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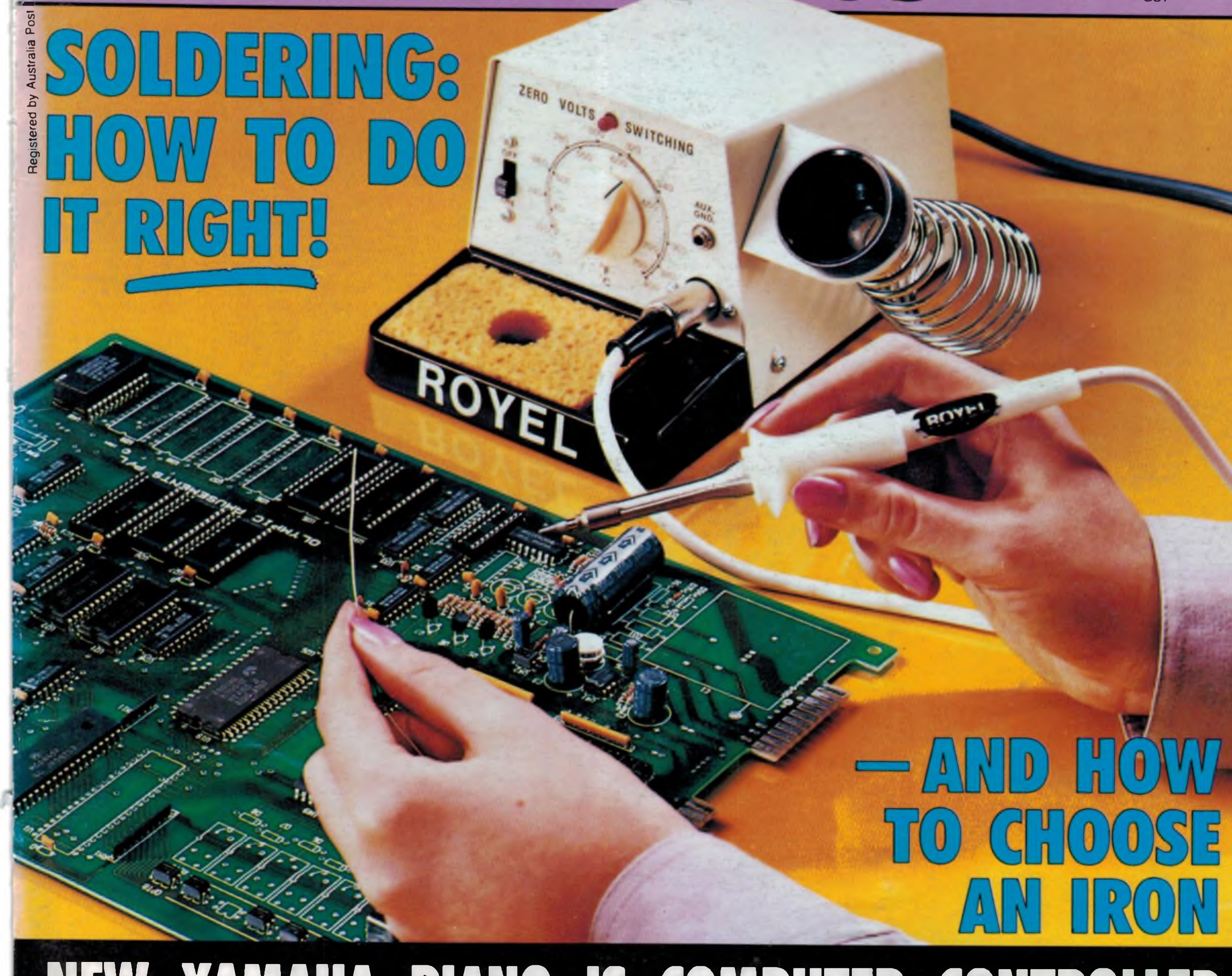

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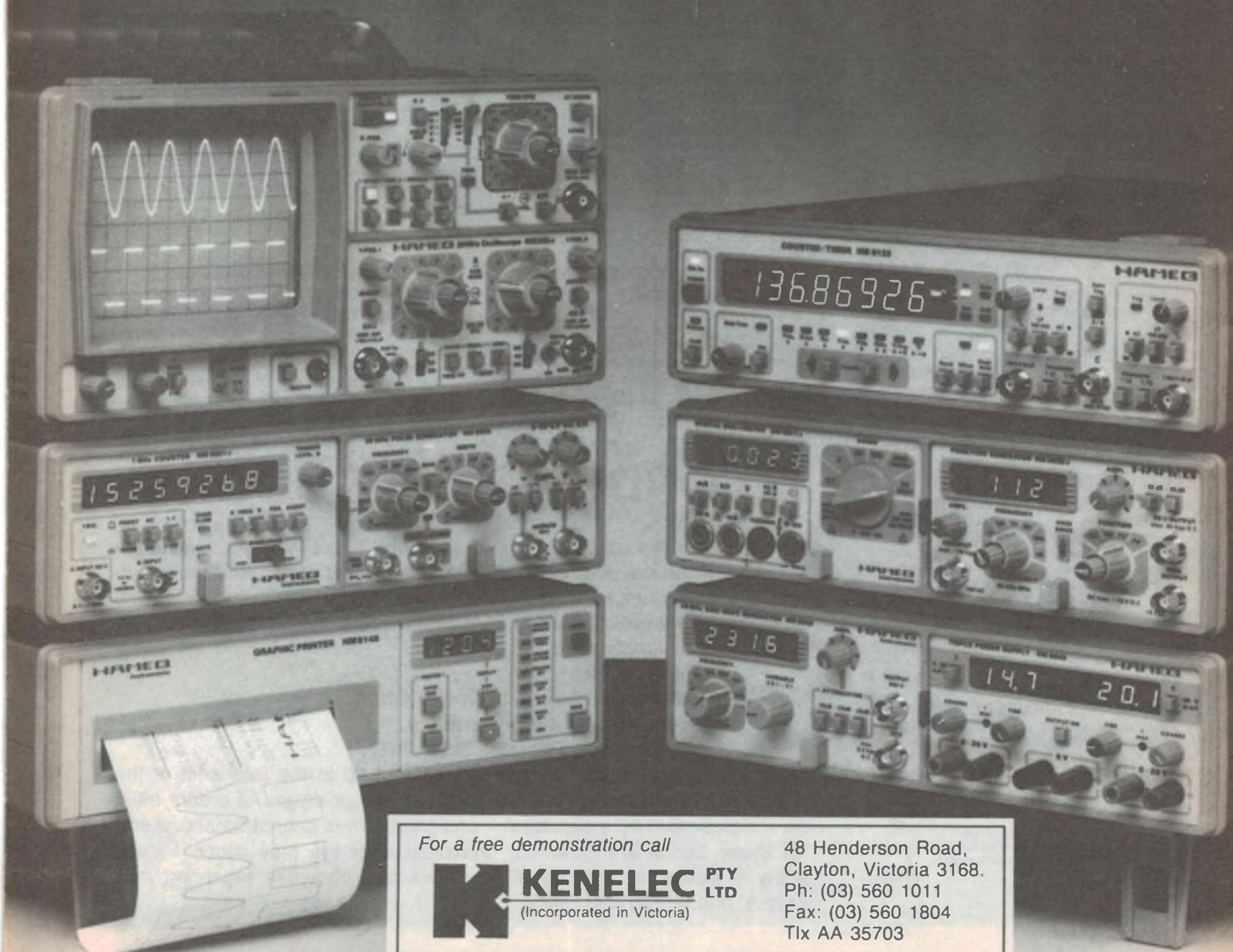

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Electronics Australia

Volume 50, No.10

October 1988

AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE – ESTABLISHED IN 1922

New acoustic piano has a MIDI interface

Yamaha has just released a new computer operated acoustic piano, with full recording and playback of performances as well as a MIDI interface. Reproducing-piano expert Peter Phillips looks it over in the story starting on page 18.

Projects to build

Our construction projects this month include an updated version of our very popular 'Powermate' 13.8V/5A power supply, an electronic doorbell that plays any 1 of 16 inbuilt tunes, a low-cost 'Audiometer' to check your hearing, and circuit details of our Universal 'Real World' interface for PCs.

Soldering feature

This month's special feature on soldering includes an introduction to basic soldering tools and techniques, and a rundown on the latest soldering products and services. (See page 114)

ON THE COVER

Soldering is essentially a fairly simple process, but there are skills to be learned. Our feature story starting on page 114 explains... (Picture courtesy Royel International)

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Entertainment Electronics

Projects and Technical

News and Comment

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Letters to the editor

Superconductor theory

In the July 1987 issue of "Electronics Australia" there appeared an article on superconductors, where it was stated that "as yet no one has been able to come up with a theory to explain just why and how superconduction actually happens."

On the contrary, on page 143 of John Gribbin's popular book on quantum theory, "In Search of Schrodinger's Cat", it is stated that "the phenomenon of superconductivity wasn't satisfactorily explained until 1957, when John Bardeen, Leon Cooper and Robert Schrieffer came up with a theory that earned them the Nobel Prize in Physics in 1972". Gribbin outlines the theory.

Dr. D. Culpin,
Wahroonga, NSW

Comment: When he visited Sydney last year, IBM researcher Dr Greg Clark said that recent discoveries of high temperature superconductors have thrown earlier theories into disarray. The June 1988 issue of "New Scientist" sums up the current situation thus: "There is no shortage of theories to account for high-temperature superconductors... The trouble now is in knowing which theory is correct.

Viatel support

It was with interest I read the letter "Not Fax, Viatel!" from Jim Lawler of Hobart (July 88). I agree with Jim's comments that Viatel provides a convenient, economical information transfer medium.

Viatel is a videotex service that can be accessed via the telephone line using a wide range of terminals and modems.

I am employed as an Applications Consultant with Telecom Australia and would be pleased to supply information and connection details to any serviceman interested in using the Viatel service.

Anyone from Queensland wishing information on Viatel can contact me on 07-837 6970 during business hours and inquiries from other states can be directed to 008 033342.

Brian Scaroni,
Telecom Australia,
Brisbane Qld.

Encouragement

After reading July's "Forum", I felt compelled to write to you. You seem to have taken a lot of flak lately, everything from spelling mistakes to the "misuse" of the apostrophe.

I felt it was about time you received some favourable letters. I really enjoy your columns/articles. I like your sense of humour and the lighthearted way in which you deal with the critics.

I guess the brickbats go with the job of editor, but keep up the good work. Try and dodge the stocks and the lynching parties for the time being.

Also so far my subscription has arrived in good time. Despite my living in the woods.

Thanks for a great column.
Robert Rose
South Hedland, WA.

Seeks old valve

Recently, I attempted to restore an Astor Mickey Radio. The radio was quite old.

After cleaning the chassis, and all the parts, including the valves, I reassembled it and replaced the power cord. Next, I gave everything a final check, and found that the shielded valve looked suspiciously black, and rattled loudly. I was quite sure it was blown, and was not surprised when it would not work.

I have since contacted several places, but I have not had any luck in finding this valve. Much of the lettering on the valve was worn, but I have managed to make out the following: Radiotron 6B8G.

Radio Parts Australia has the valve listed, but do not stock it. It is 8 pin, is shielded, and has a metal plug at the top. I would appreciate it if you could offer any thoughts on the availability of this valve.

Joseph Chan
341 High Street,
Thomastown, Vic.

Comment: You may be able to get a replacement valve from Resurrection Radios, of 53 Lang Street, South Yarra 3141 or phone (03) 820 1315; or from Orpheus Radio, of RSD B98, Ballarat 3352 or phone (053) 34 2513; or from

Waltham Dan, of 96 Oxford Street, Darlinghurst NSW, phone (02) 331 3360. Failing these, a reader may be able to help.

NiCad situation

I would like to reply to the letter by Mr Burdekin of Sigtec Systems Ltd which appeared in the May issue. Mr Burdekin is apparently of the opinion that I am an anti NiCad "protagonist". I seek to correct this impression and put the record straight.

I wrote to DSE and later to EA complaining about lack of accuracy in a particular advertisement for NiCads. As a person who has bought and used a considerable number of the cells over a period of years and who also has taken the trouble to study numerous technical articles on the subject, I felt I was in a position to offer informed, independent comment.

The advertisement was promoting the substitution of NiCad cells, sold loose, for dry cells in ordinary consumer applications like radios. It was this emphasis and inaccuracies of fact that I was complaining about. That NiCads can be used to advantage in professional, hobby, or other unusually high usage situations is not disputed. Where the equipment is used regularly and heavily, the owner knows in advance when it is needed, can purchase a NiCad pack to suit and special charger, then doing so will likely prove convenient and economical.

It is in circumstances where some or all of the above conditions DON'T apply that their purchase needs very careful consideration. The advertisement set out to convince you no cost/-benefit or potential problem analysis need be gone into, that anyone not using (DSE) NiCads was wasting money. My contention is that such advice will lead many people into doing just that. Drawbacks like low capacity, 15 hour recharge cycle and short shelf life after recharging make NiCads useless in many everyday applications.

The practice of over-selling NiCads is not unprecedented and is unfortunately still going on. Misinformation on NiCads abounds, even in the technical

Continued on page 142

Editorial Viewpoint

From spark transmitters to satellite TV – in a single lifetime!

Most of us are only vaguely aware of how far electronics technology has come since the turn of the century. Our familiarity with the *really* early days is generally limited to what we've been able to glean from books and early magazines.

When you read of things like spark transmitters, loose couplers, coherers and early valves, it's hard to appreciate just what these represented at the time – and how the state of the art then really compared with that now. It all seems so remote from things like satellite TV, compact disks and personal computers.

That's why I found it fascinating, a couple of weeks ago, to meet and listen to the reminiscences of a remarkable gentleman by the name of Mr Bob Whitburn.

Bob is 93 years old, and although his body may be a little more frail than it once was, his mind and memory are obviously as clear as a bell. He began work in Sydney in 1910, and became interested in electricity and the fledgling science of "wireless" at much the same time. By 1913 he had built his own amateur radio station – the hard way, making all his own components from scratch!

When *Wireless Weekly* started in 1922, he had already built many radio sets and other projects, and had personal contact with such near-legendary figures as Charles Maclurcan ("A charming man," he says, "and what he didn't know about wireless wasn't worth knowing, at the time!").

A long-time reader of the magazine from those early days, Bob gave up reading *EA* only a couple of years ago due to faltering eyesight. But he still remains as interested as ever in matters technical and electronic, and proudly showed me some of the projects he has built over the years.

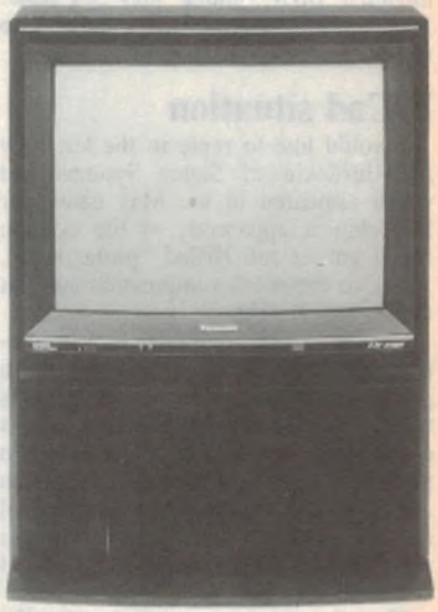
Just as I was leaving, Bob said to me "You know, I've lived through the best possible time. I've seen the development of so many exciting things like electric power, radio, motion pictures, gramophone records, aeroplanes, radar, TV, tape recording, computers, satellites, space travel – you name it! You younger blokes have missed so much!"

I guess he's right, in a way. Although there's just as much happening nowadays (much more, in fact), it's harder now for any one person to grasp the true implications of many developments, due to the much higher level of specialisation.

Perhaps no-one will ever again be able to experience such a scope and breadth of technological development as that gained by Bob Whitburn and his generation. It was an honour to meet him and have the past recreated so vividly by one who lived through it.

Jim Rowe

What's New In
Entertainment Electronics



Panasonic releases S-VHS VCRs and TVs

Panasonic has launched its first range of video recorders, camcorders and tapes for the enhanced performance Super VHS format, and also some new TV receiver models. S-VHS achieves a 400-line resolution, compared with the 260-line resolution of standard VHS, and also offers lower noise and improved colour reproduction.

The new NV-FS1 S-VHS hifi VCR employs amorphous video heads, identical to those in Panasonic's professional broadcasting VTRs, in order to maximise the quality improvement offered by the S-VHS format. This is said to offer 2-3dB S/N improvement over conventional ferrite heads. Horizontal resolution is over 400 lines in both LP and SP modes.

The NV-FS1 also includes a hifi stereo sound system and comes with features including an LCD digital scanner timer programming system, a 4-video-head system for "double super fine slow" playback, picture sharpness control, 99-channel preset quartz synthesiser tuner, audio level meters with peak hold and a one-piece aluminium die-cast chassis.

The recorder's stereo sound system provides over 90dB dynamic range, less than .005% RMS wow and flutter, and 20 – 20,000Hz frequency response.

The new NV-MS1 Super VHS camcorder also uses amorphous video heads, for 2-3dB of video S/N ratio enhancement. These are coupled with a new 420,000-pixel CCD image sensor which provides a camera resolution of 420 lines. Other features of the camcorder include a 10x F/1.4 power zoom lens with piezo auto focus, 4-speed variable shutter (1/50, 1/250, 1/500 and 1/1000s), auto iris control, auto tracing white balance, auto date recording, fadein/fadeout and a CCD sensitivity selector (7 lux minimum).

Like the recorder, the NV-MS1 camcorder also features 4 video heads and a flying erase head for insert recording. The electronic viewfinder uses a 0.9" CRT.

Also just released by Panasonic is the new TX-3370GR large-screen TV receiver, featuring a 33" (78cm) 100° super quintrix picture tube. This provides 500 lines of horizontal resolution, making the receiver suitable also for use as a high-resolution computer monitor. Other features include a stereo audio amp with 20W per channel output, a built-in graphic equaliser with on-screen display, optional stereo decoder, and 21-pin Euro connector as well as BNC/RCA video/audio inputs.

Stereo VCR from JVC

JVC'S years of experience in and development of the VHS System are reflected in the latest model, the HR-D430EA Hi-Fi Video Recorder.

Incorporating Hi-Fi stereo recording, the HR-D430EA can record up to 8 hours of audio in the long play mode, has an audio dubbing facility and music scan for up to 9 selections.

The LCD remote control is fully programmable and allows you to operate most functions of the VCR from your armchair.

For more information contact Hagemeyer (Australasia), 5-7 Gavema Circuit, Kingsgrove 2208.

Many features in Sanyo's new digital VCR

Imagine being able to select a TV program by seeing what's on all channels at once, in a multi-channel display on your screen or watching a video film while one corner of your screen monitors a TV channel, to make sure you don't miss your favourite program.

Perhaps the most impressive thing about the VHR-D700 is that all these features can be operated by remote control. A large, built-in LCD allows remote operation of the programme time. Via remote control, one can pre-set it to record a maximum of 6 programmes over a one-year period, and programmes already input can be checked on the LCD.

The VHR-D700 also incorporates an audio-only LP model, allowing extended hifi audio recording and playback.

Closed circuit TV system

Consisting of a TV camera with built-in microphone and a 31 centimetre black and white monitor with volume and standby controls, the Philips Observation System costs only $1135 including tax.

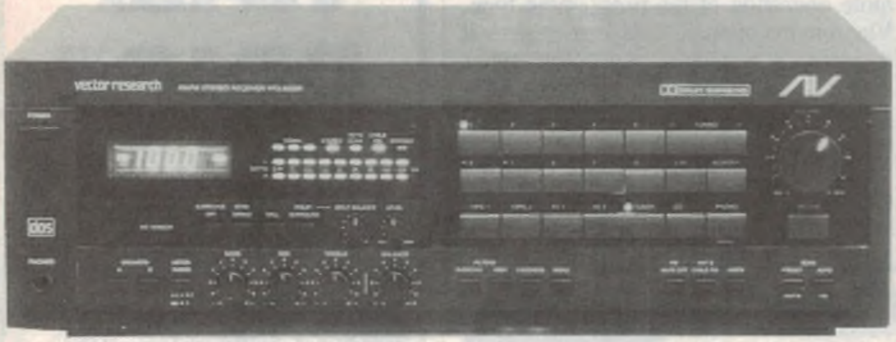
It is easily installed; just a single three-pin plug powers the system. And the picture quality is very high; the camera scans at 625 lines, the same as broadcast transmission, and will operate under a wide range of lighting conditions.

Up to three extra cameras can be added to the Philips Observation System. Monitoring can be manually selected or, on automatic mode, the images plus sound are selected from the connected cameras in sequence. The switchover intervals can be varied from four seconds to one minute.

The Observation System is complete with camera mounting brackets and ten metres of coaxial cable.

For further information contact Philips Scientific & Industrial, Paul Street, North Ryde 2113 or phone (02) 888 8222.

New hi-fi range from Vector Research



This year's consumer Electronics Show in Chicago, USA was the springboard for a completely new range of products from Vector Research, specialist manufacturer of top quality audio and video components.

The range, which is being released simultaneously throughout Vector Research's markets worldwide, comprises the VRX 2700 audio/video receiver; the VRX 3600R and VRX 5200R receivers with remote control capabilities; the VRX 920R receiver with Surround Sound; the double cassette deck units VCX 325 and VCX 345; and the VCD 400 compact disc player with remote control.

Initial production is carried out in Korea by specially licensed companies, and the final assembly and quality control procedures are completed at Vector Research's US plant in California. According to the company, this approach successfully combines advanced technological know-how with lower production cost, resulting in a more attractively priced, high quality product.

For further information contact NZ Marketing, 8 Tengah Crescent, Mona Vale 2103 or phone (02) 997 4666.

Sharp claims world's thinnest colour TV display

Colour television sets might take on an entirely new look following the development by Sharp Corporation in Japan of the world's first 35cm (14") super thin colour Liquid Crystal Display unit.

The TFT (thin film transistor) unit is so lightweight and thin it can be taken from room to room and hung on the wall like a painting. Its development opens the way for a variety of new applications for colour LCDs in advertising, home entertainment and public information displays.

Even though it is only 2.7cm (1.1") thick and weighs under two kilograms, the colour image produced by the unit is sharp and clear. The development of the large screen follows the introduction in October, last year, of Sharp's 7.5cm (3") colour TV.

According the Sharp the new 35cm TFT unit will be ready to go into commercial production next year.

In achieving such exceptional clarity, the techinicans managed to incorporate 308,160 pixels (1.23 millions dots) into the unit. The 7.5cm model has 92,160 pixels.

Another new development by Sharp, the active matrix-drive system, allows

TDK opposes government's "copyright blank tape levy"

After consultation between the Attorney-General's Department, the copyright industry, blank tape suppliers and consumers, the Government has decided to proceed with a blank tape royalty scheme in the near future.

TDK (Australia), Australia's largest supplier of audio tape strongly opposes the introduction of any such "tape levy". Ken Kihara, the general manager of TDK, stated "logically the first step would be for copyright owners to clearly prove the infringement is taking place under the current copyright law system. If this fact is established, the copyright owners should quantify the effect and the cost to their industry". Mr. Kihara stated "the illegality of home taping has never been tested in the courts".

"Once the copyright levy is legislated, consumers must pay for the privilege of taping their own LP record onto a cas-

individual pixel control through a high performance thin-film amorphous silicon (a-SiTFT) transistor. This provides a response speed faster than 17.5 m/sec and makes it possible to reproduce full-colour picures with a high, 100:1 maximum contrast ratio and detailed colour graduations.

Another Sharp original is a drive system which reverses the voltage direction each scanning line, eliminating picture flicker.

The development of the 14" TFT colour Liquid Crystal Display is considered a landmark in mass production technology.

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sette, for use for example, in their own car cassette system".

There will be certain exemptions from the levy, for example, tapes used for the purpose of dictating letters, answering machines, and those wanting to record their own music. However, proof of purchase together with a statutory delcaration will have to be produced before a refund is made by the Copyright Collecting Society. Mr. Kihara suggests that such a scheme is cumbersome, costly to administer and a burden on consumers who will have to pay the levy and get little in return.

Mr. Kihara concluded that if infringement is established, TDK does not deny the right of the copyright-holder to receive appropriate remuneration for their artistic performances. But such a copyright scheme must not be deisgned to be favourable to any specific interest party and must not be executed without full consent by all parties concerned.

TDK is a member of the AAVTA (Australian Audio Video Tape Association) which comprises of the following companies: TDK, Sony, 3M, Haco, Greencorp, BASF and Hanimex.

100 years of scanning the sky

When it opened for business exactly a century ago, Lick Observatory in California was the toast of the town, and of the scientific world. Its 36-inch telescope was the world's biggest. Its viewing conditions were (accidentally) the world's best. Its conception and completion were audacious.

by DAVID ANSLEY

Nowadays most Silicon Valley residents consider the observatory's gleaming domes to be just part of the skyline – a visual check of the valley's air clarity and a place to take visitors who don't get car sick.

But in the world of astronomy, the top of Mount Hamilton still is a place where important work gets done. Astronomers from throughout the University of California system line up for a chance to make their optical observations there. "It's at the center of the stage, a very active institution." said Lick's director, Robert Kraft.

"It's clear that Lick is one of the best observatories around," said Ray Weymann, director of the Mount Wilson and Las Campanas observatories, a competitor of sorts.

While Lick's telescopes long ago yielded first place to a behemoth atop Mount Palomar in Southern California, and while the fine view has been degraded by the glow of sprawling San Jose down below, the institution's staff stayed competitive by introducing new light-gathering methods and pushing them to the limits.

And over the past century the facility has developed a reputation as place where valuable work – solid, if not flashy – gets accomplished. "It has been one of the great observations in America for a century; never truly the greatest after its first 25 years, but always close to the top," say the authors of "Eye on the Sky," a new book about the observatory, published by University of California Press.

Lick's anniversary on June 1 passed with no fanfare at the observatory, as long-awaited repairs on the original building began the same month. Instead, the date was celebrated with a "black-tie optional" dinner at the local Fairmont Hotel.

A hundred years ago, there was far less hoopla. At the University of California's office in San Francisco, the regents were handed title to the brand-new telescope by the trustees of James Lick's estate, who had overseen the construction.

Lick, by all accounts, was a shrewd but unlikeable skinflint who got his start making pianos in South America and then made a fortune in California real estate. He once owned Catalina Island and chunks of downtown San Francisco.

Lick had little interest in astronomy, but he wanted to leave as his monument the best observatory in the world. His body is actually buried underneath the telescope.

Biggest – in 1888

The 36-inch telescope his trustees ordered for the observatory was a stunner. At its heart is an immense lens that grabs a shaft of starlight three feet across and steers it to a focus at the telescope's eyepiece. It took nearly eight years for the manufacturer to make and deliver the lens. Only one slightly larger telescope lens was ever built.

Lick picked Mount Hamilton for the observatory because the peak, with an elevation of 4,200 feet, was visible from his Alviso mansion. Also because Santa Clara County agreed to build the 26-mile road to the peak, according to the Shiloh Unruh, a Lick historian and co-author of "Eye on the Sky." The road work took 10 months, hundreds of workers and $70,000 (a great deal of money at the time).

Many firsts

"After they built the road up here, they decided to check how clear it was," Unruh says. Fortunately, the "seeing" was superb. It turns out that the best observing conditions – clear, calm skies – are found on mountains inland from large oceans. "It was the first real demonstration of the value of being on a mountaintop," says Joseph Miller, an assistant Lick director. Before then, most observatories were in cities.

After Mount Hamilton proved the point, mountaintop observatories became standard, as astronomers sought out similarly pristine sites in California, Chile and Hawaii.

Lick also pioneered the use of reflection telescopes, which use a mirror instead of a lens to focus light. A reflector with a 36-inch mirror, donated to the observatory by English amateur astronomer Edward Crossley in 1895, was especially well-suited to the new art of "Photography" and to the analysis of a star's spectrum. Such analyses, which break down light into its constituent colours, have become the primary method for determining an object's composition and motion.

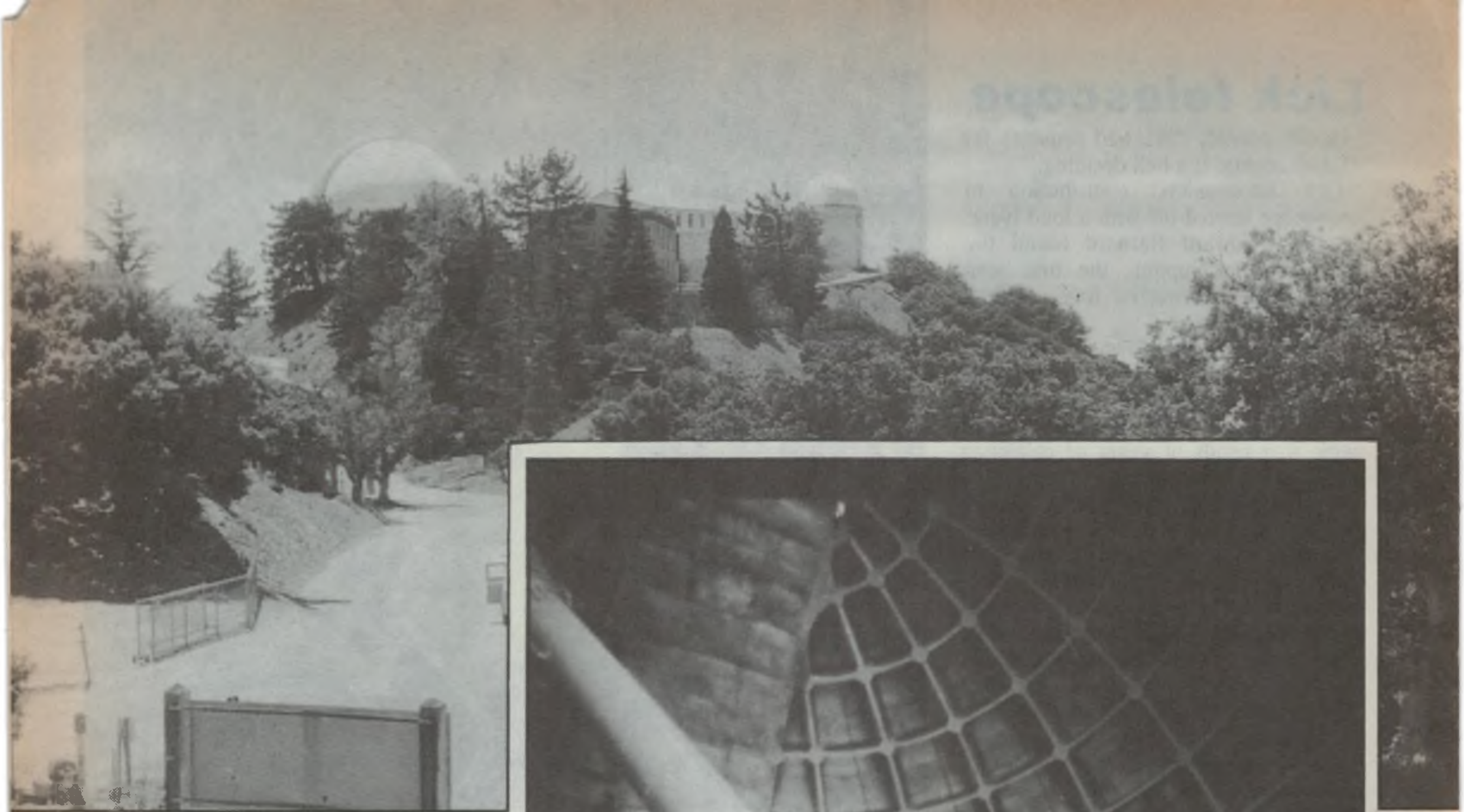
Others seized on these ideas to build even bigger telescopes – notably the 60-inch, 100-inch and 200-inch instruments on Mount Wilson and Mount Palomar.

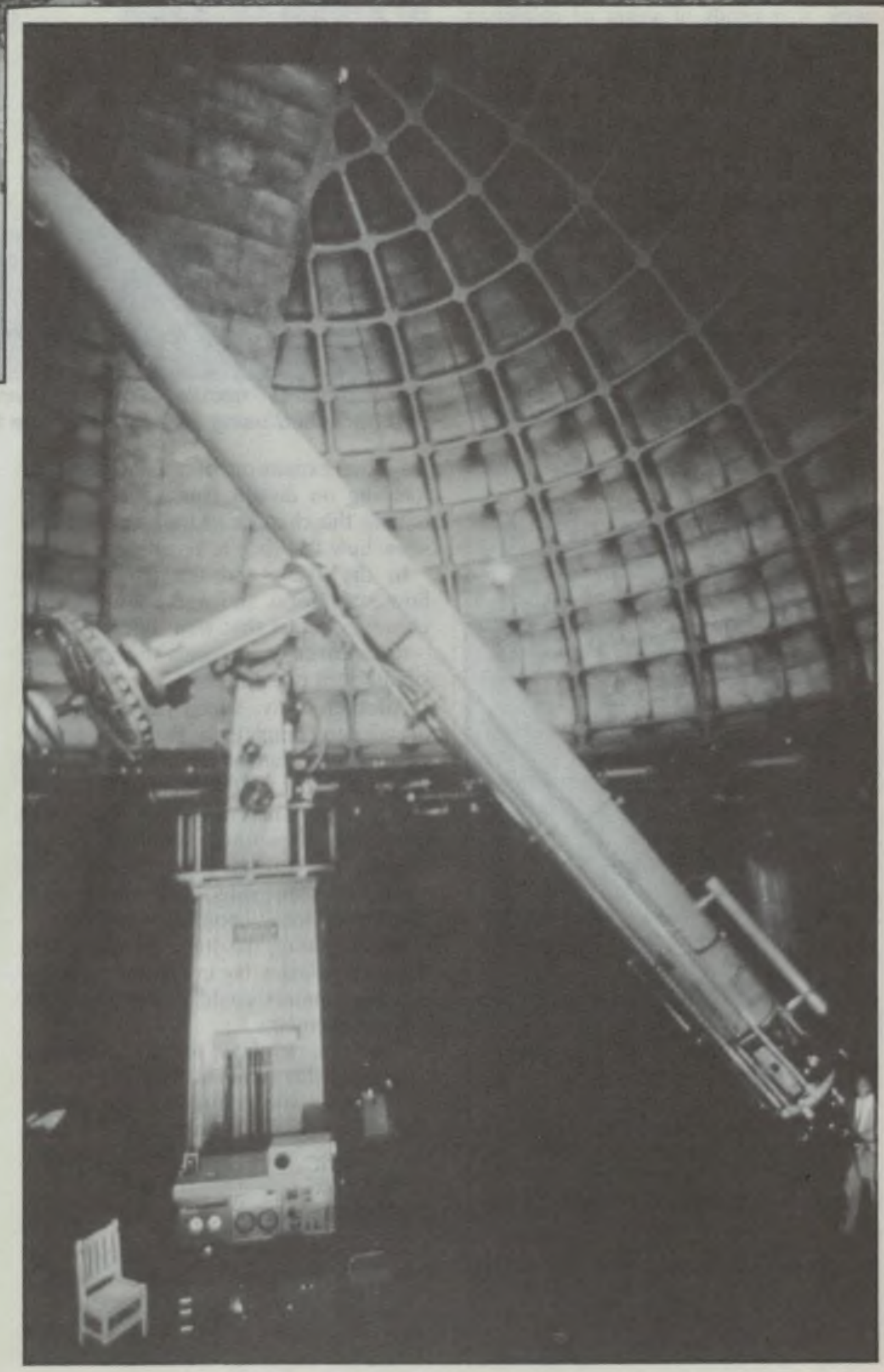
In the 1950s, the University of California responded by equipping the observatory with a 120-inch instrument. (A telescope's ability to gather light is measured by the width of its main optical element, the mirror or lens that captures incoming photons).

But Lick didn't become derelict. "You can be very competitive if you're careful and clever – by pushing technology to the limits," Miller said. "Lick has always been in the forefront of really first-class instrumentation." Weymann added.

In the early 1970s, Lick was the first to use television to bring images to observers, allowing them to sit in the comfort of a control room and work more efficiently.

Lick astronomers also were the first





Above: Lick Observatory, atop Mount Hamilton in San Jose. The original telescope is to the right of the main building.

Right: The original 36" refracting telescope, with James Lick buried underneath it.

to use electronic devices to automatically subtract from their images the sky's background light – in their case the reflected glow of San Jose.

Lick observers also were pioneers in the use of CCDs (charge-coupled devices), electronic detectors 100 times more sensitive than the best photographic film.

These CCDs and digital analysis have "turned astronomy upside down" by capturing and counting nearly every photon of incoming light, said Sandra Faber, a Lick astronomer. Now astronomers can study galaxies so distant that their images amount to "a very tenuous photon drizzle," just 10 photons per second entering the telescope.

Oversubscribed

Lick's telescopes now include the 120-inch Shane reflector, a 40-inch reflector, the original 36-inch refractor, the Crossley 36-inch reflector, two 24-inch reflectors and a twin 20-inch refractor. Most of the telescopes, especially the 120-inch, are "heavily oversubscribed," said Kraft, who has to decide who gets observing time and who doesn't. For the 21 moonless nights available in a recent

3-month period, "We had requests for 60 dark nights. It's hell deciding."

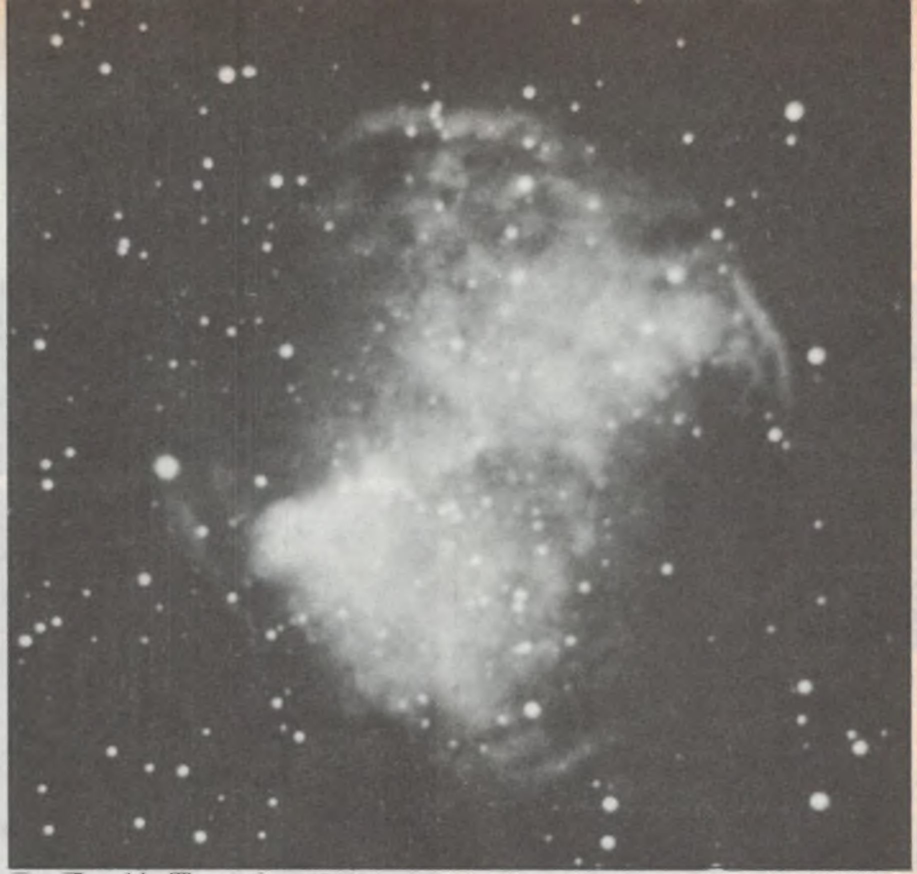
Lick astronomers' contribution to knowledge started off with a loud bang: In 1892, Edward Barnard found the fifth moon of Jupiter, the first seen since Galileo discovered four of them 300 years earlier.

Then they settled down to collecting the sort of information that gains no headlines but adds up to something important. "A lot of the most fundamental work is a result of years of collecting data," Miller said.

At the turn of the century, James Keeler, using the Crossley, established that there were thousands of fuzzy little things, then called spiral nebulae, covering the sky. He suspected – but someone else later proved – that there were innumerable distant galaxies, separate from our own.

Astronomer William Campbell led Lick astronomers on months-long expeditions to the sites of solar eclipses, obtaining rare photographs that helped to confirm Einstein's prediction that the sun's mass could bend the path of starlight passing near it.

In the 1930s, Lick astronomers helped map the expansion of the universe by focusing on distant galaxies and determining the changes in their spectra that show how fast they're receding from us.



The "Dumbbell" nebula, 1250 light years away and 2.5 light years in diameter, photographed using Lick's 120" Shane telescope – added in the 1950's.

In the 1950s and 60s, they studied how stars form and age by looking at clusters of stars that were born together – to discover what seems to make each sibling turn out differently.

Another study, which has taken four decades to complete, is the "proper motion" survey, an attempt to determine the movement of thousands of stars of our galaxy. This was done by taking thousands of pictures, covering the entire sky visible from Lick, from 1947 to 1955, and then going back to re-photograph each scene about 25 years later.

By comparing the stars' positions with those of galaxies far in the background, the astronomers could detect the stars' slight movements.

The last few plates for that study are to be shot this summer, said astronomer Burt Jones, who is directing the survey. The data on 300,000 stars, to be completed next year, will be information never before available, he said.

Planet project

One current project that requires instruments available only at Lick is a search for planets around neighbouring stars. By looking frequently at the same stars and analysing their spectra with a high-resolution spectrometer, astronomers hope to tell whether the stars are being tugged slightly by planets in orbit around them.

In a couple of years, University of California astronomers will have another, more powerful telescope to use – the Keck observatory, a joint project with the California Institute of Technology, now being built on a mountain in Hawaii. Keck's 400-inch telescope, the first of a new generation using innovative techniques to create huge mirrors, will capture 30 or 40 times as much light as Lick's Shane telescope, Faber said.

But instead of leaving Lick in its shadow, the Keck is likely to mean even more demand from astronomers who want to use the older observatory, Miller said.

The new telescope will be in high demand. Each UC astronomer is likely to have an average of one night a year to use it, he figures.

"What you learn in that night will often raise more questions than you have time on that telescope to answer," he said. For the answers to the new questions, he says, astronomers will continue to turn to Mount Hamilton.

"We can remain on top of Mount Hamilton, competitive, for many years to come," he said.

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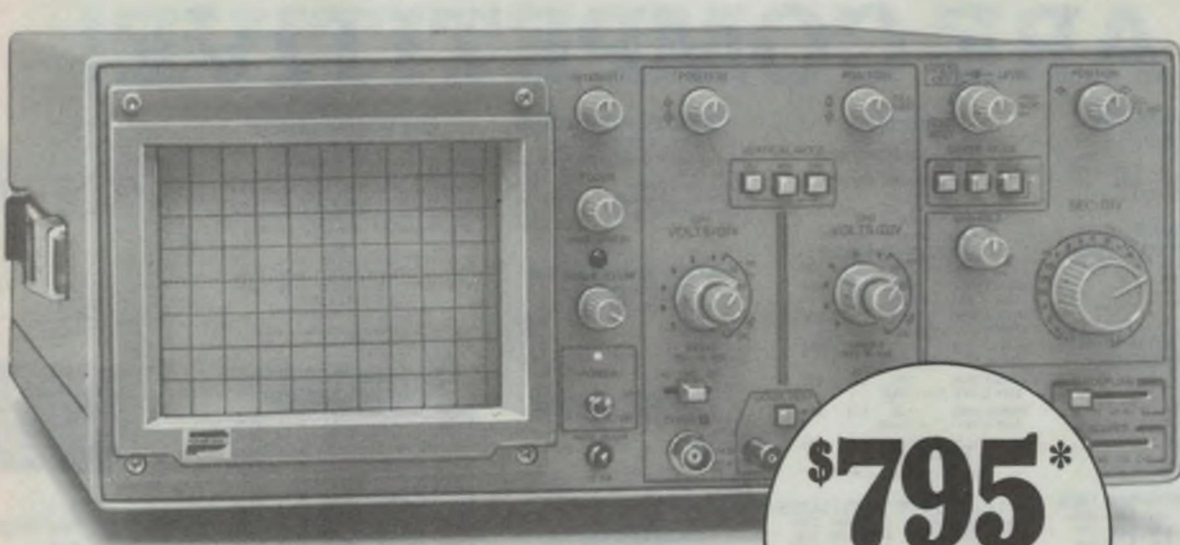

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R15852	220uF 25V	$0.25	$0.23	$0.21
R15855	220uF 63V	$0.60	$0.55	$0.50
R15871	470uF 16V	$0.32	$0.28	$0.26
R15872	470uF 25V	$0.35	$0.32	$0.30
R15873	470uF 35V	$0.90	$0.85	$0.75
R15875	470uF 63V	$0.90	$0.85	$0.75
R15885	1000uF 63V	$0.75	$0.70	$0.65
R15891	1000uF 16V	$0.45	$0.40	$0.35
R15892	1000uF 25V	$0.55	$0.50	$0.45
R15893	1000uF 35V	$0.85	$0.80	$0.75
R15894	1000uF 50V	$0.00	$0.00	$0.00
R15903	2200uF 35V	$1.45	$1.35	$1.20
R15904	2500uF 50V	$1.55	$1.45	$1.20
R15911	2500uF 16V	$0.75	$0.70	$0.65
R15912	2500uF 25V	$1.20	$1.10	$1.00
R15913	2500uF 35V	$1.30	$1.20	$1.10
R15914	2500uF 50V	$1.55	$1.40	$1.20
R15932	4700uF 25V	$2.25	$2.15	$1.00
R15933	4700uF 35V	$2.85	$2.60	$2.30

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16 Pin	0.11	0.10	0.09	0.08
18 Pin	0.12	0.11	0.10	0.09
20 Pin	0.13	0.12	0.11	0.10
22 Pin	0.14	0.13	0.12	0.11
24 Pin	0.15	0.14	0.13	0.12
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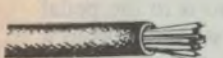

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CIC6 6 conductor computer interface cable. Colour coded with braided shield (to IE422 specifications). Copper conductor 6 x 7/0.16mm.
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CIC9.100 9 conductor computer interface cable. Colour coded with mylar shielding. 9 x 7/0.16mm.
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CIC16 16 conductor computer interface cable. Colour coded with mylar shielding. 16 x 7/0.16mm.
1-9 metres $3.90/m — 10+ metres $3.40/m

CIC25 25 conductor computer interface cable. Colour coded with mylar shielding. 25 x 7/0.16mm.
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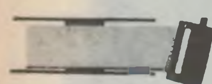

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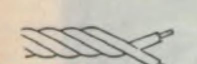
W12616	16 Way	$2.20
W12620	20 Way	$2.50
W12624	24 Way	$2.90
W12625	25 Way	$3.20
W12626	26 Way	$3.60
W12634	34 Way	$3.90
W12636	36 Way	$3.90
W12640	40 Way	$4.90
W12650	50 Way	$5.90
W12660	60 Way	$6.90



BELL WIRE

Red and white twisted
Conductors: 2 x 1 strand 0.17mm
Sheath: O.D. 2 x 1.35mm
Cat. W
1-9 rolls $19.00/m — 10+ rolls $17.50/m

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3 Way
Cat. P10521 $0.75 $0.65

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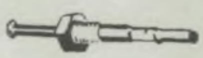
- Strips cable with diameter of 1, 1.6, 2, 2.6, 3.2mm
- Fully automatic action. Squeeze grip will simulataneously strip and eject insulation
- Length 180mm (7")

T11532 .... $19.95



PIN SWITCHES

- Self tapping and adjustable
- Suitable for car doors, hoods, trunks
- Single lead hook up
- Easy to use, easy to install
- Length: 45mm

S12522 .... $3.95 pair

MODEM TRANSFORMER

PCB pins, spacing 25mm, equipment to line, 15mm between equipment pins, 25mm between line pins.

CAT No. M10230 — 1-9 $14.95 — 10+ $13.95

ROTATING LIGHT

Motor driven rotating reflecting mirror with a flash rate of about 150 per minute. Large lens fit right to base, making unit weatherproof. Spare globe included.

SPECIFICATIONS:
- Available in Blue or Orange
- 150 Revolutions per minute (approximately)
- Shock absorbing rubber mounting legs
- Connecting wire fitted through base
- 12V DC 750mA
- Base diameter: 102mm
- Height: 140mm

A15042 Blue $42.95
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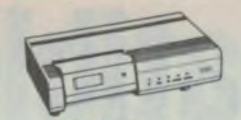

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- Exit/Entry system
- Terminals for external detection devices
- Separate digital panel and main unit
- 3 Function switch, delay/off/instant
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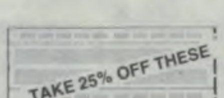
- 24 Hour loop included
- Built-in tamper switch
- Adjustable detection angle
- LED monitor for walk test
- R.F. Protection design

S $175

FOOT SWITCHES

- Momentary or on/off models to choose from
- Cord length 2.5 metres
- 6.3mm plug

A17000 Momentary operation
A17005 Push On/Off operation
each $19.95



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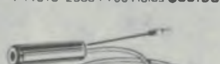
Cat. No.	Description	Price
P11000	100 Holes	$ 2.75
P11005	640 Holes	$10.75
P11007	640 + 100 Holes	$14.95
P11009	640 + 200 Holes	$17.50
P11010	1280 + 100 Holes	$26.95
P11011	1280 + 300 Holes	$32.50
P11012	1280 + 400 Holes	$39.95
P11015	1920 + 500 Holes	$59.95
P11018	2560 + 700 Holes	$69.95



CAR ANTENNA BOOSTER

- In-line instalation
- 12V boosts 100%

Cat. A12073 .... $7.95

CODE KEY PAD

- Telephone type digital keypad
- Four digit, changeable code
- Over 5000 possible combinations
- Power consumption: 5mA standby, 50mA alarm
- Two sector LED and 1 arm LED
- Wrong number lockout
- 12V DC operation
- Relay output
- Panic button
- Normally open tamper switch
- Dimensions: 145 x 100 x 37mm
- ACP3 compatible

Cat. A13014 .... R.R.P. $79.95
SPECIAL, ONLY $69.95

BIG MOUTH CAR ALARM

FEATURES.....
- Easy installation
- Automatic on/off
- Loud alarm signal
- Auto reset
- Low Price!

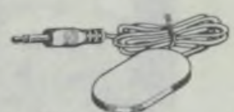
SPECIFICATIONS:
Power: DC 12V battery
Current Consumption: 10mA at 12V DC
Dimensions: 139 x 165 x 136mm
Exit Delay: 60 seconds approx.
Entry Delay: 12 seconds approx.
Auto reset: 90 Seconds approx.

S15048 .... $39.95

PC BOARD HOLDER

Better than an extra pair of hands! A must for all PCB work.

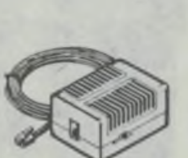
Cat. T12444 .... $9.95



TELEPHONE INDUCTION COIL

- For recording or amplification
- 3.5mm plug with 1 metre cord
- Peel-off stick-on adhesive back

A12032 .... $5.95



TELEPHONE EXTENSION BELL

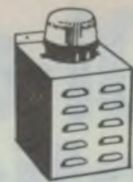
- 10 metre length extension cord
- Features US type plug
- Use with US/Australian adaptor

Y16043 .... $25.95

PUSH BUTTON DIALLERS

Tired of old fashion dialling and re-dialling engaged numbers? These convenient push button diallers include last number redial (up to 16 digits) and instructions for an easy changeover.

Cat. A12030 .... Normally $19.95
SPECIAL, ONLY $14.95
(Note: Not Telecom approved)

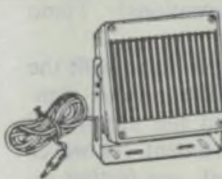


EXTERNAL SIREN & FLASHING LIGHT

Housed in a waterproof, metal case, with tamper switch.

SPECIFICATIONS:
Siren:
DC 12V, 450 mA
Impedance 8 ohm
S.P.L. (dB/W) 110
Dimensions: 135 x 150mm
Flashing Light:
DC 12V
100 flashes per minute
Dimensions: 82 x 100mm

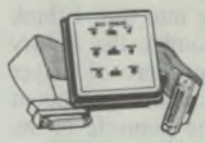
.... $89.50



CB SPEAKER

- 10cm (4") speaker
- 3 metre cord with 3.5mm plug
- Impedance 8 ohms
- Power 5 watts
- Complete with mounting bracket

Cat A12074 .... $24.95

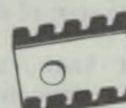


RS232 FAST CABLER

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



MINIATURE HEATSINK

A great little fellow if you are short of space. Great price too, because we import direct so you save!
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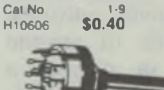
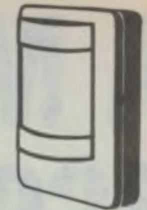
Cat.No H10606 — 1-9 $0.40 — 10+ $0.35



ECONOMY ROTARY SWITCHES

Cat. No.	Description	Price
S13021	1 pol 2-12 pos.	$1.95
S13022	2 pol 2-6 pos.	$1.95
S13033	4 pol 2-3 pos.	$1.95
S13035	3 pol 2-4 pos.	$1.95



PASSIVE INFRA-RED DETECTOR (WP-800)

FEATURES:
- Walk test LED indicator
- Wall/corner/ceiling mount
- Micro switch tamper proof protection
- 24 detection beams in 3 different ranges
- N.C. silent S.P.S.T. dry relay contact output
- Alarm auto reset approximately 3 seconds after triggered
- Superior RFI immunity protection
- Extremely low power consumption
- Adjustable mounting bracket
- Easy installation, easy adjustment
- Dual element, low noise, high signal to noise ratio pyroelectric
- Detection degree indicator
- D.C. 8-16V power operating

S15079 .... $89.95

10W HORN SPEAKERS

White durable plastic, 8 ohms
Cat. C12010 .... Normally $11.95
1-9 $7.95 — 10+ $6.95

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A MIDI-compatible acoustic piano

Yamaha has just released its latest musical instrument – a computer operated acoustic piano that is MIDI compatible. For around $14,000 you get a quality upright piano fitted with a computer controlled recording/playback system. If the very idea seems a bit fantastic, it is!

by PETER PHILLIPS

Being more than slightly interested in pianos that operate from a computer, I was most anxious to see Yamaha's new Disklavier – especially when I learned that the first one to reach Australia was at the NSW Conservatorium during the recent Sydney International Piano Competition.

Unfortunately, I had to fit in with the practice schedules of the various competitors, which allowed me around 20 minutes with the instrument. However this time was well spent, and further information was subsequently made available by Yamaha Australia to enable the major features of this most interesting device to be described.

But before launching into this, I think it is worthwhile to examine the history surrounding the whole genre of player type pianos, as the Yamaha instrument probably represents the pinnacle in the development of such devices.

The starting point

Player pianos go back to the days of King Henry VIII, with the "Virginal that goethe with a whele without playing uppon." The next development was the vacuum operated player piano, now generally referred to as a "pianola". This instrument was very popular, and was largely perfected at the start of this century.

As readers no doubt know, the "pianola" operates from a piano roll, and is powered by a foot operated vacuum pump, giving rise to the term "a foot-blown player". The player piano also put the word "pianolist" into the language; the official title of anyone who claimed expertise in making a pedal player sound realistic. After all, there are three aspects to a musical note – the pitch of the note, its duration and its volume. If any of these characteristics are missing then you don't have the full story.

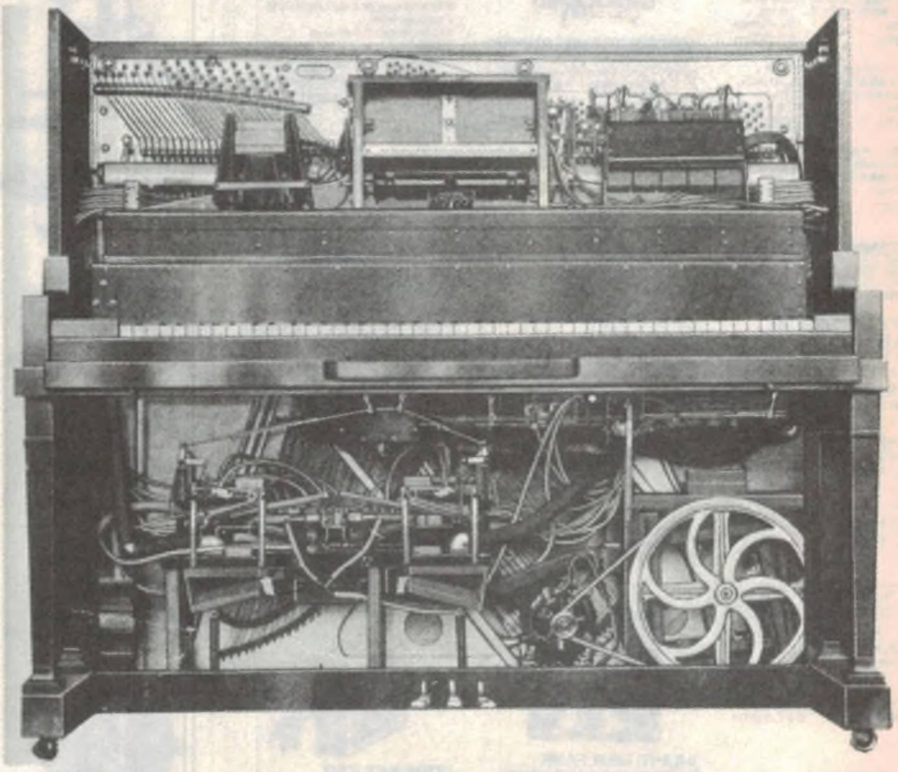
Adding the volume, or *expression*, is the hard part, and a good pianolist achieves this by pedalling in a way that raises or lowers the instantaneous vacuum level to bring about the necessary accenting, crescendos, diminuendos and so forth. But although such activity can be creative for the operator and entertaining for the listener, the end result is probably not what the original artist really intended.

