation (PCM) digital audio storage, as used on compact discs. The technical specifications of the format have now been standardised by the EIAJ, (Electronics Industries Association of Japan) ensuring compatibility between manufacturers.

However despite its technical sophistication — or rather, because of it — controversy has greeted DAT in many of the world's markets. Specifically, the prospect of a moderate-cost high fidelity digital recorder in the hands of the public has provoked outcry from the recording industry, most vocally from the record labels themselves. They envision DAT as the ultimate copying device, removing the barrier of sonic degradation from home taping. As a result, those companies have lobbied against the introduction of DAT in America and Europe.

Let's explore the technical aspects of DAT, including the state-of-the-art sophistication required to bring digital audio tape recording to the mass market. And then let's consider the implications of the technology in the marketplace, and the political battles which have arisen.

DAT Modes

DAT standards call for four record/playback modes and two playback-only modes, as summarised in Fig.1. The Standard record/playback, and both playback-only modes, called Wide and Normal, will be standard on every DAT recorder. All machines will have full digital inputs and outputs. The Standard mode offers 16-bit linear quantisation and 48kHz sampling rate. Both playback-only modes will use a 44.1kHz sampling rate.

The consumer DAT format outlaws 44.1kHz recording, thus one cannot digitally record compact discs (from CD players with digital outputs) or prerecorded DAT tapes, both recorded with a sampling rate of 44.1kHz. In addition, DAT recorders contain a "watchdog" circuit which prevents operation if the copy-inhibit flag in the bit stream of any digital source has been enabled. The intent, of course, is to discourage digital-to-digital copying. More on this later . . .

Three other record/playback modes are possible called Options 1, 2, and 3; all use 32kHz sampling rates. Option 1 provides 2-hour recording time with 16-bit linear quantisation, and option 2 provides 4 hours with 12-bit nonlinear quantisation. Option 3 provides four

Item \ Mode	DAT (REC/PB mode)				Pre-recorded tape (PB only)	
	Standard	Option 1	Option 2	Option 3	Normal track	Wide track
Channel number(CH)	2	2	2	4	2	2
Sampling frequency (kHz)	48	32	32	32	44.1	
Quantization bit number (bit)	16 (Linear)	16 (Linear)	12 (Nonlinear)	12 (Nonlinear)	16 (Linear)	16 (Linear)
Linear recording density (KBPI)	61.0	61.0			61.0	61.1
Surface recording density (MBPI²)	114	114			114	76
Transmission rate (MBPS)	2.46	2.46	1.23	2.46	2.46	
Sub-code capacity (KBPS)	273.1	273.1	136.5	273.1	273.1	
Modulation system	8-10 conversion					
Correction system	Double Reed-Solomon code					
Tracking system	Area sharing ATF					
Cassette size (mm)	73×54×10.5					
Recording time(MIN)	120	120	240	120	120	80
Tape width (mm)	3.81					
Tape type	Metal powder					Oxide tape
Tape thickness (μm)	13± 1 μ					
Tape speed (mm/s)	8.15	8.15	4.075	8.15	8.15	12.225
Track pitch (μm)	13.591				13.591	20.41
Track angle	6°22′59.5″					6°23′29.4″
Standard drum specifications	φ30 90° Wrap					
Drum rotations (rpm)	2000		1000	2000	2000	
Relative speed(m/s)	3.133		1.567	3.133	3.133	3.129
Head azimuth angle	±20°					

Fig.1: Specifications for the various recording/playback modes for DAT. There are quite a few options, as you can see. (Courtesy Sony)

channel recording and playback also using 12-bit nonlinear quantisation. These options are compatible with direct broadcast satellite (DBS) material, beamed earthside at 32kHz. Fully digital recordings could be made, if you live in the satellite's footprint. DBS is available in Japan, India and parts of Europe.

Rotary head

As noted, DAT borrows a rotating head from video technology; this permits slow linear tape speed, but the high head-to-tape speed necessary to achieve high bandwidth. The DAT rotating head drum is 30 millimetres in diameter, rotates at 2000 rpm, has two heads 180° apart and a tape wrap of only 90°. Because of low wrap, tracking stability is said to be better than M-wrap and U-wrap video systems. This should facilitate design of portable and car DAT players.

The drum's two heads are angled differently with respect to the tape; in this way successive tracks are recorded with different azimuth angles. This reduces crosstalk between adjacent tracks, and no guardband is needed. In the future, four heads could be placed on the drum, separated by 90°, to permit simultaneous monitoring of a recorded signal.

The width of each track is 13.591 microns (about 1/10 the thickness of a human hair) and the length of each track is 23.501 millimetres, as shown in Fig.2. Each bit of data occupies only 0.67 microns, with an overall recording data density of 114 megabits per square inch. With a sampling rate of 48kHz and 16-bit quantisation, audio data rate is 1.536 megabits per second. However error correction encoding, subcode, modulation and other necessities raise the data rate to 2.77 megabits per second.

Track format

To help tape tracking, a sophisticated tracking correction system, along with a good deal of tape area, is employed. Part of each data track contains tracking data, known as automatic track finding (ATF). As each track is read, the head

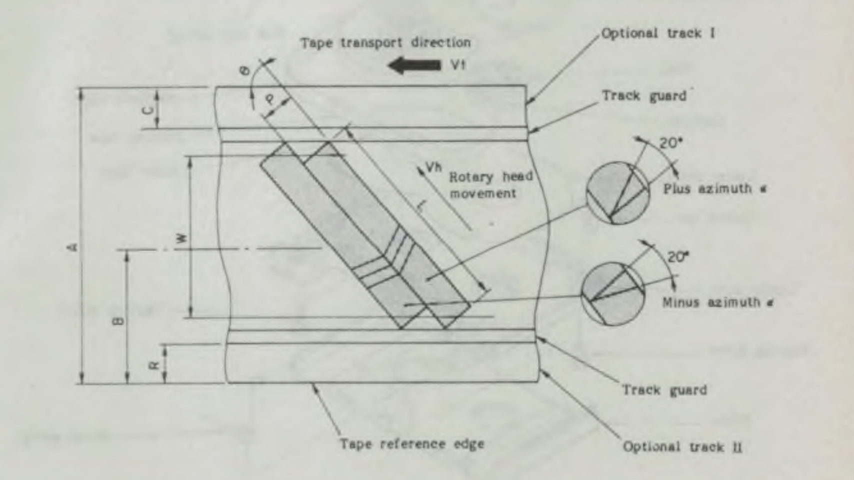


Fig.2(a): Basic DAT track geometry. Track length L is 23.5mm, while track width P is only 13.591um.

DAT in Depth

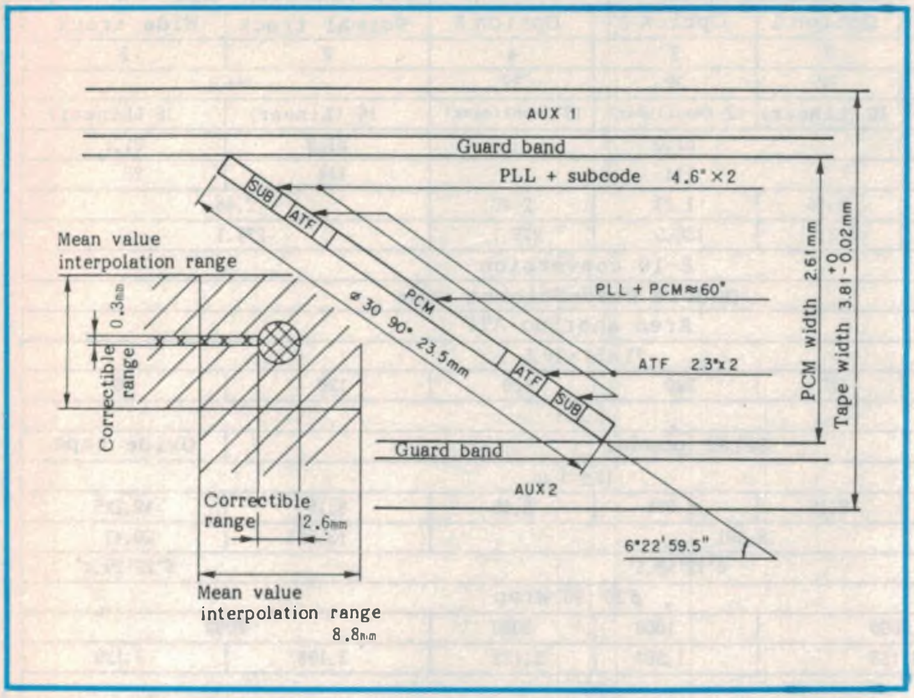


Fig.2(b): How the data is formatted in the tracks, plus DAT's error correction capabilities.

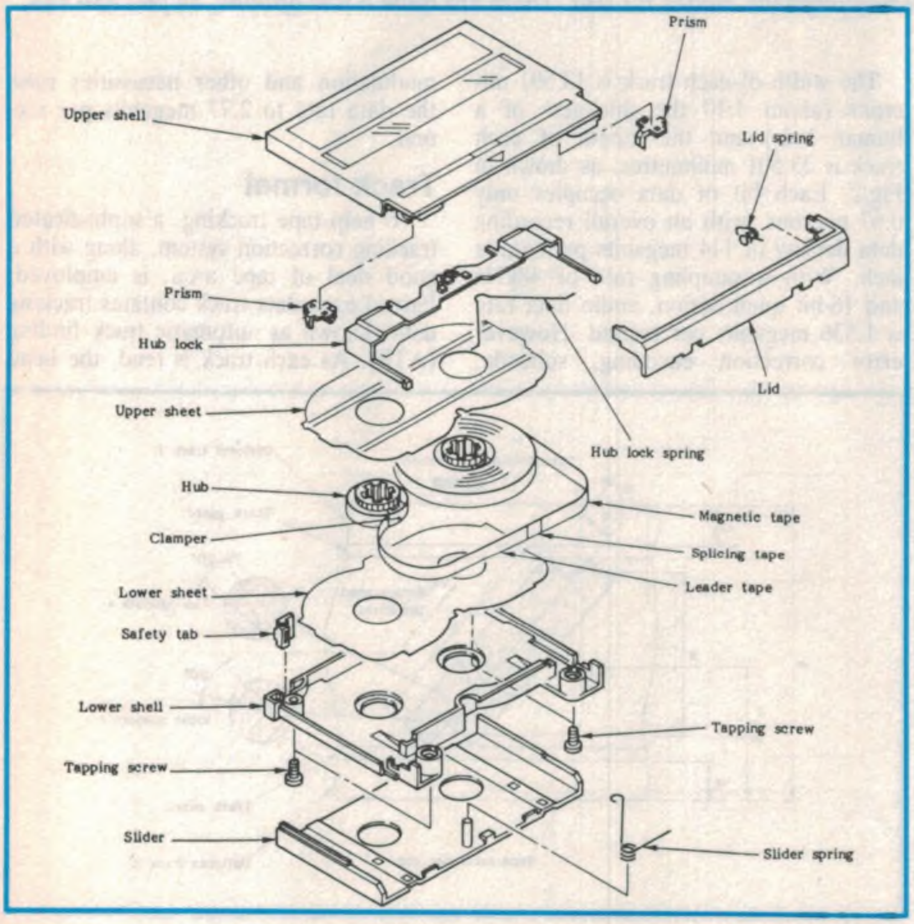


Fig.3: Construction of the DAT tape cassette. Using 3.81mm (1/8") wide metal formulation tape, it measures only 73 x 54 x 10.5mm.

overscans the track width to read a small part of the adjacent tracks. While reading the ATF portion of the track, its intensity is compared to that on adjacent tracks. A difference causes the tracking correction servo system to adjust the head accordingly.

As with any helical scan system, time compression must be used to separate the continuous input analog signal into separate "video fields" prior to recording; then rejoined again upon playback with time expansion to recreate a continuous audio output signal.

The data is recorded with eight-to-ten modulation in a block format, with 288 bits per block. Four 8-bit symbols are used for sync, and addressing. PCM data and parity account for 256 bits, arranged in 32 symbols per block. Each track consists of 128 of these blocks, for a total of 4096 symbols. Of these, 1184 symbols are used for error correction, and 2912 symbols are devoted to data storage. Other track areas are used for subcode.

As on the Compact Disc, subcode data is used for program timing, indexing, music selection, pre-emphasis, as well as sampling frequency, quantisation level, tape speed, etc. Contained in the subcode is a copy-inhibit "flag"; when set to zero, another DAT recorder will refuse to make a digital-to-digital copy, hence the tape is copy-protected.

To facilitate error correction, each data track is split into halves, between left and right channels. In addition, data for each channel is interleaved into even and odd data blocks, one for each head. If one head reads bad data because of dirty tape or a tape defect, data received from the other head can be used to perform interpolation on the missing data. All of the data is encoded with Reed Solomon error correction code, as on Compact Discs. The error correction system can correct any drop-out error up to 2.6 millimetres in diameter, or a stripe 0.3mm high. Drop-outs up to 8.8mm long an 1.0mm high can be concealed with interpolation.

DAT cassette size is 73 x 54 x 10.5mm, slightly more than half the size of an analog cassette, as shown in Fig.3. It uses 3.81mm-wide tape, equal to the 1/8" tape used in analog cassettes, and the tape is 13 micron thick, equal to that used in analog C-90s.

Prerecorded DAT

As with any audio source hardware, DAT will play back prerecorded digital tapes. Specifications for prerecorded DATs are shown in Fig.4. In the Nor-

TRACK PITCH	NORMAL (1 Tp)	WIDE (1.5 Tp)
NUMBER OF CHANNELS	2 CH	
SAMPLING FREQUENCY	44.1KHz	
QUANTIZATION	16 BIT LINEAR	
TAPE SPEED	8.15 (MM/S)	12.225 (MM/S)
TRACK PITCH	13.59 (μM)	20.4 (μM)
PLAYING TIME	120 MIN.	80 MIN.
SUB CODE CAPACITY	SUB-CODE AREA 273Kbps PCM AREA 68 (ID) + 142 (PCM) Kbps	
SIGNAL PROCESSING	SAME AS NORMAL MODE	

Fig.4: The two basic specs for pre-recorded DAT tapes. The wide pitch spec allows for high speed dubbing.

mal mode, prerecorded DAT tapes will be duplicated in real time; as with the record/playback modes, metal particle tape will be used. In the Wide playback mode, tapes can be duplicated at high speed using contact printing techniques similar to those already used to duplicate video tapes. A blank tape is fast-forwarded in contact with a master tape; a focussed magnetic field at the point of contact causes the blank tape to assume the magnetic characteristics of the original.

However the resulting signal level is lower than that from real-time dubbing, thus the Wide mode requires a track width wider than the other modes to compensate for the decrease in output level. Track width is effectively widened by increasing linear tape speed 1.5 times. Playing time is reduced to 80 minutes. However since the recording square density is lower, regular ferric oxide tape may be used instead of metal particle tape, thus further lowering dubbing costs.

From a hardware point of view, a DAT recorder utilises many of the same building blocks as a CD player, with the addition of encoding circuits. Elements such as A/D and D/A converters, modulators and demodulators, error correction encoding and decoding all make an appearance, as shown in Fig.5.

In the same way that the CD is conquering the analog disc, DAT might eventually conquer the analog cassette. Like the CD it provides higher fidelity, longer playing time, and conveniences such as programmability and indexing. It will also further open the door to future-generation audio systems in which digital outputs from sources such as the CD and DAT are digitally processed and amplified. In other words, DAT is another step toward the all-digital audio recording/reproduction system.

The politics of DAT

Perhaps no other new audio technology, including quadraphonics, has been greeted with such argument. It seems that everyone has something to say about DAT, yet no one has an answer to how the product may be integrated into the audio market in an equitable way.

First, because it would compete with Compact Disc products, CD manufacturers are wary of the new format. They argue that the CD needs time to firmly establish a foothold in the market. Because of consumer confusion or "overload" over the proliferation of new recording formats, DAT's introduction could irrevokably disrupt the acceptance of digital audio technology, to the ultimate detriment of both CD and DAT.

Furthermore, CD manufacturers are anxious to promote new CD products including CD-ROM, CD-Interactive and CD-Video. In other words, their strategy is to move as quickly as possible to entrench the CD in as many areas as possible. DAT is an obstacle.

Simultaneously, record labels perceive DAT as another encouragement to home copying, a practice which already costs those companies dearly. With DAT, they have chosen to "draw the line" against home recording. The fact that it is digital, or provides high quality is really incidental. They have, quite simply, seen the opportunity to prevent further erosion of their position before it begins, with foresight they wish they had possessed when the compact cassette was first introduced.

As noted, the denial of 44.1kHz recording and its direct incompatibility with 44.1kHz playback, and copy inhibit bits in the bit stream prevent direct digital copying of CDs and prerecorded DATs using that sampling frequency.

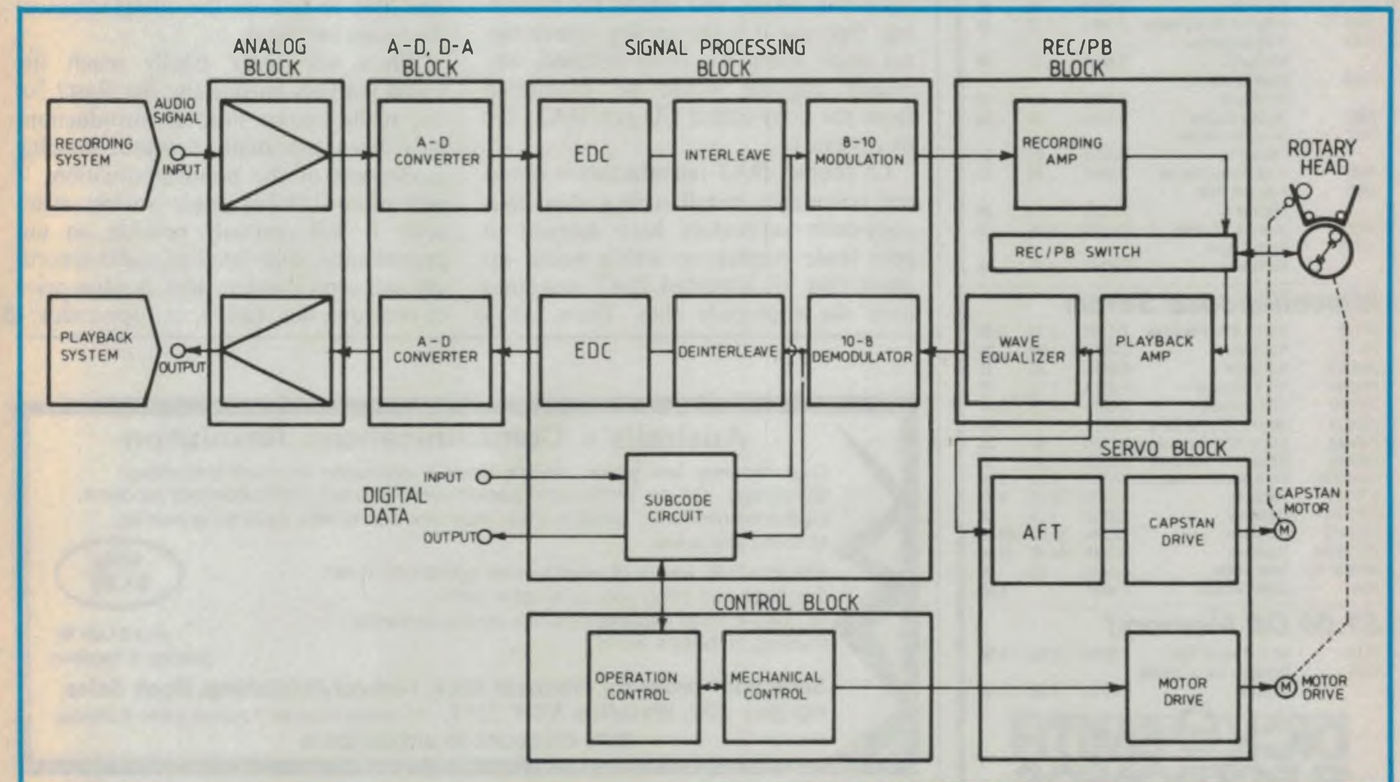


Fig.5: Functional block diagram for a basic DAT recorder, as released by Sony. Note the digital input and output.

DAT in Depth

While professionals could use a sampling frequency/standards converter, the expense of this device places it beyond consumers. However it is an easy matter for anyone to take the analog output from a digital disc or tape source, and input it through the DAT's analog inputs and A/D converters; thus the original 44.1kHz sampling rate signal could be recorded at the 48kHz sampling rate. The sonic degradation is minimal.

Given that such analog copying will take place, record labels have argued for compensation, or prevention. For example a tariff could be passed on blank DAT tape, or DAT recorders, with the money to be distributed to record labels, perhaps based on some arcane formula describing exactly who is losing how much revenue. But tariffs, such as those in place in Europe, have a number of built-in limitations, including the simple cost of overhead. Moreover, in the US market, there is no existing tariff structure, and to establish one would be costly.

That realisation has stimulated the proposal of the CBS copy-code system to prevent copying. The copy-code system would notch filter frequencies from the audio program (approximately 200Hz centred at 3.9kHz); a DAT recorder with a copy-code chip would sense this notch, and inhibit the recording. Because it is the analog source signal itself which has been notched, any analog copying would be prohibited from the copy-coded CD (or DAT, LP or cassette).

Of course, DAT manufacturers would not voluntarily install such a chip, thus copy-code supporters have lobbied to pass trade regulations which would require that all imported DAT machines have the copy-code chip. Then, when copy-coded software is manufactured, DAT owners will be prevented from copying prerecorded software.

That scenario has numerous implications most of them unsatisfactory. If copy-code is mandated, software will be notched, perhaps leading to sonic degradation. On the other hand, with copy-coded software, there would be little incentive for consumers to purchase DAT recorders — which would then have very little material to record. Thus DAT may never be widely marketed. The consumer is left with the worst of both worlds: notched software, and no DAT either.

The other question, of course, is the audibility of the copy-code notch. Whether or not it is audible appears to be a function of one's economic affiliation. Record labels claim it is not, whereas representatives of DAT manufacturers claim it is. To help decide that issue, the US Congress has assigned the National Bureau of Standards the task of ascertaining the audibility of the copy-code system. One thing is for sure, the idea of intentionally subverting the audio signal is philosophically disappointing, in the very least.

At the time of writing, DAT is available only in the Far East. The introduction of DAT, at least in the US market, thus remains in limbo, awaiting the findings of the National Bureau of Standards, or the judgement of anyone else able to fathom the complexities of the issues involved.

When will DAT finally reach the world markets outside the Far East? No one really knows. Product introductions have been repeatedly delayed, pending assessment of the political situation. If and when DAT is made widely available, it will certainly provide an unprecedented, high level of audio recording and reproduction. But at what price of controversies, tariffs, or copy-codes?

Local hifi breakthrough!

The ultimate speaker cable

This article describes a revolutionary advance in the science of sound reproduction. It outlines a method for improving the amplifier — loudspeaker interface, beyond the limits reached by current technology.

by GRAHAM LEADBEATER

The effect of loudspeaker cables is of paramount importance to the sonic performance of state-of-the-art audio systems. The improvements in performance are however difficult to measure objectively, and this has lead to many loudspeaker cable manufacturers taking advantage of this ill-defined area by promoting a multitude of exotic cables with claims of even more exotic performance. These claims are rarely substantiated by double-blind tests in certified listening-rooms. This is unfortunate, because it tends to cloud the issue and provide ammunition for the pseudo-scientific types who will not believe anything unless they can measure it.

Nevertheless, anyone serious about his music will be serious about his cables, and it is to him that this article is directed.

Some time ago I realised the limits of existing cable technology had been reached and that no amount of fiddling with oxygen-free silver bus-bars or active negative-resistance cable was going to improve my music.

Then, when a colleague joked about liquid notes, I started thinking . . . "What about Mercury speaker cables?" This then is the result of a lot of experimenting with that metal.

Once the practical problems associated with maintaining a continuous mercury link between amplifier and speakers were solved, serious evaluation could begin.

The results? In a word, superlative!"

All the old cliches about veils being lifted are totally inadequate to describe the improvement that results from the use of this technique! Tighter, firmer bass. Transparent middles. Brilliant, highly-defined top end.

Results of double-blind tests with over 15 Audio Engineers have confirmed this. It simply has to be heard to be believed. Especially with Heavy Metal music.

Now for the practical side — how is it achieved?

In short, a twisted-pair of garden hoses filled with mercury. I have found that it is best to use Nylex Premier hose as it can sound several dB more musical than other brands.

Terminating the hoses poses a few problems, but this is the recommended technique. Take a 100mm length of copper tube whose outside diameter matches the inside diameter of the hose. Scrub it up bright and shiny inside and out with steel wool. Wet it in mercury. Squeeze it flat over 2/3 of its length with a vice. Fold this flattened section back on itself. Heat the whole thing and fill the open end with solder. When cool, drill a hole in the middle of the flat part to match the binding posts on your amplifier or speakers. Insert into hose and secure with a worm-drive clip (see Fig.1).

By far the most important aspect of the whole project is to get rid of air bubbles from the mercury (to make it oxygen-free).

Stand on the roof of your house and let the hose hang vertical while *slowly* pouring mercury into it. When full, leave it for a week and top-up.

You'll find that it's not enough just to get the system full of mercury; it has to be under pressure. This is best done by providing a header tank for each hose. I used four plastic funnels on a bracket on the wall, and hoses down to "T" junctions from a garden reticulation system (see Fig.2). Once you have a pair of hoses for each speaker, you're ready to connect it all up. Twisting the pair of hoses is important, 360 degrees per metre sounds best to me, but you could experiment.

The main component of this system is the mercury which, at about $70 per kilo is not cheap. Furthermore, it will be necessary to change the mercury at least every six months as it tends to become "tired", resulting in a loss of sonic integrity. This is known as metal fatigue. This cost can be partially recovered by selling the used mercury to a scrap metal dealer.

As mercury is a cumulative poison you will need a Poisons Licence to buy it. It is a poison which attacks the central nervous system. The last thing you want is little beads of it in your carpet. Handle it carefully. Some people have suggested that, to the average audiophile, some brain damage could only be an improvement.

In conclusion, this is not a project for the faint-hearted. It is expensive it is messy and it is dangerous. But if you take your music seriously, it is the only way to go.

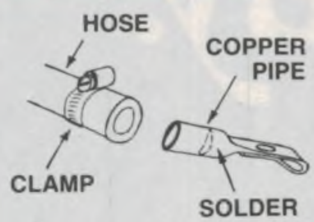


Fig.1

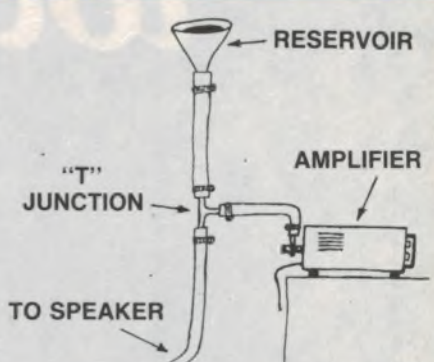


Fig.2

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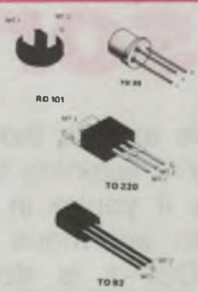

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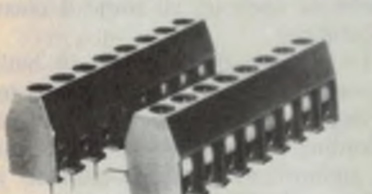

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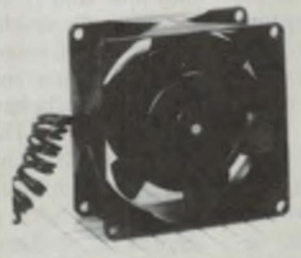

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Hifi Review:

Yamaha's DSP-1 digital sound field processor

How would you like to be able to alter the acoustics of your home lounge room, when you're listening to records, CDs or tapes? To make it sound as if you're in anything from an intimate little jazz club, to an enormous cathedral? That's exactly what the Yamaha DSP-1 is designed to do — electronically. Here's what EA found when we checked one out . . .

A few months ago, we ran a news item in the Entertainment Electronics columns on Yamaha's new DSP-1 digital sound field processor. No doubt like many of our readers, we were intrigued by the concept of a "black box" that was effectively able to change the acoustics of your listening room. So we rang up the people at Yamaha Music Australia, and asked about the possibility of us trying one out for a "hands on" report.

Yamaha was happy to oblige, although as the DSP-1 is still only available in limited quantities, it took a few weeks before they were able to send us one. But eventually it arrived, and since then we've been giving it an extended listening test.

The DSP-1 is literally a compact and elegant little "black box", measuring only 435 x 72 x 312mm and weighing 4.5kg. Considering what it does, the control panel looks disarmingly simple and straightforward. There's nothing but a power switch, a couple of level controls and an input selector switch, plus three "mix input" jacks and a display panel.

It's only when you look at the panel of the DSP-1's cordless remote control that you start getting an idea of its true complexity — because it's from the remote control that the unit is designed to be driven. There you find some 30 control buttons, many with multiple functions and initially rather bewildering legends like "SUR 1", "ST PHASING" and "L TURN".

The truth is, of course, that the DSP-1 is really a *very* complex and sophisticated bit of gear — the equivalent of fancy professional audio processing equipment that up until very recently took up racks and racks of space — and needed quite a bit of skill and expertise to drive. The fact that all of this sophistication has now been shrunk down into such an unassuming little box is quite a tribute to modern digital and IC technology.

More of a tribute to Yamaha, though, is the fact that the DSP-1 isn't anywhere near as complicated to drive as the gear whose functions it duplicates. For despite the 30 buttons on its remote control, it's designed so that you can operate it very simply indeed.

Thanks to the inbuilt microcomputer and memory system, you don't have to worry about all of the various parameters effecting how your music "sounds", and how they're each adjusted. All you have to do is choose from a built-in repertoire of sound "recipe" programs, each of which automatically duplicates the acoustic behaviour of various kind of auditorium. There are some 16 different inbuilt recipes, giving you everything from an intimate little jazz club or warehouse loft, right through to an enormous stadium or lofty cathedral (see Table 1).

Of course you *can* tackle the various acoustic parameters yourself, if you really want to; the DSP-1 certainly lets you do so, if you want to experiment. It even lets you store your combinations of parameters away, creating your own "User Programs". In fact it lets you create and store up to 16 of these. However you do need to have a fairly good understanding of what you're doing here, to achieve anything much worthwhile.

Idle fiddling with things like various delays, reverberation, chorus and sound rotation effects, vibrato, phasing and flanging certainly produces some interesting effects, but not of any great relevance for normal listening to ordinary music. I suspect that after a bit of fiddling to satisfy their curiosity, most users will go back to selecting from the DSP-1's preset programs.

Still, for those in rock bands or working in (or with ambitions to work in) the recording industry, who go in for all those weird effects, the DSP-1 will doubtless open up all sorts of creative possibilities.

To produce those handy 16 built-in acoustic programs, Yamaha sent a team of engineers around the world, digitally recording the acoustics of a wide range of auditoriums — from intimate jazz clubs and "lofts" to rock concert venues, major classical music concert halls, opera houses, churches, and cathedrals. Then the team returned to Japan, where the relevant parameters of these auditoriums were analysed and compared.

From this information, the company was able to produce a set of programs which effectively allow the DSP-1 to recreate an ideal or "typical" auditorium of each type — each literally at the touch of a button.

You connect up the DSP-1 more or less at the input to the power amplifier of your system. The "more or less" qualification is because the way the unit works, it really needs at least a four-channel power amplifier and speaker system.

Front view of the DSP-1 with its remote control. Don't be fooled by its simple appearance.

In fact there's basically two main ways of connecting the DSP-1 into a system: with *four* extra channels and speakers (apart from your existing stereo setup), to produce an overall 6-channel system, or with *two* extra channels to produce an overall 4-channel system. The main difference between the two is that in the 6-channel case your main speakers only handle the original source signals, while in the 4-channel case they also have to handle the "front" output signals from the processor.

To make the amplifier side of all this easier, Yamaha has available an optional 2/4 channel power amplifier, the M-35. This provides 20W per channel in 4-channel mode, at .07% THD (total harmonic distortion) into 8-ohm loads, or 40W per channel in 2-channel mode, at .05% THD and again into 8-ohm loads.

We actually used the M-35 to supplement our existing stereo setup during the tests, with Audiosound's new 8025 "Mini Monitor" speakers (reviewed last January) connected to the extra channels.

The basic idea is that your main system operates normally, but at 10dB down on its normal level (the DSP-1 introduces fixed —10dB pads into both channels). At the same time, the DSP-1 takes the source signals and processes them, feeding its outputs to the auxiliary speakers — and/or to the main front speakers as well, if you elect to have only a 4-channel system.

All of the actual signal processing is digital, of course. In fact the DSP-1 uses 16-bit linear sampling at 44.1kHz, exactly the same standards used for recording and playing back compact discs. As a result it offers a similar high-quality specification: 94dB dynamic range, 20Hz — 20kHz frequency response (+0, –3dB), .006% THD at 1kHz and 3V, and so on. These are for the processor section, by the way; the "Main" unprocessed channels are considerably better.

Apart from the 16 preset acoustic "recipe" programs shown in Table 1, the DSP-1 provides a further 16 preset "sound effects" programs. These are listed in Table 2. As you can see, there is again a wide range of possibilities.

Table 1: Acoustic/Surround programs

Program No.	Program Title (Program display indication)	Features/Applicable Sources
1	HALL 1	Sound field such as a wide and deep grand hall. Suitable for reproducing operatic and orchestral music.
2	HALL 2	Sound field such as a medium-sized hall (smaller than that of Hall 1). Suitable for reproducing orchestral music, e.t.c.
3	HALL 3	Sound field such as a multi-purpose hall which can seat 1000 people. Deeper ambience is obtained.
4	CHAMBER	Sound field such as a grand ballroom. Suitable for reproducing chamber music, e.t.c.
5	MUNSTER	Sound field such as in a cathedral.
6	CHURCH	Sound field such as in a church. Suitable for reproducing pipe organ music or church music.
7	JAZZ CLUB	Sound field such as in a jazz club.
8	ROCK CONCERT	Sound field with tight ambience, suitable for rock or rock-related music.
9	DISCO	Sound field such as in an intimate disco.
10	PAVILLION	Sound field such as in an indoor stadium.
11	WAREHOUSE LOFT	Sound field such as in a concrete-built warehouse.
12	STADIUM	Sound field such as in a stadium or open-air theatre.
13	PRESENCE	Effect sound is delayed separately and reproduced from the front and rear speakers.
14	SURROUND 1	Sound field applying "depth" to the screen. Suitable for AV sources.
15	SURROUND 2	Sound field applying "width" to the screen. Suitable for AV sources.
16	DOLBY SURROUND	Used to reproduce Dolby Surround-encoded movies.

Yamaha's DSP-1

For each of the 16 acoustic auditorium programs and 16 sound effect programs there are essentially 6 key parameters. In the case of most of the auditorium programs these are Type of Auditorium, Room Size (reverberation time period), Liveness (reverb decay characteristic), Initial Delay (between source and first echo), HPF (High Pass Filter cutoff) and LPF (low pass filter cutoff). The last four programs of Table 1 use different parameters, as they are largely programs for adjusting delay time between front and rear.

The parameters involved in the Sound Effects programs of Table 2 are generally fewer. In most cases they involve a delay time, a phase or pitch change, and a modulation depth.

To create your own User programs, you can start from any of the fixed programs and change any of the key parameters This is not particularly difficult. You use one key to select the parameter you want, and others to increment or decrement its value from that given by default in the starting program. In each case the DSP-1's display panel shows you what is going on, either in words or graphically (i.e., a histogram) as appropriate. Then when you want to save the parameter settings as your User Program, it lets you give it a "title" in the same way.

Some of this is a little slow and fiddly due to the lack of a full keyboard, but fairly straightforward — and *very* flexible. For example you can change reverb time from 0.3 seconds to 99.0s; liveness from 0 to 10; initial delay from 5ms to 150ms; HPF from 32Hz to 1kHz (32 steps); LPF from 1kHz to 16kHz (26 steps); flange/chorus modulation from 0.1Hz to 20Hz; modulation depth from 0 to 100%; pitch changes -100 to +100 cents in cent increments; and so on.

OK then, I hope that has given you an idea of what the DSP-1 can do, and how you drive it. But how does it all work out in practice?

Remarkably well, as it happens. We tried it out with a wide variety of different kinds of program source material — mainly from compact discs, to get the high quality, but also from black vinyl and cassette tapes. The one thing we weren't able to try was "Dolby Surround" video sound tracks, because we don't have a stereo VCR at present.

The room we were mainly using for the tests was a typical home listening room, about 3m x 4m and with the usual carpet and padded lounge suite to provide a fair amount of sound absorption. Yet with the DSP-1 operating, you could effectively "turn" it into a wide variety of auditoriums, just by selecting the appropriate program. It was uncanny — if you close your eyes, it's hard to believe you haven't been transported to somewhere else!

But probably the thing that impressed us even more than this was the *clarity* of the sound. Generally in the past, gadgets which have played around with signals in this fashion have tended to "muddy up" the sound, introducing so many other sources of distortion, noise and whatever that it was hardly worth the effort. But not the DSP-1. Apart from the effects it is deliberately arranged to create, the sound produced is as clean as the signal you're feeding in.

Of course if you're listening to an intimate little group and you select a program like Munster (Cathedral), with long reverb time and slow decay, things get pretty muddy anyway. That's exactly what you'd expect — after all, a cathedral is not the ideal venue for this kind of music!

Similarly, it doesn't really sound all that great to have a symphony orchestra revolving around the room at so many revs a second. Hardly what Beethoven or Mozart had in mind, and frankly rather disorientating. But even while they're rotating, the sound is quite clean and undistorted . . .

We didn't try to perform fancy instrument measurements on the DSP-1, because (a) in most cases, this would have been extremely difficult, and (b) it seemed hardly relevant. From our listening tests, it introduced virtually nothing to the signals that wasn't intentional.

All in all, then, we found the Yamaha DSP-1 very impressive. It certainly provides a very wide range of possible acoustic "environments" and special effects, plus enough scope for adjustment to the key acoustic parameters to keep all but the most fanatical enthusiast satisfied. Add this to its ease of use and the high sound clarity, and you have something pretty outstanding. For the quoted price of $1499 (RRP), it seems excellent value for money.

Mind you, we're not too sure exactly how many people either need or want this kind of audio signal processing firepower, but there you are.

For further information on the DSP-1 (including the location of your nearest dealer), contact Yamaha Music Australia, 17-22 Market Street, South Melbourne 3205. Telephone (03) 699 2388. (J.R.)

Table 2: Sound Effect programs

Program No.	Program Title (Program display indication)	Feature
1	DELAY	This program shifts the delay time between the front/rear and left/right channels.
2	STEREO ECHO	Shifts the delay time between the left and right channels slightly so that a stereophonic echo effect is obtained.
3	STEREO FLANGE A	Effect that tone is varying and swirling is obtained. STEREO FLANGE A has faster speed and lighter swirling effect than B.
4	STEREO FLANGE B	
5	CHORUS A	Effect that sound is rolling and swaying (drifting) is obtained.CHORUS A has slower speed and deeper effect than B.
6	CHORUS B	
7	STEREO PHASING	Effect that tone is varying periodically is obtained.
8	TREMOLO	The swirling effect obtained by CHORUS is multiplied and the volume change is emphasised.
9	SYMPHONIC	The swirling effect obtained by CHORUS is multiplied and the timing is changed irregularly.
10	ECHO ROOM	Effect such as in an echo chamber of a recording studio is obtained.
11	PITCH CHANGE A	These programs are used to change the pitch. However, initially in the preset program, pitch is not changed.
12	PITCH CHANGE B	
13	PAN L-TURN	Sound image is turned to the left.
14	PAN R-TURN	Sound image is turned to the right.
15	PAN F-R	Sound image is moved from the front to the rear continuously.
16	PAN L-R	Sound image is moved from the left to the right continuously.

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Is this the real inventor of modern TV?

Not many people have even heard of Kenjiro Takayanagi outside his home country of Japan. Yet in the mid-1920s, when well-known inventors like John Logie Baird were playing around with spinning discs and lenses, Mr Takayanagi was developing television with electronic scanning — the system we use today. In many ways he is therefore more entitled than most to the credit for inventing modern television.

Mr Takayanagi pictured recently (courtesy JVC).

by JIM ROWE

In Japan, 89-years-old Kenjiro Takayanagi has been proclaimed a living "Sacred Treasure". During his long and eventful career in Japan's electronics industry, he has gained numerous awards for outstanding achievements in the areas of television and video recording. For many years he was head of research at JVC (Victor Company of Japan), and played a key role in the development of video tape recorders. Even now he is an honoured senior consultant for JVC.

Yet outside Japan, Mr Takayanagi is virtually unknown outside a few research organisations, universities and companies. Certainly few people seem to be aware of the important role he played in the pioneering days of television, and of the fact that in many ways he is much more entitled to the credit for "inventing" modern television than most of the better-known inventors, like Baird, Jenkins and Campbell-Swinton.

Whatever the reason for this lack of recognition, the story behind his visionary work on television is fascinating, and deserves to be much more widely known.

Kenjiro Takayanagi was born in the suburbs of Hamamatsu city on January 20, 1899. In April 1921, he graduated from the Department of Electrical Engineering at Tokyo Technical College, and during the graduation ceremony he was most impressed by a speech by the Dean, encouraging the new graduates to devote themselves to important research projects for the public good.

Offered a position at a technical school in Yokohama city, he took it and looked around for a worthwhile research project. Like others elsewhere in the world, he became intrigued by the concept of using electricity to reproduce visual images at a distance — using the then-new wireless.

At this stage he was taking private French lessons at the French consulate in Yokohama, and walking home one afternoon he dropped into a bookstore selling foreign magazines. Out of curiosity he picked up a French electrical hobby magazine, and by sheer chance saw an artist's sketch of a proposed scheme for sending images by wireless. The item was titled "Television", and besides showing him that others had been thinking along the same lines as himself, it also provided a more elegant name for the concept. He very soon decided to make the development of a practical television system his personal research project.

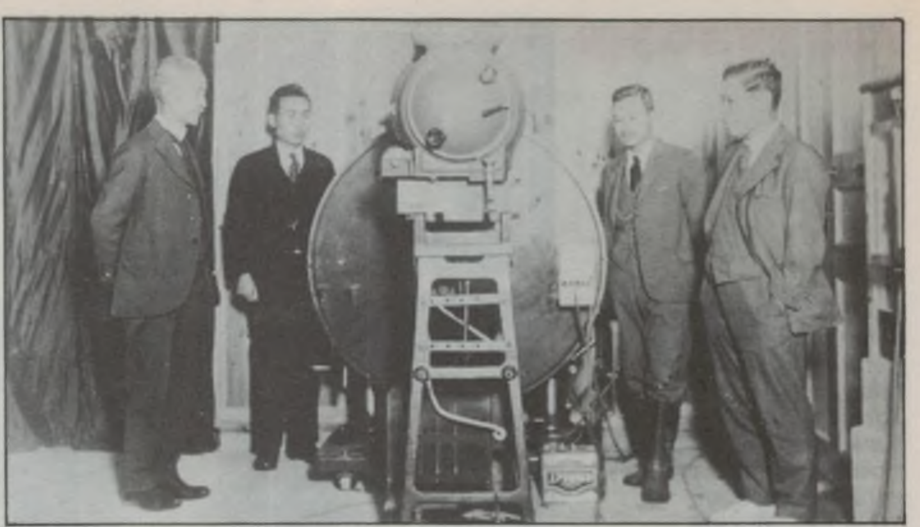
Work on the project started in earnest when the young Takayanagi moved to the Department of Electrical Engineering at Hamamatsu Technical College in May 1924, as assistant professor. The college's President Mr Sekiguchi fully approved of the project, and gave him assistance.

Around this time, news reached him that various people in other countries were also working on television: Baird in England, Mihaly in Austria and Jenkins and others in America. However he also learned that all of these people were working on mechanical systems.

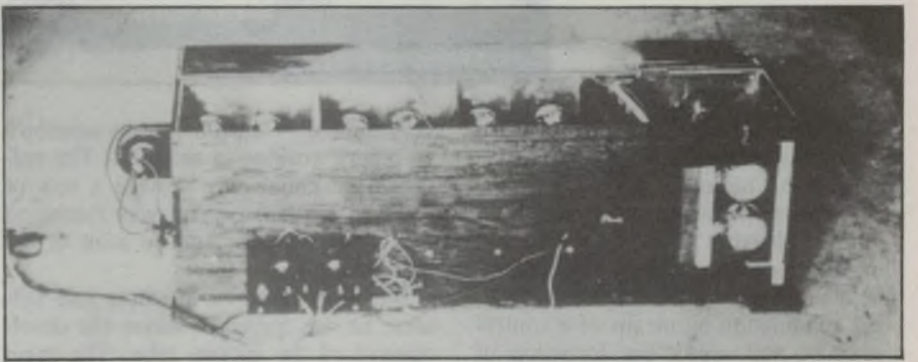
A careful and methodical thinker, Takayanagi decided that the mechanical approach really didn't have any future for a practical television system. He realised that to be practical, television would have to be capable of providing high definition images with good detail, and that this would be almost impossible to achieve with a mechanical system. So straight away, in the autumn of 1924, he decided to work on an all-electronic system using electron beams to scan the picture in both the transmitter and receiver.

This was about one year before Baird was to achieve his first crude demonstration of mechanical television.

Later Takayanagi discovered from an article in the British magazine *Wireless World* that Campbell-Swinton had proposed an all-electronic television system about 10 years earlier, in the magazine *Nature*. He writes that this encouraged him greatly in pursuing the goal of fully electronic television.



Mr Takayanagi and a group of engineers examining an improved "stopgap" mechanical spinning-disc transmitter, around 1931. This type of transmitter was used until he succeeded in achieving a working electronic camera.



The multi-stage video amplifier, using valves, which Mr Takayanagi used in his early experiments around 1926-27.

During 1924 and 1925 he spent considerable effort looking into the optical and electrical properties of selenium, transparent metal films and the use of deflected electron beams for "scanning" images. This work culminated first in a design for an electronic camera pickup tube (Fig.1), then a design for a Braun type cathode-ray picture tube (Fig.2).

Both tubes used electron beams for scanning, with electrostatic vertical and

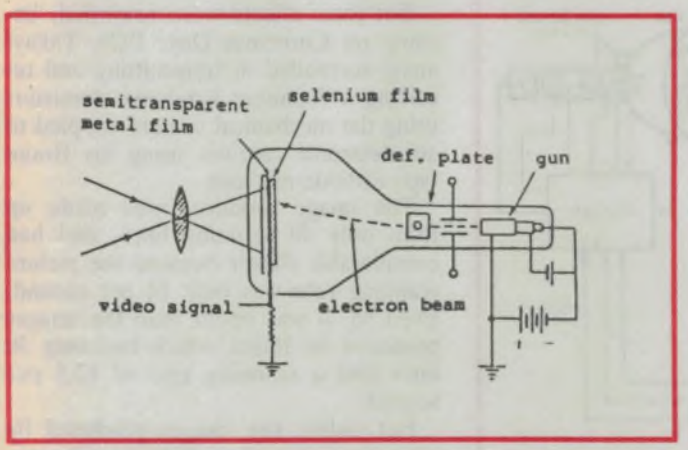


Fig.1: Mr Takayanagi's first design for an electronic camera tube, dating from 1924-25. At that time he was unable to get it working.

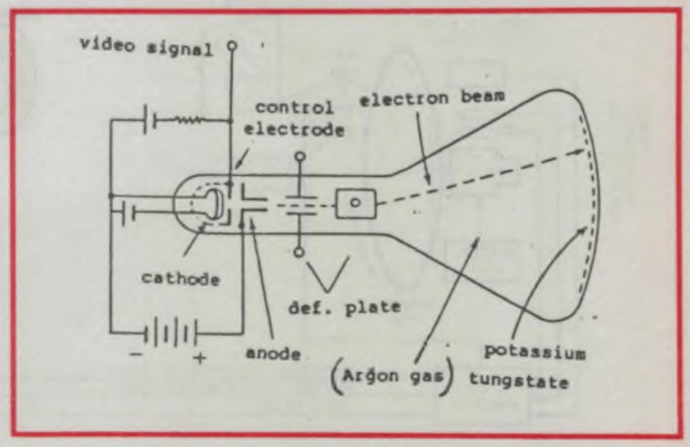


Fig.2: His design for a Braun-type cathode ray picture tube, also dating from 1925. This did work, and formed part of the first system.

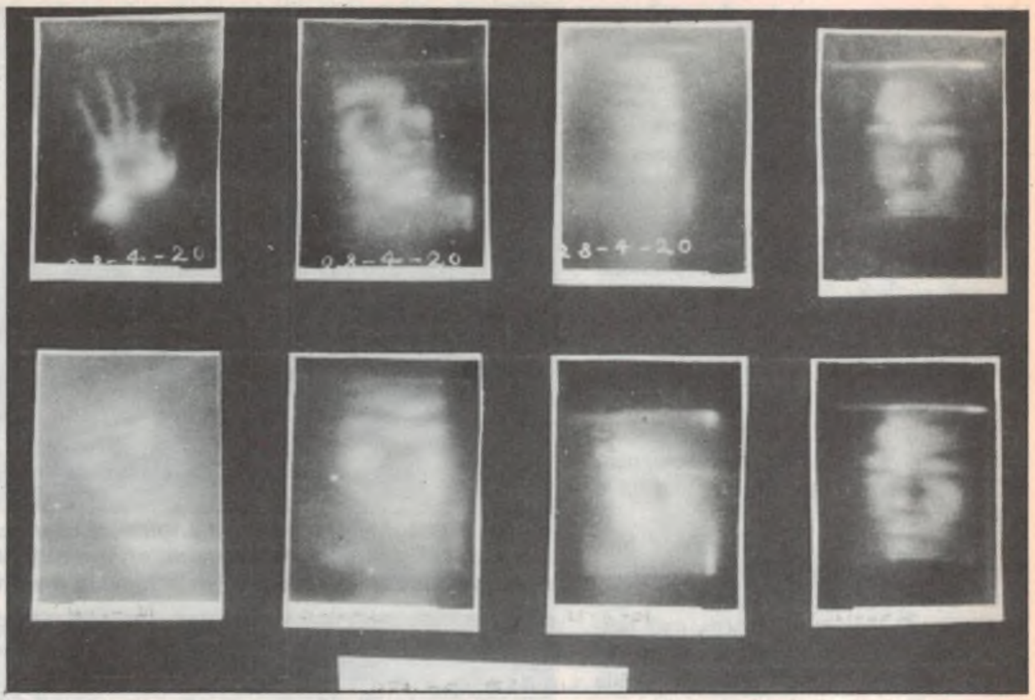


Fig.4: Photographs of some of the experimental pictures produced by Takayanagi in 1927-28, using the spinning disc transmitter and Braun-tube receiver. The first pictures were produced on December 25, 1926.

horizontal deflection using two pairs of plates. The camera tube used a selenium film "target", and in many respects was surprisingly similar in design to the much more modern vidicon and Plumbicon camera tubes. The picture tube also featured a thermionic cathode, beam modulation by means of a control electrode, and argon gas focussing of the electron beam on a potassium tungstate screen — all techniques that were very close to those used in later picture tubes!

Takayanagi and his colleagues tried making the pickup tube in the Hamamatsu college's laboratory. Funds were very limited — a problem not unknown to others working in the field. The college itself could only provide a sum of 500 yen, so Takayanagi was forced to use his own money and do a lot of the work himself.

But after repeated attempts and failures, he was forced to shelve the development of the pickup tube. The main problem seemed to be that they couldn't produce a sufficiently good vacuum to make it work satisfactorily. However with the help of Dr. Asao of the Research Institute of Tokyo Shibaura Electric, he was able to produce a working picture tube from the design of Fig.2.

This was in 1925, mind you — the same year that Baird produced his first wobbly little pictures using the mechanical system. It's quite possible that Takayanagi's tube was the first modern-type electrostatic picture tube ever produced.

Because of the problems in trying to produce a working camera tube, he reluctantly decided to use a mechanical Nipkow-disc type camera as a temporary stopgap. So work began on development of a working compromise system.

Funds were still very limited indeed, and at one stage Takayanagi was forced to ask his wife to part with her personal savings, to pay for some needed amplifier valves.

But their efforts were rewarded, because on Christmas Day, 1926, Takayanagi succeeded in transmitting and receiving a Japanese katakana character, using the mechanical camera coupled to an electronic receiver using his Braun type cathode-ray tube.

The image produced was made up from only 40 scanning lines, and had considerable flicker because the picture scanning rate was only 14 per second. Even so, it was better than the images produced by Baird, which had only 30 lines and a scanning rate of 12.5 per second.

But unlike the images produced by other experimenters, Takayanagi's picture was very steady, because he had already invented the modern principle of using horizontal and vertical synchronis-

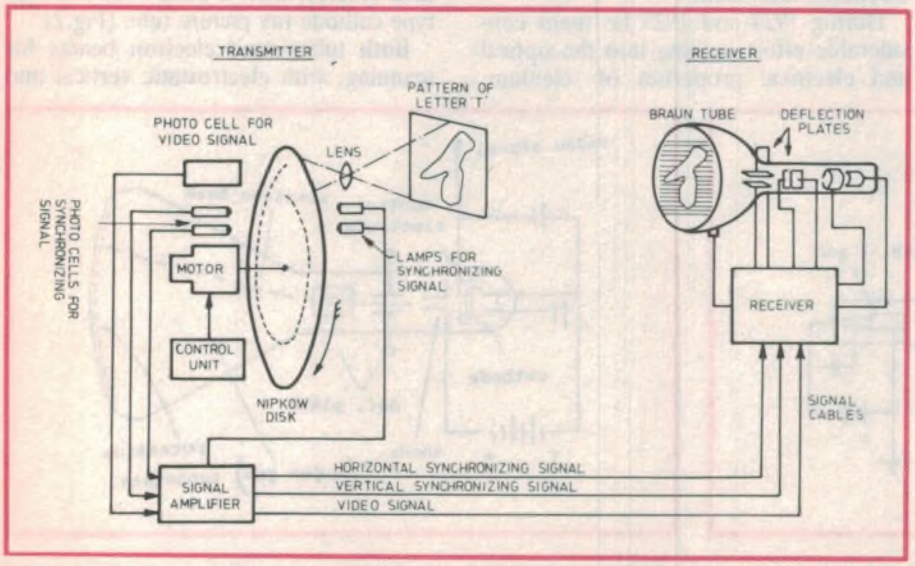
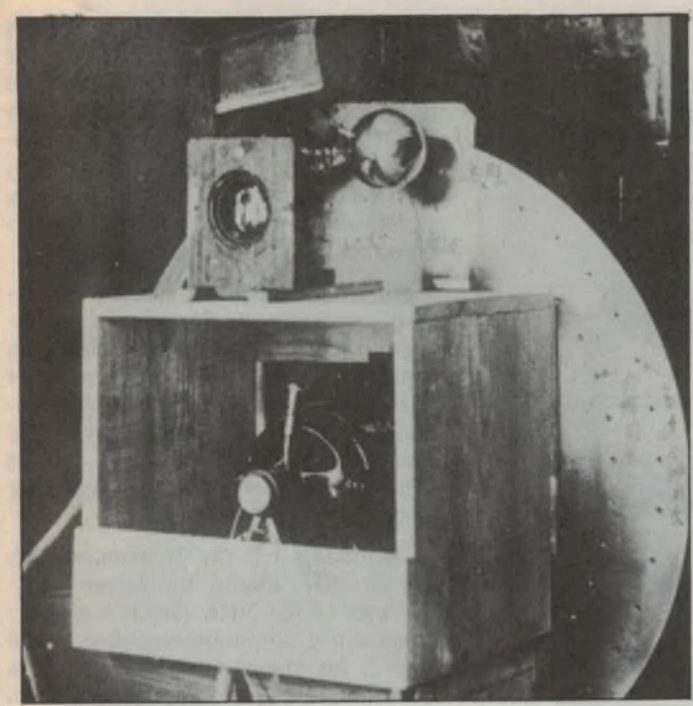
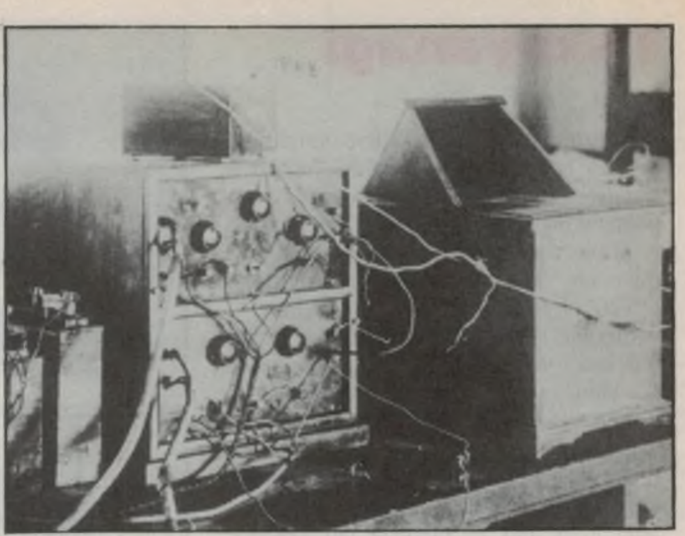


Fig.3: The basic setup used in Takayanagi's first working system. Note the use of additional lamps and photocells in the transmitter, to produce sweep synchronising pulses.





Above: Takayanagi's first receiving equipment of 1926, with the electronics on the left and the Braun tube inside the hooded box on the right.

Left: The first "stopgap" mechanical transmitter used in 1926. Note the two sets of holes in the disc - one set to produce the synchronising pulses.

ing pulses to "lock" the scanning of the receiver to that of the camera. In his first mechanical camera the pulses were produced by additional photo-electric cells, detecting light beams from small lamps on the other side of the Nipkow disc. (See Fig.3)

Over the next couple of years, he made a number of improvements to sensitivity and resolution of the system. In May 1928 he was able to give a demonstration to the Japanese Society of Electricity, transmitting images of faces and hands (Fig.4).

Takayanagi then set about improving the Braun type cathode-ray tube. He developed and patented a high-vacuum version, with a zinc silicate fluorescent screen and able to be used with an anode voltage of 2400V instead of the 240V used with the earlier gas-filled tube. This allowed the production of a much brighter and better focussed picture, and was a big improvement.

Unless something was done this was obviously going to cause problems, because for a given level of brightness in the scene to be transmitted, increasing scan rates would obviously give smaller and smaller video signals.

Takayanagi's solution to this problem was brilliant. By having the transmitter's photodetector made up of thousands of tiny photocells, each one connected permanently to a small capacitor, they would each integrate or "accumulate" an electrical charge proportional to the total illumination in that area of the picture. So by scanning the tiny capacitors with an electron beam, you would be able to generate high-amplitude video signals regardless of the scanning rate.

He had invented the principle of image charge-storage, which was to form the basis of virtually all later television camera tubes — including the iconoscope, the image orthicon, the vidicon and the Plumbicon. The patent was filed in December 1930, and was granted in November 1931. Soon after he was also granted a patent for the use of an electron beam for switching.

1931 also saw the invention of the "image dissector" camera tube by Philo Farnsworth, in the USA. This did not use electron beam scanning as in Takayanagi's first tube design; nor did it use charge storage. In fact it used rather different principles, with an electron "image" emitted from a photocathode plate being moved bodily past a fixed photomultiplier detector. Ultimately, like the mechanical scanning system, this approach didn't turn out to be the way to go, but Farnsworth used it to produce quite reasonable 240-line pictures.

Two years later, in November 1933, Takayanagi was surprised to read an article in the *New York Times* by Dr Vladimir Zworykin of RCA, describing the invention of the "iconoscope" camera tube, and a demonstration where it had been used to produce high resolution television pictures of outdoor scenes. It turned out that Zworykin had quite independently invented the principle of charge storage, and unbeknown to Takayanagi had patented his design for the iconoscope in 1928.

Shortly after this Takayanagi went to the USA for the San Francisco Exposition, and took the opportunity to visit Zworykin's laboratory in Camden, New Jersey. Zworykin was happy to show him the iconoscope, which was in effect the first camera tube to use his charge storage principle.

He also managed to visit Farnsworth, in Philadelphia, to look at the image dissector tube.

Spurred on by these meetings, Takayanagi resumed work on his own camera tube as soon as he returned to Japan. And in October 1935, he and his colleagues succeeded in making storage-type tubes which produced highly detailed pictures.

The next year they improved the camera and receiver systems to produce excellent quality 441-line pictures. He had finally achieved the goal he had set himself back in 1924, to create a fully electronic television system.

To be sure, others had in the meantime achieved comparable results. By 1935 Zworykin in the USA and the EMI team in the UK were both producing fully electronic high definition (greater than 400 lines) television, although Baird was still working with a patently obsolete 240-line mechanical system.

Dr Asano of the Research Institute at Toshiba Electric helped make 150mm and 300mm versions of the new tube, which worked well.

Not happy with the valve amplifiers he had been using to amplify the video signals, Takayanagi also carried out painstaking experiments to find ways to improve the amplifier gain at high frequencies. He discovered the shunting effects of stray capacitance, and how to overcome these effects both by reducing the stray capacitance and by reducing the values of the valve plate loads.

This allowed him in 1930 to build a wideband amplifier which gave excellent results with his improved television system, which was by now using 100 scanning lines and 25 pictures per second. Compare this with Baird in England, who at the time was still working with a fully mechanical system using only 30 scanning lines.

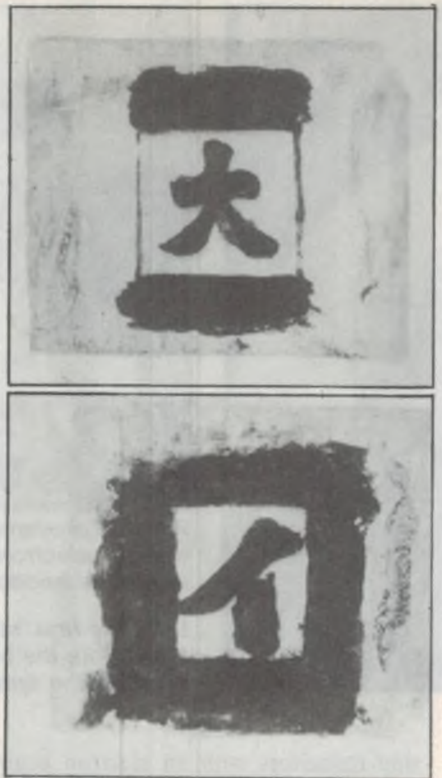
In May 1930 the Emperor of Japan visited the Hamamatsu college, and was given a successful demonstration of Takayanagi's television system. Two fully electronic receivers were used in the demonstrations, one with the 150mm picture tube and the other with the larger 300mm tube.

Although he had made considerable progress by this stage, Takayanagi realised that further improvements would not be possible while he continued to use the stop-gap mechanical transmitter. So a little later in 1930 he resumed work on the electronic pickup tube which he'd reluctantly been forced to shelve six years earlier, due to manufacturing problems.

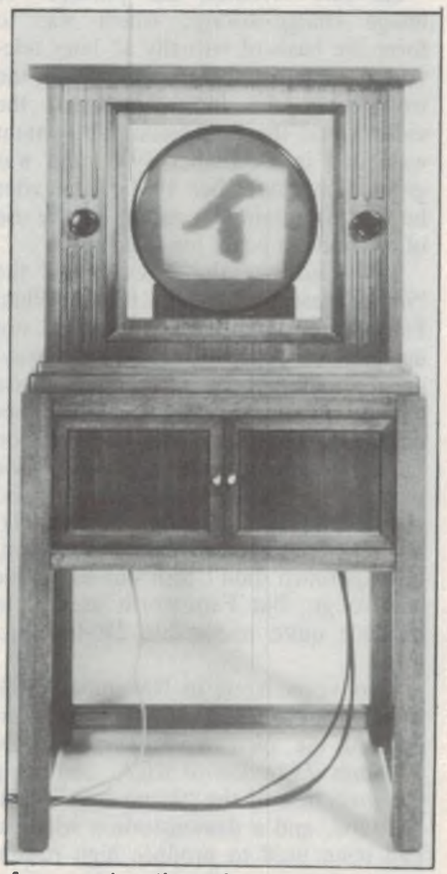
By considering carefully the operation of the human eye, he realised that whereas the eye views an image for 100% of the time, a television scanning system tends to "see" each section of the image for only a tiny proportion of the time. He also realised that as the scanning rate was increased to achieve better detail in the picture, this proportion would decrease. In effect, the higher the scan rate, the shorter the "exposure" time for each picture element.