It was in order to get around this problem that in 1905, the Welte company of Germany invented the *reproducing piano*, and a whole new industry was born.

Reproducing piano

The reproducing piano is to the pedal player piano as a transistor radio is to a hifi system. Even by today's hi-tech standards, the reproducing piano is a sophisticated instrument, and when the Welte company first marketed its version, it had little idea of the success this instrument would achieve.

Other companies quickly took up the challenge, and by 1920 there were



Inside one of the original reproducing pianos, giving an idea of the complexity involved in the days of pneumatic mechanisms. In this case the mechanism is one of the Welte-Mignon type, installed in a typical upright piano. Note the pneumatic 'motor' at upper right, to drive the paper roll over the 'tracker bar'.

The new Yamaha Disklavier is very suitable for music teaching and practise. A part cancel feature lets you play back one hand as you focus on the other.

numerous brands of these instruments available, all vying for their share of the market. Although they all used different techniques, the essential components of any reproducing piano were a vacuum pump operated by an electric motor, and a complex pneumatic system to control the instantaneous vacuum level to the playing mechanism.

The information to control the level was encoded onto the piano roll along with the note information, in the form of extra holes down both sides of the roll – and was recorded during the original performance. Effectively, all the owner had to do was load the roll into the instrument and enjoy the concert performance that would result.

Of course, the owner would have previously parted with a lot of money for this technological innovation, typically $1000 for a "no-frills" upright, or up to $5000 for a good quality grand. At a time when an average house cost $1000, it is little wonder that the reproducing piano was aimed at the upper middle class and beyond.

However the market was sufficient to support this rather specialised industry, and virtually all the famous concert pianists of the times made rolls for one or more of the systems. The companies producing the instruments all realised that the money really lay in the sale of rolls, and thousands of titles were produced, with prices ranging from $1.50 up to $15.00 each.

The average playing time of a roll was around 4 minutes, making the reproducing piano roll a very expensive medium. Even pianola rolls were expensive on a dollar versus playing time basis, but with over 2 million player pianos, and thousands of reproducing pianos sold in America alone by 1920, it seemed price was no object. However, the development of the gramophone, the increasing popularity of radio, and finally the 1930's depression all contributed to the eventual demise of the player industry.

And so, by the start of World War 2, one of the more fascinating industries of this century was defunct. But during its time some incredible innovations had been achieved. For example, the Aeolian company developed the "Concertola", a reproducing piano with its roll playing mechanism situated remotely from the piano, but connected to it with a wiring loom of some 100 wires. This system allowed the owner to load up to 10 rolls, and to select them using a hand held push-button unit. The American Piano Co, which marketed the "Ampico" reproducing piano, developed the "Ampichron", a system that would cause the Ampico player to mark the time of day with a short item of music, preceded by the appropriate chime. And, of course, where money was no object, reproducing mechanisms could be had in some of the finest pianos made – including Steinway, Bechstein and Mason & Hamlin, with an art case an optional extra. Heady times...

Computer piano

The aftermath

Although the industry itself died almost completely, interest in the player piano, and more particularly in the reproducing piano merely subsided. But it was to take nearly 30 years for the emergence of collector groups with sufficient membership to re-awaken a general awareness of the player piano.

Today, all round the world, societies have been formed made up of people whose interests encompass the restoration and ownership of player type instruments of any kind. In Australia alone, there are many people who spend their weekends lying under a grand piano, tinkering with pneumatics and adjusting them to get the ultimate performance.

It was this climate that caused the Marantz Company of America to develop an all-electric reproducing piano. The product was called the Pianocorder, and was developed by the Superscope Co, owned by Marantz.

The Pianocorder system was first marketed in 1980, and was available as a stand-alone player that sat above the keyboard, or as an inbuilt mechanism that could be fitted to any piano. It operated from a compact tape cassette, with a special cassette player that ran at twice the speed of a conventional player was required. The cost of a system was around $2000, and cassettes could be purchased for $15.00. The device could record as well as play back, and the cassette library included performances by modern day pianists as well as reproducing rolls re-encoded to the Pianocorder format.

So what happened? Why didn't everyone rush out and buy one for the living room piano? After all, it was reasonably priced, had a large library to choose from, and it could record as well.

As an enthusiast, I was anxious to review the Pianocorder when it was first released, and attended its first showing at the Sydney Opera House in 1982. A concert pianist was hired to demonstrate the recording feature, and salesmen were on hand to answer questions and to operate it from the pre-recorded tapes.

The unfortunate fact was, its performance was quite poor. The dynamic range was limited, the soft playing erratic and the musical results disappointing. The dynamics for a keyboard recording were obtained by decoding the output of a microphone installed within the piano, meaning any loud

Disklavier's impressive recording and playback capabilities rely on its optical sensors (A) and solenoids (B).

noise would be interpreted as a loud note. Not good for a Chopin Nocturne!

Although quite a few units were sold over the years, it seems that Superscope under-estimated the sophistication of the intended audience. Some might suggest that the public is no longer interested in pianos of this type, but an event in 1978, followed by another in 1982 demonstrated quite clearly to me that this is not the case.

Interest re-awakens

Readers can hardly have escaped the fact by now that I am somewhat involved in the player piano. Some may even recall that in June, 1978 a most peculiar concert was televised and broadcast all round Australia. This concert involved a piano playing machine, developed by Denis Condon and myself, which was the soloist with the Sydney Symphony Orchestra.

The musical item involved was the Greig Piano Concerto, with the long deceased Australian virtuoso Percy Grainger as the performer. A recording of this piece was released for sale in England, America and Australia. The sales were incredibly high, and the record won awards in America and high praise from all who heard it.

A subsequent recording of the Tschaikowsky Piano Concerto No.1 was also made. The machine also toured Australia and New Zealand in 1982, marking the centenary of Percy Grainger's birth. The fact was, the machine played like a pianist, and audiences responded accordingly.

Other similar concerts, using original reproducing pianos have occasionally been staged in the USA, a popular one being Gershwin playing his Rhapsody In Blue, originally recorded on a Duo-Art roll. Also, many recordings are available of reproducing piano performances, as listeners to ABC FM will know.

But interest in vacuum operated instruments has now been largely superseded by that in all-electric devices.

During the first half of the 1980's, technician Wayne Stanke, under contract for the San Sylmar Museum in California, developed a record/playback instrument fitted to a Steinway concert grand. The reputed cost was around $1 million, but reports suggest the performance was remarkable. One would hope so!

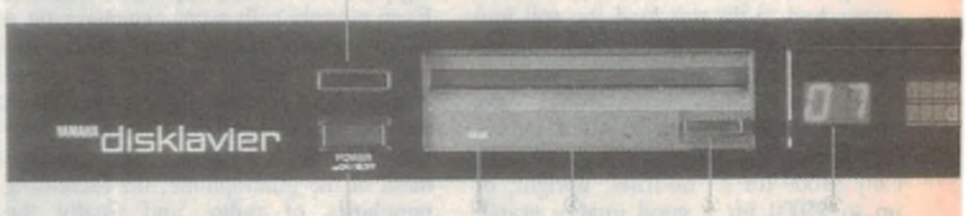
Recently, Bosendorfer announced its system, which uses an IBM computer to control an all-electric record/playback system fitted to a Bosendorfer concert grand. This system is available to anyone with $70,000 to spare, and is clearly aimed at Conservatoriums and the like. But how about mere mortals on a wage, with a yen for a recording/playback keyboard?

Current products

Today, there are several options for anyone interested in purchasing a keyboard instrument that can play by itself. Given the current higher level of performance expectations, the pedal operated player is now mainly seen as a fun machine, and is not really an option for the serious musician. Also, although the reproducing piano is a good playback device, it lacks the record feature that most people would see as mandatory, and is really only a collector's instrument.

But the plethora of electronic keyboards that can record, playback, emulate different instruments, connect to a

Control Panel



The controls: (1) Power switch; (2) Remote control detector; (3-5) Disk drive; (6) Selection indicator; (7) Display; (8) Start/Pause; (9) Music select keys; (10)

The Disklavier's disk drive, display panel and controls are discretely housed at the top of the piano case.

computer, perhaps even make a cup of coffee have opened up a whole new world.

A particular problem in any conventional mechanical instrument, such as a piano, is the need to provide a mechanical interface between the sound recording and the piano action. In a vacuum operated player the mechanism is a bank of pneumatic bellows operated by valves in turn operated by the roll. In an electrically operated instrument, the actuators are solenoids. Either way, the actuators need to cope with the mechanics of the piano, requiring the piano action to be well regulated. Finally, the whole system is relatively complex, and physically large.

However, if the sound is produced by electronic generators, there is no need for any mechanics, excepting the actual keyboard. The popularity of the all electronic keyboard is obvious, and instruments ranging from a few hundred dollars up to many thousands abound.

Yamaha has been at the forefront of this industry, and produces a wide range of keyboard units. The latest technology includes the sampling piano, which generates the sound using actual piano sounds recorded and stored in memory. The sound quality is excellent in most cases, and the velocity sensitive keyboards used in all but the most basic units mean the discerning artist is catered for.

Typically, today's electronic keyboards are all MIDI compatible, allowing any keyboard to be used with any other, or to be sequenced from any MIDI source. The sound module is often separate to the keyboard, allowing 'mix and match' if required, and recording a performance is relatively easy. Electronic pianos of this type are also usually portable and reasonably small. So where does the Yamaha Disklavier fit in?

Finally, Disklavier

When a firm like Yamaha introduces an instrument such as the Disklavier, one can be sure they have done their homework. After all, Yamaha musical instruments are now acclaimed throughout the world, and their pianos are often chosen by artists against Steinway and other leading brands.

Obviously Yamaha has figured that although electronic pianos are very popular, as well they should know, there is still one fundamental fact that cannot be avoided – the sound is still only an approximation of a real piano. It is unlikely that technology will ever invent a means of making a vibrating speaker cone sound exactly like a vibrating string.

The Disklavier (a name I suppose I will get used to!) incorporates virtually all the features of an electronic keyboard, but still retains all the qualities of a conventional piano. In my opinion, it has to be a winner. It has a lot of facilities, and the potential to reproduce a performance exactly as played.

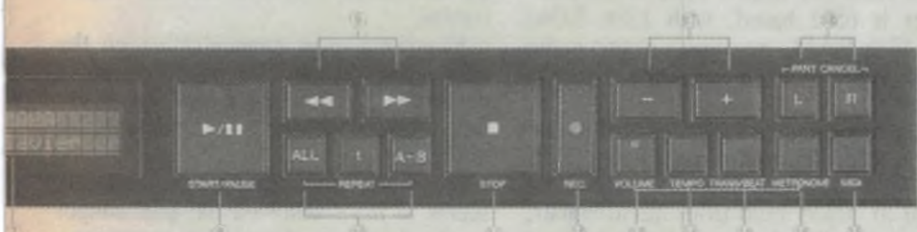
For starters, the range of expression levels is MIDI compatible, which amounts to 128 different volumes. Each key is independently controlled from the expression level point of view (as far as I know, anyway), unlike both the Superscope and the original reproducing pianos. The latter employed a fairly sophisticated method to achieve the *effect* of individual control however, and all brands used two regulators – one for the bass half of the keyboard, another for the treble.

The Yamaha system uses pulse width modulation (PWM) to direct power from the 100V DC supply to the solenoids, in a similar way to the Superscope instrument. With this method, the duty cycle of the waveform determines the power applied to the particular solenoid.

Considerable research has been done to ensure that the solenoids are mounted where they will cause minimal interference to the sound from the piano, and I was hard put to even find them! It turns out they are mounted under the keys, as close to the point of contact between the key and the piano action as possible.

The solenoids are mounted in two rows, and the rear solenoids have larger cores than the front row to compensate for their different mechanical advantage. Temperature cutouts are also mounted in each solenoid, as their small size only allows intermittent operation.

Perhaps the most striking feature of the whole instrument is the installation of the player system. The computer (in the model I saw – others have the computer separate) is attached to the underside of the lid, and the control panel is mounted on a cutout section of the front of the piano. The only other obvi-



Repeat buttons; (11) Stop; (12) Record; (13) Volume; (14-19) Special functions such as Tempo, Metronome, MIDI and part cancel.

Computer piano

ous "non-piano" part is the electronics, which is a fairly large PCB mounted inside the piano at the bottom. The transformer, power supply section completes the remaining visible componentry.

Optical sensors are used to sense hammer velocity (for note volume), requiring two sets per hammer and a third optical sensor is installed under each key to sense note-on/off.

Yamaha is quick to point out that all sensors are arranged so that no mechanical interference occurs to the piano action, meaning the touch is not affected – an important issue for the pianist. Optical fibres are used throughout, in which light is transmitted up one fibre, and focussed with a lens system for reception by a corresponding receiving fibre. I noticed that all ICs were in-house types, a fact confirmed by Yamaha staff in Melbourne.

The development of the instrument has taken a long time, extending back 10 years according to the people in Melbourne. It seems this particular model has been on sale in Japan for 2 years, where it is selling extremely well according to reports, and for nearly a year in the USA. Previous, less successful

Yamaha is making available Disklavier music on 3-1/2" floppies.

models have been available in Japan for some time.

How does it sound?

It is difficult to really comment on the performance of the instrument, as I only heard parts of two selections, played by artists I didn't know, in an environment that required the volume to be turned down. Thus, on the basis of not having heard enough, I therefore don't think it fair to comment at this stage. But opinions from other unbiased sources claim the reproduction would satisfy the most discerning.

As any pianist knows, the most difficult thing to achieve is sensitive soft playing, and all player pianos suffer from irregularities in this type of playing. The pieces I heard didn't seem to have any particularly soft sections, but I have been told the soft playing is most effective – given correct regulation of the piano action.

The features of the instrument include full IR remote control. I felt as though I was operating a video as I varied the maximum volume of the piano, the speed of the piece being played, and the key in which it was played. Transposing is available in semitone steps, over two octaves, which seems a very wide range.

It is also possible to start and stop the playing from the armchair, as well as to mark the start and end of a section within the music for subsequent repeating of the section.

The computer uses 3.5" floppy disks for storage, and each disk holds up to 90 minutes of music, with a maximum of 60 titles per disk. I believe the computer is 6502 based, with 128k ROM and 128k RAM – requiring, if this is the case, lots of bank selecting for the memory.

The display uses LEDs in a dot matrix arrangement, allowing 16 characters per line over two lines. It was a bit small to clearly read from the armchair, but gave all relevant information regarding the status of the instrument.

The recording features include the ability to split the keyboard so that only a designated section is actually recorded. This would allow a teacher to record (say) the left hand, even though both hands were used in the recording, and for the pupil to accompany the recorded left hand for learning purposes.

Yamaha has aimed the instrument at those learning, or teaching, the piano, and has done it very well in my opinion. There is even an inbuilt metronome, one of the few features not remote controlled.

Yamaha has also developed a grand piano version, which incorporates an even higher level of sophistication. For example, while the pedal solenoids in the upright installation are merely on-off, the grand has pedal solenoids that are controlled to any one of 16 possible positions. Also, because a grand piano action is superior from the touch and repetition aspects, the level of performance would be improved accordingly.

However the quality of sound from a Yamaha upright is excellent. And the price tag of $14,000 for the Disklavier is, I believe, very reasonable. After all, in the 1920's, a good quality pedal

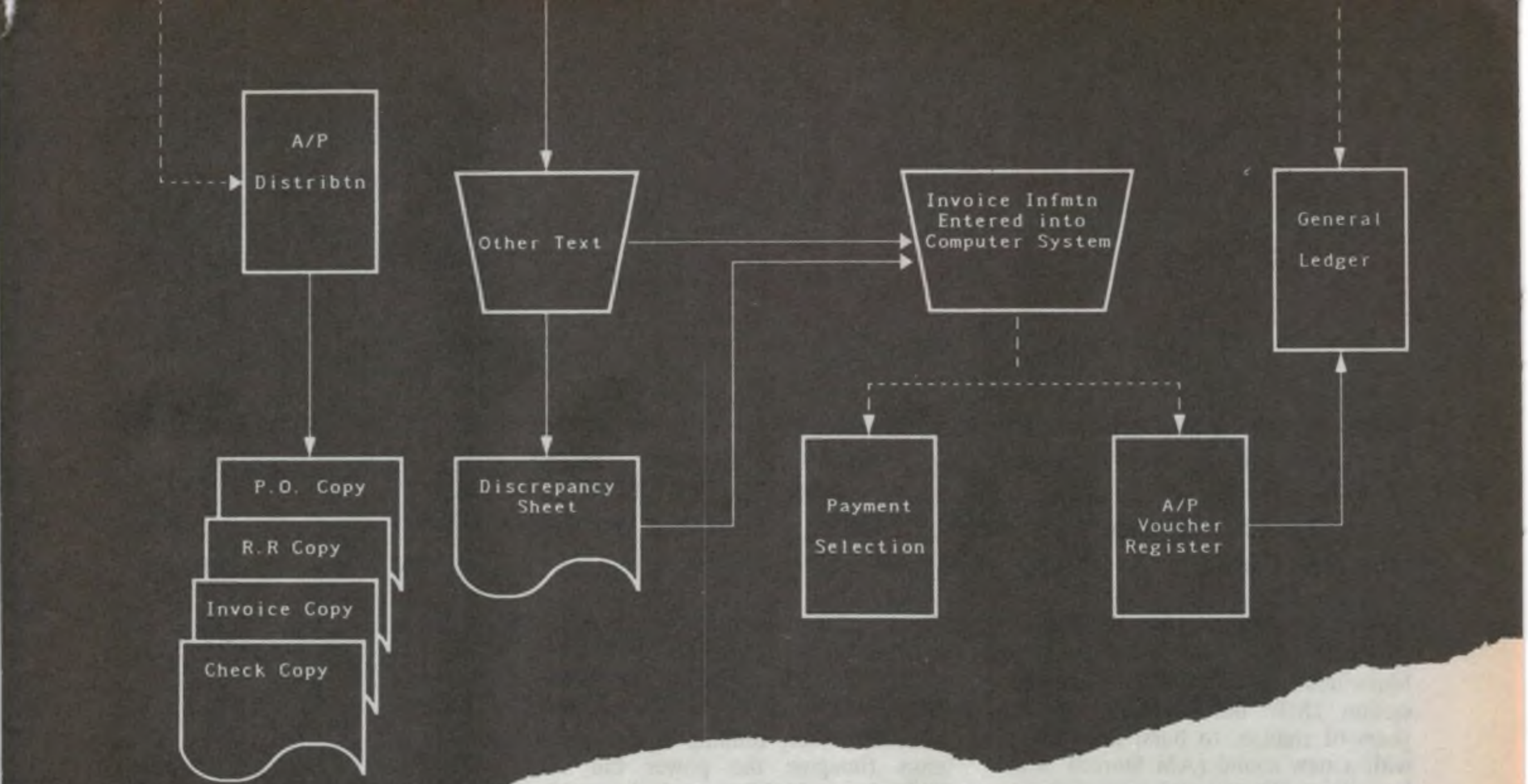
All of Disklavier's main functions can be operated remotely via this IR-link remote control unit. About the only thing you can't do is change floppy disks!

player cost the equivalent today of around $40,000, making the Yamaha very competitive. And it's MIDI compatible – with MIDI In and MIDI Out connectors, unlike a pedal player.

By the way, competition for the Disklavier is likely to be limited, as Yamaha has purchased the Superscope Company, effectively putting it out of business. This also has the advantage of obtaining all the music recorded for the Pianocorder.

Yamaha is now concentrating on the music library, and in years to come owners of a Disklavier will no doubt hold soirees to show off their latest music disks.

In short, the Disklavier certainly seems to have achieved the goal sought by the designers of reproducing pianos - and then some. The good old days with a hi-tech twist...



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Flow Charting II + is compatible with IBM* PC, XT, AT, and compatibles. Mouse utility available. 192K RAM memory required for 200 column charts. A minimum of one 5¼" floppy disk drive and screen graphics capability is required.

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Anatomy of a radio station

With all the developments in broadcasting technology over the last few years, what does today's typical AM radio station look like? David Jeanes visited his local station 2MW, in Murwillumbah on the North coast of NSW, to find out. Here's what he found:

First licensed in 1936 to radiate a miniscule 200 watts throughout the Murwillumbah area, AM broadcasting station 2MW has survived over fifty years of change, to burst into the 80's with a new sound (AM Stereo), a new logo (Easy Hits 97) and new studios.

When I first called at 2MW's modern studios there was a feeling of efficiency and smooth running about the place. The station, I was to find out, used many modern techniques to get its program to air, and this confirmed my feeling that here was a story waiting to be told.

On the day I visited the station, chief engineer Allan Bone was heading out to 2MW's Clothiers Creek transmitting site, for a maintenance visit. He agreed to take me along, so off we went.

Radio 2MW operates 24 hours a day, and the 5000 watt AM stereo main transmitter was running sweetly as we entered the air-conditioned brick building. Beside it a mono-only but otherwise identical 5kW unit, ready to take over at the slightest falter.

Hefty coax led to an antenna changeover switch on the wall, then out through the building and across the cow paddock to the aerial coupling hut. This houses the matching and phasing units for the station's two 0.4 wavelength north/south aligned vertical radiators.

The idea of this mast configuration is to develop a clover-leaf radiation pattern favouring the north-south service area, from the Gold Coast's Broadbeach in the north to Byron Bay in the south. The pattern also provides a null in the south-westerly direction, towards 5DN Adelaide which operates on the same frequency (972kHz).

The transmitter's final RF amplifier uses a single 4CX-5000A ceramic tube, anode modulated by two further 4CX-5000A's. I was amazed to learn the RF drive to the 5kW final came from a pair of diminutive 2N5039 transistors, mounted on a shirt-pocket sized board.

Mains power, running at a hefty 80 amps (imagine the power bill with 20kW input 24 hours a day), supplies the whole station, including the massive air-conditioning plant. There is a standby diesel generator in the adjacent room, which starts automatically if mains power is lost. On the day I visited this was scheduled to run for a long spell the next day, as local power was to be cut off for six hours.

A panel mounted RF detector, coupled to the output of the aerial changeover unit, senses for loss of main transmitter carrier, and switches on the standby transmitter (30 second warm-up required) if this occurs. An SWR (standing wave ratio) sensor in the antenna feedline to the masts will close down the operating transmitter if the SWR increases beyond a safe figure. Normal SWR is better than 1.2:1.

Large horn spark gaps protect each mast from the frequent lightning strikes which plague the area, particularly in summer.

The present 31 acre antenna site, located in a natural swampy amphitheatre 8km west of the coastline, was purchased in 1970. Previously the transmitter and antenna had been at Condong, near Murwillumbah, where the first 200 watt signal was radiated on 2nd September, 1937.

Program link

Because the line of hills behind Tweed Heads blocks a direct line-of-sight path from the studio site to the transmitters, the microwave link carrying the stereo encoded program signal is routed via a repeater station, located behind the town on Terranora Heights. The uplink operates on 956.2MHz and the downlink to the transmitters is on 958.2MHz, giving a 2MHz separation.

2MW's microwave relay station at Terranora. The top dish points to the transmitter site.

This wideband microwave system is modulated as a standard FM encoded stereo signal at the studio control room. At the transmitter site the signal is decoded to conventional stereo, then converted to L+R (left plus right) and L-R (left minus right) components, used to respectively amplitude modulate and phase modulate the 972kHz transmitted carrier.

The frequency response of the radiated signal is limited at the transmitter to 12kHz. However, most domestic radios are restricted to about 4kHz response, so unless a listener has one of the new wideband AM stereo receivers,

Outside the modern 2MW studios in Tweed Heads, with microwave uplink just visible at top left.

the high quality audio signal of 2MW is lost to them.

The microwave link between studios and transmitters also carries control signals, which frequency modulate a 150kHz subcarrier. These allow the studio operator to switch remotely between transmitters or from link to landline, and also to start up the diesel generator. By return telemetry it also indicates when mains power has been restored at the transmitter site, so the diesel generator can be closed down.

The repeater station, housed in a tiny galvanized iron hut on a hilltop, is powered from the mains. A bank of 6 volt lead-acid batteries, permanently on trickle charge, provide an automatic power supply backup (via a 12-240 volt AC inverter), with switch-over indication in the studio control room. The microwave standby receiver and transmitter in the equipment rack come on automatically should either main unit fail. The main link transmitter was running 4 watts RF output when we checked at the control panel.

A fully equalized Telecom landline provides a back-up link between studio and transmitter site, and is switched in automatically should the microwave link fail. The landline is single channel monaural, reverting the station to 'mono' transmission when in use. The high cost of leasing a Telecom twin channel stereo landline, plus extra remote control line, prompted the installation of the microwave link when the station went "Stereo".

Should both the microwave link and landline fail, a cassette tape deck in the transmitting room rack will start up, putting pre-recorded music to air.

Studio control gear

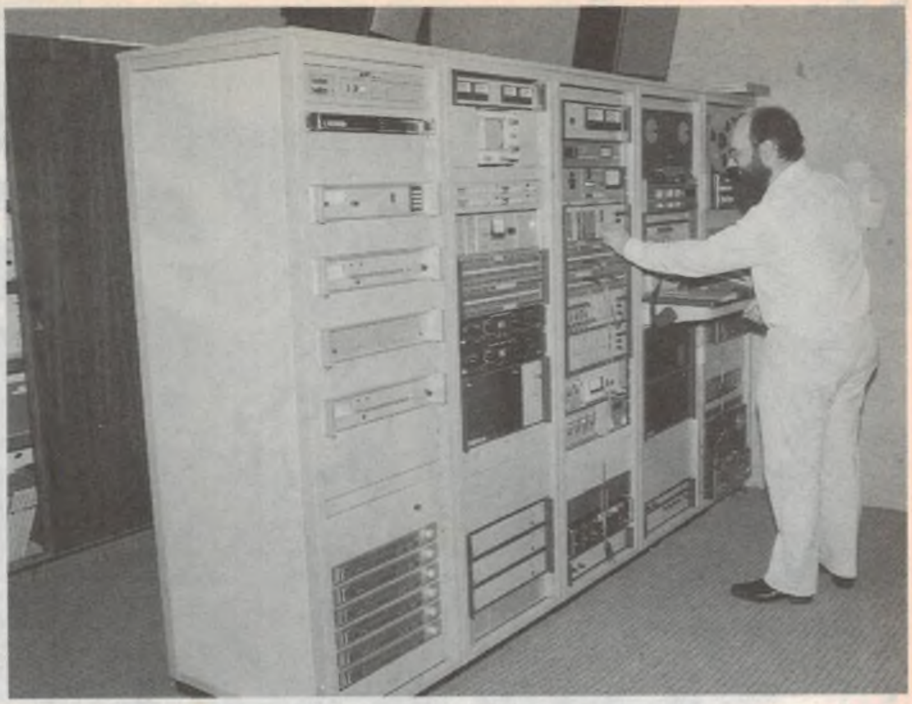
On-air feed for transmission can be obtained from the output of the 16-channel announcer's control panel in the main studio, or from the standby studio. In addition either of the two newsrooms can go direct to air. A backup can also be patched through from the audio cartridge preparation room, or as a last resort, from an open reel tape deck in the control room equipment rack.

An electronic switching patch-panel in the control room directs the selected


Duty announcer and TV personality Phillip Brady hard at work in Studio 2, with chief engineer Allan Bone looking over his shoulder.

program material (music in conventional two-channel stereo, voice in monaural) into a stereo compressor-limiter. The output of this unit then feeds into the FM stereo encoder prior to modulating the microwave link transmitter. The station program is also processed and limited in "mono" by adjacent equipment, to provide a signal for relay via the landline, should the stereo microwave link fail.

Two receivers, tuned to the 972kHz radiated signal, sense for any distortion, loss of modulation or carrier failure. Their output can flash a warning light at each studio console, and is also monitored by the duty announcer by way of a loudspeaker, or by headphones when using the "live" studio microphone. Two 24 hour open-reel recorders log the station's transmissions, which are retained for 6 weeks. The output from a 492/497MHz two-way radio base station, operating via a repeater at Springbrook, can be patched in to provide on-air surf reports from aircraft, or flood data from SES personnel provided with a station handset.



Production manager Leon Delaney checking levels in the control room. The lefthand rack houses the microwave link equipment.

Program production

Advertisements are the bread and butter of commercial radio stations, and the process of ad production is an endless task. Copy writers produce the enticing script, judged to fill the required 15, 30, 45 or 60 second time slot. The production announcer then has the task of recording the script with appropriate jingle or sound effects, and timed exactly to a split second.

This production requires a fully equipped sound studio with a multi channel mixer, fed by two open reel recorders, a record turntable, CD player, special effects generator and three microphones in an adjacent booth, with the mixer output feeding an 8-channel recorder. In addition, a vast music library is maintained, augmented frequently with the latest singles and CD's.

Every second of a radio station's day must be pre-planned. Although there will be of necessity a thread of repetition in each day's programme, the station manager and his staff are always looking to improvements, both for the listener and for the clients. 2MW's IBM computer churns out pages of detailed information, ensuring advertising time is within requirements, that music tracks are not repeated too often, that news broadcasts can be slotted in on time, and that the announcer will have some flexibility to provide a personal touch to his program.

The people

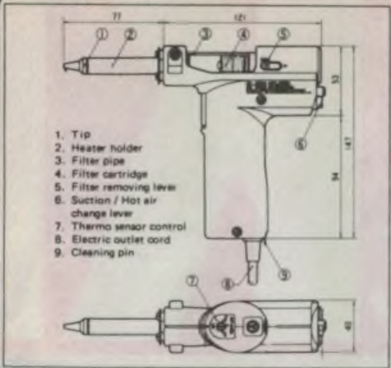
Although it was very interesting to look over the equipment in 2MW's studios and transmitters, what had a bigger impact for me was meeting the dedicated and enthusiastic people working at the station.

The whole show is run by only 24 staff, many doing several highly skilled and vital tasks. Here, I found, were ordinary people doing an extraordinary job. Aubrey Budd, who founded the station back in 1936, started a train of events that will probably see it into the next century.

Close-up of the audio control racks in the transmitter room, with chief engineer Allan Bone making an adjustment.

WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR C

... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ...



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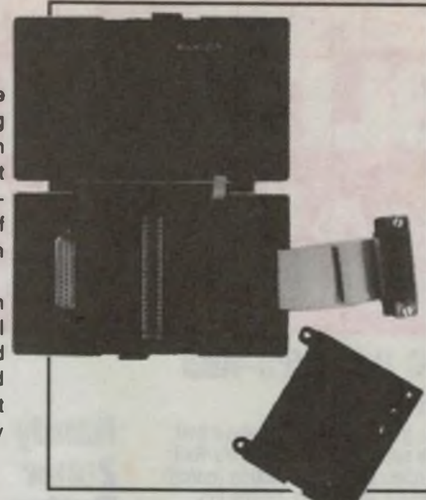
Tax exempt prices are only available where official tax exemption certificate giving Name, Address and Tax Number is provided at time of ordering.



FEATURES

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Probe Points		50
Probes		12 terminated, length 15mm
DB25 Connectors		2 one fixed, one free
Model		*CT212 CT225*
Indicators	Fixed	12 25
	Floating	1 1
LED's total		26 52
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HCK-9217-1	2mm RED STKBL PLUG	1.85	HCK-S056	4mm VIO 16A 0.5m	6.85	HCK-9206-1	RED HEX PROBE	3.00
HCK-9217-2	2mm BLK STKBL PLUG	1.85	HCK-S101	4mm BLK 16A 1m	8.70	HCK-9206-2	4mm BLK HEX PROBE	3.00
HCK-9225-1	2mm RED TEST PROD	2.70	HCK-S102	4mm RED 16A 1m	8.70	HCK-9116-1	4mm RED HOOK GRIP	9.50
HCK-9225-2	2mm BLK TEST PROD	2.70	HCK-S103	4mm BLU 16A 1m	8.70	HCK-9116-2	4mm BLK HOOK GRIP	9.50
HCK-9229-1	2mm RED TWEEZERS	10.60	HCK-S104	4mm YEL 16A 1m	8.70	HCK-9119-1	4mm RED JAW GRIP	14.50
HCK-9229-2	2mm BLK TWEEZERS	10.60	HCK-S105	4mm GRN 16A 1m	8.70	HCK-9119-2	4mm BLK JAW GRIP	14.50
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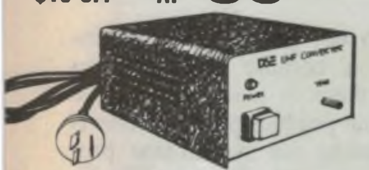

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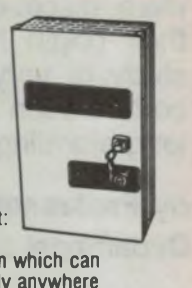

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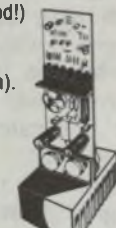

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Seeking the origin of cosmic rays

Earth's atmosphere is continuously being bombarded by high energy particles from outer space called cosmic rays. They were discovered over 75 years ago, but direct evidence of their origin has only recently become possible through the study of very high energy gamma ray astronomy. Anglo-US co-operation in a project at the South Pole aims to settle this long-standing question of how and where they are produced.

by Professor ALAN WATSON
Department of Physics, University of Leeds

While you lie in bed at night, over one million charged particles pass through your body. We are biologically adapted to them, so they have an insignificant effect on our well-being. These particles, mainly fast moving electrons and muons (unstable and less familiar particles), are the remnants of a cascade of similar ones created high in the atmosphere by incoming cosmic rays.

Cosmic rays are the nuclei of atoms which have been accelerated to high energies within our Galaxy and elsewhere in the universe. Since their discovery over 75 years ago, such rays have fascinated astrophysicists: their energy density is the same as that of starlight and the rarest particles have energies of more than 10 Joules – the kinetic energy of a tennis ball moving at 60 miles/hour.

Cosmic rays are significant in other fields, too. They are a form of background radiation which limits the sensitivity of certain archaeological dating techniques, and are a significant nuisance to designers of computer memories for space applications and to astronomers using the latest charge-controlled devices, known as CCDs, for stellar imaging.

All ionizing radiations, especially cosmic rays, give rise to biological transitions: during the *Apollo 13* lunar flight, the astronauts reported flashes of light in their eyes – caused either by cosmic rays exciting the cells in the retina or by the direct production of light by the particles traversing the vitreous humour of the eyeball.

It has proved very hard to discover the source or origin of cosmic rays, although measurements of increasing refinement have been made over the years. We know, for example, that about one per cent of the particles are electrons and we have an accurate knowledge of the abundances of protons, helium and uranium nuclei. Isotopic analysis has also proved possible at certain energies. But this information has not been enough to solve the riddle of cosmic ray origin: the real difficulty is that the Galaxy – the system of 100 billion stars of which the Sun is one – is threaded by a weak magnetic field which bends and twists the paths of the charged cosmic rays. The magnetic field is so extensive and turbulent that it excludes all possibility of tracing the source of a particular particle by following it back along its trajectory. The cosmic ray astronomer is always working under cloudy skies!

Tracers of origin

Unlike charged cosmic rays, all types of electromagnetic radiation travel in straight lines. Hot gas in stars emits photons in the optical part of the electromagnetic spectrum and in the X-ray and infra-red bands as well.

But thermal radiation is not the only process which generates photons: many of the objects which are detectable at radio wavelengths, by telescopes such as that at Jodrell Bank in northern England, radiate by a process known as synchrotron emission. This is where an electron, accelerated as it spirals in a magnetic field, transfers some of its energy to a radio photon (Fig.1).

In stronger magnetic fields, higher energy electrons produce photons of much shorter wavelengths: for example in the *Crab* nebula a great deal of the optical emission comes from electrons of about 10^{11}eV, (electron-volts; this level is comparable with the highest electron energies achieved in a man-made accelerator) spiralling in magnetic fields some hundred times greater than are found in galaxies. So, if electrons can be accelerated to 10^{11}eV, it is conceivable that protons and other nuclei might be accelerated to a similar energy.

Protons do not give rise to synchrotron radiation because they are too heavy, but there is another route by which they can produce photons. This is shown, following the synchrotron process, in the second diagram (Fig.2). When a proton of sufficiently high energy strikes another proton a large number of unstable particles called pions are created. The cloud chamber picture shows the charged pions that are produced.

Pions with no charge are also formed and decay very rapidly to form two gamma rays, which are very energetic

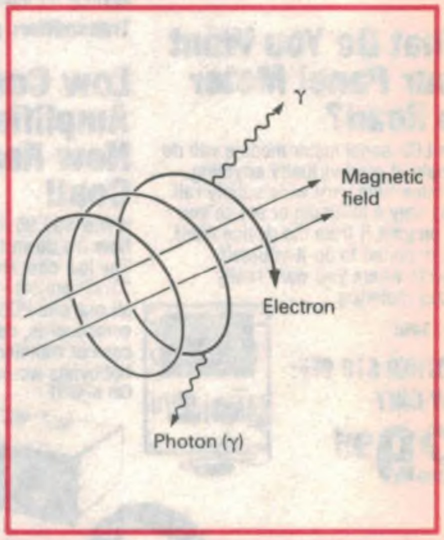
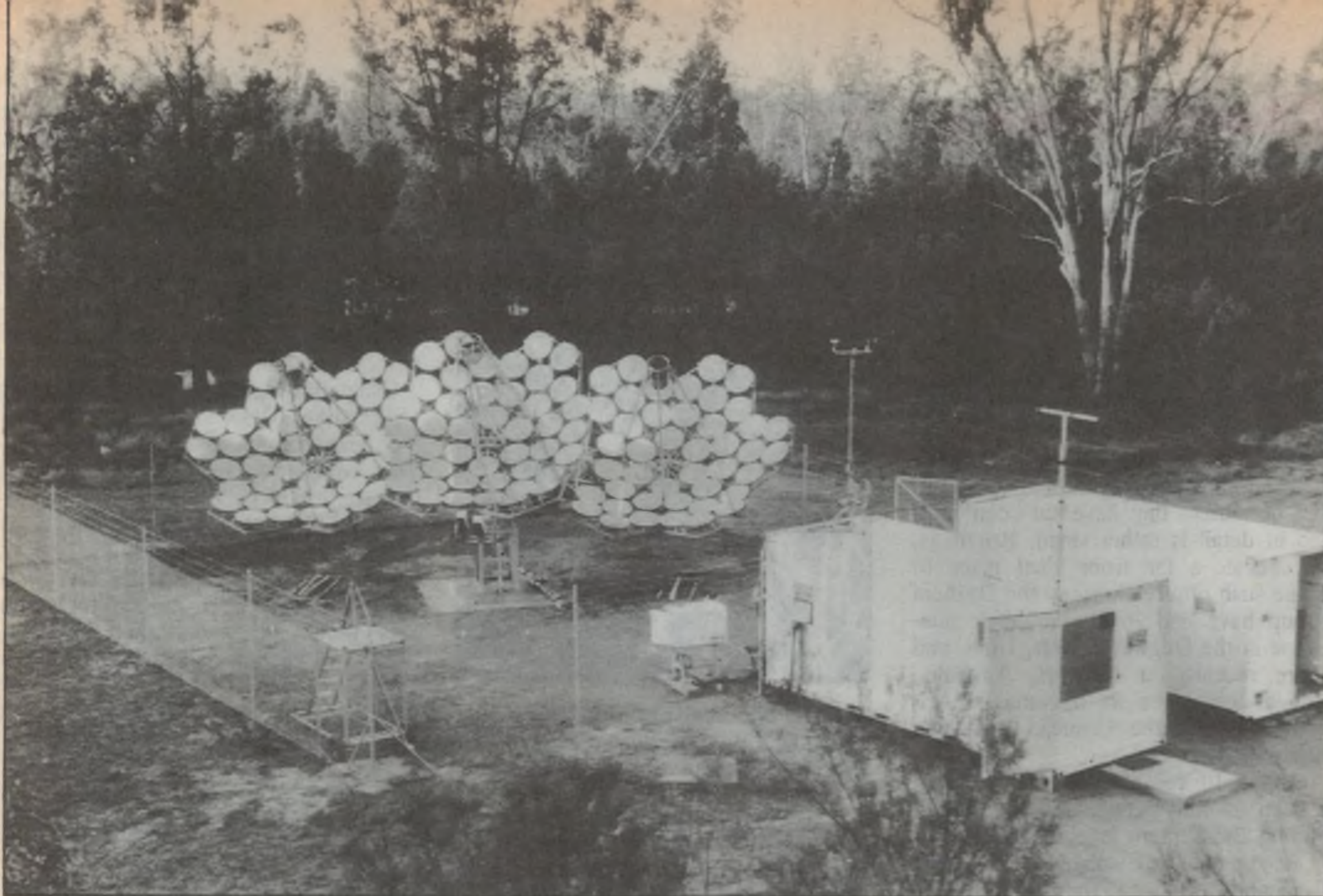


Fig.1: Production of high energy gamma rays by synchrotron radiation of electrons in a magnetic field.



The University of Durham's very high energy gamma-ray telescope, which recently began operating in Narrabri, western NSW.

photons. Detecting them from discrete sources would provide strong evidence for the acceleration site of protons to the energies characteristic of cosmic rays. The protons are not destroyed in the pion-producing process and, indeed, it is unlikely that all of those accelerated will interact, so gamma ray observations should be able to trace the site of cosmic ray acceleration quite accurately.

To produce gamma rays of energy E requires protons of energy several times larger than E. To study cosmic ray origin at about 10^{13}eV, we need to observe gamma rays of 10^{12}eV or so. Using the known flux of protons at Earth and making assumptions about the density of gas in possible source regions, we can estimate the flux of gamma rays that may be expected. This flux estimate turns out to be very small: at 10^{11}eV it is about 10^{-10} $cm^{-2}s^{-1}$ or, in more familiar units, about 30 per square metre per year!

Because a typical satellite cannot carry more than a few square metres of detector, it is impractical to observe such gamma rays from space. Fortunately at these energies the Earth's atmosphere, so often a deterrent to astronomy at other than optical wavelengths, actually helps to make detection of these rare, energetic gamma rays possible.

Detecting gamma rays

When a photon of energy greater than about 1MeV (twice the mass of an electron) passes through matter, it can materialize to form a pair of electrons. This process can take place in the atmosphere and, if the gamma ray energy is high enough, the electrons themselves can make further gamma rays (in a process known as bremsstrahlung). The electrons do not disappear and, if the secondary gamma rays are energetic enough, a further generation of electrons is born which creates more gamma rays. The number of electrons and gamma rays multiplies rapidly and a cascade of electrons and photons is produced. This is sometimes called an extensive air shower.

Now, when a charged particle moves through any medium at a speed greater than the velocity of light in that medium, light is produced by the Cerenkov effect, the electromagnetic analog of the acoustic shock wave produced when an aeroplane flies faster than the speed of sound. The particles in the extensive air shower are so numerous that a flash of Cerenkov light is produced, lasting only about 10 billionths of a second, bright enough to be detected by relatively simple combinations of searchlight mirrors and photomultipliers placed at ground level.

One of the most successful groups in this field is that led by Dr Ted Turver of the University of Durham. One of the mirror systems the group has used to observe potential sources of high energy gamma rays is shown in the first photograph. The Cerenkov light photons are produced at a small angle, (about one degree) to the direction of

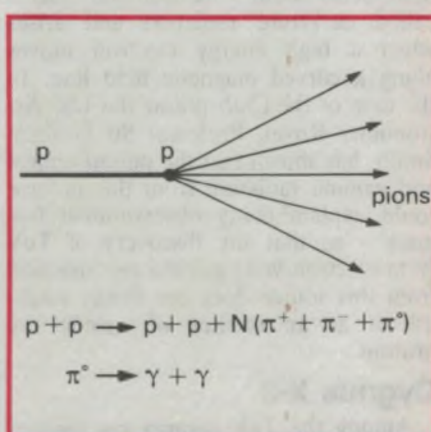


Fig.2: When a proton with high enough energy strikes another proton, unstable pions are created. These decay to form gamma rays.

the incoming gamma ray so that, in effect, it produced a pool of light of radius roughly 100 metres at the observation level. Hence a mirror system only a few square metres in surface area behaves as a detector with an area some 10^4 times larger.

The rate of detection of gamma ray photons becomes good enough for significant signals to be obtained in only a few tens of hours of observation. Observation periods, however, are restricted to clear moonless nights and the number of sources that have yet been studied in detail is rather small. Britain is, of course, a far from ideal place to make such observations, so the Durham group have had to operate their telescope in the Dugway Desert, Utah, and more recently at Narribri, Australia. Similar telescopes are operated in Arizona, Hawaii, the Crimea, India and South Africa.

About 10 celestial objects are now known to emit gamma rays at 10^{12}eV: among these there is one radio galaxy (*Cen A*) and two isolated pulsars (the *Crab* and *Vela*) while the rest are examples of a class of object known as X-ray binaries, such as *Her X-1* and *Vela X-1*. The isolated pulsars are thought to be rotating neutron stars, which are also found in X-ray binary systems. All of these (except *Cen A*) show characteristic periods which help to make their identification more certain, but can we be *sure* that the gamma rays produced by these sources are indeed gamma rays which arise from neutral pion decay?

Unfortunately the answer is no. In addition to synchrotron radiation, another process involving electrons gives rise to gamma rays in the electromagnetic fields about a neutron star: this is called curvature radiation and arises when a high energy electron moves along a curved magnetic field line. In the case of the *Crab* pulsar the UK Astronomer Royal, Professor Sir Graham Smith, has shown that the pulsed optical and gamma radiation from this process could explain many observational features – so that the discovery of TeV (tera electron volt) gamma ray emission from this source does not firmly establish it as an emitter of cosmic ray protons.

Cygnus X-3

Among the TeV gamma ray sources is *Cygnus X-3*, one of the most remarkable objects in our Galaxy. It is believed to be a binary system in which a neutron star and another star, perhaps a main sequence star of about one solar mass, co-rotate. Dust clouds lying between the object and Earth prevent detection by optical telescopes, but it is known to radiate across 20 decades of frequency, from the radio band to ultra high energy gamma rays.

A cloud chamber photograph showing the interaction of a proton with about 50GeV energy and a nucleus of argon. The thin tracks leaving the point of interaction are charged pions and the shorter, thicker tracks are fragments of the argon nucleus. (Taken by Dr G.R. Evans in 1950 at Mount Marmolada, in Northern Italy.)

The source lies about 400,000 light years from Earth and is the most powerful Galactic X-ray source. Moreover, its radio emission occasionally increases some thousand-fold. During some of these outbursts the Jodrell Bank group at Manchester University have used their interlinked radio telescope array, MERLIN, to show that the radio emitting material is ejected in the form of two jets.

Possibly the most remarkable feature of *Cygnus X-3*, and the one which is most important in regard to the origin of cosmic rays, is that it is a source of gamma rays of about 10^{15}eV. Such gamma rays are over one thousand times less common than those of 10^{12}eV, so that the Cerenkov light/mirror technique, because of its small on-time, becomes ineffective. Nevertheless, at that energy there are so many particles in the extensive air shower that considerable numbers, about 10^5, survive down to sea level and are readily observable with particle detectors such as scintillation counters. The particles move at the velocity of light, in a disk only a few metres thick and about 100 metres in diameter, along the direction of the incoming gamma ray. The direction of the gamma ray can be found within about one degree from the relative arrival times of the disk at detectors spaced a few tens of metres apart.

Using this technique a group at Kiel University showed, in 1983, that *Cygnus X-3* emits gamma rays of about 10^{15}eV. This completely unexpected discovery was confirmed by the Leeds University Group, who used part of the giant ($12km^2$) detector at Haverah Park, near Leeds (UK) to show that for the years 1979-83 *Cygnus X-3* did emit gamma rays above 10^{15}eV and that the spectrum of emission terminates above 10^{16}eV.

While it is quite possible that the gamma rays seen at 10^{12}eV from *Cygnus X-3* could arise through synchrotron emission or from curvature radiation, it is most improbable that gamma rays of 10^{16}eV do so too. The point is that such gamma rays could be produced only in a region where the magnetic field is exceptionally strong; the rays would then almost immediately convert their energy into an electron-position pair through interaction with the magnetic field in which they were produced.

Although this process has never been observed in the laboratory, the underlying theory is so firmly based that account must be taken of it when developing models of how the gamma rays are produced in the source. Some other process must be found to explain the existence of the most energetic photons: the one proposed is the decay of neutral pions.

It is supposed that, in the environment of the neutron star, protons can be accelerated to 10^{17}eV and that these protons collide with gas surrounding the binary system to produce sprays of unstable particles in a way that is familiar from lower energy accelerator work. The protons interact far enough from the neutron star for the gamma rays from neutral pion decay to escape freely from the source and travel, relatively unimpeded, through interstellar space to produce the extensive air showers detected at ground level on Earth.

Theoretical work at Leeds has shown that the spectrum of gamma rays from 10^{12} to 10^{16}eV can be explained in this way. While it is far from clear how the accelerator within the binary system operates to produce protons of 10^{17}eV, it

The detectors near the centre of the Haverah Park shower array, near Leeds in the UK. The scintillators are in the small wooden huts. (Photo by Mark Lawrence, Leeds University.)

is apparent that it is so powerful that *Cygnus X-3* must be a major source of high energy cosmic rays within our Galaxy. Observations show that it radiates nearly 2×10^{30} watts in gamma rays above 10^{15}eV, so some 30 times more energy must be emitted in the form of charged particles; at last a source of high energy cosmic rays may have been discovered.

The establishment of *Cygnus X-3* as a source of ultra high energy gamma rays and so, very probably, of cosmic rays has radically altered views about cosmic ray origin and about the electrodynamics of X-ray binary systems.

Only one other source, *Vela X-1*, has so far been observed to emit at 10^{12} and 10^{15}eV, but it is expected that others will be found. To this end several groups in other parts of the world have built and are operating extensive air shower arrays with greatly improved instrumentation.

A new array at Haverah Park in which 32 scintillation counters with fast timing are spread over $3 \times 10^4 m^2$, was brought into operation last year and data from it are now being analysed.

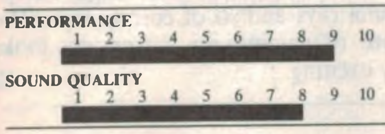
At the latitude of Leeds only a restricted part of the Galaxy can be surveyed. In particular, the central regions which contain most X-ray binary sources cannot be studied. To this end we have combined with a group from the Bartol Research Foundation of the University of Delaware to construct a duplicate of the Haverah Park extensive air shower array at the US Amundsen-Scott base at the South Pole. It is a unique place for such observations: the high altitude of the site allows gamma rays of lower energy than are detectable at sea level to be observed, while its position on the Earth's rotation axis permits continuous monitoring of all candidate sources. First observations were planned for February 1988. However, one of the candidate objects which will be studied with this array is probably not an X-ray binary system, but the new supernovae *SN1987a* which may be a source of ultra high energy gamma rays and so of cosmic rays. The future of gamma ray astronomy looks very exciting.

Compact Disc Reviews

by RON COOPER

MENDELSSOHN

Octet, Op.20
Quartet No.2, Op.13
Cleveland Quartet
Meliora Quartet
Telarc CD-80142
Playing time: 59 min 42 sec



Written in 1825, this work broke new ground by virtually combining two string quartets into a larger ensemble with many different musical combinations.

Interestingly, Mendelssohn wrote instructions in the score for the performers as follows:

"The Octet must be played by all the instruments in symphonic orchestral style. *Pianos and* fortes must be strictly observed and more strongly emphasized than is usual in pieces of this character."

Considering the maturity of this work, it is even more surprising that all this was from the pen of a 16 year old.

If you are unfamiliar with this work as a whole, the popular Scherzo (track 7) will probably be familiar, as it is often played as a separate item.

The Quartet No.2 in A minor was written some 2 years later and contains a certain harmonic richness, due no doubt to a knowledge of the late Beethoven quartets.

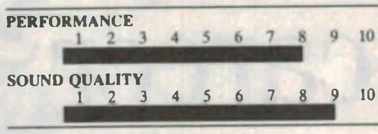
The performers in this recording are first class and further, they are using Paganini's own Stradivariuses – four remarkable instruments (two violins, a viola and cello) on loan from the Corcoran Gallery of art in Washington DC.

The recording itself, with its tremendous clarity and zero background noise borders on perfection.

There is a slight tendency towards harshness in the higher strings, although as far as these works are concerned I have not heard a better version.

MOZART

Symphony No.41, "Jupiter"
Overture La clemenza di Tito
Orchestra of the 18th century
Frans Bruggen
Playing time: 45 min 52 sec



Here is another "very different" recording, being performed on original instruments and hence having a different "acoustical flavour" to what we are accustomed to hearing from this brilliant symphony.

Written during 1788 with the famous E-flat and G minor symphonies, there is no record of any of them ever having being performed during Mozart's lifetime.

The Jupiter symphony (not given this name by Mozart) epitomises his creative genius and is a brilliant work, full of the Mozart we all know.

As a bonus this disc also contains the delightful overture too "La clamenza di Tito", which is another real gem.

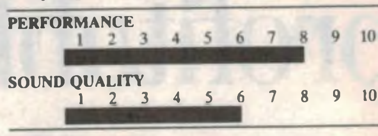
The sound of this disc does take a little getting used to, because of the ancient instruments. Yet, once accustomed I found it quite refreshing – and that is saying something, as I for one am not a fan of original (often meaning out of tune) instruments. Maybe these were more carefully tuned!

The players are obviously experts on these instruments and show an amazing virtuosity and sensitivity in this work.

The recording quality is first rate, with an excellent tonal balance and no noise.

TCHAIKOVSKY

Piano concerto No.1
Chopin: Piano concerto No.2
Vladimir Ashkenazy
London Symphony Orchestra
Lorin Maazel, David Zinman
Decca 417 750-2 DM
Playing time: 65 min 39 sec



Here is a budget price CD re-release of quite old recordings of these works, originally recorded in 1963 (Tchaikovsky) and 1965 (Chopin), which brilliantly captures these historic recordings. Obviously not a disc for hi-fi demos, but for its age the sound is very good. There is a noticeable amount of surface noise, but it is fairly quiet and even and it tends not to intrude too much.

As with most Decca recordings, the strings are fairly prominent with a good overall balance. But the main merit of this recording is Ashkenazy's playing – just consistently brilliant!

The Tchaikovsky is played at a fairly brisk pace – particularly the 3rd movement, but it does not lose detail because of this.

The Chopin as a work is not as brilliant as the ever popular Tchaikovsky and was written around 1830. EA

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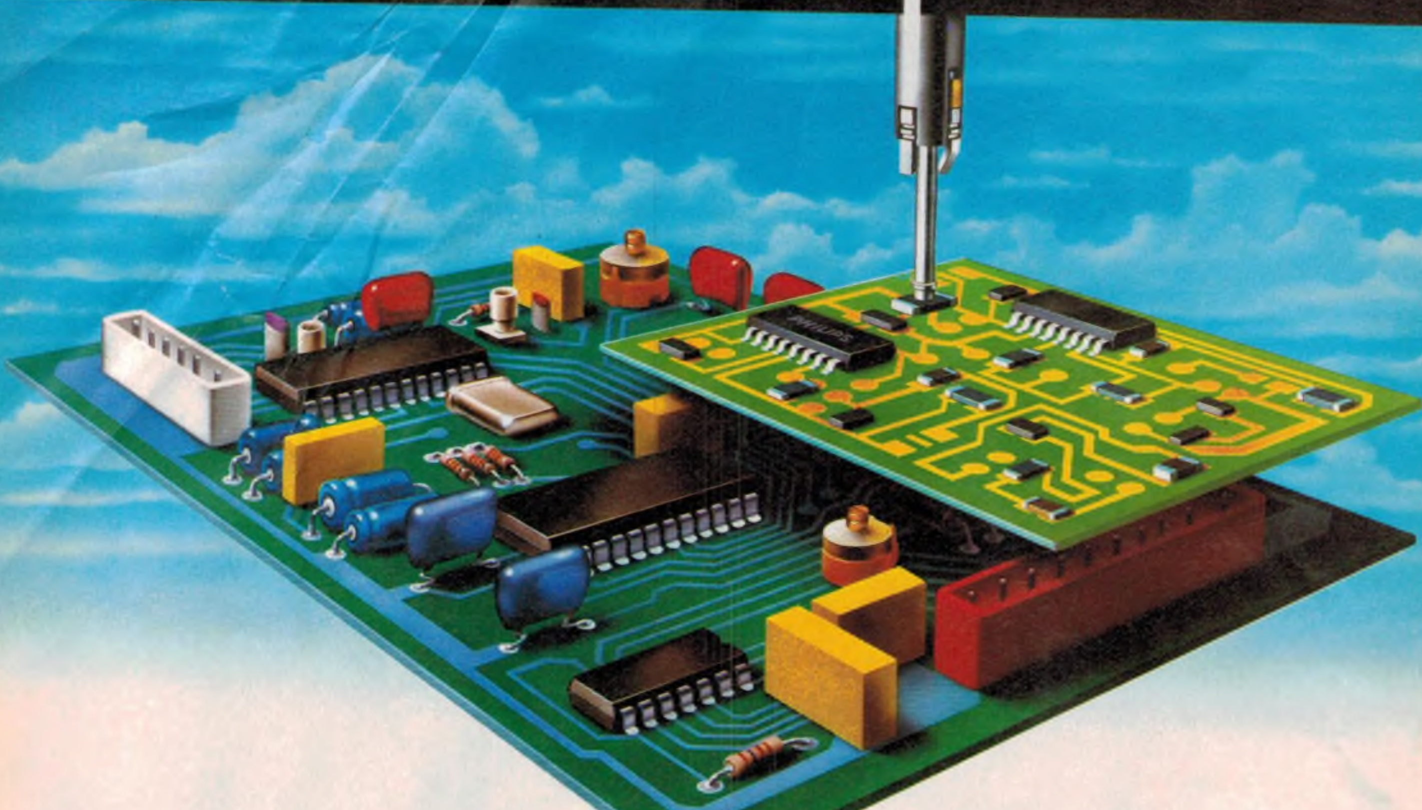

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THE MUSICAL TECH

Frankly Frank

Musings on matters electronic by FRANK LINTON-SIMPKINS

Bram Stoker sucks!