In late 1935 the Germans built the first television broadcasting station, in Berlin. This used 180-line scanning and 25 pictures per second, and broadcast on what was then called the "ultra-short wave" band: 44.75MHz. The transmitter had an output of 16kW, and was used to broadcast a television coverage of the 1936 Berlin Olympic Games.

It was also in late 1935 that the British authorities started tests to compare Baird's mechanical system with the fully electronic EMI system, to determine which would be used for permanent television broadcasting. In early 1936 they chose the EMI system. The Americans effectively decided on the fully electronic approach in 1934, but tried a variety of systems until finally standardising on the 525-line system in 1940.



Two of the Japanese katakana characters used as images for Takayanagi's early transmissions. The lower one is that first transmitted.



A reconstruction of one of his 1930 receivers, used to demonstrate television to the Emperor of Japan.

But without a doubt Kenjiro Takayanagi, working quietly away in Hamamatsu Technical College, had played an important role in the development of what was to become the final fully electronic system. And unlike many of the others, he had the vision to set his sights on this final system right from the start.

Takayanagi left the Hamamatsu college in 1937, joining the research laboratories of the NHK (Japan's national broadcasting corporation). After World War 2, he joined JVC as head of its television research department, and in 1950 he became the company's chief engineer.

Over the following years he played a key role in the development of the two-head helical scan videotape recorder, and the VHS domestic video recording system. He is also credited with developing the 45-45 stereo recording technique still used in today's "black vinyl" records, and the ill-fated CD-4 quadraphonic sound system. In all, he is the holder of over 200 patents for inventions in television, video and recording technology.

So whether or not one agrees that Kenjiro Takayanagi is entitled to the title of "inventor of modern television", I believe any reasonable person will agree that he certainly deserves full recognition as *one* of the major pioneers. He's certainly made an enormous contribution, both to television and to electronics as a whole. Small wonder that the Japanese people have honoured him as a living treasure . . .

A sad little footnote: All of Mr Takayanagi's original TV equipment was destroyed by Allied bombing during the war. The only things that he was able to preserve were his notebooks, and some of the pictures reproduced in this article.

My grateful thanks to Mr Takayanagi and JVC in Japan, for loaning us the pictures and providing valuable information for this article. Thanks also to Anthony Toope and Julie Fordham of local JVC distributors Hagemeyer Australia, for their help.

Compact Disc Reviews

by RON COOPER

BACH HARPSICHORD CONCERTOS

Conductor/Soloist Ivor Bolton
St James's Baroque players
IMP PCD 864 DDD
Playing Time: 63 min 18 sec

PERFORMANCE
1 2 3 4 5 6 7 8 9 10

SOUND QUALITY
1 2 3 4 5 6 7 8 9 10

Bach wrote his harpsichord concertos when he was well established and these would be considered as late works. Composed from around 1729 when he was involved with the Collegium Musician (founded by Telemann in 1701) all his harpsichord concertos were first performed by a small ensemble from here.

Whilst Bach would be regarded as the pioneer of the keyboard concerto, virtually all his harpsichord concertos are rearrangements of pre-existing concertos for violin or other melody instruments. All the concertos here would be regarded as "well known" and the BWV 1057 is better known as the fourth Brandenburg concerto.

The performers on this disc are relatively new on the recording scene but nevertheless produce a fine performance, though I found the sound of their original instruments took a little getting used to. This is a "different" sound from other versions.

The recording is quiet and clean, very reverberant — possibly due to the acoustics at St Johns, Smith Square where it was recorded. It does represent excellent value for money if you like your Bach on original instruments.

GLORY OF ORGAN

Denon 33CO-1260 DDD
Playing Time: 51 min 15 sec

PERFORMANCE
1 2 3 4 5 6 7 8 9 10

SOUND QUALITY
1 2 3 4 5 6 7 8 9 10

Here is an excellent disc for pipe organ fans (it is also the same if you are not!). It lets you hear quite magnificently various great organs throughout the world, and shows their different character and acoustic environments.

The first two works of Bach are fairly well known and produce an excellent typical large pipe organ sound. The 3rd work is an interesting contrast in sound colour, with the 4th track distinctly different again. I did detect a hint of mistuning in the 5th track but only briefly.

When you consider the age of these instruments, they really are quite amazing. They range from 1630 to 1745 for the first five while the magnificent Ca-

vaille-Coll Organ on track 6 is a "youngster", built around 1880 and being expertly played here by Pierre-Yves Asselin, with the famous Widor Toccata.

Whilst this disc is not a hifi showpiece by nature of the instruments, it does show however very well the characteristics of the instruments and captures the full atmosphere of their surroundings, with no additional noise — which I believe is its real intention.

TCHAIKOVSKY

Symphony No.6 in B minor
Op.74 "Pathetique" Overture to "The Storm" Op.76
London Symphony Orchestra
Conducted by Gennadi Rozhdestvensky
IMP PCD 878 DDD
Playing Time: 59 min 57 sec

PERFORMANCE
1 2 3 4 5 6 7 8 9 10

SOUND QUALITY
1 2 3 4 5 6 7 8 9 10

Much of Tchaikovsky's music has been described as over emotional, as his own traumatic experiences here affected his musical writing. The Pathetique symphony is certainly one such dramatic work, but in spite of this I feel it is his best symphony. It is certainly one to enjoy deeply, particularly after a second or third hearing.

As an interesting introduction to this work you could listen to the third movement first, just to give yourself a rythmic treat and then let this great work grow on you.

The recording here is a very new one and is an excellent performance – possibly the finest I have heard with the tempos just right, not too hurried like the Karajan version (which I don't like at all).

The first movement shows the immense feeling of this work right from its very quiet opening by the solo bassoon.

The technical quality is quite different with a lot of ambience and openness to the sound, which can take a little adjusting to. Every instrument is heard almost too clearly, having a slight detrimental effect on the overall sound on full passages.

Overall it is still in the very good category. At the price and with the overture to "The Storm" thrown in, it represents excellent value at $19.99 for 60 minutes.

Facing the Fax

In case you haven't noticed, fax machines are rapidly moving into Australian offices — in many cases replacing the older telex machines. Here's a quick rundown on how fax works, and where it's headed.

by BRUCE McKINNON

One of the most significant trends in office communications during the last couple of years has been the growth of facsimile (or fax) machines.

For those of you who have never heard of them, fax allows you to transmit paper documents very quickly over the standard public telephone network.

For me, the thought of being able to send a written document (or photograph or anything else that is two-dimensional and resides on paper) anywhere in world over a phone line initially seemed rather foreign and high-tech. But most fax machines are as simple to use as an ordinary photocopier. In fact, most of them look like an ordinary photocopier, and are just as easy to drive.

Techno phobia aside, the facsimile market is becoming one of the most lucrative sections in the business communications market, involving major multinational electronics manufacturers and a market size of $50-$75 million a year in Australia alone.

How they work

Fax machines combine three different technologies — an optical scanner, a modem and a thermal printer.

An optical scanner is used to convert documents from printed form to digital form which can then be transmitted over a phone line. The scanner circuitry is able to detect the difference between light and dark on paper and thus is able to create image data corresponding to the information sent back from the scanner.

The quality of the scanner being used has a direct effect on the quality of the data that has to be reproduced by the fax machine at the receiving end. The problem with poor quality scanners is that they tend to have trouble with anything which has some form of grey scale — photographs for example. As a result, photographs will lose some degree of definition, even when a fine resolution mode is selected. In the worst cases, the photograph will arrive as an unintelligible mess of black splotches on the paper. This problem is resolved by using higher quality scanners which incorporate a half tone mode (see sample facsimiles).

At the heart of any fax machine is a high speed modem, used to transmit and receive the image data. Depending upon the quality of the phone line being used, a fax machine will transmit data at rates of 9600, 7200, 4800, 2400 or 1200 baud. All baud rate selection is performed automatically between the sending and receiving machines and may even change whilst transmission is occurring, if the quality of the telephone line (or circuit) varies.

The thermal printer is used to convert the binary image information received by a fax back into printed form. Although they don't provide the highest resolution currently available, thermal printers are silent, give reasonable definition and are fast enough to keep up with 9600-baud data transfers.

The most obvious difference between thermal printers and normal dot-matrix printers is the paper being used. Rather than using a ribbon to deposit carbon onto the paper, thermal printers make use of specially coated paper that, when 'burnt' by the printer head, causes a black dot to appear and, thus, characters to be formed.

The fax bandwagon

With nearly 900,000 machines produced world wide in 1986, both of Australia's telephone companies (Telecom and OTC) have jumped in quickly to promote the use of facsimiles.

Although you can connect a fax machine to any standard phone line, Telecom and OTC have already begun to install special low-noise phone networks to ensure the integrity of the data being transferred.

To cover the domestic facsimile traffic, Telecom is in the process of installing a large fax-only network, Fax Stream. Telecom hopes to woo fax users away from the standard voice network to the new, higher-priced system. For a subscription fee of around $600.00 a year and nominal charges for each fax sent, the privilege of using a fax-only network may seem rather pricey, although this figure seems to be low in comparison to similar services offered in other parts of the world. The main advantages for fax users will be the quality of the phone lines available and the pricing system — which will make rates for long-distance transmissions relatively cheaper than calls made over shorter

Section from a fax transmitted using a simple scanner, without the ability to reproduce half-tones.

The Toshiba model 6330, an example of a good medium-priced current model compact fax machine.

distances.

To cater for international fax traffic, OTC in conjunction with other international telephone companies, has already installed dedicated fax lines to 15 major countries. Using a special international access code, users can connect to these lines — with the chance of data corruption being far less than over conventional voice/data lines.

Ironing out problems

Like any new technology, facsimile transmissions have their share of problems. The complaint most frequently levelled at fax is the print quality. With a resolution of around 200 dots per inch on thermal printers, facsimiles have a long way to go before they reach current photocopier quality. The transmission quality and features being offered on new machines is increasing dramatically, with the number of major Japanese manufacturers competing in the fax market.

Another problem has been excessive line noise on the standard phone network, which can cause corruption of the data being transmitted. These types of problems should decrease within Australia and other western countries as Telecom and OTC gradually bring their dedicated networks online. Some problems will still occur with transmissions to countries that do not have dedicated domestic data lines.

The bottom line

By now, most of you would have thought of good uses you could put a fax machine to. Perhaps the greatest problem with fax machines (as it is with just about every other good idea) is finding the initial outlay for the machine.

At the moment, most major Japanese electronics companies are producing a wide range of facsimile machines. The more popular machines range from around the $3000 mark (A4 sheets, half tone operation, single button dialling) up to machines costing in excess of $8000 providing auto-dialling, A3 sheets and multi-broadcasting (sending a document to multiple machines at once).

Cheaper machines do exist, but generally do not provide features such as half-tone operation (which makes legible transmission of photographs possible), use inferior quality scanners and require you to manually dial the number of the fax machine you wish to connect to.

A cheaper alternative

To cater for small businesses and individuals who don't produce the amounts of facsimile traffic necessary to justify purchasing a fax, Australia Post has introduced Intelpost. Intelpost is a combination of a fax and courier service. For a small fee ($3.00 per page, minimum charge of $6.00), you can turn up at your local post office (all capital cities, metropolitan areas and most country towns), hand over your document and money, and Australia Post will fax your document to the closest post office with a fax. It is then up the receiver of the document to actually pick it up.

For those of you who find driving to the post office a little inconvenient, an extra charge (around $6.00) will secure a door-to-door courier pickup and delivery in most parts of Australia.

Intelpost also offers an international service to just about anywhere in the world. Prices are typically around $4.00 a page for southern Pacific destinations and $6.00 per page for the rest of the world.

Getting the message

There seems little doubt that facsimile technology is already one of the major trends in business communications. With manufacturers attempting to compete more effectively by improving transmission quality and reducing hardware costs, facsimile technology seems destined to make a considerable impact on the communications of many businesses, both in Australia and around the world.

Section from a fax transmitted using a scanner capable of reproducing half-tones. Note the clearer image.

Big investments paying off:

Philips' Megachip development on target

Three years into its massive five-year Megaproject in partnership with Siemens to achieve leadership in the development of submicron CMOS semiconductor technology, Philips has announced that everything is on target for full production of 1-megabit static RAM chips by mid 1989. Pre-production samples of the chip are 30% faster than anything announced elsewhere, including Japan, and boast much lower power consumption.

by JIM ROWE

These days, it seems that every other week there comes an announcement of yet another leap forward in semiconductor chip technology — perhaps a further doubling of memory chip capacity, or microprocessor operating speed, or whatever. It's become a kind of ongoing and ever-accelerating race, with the participants seeming to spend more and more effort on topping the achievements of both their competitors and themselves (and in announcing their wins sooner).

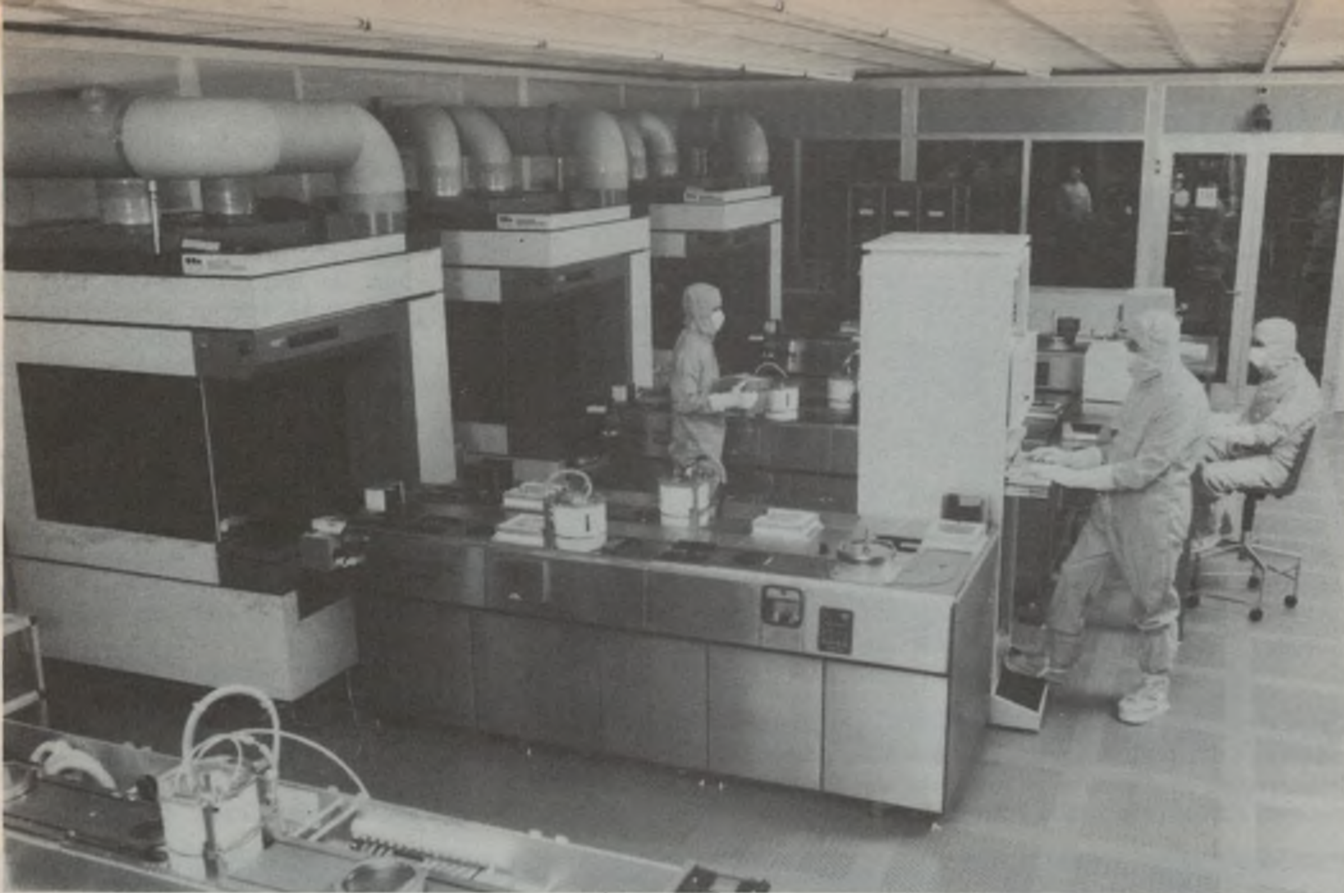
Sometimes there seems to be much more emphasis on making a new device obsolete, by coming up with its successor, than in perfecting its manufacture and delivering it in practical volumes so that it can be put to practical use in real-world products. At least that's the way it seems — perhaps the reality isn't quite that bad.

By and large we've also come to expect most of these whizz-bang hi-tech announcements to come from either Japan or Silicon Valley. In the flurry and flag waving, it's easy to overlook what's happening in Europe. But make no mistake, things are indeed happening there, quietly and almost behind the scenes. Big plans are afoot, and big investments committed. The Europeans intend to grab the world lead in a number of areas, and they're dedicated to that challenge.

Back in 1984, Philips and Siemens announced joint plans for what they called the "Mega Project". The goal was to develop the capability of producing CMOS technology with submicron geometry — that is, with features smaller than 1um (micrometre) — and in the process, lift the European semiconductor industry into the "A team" among world players.

The project was backed by both the Dutch and German governments, who together invested about 500 million guilders. Philips and Siemens committed themselves to an investment of 1500 million guilders in this project alone, so it was in every sense a major project.

Taken at the Philips Research Laboratories complex in Eindhoven, this shot shows the new VLSI Design Centre on the left, and the Submicron IC Centre on the right.



Above and below: Two views inside the Class-35 cleanroom production area of the new Submicron IC Centre. This comprises only about 7% of total building floor area.

Each company chose a specific product to act as the "vehicle" for developing the new technology. Siemens selected a 4 megabit DRAM (dynamic RAM) memory chip, while Philips and its West German subsidiary Valvo chose a 1 megabit SRAM (static RAM) chip.

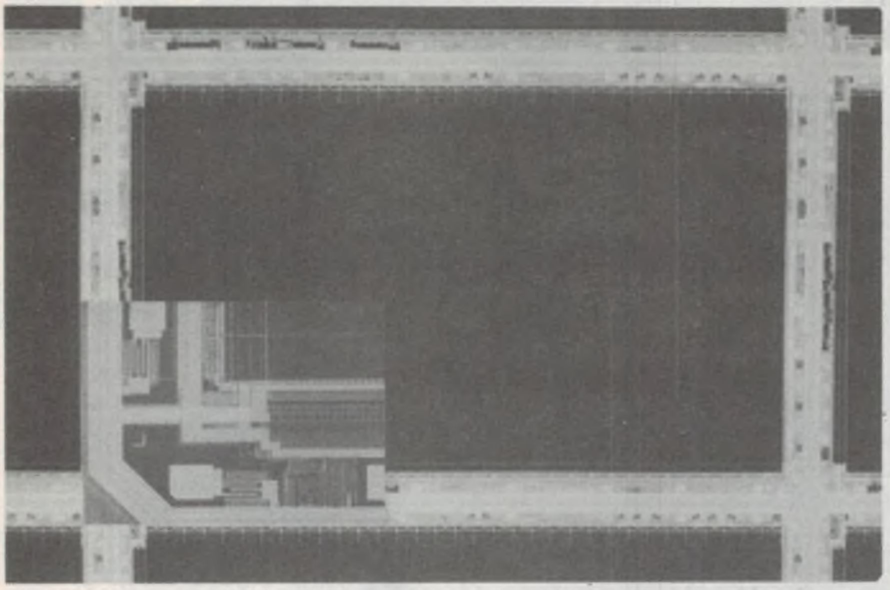
Together the two products were anticipated to involve around 2200 person-years of development, spread over a 5-year period. Pilot production was planned to begin in 1986, with limited production of commercial product in 1987 ramping up to full volume production by mid 1989.

So far, things seem to be going pretty well to schedule. By mid 1987, Philips had progressed to the point where it was able to present the Dutch Minister for Economic Affairs with a wafer of its first functional submicron 1 megabit SRAM chips, and give details of both the chip and the performance so far achieved.

The new chip is organised as 131,072 eight-bit words (128K bytes), with each of the required 1,048,576 bits stored in a 6-transistor memory cell. This means there are a total of over 6,291,456 functional CMOS transistors on each chip, which measures 7.7 x 12.2mm. The size of each bit cell is 5 x 12um, with minimum features around 0.7um.

Time to access an individual byte address is very fast for such a large memory chip: 25 nanoseconds. This is

Philips' Megachip development

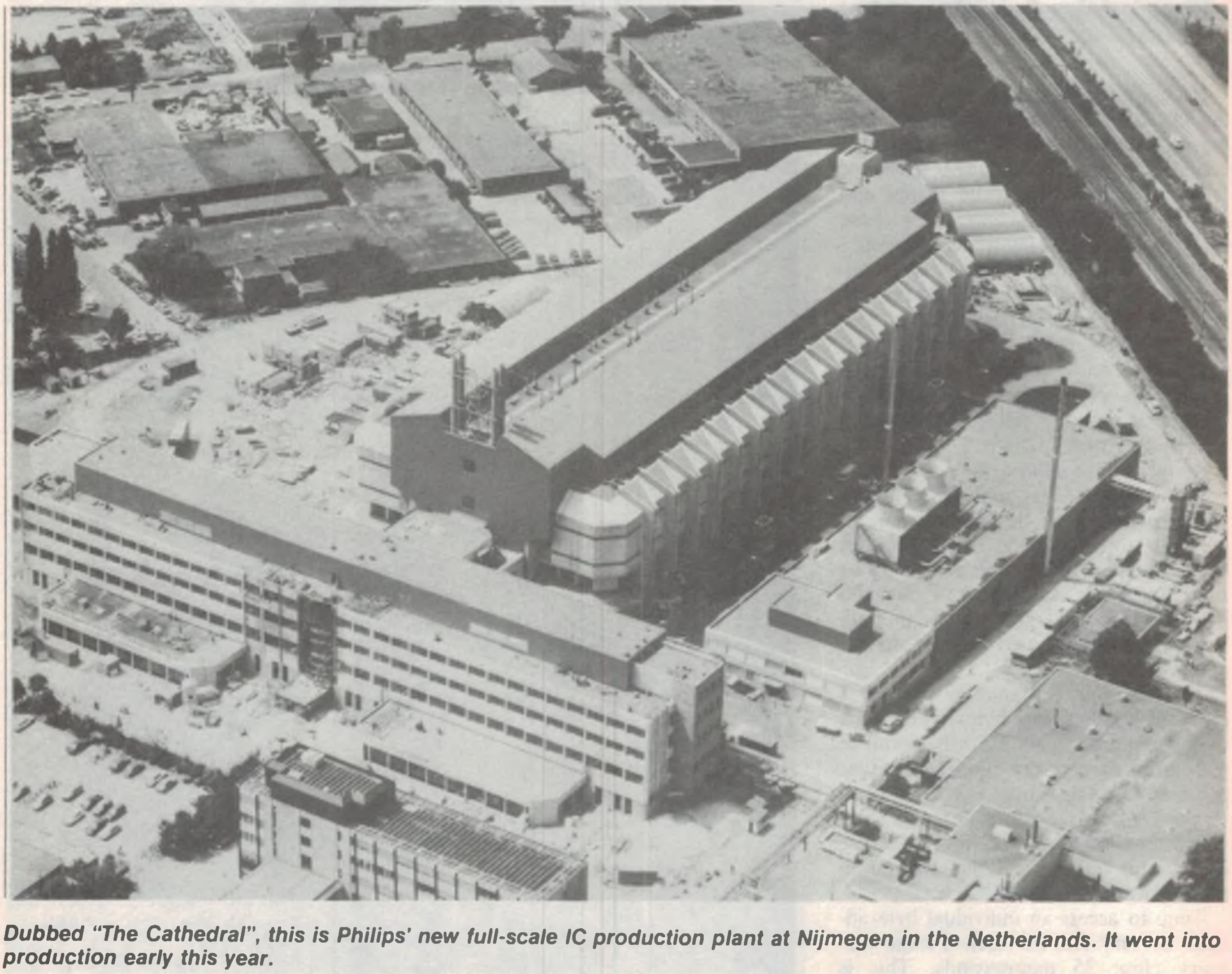


Closeup view of Philips' new 1-megabit static RAM chip, which uses 0.7um features. Actual chip size is 7.7 x 12.2mm.

nearly 30% faster than previously announced 1M-bit SRAMs. Current drain and power consumption when running at 20MHz are also considerably lower than the competitors too, checking in at 30mA and 150mW respectively. In addition, the chip also throttles back to a tiny 0.1uA/0.5uW in "standby" mode — well below the competition.

The first working samples were fabricated on 4" silicon wafers, but when the chip goes into full production it will be made on 6" wafers. As part of the development of the chip Philips has developed a single-polysilicon/double metal/twin well process using an epitaxial substrate, and involving only 13 masks. The chip has 32 pins, and will come in both DIL and small-outline packages.

To date virtually all of the work on the new chip has been carried out at two new and adjacent buildings at Philips' Research Laboratory complex in Eindhoven. One is known as the VLSI Design Centre, the other the Sub-



Dubbed "The Cathedral", this is Philips' new full-scale IC production plant at Nijmegen in the Netherlands. It went into production early this year.

micron IC Centre. As the names suggest the basic product design work is carried out in the former, while refinement of production technology and pilot production takes place in the latter.

Built especially by Philips as part of the Mega project, the two buildings were opened in December 1986 by HRH Prince Claus of the Netherlands.

In many ways the more impressive of the two buildings is the Submicron IC Centre. At its heart is the "clean room", about 2400 square metres in area, where actual chip production is carried out. Although quite sizeable, the clean room actually only comprises a mere 7% of the total building floor area — the rest is needed for things like raw material storage and support services, such as air conditioning/filtering and reticulation of various gasses used in production. Some space is also used for workshops and offices.

Approximately half of the clean room is maintained under Class-35 conditions. That is, with a maximum of 35 particles of dust 0.5um in diameter, per cubic metre. This is the highest level of cleanliness possible with current technology, and requires air filtration plant roughly three times the size of the clean room itself. It processes 2.5 million cubic metres of air every hour, and as well as filtering it maintains a constant temperature and humidity.

But although the Eindhoven IC Centre is being used for development of the basic submicron technology, and for pilot production of the new 1 megabit SRAM chip, final full-scale production of this and other devices using the same technology will be elsewhere. The most likely places are Philips' main IC factory in Nijmegen, Holland, and the Valvo factory in Hamburg, Germany. Already Philips has plans to upgrade these factories, as part of the Mega Project (raising its total planned expenditure to a staggering 2.3 billion guilders).

Very likely the Eindhoven IC Centre will then be used to work on the next generation of technology again. Apparently there's already a 4 megabit CMOS static RAM on the drawing boards, with 0.5um features. Research is also being carried out into reducing the number of photolithography masks, to lower production cost.

So all in all, it looks as if before very long we'll be seeing a lot more news of IC developments coming from Europe. There's certainly a lot of effort and money being invested by firms like Philips and Siemens, to make it all happen.

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Power +12V DC nominal @ 14mA. Case neg. Bandwidth 526-814MHz (28-63 ch). AFT +6.5V. Dimensions 150 x 65 x 28mm. Tuning multirotation of 1/4" shaft. Knob not supplied.

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10+ $3.65 ea
100+ $3.25 ea
NORMALLY $8.95 each

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7 watt 8 ohm
Cat. AS-3021
$4.25 ea
10+ $3.95 ea
100+ $3.50 ea

5" WIDERANGE
10 watt 8 ohm
Cat. AS-3022
$5.95 ea
10+ $5.50 ea

5" WIDERANGE
15 ohms
Cat. AS-3011
$3.95 ea
10+ $3.65 ea

6 x 4"
8 ohm
Cat. AS-3014
$4.95 ea
10+ $4.50 ea
NORMALLY $10.95 ea

8" TWINCONE
10 watt 4 ohm
Cat. CE-2322
$8.95 ea
10+ $8.00 ea
NORMALLY $13.95 ea

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Cat. CE-2323
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10+ $12.95 ea
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Cat. XC-4751

ONLY $13.95 box of 10

$12.95 10 or more boxes each.

OLD STYLE (Antique) TELEPHONE PLUGS AND SOCKETS

We have available a small quantity of the very old style brown bakelite 4 pin round telephone plugs and sockets. These were used on the very old black rotary dial phones.
Due to the limited quantity they are only available from the mail order department.

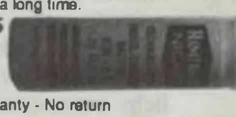
Plug $5.00 each
Wall Mount Socket $5.00 each

AA NiCads - $1!!!!!!

Yes, only $1 each, but there is a catch. They have corroded terminals from over storage. They need a good clean up and some TLC.
We cannot however give any warranty at all on these. We suggest that if you need say 4 batteries, you purchase 6 or 8 - you may even get the majority going. It's still the cheapest AA NiCad deal you'l;l see in a long time.

NORMALLY $4.25
Cat. SB-2453

$1.00 each



Limited quantity. No warranty - No return

6" x 2" SPEAKER!!!!

Yes, a 6" x 2" speaker, that's 157 x 57mm. The size may be strange, but the quality certainly isn't. They are Japanese made, with a large magnet. It even has a foam roll surround. These were used in colour TV's, so the quality is excellent. Sanyo brand 8 ohm 5 watt. Limited quantity. These would probably cost $30 as a spare part!!
Cat. AS-30

$4.95 ea
10+ $4.50 ea

MAGNAVOX WOOFER/MIDRANGE

Another new addition to our range of Australian made Magnavox woofers. Suitable as a woofer or a midrange.

Power Handling	40 watts RMS
Freq. Response	50 - 6500Hz
Resonant Freq.	55Hz
Voice Coil Dia.	25mm

Sensitivity 93dB
Will give excellent results as a midrange in the frequency range 500Hz - 5kHz. Needs to be mounted in a sealed enclosure of 2-4 litres. Will handle 60 watts RMS as a midrange.

SPECIAL INTRODUCTORY PRICE
Cat. CW-2107

$19.95 ea

WIRE WRAP WIRE

Now available in 2 sizes in 5 metre lengths. High quality US made wire wrap wire in 24 and 28 guage. Both green in colour.

Cat. WW-4350	24 guage	$2.95	5 metres length
Cat. WW-4365	28 guage	$2.95	5 metres length

Sensational Semiconductor Bargains

DIRT CHEAP!!

SERVICEMEN TAKE NOTE!
Check out the special below. You will have to be quick!

2SD870
Toshiba brand TO-3 horizontal deflection transistor. Silicon NPN, 5A IC. 600 Vce, 1500Vcb, 50W diss.
Quantity limited
Cat. ZT-2520

ONLY $2.50

2SD348
Sanyo brand TO-3, 12A IC, 400Vce. NPN silicon.
MAIL ORDERS ONLY
Cat. ZT-2515

$2.00

2SC1507/2SC1569/2SC2336
Most NEC brand TO-220 (mod). HF power transistor. Can be used as video amplifier or low power HF power amp. 300Vce, NPN, 150mA IC. FT100MHz, 12W diss.
Cat. ZT-2510

$1.50

WELLER TIP SALE

We have a small quantity of tips to suit the Weller W60D and W100D 240 volt temperature controlled soldering irons.

Weller No.			Cat. No.	Qty Avail
CT5BB8	2.4mm	427°	TS-1390	11
CT5CC8	3.2mm	427°	TS-1391	54
CT5DD8	5mm	427°	TS-1392	103
CT5EE8	6.4mm	427°	TS-1393	41

These would normally cost about $11 each. Because of the small quantities, you'd better be quick.

ONLY $4.95 each

EL CHEAPO DESOLDERING BRAID $2.50

Our usual desolderwick is sold in a plastic spool and contains 5 feet for $2.50. That's approximately $1.50 per metre.
El cheapo braid is 2mm wide and will take solder off a PCB reasonably well although the braid gets a bit hot because there is no plastic spool to hold. You could easily put some in your old spool.
Supplied in a 5 metre length for $2.50. That's 50c metre - or 1/3rd the price of normal desolderwick.
Cat. NS-3025 5 metre pack
Please note: braid is not loaded with flux and will not work quite as well as normal desolder braid.

AND NEW PRODUCTS

FORUM

Conducted by Jim Rowe

More thoughts on projects that don't work

My column in January's Digest issue discussing the question of responsibility for project kits that don't work certainly seems to have stirred up the proverbial hornets' nest. Almost as soon as the issue was published the 'phone started ringing, and within a few days letters began arriving!

Among the first callers were a couple of our main advertisers, who market kitsets. Not surprisingly, they were a little peeved at my little crack about electronics entrepreneurs, the money they make and the way they spend on expensive toys.

That's fair enough, too. I have to admit that it *was* rather a cheap crack — and more importantly, of rather dubious relevance. The mere fact that an electronics retailer may make a lot of money (assuming they do) is not in itself any reason for criticising them, of course, and I really wasn't seeking to suggest that it was.

In fact I'm happy to acknowledge that if a kit supplier or any other business person is making good money, it might well be because they're providing the right products and services, and at the right price — so the world would be understandably beating the proverbial path to their door, and plying them with money. And if that's the case, in my book they're entitled to all due praise as well as the inevitable riches.

I certainly don't subscribe to the old Aussie tradition of knocking our tall poppies or anyone who's made a lot of money, regardless of how they've done it.

Actually all I was trying to do in the original column was contrast the kind of money being made by parts retailers (at least a few years back) with that made by magazine editors and publishers, in order to show which of the two might be able to *afford* to help readers with kit problems. It looks as if I mightn't have made that point too well.

Of course I did express the suspicion that things nowadays mightn't be as rosy for kit suppliers as they were in the past, and judging by the response of the two entrepreneurs concerned, I gather that's pretty true. Apparently there's a lot more competition now than there was a few years back, and Australia's falling dollar has driven up the cost of components (virtually all of them imported).

Incidentally one of the two entrepreneurs who jumped on me (nicely!) was Jack O'Donnell of Altronics in Perth. And as it happens, Jack had another legitimate gripe about the column concerned: in talking about kit suppliers and whether or not they're prepared to help constructors who strike trouble, I stated that to my knowledge, Dick Smith Electronics was the only one of the major kit suppliers to offer this service.

Jack's firm provides the same kind of service, apparently, and he was pretty peeved that I hadn't rung him when writing the story, to find this out. Fair enough, point taken. I should have rung up to check, I agree.

The only comment I'd like to offer about this particular aspect is that perhaps if Altronics had promoted its own service a bit better, I mightn't have *needed* to ring up in order to find out that they have one. Like most of our readers, I've been well aware of DSE's "Sorry Dick, It Doesn't Work" service, because they've given it so much promotion.

So there's a constructive suggestion, Jack. Since you've got this great service too, why not make more of a song and dance about it? I'm sure it would increase the appeal of your kits quite a lot. Flat-chat technical journo's like Jim Rowe wouldn't have to ring up to find out what you're doing before they write a story, either . . .

OK then, enough about the response by the kit people themselves. Now for some of the points raised by others.

The first letter to arrive was from P.A., a service technician based in Sydney, who generally seemed to agree with most of my comments. However he took issue with my reference to "highly-paid service people", pointing out that neither he nor his immediate colleagues regarded themselves as highly paid. They didn't have any "fancy toys", either.

Fair enough, although I wasn't really suggesting they did. The point I was making was that in order for *EA* or any other electronics magazine to provide a service to fix reader's problem kits, we'd need to put on suitably qualified extra staff — and in my view, this would add significant cost.

Actually P.A. makes the point that in his view, it *would* be a good idea if magazines did put on the extra staff and provide this kind of service. He suggests that readers would be happy to pay for the service at the usual commercial rates, in order to get correct operation from an expensive kit. Moveover, he suggests, it would also provide the magazines with important feedback on project design problems, and allow them to correct things faster.

He has a point about the feedback angle, although I can assure you that readers certainly aren't shy when it comes to letting us know about problems they encounter with projects. Our

Some kit suppliers weren't happy . . .

sometimes-bulging letter basket is testament to that! So generally, it doesn't take us long to find out if one of our projects has a design problem.

Often the main delay is not in finding out there's a problem and coming up with a solution, but in letting readers know about it. Like most magazines we have a fairly long lead time, and by the time one issue goes on sale generally the next has just gone away to the printers, and we're working on the one after. So even if we find out straight away, it's almost impossible for us to let readers know sooner than two months later.

The comment I'd like to make on P.A.'s suggestion that we should provide a project repair service, is that I'm not so sure that readers would be happy to pay normal commercial rates for the service. Somehow I suspect that they'd expect us to fix them for nothing, on the basis that it was our "moral obligation", having described the project in the first place and supposedly encouraged them to tackle it.

I remember fairly clearly some of the projects that were sent in to the DSE service when I was working there. Some of them were pretty horrendous, and looked as if they'd been wired up using a 2-pound plumber's iron heated up with a blowlamp. Sometimes any resemblance between them and the original design published in the magazine — or with good wiring practice — seemed to be almost accidental.

Surprisingly some of these kits had supposedly been wired up by "highly experienced technicians" who'd been working for umpteen years in the industry, too. We often found ourselves wondering *which industry* it was, that they'd been working in!

In fact over the years, I've gained the strong impression that the *last place* many people look, when a project they've put together doesn't work or gives trouble, is their own workmanship. They're generally much more eager to blame the designer, the magazine, the kit supplier, the component manufacturer — almost anybody who can be roped in.

Of course problems have been generated by all of these other causes from time to time, including ourselves. But I have to say that in my experience, probably the most common single cause of problems is the constructor themselves. Perhaps they've over estimated their own capabilities, or not bothered to read the article, made unwise component substitutions, or adapted and modified the original design to the point where problems have crept in.

With these thoughts in mind, I'm a bit skeptical about P.A.'s suggestion that readers would be happy to pay for a repair service — particularly one run by the magazine itself. I suspect we'd end up having to make it a free service, and the costs would drive the magazine down the gurgler.

On a different note, P.A. also has a dig at some of the kit retailers, who in

... and made this clear to me!

his experience will sell kits to virtually anyone with the "readys".

He says he's personally witnessed instances of sales people glibly selling quite complex kits to customers who fairly obviously don't have any prior experience of electronics construction. In some cases they've also sold them a soldering iron and a booklet on soldering, when asked by a customer how such a kit is put together. And he's apparently heard sales staff, in reply to questions of how much skill is involved in assembling quite complex kits, offer the advice that "If you can read and follow simple instructions, you can't go wrong!"

As P.A. comments, this kind of sales approach seems very likely to lead inexperienced people into tackling projects beyond their capabilities. In cases where this happens, I think most reasonable people would agree that the kit supplier should be expected to accept most of the responsibility for the kit not working — and I agree with P.A. that there'd be a high probability of that happening.

When I mentioned this to one of the kit retailers, his answer was that all of *his company's* kits were provided with a sheet, which prominently warned the inexperienced constructor of the risk in tackling a project beyond their capabilities. I gather that the sheet advises them to return the kit for a full refund, if they have any doubts, before proceeding any further. And his sales people are apparently instructed to give a refund without question, provided that the kit is still unassembled and in as-new condition.

This does seem to get around at least some of P.A.'s criticism, at least for the firm concerned. Although I'm still inclined to think that the direct face-to-face impact of a sales person, oozing reassurance, might well outweigh a few sobering words on a sheet inside the kits. If you were a newcomer sitting down late on Saturday afternoon with your first electronics kit, all excited and keen after being psyched up by the salesman, would YOU take much notice of the sheet and pack it all up to take it back on Monday? I'm doubtful.

Not content with having a go at the kit suppliers, P.A.'s last brickbat is directed firmly back at the electronics magazines. I'll let him express this last one in his own words:

It has been my experience that the magazines are generally reluctant to print errata concerning projects, especially where there is a design mistake. They tend to dismiss criticisms from readers, even when a simple solution is offered. Some "designers" consider it a personal defamation to admit any error in print, or otherwise. I have tried unsuccessfully for several YEARS to get one magazine to publish errata of a serious nature for two of its designs, both of which are still widely sold as kits. In the trade these particular designs are a standing joke.

He goes on to suggest reasons for this behaviour, including immaturity of the project designers and magazines not wanting to lose credibility with the readers or kit suppliers by admitting they've made mistakes.

Whew — I would open up the subject, wouldn't I? I have the distinct feeling that I led with the magazine's chin on that one, especially when P.A. goes on to offer at least two examples concerning past *EA* projects. (He also offers a number of examples involving other magazines, I hasten to add!)

Now I can't comment on the actions of other magazine editors; nor would it be diplomatic to say anything about what may have happened at *EA* during the years I wasn't here. But to comment on a general level, we all make mistakes from time to time. Of course design errors creep in now and again, in every magazine's published designs — we wouldn't be human if they didn't.

More specifically than that, all I can say is that my own policy here at *EA* all along, both before and nowdays, is that we always listen very carefully to anyone claiming that we've made a mistake. We make a point of checking out these claims as fast as we can, and if they're right we act quickly to remedy

FORUM

matters. This means finding the best solution to the problem, and then advising both kit suppliers and readers as fast as possible.

As evidence of this, I'd ask P.A. or any other interested reader to look back at our "Notes & Errata" section for the last six months or so. Far from being unwilling to admit we've made any mistakes, I'd say we've being going out of our way to hang our dirty linen in public!

I'd certainly like to think that P.A. doesn't have too much to complain about *EA* designers being unwilling to accept valid criticism nowadays, at least.

Now to the comments of other people who responded. A gentleman called H.J. of Horseshoe Bay in Queensland wrote in to describe two unhappy experiences he's had, with kits from well-known suppliers.

One was apparently an amplifier kit which arrived lacking six essential parts — but with four "ring-in" components which seemed to have no possible connection with that kit. The same kit had photocopied instructions which were so blurred that at least 30% of the parts couldn't be identified.

With a second kit, many of the parts in the original project's parts list had been replaced by substitutes, but there was no information on which substitute replaced which original. H.J. relates that when he complained to the supplier, they "didn't want to know about it", and disclaimed all responsibility.

He adds that a friend who is an experienced technician told him that he personally would never buy another kit, because those he had constructed would not perform according to the claims made for them.

Finally, H.J. concludes by saying that he himself would rather pay a little extra, and buy a ready-built unit. At least then, he can ask for a demonstration before buying, and save both money and possible disappointment.

Fair enough. It's undoubtedly better to buy a piece of ready-built equipment if you don't have enough experience to be able to get a project going. Even if you do, it's certainly faster.

The only point I'd like to make here is that putting together a project or kit can be interesting, challenging and satisfying. It can also be a great way to learn more about how electronic equipment and gadgets work. There's really nothing quite like direct "hands-on" experience, with the smell of resin-cored solder up your nostrils and the thrill when you first turn whatever you've built on, and it (hopefully) springs into life.

Mind you, it's certainly true that nowadays, building something yourself isn't always a way of saving money. In fact with some kinds of equipment, it can even be dearer than buying a commercially built one over the counter. That's why in some cases, like VCRs and CD players, electronics magazines like *EA* haven't even bothered to describe them at all.

Of course there are still plenty of other things where you *can* save money by building one yourself, as well as having the satisfaction of doing so. Even in cases where it's possible to buy a ready-made one cheaper, you can often build one which performs a lot better, and is really comparable with a much more expensive model — so you're still actually saving.

With regard to H.J.'s experience with incomplete kits, or kits with unexplained component substitutions, I don't think anyone would deny that this is unfortunate. Accidents will happen, of course, and substitutions often have to be made. But just as magazines should be willing to admit their mistakes, so too should kit suppliers.

I fully agree that when a supplier replies to a complaint with what amounts to "get lost", that's a very poor way to encourage a kit buyer to come back for more. In fact it seems a very good way of ensuring they never come back at all — certainly to the company concerned, and possibly to the electronics hobby as a whole.

Mr H.J. himself is a good case in point. It seems pretty clear from his letter that his project building ambitions have been well and truly killed, and that's sad.

But let's end up on a happier note. Among the other letters that came in was one from a Mr S.Calder of Hycal Instruments, who has apparently been providing an independent and low cost kit and project repairing service for the last year or so, and with some success.

He writes that his service is called "Fix-A-Kit", and he charges only $15 an hour for labour. That's very reasonable indeed, by modern standards. He also doesn't charge for kits that can't be repaired for some reason, except a small fee to cover package and return postage.

The only kit/project he apparently won't tackle is our own Playmaster AM/FM Stereo Tuner of December 1985 — February 1986. This design has given a great deal of trouble, it would appear.

Mr Calder tends to reinforce my own comments earlier, about constructors themselves being responsible for many of their problems:

I don't like putting people down, but if they took their time, followed the instructions to the letter and checked everything before powering up, then I would have much less business in this area!.

For those who would like to take advantage of Mr Calder's Fix-A-Kit service, his address is 4/62 Great Western Highway, Parramatta NSW 2150. His 'phone number is (02) 633 5897.

Well, that's about all I have space for this month. There *was* another quite interesting letter, and one that I planned to discuss because its writer took me to task quite assertively. But somehow we managed to lose it, before I could do so. So if the reader concerned wonders why I haven't commented on his letter, that's why — not because he had a go at me!

If he cares to send me another copy of the letter, I'll be happy to discuss the points he raises in a future Forum.

Silicon Valley NEWSLETTER . . .

Japanese space agency clears National

Following several days of intense and sensitive negotiations, National Semiconductor reports that Japanese officials have assured the company that voltage regulator chips from the Santa Clara chip maker were not to blame for the delay in the launch of a Japanese communication satellite as had been charged in the Japanese press.

Earlier this year, Japanese trade journals had quoted Mikihisa Hagigara, a spokesman for the National Space Development Agency, saying that the National chips, which were part of a TRW-made electronic subsystem for the satellite, had proven defective and had caused a delay in the launch which had been scheduled for February 1.

National Semiconductor had vigorously disputed the charges, saying the chips had been in good working order when they were shipped in die form to TRW. If any defects occurred with the chips they would have been caused when TRW assembled the dies into their chip packages, according to National.

Jim Smaha, senior vice president of National's chip business, said officials of the NSDA, the Japanese equivalent of NASA have assured National that its chips were not to blame for the problem that has occurred with the TRW subassembly.

Apple-DEC link announced

Apple Computer and Digital Equipment, during a joint press conference at the MacWorld Expo in San Francisco, officially announced a landmark agreement that will make it easier for Macintosh and VAX computers to communicate with each other.

"This is truly global in scope. The combination of Digital's and Apple's technologies represents one of the strongest alliances yet in the computer industry," said Apple president John Sculley. "It brings together the best technologies from two of the industry's best-known innovators. The big winners will be large companies and universities who will have new opportunities for powerful, highly integrated, multivendor office systems that are easily accessible and usable".

Digital president Kenneth Olsen, in a very rare appearance at a non-Digital event, added that the agreement with Apple fits well into DEC strategy of "providing networked server and desktop solutions". He added that while DEC integrates various other types of personal computers with its VAX systems, "the development effort with Apple will extend that integration to our customers who use and love the Macintosh.

Both Sculley and Olsen, however, tried to lower the expectations many people may have about the impact of the agreement. While the agreement "may become the data communications story of the decade," Sculley cautioned that "there have been so many handshakes in this industry that have led nowhere."

Industry analysts, however, were unanimous in hailing the agreement as a potentially major boost for both companies to compete against IBM in the growing market for large-scale networks that integrate personal computers with mini and mainframe CPUs.

White House may support private space station

Plans to put a small, privately-owned space station into orbit years before NASA's colossal space stations will be completed, may soon get a huge boost if a White House policy group will endorse the concept as is expected.

The policy group, which includes some of President Reagan's top advisers and cabinet members, has reportedly reached agreement on backing a plan that calls for the construction of a smaller space station financed by private industry. The plan is bitterly opposed by NASA, which fears a second space station would pose a serious threat to its own project.

The plan calls for a smaller space station to be put into orbit as early as 1991 and leasing the space to private industry. NASA's space station, on the other hand, is not expected to be operational until at least 1997.

The smaller space station, called the Industrial Space Facility would cost just $700 million, as opposed to the $14.6 billion NASA plans to spend on its project. The ISF station would require only two shuttle launches to put its various components into orbit, and would be relatively simple to construct. It would be powered by a 200-foot array of solar panels, connected to a cylindrical module that would be about 40 feet long.

Despite the limited space, the facility could perform many of the industrial-related tasks envisioned for the larger NASA space station. It would engage in laboratory experiments, produce special crystals, produce drugs and research new electronic circuit technologies.

Unlike the Space Station, the ISF would not be manned permanently. Because many tasks could be performed by robots, shuttle astronauts would only need to visit the facility periodically to pick up manufactured goods, resupply raw materials and install new equipment.

High-tech executives huddle to discuss strategies

A group of executives representing many of America's top high-tech companies huddled quietly earlier this year in Santa Clara to map out broad new strategies, in hope of helping American industry regain a leading role in many areas of high technology, including some areas of the consumer electronics industry.

Among the executives at the meeting that was sponsored by the American Electronics Association, were Intel president Andy Grove, Apple president John Sculley, Tandem president James Treybig, Hewlett-Packard president John Young, National Semiconductor president Charlie Sporck, Motorola president Gary Tooker, Perkin-Elmer chairman Horace McDonell and 3Com chairman Bill Krause.

Besides issues like ways to reduce

America's huge $US2.4 trillion national debt, the executives focussed on new ways for American industry to regain its competitiveness in world markets. "The point is that it is important for the United States that we have industrial policy. If people don't talk about it how can you expect it to be logical" commented Tandem's Treybig.

The executives were said to be particularly keen on seeing American industry get back in the huge consumer electronics industry, which is dominated by Far Eastern companies. One area in which the executives feel the US could play a significant role is in the forthcoming generation of digital, high-definition televisions which feature vastly improved picture quality and numerous new features.

Sematech chooses Austin, Texas

Sematech, the US semiconductor industry's new co-operative manufacturing research group, has finally chosen Austin, Texas as its centre of operations. This was after extensive lobbying by some 11 different cities and states. Officials of Austin's Chamber of Commerce are overjoyed at the decision, which should mean at least 800 new jobs at a time when the Texas economy is still suffering from an oil shock.

Sematech will be within a short distance from existing chip production facilities of AMD, TI, Motorola, Cypress Semi and even National Semi (which has major facilities in nearby Arlington). Currently some 40% of US semiconductor production comes from Texas plants, and some industry observers believe that Sematech's decision will make Austin the US chip-making capital.

Meanwhile, IBM has announced that it is donating its 4-megabit DRAM chip designs to Sematech, while AT&T is to provide Sematech with its 0.7-micron 64K SRAM technology. According to IBM executive vice president Jack Keuhler, his company's donation is "not simply a case of giving our latest technology to the industry. Sematech will be a rich source of ideas for IBM".

Similarly AT&T Microelectronics vice president William Warwick said that "By offering the consortium one of our most advanced technologies, we expect to increase the chances for a substantial return on investment for all members of this co-operative effort."

National president and Sematech chairman Charlie Sporck said "IBM and AT&T have agreed to give manufacturing demonstration vehicles that utilise their best technology, and Sematech will assimilate the best of both to drive the market and lead the technology."

Chips & Tech unveils PS/2 clone chips

The starting gates have opened. But the betting is not on which horse will win the race, but on which one will dare to come out of the gates first and try to run through the potentially lethal obstacle course.

As expected, Chips & Technologies has introduced the first complete IBM PS/2 compatible chip set. But according to most industry analysts, it may well be until the end of this US summer or later before the first PS/2 clones will be introduced and even longer before any will become available.

As with the current generation of PC, XT and AT compatible chip sets, the PS/2 chip set features significantly improved performance ratios over the IBM systems. Chips & Technologies president Gordon Campbell said his first chip sets work twice as fast as the IBM machines they are modelled after.

The Serviceman

The volume control that did everything

Normally when you twiddle the volume control on a TV set, you expect it to vary the volume — right? The last thing you'd expect it to do is vary the picture brightness and colour as well, in a manner that varied from day to day . . .

I haven't had any really interesting jobs myself this last month, just a steady stream of the usual "bread and butter" jobs that pay the bills and keep the tax man and the bank manager at bay. Necessary, but hardly exciting enough to write about.

But just as I was wondering what to write about for this column, the postman brought two letters from colleagues interstate — both with interesting stories of their own to relate. So thanks to them, the problem was solved.

The first story comes from a very experienced mate of mine in Hobart, and concerns a TV set's volume control that almost seemed to have developed a will of its own. I certainly found it an interesting story, and I think you will too. Here it is:

A customer brought in a Rank C2205 colour TV recently and with it gave me the most ridiculous set of symptoms I've ever heard of. I couldn't make head or tail of his story, until we turned the set on and I actually saw it for myself.

In fact the owner was also a bit nonplussed, because the symptoms had apparently "inverted themselves" since the fault began the night before. They were still strange enough to warrant this story and I hope that my interpretation of the reasons for the symptoms will be a satisfactory explanation to the reader.

Before I start, I should explain that here in Hobart we have only two VHF TV channels. They are the ABC channel 2, and TasTV's channel 6. The symptoms to be described apply to those channels. I have no idea what the results would have been on 7, 9 or 10 (or on SBS if the set had been fitted with a UHF tuner).

The customer described the original fault this way. He had to use the volume control to adjust the picture (!). With the volume at a normal level, the picture suffered noisy colour and herringbone patterning. At a higher volume the picture disappeared completely, while at very low volume the picture was normal, although with rather weak colour. As far as he could recall, it was the same on both channels.

When I tried the set next morning, I found the symptoms almost reversed, and somewhat different on each channel. Channel 6 suffered from severe herringbone patterning, at every volume control setting except at one tiny spot, about one third up from minimum. The colour was not particularly noisy, although it was weak.

On channel 2, the symptoms were quite different. For a start, there was no picture at all at minimum volume. Then with the sound just on, the picture was quite satisfactory, and the colour was good. With the volume control at a near normal setting, the chroma was extremely noisy, and at full volume the picture was suffering with a bad herringbone pattern as well.

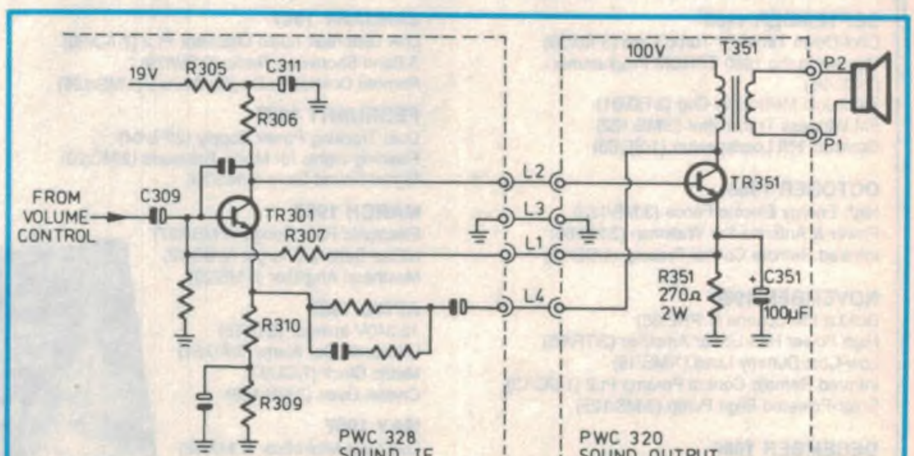
Through all of these experiments, the sound quality had been almost normal, although I did think that the maximum volume was a bit low. It was the nature of the volume changes that worried me. There was none of the smooth transition from one level to the next. The changes were made in series of steps, each accompanied with a soft "pop", and each coinciding with a change in the picture quality.

Well what do you make of that lot? And where on earth would you start looking for a cause?

Now, there is one thing about these old Rank sets that makes them a bit easier than most sets to service. In fact, the Rank chassis designation points to the reason. The makers did not give chassis type numbers to these early sets, but described them by the number of separate boards used in each model. The C2205 uses chassis type "14 PCB's".

The advantage of having so many boards is that substitution is relatively easy. Only on the line output boards are there any hard wired connections. All the rest are plug and socket types, and it only takes a moment to remove a suspect board and replace it with a known good one. So, with 14 of them to choose from, which one should I start with?

In fact, I decided to start with the video IF strip. For one thing, the symptoms were different on each channel, and different to those at the customer's home. So signal strength variations might have had some bearing on the problem, and



The relevant section of the Rank C2205 set. It all looks pretty straightforward, doesn't it? That's what my mate thought . . .

AGC faults can produce some pretty funny symptoms. Another reason was that the video IF board produces the audio IF, and it carries one of those 5.5MHz ceramic filters that can cause some funny effects.

But all of this was to no avail, because the new board presented the same symptoms as the old one.

So next I turned my attention to the sound IF board. Although we had picture problems, it was in some way tied to the volume level and that control was situated right in the middle of this board. In fact, it now looked as though I might be getting somewhere, because the nature of the symptoms changed with the new board.

Not that there was that much difference between the two boards — just that the change from bad to good picture was at different places on the volume control, and the sound "pop" was now more of a "click". I decided that there were just subtle differences between the boards, rather than a fault on the old one. But I was even more convinced that this had to be a sound fault rather than a video one. So it was on to the next audio board — the PWC320 sound output.

It was here that I struck oil, because a known good output board cured the fault completely. So what, on the audio output board, could foul up both picture and colour, with very little effect on the sound? In the answer to this question lies the clue to ninety percent of all faults in early Ranks!

The actual faulty component itself was not hard to find. There are only seven parts on this board and two of them belong to a family of components known to be unreliable — electrolytic capacitors. In fact it was C351, a 100uF 16 volt emitter bypass on the audio output transistor. It had gone open circuit (or dried out) and a new cap restored normal picture and chroma, and full maximum volume to the sound.

So, having solved the problem, it only remained to work out how a sound output emitter bypass cap could so totally compromise the operation of the receiver. The answer turned out to be via its effect on the 19V supply rail, which in these models serves almost all parts of the set.

Consider the audio driver transistor TR301. Its collector is fed from the 19V rail through R305 and R306. Its emitter goes to ground through R309 and R310, while its drive comes from the volume control via C309. It is only the base bias on this transistor that is in any way unusual.

The source of bias for TR301 is in fact the emitter of TR351, the audio output transistor. It is fed via plug L1 and R307 on the sound IF board. So if the output emitter bypass goes open circuit, then the bias (and audio) referred back to the audio driver must reflect the excessive negative feedback being applied to the output transistor.

Then, because the audio driver is powered from the 19 volt rail, any upset in that transistor is bound to have an effect on the rail. And these early Rank sets, many parts of the set are quite susceptible to variations in the 19V rail voltage.

Certainly, there are bypasses on the rail which should stabilise the voltage, but these are old sets and many of the bypass caps are probably drying out. C311 is a case in point. It should bypass the supply to TR301, but in this set and under these fault conditions, it was not sufficient.

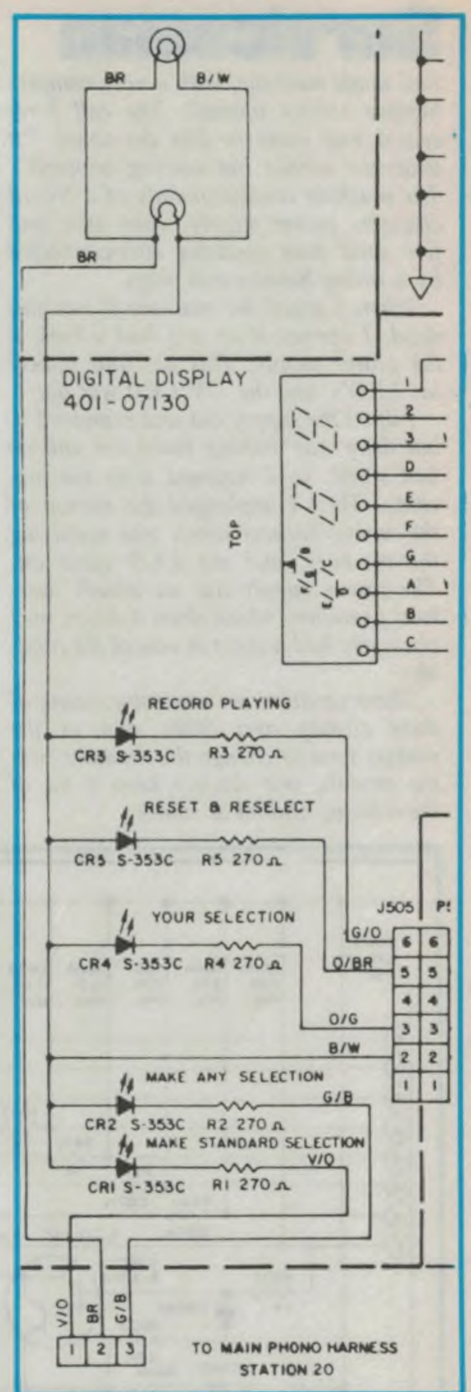
So there you have another bizarre symptom to add to the catalog of 19 volt rail problems that bedevil Rank receivers.

Next time one of these sets comes into the workshop, I'll remove C351, just to see what happens. The cap is easy to get out, and it will be interesting to see which symptoms its absence causes.

Well, what an interesting story! I must confess that when reading it myself, I half expected to learn that the audio stage was somehow "taking off", and oscillating at a couple of megahertz. It was probably the reference to a herringbone pattern that fooled me; I really wouldn't have expected that those strange symptoms could be due to DC voltage changes carried all round the set by our old Rank bugbear, the 19V supply rail.

But now to our second story, which this time comes from Brian C, a technician in rural Queensland. Brian tells me he doesn't do a great deal of servicing nowadays, having managed to work himself into a position of semi-retirement by gradually acquiring a quantity of amusement machines. These he has distributed in strategic locations around the town, and they bring in a modest income — enough to let him ease up quite a bit, he says. Sounds like the great Aussie dream!

There's always a catch, of course, and apparently in this case it's that whenever one of the machines goes bung, there's only one logical person to fix it. So it seems to me Brian might not have escaped servicing after all — the only difference is that he's now his own customer. And presumably gets rather irate with himself, if he can't fix a job quickly.



The console section of the circuit for the AMI R82 juke box — read it together with the circuit overleaf.

Anyhow, enough of my philosophising. Let's hear the story from the man himself:

Your article a few months ago, which made the point that sometimes a simple fault can cause a lot of work, has prompted me to write. I have had a case of this recently which is a bit off the beaten track, and I thought you'd find it interesting.

The machine involved was a juke box, an AMI R82. This is quite a large and

Serviceman

well made machine, with a very comprehensive service manual. The call I received was more or less the usual: "It takes the money but nothing happens". The machine consists mainly of a record changer, power supply, coin unit, and five solid state modules inter-connected by a wiring harness and plugs.

When I tested the machine it was just dead. I opened it up and had a look at the power supply. This has four indicator LED's, and the –7V LED was out.

I lifted the supply out and examined it, but there was nothing burnt out and no bad smell, so I returned it to the machine. Then I unplugged the section of the wiring harness which was supplying the modules, and the LED came on. The power supply has an inbuilt overload protection which shuts it down, so I obviously had a short in one of the modules.

These modules are expensive, some of these costing over $600, and as the makers tend to change the modules with the models, one doesn't keep a lot of them laying around as spares.

As the supply lines ducked in and out of the modules via the wiring harness, I decided to replace the machine and make it a workshop job. This is rather a big job, as records have to be brought up to date, the volume control changed, and a fair bit of fussing with extension speaker connections.

I had the machine in the workshop for a few days before I got around to it, and after about an hour or so of tracing wires and unplugging plugs I found that the last module supplied by the –7V brown wire was the "credit computer". At this stage I mentally kicked myself, because I had a spare one of these. I therefore plugged in the spare, switched on the machine, and stood back quite confident that it would work.

To my complete surprise the –7V LED still stayed off. This really set me back on my heels, as it didn't make sense.

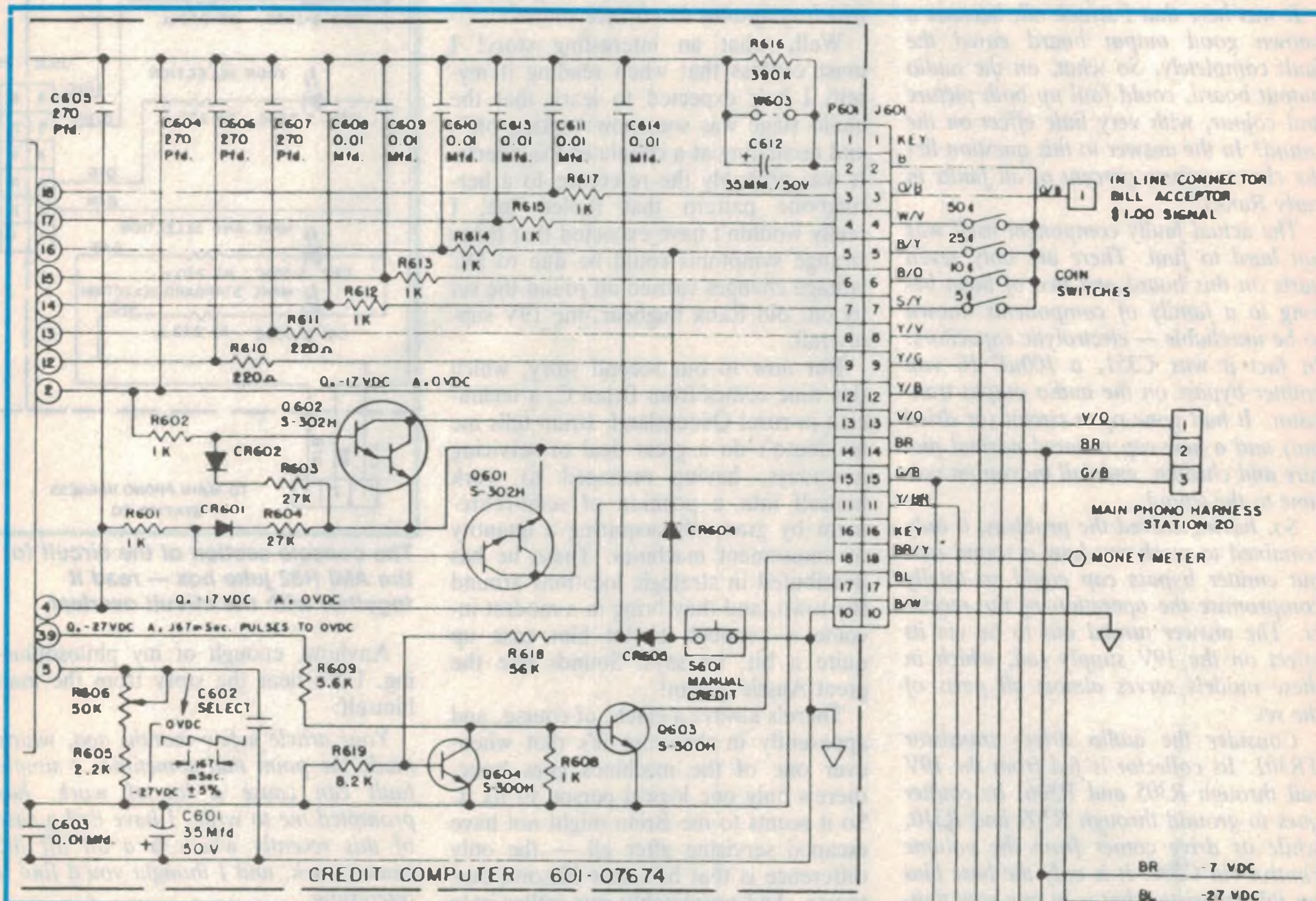
There is a three-pin plug coming from this module, which supplies two LED's indicating that credit has been established. Just because I was at my wit's end, and as an idle thought I unplugged this plug, switched the machine on, and it came to life. On closer examination I found that only two wires supplied the LED's, and the other was –7V to two general illumination bulbs (dial lamps) which lit up the ten pushbuttons.

Both bulbs were blown, so I dismissed them and started to check the wiring. The brown wire and black return passed under the midrange speaker housing, so I lifted this out expecting to see the housing had cut through the plastic insulation. But this was not the problem, either.

I had checked the brown wire with an ohmmeter, and it was definitely shorted to the black return. I had left the ohmmeter clipped to the plug, and on unscrewing the bulbs to test the sockets the short disappeared. In fact, one of the bulbs had shorted internally.

Like most such cases it's easy to explain things afterwards. Being driven from a DC supply, the bulb must have arced over and fused when the filament burnt out. This caused the power supply to shut down. At that stage the weld would cool down, and become permanent.

What made this simple fault so hard to



The other relevant part of the juke box circuit, which led my colleague Brian C. up the garden path. The strange things we servicemen have to find our way around — the hard way!

find was the fact that the circuit diagram showed the connection between the bulbs and the –7V power supply as being directly via the brown wire in the wiring harness. If this was the case, unplugging the credit computer module wouldn't have effected the fault; it would have stayed there.

But because the connection actually went via the credit computer module connectors, rather than direct, unplugging the module made the fault disappear. It was this that led me to believe that the fault was in the module, rather than where it had really occurred.

So to sum up, I had to spend a lot of time and work to fix a fault that should have been fixed in minutes. But then, who would expect a misleading error in the circuit diagram, whoever heard of dial lamps shorting internally, and whoever heard of driving the lamps for general illumination from a logic supply?

Thanks Brian, that was a lesson for all of us — not to assume that a manufacturer's circuit is gospel. I've never had to try and fix a juke box myself, but it sounds like they're subject to the same kinds of problems you find in more familiar equipment.

And that's all for this month. Hopefully by next time I'll have something interesting myself to tell you about, from my own workshop. This modern gear with its ICs is too reliable — in the good old days they really thought about the poor old serviceman, and built in all kinds of unreliability!

Still, when the new gear does go down, the faults can be even harder to track down than before — and more challenging to work out, when you have found them. So one way or another, there's generally still lots to learn and talk about. I hope you'll join me. EA

TETIA Fault of the Month

Pye T30

Symptom: Repeated failure of Q65, the line output transistor. This, even after all the expected dry joints have been repaired.

Cure: R624 (2.2Ω 1/2 watt) intermittent open circuit. This resistor, with D603 and C616, moderates the drive to Q65 and when it goes open circuit feeds faulty drive to the output transistor.

This information is supplied by courtesy of the Tasmanian branch of The Electronic Technicians' Institute of Australia. Contributions should be sent to J. Lawler, 16 Adina St, Geilston Bay, Tas 7015.

Frankly Frank

Musings on matters electronic by FRANK LINTON-SIMPKINS

Electrons and the Universe

There must be a specially deep, fiery and unpleasant place in hell for the man who invented the amplifier and allowed it to fall into the hands of teenagers with defective hearing.

Somewhere below the circle in hell that Dante tells us was reserved for matricides, there you will find the men and women who invented the amplifier, the two-stroke lawnmower, MTV and the person who first domesticated Brussel Sprouts. Shortly you will also find the man who rides into the city on my train, after having his annual bath in Garlic oil. But I digress from my point, that is the Universe and its electrons.

When I was a child, the Electron occupied a place of great significance in the scheme of things. There were only the big three, the Electron, the Proton and the Neutron; but no one really bothered about the neutron.

Now things are different. There are Mesons, Pions, Gravitrons, Photons, Quarks and odd things that seem to arrive at destinations even before they leave on their trips. There are even six sorts of Quarks.

Once it was much simpler. Electrons occupied a place of true importance, as sort of micro planets in orbit around minute suns without heat — atomic nuclei. That is what we were in fact taught at school. Now, the poor electron isn't in an orbit, it occupies an electron shell and if Werner Heisenberg is right we can't ever say where it is, just express a probability that it is within a certain space.

In fact it is now thought by some people that unless we are trying to observe it, the electron isn't there at all — and when we observe it, we change it in all sorts of arcane ways. So the electron has fallen from being one of the big three to being only a wretched probability that may not have any objective reality at all. How are the mighty fallen!

Now these probabilities that we mentioned above have had a probable existence for a rather long time. Since they were only a rather remote possibility, in fact.

Those of you who can accept the calculation made by the American bishop last century that the world was created 5,555 years back at approximately nine o'clock one Thursday can immediately stop reading this and move to Queensland where it is required that Creation Science (?) be taught.

Apart from the Thursday morning theory there are two others which rather more closely fit the research, one that the Universe was created about 15,000 million years ago as the result of a gigantic explosion, and the other that somewhere out there past Pluto something is creating matter all the time. The Creation Science/Thursday at 0900 mob feel that both the above theories are wrong, that all those dinosaur bones and the evidence of agriculture in the Danube delta about 12,000 years ago were all faked, by non-believing scientists to promote the work of the devil.

Well personally I feel that the big bang theory is the one that I can live with best. I discount the Thursday morning one, as the dates don't tally — the Jewish year is greater than the bishop's figure by several hundred years. Besides, there was a settlement on the site of Paris and one at Seoul that are both over 6,000 years old. Seoul is probably the elder.

If we subscribe to the Big Bang theory other things follow. Some time in the first few seconds after the bang, some people say about 11 seconds (but were they there to watch and work the stopwatch, I ask?), when space was only about a metre or so wide, electrons and other sub-atomic particles appeared. My theory is that it was around 2330 on a Monday night, during the Don Lane late show. The audience sizes would have been about the same.

The rest is history, and perhaps a mite too well known to bear repeating.

Taking out my trusty Macquarie dictionary, I looked up what the lexicographer said about our once powerful friend sadly fallen on hard sub-atomic times. Electron is defined as being a noun, and the dictionary hasn't caught up with Heisenberg yet, as it says, "An elementary particle orbiting the nucleus in all atoms, it has a mass of 9.1083 by ten to the minus twenty-eighth power grams and a charge of 1.6 by ten to the minus nineteenth power coulomb." Coulomb - ah, that's a word I haven't seen for years!

Electron is a Greek word and from the same root comes the word "Electrum". Plato tells us that Electrum was the metal that was used to side-board clad the walls of Atlantis. Mind you, Plato had his information from a Greek traveller, who heard of it in Egypt where they told of tales told to the priests by either other Greek travellers — or perhaps refugees from Atlantis itself. Since some rather weird tales have been told to priests of all faiths in all times, one suspects that the Electrum walls might be of the Thursday morning school of history. But we could be wrong.

Harking back to the "Big Bang" theory, one is urged to ponder on what was there *before* the primal atom decided that it was time to blow up and eventually make Macdonalds, Pizza Hut and Colonel Sanders possible. Also Dolly Parton, et al...

There is a definite problem about our primal atom, the father of all the Electrons that we love. It is simply that there seems to be no reason for it to appear and blow its top for us.

There is a theory that our universe simply expands to a certain size, then gravity pulls back all the matter into another primal atom and it all starts over again. But we simply don't know if there is sufficient matter in the universe for it to begin collapsing in upon itself. In fact we are almost certain that the energy, it could be called *matter energy* from Einstein's E equals MC-squared, is almost equal to the gravitational energy, hence the total energy in our universe could be zero - a condition I am fully experienced in.

If that is so, then our Universe could

Continued on page 143

"The best prices with unbeatable specs"

That's the GW Promise

20MHz

40MHz

Why buy just a basic 20MHz or 40MHz oscilloscope when you can treat yourself to a fully featured Vertical Mode Triggering oscilloscope with Auto Trigger Level Lock and Variable Hold-Off.

These extra features are normally not found on low cost oscilloscopes, but GW can offer them at a truly unbeatable price. How do they do it? Probably because GW are the leaders in cost effective CRO technology.

The GOS-522, for example, is a true 20MHz bandwidth CRO with a calibrated 20ns/DIV range (unlike CROs offering ranges calibrated to only 100ns/DIV where timing measurements become very difficult). Also, the Vertical Mode Triggering found on both the GOS-522 and the GOS-543 is especially designed for service applications. This allows you to simultaneously compare test points between good and bad boards.

Other features that make these CROs unique in their class include: Auto Trigger Level Lock ensuring perfect triggering without the need to readjust the trigger level when making measurements; Variable Hold-Off which is ideal for stable viewing of digital and video waveforms; fast 20ns/DIV sweep speed offering high precision; DC trigger coupling for low frequency signals and Auto, Normal and Single Shot sweep modes.

Features	GOS-522	GOS-543
Bandwidth	20MHz	40MHz
Channels	2	2
Vertical Sensitivity	1mV/DIV	1mV/DIV
Max Sweep Speed	20ns/DIV	20ns/DIV
Delayed Sweep	NO	YES
Trigger Modes	CH1, CH2, VERT MODE, LINE, EXTERNAL	
Variable Hold-Off	YES	YES
Delay Line	NO	YES
Accel. Voltage	2.2kV	12kV
Warranty	1 YEAR WARRANTY ON PARTS AND LABOUR	
Probes	2 QUALITY SWITCHABLE PROBES INCLUDED	
*PRICE INCL. TAX	$912	$1,465

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News Highlights

Mixed reaction in US to 3" CDs

This year's Winter Consumer Electronics Show in Las Vegas saw a mixed reaction to the new 3" mini-CD format proposed by Philips and Sony. Many vendors of CD players introduced models capable of playing the smaller discs in addition to the familiar 5" size, but only Sony has announced plans to produce a dedicated 3" player. Similarly there were a few 3" sampler discs in evidence, but most of the larger recording companies seem to be adopting a cautious approach to the new format. Many hifi retailers seem skeptical that the format will "take off" in the intended youth market, particularly if recording companies use the format mainly for so-called "B cuts".

The small CDs provide 20 minutes of recording time, and are expected to sell for less than half the price of 5" discs. They are said to play on existing players, providing a small adaptor is used.

LDL buys US sign maker

Gold Coast laser systems manufacturer Laser Dynamics has purchased a leading California sign making company to introduce advanced Australian technology to the USA.

LDL has purchased Graphix Depot at Richmond, in the San Francisco Bay Area, and is re-equipping the California firm with a $200,000 LDL 500-watt laser profiling system.

LDL North American marketing consultant, Mr Phil Ladenla, says the LDL system has the potential to revolutionise the US sign making industry.

Mr Ladenla says the US industry has undergone a revolution in the past five years through the introduction of computer controlled conventional router and saw cutting methods, but it is now wide open for something more.

"The LDL system has leap-frogged US technology by combining full computer control with laser cutting," he says.

Mr Ladenla says two Californian firms are using US developed laser profilers but both are troublesome, use inferior computer systems and in reality are little more than prototypes without several of the advanced LDL features.

The LDL system costs about the same as conventional US systems but it is six times as fast, more flexible and precise. It is also more efficient in reproducing multiple copies of exacting designs.

Disctronics launches CD-ROM

Melbourne based Disctronics, the world's third largest manufacturer of audio compact discs, has announced the release of its first CD-ROM.

Disctronics' first CD-ROM product is a multi media disc containing text, graphics, images and audio. The disc includes the following:

1. Telephone/Business directory containing details from both the yellow and white pages — suitable for direct marketing compaigns.
2. Parts catalog — containing parts and components data, with associated diagrams.
3. 600-page book with pictures highlighting the use of computer pictures with reference documents. Possible applications include:
   - Instruction manuals
   - Service manuals
4. Computer based interactive training database for student nursing training multi-media database containing text, images and audio.
5. Financial procedure manual, demonstrating the benefits of electronic publishing via CD-ROM over traditionally printed procedural manuals.
6. The St. James Bible — sample database showing search/retrieval capabilities on large database.

The managing director of Disctronics, Mr Roger Richmond-Smith said the dual launch of Disctronics' first CD-ROM and the company's establishment of the only "One-Stop-Shop" facility for the production of CD-ROM in Australia was a major development.

"Disctronics is the only company in Australia which can offer clients a comprehensive and totally integrated CD-ROM service."

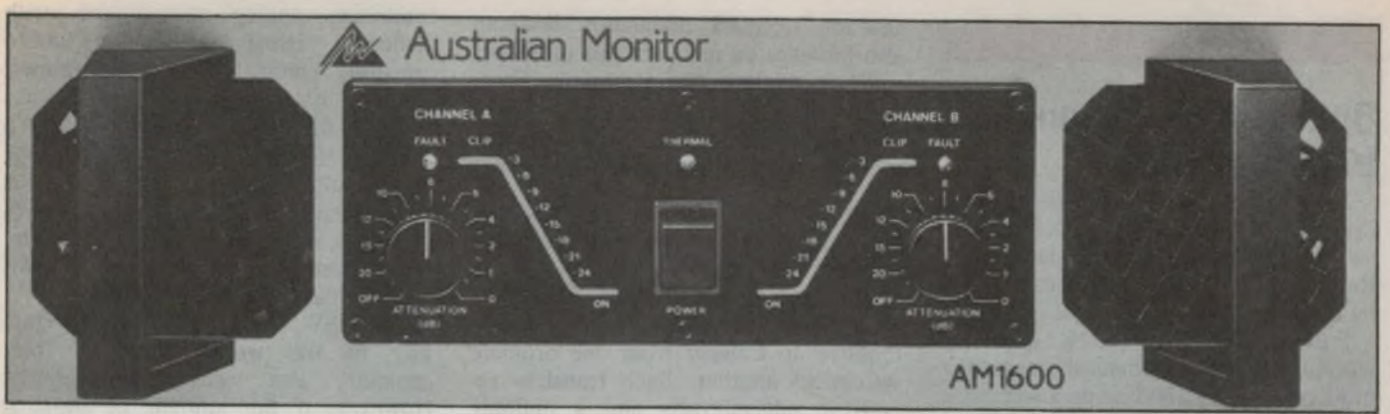
Disctronics can supply a client with a finished disc within as little as eight weeks of the supply of the raw data, for a first title.

Local bank installs fibre optics

The National Australia Bank has recently installed an optical fibre network at one of its major administrative centres in Melbourne, with results described by the Bank as "extremely satisfying".

The project involved internal reticulation of fibre optic cable for building backbone cabling associated with an advanced building cabling system. Australian fibre optic technologies Olex Cables supplied the fibre optic components and ancillary rack equipment and managed their installation and the ducting and splicing of the fibre optic cable.

The purpose-built fibre optic network and the high technology building cabling system are used for interconnecting IBM terminals and departmental systems with an IBM mainframe, connecting remote Line Interface Modules of an LM Ericsson MD110 PABX, and supporting the building control system.



Pictured above is the Australian Monitor AM1600 power amplifier, which has created considerable interest when demonstrated at overseas audio shows in New York, Los Angeles and Frankfurt — where it was billed as "Thunder from Downunder!". To emphasise the amp's hefty power handling capability (1600W into 4 ohms, 2200W into 2 ohms) in New York it was used to drive a 2000W fresnel spotlight with signals from a CD player, for an impressive light show! The AM1600 is made by Graftons Sound, of 175 Campbell Street, East Sydney.

AT&T scientists develop photonic amplifiers

Scientists at AT&T Bell Laboratories in New Jersey have demonstrated an experimental fibre-optic system using four in-line optical amplifiers to increase the span between regenerative repeaters to a record-breaking 372 kilometres. The amplifiers, made from modified semiconductor laser chips, boost lightwave signals without first converting them to electrons and back to light, as is done in current systems.

"This is an important step forward in realising the capability of photonics," said David Lang, director of the solid state Electronics Research Laboratory at AT&T Bell Laboratories. "This experiment shows that optical amplifiers may be practical in the future".

Bell Laboratories researcher Anders Olsson described the amplifier as a "converted laser," an indium-phosphide laser made twice as long as usual with anti-reflection coating on the mirrors. When a steady current is sent through the device, the low-level light coming in can be amplified in the lab by about a thousand times, although in practice net gains of about 100 times are expected.

Olsson said, "An attractive feature of these amplifiers is that they can handle various bit rates and modulation formats. Unlike repeaters, which have to be replaced if the bit rate or modulation is changed, optical amplifiers can handle varying system configurations."

In the experiments, the same optical amplifiers were used both for 400 megabit-per-second coherent frequency modulation and for 1000 megabit-per-second (one gigabit-per-second) conventional amplitude modulation. The bandwidth can be as large as 5000 gigahertz.

New dates for Perth Electronics Show

The tenth annual Perth Electronics Show moves forward two weeks this year to allow maximum impact from all sectors of the community.

The show will be held at Claremont Showgrounds from July 13 to 17 — around two weeks earlier than traditional show dates — to ensure the innovation planned for the exhibition's anniversary achieves maximum impact with industry, media and consumers.

Organisers have been endeavouring to work around the Retravision Conference in Queensland.

The new July 13-17 dates are believed likely to ensure a big attendance by consumers, because the Perth Electronics Show is clear of any other competing attraction in the State. Nationally, the electronics industry will also be purely focussed on Perth because the exhibition does not clash with any other industry event throughout Australia.

President of the committee, Bob Rogers, said every effort was being made this year to ensure the success of the 10th anniversary show. Fresh ideas on content and promotions mean the committee expects big crowds to support the show, which has become the most successful consumer electronics and homeware exhibition in the southern hemisphere.

Sydney — Paris: 9600 bit/s full duplex

Field tests carried out between three continents have demonstrated the operating simplicity and reliability of a new high speed data modem capable of transmitting at 9600 bits per second simultaneously in both directions.

Jean-Paul Esnault of Philips Telecommunication and Data Systems at Moorebank describes the new modem's full duplex high data rates on two wire line as "quite an achievement, considering a normal telephone bandwidth of 3400Hz".

In the field tests transmission between Sydney — Paris, Sydney — London, Sydney — New York and Sydney — San Francisco, the modem automatically called the memorised number, adapted itself to the line conditions (cable, satellite, etc) and established the link.

Developed by the Philips communication equipment company TRT and just released in Australia by Philips TDS, the Sematrans 9696 is said to work four times faster than previous generations of V22 bis equipment.

The highlight of the S9696 is its digital echo canceller, which enhances international data transfer by using three digital signal processors and a 16K byte coefficient memory to cancel a 15ms local echo, calculate transit delay and then cope with a 15ms remote echo. The S9696 has internal memory for automatic dialling of internally stored telephone numbers (V25 bis).

Designed to international specifications (especially CCITT-V32 recommendation Treillis Coding) its specific role is the interconnection of data equipment on switched networks via local or international links. It can also provide automatic back-up of leased lines over dial-up lines.

News Highlights

Optical track scanner trialled by SRA

Australian company Electrologic has installed and commissioned its first optical measurement system, known as Railscan on board a railway car owned by the State Rail Authority of NSW.

Previously, railway track geometry was measured by mechanical means, the most common method being a wheelset, free to float with respect to the car and thus able to follow the undulations of the track. Instrumentation attached to the wheelset conveys the position of the wheelset and therefore the track with respect to the car. At higher travelling speeds, the wheelset cannot accurately follow the track.

Railscan follows the track undulations in a non-contact sense, by using a sheet of light and CCD cameras. Similar systems have been tried before, in Australia and overseas. Such systems updated at the rate of once per minute.

Electrologic has succeeded in producing a commercial unit which operates continuously with an update rate of 50 times per second, allowing recording speeds of up to 160kph (against 60-80kph for mechanical methods). In addition to track undulation Railscan also provides an image of this railshape, which is displayed on a monitor. From this railshape, the amount of wear of the rail can be measured. The wear is represented by two numbers.

Despite the help provided by the SRA in the form of a test car and some financial support, the project took 7 years to complete. Main stumbling blocks were the amount of computation required to transfer from one ordinate system to another. Such transfers require 6 add/subtracts and 4 multiply operations for each data point, of which there are 250,000. At 50 updates per second, 150Mips capacity is required. Then the railshape needs to be found, which is equally time consuming. By combining analog computation with dedicated high-speed digital hardware executing complete software routines, gradual data-reduction takes place which at the final stage is handled by a common 8MHz processor. The railshape is currently recorded in the form of a video signal because the original coordinate data quantity cannot be economically recorded in digital form (1,150M-byte per day, 5 days per week).

The NSW SRA is now the only railway in the world recording track geometry and wear simultaneously. However, if the amount of overseas enquiries is any guide, it will not remain the only organisation for long. Another multi-million dollar export market may well have been created, using Australian talent and ingenuity.

Mitec wins OTC contract

Local company Mitec has been awarded a $1.29 million OTC contract to supply specialised equipment for installation at OTC's Sydney Ceduna and Perth satellite earth stations.

"Mitec will develop C-band frequency conversion equipment, comprising high stability synthesised and fixed frequency up and down converters, together with switchover modules for a range of redundancy configurations, to be used for the transmission and reception of digital carriers at these earth stations," said Rick Abbasi, Project Manager Satellite Facilities Engineering.

"Prior to the awarding of this latest contract Mitec had participated in OTC's $3 million external R&D program, which aims at encouraging Australian industry participation in developing new technologies."

Mitec, a totally Australian owned company, specialises in the design development and production of microwave sub-systems.

News Briefs

- A technology support centre for ASICs (application-specific ICs) has been set up by ***Texas Instruments*** at its Melbourne premises in St Kilda Road. The centre is equipped with an advanced Mentor Graphics design workstation.
- ***Intel Australia*** has installed a direct computer link to the USA in its Sydney office at Level 6, Spectrum building, 200 Pacific Highway Crows Nest. The link provides real-time access for stock information, order entry and shipping advice.
- Sydney audio parts distributor ***Audio Investments*** has been appointed exclusive NSW/Qld distributor for Audax, Micro Seiki and SAEC professional and consumer audio products. The firm may be contacted on (02) 488 8184.
- UK-based Consumer Microcircuits has appointed ***VSI Electronics*** as its exclusive franchised distributor for Australia and New Zealand. CML makes CMOS ICs specifically for communications applications.
- ***Elmeasco Instruments*** has moved its Sydney office to 18 Hilly Street, Mortlake. The mail address and telephone number are unchanged, but the fax number is now (02) 736 3005.
- US component maker Cornell Dubilier has appointed ***Crusader Electronic Components*** as Australian distributor for its entire range of products. These now include the products of Sangamo Weston.
- Computer and instrument maker ***Hewlett-Packard*** is to spend $88 million on R&D in Australia, under a Partnership for Development Agreement announced by Senator John Button. The company will also increase its exports to $78 million annually, by 1994.
- Melbourne-based semiconductor distributor ***Fairmont Marketing*** has been appointed exclusive Australian and NZ distributors for Silitek (Taiwan), New Era Electronics (USA) and J&K Electronics (Taiwan). It is now also Australian and NZ representative for Japanese semiconductor maker Rohm.
- Rapidly-growing Sydney cable assembly firm ***CSSC Australia*** has acquired PCB assembly company ***Sanders Electronics***, and both companies are now housed in larger premises at Unit 3, One River Road, Parramatta.

Sanyo announces double-sided LV disc player

In Japan, Sanyo has announced a new "Jet Turn" player for LaserVision video discs, which automatically plays both sides of the disc without the user having to turn it over.

The player uses a single laser pickup sled, which travels along rails shaped like a horizontal "U". After playing the lower side of the disc from the underside as in other players, the sled moves around the bend of the rails, turning over in the process to play the top of the disc upside down. At the same time the disc itself is stopped, and then rotated in the reverse direction to give correct sensing. The process takes about 15 seconds.

Because double-sided LV discs are actually two discs laminated together, playing the top surface in this way tends to cause timing jitter. Sanyo accordingly had to develop special digital timebase-correction techniques to remove the jitter.

The new player offers 420-line resolution and 45-46dB signal to noise ratio.

Satellite services for Imparja

The licensee of the Central Zone Remote Commercial Television Service (RCTS), Imparja Television, will be able to commence long term satellite transmissions in the Northern Territory and South Australia, following Federal Cabinet approval of funding to allow the Northern Territory Government to purchase increased satellite services from Imparja.

The decision will benefit thousands of Aboriginal and non-Aboriginal people throughout Central Australia, who will for the first time gain access to commercial television services.

Cabinet has agreed that a payment of $0.9 million this financial year and $2 million in subsequent years be made through the Department of Aboriginal Affairs to the NT Government for the purchase of a range of services from Imparja.

This will be a significant contribution to the funds needed by Imparja to lease a 30 watt transponder on an Aussat satellite for satellite transmissions to all parts of the Central Zone service area.

New time receiver to study earthquakes

A new receiver which will enable scientists to continue to accurately record earthquakes, and nuclear explosions has been developed by the Federal Bureau of Mineral Resources.

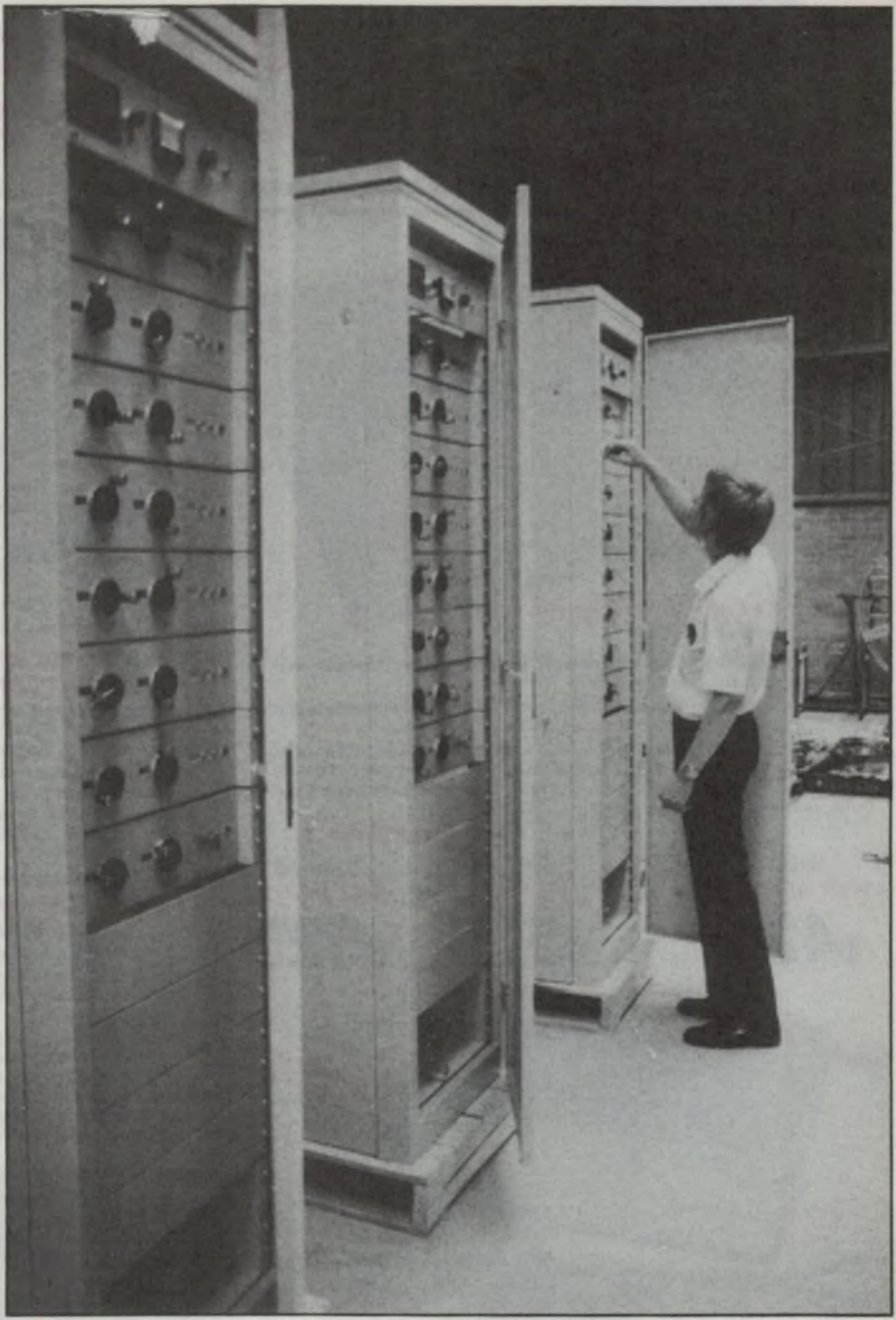
Federal Minister for Resources Peter Morris, launching the receiver, said the new equipment could pick up accurate time signals to 2-3 thousands of a second and had been developed to replace the national time service (VNG) switched off on 30 September last.

"The receiver was designed, developed and produced in Australia in just nine weeks," Mr Morris said.

"When the previous, Telecom operated, time service was turned off, scientists were left without the time information needed to determine the precise location of nuclear explosions and earthquakes," he said. "The new receivers will fill that gap."

"The receivers will also service BMR's field seismic survey operations. They have been developed to use the time signals from the Omega global navigational system."

Mr Morris said BMR's engineering staff would assemble 70 receivers (which comprise a printed circuit board of 140 components and an aerial) for its own use.



Locally made combiners for RAAF

Designed especially for military use, the combiners pictured are part of a batch destined for the Royal Australian Airforce. The 8-channel combiners will allow common antenna working by up to 8 transmitters, or receivers, on different frequencies. Four additional channels may be added to give a total of 12 channels.

Each channel is continuously tunable over the range 225-400MHz. Frequency separations as close as 1% will give greater than 40dB isolation. An additional filter per channel will permit separations as close as 0.5%.

Power rating is 200W average per channel and each module can be removed for routine maintenance without the need to switch off other channels.

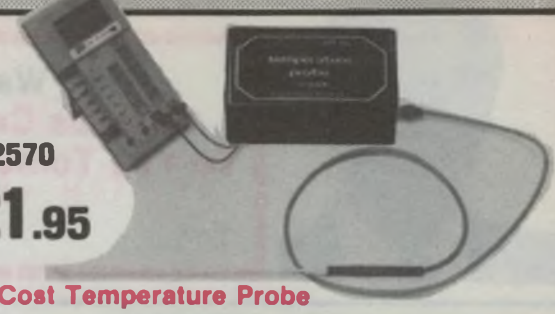
A power and VSWR meter is included with the equipment, which was designed and manufactured by Radio Frequency Systems, of Croydon, Victoria (previously known as Antenna Engineering Australia).

Low Cost Dual Tracking Supply

(See SC Jan'88)

Ideal For Experimenting & Prototyping with Memory, Logic & Op Amp.
Features: Adjustable + or - 18.5V at 1.7A • Volt Meter • Floating Ground • Doorout Indicator • Load Switch • Compact Sturdy "ABS" Instrument Case.

K 3325 $99.00



K 2570

$21.95

Low Cost Temperature Probe

Here's an easy to build probe design which adapts a multimeter or electronic voltmeter into a general purpose thermometer. It's just the shot for measuring heatsink temperatures, how hot it gets inside your car, or whether little Johnny has a fever!

Measures accurately from -20 deg.C to +120 deg.C.

Congratulations To The Design Team At Sillicon Chip Magazine for this Excellent Design

K 2515 $299.00

1GHz Digital Frequency Meter

(See SC Nov'87 Jan'88)

This superb 1GHz Frequency Meter will out perform many other instruments twice its price.

Features: Professional machined and screen printed red perspex front panel • Easy to asemble and construct • No special tools required • Bright Hewlett Packard 8 digit display • Electronic switch latching • High performance IC's • High Quality Components.

T.V. Colour Bar and Pattern Generator

(See EA Oct'87)

Service Your Own TV & Save Dollars

Ideally suited to T.V. repairs and amateur television production.
Features: 8 patterns to choose from
• PAL or NTSC compatible
• Operates on Channel 1
• Horizontal sync output • Vertical sync output • RF Output.
Housed in rugged "ABS" instrument case.

K 2700 $179.00

Digital Photo Timer

(See EA Aug'86)

Precision time your Processing with this Low Cost Project

This classy digital timer allows precision timing for photographic processing from 1 second up to 9 minutes 59 seconds in 1 second increments.

GREAT VALUE

K 1850 $85.00

Capacitance Meter Adaptor

(See SC Nov'87)

Great for hand selecting exact values e.g. exact values for timer circuits etc.

It allows measurements up to 2.2uF Plugs directly into your meter via. in-built banana plugs.
Suits Labtech Q 1075

K 2520 $24.99

Telephone Off Hook Indication

(See SC Nov'87)

Use where 2 or 3 phones are connected on the one line. If one extension is in use a LED will flash in each of the other extensions. Requires no external supply. Runs off the telephone line. One module required for each phone.

K 1400 $9.95

Regenerative Radio

(See EA Jan'88)

Step back in time and build this simple regenerative radio receiver. Using only 3 transistors, its not only fun to build, but uses Varicap tuning.

K 1150 $55.25

Low Ohms Adaptor For Your DMM

(See SC Feb'88)

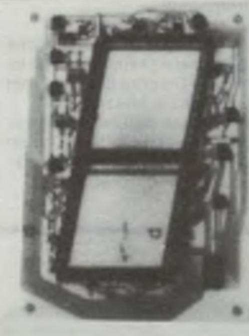
Measure Accurately Down To 50 Milli Ohms!

Door Minder

(See SC Feb'88)

This project will sense a door opening in a large or small room and will sound a two-tone chime. It does not have to be anywhere near the doorway as it uses an ingenious sensor to detect the pressure change caused when the door opens. Ideal for use in shops, offices, doctors surgeries, Chemists etc.

K 1915 $45.00



Large 7 Segment Display

This large 153mm high seven segment display can be configured for use as either common anode or common cathode. Multiplexed on DC driver and arranged to have a decimal point on either the left or right handside.

It can be used to interface equipment with existing displays for large elapsed times & digital clocks.

K 1225 $59.95

As we all know it's difficult to obtain accurate resistance measurements below 50 Ohms or so with conventional multimeters. This natty little adaptor plugs directly into your DMM via. in-built banana plugs enabling quite accurate measurements to 50 Milli Ohms and less. Full instructions provided.

K 2518 $24.99

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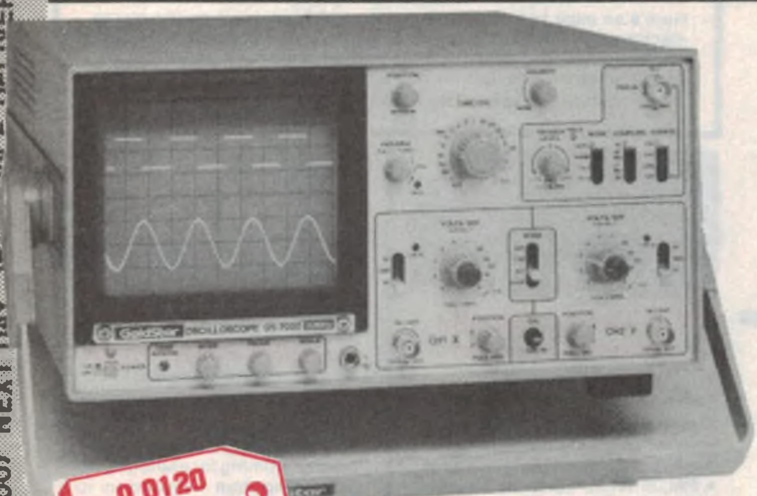
Country Clients Please Allow Additional 48-72 Hours



Q 0120 **$899**

"Australia's Finest Dual Beam 20MHz CRO is Under a Thousand Dollars"

Dual Trace 20MHz Oscilloscope

This all new CRO must be the best valued quality Oscilloscope in Australia!

This new model is a 20MHz dual-trace Oscilloscope using a high brightness CRT with an illuminated scale. The vertical amplifiers have high sensitivity 1mV-5V/Div. The unit has LED's to indicate when the controls are in the 'uncal' postion, and to indicate if the trace has been triggered. The brilliant triggering circuit will trigger on just about any waveform applied. The highest triggering sweep is 0.2uSec/Div. The Q 0120 also features a 'Hold Off' control for seeing the front end of the input wave form.

Features: Large 6" rectangular CRT with internal graticule. • High sensitivity: 1mV/Div. • High accuracy: + or -3% • Stable, low-drift design • 8 divisions of displayed dynamic range and accurate distortion-free waveform measurements • This instrument has a special TV sync separation circuit for quick measurements of video signals • A convenient X-Y operation mode allows phase difference measurements between two waveforms.

Full 12 Months Warranty

CRO Probe Sets

High quality LABTECH Oscilloscope probes. Ideal for use with the Q0120 Oscilloscope. Suits all other brands. 1:1 or 10:1 Attenuation.

Q 0175 **$49.95**

1 GHz Frequency Counter

This new addition to the LABTECH range will astound you with its high accuracy and stability. A truely Professional Instrument that will perform brilliantly in the workshop, laboratory, university etc.

Specifications: The pertinent specifications for the Model Q 1530 are listed as follows:-

1. **Measuring Mode - Frequency Measurements - Channel A** • Range: 10Hz to 10MHz direct counter 10MHz to 100MHz prescaled by 10 • Resolution: Direct counter: 1, 10, 100Hz switch selectable - Prescaled: 10, 100, 1000Hz switch selectable. • Gate time: 0.01S, 0.1S, 1S switch selectable • Accuracy: +/- 1 count +- time base error x frequency. **Channel B -** • Range: 100MHz to 1 GHz • Resolution: 100Hz, 1KHz, 10KHz switch selectale • Gate time: 0.027S, 0.27S, 2.7S switch selectable • Accuracy: +/- 1 count +/- time base error x frequency. **Period Measurements (Channel 4) -** • Range: 10Hz to 2.5MHz • Resolution: 10-7S, 10-S switch selectable • Accuracy: +/-1 count +/- time base error x period. **Totalize measurements (Channel A)** • Range: 10Hz to 10HMz • Resolution: +/- 1 count of input. **General-** • Display: 8 digits, 7mm red LED display with decimal point, gate, overlow, KHz, MHz and uS indication. • Check: Counts internal 10MHz time base oscillator • Power requirement: Line: 115/230V +/- 15%, 45Hz - 70Hz Internal Battery: Option • Temperature: Rated range of use: -5 deg. C - +50 deg. C — Storage and Transport: -40 deg. C - +60 deg. C • Humidity: Operating: 10-90% RH. Storage: 5 - 95% RH.

Superbly Engineered

Q 1530 **$499.00**

Audio Frequency Generator

Often in testing audio circuitry it is necessary to have an accurate and adjustable audio signal source available. This little generator even allows you to test 455KHz IF stages

Specifications: Freq.Range 10Hz - 1MHz **Accuracy** +/-3% +2Hz **Output Waveforms** Sine/Square **Output Level** Sine : 8V RMS Square : 10V P-P **Output Attenuator** -20db, -40db and fine adjust.

New Model For '88

Q 1550 **$229.00**

RF Signal Generator

An RF signal generator is an absolute necessity when it comes to radio servicing. With provision for both internal and external modulation, this generator is a winner.

Specifications: Freq.Range 100Kz - 150MHz in 6 Ranges **RF Output Level** 100mV RMS **Accuracy** +/-3% **Modulation:**- Internal (30% depth) 1KHz • External - 50Hz - 20KHz • Crystal Locked Oscillator

New Model For '88

Q 1540 **$249.00**

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Digital Multimeter With Built-In Capacitance Meter

Not only do you get all the normal ranges of current, resistance and voltage - but also a convenient and simple to use capacitance meter in five ranges. And as if that's not enough, you also get a transistor tester. Check the features of this top quality new addition to the labtech range.

General:

Display: 3½ digit LCD, 0.5" height, with polarity & L0-BAT indication. **Overrange Indication:** 3 least significant digits blanked. **Maximum common Mode Voltage:** 500V peak. **Operating Environment** 0 deg to 50 deg. C; less than relative humidity from 35 deg C to 50 deg. C **Power:** 9V alkaline or carbon-zinc battery. **Battery Indicator:** Display indicates "L0-BAT" when less than 20% of life remains. **Dimensions, Weight** 170mm x 87mm x 42mm, 350grams.

Q 1085 $139.00

Free Carry Case This Month

Normally $12.50

Solar Cell Module .4V at 450mA

X 0210

Normally $5.98

This Month $4.50

10 or more $4.00 ea

Solar Charger

Charges 4 X AA Cells

A 0230

Normally $14.95

This Month $10.00

DC Brushless Fan

120MMx120MMx38MM Brushless, Electronically Commuted DC Motor

Voltage	24V DC
Current	330mA
Speed	3100 RPM
Air Flow	23 C.F.M.
Noise Level	32 dbA

Normally $29.98

This Month

F 1040 $24.00

6 or More $20 ea

High Performance ALC Wireless Microphone

Our incredible ALC Mic is one of the most exciting products for '88. Wireless Mics suffer from overmodulation distortion with too higher input sound level making them unsuitable for high grade vocal entertainment use of ALC (Automatic Level compressor) fixes all this.

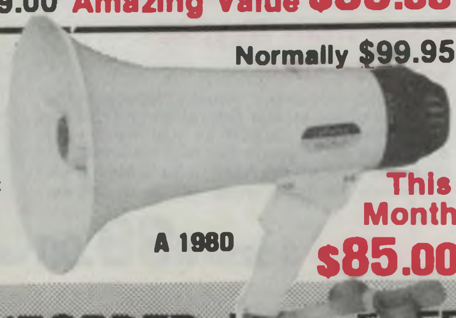
SPECIFICATIONS:

• Cardiod-Uni Directional Pick-up pattern • Freq.Res.: 30Hz-15KHz • Carrier Frequency Adjust Range: Within +1MHz, 88-108MHz. Built-in Antenna **C 0328**

Normally $129.00 Amazing Value $99.00

Professional 15 Watt Megaphone PA

Ranges: 300M approx **Power:** 8 X AA cells not supplied (order separately 2 of Altronics S 4970)



Normally $99.95

A 1980

This Month $85.00

Look! Check These Great Bargains

Save 20%

UV Eprom Eraser

erase your EPROMS quickly and safely. It will erase up to 9 x 24 pin devices in about 40 mins. for 9 chips (less for less chips) • Erase up to 9 chips a time • Chip drawer has conductive foam pad • Mains powered • High UV intensity ensures thorough erase • Engineered to prevent UV exposure • Long Life UV Tube.

This Month $80.00

Normally $139

Save $40 This Month

Fantastic Woofer Bargain

100W Continuous Power rated 150W Max. Intermittent. Massive 1.4Kg Magnet. 8 Ohm.

C 3070 $99

AMAZING PRICE $149 OFF!

A 1510

Normally $399

Microprocessor Controlled Detector Clips On To Sunvisor

World Famous Microeye Detector

This super compact "Sunvisor Clip On" Microeye Detector is virtually invisible from the outside of most vehicles at normal eye height hence its very unlikely yours would attract the attention of a thief (or the Gendarmes for that matter) However, please remember that use of Radar Detectors is not permitted in some states.

This Month $250 — Be Quick

Super Bargain 1/2 Price

Fantastic Negative Ion Generator

There have been volumes written about the benefits of negative ions 'combating air pollution, cigarette smoke etc. can be very beneficial to Asthma sufferers. Our great little Rover generates billions of ions per second! Includes tester.

Were $79.00

This Month

A 0990 $39.00

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Just Imagine a Security/Alarm System you can install in about an hour — Uses no Wiring or Cables and Costs Less than $1 for the Mounting Hardware

UHF 305MHz Microprocessor Controlled Wireless Security System

Commercial grade, quality alarm systems are expensive - Just phone one of the "Name" security firms and get a quote for your home - our estimate is that it will be anything up to $1,000 just for the equipment - **then there is the installation** - countless holes punched through walls, miles of wiring and a day or two of installers labour and **that's around $35 per hour these days. Hardly worth the effort is it? After all what have you got to loose? - Only the Video Player CD Player, Camera, Hi Fi, TV, Jewellery and so on!**

Well all that is now changed - with our brilliantly engineered Home Guard Wireless Security System Read On —

Take It With You If You Move

Apart from the flawless operation of the Home Guard System—One of the great features is its application with rented or leased premises—Lets face it, money spent on installing a wired system in your Home or Office, Factory etc. is irrevocably lost when you move on. With the Home Guard you simply take it with you.

This alarm system is a brand new design that features completely wireless connection to all accessories, even the reed switches. Think of how easy it is to install a "Wireless" alarm system. The benefits are endless. e.g. arming your Flat or Townhouse with an alarm you don't need to run wires through the roof or drill great holes through your walls. When moving house the alarm is simple to dismantle and re-install elsewhere.

The system divides protected areas into either perimeter zone or internal zone, programmable by dip switches in each transmitter/detector. **Pocket remote control** can simply arm or disarm your house perimeter from your bedside when retiring etc. this allows essential protection while cancelling internal zone as desired. Each transmitter/detector unit can be programmed into interior or perimeter zone. Zones can be programmed for instant or delayed trip. The system has a built-in ear piercing siren for intrusion and panic alarm signals.

System Is Comprised Of :

Main Control Receiver

S 5265 $349

Features:

- Wireless reception of external or internal sensors or detectors.
- Selectable home or away modes for selecting internal and external arming or just external to allow movement inside the building
- Built in Piezo electric siren gives different signals to indicate different functions.
- Sends signal down power line to activate one or more remote sirens.
- Programmable Arm/Disarm switch buttons.

The main control receiver runs on 240V AC with a 12V 1.2AH battery for emergency backup. All other units with the exception of the line carrier, run on a 9V battery each. The average life expectancy is approximately one year. System works around the 305MHz frequency where there is less chance of false alarm. The range of the unit is normally 80 metres in open space.

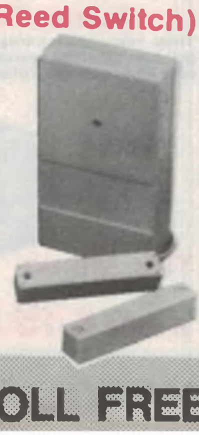
Alarm and Indication Sounds

Intrusion Alarm — Panic Alarm — Arm Tone — Disarm Tone — Exit Click Tone — Monitor Tone — Tampering Alarm.

Detector/Transmitter Unit (Reed Switch)

Suitable For Windows and Doors

This consists of an enclosed reed switch and compact UHF transmitter and a removable enclosed magnet. The unit is at rest when magnet and reed are side by side (within 25mm or 1 inch). When the magnet is moved away more than approximately 1 inch the alarm signals to the Main Control Receiver and the alarm is sounded. In practise the Reed/Transmitter is mounted on the door or window frame with the magnet on the moving door or window.



S 5270 $55.00

Passive Infra Red Movement Detector

Ideal for the lounge room, family room or hallways e.g. anywhere where an intruder is likely to pass through. Mounts up on the wall or on top of bookshelves etc. Detects movement within an area of 9M by 9M by sensing intruder body heat movement through the protected area. Should not false trigger with the family cat or curtain movement etc. — as is the case with the cheaper Ultrasonic alarms.

S 5280 $129.00

Remote Piezo Siren

This unit is an optional line carrier receiver. Receives signal through 'AC' line i.e. it would ideally be located in, say, the roof space and plugged into mains power.

S 5290 $125.00

Complete System Special Package Price

One	S 5265	Main Controller
One	S 5270	Reed Switch
One	S 5280	Passive I/R Detector
One	S 5285	Wall control unit.

Including Batteries

This Month $499

S 5260 Normally $570

Accessories

Note: For larger installations your system may well require several Reed switches, movement detectors and 2 or more sirens. Also the remote door controller and or pocket remote controls could be very worth while accessories. The fantastic thing about the Altronic system is you simply add more detectors as you discover the need — no wiring, no expensive technicians, no modifications to equipment.

Hand Held Control Transmitter Unit

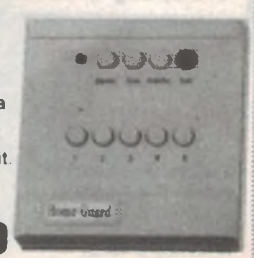
A real joy to use — keep it at the bedside table — allows you to, say, arm the house perimeters when retiring or you can take it with you when you go out, arming your system after you lock the door. Unit is a function control transmitter — to send 4 different signals.

Off — To disarm the system before entering. **Home** — To instantly arm the system with 'Perimeter' detection only. **Away** — To arm complete system after a given exit delay time of about 40 seconds. **Panic** — To start an emergency signal whenever needed, in any mode.

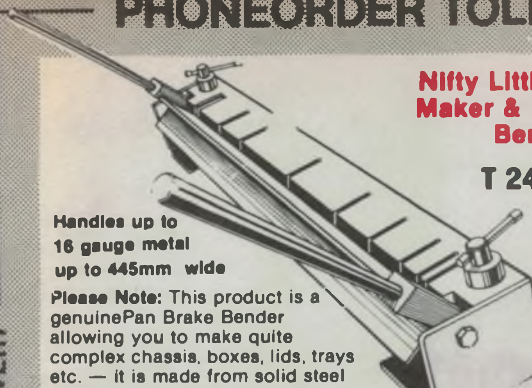
S 5275 $59.00

Front Door Keypad Control Unit

This handy accessory virtually duplicates the function of the Master Controller unit but at a more convenient location i.e. just inside your entry door etc. System can thus be armed or disarmed without the need to go to Master unit. Especially handy for larger homes or offices.



S 5285 $99.00



Nifty Little Chassis Maker & Pan Brake Bender

T 2400 ~~$99.95~~

NOW $80

Handles up to 16 gauge metal up to 445mm wide

Please Note: This product is a genuinePan Brake Bender allowing you to make quite complex chassis, boxes, lids, trays etc. — it is made from solid steel and is not to be confused with inferior Non Pan Brake simple benders currently sold by our competitors.

Make Your Own Chassis Boxes, brackets,etc. Unique slotted upper clamping bar allows complex corner bends

Save Over 30%

Sealed Lead Acid Batteries

These rugged high performance batteries are ideally suited for systems where uninterrupted DC Power is required i.e. Security Systems, Computers, Solar Power Systems etc.

		Normally	Now
S 5065	12V/1.2AH	$22.95	$15.00
S 5067	12V/2.7AH	$34.50	$25.00
S 5069	12V/4.5AH	$45.00	$35.00

Clock Movement

Fit your own custom clock face. Great for novel applications such as fitting to pictures etc. Very accurate, runs for approx. 1 year on one AA battery.

X 1010 $18.50

Portable Multimeter With Bench Stand

Includes Continuity Buzzer

20,000 Ohms/Volt DC • 8,000 Ohms/Volts AC, Mirror backed scale • Overload protected, 10 amp DC current range. Unique carry handle doubles as a bench stand.

Includes Battery Tester

Free Carry Case This Month Normally $4.95

Q 1080 $39.95

Economy Pocket Tester

High 2000 Ohms/Volt sensitivity • Overload protected • Dimensions 90 x 60 x 30mm • Mirror back scale helps prevent parallax error • Complete with test leads and instructions • Uses 1 x AA Battery.

Q 1013

Free Carry Case This Month

Normally $4.95

$19.50

New Model IRD Has Fantastic Range

Infra Red Movement Detector

With Two Mode Lens

Why Pay $150 or More

This Month

$79.00

Features: • Lens simply 'snaps' to either **wide angle** (range 40 ft.) for normal use or **Normal angle** (range 80 ft. plus) for corridor applictions. • Snazzy integral mounting brackets allows corner 90 deg. mounting as well as normal surface mount. (This is a fantastic feature as these work best in corners & are visually unobtrusive) • 12V DC Powered • Built-in test lamp • Alarm output SPDT 30V 1a.

S 5301

N.B. These professional detectors use state of the art circuitry to achieve ultra reliability in operation. They are currently specified by several "Name" commercial Security Companies.

ALTRONICS

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Chances are there is an Altronics Reseller right near you - check this list or phone us for details of the nearest dealer. **Please Note:** Resellers have to pay the cost of freight and insurance and therefore the prices charged by individual Dealers may vary slightly from this Catalogue - in many cases, however, Dealer prices will still represent a significant cost saving from prices charged by Altronics Competitors.

Don't forget our Express Mail and Phone Order Service - for the cost of a local call, Bankcard, Visa or Mastercard holders can phone order for same day despatch.

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If you have a Retail Shop, you could increase your income significantly by becoming an Altronics Dealer, Phone Fred Bloffwitch (09) 328 2199 for Details.

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Construction project

Low cost Bench Amp/Signal Tracer

Here is an invaluable piece of test gear which offers high input impedance, a wide range of input sensitivities, and up to 5 watts of output power.

by ROB EVANS

OK, lets face it, the world has gone digital. Very few facets of our lives are not effected by digital technology, whereas analog techniques are tending to be used as an interface between the technology and we mere humans. However, our analog senses are not about to be digitised by an over-zealous "Big Brother" and will always be with us. Hence the future of analog technology is assured, because after all, electronics has no other purpose than to serve us!

If this analog circuitry is to be designed and maintained, there is an equally important role for analog test equipment in present day electronics. Most well equipped workshops will satisfy the visual senses with an oscilloscope, yet our well-trained ears are rarely catered for. Indeed, a means of audibly tracing through a circuit or listening to the end result is a most welcome facility.

In many workshops, one channel of a spare hi-fi amplifier is pressed into service for this purpose, although it is hardly an ideal solution. The input stage will offer only a moderate impedance and sensitivity, and may overload on large signals. It also takes up more than its share of bench space, not to mention the size of its associated loudspeaker.

What we need is an amplifier designed with this task in mind. It requires a high input impedance to minimise loading of the circuit under test, and a wide range of input sensitivities for the variety of signals encountered. Also, it should be physically small yet contain an internal loudspeaker.

So here it is, the EA Bench Amp. It easily meets the above requirements, is simple to build at quite a low cost, and isn't digital! It has an input impedance of over 1M ohm and selectable input sensitivities of 10mV, 100mV, 1V, and 10V. An input overload indicator has been included, as well as facilities for connecting an external speaker. The external speaker may have a minimum impedance of 4 ohms and will produce a surprisingly high volume when driven by the Bench Amp.

Also, for those who service and experiment with radio, stay tuned to EA for an active RF probe designed to connect to the Bench Amp.

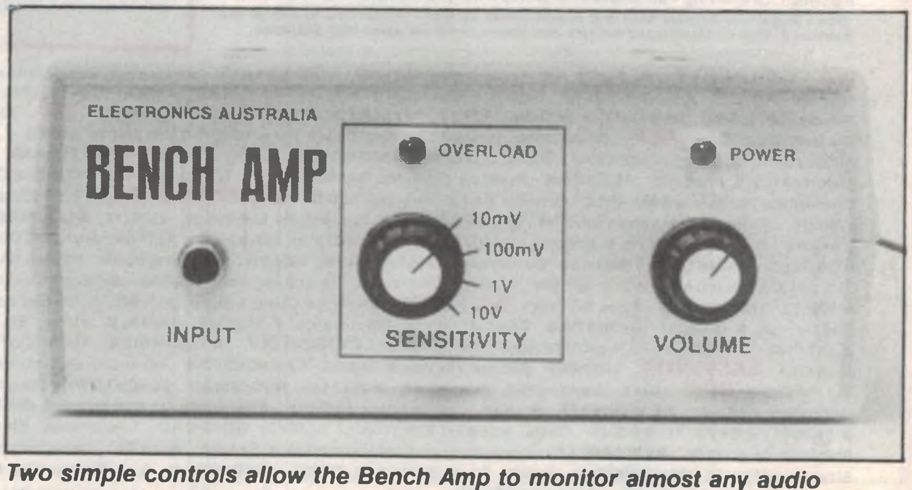
The Circuit

The circuit diagram of the Bench Amp may be divided into four main sections; preamp, overload indicator, power amp, and power supply. These sections are split between two small printed circuit boards (PCBs) with only three interconnecting wires. The preamp and overload indicator circuits are on one PCB which mounts behind the front panel, while the power amp and power supply occupy the other PCB which is mounted on the bottom of the case.

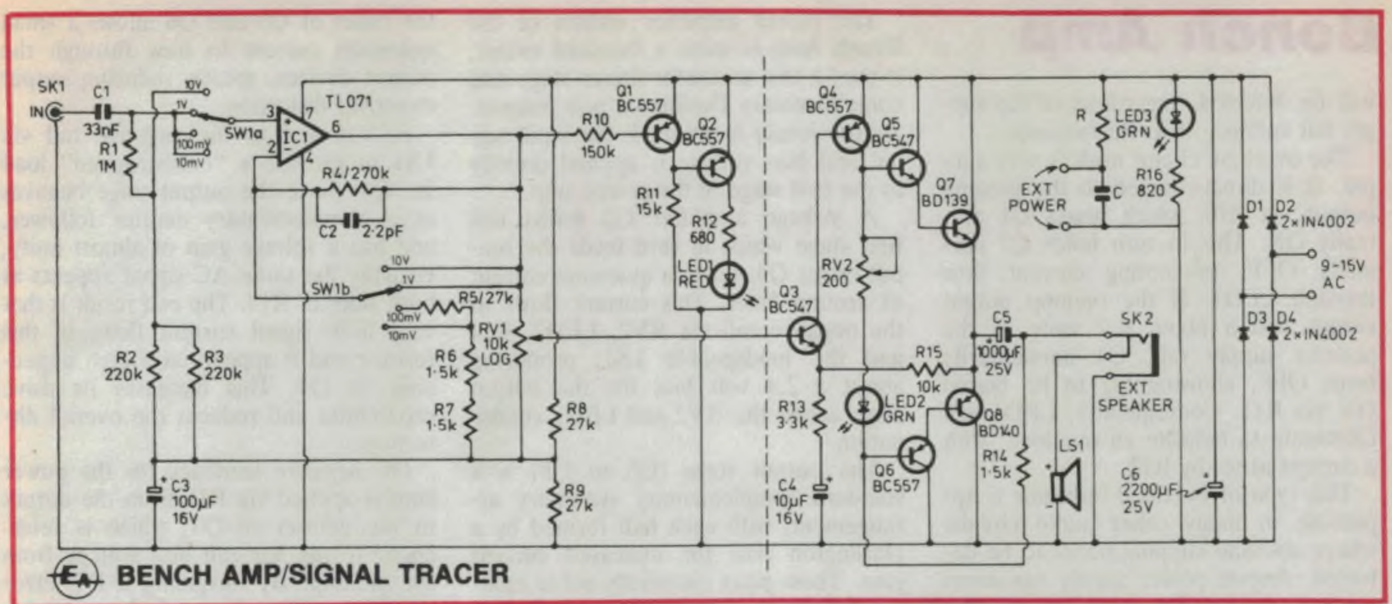
The preamp circuit is based around a TL071 Bi-FET op-amp (IC1), which is arranged as a non-inverting amplifier. The total gain (or attenuation) of the preamp is selected by the two sections of SW1, providing ranges of -20dB, 0dB, +20dB, and +40dB. For convenience, the switch positions are labelled with the approximate voltage required to run the amplifier at a reasonable level. This also provides the user with a rough idea of the signal level under test. For nominal input levels of 10V, 1V, 100mV, and 10mV respectively, the preamp produces a 1 volt output.

When the 10V range is selected, SW1a applies the input signal to IC1 via the DC isolating capacitor C1 and the 20dB input attenuator formed by R1, R2, and R3. Also, SW1b selects a 0dB gain for the op-amp IC1.

The 1V position is effectively



Two simple controls allow the Bench Amp to monitor almost any audio signal.



The circuit is split between two PC boards; the dashed line indicates the separation.

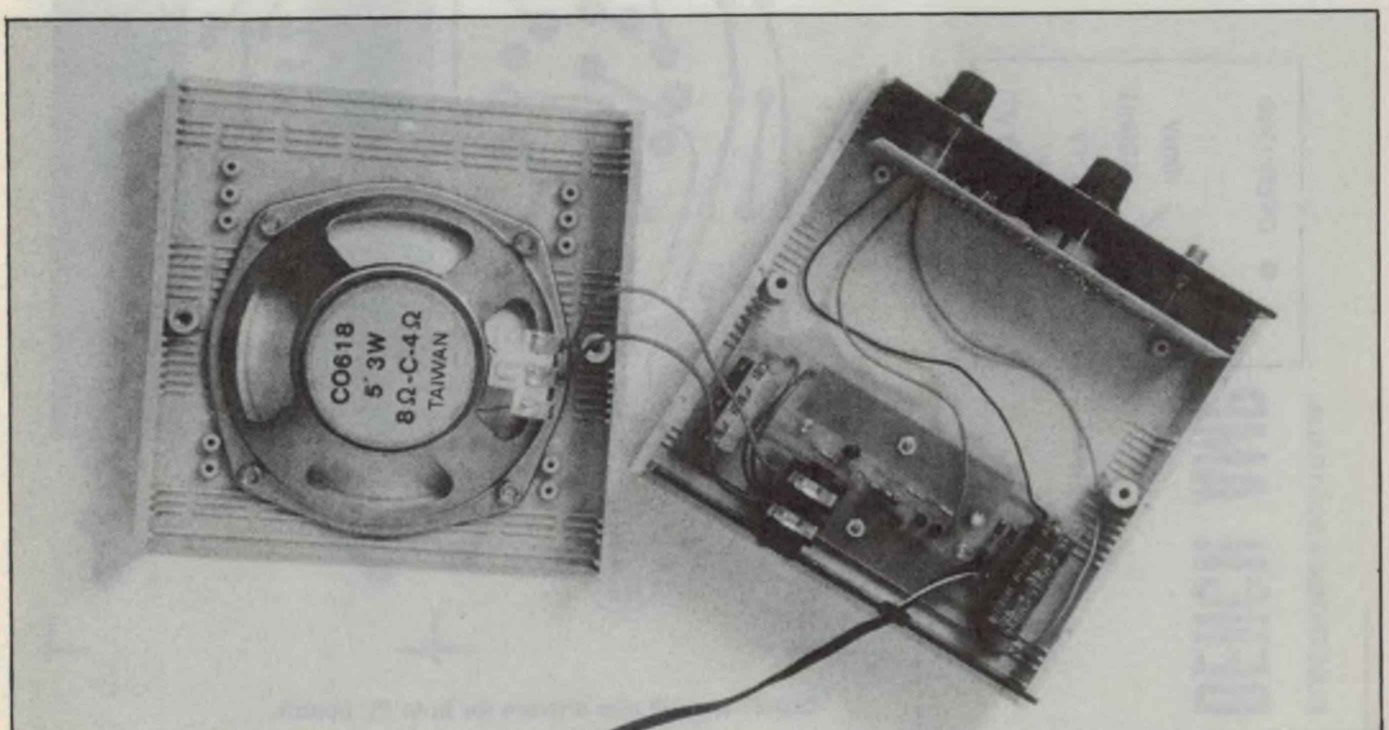
"straight through" with no attenuation or gain applied, the preamp simply acting as a high impedance buffer. The attenuator is also bypassed by SW1a in the 100mV and 10mV positions, while SW1b selects gains of +20dB and +40dB respectively.