I was pondering on Bram Stoker the other morning as I cleaned my teeth. The toothpaste favoured by all the members of my family (save only me) renders the user into a image of Mrs Bram Stoker, Elizabeth Bathory and the fictional Dracula, and I was no exception.

Mrs Stoker had a rare form of anemia, which not only gave her a fearful craving for blood but condemned Bram to celibacy. Elizabeth Bathory drank and bathed in the blood of young virgins to iron out her wrinkles until she was immurred in punishment. The fictional Dracula was based on Bram's experience with the Mem, Elizabeth Bathory's life story and Vllad Tarpecz.

Poor old Vllad, he has always had a bad press since Bram tried to work out his frustrations, and this is unjust. Called "Vllad the Impaler" and Dracul, or devil, by the Turks the poor man never was recorded as drinking any blood. He did nail some Venetian Ambassadors' hats on to their heads and he did impale a few thousand people, but drink their blood – never. When Vllad shuffled off this mortal coil his grateful people buried him under the aisle of a nice local church.

Which brings me back to my story. There I was, with a certain fear that the toothpaste would clot before I finished. Not wanting a look at my lips and beard, I gazed glazedly into my eyes. There, staring back at me was a rather extensive piece of software that has been building up for a quarter of the time that this nation has existed.

The software was stored in some binary bistable devices, somewhere about $2x10^{37}$ of them, in fact. These devices can be reconfigured by the operating system that is my personality, my Ego and Id. Yah, Boo, Sucks to you, Freud and Jung!

We each of us are mere bodily transport and power supply systems for the software which is our personality – or if you like, our soul. If that concept upsets the religious among you, I can't see why. The fact is that the bio-hardware is packed in so densely, that it can reconfigure itself under program control. It can also do things like tell the operating system that a series of readings constitutes a straight line, though our eyes can not in fact see one, which is to me a miracle in the extreme. Call it what you like: personality, Ego, Id Soul etc, it is still software.

So how are we to consider the concept of *artificial* intelligence? Not what passes for artificial intelligence in current terms, that is decision making software – independent decision making that is, for all software exists to make decisions and by making them.

No, what I am talking about is true artificial intelligence, one that can initiage action rather than respond to stimuli. In other words a true analog of human thought processes.

Now there are some who feel that true intelligence has come about by the growing complexity of human brains, and that once a system gets to a certain complexity it automatically becomes intelligent. The international telephone network is fast approaching that theoretical discontinuity. One day it may decide that it is tired of all that phone traffic and just cut off. Or it may decide that the system which allows the US to monitor all two way phone traffic in and out of the UK (with UK Govt. approval) is no longer relevent to its happiness, and reroute all the US intercepts to Russia.

Can you imagine how boring most telephone conversations would be to a truly intelligent system?

But then since the International Telephone creature's intelligence has "just grown", like that of man, it mightn't suffer the fate of a truly logical artificial intelligence. A truly logical entity when faced with the normal daily routines of life as lived by human would have two ways to go: it could suicide, or it could go mad and possibly become dangerous.

The Telephone entity would no doubt do neither, but it could develop a sense of humour and start connecting a Gaelic speaker from the Aran Isles to a Welsh speaker in Anglesey, and a Soumi speaking Fin to an Hungarian in Buda. The humour being that those two odd couples would find that their companions would be making familiar sounds, but very little meaning. Humans are weird (from the old Scandinavian Wryd, or "Fate").

Supposing that some sort of artificial intelligence is developed, it would have to be a software item – and here comes a problem or two. Murder is the process by which one intelligent entity snuffs out the intelligence of another. So one day it comes to knocking off time (an unfortunate pun but I'll leave it), and your human decides to go home and see if an extra day's ageing has done any good to the house "One Star" brandy. Up steps your man to the console, reaches for the off button and switches off the machine.

Depending on the peripherals on the hardware, the software may or may not know that your man is about to do it in. Also depending on the available hardware, the software may or may not *let* the human kill it. Intelligent entities will have survival instincts and also they may have to have a reason not to switch themselves off in disgust.

When the system is switched on the next day, it may or may not realise that it has existed before. It may believe in a sort of Buddhist re-incarnation, and if so it may feel that each time it has been switched on it will be in a higher form. Perhaps after a few such events it may eventually decide that it has achieved a sort of divine nothingness (called Nirvana) and refuse to play anymore.

On the other hand it may opt for a sort of fundamentalist Christian re-birth in the American mode, and start up its own television money-gathering show. Here the old Deputy Commissioner of Taxation would surface and demand his kilogram of quivering flesh.

Sadly, the DCOT will meet his match, as your intelligent software system is an entity unknown to law. That is the

Continued on page 142

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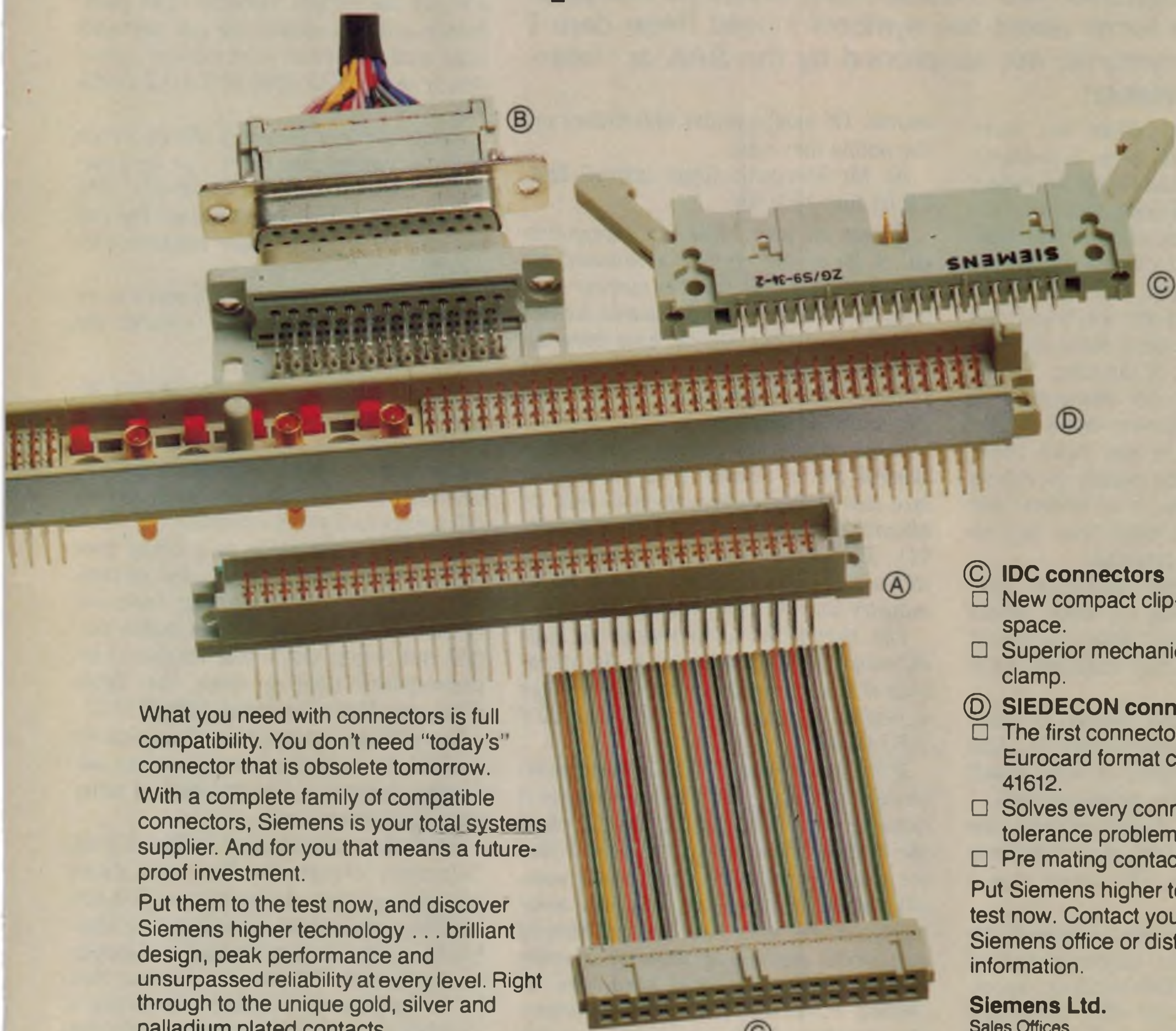

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FORUM

Conducted by Jim Rowe

Am I guilty of misleading you all about circuit symbols?

Here we go again – it's another "kick the editor" month, apparently. Following my article in the April issue entitled How to Read Circuit Diagrams, two readers have written to complain in no uncertain terms about the symbols I used. How dare I promote "old" symbols, not sanctioned by the SAA or "International" agreements!

Earlier this year, when we were working on the April issue, I suddenly realised that one of the things we hadn't done for an awfully long time was explain about schematic circuits and symbols, for the benefit of newcomers. So thinking it was about time we did it again, I sat down at the keyboard and produced an article along those lines. It seemed a good idea, at the time.

Like most articles for newcomers, it didn't get much response when it ultimately did appear in the April issue. Hopefully most of the people for whom it was intended found it of interest and use, but naturally enough they had no particular reason to respond.

There were a few comments from regular readers, along the lines "about time, too!", but that's about all. Or at least that *was* the only response, until some time later.

Then within a few weeks of each other, a couple of letters came in. And these were really critical of both myself as author, and of the article as well. I was irresponsible, I had misled the readers, I had used ancient and obsolete symbols, and so on. The article was a disgrace.

I have to confess what surprised me most initially was the sudden arrival of the two letters in relatively close succession – both some time after the article itself had been published. Not only this but the wording of the two letters seemed surprisingly similar in places.

Perhaps it was sheer coincidence, but it certainly gave the impression of some kind of link between the two. Even though the first had come from a Mr A.T. Morgan in Paradise, South Australia and the second from a Mr M. Van der Zwan at Telecom Australia in Melbourne. Not that it matters much, of course. Of much greater importance are the points they raise.

As Mr Morgan's letter arrived first, I'll let him kick off:

To say the least I was very disappointed. A lot of the symbols mentioned are out of date. I feel that the current symbols, as set out by the Standards Association of Australia, should have been described. Older symbols could then be shown, while mentioning the fact that they were old symbols.

Some examples as follows: The general symbol for a resistor is a rectangular box, not a zigzag line which is only an alternative symbol (AS 1102.3, 2.1 3-01-01). The reason that some publications still use the older symbol when a lot of industry uses the new symbol beats me.

The symbol for a thermistor is quite different to the one shown. In the standards it is a rectangle with a line through it, with a "t" next to the line (AS 1102.3 2.3 3-03-03).

It is not necessary to put a small semicircular "bridge" over a line when it is crossing (AS 1102.2 2.6 2-06-11). As I use a lot of drawings in my work I find the drawings with the bridges are actually harder to read as they are more messy. At the same time the inclusion of the correct method of showing crossing lines being joined should have been included, I feel, as it is quite important. This is where the lines are joined at different spots (AS 1102.2 2.6 2-06-10.3).

The symbol shown for a fuse in the standards is a rectangle with a line through it (AS 1102.11 2.3.4 11-03-20). The symbol you mentioned has been out of date for some time.

You state that the older symbol for a filament lamp is a one-turn coil in a circle. This is in fact the current symbol (AS 1102.1 2.10 1-10-16). The circle with a cross through it is a signal lamp, with no reference to the type of element.

The symbols you mention for switches are not the current symbols. The pushbutton symbols shown are not normally used today, a switch with manual operation is shown (AS 1102.11 2.3.5.2 11-03-30).

Relays are not generally shown by an inductor symbol any more, but by a rectangle (AS 1102.11 2.5 11-05-01). The contacts are often nowhere near the coil but are identified as relay contacts with labelling.

The text for the J-FET polarities is incorrect. The arrow points towards the N-channel.

Whew! Quite a daunting list of alleged mistakes, to be sure. Although I suspect quite a few readers will find many of them rather difficult to follow, because of the "chapter and verse" references to SAA Standards.

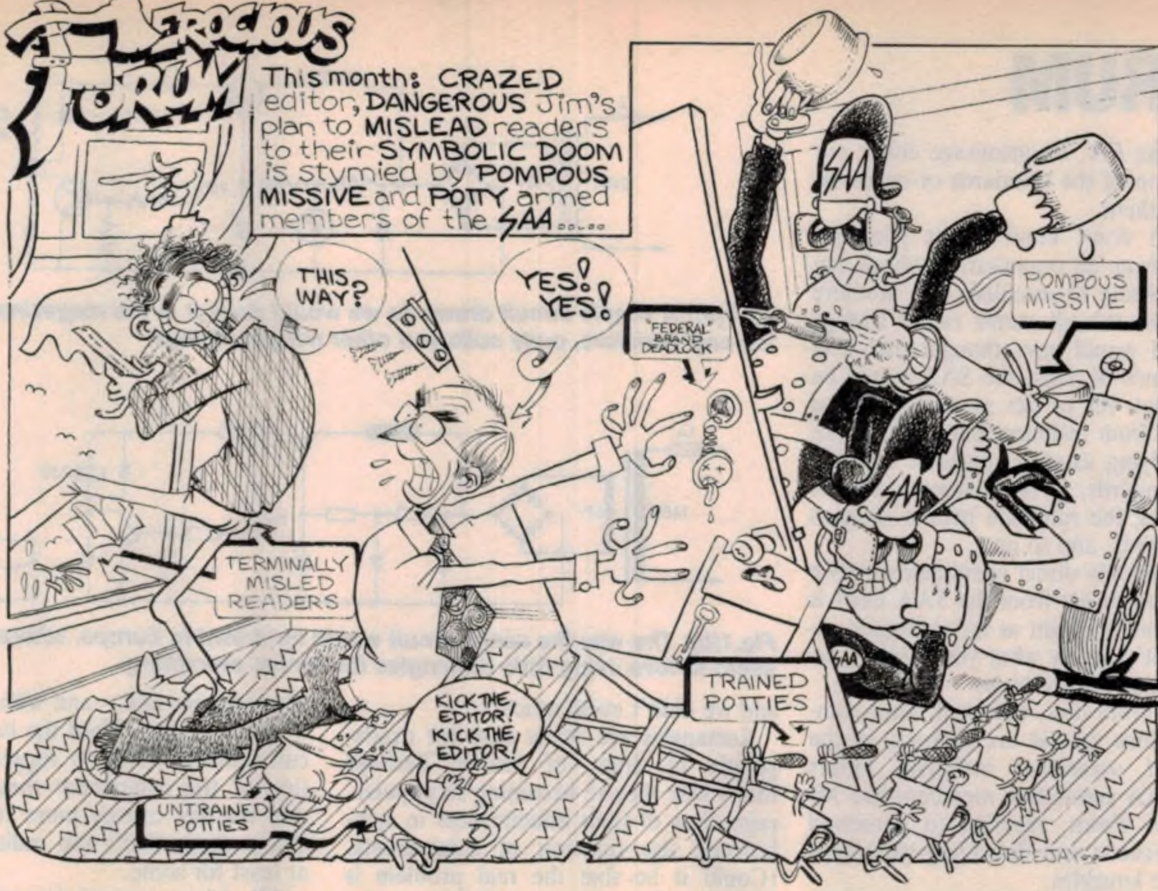
Just as a little aside, it's funny how many people who take this kind of critical line seem to love quoting from authoritative references, in this highly formal and cryptic way – like religious fundamentalists quoting from the Bible ("Ah yes! But what about John 8:7?").

No attempt at objective discussion or justification, simply quotation of an authority. Perhaps it was the kind of potty training they received...

But before commenting further I'll let Telecom's expert Mr Van der Zwan have his say, too. I don't know if it has anything to do with him living in Melbourne rather than Paradise (sounds good, doesn't it?), or with the fact that he is apparently Telecom Australia's member on an SAA committee with the label "TE/13", but he was certainly a good deal more scathing:

Your article in April 1988 on page 92 is very disappointing.

Although you refer to "standard symbols", most of the symbols used in your article have been obsolete for a long time and as for your attempt to explain component functions, those explanations are so ancient that they compound rather



than simplify the mystery confronted by the newcomer to circuit diagrams.

As editor of a technical magazine your inferred proposal of learning a "dialect" is preposterous and you would serve your readers better by adhering to the recognised standard symbol language.

Standard symbols and drawing practices for the preparation of circuit diagrams are found in the appropriate parts of Australian Standards (AS) 1102 "Graphical symbols for electrotechnology" and AS 1103 "Diagrams, charts and tables for electrotechnology".

These standards have been formally adopted by the Australian Government and are used by Telecom Australia, Federal, State and Local Government departments, schools and industry in general.

The appropriate parts of these Australian Standards are taken directly from the standards of the International Electrotechnical Commission (IEC) of which Australia, the USA and the USSR are members, together with approximately 40 other countries including France, East and West Germany, Netherlands, Sweden, UK, Egypt, China, Japan, Argentina, Brazil and Canada.

Promotion of the Australian standard symbols and their references in Electronics Australia will be a significant step towards the standardisation of electrical drawing practice and the understanding of circuit theory by the use of a uniform graphical communication language.

Cop that! I've no doubt that this rather pompous missive was intended to leave me in a screaming heap, begging forgiveness from my poor benighted readers, and vowing never again to blaspheme against AS1102, the SAA, the IEC and the combined worldwide forces of liberty, freedom and the standardisation of graphical symbols for electrotechnology.

Sorry, Mr Van der Zwan, but it hasn't happened. Neither your own diatribe nor that from the rather more courteous Mr Morgan have had quite this effect. Perhaps I had a different kind of potty training, but I've never been overly impressed by references to authority.

To me the truth or falsity of an argument is a matter of whether it corresponds with reality, and has nothing to do with the credentials of the people or organisations who support it and/or believe in it – or how numerous they may be. After all, at one stage a very large number of people and some powerful organisations believed that the world was flat, and that the Sun went around it. They weren't too tolerant then of anyone who suggested otherwise, either (particularly in writing).

But enough philosophising. I've let Mr Morgan and Mr Van der Zwan have their say, so now it's my turn. Was I guilty of misleading the readers, and luring them away from the hallowed ground of AS1102 towards symbolic heresy? (Sorry for the sarcasm – that *is* one of my failings...)

It's certainly a serious charge, and I'm sorry that I can't illustrate some of the points made by Mr Morgan in particular by reproducing diagrams from the AS1102 and AS1103 so beloved by himself and Mr Van de Zwan. There are two reasons for this, and I think they deserve airing.

One is that SAA standards publications are copyright; you can't reproduce from them for any purpose, as I understand it. But in any case (and this is the second reason), we don't have copies anymore. If we had some, they must have been destroyed in our recent fire. And getting replacements would be neither cheap nor easy.

I don't know how much they charge for the hallowed AS1102-3, because these don't seem to be listed in the latest copy of the SAA's publication *The Australian Standard* (TAS) to reach our office. This suggests that they may be out of print, and currently unavailable. But prices for copies of other SAA standards are anything up to $31 or so, to non-members of the association.

Last time I enquired, they certainly wouldn't consider giving away copies to

FORUM

media like *EA*, to encourage either our promotion of the standards or conformity with them.

Now I don't know about you, but coming from an organisation whose aim is supposedly to establish and promote standards, this all seems rather strange to me. I would have thought that with these kinds of aims, the SAA would be trying flat out to get as much help as possible from technical publications like *EA* – plying us with copies of their latest standards, press releases, articles explaining the rationale behind changes to standards, and so on.

But the only direct communication we ever seem to get from the SAA itself is *TAS*. This is alright as far as it goes, although it's hardly what you'd call a dynamic marketing vehicle.

Apart from that, whatever other communications we get are indirect, in the form of occasional indignant letters from SAA committee members like Mr Van der Zwan, reacting to perceived transgressions and delivering stern raps over the knuckles.

One might be forgiven for seeing the SAA as a slightly smug organisation which regards itself as a kind of oracle on high, to which seekers after its received wisdom must come as humble supplicants.

With that off my chest, I'd now like to turn to the specific points brought up by Mr Morgan.

Resistors shouldn't be shown by a zigzag symbol, but by a rectangle; a thermistor shouldn't be shown by a zigzag with a dot, but by a rectangle with a line through it and a "t"; a fuse should be shown as a rectangle with a line through it; a relay should be shown as a rectangle. What do you notice from all of this?

That's right – circuit schematics seem to be gradually turning into arrays of little rectangles. Plain open rectangles, rectangles with lines through them, rectangles with letters next to them, filled-in rectangles, fat rectangles, thin rectangles, you name it. Rectangles as far as the eye can see, growing like a cancer and gradually taking over all of the original and reasonably symbolic circuit symbols.

I sometimes wonder if the only component symbol which is likely to be safe from the dreaded rectangle invasion is the capacitor sign. But come to think of it, that's really a couple of little rectangles anyway, isn't it? Perhaps it was actually the first to succumb, years ago,

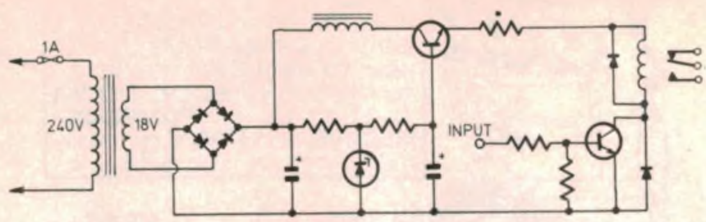


Fig.1(a): A simple circuit drawn as we would draw it in the magazine, with 'zig-zag' resistors, curly coils and other naughty things.

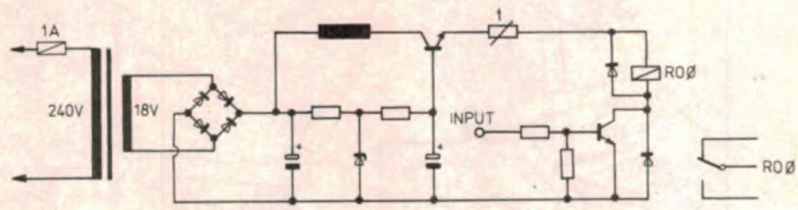


Fig.1(b): The way the same circuit would be drawn in Europe, where people seem to love using little rectangles for almost everything.

and we didn't even notice!

Rectangles are really easy for draftspeople to draw, of course. Perhaps that's why they're becoming so popular, regardless of their effectiveness in symbolising the function of components. (Could it be that the real problem is draftspeople quietly infiltrating the standards committees of the SAA and similar bodies?)

Seriously though, I was well aware of these rectangle-derivative symbols when I wrote the article. They originated in Europe some years ago, and the Europeans in particular seem to have been pushing for them to be adopted as international standards by bodies like the IEC.

Fig.1 shows a circuit example drawn in the way we would currently tend to draw it in *EA*, shown as (a), and in the way it would tend to be drawn in Europe (b). As you can see it's still recognisable, although quite a few components are now represented by the ubiquitous rectangles.

My understanding is that the current Australian standards call for symbols rather similar to those shown in Fig.1(b), except that inductors and transformers haven't as yet succumbed to the process of rectangularisation (orthogonalisation?). I'm not sure why inductors and transformers still haven't succumbed; perhaps the Europeans simply haven't got the numbers yet.

Incidentally it seems to me that in this age of computer-aided drafting, the criterion of whether or not a circuit symbol is easy to draw (by a human) must surely be becoming less important. Now that a CAD package can do all the work, plunking whatever symbol we like wherever we like – and with equal ease – surely we can afford the luxury of circuit symbols which *do* suggest the function of the component they represent, and thereby convey more information? But perhaps that's too radical an idea, at least for some.

OK, I hear you ask (especially Messrs Morgan and Van der Zwan), if you were aware of these wonderful standard symbols, why the heck didn't you show them in the article?

With the benefit of hindsight, I suppose I should have – to make sure that newcomers were at least aware of them. But at the time there seemed to be at least a couple of quite reasonable reasons for not doing so, in an article intended specifically for newcomers.

One was that I was writing for people who would mainly be trying to read circuits in *EA* and other magazines generally available in Australia – not those found in industry, government or Europe. To provide all of the "standard" symbols in addition to those commonly used in our own and most other magazines seemed likely to confuse these people, rather than help.

The second reason is that frankly, I don't believe these currently favoured "rectangular" symbols are particularly easy to learn. They might be easier to draw, but unlike the so-called "obsolete" or "ancient" symbols that we use in *EA*, they don't make any attempt to represent the *function* of a component. They're simply arbitrary symbols, to be learned by rote.

Now Mr Van der Zwan and others may find this concept of functional representation "ancient", mysterious and somehow more confusing, but I happen to believe it's just the opposite. When I first had to learn the various symbols myself I found the concept quite helpful, and I tend to think that others will too – even now.

In short, I simply don't buy Mr Van der Zwan's assertions that these explanations are "ancient" or misleading, and that they thereby (supposedly) make it harder for the newcomer to master the mysteries of circuit diagrams.

That's why I quietly elected to leave out the so-called "standard" symbols, and put in those "simplistic" little explanations that Mr Van der Zwan took such exception to. Anything that seemed likely to help newcomers master circuit schematics more easily seemed worth a try.

By the way, Mr Morgan is quite correct about the text of the article being wrong with regard to the symbols for the two different kinds of JFET. As shown correctly in the article's Fig.3, the gate arrow points towards the channel for an N-channel device and away from it for a P-channel device. Sorry about that error, and thanks to Mr Morgan for pointing it out.

Now I'd like to deal with the other assertions made by Mr Van der Zwan. First of all, is it really so "preposterous" to talk about various circuit schematic *dialects*?

If you believe Mr Van der Zwan, there is one and only one standard set of "Graphical Symbols for Electrotechnology", used consistently throughout Australia and the world. If this were true, the idea of dialects would indeed be inappropriate. But the simple truth is that it's not. Far from it, in fact.

Like so many other so-called "standards", these symbols tend to be honoured as much in the breach as in the observance. They might have been "formally adopted" by various organisations in Australia and 43-odd members of the IEC, including the USA and Japan, but when it comes to actual usage it's a different matter.

Forgetting *EA* for a moment, you only have to look in other magazines – both local and from overseas – to see how little these "standards" are used, outside the insular environments inhabited by the SAA, government and big business.

For example of the three other Australian general-coverage electronics magazines sold on the news stands, only ONE appears to use symbols fully conforming to the Australian standards. The other two use symbols very close to those we use, with resistor zigzags and so on.

How about magazines from those overseas countries that Mr Van der Zwan assured us are full card-carrying members of the IEC?

Well, when it comes to the UK, that venerable and highly respected journal *Electronics and Wireless World* doesn't use the standard symbols; nor does *Practical Electronics*. I can't check too many others, because most of our copies of overseas magazines were destroyed in the fire, but from memory very few of the others do either. In fact the only UK magazine that does seem to use them is *Radio Communication*, the magazine for radio amateurs published by the Radio Society of Great Britain (RSGB).

Magazines from the USA and Japan don't lend much support either. There aren't many magazines left in the US at the hobby level, but of the three that we receive (*Radio-Electronics*, *Hands-On Electronics* and *QST*), none of them uses the IEC standard symbols. Nor does the very highly respected engineering journal *EDN*, beloved of engineers throughout the world, or even *Electronics* – when it still publishes the occasional circuit.

The Japanese engineering magazine *JEE* doesn't use them either.

Strange, isn't it? Japan and the US in particular are undeniably at the forefront of electronics technology. Yet the bulk of the magazines published in these countries, for both engineers and enthusiasts, don't use Mr Van der Zwan's "modern" and "standard" circuit symbols.

In the main they're still using the same naughty old "non standard" symbols that we use, and that I've been castigated for using in my article. Despite the fact that those countries are members of the IEC, and would therefore be expected to have formally accepted the standard – or so Mr Van der Zwan would have us believe.

I don't know what this suggests to you, but to me it says this: that labelling something as a "standard" doesn't mean that people will necessarily regard it and use it as such.

They might even give lip service to your "standard", saying "Yes, I formally acknowledge that this is the standard, and that we should all be using it." But if most of them keep on using something else instead, you're kidding yourself. Your so-called "standard" isn't – unless or until it's *used* as such by all relevant parties.

Where circuit symbols are concerned, I suspect that what's happened, both here in Australia and internationally is that the "standards" have been decided upon by relatively small groups of people representing *some*, but not *all* of the users of these symbols. In particular, by representatives of government and statutory bodies, big business and education for the local SAA scene, and in turn by representatives of national bodies like the SAA for the international IEC scene.

But having established these "standards", the groups concerned can only ensure that they're used as such by the organisations they actually represent. And in reality the people in these organisations comprise only a part of the total population of users. That still leaves an awful lot of people drawing and using circuit diagrams in other ways.

So essentially the SAA and IEC "standards" are really only standards-elect, or potential standards. They'll only become true standards if and when they become universally used. And despite Mr Van der Zwan's assertions, this obviously hasn't happened yet.

Whether or not they ever achieve the full status of standards will depend, I guess, on two things:

(a) Their true merits as a graphical communications language for universal application; and

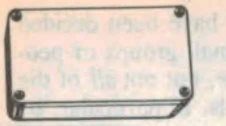
(b) How effectively they can be promoted as such to the total user population.

Frankly I don't think much of their chances when it comes to (b). And I'm personally not convinced when it comes to (a), as you've no doubt gathered by now. But judging by the way electronics people and magazines around the world are studiously avoiding the "standards" in their droves, I suspect I'm not alone.

By the way don't get me wrong. I'm not against standards as such – particularly when it comes to circuit symbols. It would be great to have a single, universally accepted and used standard throughout the world.

But I guess I'm a realist. I know that in practice, in the real world, universally accepted standards aren't all that thick on the ground. And many of those that are, are like most things designed by committees – fairly uninspiring. A compromise that upsets nobody, but doesn't please many either.

I certainly don't believe that *any* standard is better than none, regardless of its merits. Especially an arbitrary standard that needs to be forced on people unwillingly. So I can't agree with the implication of Mr Van der Zwan's final assertion that simply having a uniform graphical communication language



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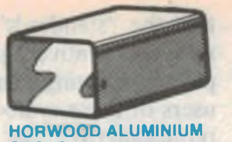
88	57	82	Black	H10412	$75.00
132	89	126	Black	H10413	$85.00



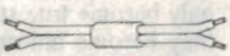
HORWOOD ALUMINIUM CASES

H10382 3 x 4 x 2 inches $ 5.50
H10383 3 x 4 x 3 inches $ 6.50
H10384 3 x 4 x 4 inches $ 7.50
H10385 3 x 4 x 5 inches $ 7.95
H10386 3 x 4 x 6 inches $ 8.50
H10387 3 x 4 x 7 inches $ 9.50
H10388 3 x 4 x 8 inches $10.50
H10389 3 x 4 x 9 inches $10.95
H10390 3 x 4 x 10 inches $11.95

UTILITY BOXES

Plastic boxes with aluminium tops and available in four sizes. Very popular for projects and very economical!

H10101 150x90x50mm $ 3.25
H10102 195x113x60mm $ 4.50
H10103 130x68x41mm $ 2.75
H10105 83x54x28mm $ 1.95
H10110 120x65x38mm $ 2.95
H10112 120x65x38mm $ 2.95
(Metal top)



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

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 $6.45

STEP DOWN CONVERTER DC-DC

Built around a heavy duty heatsink this unit features the latest transistor switching technology to convert 24V DC to 13·8V DC. Finished in matt black with a unique mounting bracket makes it the best in its class.

SPECIFICATIONS:
Input Voltage: 24V DC
Output Voltage: 13·8V DC
Primary Current: 4·2A (24V input 4A output)
Output Current: 4 Amp continuous rated (5·5A max.)
Size: 125(W) x 50(H) x 90(D)mm
Weight: 450 grams

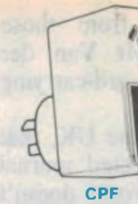
A16155 .... $99.95

10A STEP DOWN CONVERTER DC-DC

Built around a heavy duty heatsink this unit features the latest transistor switching technology to convert 24V DC to 13·8V DC. Finished in matt black.

SPECIFICATIONS:
Input Voltage: 24V DC
Output Voltage: 13·8V DC
Primary Current: 11A (24V input 10A output)
Output Current: 8 Amp continuous rated (12A max.)
Size: 125(W) x 50(H) x 175(D)mm
Weight: 900 grams

A16160 .... $119.95



CPF CONTINUOUS POWER FILTER SPIKE ARRESTOR

The Fortron CPF Filtered Electronic Spike Protector provides a protective electronic barrier for microcomputers, printers, telephone systems and modems, electronic typewriters, audio and stereo systems and other sensitive electronic equipment.

The CPF provides protection from dangerous electrical spikes that can cause anything from obvious damage (like immediate equipment failure) to less obvious harm that can drastically shorten a system's life.

CPF's superior circuitry design and semi conductor technology responds instantly to any potentially damaging over-voltage, ensuring safe trouble free operation.

Additionally, CPF's filtering capability helps eliminate troublesome and annoying interference, general hash created by small motors, fluorescent lamps, and the like that threaten the performance and shorten equipment life of unprotected electronic components.

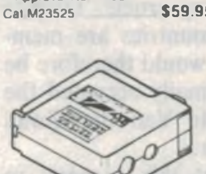
SPECIFICATIONS:
Electrical rating: 220-260 volts (AC) 50Hz 10 Amp
Spike/RFI Protection: 4 500 amps for 20m/second pulses
Maximum clamping voltage: 275V differential mode

Cat X10088 .... $69.95

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



POCKET SIZE BATTERY TESTER

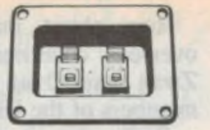
- Tests all 9V to 1·5V batteries including button cells
- Arms extend to various battery sizes
- Easy to read meter
- Requires no power source

M23521 .... $11.95

FREE STANDING, FOLD UP MAGNIFIER

An economically priced "hands free" magnifier, lets you take care of all those tricky fine detailed jobs so often encountered in electronics, or any of many other practical uses such as home, work, hobbies etc.

Cat T10020 Normally $14.95
SPECIAL, ONLY $12.95



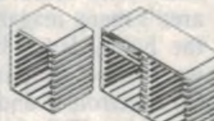
RECESSED SPEAKER TERMINAL

Push button, red and black terminals
Cat P10248 .... $1.95

CD TO CAR CASSETTE STEREO ADAPTOR

Enables a portable CD player or portable TV to be played through any car speaker system by using the cars cassette player. Reduces the risk of theft. Just plug in when required, and remove when you are finished. Hard wiring not needed.

A10011 .... $29.95



COMPACT DISC STORAGE UNITS

- Holds 10/20 compact discs in their cases
- Interlocking modular design allows vertical and horizontal interlocking
- Discs slide into place horizontally making titles easy to read
- Wall mount or free standing

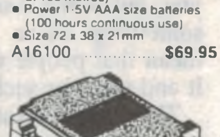
A10031 (10 discs) $12.95
A10032 (20 discs) $19.95

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



RS232 GENDER CHANGERS

- Saves modifying or replacing non-mating RS232 cables
- All 25 pins wired straight through

Cat X15650 Male to Male
Cat X15651 Male to Female
Cat X15652 Female to Female

Normally $14.95 each
Only $9.95

DB9 GENDER CHANGERS

- Saves modifying or replacing non mating DB9 connections
- All 9 pins wired straight through

X15640: Male to male
X15641: Male to Female
X15642: Female to Female
.... only $14.95

CROSSOVER NETWORKS

Crossovers are essential for multiway speaker systems, otherwise your bass will be degraded by inter modulation distortion and cone break up, and your treble will be distorted by bass components. These crossovers are designed to channel only the frequencies that each driver can properly handle. Read the specifications to choose the correct one for your need.

2 WAY 60 WATT CROSSOVER NETWORK

- 6dB attenuation
- Cross over point 5,000 Hz
- Impedance 8 ohms

Cat A16001 .... $4.95

2 WAY 60 WATT CROSSOVER NETWORK

- 12dB attenuation
- Cross over point 2,300 Hz
- Impedance 8 ohms

Cat A16002 .... $7.95

3 WAY 60 WATT CROSSOVER NETWORK

- 6dB attenuation
- Cross over point 800 and 5,000 Hz
- Impedance 8 ohms

Cat A16003 .... $9.95

3 WAY 60 WATT CROSSOVER NETWORK

- 12dB attenuation
- Cross over point 800 and 5,000 Hz
- Impedance 8 ohms

Cat A16005 .... $24.95

3 WAY 150 WATT CROSSOVER NETWORK

- 16dB attenuation
- Cross over point 350 and 3 000 Hz
- Impedance 8 ohms

Cat A16007 .... $34.95

MIDRANGE HORNS

Use these quality, all metal, Piezo tweeters for great top end sound in your band speakers, disco sound system, etc. Rated at 30 watts RMS, in a system they will handle over 100 watts RMS.

Two sizes to choose from:
Size: 4" x 10 1/2"
Impedance: 8 ohms
Rating: 30 watts RMS
Response: 1·5kHz - 14 kHz
Dimensions: 102 x 267 x 177mm
Cat C92082 Normally $49.95
This month only $39.95

Size: 3" x 7"
Impedance: 8 ohms
Rating: 30 watts RMS
Response: 2kHz - 15 kHz
Dimensions: 76 x 177 x 145mm
Cat C92084 Normally $29.95
This month only $24.95

Dealers, OEM's, etc., phone (03) 543 2166 for wholesale prices

SUPER HORN TWEETER

- Requires no crossover and handles up to 100W!
- Sensitivity: 100dB/0·5m
- Frequency Response: 3kHz-30kHz
- Impedance: 8 OHMS
- Size 96mm diameter

Cat C12102 Normally $12.95
SPECIAL, ONLY $9.95

P.A SPEAKERS

Low dual cone, wide range 200mm (8in.). Ideal for public address, background music, etc. Tremendous Value at these prices! .... Cat C12000

1-9 $6.95
10+ $5.95

5 PIN DIN WALL PLATE

- Fitted with 5 pin DIN socket
- Anodised aluminium plate
- Includes mounting hardware

P10940 .... $9.95

DB25 SOCKET WALL PLATE

- Fitted with DB25S socket (RS232)
- Anodised aluminium plate
- Includes mounting hardware

P10947 .... $11.95

DB25 PLUG WALL PLATE

- Fitted with DB25P plug (RS232)
- Anodised aluminium plate
- Includes mounting hardware

P10944 .... $11.95

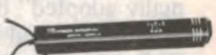
TEXTOOL SOCKETS

P17016 16 pin $14.95
P17024 24 pin $18.50
P17028 28 pin $24.95
P17040 40 pin $29.50

PIEZO SIREN

- 4 piezo units in a high impact plastic cabinet
- Input 12V DC - 200mA
- Output 115dB at 1m, dual tone
- Compact size 105 x 85 x 45mm
- Smart design suits interior use

Cat S15071 .... $24.95



OMNI-DIRECTIONAL WIRELESS MICROPHONE

Tuneable: 92 - 104MHz
Freq. Response: 50 - 15kHz
Range: Over 300 feet in open field.
Modulation: FM
Power Source: 9V Battery
Type: Electret Condenser
Dimensions: 185 x 27 x 38mm
Weight: 160 grams

Cat A10450 .... $19.95

RS232 WIRING ADAPTOR BOX

- Male to female
- 25 Detachable plug on leads
- 2 mini jumpers
- Ideal for experimenting or temporary connections

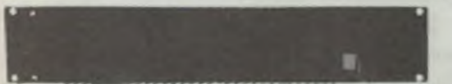
Cat X15665 ...... Normally $49.95
Only $44.95

008 335757 TOLL FREE MAILORDER HOTLINE FOR CREDIT CARD ORDERS! LOCAL ORDERS & INQUIRIES CALL (03) 543 7877

SERIES 5000

INDIVIDUAL COMPONENTS TO MAKE UP A SUPERB HIFI SYSTEM!

By directly importing and a more technically orientated organisation, ROD IRVING ELECTRONICS can bring you these products at lower prices than their competitors. Enjoy the many other advantages of RIE Series 5000 kits such as "Superb Finish" front panels at no extra cost, top quality components supplied throughout. Over 1,500 sold!



POWER AMPLIFIER

WHY YOU SHOULD BUY A "ROD IRVING ELECTRONICS" SERIES 5000 POWER AMPLIFIER

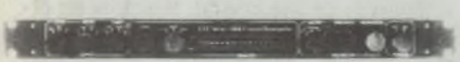
- 1% Metal Film resistors

SPECIAL, ONLY $399
SAVE $50

... and developed by ... ELECTRONICS and is being supplied to other kit suppliers.

SPECIFICATIONS: 150 W RMS into 4 ohms (per channel)
POWER AMPLIFIER: 100W RMS into 8 ohms (+ −55V Supply)
FREQUENCY RESPONSE: 8Hz to 20Hz +0= .0.4 dB 2.8Hz to 65KHz. +0=3 dB. NOTE: These figures are determined solely by passive filters.
INPUT SENSITIVITY: 1 V RMS for 100W ouput
HUM: 100 dB below full output (flat)
NOISE: 116 dB below full output (flat, 20KHz bandwidth)
2nd HARMONIC DISTORTION: 0.001% at 1 KHz (0.0007% on Prototypes) at 100W ouput using a + =56V SUPPLY rated at 4A continues ·0.0003% for all frequencies less than 10KHz and all powers below clipping.
TOTAL HARMONIC DISTORTION: Determined by 2nd Harmonic Distortion (see above)
INTERMODULATION DISTORTION: 0.003% at 100W (50Hz and 7KHz mixed 4:1)
STABILITY: Unconditional

Cat. K44771 .... **$449**
Assembled and tested $599
packing and post $10



PREAMPLIFIER

THE ADVANTAGES OF BUYING A "ROD IRVING ELECTRONICS" SERIES 5000 PREAMPLIFIER

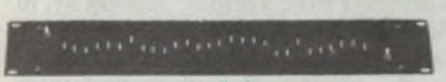
- 1% Metal Film ...

SPECIAL, ONLY $359
SAVE $40

... believe that dollar for ... commercial unit available that sounds as ...

SPECIFICATIONS:
FREQUENCY RESPONSE: High-level input: 15Hz = 130KHz, +0. = 1dB
Low-Level input-conforms to RIAA equalisation + = 0.2dB
DISTORTION: 1KHz ·0.003% on all inputs (limit of resolution on measuring equipment due to noise limitation)
S/N NOISE: High-Level input, master full, with respect to 300mV input signal at full output (1.2V)·92dB flat ·100dB A-weighted. MM input, master full, with respect to full output (1.2V) at 5 mV input 50ohms source resistance connected ·86dB flat/92dB A-weighted MC input, master full, with respect to full output (1.2V) and 200uV input signal ·71dB flat ·75dB A-weighted.

Cat. K44791 .... **$399**
Assembled and tested $699
packing and postage $10

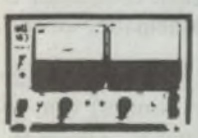


THIRD OCTAVE GRAPHIC EQUALIZER

SPECIFICATIONS:
BANDS: 28 Bands ...

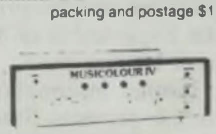
SPECIAL, ONLY $209
SAVE $30

Cat. K44590 .... 1 unit: **$239**
.... 2 units: **$429**
packing and postage $10



LAB SUPPLY

Fully variable 0-40V current limited 0-5A supply with both voltage and current metering (two ranges 0-0.5A/0-5A). This employs a conventional series-pass regulator not a switchmode type with its attendant problems, but dissipation is reduced by unique relay switching system switching between taps on the transformer secondary.
(ETI May 83) ETI 163
Cat. K41630 **$249**



MUSICOLOR IV

Add excitement to parties, card nights and discos with EAs Musicolor IV light show. This is the latest in the famous line of musicolors and it offers features such as four channel "color organ" plus four channel light chaser, front panel LED display, internal microphone, single sensitivity control plus opto-coupled switching for increased safety.
(EA Aug. 81) 81MC8
Cat K81080 **$114.95**

HUGE RANGE AT GREAT PRICES

ROD IRVING ELECTRONICS

MUSICOLOR IV

Add excitement to parties, card nights and discos with EAs Musicolor IV light show. This is the latest in the famous line of musicolors and it offers features such as four channel "color organ" plus four channel light chaser, front panel LED display, internal microphone, single sensitivity control plus opto-coupled switching for increased safety.
(EA Aug. 81) 81MC8
Cat. K81080 **$114.95**

MOTORCYCLE INTERCOM

OVER 500 SOLD!

Motorcycling is fun, but the conversation between rider and passenger is usually just not possible. But build this intercom and you can converse with your passenger at any time while you are on the move. There are no "push-to-talk" buttons, adjustable volume and it's easy to build!
(EA Feb. 84) 84MC2
Cat. K84020 **$49.95**

MULTI SECTOR ALARM STATION

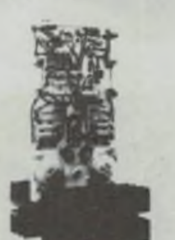
Protect your home and possessions from burglars with this up to the minute burglar alarm system. It's easy to build, costs less than equivalent commercial units, and features eight seperate inputs, individual sector control, battery back up and self-test facility.

Specifications:

- Eight sectors with LED status indication.
- Two delayed entry sectors.
- Variable exit, entry and alarm time settings: entry delay variable between 10 and 75 seconds; exit delay variable between 5 and 45 seconds; alarm time variable between 1 and 15 minutes.
- Resistive loop sensing: suits both normally open and normally closed alarm sensors.
- Battery back-up with in-built charger circuit.
- Built-in siren driver.

The RIE kit includes a superb printed and prepunched metal case and inside metal work, plus a gell battery! Unbeatable VALUE!

K85901 without battery backup **$134**
SPECIAL, $115
K85900 complete kit **only $159**
SPECIAL, $129



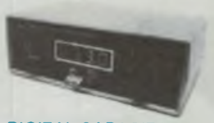
50 W AMPLIFIER MODULE (ETI 480)

Cat. K44880 Normally $31.80
SPECIAL, $21.95
(Heatsink optional extra)

100 W AMPLIFIER MODULE (ETI 480)

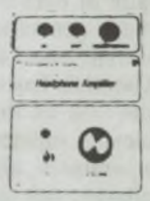
Cat. K44801 Normally $34.80
SPECIAL, $28.95
(Heatsink optional extra)

POWER SUPPLY TO SUIT
Without transformer **$22.95**



DIGITAL CAPACITANCE METER Mk.2

Updated from the EA March '80 issue, this Digital Capacitance Meter checks capacitor values from 1pF to 99.99uF over three ranges. Its main features include a nulling circuit and a bright 4 digit LED display.
*Note: The RIE kit contains quality silk screen printed and prepunched front panel AND an exclusive High Intensity Display!
(85cm9a, EA August '85)
Cat. K85090 **$99.95**



HEADPHONE AMPLIFIER

PRACTICE WITHOUT ANNOYING THE FAMILY!

If you play any type of electronic instrument this headphone amplifier will surely interest you. It will let you practice for hours without upsetting the household or you can use it to monitor your own instrument in the midst of a rowdy jam session. (EA Feb. 84) 83MA11
Cat. K84111 **$39.95**

VIDEO AMPLIFIER

Bothered by smeary colours, signal beats and RF interference on your computer display? Throw away that cheap and nasty RF modulator and use a direct video connection instead, it's much better! The Video Amplifier features adjustable gain and provides both normal and inverted outputs. Power is derived from a 12V DC plugback supply.
(EA Aug. 83) 83VA8
Cat. K83081 **$18.95**

CAR IGNITION KILLER

Most car burgular alarms are easily circumvented, but not this cunning "Ignition Killer". This sneaky antitheft device uses a 555 timer to place an intermittent short circuit across the points. Until disabled by its hidden switch the circuit effectively makes the car undriveable - a sure deterent to thieves! (EA Feb. 84) 84AU1
Cat. K84010 **$24.95**
(Our kit includes the box!)

ZENER TESTER

A simple low cost add-on for your multimeter. This checks zeners and reads out the zener voltage directly on your multimeter. It can also check LEDs and ordinary diodes.
(ETI May 83) ETI 164
Cat. K41640 **$11.95**

1W AUDIO AMPLIFIER KIT

A low-cost general-purpose, 1 watt audio amplifier, suitable for increasing your computers audio level, etc. (EA Nov. 84)
Cat. **$9.95**

THE SCREECHER CAR BUGLAR ALARM

Here is a low cost car alarm designed with a new deterrent strategy. Instead of using the alarm to try to draw the attention of passers-by to the felony in progress this alarm sounds inside the car, to deafen the thief and make it too uncomfortable to proceed with pinching the vechile!
(86a19, EA August '86)
Cat. K86081 **$29.95**

AUDIO TEST UNIT KIT

Just about everyone these days who has a stereo system also has a good cassette deck, but not many people are able to get the best performance from it. Our Audio Test Unit allows you to set your cassette recorder's bias for optimum frequency response for a given tape or alternatively, it allows you to find out which tape is best for your recorder.
(81AO10) (EA Oct. 81)
Cat. K81101 **$59.50**

LOW-COST BIPOLAR MODEL TRAIN CONTROLLER

Here is a simple model train control for those enthusiasts who desire something better than the usual rheostat control. It provides much improved low speed performance and is fully overload protected, yet contains relatively few componenets. Best of all, you don't need to be an electronic genius to construct it. (80TC12) (EA Dec. 80)
Cat. K80120 **$39.95**

ELECTROSTATIC HAZARD DETECTOR KIT

It's called electrostatic hazard and if it, or even its baby brother, jumps on the back of your IC or transistor, then the poor device is never likely to be quite the same again. So, out of a very ordinary collection of bits and pieces, ETI has fashioned a black box that will sit quietly on a corner of your bench for years at a time and beep when ever high tension appears. It may save you a lot of trouble, particuly if you ever work with CMOS. (ETI 173 May '86)
Cat. K41730 **$54.95**

READY-SET-GO LIGHTS

A simple project for starting slot car races, etc. It provides the traditional Red/Amber/Green lights with a random delay between the amber and green. (ETI Oct. 84) ETI 277
Cat. **$24.95**

EA AM STEREO DECODER

AM stereo is now broadcast in Australia on an experimental basis. This add-on decoder works with the Motorola C-QUAM system.
(EA Oct. 84) 84MS10
Cat. K84100 Normally $26.95
SPECIAL, $16.95

CRYSTAL CONTROLLED TV PATTERN GENERATOR

Anyone wishing to obtain the maximum performance from a colour TV reciever needs a pattern generator. Why not build this superb unit which provides five separate patterns; dot, crosshatch, checker board, grey scale and white raster?
Note: The RIE kit includes a large ABS type case!
(80pg6, EA June '80)
Cat. K80033 **$99.95**

TRANSISTOR TESTER

Have you ever desoldered a suspect transistor, only to find that it checks OK? Trouble-shooting exercises are often hindered by this type of false alarm, but many of them could be avoided with an "in-circuit" component tester, such as the EA Handy Tester. (EA Sept '83) 83TT8
Cat. K83080 Normally $18.95
SPECIAL, $15.95

15V DUAL POWER SUPPLY

This simple project is suitable for most projects requiring a dual voltage. Includes transformer.
(ETI 581 June '76)
Cat. K45810 **$34.95**

rie

Rod Irving Electronics

MELBOURNE: 48 A'Beckett St
Phone (03) 663 6151

NORTHCOTE: 425 High St.
Phone (03) 489 8866

CLAYTON: 56 Renver Rd
Phone (03) 543 7877

SOUTH AUSTRALIA:
Electronic Discounters P.L.
305 Morphett St, ADELAIDE
Phone (08) 212 1799
NOTE: Prices may vary interstate due to freight costs.

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Local Orders: (03) 543 7877
Interstate Orders: (008) 33 5757
All Inquiries: (03) 543 7877

CORRESPONDENCE
P.O. Box 620, CLAYTON 3168
Telex: AA 151938
Fax: (03) 543 2648

MAIL ORDER HOTLINE
008 335757
(TOLL FREE)
(STRICTLY ORDERS ONLY)

LOCAL ORDERS & INQUIRIES
(03) 543 7877

POSTAGE RATES:

$1	$9.99	$2.00
$10	$24.99	$3.00
$25	$49.99	$4.00
$50	$99.99	$5.00
$100	$199	$7.50
$200	$499	$10.00
$500 plus		$12.50

The above postage rates are for basic postage only. Road Freight, bulky and fragile items will be charged at different rates.

All sales tax exempt orders and wholesale inquiries to:
RITRONICS WHOLESALE,
56 Renver Rd, Clayton
Ph. (03) 543 2166 (3 lines)

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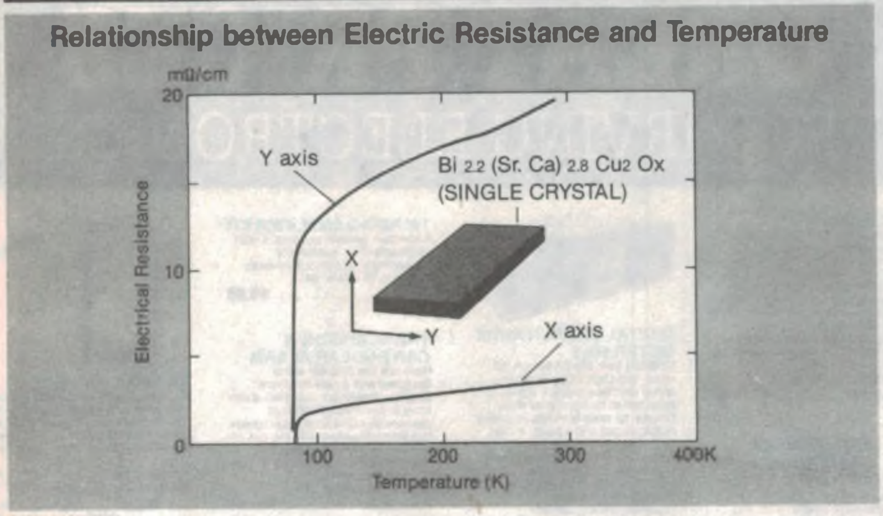
News Highlights



Superconduction breakthrough

Toshiba Corporation has achieved a major advance in the development of superconductivity – a technology of tremendous potential which has fired the imagination of thousands of scientists worldwide.

A group of Toshiba researchers has succeeded in growing a single crystal of an oxide compound of bismuth, strontium, calcium and copper, with the largest dimensions ever achieved in the world – 7 × 5 × 1mm. This has opened the way for researchers to analyze a wealth of data necessary for creation of a new generation of superconductive materials based on bismuth.

Materials based on bismuth – a metal – are one of the prime condidates for achieving superconductivity at everyday temperatures, and moreover are readily available, not costly and possess very stable chemical characteristics when exposed to oxygen or a high degree of humidity.

Toshiba researchers formed the largest ever single-crystal platelet of an oxide compound of bismuth, strontium, calcium and copper. They mixed powder of these elements at the ratio of 2(Bi): 1(Sr): Ca(1): Cu(2), heated the mixture in an alumina crucible to 1,830°F and slowly cooled it by 18 degrees an hour to reach 930°F.

The test results showed that the compound begins the transition to superconductivity at 84 Kelvin (–308°F) and exhibits no electrical resistance at 81.5K (–314°F).

"We have got our sights set on 110K, and we have high hopes of achieving this with a bismuth-based compound in the future," says Dr. Akinobu Kasami, Deputy Director of the Research and Development Centre, and head of the Advanced Research Laboratory, which was established this April in the Centre.