To ensure a symmetrical voltage swing at the preamp output, the inputs of IC1 are biased at half of the supply rail voltage. This is derived from the voltage divider R8 and R9, whilst any remaining power supply ripple is filtered by C3. Further filtering of the supply to the TL071 op-amp was found to be unnecessary, due to its excellent supply rail ripple rejection.

The final preamp output is DC coupled to the power amp via the volume control RV1, which is referenced to the half-rail bias supply. This simple arrangement avoids the complications of coupling capacitors, and separate biasing for the power amp input.

Since a large range of signal levels are to be handled by the Bench Amp, the preamp's output may be driven into clipping due to an incorrect setting of the Sensitivity control (SW1). The resulting distortion could easily be interpreted as a fault in the circuit under test. This situation is avoided with an overload indicator circuit which will detect preamp overload, and (hopefully!) prompts the user to reduce the Sensitivity control by one "notch".

The design of the overload circuit is slightly unusual in that it senses the difference between the op-amp output and the supply rail, rather than some predetermined output level. The advantage of this type of sensing is that clipping



Quite a large loudspeaker (125mm) is used, for the best possible sound quality.

Bench Amp

will be detected, *regardless* of the supply rail voltage, or its fluctuations.

The overload circuit itself is very simple. It is direct-coupled to the preamp output via R10, which biases Q1 normally ON. This in turn holds Q2 normally OFF, preventing current flow through LED1. If the op-amp output swings within about 0.7 volts of the positive supply rail, Q1 momentarily turns OFF, allowing Q2 to be biased ON via R11. Consequently, LED1 will illuminate to indicate an overload, with a current as set by R12.

This type of overload indicator is applicable in many other audio circuits where absolute clipping needs to be detected, despite power supply variations (in fact, most audio amplifiers fall into this category).

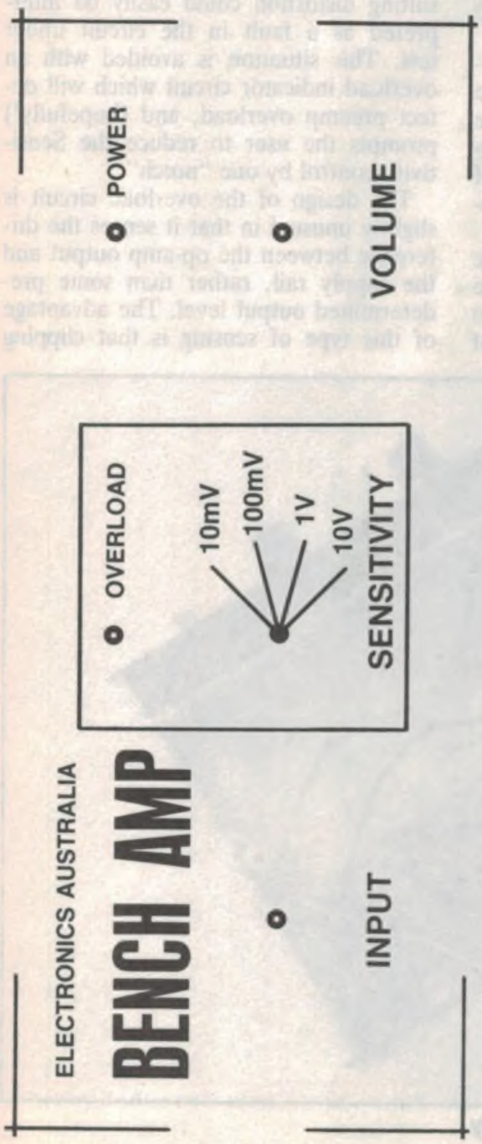
The power amplifier section of the Bench Amp is quite a standard circuit; it uses a two transistor driver stage and complementary Darlington pair outputs. As previously mentioned, the input signal and bias voltage is applied directly to the first stage of the power amp.

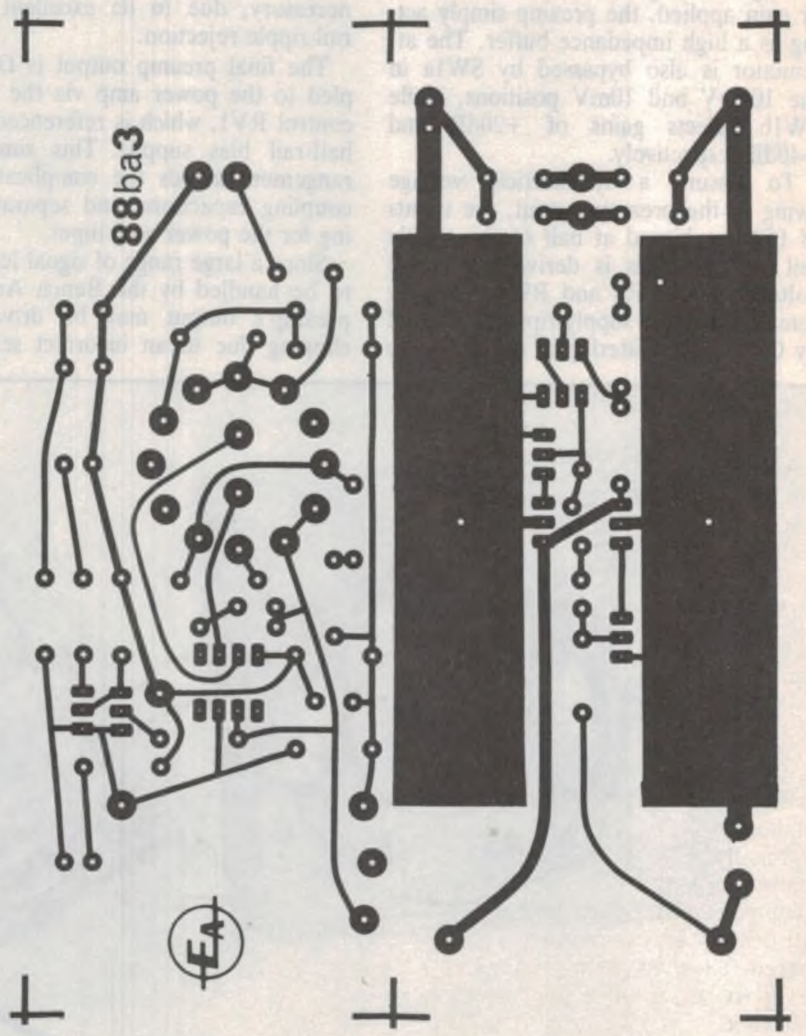
A voltage amplifier Q3 forms this first stage which in turn feeds the output driver Q4, set to a quiescent current of around 5mA. This current flows to the negative rail via RV2, LED2, R14 and the loudspeaker LS1, producing about a 2.4 volt bias for the output stage across the RV2 and LED2 combination.

The output stage (Q5 to Q8) is a standard complementary symmetry arrangement, with each half formed by a Darlington pair for increased current gain. These pairs essentially act as emitter followers, one side for each half cycle. The 2.4 volt difference between the bases of Q5 and Q6 allows a small quiescent current to flow through the output devices, greatly reducing output crossover distortion.

R14 is tied to the negative rail via LS1 to provide a "bootstrapped" load for Q4. Since the output stage behaves as a complementary emitter follower, and has a voltage gain of almost unity, virtually the same AC signal appears at both sides of R14. The end result is that very little signal current flows in this resistor and it appears as a high impedance to Q4. This increases its drive capabilities and reduces the overall distortion.

DC negative feedback for the power amp is applied via R15 from the output to the emitter of Q3, which is referenced to the half-rail bias voltage from the preamp. By imagining a DC error condition, the effect of the negative feedback is quite easily followed.





Above: The full size artwork for both PC boards.

Left: The actual size artwork for the front panel.

If the output is (say) low, R15 will increase the bias on Q3, turning it on a little harder. This also increases the bias on Q4, causing more current to flow in its load. Therefore, more voltage will be developed across R14, raising the voltage at the bases of the Darlington pairs (there will be little increase *between* the bases due to the low effective resistance of RV1 and LED2). Finally, this higher voltage is transferred to the output by the Darlington pairs, thereby correcting the error.

AC negative feedback is also applied via R15, but reduced by the voltage divider action of R13. This resistor only effects the AC feedback due to the coupling capacitor C4. The overall voltage gain of the power amp is about 4 as set by R13 and R15.

The final output of the power amp is AC coupled to the loudspeaker LS1 by C5, via the external speaker socket SK2. This socket enables a higher quality speaker to be used (with a minimum impedance of 4 ohms), and automatically disconnects the internal speaker.

Since the power transformer for the Bench Amp is an external plug-pack, only a low AC voltage enters the unit which avoids the need for mains wiring and switching. The AC voltage is full-wave rectified by D1 to D4, and filtered by C6. LED3 acts as a "power on" indicator, while "R" and "C" may provide a filtered power output to extra circuitry.

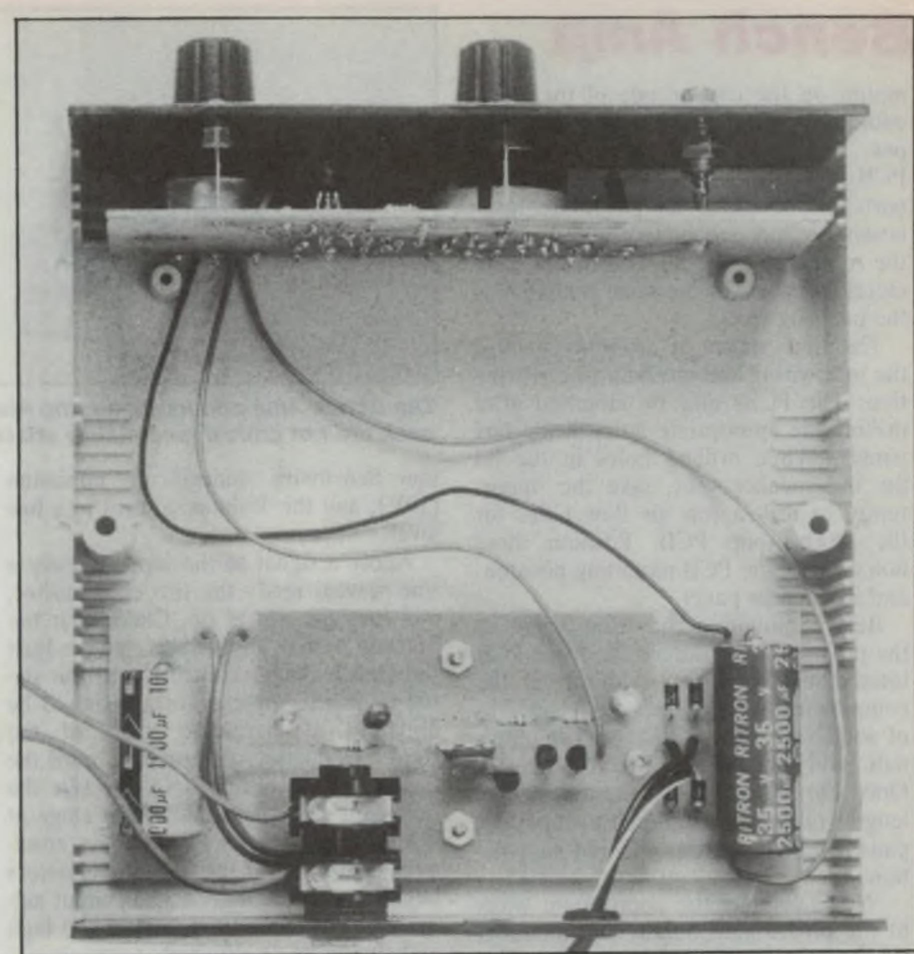
Construction

To begin the assembly of the PCBs for the Bench Amp, the two halves of the board must be separated, and checked for any etching errors. The PCB is coded 88ba3, and measures 132 x 100mm.

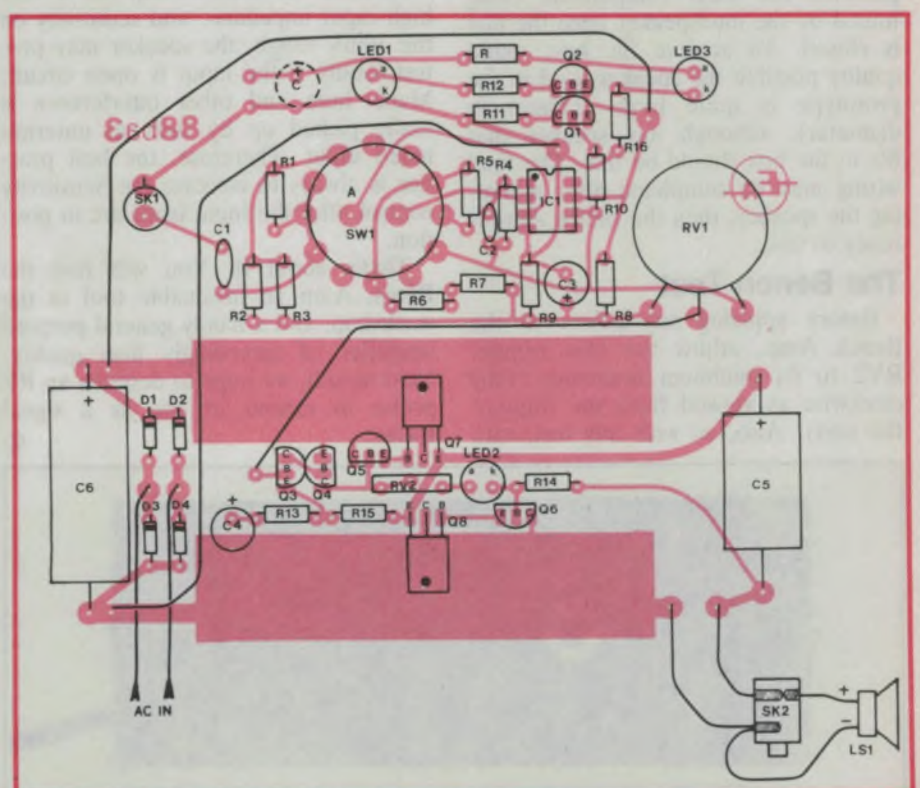
Starting with the preamp PCB, mount the lower profile components first. Using the component overlay as a guide, pay particular attention to the orientation of any polarised components (IC1, Q1, Q2, C3, etc). The controls SW1 and RV1 should be installed last, with SK1 left until the front panel is installed.

Finally, RV1 is attached to the PCB pads via short lengths of solid wire (component leg offcuts). LED1 and LED3 should be installed but not soldered, allowing their height above the PCB to be set when the front panel is attached.

The power amp board may now be assembled, taking the same care with component orientation. Note that the output power transistors Q7 and Q8



Inside the Bench Amp. Note the mounting positions of the PCBs



Component overlay and wiring diagram. Note that Q7 and Q8 mount under the PCB.

Bench Amp

mount on the *copper* side of the PCB, with their metal faces against the copper. This allows the large tracks of the PCB to act as heatsinks, avoiding extra parts and mounting complications. Insulation washers are unnecessary because the collectors of the transistors (the metal face), are at the same potential as the heatsink tracks.

The final stages of assembly involve the interwiring and mechanical construction. The PCBs may be mounted after drilling the appropriate holes in the box panels. While drilling holes in the lid for the speaker vent, take the opportunity to drill a few air flow holes for the power amp PCB. Position these holes below the PCB mounting position, and in the rear panel.

Before mounting the front panel to the preamp board, attach the three PCB interconnection wires as shown in the component overlay. Also, solder lengths of solid wire to the input socket terminals, and mount it on the front panel. Once the PCB is installed, these short lengths of wire are soldered to the input pads, and the LEDs soldered in position.

Next, connect the appropriate wires to the power amp board, and mount it close to the rear panel of the box. This prevents the PCB components being fouled by the loudspeaker once the box is closed. To achieve the best sound quality possible the speaker used in the prototype is quite large (125mm in diameter), although any speaker that fits in the box should be fine. The final wiring may be completed after mounting the speaker, then the Bench Amp is ready to test.

The Bench Test

Before applying any power to the Bench Amp, adjust the bias trimpot RV2 to its minimum resistance (fully clockwise as viewed from the front of the unit). Also, as with any test, turn the Sensitivity control to minimum (10V), and the Volume control to a low level.

Apply a signal to the input (ideally a sine wave), ready the fire extinguisher, and turn the power on. Check that the "power" LED illuminates, and adjust the Bench Amp's controls until the signal is heard. Some distortion should be apparent as harmonic tones of the source frequency. Adjust RV2 until the distortion *just* disappears. This sets the quiescent current in the output stage at a high enough level to eliminate crossover distortion. If the output transistors begin to run hot with a small input signal, the quiescent current is set too high and should be re-adjusted.

Because the Bench Amp has a very high input impedance and sensitivity on the 10mV range, the speaker may protest loudly if the input is open circuit. Mains hum and other interference is easily picked up by such an unterminated input. Therefore, the best practice is always to increase the Sensitivity control *after* the input leads are in position.

That's about it. You will find the Bench Amp an invaluable tool in the workshop, and a handy general purpose amplifier of surprisingly high quality. Next month, we hope to describe an RF probe to extend its use as a signal tracer.

The Bench Amp and its friend, the Plug Pack. The specifications of the plug pack are not critical, and mainly effect the amplifier' s maximum power.

Parts List

1 instrument case, 150x160x66mm
1 125mm (or smaller) loudspeaker
1 PCB, code 88ba3, 132x100mm
1 2-pole, 4-position PCB mount sealed rotary switch
2 knobs
1 RCA chassis socket
1 6.5mm mono chassis socket (switched)
1 plug pack, 9 to 15 volts AC, approx 500mA

Semiconductors

1 TL071 BIFET op-amp
2 BC547 NPN transistors
4 BC557 NPN transistors
1 BD139 NPN transistor
1 BD140 PNP transistor
2 5mm green LEDs
1 5mm red LED
4 1N4002 diodes

Capacitors

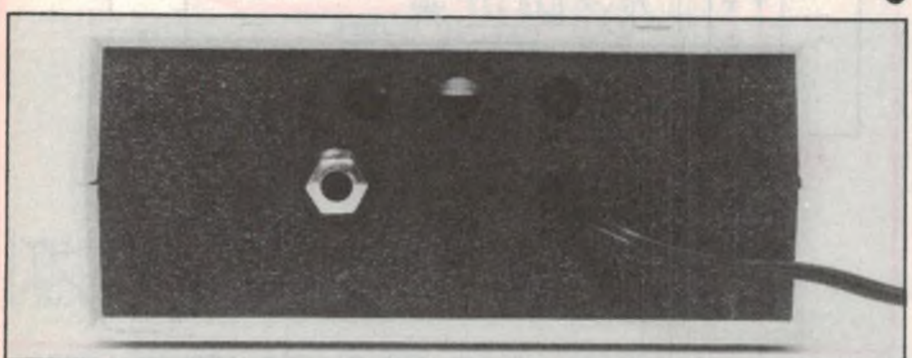
1 2.2pF ceramic
1 33nF metallised polyester
1 10uF 16VW PCB mount electrolytic
1 100uF 16VW PCB mount electrolytic
1 1000uF 25VW axial mount electrolytic
1 2200uF 25VW axial mount electrolytic

Resistors (all 0.25W, 5%)

1 x 680Ω, 1 x 820Ω, 3 x 1.5k, 1 x 3.3k, 1 x 10k, 1 x 15k, 3 x 27k, 1 x 150k, 2 x 220k, 1 x 270k, 1 x 1M,
1 x 200Ω horizontal miniature trimpot
1 x 10k log potentiometer

Miscellaneous

Spacers, nuts and bolts, hookup wire, rubber grommet, Dynamark front panel.



Holes in the rear panel provide air flow for the power amp PCB.

Experimenters' Corner:

An "El Cheapo" FM stereo tuner

Here's a little weekend project for beginners: build your own FM stereo tuner for around $30, using a set of pre-assembled modules! They're also pre-aligned, so you don't need any fancy test equipment to get the tuner working.

Normally, building an FM stereo tuner is a fairly big and relatively expensive project. Traditionally you've also tended to need at least a basic set of test equipment, to align the finished tuner and get it going properly. Things like a signal generator, and either a CRO or an electronic voltmeter.

Here's an alternative approach, for the person who wants to put together a quite reasonable little tuner, with a minimum of cost and hassle. It uses a set of pre-assembled and pre-aligned modules, for all of the critical circuit functions. The set of three modules is available for only $22, plus $1.90 for packing and postage if you order them by mail.

All *you* really need to do is connect them together using a handful of other parts, and build the lot into a box of your choice. The whole project is very quick and easy, and makes an ideal weekend project for the experimenter and newcomer to electronics.

The modules used in the project come from one of our long-time advertisers, Lance Chapman of L.E.Chapman — who are located at 122 Pitt Road, North Curl Curl 2099. Mail orders can be sent to the firm at PO Box 156, Dee Why 2099. Incidentally along with the three basic modules, the kit also provides the two trimpots needed as part of the support circuitry.

Actually Lance Chapman has had these modules available for a few years now. Apparently he purchased a big job lot of them back in late 1980, when one of the large companies stopped local manufacture. We published a small announcement about them in the New Products section of the February 1981 issue of *EA*, and since then he's sold nearly 3000 sets of modules to experimenters. But he still has about 600 of the sets left, which means that today's experimenters still have an excellent chance to build themselves an "el cheapo" FM tuner.

The three modules which make up the set consist of an RF front end, an IF strip and FM quadrature detector, and a stereo decoder.

The RF front end uses discrete transistors and is housed in a metal box for full screening. Tuning over the full 88 — 108MHz FM band is by means of variable inductors built into the case, but the module also features a two-gang solid dielectric tuning capacitor on the back of the drive spindle, for possible use by an AM front end (if you wish to add one). The module also includes reduction gearing to make tuning smoother and easier.

Other features of the front end module include the ability to accept either 300-ohm balanced or 75-ohm unbalanced input, and an input pin for controlling the local oscillator frequency for AFC (automatic frequency control).

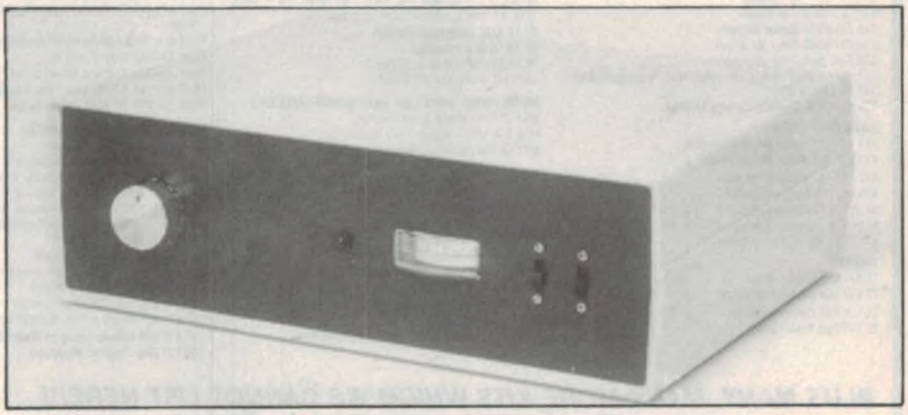
The IF strip/detector module is a small PCB (printed circuit board) assembly measuring only 44 by 61mm. It is based on the Philips TCA 420A, which provides full IF amplification at the standard FM intermediate frequency of 10.7MHz, together with a quadrature-type FM detector. As well as providing demodulated audio, it also provides a DC control voltage for feeding to the AFC input of the front end, plus a signal to drive a tuning/signal strength meter (again if you want one).

The stereo decoder module is also a PCB, this time about 125 x 40mm. It too is based on a Philips IC, the TCA 290A. This is specifically designed for stereo decoding, and is capable of quite good performance. Harmonic distortion is typically around 0.2%, with a channel separation of better than 40dB. In the circuit used here, it gives 30dB and 40dB rejection respectively for the 19kHz pilot tone and 38kHz stereo subcarrier signals.

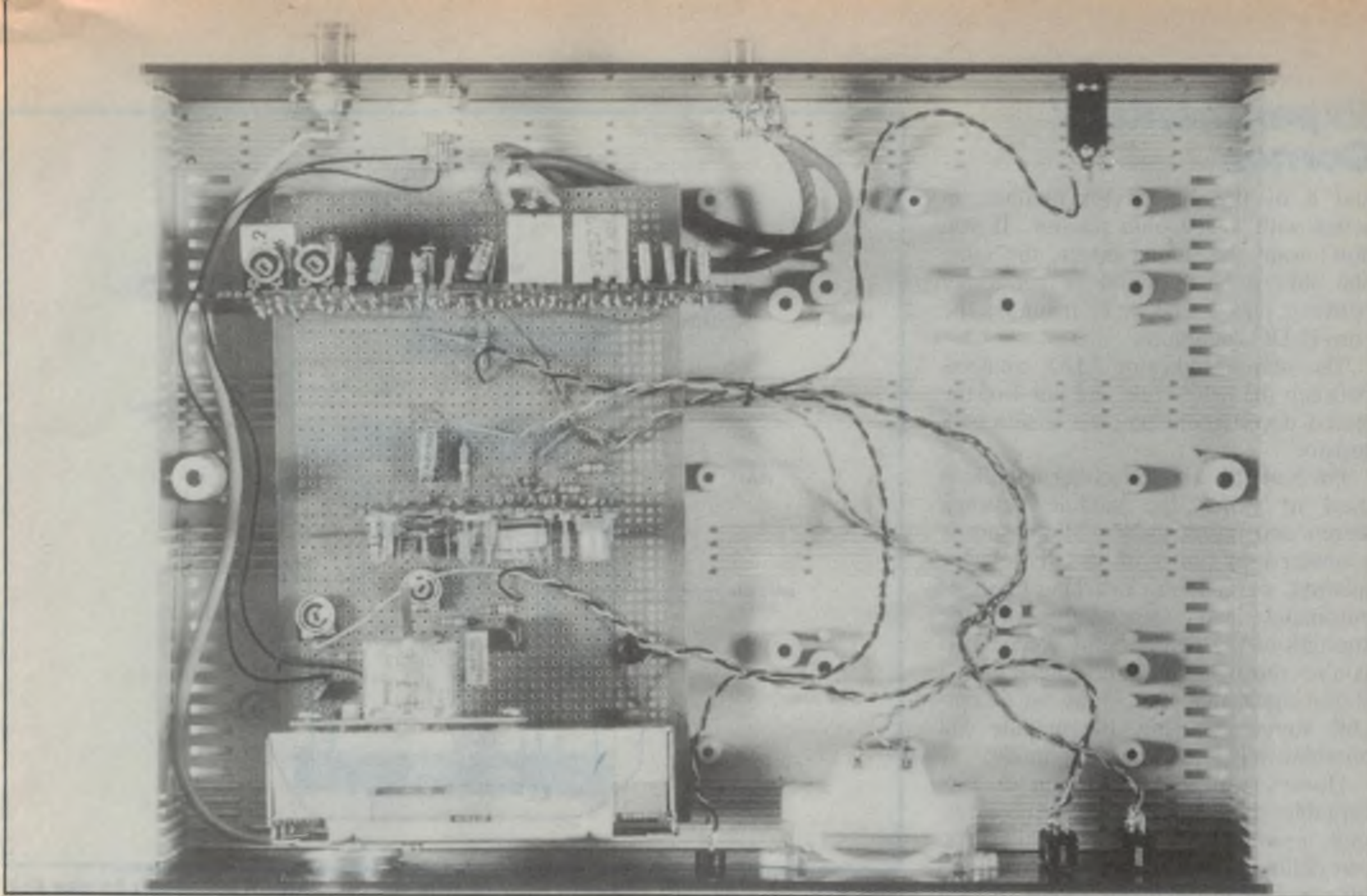
The decoder module provides inbuilt preamps to boost the right and left channel stereo outputs, giving plenty of output to drive almost any amplifier system. It also provides an output to drive a LED "stereo" indicator.

All three modules run from low voltage DC, which can be anywhere between 12 and 15 volts. The total current drain is about 60 milliamps.

As you can see from the circuit diagram, hooking up the three modules to



Outside view of the tuner. Maybe it's not all that pretty, but when you consider the price, its starts looking better.



Inside the tuner we built up. The three modules were wired up on a length of utility perf board, with copper conductor strips. The overlay diagram overleaf shows the connections, for this approach.

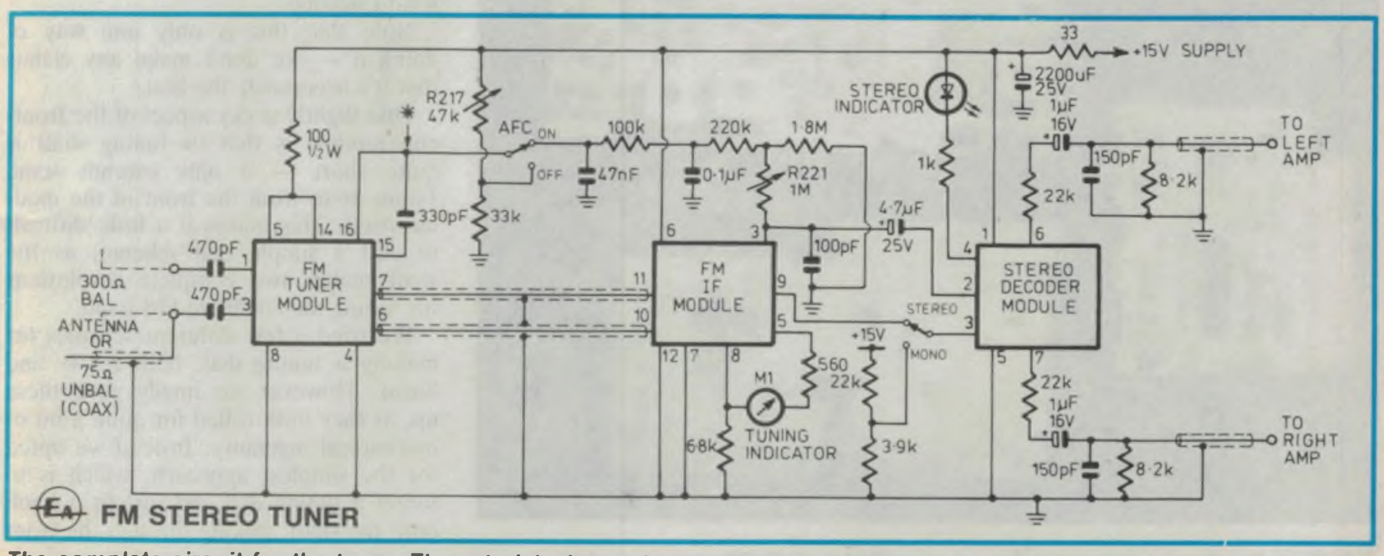
produce a complete FM stereo tuner is fairly straightforward. Apart from the three modules themselves and the two trimpots you get with them as part of the kit, all you need is a handful of low-cost parts: 14 resistors, 11 capacitors, a LED, a couple of slider switches and a few plugs and sockets.

Plus a standard DC plug-pack supply delivering 12 to 15 volts, of course, if you don't already have one. And if you want to have the optional tuning meter, you'll need a suitable small meter movement as well.

Basically there's not much more to it than connecting up the three modules. The aerial inputs go to pins 1 and 3 of the front end tuner module, which produces IF signals at pins 6 and 7. These connect to pins 10 and 11 of the IF/-detector module, which produces audio signals at its pin 3. These are then fed via the 4.7uF coupling capacitor to pin 2 of the stereo decoder module, which produces the decoded right and left channel stereo signals at its pins 6 and 7. The resistors and capacitors between these pins and the output connectors are used for DC blocking and filtering.

As well as producing audio output at its pin 3, the IF/detector module also produces the DC voltage for the tuner's AFC. This is fed back to pin 16 of the front-end module, via trimpot R221, a simple low-pass filter using the 220k and 100k resistors and their associated capacitors, and the AFC on/off switch. Trimpot R217 is used to provide a preset fixed voltage to the front-end module when AFC is not being used.

As you can see, the optional tuning meter M1 is connected between pins 5



The complete circuit for the tuner. The asterisk shows the test point (see text).

Experimenters' Corner

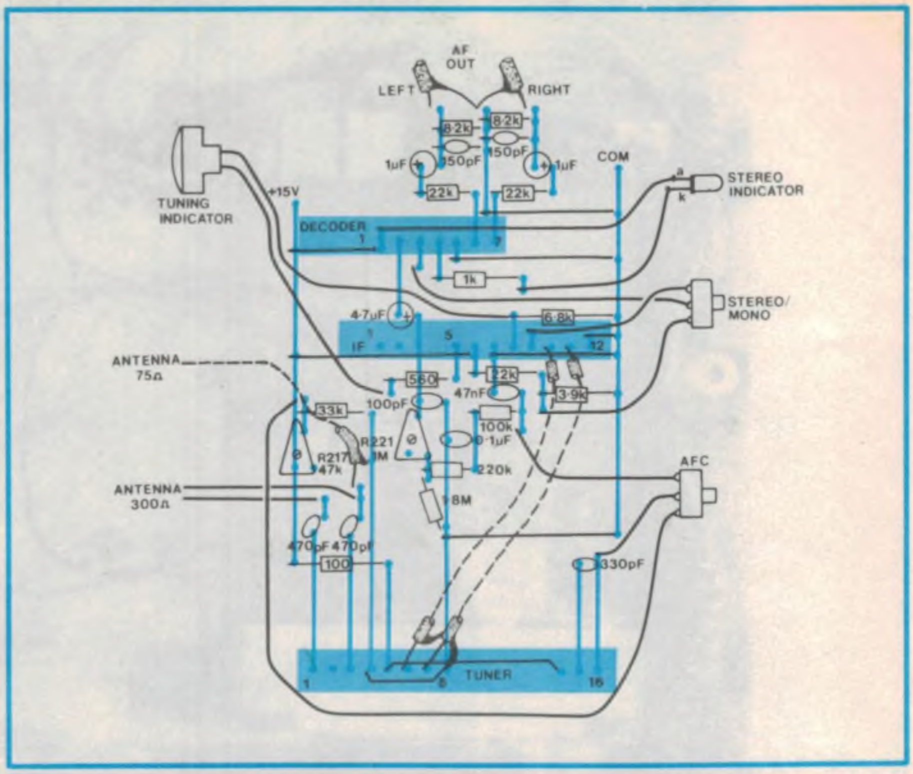
and 8 of the IF/detector module, in series with a 560 ohm resistor. If you don't want the tuning meter, the same 560 ohm resistor should be connected between pins 5 and 8, to maintain the correct DC conditions.

The stereo indicator LED connects between the +15V line and pin 4 of the stereo decoder module, via a series 1k resistor.

Pin 3 of the stereo decoder module is used to switch the module between stereo and mono modes. If this pin is connected to pin 9 of the IF/detector module, stereo/mono switching becomes automatic and dependent on the strength of the signals being received. If you're receiving a mono signal, or a stereo signal that's too weak for acceptable stereo decoding, the module will automatically switch to mono mode.

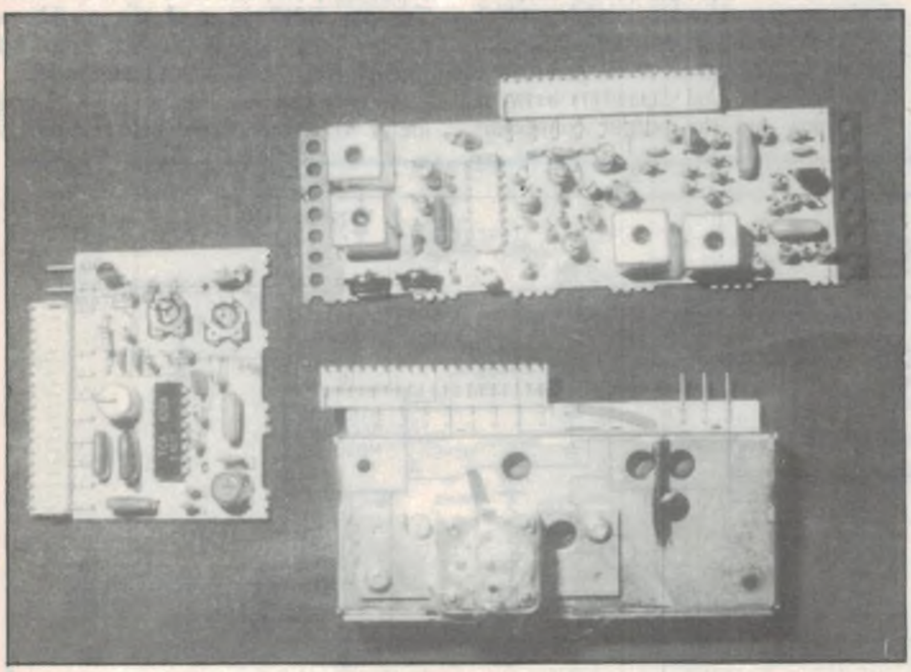
However since the criterion of "acceptable stereo" is largely a subjective one, a switch has been provided so you can deliberately force the decoder module to remain in mono mode, if you wish. This will give quieter reception for signals that are weak and noisy, but not quite weak enough to make the decoder itself switch to mono.

Note that a simple R-C filter circuit is used on the positive supply rail, to provide smoothing of the DC input from the plug-pack. If this isn't done, you tend to get fairly pronounced hum as the output of most plug-packs is poorly filtered.



The overlay diagram, showing how to wire up the tuner if you elect to use the perf-board approach. The three modules themselves are shown by the dotted rectangles.

We built up the simple FM tuner in one of the plastic cases sold by a number of the supply chains. This measures 260 x 192 x 82mm and is really a bit too big, but we had it handy. It also made it easy to fit in the tuning meter, slider switches and stereo LED along the front panel, alongside the tuning module.



A look at the three basic modules, as supplied by L.E. Chapman.

The aerial input, audio output and DC power input connectors are mounted along the rear panel, as in most FM tuners.

The three modules themselves we mounted on a section of perforated utility board, with the front-end module at the front, the IF/detector module in the centre and the stereo decoder module at the rear. This worked out fairly well. There's not much involved in wiring up the modules on the utility board, but if you need a bit of guidance, the photos and the wiring diagram should show what's needed.

Note that this is only one way of doing it — we don't make any claims that it's necessarily the best.

One slightly tricky aspect of the front-end module is that its tuning shaft is quite short — it only extends some 14mm or so from the front of the module itself. This makes it a little difficult to add a simple dial scheme, as the shaft makes two complete revolutions for tuning the complete FM band.

We tried a few different schemes for making a tuning dial, both rotary and linear. However we finally gave these up, as they both called for quite a bit of mechanical ingenuity. Instead we opted for the simplest approach, which is to forget a tuning dial and just fit a knob onto the shaft, poking through the front panel for tuning.

Although there's no visual indication of where you're tuned, this still seems to work out OK for such a simple and low cost project. But if you're very handy mechanically and you have a good collection of little drums, pulleys, spacers and strips of metal, you could no doubt make up a suitable dial.

We used a small edge-type 250uA meter for the tuning meter, as you can see from the photos. This worked out well. We also used a couple of miniature slider switches for the AFC and Stereo switching.

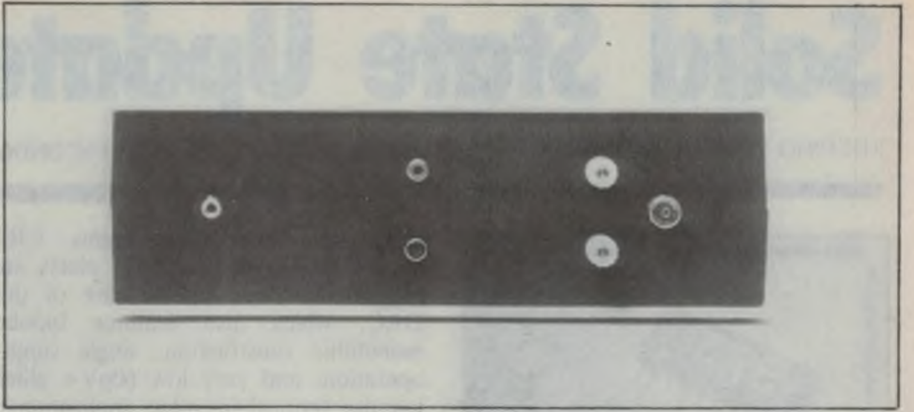
When you've got it all together, check over everything carefully before you connect up the power. Make especially sure that you have the plug-pack connections right, with the positive side of the plug-pack output going to the +15V line, and the negative going to the tuner's earthy side. A mistake here could cause quite a bit of damage inside the modules.

If it all checks out OK, connect up the power and also connect the tuner's audio outputs to the "Tuner" or "Aux" inputs of your amplifier. You'll also have to connect up a suitable aerial. In a really good signal area this might be nothing more than a couple of metres of hookup wire, connected to the 75-ohm unbalanced input.

Elsewhere, you'll probably need something a little more elaborate. Not necessarily a full-scale outdoor FM aerial, though. Often you'll get quite good results from a simple dipole made up from standard 300-ohm aerial lead (the flat type used for many TV aerials).

Fig.1 shows how to make up this kind of simple aerial. The aerial itself is simply a length of lead with the two wires soldered together at each end, to make a folded dipole. Then one of the two wires is cut in the centre, and its two ends soldered to the wires of another length of lead which is long enough to connect it to the tuner.

The dipole part is then mounted up fairly high — say on the picture rail of your room, or at the top of a window frame. Strictly speaking it should be mounted either vertically or horizontally, depending on the polarisation of the FM signals, and turned so that it's "broadside on" to the direction of the stations. However in most cases you'll still get quite good results without going to these lengths.



Rear view of our tuner, showing (left to right) the DC power input, the audio outputs and the antenna inputs.

As for your new FM tuner itself, this only needs a couple of quick adjustments of the preset trimpots to ensure that it's working properly.

Both adjustments are made using a multimeter to check the voltage at pin 16 of the front-end module. This point is marked with an asterisk on the circuit. It's also the same point as the centre connection to the AFC slider switch. As this point is at a fairly high impedance, you should use a sensitive meter (i.e., 20,000 ohms per volt) or better still an electronic voltmeter (like a DVM) to make the measurement.

First move the AFC switch to the OFF position, and adjust trimpot R217 until the meter reads +7.5V at the test point. Then tune into a station and turn the AFC switch to the ON position, and this time adjust trimpot R221 to produce the same reading of +7.5V. That's all there is to it.

The good thing about this kind of project is that you'll have fun building it and you'll end up with a useful piece of equipment for much less money than you'd otherwise have to spend. At the same time, you'll have learned a bit about electronics as well.

Happy experimenting! (J.R.)

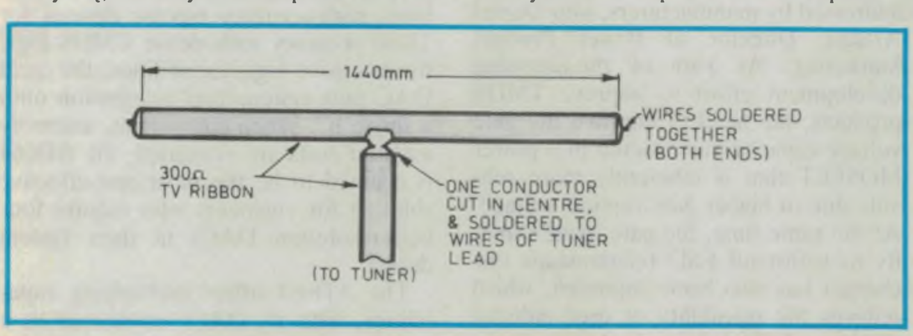


Fig.1: How to make a simple FM antenna from 300-ohm ribbon.

PARTS LIST

- 1 Set of FM tuner modules (see text)
- 2 Trimpots, 1M and 47k (included in module kit)
- 1 250uA edge-type meter
- 1 Case of your choice
- 1 DC plug pack power supply, 12-15V at 100mA or more
- 2 Miniature SPDT or DPDT slider switches
- 1 Red LED with panel bezel
- 1 Unbalanced RF input connector
- 2 Input screw terminals
- 2 RCA-type audio connectors, panel type
- 1 DC input connector, panel type, to suit plug pack
- 1 Piece of perf utility board, 95mm wide by 145mm long

Resistors (1/4W unless specified)

1 x 560Ωs, 1 x 1k, 1 x 3.9k, 1 x 6.8k, 2 x 8.2k, 3 x 22k, 1 x 33k, 1 x 100k, 1 x 220k, 1 x 1.8M.
1 100Ω 1/2W

Capacitors

- 1 100pF ceramic
- 2 150pF ceramic
- 1 330pF ceramic
- 2 470pF ceramic
- 1 47nF metallised polyester
- 1 0.1uF metallised polyester
- 2 1uF 16V electrolytic
- 1 4.7uF 16V electrolytic

Miscellaneous

Hookup wire, knob for tuning front-end module, etc.

Solid State Update

KEEPING YOU INFORMED ON THE LATEST DEVELOPMENTS IN SEMICONDUCTOR TECHNOLOGY

250MHz video DAC

Designed primarily for high-resolution video displays, Analog Devices' AD9701 digital to analog converter provides 8-bit updates at 250MHz with fully synchronous operation. Built-in composite blanking, reference white level, and 10% bright level — minimise additional raster scan logic requirements. CRT resolutions up to 1K x 1K pixels are supported by the update rate of this DAC, which also features bipolar monolithic construction, single supply operation, and very low 60pV-s glitch impulse (critical in video applications), all in low-cost DIP or LCC packages.

Applications include raster scan displays, multicolour displays (with multiple AD9701s), and ATE. High-speed ECL input registers provide synchronous operation of data and control functions up to the maximum update rate. An internal voltage reference allows the AD9701 to operate as a stand-alone video reconstruction DAC. The video output setup level is adjustable through the control pin from 0 IRE units to 20 IRE units. A single –5.2V power supply is required, with typical power dissipation at 728mW.

Further information is available from Parameters, 25-27 Paul Street North, North Ryde 2113.

Very low noise, precision dual op-amp

Precision Monolithics has introduced the OP-270, a precision dual operational amplifier with exceptionally low voltage noise, only 5nV per root Hz at 1kHz max, offering comparable performance to PMI's industry standard (single) OP-27.

The dual OP-270 features an input offset voltage of 75uV maximum, eliminating the need for offset trimming. Input offset drift is less than 1uV/°C over the military and industrial temperature ranges.

Open-loop gain of the OP-270 is over 1,500,000 insuring excellent gain accuracy, even in high gain applications. Input bias current is under 20nA which limits errors caused by source resistance. The OP-270's common-mode rejection of 106dB minimum, and power supply rejection of 110dB minimum, significantly reduce errors due to ground noise and power supply fluctuations.

For further information contact VSI Electronics (Australia), 16 Dickson Avenue, Artarmon 2064.

Power MOSFETs with high gate rupture voltage

Motorola has announced the development of a process to fabricate power MOSFETs with improved gate rupture voltage capability. Motorola's "Bullet-Proof" process is based on processing technology developed in the fabrication of microprocessor and memory devices, with minor modifications to fit the TMOS power FET wafer process. This new process does not result in any additional or parasitic components such as zener diodes, or affect the gate capacitance ratings.

Gate ruggedness is an issue that has been of great concern to power MOSFET users, but in the past has not been addressed by manufacturers, said Daniel Artsusi, Director of Power Product Marketing. As part of the ongoing development effort to improve TMOS products, the need to improve the gate voltage capacity has resulted in a power MOSFET that is inherently more reliable due to higher gate rupture voltage. At the same time, the gate oxide's ability to withstand ESD (electrostatic discharge) has also been improved, which reduces the possibility of user induced and stray ESD failures in the user's assembly process and in the application.

4-channel MUX/op-amp

National Semiconductor's LM604 Mux-Amp is an op-amp with four selectable differential inputs, combining the functions of a multiplexer with an op-amp. The LM604 can select, buffer and amplify one of four different input signals, providing a complete system for multiplexing analog signals. It also has a bi-state output which allows two or more mux-amps to be connected together at their outputs, to increase the number of multiplexed channels.

Channel selection and the bi-state output are controlled by internal logic that interfaces directly to a microprocessor. Besides these features, the LM604 has excellent AC and DC op-amp specifications and is internally compensated.

Applications include signal multiplexing and linear circuits that are controlled by digital signals (i.e. programmable gain blocks, filters and other op-amp circuits).

For further information contact George Brown Group offices or The George Brown Group, Marketing Division, 456 Spencer Street, West Melbourne 3003.

Quad 12-bit DAC on single chip

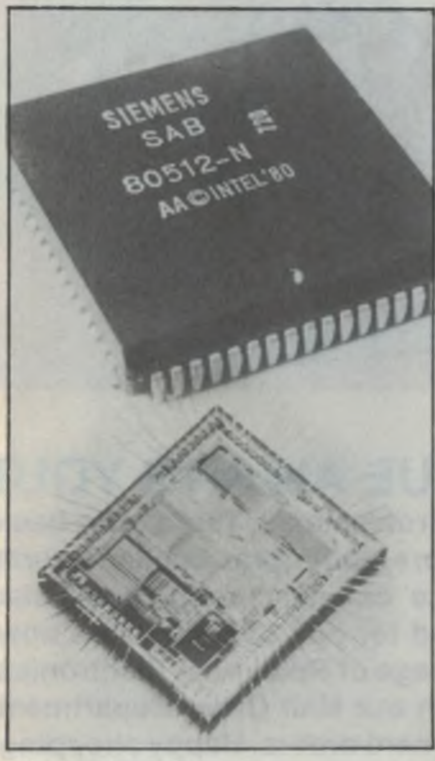
Claimed to be the industry's first complete monolithic quad 12-bit digital-to-analog converter, the Analog Devices AD644 merges four 12-bit voltage-output, digital-to-analog converters on a single chip. The device replaces up to 15 discrete ICs with a 28-pin DIP or 44-terminal LCC.

Manufactured in Analog Devices' proprietary BiMOS process, which combines high-accuracy bipolar devices for 12-bit accuracy with dense CMOS logic for extensive logic capabilities, the quad DAC puts system-level integration onto a single IC. When component, assembly and test costs are evaluated, the AD664 is claimed to be the most cost-effective solution for engineers who require four high-resolution DACs in their system design.

The AD664 offers multiplying capabilities, with its DACs connected to a common fixed or variable external

New chip offers six parallel 8-bit channels

For microcontroller users Siemens is indenting a chip offering six parallel 8-bit channels for input/output and one 8-bit channel for the input of digital or analog values. In addition, the SAB80512 has an A/D converter (8 bit) integrated on the chip to allow digital processing of analog test data, such as temperature, pressure or humidity, without peripherals.



Other principal features of the device are a program memory (4Kbyte ROM) and a data memory (128-byte RAM), 256 bits directly addressable, a standby supply for 40 bytes of the data memory, a serial full-duplex interface with additional clock generator for two standard baud rates, two timers/counters (16-bit) and six interrupt vectors.

The A/D converter of this chip has eight multiplexed analog inputs. The reference voltage range of the converter can be set externally. Compatibility of the CPU facilities allows unrestricted use of already existing 8051 programs. A ROMless version is offered under the designation SAB80532 (both chips in a space-saving PLCC package with 68 outside contacts). Data sheets are available.

For further information please contact Electronics Components Department, Siemens Ltd., 544 Church Street, Richmond, Vic. 3121, telephone (03) 420 7315.

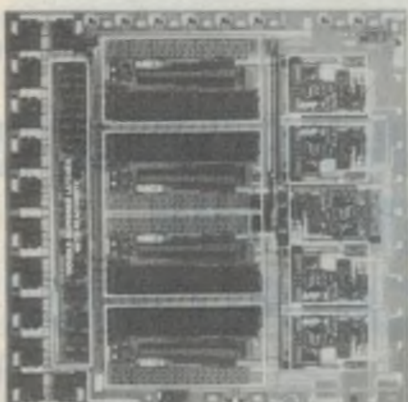
5A three-terminal regulator

New Era Electronics has released a new series of high current variable voltage regulators.

The 78AH05A positive 3 terminal fixed linear voltage regulator is capable of delivering a continuous load current in excess of 5 amperes, at a nominal regulated output voltage of 5 volts. The 78AH05A has built-in protection features such as output short circuit current limiting, thermal overload and safe operating area protection. If external conditions exceed the 78AH05A's capabilities, the device temporarily shuts down, protecting itself and the load circuit until the fault is removed. The feature eliminates costly additional protection circuitry as well as overly conservative heat sinks typical of discrete high current voltage regulator designs.

The 2 lead hermetic TO-204MA (formerly called TO-3) package provides up to 50 watts of internal power dissipation.

For further information contact Fairmont Marketing, Suite 3, 208 Whitehorse Road, Blackburn 3130. Telephone (03) 877 5444.



reference. All four DACs in the AD664 guarantee ±1/2LSB maximum integral nonlinearity, ±1/2LSB maximum differential nonlinearity, and ±5LSB maximum gain error. Each DAC is guaranteed monotonic over the respective operating temperature ranges.

Further details are available from Parameters, 25-27 Paul Street North, North Ryde 2113.

Toshiba develops submicron Bi-CMOS

Toshiba Corporation has developed a new technology for making Bi-CMOS devices, featuring a next-generation design rule of 0.8 micron — the same level as prototype 4-megabit DRAMS (Dynamic Random Access Memories). The 0.8 micron design rule is the world's finest rule used in Bi-CMOS circuits, and the typical propagation delay time of 0.3 nanoseconds is the world's shortest of such devices. In the future, this technology will be gradually applied into high-speed memory chips, semicustom ICs and microprocessors.

Basically, there are two widely-used silicon technologies — CMOS (Complementary Metal Oxide Semiconductor) and bipolar. CMOS devices feature lower power consumption, less heat dissipation and higher integration density than bipolar devices, but are not as fast. On the other hand, bipolar devices generally operate faster and are superior in output drive capability than CMOS devices.

Bi-CMOS, a device combining CMOS and bipolar transistors on the same silicon chip, is of particular interest among the world's leading manufacturers because semiconductor engineers believe Bi-CMOS devices will incorporate the advantages of both bipolar and CMOS devices: low power-consumption, high integration density and high-speed operation. Therefore, Bi-CMOS ICs are expected to be used in various fields which require both speed and low power-consumption such as higher-performance computers, office automation equipment and telecommunication equipment.

In developing the new Bi-CMOS technology, Toshiba researchers made several major technological breakthroughs:

Previously, it was technologically difficult to fabricate CMOS transistors with submicron design rules and high-performance bipolar transistors which perform as fast as ECL (Emitter Coupled Logic) devices, on the same silicon wafer. This was because conventionally temperatures over 1,000° were used during manufacturing processes to form high-performance bipolar transistors, while such high temperatures destroy the structure of sensitive CMOS circuits.

Toshiba solved this problem and realised the 0.8 micron Bi-CMOS technology by using processing at 900° to produce the emitters of bipolar transistors, using ion implantation instead of a polysilicon diffusion layer.

A SMALL SAMPLE OF THE NEW PRODUCTS YOU'LL FIND IN THE NEW 1988 ROD IRVING ELECTRONICS CATALOGUE

METEX M-3650 MULTIMETER

20A, 3½ digit frequency counter multimeter with capacitance meter and transistor tester.

This spectacular, rugged and compact DMM has a bright yellow high impact plastic case. It features a frequency counter (to 200kHz) diode and transistor test, continuity (with buzzer), capacitance meter, up to 20 amp current measurement and comprehensive AC/DC voltage current and resistance ranges.

CHECK THESE FEATURES
- Push-button ON/OFF switch
- Audible continuity test
- Single function, 30 position easy to use rotary switch for FUNCTION and RANGE selection
- Transistor test
- Diode test
- Quality probes
- ½" High contrast LCD
- Full overload protection
- 20 Amp
- Built in tilting bail
- Capacitance meter
- Instruction manual

Q91550 .... Normally $165
Special, only $149

METEX 4500H MULTIMETER

10A, 4½ digit multimeter with digital hold, transistor tester and audible continuity tester.

The Metex 4500H is perfect for the technician, engineer or enthusiast who requires the higher accuracy of a 4½ digit multimeter. This meter is exceptionally accurate, (just look at the specifications), and yet, still retains an exceptionally low price!

The Metex 4500H features digital hold which is normally only found on very expensive multimeters. This enables you take a reading and hold that reading on display even after you have removed the probes simply by pressing the hold button.

CHECK THESE FEATURES
- Readout hold
- Transistor Tester
- 4½ digit x ½"(H) LCD
- Audible continuity tester
- Push-button ON/OFF switch
- Quality set of probes
- Single function, 30 position easy to use rotary switch for FUNCTION and RANGE selection
- Built in tilting bail
- Instruction manual
- Full overload protection
- hFE test
- Battery and Spare fuse
- Diode Tester
- Vinyl case

Q91560 .... Normally $175
Special, only $159

CAR BATTERY ISOLATOR

Designed for car burglar alarm back-up battery. Allows the back-up battery to be charged from the car battery and isolates the back-up battery by not allowing the back-up battery to drain back to the car battery.

A12095 .... $3.20

SAMSUNG 12" TTL/COMPOSITE MONITOR ONLY $179

FEATURES
- At last a monitor with both TTL and Composite modes!
- High contrast, non-glare screen
- High resolution, 80 or 40 character display

SPECIFICATIONS
Picture tube: 12" diagonal and 90° deflection
Phosphor: Green (P42)
Video input signal: Composite/TTL Switchable
Polarity: Negative/Positive
Level: 0.5 - 2.0Vp-p 4.0 - 1.5Vp-p
Impedance: 75ohm more than 6.8K ohm
Scanning frequency
Horizontal: 15.75 KHz · 0.1%/18.432KHz · 0.1%
Vertical: 47-63Hz
Video bandwidth: 20MHz
Active display area:
Composite: 206(H) x 160(V)mm
TTL: 216(H) x 160(V)mm
Display character: 80 characters x 25 rows
Input terminal: Phono Pin Jack 9 pin D-Sub Connector
Controls:
Outside: Power Switch, Contrast, Brightness, Signal Select, V-Hold, V-Size
Inside: H-Width, H/V linearity, Focus, H/V-Shift
Power supply: 110/120V 60Hz 220/240V 50Hz
Dimensions: 308(W) x 297(H) x 307(L)mm
Weight: 7.3 Kg
Shipping weight: 8.3 Kg

Cat No	Description	Price
X14509	(GREEN)	$179

INSIDE MICROSOFT OS/2

-Gordon Letwin

A rare and exciting technical examination of the philosophy, key development issues, programming implications, and future of the MS OS/2 operating system. Gordon Letwin, Chief Architect for MS OS/2 provides a true behind the scenes view of the process of merging Microsoft's vision of an automated office system with the realities of software development. Here is revealing information every MS OS/2 programmer, as well as high tech and office automation specialists, will find invaluable.

Letwin discusses:
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- The restrictions of the microprocessor and the constraints of upward and downward MS DOS and MS OS/2 compatibility
- The software architectural details from a design and programming perspective
- Central issues for the future: a new MS OS/2 file system, a fully protected environment, and an enhanced network support

This book will be a cornerstone book in the library of anyone interested in MS OS/2. You can't get a more "inside" view!
(352 pages)
B20720 (Available mid April) .... P.O.A.

SUPER DELUXE BATTERY CHARGER

- Charges from 1 to 10 D, C, AA, AAA, N, and up to 3 x 9V batteries at the same time
- Dual colour LED in first three compartments to designate 1.5V or 9V
- 240V AC/50Hz
- Approval No. N10637

Cat M23525 .... $59.95

STEREO WIRELESS TRANSMITTER

This unit was developed to allow portable compact disc players to be used in cars by transmitting the headphone output signal directly in to your stereo FM car radio. It will also transmit any mono/stereo signal from any headphone output to any FM receiver.

SPECIFICATIONS:
- Input 3.5mm stereo phone plug Impedance 32 ohm
- Mono/stereo switch has plug mounting clip
- FM Transmission approx 90.35MHz (Tuneable 89-91MHz)
- Range 15 metres (below 15mV/m at 100 metres)
- Power 1.5V AAA size batteries (100 hours continuous use)
- Size 72 x 38 x 21mm

A16100 .... $69.95

ADCOLA E024 SOLDER SYSTEM

The E024 is a top quality Australian made soldering station suitable for use with either the Adcola CT-6, CT-7 irons or desoldering pencil. The E024 features a continously adjustable temperature range from 200°C to 400°C. The E024's electronic temperature control circuit monitors the temperature element in each of the irons, allowing it to maintain a constant temperature to within an incredible +/- 5°C of the temperature dial setting on the front panel.

Power to the irons is via a "zero crossing" controller. The power to the irons is switched on/off at a point on the AC power supply where the voltage passes through zero. Hazardous spikes caused by commutated AC are avoided using this technique.

Mains spikes are virtually eliminated by an electrostatic shield wound between the primary and secondary of the power transformer, an important safeguard for easily damaged MOS devices. To further safeguard sensitive components, an auxiliary ground lead earths the equipment to be soldered to the same level as the solder station, limiting the effective tip EMF to approximately 10mV. (Well below the damage level for MOS devices). If static control is important, the E024 unit is an excellent choice.

E024 Base Station with: CT7 Iron.
Cat T12570 .... $165

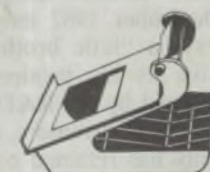
Base Station with: CT7 Iron & Desoldering Tool
Cat T12580 .... $220

VIDEO/AUDIO TRANSMITTER

A small compact unit that allows transmission of video and audio signals (RF) to any TV set or VCR within a range of 30 metres (100') simply by tuning in on Channel 11. Can be used as a transmitter for a video camera. With power on LED, on/off switch, audio and video leads and supplied with an AC adaptor.

Transmission: VHF channel 11 (PAL)
Video Input: 75 ohms, 1V p-p
Audio Input: 600 ohms
Output Control: Audio-video fine adjustment
Power Sources: 9V battery or power adaptor
Accessories: RCA to RCA audio lead, RCA to BNC video lead
Size: 70(W) x 85(D) x 28(H)mm
Weight: 170 grams

A16150 .... $69.95



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- Made of moulded plastic
- Suitable for most printers

C21058 (80 column) $69.95

COPY HOLDER (YU-H33)

- Copy area 9½" x 11"
- Sliding line guide
- Flat metal base

C21060 .... $39.95

COPY HOLDER (YU-H32)

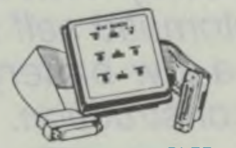
- Adjustable arms allows easy positioning
- Copy area 9½" x 11"
- Sliding line guide
- Clamp mounting

C21062 .... $39.95

MINIATURE HOBBY VICE

- Lever operated suction grip base for instant mounting and portability
- Mounts on smooth non-porous surfaces
- Ideal for holding components, and other small/light objects

Cat T12458 .... only $5.45

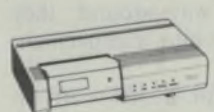


RS232 FAST CABLER

Makes RS232 interface configurating fast and simple. 3 slide switches enable line swapping functions, positive and negative voltages are displayed on 6 tricolour LED's.

SPECIFICATIONS:
Connector: DB25 plug on 100mm cable and DB25 socket on 100mm cable
Indicators: Tricolour LED's for pins 2(TD), 3(RD), 4(RTS), 5(CTS), 6(DSR), 20(DTR)
Switches: 3 Slide switches to swap leads
Power: Interface power
Enclosure: Black, high impact plastic
Dimensions: 85 x 95 x 30mm

X15710 .... $145



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- 7 LED indicators
- Passive Infra-red detection radium
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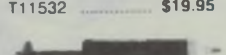
- External siren connections
- Exit/Entry system
- Terminals for external detection devices
- Separate digital panel and main unit
- 3 Function switch: delay/off/instant
- 3 Adjustable timers
- 24 Hour loop included
- Built-in tamper switch
- Adjustable detection angle
- LED monitor for walk test
- R.F. Protection design

S $175

AUTOMATIC CABLE STRIPPER

- Strips cable with diameter of 1, 1.6, 2, 2.6, 3.2mm
- Fully automatic action. Squeeze grip will simulataneously strip and eject insulation
- Length 180mm (7")

T11532 .... $19.95



ECONOMY SOLDER SUCKER

- Light weight
- Sturdy construction
- Easy to remove tip
- Excellent value for money!

Cat. T11271 .... $11.95

ECONOMY ANTISTATIC SOLDER SUCKER

- Light weight
- Sturdy construction
- Easy to remove tip
- Excellent value for money!

Cat. T11281 .... $13.95

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- Dial-up or leased line operation
- Pulse or Tone Dialing
- Automatic speed ranging
- Speaker for call progress monitoring
- Baud-rate converter with 48 character buffer (V23)
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- Fully self contained power supply
- Low power operation
- Metal case (R.F. shielded)
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- Full or half duplex (V23)
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- Telecom Authorised (C87/37/65)

.... $595

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New design uses power MOSFETs:

Improved 300W 12/230V inverter

Here's an improved design for a 300 watt inverter, suitable for powering 230V appliances away from the power mains. It features automatic self starting, voltage regulation, a low battery voltage indicator and simplified construction.

by PETER HARRIS

Power inverters are very popular devices, no doubt because they allow many standard electrical appliances like TV sets, lights and electric drills to be used away from the power mains. In effect, they convert the appliances so that they run from a 12V battery — or looking at it the other way around, they turn the 12V battery into a convenient source of 230V DC.

This new design for a 300 watt inverter has been developed as a replacement for an earlier design of similar power rating described in the September 1985 issue of *Electronics Australia*.

It is also a development from the 600W inverter design described in the December 1987 issue, and is in many ways a "little brother" to that design. Like its big brother, it has been developed by the R&D department of Altronics Distributors, in Perth. This company has retained copyright for the PC boards used in the project.

Complete kits for the new inverter are available from Altronics, under the catalog number K 6750. Please see the company's advertising for further details.

Compared with the previous 300W design, this new inverter uses a simpler circuit with fewer parts. It also uses a pair of power MOSFET devices for the input DC switching, instead of the paralleled pairs of bipolar power transistors used in the earlier design. This gives better thermal stability, because of the intrinsic stability of MOSFETs compared with bipolars. It also makes assembly easier.

Features of the new design include voltage regulation, a LED indicator which shows when the battery is getting low, and a choice of either manual or autostarting, at the flick of a switch. In auto-start mode, the inverter draws virtually no current from the battery until the 230V appliance in the load circuit is plugged in and turned on.

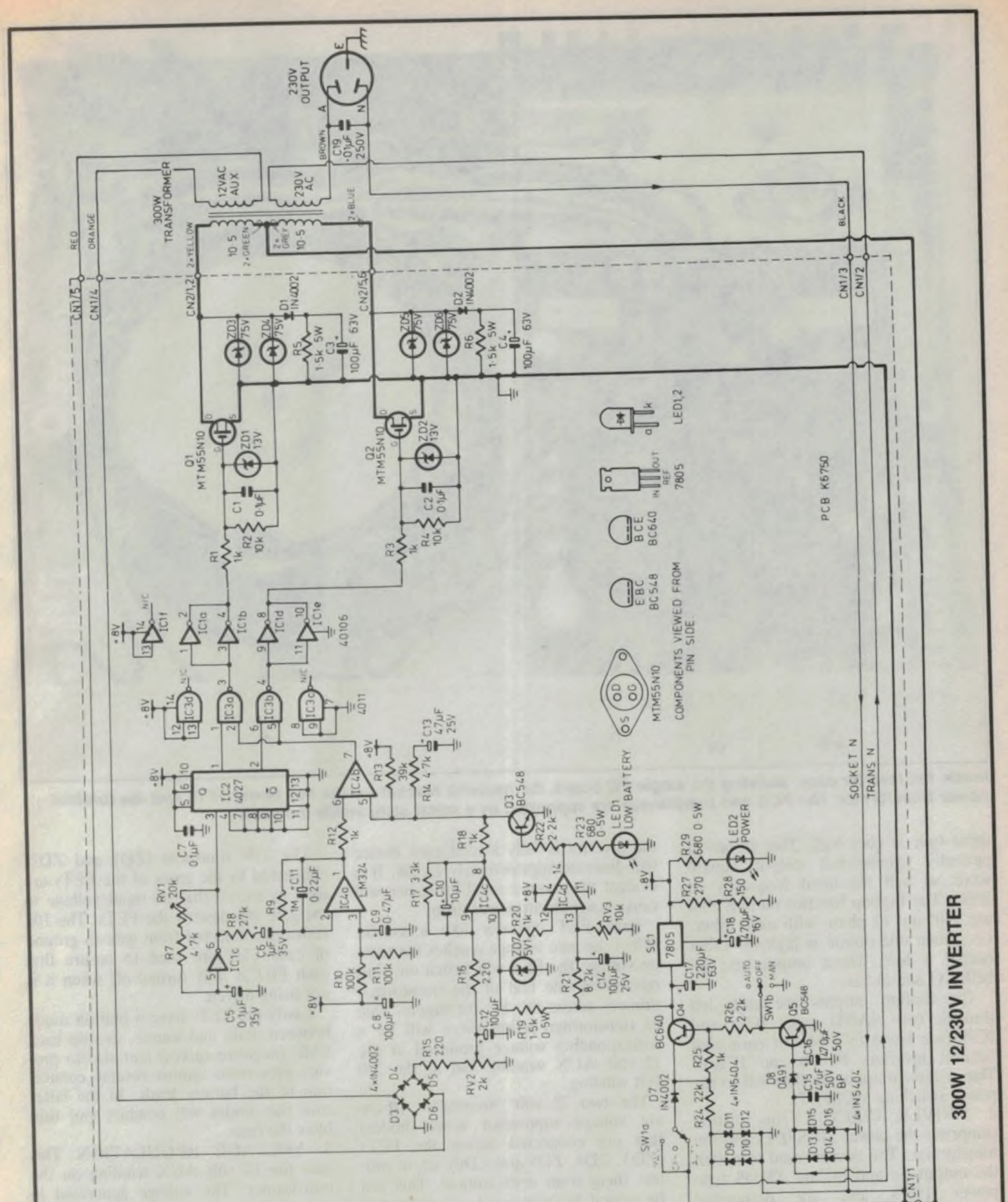
Circuit description

The circuit of the inverter can be broken up into several sections, as this will make it easier to understand. They are 1. the oscillator; 2. the driver circuit; 3. the voltage regulation circuit; 4. the power supply and auto-start circuit; and 5. the low battery voltage shut-off circuit.

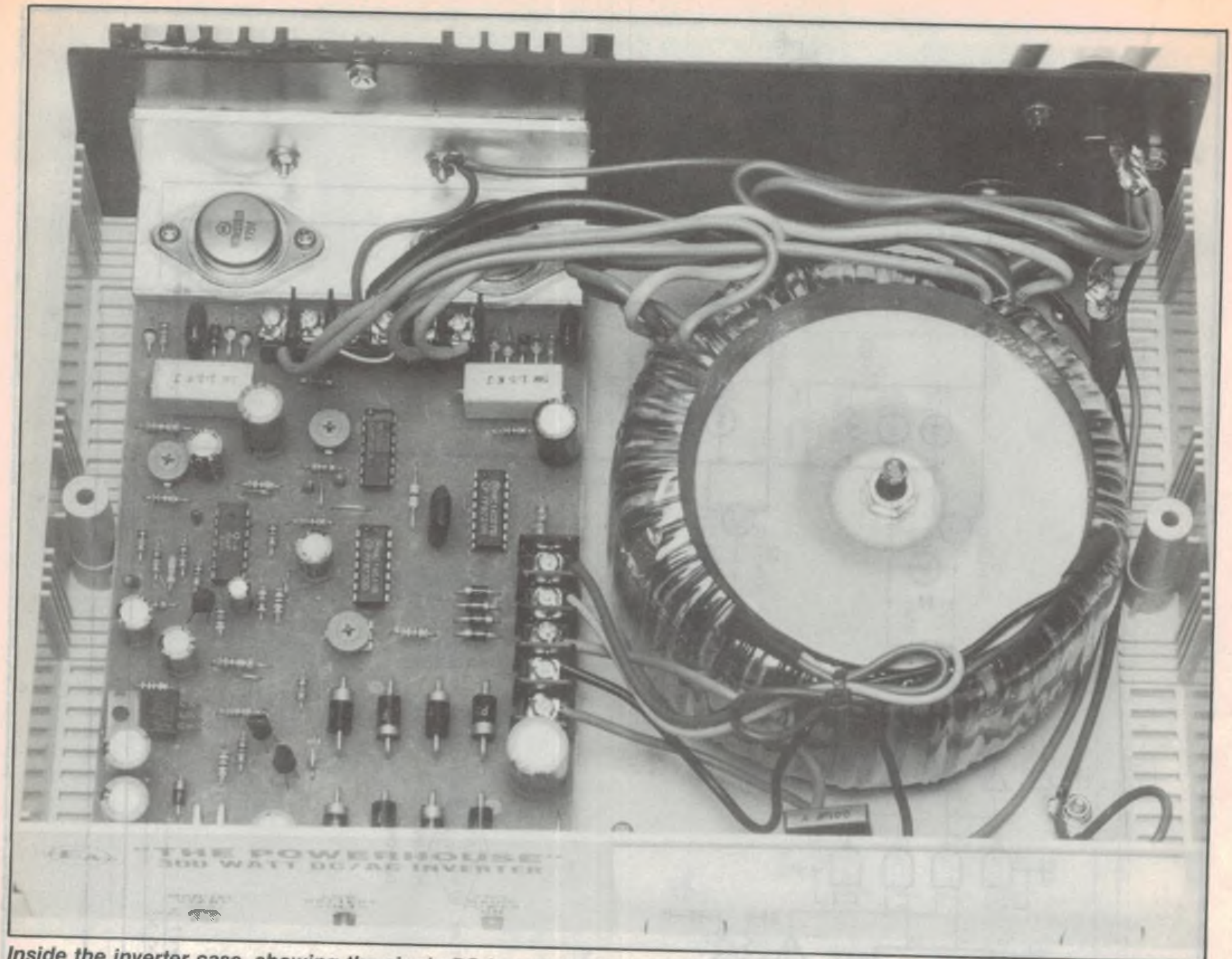
1. OSCILLATOR This uses an RC circuit using one section of a 40106 or 74C14 CMOS Schmitt trigger (IC1c).

The oscillator works as follows: Initially the input to pin 5 of IC1c is low and the output is high. Capacitor C5 will start to charge up via R7 and RV1 until the upper hysteresis level of the Schmitt trigger is reached, at which point the output will switch low. This then starts to discharge the capacitor, until the lower hysteresis level is reached, when the output switches high again. The frequency at which this is set to operate is at 100Hz — twice the ultimate output frequency.

The output of IC1c pin 6 is fed into pin 3 of IC2, a dual flipflop connected in toggle mode. In this mode the outputs only change state when the clock



The full circuit diagram for the improved 300W inverter.



Inside the inverter case, showing the single PC board, the heatsink bracket for the two power FETs and the toroidal power transformer. The PCB and transformer are supported by a metal plate inside the case.

input (pin 3) goes high. This ensures a perfectly symmetrical output square wave, at half the input frequency — 50Hz. The flipflop has two outputs that are 180° out of phase with each other, i.e., when one output is high the other output is low. These outputs are labelled Q and Q-bar.

The flipflop outputs are each fed through two NAND gates IC3a and IC3b (see later) to a pair of paralleled Schmitt inverters IC1a/b and IC1c/d. The inverter outputs are then fed to the power switching MOSFETs.

2. DRIVER CIRCUIT This section comprises the power MOSFETs and the transformer. The devices used to switch the output on and off are TMOS type power FETs and are designated MTM55N10. These are very high current devices, rated at 55 amps continuous each and 100V working. The on-resistance of these devices is quoted at being 0.04 ohms. This means that when the inverter is fully loaded each device will dissipate approximately 12.5W. It is evident that even a small resistance will cause a significant power drop.

Each FET operates like a switch. When the gate voltage reaches the turn-on voltage the FET will switch on, thus connecting one half of the transformer primary across the 12 volt supply. Due to transformer action there will be a corresponding voltage produced at the 12 volt AUX winding and at the 230 volt winding.

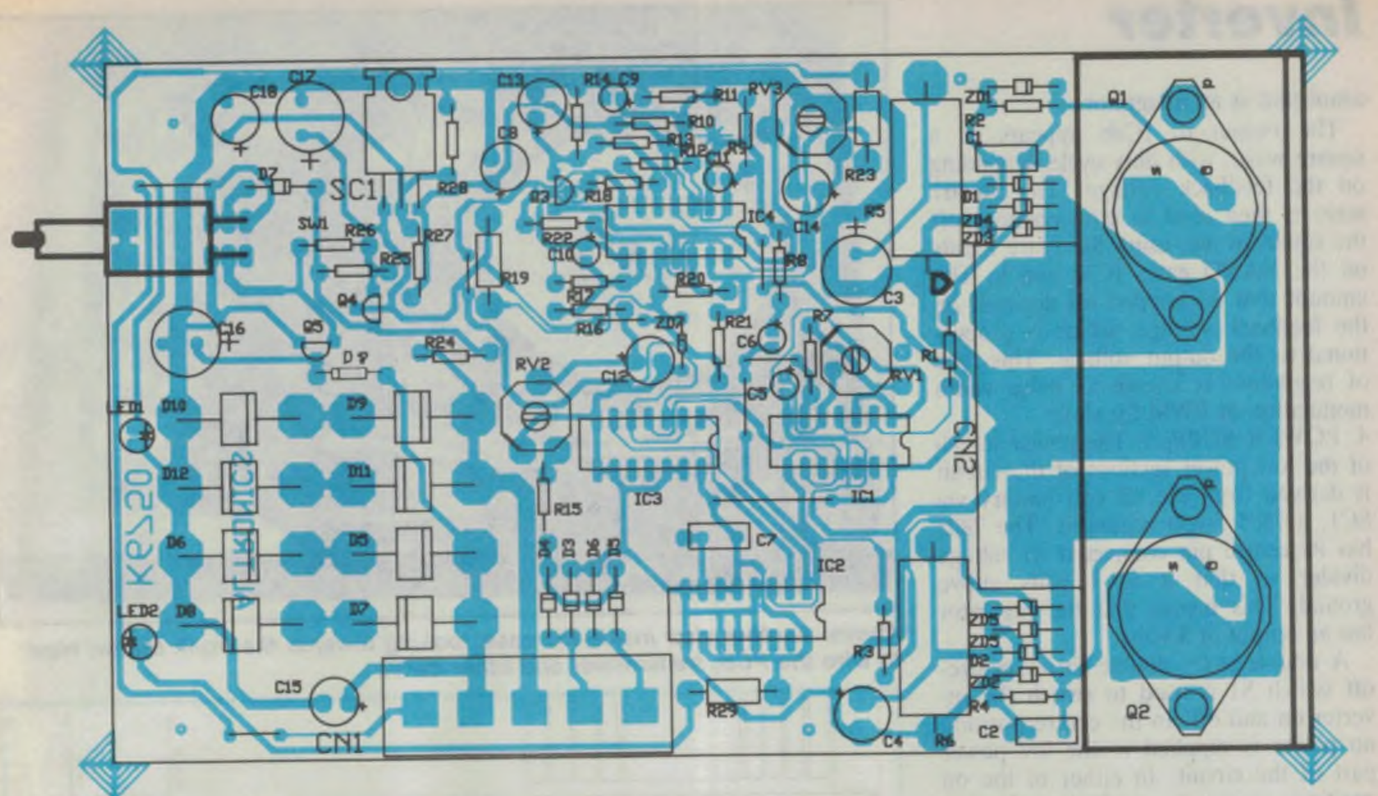
The two 75 volt "transorbs" (these are voltage suppressor zener diodes) that are connected across the FETs (ZD3, ZD4, ZD5 and ZD6) are to protect them from over voltage. This can be caused by inductive loads connected to the inverter. Similarly the 1N4002 diodes, 1.5k 5W resistors and 100uF capacitors are used to suppress very large voltage spikes that could otherwise destroy the transorbs (extra protection!).

The 13V transorbs (ZD1 and ZD2) connected to the gates of the FETs are used to ensure that no input voltage to the gate can destroy the FETs. The 10k resistors connected from gate to ground of each FET are used to ensure that each FET is fully turned off when it is not being driven.

Lastly the FETs have a built-in diode between drain and source, to stop back EMF (negative spikes) and also to provide protection against reverse connection of the battery leads. In the latter case the diodes will conduct and thus blow the fuse.

3. VOLTAGE REGULATION This uses the 12 volt AUX winding on the transformer. The voltage generated in this winding is rectified and smoothed by D3-D5, R15, RV2 and C12. The DC voltage at the wiper of RV2 is thus proportional to the output voltage on the transformer.

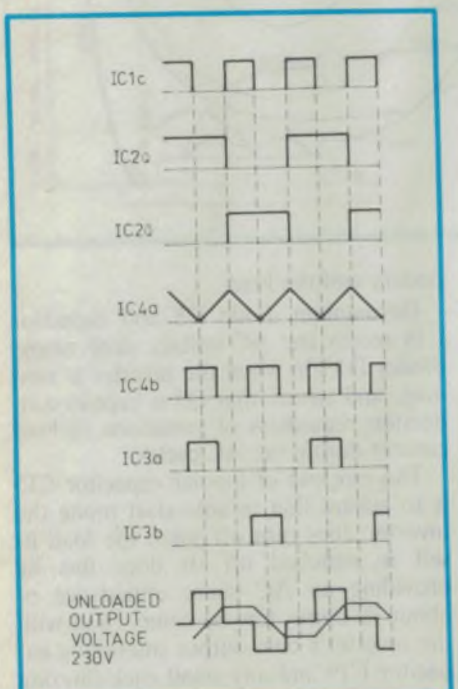
This voltage is then fed into an in-



Use this overlay diagram as a guide in wiring the components to the inverter's PC board.

verting op-amp formed by IC4c, connected as an inverting comparator with a gain set at 3300/220 = 15. This compares the voltage from RV2 with a nominal 5.1V reference voltage developed by zener diode ZD7, applied to the positive op-amp input. So if the feedback voltage from RV1 falls below 5.1 volts, the output of IC4c will swing high. The value of the 3.3k resistor in the feedback path has been chosen for the best regulation characteristic.

The output from here is taken to IC4b. This op-amp is set up as a comparator, which compares the control voltage from IC4c with the 100Hz triangle wave produced by IC4a from the master oscillator IC1c. Op-amp IC4a is



The basic waveforms found inside the inverter. They show how the circuit works.

SPECIFICATIONS

Nominal supply voltage .... 12V DC
Output voltage .... 230V nominal
Frequency .... 50 Hz ± 5%
Regulation .... see table below
Maximum load 300VA
Standby current 16mA

LOAD POWER (W)	INPUT CURRENT (A)	INPUT VOLTAGE*	OUTPUT VOLTAGE** V RMS (AVG)
0	0.03	12.62	249 (246)
40	3.2	12.47	242 (240)
100	7.7	12.39	239 (239)
150	13.1	12.2	228 (242)
300	28.5	11.95	178 (193)

Notes

* During tests, prototype unit was powered from a 50 amp-hour battery. Input voltage variations shown are therefore likely to be typical.

** As the inverter's regulation circuit uses an average value measuring rectifier, its output voltage is substantially constant in terms of average value (figures in brackets). Due to changing form factor in the PWM rectangular output waveform, this causes changes to the RMS output as sown. Apart from lighting or heating loads, the average value is likely to be more relevant in many applications.

connected as an integrator.

The output of IC4b appears as a square wave, with duty cycle depending on the feedback voltage. This square wave is then used to crop portions off the square wave, using the spare inputs on the NAND gates IC3a and b. The amount that is chopped off depends on the feedback voltage, which is proportional to the output voltage. This type of regulation is known as pulse width modulation or PWM for short.

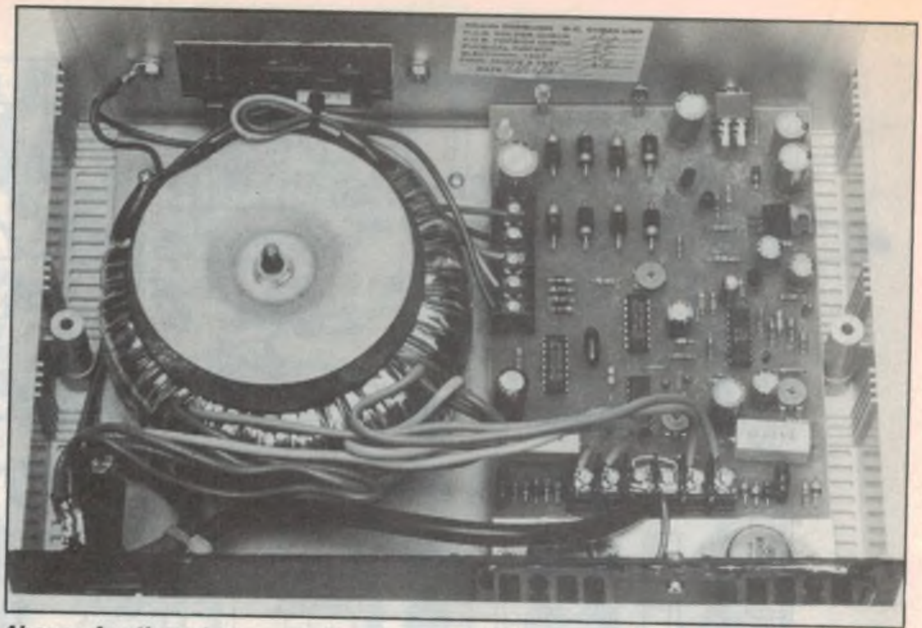
4. POWER SUPPLY The power for all of the low power sections of the circuit is derived from the 12 volt battery via SC1, a 7805 5-volt regulator. The 7805 has its centre pin connected to voltage divider so that it is 3 volts above ground. This means that the regulator has an output of 8 volts.

A double pole, double throw centre-off switch S1 is used to switch the inverter on and off. In the centre position no power is supplied to the low-power part of the circuit. In either of the on positions, power is supplied to the low power circuitry via D7 and Q4.

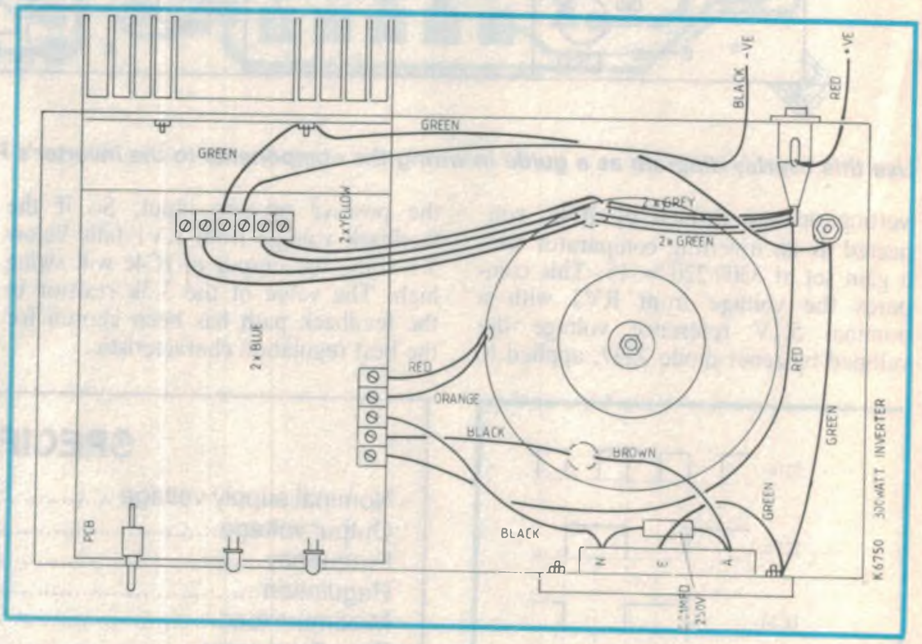
In the manual start position, Q5 is shorted out, so that Q4 will turn on and supply power to the regulator and the rest of the circuit. This is handy for starting devices that do not draw any current until they have 230 volts across them (e.g., fluoro lights).

In the auto-start position of S1, transistor Q5 is fed with a small DC forward bias whenever a load is connected to the inverter's 230V output. This bias current flows from the 12V battery via D7, R24, the 230V output winding of the transformer, the load itself and diode D8. The current is sufficient to saturate Q5 which turns on Q4 as before to power the circuit.

Diodes D9-D16 protect the auto-start circuitry from damage when the inverter is operating, by limiting the voltage applied to either R24 or D8 to ±1.3V peak. At the same time, the diodes complete the inverter output circuit, providing a high-current and low impedance link between the transformer secondary and the load.



Above: Another view inside the case, looking towards the front. Below: How to wire the PCB, transformer and other items.



Germanium diode D8 and capacitor C16 rectify the AC voltage drop across diodes D13-16 when the inverter is running, and ensure that Q5 is kept in conduction regardless of variations in load current during the AC cycles.

The purpose of bipolar capacitor C15 is to ensure that in auto-start mode the inverter does turn off when the load itself is switched off. It does this by providing an AC shunt impedance of about 70 ohms, low by comparison with the inverter's own output smoothing capacitor C19 and any small click-filtering or suppressor capacitors likely to remain connected across the 240V line inside the load appliance when it is nominally

WARNING!

Equipment to be operated from this inverter must be in a safe condition, since the voltage produced are at mains potential. This means that frayed cords, exposed unearthed metal parts (unless double insulated), and broken or wet insulators must be repaired before the item is used. **Note that contact with both output lines could prove fatal!**

It is also important to keep the electrolyte level of the battery above the plates. This prolongs battery life and reduces the risk of the battery explosion. When charging the battery, do so in a well ventilated area. They hydrogen given off from a charging battery is highly explosive. When connecting the inverter to the battery, make sure that the appliance is not plugged in so that sparks do not occur near the battery.

turned off. Without C15, there could well be enough AC flowing through D13-16 via load circuit capacitance to keep the inverter running.

LED2 is connected across the 8V supply rail via R29, to indicate when the inverter is operating.

Note that although the inverter's output FETs are permanently connected to the battery via the primary windings of the transformer and fuse F1, they do not conduct any current unless drive signals are applied to their gates. So when power is removed from the low-power section of the inverter, the output FETs automatically turn off as well.

5. LOW BATTERY VOLTAGE INDICATOR This uses IC4d to compare a proportion of the input battery voltage produced across RV3 with a reference voltage formed by 5.1 volt zener diode ZD7. If the input voltage is less than the reference voltage, then the output of the comparator will go high, thus turning on LED1 and Q3. Q3 shorts pin 5 of IC4b to earth, thus stopping the inverter from running, RV3 is used to set the low battery cutoff point.

Construction

The construction of the inverter is very simple. The majority of the components mount on a single PCB measuring 176 x 103mm.

Start by assembling the smaller driver PCB (K 6770A). First mount and solder all links and resistors, then the smaller diodes. Follow the overlay diagram carefully, to ensure correct orientation.

Progress from here by next positioning the smaller capacitors, trimpots, ICs and transistors, leaving the eight large diodes and terminal block until last. Once again take extreme care with component orientation. With the large diodes, mount them off the PCB by a couple of millimetres, to allow better heat dissipation.

Take care in identifying the transorbs (transient suppressor diodes). These are clearly marked on their bodies. Also take note of their orientation. With the 1.5k 5W resistors, mount these also off the board to allow for some heat dissipation.

The indicator LEDs and switch SW1 mount on the front end of the PCB. We used a red LED for the "battery low" position, and a green one for the power indicator.

Finally mount the completed board onto the heatsink bracket, by mounting the power MOSFETs. It is important to note here that the output devices are MOS devices, and can be damaged by careless handling. Make sure you are earthed before you handle them. The MOSFETs have to be insulated from the angle bracket, using the insulating mica washers provided.

Firstly smear the face of each MOSFET with heatsink compound. Align the PCB with the angle and position the MOSFET through and bolt down lightly. Check that the other holes line up correctly and the PCB is square with the back of the angle. When this is done tighten up the screws. Check with a multimeter (on the low ohms range) that no part of the MOSFET is touching the heatsink prior to soldering it in.

Install both devices in the same way. When all are positioned and you have checked for shorts, solder the pins with an earthed soldering iron.

With the PCB complete, now assemble all the bits into the chassis. The toroidal power transformer bolts to a metal baseplate, which is held into the case by nine PK screws to ensure rigidity.

The rear of the PCB is supported by two 3mm bolts, which attach the heatsink bracket to the rear of the case (and the main heatsink). The front of the PCB is supported by two nylon standoffs with the LEDs and switch SW1 protruding through the front panel.

Note that the main heatsink attaches to the outside of the case rear by two 3mm screws, separate from those attaching the PCB bracket.

Use silicone grease under both heatsink brackets where they contact the rear panel, to ensure good thermal contact.

Use 4mm bolts also to mount the double GPO (general-purpose outlet) to the front. Use a 3mm x 12mm bolt to secure the earth lead to the chassis plate, and ensure that this connection is TIGHT. The fuse holder is mounted on the rear panel using 3mm x 9mm bolts. This completed, it is now time to wire the unit.

Wiring the unit is straightforward as the only connections are to the transformer and to the power outlet. If the wiring diagram is followed carefully you should have no problems.

Make sure you use 240V cable for the mains connections, and make sure all high current connections are tight. Now it's time for testing.

Parts List

Semiconductors

7 1N4002 diodes
8 1N5404 diodes
1 0A91 germanium diode
1 5.1V 400mW zener
2 BZT 03 — 13 transient diodes
4 BZT 03 –75 transient diodes
2 MTM55N10 TMOS FET
1 BC 640 transistor
2 BC 548 transistors
1 7805 5V regulator IC
1 5mm green LED
1 40106/74C14 Schmitt trigger
1 4027 dual JK flipflop
1 4011 quad NAND gate
1 LM324 quad op-amp

Capacitors

1 .01uF 250V AC rated
3 0.1uF metallised polyester
1 0.22uF 35V tag
1 0.47uF 35V tag
2 1uF 35V tag
1 10uF 16V RB electro
1 47uF 16V RB electro
1 47uF 50V RB bipolar
3 100uF 25V RB electro
2 100uF 63V RB electro
1 220uF 25V RB electro
2 470uF 16V RB electro

Resistors (all 1/4W unless noted)

1 150Ω
2 220Ω
1 270Ω
6 1k
2 2.2k
1 3.3k
2 4.7k
1 8.2k
1 22k
1 27k
1 39k
2 100k
1 1M
2 1.5k 5W
2 680Ω 1/2W
1 1.5k 1/2W
1 2k 10mm horizontal trimpot
1 10k 10mm horizontal trimpot
1 20k 10mm horizontal trimpot

Hardware

6-way PCB terminal block (1), 5-way PCB terminal block (1), PCB supports (2) DPDT centre-off switch (1), rubber feet (4), 5AG panelmount fuse holder (1), 4mm solderlugs (3), 3mm x 10mm round-head bolts and nuts (8), 3mm x 12mm csk had bolts and nuts (2), 4mm x 12mm bolts and nuts (2), double power point (1), chassis and lid (1), self tapper 4G x 1/4 (9), cable grommets (2), input leads (1 ea), heavy duty hook up wire, rainbow wire, solder, tinned copper wire light and heavy duty, sleeving, 5AG 30A fuse (1), 300W toroidal transformer and mounting hardware (1), PCB K6750.

Inverter

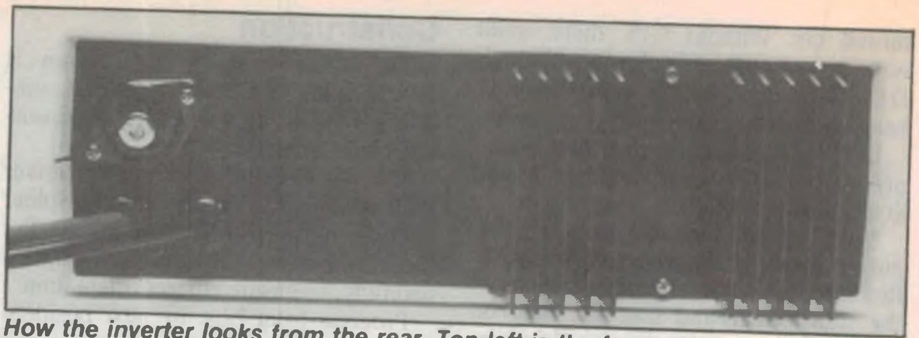
Set up and testing

Once the inverter has been constructed and all the components and wiring have been checked, then power can be applied to the circuit.

If it draws large amounts of current (or blows the fuse), then disconnect the two 1k resistors that feed the gate of each FET (R1 and R3), and try again. If it still blows fuses, then there is a problem with the power FETs, so disconnect the battery leads and find the problem.

The most probable cause of blowing fuses would be a short from the case of a FET to ground or the battery leads are the wrong way around! Note that there will be a small spark when it is connected up. This will be the two 100uF capacitors charging up.

If the fuse only blows when R1 and R3 are reconnected, there is a problem on the control PCB. Pull the PCB out of the case and give it a good hard look. 95% of all problems occur though careless construction, bad soldering, components wired in the wrong way around, etc.



How the inverter looks from the rear. Top left is the fuse.

Once the unit has passed the "smoke test" you can proceed to set it up properly. If you have access to a frequency counter, then connect it to either R1 or R3. Rotate RV3 fully anti-clockwise and set RV2 and centre position. Connect a 40W (or similar) light globe to the output and switch on (either MANUAL or AUTO).

Adjust RV1 for a reading of 50Hz on the frequency counter. If no frequency counter is available, then the use of a frequency sensitive device can be used to set the frequency. An example would be a mains clock, a record turntable or a small fan with an induction motor. The speed of these devices will vary with frequency — so adjust RV1 so the speed of the devices matches that of the same device operated of the mains.

Next set the output voltage. This can be done using a true RMS meter, or by using the comparison method. Plug a small load into the inverter (approximately 60W) and switch on. Measure the output voltage and adjust RV2 for a reading of 230 volts. Alternatively, compare the brightness of the globe to the brightness of the same globe running off the mains. Adjust RV2 accordingly.

The last thing to do is to set the low battery voltage cutoff point. For this a variable voltage supply is needed. disconnect R1 and R3 and reconnect and supply. Set the DC supply for 10 volts, then adjust RV3 until the LED just comes on. Finally reconnect R1 and R3 leads and give the inverter a full test. Then put the lid on.

You should now have a fully functional 300 watt inverter. EA

Construction project:

Digital current tracer probe

Current tracing probes are very useful for troubleshooting in digital circuitry, but commercial probes are very expensive and beyond the reach of most enthusiasts and small labs. Here's how to make your own, for around $20.

by BARRY KAULER

Technicians and enthusiasts working with digital equipment are always conscious of the need for "something better" with which to troubleshoot. However all servicing instruments that look like they may be particularly useful generally also turn out to be particularly expensive.

A digital current tracer probe is an example of a handy little trouble-shooting tool, but the only (well-known) manufacturer of such a device, not to be named, is asking almost $600.

The build-it-yourself equivalent unit described here has a very much lower component cost, of about $20, but its performance compares favourably with the competition.

A digital current tracer detects the presence or otherwise of current in a wire and needs to be sensitive enough to detect the very small currents flowing in digital circuits, even those using CMOS.

Whenever the output of a gate switches state, current travels down the line to charge the line and input capacitance of the receiving gate, and this current is large enough to be detected. Thus printed circuit board conductors can be traced along and hairline cracks and solder bridges easily located, while the circuit under test is still operating.

With care, it is even possible to detect the presence or otherwise of current flowing in the pins of integrated circuits.

The tracer described here also functions much like a logic probe (and makes use of them partially redundant), in that a single narrow pulse on a line is registered by a loud beep from the piezo-electric buzzer on board the tracer. A logic pulser could be a handy companion instrument, to provide this single-pulse or multiple-pulse stimulus.

A particularly nice feature of this current tracer is that no external power or ground connections need be made, so the user isn't hampered by wires dangling out of the tracer. The internal NiCad battery is a special low self-discharge PCB mounting type, and on-board current regulator circuitry enables external charging from any DC supply from 5V to 15V.

Specifications

Commercial current tracers are very compact and easy to handle. I have not achieved this degree of compactness of body and sensing-head, so for very dense printed circuit boards the more compact unit may be preferred. On the other hand, my unit is perhaps more sensitive than necessary, and the reader might like to try constructing a smaller sensing head. Some hints for doing so are given later in this article.

An excellent possibility is a magnetic head from a video player. Video recorders/players have an internal assembly with two heads, and when one fails, the servicing technician removes both, as they are mounted on the same assembly. These are disposed of, but since one head may still be functional, you could ask for it for free, and use it in this project. The active part of a video head is tiny, and is very delicately cemented to the main assembly, so care is required. The only disadvantage is that the ferrite head has relatively few turns, and sensitivity will be less than my prototype.

The commercial competition probe has sensitivity from 1mA to 1 amp adjustable, will latch single current pulses with a duration greater than 50 nanoseconds, and detects pulse trains up to 10MHz. At the maximum sensitivity setting, the risetime to reach 1mA must be less than or equal to 200ns. External power of 4.5V to 18V is required, at up to 75mA.

My unit will sense single pulses, but due to a limitation of my test equipment, I was not able to experiment on logic with voltage pulse risetimes of less than 10ns. I managed to produce a single pulse of 15ns width, 10ns rise and 5ns falltimes approximately, with an amplitude 3 volts. When this was fed into a line of 1 or 2pF to ground, my tracer detected it with sensitivity to spare. A more precise analysis is given later.

So I know my tracer will detect pulse trains up to at least 66MHz. Into a line of 4pF, pulse risetimes of 150ns or less will be detected, which is quite sufficient. Theoretically I have estimated that for a 1pF load, the pulse rise time must be less than 75ns.

A far less sensitive unit would still give satisfactory service.

How to use it

The simplest application is as a partial replacement for a logic probe. A single pulse or glitch will cause a single clear beep. I have never had any need to latch the beeper or LED on continuously after occurrence of a single pulse; one beep is sufficient notification.

Continuous pulse trains will cause continuous beeping. Of course logic probes require external power, or at least a ground link, which can be a hindrance, and the probe tip must make electrical contact with the conductor. But my tracer needs no ground link, and will detect through plastic insulated wires and coated PCBs.

A typical fault is shown in Fig.1(a), in which a short to ground has occurred. If the driver isn't providing pulses, then stimulation can be provided by a logic pulser. Set the tracer to the minimum sensitivity that still gives beeps, and follow along the track. Current will divide at nodes, but if all or most current is taking one path only, then the tracer will become silent on the other path. Thus it can be determined that nearly all current is going one way only.

If the tracer reaches a node and then follows a number of paths from the node, the current in the individual paths will be lower, so to follow it along one particular path readjust the sensitivity so that beeper is just on, and continue tracing toward the next node.

The same current "hogging" occurs with bridged tracks, as shown in Fig.1(b). This creates an unexpected node, so the sudden drop in current on passing this "node" will cause the beeper to become silent.

You may be surprised to find that open-circuits on tracks can also be located. Fig.1(c) illustrates this kind of fault. Cracks may have occurred during PCB manufacture, or through flexing. Plated-through holes are sometimes at fault.

Generally you'll find there is sufficient current flowing in such a track, right up to the point where the crack is. Actually, if we take a closer look at the line, it is in fact a delay line with a certain characteristic impedance and an unmatched termination that reflects the pulse. But in the macro-time view the reflections are not seen and the line is simply viewed as being capacitive or inductive.

Last, but certainly not least, the tracer will detect 50Hz sinusoidal current. But due to the slow risetime, at least 2.5 amps RMS must be flowing — which I guess would be okay in high power applications. The highest 50Hz current I have tried the tracer on is 30A and I don't know what the current threshold will be at minimum sensitivity setting, though it could be calculated theoretically.

Circuit description

The full circuit of the tracer is shown in Fig.2. Let's now look at the way it works.

When current flows in a conductor, a magnetic field is produced around it. The sensing head on the tracer channels this field through a coil, which induces an EMF. This in turn triggers the beeper timing circuit. The requirement here is a difficult one, as the sensitivity must be 1mV and the frequency response must be up around 100MHz.

A high gain of about 2000 is required to convert the 1mV signal into a useful level that can control a beeper.

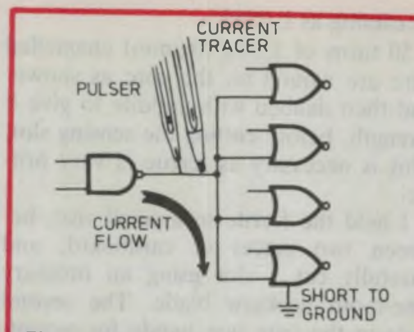


Fig.1(a): Using the current probe with a pulser probe, to track down a shorted gate input.

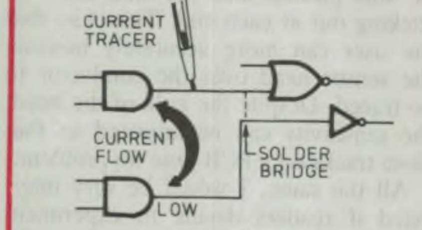


Fig.1(b): Tracking down a solder bridge between PCB tracks.

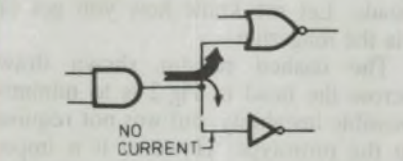


Fig.1(c): The probe can also find hairline breaks in PCB tracks.

Some lateral thinking was called for, and this led to the design of Fig.2, which has the required sensitivity and is very stable.

A 74HC-series high speed CMOS device is used, as this has good gain in the active region. Also, to a certain extent the transition region of the transfer characteristic is proportional to the supply voltage, minimising drift.

TTL exhibits a small hysteresis in the transfer characteristic, which I expect to be less or non-existent in the CMOS. However I designed the circuit to tolerate hysteresis.

Basically the circuit is based on a very sensitive one-shot multivibrator using two of the gates in a 74HC02. At power "on", the potentiometer wiper is at the bottom of the pot element, which gives minimum sensitivity. It is turned up until beeping starts and then backed off fractionally; this provides maximum sensitivity. Thus the voltage on pin 2 of the 74HC02 is just below the threshold, and any signal from the sensor will exceed the threshold, bringing pin 1 low and thus pin 4 high. This brings pin 3 high, which holds pin 1 low.

This also starts the beeper going, but after 0.1 seconds C1 times out, bringing pin 4 low again. Pin 1 must now be reset high, and to achieve this, in case the gate has hysteresis, C2 kicks pin 2 down below the threshold. If the sensor is no longer producing a signal then pin 2 will gradually come back up to just below the threshold, otherwise the process will repeat.

The information that I have on the 74HC series does not completely indicate the threshold spread and gain, but for the chips I have investigated it was close to 1.5V. If you find that the chip you buy has a different threshold, then you may have to modify R1 and R2.

I have been toying with an enhancement to the circuit that compensates for threshold spread and temperature drift, (and also gives a variable beeping rate in proportion to detected current level) but decided to get the article written at this stage, otherwise it will get put off for another twelve months!

The unit is powered by a PCB-mounting NiCad battery of nominal rating 3.6V and 100mAH.

External terminals enable connection of a DC supply of 5V to 15V, to charge the battery. The external charging sup-

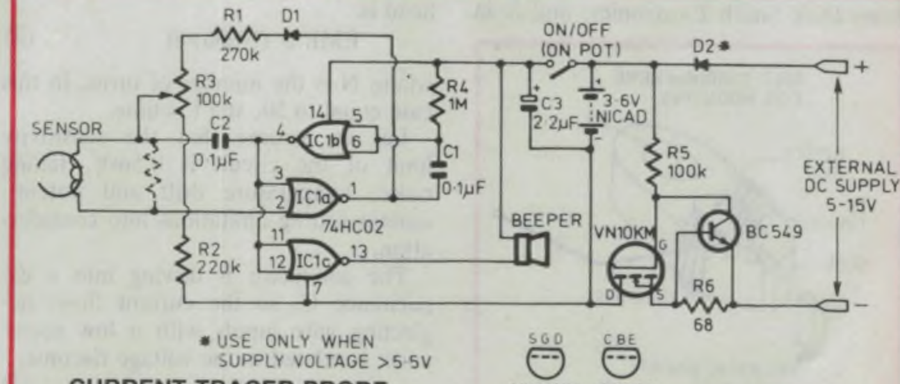


Fig.2: Complete circuit of the current tracer probe. Pot R3 is used to adjust its sensitivity.

Tracer Probe

ply passes to the battery through a 10mA current regulator circuit, which uses a VN10KM power FET. Series diode D2 is also used for reverse voltage protection, but as this introduces a further voltage drop it should only be used if the external charging voltage is greater than 5.5 volts.

The BC549 transistor senses when current approaches 10mA by the voltage drop produced across the 68 ohm resistor. Normally the VMOS transistor is turned on by the 100k resistor pulling up the gate, but when the BC549 starts to turn on, the VMOS transistor starts to turn off, so achieving regulation.

On charge, the battery voltage can rise as high as 4.5V, and if the external supply is only 5V, certain constraints are placed on the design of the regulator circuit, notably omission of the reverse-polarity protection diode.

This particular combination of bipolar junction transistor and VMOS transistor minimises voltage drop and does not allow discharge of the battery through the 100k resistor.

The VN10KM device is available from Radiospares, who list it under catalog number 295-107. The NiCad battery I used is also from Radiospares, catalog number 591-477. The beeper is of the piezo-electric type; I used a Tandy type, catalog number 273-065. The 100k switch pot can be either a Tandy Electronics type 271-216 or a DSE type R-6884.

Note that if the tracer is built without the on-board battery and charger, D2 should be left in and the circuit operated from a 5V supply.

Sensor head

A small high frequency ferrite core of the type having two holes is used, as shown in Fig.3. The core I used was from Dick Smith Electronics, and is in its catalog as L-1352.

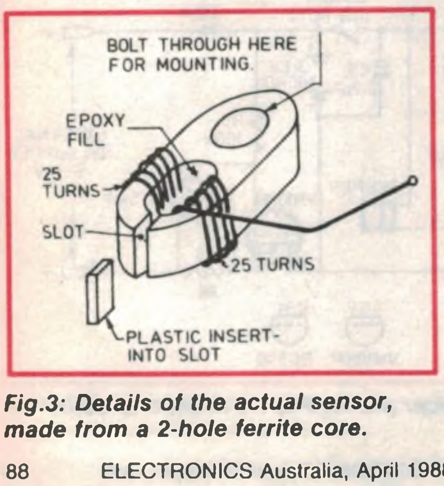


Fig.3: Details of the actual sensor, made from a 2-hole ferrite core.

50 turns of 32swg (0.2mm) enamelled wire are wound on the core as shown, and then daubed with araldite to give it strength, before cutting the sensing slot. This is necessary as ferrite is very brittle.

I held the ferrite in a small vice, between two pieces of cardboard, and carefully cut a slot using an ordinary fine-tooth hacksaw blade. The second hole in the core was handy for mounting purposes.

Finally a small length of plastic cable-tie was pushed into the slot, and left sticking out at each end. This is so that the user can more accurately position the sensor head over the conductor to be traced. Despite the bulk of the head, the sensitivity can be adjusted so that close tracks on a PCB pose no problem.

All the same, I would be very interested if readers decide to experiment with smaller ferrite beads, such as the Dick Smith Cat No. L-1430 or video heads. Let me know how you get on, via the magazine.

The dashed resistor shown drawn across the head in Fig.2 is to minimise possible instability, but was not required in the prototype. However it is important during construction to avoid long leads, to keep the head close to the electronics, and the decoupling capacitor close to the IC pins.

Some calculations

I used these calculations while designing the tracer, but note that they are intended to give ball-park results only.

A very rough estimate of the total magnetic flux ϕ available around a conductor, per length W, is:

$$\phi = 10^{-6}.I.W \qquad \ldots (1)$$

where I is the electron current in the conductor.

The emf generated by the sensor head is:

$$EMF = (N.d\phi)/dt \qquad \ldots (2)$$

where N is the number of turns, in this case equal to 50, and t is time.

Let us assume that the sensitivity limit of the circuit is 0.5mV, taking noise, temperature drift and potentiometer setting limitations into consideration.

The conductor is driving into a capacitance C, so the current flow, neglecting gate inputs with a low resistance, is related to the voltage risetime:

$$I = C.dV/dt \qquad \ldots (3)$$

It would be reasonable to take dV, the voltage change, as being at least 3V. Combining equations 1, 2 and 3 we obtain

$$C = \frac{EMF\,.\,dt^2}{10^{-6}.W.N.\,dv} \qquad \ldots (4)$$

This is the *minimum* value of line capacitance required.

Tabulating, for EMF = 0.5mV and with an effective W of 20mm, and with N = 50, dv = 3:

Pulse Risetime dt (nsec)	Minimum line capacitance (pF)
300	15
150	3.75
75	0.94

Final note

The prototype was built on a small piece of Veroboard and not housed, however you might prefer some type of case. A probe case would be nice and some arrangement could be worked out for mounting the sensor on the probe tip; use Araldite, maybe. Probe cases are available from Jaycar and Radiospares.

This is a project for fiddlers. It's fun to build and even more fun to operate. The final product is however a serious and extremely useful troubleshooting tool.

If you are happy to have leads trailing out of your tracer while in use, then you won't need the NiCad battery or charging circuit. If you try an original design for the sensing head, let me know how it works.

PARTS LIST

Semiconductors

1 74HC02 IC (Motorola)
1 BC549 NPN transistor
1 VN10KM VMOS power FET (Siliconix)
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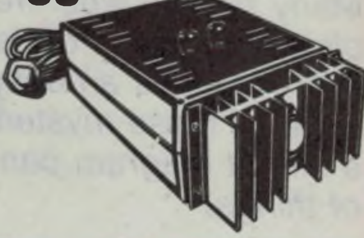

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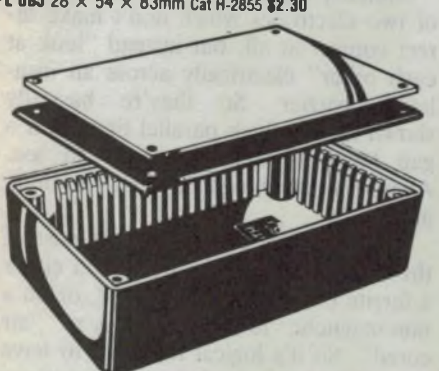

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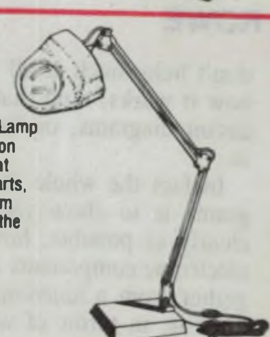

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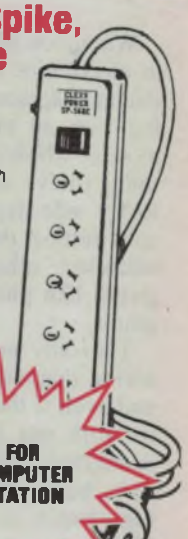

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For the newcomer:

How to read circuit diagrams

Many people who are newcomers to electronics find circuit diagrams or "schematics" rather hard to follow. Here's an easy to understand explanation of what all those mysterious symbols mean, and what a circuit diagram can tell you once you get the hang of things.

by JIM ROWE

When you first start getting interested in electronics and building up projects, circuit diagrams can look rather daunting with all of those little symbols — most of which don't look much like anything you've seen before. It's tempting to try side-stepping the circuit diagram and putting the project together using whatever other information may be given, like photographs and wiring diagrams.

The only problem is that things like wiring diagrams aren't always given — and even if they are, it isn't always easy to work out how each of the parts is connected. Even photographs don't always help, perhaps because they aren't big enough or taken from the right angles.

There's another disadvantage of relying on wiring diagrams and photographs, too: they may show you how to wire up something, but generally they don't help much at all in understanding how it works. And that's exactly where circuit diagrams, or "schematics" come in.

In fact the whole idea of circuit diagrams is to show you, as simply and clearly as possible, how a collection of electronic components are connected together from a *functional* point of view. That is, in terms of what they actually DO, rather than what they happen to look like or how big or small they are physically.

That's why a circuit diagram doesn't have little drawings of the actual components themselves, but represents them simply by standard symbols according to the job they do.

Because of this, it's generally a lot easier to see from the circuit diagram how the parts are being used together to achieve the desired result.

And this tends to apply whether you're looking at a circuit produced in Australia, the USA, Europe or even the USSR - because circuit symbols and diagrams are *reasonably* standardised the world over. Not fully standardised (what is?), but generally close enough that once you're fairly familiar with one 'dialect', you can usually find your way around most others.

So in a very real sense, circuit diagrams are the "Esperanto" or *lingua franca* of electronics, a kind of international shorthand way of describing circuits. That's why it really is a good idea to master them as soon as you can, whether you're planning to make electronics either your hobby or your career.

Mastering them isn't as difficult as you might think, either. The symbols used to represent the various kinds of component are generally fairly logical, once you get the basic idea.

For example resistors are basically parts used to make the flow of current "more difficult", by presenting a path that's effectively "longer" than a plain wire. So generally to suggest this *longer current path*, they're shown as a small zigzag line symbol, as you can see in Fig.1. That makes reasonable sense, doesn't it?

Similarly capacitors essentially consist of two electrodes which don't make direct contact at all, but instead "look at each other" electrically across an insulating barrier. So they're basically shown as two thick parallel lines with a gap between them, as you can see. Again it's pretty logical, when you think about it.

When it comes to inductors, most of these are coils of wire, wound on either a ferrite or laminated iron core, or on a non-magnetic former so they're "air cored". So it's logical for them to have a simplified *coil* symbol, as you can see again from Fig.1.

A transformer being basically two or

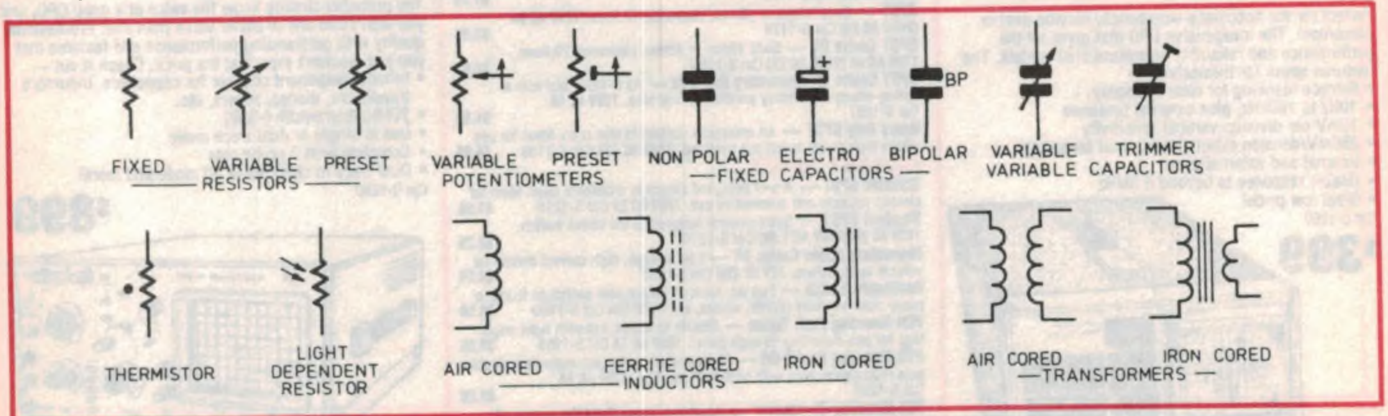

Fig.1: The basic circuit symbols for resistors, capacitors, inductors and transformers.

more inductors wound on a common core, or otherwise placed near each other so they can interact with each other magnetically, it's also logical to show them as two coil symbols (or more). And so it goes. Each symbol is designed to show the *function* of the kind of part concerned, as simply and clearly as possible.

Of course, there's a little more to it than that — isn't there always? But that's the basic idea, at least, and once you grasp it you really won't find the rest all that difficult.

Now let's look at some of the details. Turning again to Fig.1, you've probably already realised that the general way to show that a component is *variable* in terms of its resistance, capacitance or whatever is to show an arrow through its symbol. So a variable resistor (what the old-timers called a "rheostat") is shown as a zigzag with an arrow through it, and a variable capacitor (like the tuning capacitor in most radios) as a pair of thick lines with an arrow through them.

A slight variation on this idea is the symbol for a potentiometer (or "volume control"), which is essentially a resistor with an adjustable *tapping* connection able to move from one end to the other. As you can see, this is shown as a zigzag line with another line at right angles, touching it with an arrow head. Often a second small arrow is shown to indicate which way the tap connection moves (functionally) for *clockwise* rotation of the pot's shaft and knob.

Of course not all variable resistors, pots or variable capacitors are made to be adjusted via a control shaft and knob. Many are "preset" or "trimmer" parts, intended to be built inside equipment and used only for initial setting-up or occasional later adjustments. This kind of component is symbolised by means of a small line with a "T" head, rather than an arrow head.

Another little complication with capacitors in particular is that some of them (like electrolytics) are *polarised*. That is, they must be wired into circuit with a particular end connected to the more positive side of the position concerned. This is generally shown by adding a small "+" sign near the appropriate end of the basic symbol, as shown again in Fig.1. As you can see the bar representing the same end is often shown in outline form rather than solid, for increased emphasis.

The special "bipolar" electrolytic capacitors made for use in AC circuits are indicated by the letters "BP" alongside the basic symbol. Sometimes with these parts *both* bars are also shown in outline form, for further emphasis.

With inductors, the basic coil symbol is used alone to indicate an air-cored type. If on the other hand it is wound on a ferrite rod or core (or the older "iron-dust" core), this is shown by a pair of dashed lines alongside. Similarly if it is wound on a laminated iron core, this is shown by a pair of solid lines alongside.

The same basic convention is used for transformers, too. An air-cored transformer (as used for RF) is shown simply by two adjacent coil symbols, but if the windings are wound on a ferrite core a pair of dashed lines is shown between them. Similarly if they're wound on a laminated iron core, a pair of solid lines is shown between them.

Again there's often a slight variation on this if the transformer is essentially an air-cored type, but is fitted with adjustable "slugs" of ferrite (or the older "iron dust" type). Here the slugs are generally shown as a small pair of short dashed lines at either end, possibly with a small arrow to indicate that they're adjustable.

Before we leave Fig.1, notice that a temperature-dependent resistor or *thermistor* is shown as a basic resistor zigzag, but with a small round "blob"

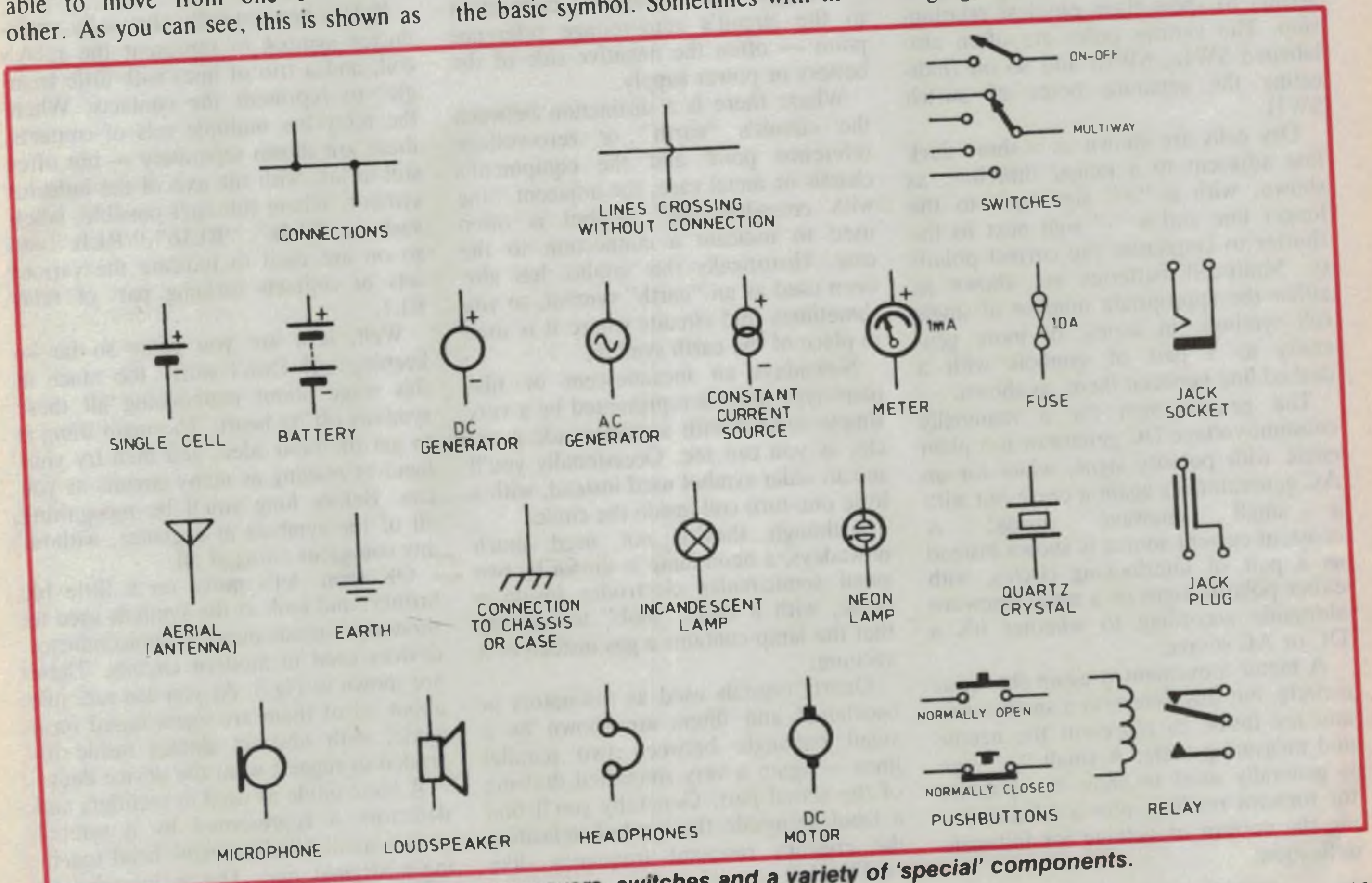

Fig.2: Circuit symbols for connections, crossovers, switches and a variety of 'special' components.

Reading circuits

added to the side to indicate its temperature dependence. Similarly a light-dependent resistor or *LDR* is shown by a zigzag with a pair of small arrows symbolising the effect of light photons.

Now let's turn to Fig.2, which shows many of the other symbols you'll find in circuit diagrams. We'll discuss these briefly in turn, starting at the top left and working down.

First there's the way of showing connections, compared with the way of showing two lines on the diagram that need to be drawn crossing one another, with no connection implied. As you can see, actual connections are indicated by solid "blobs" where one line meets another, while a crossover with no connection is shown by a small semicircular "bridge" in one line or the other (it doesn't matter which).

Switches are shown very simply, with small circles used to indicate the various connections and a short line with an arrow head used to show the moving "pole". To symbolise multi-pole switches with a number of separate poles moving together (or "ganged"), a number of similar symbols are used, with a light dashed line linking the pole arrows to show their physical relationship. The various poles are often also labelled SW1a, SW1b and so on (indicating the separate poles of switch SW1).

Dry cells are shown as a short thick line adjacent to a longer thin line, as shown, with a "+" sign next to the longer line and a "-" sign next to the shorter to emphasise the correct polarity. Multi-cell batteries are shown as either the appropriate number of single cell symbols, in series, or more generally as a pair of symbols with a dashed line between them, as shown.

The general sign for a nominally constant-voltage DC generator is a plain circle with polarity signs, while for an AC generator it's again a circle but with a small sinewave inside. A constant-current source is shown instead as a pair of interlocking circles, with either polarity signs or a small sinewave alongside according to whether it's a DC or AC source.

A meter movement is again shown as a circle, but this time with a small arrow and arc inside to represent the needle and measuring scale. A small "+" sign is generally used to show the polarity for forward reading, plus a label showing the current or voltage for full-scale deflection.

A fuse is shown as two small circles with a pair of crossed lines between them, the narrow crossover in the centre intended to represent the "weak point" of the fuse itself. Generally there will be a label alongside showing the fusing current in amps or milliamps.

The symbol for a jack socket (as used for headphones, etc.) is essentially a very simplified drawing of an actual part, as you can see. The same applies for the matching jack plug, with its circle to represent the plug tip and two lines to represent the sleeve.

Other types of connector are generally also shown by very simplified drawings of the connector itself — often just a circle or rectangle, with smaller circles to represent the individual connection contacts. In many cases a symbol for a plug or "male" connector has filled-in circles for the individual connections, while that for a socket or 'female' connector has hollow circles.