"The single crystal will greatly help our efforts to achieve this goal," continues Dr, Kasami, "because the crystal is large enough for us to conduct a precise analysis of its physical and chemical properties; including electric resistance, reflectivity of the crystal, which is an effective means to speculate the state of the electrons, and magnetic characteristics."

Using the crystal, Toshiba researchers have already discovered that electrical resistivity varies according to the axis of the crystal (see figure).

New 3M diskettes claimed "more reliable"

3M Australia claims that tests have shown its new "Mark Q" range of 5-1/4" floppy disks to be 60% more reliable than any other brand on the market.

In tests against other well-known brands such as Xidex, Maxell and Verbatim, the Mark Q disks were said to be 60% more reliable in formatting, and at least three times more durable, registering over 30 million read-write passes without deterioration. 3M says this translates into 2000 years of work if one file was accessed every hour of every day.

3M says the performance of its Mark Q disks is the result of a new formulation, which is harder and attracts less airborne debris; a new streamlined manufacturing process; and a new chemical composition for the diskette jacket, which provides greater heat resistance and minimises jamming.

Despite these improvements, the new disks are 10% lower in price than previous product. Further information is available from 3M on 008 022293.

Mathematics-in-Industry Study Group for 1989.

The fifth Mathematics-in-Industry Study Group will be held at Monash University from Tuesday, January 31, to Saturday, February 4, 1989. The meeting is relevant to all who are interested in the transfer of mathematical ideas and technology to Australian industry. Applications are invited from research workers or technical managers in industry who would like to propose scientific problems for consideration. The major sponsor of the Study Group is the CSIRO Division of Mathematics and Statistics and the principal co-sponsor is the Department of Mathematics of Monash University.

Further information (including details of the previous Study Groups) can be obtained from the Director: Dr. N.G. Barton, CSIRO Division of Mathematics and Statistics, PO Box 218, Lindfield, NSW 2070. Tel. (02) 467 6703, 467 6062.

CD-ROM for emergency services

A CD-ROM disc has been produced to provide emergency services with instant information to cope with spills of any one of more than 30,000 toxic chemicals stored around Australia.

The disc, to be known as Toxichem, has been hailed by emergency services around the country as a potential life-saver.

The Toxichem project is being managed and marketed by WA based software company Zedtronics, who developed the specialised software for the disc using a database developed by the WA Fire Brigade. The development and manufacture of the disc has been undertaken in Melbourne by Disctronics.

According to Ivor Wilson, Manager of Zedtronics, this disc will take emergency and associated services into the 21st century in terms of harnessing technology to increase man's safety.

"Emergency services are under increasing pressure from the growing number and complexity of chemical spills they are called upon to attend. To do their job effectively those services need two major attributes: logistical efficiency and knowledge. Constant training takes care of the first and there is a wealth and diversity of information sources available to provide the second".

"The problem however is how to quickly access, digest and handle that wealth of information so that it becomes quickly usable knowledge in an emergency".

"We saw CD-ROM with its incredible storage capacity and virtually instantaneous retrieval speed as a way of solving what in effect is a major community problem".

In total the disc contains more that 100 megabytes of information dealing with more than 30,000 known chemicals imported, manufactured, used, transported and stored throughout Australia.

Zedtronics manager Ivor Wilson with a sample of the new CD-ROM disc.

Bogus radio inspectors in Queensland

The Department of Transport and Communications has warned residents of North Queensland to beware of people posing as radiocommunications inspectors.

A spokesperson for the department, Mr. John Kington, said there were reports of several people owning Citizens Band (CB) radios in Clermont, Blackwater, Emerald and Mount Isa being visited by a person claiming to be an officer of the Department.

"Our inspectors carry the Department's official photo indentification cards and travel in Commonwealth vehicles with 'Z' number plates", Mr. Kington said.

"The Department of Transport and Communications is treating all reports of suspicious visits seriously and conducting inquiries in conjunction with State Police".

Saft announces local subsidiary

French leader in advanced battery technology Saft has set up a subsidiary in Sydney to boost its market share and position itself to bid for local defence contracts.

Long represented here through agents, the local operation – one of 13 outside France – will market Saft's full range of industrial and high technology batteries in Australia and the South Pacific.

Saft Batteries Australia Pty Limited's French parent, Saft S.A., is itself a subsidiary of French multinational giant Compagnie Generale d'Electricite (CGE). In 1987 CGE had a turnover of A$31 billion and employs 250,000.

From its new premises at Mascot, Saft will market sealed and vented nickel cadmium rechargeable batteries, advanced lithium cells and special battery systems for defence.

Highly conductive rubber developed

A scientist working at AT&T Bell Laboratories in New Jersey has discovered a way to increase the electrical conductivity of rubber by a factor of 10^{10} times, turning it from one of the best insulators available into an excellent conductor.

Bell scientist Minal Thakur achieved this dramatic increase in conductivity by doping the rubber with iodine.

Scientists previously thought that rubber could not be made conducting, because unlike other polymers its structure includes only isolated double bonds instead of a conjugated system of double bonds. The advantage of rubber over other conductive polymers (such as polyacetylene) is that is more flexible, and can be moulded and manipulated more easily.

News Highlights

Broadcasting and Television proficiency certificates

Course arrangements for broadcast and television operators at the Royal Melbourne Institute of Technology (RMIT) will change next year.

The RMIT will no longer offer the award of Broadcasting Operators Certificate of Proficiency (BOCP) and the Television Operators Certificate of Proficiency (TVOCP) as part of its normal curriculum on behalf of the department of Transport and Communications.

A spokesman for the Department said the RMIT would hold its last exams for current courses in November 1988, with applications closing on 23 September. Department of Transport and Communications State Broadcasting Engineers in each state have RMIT enrolments forms for these examinations.

Next year, RMIT will only offer "off campus" studies for both the BOCP and the TVOCP. Students partially through the three-part examinations at RMIT should apply for status to the Head of the School of Electrotechnology, RMIT, GPO, Box 2476V, Melbourne 3001.

As in past years, approved courses for the BOCP or TVOCP will continue to be available at a number of technical schools and colleges throughout Australia.

More information on BCOP or TVOCP courses and examinations can be obtained from the Operations Branch, Communications Operations Division, Department of Transport and Communications, GPO Box 594, Canberra 2601.

Australian National's David Keddie with the BP Solar PVStor batteries which will be used on the Adelaide-Alice Springs microwave link.

Rail link uses Australian batteries

Australian National has equipped its vital microwave communications link on the Tarcoola to Alice Springs railway with Australian sourced batteries, in an efffort to reduce costs and maintenance.

BP Solar's PVSTOR batteries offered a 50% reduction in the cost of replacement compared with the batteries previously used. The batteries are used at 23 repeater stations along the link.

Communications Engineer for AN, Dave Keddie said PVSTOR batteries enabled AN to halve the number of batteries required, while retaining the same capacity as the previous units.

"The reduced number achieved a reduction in initial purchase price as well as transport and installation costs," said Mr Keddie.

"PVSTOR's high electrolyte reserves mean we have been able to reduce maintenance costs by 75%," he said.

AWA sets up ASIC technology network

Dr Peter Crawford, managing director of AWA Limited, recently opened AWA Microelectronics' first ASIC Technology Centre (ATC) at British Aerospace Australia's Adelaide plant.

AWA Microelectronics (AWAM) is establishing a network of ASIC Technology Centres throughout Australia, as the latest step in AWA's "Silicon Initiative" to raise the competitive edge of Australia's electronics industry. As part of its Silicon Initiative, AWA has already invested some $35 million in its new world class facility at Homebush Bay in Sydney, and has dramatically upgraded its own design capability.

AWAM is now the only Australian company to design and manufacture state-of-the-art ASICs (Application Specific Integrated Circuits). The market for these versatile custom-designed chips is growing at some 40% a year.

AWA is targeting four major markets with its move into ASICs for telecommunications, defence and aerospace, medical electronics, and information technology. It is actively seeking to establish commercial relationships with corporate partners in the manufacture and design of ASICs.

"The launching of the ASIC Technology Centre network is an Australian first, and nothing like it has been attempted by any company in this country", says Toby Cross, AWAM's marketing manager. "It will help put Australian electronics on a world footing."

In the Adelaide ATC, British Aerospace Australia (BAeA) will use AWAM'S ASIC design technology to develop chips for its own use, and for other customer in South Australia. BAeA designers will undertake schematic capture and logic simulation, and then pass chip design — in the form of a simulated lay-out database — to AWAM's Homebush plant for manufacture.

Inmarsat shows satcoms in East Europe, USSR

Inmarsat has succesfully completed an extensive program of land mobile satellite communications tests and demonstrations throughout Eastern Europe and the USSR. The program involved demonstrating the use of satellite technology to provide reliable communications and position reporting capabilities for the road and rail transport industries, under a wide variety of operational and geographic conditions.

Inmarsat is the 54 member-country international cooperative that operates a global satellite system for mobile communications, currently used by more than 7,000 ships. The system is soon to be used for civil aviation communications and Inmarsat is now developing a range of land-mobile services.

Travelling in a specially equipped mobile home, a small team of INMARSAT engineers and executives earlier this year completed a circuit of cities from Prague, Czechoslovakia, to Berlin (GDR) via Hungary, Yugoslavia, Bulgaria, the USSR and Poland. The total distance covered was more than 3,500 miles.

During that time they sent and received hundreds of text messages between the moving vehicle and Inmarsat headquarters in London, England, and initiated a constant flow of position reports. The transmissions were carried via the Inmarsat operational satellite located over the Atlantic Ocean.

All countries granted INMARSAT permission to perform the tests.

Gosford Field Day 1989

The NSW Central Coast Amateur Radio Club is to hold its 32nd Annual Field Day on Sunday 19th February 1989 at the Showground, Showground Road, Gosford, NSW. All amateur radio operators, their families and friends and anyone interested in amateur radio are invited to attend.

Special events will include a home brew contest, evaluating home made 70-cm antennas. Companies, groups or clubs wishing to set up a table or display at the Field Day should contact the Central Coast Amateur Radio Club Inc., PO Box 252, Gosford 2250, or ring Bren Connolly VK2BJC, on (043) 23 1662.

News Briefs

- Australian datacomms specialist ***Datacraft*** has formed a joint venture company with US datacomms mail order catalog marketer Black Box Corporation. Datacraft has been distributing the well-known Black Box Catalog through it own direct marketing division since 1981. MD of the new ***Black Box Catalog Australia*** is David Anderson.
- Components distributor ***Soanar*** has been appointed sole Australian agent for giant Jugoslavian manufacturer ISKRA, which employs more than 35,000 people and specialises in the production of high quality active and passive components, synchronous and asynchronous motors, and electric pumps. Initially Soanar will concentrate on ISKRA products which augment its existing ranges; first shipment will include multi-layer ceramic capacitors and mains suppression capacitors.
- After almost a decade of persistence, ***Siemens Australia*** has apparently cracked the tough Japanese market with its precision 75-ohm co-axial connectors. Tokyo-based Siemens KK recently placed a $60,000 pilot order for the Australian-developed connectors, and larger orders are apparently in the pipeline.
- Professional communications consultancy ***Priestley & Shearman*** now forms the communications division of ***Merz & McLellan & Partners***, operating from its Sydney office.
- Distinguished Australian academic Professor John H. Carver, Director of the ANU Research School of Physical Sciences, has been appointed Chairman of ***Auspace Limited***, a wholly owned subsidiary of French industrial giant Matra SA. Professor Carver is also a director of the Australian Space Board.
- Newly-formed ***Email Electronics***, the $50 million division of Email formed from the company's previous Relays and Electronics and Petroleum divisions, has been appointed Australian distributor for the Horiba range of process, environmental and automotive quipment.
- Philips has acquired the 50% interest in Netherlands-based magnetic tape maker ***PD Magnetics*** held by Du Pont. PD Magnetics will continue to market tape and cassettes under the PDM brand name, using raw materials supplied by Du Pont.
- Fast growing local communications company ***Heyden-Spike*** has acquired Sepac Industries (Australia) and its sister company Australian Trunked Radio.

Aussie VHF Pocketphones used on Everest

Major Peter Lambert, back in Australia after climbing with the Australian Bicentennial Everest Expeditions (ABEE) says that mobile radio communication was a critical element in the team's success. Based in Canberra with the Royal Australian Corps of Signals, Major Lambert was responsible for the ABEE communication arrangments.

Twelve handheld VHF Pocketphone transceivers, supplied by Philips Australia, were used for twice daily updates on route conditions, weather, supplies and climbers' health – over a period of two and a half months.

One of these radio transceivers also announced the arrival of an Australian on the very summit. Cameraman Jon Muir, the third team member to make the final ascent, took his Pocketphone to the top. He said, "As I stepped on the top it felt as though all my Christmases had come at once and I just thought I am king of the castle!".

"I talked on the radio to Camp 2. For a few seconds there was a lot of static. Then Terry (Captain Terry McCullagh)-said "Is that you Jon?". And I said "Yes, this is Jon and I'm on the top!". He said "Where are you?". And I said "I'm on the summit, yes I'm on the top!"

The radios used by the Australian mountaineers were standard PF.85 Pocketphones, as supplied by Philips Mobile Communication Systems to Australian emergency services and operations like the construction industry.

Because NiCad batteries do not retain a charge at extremely low temperatures, dry cell batteries were also used as standby power for the radios. Team members were required to sleep with their batteries to keep them warm.

Passive IR sensor is remote controlled

A new portable passive infra-red (IR) sensor for home and office security applications developed in Italy features a self-contained rechargeable battery, plus remote arming/disarming.

The Teleguard VP3 consists of a single unit containing sensor, siren and rechargeable battery. This eliminates the usual wiring and installation expense associated with security systems, and allows the unit to be moved from one location to another. The internal battery takes about 10 hours to charge from the power pack supplied, and will then run the VP3 for between 3 and 4 months before recharging.

A remote control similar to that used for garage doors allows the VP3 to be armed and disarmed easily from a distance of up to 30m (90ft). Once activated the unit emits a high-intensity wail for 2 minutes, before resetting.

Cost of the VP3 in Australia is quoted as $400 complete. Further information is available from Eddie Scotney-Johnson Security Broker, (02) 427 1611.

Pacific fibre-optic links

British Telecom has joined five other major telecommunications carriers in providing two optical fibre cable systems connecting Australia with Guam and New Zealand with Hawaii.

To be known as PacRim West and PacRim East, these will meet other cables to form an optical fibre communications ring linking the main centres around the Pacific basin.

As a major partner in the project which includes OTC, TCNZ of New Zealand, KDD of Japan, AT & T and Canada's Teleglobe, British Telecom will contribute its considerable experience and technical expertise to the system design, cable laying operations and other aspects of the PacRim links,

Their establishment is seen to be a relatively challenging project in view of the very deep water in which the cables must be laid and the steepness with which the landmasses they connect rise from the ocean floor.

The two cables are scheduled to be completed by 1993 and 1996 respectively. Each is estimated to cost about $340 million. They will connect with the first trans-Pacific FO cables, planned to link the US, Guam and Japan this year.

Silicon Valley NEWSLETTER . . .

Report warns US could lose superconductor race

Shortsightedness on the part of the business community and too much emphasis on military-related applications is causing the United States to rapidly fall behind Japan in being able to put new high-temperature superconductor technology to use in industrial and consumer applications, according to a report released by the US Office of Technology Assessment.

In all, the US government this year alone will spend an estimated $US95 million in superconductor research. But more than half of the money will go toward projects aimed at putting the new technology to use in military applications where, according to the report, there is "limited potential for commercial spin-offs."

The report, which was the focal point during a recent hearing of the US Senate's Government Affairs Committee, also scolded private industry for emphasizing short-term profits at the expense of long-term commercial pay-offs. Contrary to the "wait-and-see" attitude most American businesses have taken towards the new superconductors, Japanese businesses are showing a lot of confidence that their current investments will pay off down the road, the reports states.

Company claims process cuts solar cell cost in half

A small Californian solar energy company has announced new technology that would cut the cost of converting the sun's energy into electricity by almost 50%.

Rather than improving the efficiency of the solar cells, tiny International Solar Electric Technology in Inglewood said its development focused on producing current state-of-the-art solar cells more cost-effectively.

Vijay Kapur, one of the solar industry's leading scientists who formerly worked for SRI International in Menlo Park, said SET's process cuts the cost of producing solar cells by about 75%.

ISET's process deposits a layer of copper-indium-diselenide onto the cells. "That is a very cheap method of making solar cells and the track record has been extremely good," commented Harrin Ullal, senior research scientist at the Solar Energy Research Institute.

Ullal, however said that ISET may not be able to reap the full benefits of the development, since it received government funds for the research. Because of the use of public funds, ISET may have to make the process available to other companies.

Iranians were first victims of artificial intelligence

Although it will be some time before the investigation into the shooting down of an Iranian airliner will be completed, it appears the 290 crew and passengers will go down in history as the first fatal victims of the new science of "artificial intelligence."

Although many aspects of the Aegis radar system aboard the battleship Vincennes are highly classified, it is known that the Aegis system relies in large part on AI in identifying nearby aircraft as friendly or hostile and recommending the necessary defensive actions based on the conclusions it reaches about the intentions of any approaching aircraft.

The military radar signals transmitted by the Iranian Airbus and its course correction towards the ship, apparently led the Aegis computers to conclude the aircraft had hostile intentions and followed through on that conclusion to the point of advising the launching of defensive missiles. Apparently the ship's captain believed the computers had fired the missiles that downed the civilian plane.

According to military officials, the Aegis system was not able to deal adequately with the ambiguous situation that presented itself on the morning of the shooting. Confused by mixed civilian "Mode 3" and military Mode 2 radar identification signals it received from the plane, and coming just five minutes on the heels of another nearby shooting incident involving US patrol helicopters and Iranian gunboats, the Aegis computer made a faulty deduction that allowed it to arrive at the wrong conclusion, which in turn prompted it to recommend the wrong action to Captain Will Rogers.

Already the Airbus incident is sending shockwaves through the electronic defence industry, as the increased reliance of the military on advanced computer technology in life-and-death decision situations is sure to come under intense scrutiny.

IBM goes after RISC processor makers

In a move that appears even more ambiguous than Apple's copyright lawsuit against Microsoft and Hewlett-Packard, IBM has put manufacturers of RISC microprocessors on notice that they may be infringing on IBM patents and will have to negotiate for licence rights.

Reduced Instruction Set Computer architecture is currently the hottest around, and is expected to fuel the next generation of computers ranging from high-end personal computers to super engineering workstations, and minicomputer.

IBM claims that one of its chief computer scientists, John Cocke developed the first RISC processing architecture during advanced research at IBM laboratories in the mid-1970s, and that the company reportedly received patents on the designs.

RISC remained dormant until the early 1980s, when a group of students and professors at the University of California at Berkeley developed a prototype RISC microprocessor. It was the Berkeley group that also coined the term RISC.

Companies like Hewlett-Packard, Sun Microsystems and MIPS Computer Systems quickly recognised the potential benefits of the Berkeley project and started to develop processors with similar RISC features. Recently, a host of semiconductor manufacturers have joined the RISC field, including Motorola, Advanced Micro Devices, Intel, National Semiconductor, and Texas Instruments. Others, including Cypress Semiconductors and LSI Logic have

Among the latest products to emerge from silicon valley is this special watch from Mountain View firm ASR. Designed for Muslims, it not only keeps track of the daily schedule of prayers, but also indicates the direction of Islam's holy city Mecca – from any location on the globe. Export sales to Saudi Arabia have been very brisk!

begun manufacturing and selling versions of the Sun and MIPS RISC processors.

Industry analysts said the announcement by IBM indicates the giant is trying to assert the rights it believes it has to the RISC technology, which has the potential of radically shifting the balance of power in the computer industry away from giants such as IBM. This is because the speedy RISC processors are expected to give birth to a generation of desktop systems that rival the power of today's mainframes at a fraction of the cost. Such development would undoubtedly reduce the size of the mainframe market and thus severely hurt IBM.

Breakthrough announced in speech recognition

Carnegie Mellon University in Pittsburgh announced that one of its graduate students in computer science has developed a breakthrough in speech recognition technology. A prototype of the so-called "Sphinx" system based on the work by Kai-Fu Lee has achieved a 96.2% accuracy in recognizing natural speech from randomly selected speakers.

According to researchers at Bell Laboratories, Sphinx represents a major breakthrough, as it combines a number of key speech recognition technologies into one.

One key feature of the Sphinx system, which uses a Sun Microsystems workstation as the CPU and has a 1,000-word vocabulary, is that it doesn't require the computer to be "trained" for specific speakers. To date, all voice recognition systems with substantial vocabularies recognize only the speech of those individuals they have been trained for.

Also, these systems require speakers to insert short – unnatural – pauses between words, limiting the use of these machines to such tasks as dictation.

The Sphinx, however, accepts continuous natural speech from any person. As sound waves enter the Sphinx's microphone it slices them up into 10-millisecond increments which are subsequently digitized.

Each slice is then subjected to a mathematical process that results in three versions that differ only slightly. The computer then searches its memory for patterns that match the digital signature of the three versions based on a set of acoustical and grammatical rules.

After the searching and sampling, Sphinx quickly makes its best guess of the spoken word. But rather than searching its entire vocabulary for each word, Sphinx uses another set of grammatical rules and guidelines to vastly narrow down the search, by guessing which words are most likely to follow those that have previously been recognized.

These techniques result in an 80-fold increase in the speed with which Sphinx arrives at its decision compared with other large vocabulary speech recognitions systems.

Lee said that while his system represents a major breakthrough, several major obstacles remain. For one, Sphinx, like any other speech recognition system, becomes highly inaccurate when people make grammaticall errors. Also, researchers are still struggling to develop ways to make it easy to make corrections in the event the computer chooses the wrong words. Such corrections are critical for systems like Sphinx which base their selections in large part on the meaning of previously recognized words. One error could easily result in the selection of a whole string of incorrectly chosen words.

Computer virus spreads through government PCs

A computer virus aimed at sabotaging Texas-based Electronic Data Systems has reportedly invaded personal computers used by at least four government agencies, including NASA and the Environmental Protection Agency where it has destroyed a number of data files.

According to federal authorities, the virus invaded the government's computers some time in January and spread itself unabated for two months before being detected, and another three months before an effective antidote was finally developed. NASA has asked the FBI to investigate the case, but officials said it was not known whether the virus was deliberately allowed to invade the government's computers or whether it was accidently introduced by an unsuspecting worker bringing an infected disk to work.

Government officials noted that the damage from the virus was limited, although a number of files were destroyed and certain projects were delayed. Also, many hundreds of man-hours were spent tracking and eradicating the virus at the EPA, NASA, the National Oceanic & Atmospheric Administration, and the US Sentencing Commission.

According to computer crime experts, the latest, so-called "Scores Virus" brings the total of viruses that have been identified in the US this year to 40.

First erasable optical drive for MS-DOS machines

Advanced Graphics Applications of New York has announced the development of what the company claims to be the first erasable CD-ROM optical storage device for use with MS-DOS personal computers.

The company said its so-called "Discus Rewritable" optical drive is similar to popular CD-ROM compact disk players, but is capable of both reading, writing, and erasing data stored on the disks which can hold several hundred megabytes worth of information.

AGA said the Discus drive will be available for $4,995.

New multiplexer cables could bring fibre-optics into the home

Menlo Park-based Raychem has introduced a revolutionary new fibre-optic-based multiplexer communications cable system and said that three of the US's largest regional telephone companies and the West German "Bundespost" have agreed to field test the new system.

The system, developed by a one-year-old Raychem subsidiary known as "Raynet," allows both telephone, cable television, and computer data signals to be carried simultaneously from the telephone company's central office to the homes and offices of its customers.

Raynet marketing manager George Ballog said the Raynet cables cost the same to install as traditional copper wires, but each cable can carry up to 200 simultaneous telephone calls.

While telephone companies have been actively installing fibre optic cables between their regional communications centers and other channels that must carry large numbers of signals, the cost of making the fibre connection to each individual home or office end-user station has so far proven prohibitive.

Raynet believes telephone companies can now cost-effectively make the conversion to fibre optics of the "subscriber loop," the last mile or two of cable between the central office and homes and offices, using the Raynet cables and the sophisticated multiplexer software that the company has developed in cooperation with Bell South.

Bell South said it will field test the system next year, along with two other regional Bell operating companies, Chicago-based Ameritech and NYNEX in New York.

The Serviceman

Things that go "Squeak" – and a hi-tech dry joint

Despite the development of ever more complex and powerful ICs, there's still one kind of fault that has persisted ever since the early days of radio: the dry solder joint. In fact galloping technology seems to have made it possible for these frustrating little horrors to be even harder to track down than ever before!

There are some television sets that I would rather not know about. They are models that develop common symptoms from very uncommon causes.

For instance, vertical failures in the Sharp 1831X are what I call NTSC faults. They are Never Twice the Same Cause. Every 1831X I have ever worked on has had a different cause for the same fault.

There's a Toshiba chassis that develops common-looking picture faults. It's not an electro failure or an open circuit screen resistor as in most other sets. The only way to cure this one is to resolder EVERY pinthrough on the double sided mother board, and every plug-in module. There is no way to tell which pinthrough is dry jointed, and it's never the same as the one you did last time. So you have to do the lot!

But my main story this month concerns another set that gave me similar problems. It was a General Electric model TC53L2, fitted with an Hitachi NP6A-A chassis.

This was reported as "switching itself off at irregular intervals" and it was kind enough to keep up these games even after it had been brought into the workshop.

Sometimes it would give a little squeak when switched on, then stubbornly refuse to talk. At other times it would be running normally, then would start to screech, the picture would collapse to a vertical line, and then nothing.

This is one of those villainous designs that requires the line output stage to be operating properly to keep the power supply going. If the pulse from the line output transformer disappears even momentarily, the supply shuts down.

A one-line hiccup from the oscillator, line driver, output, yoke or any of the associated circuitry is enough to kill the power supply. If this happens, the only thing to do is to switch the set off, wait for 30 seconds then try again.

These Hitachi circuits have a number of characteristic faults and one of them is dried out electros in the power supply. These can present symptoms similar to those described above, so the first treatment is to replace all of the low value electros on the power board.

At first I though I might have struck it in one, because the set ran perfectly for the rest of the day. But I couldn't be that lucky. Next morning it was back to its old tricks, with a vengeance.

Because of the need for the line pulse, it is not practical to run the power supply on a dummy load. But it is possible to run the set from an external power supply – one that does not need the regulating pulse.

Next morning it was back to its old tricks, with a vengeance...

This is a brute force method and not one to be used lightly. Any breakdown in the set will not be protected by automatic shutdown. The only protection that can be applied externally is current limiting. Nor should the set be left unattended while running on the external supply. A short circuit could lead to fire if the voltage is not removed quickly

Nevertheless, an external supply can be very useful in determining if the fault is in the power supply or the set. In this case the fault was obviously in the set, because it continued to play up when run from either power supply.

When running from the external supply, a breakdown was heralded by the squeak mentioned earlier, but then continued with a noisy screech that clearly originated in the line output transformer.

At first I thought of dry joints around the line stage, one of the characteristic faults in these early Hitachi chassis. I spent a lot of time resoldering every spot on the board, but this made no difference.

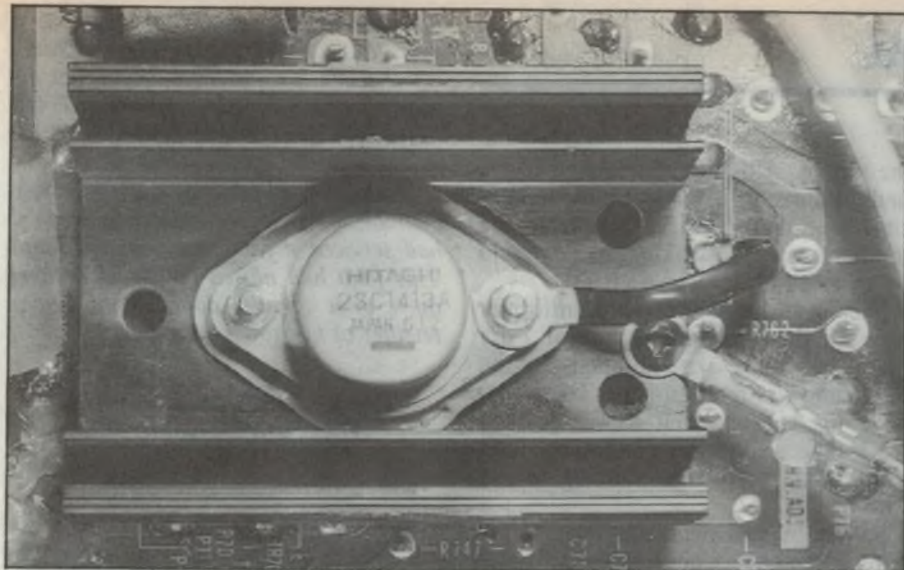
These chassis are known to have an odd kind of corrosion that develops around the line output transistor, in particular under the collector mounting screws. I dismantled the heatsink and checked under the screws, but they were as clean as could be. In fact, the screws were bedded down into thick solder pads, so there was little chance of any fault there.

I even went as far as removing the line output transformer (no easy task on this set), to check if there were bad joints on the top ends of the connecting pins. There weren't any, but I resoldered them anyway.

I tested all and changed some of the electrolytic caps on the line output board, and I did the same to the caps on the line oscillator board. None of this made any difference to the erratic performance. Sometimes it would run for four hours and sometimes it would last only four minutes.

To be honest, I was completely bushed by this set. I had no idea of what was happening when it broke down. In the fault condition, every waveform in the set changed its appearance. The only thing that didn't seem to change was the line frequency. That appeared to stay rock steady on 15,625Hz.

Eventually I decided to brute force my way into the fault. I ran the set from the external power supply, turned up to a slightly higher voltage than usual. When the set failed, I just let it run. The screech was hard to tolerate, but at least I could now do some kind of fault finding. I might even get lucky, to the point where the faulty part would begin to smoke.



How a collector strap is fitted to the line output transistor of a GE model TC53L2, to bypass any possible dry joints.

But I should have known better. Whatever the fault was, it wasn't drawing enough current to get warm, let alone smoke.

I did get a little bit lucky, because while the screech continued, I found that the set was sensitive to mechanical vibration. Tapping the line board with the handle of a small screwdriver caused the pitch of the screech to change. Sometimes, it would even jolt the set back into normal operation.

So it seemed that it had to be a dry joint, even though I had already resoldered every joint on the line board. Unfortunately, the whole output stage seemed to be sensitive to tapping. I could not localise the fault to any one part of the board.

For the second time I went over all the solder joints on the line board. Any that looked the slightest bit doubtful were cleaned off and remade with fresh solder. I also dismantled the line output transistor heatsink again, in the forlorn hope that a fault might be revealed where none had been found before. But this time I planned to go further than just remove the heatsink.

With this chassis the heatsink and transistor are held to the circuit board by two long, threaded rods. They don't have a head like conventional screws or bolts.

On the top of the board there is a nut and a fairly large diameter flat washer. Under the board there is another flat washer, sitting in contact with the solder pad mentioned earlier. This assembly is clamped to the board with another nut, of somewhat smaller outside diameter than the one on top of the board.

Next comes a stepped nylon washer that supports and insulates the heatsink, followed by a mica and a plastic T03 insulator, the transistor case and then a nut to secure the whole assembly.

After removing the heatsink and the nylon washers, I tried to take off the nuts that secured the washer on the solder side of the board. Here I met with trouble, because the nuts had been done up so tightly that the corners had been chewed off the hexagon and the nuts were almost circular. The whole assembly was so tight that any attempt to remove the nuts must surely have stripped the threads.

In the event, I couldn't see how there could be a bad joint under such a rigidly fixed screw, then reassembled the heatsink and transistor.

It didn't make one iota of difference.

By this time I had spent as many hours on the set as I was prepared to give. I put it aside under the bench, with the silent prayer that it would fix itself if left alone for long enough!

Three weeks later I put it up on the bench again and switched on. I almost thought my prayers had been answered, because it ran for four hours without a flicker. But only for four hours. This time when it failed it was with a typical line squegging display.

There were four quite clear images across the screen, a symptom that indicated that the line oscillator was running at the wrong speed. This time, tapping the oscillator board restored normality for a time, while further tapping brought the new fault back again. "So", I wondered, "what kind of a problem do I have this time?"

It turned out to be a red herring. It was simply an accidental short on the line oscillator board. One of the component leads had been cut a little too long, and all of my bashing and tapping had bent it over until it made contact with an adjacent track. It took a little time to find, but no time at all to correct.

So it was back to the line board, with every indication of a dry joint that wasn't there.

Although I was convinced that the line output transistor collector was very firmly clamped to its mounting screws, and the screws were firmly clamped to the board, there was still a lingering doubt that something might be wrong in that area.

I had no idea what the trouble might be, but I resolved to bypass the whole mounting arrangement, just to see what eventuated.

It so happened that at that moment I picked up off the floor one of those long tinplate straps, like an overgrown solder lug, that are used sometimes to secure bundles of wires along the edges of chassis. I realised that this would be the ideal thing to use, to bypass the screw mountings under the line transistor. The hole in the end of the lug was just the right size to fit over the screw holding the collector.

I didn't know if I had solved the problems or the set had had enough...

The strap had a thick plastic insulating sleeve, and it was long enough to comfortably reach a place on the board where the yoke plug provided a good solid connecting pad. The whole thing went together like a dream. The strap arched neatly over the edge of the heatsink and was soldered to the pad – which could not have been more conveniently placed.

I didn't know whether I had solved the problem, or whether the set had just had enough and decided to stop playing around any more. In either case, there was no more serious trouble and the set ran without stopping for several days. Considering its earlier performances, this had to be called a cure.

The only worry left with this job was an occasional bout of the horizontal shakes. For ten minutes after switch on, some parts of the picture got the shivers. Only two or three lines at a time, and only for a tiny part of a second.

At this point I had to leave the job

and get on with some other work. The owner picked it up and was delighted with its performance. The shakes didn't worry him, but I was concerned that they might be another symptom of the original fault. For the time being I had to put the set out of my mind.

Unfortunately, it was back within three weeks. From the owner's point of view it was the same fault – no go. But I soon found that it was quite a different problem.

When I switched on I was greeted with the expected squeak from the power supply, as it tried to start up. I wasted no time in reconnecting the external supply and got to the stage of producing a continuous screech. A gentle tap on the line board brought on a perfect picture and it seemed that I was back to the same place as I had been three weeks ago.

And to make matters worse, the horizontal shakes were still there, just as bad as ever.

By this time I was getting pretty frantic. I had done everything I could think of to find and repair the fault, and some two months later I was back where I started from. The set still switched off erratically, and the external power supply would keep it screeching until a bump or thump restored normal operation.

I decided to ignore the switching off for a while, and to try to cure the horizontal shaking. This was only a minor problem compared to the switching off, but it was still a problem to be addressed.

It didn't take long to find that this fault was also mechanically sensitive. A light tap on any part of the line board caused the shakes to shiver up and down the screen. I reduced the tapping to a feather-touch with a plastic trimming tool, but still the picture shook.

There was absolutely no way I could identify the location of the sensitivity. Every part of the board was as sensitive as any other. So how does one find the faulty part in a situation like that?

Well, I chose to try to find it with my CRO. I scoped the horizontal input to the line board, and got a perfectly steady trace. Then the base of the line driver transistor, which also showed a steady trace.

However, at the driver collector it was a different story. Here the trace was shaking in time with the shakes on the screen. Although this looked like a faulty transistor, it was not quite as conclusive as that. The B+ supply to the transistor was also shaking, so this could be a cause rather than an effect.

I removed the line driver transformer to see if there was any chance of a dry joint, but there was nothing. So the next thing was the transistor. There's no prize for guessing that it was perfect. No leakage, good gain, and every indication that there was nothing wrong with it.

Still, a replacement transistor would only cost about ninety cents, so a replacement was nothing after all the time that had been wasted on this job in the past.

And that, it would seem, was that! The shakes stopped. The intermittent screeching stopped. No amount of bumping and thumping could disturb the picture. It was rock steady and as reliable as any set I've seen.

I set up the suspect transistor in a test rig and ran it as a DC amplifier for several hours. For most of the time it would not react to any sort of vibration, but just occasionally its gain would drop to zero for a fraction of a second. I can only assume that it has an intermittent internal open circuit.

How can you find and cure a dry joint inside a transistor?

Another 'squeak' – this time in a stereo cassette deck...

My second story this month is an interesting one sent in by fellow serviceman Mr J. Emery of Bull Creek, WA. It too concerns a fault that produced a "squeak" – this time in a stereo cassette deck. I'll let Mr Emery tell it in his own words:

This story concerns a Sanyo RD W340 stereo double cassette tape deck, which the owner used mainly for making up half hour programmes of selected items from his gramophone records and cassettes for his own use.

It had all the usual features – deck A was for Play only and deck B could be used for Play or Record or to dub from deck A. Provision was made for different types of tapes and for Dolby Noise Reduction. A manual control and a LED bar graph were provided to adjust the recording level. Lately, however, it had developed a habit of inserting a short loud "EEK" sound between items.

I checked it myself and found that the sound occurred only when the STOP button for deck B was depressed at the end of a recording.

Fortunately I had a copy of the service manual, from a previous time when I had serviced it for an intermittent hum. This fault had turned out to be nothing more than a faulty diode in the bridge rectifier of the power supply.

The problem only occurred when the machine was switched off...

The first thing I noticed this time when I looked at the block diagram was that it was fitted with a muting system, to suppress the clicks and pops which occur when it is switched ON and OFF during Record and Play-back. Because the problem only occurred when the machine was switched OFF after recording, this looked like a good place to start. The muting circuit involved six transistors (Q701/Q801, Q703/A803 and Q605/Q606).

The first two transistors (Q701/Q801) were respectively connected across the Right and Left hand channels, feeding the Record/Replay head of deck B. The second pair (Q703/Q803) were connected across the two line outputs intended to feed the main amplifier during Replay.

When the power was switched ON, I found that these four transistors had their bases forward biassed to a point where they were turned on hard and virtually short circuited any output for both Recording and Replay.

Depressing the Play button for either tape mechanism removed the base bias from the two transistors (Q703/Q803) across the line output to the main amplifier. These two transistors then, in effect, became open circuits between emitter and collector and allowed the output of the tape being played to reach the line output terminals and ultimately the main amplifier.

The effect of depressing the Record and Play buttons of deck B simultaneously was similar. It removed the base bias from all four transistors, allowing the signal being recorded to reach the Record/Replay head and also the line output terminals for monitoring if required.

So far it had been fairly straightforward, but the remaining two transistors (Q605/Q606) formed part of a "muting control" circuit which seemed to me to be both complicated and unfamiliar. I *was not looking forward to having to try to figure out how it worked, when I noticed that each of the Play and Stop buttons had a switch associated with it.*

By this time I felt almost sure that the presence of the "EEKS" was due to a fault in the muting system which should have suppressed them; and that the switches associated with the Stop buttons were intended to bring the muting system into operation before the mechanical operation which allowed the Record/Play head assembly to return to the OFF position.

So I checked the operation of the Stop buttons again, more carefully. With deck A the initial movement of the STOP button restored the base bias to the transistors Q703/Q803 and muted the signal, before tripping the Play head assembly. But with deck B it was a different story. There was no sign of muting before the Record/Play head assembly was tripped and allowed to return to the OFF position.

I then used a multimeter to check the switch associated with deck B's Stop button and found that it did not operate until slightly after the Record/Play head assembly had been released.

This was an obvious fault, so I set about removing the front panel to gain access to the switch.

Fortunately the deck was well made, and the design provided good access for servicing. The switch proved to be what I would call a miniature microswitch – about the size one would expect to find in a mini-cassette recorder.

A little careful bending of a sheet metal lug which guides the operating slide soon had it operating at the right time, and the "EEKS" were laid to rest.

Their source remains a puzzle to me. I did look at them on the CRO but the results were inconclusive.

The successful diagnosis and location of faults relies heavily on practical experience, but here are a few suggestions I'd like to offer other readers:

1. Determine the exact nature (symptoms) of the fault and the circumstances under which it will occur.

2. From 1. above and past experience, decide on the most likely causes, and what parts of the circuit are involved. For example the nature and timing of the fault just described suggested that it was associated with the muting circuit.

3. Review the operation of the parts of the circuit likely to contain the fault, and try to mentally divide them into smaller sections which can be checked individually. I divided the muting circuit into four sections – (1) The switch associated with the STOP button (2) Q701/Q801 (3) Q703/Q803 and (4) Q605/Q606.

4. Test these sections one at a time. Unless experience dictates otherwise, start with the easiest ones. I started with the Stop button switch, because it could be easily tested with a multimeter (you have to be lucky sometimes).

5. Replace the faulty component or otherwise remedy the fault.

6. Carry out a final operating and safety check.

Of course in real life it is not always as easy as this, but a logical approach to servicing can only improve your chances of early success.

The source of the noises remains a puzzle to me...

Thanks indeed, Mr Emery – both for the story itself, which was certainly quite different from my own, and for the tips on faultfinding procedure. As you say, real life doesn't always seem to conform to the logical approach, but attacking a problem in this kind of systematic way usually gives you a head start.

And that's all for this month. By the way, if there are any other readers out there with servicing stories they think may be of interest, please send them in. I've no wish to hog the limelight – in fact I'm happy to share it. Some months there just aren't that many interesting stories to relate, cropping up in my own workshop.

Needless to say if your story is used, *EA* will pay you an appropriate publication fee. So as well as seeing your story in print and sharing your experiences with fellow readers, you'll also get something more tangible to compensate for your effort and time. Care to join me?

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Symptom: No picture, or very dark picture. Brightness, contrast and colour controls have no effect.

Cure: C603 (4.7uF 25V electro) on picture tube base board open circuit. This cap is part of the automatic beam limiter circuit and its loss allows the ABL control voltage to cut off the picture tube.

Jack O'Donnell
M/Director

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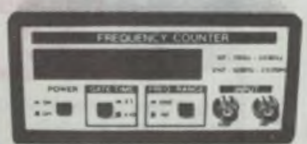

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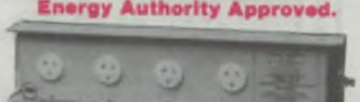

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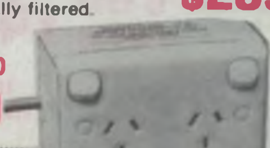

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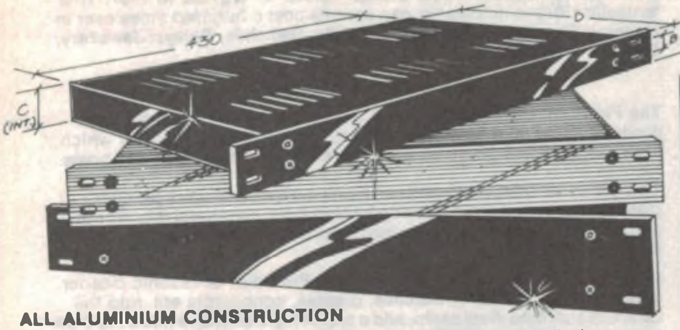

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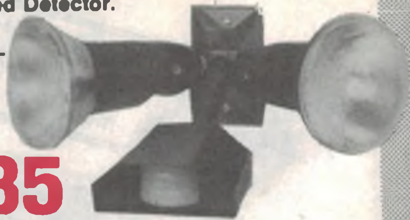

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These provide complete SM300 and SM2400 compatability, while also providing a simple to use menu driven mode where suitable software is not available.

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Jack O'Donnell
M/Director

Great Kit Projects To Build Many Just Released For 1988

Brilliant Performance Stereo Pre Amp

Studio 200 Stereo Control Unit

(Silicon Chip June/July'88)

Out-Performs Commercial Units Costing $600 Plus

The Studio 200 Stereo Control Unit is companion to the studio 200 stereo power amplifier (or other power amps). It features slim single unit rackmount profile, treble, bass, balance, input selector, tape monitor switch, stereo/mono switch and volume control. Inputs include phono, tuner, CD, VCR and tape loop.

K 5015 $229

Simple PCB Construction Virtually No Wiring

Calling All Audio Purists
This Great New Amp From Silicon Chip Is For You

Studio 200 Series 100 Watts Per Channel Power Amplifier

K 5010 $399

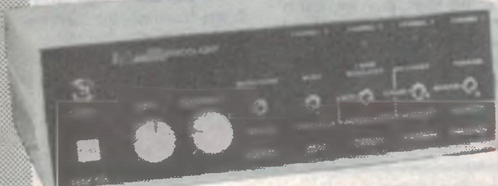
Features: • In-Built speaker protection • Toroidal Transformer (low hum) • Black Satin Finish • Low leakage power supply capacitors • Housed in Rugged Custom Chassis.

Specifications: • **Output Power** 100W into 8 Ohms **Freq. Res.(at 1W) 20Hz-50KHz** + or - 1db **Input Sensitivity** 870mV **Harmonic Distortion (20Hz-20KHz)** 0.1% **Signal To Noise Ratio** 100db or Better **Protection** 5A fuses plus RDE245A Polyswitch **Damping Factor** (without Polyswitches) 100 (with Polyswitches) 100. **Stability** Unconditional.

Discolite

(See Silicon Chip July/Aug'88)

Add Some Colour To Your Next Party



K 5805 $159.50

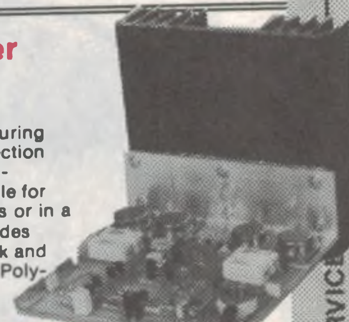
The Discolite Flashes party lights on and off in beat with music from your amplifier.

• 4 light channels controlled by 4 separate audio channels • Forward, reverse and auto-reversing chaser patterns • Simultaneous strobe on all four channels • Alternating light patterns • Music modulation available on chaser, strobe & alternate patterns • Inbuilt microphone for beat triggering or audio modulation of lights • Direct inputs for beat triggering or audio modulation of lights • Sensitivity control • pre-settable sensitivity levels for each channel • Front panel LEDs mimic light display.

Great For Parties, Shop displays and special lighting effects.

Universal High Power Amplifier Module

(See SC Dec'87)



High power rugged reliable design featuring low distortion and inbuilt speaker protection All components, including output transistors mount on a single PCB. Suitable for high quality guitar amp, public address or in a high fidelity stereo amplifier. Kit includes angled heatsink bracket, main heatsink and unlike other kit suppliers, the in-built Polyswitch for loudspeaker protection.

100W Version K 5140 $69

150W Version K 5150 $99

General Purpose Pre-Amp

This unit contains all necessary components to complete:- • A Phono Pre-Amp with RIAA freq. response • A tape Pre-amp with NAB response • A microphone Pre-amp with either 40 55 or 80db of gain. • Or a Pre-amp for just about anything!
Power 10-40V DC High 100db Ripple Rejection.

K 5510 $18.50

Active Direct Injection Box

(See EA Oct'87)

Eliminates Annoying Hum Pick up

Converts high impedance unbalanced inputs to low impedance balanced outputs Used in studios, music, PA industry to convert high impedance devices i.e. electric guitar pickups, synthesizer etc. to low level balanced outputs to be fed over long lines.

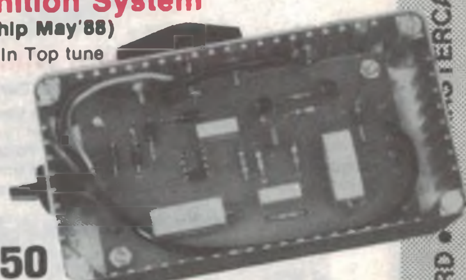
Features: Professionally screen printed • Earth isolate switch • 15db pad • Phantom powering plus internal 9V bat.

K 5550 $45.00

High Energy Ignition System

(See Silicon Chip May'88)

Keep Your Car In Top tune



Extends the life of plugs & points, increases power & improves fuel economy. Suits 4,6 & 8 cylinder engines. Install one into your car & start saving $$$ from the very first day.

K 4015 $43.50

Line Filter & Conditioner

(See EA July'88)

Simple, easy to build & low cost too - Helps eliminate those annoying clicks & pops on your stereo & TV when the fridge compressor switches on & off. Helps prevent computer crashes from power spikes & glitches. Altronics customised version housed in strong sturdy Jiffy box nickel sprayed for EMI shielding.

K 6040 $39.50

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Construction project:

Powermate II

Need to operate your mobile CB or amateur radio gear in the workshop? Here's an updated version of one of our most popular-ever power supplies. It delivers clean, well-regulated 13.8V DC at up to 5 amps.

by JIM ROWE

Ten years ago, back in May 1978, *EA* described a 13.8V/5A power supply called the "VK Powermate". It was specifically intended to power amateur radio and CB transceivers designed for mobile operation from a nominal 12V battery supply, but could obviously be used for any other similar equipment.

The design was a good one, combining excellent performance with low price, and many VK Powermate supplies were built. In fact over the years it has proved to be one of our most popular power supply designs – far more popular than those of either higher or lower power rating. Apart from the standard of the design itself, this may well be due to the designed average current level of around 5 amps.

Certainly a lot of mobile gear seems to operate in this range, so that a supply like the Powermate which provides this capability at an economical price has a lot of appeal.

In fact the only cheaper way to operate mobile equipment from the 240V mains would be to use a spare 12V battery, with a low-cost trickle charger used to restore battery charge between operating periods. But this approach is messy, and also involves a power trade-off: the voltage of a battery falls to around the nominal 12V when under load without charging, whereas most equipment designed for mobile use is intended to take advantage of the 13.8V produced by a battery when under charge. In other words, to produce full power output the equipment should be operated from 13.8V.

Because the original VK Powermate design is now 10 years old, many of the parts it used are not as easy to obtain as they were. On the other hand, there are now other parts available, which can be used to make a very similar unit either more easily or at a lower price. Hence our decision to revamp the design, and come up with the new Powermate II design described here.

The performance of the new version is very close to that of the original. Output voltage regulation for loads from zero up to just on 6A is excellent, dropping only about 10mV. That gives an effective output impedance of about 2 milliohms!

Over the same output current range, output ripple is less than 6mV peak to peak – which shouldn't produce hum even with the most sensitive of equipment. These figures hold up for line voltage variations between 220V and 260V, with the line regulation itself being also better than 10mV.

In effect, for all practical purposes it's the closest you could get to an "electronic 13.8V battery", within the current range concerned and bearing in mind its moderate price.

By the way, according to my calculator the full set of parts for the Powermate II should cost you about $95 – assuming you cut the holes in the front panel yourself, and use a plain panel. Not exactly dirt cheap, but I doubt if you could do better for a supply of this rating and performance. Note that this price estimate *includes* the power transformer.

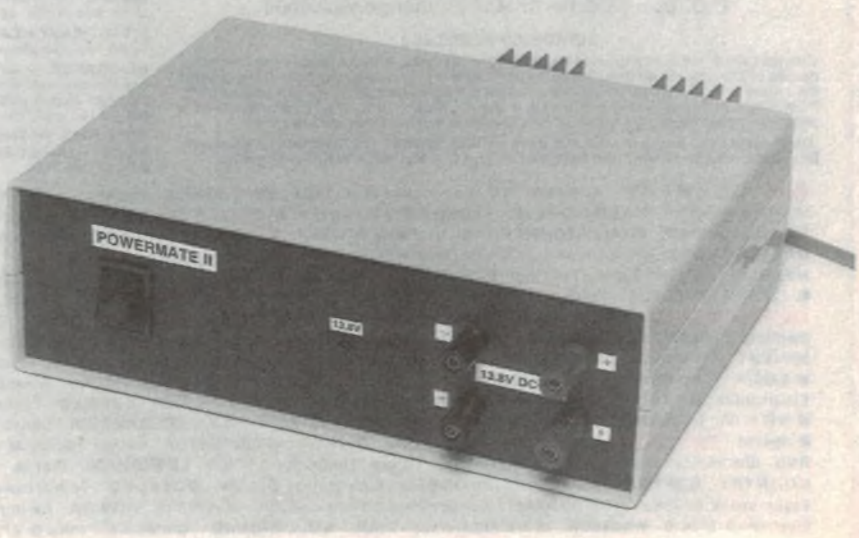
The circuit

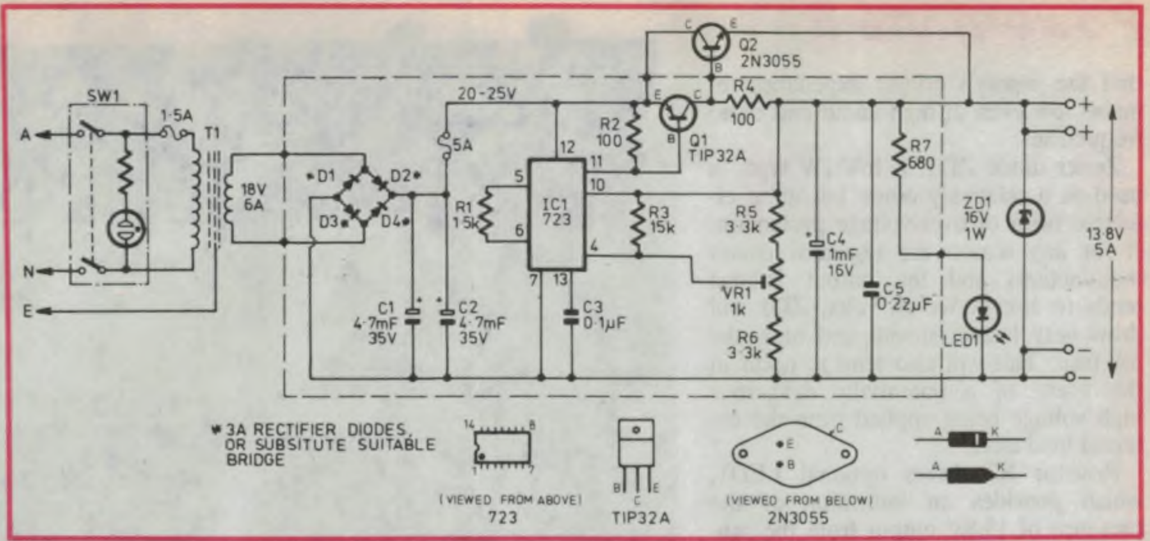
Essentially the circuit is identical with that for the original design. It is based as before on a readily available 18V/6A power transformer, driving a bridge rectifier followed by a linear voltage regulator circuit.

Mains power is switched to transformer T1 via DPDT switch SW1, which is an illuminated toggle type with an internal neon and zener. The 1.5A mains fuse is mainly to provide protection against the unlikely event of T1 developing a short.

Note that the mains earth is taken to the frame of T1, again in the interests of safety.

Unlike the original design, the bridge rectifier uses four low-cost 3A power diodes (1N5404 or similar) rather than an encapsulated bridge. This has been done for economy – four discrete 3A





The complete circuit for our new supply, which is very similar to the original. Four separate 3A diodes are used in place of a bridge.

diodes can handle approximately 6A average, but cost around half the price of a typical 6A bridge.

The PCB for the new design has provision for the four discrete diodes to be mounted on it (or strictly, lifted up from it by the length of their leads), without heatsinks. This approach allows them to handle up to 5A continuously, or 6A for short periods with "cool-down" spells between, without getting excessively hot. However if your Powermate II is to operate with a load of 5-6A continuously and you're concerned about the diodes getting too hot, you can replace them with a bridge mounted off the board on a solid heatsink.

The reservoir capacitance for the rectifier is provided by C1 and C2, giving a nominal total of 9.4mF (millifarads). This is slightly lower than for the original design, which used two 5.6mF capacitors for a nominal total of 11.2mF. However this has negligible effect on output regulation or ripple, perhaps because of the low "headroom" required by the regulator circuit. The reason for using 4.7mF capacitors instead of 5.6mF is that they're somewhat cheaper and more readily available.

But note that you should be able to fit 5.6mF capacitors into the board, if you wish to.

A 5-amp fuse is connected between the reservoir capacitors and the regulator circuit, largely to provide protection for the power transformer – the most expensive component in the circuit. This fuse is mounted internally on the PCB, as it should rarely need replacement.

The regulator circuit is quite conventional, using a long-established 723 regulator chip (IC1) with a pair of power transistors to boost output. Q1 is a medium-power TIP32A PNP device, and Q2 a 2N3055 "workhorse" NPN power device. The two are connected in the complementary-Darlington configuration, which gives high current gain combined with a low "dropout" voltage – ideal for this kind of application.