For radio circuits, an aerial or antenna is generally represented by the triangular symbol shown. Similarly a connection to earth or ground is shown by the trio of parallel lines, tapering in length. This latter symbol is also more widely used in almost every kind of circuit diagram, to represent a connection to the circuit's zero-voltage reference point — often the negative side of the battery or power supply.

Where there is a distinction between the circuit's "earth" or zero-voltage reference point and the equipment's chassis or metal case, the adjacent "line with cross-hatching" symbol is often used to indicate a connection to the case. Historically this symbol has also been used as an "earth" symbol, so you sometimes find circuits where it is used in place of the earth symbol.

Nowadays an incandescent or filament-type lamp is represented by a very simple symbol with a cross inside a circle, as you can see. Occasionally you'll see an older symbol used instead, with a little one-turn coil inside the circle.

Although they're not used much nowadays, a neon lamp is shown by two small semicircular electrodes inside a circle, with a small "blob" to indicate that the lamp contains a gas instead of a vacuum.

Quartz crystals used as resonators in oscillators and filters are shown by a small rectangle between two parallel lines — again a very simplified drawing of the actual part. Generally you'll find a label alongside the symbol indicating the crystal's resonant frequency, like "4.43MHz".

A microphone is shown as a circle with a small tangential line, as you can see. This is probably a simplified drawing of an early type of microphone. Similarly a loudspeaker is shown by another very simplified drawing, with a rectangle to represent the actual transducer and a truncated triangle to represent the cone.

The same approach is used for the symbol for headphones, which as you can see is merely two small circles linked by a semicircular arc to represent the headband.

For a conventional DC motor, the symbol is again based on a circle, but with two small filled-in squares to represent the brushes. You don't find AC motors represented much in electronic circuits, but when you do they're usually shown by a combination of a circle for the rotor, and inductor coil symbol(s) for the stator winding(s).

There are two symbols for pushbuttons, depending on whether they're normally open circuit or closed-circuit (that is, before you press the button). As you can see the symbols make this pretty clear, although sometimes you'll find the labels "N/O" or "N/C" alongside just to make sure.

Relays are generally shown by an inductor symbol to represent the relay's coil, and a trio of lines with little triangles to represent the contacts. Where the relay has multiple sets of contacts, these are shown separately — but often still in line with the axis of the inductor symbol. Where this isn't possible, labels such as "RL1a", "RL1b", "RL1c" and so on are used to indicate the various sets of contacts forming part of relay RL1.

Well, how are you going so far — keeping up? Don't worry too much at this stage about memorising all these symbols off by heart. The main thing is to get the basic idea, and then try your hand at reading as many circuits as you can. Before long you'll be recognising all of the symbols at a glance, without any conscious effort at all.

OK then, let's move on a little bit further, and look at the symbols used to show the various discrete semiconductor devices used in modern circuits. These are shown in Fig.3. As you can see, just about all of them are again based on a circle, with abstract shapes inside intended to suggest what the device does.

A basic diode as used in rectifiers and detectors is represented by a symbol with a small filled-in arrow head touching a straight line. This is intended to indicate the fact that the diode is essen-

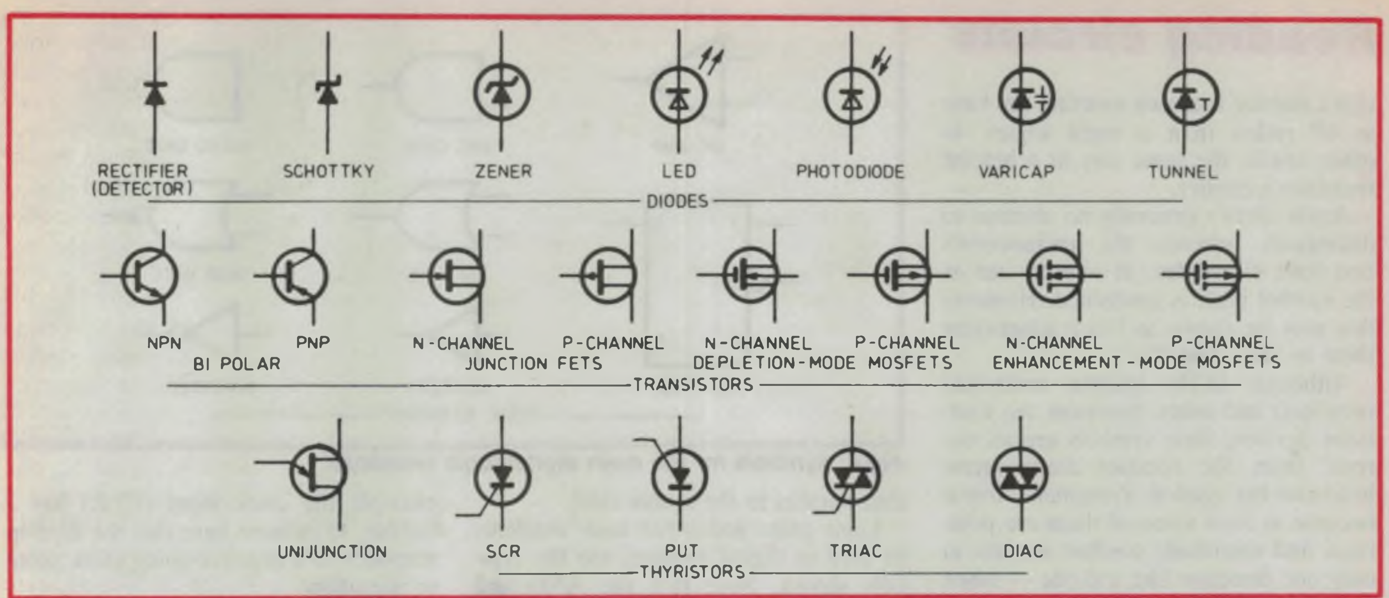

Fig.3: The symbols for the main discrete semiconductor devices - diodes, transistors and thyristors.

tially a "one-way" device, conducting current only in the direction of the arrow (at least in terms of conventional current flow). The arrow head side is the anode, while the line is the cathode.

For a Schottky or "hot-carrier" diode, the straight line is given two small "tails" at right angles. These are apparently meant to represent the sharper conduction "knee" exhibited by this kind of diode.

Most other kinds of diode are also derived from the basic diode arrow-and-line symbol, as you can see, but generally enclosed in a circle and with minor embellishments. A zener or voltage-regulator diode symbol is similar to that of a Schottky diode, but with the little "tails" at about 45° to the straight line rather than at right angles.

You'll sometimes come across an alternative symbol for the zener diode, with a circle enclosing basic diode symbol together with two lines at right angles — rather like a long upside-down "L". This is meant to show the way the diode's current suddenly increases at its reverse breakdown voltage.

Don't forget that because a zener diode is used in reverse breakdown mode, the "line" side of its symbol becomes the anode (connected to positive), and the "arrow" side the cathode.

LEDs and photodiodes have a basic diode symbol again, but with a hollow arrow head and with two small arrows outside to indicate light photons either leaving the diode (for a LED) or entering it (for a photodiode).

A varicap diode is mainly used as a variable capacitor, so its symbol shows a little capacitor inside the circle alongside the basic diode symbol. Occasionally the little capacitor is shown just outside and alongside the circle, instead.

And finally there's the tunnel diode, which you don't come across very often. When you do, it's generally shown by the symbol shown, with a small "T" inside the circle — perhaps because noone could think of any other way to symbolise what a tunnel diode does, or how it works!

Now for transistors. As you can see from Fig.3, the symbols for these are all based on a solid rectangle inside a circle, again with embellishments for the various types and varieties.

For bipolar transistors, the rectangle represents the base, with its connection joined to the centre at right angles. The collector and emitter leads are shown touching it at 45°, as a kind of simplified drawing of the very first point-contact transistors. Two distinguish between the two, the emitter lead is given an arrow head — pointing away from the base for an NPN transistor and towards it for a PNP type.

For junction FETs, the rectangle represents the transistor's channel region, with the source and drain electrodes shown as lines meeting it at right angles near the ends. Note that generally no attempt is made to distinguish between the two, as in many devices they're interchangeable. The gate is shown as a third line with an arrow head, pointing towards the channel for a P-channel type and away from it for an N-channel FET.

The symbols for MOSFETs vary a little, depending on whether they're of the *depletion mode* (normally conducting) or *enhancement mode* (normally off) type.

For depletion mode devices, as you can see, the symbols aren't too different from those for junction FETs. The main difference is that the external gate electrode is shown ending in a "T-bar" instead of an arrow head, and doesn't actually touch the channel rectangle. Sometimes the line representing the gate electrode is drawn meeting the short and firmer gate line at one end, rather than in the centre, making it an "L-bar" instead of a "T-bar".

There's still an arrow-headed line meeting the centre of the channel rectangle, but now it's on the other side and is meant to represent the transistor's substrate. Generally this is shown connected to the source electrode, either internally (inside the circle) or externally.

To indicate that enhancement-mode devices don't actually have a continuous channel region until bias is applied to them, their symbols don't have a long solid rectangle for the channel. Instead they have a "dashed" rectangle, as you can see — made up from three smaller and shorter sections with gaps between them. Apart from that, they're very similar to the symbols for depletion-mode MOSFETs.

By the way, the symbols for *dual-gate* MOSFETs are very similar to those shown for the single gate type. The only difference is that there are two "T-headed" gate lines side by side, instead of just one.

The symbol for a unijunction is not all that much different from that for an N-channel JFET. However to distinguish between the two, the arrow-headed line representing the unijunc-

Reading circuits

tion's emitter is drawn meeting the base at 45° rather than at right angles. In other words, the same way as a bipolar transistor's emitter.

Again there's generally no attempt to distinguish between the unijunction's two base electrodes, at least as far as the symbol itself is concerned. However this may be shown as labels identifying them as "B1" and "B2".

Although SCRs (silicon controlled rectifiers) and other thyristors are four-layer devices, their symbols are all derived from the rectifier diode arrow head-and-bar symbol. Presumably this is because at least some of them are polarised and essentially conduct current in only one direction like a diode — when they do conduct, that is!

The symbol for the standard cathode-gate SCR itself is just a diode symbol in a circle, with the gate lead shown touching the "bar" at 45°, near the cathode lead.

Similarly the PUT or programmable unijunction, which is basically a sensitive anode-gate thyristor, is shown again as a diode but with the gate lead coming in at the anode end and meeting the arrow head at one "point". The same symbol is used for an anode-gate SCR.

A fancier symbol is used as the basis for the more elaborate bipolar thyristors, like the Triac and Diac. Here the basic symbol is essentially two diodes in reverse parallel, as you can see - to indicate that these devices conduct in both directions.

For the Diac this basic symbol is used alone, while for the Triac with its additional gate electrode the symbol is provided with a line joining the "bar" at one end at 45°.

That's about it for the main component symbols you're likely to meet in circuits. Now let's look briefly at a few symbols used for integrated circuits and parts thereof. These are shown in Fig.4.

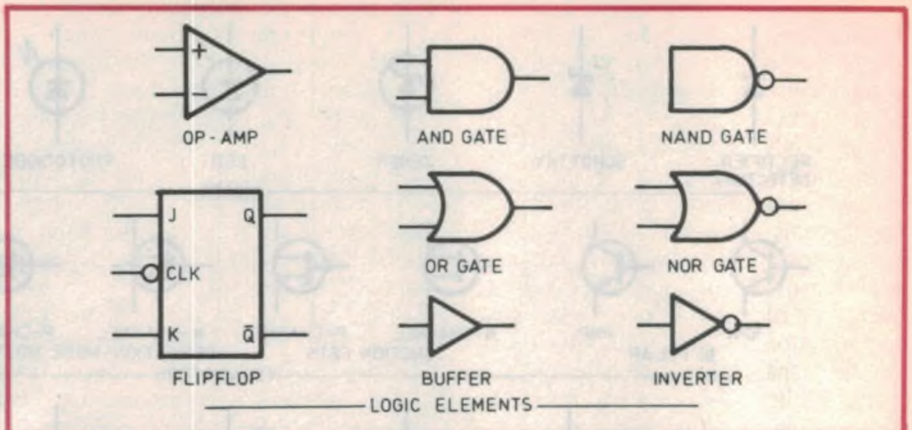

Fig.4: Symbols for the main digital logic elements.

The symbol for an op-amp (or to give it the full name, *operational amplifier*) is basically an elongated triangle, as you can see. The inputs are shown as lines entering the "square" side, while the output is the line leaving the "point". Generally the inputs are marked as shown with polarity signs, to indicate whether the op-amp's output signal is in phase or out of phase with that input. Other connections to the op-amp such as power supply leads, frequency compensation and bias nulling terminals are generally shown as additional lines entering the sloping sides of the triangle (but parallel to the square side).

Logic gates and other basic elements as used in digital circuitry use the symbols shown. Note that the AND and NAND gates have a "square" front and a half-round back, while the OR and NOR gates have a concave front and a pointed back. A non-inverting buffer and an inverter both use a basic triangle symbol, rather like that for an op-amp.

Note too that with logic elements such as these, the only difference between the symbols for those which invert the signal and those which don't is the small circle or "bubble" shown at the output, for an inverting element. This convention is in fact widely used in most digital circuits: the bubble on the end of a line means that the signals at that point conform to negative logic.

Many of the more elaborate digital logic ICs contain so many transistors inside and are so complicated in terms of what they do, that no attempt is made to show this in the circuit symbol. Instead they're shown as a simple rectangle, with various inputs and outputs joining to the sides. Labels are then used to identify each connection and its function.

An example of this is the remaining symbol in Fig.4, that for a flipflop. As you can see, the symbol is basically just a rectangle, with the three main functional inputs and two main outputs are labelled as necessary. Note that in this example the clock input (CLK) has a bubble, to indicate here that the flipflop responds to a negative-going clock pulse or transition.

At this stage the one main type of electronic component that we haven't discussed is thermionic valves (or what our American friends call "tubes"). That's because you don't really come across them much anymore!

However just for the sake of completeness, the symbols for a few different types are shown in Fig.5. The two smaller ones are for indirectly heated triode and pentode amplifier valves, while the larger symbol is for an electrostatic-deflection cathode ray tube or "CRT". This is in fact the one you're most likely to meet nowadays, in circuits for oscilloscopes or CROs.

The four bar electrodes arranged in a square near the end of the narrow section are the deflection plates, of course.

A very similar symbol is used to represent the picture tube in a circuit for a TV set or video monitor. The main difference is that these tubes generally use electromagnetic deflection, so you won't see the deflection plate bars inside the symbol. Instead you'll see two inductor coils nearby, representing the windings of the deflection "yoke". With colour tubes the symbol will have not just a single cathode and set of dashed grids, in the narrow section, but three (for the three colour guns).

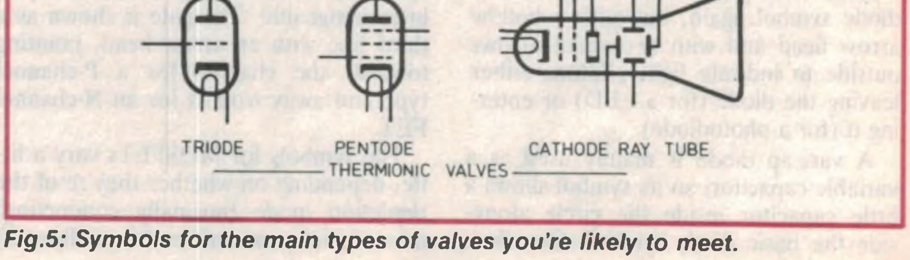

Fig.5: Symbols for the main types of valves you're likely to meet.

OK then, so much for the symbols used to represent most of the common components in circuit diagrams. But what about the actual diagrams themselves — how do you read them?

In a sense, it's a bit like reading music. Once you become familiar with the symbols used, the rest tends to fall into place. Like a piece of music, a well-drawn circuit diagram tends to "flow" in a logical manner, almost leading you along as you follow the course of the signals which pass through the circuit itself.

Generally speaking, circuit diagrams tend to be drawn so that whatever signals the circuit may handle, generate or process, they are brought in or produced at the left, and leave the circuit at the right. So as a rule of thumb, you'll find the *input* circuitry to the left, and the *output* circuitry to the right.

Most circuits need various supply voltages to function, so you'll tend to see various *supply voltage rails* on the circuit diagram. Generally these will be drawn as horizontal lines above and below the main signal-processing part of the circuit, and labelled with such markings as "+9V" or "-12V". By convention the more *positive* supply voltage rail(s) is (are) generally shown at the top of the circuit, and the more *negative* supply rail(s) at the bottom.

A point to remember is that the more negative supply rail, if there are only two, or the "zero" volts rail if there are more than two, may not actually be drawn as such. Instead it may be implied, by showing the connections to it via individual "earth" symbols as shown in Fig.2.

Similarly it may not always be possible for all connections to a particular supply rail to be shown as lines connecting to a single unbroken "rail line". Some of them may be shown connecting instead to a short horizontal line, labelled to indicate that it really represents part of the main supply line.

The power supply circuitry itself is generally shown underneath the main circuitry, as it is in a sense secondary. The main exception to this is where the source of power is a battery or batteries; in this case they are frequently shown over on the far right.

As for reading the main signal-processing part of the circuit diagram itself, it's not really possible to give you any hard and fast rules because there aren't any. Each different kind of circuit tends to have its own distinctive pattern, and you'll gradually learn to recognise them.

A good rule of thumb when you come across a circuit for the first time is to identify the supply lines, then try tracing the main signal path from input to output, left to right. Needless to say the path will often be from the output of one transistor stage to the input of the next stage on the right, or from one IC op-amp or logic gate output to the input of the next.

Then see if you can find any other signal paths leading back, from right to left — either around the circuit as a whole, or around smaller sections, even individual transistors or op-amps. If they're present, these signal paths will generally represent *feedback* circuits.

Again it will usually be very useful to try working out whether these feedback paths, if they're present, are achieving *positive* or *negative* feedback. Generally the best way of doing this (at least roughly) is to work out how many phase reversals will occur around the circuit "loop" affected by the feedback. A phase reversal will tend to occur in every normal common-emitter or common-source transistor amplifier stage, but not in common-collector ("emitter follower") or common-drain ("source follower") stages. Similarly there will be a phase reversal in op-amp stages where the signal enters via the "-" input, but not where it enters via the "+" input.

If there are an even number of reversals inside the feedback loop, so they cancel out, the feedback will probably be positive. On the other hand if there's an odd number, producing a net reversal, it's probably negative feedback. This isn't an infallible rule, because it doesn't take cumulative phase shifts into account. However it can be a useful guide.

Remember too that positive feedback tends to imply that a circuit is designed to oscillate, or at least exhibit increased gain and narrower frequency response. On the other hand negative feedback tends to imply a circuit designed for lower gain and noise, greater stability and broader frequency response — i.e., linear amplification.

Let's look at a very simple example, to illustrate at least some of the principles we've discussed. The circuit diagram we'll examine is shown in Fig.6.

First of all, you can see that over on the right there's the symbol for a 9 volt battery. As this appears to be the only source of power, it's a fair bet that this powers the circuit. The positive side of the battery is shown connecting via a switch to the rest of the circuit, so this

Reading circuits

is undoubtedly the power switch. And the horizontal line to the left of the switch, labelled "Vcc", is obviously the circuit's positive supply rail.

Note that the negative side of the battery is shown connecting to the circuit's earthy side, and many other parts of the circuit are shown with similar connections. From this you can deduce that this circuit is one where "earth" is used as the negative rail.

Now then, to try and trace the signal flow, which will probably be from left to right. Over on the left near the top there's an aerial symbol, and below it an earth. These are shown connected to the primary of an air-cored transformer, as you can see. The full secondary winding of the transformer is then shown connected to a 415pF variable capacitor, labelled "TUNING".

Fairly obviously, we have here the front end of some kind of radio receiver, with signals from an aerial and earth setup being coupled into a parallel tuned resonant circuit. OK so far?

Right. Now there's a tapping connection shown on the secondary of the air-cored transformer, with a connection to the anode of a diode marked 'OA91' The cathode of the diode is shown connected to earth via a 4.7k resistor and a 2.2nF (.0022uF).

If you remember your theory, this is basically a half-wave rectifier setup. So in the context of a tuned circuit and signals from an aerial, it's likely to be a simple RF detector — with the 2.2nF capacitor providing some smoothing of the RF ripple.

So far then, we seem to have something very like a simple "crystal" radio set. But there's obviously more of the circuit left to come, so let's look further.

At the heart of the remaining section there's an NPN bipolar transistor, as you can see, with its emitter taken to earth via a resistor and capacitor in parallel. The audio signal produced by our diode detector circuit looks as if it's being coupled into the transistor's base, via a 0.1uF capacitor, while the collector of the transistor is connected to the Vcc supply line via the primary of an iron-cored transformer. And the secondary of the transformer is connected to a pair of headphones.

In other words, it's fairly clear that what we have here is a common-emitter audio amplifier stage, boosting the signals from the diode detector so they will produce louder sounds in the headphones. Without a doubt the 27k and 10k resistors connecting to the base of the transistor are to supply it with the correct DC bias voltage, while the 220 ohm resistor connecting the emitter to earth is to introduce a small amount of negative current feedback to improve the stage's DC stability. The 100uF electrolytic capacitor connected across the resistor will be to provide a low impedance AC path from emitter to earth, to prevent any AC negative feedback.

So there you have it: our circuit diagram example is nothing more than an amplified crystal set, a very simple radio receiver. And we've been able to deduce this simply by working through the circuit diagram itself, in a logical manner!

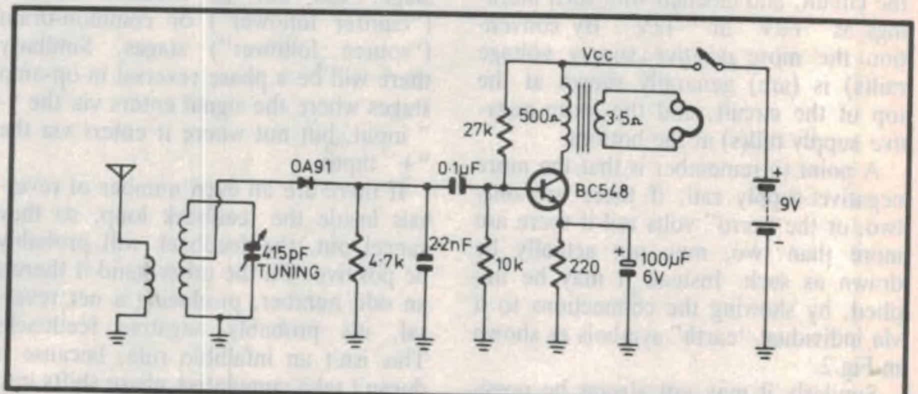

Fig.6: A sample circuit diagram, to try yourself out on (see text).

I hope this simple example gives you at least a basic idea of how circuit diagrams are read and used. Hopefully from here on, now you're familiar with the basic idea, you'll be able to work your way through others. Like most skills, it's mainly a matter of practice — so try to wade through as many as you can, and you'll make rapid progress.

The main thing to bear in mind is that a circuit diagram is basically intended to show you how the circuit concerned *works*, not what the parts look like, either separately or when they're connected together.

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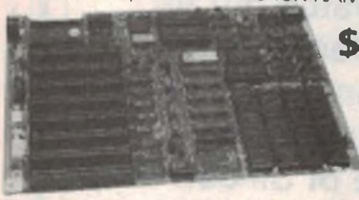

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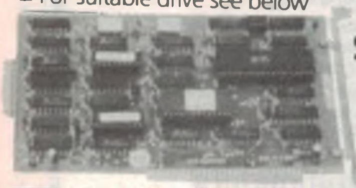

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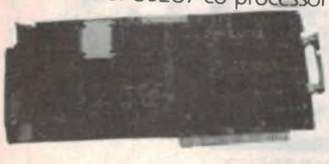

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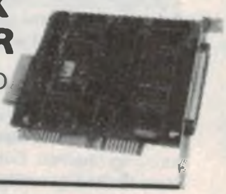

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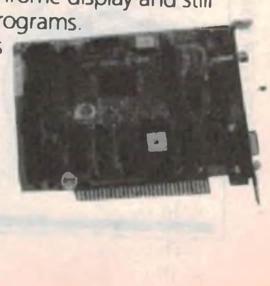

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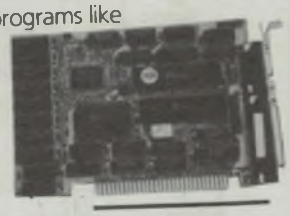

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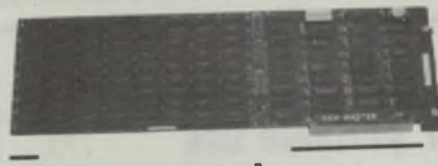

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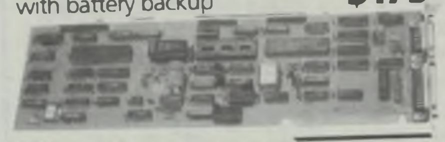

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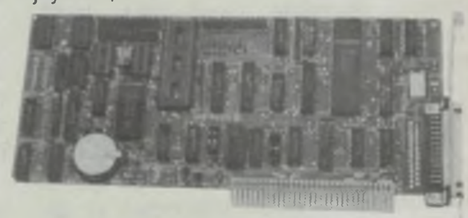

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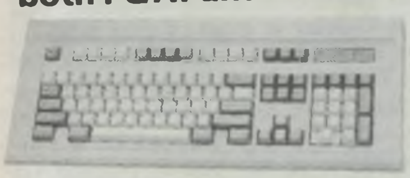

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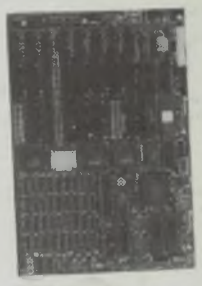

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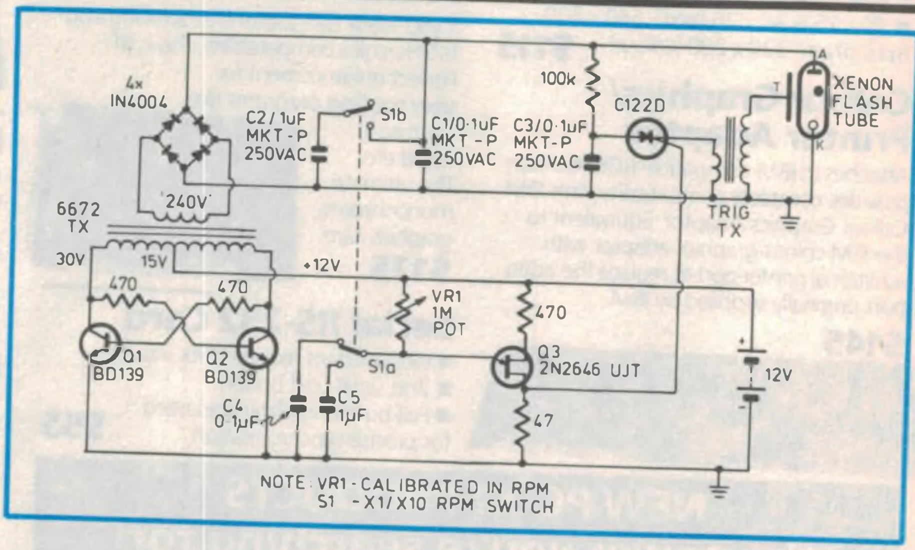
Circuit & Design Ideas

Interesting circuit ideas from readers and technical literature. While this material has been checked as far as possible, the circuits have not been built and tested by us. As a consequence, we cannot accept responsibility, enter into correspondence or provide constructional details.

12 volt stroboscope for portable use



For checking and measuring the speed of rotating machinery, a Xenon stroboscope is almost ideal. It has the advantage of being relatively cheap, and of not needing physical contact with the machine.

Most strobes run off the 240V mains, which means that they are not easy to use if a power point is not nearby. This strobe however will run off 12V DC, allowing it to be run from a car battery or eight D-cells.

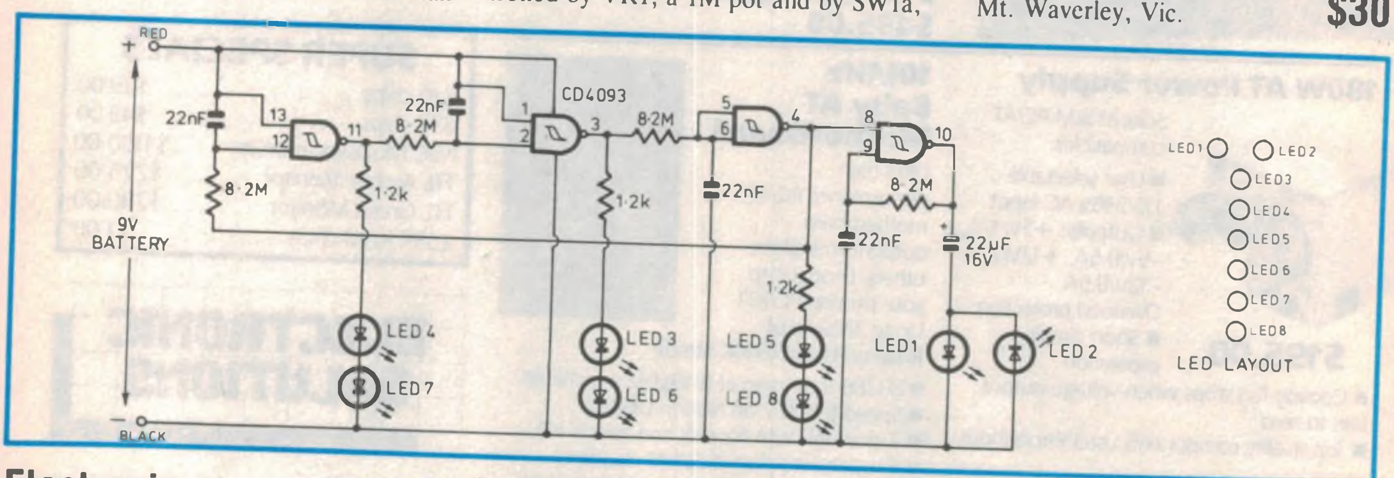
Q1 and Q2 form a simple ringing type inverter, which powers the 6672 Transformer, providing about 200V RMS through its 240V winding. This is then rectified and is used to charge capacitor C1 and perhaps the 1uF capacitor C2, if it is switched into circuit.

The flash tube is triggered every 1 to 1 hundredth of a second by the Q3, a unijunction transistor connected as an oscillator triggering the SCR. This discharges a 0.1uF capacitor through the trigger transformer, triggering the flash which then discharges capacitor C1 (or C1 and C2) through the tube.

The basic rate of triggering is controlled by VR1, a 1M pot and by SW1a, which switches between the 0.1uF (C4) and 1.0uF (C5) timing capacitors. SW1b also switches the 1uF capacitor C2 out of circuit at high flash rates, to prevent overloading the inverter.

Jeffrey Harrison,
Mt. Waverley, Vic.

$30



Electronic "flasher" novelty

Originally this circuit was designed as an electronic novelty. Believe it or not, it was to be built into a T-shirt (battery in the pocket). Alas the manufacturers shelved the ideal (perhaps wisely), but the circuit itself is still quite cute.

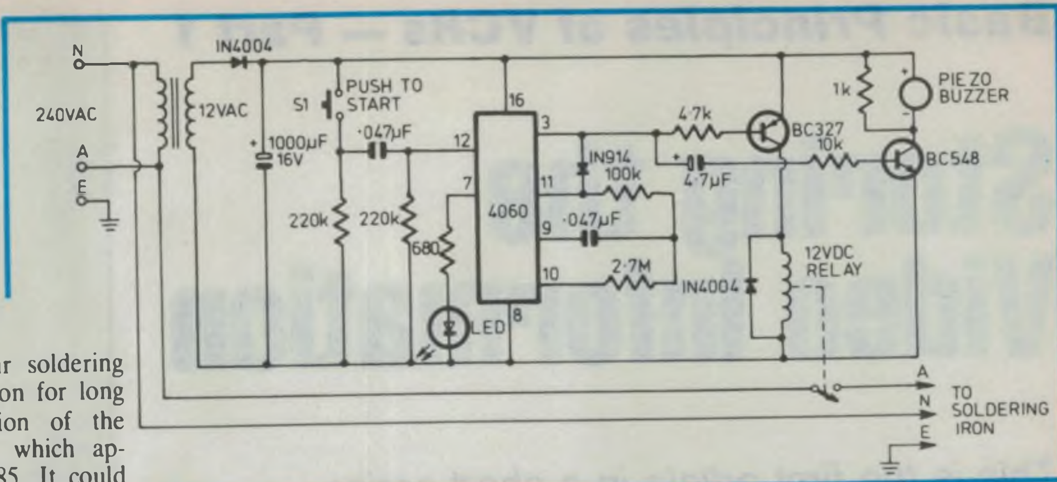
The simplicity of the circuit is perhaps deceptive — the effect is quite good. LEDs 1 and 2 flicker, while a chase proceeds down LEDs 3, 4, 5, 6, 7, 8. For best results it is necessary to use high efficiency LEDs. I used red LEDs for 1 and 2 and green LEDs for 3, 4, 5, 6, 7, 8. The physical arrangement of the LEDs is important to observe the chase effect, but it will still only look good in low light.

The circuit was designed for mass production and should cost very little in parts. 10M or 6.8M can be used instead of the 8.2M resistors, and the brand of 4093 used will affect the chase speed, but it hardly matters for a toy. I used an RCA CD4093. With such high resistances, touching the circuit board will stall the lights for an instant. A 9V type 216 battery should last a fair number of hours.

Three of the Schmitt trigger NAND gates function as a ring oscillator, with an R-C delay in front of each stage to slow the chase down to a speed we can see. The other NAND gate functions as a square wave oscillator that is enabled only when the last chase LEDs are lit. The output of this gate is coupled via the 22uF electrolytic to the two "flicker" LEDs. The flicker effect is the 22uF capacitor charging and discharging through the LEDs in series with the gate output resistance.

Steven Murray,
Auckland, New Zealand.

$30



Soldering iron timer with "time up" beeper

This circuit prevents your soldering iron being accidentally left on for long periods. It is an adaptation of the "Driveway Sentry" circuit, which appeared in *EA* in March 1985. It could also be used for controlling stairwell lighting.

and starts it counting. The LED flashes to indicate this. At the same time pin 3 goes low, turning on the BC327, the relay and the iron.

When pin 3 returns high, turning off the relay, it also charges the 4.7uF capacitor, thus briefly turning on the buzzer to indicate timing is completed.

With values shown, the duration is 30 minutes. The diode on pin 3 inhibits the 4060 clock when counting is complete.

David Duffy,
Thornlands, Qld.

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Dreamed up a great idea?

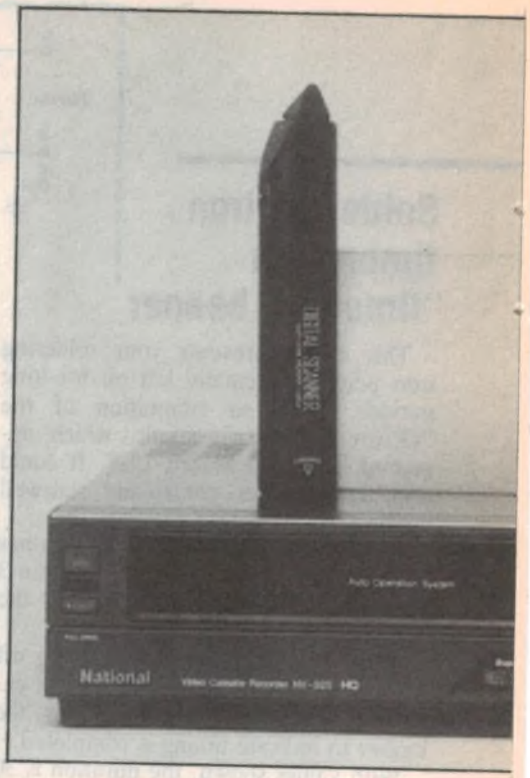
If YOU have developed an interesting circuit or design idea, like those we publish in this column, why not send us in the details? As you can see, we pay for those we publish — not a fortune, perhaps, but surely enough to pay for the effort of drawing out your circuit, jotting down some brief notes and popping the lot in the post (together with your name and address, or course!). Send them to Jim Rowe, Electronics Australia, PO Box 227, Waterloo 2017.

Basic Principles of VCRs — Part 1

Storing the Video Information

This is the first article in a short series explaining the operation of video cassette recorders — with special emphasis on the popular VHS, Betamax and Video 8 systems. Here the author introduces the basic concepts of video recording.

by DAVID BOTTO



In order to gain an understanding of the principles of video cassette recorders, we'll begin by considering the fundamentals of magnetic recording itself. By magnetic recording we mean the process during which some type of ferrous material is magnetized in accordance with an electrical signal variation.

With a reasonably priced domestic audio cassette recorder, audio frequency signals between about 60Hz to 10kHz can be recorded. Here the magnetized material is flexible tape coated with some type of ferrous oxide.

In such a recorder the sound waves are first converted to electrical energy by the microphone. This energy is then passed through an amplifier and supplied to the recording head. The tape passes over the head at a constant speed during the recording process.

The recording head consists of a coil of wire wound on a core made of ferrite material. When the AC signal is passed though the recording head, the core of which has its two ends close together, magnetic flux extends across the gap (Fig.1a). We'll refer to these ends as north and south magnetic pole pieces. They reverse their polarity as the AC signal goes through its cycle (Fig.1b).

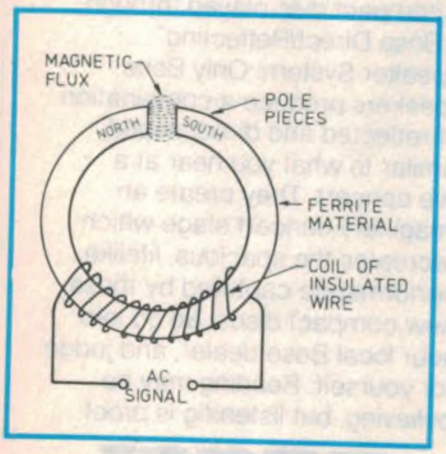


Fig.1(a): Basic idea of a magnetic tape recording head, as used for both audio and video.

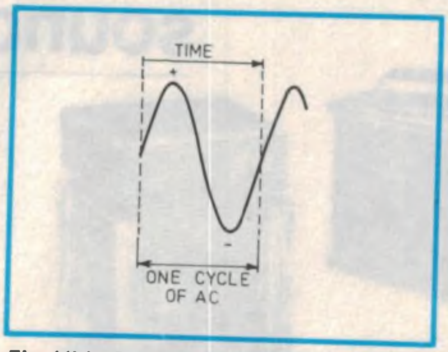


Fig.1(b): On alternate AC half-cycles, the magnetic poles are reversed.

As the intensity of the AC signal increases and decreases, so the strength of the magnetic flux increases or fades away according to the strength of the signal.

During the recording of speech or music not only does the intensity of the AC signal vary, but also the spectrum of frequencies. Each time the signal changes polarity so does the direction of the magnetic flux.

If the tape were stationary or moving very slowly, the magnetized areas would cancel each other out so that no magnetic pattern would be produced on the tape. The tape must be moved at a constant and sufficient speed across the head gaps, so that discrete areas are magnetized according to the signal content at each particular moment (Fig.2). Notice the length needed to

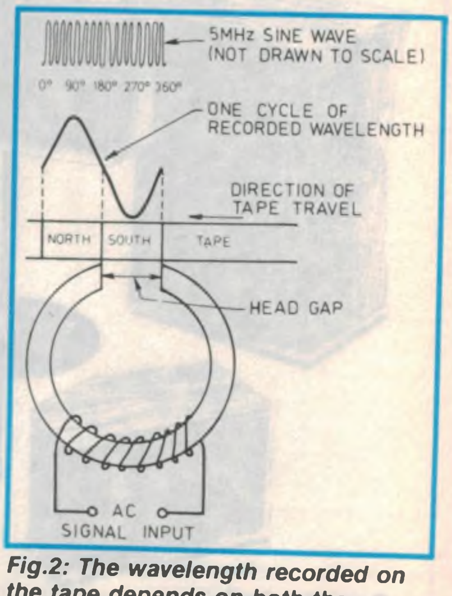


Fig.2: The wavelength recorded on the tape depends on both the tape/head speed and the frequency.

The National NV-G25 HQ, a VCR featuring cordless remote control and bar-code programming.

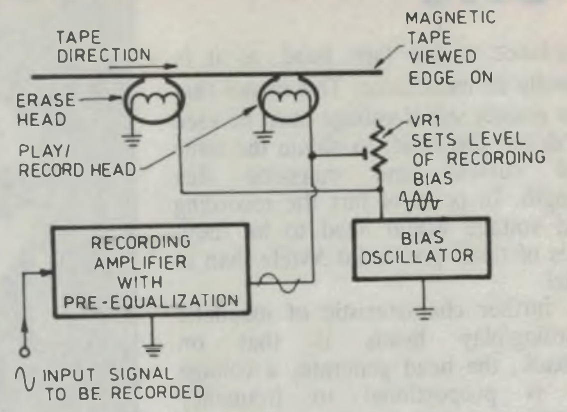


Fig.4: The basic arrangement for conventional audio recording, using a supersonic signal both for erasing the old recording and providing "bias".

record one complete cycle of 360 degrees. This is known as the recorded wavelength.

The basic formula for this is

$L = V/F$

where L is the recorded wavelength in metres, V is the speed of the tape relative to the head, in metres per second, and F is the frequency recorded, in Hz.

However if the head gap size is made very small, the tape speed may be reduced. The approximate relationship is then given by

$G = V/2F$

where G is the head gap width, and V and F are as before.

Make a special note of these formulas, because they help in the understanding of the video recording/playback process.

When the magnetic force across the head gap doubles it does not produce twice the amount of magnetism in the recording material of the tape.

The relationship between the tape head and tape is thus nonlinear. There is also the effect of magnetic hysteresis to consider — the fact that when the signal current in the recording head falls to zero, some magnetism is retained by the head. The distortion shown (Fig.3b) is largely overcome by the use of an AC bias voltage, plus careful head design.

A sinewave "bias" signal having a frequency above audible range is generated by an oscillator contained in the recorder. The sinewave signal is also applied to another head called the erase head, to erase previous recordings.

With the bias signal added to the audio signal fed to the record/play head (Fig.3c), the result is as in Fig.3d. The effect of the bias signal is to prevent the head and tape from operating in the non-linear centre section of the characteristic, giving linear recording.

The diagram of Fig.4 shows the basic recording method used for audio recording. The same principles including the use of bias voltage apply to the sound recording circuitry of a video cassette recorder. (For example in the Sony model SL-C6UB VCR the frequency of the sound channel bias signal is 65kHz, plus or minus 6.5kHz).

In an audio cassette recorder using standard cassettes the speed of the tape across the head is 4.75 centimetres per second or 1-7/8" per second. We'll refer to this as the head to tape speed. When the recorded tape is "replayed", by passing it over the play/record head, the areas of magnetism on the tape set up a magnetic flux at the head gap.

This induces a voltage in the coil of the head, which is amplified and fed to a loudspeaker. The output produced is a reasonable reproduction of the original recorded sound (subject of course to various losses and distortions).

Recording video

Although the same basic principles of magnetic recording we've described apply when recording signals of video frequencies, there are various complications to be considered. For example you'll recall that video signals which contain the fine detail of a TV picture occupy a bandwidth of 5MHz. Can such a signal bandwidth be recorded on magnetic tape?

Look again at Fig.2. You will see that the polarity of a 5MHz signal will reverse 5000 times faster than say an audio frequency signal of 1000Hz. If the head to tape speed remained at 4.75 cm per second, the "north" and "south" fields would overlap on the tape — cancelling out the signal.

Another problem is that as the signal frequency increases, so does the

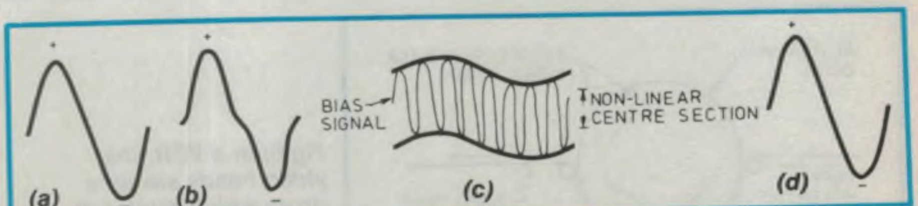


Fig.3: Using supersonic bias to obtain linear recording. (a) shows the original signal, and (b) the recording without bias. The bias signal is added to the audio (c), to "skip" over the nonlinear magnetic region and produce a linear output (d).

impedance of the tape head, as it is basically an inductance. This means that a far greater signal voltage must be used to "drive" the head, to obtain the same head current and magnetic flux strength. In point of fact the recording head voltage would need to be thousands of times greater at 5MHz than at 10Hz!

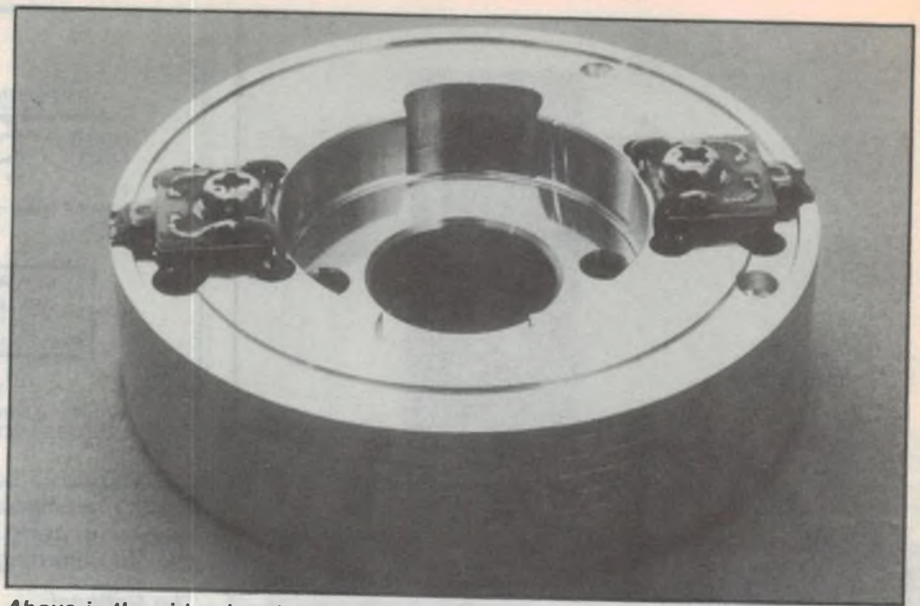
A further characteristic of magnetic recording/play heads is that on *playback*, the head generates a voltage that is proportional to frequency (assuming a constant magnetic flux level on the tape at all frequencies). This means that with a video head designed to handle frequencies up to 5MHz, the signal output at very low frequencies will be practically zero.

In standard audio tape recorders in play mode, the lower frequencies from the head are boosted to the level of the higher frequencies by post-equalisation. When recording, pre-equalisation is given by boosting the high frequency signals. However remember that for audio recording, the frequency range covered is typically only 50-20kHz — a little over eight octaves. (*Electronics Australia* readers will remember that frequency doubles for each successive octave)

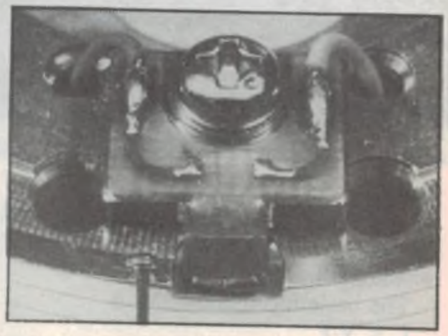
In comparison, the frequency range for a full video signal will be 17-18 octaves. Each time the frequency is halved, the video head output voltage drops by 50%. So the output at very low frequencies would be around 250,000 times smaller than that at the highest frequency. Such a range could not be compensated using an equalisation process.

Forgetting this problem for a while, what tape speed would be required in order to record signals of up to 5MHz — assuming a head gap of say one micrometre, and a straight reel to reel cassette machine?

The approximate speed is calculated by the formula: $V = G \times 2F$



Above is the video head drum from a typical VCR, showing the two magnetic heads. A close-up of one head is shown at right.



where V is again head to tape speed, G is the head gap width, and F is the frequency. So for a 5MHz bandwidth, the required tape speed would be 0.000001 times 2 times 5000000, or 10 metres per second. To play such a VCR tape for one hour, you'd not only need a giant cassette holding 36,000 metres of tape, but also a VCR of colossal size! This would of course be unacceptable.

However the tape format in a domestic VHS-type VCR is such that the linear tape speed is actually only 23.39mm per second, +/-5%. In fact a standard one hour play "E60" VHS cassette contains just over 88 metres of magnetic tape. Yet the head to tape speed is obviously sufficient to handle the video signal — so how's it done?

Helical recording

The secret is the use of helical recording, which enables the linear speed of the tape itself to be reduced, while increasing the relative speed between it and the head(s).

Instead of a single fixed play/record video head, two heads are set diametrically into a small drum which rotates. The tape wraps around the drum as it moves forward, and in this way both heads and tape move forward together. However the head drum is tilted at an angle to the tape, and this plus the fact that the drum is rotated at quite high speed causes the heads to "scan" the tape in slanted tracks.

Because the heads move across the tape at speed, the linear tape speed can be considerably reduced. You can see from Fig.5 that the drum moves in an anticlockwise direction and so does the magnetic tape. (This diagram shows the basic VHS system — the Betamax arrangement will be discussed in a later article.)

To slow the tape speed still more, and also to reduce the width of the magnetic tracks, the head gaps of each head are reduced in size to about 0.3 micrometres. Since the heads are smaller, less head material is used reducing their efficiency. This is overcome by careful design, extremely precise construction, and the use of hot pressed ferrite material for the cores.

Two video heads are needed because as the drum rotates, only one of the heads is in contact with the tape at a given moment.

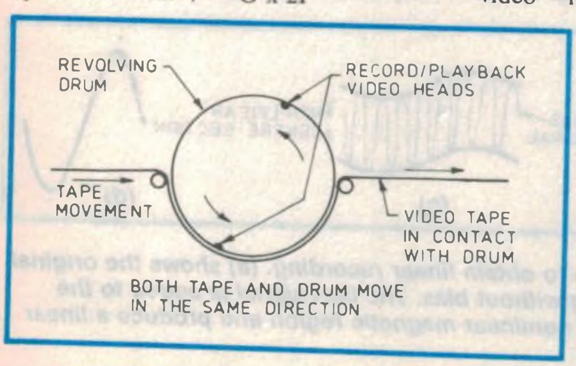
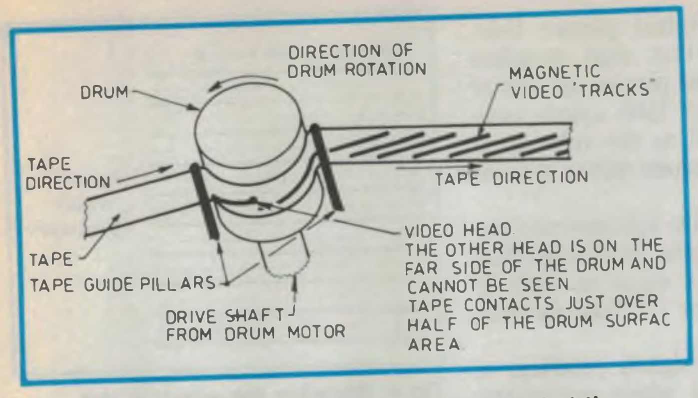


Fig.5: In a VCR, the video heads are on a drum which rotates at 1500rpm, to achieve the necessary head-to-tape speed.



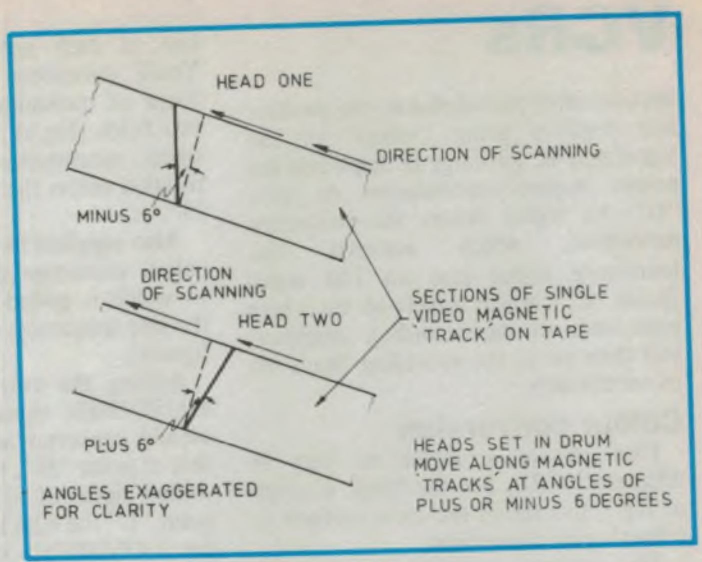


Fig.6(a): (Above) The head drum is tilted, so that the rotating video heads produce obliquely slanted "tracks". Fig.6(b): (Right) The two head gaps are also given opposite polarity azimuth angles, for correct track identification.

Fig.6(a) shows the path of the tape around the drum. Notice that the two heads are removed from each other by 180 degrees. A rotary transformer set inside the complete drum assembly conveys the signals between the heads and the VCR circuitry. The rotating drum has a diameter of 62mm.

From Fig.6(a) you can also see that the tape is wrapped round the drum in the shape of a helix, because of the drum being tilted.

A further complication is that the two heads are not set in the drum with their gaps exactly at right angles to the direction of rotation. Instead they are each set at an angle of 6 degrees plus or minus from this "zero" position (i.e., one is at +6°, and the other at –6°). This angle of six degrees is known as the *azimuth* angle. The two different "opposite polarity" azimuth angles are used to ensure that each head identifies its own tracks for playback — see Fig.6(b).

As each head moves across the tape once, the resulting magnetic track is used to record one TV picture field, consisting of 312.5 lines (each complete picture, or *frame* consists of 625 lines).

The video head-to-tape speed is called the *writing* speed, and for the VHS format this is 4.85 metres per second. In the same format the linear tape speed is only 23.39mm per second. Because the vertical scan rate of a TV picture is 50 fields per second, each head has to scan 25 tracks per second, a total of 50 tracks. This means that the video head drum has to rotate at 25 revolutions per second, or 1500rpm.

The width of each of these video tracks is 0.049mm. The total width of the tape is 12.65mm. Besides the video tracks the tape carries one or more sound tracks, and a control track for synchronizing the tape speed. These tracks are all recorded in the normal linear fashion, as in Fig.4. We will discuss these additional tracks in a later article.

The VHS video head to tape writing speed is considerably slower than the 10 metres per second previously discussed. Partly this is due to the use of head gaps of only 0.3um.

Yet another reason why the head to tape speed can be reduced is that — with a domestic VCR — the full 5MHz bandwidth of the luminance or detail signal is not present. In the colour record mode the VCR circuitry passes the complete TV signal through a low-pass filter, which removes any chroma content and allows only a luminance signal with a bandwidth of about 30Hz — 3MHz to pass. However some VHS video cassette recorders allow a luminance bandwidth of about 4MHz when recording a monochrome signal.

Despite the reduced bandwidth, a domestic VCR still produces quite a good picture, as most users would agree.

Just the same, if you examine a recording of a test pattern you will see that the very high frequency bars cannot be distinguished. This explains what is sometimes called the "weakness" of the video signal produced by a VCR. However the latest generation of machines use a special image signal processing technique known as "HQ" (high quality) circuitry, and this produces a significant improvement in the picture.

Frequency Modulation

Earlier we referred to the fact that the very wide bandwidth of a video signal tended to pose a problem, due to the way that the inductive impedance of the recording head rises with frequency. Because of this, for normal magnetic recording as in Fig.3 we would require thousands of times more head voltage at say 5MHz, compared with say 30Hz.

To avoid this problem, the wide bandwidth luminance signal is not recorded directly, but is instead recorded using a process of frequency modulation (FM), using a high-frequency carrier signal. This doesn't actually reduce the bandwidth, but effectively moves it upward in frequency, reducing the ratio between the highest and lowest frequencies.

Using FM also gives better signal-to-noise performance than would be achieved using direct recording. FM signals of sufficient strength are far less sensitive to unwanted interference.

Keep in mind too that provision must also be made for recording the colour and synchronizing signals.

Recording the luminance

Fig.7 shows a simplified block diagram of the luminance and chrominance signal recording section of a typical VHS domestic machine.

To understand the processing of the signals a knowledge of colour TV principles is helpful. (See "Understanding Colour Television" January to March, and May to September 1987, *Electronics Australia*)

The complete video input signal enters the circuitry at point "A". The low pass filter removes the chrominance signal, leaving only the luminance signal — now reduced in bandwidth from 5MHz to about 3MHz. The signal next enters the pre-emphasis circuitry, (point "B"), where the high frequencies of the signal are boosted.

From point "C" the signal passes through the white/dark clip circuitry. The W/D clip circuitry is required because after pre-emphasis, the positive and negative going "spikes" of the signal may be too large in amplitude for proper frequency modulation. At point "D" the signal enters the frequency modulator, which converts the luminance signal into an FM signal (point "E"), which travels on via a high pass filter to the recording amplifier, and then on to the recording heads via mixer circuitry.

Colour conversion

Exact circuit arrangements vary in different VCR's, but the block diagram of Fig.7 also shows the basic method of colour signal conversion.

To prevent patterning on the recorded picture, due to "beating" between the luminance and chrominance signals, the colour signal is passed through a bandpass filter, (point "F") to converter circuitry (point "G"). You'll see from the diagram that the video signal also goes to the horizontal synchronization separator circuitry which then feeds 15,625Hz (TV line frequency) at point "H" to a multiplier, and then to the phase shift circuitry.

The multiplier produces a frequency of 625kHz, which is forty times the line frequency. The 625kHz signal enters the phase shifter circuitry, (point "I"), to the first subconverter but is delayed in phase by 90 degrees for each successive line of each individual picture field. You'll remember that each complete frame of transmitted picture consists of two fields (Fig.8). A 25Hz square wave signal, synchronized to the video head rotation enters the phase shifter at point "J".

Also supplied to the subconverter is a colour subcarrier signal (4.433619MHz) to which is added a signal at 1/8th of the line frequency, or 1.953kHz (to four figures).

Adding the two signals produces a 4.435572MHz signal which enters the second converter at point "K". Notice that at point "M", the continually phase shifted signal of 625kHz is present. At point "L" the 625kHz signal is added to the 4.435572MHz signal, to produce a frequency of 5.060572MHz. This signal feeds through a high pass filter and enters the converter at point "N".

The chroma signal at point "G" has a bandwidth of approximately 1.2MHz, centred on 4.433619MHz. This is mixed in the converter with the 5.060572MHz signal, to produce at point "R" a down-converted signal of the same bandwidth, but centred on 626.953kHz.

This frequency, you'll notice, is the sum of 40 times the line frequency plus 1/8th of the line frequency. It is usually referred to as the 627kHz *rotational chrominance* signal.

The 627kHz rotational chroma signal is taken through a low pass filter, to enter the final mixer circuit at point "P". The FM luminance signal fed to the mixer at point "Q" is used as the bias signal for the chrominance signal.

The luminance and chroma signals are then taken to the two video heads and recorded on the video cassette tape. We will discuss this recording process, together with the alternate azimuth-phase "tracks" produced on the cassette tape in greater detail in a later article.

Next month we'll discuss various recording systems, together with the drawbacks of some earlier systems. We will also examine how the new 8mm VCR system works.

In future articles we'll also look at some of the more advanced developments in VCR technology, such as the VHS-C compact cassettes and the new S-VHS system.

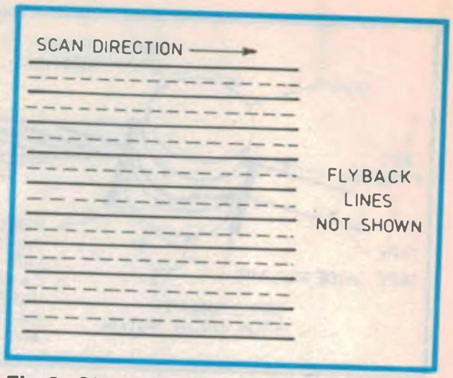


Fig.8: Showing the way that the scanning lines for alternate TV fields are "interlaced".

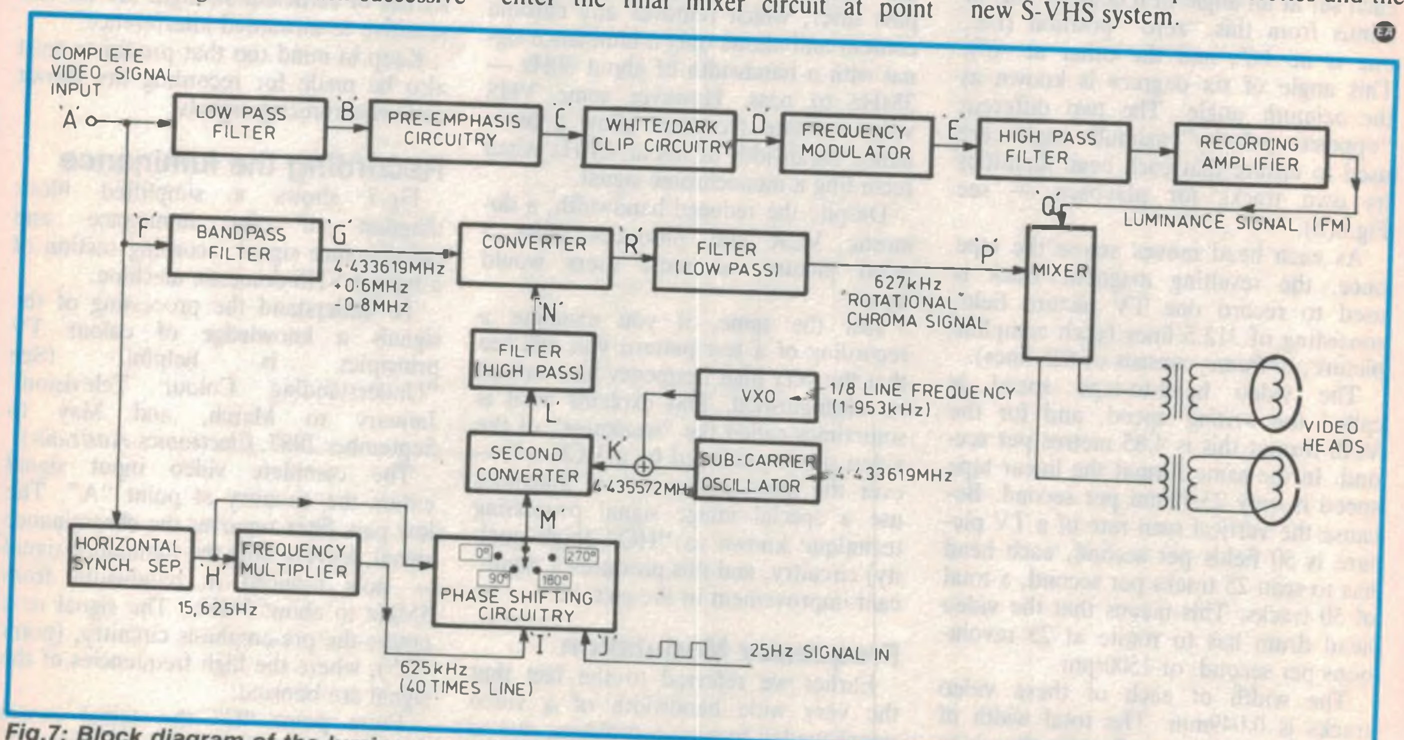


Fig.7: Block diagram of the luminance and chrominance recording section of a typical VCR. The frequency modulated luminance signal acts as bias for the chroma signal.

Books & Literature

Antenna text

UNDERSTANDING ANTENNAS FOR RADAR, COMMUNICATIONS AND AVIONICS, by Benjamin Rulf and Gregory Robertshaw. Published by Van Nostrand Reinhold, 1987. Hard covers, 236 x 160mm, 335 pages. ISBN 0 442 27772 5.

According to the authors, the reason for producing yet another textbook on antennas was to provide one for those engineers and technicians who do not have an extensive background in electromagnetic theory or vector maths. The idea was to provide these people with a useful and informative book on antennas, sufficient for them to undertake design work. It evolved originally from a set of notes used for a short "continuing education" course.

Basically it starts with the theory of sinusoidal waves, transmission lines and the electromagnetic field. It then moves through wire antennas and basic antenna theory, plane waves and geometric optics, to waveguides and horn, slot and microstrip patch antennas. Later chapters then deal with arrays, reflector and lens antennas, travelling wave and broadband antennas, radomes and things like reciprocity and noise temperature.

The text may not be highly mathematical, but still needs a good working knowledge of and facility in trigonometry, algebra (including complex numbers), differential and integral calculus. It's therefore mainly for practising engineers and later-year engineering students. But for these people, my impression is that it provides a readable, down-to-earth and up to date treatment of the subject.

The review copy came from Van Nostrand Reinhold, 480 La Trobe Street, Melbourne 3000. (J.R.)

OSI reference

STANDARDS FOR OPEN SYSTEMS INTERCONNECTION, by T.Knowles, J.Larmouth and K.G.Knightson. Published by BSP Professional Books, 1987. Hard covers, 243 x 162mm, 388 pages. ISBN 0 632 01868 2. Recommended retail price $99.00.

A book intended mainly for EDP systems managers, data communications engineers, engineering programmers and computing science students. It's basically a reference work describing the Open Systems Interconnection "OSI" basic reference model, becoming more and more widely used for data communications and computer networking.

The first section introduces the concepts and philosophy behind the OSI model, describes its evolution and the model itself. Later sections then deal with the various layers of the model, working upwards from the most basic physical level and dealing with the protocols involved. Finally, there are sections on wider issues, such as system management and security.

All in all, it seems a comprehensive reference on this increasingly important subject, for those who need to delve into it.

The review copy came from the Australian office of BSP, at 107 Barry Street, Carlton Victoria 3053. (J.R.)

Ham radio history

HALCYON DAYS, by Alan Shawsmith VK4SS. Published by Boolarong Publications for the Wireless Institute of Australia (Qld Division), 1987. Soft covers, 238 x 160mm, 177 pages. ISBN 0 9596161 6 0. Price $12.00, including postage.

The subtitle on the front cover of this book is "The Story of Amateur Radio in VK4, Queensland, Australia", which gives a good idea what it's about. Not a rigorous history of amateur radio in Queensland during the 1920's and 1930's (which would probably be a lot less interesting), but rather a warm and informal blend of researched facts and first-hand anecdotes, dealing primarily with this period.

Alan Shawsmith is a well-known radio amateur and enthusiastic amateur radio historian, who has also been a prolific writer for the last 20 years or so. This book seems very much to have been a "labour of love", with a lot of effort spent searching through old magazines and documents, and gathering experiences from many of the surviving amateurs who lived through the era concerned. Alan calls them *OOTers*, and I confess I had to look up this term in his glossary at the back, to discover that it means "amateurs of more than 50 years standing". I suspect that in the peculiar shorthand beloved

by the ham fraternity, it's short for "old-old-timers".

The book is liberally laced with this kind of shorthand, so if you're not too familiar with the lingo, it can be a little tricky in places. It's also not really a continuous narrative, more a compendium of "snapshots" describing the various aspects of early amateur radio — the equipment, the people, the regulations, operating techniques, who sold what, the magazines of the day, and so on. I note quite a few little quotes from our own early issues of *Wireless Weekly*, for example.

If you're interested in the early days of amateur radio in Australia, you should find it interesting. I certainly did!

Copies are available from the Librarian, WIA Queensland Division, GPO Box 638, Brisbane 4001. The very reasonable price of $12.00 includes packing and postage. (J.R.)

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machines examined provided a standard PC clock rate of 4.77MHz as a minimum, although the Uni-x delivered higher than standard performance even on this clock rate by virtue of the V20. The Atlanta and machines

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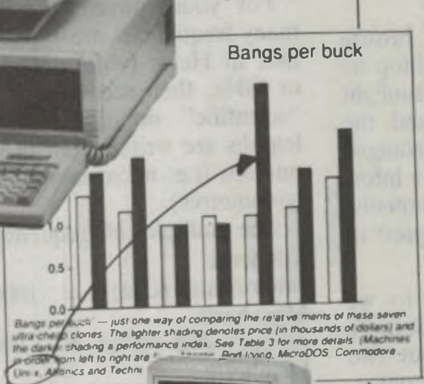

'Bangs per buck' — just one way of comparing the relative merits of these seven ultra-cheap clones. The lighter shading denotes price (in thousands of dollars) and the darker shading a performance index. See Table 3 for more details. (Machines in order from left to right are ... Bondwell, MicroDOS, Commodore, Uni-x, Atlonics and Techn...

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Basics of Radio Transmission & Reception

How it all started — 1

In this, the first article in a new series, we see that radio and TV transmissions, or to use their proper name "electromagnetic radiation", all consist of travelling associated electric and magnetic fields. We also learn more about this radiation, and the way it behaves.

by BRYAN MAHER

According to legend, the first recorded account of communication by electromagnetic radiation comes from accounts of the Roman Army. It seems that a certain Roman Centurian, Glutius Maximus (not his real name) spent all night leading his scouting platoon deep into enemy territory, to provide his General with instant information on the enemy's movements.

Using his brightly polished bronze shield, from his position on a hilltop he reflected the morning rising sunlight straight back to his General and the main army. By a series of pre-arranged codes of flashes he gave complete information on the enemy's movements, leading to the Roman army conquest of Hispaniola in 133 BC.

And why is this of interest to we radio and electronics bods? Because sunlight and radio waves are but two forms of the same thing — electromagnetic radiation. The only differences between them are their frequencies, wavelengths and energy levels. You don't have to be a technofreak to see the inherent beauty in nature's design!

The complete spectrum of electromagnetic radiation frequencies is like an enormous extended rainbow, extending from sub-audio frequencies around 3Hz (wavelength = 100000km) to the highest frequencies known for Gamma rays, above 10^{22}Hz (10 million million gigahertz), with wavelengths less than a billionth of a metre. All are fundamentally the same electromagnetic radiation.

Many natural and man-made kinds of radiation use various groups of frequencies. Some of the most important are named in the left column of Table 1, our Electromagnetic Spectrum table. For every frequency there corresponds a wavelength and a level of energy of the fundamental "bundle" of radiant energy, the *photon*. (For an explanation of those last few terms, read on . . .)

For your convenience in this table, many frequencies are expressed twice — first in Hertz (written Hz), kHz, MHz or GHz, then secondly in exponent or "scientific" notation. Similarly wavelengths are written first in km, m, mm, microns (i.e. micro-metres) and nm (i.e. nanometres).

The multiples of frequency used are:
kilohertz
(abbreviated kHz) = 1000Hz
Megahertz
(abbreviated MHz) = 1,000,000Hz
Gigahertz
(abbreviated GHz) = 1,000,000,000Hz

For years the radio frequencies were named in hazy groups, but nowadays we use the frequency groupings defined by the Societe Internationale (responsible for the SI units). These are:

Very Low Frequencies (VLF): 3kHz — 30kHz, capable of long range but needing very long wire transmitting antennae. Can penetrate slightly through the surface of the ocean, and down into caves.

Low Frequencies (LF): 30kHz — 300kHz, used where long wire antennae are possible, as on ships.

Medium Frequencies (MF): 300kHz — 3MHz, including the Broadcast Band for local commercial stations. Work well with short antennae over medium distances.

High Frequencies (HF): 3MHz — 30MHz, pioneered by radio amateurs for long distance international communication, even using low power.

Very High Frequencies (VHF): 30MHz — 300MHz, including long range mobile communications, FM broadcasting and our original VHF television system. Propagation characteristics vary greatly over this frequency range. The high frequency end needs high power unless "line-of-sight" path is possible.

Ultra High Frequencies (UHF): 300MHz — 3GHz, including the UHF television stations, early spacecraft and short range mobile communications and radar. Requires "line-of-sight" path. Also includes microwave cooking at 2450MHz, as water molecules will absorb this photon energy level.

Super High Frequencies (SHF): 3GHz — 30GHz, including modern spacecraft communications, radar and some amateur experimental bands.

Extra High Frequencies (EHF): 30GHz — 300GHz, bordering on the low end of infra-red heat rays. This band includes radar, amateur and other experimental transmissions.

Perhaps you wonder about radiation of radio and any other electromagnetic signals — just what is being radiated? Also how does radiation of power into the air from a wire occur?

The first answer is that it is an alternating electric field, together with an associated alternating magnetic field which is being radiated.

Before you ask "how?" you probably ask "Just what are these things called "fields?"

Electric fields

Everyone knows some basic facts about electric fields, even far back in history. Thales of Miletius in 600 BC was experimenting with the electrostatic attraction exhibited by a piece of rubbed amber. Indeed our word "electron" is simply the Greek word for "amber". You have perhaps rubbed a plastic comb and found it then attracts bits of dust and paper. Or you got electric shocks after walking across a dry carpet, or after sliding out of a car.

A precise definition of the electric field is just:

An electric field is any region of space in which a stationary or moving charge or charged object experiences a force, but uncharged objects do not.

So far so good!

Magnetic fields

Now everyone knows the attractive properties of magnets; they are nothing new. Even as far back in history as the era of the captivity of the Israelite nation and their exile by the Rivers of Babylon in 587 BC, at the other end of the Euphrates River in the district of Magnesia in Turkey, the Greeks were conducting magnetic experiments, using pieces of magnetic iron ore from the very much older iron ore quarries. It is from the "Magnesia district" that we get our word "magnet".

Jumping over 2400 years of history to Denmark, Hans Christian Oersted found the magnetic effect of an electric current flowing in a wire, and William Sturgeon in England in 1825 increased the effect by winding the wire into a coil.

William Cook with Charles Wheatstone in England, and Karl Frederich Gauss of Gottingen in Germany separately invented wired telegraph machines, anticipating Samuel Morse. Gauss, always a mathematician, commenced formulating the mathematical theory of magnetism in the early 1800's. Before SI units were in use, magnetic field strength was measured in terms of the unit "gauss", a fitting memorial to that eminent genius. You may still find this (now-outdated) unit used in some loudspeaker data sheets.

These studies and the motor experiments of Michael Faraday in England around 1831 led the Scotsman James Clerk Maxwell in 1864 to devise an exact mathematical representation of the alternating electric and magnetic fields which Faraday had proposed.

In contrast with an electric field, we define a magnetic field as:

A magnetic field is any region of space wherein a moving electric charge or charged body experiences a force, but a stationary charge or uncharged body does not.

COMMON NAME OF RADIATION	FREQUENCY : HZ		WAVELENGTH : METRES		ENERGY OF ONE PHOTON eV
		3.0E+22	0.00001nm	1.0E-14	123960000
GAMMA RAYS		3.0E+21	0.0001nm	1.0E-13	12396000
HARD X RAYS		3.0E+20	0.001nm	1.0E-12	1239600
		3.0E+19	0.01nm	1.0E-11	123960
X RAYS		3.0E+18	0.1nm	1.0E-10	12396
SOFT X RAYS		3.0E+17	1.0nm	1.0E-9	1239.6
		3.0E+16	10 nm	1.0E-8	123.96
ULTRA VIOLET		3.0E+15 7.5E+14	100nm 400nm	1.0E-7 4.0E-7	12.396
VISIBLE LIGHT: VIOLET		7.14E+14	420 nm		2.94
BLUE		6.52E+14	460 nm		2.68
GREEN		5.36E+14	560 nm		2.20
YELLOW		5.09E+14	589 nm & 589.6 nm		2.09
ORANGE		4.76E+14	630 nm		1.96
RED		4.13E+14	725 nm		1.70
		3.0E+14	1 micron	1.0E-6	1.2396
INFRA RED		3.0E+13	10 micron	1.0E-5	0.12396
	3000GHz	3.0E+12	100 micron	1.0E-4	0.012396
	300 GHz	3.0E+11	1 mm	1.0E-3	0.0012396
RADAR EHF	30 GHz	3.0E+10	10 mm	1.0E-2	0.000124
SHF	3 GHz	3.0E+9	100 mm	1.0E-1	0.0000124
microwave oven	2450 MHz		122.4 mm		0.00001
UHF TV 520-820 MHz UHF	300 MHz	3.0E+8	1 m	1.0E+0	1.24E-6
VHF TV 45-230 MHz VHF	30 MHz	3.0E+7	10 m	1.0E+1	1.24E-7
OVERSEAS RADIO 3 MHz-30 MHz HF	3 MHz	3.0E+6	100 m	1.0E+2	1.24E-8
BROADCAST RADIO 535 kHz to 1606.5 kHz MF	300 kHz	3.0E+5	1 km	1.0E+3	1.24E-9
NAVAL & MARITIME RADIO LF	30 kHz	3.0E+4	10 km	1.0E+4	1.24E-10
VLF	3 kHz	3.0E+3	100 km	1.0E+5	1.24E-11
AUDIO FREQUENCIES 20 Hz to 20 kHz	300 Hz	3.0E+2	1000 km	1.0E+6	1.24E-12
(power mains	50Hz		6000 km		
	30Hz	3.0E+1	10 000km	1.0E+7	1.24E-13
SUB AUDIO	3 Hz	3.0E+0	100 000km	1.0E+8	1.24E-14

TABLE 1: An overall look at the electromagnetic spectrum — all the way from sub audio up to gamma rays. Note the use of scientific notation: 3.OE+6 means 3.0 times 10^6, and so on.

Electro magnetic radiation

In one giant step forward for mankind, Maxwell alone used his theory to predict that alternating electric and magnetic fields would act in association, to produce a radiant energy which would propagate through the air or space in the form of waves, travelling at the speed of light.

Maxwell said that the propagation would consist of the electric field and the magnetic field at right angles to each other, and both of them at right angles to the direction of propagation through the air.

Furthermore both fields would be "in-phase" with each other, meaning that their amplitude or strength would rise and fall each cycle, but both would rise at the same time, and both fall at the same time.

Basics of Radio Transmission

Where the electromagnetic radiation originates from a straight conductor (i.e., a transmitting antenna) the alternating electric field is physically aligned in space in the direction of that straight conductor. We call this direction the "direction of polarisation" of the radiation.

If for example the transmitting antenna wire is mounted vertically, we would say the electromagnetic radiation is "vertically polarised". In that case the alternating magnetic field would exist horizontally in space, at right angles to the horizontal direction of propagation.

Furthermore Maxwell proposed that light itself is one form of this radiant energy, so light consists of travelling associated electric and magnetic fields.

Some scientists disputed Maxwell's theories, especially the claim that light and all radiant energy can travel through a vacuum, requires no medium for its propagation and can produce effects at a distance. These arguments raged for many years.

The first radio transmitter

It remained for Heinrich Rudolph Hertz of Germany to experimentally validate Maxwell's theoretical predictions, by constructing in 1887 the very first radio transmitter. Using inductance, capacitance, an electric spark and lots of power, Hertz generated VHF radio waves at a base frequency of around 50MHz. These he transmitted through the air across his laboratory to a very simple "receiver" consisting of a wire loop and spark-gap current indicator.

The age of Radio had begun.

Hertz demonstrated that his waves obeyed the laws of straight line propagation and absorption. Cleverly blocking his transmission by a wall between transmitter and receiver, he showed how a horizontal sheet of metal high overhead above the wall could be used to reflect the signals back down to the receiver. Thus showing that his radio waves did in fact obey all known laws of optics, he convinced the world that radio waves and light are one and the same thing, differing only in frequency and wavelength.

Scientists then believed they had a theoretical explanation for everything, that no new theories would ever be needed, and it only remained to refine their measurements. But how false such complacency proved to be!

An unexplainable observation

The world turned over when later experiments with a simple vacuum tube photo diode upset their applecart completely, showing effects unexplainable by the current theories that light and radio were simple waves.

The vacuum photo diode or "photocell" is just a wire anode and a cold cathode of sensitive material such as zinc, caesium or their compounds, all mounted inside an evacuated glass or quartz envelope. (It was the forerunner of our modern semiconductor photodiodes.)

It was found that with a suitable bias voltage applied, light of a certain colour shining on the cathode caused electrons to be emitted from the cathode, to be collected by the anode. These electrons could then be measured as an electric current flowing in an external circuit.

Light of colour higher up on the frequency scale in the electromagnetic spectrum also caused the same effect, but light below some critical colour would not produce any electron emission at all, even if the light intensity was increased. It became clear that there is a threshold light frequency for this effect. The same idea of a minimum frequency (i.e., colour) of light is a requirement today for semiconductor photo diodes, photo transistors, photo thyristors and solar cells.

No one could explain all these goings-on using the current theories of that day.

It required the genius of Albert Einstein, then an unknown humble clerk in a German patent office, to devise a radical, way-out, brand new theory of radio waves and light.

He theorised that light, and hence all radio waves too, could be viewed as bundles of energy, the energy level of each bundle or *quantum* being proportional to its frequency, and nothing to do with its intensity or strength.

Thus was born the quantum theory of everything.

Energy level

As a result, our table of the electromagnetic spectrum is also a quantum energy table. Calling one "quantum" or "energy bundle" by the name "photon", the right hand column shows the energy level corresponding to each frequency in units of electron-volts (eV).

By definition, one electron volt is the energy possessed by one electron when it has been accelerated through an electric field of one volt.

When you study colour television you will find this quantum idea of light vital to the choice of material for the photocathode of TV camera tubes, and related to the screen material chosen for the TV receiver picture tube.

Also the idea of "quantized colour energy" comes into the colours obtainable from LEDs (light emitting diodes), and rules the colour sensitivity of everything from photo isolator-couplers to photo-multipliers to solar cells. Yet again, amongst the "microwave" or gigahertz radio frequencies, the energy level of each quantum of radio energy decides the wavelength and frequency chosen for your microwave oven.

Quantum energy considerations also predict how dangerous it is for you to stand in front of a radar transmitting dish antenna.

Note that the quantum energy level of a radio or light transmission is just the energy of each photon or "fundamental bundle" of transmitted energy. The quantum energy level for each transmission is decided only by the frequency:

Quantum energy $E = hf$

where E is the energy of each quantum in joules (or eV if converted), f is the frequency of the transmission in Hz and h is a universal constant, called Planck's Constant and equal to 6.625×10^{-34} joule seconds.

The *total energy* of any radio or light transmission is simply the product of the energy of each quantum, multiplied by the total number of quanta.

Wavelength

Now we define this term "wavelength":

The wavelength of any travelling wave is the distance travelled by the wave in the time of one period.

Or in other words,

Wavelength (in metres) = propagation velocity x period

and

Wavelength (in metres) = propagation velocity/frequency

This is why, in our table of the electromagnetic spectrum, you can observe that large frequencies correspond to small wavelengths, and vice-versa.

You are probably bursting with objections by now, gasping something like "Well, is a radio transmission or light a wave or is it not?" or "We have been hearing about 'bundles of energy', which don't sound very wavelike!"

The not-so-simple answer is that it is both! Perhaps this is a bit hard to swallow at first, but that point will become clearer in later episodes. As the man says, "Trust me!"

Propagation velocity

All electromagnetic radiation travels through a vacuum at the speed of light, which is approximately 300 million metres per second. This velocity is a natural constant, known by the symbol "c".

If you want that more precisely, it is

$c = 299{,}792{,}900\ (+/-800)$ metres per second

in vacuum, only slightly slower in air, and slower still through transparent solids. "Transparent" in the radio sense means any material, such as a brick wall, through which radio transmission will pass.

Radio signal propagation slows down to about 2/3 of the above value if travelling in a coaxial cable, or about 4/5 if travelling in an open wire balanced pair of conductors such as open wire TV down lead cable. The exact value of those fractions depends on the details of each cable construction, tending to be faster for cables having more air and less solid material between the conductors.

That is all very nice but just how and why does energy radiate from a wire?

Later on, we will deal with antenna theory in some detail, but basically this is what happens: When an alternating current generator at low frequency is connected to a wire which is connected to nothing at the far end (i.e., an open circuit end), energy travels out from the generator to the far end of the wire at nearly the speed of light. Call this the forward flow of energy.

On arrival at the open circuited far end of the wire, having nowhere to go from there the energy flow turns around and travels back along the wire, back to the generator. We say the energy is reflected back from the open end. Call this the return flow of energy.

For low frequencies such as the 50Hz power line, that's about all that happens. The generator sees the line as an extremely high impedance capacitive load, consuming no power. (Actually a microscopically small amount of energy does radiate from the wire.)

But possibilities are very different if the generator frequency is higher (and hence the wavelength shorter). Where the length of the wire is of the same order as the wavelength, some energy can radiate from the wire in a direction at right angles to the wire.

This is the electro-magnetic radiation. The art of designing radio transmitting antennae is to have as much energy as possible radiated from the wire, and almost none returned back to the high frequency generator. This means the transmitting antenna looks like a power load driven by the high frequency generator.

Many and varied are the types of transmitting antennae used. Their design is a wide ranging science, a glimpse of which we will see at a later date. The high frequency generator used is called the "Transmitter". It would usually be a transistor circuit of some type, or if either the frequency or the power level (or both) were very high we would expect to see one or more vacuum tubes (valves) included. The design of transmitters is a very complex art, a little of which will again keep us entertained in later episodes.

Next month we will look at those electromagnetic waves again, in some detail.

Product Review:

Portasol's "Pro" gas soldering kit

Tried out one of the new shirt pocket-sized gas soldering irons? EA's editor Jim Rowe hadn't, until he was sent Portasol's new "Professional Pack" for review. Here's what he found:

A self-contained portable soldering iron the size of a large fountain pen, running from butane gas yet suitable for delicate work on electronic equipment? I have to admit that when I first saw the ads, I was pretty skeptical. It sounded too much like those old jokes about the beginner wiring up his first crystal set with a 5-pound plumber's iron and blowlamp.

It didn't help much when I discovered they were developed and made in Ireland, either. In fact I began to wonder if the whole idea was some kind of Irish practical joke, to get back at us all for not believing in the "little people"!

But then I started to hear glowing stories from people who'd tried them out, and about Telecom technicians apparently buying them in droves. Obviously they were for real, and they were capable of doing some very down to earth jobs. It sounded like we ought to get hold of one and try it out, to tell *EA* readers about this interesting development.

I suppose what made the idea particularly interesting to me was that I had recently reviewed/one of the Scope C60 cordless electric irons (see the February issue). This is powered from a pair of inbuilt NiCad cells, and thanks to its ingenious use of the carbon element principle, seems to represent about the most efficient way of providing a truly portable iron using electrical energy storage and heating.

With memories of this approach still clearly in mind, I thought it would be intriguing to look at the alternative way of achieving a similar result, using butane gas a catalytic heating.

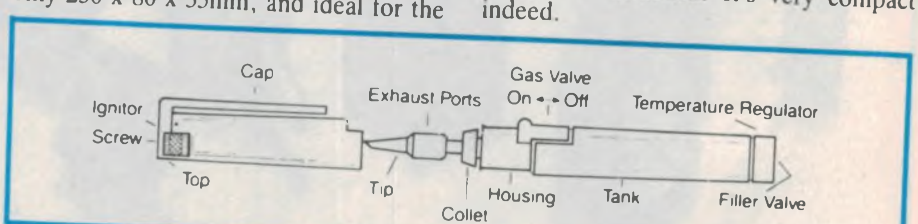
My opportunity to do this came a couple of weeks ago, when the new Portasol "Professional Pack" was released. Our old friends Geoff Wood Electronics are one of the Portasol dealers, and they very kindly offered to send me one for review.

When it arrived I soon discovered that the Pro Pack provides not just the basic soldering iron, but a complete multipurpose tool with tips and nozzles for soldering, brazing, hot-knife cutting of plastics, and both flame and hot air heating. The whole setup comes in a neat little ABS plastic case measuring only 230 x 80 x 35mm, and ideal for the typical serviceman's tool kit.

Needless to say the heart of the pack is the butane powered iron/torch itself, which I for one found most interesting — not the least because of its tiny size!

This consists of a cylindrical gas tank and valve unit measuring only 19mm in diameter and 116mm long, which forms the unit's "handle". Into a threaded hole at the business end you screw the various bits and nozzles, to adapt it for the various kinds of jobs. And over the top of the bit or nozzle you can slip a protective cap, very much like that on a fountain pen, so that the iron can be popped into your pocket or bag by itself. You can even do this while the iron is still fairly hot (but not still going!), as the cap is made from heat-resistant plastic.

By the way, as well as having a long "clip" for anchoring it in a pocket, the cap also features a flint-type lighter in the top for lighting the iron/torch. How's that for a well thought-out design! The cap measures 80mm long, and the complete iron measures 176mm long when it is attached. It's very compact indeed.



Basic construction of the Portasol Pro iron. It's very elegant. A collet system makes it easy to exchange tips and nozzles.

But back to the basic gas tank/handle. Down at the cold end this has a rotary regulator knob to adjust the gas flow and heating. There's also a small window in the back of the knob, to let you inspect the level of liquid gas in the tank. And finally there's a small one-way valve for refilling the tank, using any normal source of butane (such as the aerosol cans sold to refill gas cigarette lighters).

Up near the business end, there's the main sliding on-off valve, in a contrasting orange coloured plastic (the rest of the iron is blue) and shaped in a way that seems to demand the use of your thumb.

The basic iron accepts a range of some seven different bits and nozzles. There are four different soldering bits, with tips ranging from 1.0mm to 4.8mm in diameter, and a "hot knife" bit with a wedge-shaped blade about 15mm long. To round out the range there's also a gas torch nozzle, with a diameter of 5.5mm, and a "hot blow" nozzle about 6.5mm in diameter.

The only one of these which actually produces an external flame in normal operation is the gas torch nozzle. The rest use catalytic combustion; after you light them with sparks from the flint lighter, the external flame quickly disappears and there's merely a red glow visible inside the metal gauze. The only other sign of operation is a gentle hissing.

Each of these bits and nozzles fits to the handle with its own captive threaded collet. These are deeply grooved on the outside, and look a little like bevel gears. No doubt this is to help keep them cooler, so you can more readily change from one to another during use.

As part of the Professional Pack you get the 2.4mm soldering bit, the hot knife bit, the hot blow nozzle and the gas torch nozzle — enough to cover the full basic range of applications. You also get a wire stand, which fits into a slot at the end of the storage case to support the iron when it's going. And finally there's one of those little sponge pads in a metal cup, to wipe excess solder and flux off the soldering bit.

What's it like to use? Well, I've been able to give it quite a reasonable workout over the last couple of weeks, and I'm very impressed.

It's very easy to change bits and nozzles by hand, and the flint lighter in the cap generally takes the hassles away from lighting. The only minor trouble I had with lighting was with the "hot air" nozzle, which seems to need a good squirt of sparks straight down inside (a little tricky). The rest were much less critical, and very easy to get going.

As a soldering iron, the Portasol Pro is rated as equivalent to an electric iron adjustable from approximately 10 to 60 watts, and with tip temperature adjustable up to about 400°C. From my trials it certainly seems to live up to this.

I found you could adjust the heating level quite smoothly with the regulator knob, from high power with the bit almost glowing right down to very low power where there was barely a glow from the little gauze window. At the low end it was quite suitable for very delicate work on PCBs and other electronics, as there's very little heat or fumes from the bit's exhaust ports.

Much the same comments apply to the hot knife bit, which seems very suitable for things like cutting plastic rope, or joining thermoplastic belting.

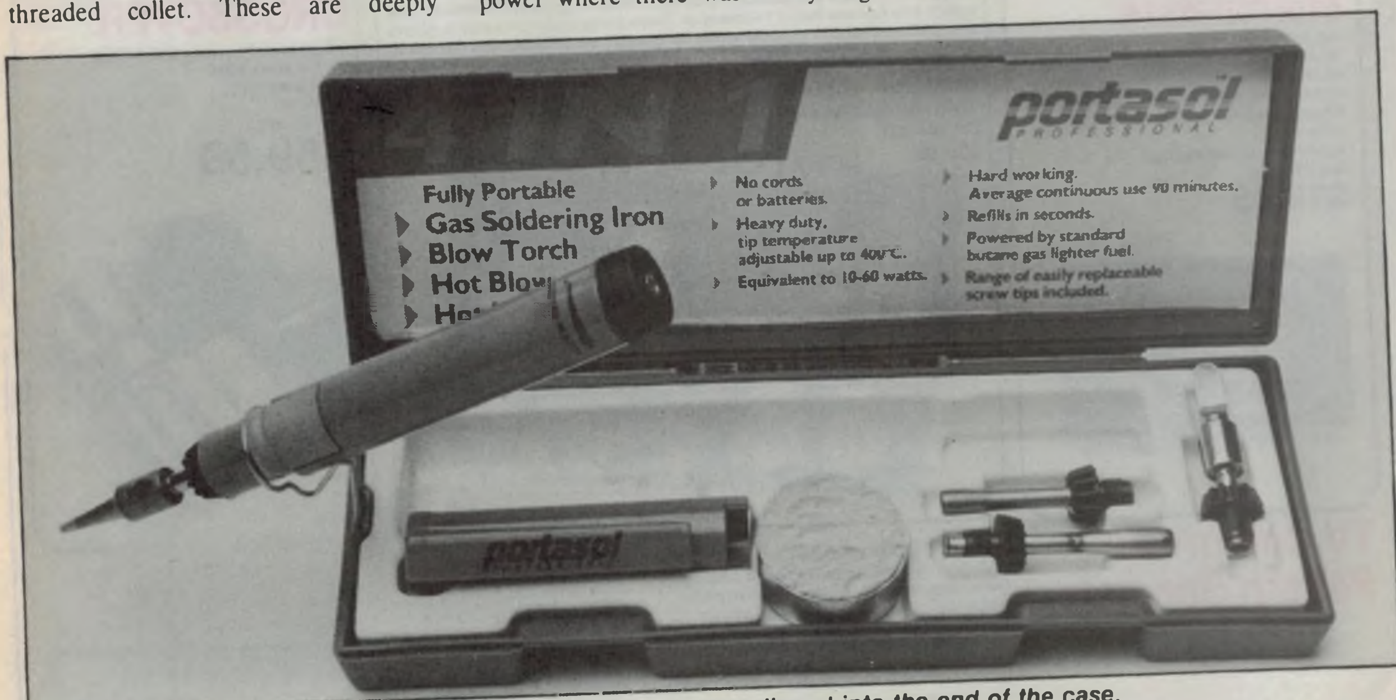
The gas torch nozzle produces a very precise flame, with the inner blue cone about 2.5mm wide at the base, and about 1mm in diameter at the tip. With the regulator you can easily adjust its length and intensity over quite a range. Although a butane/air flame basically isn't all that hot, in this case it's quite concentrated and is quite capable of performing small brazing and silver soldering jobs. Being very small and light it's also a delight to manipulate.

With a little patience and careful use of a few small pieces of ceramic tile I found it would even heat very small steel items to cherry red (i.e., about 800°C). So you could use it for heat-treating small milling cutters and similar tool bits, for example.

So all in all, the Portasol Professional Pack is a very flexible little tool kit. But how much work can you do with a single tankful of butane?

The Portasol instruction sheet claims about 90 minutes for continuous operation, which sounds more than adequate for most applications. Although I didn't use it for anything like this time in a single burst, I certainly got the impression that it would come close to this

Continued on page 144



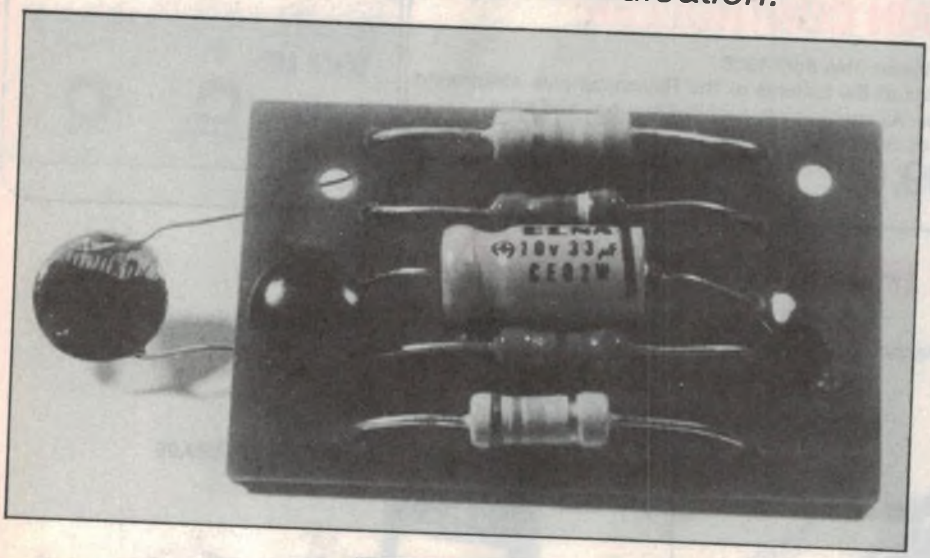
The complete Portasol Pro kit, with the wire iron stand shown clipped into the end of the case.

Spotlight on Components:

Evolution of a lamp flasher chip

Here's an interesting example of the way evolving component technology can be used to make continuing improvements in equipment performance, reliability and cost effectiveness. In this case the equipment concerned is a light sensitive flashing lamp, as used for roadside hazard indication.

by PHILIP TRACY



Left: The original discrete-components flasher circuit, using two transistors and an LDR - plus resistors and a capacitor. (Courtesy Artcraft Engineering)

Originally, flashing lamps for use in warning motorists of road hazards were red and square shaped. They were activated by kerosene dripping slowly onto a wick, causing tiny explosions and flashes of light. A "lamp lighter" had to go around and light them at the end of each day, and also refill them regularly with kerosene.

Back in 1959, Melbourne flashing lamp manufacturer Artcraft Engineering produced an improved electronic flashing lamp. This used a battery for power, with the flashing controlled by a circuit using then-new germanium transistors.

All of the electronic components, which were discrete, had to be hand soldered into circuit and made to fit into a metal holder on which the lamp itself sat.

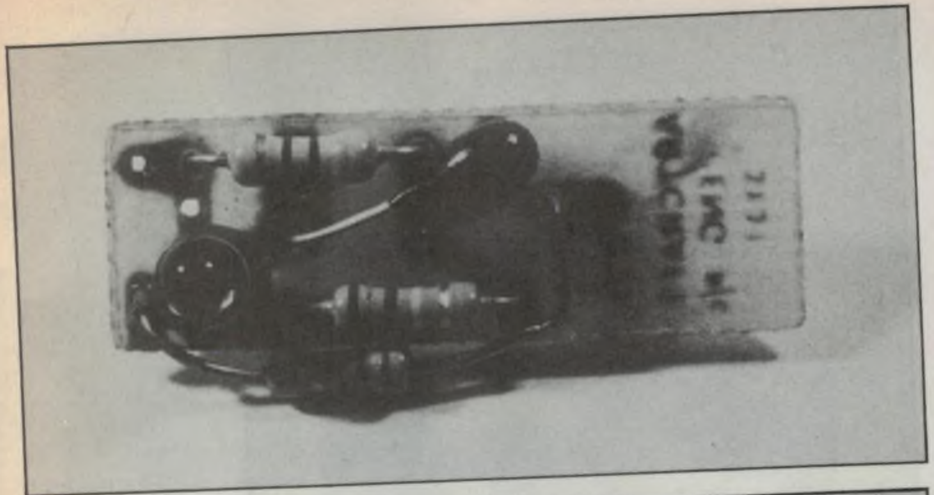
By 1964, the flashing lamps were using transistors which were embedded in wax within the metal holder. By this stage the circuit included a light-

Right: The first Philips monolithic IC flasher chips came in two TO-18 versions, first the OM801 in metal can with glass window (right) and then the OM805 with epoxy top (left).

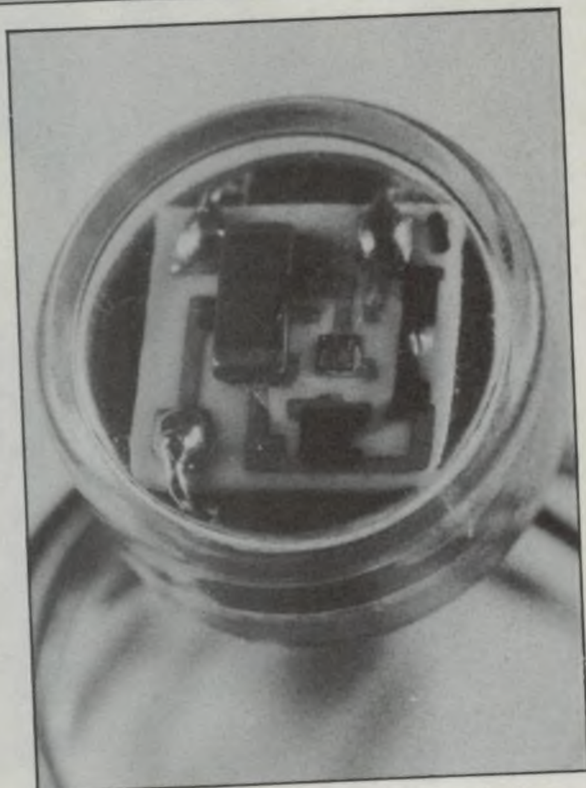
sensitive controller, to automatically switch the flashing light off during the day and on again at night.

The entire circuit was still hand wired, and therefore labour intensive. However it did demonstrate that Artcraft management had been far-sighted and innovative in using the new semiconductor technology to achieve considerable savings in operating costs, for major utilities such as Main Roads departments.

The discrete model lasted for about six or seven years, until 1971-72. But around 1970 Artcraft decided to explore the possibility of taking advantage of integrated circuit technology, to reduce the labour content and improve reliability. The company approached the Electronic Components and Materials division of Philips, with its local design and development expertise in microelectronics, and its manufacturing facilities in Hendon, South Australia.

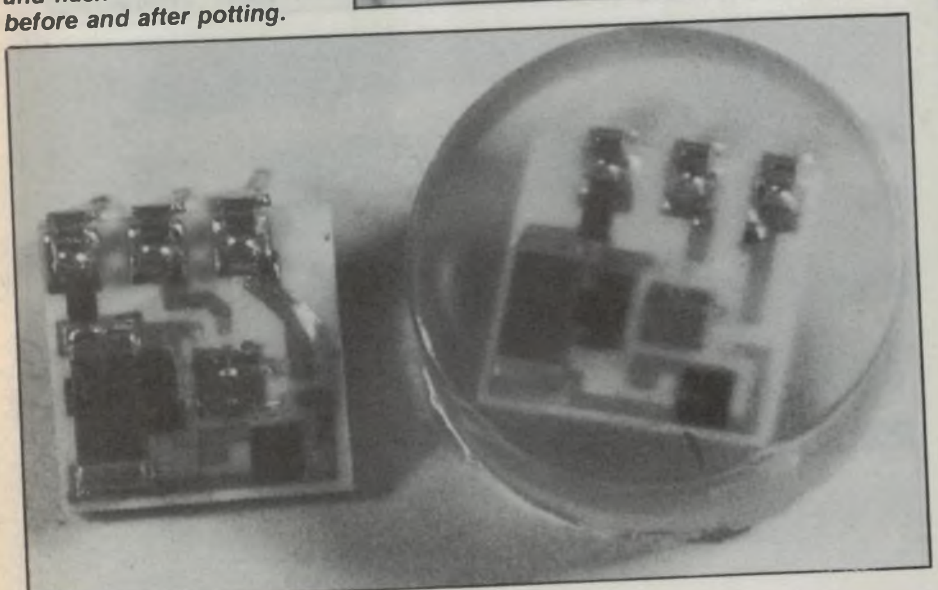


Above: The flasher using the OM805 chip, which replaced both the transistors and the LDR - but not the passive components. (Courtesy Artcraft Engineering)



Right: The first hybrid IC flasher, with the monolithic chip mounted on a small ceramic substrate with the passive parts, and potted in an LDR case with flying leads.

Below: The second, improved hybrid device with independent adjustments for "on" time and flash rate. Shown here before and after potting.



As a result, the two companies embarked upon a joint development project. Philips designed a monolithic chip, which replaced both the individual transistors and the light sensor.

The change to monolithic integrated circuit technology was a timely move, because the original hand-made germanium transistors were increasing in price, and the newer silicon planar transistors could not directly replace them. The new IC used three transistors to replace the original two germanium devices, but with the change to an integrated circuit it was cost effective to use more transistors to replace the smaller number of discrete parts.

At this stage the new IC was still hand wired with the other components into the body of the flashing lamp.

In the mid 70's Philips began Australian production of a new technology, the *hybrid circuit*, which enabled the monolithic IC chip to be assembled with the other components on a single tiny piece of ceramic plate just 8mm square. This eliminated the hand wiring and enabled the entire electronics of the flasher to fit into the space occupied by the light sensor alone in the original model.

This meant that the electronics could be positioned for optimum reception of light, thus making the light sensor work more effectively. It also facilitated factory adjustment of the unit's light sensitivity.

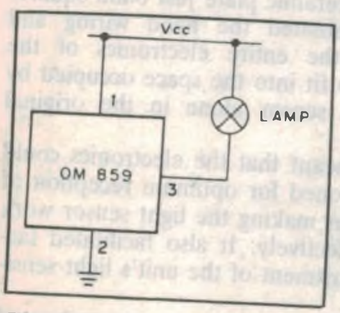
Due to the stringent controls and regulations of the Australian Standards Association affecting the engineering specifications for hazard warning lamps, there had to be adjustments for rate of flashing and the duration of each flash. Hybrid technology allowed these adjustments to be made by Philips on each circuit, prior to delivery to Artcraft. The technique involves computer controlled adjustments, with "trimming" of component values made using precision laser cutting.

Recently the next step again was taken, with all of the components of the hybrid circuit integrated into a single monolithic chip only 2mm square. This is still mounted onto a small ceramic substrate, for handling, but all of the electronics is now contained within the silicon chip. This has all of the adjustments required to meet the Australian Standards performed inside it during the computer controlled testing stage.

The process of introducing each new technology in this evolution of the product was totally cost and competition driven. As labour costs increased while electronic component costs were stable, or fell in real terms, it became possible both to automate production and achieve significant improvements in quality control of manufacture and adjustment.

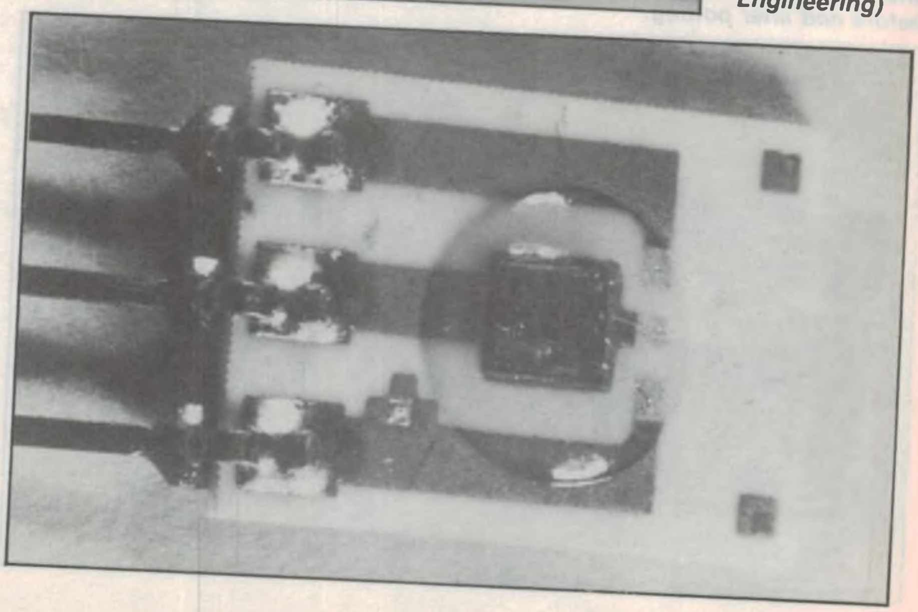
While the current fully monolithic circuit design may seem to represent the "ultimate" step, history in the microelectronics industry has shown that very few years pass without new and undreamed-of challenges, and movement to even better techniques and technologies.

The lesson is clear, that the skills of two companies — one providing the mechanical knowhow (and the specific market application knowledge), but not involved in microelectronics, and the other specialising in this technology — make an ideal combination to allow an Australian product to remain competitive.



Right: Closeup view of the latest fully monolithic flasher circuit. Above shows how simply it's used.

Left: The current model Artcraft hazard flasher, which uses the new fully monolithic flasher circuit. (Courtesy Artcraft Engineering)

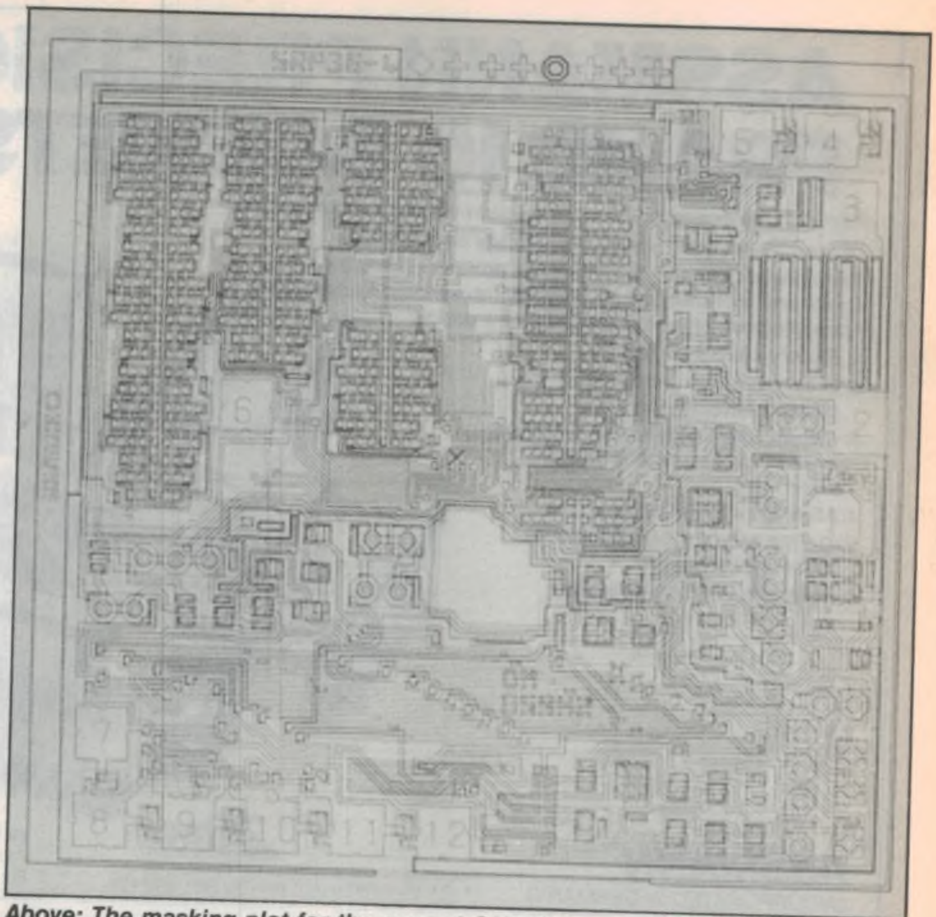


Lamp flasher chip

Market acceptance of the flasher has been particularly good, due to excellent quality control and the high resulting reliability.

The initial costs in developing micro-electronics can be high, representing a deterrent to development. In this case a clear market was available, and each company took its share of the costs and risks to develop the products which would tap and hold that market.

Where markets are not clearly established, it is usual for the user of micro-electronic products to pay the full development costs in advance of production. In this case co-operation overcame the problem.



Above: The masking plot for the current OM859 monolithic flasher chip, showing its circuitry. The chip itself is shown below.

Inside the latest chip:

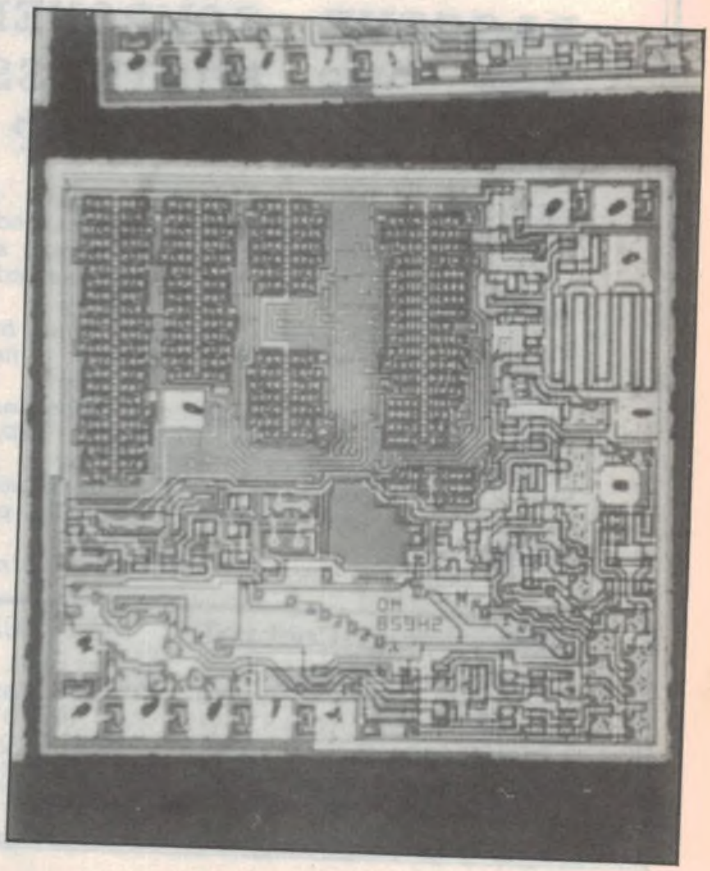
The latest version of the flasher circuit discussed in this article is the Philips OM859/1572-3-4-5 family of devices. Here the OM859 is the basic monolithic flasher controller chip, which can be supplied directly to OEM users as tested chips, in either pre-programmed or programmable form. The OM1572-3-4-5 are derivative devices, with the chip mounted on a small ceramic substrate (0.3x0.4"), encapsulated in clear plastic and provided with three pins in single in-line (SIL) format for connection to a PCB.

Each of these derivative devices is supplied pre-programmed, with different flash rates and duty cycles intended for different applications. These are summarised as shown:

Type	Flash Rate	Duty Cycle	Function
OM1572	1.16Hz	18.8%	Flasher
OM1573	1.16Hz	12.5%	Flasher
OM1574	11.6Hz	50.0%	Ripple
OM1575	-	-	Light Switch

Features of the devices include 100mA continuous output current rating, 900mA surge current rating, 4.5V to 10V supply voltage range, low off-state current drain, reverse battery protection and –30 to 100°C operating temperature range.

Further information on these devices is available from Philips Elcoma, 11 Waltham Street, Artarmon 2064.



Right: A microphotograph of an OM859 chip, before bonding. The actual chip is only about 2mm square.

Spotlight on Components:

New chip gives programmed pulse times down to 10ps

A new programmable delay device or digital-to-time converter (DTC) from Analog Devices can control time delays as small as 10 picoseconds, on a minimum full-scale span of 2.5 nanoseconds. The digital input word scales the circuit's time reference, in much the same way that a digital word scales the voltage or current reference of a DAC.

by CRAVEN HILTON & JEFF BARROW

Accurate control of pulse timing is extremely critical for all digital electronic systems. With specifications for propagation delay and access time decreasing to 5 nanoseconds or less, electronic systems must be able to achieve sub-nanosecond timing accuracy. Achieving repeatable delays of less than 100 picoseconds is possible by using an analog technique with an RC time reference. However, for some applications, system requirements dictate that delays must be digitally controlled. Until now, designers would have used a high-speed comparator to detect incremental delays on a linear ramp, and a digital-to-analog converter (DAC) to set the threshold of the comparator. But three nanoseconds is the smallest practical delay resolution attainable with this type of circuit.

The Analog Devices AD9500 is a new variable delay device, or digital-to-time converter (DTC) which performs like a high-speed counter, but can be programmed with a binary digital word. The digital input word scales the circuit's time reference in much the same way a digital word scales the voltage or current reference of a DAC.

Fig.1 shows the block diagram of the AD9500 as well as the necessary external components to form a DTC function. The circuit's timing control circuit generates a linear ramp to feed to the high-speed voltage comparator. An 8-bit digital word sets the DAC's output voltage, which in turn sets a threshold level for the comparator. When the linear ramp passes through the threshold level, it triggers an output pulse.

The input word to the AD9500 can be held in the latch for the duration of a test routine by applying a logic level "1" to the latch Enable pin (after allowing sufficient data setup time with the Latch Enable at logic level "0"). In other cases, the latch can be made transparent and can be continuously updated by holding the Latch Enable at a constant logic level "0". The digital inputs and latch are TTL-compatible.

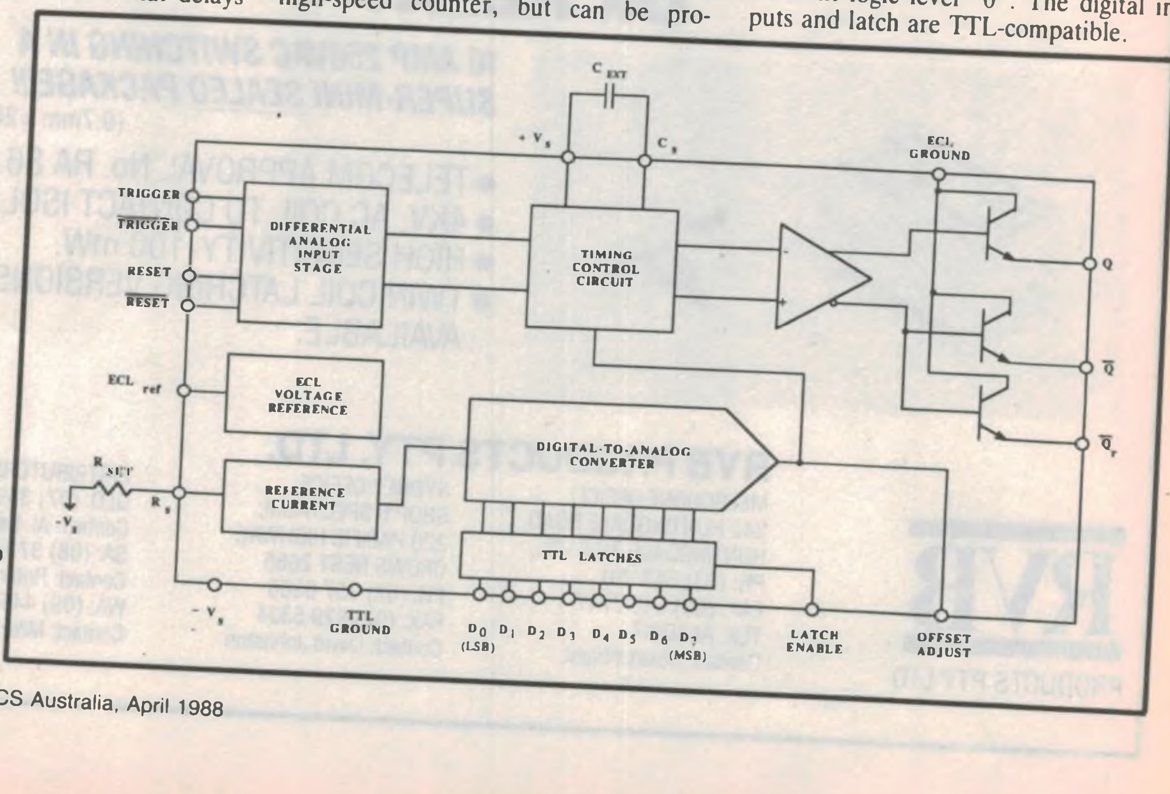
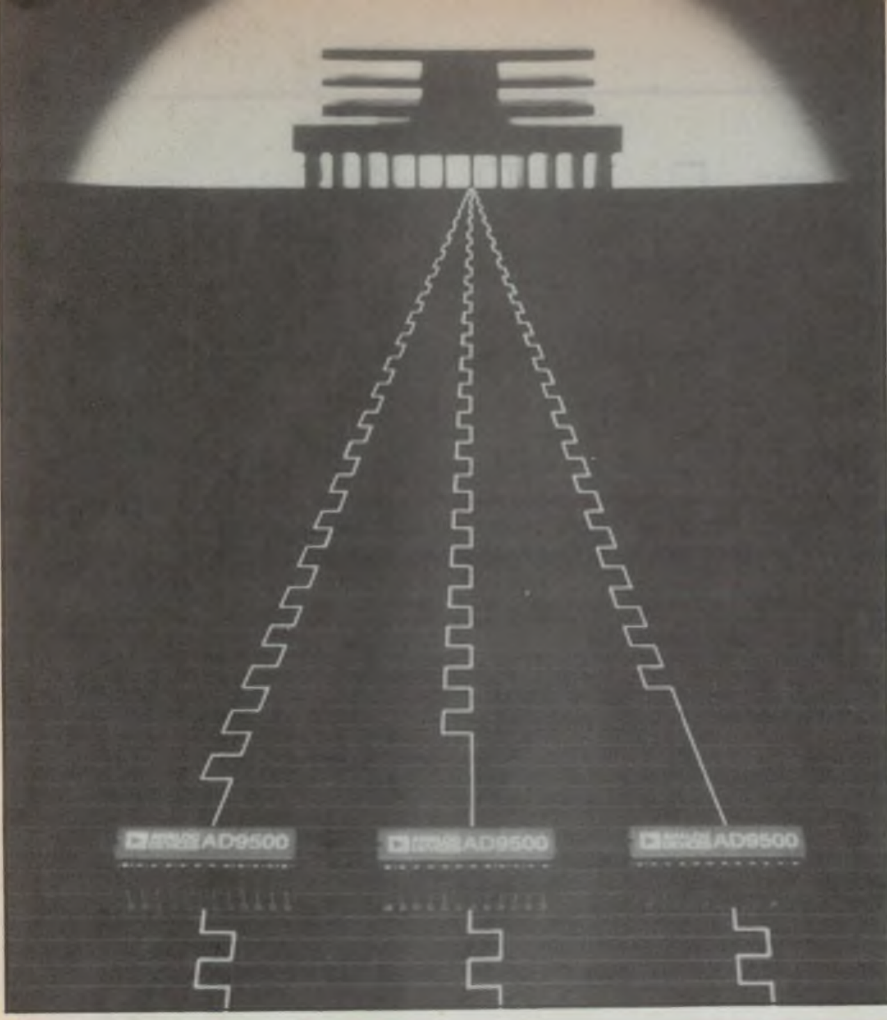


Fig.1: Functional block diagram of the new Analog Devices digital-to-time converter (DTC) chip. It operates in a similar fashion to a DAC.

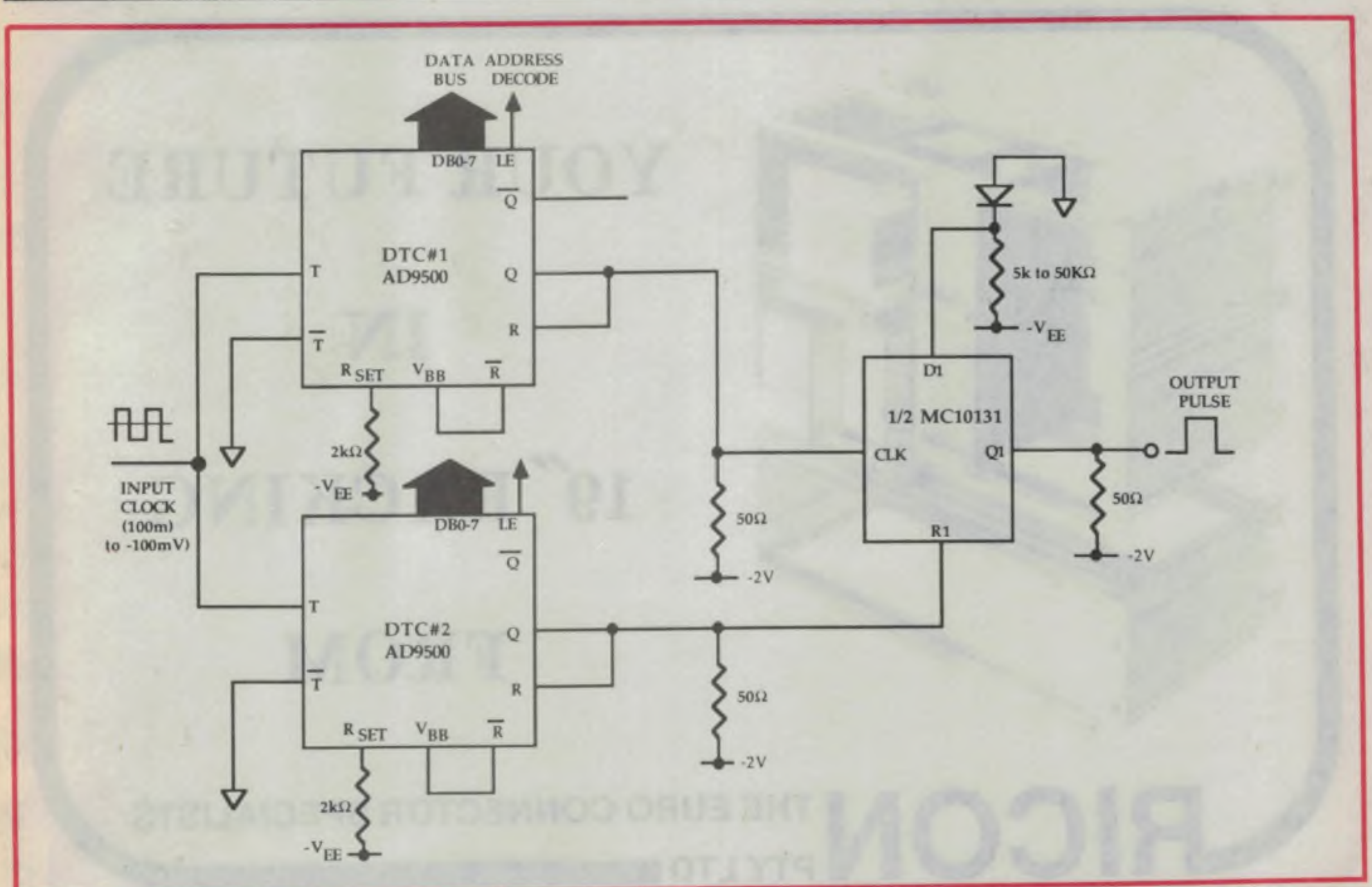


Since the DTC controls precision delays for very-high-speed signals, its delay path inputs and outputs are ECL compatible. The differential input stage controls reset and triggering of the ramp integrator. Differential inputs and outputs permit maximum timing noise immunity when interfaced to either 10K or 100K logic. The on-chip ECLREF also permits single-ended operation with 10K logic. Reset is level-sensitive, and overrides the trigger input. Reset is most frequently triggered from the programmed delay output. The trigger responds to the rising edge of the non-inverting input.

The delay trigger rate is as high as 100MHz. To facilitate matching the delay profiles of complementary DTCs, or to operate two DTCs in ping-pong to double the trigger rate in excess of 100MHz, an offset adjustment is provided.

The reference current and timing control circuits combine to form a time reference based on the values of R_{SET} and C_{SET}. C_{SET} is the sum of C_{INT} and C_{EXT}, with C_{INT} typically being 10pF.

Fig.2 (below): How two DTC chips can be used, with an ECL D-type flipflop, to produce a programmable pulse generator.



DTC chip

The gain of the DAC, slope of the ramp, and a DC offset which causes the comparator to pass over the first non-linear portion of the ramp, are all proportional to the Time Reference.

Full-scale delay from 2.5 nanoseconds to 100 microseconds is set by the external passive components. Full scale delays greater than 100 microseconds are easily achievable, but linearity and repeatability may suffer because of the low rate of change of the ramp at the comparator input. At the shortest full-scale range of 2.5 nanoseconds, the smallest incremental delay or (LSB) is 10 picoseconds.

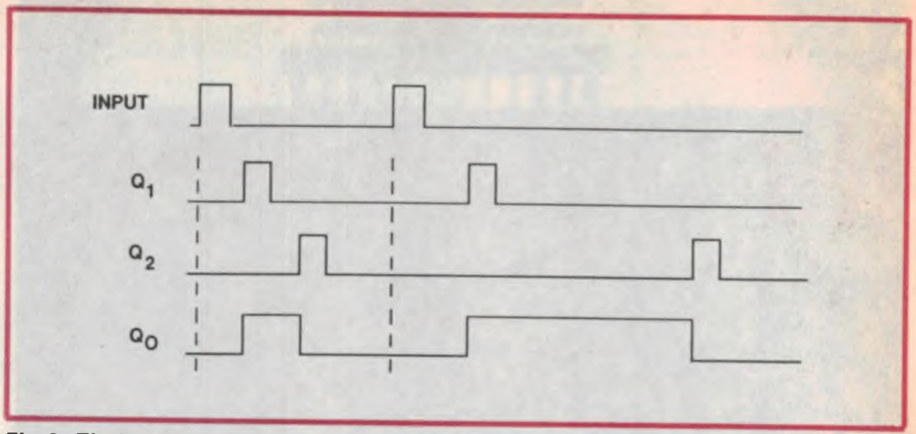


Fig.3: Timing diagrams for the circuit of Fig.2, showing how the programmable delays for Q1 and Q2 produce variable width pulses at Q0.