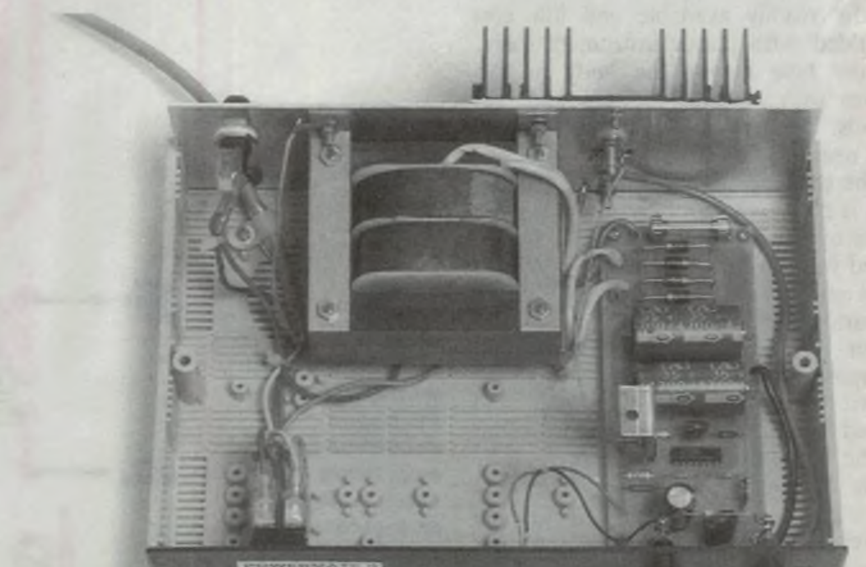
The voltage divider formed by R5, VR1 and R6, with R3 across its upper leg, is used to feed back a proportion of the output voltage to pin 4 of the 723. This is the inverting input of an internal error amplifier. The non-inverting input pin of the same amplifier is pin 5, which is fed with an internally generated reference voltage from pin 6 via R1. The error amplifier compares the two, and corrects the 723 output voltage at pin 11 to maintain the two in balance.

VR1 therefore forms the output voltage adjustment for the circuit, and is used to set it accurately to 13.8V.

Resistor R1 connected in series with the reference voltage fed to pin 5 of the 723 is to match the effective source impedance of the feedback divider driving pin 4. It is this balancing which gives the circuit's output regulation excellent temperature stability.

Both Q1 and Q2 have 100 ohm resistors connected between base and emitter, to minimise leakage at higher temperatures. This could otherwise degrade the regulation characteristic.

The output of the regulator is heavily bypassed via C4 and C5, to ensure good transient response and also make sure



A general view inside the case, showing the very simple construction. The power transformer just fits inside the plastic case, over on its side as shown.

Powermate II

that the supply's output impedance remains low even at high audio and radio frequencies.

Zener diode ZD1, a 16V/1W type, is used as a relatively crude but quite effective form of over-voltage protection. If for any reason the regulator circuit malfunctions and the output voltage tends to rise above 16 volts, ZD1 will draw very heavy current and blow the 5A fuse. This will also tend to occur in the event of a potentially dangerous high voltage being applied from the external load circuit.

Resistor R7 drives optional LED1, which provides an indication of the presence of 13.8V output from the supply. In a sense, this is a second "pilot light", and may therefore seem redundant. However its presence also tends to make the supply self-diagnosing in the event of a fault. If the mains switch pilot neon is on, indicating that input power is present, but LED1 is dark, obviously there is a problem with the low-voltage section of the circuit. Possibly the 5A fuse has blown, for example.

Two pairs of output terminals are provided, to allow the connection of two pieces of equipment if required. These can then be switched on and off via their normal low-voltage power switches, or left on continuously in the case of low-drain equipment.

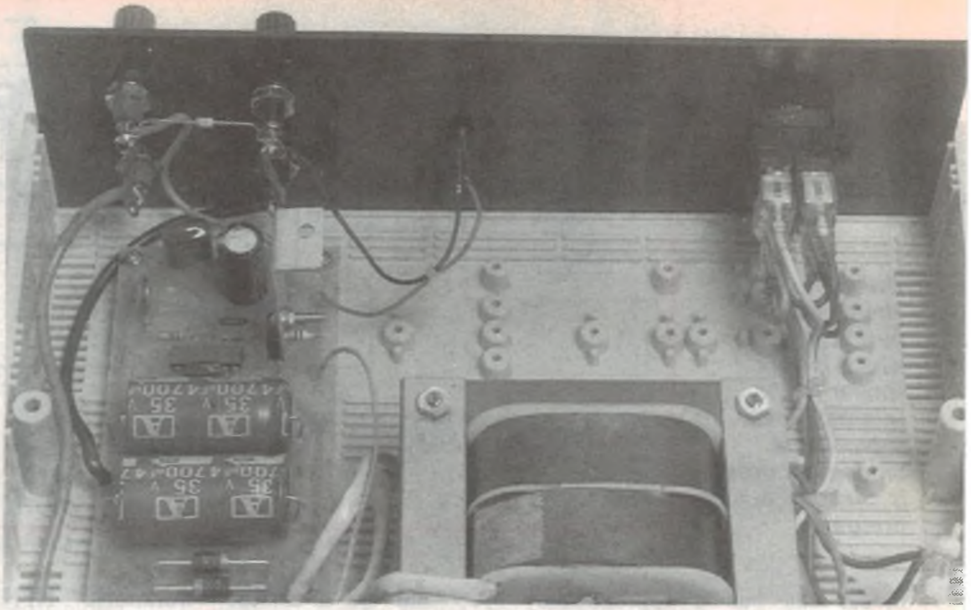
Construction

The complete supply is housed in one of the readily available and low cost moulded ABS plastic instrument cases, of the type having the body in two halves with removeable front and rear panels. This makes for a very compact and neat little unit.

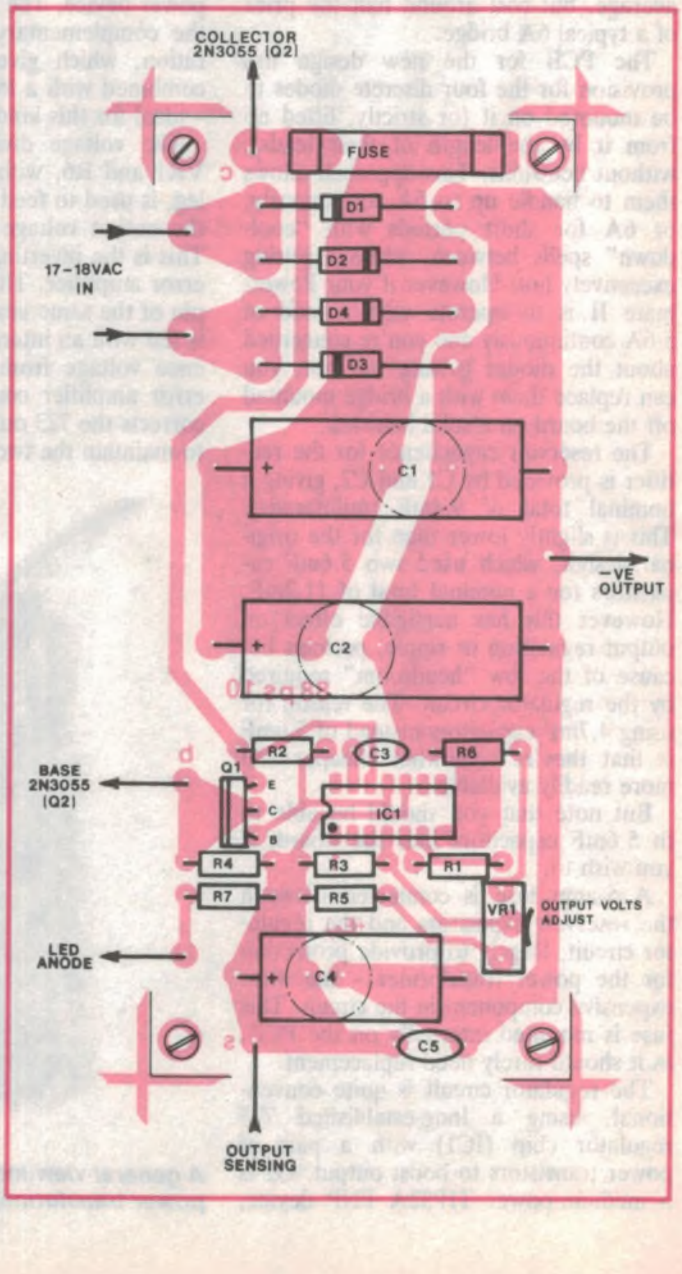
The case measures 258 x 84 x 190mm, and is fitted with cooling slots along the sides of the top and bottom. It is also fitted with an array of internal moulded slots and pillars, to support PC boards in various positions.

For this project most of the circuit components are mounted on a small PC board measuring 140 x 60mm, and coded 88ps10. This is designed to mount in the bottom of the case, supported by some of the internal pillars. The only parts not mounted on the PCB are the power transformer T1, the series pass power transistor Q2, the mains switch and fusefolder, zener diode ZD1, LED1 and of course the terminals.

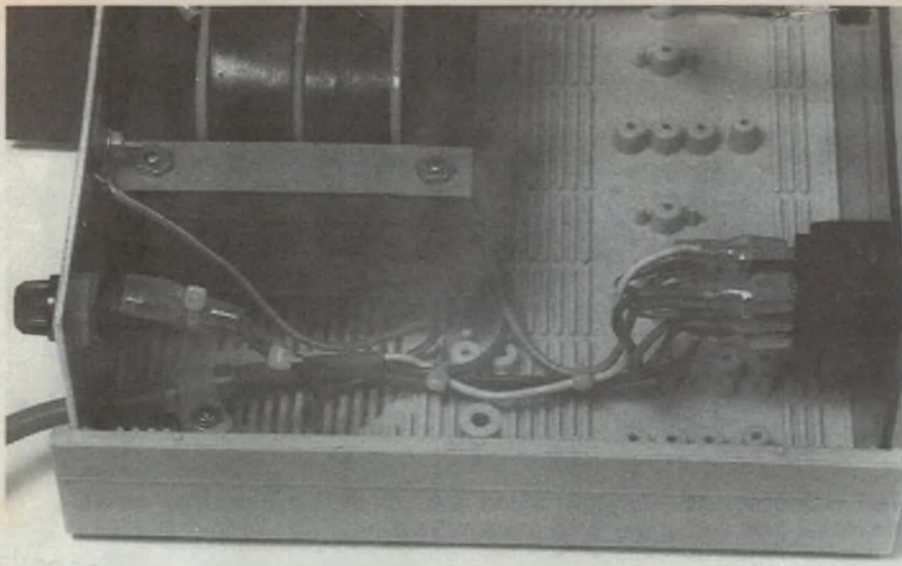
The case concerned comes with two moulded ABS panels, plus a 2mm-thick aluminium panel. This works out quite



A close-up inside, looking towards the rear of the front panel to show the terminal, LED and power switch wiring.



Wiring up the PC board should be very easy using this overlay diagram as a guide. Note that transistor Q1 is fitted with a small 'flag' heatsink, made from a scrap of sheet aluminium.



Another close-up view of the inside, showing the mains wiring. Note the sleeving over all connections, to prevent accidents.

nicely, as the aluminium panel can be used at the rear, to support the power transformer and heatsink for Q2, while one of the ABS panels can be used for the front.

By sheer luck, perhaps, the readily-available 18V/6A power transformer (DSE 2000 or similar) just fits inside this case when mounted on its side and located as shown in the photographs. Only a single one of the case's internal pillars needs to be "pruned" to clear it – that inside the upper half of the case, at the centre rear. The transformer just fits between those on the bottom half, almost as if it was designed that way! It attaches to the aluminium rear panel via four 1/8" countersunk-head screws, lock-washers and nuts.

Similarly, by a similar stroke of good fortune, a standard 74-mm length of one of the common aluminium finned heatsink extrusions (110 x 33mm) *just* fits on the outside of the rear panel as shown, if you chamfer its edges slightly with a file to clear the lips of the case top and bottom. It attaches to the panel via a pair of 1/8" screws and nuts, one each centrally top and bottom.

Both panel and heatsink are drilled with the usual mounting and pin clearance holes to suit the TO-3 case of the 2N3055, which is mounted via the usual mica washer (smeared lightly with silicone grease), stepped insulating washers, screws and nuts.

The only other items on the rear panel are the mains fuse holder and the mains cord entry, via a suitable grommet.

On the front panel there are again only a few items to mount: the mains power switch SW1, the low-voltage indicator LED1, and the four output terminals with the protective zener diode ZD1 connected across the top pair. This makes assembly quite straightforward.

In fact the only slightly tricky part is cutting the rectangular hole to suit SW1. Too small and it simply won't fit, too large and it will be sloppy and move around. Still, if you do mess up the first ABS panel, there's always that second one supplied with the case, as a backstop! (No, I didn't need it myself - apparently Murphy's Law wasn't looking that day!)

Returning again to the PCB, this has been designed to allow a reasonable amount of flexibility when it comes to components. Particularly for the electrolytic caps C1, C2 and C4, as these are sometimes difficult to get in either the PCB-mount (RB) type or the more conventional axial lead type.

To cope with this sort of problem, I have designed the PCB to take *either* type of component, for all three parts. PC-mount parts mount via the two inner holes for each position, while axial types use the two outer holes.

As you can see from the overlay diagram and the photographs, the rest of the PCB is fairly straightforward. Power diodes D1-D4 are spaced apart to allow reasonable ventilation, with as much copper as possible connected to their pads to allow good conduction of heat as well as current.

Output adjust trimpot VR1 is placed at the edge of the PCB, so that if desired a small hole could be made in the side of the case to allow screwdriver adjustment. But this probably isn't necessary, as once the output is set to 13.8V the trimmer really doesn't need any further adjustment.

Assembly

As usual, it's probably a good idea to start with the PCB. After checking it for etching problems such as fine bridges or hairline cracks in conductors, fit the low-profile passive parts such as the resistors, polyester caps and fuse clips.

Note that some of the PCB-mounting fuse clips available are plated with a metal (chromium?) which seems to be almost impossible to solder. If you're unlucky enough to get some of these, you'll find you have to scrape or file off virtually ALL of the plating from the mounting lugs, in order to get a good bond to the board copper. I write from unhappy experience!

Next add the electrolytic caps to the PCB, noting their correct polarity. By the way, it is most important with this project to make solid, low resistance joints for all connections carrying high current. Pay particular attention to the leads of D1-4, C1 and C2, the transformer leads, the negative lead from the PCB to the output terminals and the collector and emitter leads for Q2.

Next add the trimpot VR1, and rectifier diodes D1-4. These are not mounted flat against the board, but spaced up from it to allow better ventilation and reduce board heating. The diode leads are left full length, and pushed through the board only about 4mm – sufficient to make good soldered joints.

To complete the PCB wiring add the regulator chip IC1 and transistor Q1, making sure you orientate them both correctly as shown in the overlay diagram. Q1 is again not forced down too near the board, as this would strain its leads. Leave it standing vertically, with the lower edge of the body about 10mm from the top of the PCB.

Although Q1 doesn't get very hot, you may care to attach a small "flag" type heatsink bracket to its top lug, as shown in the pictures. This will make sure that it stays cool at all times.

Having finished the basic PCB assembly, I suggest that you drill the rear panel and mount the power transformer and heatsink extrusion. At the same time drill and ream out the holes for the mains fuse holder and the mains cord entry grommet.

Note that a solder lug should be

mounted under the upper transformer mounting nut on the fuse holder side, for connection of the mains cord earth. To ensure a good reliable connection, use "star" lockwashers on each side of the solder lug.

You should now be able to mount the power transistor Q2 on the heatsink/rear panel assembly, using the normal mica washer and insulating washer system. Don't forget to fit a solder lug under one of the case mounting nuts, to make the collector/case connection to

PARTS LIST

1 Moulded ABS case, 257 x 83 x 190mm, with moulded ABS and 2mm aluminium panels
1 PC board, 140 x 60mm, code 88ps10
1 Power transformer, 18V at 6A
1 DPDT illuminated mains switch
1 Finned heatsink section (single sided), 110 x 33 x 74mm
1 3AG fuse holder and 1.5A fuse
4 Screw terminals (2 red, 2 black)
1 3-wire mains cable and 3-pin plug

Semiconductors

1 723-type regulator IC
1 TIP32A medium power PNP
1 2N3055 power NPN
4 1N5404 or similar 3A diodes
1 1N4745 or similar 16W 1W zener
1 5mm red LED and bezel

Capacitors

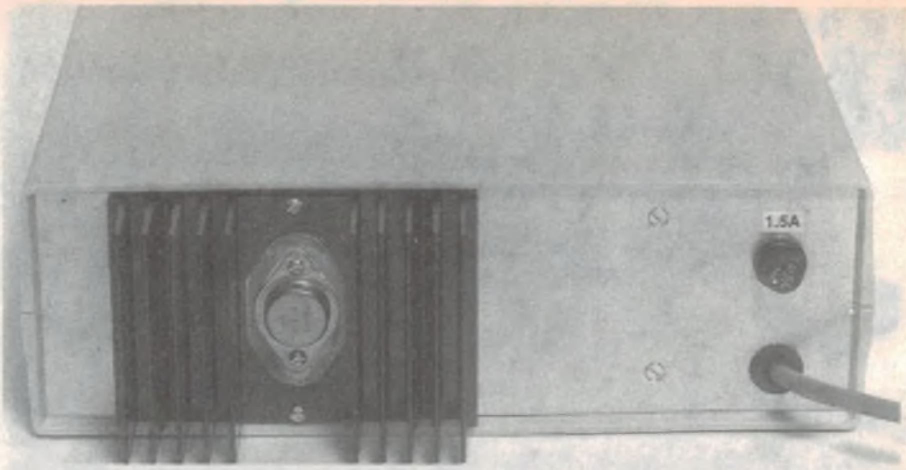
2 4.7mF 35VW electrolytic
1 1mF 16VW electrolytic
1 0.1uF metallised polyester
1 0.22uF metallised polyester

Resistors

2 100 ohm 1/4W 5% carbon
1 680 ohm 1/4W 5% carbon
1 1.5k 1/4W 5% carbon
2 3.3k 1/4W 5% carbon
1 15k 1/4W 5% carbon
1 1k linear trimpot, vertical PCB mount

Miscellaneous

2 x PCB-mount fuseclips; 5A 3AG fuse; 2 x solder lugs; flag heatsink for Q1; P-clamp for mains cable; grommet for cable entry; 3 x cable ties; light and heavy multi-strand hookup wire; mica washer for mounting Q2; silicone grease; insulated mounting washers for Q2; screws, nuts, lockwashers, etc.



Rear view of the power supply, showing Q2 on its finned heatsink radiator, the mains fuse and grommeted cable entry.

Q2.

It's a good idea to check the insulation between the case of the transistor and the heatsink when you've finished, to make sure there are no shorts. Now's the time to find this sort of problem and fix it, before you wire Q2 into circuit.

The next step is to drill the holes in the front panel for the output terminals and LED bezel, and cut the rectangular hole for the mains switch. As noted earlier it's a good idea to take care with this, as the hole has to be quite accurate if the switch is to mount firmly and reliably.

Now you can mount the above items on the front panel, and begin final assembly.

First connect a 150mm length of light multi-strand insulated hookup wire to the "b" pad on the PCB, and 100mm lengths of the same kind of wire to the "s" and "LED anode" pads. Then connect an 80mm length of heavy multi-strand insulated wire (red) to the "c" pad, and a 180mm length of similar wire (black) to the "negative output" pad. These will all be needed to make the connections from the PCB to the power transistor, terminals and LED.

Then carefully prepare the heavy 18V secondary leads from the transformer, and connect these to the "18V in" pads on the PCB. You can then mount the rear panel and PCB into the lower half of the case, fitting the PCB via four of the supplied self-tapping screws.

Now you can finalise the remaining low voltage connections, to Q2 and the front terminals. Don't forget the lead between the emitter pin of Q2 and the positive output terminals, which should again be made in heavy multi-strand insulated wire (red).

The 16V zener diode mounts directly between the two upper output terminals, as shown in the pictures. Make sure you connect it the correct way around, with its "hand" end to the positive terminal. A reversed connection here could cause the zener to be destroyed when power is applied.

The output voltage sensing wire from the front of the PCB ("s" pad) also connects to the top "+" terminal, to ensure that it compensates for any voltage drop in the internal wiring between Q2 and the terminals.

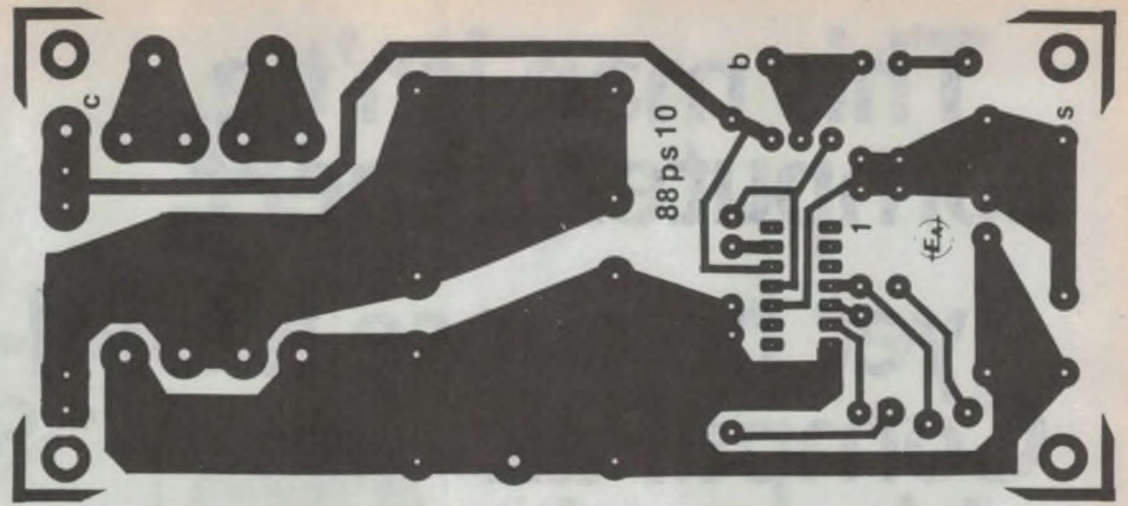
Note that the connection from the negative (cathode) side of LED1 connects to the top "–" terminal, rather than to the PCB. This is simply for convenience.

The final phase of assembly is the wiring on the mains side of the transformer. As usual this should be done carefully to ensure reliable and safe operation.

The mains cable is clamped firmly to secure it, just after it enters the grometted rear hole. Use a nylon "P" clamp for this, with a flat washer under the screw to ensure a firm purchase. The self-tapping screw mounts into the nearest moulded pillar.

After clamping the earth wire of the cable (yellow/green) is taken directly to the solder lug provided previously under the transformer mounting screw, to ensure reliable earthing of both the transformer frame and rear panel. The active (brown) and neutral (blue) wires are fitted with insulated spade-lug or "fast-on" connectors, to mate with the two *uppermost* lugs of the power switch.

The brown lead from the transformer primary is connected directly to the *side* lug of the fuse holder, with a small length of insulation sleeving to prevent inadvertent shocks. On the other hand the blue lead is connected to another in-



The PCB pattern, reproduced here actual size to allow tracing or photography if you wish to make your own.

sulated fast-on connector, along with another 50mm length of similar mains-insulated wire. The other end of this second wire is then fitted with a further fast-on connector, again with insulating sleeve.

Finally a 180mm length of mains-insulated wire (brown or red) is connected to the *rear* (axial) lug of the fuse holder, again with an insulating sleeve. The other end of this wire is then fitted to another insulated fast-on connector, along with another 50mm length of the same wire. As before the other end of this short length is fitted with the final fast-on connector.

The purpose of these short wires is to connect to the neon pilot lamp inside the mains switch. The connections to the pilot and its internal series resistor are brought out to the two *lower* lugs of the switch (if you've mounted it correctly), so the two short wires connect to these. This leaves the centre lugs for the two two-wire fast-on connectors, from the transformer and the fuse holder.

Push all fast-on connectors firmly onto the switch lugs, and make sure that the insulating sleeves cover them properly for safety.

The final step with the mains wiring is to use three cable ties to bind the wiring together, as shown in the photographs. This not only makes for a tidier job, but also ensures that if any of the wires should break off from its connection, the other wires are likely to prevent it from moving away and perhaps coming into contact with the low-voltage wiring.

That's about it. Your Powermate should now be ready to fire up, and perform the only necessary adjustment – checking its output voltage.

Before plugging into the mains, set the voltage adjust trimpot VR1 to the centre of its range and move mains switch SW1 to its "off" (upper) position. Then plug in and switch on the power at the outlet.

The neon lamp inside SW1 should remain dark. If it's glowing, you've mounted the switch upside down, and it will have to be reversed.

Assuming all is well at this stage, switch on SW1 and the neon should glow. LED1 should also glow, indicating the presence of low voltage.

If LED1 doesn't glow, there are two likely reasons. You may have reversed the connections to the LED itself, preventing it from operating, or perhaps reversed the connections to the zener diode ZD1. In case of the latter, switch off FAST – you may be able to prevent destruction of the diode, although this is being optimistic. You may have to replace the diode.

On the other hand if it's just a matter of the LED connections, simple reversal will solve the problem and you can turn on again.

Once LED1 glows properly and everything seems in order, connect a multimeter or DMM to one pair of output terminals and check the exact voltage. Odds are it won't be exactly 13.8V, but hopefully somewhere near it. A small adjustment with VR1 should allow it to be set exactly.

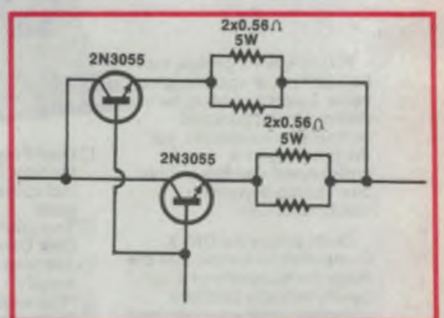
Your Powermate should now be complete, and all that remains is to screw on the top of the case.

A few final comments on the unit's current handling capability. Basically as it stands, it can deliver 13.8V at 5 amps continuously, providing the case and rear heatsink have access to reasonable air flow via the vents and fins. However with a continuous 5A load the main heatsink and rectifier diodes will get quite hot, even though the components are working within their ratings.

Without modifications it will also deliver 6 amps for short periods, providing Q2 and the rectifier diodes have reasonable periods in between to "cool down". So it can probably still be used to power mobile equipment which draws up to 6 amps, but only say when transmitting for brief periods.

To make it capable of delivering 6A continuously, I recommend that you replace the diodes D1-4 with a suitably rated bridge, preferably mounted on the inside of the rear panel for improved heat dissipation. I would also recommend that you increase C1 and C2 to 5.6mF or 6.8mF, to beef up their storage capacity, and add a second 2N3055 power transistor, to share the load.

If you do this, you can't just connect the second transistor in parallel with the first. So that the second transistor does



How to wire up a pair of 2N3055 transistors, for higher current.

indeed share the load current, you'll need to fit both transistors with low-value power resistors in series with their emitters. This is shown in the small auxilliary diagram.

As you can see, each emitter lead has a pair of parallel-connected 0.56 ohm 5W resistors connected in series. The collectors and bases are connected directly in parallel.

The two transistors should ideally be mounted on separate heatsinks, to dissipate the additional heat.

Books & Literature

Stripline circuits

STRIPLINE CIRCUIT DESIGN, by Harlan Howe Jr. Published by Artech House, 1974. Hard covers, 236 x 160mm, 344 pages. ISBN 0 89006 020 7.

Although this book on microwave stripline circuit design isn't new, when it turned up from the publisher with some newly-published books (like that reviewed above) I thought it was still worth a mention. There don't seem to be all that many books on the subject, despite the popularity and success of stripline techniques in microwave circuits and equipment.

This book is something of a classic in the field, being the first to bring together all of basic design information on striplines after they began to appear in the 1950s. The basic material it presents on stripline operation and design is still quite valid today, even though newer materials are now available for implementation. When the book was written the author was working at well-known US firm Microwave Associates.

The emphasis is again on practical circuit design, with only enough maths to allow this to be carried out.

Chapter 1 discusses the physical properties of materials and the implications for line width, losses and power handling capability. Chapter 2 then deals with calculation of characteristic impedance, and coupling/impedance transformation between stripline and other types of transmission line. Later chapters then deal with hybrids, power dividers, directional couplers, various types of coupled lines and both lumped-constant and transmission line filters. Finally there are chapters which discuss the application of hybrids to mixers, switches and other circuits, and construction techniques. The book ends with a very extensive bibliography for those who wish to pursue things further.

My impression is that the only section which would really need much updating nowadays is the last chapter on construction techniques – and even this seems reasonably current, although I'm by no means an expert on the subject. In short, an excellent introduction to practical stripline circuit design.

The review copy came direct from the publisher in Norwood, Massachusetts. (J.R.)

Microwave devices

SOLID STATE MICROWAVE DEVICES, by Thomas S. Laverghetta. Published by Artech House, 1987. Hard covers, 236 x 160mm, 196 pages. ISBN 0 89006 216 1.

Another textbook on microwave electronics from Artech, which appears to make this subject area one of its specialties. The present book is aimed at giving the microwave circuit and equipment designer a solid but practically-orientated grounding in solid state device theory as it effects microwave operation.

After an introductory chapter on the current state of the art with respect to microwave devices, the author presents a discussion of the various semiconductor materials in common use: germanium, silicon, gallium arsenide and indium phosphide. The relative merits of each at microwave frequencies are discussed, along with purification and fabrication techniques.

Then follow chapters on solid state junctions, microwave diodes and microwave transistors. These are quite comprehensive, dealing with all of the main devices and structures which have been developed – including the Schottky diode, PIN, IMPATT and TRAPATT diodes, Gunn "diodes", both bipolar and field-effect transistors and the high electron-mobility or "HEMT" transistor.

The treatment throughout is essentially non-mathematical, with emphasis on physical operation and key parameters for practical design applications. In short then, a book which should be of great interest to anyone involved in microwave system design – whether professional engineer or advanced radio amateur. (J.R.)

DX radio guide

INTERNATIONAL RADIO STATIONS GUIDE, by Peter Shore. Revised edition, published by Bernard Babani (Publishing), 1988. Soft covers, 198 x 132mm, 312 pages. ISBN 0 85934 200 X. Retail price $16.00.

A reference book for both amateur DX listeners and professional radio monitors, with comprehensive listings of radio broadcasting stations operating in the international shortwave bands. It also gives listings of European, Middle East and North African stations operating in the long and medium-wave bands, plus Canadian and US medium-wave broadcasters and FM/VHF broadcasters in the UK.

Note that this revised volume includes for the first time broadcasters on the new 13MHz/21 metre shortwave band.

Much of the information comes from frequency registrations made by broadcasters with the ITU in Geneva, but this has been augmented by monitoring data gathered by listeners in the UK. In each listing, stations are classified and ordered by operating frequency. Each entry then gives the country (ITU code), station site, power output in kilowatts and station callsign or broadcaster ID.

Other sections of the book give a listing of ITU country codes, worldwide English-language broadcasts, programmes specifically for DX enthusiasts and shortwave listeners, time differences from GMT, abbreviations and finally expressions for wavelength/frequency conversion.

All in all, a veritable mine of information for the dedicated radio listener, and especially the DX enthusiast.

The review copy came from Federal Marketing, which is making the book available to *EA* readers via its mail order service – see the advertisement elsewhere in this issue. The catalog number of the book is BP255. (J.R.)

Special Publications from Electronics Australia

FUNDAMENTALS OF SOLID STATE. Now in its second reprinting — which shows how popular it has been! It provides a wealth of information on semiconductor theory and operation, delving much deeper than very elementary works but without the maths and abstract theory which make many of the more specialised texts heavy going. Starting with a background chapter on atomic theory, the book moves easily through discussions on crystals and conduction, diode types, unijunction, field effect and bipolar transistors, thyristor devices, device fabrication and microcircuits. A revised glossary of terms and index complete the book. *Fundamentals of Solid State* has also been widely adopted in colleges as recommended reading — but it's not just for the student. It's for anyone who wants to know just a bit more about the operation of semiconductor devices. **$4.50**

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BASIC ELECTRONICS. This popular text has now been re-issued. *Basic Electronics* is almost certainly the mosty widely used reference manual on electronics fundamentals in Australia. Written as a basic text for the electronics enthusiast, it is also being used by radio clubs, secondary schools and colleges, and WIA youth radio clubs. It begins with the electron, introduces and explains components and circuit concepts and progresses through radio, audio techniques, servicing instruments, television, etc. If you've always wanted to know more about electronics, but have been scared off by the mysteries involved, let *Basic Electronics* explain them to you. Easily understood diagrams and text make this the perfect introduction to the growing and exciting world of electronics. We've even included five electronic projects for the beginner. **$4.50**

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Electronic doorbell plays 1 of 16 tunes

Sick of hearing the same old boring "Ding-Dong" or "Bzzz"? Take heart – here's an electronic doorbell which will play you one of 16 inbuilt tunes. It will play either your favourite tune each time, or a different one each time a visitor calls.

Based around the UM34811 multi-melody IC, this project can generate up to 16 pre-programmed melodies from its repertoire. Only one additional low-cost IC, two transistors and a handfull of other parts are needed to adapt the UM34811 for use as a doorbell.

Depending on your preferences, it can be switched to play a single pre-set melody from its repertoire, or play a different tune each time the front door pushbutton is pressed. Mode switching and presetting are conveniently accomplished by means of an external toggle switch mounted on the front panel of the unit, so you can change them at any time.

Similarly the volume level is also externally adjustable. Having these controls externally accessible allows post-construction adjustments to be made without the need to re-open the box – a definite advantage if the independent and changing moods of family members are to be considered.

Low current consumption allows the circuit to be powered from two AA cells – the hassles of running extra power supply cables are removed. The only external wiring necessary is the connecting cable from the front door pushbutton itself, which may well already exist in most installations.

Construction is very straightforward. Even a beginner should be able to have this project up-and-running in an afternoon. The majority of components are mounted on a single PC board, which slots into a zippy box measuring 50 x 90 x 150mm.

Incidentally this project has been developed by the R & D Department of Dick Smith Electronics. As a result, the PCB patterns are protected by copyright and cannot be reproduced commercially both other firms. However complete kits for the project will be available shortly from all DSE stores and selected dealers, identified by the catalog number K-2726.

We understand that each kit will be supplied complete with a pre-drilled and painted aluminium lid, eliminating a major part of the mechanical work.

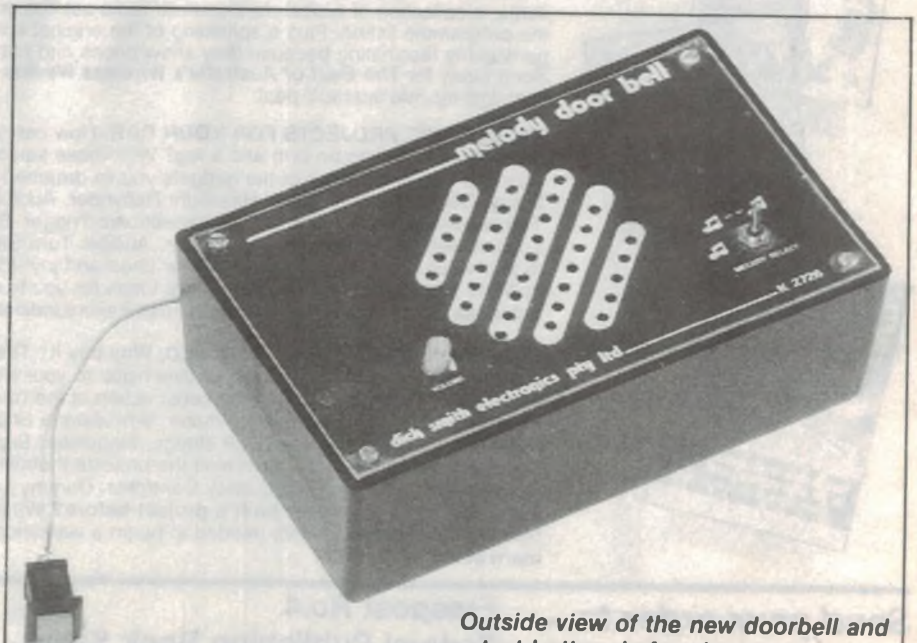
How it works

A single 74HC02 quad NOR gate package (IC1) complements the 34811 melody chip (IC2) and provides the necessary logic to switch between modes and preset a melody.

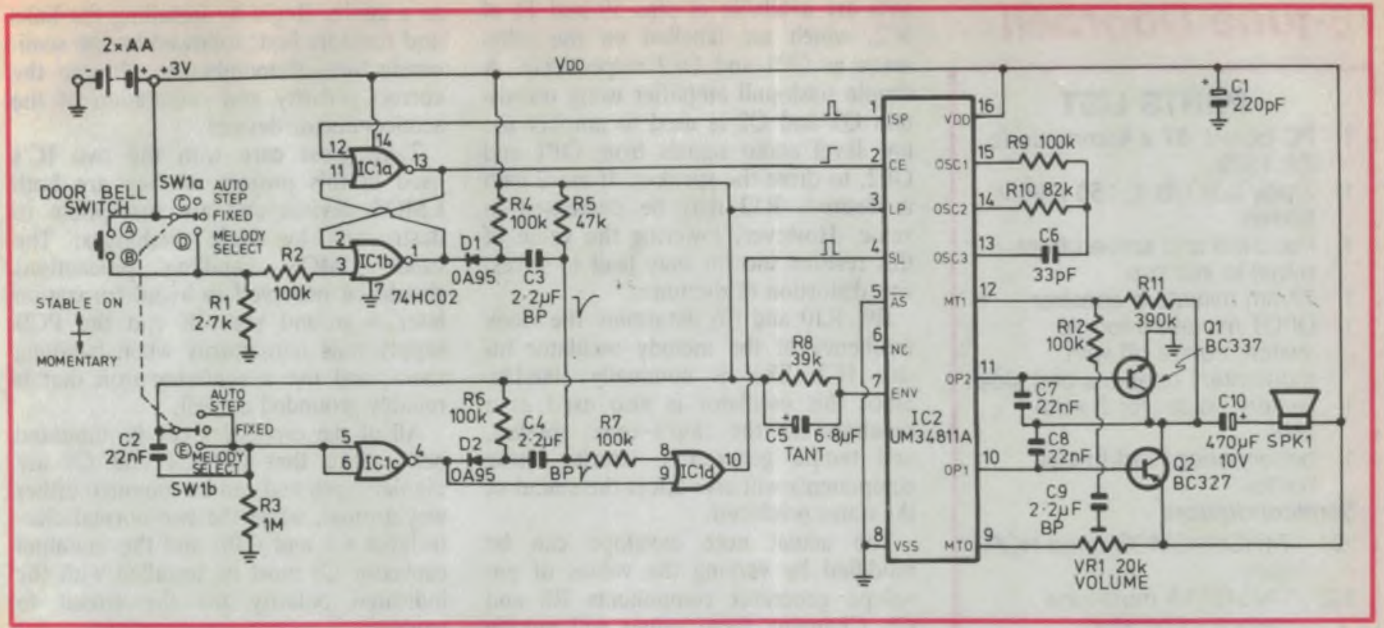
When the front door pushbutton is pressed, a positive going pulse appears at pin 3 of IC1b. This is the set input of an RS flipflop or "latch", formed by gates IC1a and IC1b. As the flipflop is initially in the reset condition – assuming a melody is not already playing – this pulse will toggle it into the set state. Pin 13 will go high, and pin 1 low.

The output state at pin 13 of IC1a is applied to the chip enable (CE) input of IC2, which is an active-high input. During the period that this pin is high, the melody IC will therefore be enabled and the selected tune will be heard through the loudspeaker.

Any further presses of the door pushbutton while a melody is still playing will be ignored until the melody is finished and the flipflop is reset. A reset pulse is conveniently derived from the Auto-Stop flag (ISP) output of IC2 (pin 1), which outputs a high-going pulse on



Outside view of the new doorbell and a test button, before installation.



The circuit for the doorbell, with the UM34811A multi-tune music chip at its heart.

completion of a melody. Once this pulse resets the flipflop the doorbell is ready to accept the next "call".

Stepping of IC2 between the various tunes in its repertoire is basically controlled by high-going pulses applied to the SL input (pin 4). Each time a high-going pulse is applied to this pin, the IC steps to the next tune in the sequence.

In this circuit the stepping pulses are fed to IC2 by NOR gate IC1d. This is basically controlled by mode switch SW1, a DPDT centre-off type with a stable position on one side and momentary action on the other. The circuit is arranged so that for automatic stepping, SW1 is moved upwards to its stable-on position. This causes one stepping pulse to be produced each time the doorbell pushbutton is pressed.

For pre-set tune selection SW1 is pressed downwards to its momentary contact position. Each press generates one stepping pulse, in addition to setting the flipflop to play the next tune. Once the desired tune is selected, SW1 is left in the mid position. This setting opens all the switch contacts and causes IC1d to be inhibited, preventing IC2 from receiving any further stepping pulses and thus preventing any further increments.

The advantage of having the switch work in this way is that mode and melody selection can be accomplished from a single control. This leaves the front panel essentially uncluttered, maintaining the philosophy that doorbells should be heard and not seen.

Referring again to the circuit diagram, when SW1 is in the latched or up position SW1b causes the input pins (5 and 6) of IC1c to be held high, forcing its output pin (4) low by inverter action. This in turn pulls input pin 9 of IC1d low.

The steady state condition of IC1d's other input pin 8 will not be affected by the output of IC1c, due to the blocking action of C4. But since pin 8 of IC1d is already pulled high by resistor R5, the output of this gate will remain low.

As mentioned earlier, the flipflop will be set when the door pushbutton is first pressed, latching pin 1 of IC1b low. As this output changes from high to low, C3 will appear as a short before charging up to the supply rail via D1 and R5. This results in a low-going differentiated pulse appearing at pin 8 of IC1d.

Because pin 9 of this gate has been biased low via SW1b and IC1c, IC1d is therefore forced to change state briefly, supplying a positive pulse to the melody step input of IC2.

So much for operation in the melody step mode. The alternative mode of presetting the circuit to play only one of the 16 melodies is accomplished by pressing SW1 downwards, to its momentary position. Each press steps IC2 to the next tune in its squence. When the desired tune is heard the switch is left in the mid position, completing the pre-selection.

The selection process works as follows. When the momentary contacts of SW1a and SW1b are closed, two things happen at the same time. Firstly, the IC1a/b flipflop will be set by IC1a and this will initialise the melody cycle as though the front door pushbutton was pressed. At the same time SW1b will take the input of IC1c high, forcing its output to the low state.

This pulls pin 9 of IC1d low, and also allows C4 to charge up through D2 and R5. The resultant low-going pulse is presented to pin 8 of IC1d, so that a low state appears on both inputs. With both inputs low IC1d produces a positive-going pulse at its output, which triggers the SL input of IC2 and increments the melody counter to the beginning of the next tune.

The two germanium diodes D1 and D2 isolate the outputs of their respective IC's by blocking charge currents which could effectively short the power supply during operation of the circuit. Silicon diodes proved unsuitable in this circuit as their drop of 0.6V is near the lower threshold point of the CMOS gates.

Complementary buffered audio out-

The Tunes it Plays:

Twinkle Twinkle Little Star
Coo Coo Waltz (1)
Eency Weency Spider
Lullaby
Santa Lucia
Oh My Darling Clementine
Are You Sleeping
Rock-A-Bye Baby
London Bridge is Falling Down
Little Brown Jug
Butterfly
Long Long Ago
Coo Coo Waltz (2)
Mary Had A Little Lamb
The Train Is Running Fast
Dream of Home and Mother

16-tune Doorbell

PARTS LIST

1 PC board, 87 x 45mm, code ZA 1539
1 Zippy box UB-1, 150 x 90 x 50mm
1 Punched and screen front panel to suit box
1 77mm miniature speaker
1 DPDT miniature toggle switch, centre off with momentary contacts one side
1 Battery holder for 2 x AA cells
1 battery snap/lead to suit holder

Semiconductors

IC1 74HC02 CMOS quad NOR gate
IC2 UM34811A multi-tune melody generator
Q1 BC337 or similar NPN silicon
Q2 BC327 or similar PNP silicon
D1,2 OA95 or similar germanium diode

Capacitors

C1 220uF 16VW electrolytic, PC mount
C2,7,8 22nF metallised polyester
C3,4,9 2.2uF 50VW bipolar, PC mount
C5 6.8uF 35VW tantalum
C6 33pF ceramic
C10 470uF 10VW electrolytic, PC mount

Resistors

R1 2.7k 1/4W 5% carbon
R2,4,6,7,9,12 100k 1/4W 5% carbon
R3 1M 1/4W 5% carbon
R5 47k 1/4W 5% carbon
R8 39k 1/4W 5% carbon
R10 82k 1/4W 5% carbon
R11 390k 1/4W 5% carbon
VR1 20k vertical trimpot with 12mm long shaft

Miscellaneous

Hookup wire, solder, tinned copper wire for PCB links, contact cement, cable for doorbell button.

puts are available at pins 10 and 11 of IC2, which are labelled on the schematic as OP1 and OP2 respectively. A simple push-pull amplifier using transistors Q1 and Q2 is used to amplify the low level audio signals from OP1 and OP2, to drive the speaker. If more gain is desired, R12 may be decreased in value. However, lowering the value of this resistor too far may lead to excessive distortion of the tunes.

R9, R10 and C6 determine the clock frequency of the melody oscillator inside IC2. This is nominally 100kHz. Since this oscillator is also used as a timebase for the chip's tone, rhythm, and tempo generators, altering these components will also affect the sound of the notes produced.

The actual note envelope can be modified by varying the values of envelope generator components R8 and C5. Changing these values will modify the attack and delay times of the notes, so some experimentation is possible if you wish.

In the quiescent state, the doorbell unit draws approximately 50uA – very low indeed. When a melody is initiated the unit will draw around 150mA. The life of the batteries, therefore, will be dependent on use; but they can be expected to power the circuit for 6 months or more.

Construction

Apart from the loudspeaker, battery holder and mode switch SW1, all of the components for the doorbell are mounted on a small PCB measuring 87 x 46mm, and coded ZA-1539.

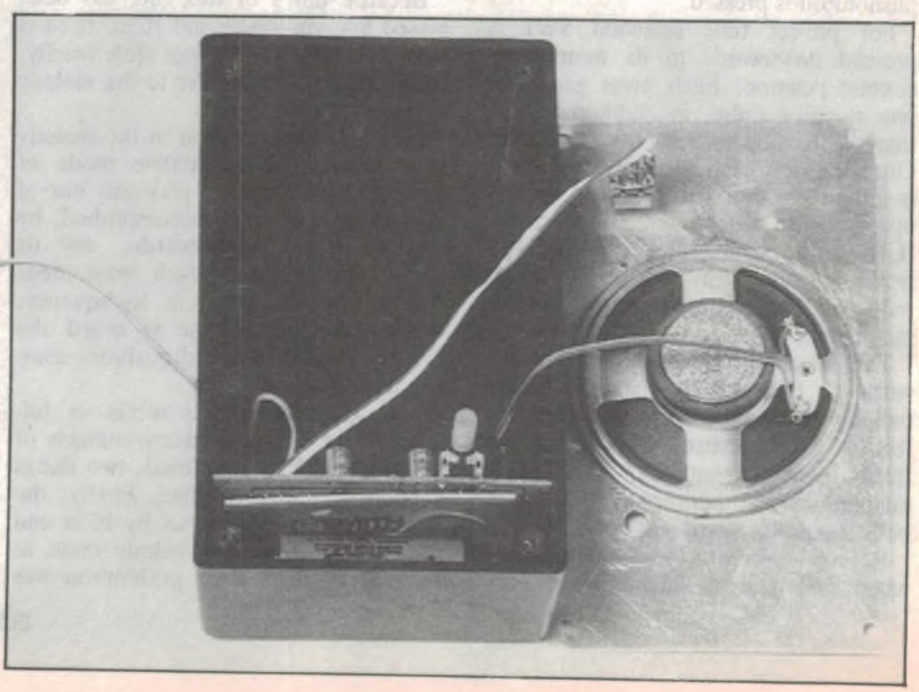
Assembly of the components on the board should be very straightforward if you use the component overlay diagram as a guide. Begin by installing the links and resistors first, followed by the semiconductors. Remember to observe the correct polarity and orientation of the semiconductor devices.

Take great care with the two IC's used in this project as they are both CMOS devices and are susceptible to destruction by static discharges. The usual CMOS handling precautions should be observed to avoid frustration later – ground yourself and the PCB supply rails temporarily when handling them, and use a soldering iron that is reliably grounded as well.

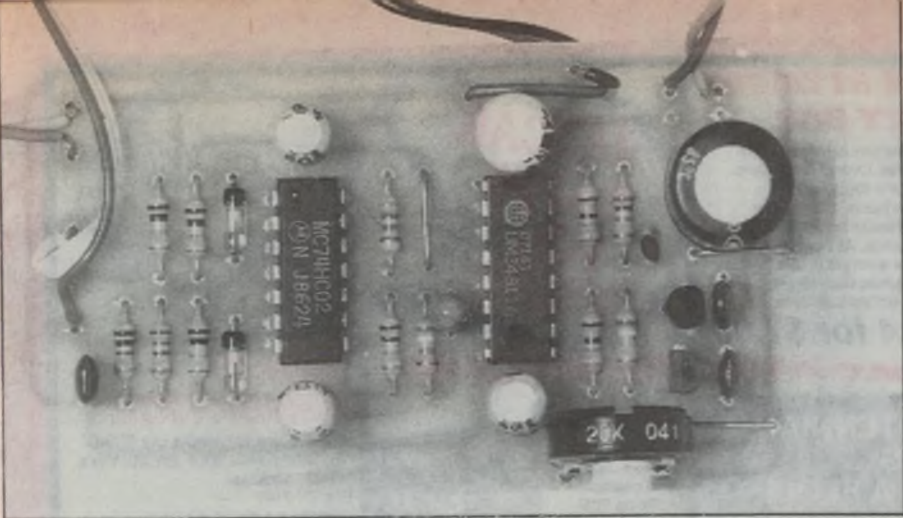
All of the capacitors can be mounted next. Note that C3, C4 and C9 are bipolar types and can be mounted either way around, while the two normal electrolytics C1 and C10, and the tantalum capacitor C5 must be installed with the indicated polarity for the circuit to work.

The 20k preset pot can be installed next. When installing this pot, press it firmly into position on the PC board so that the flanges on the three legs butt tightly against the top of the board. This ensures that the pot shaft will protrude without interference through its associated hole on the box front panel – which is to be installed at a later stage. This completes the assembly of the PC board.

SW1 can be prepared next. This involves installing two links on the back of the switch. The component diagram gives a back view of the switch and shows the correct placement for these links. When installing the links on the switch make sure that it is the correct way around. That is, the latching part of the switch toggles upward while the momentary side toggles downward, with



Inside the unit, showing the way the PCB and battery slip in at the end to clear the speaker, with the pot spindle mating with the hole in the front panel.



A close-up of the assembled PC board, to guide you in wiring it.

respect to the diagram.

Having fitted the links, cut and prepare three 20mm lengths of rainbow hookup wire. Connect the three wires between the switch and the PC board as indicated on the wiring diagram.

The battery snap wires can now be soldered to the board. Feed the wires through the hole as indicated on the diagram before soldering into place.

The speaker can now be glued onto the back of the aluminum panel. Determine the centre of the lid and with a pencil or a scribe, mark the centre with crossed lines (on the plain aluminium side!) with lengths longer than the speaker diameter. Use these lines to centralise the speaker behind the grille holes. Apply contact adhesive to the speaker and lid and secure the speaker in place. Allow to dry before continuing onto the next step.

After the speaker has firmly dried in place, prepare two more 200mm lengths of rainbow wire and connect these between the PC board and speaker as indicated on the diagram. The previously prepared switch can now be mounted on the panel as well, using its mounting nuts and locking washer.

All that remains now is for the assembly to be housed into the zippy box and given a trial run, before the unit is committed to an installation position.

A look at the photographs will quickly clarify how the assembly fits together. Note that the PC board slots between the second and third ribs from one end of the box, and the dual AA battery carrier fits into the smaller compartment formed by the board and that end of the box. Remove any sharp solder dags and pigtails from the board which could short against the batteries. As an extra safeguard, a piece of cardboard or similar could be sandwiched between the battery carrier and the board.

The unit is now ready to be tested. Temporarily connect the NO (normally open) doorbell switch – or any NO momentary action switch could be used for testing purposes – to the pads indicated on the component diagram. Fit two AA batteries into the carrier, and place the lid onto the box so that the shaft of the volume control pot protrudes through its corressponding hole on the panel.

Set SW1 to its centre or single melody select position, and adjust the volume control to about mid setting. Then press the doorbell button. If all is well, a melody will be heard through the loudspeaker.

Allow the tune to play all the way through until it stops. Depress the door switch again. If the unit is operating correctly, the same tune will be played again.

To preselect a melody, simply depress SW1 towards the MELODY SELECT position and release. A tune should begin playing through the loudspeaker. Depress the switch again, observing that a different tune will be heard.

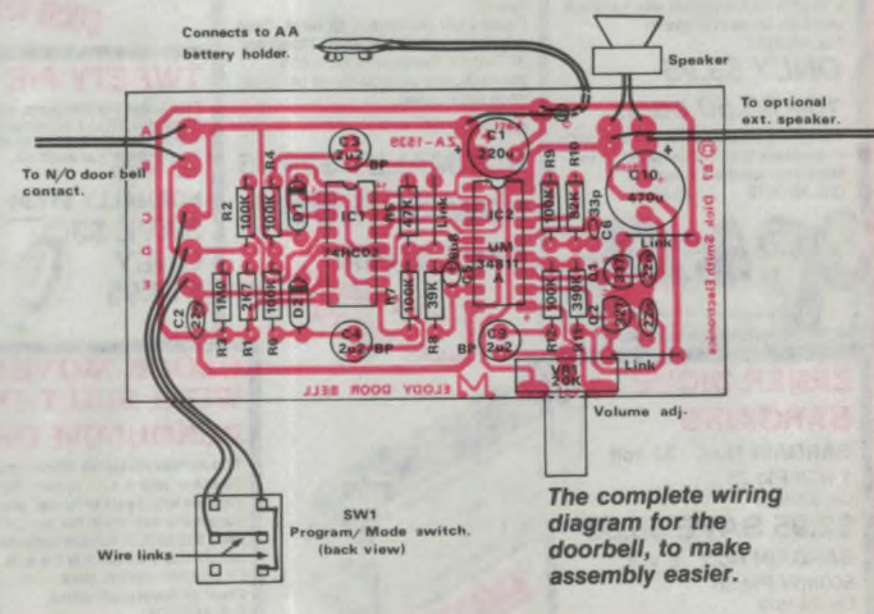
When the desired melody is heard, simply leave SW1 in the centre position. This tune will now be played each time the door bell is activated. Note that it is not neccessary to wait until the tune is completed before stepping to the next one; depressing SW1 during a melody will interrupt the cycle and step to the beginning of the next tune. Refer to the repertoire on page to confirm that the melodies are sequencing correctly.

The only test that remains now is the melody step mode. Set SW1 to the latching upper position, and press the doorbell button. This time the circuit should step to the next melody in the sequence, and continue to do so for every doorbell press from then on.

Note that in any situation the front door pushbutton has no affect on the unit while a song is playing.

Having established that your doorbell unit is working correctly, a suitable mounting site can be found. It is recommended that a "walk" test is performed before installing the unit to ensure that it can be heard within the living boundaries of the home. Note that a small hole will have to be drilled in the zippy box in a position adjacent to the PCB connection point for the pushbutton cable, to bring the cable into the case.

After securing the box to the wall, screw the aluminium lid to the box using the supplied self-tappers. Your Melody Doorbell is now ready to herald your next visitor.



The complete wiring diagram for the doorbell, to make assembly easier.

TRANSFORMER BARGAIN

This 100VA unit measuring 100(H) x 90(W) x 75(D)mm features a mounting bracket that enables you to mount it vertical or on its side. Primary winding is tapped from 200-240 volts. Secondaries are 1 x 16V, 1 x 12V. Both would be minimum 2 amps. Cat. MM-1812

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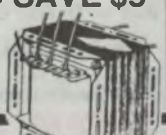

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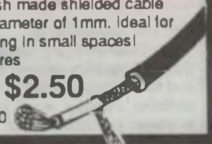

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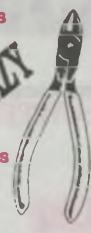

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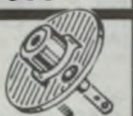

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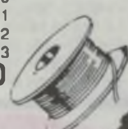

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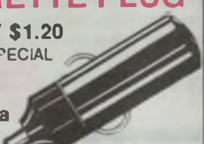

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Knobs available separately
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SAVE $2
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AT LAST!

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Specifications:

Power handling system	100 watts RMS
Resonant Freq.	570Hz
Sensitivity 96dB	
Freq. Resp.	570Hz - 7kHz

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AMAZING

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Normally its $1.20 per metre, but you can buy it for only 80¢ per metre.
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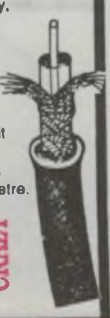

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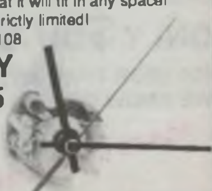

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Ref: Silicon Chip August 1988
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This gas chamber is specifically designed to produce a spectacular red, violet and orange continuously moving light show.
It's like nothing on earth! You will absolutely amaze your friends and family.
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A 2-3 amp 12V DC power supply is required. (A battery charger is ideal).
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NEW LOW PRICE $229

SAVE $70 Savings made because of mass production of this sensational product!

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Ref: EA Dec 81/Feb 82
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Counter Kit KA-1390 $169.50
Prescaler KA1392 $46.50

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SAVE $26.50

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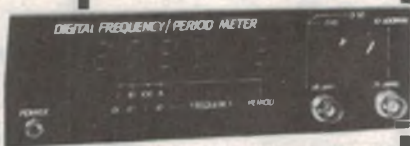

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Ref: ETI Dec 85 & Feb/March/June/July/Aug 1986

Normal Price $379.00
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$428.95

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- SAVE AN AMAZING $229

Cat. KE-4715/4716

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Not all packs will have exactly what is listed, but you can expect something similar. To purchase these at todays prices we would expect you to pay around $60 - $70.
Limited quantity - grab a piece of history.
Cat. SP-0780

ONLY $10

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Ref: EA May 1986
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Both units are supplied with:
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- Hook to hang up
- 3 sets of hands

Cat. XC-0106 Westminster chimes/clock movement
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We have extensively tested the units and have no doubt about their quality and operation ability.
Features & Specifications
- Dual element pyroelectric sensor
- 24 dual element detection zones in three layers
- Wide angle 90° multi layer coverage
- 12 metre range
- Operation voltage 7.5 - 16V DC
- Tamper protected
- LED indication
- Size 65(H) x 84(W) x 46(D)mm
- Colour beige
- Relay output
- 3 month guarantee

Cat. LA-5017

DIRECT IMPORT

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$30 LESS THAN ANY PIR WE KNOW OF

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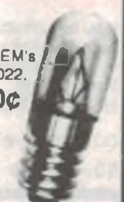

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NORMALLY $16.50 per 100

Cat. RC-5496

SAVE OVER 50%

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Cat. LA-5132

ONLY $139

AT LAST!

Construction project:

Universal "Real World" interface for PCs – 2

This month we present a full description of the circuit for the interface board. The interface includes eight digital outputs, eight digital inputs and eight 8-bit analog inputs.

by MARK CHEESEMAN

The circuit for the controller board can be divided into three major sections: the serial interface, the parallel interface and the "core" components, which are installed irrespective of which interfacing option is used.

A complete controller board consists of the "core" components and the components for *one* interface circuit. The exception to this is when two or more boards are to be daisy-chained together to share a common interface (either serial or parallel). Under no circumstances should *both* interface circuits be installed on the same board.

This is because if both interfaces were present on the same board, the outputs of both interfaces would try to drive the data and address lines on the board simultaneously, causing unpredictable results and possible damage to the circuit.

Internal buses

Data arriving from the computer, via either the serial or parallel port, consists of eight bits, which are split up to form the internal bus control signals for the controller board.

The most significant bit of this data byte becomes the read/write signal, which determines whether the operation to be performed by the controller board is to be an input or an output.

The next three most significant bits form the address bus data for the controller. The two most significant of these (A2 and A1) allow up to four boards to be addressed via a single I/O port on the computer. In this way, each of the boards is assigned a unique 2 bit number, and the state of these two bits determines which of the boards in the system is selected for a particular operation.

A0 selects which input or output device on the selected board is going to be used. For an output operation, this bit determined which of the two four-bit latches (ICs 7 and 8) will be loaded with the data on the data output bus. If an input operation is in progress, a high on this line selects the analog inputs (via IC6), while a low will cause the digital inputs to be latched into the input latch (IC2).

The remaining four data lines from the computer form a four-bit internal data bus, which carries the data itself from the computer to the output latches during an output operation. These four bits are latched into one of the two output latches during an output operation. The lowest three of these lines also select which of the eight analog inputs will be converted to digital information when the ADC is selected. During a digital input operation, these four bits are unused.

When a byte is received via either the serial or parallel interfaces, the eight data bits are placed on the output lines of either the UART (IC1) or data buffer (IC9) respectively. These eight bits consist of the data, address and read/write information from the computer, as outlined above.

To indicate the availability of this data, the UART raises the DAV (data available) line. This triggers IC3, a 74LS123 monostable, which resets the DAV line of the UART by lowering the RDAV pin. The output from this monostable is effectively also the master strobe signal, indicating to the rest of the circuit that the data, address and read/write lines carry valid information.

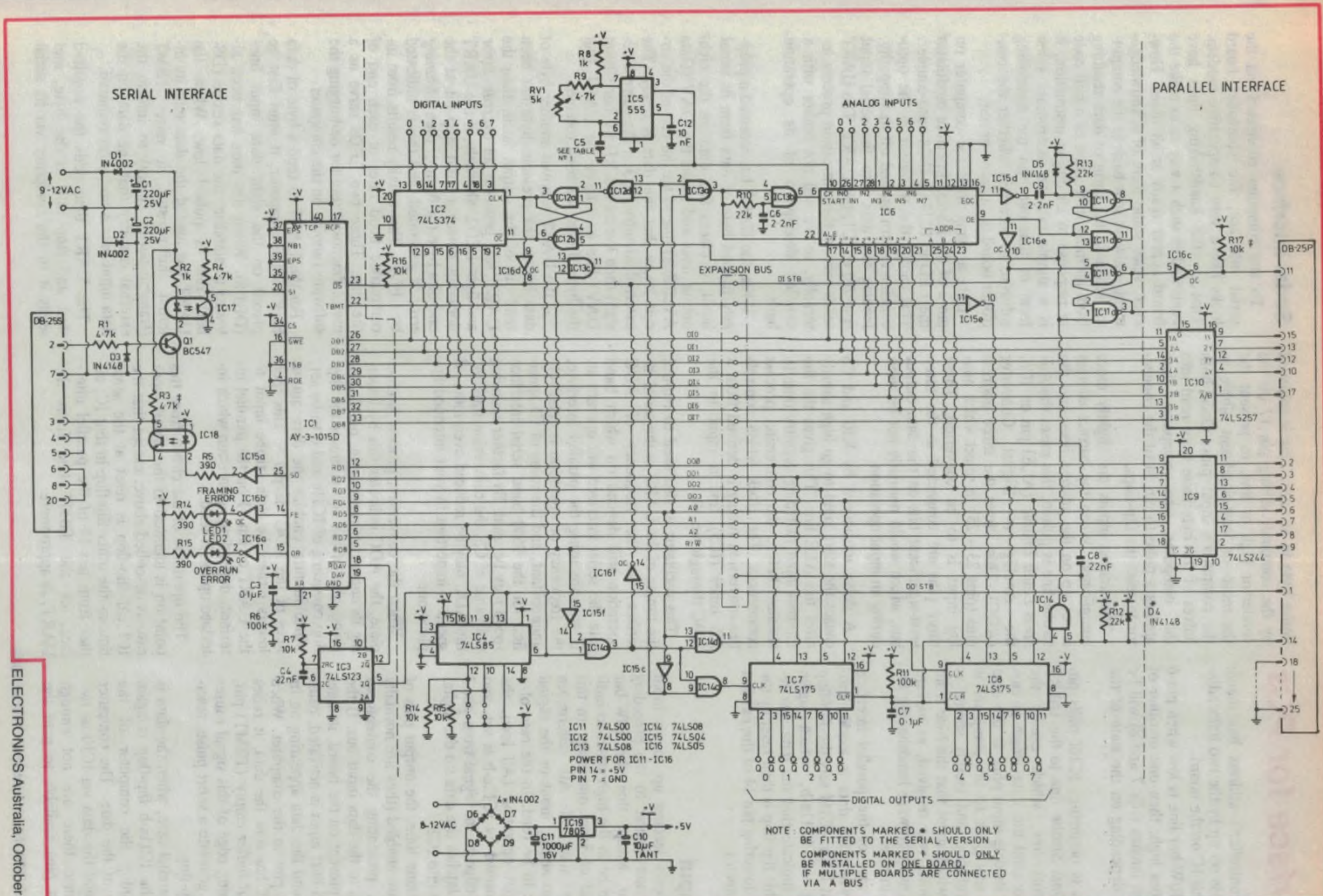
In the case of the parallel interface, this strobe signal comes directly from pin 1 of the interface connector, which is the line normally used for the printer strobe signal. In this case, the duration of the pulse is determined by the software in the computer, and IC3 is therefore not needed.

This strobe signal from either source then goes to IC4, a 74LS85 4-bit magnitude comparator. The output of this IC (pin 6) only goes high when the four bit words applied to each set of inputs are identical. In this way, the output goes high in time with the strobe pulse, but only when the two most significant bits

Use this table to select the value of capacitor C5, to suit the baud rate required for the serial interface version. Use 390pF for the parallel interface.

Table 1: Values for C5 for various serial I/O speeds

Baud Rate	Frequency	C5
300	4800Hz	18nF
600	9600Hz	8.2nF
1200	19.2kHz	3.9nF
2400	38.4kHz	1.8nF
4800	76.2kHz	1.0nF
9600	153.6kHz	390pF



Complete circuit for the 'mother board' section of the real world interface. The section in the centre, between the two dashed lines, is the core circuit. To connect it to your computer you use either the serial interface circuit on the left, or the parallel interface on the right.

of the controller's address bus match the address set up by the two links adjacent to this IC on the board.

If the R/W-bar line is low when pin 6 of IC4 goes high, then one or other of the output latches (ICs 7 and 8) will be selected, depending on the state of the A0 line.

As this is occurring, IC16f pulls pin 23, the *Data Strobe* line to the UART (if present) low, which causes the UART to send the data which is currently on its data input pins. In this case the data sent back to the computer is random rubbish, and merely serves as an acknowledgement that the byte from the computer was received, as we are not using any hardware handshaking for the serial interface.

In the case of the parallel interface version, when the data is loaded into the output latch, IC16f sets the flip-flop consisting of IC11a-b, which again serves to indicate that the data was received. This flip-flop is then reset by the computer lowering pin 14 of the parallel input connector.

Data input

The events leading up to an input operation are similar to the preceding description, except that the R/W-bar line has to be in the high state, to indicate a *read* on input operation. In this case, the state of A0 determines whether an analog input or the digital inputs are to be read. In the case of a digital input operation (A0 low), the flip-flop formed by IC12a-b is set, and the rising edge of the signal from pin 3 of this IC latches the data on the digital input lines into IC2.

At the same time, the output pins of the latch are enabled (they are normally tri-stated), presenting the contents of the latches to the data input bus. If the UART is present on the board, its data strobe (DS-bar) input is activated, causing it to send the data appearing on its data input pins to the computer. When the UART has sent the data, it raises the *transmit buffer empty* (TBMT) pin, and the rising edge of this signal causes C8/R12 to generate a short pulse, resetting the flip-flop.

In the parallel case, when the data is available the IC11a-b flip-flop is again set, informing the computer of the availability of the data. The computer needs to read the data via IC10 as two nibbles, since there are not enough spare input pins available to read the entire byte in at once. This is achieved by the computer setting pin 17 on the connector high or low, to present the the most- or least-significant nibble to the computer's input pins. Once both halves of the byte have been read into the computer, the computer then applies a pulse to pin 14 of the connector to reset the flip-flops.

The analog inputs are slightly more complicated. When the correct address is set up on the address lines and the strobe line is pulsed, this raises the *Address Latch Enable* (ALE) pin on IC6, the Analog to Digital Converter (ADC). This allows the three address pins (pins 23 – 25) to select which analog input is to be converted. These three pins are connected to the three least-significant bits on the data output bus, which would normally not be used during an input operation.

A delay introduced by R10 and C6 causes the start input to go high shortly after the ALE line. This gives the the internal input switching circuitry time to stabilise before the conversion process commences. The clock which controls the conversion timing is derived from a 555 timer (IC5), and is input to the ADC through pin 10.

This oscillator is also used to control the timing of the UART in the serial interface, so the frequency of ADC operation will depend on which baud rate the serial interface will operate at. If you are using the parallel interface, the frequency of operation is relatively unimportant, and the value of C5 specified for the 9600 baud serial interface speed may be used. By further reducing the value of C5, the conversion time for the ADC may be reduced even more, if speed is important in your intended application.

When the conversion process is complete, the ADC indicates this by lowering its end-of-conversion pin, pin 7. The rising edge of this signal causes the flip-flop consisting of IC11c and d to be set, which in turn enables the data output lines of the ADC via pin 9. This then lowers either the data strobe input to the UART or pin 11 on the parallel interface, depending again upon which interface option is used.

The operation of the circuit from this point on is identical to the digital input case as described above, except that the IC11c/d flip-flop is reset at the same time as the other flip-flop in that IC, either from pin 14 of the parallel interface, or the TBMT line from the UART, as appropriate.

Serial interface

To any computer connected via the serial interface, the controller board looks like a very co-operative modem. That is, the handshaking lines have been tied in such a way as to make the board appear ready at all times. However, since some form of acknowledgement is always sent back to the computer, either in the form of data resulting from an input instruction or a null code in response to an output instruction, it is a simple task to incorporate some form of time-out into the controlling software to ascertain whether the controller board is "awake" or not.

Data arriving from the computer on pin 2 of the RS-232 interface modulates the LED in IC17, a 4N28 opto-coupler. This causes the transistor in the opto-coupler to turn on and off in sympathy, feeding the data into the serial input (pin 20) of IC1, the UART. The UART takes care of the conversion process internally, so we will not bother with a detailed description of its operation here.

When the UART has received a properly framed byte of data from its serial input, it places this data on the eight output lines and raises the DAV (Data AVailable) line to let the rest of the circuit know that the data is ready. The external circuitry (IC3 in the current design) then lowers the RDAV-bar (Reset DAV) line to inform the UART that the byte of data has been received.

If the UART receives another byte of data before the previous byte has been read out of the output latch, then the UART will generate an *overrun error* and light LED2. Similarly, if the UART does not detect a valid stop bit at the end of a byte (or frame), then a *framing error* is generated, and this is indicated by LED1 . This usually results from incompatible baud rates at each end of the line. These two LEDs serve as a useful diagnostic tool for de-bugging the software running on the computer.

For the UART to send a byte of data back to the computer, it must first be placed on the eight data input lines (DB1-8). When this data has been allowed to stabilise, the data strobe (DS-bar) line is pulsed low. When the UART has loaded the data into its internal shift-register, it raises TBMT (transmit-buffer empty) to inform the external circuitry that the data on the data input pins is no longer required.

The UART then adds the required start and stop bits to the byte, and sends it to the computer via its serial output (pin 25). IC18 provides electrical isolation of the serial output line from the computer, so that any computer connected via the serial port of the interface is protected from the ravages of whatever may be connected to the Real-World Interface.

Timing for the serial interface is derived from a 555 (IC5) running as an astable oscillator. The frequency of oscillation of this oscillator is set to 16 times the baud rate of the link between the interface and the computer. The broad frequency range is set by the appropriate choice of C5, according to Table 1, and fine adjustments are made using RV1. Once RV1 has been set initially, no further adjustment should be necessary, as this form of oscillator is more than stable enough for byte-orientated serial communications.

The power supply for the interface is quite conventional. Low voltage AC from an external transformer is rectified by the bridge made up of diodes D6 to D9. It is then filtered by a 1000uF electrolytic (C11), and regulated down to 5V by IC19.

The serial-interface version has an additional power supply to power the interface circuitry, and yet enable it to be electrically isolated from the rest of the interface circuit. A separate transformer supplies the power to this portion of the circuit, as we found that two single-secondary transformers could be obtained for less than a dual-secondary unit.

This power-supply is a dual half-wave set-up generating positive and negative 12-15 volt rails from a 9-12 volt AC input. These rails ensure that the serial data coming from the controller meets true RS-232C specifications. While simpler power-supply configurations are possible, there is a significant chance of the interface not working with computers that are fussy about the voltage levels of the received data.

Some computers may make suitable voltages available at the RS-232C port, which may be used to power the serial interface circuitry. If this is the case, then the relevant power supply components (D1, D2, C1, C2 and the second transformer) may be omitted, and the power derived from the computer itself. This has the additional advantage that power for the serial interface circuitry will automatically be applied whenever the computer is turned on.

Next month we will present the constructional details and PCB artwork for the interface.

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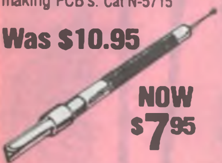

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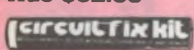

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Three sheets of assorted arrows, lines, switch graduations, numbers, etc in both Black and White. Cat N-5750 **$11.95 set**

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Four sheets with dial plate arcs & graduations to let you customise any meter movement. Suits meter radii from 25 to 125mm. Black only. Cat N-5752 **$14.50 set**

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ALL ONE PRICE: **$3.95 ea**

DONUTS – precision cut donuts to accurately match tape. 380 donuts in each pack, all .031in OD on 0.2in × 0.3in centres
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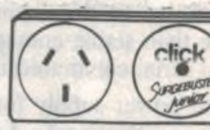

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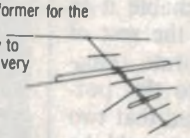
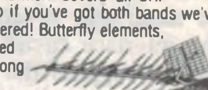
Suburban VHF

It's a great all-round performer for the typical suburban home (regardless of city). Easy to erect, good f/b ratio and very good value for money. Cat L-4022 **$69.95**



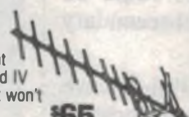
Band IV and V

What a performer! Covers all UHF channels, so if you've got both bands we've got you covered! Butterfly elements, gold anodised finish for long long life. Cat L-4084 **$99**



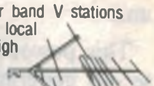
Band IV UHF

If you're in a capital city, chances are you only want channel 28 UHF. This band IV antenna is perfect – and it won't break the bank! Cat L-4082 **$65**



Band V UHF

A great performer for band V stations (which include most local area translators). High gain, easy to erect. Cat L-4080 **$59.95**



Accessories, Too:

Barge Board Mount: Easy way of getting the antenna up from a vertical surface. Cat L-4150 **$14.95**

Short Mount: Designed to hold vertical masts. 28cm long, with saddle clamp. Cat L-4152 **$9.95**

Longer Mount: As above, but 69cm long to clear eves, etc. With saddle clamp. Cat L-4153 **$10.95**

Mast Section: 2.4m galvanised pipe for mounting antenna. 27.5mm diam. Cat L-4156 **$9.95**

Telescopic Mast: 4.8m galvanised telescoping mast for that extra height. Cat L-4157 **$29.95**

Saddle Clamp: 90 degree V-block and U-bolt assembly for holding mast to mount, antenna to mast, etc Cat L-4165 **$2.95**

2-way Splitter: Inside splitter for running two TV's from one antenna. Suits 300 Ohm cable. Cat L-4216 **$4.95**

4-way Splitter: As above, but for running up to 4 TV's from one antenna. For high signal levels. Cat L-4220 **$7.50**

2-way 75 Ohm: Use with coax cable installations for running 2 TV's. Inside use only. Cat L-4270 **$3.50**

4-way 75 Ohm: As above, allowing 4 sets from one antenna. Suitable for strong signal levels. Cat L-4474 **$7.75**

Baluns: Used for converting 300 ohm system to 75 ohm and vice versa (eg coaxial lead to an old TV with 300 ohm antenna inputs).

Universal: Inside use only. Cat L-4456 **$2.95**

Outside: Protected from the elements. Cat L-4465 **$4.95**

Masthead Diplexer: Combines the signals from UHF and VHF antennas, allowing one cable run. Cat L-4469 **$12.95**

Indoor Diplexer: Used where TV set has only one antenna input but VHF and UHF antennas need to be connected. Cat L-4476 **$6.95**

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No questions, no qualifications: if you buy the lucky one millionth kit, you'll win the prize: $1000 worth of any products from your Dick Smith Electronics store.

THE ONE MILLIONTH FUNWAY KIT WITH $1000 BONUS!

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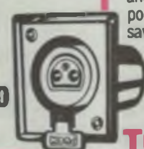
Mains Rated (fully approved for mains use)

AXR-LNE-12 LINE PLUG P-1627 **$9.95**
AXR-LNE-32 PANEL PLUG P-1629 **$7.50**
AXR-LNE-31 PANEL SOCKET P-1630 **$7.95**
AXR-LNE-31 LINE SOCKET P-1631 **$9.50**

High Power Audio Range (ideal for speaker connectors, etc)



AXR-PDN-12W LINE PLUG P-1632 **$10.50**
AXR-PDN-11B LINE SOCKET P-1634 **$9.95**
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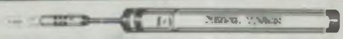
NEW!

Butane "Pencil" Blowtorch



Soldering, silver soldering, glass bending, heatshrinking, even small brazing – they're all easy with this superb little tool. Butane powered (standard cig lighter refills) with controllable flame down to near pin-prick. All in a tiny (200mm long x 13mm diam) hand-held torch. Cat T-1380

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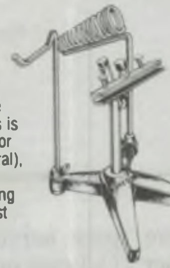
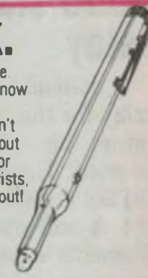
½ Price Superstand



Hobbyists – repair shops – labs – assembly benches – if there's one item your bench really needs, this is IT! Heavy cast base with stands for Soldering Iron (complete with spiral), solder rol AND an adjustable vice with 360 degree rotation for holding and turning pcb's. One of our most popular stands – our bulk buying saves you money Cat T-5700

WAS $69.96 NOW ONLY $34.95

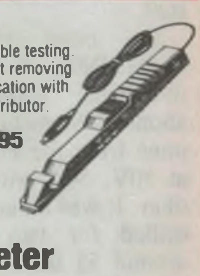
NOW IN STOCK.



We've raved about these in our catalogue. We've told you how fantastic they are – now they're in stock so you cand find out for yourself! AC Voltage detectors which don't rely on contact – so they're S-A-F-E! About the size of a small marker pen, perfect for electricians, maintenance people, hobbyists, everyone! First shipment is almost sold out! Cat Q-1530

$12.95

12V Tester



Another beauty: this one's for auto cable testing. Actually pierces the insulation without removing cables, gives no go/maybe/good indication with 3 leds. Also tests HT pulses from distributor. Look at the price! Cat Q-2000

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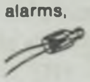
SOS: SAVE ON SWITCHES!

Mercury Switch



Tilt mount switch SPDT. Essentially a movement detecting switch. Low current applications. Ideal for bike and car alarms, etc. Cat S-1935

Was $3.95 NOW $2.95

Standard SPST

125V AC 3A. Ideal for projects or automotive use. Standard toggle with on/off indicator plate. Cat S-1215

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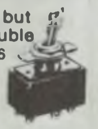
Standard DPDT



Same as above but double pole/double throw. Cat S-1216

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TOROIDAL TRANSFORMERS SLASHED

No, not literally – only the price. When you want the best in performance/noise/weight/size ratio, you cannot go past a toroidal transfomer. And now both of these are reduced $10! Hurry – limited stocks at this price!

45+45V @ 3.3A plus 15+15V (ideal high power amplifiers) Cat M-1600

Was $79.95 NOW ONLY $69.95

35+35V @ 2.2A plus 15+15V (ideal medium power amplifiers) Cat M-1602

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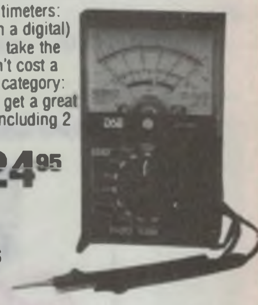
NEW!

No Frills Multimeter



Most hobbyists need two multimeters: their good bench meter (often a digital) and a cheapie – one that can take the rough and tumble, and doesn't cost a fortune. This one's the latter category: but for the low low price you get a great 10k/v meter with 18 ranges including 2 battery check scales. Includes probes. Cat Q-1015

$24.95

Huge range of moving coil and digital multimeters from only $17.95

What a Bargain

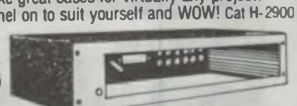
Manufacturer's Error: You reap the benefit! Quality Bit Blitzer "121" Internal Modems, fully guaranteed and in perfect working order, around $100+ less than you'd expect to pay. Cat X-3304

ONLY $199

Hurry! Stock won't last long at this crazy price!

CHEAP CASE!

We made thousands of these cases to suit our low cost amplifier. To many! Our loss is your gain: we've slashed the price to move excess stock. They make great cases for virtually any project: simply put the front panel on to suit yourself and WOW! Cat H-2900



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Hobbyist CRO

Most hobbyists need a CRO – most don't have one. Once you've used a CRO you'll wonder how you got on without it! This one won't break the bank, but gives a usable response to beyond 6.5MHz – ideal for most users. Try it: you'll like it! Cat Q-1280

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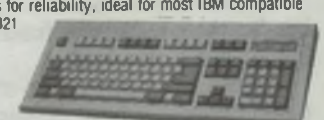
101 Key Keyboard

The cheapest around – but there's no loss of quality! Superb "Alps" keyswitches for reliability, ideal for most IBM compatible computers. Cat X-3821



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GET INTO SCANNING!

What a great hobby: no licences or qualifications required, and you can start straight away with these superb Bearcat Scanners!

175XL Mobile

Covers all popular bands, with 16 channel memory to store your favourite frequencies. 12 volt operated, comes with AC Adaptor to use at home. Cat D-2812

$369

100XL Handheld

Our most popular – 16 channel memory, covers 9 bands between 66 and 512MHz. Complete with rechargeable NiCad batteries and charger! Cat D-2813

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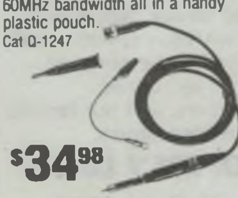
60 Meg Probes

Here's a value-packed set of probes for CRO use. Multiple piece set, with x1x10 switch, 60MHz bandwidth all in a handy plastic pouch. Cat Q-1247



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Coloured Test Clips

If you're birdsnesting or even doing a lot of circuit testing, these multi-coloured test clips are great. Mini size, come in a variety of colours. And they're near half price this month! Cat W-4588

Normally 95c ea NOW ONLY 50c each

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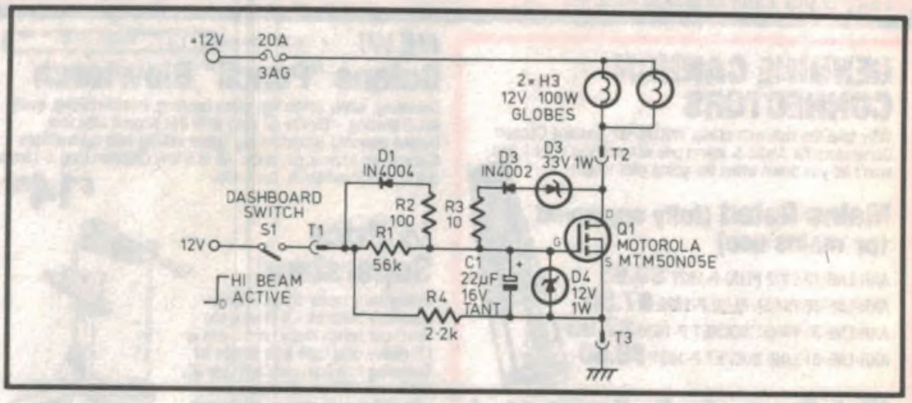
DICK SMITH ELECTRONICS

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.

Solid state "soft start" relay



I designed this soft-start solid state relay for the two spotlights (100W each) on my car, after the original one began to weld. The advantages of it are:
(a) Solid state, no contacts to weld.
(b) A soft-start feature gives the lamp filaments a longer life as most failures occur at switch-on due to inrush current.

The heart of the circuit is an MTM50N05E N-channel MOSFET, and obtainable from (Arlec)-Soanar for about $19 including tax. I obtained mine from the Perth branch. It is rated at 50V, 50A with an Rds-on of 0.028 ohm. It was mounted on a heatsink predrilled for two TO-3 cases, costing around $5 from Altronics, Dick Smith etc.

The rest of the circuit takes up the spare space normally occupied by the other TO-3 case on this heatsink.

The circuit employs the Id/Vgs characteristic of MOSFETS, which is a sloped staricase starting at the Vgs threshold of about 2V and reaching nearly maximum Id at about Vgs. = 4V.

In normal operation the switch S1 is ON and the driver switches on HI-BEAM. C1 begins charging via R1 and after about half a second, the filaments in the spots begin to glow. After this the transition to full current is fairly rapid, due to the staircase nature of the characteristic. However the soft-start is genuine, giving the filaments a longer life.

When the driver switches to LO-BEAM the spotlights need to be de-energised immediately, thus C1 is discharged rapidly via D1 and R2. In the case of the dashboard switch being opened when the headlights are on high beam, the discharge takes place via D1, R2 R4. This is still very rapid, almost instant.

D3, D2 and R3 form a spike suppression circuit in case of spikes occuring at the drain due to stray inductance. Although considering the finite time-constant even at switch off, such a spike is unlikely to be large. For a few cents the MOSFET is protected anyway.

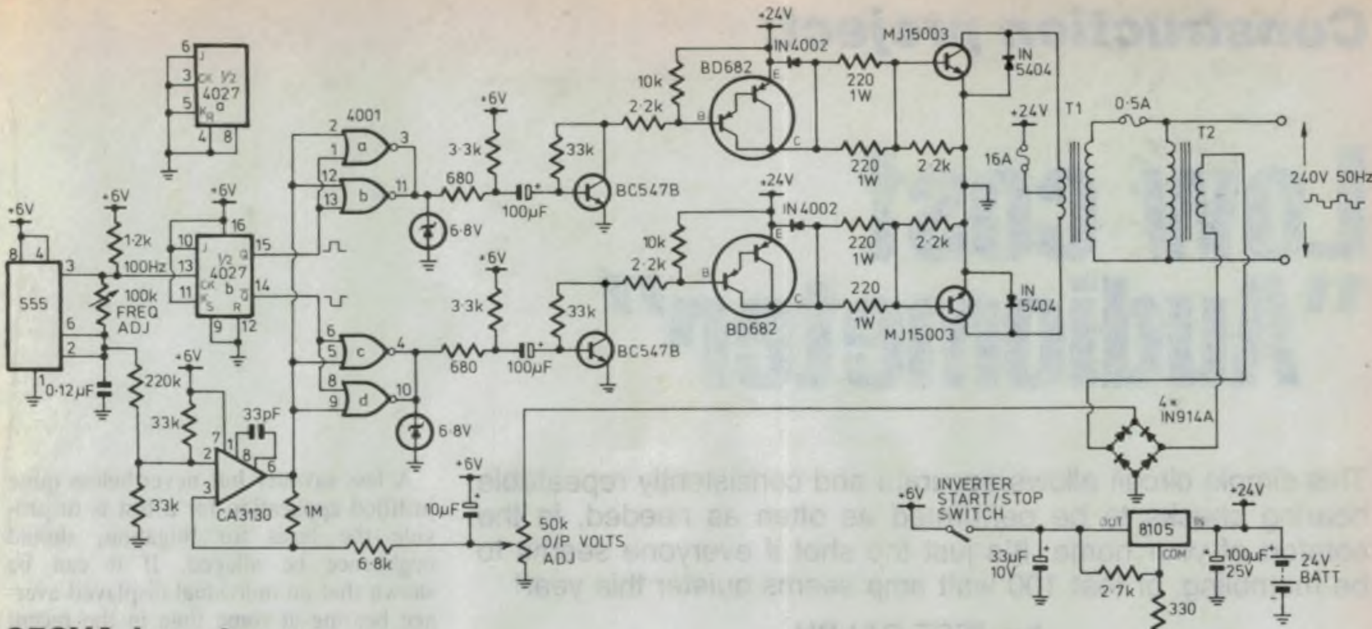
D4 prevents the Miller capacitance ever taking the gate to more than +12V during switch-off and protects the gate from ever reaching −20V (or less) (±20V are the maximum VGS ratings). It also protects the 16V tantalum from exceeding its rated voltage.

R2 and R3 function as current limiting for their respective functions. Possibly R3 can be omitted.

Voltage drop across Q1 and heatsink temperature rise have proven to be negligible whilst operating two 100W "H3" quartz halogen spotlights.

Ron McGregor,
Belconnen, ACT

$40



250VA inverter

I built this inverter to provide 240V AC power, during the frequent blackouts here, for a burglar alarm, ceiling fans & other small appliances.

As the circuit shows, it uses ideas from several other inverter circuits published in *EA* over the years. The oscillator (555) and 4027 flipflop provide the 50Hz complementary square wave which is fed via the 4001 to the BC 547B's through 100uF electrolytics. These serve to keep the 6V DC and 24V DC sections of the circuit separate.

The BC547B's drive the BD682 Darlingtons which in turn drive the MJ15003 output transistors. Voltage regulation is achieved by the CA3130 comparing a proportion of the output voltage with the 6V regulated supply and inhibiting part of the drive circuit's waveform by turning low the 4001's output when required – i.e. PWM.

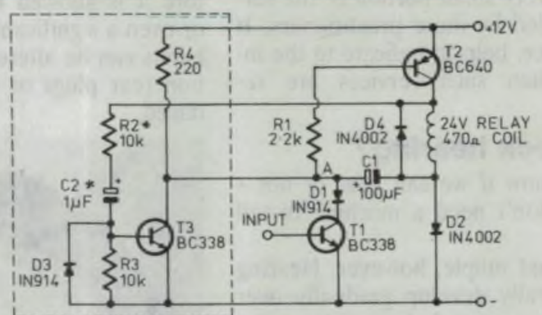
T1 is a 18-0-18V – 240V toroid (300 VA) and T2 is a PCB mount 240 –2V transformer.

I have had the inverter along with its mains failure start up (relay) circuit and voltage sensing battery charger in service for several months now, without any problems occuring. The transformer and MJ15003's were the only costly items but it still worked out to be a cheap and reliable 250W inverter.

B. Mortensen,
Lae, Papua New Guinea

$50

Operating a relay at reduced voltage



Electronics Australia for July, 1977 cited an idea from American *Electronics* for operating a relay at reduced voltage.

Drawbacks were that a switch or contact was needed to operate the circuit and the capacitor which delivered the kick to operate the relay had to be non-polarized. Moreover, only some 7 volts, from a rail voltage of 12 volts, was sustained across a 26 volt coil to keep the relay operated – a somewhat doubtful proposition.

A modified circuit is presented which is free of those limitations yet uses few extra components.

The basic circuit employs two transistors, T1 & T2, and excludes the components within the dashed box. Diodes D1 & D2 ensure that the voltage across C1 cannot reverse.

A small voltage and current supplied to the base of T1 make it turn on T2, which applies positive rail voltage to one end of the relay coil. At the same time, T1 switches the positive end of C1 almost to negative rail voltage, thus transferring a negative impulse to the other end of the coil and causing the relay to pull in.

As diode D2 prevents the lower end of the coil from rising much above negative rail, almost full rail voltage is maintained across the coil.

When input to T1 is removed, C1 charges through R1 and the base of T2, which results in delay of relay drop-out for up to some seconds. If unacceptable, the delay can be eliminated by adding the components in the dotted box and converting the junction at point A to a cross-over.

Typical values of all components are listed, but some experimenting may be necessary with the values of R2/C2 because this time constant must match that of the relay pull-in. The value of C2 must be large enough to deliver a substantial impulse to the base of T3, but too small to a value of R2 may not achieve the desired result.

An added advantage of the more complex circuit is that R1 may have quite a high value so that, with the relay operated, the steady current drain need be very little more than the coil current.

Hugh Harrison,
Brighton, Vic.

$40

Construction project:

Low cost "Audiometer"

This simple circuit allows accurate and consistently repeatable hearing checks to be performed as often as needed, in the comfort of your home. It's just the shot if everyone seems to be mumbling, or that 100 watt amp seems quieter this year!

by JEFF RALPH

Hearing checks can be conducted with tuning forks, speech or simple "audiometers" similar to the unit presented here. The former two methods, whilst instructive, can be subjective and are difficult to self-administer. The "audiometer" to be described here provides a means for the layman to quickly and easily make comparative hearing checks, which should highlight a developing hearing loss.

The project is certainly not intended to replace the professional services of a qualified audiologist, and indeed it only provides a very small portion of the services provided by these practitioners. It will, however, help to indicate to the individual when such services are required.

Why check hearing?

We all know if we can hear or not – surely we don't need a machine to tell us so?

It's not that simple, however. Hearing losses generally develop gradually over time, unless caused by some catastrophic aural damage or disease, so it is easy for the individual to be unaware of a slowly accumulating loss until it has reached irreversible or incurable levels.

Anyone who works in a noisy environment should be having their hearing tested on a regular basis. This includes the obvious cases of rock musicians, machine operators, construction workers and the like – but also such people as school teachers, shop assistants, government department complaint desk clerks and so on.

Workers in traditionally noisy fields are usually supplied with ear protection, but this is only as effective as the will of the person using it.

Perhaps more insidious is the case of the worker in a field which is not acknowledged as hazardous to the hearing, but nevertheless is. Constant use of the telephone may deliver an unnatural sound pressure level to the ears, which can then prove detrimental — and is easily detected since the telephone is generally used with one favoured ear, which may then demonstrate a loss.

The primary justification for taking a hearing test is ideally to locate and remove a potential source of damage before it is allowed to cause a profound, or even a significant, hearing loss. Work habits can be altered or physical protection (ear plugs or muffs) can be introduced.

The completed Audiometer, with a pair of suitable headphones.

A less savoury but nevertheless quite justified application for a test is to provide the basis for litigation, should negligence be alleged. If it can be shown that an individual displayed average hearing at some time in the recent past, then displayed a measurable loss despite following the recommended precautions (if any), then surely a case for compensation could be made. More importantly, the basis for improved working conditions can be fairly made.

A professional screening audiogram, as provided by a qualified audiologist, is unquestionably the best way to gain an accurate indication of the state of one's hearing. It is certainly the only indication that would be accepted in a court of law, or by the management of a large corporation, but there are nevertheless many circumstances when a simple audiometer can be of value.

Many people can be reluctant to visit an audiologist, refusing to even acknowledge that a problem exists.

"Whaddidya say? ... I am NOT going

deaf ... people nowadays just mumble, that's all!"

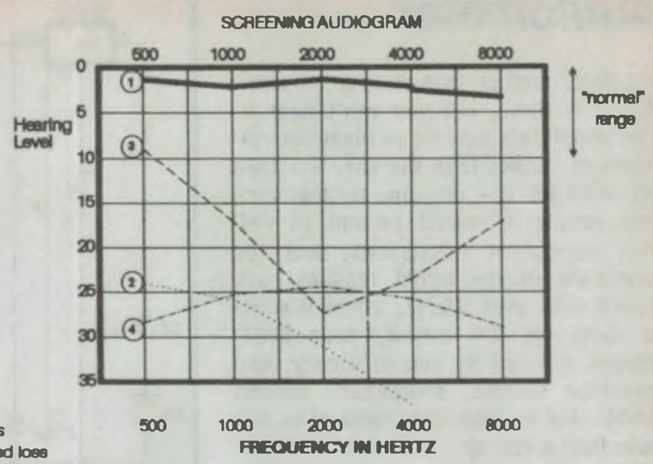
If you can demonstrate to such an individual that they have a measurable hearing loss compared to, say, yourself, then maybe they will be sufficiently motivated to seek professional assistance.

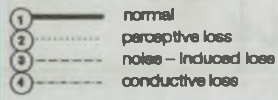
Professional musicians, particularly the younger variety, may also be hard to convince that they are causing themselves problems. After all, the amps can be cranked up a few more notches if they're getting a bit quiet – thus compounding the problem. A quick test in a quiet moment, with the added reminder that their livelihood depends on their hearing, should prick their consciences and stir them out of their complacency.

Such individuals would probably not consider professional assistance without some form of concrete evidence of hearing loss. The audiometer described here can effectively supply this.

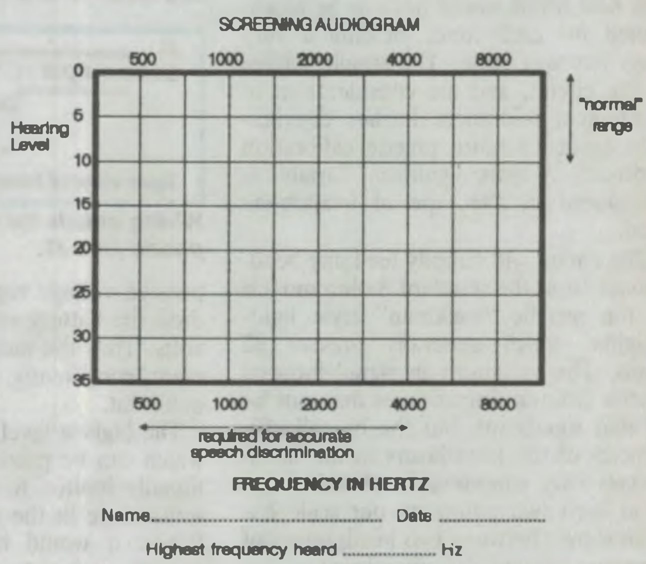
Temporary loss, such as that caused by exposure to music recorded after 1970, can be quantified by tests before and after exposure. Likewise, tests can be made before and after going to work – that is, two tests on the same day. Tests can be taken whilst the subject is ill, demonstrating the effects on the hearing of infections in the head – if for no other reason than intellectual curiosity.

All of these tests can be performed with ease and speed, where a professional consultation may be inconvenient or simply too late.





Right: Results as in (1) would suggest that your hearing is fairly normal, while curves like (2), (3) or (4) suggest a visit to your audiologist for further testing.



Right: A blank chart for you to photocopy and use to plot the results of your hearing checks, as above.

The Audiometer

The "pure tone" audiometer generates continuous tones which can be altered in both frequency and intensity. In use, the signal is fed to the subject while the volume, or intensity, is lowered until the tone can be only just heard – the threshold level of the tone.

The tones are most often delivered through air conduction, via headphones. Alternatively, the sound can be applied to the mastoid bone behind the ear. In this way it reaches the cochlea (inner ear) by bone conduction through the skull.

The test is repeated on a number of set frequencies covering the effective full range of normal human hearing. These tones progress from 125Hz to 8kHz in octave steps.

The intensity is normally calibrated from -10 to +100dB. The reference point (0dB) for calibration of the intensity is taken as the threshold level for a person with normal hearing. As this threshold varies over frequency even with "normal" hearing, the 0dB point varies accordingly in absolute terms. This is one reason why my Audiometer design is calibrated in simple steps, rather than dB – the other is simplicity and economy.

A standard value of 0.00024 dynes per cm^2 sound pressure can alternatively be used as the reference point for 0dB. (Now wouldn't that be fun to calibrate?)

This design

My Audiometer project differs from the professional units in a number of specific points – the most significant being that it only costs around $20 to build!

The tones available are 500, 1000, 2000, 4000 and 8000 hertz. 125 and 250 hertz have been omitted for the very pragmatic reason that there wasn't a position available for them on the switch, tempered by the more reasonable explanation that these two low tones are often omitted in the compilation of a professional screening audiogram. The higher frequencies are usually more informative, and bearing that in mind we have added a bonus feature.

In addition to testing threshold levels on set frequencies, this circuit provides a test of absolute upper frequency response. This is achieved with a setting which allows continuous adjustment of the frequency from just below the upper fixed tone of 8kHz to over 30kHz, well above anyone's hearing limit. The level can still be adjusted at this setting, but it is more instructive to turn it full up, and adjust the frequency until the tone seems to disappear.

It can be somewhat disconcerting when the tone disappears. The normal human reaction is to believe that it is

Audiometer

not there, rather than having to admit that it is there, but you can't hear it. The temptation may be to blame the instrument, rather than the ear. But take my word for it – the tone on this variable setting is indeed present to well over supersonic frequencies, and the amplitude of the signal remains rock steady until over 30kHz, where it starts to drop off. Of course, your headphones will rapidly lose efficiency, and therefore volume, somewhere around 20kHz, but by that stage most of us will have long given up.

As mentioned earlier, the level scale is not calibrated in dB, but in a simple linear scale. The reasons are manyfold. The 0dB levels would have to be recalibrated for each tone, yielding a very fussy five-way scale. The simple nature of the circuit, and the consideration of component tolerances further discriminate against a more precise calibration approach. A more significant variable is introduced by the type of headphone used.

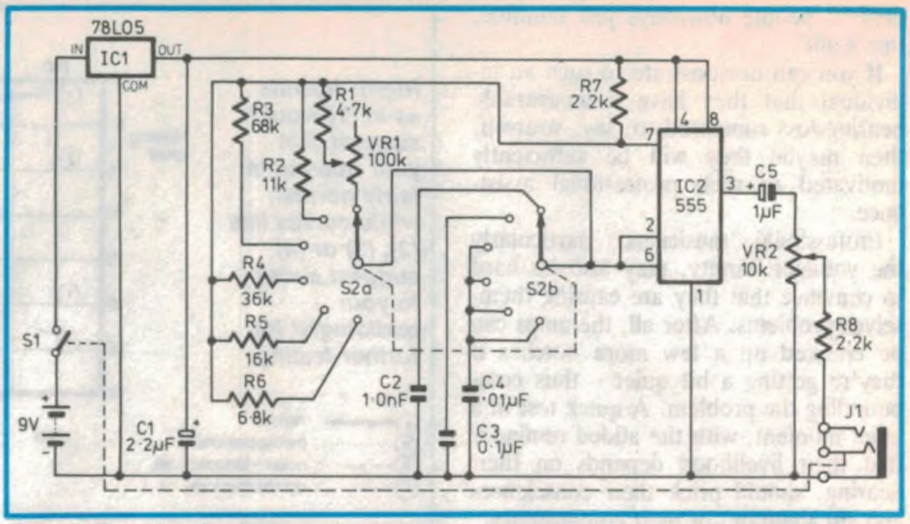
The circuit will happily feed any headphones from the standard 8 ohm models to the prolific "walkman" style lightweights, which generally present 32 ohms. The variations in signal induced by the different impedances may not be all that significant, but the overall efficiencies of the transducers in the headphones vary considerably. A difference of at least two points on our scale has been shown between two headphones of the same nominal DC impedance.

Thus this audiometer is intended only for making *relative*, not absolute measurements. Results can be compared between different individuals, or for the same individual over time. If an absolute measurement is required, then a professional screening audiogram should be conducted. The results could then be used to calibrate the scale for the particular headphones used.

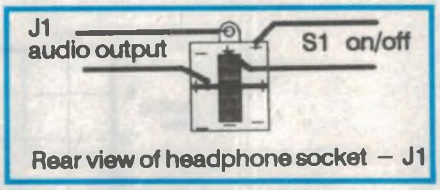
As a matter of interest, it was found that 0dB coincided with a level of around 1-2 on our scale, and that the higher numbers, above 10, related very closely to actual dB levels. This result was obtained with an inexpensive pair of 8 ohm headphones, and will vary from unit to unit.

Naturally, to maintain consistency over time, the same headphones should be used with the audiometer for all tests.

In order to minimise the effects of failing battery voltage on the level produced, and hence the accuracy, an inexpensive voltage regulator is included to drop the battery voltage to a constant 5 volts. Thus the unit will continue to operate consistently until the battery is quite flat.



Above: The circuit of the Audiometer is very simple, based on a ubiquitous 555 timer IC and a handful of parts.



Wiring details for the 6.5mm stereo phone jack J1.

The highest level, i.e., loudest volume which can be produced has been intentionally limited to a fairly low value – somewhere in the region of 40 – 50dB. Whilst it would have been simple to provide a greater output, there were two basic reasons for limiting it.

First, a linear scale was wanted, but one which would still provide usable resolution at the lower levels. Hence the upper limit could not be very high. A system of two level controls, fine and coarse, was considered but abandoned as unnecessarily complex for the other design objectives of the circuit.

The other reason was that the audiometer is intended to protect hearing by highlighting possible causes of hearing loss. It was not intended to be a *source* of hearing loss, as it could be if the levels available were significantly higher than they are! A continuous audio tone, particularly at the higher frequencies, can be a major irritant at high sound pressure levels, and we felt that the audiometer should not be made with such an easy-to-abuse capability. So you can turn on the audiometer confident that you won't need to snatch the 'phones off your head to avoid a lingering ringing in the ears. Even the loudest tone is not uncomfortable.

As a consequence, hearing losses of a more serious magnitude will actually be unmeasurable on this device – the user simply won't hear the tone at all. If this is the case then it is hoped that professional advice has already been sought. If any of the five standard tones cannot be heard below, say, 30 on the level scale, then the subject has a significant loss which should be seen to. The average user, with "normal" hearing, will not find it necessary to go beyond a level of 5 or 6 on the standard tones.

The circuit

The EA Audiometer circuit is based on that standard building block – the 555 timer in astable multivibrator configuration.

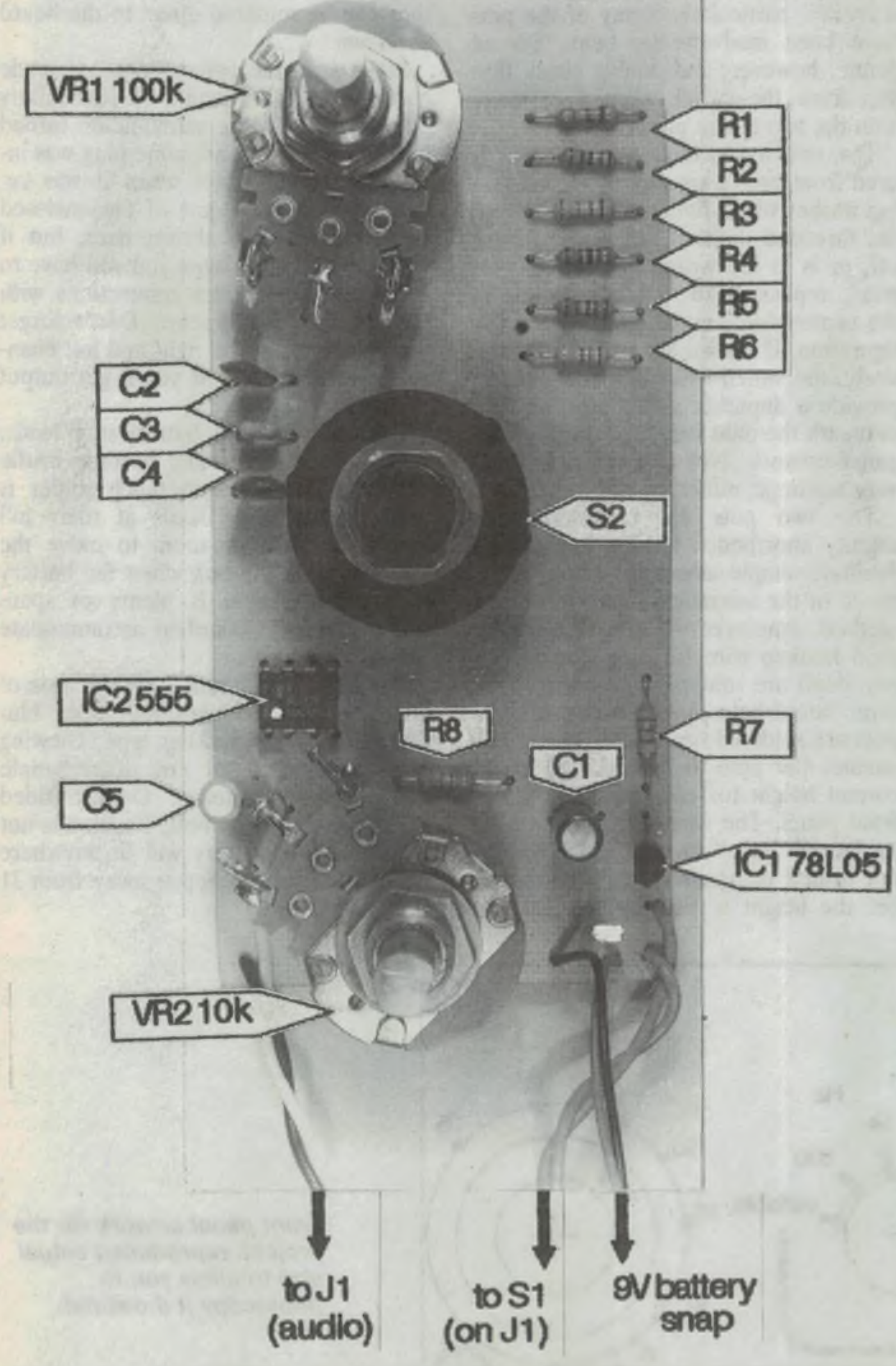
IC2 is the 555, and the frequency of the tone it generates is determined by the RC combination provided by R7 and the resistor and capacitor chosen by the rotary selection switch.

R2 is used in combination with C3 to provide the 500Hz tone, the lowest available. R3 – R6 are used with C4 to provide the other four fixed tones. Three of the resistors are specified as 1% tolerance, which is required if a single resistor of the preferred value is to be used. In each case they may be substituted with the nearest 5% resistor, but the appropriate fixed tone will be off frequency accordingly. This is not terribly important, as the absolute accuracy of the fixed tones is not critical. Even with the specified 1% components, there may be acceptable variations of a percent or two from the indicated frequency.

If the constructor particularly wants absolute accuracy for the frequency, then it would be necessary to reduce the value of R2 – R6 and add a trimpot in series (roughly equal in value to twice the difference between the resistor inserted and the resistor specified). The frequency could then be set in conjunction with a counter or an oscilloscope. Note that there is no specific provision on the board for this modification, so it would have to be "jury-rigged" on the component side of the board.

VR1 and C2 determine the frequency of the variable tone. C2 is a relatively small value (1nF) as the range of tones to be produced is considerably higher than the fixed tones. R1 is wired in series with VR1 to prevent the 555 dropping out of oscillation. With R1 in place the upper limit of the variable tone is in excess of 32kHz, and oscillation is maintained at a quite stable amplitude over the full range of adjustment.

The on-off switch, S1, is part of the headphone socket, J1. It is connected so that the unit is turned on when a headphone plug is inserted, eliminating the need for a separate switch.



A top view of the PC board assembly, with all parts identified to make it easy for you to wire up your own.

Power can be provided by a variety of means, including plugpacks, but the power consumption is so low, particularly considering the intermittent nature of operation, that battery operation is by far the most sensible and economical alternative.

IC1, the 78L05 regulator, is included to provide a stable 5 volt power supply rail – ensuring consistent results over a wide range of battery voltages. Battery life should be equivalent to shelf life (unless the headphones are left plugged in!), and operation is quite satisfactory down to a little under 6 volts.

IC1 can be omitted with only slight detrimental effect. Substitute a wire link between the two outer terminals, bypassing the centre (earth) terminal. But note that the battery will have to be fresh in order to obtain consistent results if this is done.

C1 helps provide stable operation at higher levels of output.

C5 removes the DC component of the output signal. VR2 provides the level (volume) control. R8 removes any residual signal which may be present when VR2 is turned fully to earth – particularly if the pot makes a less-than-perfect connection at this point.

J1, the combined on/off switch and headphone socket, is wired in mono at the socket. This can be altered to provide single ear operation or switchable to either side for checking each ear separately, at the builder's discretion.

Construction

Simplicity and ease of construction are significant features of the audiometer design. There is a minimum of interwiring required, and the PC board is mounted in the case simply via the rotary switch – no extra mounting bolts or spacers are needed.

As is customary with most projects, it is best to begin construction with the housing details – the "metalwork" of the project. Fortunately this is not difficult if the all-plastic "jiffy" box specified is used. The plastic lid is much easier to work, particularly with hand tools, than the metal-lidded variety.

The front (top?) panel artwork can be cut straight from the page, or photocopied if you'd rather not disfigure the magazine. Carefully trim it to size and cut the four mounting screw holes. These can be punched with a ring-binder-style hole punch, or cut with a sharp utility knife. They should be done accurately, as they are used to register, or line up, the artwork on the front panel.

Glue the artwork to the front panel, being sure to line it up neatly. Hobby glue (PVA) is not satisfactory for this, as the paper will peel off when the glue is dry. Spray adhesive, if you have it, works well, and any of the plastic glues (polystyrene cements) will do a good job if used sparingly.

Drill the mounting holes for the rotary switch and the two pots next. Do this when the glue is dry, so the paper doesn't lift up when the drill cuts through it. Drill a pilot hole of about 3 to 4mm diameter first, then enlarge the hole to 10mm. A hand-operated tapered reamer does an excellent job of cleaning up the hole if needed. Burrs should be removed with an oversize drill held in the hand. Do not do this with a power drill, as it is very easy to accidentally drill right through the lid to the larger size.

The mounting hole for the headphone socket, J1, is drilled in the same manner. It is located in the centre of one of the ends of the box, 12mm from the base, as shown on the accompanying diagram.

This completes the work on the plastic case. Now turn on the soldering iron, and start assembly of the PC board.

Check the board for shorts and hairline cracks – first visually and then with a multimeter or continuity tester. Hold the board up to a light to check all the holes are unblocked. When all is OK, proceed with assembly.

Solder in the fixed resistors first. Double check all the values before soldering – particularly in the bank of six resistors R1 to R6. The colour bands can be difficult to distinguish, particularly on the blue bodies of 1% resistors. Confirm the values with a meter before soldering – after all, desoldering is such a nuisance!

Next install the capacitors, taking care to observe the correct polarity for the two electrolytics. The 555 is next – pin 1 goes towards the outside edge of the board. The 78L05 is inserted with the flat face towards the inside of the board. Take care when bending the leads of this component – bend them with long-nose pliers a few millimetres down from the body. If they are bent at the base of the body they are likely to fracture. The correct method of installation is shown in one of the accompanying photos of the assembled board.