Programmable pulse generator

Two DTCs triggered from a common clock signal, as shown in Fig.2 can program the leading trailing edges of an output pulse. DTC #1 which produces the leading edge of the output pulse, drives the clock input of an MC10131 D-type flipflop, whose D input is biased to logic level '1' by a diode to ground and a 5—50k resistor to $-V_{EE}$. The trailing edge of the pulse occurs when the output of DTC #2 resets the flipflop by applying a trigger pulse to R1.

The timing diagram of Fig.3 illustrates that the leading edge of the output pulse occurs after the propagation delay, plus the programmed delay. Since the propagation delays of the two DTCs cancel each other (typically ±1% of FS delay without adjustment), the pulse width is the difference between the two programmed delays. The programmed delay of each DTC can be calculated by the following equation:

$$t_d = t_{pd} + XX_H/FF_H\,(R_{SET} \bullet C_{SET})$$

TTL interface

The AD9500 can be used in TTL circuits by utilising two diodes as the input clamps, and a high-speed comparator, such as the AD9686 as the output ECL-to-TTL translator. The comparator is recommended over a logic translator because it offers differential inputs and outputs which provide more noise immunity.

Further information on the AD9500 is available from Parameters, 1064 Centre Road, Oakleigh South 3167.

Spotlight on Components:

New Components

Terminal strips

E.S. Rubin carries a comprehensive range of Contact-Adel terminal strips to suit every application from transformer mounted versions to PCB style, which are stackable in groups of two or three pins. With pin spacing of 5.08mm these are ideal for PCBs in power supply units.

The terminal strips are equipped with wire protection that provides a suitable unit for stranded wiring.

E.S. Rubin has offices in Sydney, Melbourne, Adelaide and Perth.

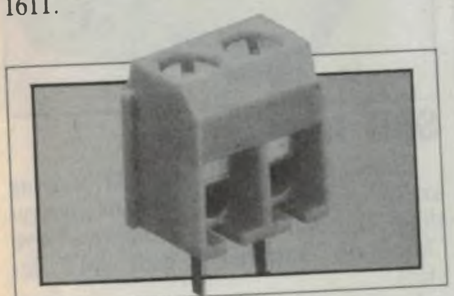
900MHz RF relay

The RG Series relay from Matsushita is part of a developing range of RF switching devices under the National banner. Measuring only 25x23x9.4mm, the 2 c/o relay offers a minimum isolation of 65dB at 900MHz and a maximum insertion loss of 1.0dB at the same frequency.

The RG relay offers either single c/o or 2 c/o contacts rated at 1A/24V DC and is available with 50Ω or 75Ω matching impedance. Coil voltages are from 3V to 48V DC in single side stable single or two coil latching versions.

Applications for the RG relay include EtherNet and other high frequency local and wide area networks, video signal diversion, measuring and test equipment, CATV and MATV, and carrier equipment.

Further information is available from RVB Products, 242 Huntingdale Road, Huntingdale 3166. Telephone (03) 543 1611.



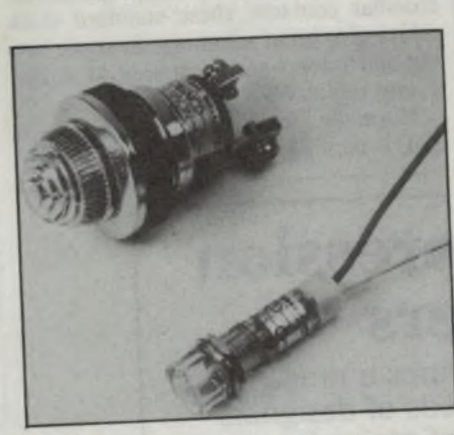
Modular terminals

The PCT 1.5 Modular Terminal has been designed to give the smallest plan area of printed circuit board, with screw clamp connections, and captive screw, for flexible, stranded and solid conductors up to $1.5mm^2$. Terminal body is moulded in orange polyamide 6.6 two way and three way with interlocking dovetails to permit any number of ways to be built up. To accommodate manufacturing tolerances, 24 way is the maximum recommended.

It has been designed and tested to comply with VDE 0110, Groups A, B and C.

Marking strips are available for identification.

Further information is available from Klippon Electricals, PO Box 323, Penrith 2750. Telephone (047) 35 4211.



Panel lamps

Novatech has released a new range of neon and incandescent lamps for industrial control panels and electrical appliances. Panelamps offer quality, reliability and safety in a range of colours and operating voltages.

Features include low power consumption and heat output, long operating life, and operating voltages of 110V, 240V, 415V AC (neon) and 24V DC (incandescent) — with other voltages available on request.

The PL10 range features a round cheese-head lens of 10mm diameter. This model is supplied with pre-stripped leads or solder terminals.

The Pl25 range features a round convex lense of 215mm diameter. Wiring is terminated with screw lugs.

For further information contact Novatech Controls (Aust), 429 Graham Street, Port Melbourne 3207.

Low voltage zeners

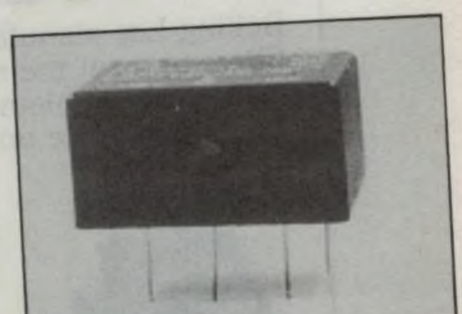
TRW Optoelectronics Division has released two new LVA zener diodes, which exhibit considerably sharper breakdown characteristics than normal zeners in the 4-10 volt range.

Above 10 volts, the breakdown mechanism of zener regulators is avalanche, which produces a very sharp knee and provides good voltage regulation. Below 10 volts, the field emission phenomenon starts, and as the operating voltage decreases field emission accounts for an increasingly higher percentage of the device breakdown mechanism.

In the LVA device the field emission breakdown mechanism is suppressed, producing a predominantly avalanche breakdown in the voltage range that has historically been characterised by soft, field emission knees.

The LVA comes in two packages, the standard axial lead hermetic DO-7 package and also a surface mountable hermetic leadless chip carrier package at very competitive prices.

For further information contact Total Electronics, 9 Harker Street, Burwood 3125.



Hall effect current sensors

LEM has announced an addition to the bottom end of its range of Hall Effect Devices.

The LASO-P measures from 0 to 70A and provides an output current proportional to the primary current with galvanic isolation between the primary and secondary.

Further information from Fastron, 11 Kembla Street, Cheltenham, 3192. Telephone (03) 584 8988.

New Components

D connectors

Utilux has released a range of crimp removable subminiature "D" connectors and accessories.

Connectors are available in circuit sizes of 9 through to 50 whilst crimp contacts are available in either loose or reel form, with three styles of selective gold plating which accommodate conductors of 20 through to 28 AWG.

Accessories include plastic and metallised hoods for use with screwlocks, cable back shells for clip and retainer attachment and a slide latch assembly.

For more information contact the Utilux Electronics Division at 14 Commercial Road, Kingsgrove 2208.

Miniature relays

Cornell-Dubilier miniature enclosed printed circuit 800 series relays require only 39 square mm of printed circuit board area. With 2 amp palladium crossbar contacts, these standard stock relays give great advantage in space saving and price when compared to similar 2 amp relays.

Normally available from stock in SPDT configuration and SPDT, SPST-NO or SPST-NC on a special order basis. Special types are also available up to 5 amp rating.

Switching capability is consistent with most electronic outputs including, low level switching in transistor circuits, other relays, small motors, indicator lamps etc.

Coil voltages range from 3V DC — 28V DC. Size of relay is 32(L) x 31.5(W) x 20.83(H).

For further details and free catalog contact Crusader Electronic Components, 81 Princes Highway, St. Peters 2044.

Realtime clock module

The Fox RTC-72421 realtime clock module is designed for use in direct bus-compatible microprocessor applications. It features a built-in quartz oscillator and tuning capacitor, time and date functions and an integrated circuit with a 1Hz output.

The RTC 72421 is programmed in Gregorian Mode, while the RTC 32768 requires selection for leap year mode. 12 and 24 hour clock operation is provided. Access time is 120ns, compared with older models at around 2us. The CMOS IC boasts low current consumption at 10uA at 5V, compared with the RTC 32768 at 500uA. Installation is made easy by the 18 pin DIP design.

Technical information on this product can be obtained from Clarke & Severn Electronics, PO Box 129, St. Leonards, 2065. Telephone (02) 437 4199

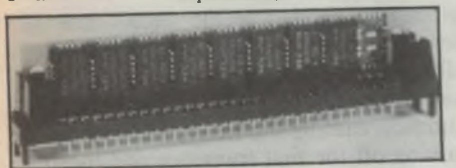
SMT training kit

Claimed to be the first SMT training kit of its type, this kit provides everything needed for a comprehensive "hands-on" experience with SMT devices.

It provides direct experience in designing circuit layouts making interconnections, mounting and detaching devices using solder, solder pastes and a new conductive adhesive.

A comprehensive 52-page illustrated manual covers surface mount terminology, descriptions and package size standards; how to do PC board layout; wiring for SMT devices; how to attach devices and hand assemble with solder, solder paste, conductive adhesive and solder reflow; how to remove devices and do board rework. It also includes names and telephone numbers of SMD manufacturers of ICs, chip capacitors, resistors, transistors and diodes.

For further information contact Current Solutions, 12A Church Street, Bayswater 3153. Telephone (03) 720 3298.



SIMM sockets from utilux

The new Molex line of SIMM sockets from Utilux can improve production flexibility and help to save PCB real estate.

The range conforms to the SIMM packaging dimensions approved by Jedec, providing more efficient contact with a plastic latch to eliminate misconnection; tighter packing; simplified assembly; faster layout; easier memory upgrades; and more options. There are ten different types of SIMM sockets including perpendicular, 45° and parallel configuration in many different circuit sizes.

For more information contact the nearest office of Utilux, or the company's Electronics Division at 14 Commercial Road, Kingsgrove 2208. Telephone (02) 50 0155.

Preassembled LED arrays, test sockets

Elma preassembled LED arrays and PCB test/programming sockets guarantee exact positioning of these components on user PCBs, simplify assembly and obviate polarity errors — hence reducing production costs.

LED arrays are available with 1, 2, 4, 8 and 16 LEDs in a row. All parts are tested before assembly, and matched to ensure uniform light intensity. Tinned leads ensure reliable soldering.

PCB test and programming sockets are available in various colours for coding. Pins are available with either gold of nickel plating, for reliability.

Further details are available from Associated Controls (Australia), 12 Green Street, Revesby 2212.

Visible-light semi-conductor laser

Toshiba has developed a new semiconductor laser that can continuously emit a visible (red light) laser beam, at room temperature, at a wavelength of 670nm — the shortest wavelength ever achieved for semiconductor lasers.

The new TOLD 9200 semiconductor laser requires only 85 milliamperes for continuous-wave operation, and has a light-output power of 3 milliwatts. Moreover, its laser life is estimated at more than 10,000 hours — long enough for practical applications.

No conventional semiconductor laser can produce visible light. Because the new device emits bright red light, it is expected to replace the helium-neon gas lasers and infrared semiconductor lasers currently used in the bar code readers of point-of-sales systems at shops, supermarkets and department stores.

Rocker switches

Kautt & Bux of Germany has recently introduced its range of rocker switches for both electrical and electronic equipment.

The switches are generally designed with a positive snap mounting feature and the operator button/levers are in various colours to easily match a customers equipment. The range includes single, double and triple pole units, changeover selection, integral signal lamp, etc. Tab connection terminals are available for 2.8, 4.8 and 6.3mm. Current ratings are up to 12 amps resistive and 6 amps inductive at 250V AC.

K & B rocker switches and full descriptive catalogs are available from Clarke & Severn Electronics, PO Box 129, St. Leonards 2065.

Surface-mount LEDs

Rohm has just released a number of new products extending their already wide range of optoelectronic devices. These include:

- SLM23 High Luminance Surface Mounted LEDs with Lens R.O.Y.G.
- SLA590/5 5mm Red High Luminance Reflector type (300-3000 mod).
- LA2216R 57mm high, 7 segment displays.
- SIM-22ST Infrared LED with small profile, low power, wide angle. Suitable for applications such as security equipment.

Further information from Fastron, 11 Kembla Street, Cheltenham, 3192. Telephone (03) 584 8988.

Basics of DC/DC converters

A number of readers have told us they really appreciated the article in our February issue explaining switch-mode power supplies. Here's a sequel, discussing DC/DC converters.

DC/DC converters are widely used to transform and distribute DC power in systems and instruments. DC power is usually available to a system in the form of a system power supply or battery. This power may be in the form of 5V, 24V, 48V or other DC voltages. Further, the voltage may be poorly regulated and have high noise content.

A common use of DC/DC converters is in local power distribution applications, such as the one shown in Fig.13. Here the system power source provides a regulated 5V power bus which typically goes to a number of individual circuit boards. Each circuit board in addition to its logic circuitry, requires ±12V DC, ±15V DC or other voltages to power operational amplifiers, A/D and D/A converters, transducers, displays or other circuits.

Therefore each system circuit board may have one or more DC/DC converters, using the 5V power bus as an input and producing the other voltages required on the board.

Another common requirement for DC/DC converters is in transforming a battery voltage into another more useful and well-regulated voltage, for powering circuits and systems. A typical battery voltage may be 12, 24 or 48V DC, each used in specific applications. The output voltage of the battery can vary over a wide range, however.

For example, a 12V vehicle battery may go to 15V or higher during charging and as low as 6V while starting the engine. In such an application for a vehicular electronic system, the DC/DC converter is required to accept this wide input voltage range and produce a stable, well-regulated output voltage to run the electronic system.

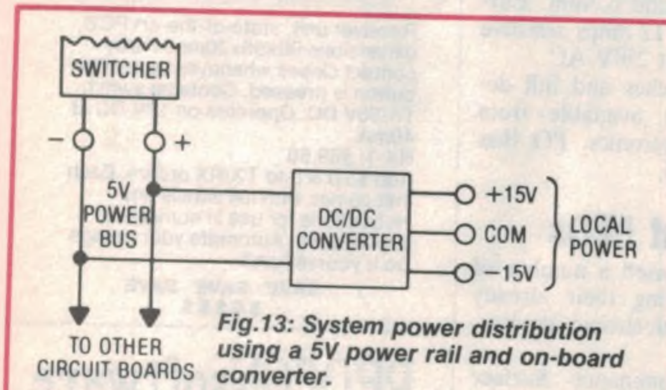


Fig.13: System power distribution using a 5V power rail and on-board converter.

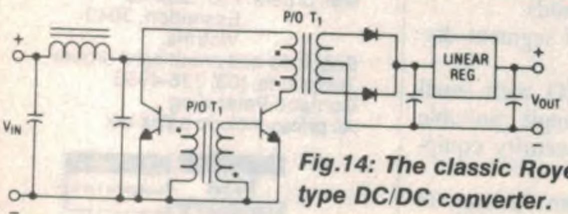


Fig.14: The classic Royer type DC/DC converter.

Classical type DC/DC converter

Fig.14 shows the classical, or Royer, type DC/DC converter circuit. The transistor switches operate in a push-pull configuration with a centre-tapped transformer.

When input voltage is first applied to the circuit, one of the transistor switches begins to turn on. The transformer provides positive feedback to the base of this transistor, turning it on hard. This switch remains on until the magnetic flux of the transformer saturates, causing the transformer voltages to reverse, thereby turning off the first transistor and turning on the second one.

The circuit continues to self-oscillate and produces an output square wave of voltage which is full-wave rectified and filtered. This rectified square wave, before filtering, appears as shown in Fig.15. Since the square wave is of high frequency, with a relatively fast rise and fall time, it is relatively easy to filter with an electrolytic capacitor.

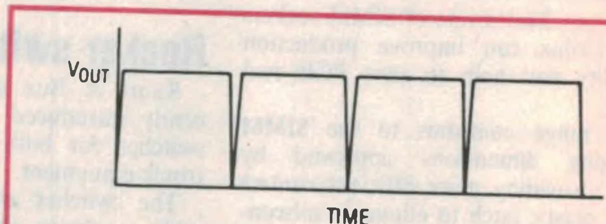


Fig.15: Converter output voltage after rectification.

The rectified and filtered square wave, however, is not regulated, and any change in input voltage will be transferred directly to the output. Regulation is provided by a linear output regulator, which gives a constant DC output voltage and also provides current-limiting and short circuit protection on the output.

The classical DC/DC converter is widely used today, providing economical DC voltage conversion. Since the regulation is dissipative in this converter, overall efficiency is generally limited to about 65%. As in the linear power supply, the linear regulator must operate with sufficient voltage drop across the series pass element at the minimum input voltage to the converter. This establishes one's operating point.

As input voltage increases, the drop across the series pass element and the dissipation increase directly. Therefore, to maintain reasonable efficiency, the input voltage range is usually ±10% with some units as wide as −12% to +30%.

The switching regulator

A popular type of DC/DC converter is the switching regulator, shown in Fig.16. This is a three-terminal, non-isolated circuit which converts a higher DC voltage into a lower one with a typically wide range input voltage; the input voltage range may be as high as 4 to 1. With this type converter output power levels to 300 watts are achievable. The configuration is the same as that of the buck regulator described earlier in the article on switching power supplies.

The output voltage is compared with a reference voltage

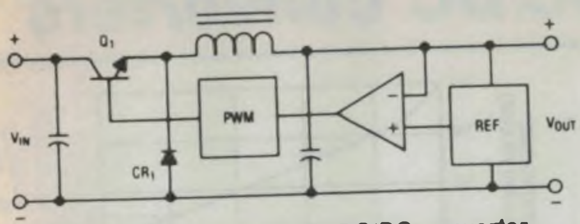


Fig.16: A three-terminal DC/DC converter.

and the difference is amplified to drive a pulse-width modulator, which in turn drives the switch. The energy stored in the inductor is determined by the on-time to off-time of the switch. Current flows through the inductor during both halves of the switching cycle, either through Q_1 or through CR_1.

Wide-range input DC/DC converters

To achieve a wide input voltage range of ±20% or greater with high efficiency, a DC/DC converter must operate like a switching power supply, employing pulse-width modulation with either a flyback or forward conversion circuit.

Fig.17 shows such a DC/DC converter circuit using the flyback conversion technique. This circuit works identically to the flyback type switching power supply described earlier. Most DC/DC converters are isolated from input to output, and this requires that the feedback loop be isolated. The isolation is normally provided by a small transformer or opto-isolator circuit.

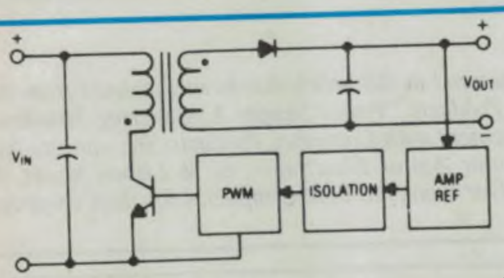


Fig.17: Flyback type DC/DC converter for wide input voltage range.

An example of a DC/DC converter using forward conversion is shown in Fig.18. This circuit employs a power MOSFET switch, which can operate at higher frequencies than bipolar transistors. When the switch is on, the voltage is transferred to the secondary winding and applied to the output inductor which stores energy. This circuit operates just like the forward converter switching power supply described previously and can operate with greater than a 2 to 1 input voltage range.

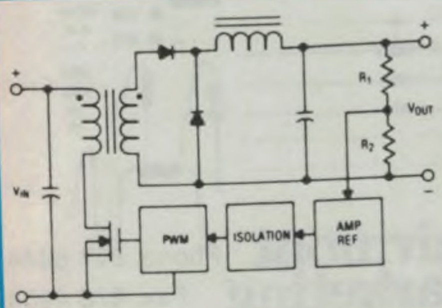


Fig.18: A forward DC/DC converter using a power FET switch.

Reflected ripple current

An important specification for DC/DC converters is the input reflected ripple current. This is defined as the AC current generated at the input of a DC/DC converter by the switching operation of the converter, and is fed back to the DC voltage source. It is usually stated as a peak-to-peak current.

One of the ways in which reflected ripple current is generated can be seen in Fig.14. With the classical type DC/DC converter circuit, there is a very short period of time when the transformer core goes into saturation and the converter input looks like a low impedance. This means that a large current pulse is drawn for a fraction of a microsecond, while the conducting transistor is turning off.

Reflected ripple current is present not only in DC/DC converters but also in switching power supplies. In both cases this ripple current can be suppressed by an input pi filter as shown in Fig.14. This filter effectively smooths the current spikes to a peak-to-peak value that is a few percent of the DC input current; typically the current ripple is reduced by a factor of 100 by the input filter.

Most high performance DC/DC converters have an internal pi filter for this purpose.

Another circuit technique that reduces the amount of reflected ripple current is separating the drive transformer from the power transformer in a DC/DC converter such as the one shown in Fig.14. The self-oscillation and transistor drive then takes place at a much lower power level by having a smaller transformer go into saturation. This substantially reduces the effect which causes reflected ripple current.

Unregulated DC/DC converters

There are many applications of DC/DC converters where the input voltage is from another regulated power supply and also where load current is relatively constant. In such cases, in addition to those applications where regulation is not a critical requirement for other reasons, an unregulated DC/DC converter is frequently used.

The advantage of an unregulated DC/DC converter is that it has a significantly higher efficiency than the classical converter, in many cases achieving 80% efficiency or higher. Because of this it is usually possible to deliver more output power to the load from the same size package.

An unregulated DC/DC converter is shown in Fig.19. It is basically identical with the classical converter design except

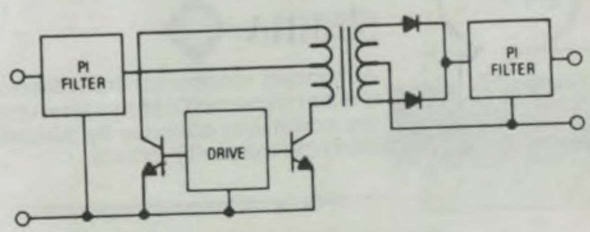


Fig.19: Unregulated DC/DC converter.

that there is no linear output regulator. Instead, there is additional output filtering done by a pi filter to reduce output voltage ripple.

Unregulated DC/DC's usually have a special output short circuit protection circuit, since there is no linear output regulator.

DC/DC converters

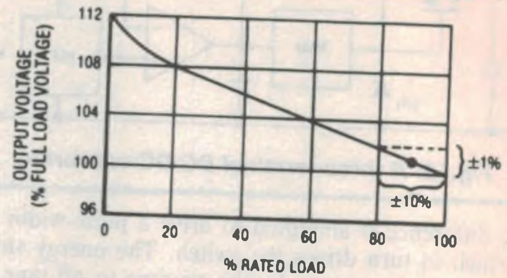


Fig.20: Load regulation for unregulated DC/DC converter.

Since this circuit is unregulated for either line or load, any changes in input voltage feed directly through to the output. A typical load regulation curve is shown in Fig.20. As the load current decreases from 100% rated load to 20%, the output voltage rises by 8%. However, if the load is relatively constant at say 90% of rated load ±10%, the output voltage will change by only ±1%, which is satisfactory for many applications.

The material in this article has been extracted from the Computer Products "Power Supply Engineering Handbook", by arrangement with Computer Products, Inc. and its Australian distributor Amtex Electronics, of 36 Lisbon Street, Fairfield 2165. Our thanks to both companies for their co-operation.

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COMMON ABBREVIATIONS

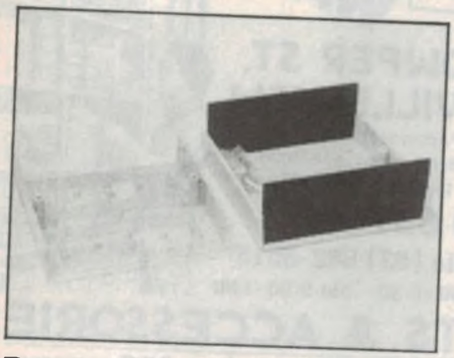
Here is a listing of the main abbreviations and acronyms you'll tend to find in modern electronics.

AC	alternating current
ADC	analog-to-digital converter
AF	audio frequency
AFC	automatic frequency control
AFSK	audio frequency-shift keying
AGC	automatic gain control
AM	amplitude modulation
ASCII	American Standard Code for Information Interchange
ASIC	application-specific integrated circuit
BIOS	basic input-output subsystem (software/firmware)
CAD	computer-aided design or drafting
CAE	computer-aided engineering
CAM	computer-aided manufacture
CCD	charge-coupled device
CD	compact disc
CIM	computer-integrated manufacturing
CMOS	complementary metal-oxide semiconductor
CPU	central processor unit
DAC	digital-to-analog converter
DC	direct current
DFM	digital frequency meter
DIL	dual in-line (packaging format)
DIN	Deutscher Industrie Norm (standards body)
DIP	dual in-line package
DMM	digital multimeter
DOS	disk operating system
DRAM	dynamic RAM
ECL	emitter-coupled logic
EEPROM	electrically eraseable PROM
EFT	electronic funds transfer
ENG	electronic news gathering
EPROM	eraseable PROM
FET	field-effect transistor
FFT	fast Fourier transform
FM	frequency modulation
FO	fibre optics
FSD	full-scale deflection
FSK	frequency-shift keying
GaAs	gallium arsenide
GPIB	general-purpose interface bus (IEEE-488)
IC	integrated circuit
IEEE	Institution of Electrical & Electronics Engineers (US standards body)
IR	infrared
ISO	international standards organisation
LAN	local-area network
LCC	leadless chip carrier (device package)
LCD	liquid-crystal display
LED	light-emitting diode
LSB	least significant digit
LSI	large-scale integration or integrated
MOS	metal-oxide semiconductor
MOSFET	MOS field-effect transistor
MSB	most significant digit
MUX	multiplexer
Ni-Cad	nickel-cadmium (secondary cell)
NMOS	N-type substrate MOS
NPN	P-type base form of bipolar transistor
NTSC	US TV standard (National Television Standards Committee)
OEM	original equipment manufacturer
OSI	open systems interconnect (data comms model)
PAL	phase-alternating line (Aust/UK/ German TV stand.)
PC	personal computer
PCB	printed circuit board
PGA	pin-grid array (device package)
PLCC	plastic leadless chip carrier
PLL	phase-locked loop
PMOS	P-type substrate MOS device
PLA	programmable logic array
PLD	programmable logic device (generic term)
PROM	programmable read-only memory
RAM	random-access (read/writ e) memory
RF	radio frequency
RMS	root mean square
ROM	read-only memory
RS-232C	asynchronous serial interface standard
SECAM	French colour TV standard (field sequential)
SCSI	small computer systems interface
SIL	single in-line
SIP	single in-line package
SMD	surface-mounted device
SMT	surface-mount technology
SOT	small outline transistor
SRAM	static RAM device
UART	universal asynchronous receiver-transmitter
USART	universal synchronous/asynch receiver-transmitter
UV	ultraviolet
VLSI	very large-scale integration

SI standard multipliers and contractions:

T = terra (trillion, or million million)
G = giga (thousand million)
M = mega (million)
k = kilo (metric thousand or 1000)
m = milli (thousandth)
u = micro (millionth)
n = nano (thousand-millionth)
p = pico (billionth)
f = femto (thousand-billionth)

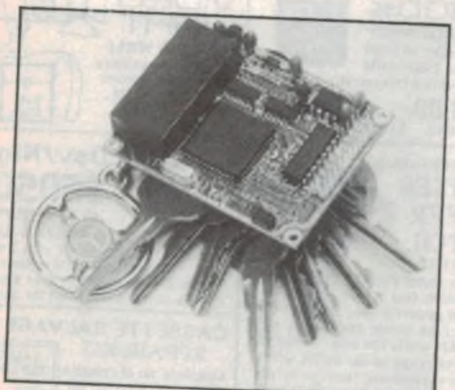
New Products



Project cases

Jaycar Electronics has added a smaller size model to its popular range of four-piece utility cases. Measuring 155 x 65 x 158mm (w x h x d), the new case is well suited for smaller electronics projects and equipment. The top and bottom are moulded from light grey plastic, with the front and rear panels from black plastic. The interior of top and bottom are provided with convenient mounting posts for PCBs, transformers, etc.

The Jaycar catalog number of the new case is HB 5913, and its retail price is $12.95. It is available from all Jaycar stores, or from Jaycar Electronics at 115-117 Parramatta Road, Concord 2137.



Digital voice scrambler

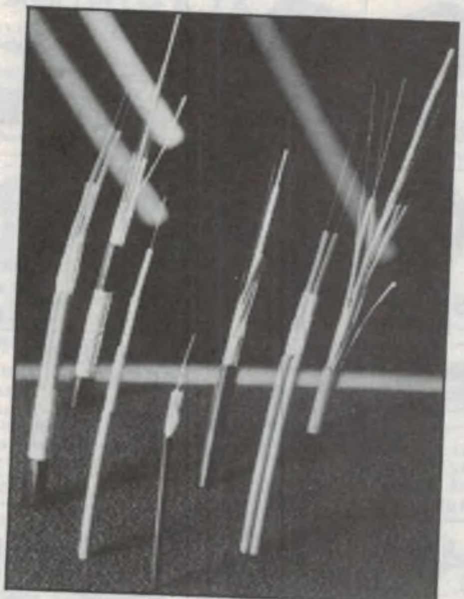
GSA Technology has announced the release of a digital voice scrambler for radio network users. The GSA 1300A digital Voice Privacy Device (VPD) will provide commercial and government radio users with a very high level of speech security.

The GSA1300A series offers 8, 16 and 32 segment time-domain scrambling offering medium, high and very high levels of communication security.

This VPD is thought to be the most advanced of its kind to be designed and manufactured in Australia. Application of surface mounted CMOS technology, and auto processor stand-by ensures that the GSA1300A consumes a minimum of power from the host radio. This makes it suitable for installation into portable radios where battery life is most important.

A hand held programmer has also been developed to program keys into the GSA1300A series. Application of this unit is simple and keys can be changed regularly if desired.

Further information is available from GSA Technology, 511 Keilor Road, Niddrie 3042. Telephone (613) 379 1828.

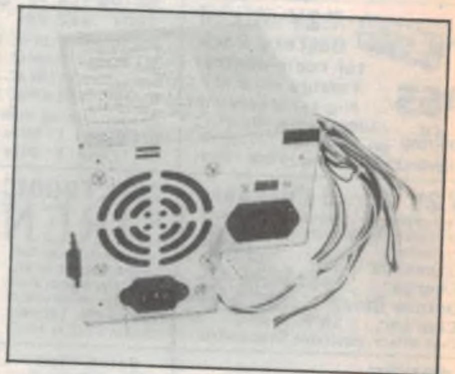


Fibreoptic data cables

Belden Electronics now offers 62.5/125 micron (core/cladding) fibre optic cables for data and local area network communications. Two optical performance levels are available: cables with a high performance attenuation of 3.75dB at 850nm and a 160MHz-km bandwidth (1.75dB/km at 1300nm — 500MHz-km bandwidth) which meet the optical requirements of the IBM 3044 channel extender system, and a second set of cables with an attenuation of 5.0dB/km at 850nm and a 100MHz-km bandwidth (3.0dB/km at 1300nm — 200MHz-km bandwidth).

These dual window optical fibre cables are available in both loose and tight buffer construction with strength members of Kevlar, fibreglass epoxy rod, steel or a combination of fibreglass epoxy and Kevlar. The number of fibres in each cable can vary from one to 18 with cable jackets of either polyurethane, PVC or polyethylene. The heavy duty cables also have an inner PVC jacket.

For additional information contact Belden Electronics, PO Box 322, Clayton 3168. Telephone (03) 240 0448.



180W AT-compatible switcher

Electronic Solutions has released a 180W switch-mode IBM PC/AT supply priced at only $180, around half the price of the opposition.

The supply is a high efficiency switching type and is a direct physical replacement for the IBM PC/AT supply. It features hard disk and floppy disk power connectors as well as connectors to the motherboard.

Specifications include 85-130V or 180-265V AC input voltage at 47-63Hz; and an efficiency of 68%.

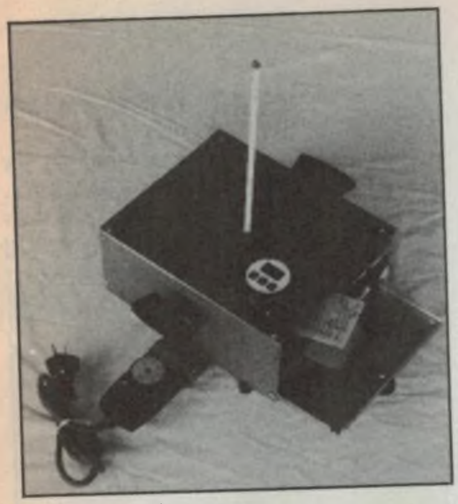
Features of the supply include a built-in EMI filter, over voltage protection, short circuit protection and 100% thermal cycle and burn-in.

For further information contact Electronic Solutions, Box 426, Gladesville 2111.

PCB oven

Precise control over PCB resist curing temperature and time is possible with the PC Oven from Sesame Electronics.

The cabinet has a hinged sidewall and an external heater, and will take PCBs up to 25cm x 20cm. There is a dial thermostat, a thermometer, and a digital



countdown timer.

The oven joins Sesame's UV Lightbox and Bubble Etcher in a line of equipment for PC prototyping.

Further information from Sesame Electronics, PO Box 452, Prahran 3181. Telephone (03) 527 8807.

22 bit ADC

A new 22-bit analog-to-digital converter (ADC) from Analog Devices, the AD1175, is claimed to be the industry's most accurate ADC. Maximum +0.5ppm integral nonlinearity (INL) and maximum ±0.5LSB differential nonlinearity (DNL) insure accuracy of 20 bits or more. High stability extends accuracy over a wide operating temperature range: ±1ppm/°C maximum gain drift, ±0.5uV/°C maximum zero drift, ±0.005ppm/°C DNL drift, and ±0.02ppm/°C INL drift.

Designed for scientific instrumentation, weighing equipment and test and measurement systems, the AD 1175 provides a low-cost alternative to expensive benchtop instruments. By mounting the ADC on an I/O card, a personal computer can be transformed into an accurate 6.5-digit voltmeter.

Under internal uP control, the AD1175 performs an analog-to-digital conversion using an auto-zeroed, multi-slope, integration technique. Either 20 or 16 conversions per second are selectable to eliminate the effects of 60 and 50Hz line noise, respectively. Software commands also control offset adjust, coarse gain adjust, an external offset null, and conversion initiation. The AD1175 performs an autozero calibration once during every conversion with no reduction in the throughput rate.

Further details from Parameters, 1064 Centre Road, Oakleigh South 3167.

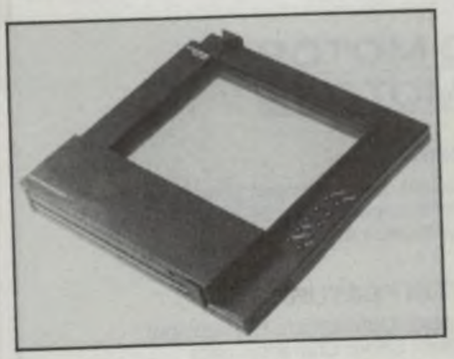
Intelligent thermostat

The Enerstat system 3 plus 2 microcomputer thermostat is designed to allow a single heating and cooling system to control from 3 to 5 zones. Each zone is controlled by its own space thermostat and motorised damper which interfaces with a microprocessor based logic panel. This logic panel then puts the system in the proper mode of operation and brings on the correct number of stages of heating, cooling or economiser.

The unit will handle multi-stage and heat pump systems, incorporating either manual or automatic changeover.

Features include built in time delays, compatibility with the W973 controller, automatic or intermittent fan and anti-short cycle protection.

For further information contact Valera Corporation Australia, 37 Benwerrin Drive, Burwood East 3151. Telephone (03) 233 5744.



PC display via overhead projector

Compatible with the most advanced personal computers and workstations, the Electroboard Personal Computer Viewer enables all information displayed on the computer screen to appear on a wall screen, projected via an overhead projector. The data can be interactive, real-time, or in a presentation format.

Electroboard's PCV Models 2, 3 and 4 are capable of connecting to the new IBM PS/2 range of personal computers, all models of Apple Macintosh and Apple II series, IBM compatibles plus other PCs on the market.

A key element of the new Electroboard PCV is a super twisted LCD plate with pixel resolution of 640 x 480 pixels accommodating direct connect to the IBM PS/2 via the VGA or EGA ports without special cables, adapters or interfaces. The PCV is connected to the Apple Macintosh through the high resolution monitor port. All synchronisation is accomplished automatically.

Further information is available from Electroboard, 12th floor, 275 Alfred Street North, North Sydney 2060.

Storage system

Huliot Plastics Australia has announced a new space saving storage system, the "Multi-Store".

Multi-Store has been designed to provide neat, space efficient and inexpensive storage in a visible way. It has a range of compartment sizes, with applications such as fully hand held portable units for on site work, mobile trolley units, van racking for service calls, wall and island units for warehousing and handyman uses.

Multi-Store is constructed from high quality polypropylene which is very flexible, durable and also impact and scratch resistant. The compartments can easily be tilted to a 45° angle for filling and removing.

For further information contact Huliot Plastics, PO Box 328, Brunswick 3056.

"Super" superglue

Superglues often don't produce good bonds with natural materials such as wood, leather, cork and fabrics. The reason is that organic materials frequently have random acidic deposits. These deposits can weaken and sometimes defeat an "instant" adhesive.

To overcome these problems Loctite Australia has released the new "Prism 454 Surface Insensitive Gel". This "single" instant cyanoacrylate adhesive

New Products

bonds almost anything in less than 60 seconds. It fixtures fast on metal, plastic, rubber and ceramics as well as porous materials. As a gel, Prism 454 fills gaps, doesn't run on vertical surfaces and stays under total control at all times.

Prism 454 is only one of a new Prism range of 12 Superglues. These have been formulated for exceptional toughness to handle high impact loads and/or temperature extremes, with products for applications where bond line appearance is critical. The high purity low odour formulations are non-migrating and leave no white residue around the bond line.

For further information contact Loctite Australia on (02) 525 8366.

50MHz A/D scope

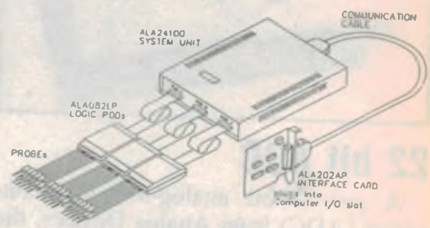
Tektronix has introduced an analog/-digital storage oscilloscope that is claimed to combine waveform storage capabilities and high bandwidth never before seen in such a low-cost scope. Tektronix' new 2210 oscilloscope, features 50MHz analog bandwidth, 20 megasample/sec per channel sampling and 8-bit vertical resolution.

The 2210 oscilloscope is suitable for users who work with low frequency, single-shot measurements and need digi-

tal storage capabilities. Applications include field and in-house service, including testing power supplies, TVs and VCRs. TV trigger is standard on the 2210 with triggering capabilities on TV lines and TV fields.

The 2210 is also suited for such varied applications as biomedical and medical research, electromechanical testing, education, production test and process control.

Further information is available from Tektronix Australia, 809 Waterloo Road, North Ryde 2113.



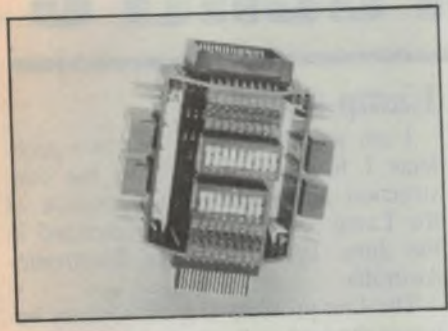
PC-based logic analyser

The Axelen ALA24100 is an adaptor that converts an IBM-PC/XT/AT or compatible into a high performance 24-channel, 100MHz logic analyser. Not only is the system extremely user friendly, but it also offers a cost advantage that makes it much more accessible compared to equivalent stand alone instruments.

All that is required with the ALA24100 is a PC with one floppy disk drive, 256Kb memory and any graphics display card.

The powerful multi-level, multi-command sequential triggering ensures that you can specify complex events precisely and thereby, capture and record the required information. In addition, data qualification can be enabled to achieve optimum use of memory, ensuring that only events of interest will be recorded.

Further information from Emona Instruments, 86 Parramatta Road, Camperdown 2050.



SMT debugging tool

The Bug Isolator is a new debugging and troubleshooting tool. Now you can easily make rapid circuit checks and changes — any pin of your socketed IC's can be isolated or reconnected by a DIP switch. Test points on both IC side and circuit side can be used to make wiring changes or to connect test equipment.

For further information contact Current Solutions, 12A Church Street, Bayswater 3153.

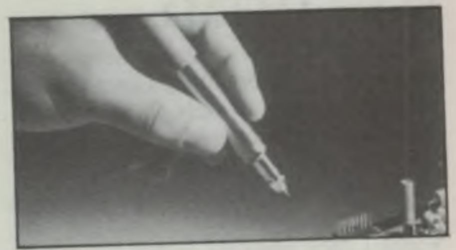
Power transducers

University Paton has released its new "Series 88" Power Transducers. The new range has been designed to incorporate the best features of both the University and Paton ranges. This combined with the latest technology available is said to have produced a very accurate and stable unit.

A feature of the new 88 series is compact size, being housed in the smallest DIN style housing possible. This miniaturises the range and allows for DIN rail or panel mounting.

The range includes Volts, Amps, Hz, Watt, Watt Hr, kVA, kVAR, Power Factor etc, and as they are manufactured locally they can be supplied with many options to customers specifications.

UPI claims that the new range is very competitive, and superior to other units available. Catalogs fully describing the range are available from University Paton Instruments, 106 Belmore Road North, Riverwood 2210.



Low-loading HF probe

A new high-frequency probe with low circuit loading has been introduced by Hewlett-Packard Australia, designed as an accessory for spectrum and network analysers. It uses GaAs technology for improved performance.

The HP 85024A high-frequency probe makes in-circuit measurements on devices such as printed-circuit boards and hybrids at frequencies higher than previously possible. It has 0.7pF input capacitance shunted by an input resistance of 1M. HP believes this to be the best available. This has been achieved by using an HP-designed GaAs IC in the probe front end.

The 3dB bandwidth nominally is 100kHz to 3GHz. When spectrum and network analysers are used, the measurement range usually is determined by the noise floor of the analyser, not the probe. Further information from HP Australia, 31-41 Joseph Street, Blackburn 3130.

Do you have any old Wireless Weeklies?

As many readers will be aware, the original magazine from which *Electronics Australia* ultimately evolved was *Wireless Weekly*, which was first published in August 1922.

At the EA office we have reference copies of the magazine going back to January 1927. But we don't have any copies earlier than this, and we'd very much like copies of the earlier issues — ideally, right back to Volume 1, No.1: August 4th, 1922.

If you have copies of these historic issues, our editor Jim Rowe would very much like to hear from you.

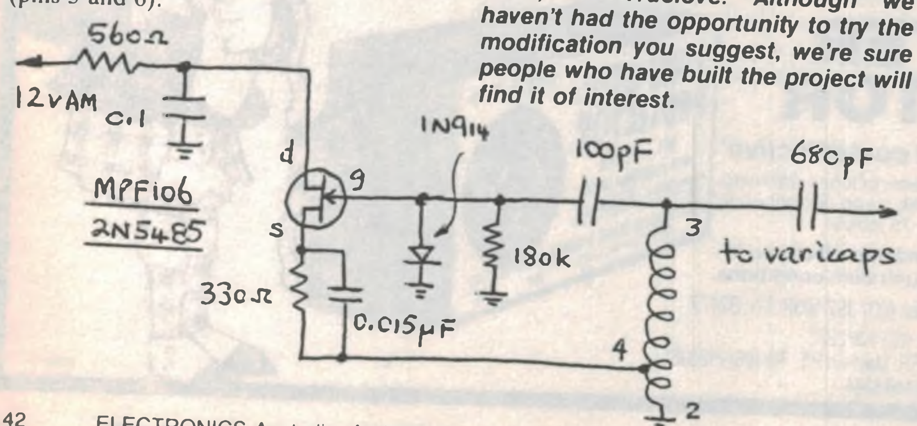
Information centre

Stereo AM/FM tuner

It is clear from correspondence published in the Information Centre that a number of your readers (including myself) have encountered problems with the local oscillator in the AM section of the Stereo AM/FM tuner. The following alternative oscillator configuration which I have installed in my tuner may be of interest to readers experiencing difficulties with the original design.

There are basically two problems with the local oscillator. First, unless the feedback winding on the oscillator coil is precisely adjusted the oscillator either delivers too much output, forward biassing the varicap diodes at the low frequency end of the band, or fails to start when power is applied. Secondly, when the resistor at the emitter of the oscillator transistor is adjusted for satisfactory operation the transistor runs at a collector current of about 10mA, too high for noise-free (hiss-free) performance. Curiously, the original article does not mention noise in describing the AM oscillator, although subsequent discussion in the Information Centre has focussed on noise in relation to the adjustment of the emitter resistor. In the high-quality AM tuner described some years ago (EA Dec 1972), Ian Pogson found it necessary to run the local oscillator transistor at no more than 1mA in order to achieve noise-free performance.

In the circuit, illustrated below, the FET is connected as a Hartley oscillator. The oscillator output can be adjusted relatively easily and the operating current is about 1mA. The oscillator coil is identical to that in the original design, minus the feedback winding (pins 5 and 6).



Retro fitting the new oscillator is straightforward. The feedback winding is removed from the oscillator coil and pins 5 and 6 linked on the track side of the PCB. Alternatively, the PCB track between pin and the collector of the oscillator transistor can be cut and a link installed between pin 6 and the collector. The FET is substituted for the BF494 oscillator transistor with pins (d,s,g) in the PCB holes corresponding to (c,e,b).

The original base bias resistors and bypass capacitor, and the emitter trimpot and feedback capacitor are removed. Most new components are accommodated in existing PCB holes. The 100pF polystyrene capacitor is mounted on the track side of the PCB. A greencap is used for the 0.015uF feedback capacitor.

The correct oscillator output is about 5V p-p at the top of the oscillator coil, which can be checked with an oscilloscope or by measuring (with a high impedance voltmeter) the voltage at the gate of FET which should be about –2V with respect to ground. The output can be adjusted by varying the source resistor in the range 220-1000 ohms; increasing the source resistor reduces the output. However, due to the wide spread in FET parameters it may be necessary to try a number of samples to obtain the correct output voltage.

Although I do not have the equipment to measure the tuner noise, listening tests suggest that the level of background hiss is lower with the modified oscillator. (J.S. Truelove, Elermore Vale, NSW)

• ***Thanks for taking the trouble to write, Mr Truelove. Although we haven't had the opportunity to try the modification you suggest, we're sure people who have built the project will find it of interest.***

Lamp saver

I am writing to point out two problems I have encountered in the construction and subsequent operation of the Lamp Saver circuit as described in the June 1986 edition of *Electronics Australia*.

The first problem is a discrepancy between the layout diagram and the circuit diagram. In the soft start section of the circuit the 1M and 100k resistors used to switch the transistor on and then off after turning the lamp on are transposed in the layout diagram.

The second problem was discovered after the circuit had been in operation for three months on a South Australian farm. The farm is supplied by a SWER (single wire earth return) line. I am told that it is not unusual for the supply voltage to rise to 270 volts under light conditions. The circuit failed. On examination it was found that the 10k 0.5W resistor had burnt out.

Replacing the resistor and measuring voltages around the circuit revealed that the voltage across the 10k resistor was 112V rms (measured with a true rms reading digital meter). The output voltage was 200V rms while the supply was 230 volts. Some thought revealed that the failure of the resistor was to be expected as it was dissipating 1.3 watts under these conditions.

My solution was to install a resistor that would not fail even if the circuit dropped the full mains voltage. After some compromise and experimentation I settled on using a 2 watt 34k resistor (made of two 68k resistors in parallel) in place of the 10k resistor. To allow the circuit to continue to apply a reasonable voltage to the lamp, I reduced the 0.22uF capacitor to the next smallest size I had available of 0.15uF. The 1/4 watt 10k resistor in series with the capacitor was then adjusted to 12k to provide an output of 215V with an input of 260V (I was after long life from the lamps as they are left on continuously).

Could you please advise me if you have had other reports of such a failure and of any solutions you or others may have suggested. Due to the suggested inclusion of this circuit in the permanent wiring of a house and the fact the kit suppliers are still selling the same kit. (I purchased another kit in January), I consider this is a problem that needs to have an appropriate solution found. (D.G., Piccadilly, SA)

• *We haven't had any other reports of similar problems with this project. However there have been two Notes & Errata published for it. One advised of the transposition of the 100k and 1M resistors in the overlay diagram, while the other advised that zener diode D5 must be a 400mW component, as shown in the original article. Apparently the circuit will not operate correctly with a 1W or higher rated zener.*

Frankly, it sounds as if your unit(s) may have been damaged by very high voltage "spikes" on your SWER power line. These can occur with these lines, particularly if they are long, and can certainly damage semiconductor devices such as the triac, the rectifier diodes D1-D4, the zener D5 or the silicon bilateral switch device. If any of these have been even partially damaged, they will need to be replaced.

In operation the power dissipated in the 10k 0.5W should be quite small, as the triac normally conducts for most of the AC cycle. We would not recommend the fairly extensive circuit changes you have made, even though they may have produced the desired output voltage in the unit concerned. Once you have found the faulty parts, we would recommend changing the circuit back to its original form.

To prevent further damage, you might consider the use of a VDR or "GE-MOV" surge suppressor, or even a lightning arrestor on the incoming power line.

Needs project PCB

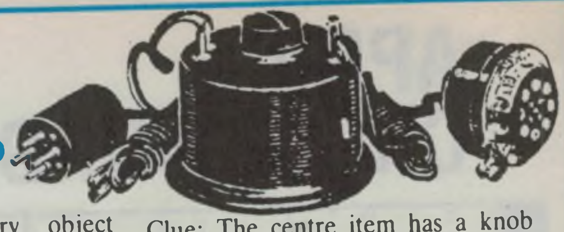
I need a PCB, code 85tf10, 161x112mm for the video fader circuit that appeared in the January 1986 issue of EA. Can you please advise where I may purchase this board?

Also I require back issues of March and April 1983 EA, are these still available? (C.A.R., Parramatta, NZ)

• *PCB boards for the video fader circuit of January 1986 and most other EA projects are available from RCS Radio, 651 Forest Road, Bexley NSW 2207.*

Back issues of March and April 1983 are no longer available but we can usually assist with photocopies of articles that you are especially interested in. Failing that, an advertisement in our Marketplace classifieds may result in one of our readers being able to provide you with these issues.

What was it?



This month's mystery object would also have been found in many home lounge rooms around 1928. It cost 3 pounds 15 shillings.

Clue: The centre item has a knob on the top, and the other two parts connect to this item via cables.

(Answer next month)

Answer for March issue:

The mystery item pictured in our March issue was a B-battery eliminator, used to replace the expensive "B" batteries which provided the plate and screen voltages for the valves of early radio receivers. Before full mains-powered sets became available, the earlier battery-powered sets were "converted" for mains operation by using one of these eliminators to replace the B batteries, and a "trickle charger" to keep a lead-acid battery charged for running the valve filaments. A B-battery eliminator was basically a transformer-rectifier-filter power supply, typically capable of providing voltages from 45 to 135V DC at a few tens of milliamps.

Frankly Frank

Continued from page 52

have come from nothing without outraging mass-energy conservation laws.

So where have our electrons come from? One theory suggests that our big bang resulted from a bubble of space-time bursting into our dimension from another. This bubble is smaller than an electron (I use the present tense as time means nothing before the Big Bang).

Why did it burst through? Well one man suggested that 'These things happen from time to time'; the dire pun will not be commented on. I am not sure I want to be the end product of something blowing the froth off the beer glass of time, but what the hell, these things happen in the best of space time continua.

We got the Electron (electron?) as our guiding light, even if it's only a probability of something or other being there for us to observe and so bring into existence.

Pity about the invention of hifi sets though, and their sale only to persons with impaired hearing whom even their own lesser gods couldn't love.

Notes & Errata

LOW COST TRANSISTOR/-FET/ZENER TESTER (February 1988, File: 7/VT/18): It should be noted that like most other simple low-current testers, this design is not really suitable for measuring the gain of high power transistors. Many high power transistors have very low gain at low current levels, and will thus give readings on the tester that are misleading when compared with their performance at intended and realistic current levels. Some high power devices also contain inbuilt base-emitter resistors, which are relatively low in value; this will prevent the tester's base bias circuit from applying anything like the intended bias current — further falsifying readings.

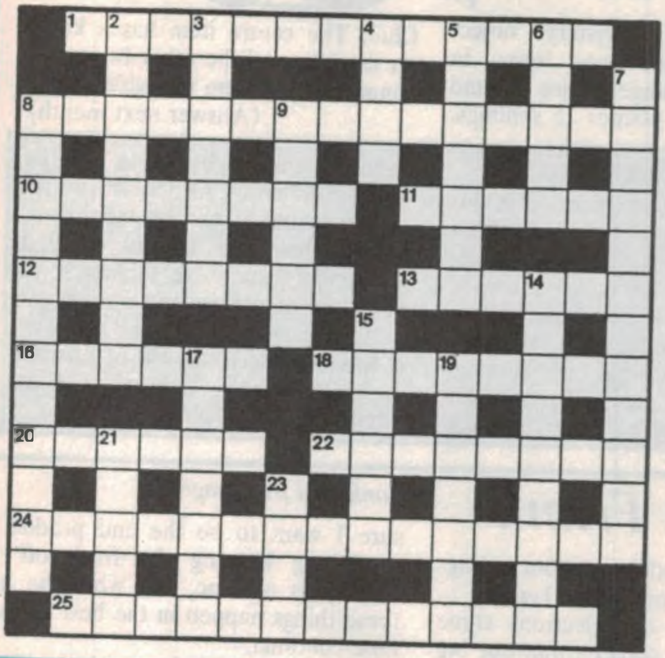
These kinds of high-power devices really need their own custom-designed tester for reliable and meaningful testing. The same tends to apply for many Darlington devices — especially those which also contain inbuilt resistors.

LOW COST TEMPERATURE PROBE (January 1988, File: 7/MS/20): The Zener ZD2 is shown reversed on the overlay diagram. Also, the resistor shown on the overlay as R8 is in fact R2 on the circuit diagram.

PLAYMASTER 60/60 AMPLIFIER(May-July 1986, File: 1/SA/74-77): Reports from kit suppliers suggest that in some cases instability can be caused by using RCA output transistors (MJ15003/4), instead of Motorola devices. This may perhaps be due to the RCA devices having higher gain at high frequencies.

Other reports suggest that some devices being offered as "bargain priced" MJ15003 and MJ15004 transistors are not brand new product, but old and possibly inferior product which has been relabelled to give the appearance of new premium product. We therefore suggest that readers exercise caution, when buying these devices.

APRIL CROSSWORD



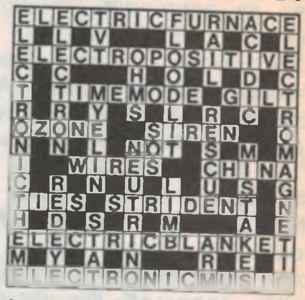
ACROSS

1. Effect of current on the body. (8,5)
8. Charge for consumption of same. (11,4)
10. Seismographs help determine such a point. (8)
11. Concerned with glass. (6)
12. Earth could be moved with this, said Archimedes. (3,5)
13. Adjunct to a magnet. (6)
16. Point allowing access to a circuit. (6)
18. Said of a transient bolide. (8)
20. Bear without resistance. (6)
22. Nature of a flip-flop. (8)
24. These pairs have equality but the signs indicate the opposite. (8.7)
25. An example of assault and battery? Possibly striking one time after time! (8,5)

DOWN

2. Touchstone's seventh degree of untruth that would send current to the polygraph. (3,6)
3. Negative electrode. (7)
4. Crystalline unit. (4)
5. Said of unstable circuits (possibly with feedback problems). (7)
6. Forerunner of electronic media, the town ——. (5)
7. Use these when no current can flow in the drains. (8,4)
8. Instrument for detecting potential difference. (12)
9. What are formed in an orthicon? (6)
14. Such is the shape of a certain kind of antenna. (9)
15. Interval determined by frequency. (6)
17. Subject to irregular conduct. (7)
19. Concerned with production after development of the prototype. (7)
21. Electrical delay of wipers. (5)
23. Level of structural unit, e.g., a cell in a voltaic pile. (4)

MARCH SOLUTION



Product Review

Continued from page 117

kind of figure if you did.

Needless to say this compares extremely well with portable electric irons using NiCad batteries. The Scope C60 was at least twice as big as the Portasol, and weighed roughly twice as much, but I suspect would be very hard pressed to achieve anywhere near the same capacity on a single charge.

I guess this is mainly due to the energy storage efficiency of butane, compared with batteries. I don't know exactly what the figures are, but I suspect there's a big difference.

There's also the time needed to refill the tank of the Portasol, compared with the time needed to recharge an electric portable. You're talking here of a few seconds, compared with hours.

Of course in practice the two kinds of iron will tend to have different applications, so it's not entirely fair to make a direct comparison.

The main point to make here is that the Portasol does offer small size, light weight, very fast "recharging", and a good range of heat adjustment. These features together with the Professional Pack's range of bits and nozzles must make it an extremely attractive approach for many applications — both in electronics and other light engineering.

One small point: the bits and nozzles for the Professional model are apparently *not* compatible with those used on the other Portasol models. This seems a pity, but presumably there's some good reason behind it.

The only other minor criticism I'd make is that the clip on the side of the Portasol's cap doesn't have any real grip. It wouldn't hold the unit in your shirt pocket if you bent over, for example. But then I suppose the iron really is a bit too large to fit in your typical shirt pocket, anyway. Perhaps they have bigger pockets and much thicker material in Ireland . . .

As I noted earlier, the sample Professional Pack I tried out came from Geoff Wood Electronics, who can supply it for $81.00 including tax. That seems very reasonable, considering how much more it can do apart from straight soldering. Replacement bits and nozzles cost $12.95 each.

Further information about the Portasol range is available from Geoff Wood Electronics at 229 Burns Bay Road, Lane Cove West NSW 2066. You'll also find Portasol products at other major electronics suppliers.

EA marketplace EA marketplace

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50 and 25 years ago..

"Electronics Australia" is one of the longest running technical publications in the world. We started as "Wireless Weekly" in August 1922 and became "Radio and Hobbies in Australia" in April 1939. The title was changed to "Radio, Television and Hobbies" in February 1955 and finally, to "Electronics Australia" in April 1965. Below we feature some items from past issues.

Wireless Weekly 3d

April 1938

Amplifier installed at Westminster Abbey: Westminster Abbey is being wired for sound. Six microphones and 70 amplifiers are involved. The system is regarded as one of the most complete and most modern in use anywhere. Special installation problems are being met in the placing of the loudspeakers. It has been possible to locate most of them so that they are invisible to the audience, but where this might impair the performance of the equipment, the speakers have been finished to match exactly their surroundings.

Philips invisible ray: Excellent use is being made by Radioplayer retailers of the Philips invisible ray device, operated by a photo-electric cell in conjunction with an amplifier and relay switch. Radio Service and Maintenance Co., used the invisible ray as an eminently successful attention-getter at the recent Maitland Radio and Electrical Exhibition. The ray was so arranged that a bell rang whenever anyone entered the door of the hall, the entrance to the stand or reached out to pick up a leaflet from the top of a Radioplayer — all by means of on the one ray.

Baird's colour television: "Before long it will be possible for a son in Australia to ring up his mother in England on the television-telephone, and, while talking to her, see her in natural colours".

So said John Logie Baird, the inventor of television, visualising the marvellous possibility — colour television — which he claims to have near perfection. A public demonstration is to be given shortly.

RADIO, TELEVISION and HOBBIES

April 1963

Pilot landing aid: Ten US aircraft carriers are currently being fitted with Pilot Landing Aid Television (PLAT) to increase the safety and precision of carrier landings. Four cameras per ship are involved in this joint Marconi-Ampex installation, two of the cameras being lined up with the optimum approach path from modified lighting blisters on the deck near the touch-down point. Videotape recording retains a record of each landing for later examination, if required.

Fastest airliner: Swissair will soon introduce the world's fastest jet airliner, an improved version of the Convair 990 Coronado. The new model of the familiar Convair has a top speed of 682mph and a cruising speed of about 620mph.

370,000,000 radios: The total number of radio receivers throughout the world has reached 370 million, according to the BBC's annual report, published recently.

This represents an increase of 56% since 1955, and it means that there were now 125 radios for every 1000 people in the world.

Philips radio products chief in Australia, Mr John Ivimey said recently that the Australian market for portable radios alone was expected to exceed 225,000 units in 1963.

Test in safety: Engineers at an American company's new indoor tyre testing laboratory at Brecksville, Ohio, have close-up views of car and lorry tyres undergoing high-speed endurance tests, without exposing themselves to injury — thanks to British television.

Constant observation of test operations is made possible by four EMI Electronics cameras, installed in two Fairbanks-Morse closed-circuit television systems.

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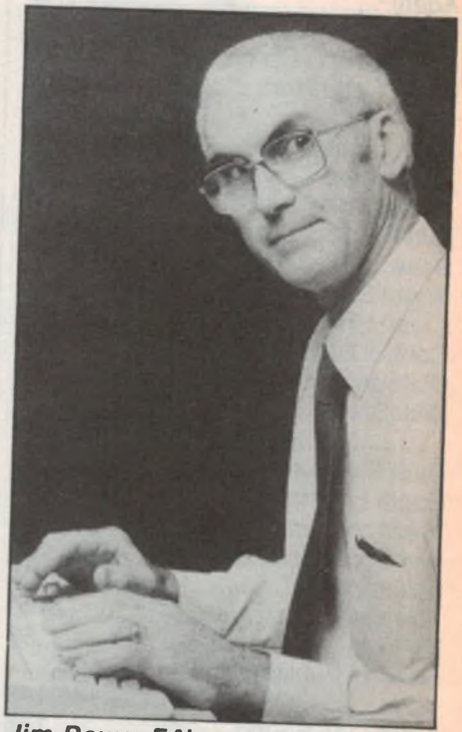

Jim Rowe, EA's managing editor

As editor of EA, I know that our readers are a pretty bright bunch. Generally you're also reading the magazine not just because you're interested in electronics as such, but because you're keen to keep up with it for your job. That means you're mainly interested in finding a magazine that will give you the most timely and informative articles, at the best possible price.

If you *are* a regular reader, I don't really have to tell you that this is exactly what you get with *Electronics Australia*. We've been striving to give you these things for the last 65 years, ever since the magazine began. It's made us the Aussie electronics magazine with by far the largest paid circulation and readership.

But because you *are* pretty intelligent people, you naturally tend to be a bit skeptical of ads trying to talk you into plunking down your hard-earned cash for 12 months or more in advance, by taking out a subscription. Fair enough.

Let's be honest. People who take out a subscription really do help us quite a lot, as well as themselves. That's why I've asked our marketing people to let me try to explain it all to you. I've also persuaded our management to let me offer you a special low subscription price, for a limited time.

So right now, there's one big reason why you should subscribe, and it's easy to explain: Instead of paying the normal news stand price of $43.45 for 11 normal issues plus the annual digest, a 12-month sub will get you them for only $30 including postage. That's a very healthy saving of just on 31%.

How can we afford to give you such a cut? I'll let you into a secret. For every reader who takes out a subscription, instead of buying the magazine off a news stand, that's roughly one LESS copy of the magazine we have to print.

Sound crazy? I can assure you it's true. For every magazine we sell on the news stands, on the average we have to print and distribute 1.9 copies. Because of the wastage in Australia's far-flung distribution system, it's almost impossible to achieve a better sales percentage than this for news-stand sales — at least for special interest magazines like EA, appealing to a relatively small proportion of the population. With smaller magazines again, it's even worse.

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But for every copy we send to a subscriber, we only have to print just that copy. There's no wastage at all — it's 100% efficient. Buy a sub and save a tree!

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Another simple reason for subscribing is the convenience. It gets you the magazine delivered right to your home or office, without any hassles and generally at least two or three days before it hits the news stands.

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Incidentally we really do value our loyal subscribers — we regard you as part of EA's "family". So much so that from now on, we've decided to offer all of our subscribers a "family discount" of 20% on things like binders and EA's own one-shot books. To say "thanks" for your continued support . . .

By the way, if you had a sub in the past and had trouble with late copies, I can assure you that those hassles are now well and truly fixed. I'm on the subs list myself nowadays, to monitor things — and they've been consistently arriving well before they hit the stands.

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