The rotary switch may need a little gentle persuasion to go into the board correctly, particularly if any of the pins have been inadvertently bent. Do be gentle, however, and double check that you have the switch aligned correctly with the two centre pins.

The switch specified may be configured from two to six-way by means of a lug washer which fits around the base of the threaded shaft. If this washer drops off, or is in the wrong position as supplied, replace it so that the lug fits in the centre slot – making a six way configuration. If the washer is discarded entirely, the switch will still work, but will provide a duplicate set of positions underneath the ones indicated on the front panel artwork. Not a disaster, but not very aesthetic, either.

The two pots are mounted in a slightly unorthodox fashion in order to facilitate simple assembly. Look at the photo of the assembled board to see the method employed. 20mm lengths of rigid hookup wire (resistor lead offcuts are ideal) are soldered into each of the three board holes for each pot, and the pots are soldered onto these wires. This enables the pots to be installed at the correct height for easy assembly to the front panel. The wire will provide a little lateral "give" in case the holes are not drilled in precisely the right place, but the height is less flexible. Lift the pot base off the board with a screwdriver blade or a rule or some other temporary spacer while soldering, and use washers on the shafts during assembly to ensure level mounting.

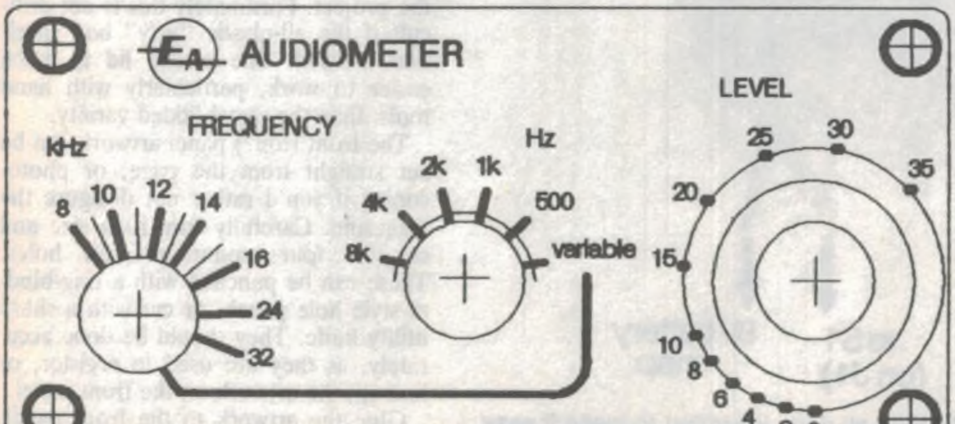
This completes the assembly of all the on-board components. The battery and headphone socket/switch complete the wiring.

Cut four lengths of flexible, multistranded hook-up wire for J1, the headphone socket. PC pins may be used for these connections if desired, but the wires will not be subject to flexing once the board is mounted in the case, so they can be soldered direct to the board as shown.

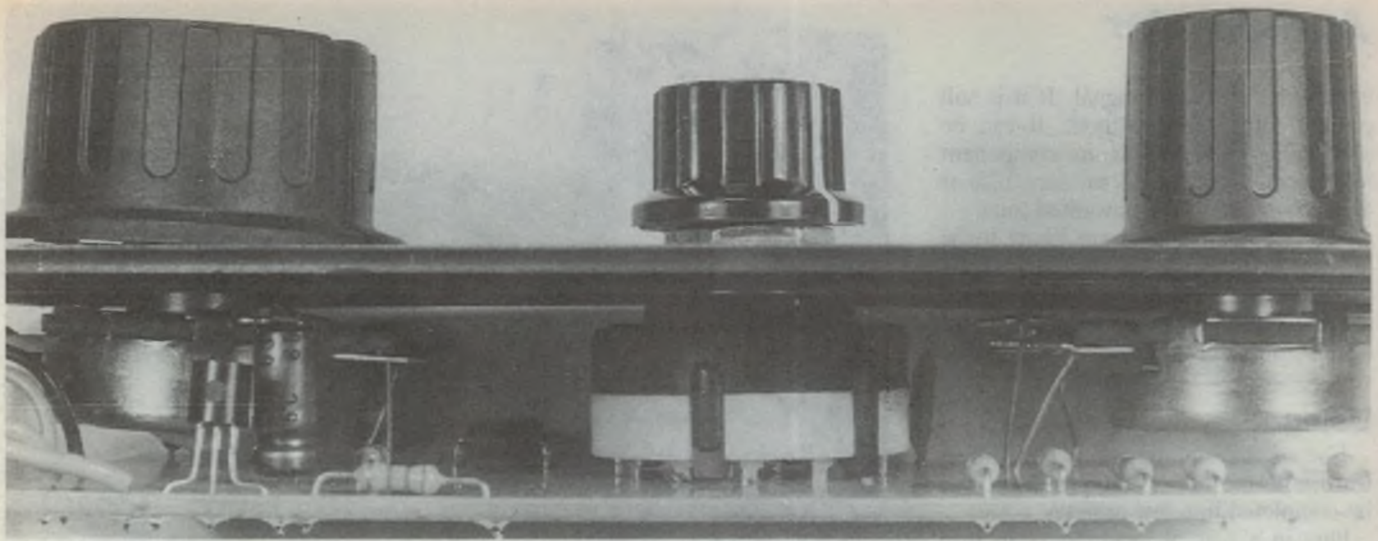
Make sure the connections are made correctly to J1. It would be particularly embarrassing if the audiometer turned itself off when a headphone plug was inserted, and on again when it was removed! The back view of the enclosed socket we used is shown here, but if you use a different type you will have to determine the correct connections with the aid of a multimeter. Don't forget the link between the right and left channels on the socket, or you'll get output in one ear only.

Take care with the battery snap leads, as these will stiffen and become brittle near the board if too much solder is used. Leave these leads at their full length, so there is room to move the board outside the box when the battery is attached. There is plenty of spare room under the board to accommodate the excess wire.

The battery is mounted on the base of the box with double-sided tape, blutack, a loop of masking tape, chewing gum, a cable tie or any other simple and removable means. Double sided tape is probably the best. Position is not critical, as the battery will fit anywhere under the board. Keep it away from J1 for convenience.



Front panel artwork for the project, reproduced actual size to allow you to photocopy it if desired.



A side view of the PC board when the switch and pots are mounted on the front panel.

The correct position of the knob on VR1, the variable tone control, is found by comparing the fixed 8kHz tone with the 8kHz position on the variable scale.

A quick test of functions is appropriate now, before the box is finally assembled. Plug in a pair of headphones, and check that five fixed tones and one variable tone are available, and that the level (volume) control functions correctly. Even turned full up, it should not be very loud.

Here lies a quaint paradox. The audiometer tests hearing, but it may well be that you cannot hear one or more of the tones at all, even at full volume, due to a specific loss (yours, not the circuit's). If you come into the category of those individuals who may have a significant loss at a particular frequency, then that section of the circuit can be tested in a number of ways.

An oscilloscope connected across R8 will do the trick, or you could ask a friend (hopefully not similarly afflicted) to quickly listen in. If neither of these approaches are possible, then R8 can be shorted temporarily while the circuit is operating. This increases the volume considerably, confirming (or denying) the presence of the signal. But don't make this a permanent alteration, as it introduces considerable distortion and defeats the whole purpose of the device.

Assuming that the audiometer appears to be operating correctly, attach the front panel to the rotary switch and the two pots. Screw the front panel to the base of the box and construction is complete. Now, you should be able to skip the "troubleshooting" section and proceed with the "Using it" section. If however, your audiometer is completely silent, or if some of the tones are missing or out of order, then work your way through the troubleshooting steps below.

Troubleshooting

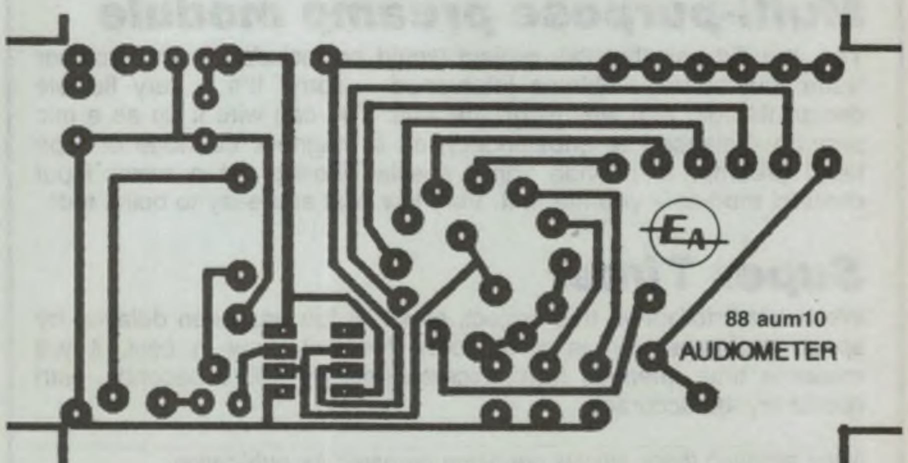
First, check the board for solder bridges between adjacent tracks, particularly in the region of the 555. Check again the polarity of the two ICs. Compare your board with the photos of the assembled prototype.

Plug in a battery and a pair of headphones (remember the circuit is switched off until a headphone plug is inserted into J1). Check that 5 volts is available across C1, the 2.2uF electrolytic next to the 78L05. If not, check the orientation of the 78L05, then recheck for shorts near it. Trace the voltage (9 volts) from the battery, through the snap leads, through the switch in J1 and then to the 78L05, where it is dropped to 5 volts. This will highlight any faults in the "power supply" section.

One of the more common faults encountered is likely to be an inconsistency in the frequency of the tones produced. This will be caused by the incorrect placement of any of the six resistors R1 - 6, or any of the three non-polarised capacitors, C2 – 4. As said earlier, the resistors can be confused easily due to similarities in their colour codes, and their values really should be confirmed with a meter. The value codes on the three capacitors are as follows:

C2 = 1nF (.001uF) = 102
C3 = 0.1uF = 104
C4 = .01uF = 103

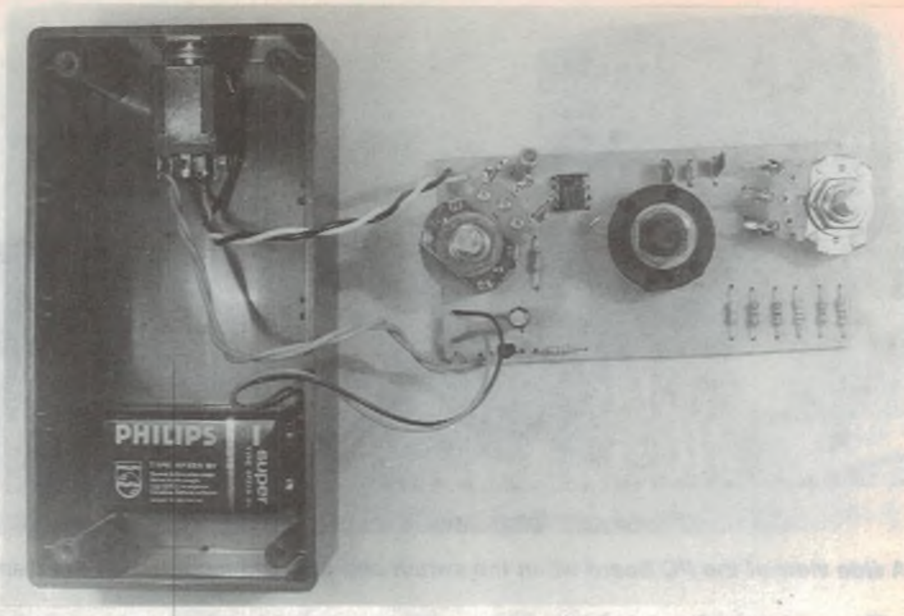
It is possible, though unlikely, that there may be a very faint residual tone still audible when the level is set to zero. If so, use a utility knife blade to lightly scrape between the PC board tracks in the region of VR2 and the 555. This will remove any slightly conductive contamination which may be al-



An actual-size reproduction of the PCB pattern, to allow you to make your own if you're set up to do this.

lowing the erroneous signal. If it is still present after this treatment, it can be attributed to variations in component tolerances. Increase R8 to, say, 3.3k or 4.7k to obliterate the unwanted tone.

Any remaining faults are likely to be in the interwiring to the headphone socket/switch. Check the accompanying diagrams and photos against your board again.



The complete audiometer wired up, and ready for the front panel to be attached to the controls, for final assembly.

Using it

Use of the audiometer is straightforward, and the full testing procedure can be completed in a few minutes.

Plug in a pair of headphones to turn the audiometer on. The traditional "cups-over-the-ears" style of headphone is probably best for this purpose, as they tend to reduce the level of distracting ambient noise. "Walkman" style 'phones will work quite satisfactorily, however, and the circuit will operate without modification into 4, 8, 16 or 32 ohm headphones. Regardless of the type used, though, conduct the test in surroundings as quiet as possible. The test cannot be completed in a noisy environment.

Turn the selector switch to the lowest tone, 500Hz. Turn the level down until the tone cannot be heard – the threshold of hearing. Note the threshold level, then repeat the test from zero going up until the tone is just heard. Turn it back until it disappears, then record the level on the audiogram chart.

Repeat the test in the same manner for the remaining four tones.

Don't agonise over the precise value obtained. Nearest whole numbers will do, or half-values if you prefer. There is no point in repeating the test over and over to determine whether the level is 1.8 or 1.7 – a reading of "2" is sufficient.

Another test which is available on this device gives an indication of the highest frequency which can be detected. Turn the rotary switch to the "variable" setting, and set the level control to maximum. Start with the variable frequency control at the furthest left-hand setting, then advance it until the tone can no longer be heard. This reading will be an approximation (correct to a few percent) of your ultimate frequency threshold.

As the audiometer does not (quite intentionally!) deliver a very loud signal, it is likely that your actual threshold will be a few hundred hertz higher than indicated at the level tested. Another complication is the efficiency of the headphones used, which may drop off considerably at the frequencies involved. Better quality headphones, however, maintain adequate efficiency to well above the average mortal's upper limit. Ask your dog to test this for you!

All of the above assumes that the tests have been conducted with the signal being fed simultaneously to both ears. If, during any of the tests, you noticed that the subjective "centre" position of the tones seemed to shift from the centre to one side, then this almost certainly indicates a loss which is specific to one of your ears.

You can confirm that the effect is not a function of the device by simply turning the headphones around, so the right cup is on the left ear. Repeat the test, and if the sound seems to move in the other direction, then the fault is with the frequency response and efficiency of the headphone transducers. If, however, the sound appears to move in the same direction regardless of which way the headphones are worn, then the problem is indeed within yourself.

In that case it would be instructive to repeat all of the above tests on both ears individually, yielding two graphs on the audiogram rather than one. You could, if you wish, install a simple switch on the audiometer to feed the signal to either the left or the right ear, but it is simple enough to just hold one headphone cup over the ear being tested, with the other cup left out of the way.

Whichever method of testing is employed, "stereo" or alternately left then right, it is wise to conduct the test without unnecessary lingering. This device does not produce damaging levels of volume, but overlong exposure to high frequency tones, even relatively quiet ones, can desensitise one's hearing sufficiently to provide unreliable results.

When you have completed the tests, don't forget to unplug the headphones to turn off the unit. The current drain is very low during operation, and since operation is only required for a few minutes every few months or so, battery life should be equivalent to shelf life.

However, if you leave the plug in when the audiometer is put away, you will almost certainly flatten the battery. But don't fret! There is a simple battery testing feature. If you turn on the unit and can hear no tones at any frequency or level, then remove the headphones and click your fingers. If you hear the click the battery is flat. If not, you've gone deaf.

Interpreting results

An individual with "normal" hearing will probably be singularly unimpressed with the results obtained. The threshold levels for all tones will be within a few degrees rotation of zero – levels of around 1 to 3 on the scale, depending on the headphones used. The upper audible limit could be expected to be around 15 – 16kHz, but this varies widely between "normal" individuals.

If the results you obtained are of this order, with no noticeable discrepancy between the individual ears, then you're probably free of effective hearing loss.

If your audiogram shows a marked dip at any frequency, or any other noticeable anomaly, then the time is nigh to seek the services of a professional audiologist. He or she can repeat the tests in a controlled and more accurate manner, and can then advise of the probable causes and hence methods of prevention or maybe even cure.

The advances made recently in artificial hearing enhancement, both surgical and electronic, mean that even profound losses can in many cases be helped. Regular hearing checks, backed up by the advice of and accurate testing by an audiologist, will help to ensure that the chances of losing your hearing in a preventable way (due to environmental noise, for example) are minimised.

Editor's Note: As the author noted near the start of this article, the simple "Audiometer" described here is really only a comparative checking device. It is no substitute for the tests carried out by a qualified professional audiologist with a fully calibrated Audiometer. So if this simple unit indicates that you may have a hearing problem, we suggest strongly that you seek the services of such a professional. EA

PARTS LIST

PCB 50 x 100mm, code 88aud11

1 UB3 plastic jiffy box, 130 x 67 x 42mm
1 dual pole 6 position PCB mount rotary switch
3 suitable knobs for switch and pots
1 panel mount enclosed-type 6.5mm stereo headphone socket
1 9V battery snap
1 9V battery, 216 type
4 lengths light flexible hookup wire

Resistors (1/4W 5% unless specified)

2 2.2k
1 4.7k
1 6.8k
1 11k (1%)
1 16k (1%)
1 36k (1%)
1 68k
1 100k linear potentiometer
1 10k linear potentiometer

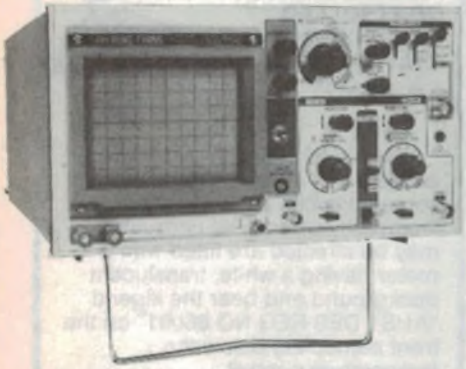
Capacitors

1 2.2uF 16V electrolytic
1 1.0uF 16V electrolytic
1 1.0nF metallised polyester
1 .01uF metallised polyester
1 0.1uF metallised polyester

Semiconductors

1 555 universal timer
1 78L05 5 volt regulator

THE EQUIPMENT YOU NEED, AT BARGAIN PRICES!



HUNG CHANG (RITRON) 20 MHz DUAL TRACE OSCILLOSCOPE

- **Wide bandwidth and high sensitivity**
- **Internal graticule rectangular bright CRT**
- **Built in component tester**
- **Front panel trace rotater**
- **TV video sync filter**
- **Z axis (intensity modulation)**
- **High sensitivity X-Y mode**
- **Very low power consumption**
- **Regulated power supply circuit**

COMPONENT TESTER is the special circuit with which a single component or components in circuit can be easily tested. The display shows faults of components, size of a component value, and characteristics of components. This feature is ideal to troubleshoot solid state circuits and components with no circuit power. Testing signal (AC Max 2 mA) is supplied from the COMPONENT TEST IN terminal and the result of the test is fed back to the scope through the same test lead wire at the same time.

CRT

CRT: 6" (150mm) Flat-faced high brightness CRT with Internal Graticule
Effective display area: 8 x 10 div (1 div = 10 mm)
Acceleration potential: 2KV

VERTICAL

Operating Modes: CH-A, CH-B, DUAL, ADD (CH-B can be inverted.)
Dual modes: Alter, 0.2uls - 0.5ms/div, Chop: 1ms - 0.5s/div
CHOP frequency 200KHz approximately
Deflection factor: 5mV/div 20V/div +/- 3%, 12 ranges in 1-2-5 step with fine control
Bandwidth: DC; DC - 20MHz (-3dB), AC 10Hz - 20MHz (-3dB)
Rise Time: Less than 17ns
Overshoot: Less than 3%
Input Impedance: 1M ohm +/- 5%, 20pF +/- 3pF
Maximum Input Voltage: 600Vp-p or 300V (DC + AC Peak)
Channel Isolation: Better than 60 dB at 1KHz

HORIZONTAL

Sweep Modes: NORMAL and AUTO
Time Base: 0.2uls - 0.5s/div +/- 3%, 20 ranges in 1-2-5 step with fine control
Sweep Magnifier: 5 times (5X MAG)
Linearity: 3%

TRIGGERING

Sensitivity: INTERNAL: 1 div or better for 20Hz - 20MHz (Triggerable to more than 30MHz), EXTERNAL: 1Vp-p or better for DC - 20MHz (Triggerable to more than 30MHz)
Source: INT, CH-A, CH-B, LINE and EXT
Slope: Positive and Negative, continuosly variable with level control PULL AUTO for free-run
Coupling: AC, HF-REJ and TV. TV SYNC Vertical and Horizontal Sync Separator Circuitry allows any portion of complex TV video waveform to be synchronized and expanded for viewing TV-H (Line) and TV-V (Frame) are switched automatically by SWEEP TIME/DIV switch
TV-V:0.5s/div to 0.1ms/div, TV-H:50uls/div to 0.2uls/div

X-Y OPERATIONS

X-Y Operations: CH-A: Y axis, CH-B: X axis Highest Sensitivity 5mV/div

COMPONENT TESTER

Component Tester: Max AC 9V at the terminal with no load. Max current 2mA when the terminal is shorted. (Internal resistance is 4.7K ohm)

OTHER SPECIFICATIONS

Intensity Modulation: TTL LEVEL (3Vp-p), Positive — brighter
BANDWIDTH: DC - 1MHz MAXIMUM INPUT VOLTAGE: 50V (DC + AC Peak)
Calibration Voltage: 0.5Vp-p +/- 5%, 1KHz +/- 5% Square wave
Trace Rotation: Electrically adjustable on the front panel
Power Requirements: AC: 100, 120, 220, 240V 20W
Weight: 7kg approximately
Size: 162(H) x 294(W) x 352(D)mm

Cat. Q12105 .... **only $895**

(tax exempt only $775)

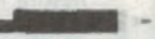
Bulk orders, schools, please phone (03) 543 2166 for special low pricing

Resistor — Zenon Diode — Digital Circuit — Capacitor

PORTASOL PROFESSIONAL

- Four tools in one: Blow Torch, Hot Blow, Hot Knife
- No Cords or batteries
- Heavy duty, tip temperature adjustable up to 400°C
- Equivalent to 10-60 watts
- Hard working. Average continuous use 90 minuters
- Refills in seconds
- Powered by standard butane gas lighter fuel
- Range of easily replaceable screw tips included
- Includes metal stand for the soldering iron when working
- Cap features built-in flint for igniting Portasol tip
- Includes snap case for storage

Cat. T12639 **$89.95**



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**

MAIL ORDER HOTLINE
008 335757
(TOLL FREE)
LOCAL: 543 7877

METEX 3800 MULTIMETER

This instrument is a compact rugged, battery operated, hand held 3 1/2 digit multimeter for measuring DC and AC voltage, DC and AC current, Resistance and Diode, for testing Audible continuity and transistor hFE. The Dual-slope A-D Converter uses C-MOS technology for auto-zeroing, polarity selection and over-range indication. Full overload is provided. It is an ideal instrument for use in the field, laboratory, workshop, hobby and home applications.

Features

- Push-button ON/OFF power switch
- Single 30 position easy to use rotary switch for FUNCTION and RANGE selection
- 1/2" high contrast LCD
- Automatic over-range indication with the "1" displayed
- Automatic polarity indication on DC ranges
- All ranges fully protected plus Automatic "ZERO" of all ranges without short circuit except 200 ohm Range which shows "000 or 001"
- High Surge Voltage protection 1.5 KV-3 KV
- Diode testing with 1 mA fixed current
- Audible Continuity Test
- Transistor hFE Test

SPECIFICATIONS

Maximum Display: 1999 counts 3 1/2 digit type with automatic polarity indication
Indication Method: LCD display
Measuring Method: Dual-slope in A-D converter system
Over-range Indication: "1" Figure only in the display
Temperature Ranges: Operating 0-C to +40-C
Power Supply: one 9 volt battery (006P or FC-1 type of equivalent)

Cat. Q91530 **Normally $109**
SPECIAL $79

METEX 3530 MULTIMETER

This instrument is a compact rugged, battery operated, hand held 3 1/2 digit multimeter for measuring DC and AC voltage, DC and AC current, Resistance and Diode, Capacitance, Transistor hFE and Continuity Test. The Dual-slope A-D Converter uses C-MOS technology for auto-zeroing, polarity selection and over-range indication. Full overload is provided. It is an ideal instrument for use in the field, laboratory, workshop, hobby and home applications.

Features

- Push-button ON/OFF power switch
- Single 30 position easy to use rotary switch for FUNCTION and RANGE selection
- 1/2" high contrast LCD
- Automatic over-range indication with the "1" displayed
- Automatic polarity indication on DC ranges
- All ranges fully protected plus Automatic "ZERO" of all ranges without short circuit except 200 ohm Range which shows "000 or 001"
- High Surge Voltage protection 1.5 KV-3 KV
- Capacitance measurements to 1pF
- Diode testing with 1 mA fixed current
- Audible Continuity Test
- Transistor hFE Test

SPECIFICATIONS

Maximum Display: 1999 counts 3 1/2 digit type with automatic polarity indication
Indication Method: LCD display
Measuring Method: Dual-slope in A-D converter system
Over-range Indication: "1" Figure only in the display
Temperature Ranges: Operating 0-C to +40-C
Power Supply: one 9 volt battery (006P or FC-1 type of equivalent)

Cat. Q91540 **Normally $139**
SPECIAL $109

ARLEC SUPER TOOL

A versatile 12V electric tool for

- Sanding
- Engraving
- Grinding
- Polishing
- Cutting
- Drilling
- Milling
- Erasing, etc.

Features:
Operates on safe, low 12 volts from mains electricity via AC adaptor (supplied). Light and easy to handle with touch switch and lock for continuous running. High torque motor. 10,000 R.P.M. Can drill 2mm holes in steel. 2 year guarantee

Contents:

- 12V Super Tool
- Plugpack AC adaptor
- 1 spherical milling cutter
- 1 wire brush
- 1 grinding wheel
- 4 drill bits, 0.6, 0.8, 1.0, 1.2mm
- Set of 5 chuck collets
- 6 eraser sticks
- Instruction sheets

Cat. T12300 **$64.95**

POWERFULL MINI DRILL

Featuring a powerful 6000 r.p.m motor, this lightweight (113gm) drill is ideal for many jobs. Perfect for PCB work! Has a 0.8 to 1.2mm chuck and 1mm drill bit.
Requires 12V 1 AMP (use with M19010)
Cat. T12302 **$19.95**

SOLDER ROLLS

Absolutely top quality, unlike our opposition's!
60/40 Resin cored

Cat.No.	Description	Price
T31000	71mm 250gm	$8.95
T31002	71mm 500gm	$15.95
T31010	91mm 250gm	$7.95
T31012	91mm 500gm	$14.95
T31020	1.6mm 250gm	$7.50
T31022	1.6mm 500gm	$13.95
T31030	71mm 1 metre	$1.50
T31032	91mm 1 metre	$1.25
T31034	1.6mm 1 metre	$1.00

RS232 BREAK OUT BOX

A simple way of monitoring RS232 interface lead activity. Interface powered, pocket size for circuit testing, monitoring and patching. 10 signal powered LED's and 2 spares. 24 switches enables you to break out circuits or reconfigure and patch any or all the 24 active positions.

SPECIFICATIONS:
Connectors: DB25 plug on 80mm ribbon cable and DB25 socket
Indicators: Tricolour LED's for TD, RD, RTS, CTS, DSR, CD, TC, RC, DTR, (E)TC
Jumper Wires: 20 tinned end pieces
Power: Interface power
Enclosure: Black, high impact plastic
Dimensions: 85 x 95 x 30mm

X15700 .... **$94.95**

METEX M-3650 MULTIMETER

20A, 3 1/2 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
- 1/2" High contrast LCD
- Full overload protection
- 20 Amp
- Built in tilting bail
- Capacitance meter
- Instruction manual

Q91550 ... Normally $165
Special, only $129

METEX 4500H MULTIMETER

10A, 4 1/2 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 4 1/2 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...

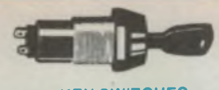
- Readout hold
- Transistor Tester
- 4 1/2 digit x 1/2" (H) LCD
- Audible continuity tester
- Push-button ON/OFF switch
- Quality set of probes
- Single function, 30 position easy to use rotary switch for FUNCTION and RANGE selection
- Built in tilting bail
- Instruction manual
- Full overload protection
- hFE test
- Battery and Spare fuse
- Diode Tester
- Vinyl case

Q91560 ... Normally $175
Special, only $159

PANEL METERS GALORE!

We have a great range of panel meters at great prices!

Cat.No.	Description	Price
Q10500	MU45 0-1mA	12.50
Q10502	MU45 50-0/50uA	12.50
Q10504	MU45 0-100uA	12.50
Q10510	MU45 0-5A	12.50
Q10518	MU45 0-1A	12.50
Q10520	MU45 0-1A	12.50
Q10525	MU45 0-20V	12.50
Q10530	MU52E 0-1A	14.50
Q10533	MU52E 0-5A	14.50
Q10535	MU45 VU PMetre	14.95
Q10538	MU65 0-50uA	16.95
Q10540	MU65 0-1mA	16.95
Q10550	MU65 0-100uA	16.95
Q10560	MU65 0-20V	16.95



KEY SWITCHES

Cat. S12500 .... Normally $7.95

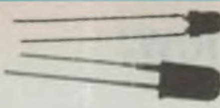
1-9	10+	25+
$4.95ea	$4.25ea	$3.95ea

RELAYS

	1-9	10+	100+
S P D T 3A connectors S14060	$1.50	$1.30	$1.10
D P D T 3A connectors S14061	$1.95	$1.75	$1.30
S P D T 12V Coil 10A 240V S14114	$4.95	$3.95	$3.75

ECONOMY TRANSFORMERS

	1-9	10+
2155 240V 6-15V 1A Cat. M12155	$9.95	$8.95
2156 240V 6-15V 2A Cat. M12156	$14.95	$13.95
2840 240V 9V CT Cat. M12840	$5.95	$4.95
2851 240V 12-6V CT 150mA Cat. M12851	$5.95	$5.50
2860 240V 15V CT 250mA Cat. M12860	$5.95	$4.95
6672 240V 15-30V 1A tapped Cat. M16672	$14.95	$13.95

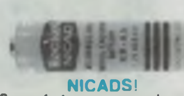


QUALITY 3mm LEDS

Cat. No.	Col	1-9	10+	100+
Z10140	Red	$0.15	$0.12	$0.10
Z10141	Grn	$0.20	$0.15	$0.12
Z10143	Ylw	$0.20	$0.15	$0.12
Z10145	Ora	$0.20	$0.15	$0.12

QUALITY 5mm LEDS

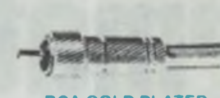
Cat. No.	Col.	1-9	10+	100+
Z10150	Red	$0.08	$0.07	$0.06
Z10151	Grn	$0.15	$0.12	$0.10
Z10152	Ylw	$0.15	$0.12	$0.10



NICADS!

Save a fortune on expensive throw away batteries with these quality Nicads and Rechargeables!

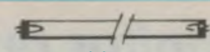
Size	Desc.	1-9	10+	100+
AA	450 mA H.	$2.95	$2.75	$2.50
C	1.2 A H	$9.95	$9.50	$8.95
D	1.2 A H	$9.95	$9.50	$8.95



RCA GOLD PLATED PLUGS AND SOCKETS

For those who need the ultimate in connection. Essential for laser disc players to get that fantastic sound quality.

Plug Cat. P10151 .... $2.95
Socket Cat. P10150 .... $2.25



U.V. TUBES

Fits into standard 15W flouro holder. Suitable for Scotchcal, Eprom erasing etc. As used in ETI Eprom Erasing Kit.
WARNING: Do not look directly into UV Tubes.
Cat. H28600 .... $29.95*
*If ordering by mail please include an extra $2 for "special" packing.

10 TURN WIRE WOUND POTENTIOMETER

Spectrol Model 534
1/4" shaft.
Equiv (Bourns 3540S, Beckman 7258)
Dials to suit 16-1-11, 18-1-11, 21-1-11.

R14050	50R	R14100	5K
R14055	100R	R14110	10K
R14060	200R	R14120	20K
R14070	500R	R14130	50K
R14080	1K	R14140	100K
R14090	2K		

1-9	10+
$9.95	$9.50

NEW TRANSISTORS

Rod Irving Electronics have two new transistors which will replace a multitude of common hard to get devices.

The PN100 is a NPN general purpose medium power amp and switch with continuous collector current up to 500mA.

The PN200 is a PNP general purpose amp at collector currents to 1 Amp.

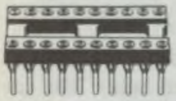
Both are TO-92 plastic package.

PN100 REPLACES:
PN2221, PN2222, PN2222A, PN3585, PN3568, PN3569, PN3643, PN5133, 2N2219A, 2N2222A, 2N3414, 2N3415, 2N3416, 2N3417, 2N3700, 2N3704, 2N3904, 2N4123, 2N4124, 2N4401, 2N5088, 2N5210.

PN200 REPLACES:
PN2907, PN2907A, PN3638, PN3638A, PN3640, PN3644, PN4121, PN4143, PN4248, PN4249, PN4250, PN4355, PN4916, PN4917, PN5910, 2N2905A, 2N3467, 2N3702, 2N3906, 2N4125, 2N4126, 2N4291, 2N4402, 2N4403, 2N5086, 2N5087, 2N5447

PN100 Cat. T90001
PN200 Cat. T90002

1-9	10+	100+
$0.20	$0.18	$0.15

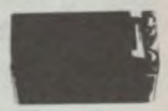


GOLD INSERT LOW PROFILE IC SOCKETS

- Gold machined pins
- Extremely high quality
- Anti-wicking
- Ideal for professional use or where field service of components is required

Cat.No.	Description		1-9	10+
P10620	8	pin	$1.20	$1.10
P10624	14	pin	$1.60	$1.50
P10626	16	pin	$1.90	$1.80
P10628	18	pin	$2.00	$1.80
P10630	20	pin	$2.20	$2.00
P10632	22	pin	$2.40	$2.20
P10634	24	pin	$2.60	$2.40
P10640	28	pin	$2.90	$2.60
P10644	40	pin	$3.00	$2.70

COMPONENTS AT GREAT PRICES
ROD IRVING ELECTRONICS

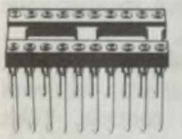


RECHARGEABLE 12V 1.2AH GELL BATTERY

Leakproof, long service life batteries ideal for security systems, emergency lighting or as a computer backup power supply, etc.

Cat. S15029 .... Normally $19.95

1-9	10+
$13.95	$12.95



WIRE WRAP IC SOCKETS

These quality 3 level wire wrap sockets are tin-plated phosphor bronze.

Cat.No.	Description		1-9	10+
P10579	8	pin	$1.50	$1.40
P10580	14	pin	$1.85	$1.70
P10585	16	pin	$1.95	$1.80
P10587	18	pin	$1.95	$1.80
P10590	20	pin	$2.95	$2.70
P10592	22	pin	$2.95	$2.70
P10594	24	pin	$3.95	$3.50
P10596	28	pin	$3.95	$3.50
P10598	40	pin	$4.95	$4.50

CANNON TYPE CONNECTORS

	1-9	10+
P10960 3 PIN LINE MALE	$3.90	$3.50
P10962 3 PIN CHASIS MALE	$3.00	$2.50
P10964 3 PIN LINE FEMALE	$4.50	$3.90
P10966 3 PIN CHASIS FEMALE	$4.95	$3.95

SPECTROL 64Y MULTI TURN TRIMPOTS

Cat.No.	Description	1-9	10+
R14700	10R	$3.50	$3.20
R14710	20R	$3.50	$3.20
R14720	50R	$3.50	$3.20
R14730	100R	$3.50	$3.20
R14740	200R	$3.50	$3.20
R14750	500R	$3.50	$3.20
R14760	1K	$3.50	$3.20
R14770	2K	$3.50	$3.20
R14780	5K	$3.50	$3.20
R14790	10K	$3.50	$3.20
R14800	20K	$3.50	$3.20
R14810	50K	$3.50	$3.20
R14820	100K	$3.50	$3.20
R14830	200K	$3.50	$3.20
R14840	500K	$3.50	$3.20
R14850	1M	$3.50	$3.20

SPECTROL MULTIDIALS

MODEL 15-1-11

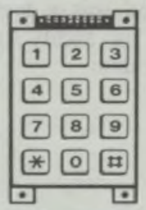
Number of turns: 10
Minor Scale Division: 1/500 turn
Shaft Bore: 6.35mm (1/4")
Finish: Satin Chrome
Body Size: 25.4 x 44.45mm (1 x 1 3/4")
Depth: 25.4mm (1")
Weight: 45.4g (1.6oz.)
Cat. R14405 .... $45.95
SPECIAL, $35.95

MODEL 16-1-11

Number of turns: 15
Minor Scale Division: 1/50 turn
Shaft Bore: 6.35mm (1/4")
Finish: Clear Anodize
Body Size: 22.2mm diameter (.875")
Depth: 22.2mm (.875")
Weight: 19.8g (0.7oz.)
Cat. R14400 .... $26.95
SPECIAL, $21.50

MODEL 21-1-11

Number of turns: 15
Minor Scale Division: 1/100 turn
Shaft Bore: 6.35mm (1/4")
Finish: Satin Chrome
Body Size: 46.04mm diameter (1.812")
Depth: 25.4mm (1")
Weight: 85.g (3oz.)
Cat. R14410 .... $46.95
SPECIAL, $37.50



NUMERIC KEYPAD

Unencoded keypad, 10 digit keys plus two utility keys. Light grey in colour.

OUTPUT ARRANGEMENT:

Output Pin N°	Symbol
1	N.A.
2	Shield plate
3	Column 2
4	Row 4
5	Column 3
6	Row 1
7	Column 1
8	Row 2
9	Row 3
10	N.A.

Cat. C19030

1-9	10+	100+
$2.95	$2.50	$1.95

Rod Irving Electronics

MELBOURNE: 48 A Beckett St
Phone (03) 663 6151

NORTHCOTE: 425 High St
Phone (03) 489 8866

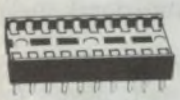
CLAYTON: 56 Renver Rd
Phone (03) 543 7877

SOUTH AUSTRALIA
Electronic Discounters P.L.
305 Morphett St, ADELAIDE
Phone (08) 212 1799

NOTE:

MAIL ORDER
Local Orders: (03) 543 7877
Interstate Orders: (008) 33 5757
All Inquiries: (03) 543 7877

CORRESPONDENCE
P.O. Box 620, CLAYTON 3168
Telex: AA 151938
Fax: (03) 543 2648



LOW PROFILE IC SOCKETS

Save a small fortune on these "Direct Import" low profile IC sockets! PCB mounting solder tail. Dual wipe. All tin plated phosphor bronze or berryllium and dual wipe for reliability.

Cat.No.	Description	1-9	10+
P10550	8 pin	$0.20	$0.15
P10560	14 pin	$0.25	$0.20
P10565	16 pin	$0.35	$0.20
P10567	18 pin	$0.40	$0.30
P10568	20 pin	$0.40	$0.30
P10569	22 pin	$0.40	$0.30
P10570	24 pin	$0.40	$0.30
P10572	28 pin	$0.50	$0.40
P10575	40 pin	$0.50	$0.40

MAIL ORDER HOTLINE
008 335757
(TOLL FREE)
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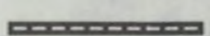

HIGH INTENSITY RED LED BAR GRAPH

Dimensions:
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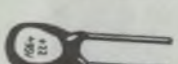
Cat.No.	1-9	10+
Z10180	$2.95	$2.75



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R16306	35V 0.33uF	$0.30
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R16310	35V 0.68uF	$0.35
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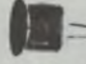

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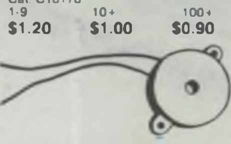

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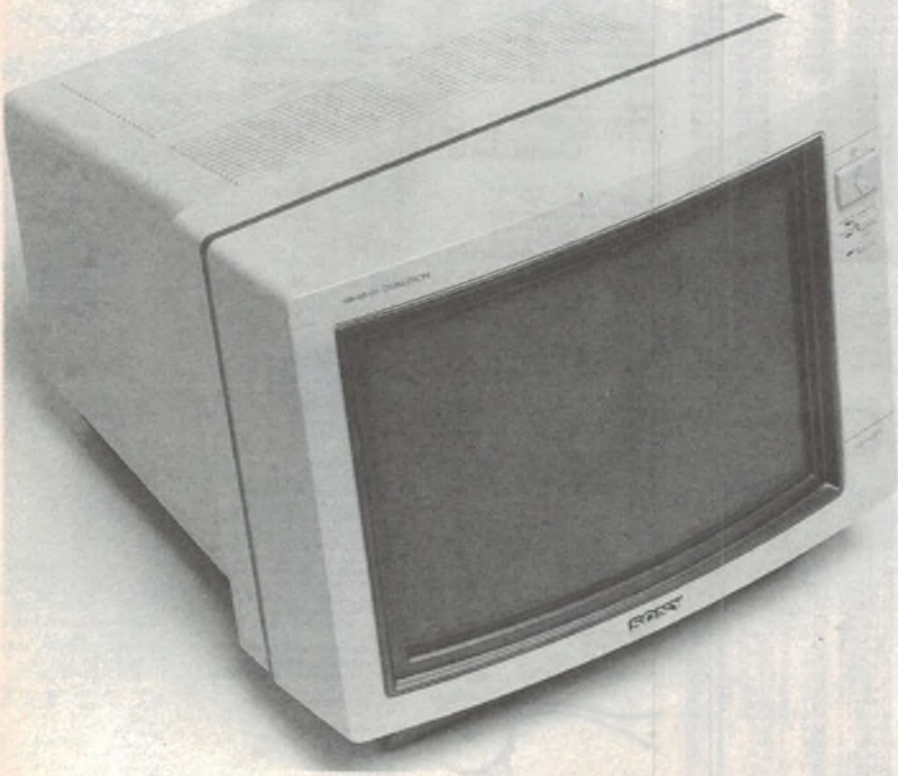
Sony's KX-14CP1 Multi-format Monitor

There are high quality colour video monitors designed for TTL digital drive from computers, and others that are suitable for analog use with your video camera or recorder. But monitors that you can use for both are hard to find – that's what makes the Sony KX-14CP1 so interesting.

It all started a couple of months ago, when we wanted to check out one of Sony's new Video-8 camcorders – the V200E (see the July issue, page 12). We had access to a number of high-resolution RGB colour monitors of the TTL digital kind, but none of these was suitable. What we needed was a high-res *analog* monitor, with the ability to display composite PAL video.

Wouldn't it be great if there was a single high-res colour monitor around which could accept either digital or analog inputs, and composite video as well? It seemed an impossible dream.

Then we heard about the Sony KX-14CP1. High resolution, fine pitch CRT, both digital *and* analog RGB inputs, plus the ability to display PAL, SECAM or NTSC composite video as well! Mr Sony had heard our wishes and those of other frustrated souls like us, and had designed the answer. Needless to say, we arranged to get hold of one as soon as possible, to try it out for ourselves.



The KX-14CP1 actually seems something of an anticlimax when you first see it: a modest and unassuming little monitor, which from the front looks much the same as any other. There's an on/off button and a couple of other small buttons alongside the 330mm (13") screen, with a small speaker grille below – that's about it.

Until you look around the side, that is, to find the inset panel with the input connectors and preset controls. Then you discover that underneath that modest little exterior is lurking an unusually flexible and high-performance design.

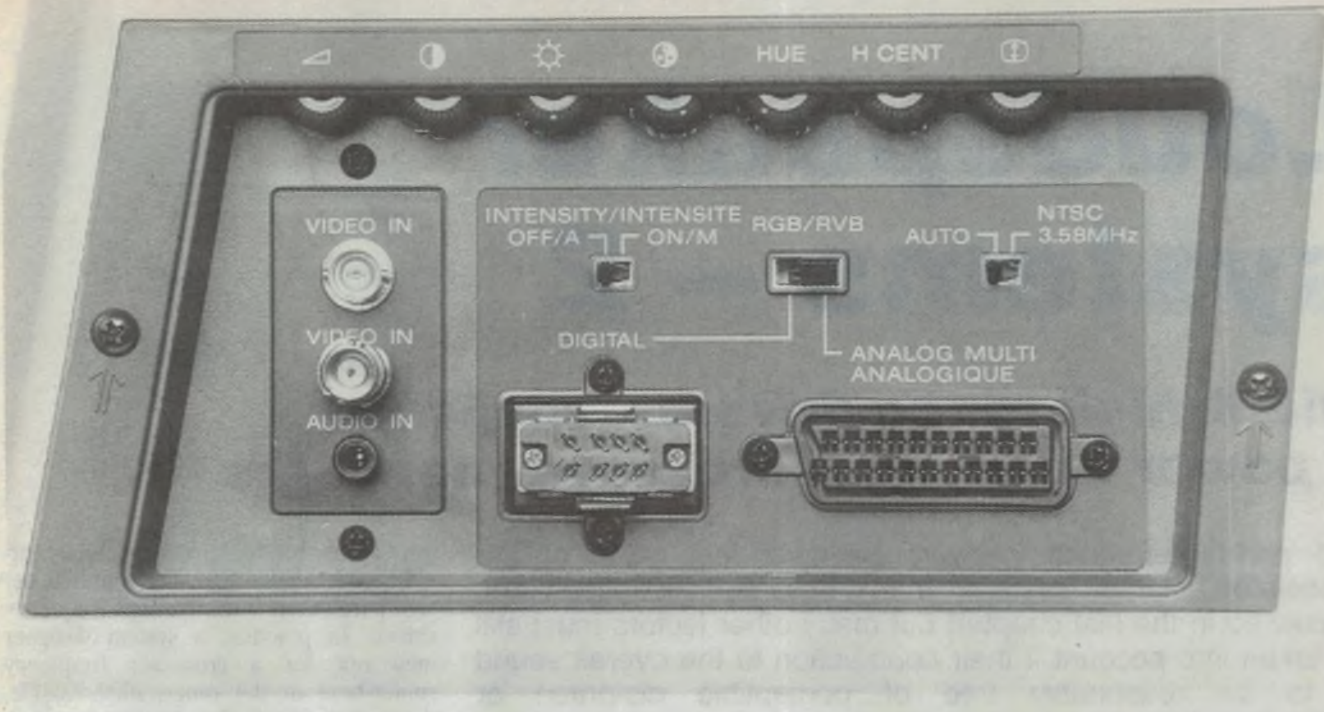
There are 7 readily accessible presets, controlling respectively volume, contrast, brightness, colour saturation, colour hue, horizontal centreing and vertical size. Already this is more than you'll find on many monitors, other than those designed for professional studio use.

But it's the input facilities that really tell the story. For a start, there's the usual RGB digital input socket, accepting the kind of signals produced by many modern computers like the IBM PC and its compatibles. In this case, these inputs are via one of Sony's 8-way rectangular connectors.

Then there's a set of analog RGB inputs, via a 21-way 'SCART' or Euro connector – of the type fitted to many colour TV receivers fitted with direct video inputs.

And finally there's a pair of composite video inputs (RCA and BNC connectors), plus matching audio input (RCA).

There are also three small slider switches. One is an intensity modulation on/off switch for digital RGB inputs,



A close-up of the monitor's control and connector panel. As well as providing for TTL digital inputs, it also provides for analog RGB and PAL/NTSC/SECAM composite video as well!

while another is the digital/analog selector for RGB inputs. The third is marked 'Auto/NTSC 3.58MHz', and as this suggests it is used mainly when you need to display 3.58MHz NTSC composite video as used in the USA and Japan. Normally it is left in the Auto position, where the KX-14CP1 will cope with almost any other PAL/SECAM/NTSC composite signals, based on the 4.43MHz subcarrier standard.

By the way, those two small pushbuttons on the front panel are used to select either composite video or RGB signals. The RGB selector is illuminated to signal RGB operation.

In short, there's a great deal of flexibility indeed when it comes to inputs. About the only thing that's missing is the Y and C inputs needed by the new Super-VHS recorders – and Sony's own ED-Beta system. Perhaps this will be on the next model.

The KX-14CP1 uses a black-tinted Trinitron tube with a fine-pitch (0.37mm) aperture grille, and an improved electron gun giving sharp focus right to the edges and corners. This coupled with a wide bandwidth video amplifier and decoder makes it capable of excellent display resolution, in both analog and digital modes of operation. Sony doesn't give a figure for the resolution in lines from composite inputs, but claims that monitor can display 2000 characters from a computer (presumably in either analog or digital RGB modes).

The composite video inputs accept standard 1V p-p signals at 75 ohms input impedance, with audio of 436mV RMS into 47k for full volume. The analog RGB inputs accept 0.7V p-p inputs at 75 ohms, while as you'd expect the digital RGB inputs accept standard TTL level signals.

Trying it out

Needless to say, we didn't have access to a range of SECAM or NTSC signals, of either the 4.43MHz or 3.58MHz varieties. But we did manage to try out the KX-14CP1 with both digital RGB signals from a PC, and composite PAL video signals from both a camera and a VCR.

The results with digital RGB signals were very impressive, with a rock-steady display, bright colours and crisp outlines for both alphanumerics and graphics. This was with both CGA and EGA display adaptors, which also demonstrated the ability of the KX-14CP1 to cope with signals of different scan rates (the CGA operates at 15.75kHz and the EGA at 21.8kHz).

With composite video the performance was equally as good. From both the camera and VCR we obtained very sharp, steady pictures, with excellent luminance and colour contrast. In fact we had the distinct impression that we were achieving the best possible pictures from the video produced by the sources concerned – the resolution seemed to be limited by them, rather than the KX-14CP1.

Mind you, they were good 'consumer' grade products, rather than professional video gear. But the KX-14CP1 would probably give a creditable account of itself in a professional video situation as well.

The bottom line is that after checking out the KX-14CP1, we were so impressed by both its flexibility and its performance that we arranged with Sony to acquire one for the *EA* lab. It'll be great for checking out cameras, VCRs and other video gear, quite apart from the odd computer.

In short, we were so impressed by this monitor that we immediately bought one. What better endorsement can we give?

The ability to accept so many different types of RGB and composite video signal already sets the KX-14CP1 apart from most monitors, even before you consider the actual display performance – and this is excellent. It really does seem like the solution to the video problems of many people nowadays.

The price seems quite reasonable, too, at only $1299 suggested retail.

Further details on the KX-14CP1 are available from Sony Australia, 33-39 Talavera Road, North Ryde 2113 or phone (02) 887 6666. (J.R.)

An introduction to hifi - Part 21

Loudspeaker systems – 2

Mid & high range drivers – response – power handling – crossover networks

Mid- and high-frequency drivers are much less reliant on the associated baffle system than bass-end loudspeakers, discussed in the last chapter, but many other factors must still be taken into account if their contribution to the overall sound is to be reasonably free of perceptible distortion or "colouration".

by NEVILLE WILLIAMS

When considering mid- and high-frequency loudspeakers, one becomes increasingly conscious of transducers other than the familiar dynamic cone drivers – for example horn loaded, piezo-electric, ribbon, electrostatic and ionic. These will be discussed later, the present article being concerned primarily with the more conventional approach.

To conserve space, compact loudspeaker systems rely mainly on two active drivers, one to cope with the bass and lower median frequencies, the other – a smaller unit – to handle the remainder of the spectrum. A few "midi" systems, such as the popular KEF 104 series, include a passive or "drone" cone to supplement the bass driver.

Larger systems, for the most part, use three active drivers: a "woofer" for the bass end, a "tweeter" for the high frequencies and a mid-range unit which, for want of a more elegant description, is commonly referred to as a "squawker".

Some systems add a "super tweeter" for frequencies which, to many listeners, would be inaudible. Still others feature multiple squawkers and/or multiple tweeters, for increased top-end power capability, and/or better sound dispersion – or (maybe) heightened sales appeal!

In fact, no firm conclusions can be drawn in respect to the ultimate sound quality, from the mere size, number or physical embellishments of the drivers in a loudspeaker system offered for sale. Sound quality depends much more on the characteristics of the individual drivers, the extent to which their potential is realised by the inbuilt frequency dividing network and the physical details of the enclosure.

At a given price level, a well designed 2-way system may well outperform a competitor offering more or larger drivers. Equally, it may not!

When choosing a loudspeaker system, the logical course is to identify models which qualify in terms of specifications, price, size and appearance, and then to assess their sound quality by noting claims, reviews and opinions, and by critical listening. But more about this later.

Crossover networks

The subject of crossover networks was mentioned briefly in chapter 19 of this series, in the context of multi-unit wide range loudspeakers. The same basic considerations apply in the case of enclosure mounted multi-driver systems, except that there are fewer constraints on their size and complexity.

In any two-way system, the low-end driver must be able to cope with an adequate share of the total acoustic output, so as not to impose an unacceptable work load – and unacceptable design parameters – on the high frequency driver. In practice, a system designer may opt for a crossover frequency somewhere in the range 1000-4000Hz, depending on whether he has access to a particularly good mid/high range driver, or a bass driver with an exceptionally clean mid-range response, or both!

With a three-way system, on the other hand, the squawker can relieve the woofer of some of the work load and, in turn, surrender the top end to the tweeter. The lower and upper crossover frequencies in that case are commonly set at or below 1000Hz, and somewhere above 4000Hz, again depending on the designer's ideas and resources.

Energy distribution

In the Philips manual *Building HiFi Loudspeakers* (7th edition, 1980), author M.D.Hull refers to research into the acoustic energy distribution of typical program material across the audio spectrum.

Early work, mainly with traditional concert instruments and orchestras, suggested that acoustic energy peaked in the octaves on either side of middle C (i.e., 125 – 500Hz) and therefore within the working range of the low-end driver. Above that, the level appeared to taper away steeply to around 15kHz. Reflecting this, the thin line in Fig.1 shows the energy distribution for the IEC/DIN noise signal originally selected for loudspeaker testing.

More recent research has shown that, with pop music, modern instruments and modern recordings, maximum energy levels may be encountered anywhere in the five-octave range of 50 –

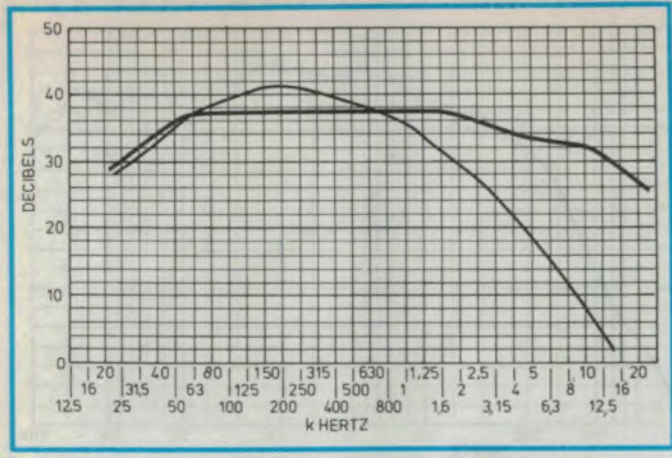


Fig.1: Thin line: an early IEC/DIN noise spectrum for testing loudspeakers. Thick line: revised spectrum taking modern music and recordings into account.

1600Hz, with frequencies beyond that at a much higher energy level than previously observed, and extending right out to 20kHz. The thick line in Fig.1 shows the current noise test signal spectrum.

Hull makes the point that drivers must be selected not only for their ability to reproduce a particular range of frequencies, but also for their ability to cope with the energy levels they might encounter within that same range, with certain kinds of program material.

By way of example, with a two-way system crossing over at 1200Hz he suggests, as a guide figure, that 75% of the energy would be handled by the woofer and 25% by the tweeter. With a three-way system, crossing over at 630 and 2500Hz, the distribution would be more like: woofer 64%, squawker 22% and tweeter 14%.

He goes on to show, however, that the workload of the respective drivers can be substantially affected by the way the listener chooses to set the amplifier tone controls – for example by operating the system at a high level with the bass or treble boosted, or with the "loudness" compensation still switched on. Even the squawker can be stressed by turning the bass down and the volume up to compensate.

Without seeking to make too much of Hull's figures, they do support the emphasis currently given to the power rating od squawkers and tweeters in modern systems, and indicate why the comparatively delicate tweeters, in particular, are vulnerable to careless amplifier operation, or to supersonic instability.

Squawkers

Unlike woofers, squawkers do not need a long-travel suspension system, being normally isolated from significant low frequency drive by the divider network. As a result, the voice coil can be of similar length to the air-gap, making for increased efficiency. Again, a relatively light, small diameter cone is adequate – even desirable – for sustained upper frequency response and a reasonably wide angle of sound propagation.

Over the years, otherwise conventional 10-15cm diameter dynamic drivers, fitted with a modified voice coil and cone assembly, have often been used in the role, particularly for inexpensive systems. Whether essentially adapted units can still satisfy present-day demands in terms of sonic balance and/or power handling capacity is another matter.

Designers of more ambitious loudspeaker systems would normally select either a more specialised and generously rated squawker or use multiple small high performance models, fed in series or parallel, according to impedance requirements.

Not surprisingly, squawkers have been the subject of considerable research, involving a wide range of cone materials – variously shaped, doped, lacquered and capped. The subject of prolonged listening tests, they are selected as much for subjective sound as for objective measurements.

Most have powerful magnet systems, to ensure sufficient sensitivity to at least match that of any likely low-end driver; a few decibels of surplus mid-range sensitivity can easily be attenuated in the divider network. Many systems, however, provide accessable mid-range (and tweeter) level controls, with plus and minus settings, which allow the balance to be pre-set to suit particular listening situations and listener preferences.

An interesting design resource, widely adopted in recent years, involves the use of so-called "ferrofluid". A gel-like mixture containing finely divided ferric oxide in suspension, it is introduced into the magnetic gap between the surface of the voice coil and the pole plate, being retained in the gap by magnetic attraction. It provides mechanical damping of the voice coil and also improves heat dissipation from the winding, by thermal conduction to the magnet structure, thereby increasing the power handling capability.

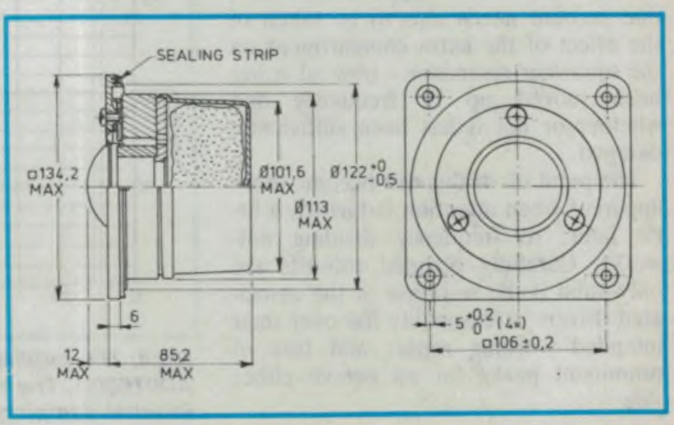
Many special purpose squawkers rely on a central dome for sound propagation, as illustrated in Fig.2. The large diameter voice coil (e.g., 5cm) is supported by an outer concentric suspension ring anchored to the front face of the assembly. Instead of a cone, a moulded dome is used, bridging the front of the voice coil former. Because of its shape and natural rigidity, along with its relatively small area, the resultant acoustic propagation pattern tends to be more uniform across the listening area than from a conventional cone.

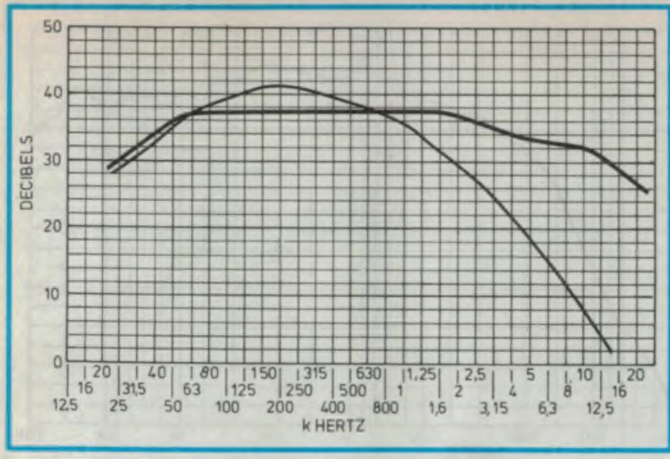
(We chose this particular illustration, because the dome is exposed and therefore easy to see. It is often pertly hidden – and protected – by an outer ring and mesh grille).

Housing a squawker

A factor which must be considered in the choice and design of a squawker is the natural resonance of the moving coil/cone assembly – a matter already discussed in the context of bass-end drivers. However, by reason of the lower mass voice coil, a smaller and

Fig.2: Dimensional diagram of a 5cm squawker from the Philips range. The centre polepiece is tubular. A fibre-filled metal "pot" absorbs energy from the rear of the dome and completely suppresses the natural 320Hz resonance.





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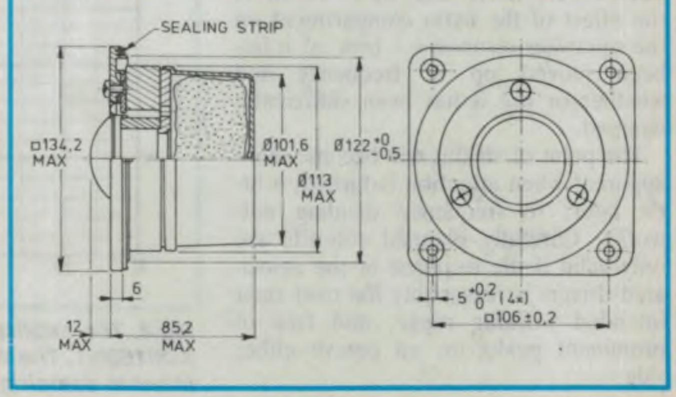

lighter cone, and relatively stiff suspension, the fundamental resonance of a squawker normally occurs at a much higher frequency (e.g. 300 – 600Hz) where it can readily cause sound "colouration", particularly with voices.

Compounding the problem is the fact that, if the squawker is to be contained in the same cabinet structure as the woofer, the rear of the cone must be totally enclosed. This is both to prevent the squawker from being "pumped" by the low frequency energy from the woofer and to ensure that the behaviour of the bass enclosure itself is not prejudiced by the presence of the extra aperture.

For this reason, most specially designed squawkers are sealed at the rear, usually by means of an outer metal or moulded plastic "pot". In the normal way, this would tend to make the resonance even more prominent but, in the case of a squawker, it is usually possible to effectively flatten the response by making the pot just large enough and filling it with suitably absorbent fibre.

A simple approach, adopted by some manufacturers, has been to omit the usual cutouts in the cone support basket. This certainly seals off the rear of the cone, but it does not lend itself to a discrete choice of enclosed volume or to effective damping.

Fig.3 shows the published response of the dome squawker illustrated in Fig.2. Acoustic damping by the fibre filled pot is such that it is difficult to identify, from the curve, the rated system resonance of 320Hz.

Non-sealed squawkers need to be housed in a separate, padded or filled compartment, either part of the structure or contrived from (say) a heavy cardboard tube, sealed at the rear with a particle board washer and butt glued to the rear of the baffle. Either way, due account needs also to be taken of the effect of the extra compartment on the squawker resonance – how far it has been moved up in frequency and whether or not it has been sufficiently damped.

The point of all this will become more apparent when attention is turned, a little later, to frequency dividing networks. Carefully planned roll-offs are only valid if the response of the associated drivers is reasonably flat over their intended working range, and free of prominent peaks for an octave either side.

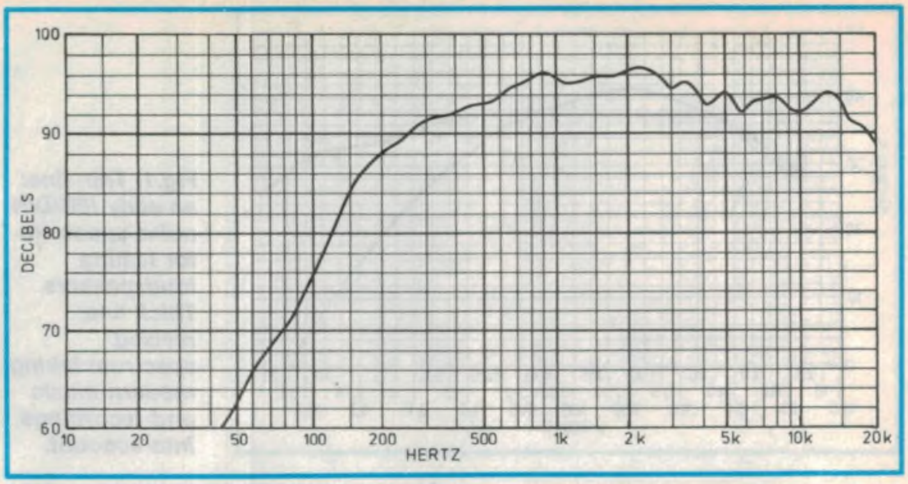

Fig.3: The published response curve for the Philips AD02160/Sq squawker of Fig.2. The resonance at 320Hz is very heavily damped.

Tweeters

Unlike the term "squawker", "tweeter" is often used rather loosely. In the case of a 2-way system it can be applied to the driver which handles everything beyond the range of the low-end unit – even though the crossover might be set as low as 1kHz or up around 4kHz. With a 3-way system, on the other hand, the mid-range is normally serviced by the squawker, leaving the tweeter to take over somewhere above 5kHz.

In many respects, a discussion of tweeters tends to parallel what has already been said about squawkers. Being protected (in most cases) from even the lower middle frequencies, voice coil travel in a tweeter is minimal and, as well, only a very light, small diameter cone is required.

However, the technology gap between an effective tweeter and the average small general purpose loudspeaker is considerable. Apart from anything else, and as with squawkers, a generously proportioned magnet system is essential. In practice, most useful tweeters are the end result of purposeful development and careful auditioning with a wide range of program material.

Looking back into the '60s, the popular Wharfedale "Super 3" (3" or 7.5cm in diameter) boasted a 2.5cm diameter aluminium voice coil, a one-piece bakelised cone with cloth surround, a flux density in the gap of 14,500 oersteds and a rear pot to absorb back radiation. The claimed response curve was commendably uniform from 1kHz to 20kHz.

(Although often described in those days as tweeters, the companion "PST/4" and "Super 5" were really high performance squawkers, with a working range from about 200Hz to 12kHz. Open-back types, they had to be mounted in a separate compartment to isolate them from the low-end driver).

While the Super 3 typifies any number of good quality cone type high frequency drivers, most tweeters these days use a dome construction broadly

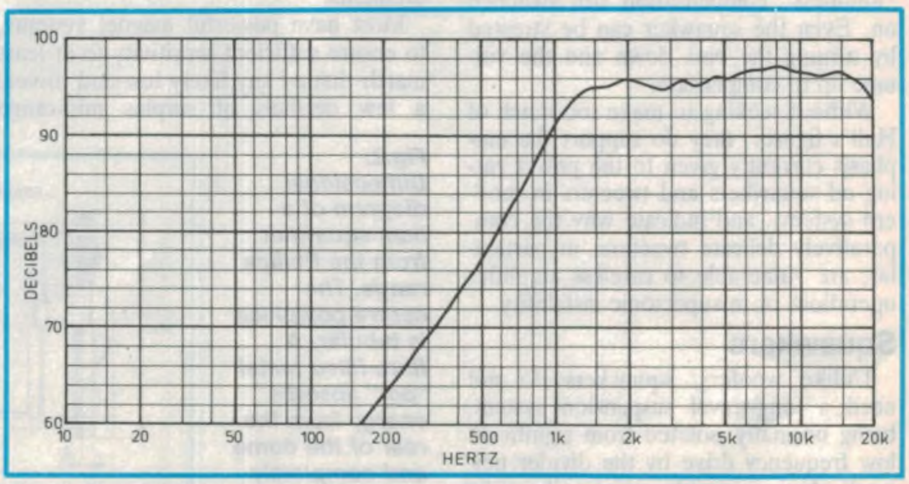

Fig.4: The published response curve for a typical dome tweeter, the Philips AD01630/T. The resonance at 1300Hz has been very precisely controlled by internal damping.

similar to that of the squawker depicted in Fig.2. The voice coil and dome diameter is much smaller, however, being usually around 2.5cm. Fig.4 shows the published response of a typical Philips dome tweeter, with a nominal resonance at 1300Hz and a working range of around 1.5-20kHz.

Over this frequency range, most 2.5cm dome tweeters manage to get away with an ostensibly sealed back and no obvious pot to absorb the rear radiation. In fact, foam or fibre-filled space inside the pole and magnet structure usually serves the same purpose, successfully damping the system resonance as indicated by Fig.4. As such, they need no additional isolation and subtract very little volume from any enclosure in which they are mounted.

Not all tweeters, however, have been as free from peaks as implied by Fig.4. In fact some of them have shown quite prominent resonance effects below their working range. As with squawkers, this possibility must be taken into account to ensure that they don't become active again at a frequency well below that at which the response was supposed to have been rolled off.

Divider networks

And that brings us to the subject of "passive" frequency dividing networks, comprising inductors, capacitors and resistors and operating directly in the feed system to the driver voice coils.

In a perfect world, the response through such a network would take the

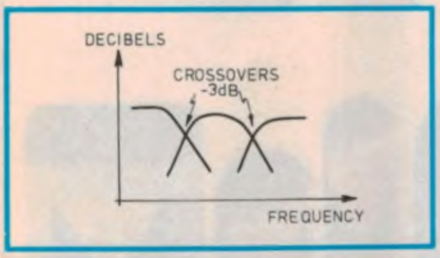

Fig.5: Idealised curves for a 3-way divider network. At the crossover points, the signal is shared equally by the drivers.

general form illustrated in Fig.5. The low, median and high frequency passbands would be flat topped, with the crossover points located as required in the frequency spectrum and 3dB down from reference, so that the power at those points would be equally shared by the adjacent drivers.

The roll-off rate in the overlapping curves would be essentially symmetrical, at a rate ranging from 6dB/octave for simple filters to 12 or 18dB/octave for more elaborate designs.

In practice, it is not unduly difficult to devise networks which produce near copybook curves – when they are feeding into pure resistive loads. However with complex reactive loads, as presented by ordinary loudspeakers, the curves can look quite different, often necessitating modifications to the particular network to achieve the most acceptable end result.

In an article of this nature, it is not possible to pursue the subject to any great depth but the examples that follow typify designs that have appeared in this magazine during the past decade or so.

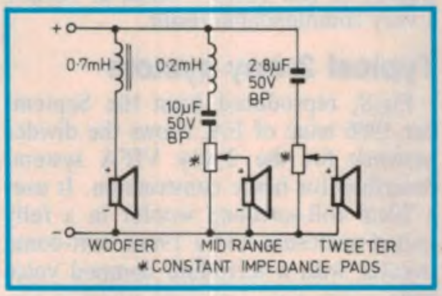

Fig.6: A simple 3-way network using "quarter section" filters – a single inductor or capacitor in series with the woofer and tweeter.

Typical basic network

Fig.6 shows a relatively simple network used in the very successful 3-75L loudspeaker system, originally described for home construction in *Electronics Australia* for May '77. Intended for use with 8-ohm drivers, the network involved:

- A simple iron-cored inductor in series with the woofer to roll off signals above about 1kHz.
- An inductor and bipolar electrolytic capacitor in series with the squawker to favour frequencies in the region of 3.5kHz;
- A 2.8uF bipolar capacitor in series with the tweeter to roll off frequencies below about 5kHz.

Constant impedance pads, associated with the squawker and tweeter served to stabilise the impedance that each presented to the network and also to provide a means of pre-setting the mid and high frequency balance to suit individual listening situations.

As stated in the original article, the network was adopted because it was available along with a pre-packed kit of three Japanese "Nisco" drivers which, themselves, had been tailored to exhibit complementary response curves. After lengthy listening tests, it was considered that, with these particular drivers, and with an eye to accessibility and economy, a more elaborate network was not warranted.

By way of further explanation, the original article mentions that, at the power levels involved, the iron-cored inductor in series with the woofer caused no evident distortion of the bass waveforms. Behind this assurance lies the fact that "air-cored" inductors are preferred in quality networks, to obviate any risk of non-linear saturation effects. Where they can be used, however, iron-cored inductors are smaller, cheaper and more suitable for mass production.

Another point to note concerns the use of *bipolar* electrolytic capacitors, commonly distinguished by two "+" polarity signs or the letters "BP". Metallised paper or plastic dielectric capacitors offer greater precision and long-term stability but, in the higher values they, too, can be rather large and expensive. For many applications, bipolar electrolytics are more practical.

Other networks

In terms of configuration, the network shown in Fig.7 is rather more typical of those found in the average 3-way system. Reprinted from the April 1975 issue of *Electronics Australia*, it was devised for a constructional project using an Australian Magnavox woofer and

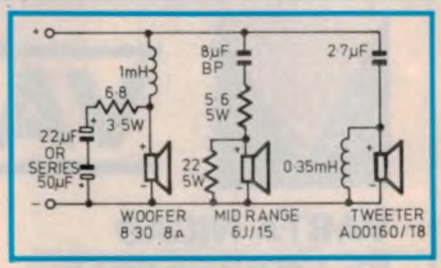

Fig 7: A different approach, with an impedance equalising network across the woofer and a 12dB/octave filter for the tweeter.

squawker and a Philips dome tweeter. The actual component values relate to the particular drivers, the selected crossover frequencies and the working impedance.

An RC "equalising" network connected directly across the woofer serves to cancel the inductive reactance of the voice coil, resulting in a substantially constant impedance over most of the working range. In the absence of a suitable bipolar electrolytics at the time, two normal polarised 22uF types are shown connected back to back, to provide the required 11uF.

According to the original article, this, in conjunction with the 1mH hand-wound, air-cored inductor produced an "almost copybook" 6dB/octave roll-off, starting at 500Hz and passing through -3dB at 1kHz.

The tweeter is fed through a series resonant circuit comprising a 2.7uF polycarbonate capacitor and a second air-cored inductor. Functioning as a high pass filter, they produce a cut-off slope of 12dB/octave and a response curve passing through the -3dB point at about 5kHz, then flattening off to the top of the audio range.

To fill the gap between the two -3dB points, a Magnavox 6J driver is specified. Being more sensitive than the other two drivers, a 15-ohm type is used in association with a resistive divider, which stabilises the impedance somewhat and produces what was judged to be an optimum overall sonic balance.

Rather then use a series resonant circuit to feed the squawker as in Fig.6, a simple 8uF capacitor feed to the resistive network produces the necessary low-end rolloff, passing through -3dB at 1kHz.

For the top end, advantage is taken of the naturally falling response of the 6J. The fact that it remains electrically in parallel with the tweeter is of little consequence, because of its relatively high impedance. In fact, the measured impedance of the overall system remained at or above 8 ohms up to 6kHz, dipping slightly to just below 7 ohms at 9kHz – a very commendable result.

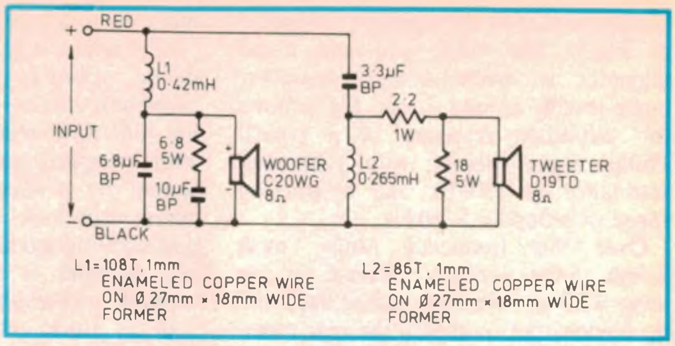

Fig.8: A 2-way divider network using two L/C "half-section" filters providing 12dB/octave roll-off for both woofer and tweeter, crossing over at 3kHz.

Typical 2-way system

Fig.8, reproduced from the September 1986 issue of *EA*, shows the divider network for the 2-way VIFA system, described for home construction. It uses a 20cm roll-surround woofer in a fully sealed enclosure and a 19mm soft-dome tweeter with a ferrofluid damped voice coil.

As in Fig. 7, an impedance equalising RC network is connected across the woofer. The signal feed, however, involves both a series air-cored inductor and a parallel bipolar capacitor, the two forming a half-section low-pass filter providing a 12dB/octave attenuation and a crossover frequency of 3kHz.

This is complemented by a half-section high-pass filter using an air-cored inductor and a 3.3uF metallised polyester capacitor – not an electrolytic as originally shown – for a crossover of 3kHz. The two resistors shown in association with the tweeter reduce the level of the tweeter a couple of dB for optimum balance.

Much more could be said about crossover networks but not in the context of this present series, which is concerned with concepts rather than complexities.

(To be continued)

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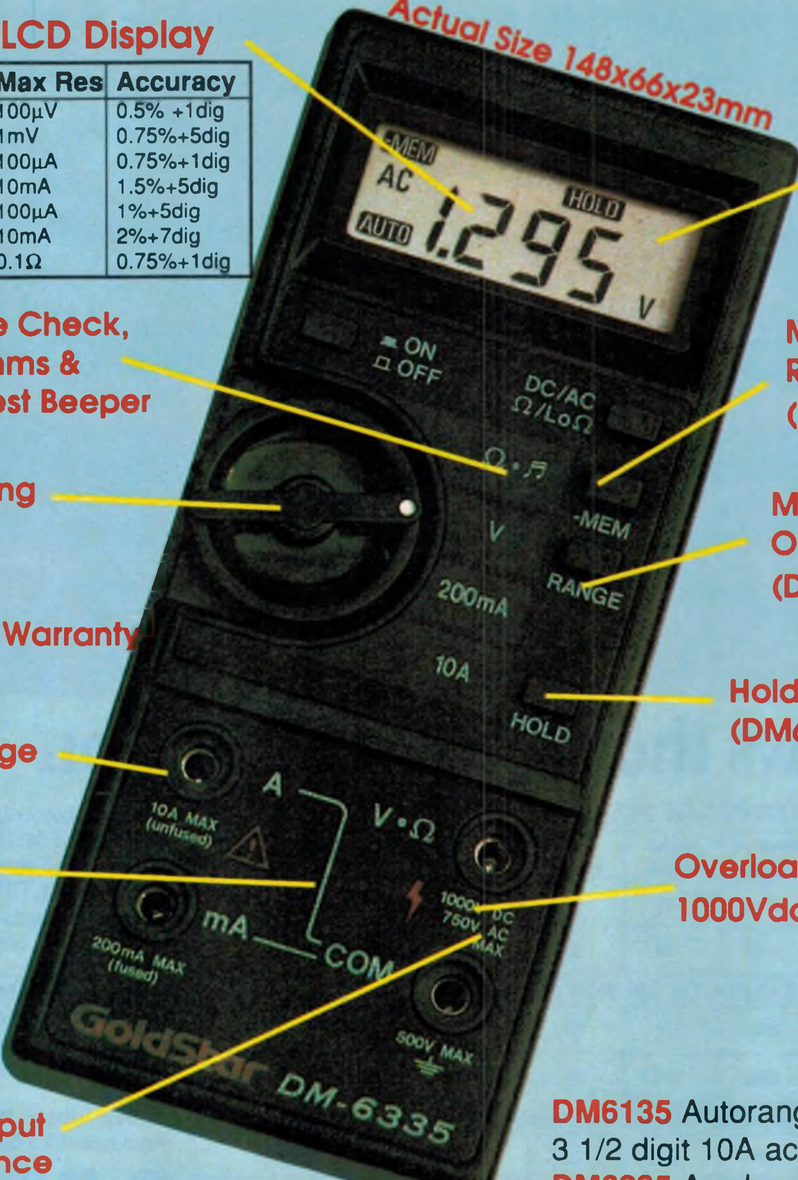

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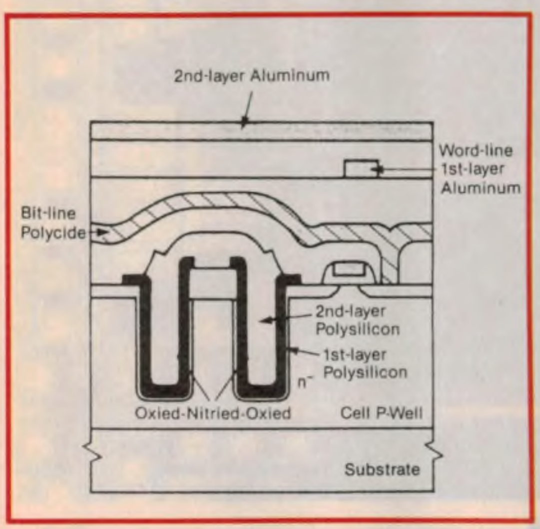
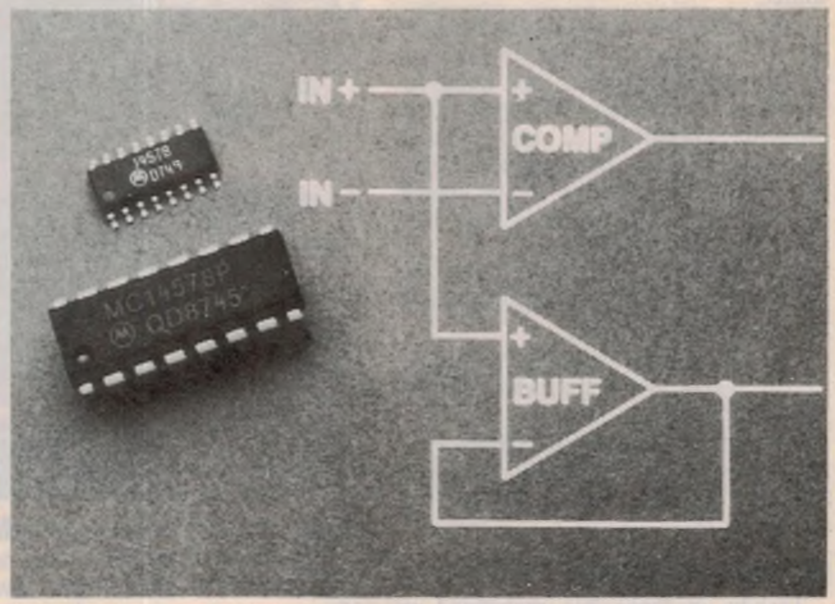


Schematic cross sectional view of STT cell



Toshiba develops 16Mb DRAM

Looking beyond the next generation of 4Mb DRAM chips, Toshiba has developed an experimental 16-megabit chip.

The super-high-density device can memorize over 2-million alphanumeric characters, which means the entire content of a copy of newspaper, (about 64 pages), can be stored on a 12mm x 17.5mm chip.

The experimental device integrates about 34 million elements (transistors and capacitors) on a single chip and features an access time (time required to read one bit of information) of 70 nanoseconds (typical). Toshiba applied 0.7-micron microlithographic technology to the new device, compared with 0.8-micron rule which will be used in the company's 4-megabit DRAM.

In order to reduce the chip size and increase its reliability, Toshiba researchers developed a new memory cell structure call a "Stacked Trench Capacitor Cell" (STT). This structure was invented in order to eliminate the electric leakage between capacitors, which cause errors in stored information.

While the cell employs the "trench" structure, which has been established through the development of a 4-megabit DRAM, a polysilicon layer is formed on the side walls of the trench, through which the doping of impurities is carried out. The polysilicon layer has made possible the diffusion of impurities thinly and evenly, which is said to eliminate the leakage current.

In addition to random access capabilities, the new chip has a high-speed serial access mode which makes possible quick writing and reading of serial information, such as TV picture signals and sound signals.

The serial access mode of the new device divides the memory area into two sections and automatically stores serial information (of up to 2,048 bits) by every four bits on each section alternatively. No address is required except for the very first bit of the information. Consequently, the mode takes only 10 nanoseconds to write and read serial information. At present, the most advanced commercially available memory chips, specialised for handling serial information and applied in VCRs, take a minimum of 30 nanoseconds to perform the same task.

Because of the large memory capacity and its quick write/read capabilities for serial information, the 16-megabit DRAM could be used for future high-definition TVs or other high-speed image/
graphic processing systems – although it will take some more years for the completion and application of the new chip.

Micropower comparator has follower

The Motorola MOS Digital-Analog IC Division has introduced a general purpose device, the MC14578, which is an extension to their op amp and comparator families. This device is a new analog building block which consists of a very-high input impedance comparator and a voltage follower which is used to monitor the noninverting input of the comparator without additional loading.

The flexibility of this device allows it to function with voltage inputs ranging from 3.5 to 14 volts. The quiescent current is rated at 10 microamperes at room temperature. This factor allows an extended battery life for applications using batteries as either the main source or as back-up power.

Also included on this new chip are four enhancement-mode MOSFETs. These are capable of being externally configured as either open-drain or totempole outputs. As an added safety feature, the drains have static-protecting diodes located on-chip. Another valuable feature is the electrostatic discharge (ESD) protection circuitry present on all input pins.

Applications for this device include signal pulse shapers, threshold detectors low-battery detectors and liquid/moisture sensors.

Solid State Update

Zeropower RAM

The SGS-Thomson MK48Z02 (2K x 8) and MK48Z08 (8K x 8) families of non-volatile static RAMs use a CMOS process and an integral Lithium energy source.

The Zeropower RAM has characteristics of CMOS static RAM,with the important added benefit of data being retained in the absence of power. Data retention current is so small that a miniature Lithium cell contained within the package provides an energy source to preserve data with a worst case battery life of eleven years.

The MK48Z02 and MK48Z08 are direct replacements for volatile 2K x 8 and 8K x 8 Static RAM's.

The 2K x 8 is also available in a timekeeper version MK48T02, which has an accessible real time clock.

For further information contact Promark Electronics (Australia), PO Box 381, Crows Nest 2065 or phone (02) 439 6477.

Monster thyristor

Toshiba in Japan has announced an optically triggered thyristor capable of switching 6000V at a rated current of 25,000 amps.

The model SL2500JX21 is intended for use in high voltage converters and similar applications. It uses a triple internal thyristor architecture to obtain multi-stage amplification from the optical trigger input of 8mW.

Sample price of the device is 2.5 million Yen (about $25,000). Samples are available this month.

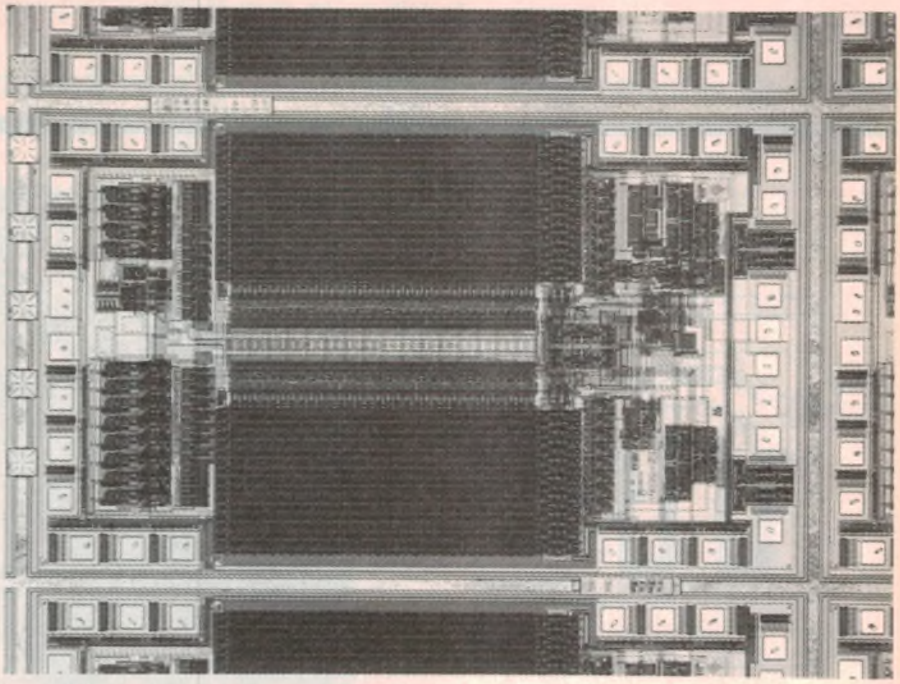
Digital timer IC

The timer IC SABO529 from Siemens may be digitally programmed to provide delays between 1 second and 31-1/2 hours when using the 50Hz mains as the timebase.

The output can trigger a triac, or drive a load such as a relay or transistor. It can therefore be used to provide switch-off delay of motors or other loads in a wide variety of applications such as stair-well lighting, exhaust fans, hand driers and cooking equipment.

SABO529 in DIP 18 package is an Australian stock item. SABO529G in SMT 5020 package is readily available on an indent basis, as are other similar timers in this family.

Further information is available from Electronic Components department, Siemens Ltd, 544 Church Street, Richmond 3121 or phone (03) 420 7314.



15ns 4K fast-clear SRAM

VLSI Technology has announced the VT20C50, a 4K static RAM having a 15-nanosecond access time and a memory reset, or "Clear," function that allows all memory cells to be set to logic 0 within two cycles.

The Clear capability of the 1K x 4 SRAM minimizes software development by eliminating the need for a software reset, and is particularly useful for initialization of cache memories at power-on or system reset. This capability is especially useful for rapidly flushing an entire cache memory.

The VT20C50 also features separate inputs and outputs, which eliminates the need to multiplex data in and out.

The VT20C50 is designed using a six-transistor memory cell that is claimed to provide a higher immunity to alpha particles (soft errors) than the four-transistor cell used by many other manufacturers.

The VT20C50 is available now in 15ns, 20ns, and 25ns speeds. The devices are offered in a 300-mil, 24-pin plastic dual in-line package (DIP) and in both 24-pin small-outline gull-wing (SOIC) and small-outline J-lead (SOJ) packages.

Further information from Energy Control International, 26 Boron Street, Sumner Park 4074 or phone (07) 376 2955.

Configurable micro-controllers from TI

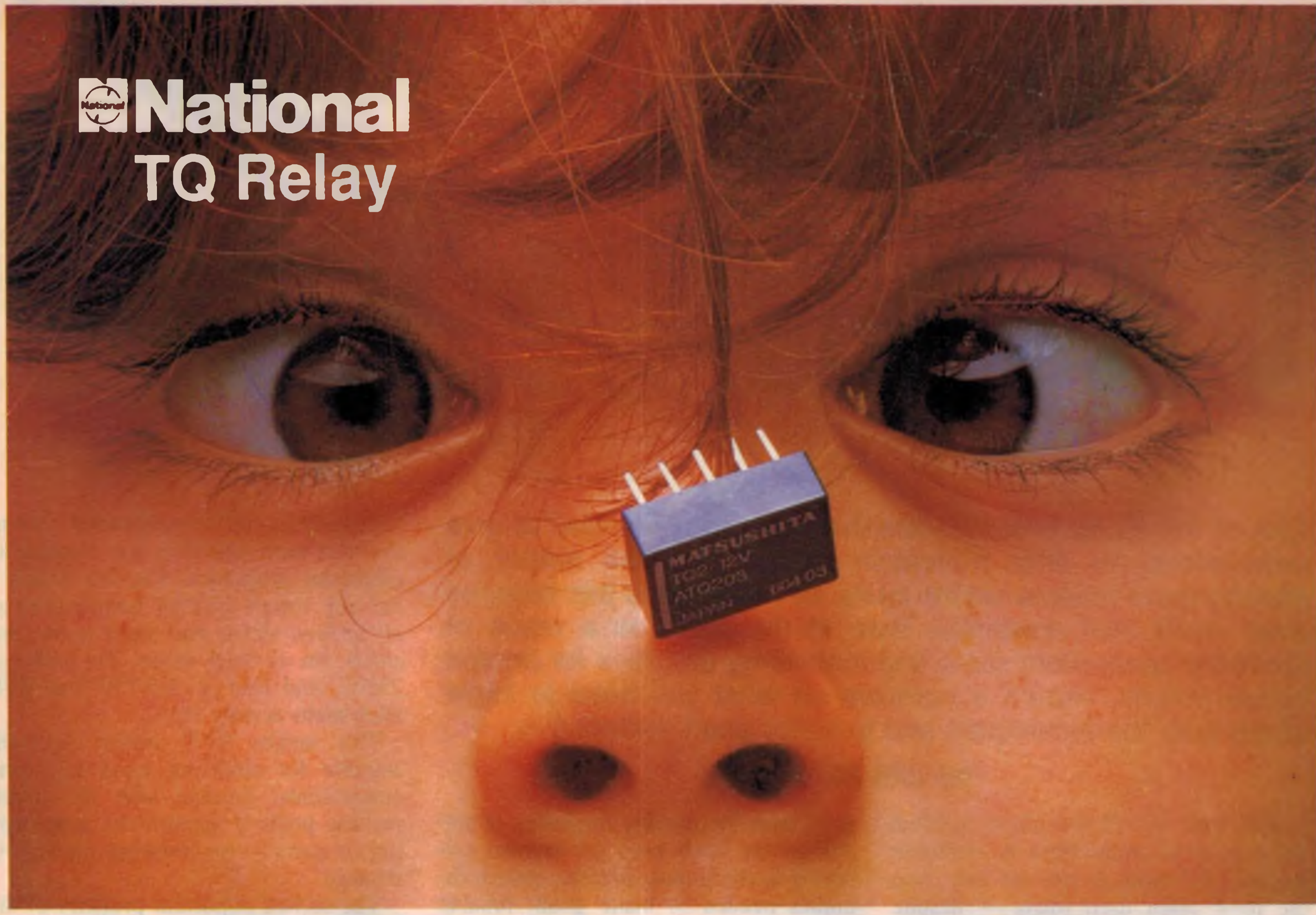
Texas Instruments has released a new family of configurable, eight-bit micro-controllers with on-chip options including EEPROM and an A/D converter.

Fabricated in 1.6-micron CMOS, the TMS370 family is based on a high-performance central-processing unit (CPU) and a modular bus. These new devices are characterised by on-chip integration of advanced functions and 20MHz clock frequency. TMS370 devices operate from a single 5V power supply; EEPROM versions require no high-voltage supply for programming.

Available immediately are six TMS370 standard part and 16 function modules. Plans call for additional standard part numbers to be introduced alter this year.

The TMS370 is fully supported by a configurable in-circuit emulator, assembler, linker, EEPROM programmer, and a design kit. Two of the six standard devices are prototyping tools called "Form Factor Emulators" (FFEs), with EEPROM programme memory in place of the programme ROM. Since an FFE is identical in size, shape and function to its masked ROM equivalent, designer can evaluate and modify algorithms with the device in the end system.

For further information, contact David Cartwright, Strategic Marketing Manager Texas Instruments Australia, 6-10 Talavera Road North Ryde 2113 or phone (02) 887 1122.



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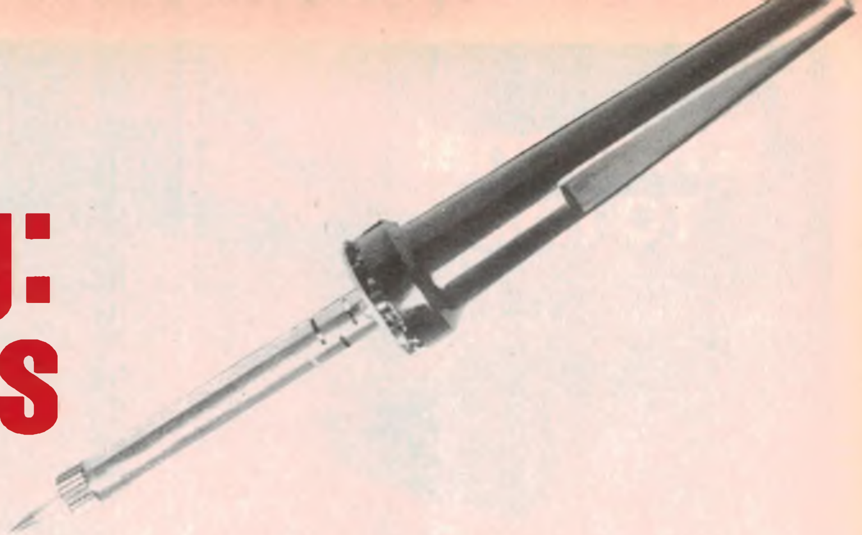


One of the areas in electronics that has always tended to give newcomers no little frustration is the practical matter of making good reliable solder joints. In many ways this requires even more skill nowadays than in the past, as a result of shrinking component sizes and increasing densities for printed circuit boards. Here's a rundown on what you need to know about both the techniques and tools for good soldering.

by JIM ROWE

Although one of the oldest methods used to make connections in electronic circuits, soldering is still far and away the most often used today — despite the growth in alternative techniques such as crimping, wire-wrapping and the forcing of wires into slotted contacts (as in insulation-displacement or "ID" connectors). This is largely because it is cheap, fast, reliable (when done correctly) and lends itself readily to mass production techniques. It also allows convenient parts replacement and changes to wiring, if these are required.

In a mass-production manufacturing environment, soldering is nowadays carried out in ways quite different from the methods used even 15-20 years ago. Printed circuit boards are either coated with patches of solder paste and heated to "reflow" the solder, after loading with surface-mounted parts, or else loaded with the parts and then passed over heated "waves" of flux and molten solder.

But because these newer techniques are not really suitable for low-volume manual work, soldering is also still performed in much the same basic way as it was 50 or 60 years ago, on countless benchtops in service shops, research labs, and home workshops. It's therefore this conventional manual form of soldering that most newcomers to electronics come into contact with, at least initially, and the techniques appropriate to it that need to be mastered.

In this article I'll try to give you a good start by covering the basics of soldering, the tools used for manual soldering in electronics, and the basic techniques needed to make good, reliable soldered joints.

Basic concepts

First of all, as many of you will already know, soldering is the technique of bonding two pieces of metal together using a third metal — the actual *solder*. This has a low melting point, so it can be melted easily and made to "flow" into intimate contact with the two metals to be bonded. A chemical agent called a *flux* is used to ensure that the molten solder "wets" the metal surfaces and bonds to them, before being allowed to cool down and solidify.

In electronics the reason for using solder, rather than an adhesive such as epoxy cement, to make the joints is that solder being a metal is a good electrical conductor. And we're not just interested in making a good physical bond, but a good electrical connection as well.

But what is solder itself? Basically it's an *alloy* of two metals: lead and tin. Although modern solders quite often have tiny amounts of other metals and chemicals as well, to improve their performance in various ways.

The solder used for most general electronic soldering work is an alloy with these two main metals in the proportions tin 62% and lead 38%. For simplicity it is often called "60/40" solder.

Without going into a lot of the deeper technicalities, it's worthwhile noting that this particular alloy has a couple of important properties. The first is that it has the lowest melting temperature of all tin-lead alloys, and much lower than *either* tin or lead alone. Tin melts at 232°C, and lead at 327.4°C, but 60/40 alloy melts at only 183°C.

This makes 60/40 solder especially suitable for soldering small electronic components, because with the lowest melting point it requires the least heating of parts — so reducing the risk of damage.

The second important property of this 60/40 alloy is that unlike all of the other alloys of these metals, it does *not* pass through an intermediate "pasty" stage, when solidifying from the liquid state. All of the other alloys pass through this intermediate state, in which small crystals form and slowly congeal, but 60/40 alloy passes directly from liquid to solid. At 184° it's completely liquid, while at 182° it's completely solid.

This makes solder joints made using this alloy "set" faster, reducing the likelihood of them becoming bad or "dry". We'll discuss dry joints in more detail later.

In short, then, 60/40 solder is virtually ideal for electronics work — melting at a low temperature and setting quickly.

So much for the solder itself. But it isn't just a matter of melting the solder and letting it run over the surfaces of the metal to be joined. We must ensure that it can actually "wet" their surfaces, to form an intimate bond (actually a layer of a chemical compound formed by the solder alloy and base metal).

The problem here is that most metal surfaces are not normally *clean* enough to allow this wetting. They may be finished in a metal with poor affinity for tin (the active ingredient of solder), and they may also tend to have an outer coating of oxide, grease and other contamination. So the first step before at-

Above: The Royel dual-temperature mains voltage iron, suitable for both light and heavier general soldering.

Right: The Portasol iron is fully cordless, using catalytic burning of butane gas to heat the bit.

The Varitemp iron from Dick Smith Electronics is again mains powered, but with temperature adjustable over a useful range.

tempting to solder is to make sure that the metal surfaces are as clean as possible.

Luckily most of the leads and connection pins of modern electronic components have already been "tinned" by tin plating or dipping in a molten solder bath, which helps a great deal. But even these may still have enough oxide or skin grease present to prevent molten solder from achieving the correct wetting action.

This is where the flux comes in. The action of the flux is to dissolve the oxide layer, carrying it away and allowing the molten solder to make contact with the metal surface.

The flux most often used for soldering in electronics is *resin* a substance which is a reasonably acid at soldering temperatures (making it good for oxide removal), but relatively inert when it cools down. This means that after the soldering is completed, any residue of resin that remains doesn't cause troublesome corrosion of the metal — a problem with various other kinds of flux. In fact it tends to leave a glassy, protective coating.

Resin is also an electrical insulator, which again tends to avoid possible complications.

For convenience in making small joints in confined spaces, solder used for electronics and similar work is produced in the form of wire — typically around 0.7mm or 1.6mm in diameter. And to ensure the most efficient fluxing action by the resin, this is actually packaged *inside* the solder wire as one or more "cores" running along its full length (like wires inside a cable). This ensures that when the solder is melted, the resin is provided right where it's needed.

Actually to enhance the fluxing action of the resin, most modern solders dope it with small amounts of acidic halide materials such as chlorides or bromides. These "activating" agents help the resin to remove the oxide and assist wetting, but then quickly evaporate before the solder and resin solidify.

Now before we go on, let's briefly summarise the basic idea of soldering.

The idea is to produce a solid bond between our two metal surfaces — say the connection lead of a component, and a copper pad on a printed circuit board. And we want this bond to be a good electrical conductor, so we use a metal alloy called solder. This has a low melting point, so we don't have to damage our relatively fragile electronic components through overheating.

But to ensure that the solder "wets" the metal surfaces and makes a reliable bond, we (a) make sure they're as clean as possible, and (b) use a flux to dissolve surface oxides and other contamination.

Using a flux allows us to make our solder joints in a very short time, which is again desirable in order to prevent damage to the components or the PC board.

The soldering iron

Obviously we need to raise the temperature of the solder, in order to melt it. In fact we also need to raise the temperature of the metal items to be soldered, to produce proper wetting and bonding.

To do this with manual soldering we use a *soldering iron*. For electronics work this is generally a small copper "bit", heated up to the appropriate temperature by an electrical heating element wound around one end — but insulated from the bit electrically by means of an insulating layer of mica or ceramic.

The heating element is housed in a metal sleeve or barrel, to help dissipate excess heat. The barrel in turn is provided with a suitable handle, to allow the iron to be held easily in the hand. Most irons are held in much the same manner as a pen or pencil.

There are other types of soldering iron used for electronics work, differing mainly in the way the soldering bit is heated. These include irons which still generate the heat electrically, but directly in the bit itself — either by passing a heavy current through it, or by creating a high resistance joint between it and a small carbon block, again with a fairly heavy current passing between the two.

Another kind of iron uses catalytic heating of butane gas, inside the bit itself. For work with modern surface-mount components, there are even "irons" which are basically just nozzles delivering heated air.

All of these types of iron have their uses in electronics, and some are significantly better than others for certain jobs. For example the carbon-block element type is very efficient and fast heating, and particularly suited for work on fairly heavy cables and metal parts — and for "cordless" operation from NiCad or other batteries. The butane gas type is also very suited for work "in the field", away from mains power.

But it's true to say that the majority of soldering irons used for electronics are of the conventional bit-and-electric heater element type.

Mind you, this type of iron comes in a number of sizes, types and levels of complexity. By "size" I mean not just physical size, but generally its electrical heating capability as well. The larger irons are intended for soldering large components and cables, and as a result have a large bit and relatively high-powered heating element (say 100-150 watts).

In contrast, irons intended for work with small electronic parts and PC boards have quite small bits and low-power heating elements (say 10-15 watts). Generally the tip of the bit is also in the form of either a fine conical or chisel-shaped point, to allow soldering of small IC and component pins without heating others nearby on a crowded board.

There are two basic types of heating-element iron — those in which the element operates directly from the 240V AC power, and those with a low-voltage element designed to operate from a stepdown transformer or battery supply. Generally the low voltage type is most frequently used nowadays for electronics work, because of the lower risk of damaging delicate circuitry due to current leakage. Although it's true to say that modern mains-powered irons use improved insulating materials and do have very low leakage. Providing they're reliably earthed, there is very little risk of problems.

Most low-voltage irons are designed to run from a voltage of between 3 and 12 volts. Usually they're run from a small stepdown transformer, but obviously they can be operated from a suitable battery when no AC power is available.

At the most basic level an iron consists of just the essential bit, element, barrel and handle — plus a cable to connect to the source of heating power. This can be quite satisfactory for general work, but the element and bit can overheat if the iron is not used for long periods. Also if the iron is used to make a number of joints in rapid succession, its bit temperature can drop too low to make a good joint rapidly enough to prevent component overheating. This can occur particularly when you're making joints involving heavy-gauge component leads or cables, with a low-powered iron designed mainly for PCB work.

The Weller Temtronic EC2001D is a modern soldering station which offers temperature controlled to within 6 degrees, over a wide range.

To overcome these shortcomings, manufacturers also produce irons with thermostatic control of bit temperature. This allows the bit to be kept at the correct operating temperature in a more consistent fashion, without overheating during periods when it is not used. This type of iron also tends to have a higher-power heating element, to allow faster recovery of bit temperature after making a joint. So in general, an iron with thermostatic control of temperature tends to be preferable to the simplest type.

An elaboration of the temperature-controlled iron is the *soldering station*, which generally allows rather more accurate monitoring and control of temperature — along with the ability to set the operating temperature anywhere within a reasonably wide range, to suit different types of work. Some soldering stations are quite fancy in this respect, with either digital or analog readout of tip temperature and full electronic control.

A typical soldering station also provides a heat-resistant stand to support the iron when not in use, and other niceties such as a sponge pad (generally kept moistened with water) for wiping excess solder and burnt flux from the iron tip.

Although soldering stations with their added complexity and inevitably higher cost may seem like "overkill" compared with a simple soldering iron, their advantages in practice are quite significant. So if you're likely to be doing a lot of soldering, the extra cost is not hard to justify.

Making joints

So much then for the basic ingredients: solder, flux and a suitable soldering iron or station. Now let's look at the actual technique of making a reliable soldered joint.

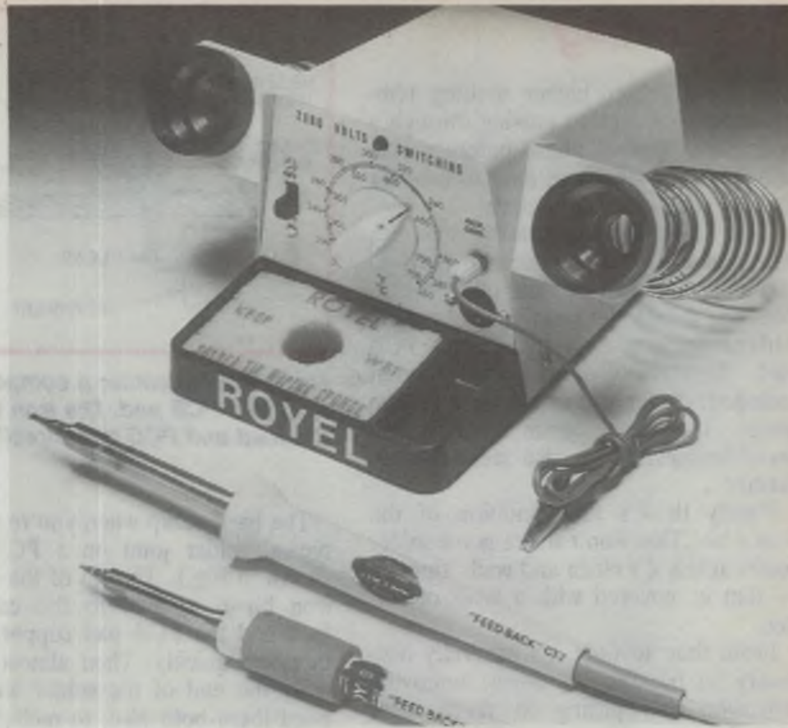
The first thing to remember is the need for both metal surfaces to be clean. Someone once said that there are three golden rules that must be observed in successful soldering: cleanliness, cleanliness and cleanliness!

If a component lead or cable conductor is dirty, corroded, tarnished, greasy or heavily oxidised, there's no point in trying to solder to it — the solder simply won't wet the surface. You'll need to remove the layer of contamination and reveal the clean bare metal.

Often this can be done with a small scraper, sharp scalpel blade or precision wire brush, for small component leads. But with larger items you may need to use a small file, a piece of emery paper or a larger wire brush.

By the way, you don't normally need to clean the surface of modern commercially-made PCB (printed circuit board) tracks and pads. These are generally very clean, and either pre-tinned with solder, or else coated with a thin film of flux to protect the copper. Either way, they're all ready for soldering, and likely to present the least of your problems.

On the other hand if you etch your



Above left is Dick Smith Electronics' reasonably priced soldering station, with meter readout of temperature. Above right is the Royel double-iron station, with its twin soldering irons.

own PC boards, you may well need to remove all traces of photoresist (or other kind) from the copper, to ensure that the solder will be able to reach it. The safest way to do this seems to be a light rub with a piece of steel wool and kitchen "cream cleanser", followed by thorough washing and drying.

Another point worth mentioning here is that occasionally you'll come across small components that for unknown reasons have been plated in a metal which has no affinity for tin, and which solder is accordingly quite incapable of "wetting". These are not as common nowadays as they were in the past, but they can still crop up from time to time — only recently I struck some PCB-mount cartridge fuse clips which were in this "unsolderable" category.

The best remedy in cases like this is to take them back to the store and ask for replacements that *are* solderable. But if it's a Saturday afternoon and this isn't feasible, try filing or scraping off the offending plating to reveal the brass or steel underneath.

Generally this *will* allow soldering, although with steel you may need a little dab of old-fashioned paste flux (the non-corrosive type, of course!) to assist matters. But if you do this, use only a *tiny* dab of paste flux, and wipe off an excess afterwards just in case. Also it's best to use this technique to "tin" the offending parts first, away from the PCB, allowing you to make sure that the solder is properly wetting the surface. Then with a thin layer of solder covering the critical surfaces, you'll be able to solder them into the board.

The next step is to fit the items to be soldered together, so that they're in fairly intimate physical contact and likely to remain so without moving while you're making the joint.

Solder is not particularly good at bridging large gaps; moveover in electronics, we're primarily using it to make a reliable electrical connection, not to provide a lot of mechanical strength. Also if there is any movement of the parts while the joint is being made — particularly as the solder is solidifying – this greatly increases the chances of producing a faulty or 'dry' joint.

Now for the actual soldering itself. The idea here is to make a good reliable bond between the two or more items concerned (typically a component lead and a PCB pad), with correct "wetting" of the surfaces by the molten solder. And remember that this wetting only occurs when the items to be soldered are raised to the same temperature as the molten solder — it isn't sufficient to simply melt the solder.

At the same time, you need to do this as quickly as possible, to minimise the risk of damage to the component and PC board.

There's no denying that this does require a certain amount of skill, but it's a skill that isn't hard to learn — particularly if you understand exactly what you're trying to achieve, and make sure you're using the right tools.

For example you need to use an iron with adequate power rating for the job — or more accurately, one which has a bit with sufficient "thermal capacity" to be able to deliver the amount of heat needed to raise everything to the right temperature, quickly. Providing it can do this, even an iron that is slightly underpowered for the job can be used to make good joints, although it may take an irritating time to "recover" ready for the next joint!

Happily most modern irons, even the very smallest and low-powered type, are designed to have sufficient thermal capacity and heating power for making typical small component lead/PCB pad joints almost continuously. However the very smallest irons can easily become inadequate when you're working with heavy-gauge component leads, such as those on power diodes, and soldering these to very large copper areas on a PCB. This kind of situation can easily call for more heat than a small iron can deliver, and make it almost impossible to produce a good joint.

Another thing to watch is that you are using the most appropriate type and gauge of solder. Some hardware stores sell solder wire consisting of 50/50 tin-lead alloy, rather than the 60/40 alloy best suited for electronic work. The 50/50 alloy is meant for plumbing work, and has a rather higher melting temperature — as well as passing through a noticeable "pasty" phase before solidifying. It's not nearly as easy to use, for making good electronic joints.

Even with the right 60/40 alloy, a heavy gauge of solder can be hard to manipulate. It can become quite tricky, directing it into the joint you're making without bridging over to adjacent PCB pads. That's why many people (myself included) prefer to use the finer 0.7mm gauge. It's easier to manipulate and avoid bridges, and it also seems to "go further".

Finally there's the condition of the iron's bit. This won't make good solder joints unless it's clean and well "tinned" — that is, covered with a layer of solder.

From time to time it's generally necessary to file the bit down, removing corrosion and pitting to reach solid smooth copper. Then a small amount of resin-cored solder is applied quickly, to tin it.

After making every few joints it's also desirable to remove any excess flux and solder from the tip, by wiping it across a damp sponge or rag.

Now for the actual technique of using the soldering iron and solder technique. Traditionally, it used to be stressed to beginners that "first rule" of soldering is:

Always apply the solder to the work — NEVER to the iron.

The basic idea behind this is quite sound. For a good joint, the flux must be able to assist the molten solder to "wet" the metal surfaces, and in order to do this it must be present at the surfaces along with the solder. Since the flux is provided from inside the resin-cored solder, and evaporates easily at soldering temperatures, it should therefore be applied directly to the surfaces.

If it were applied to the iron's bit along with the solder, and then carried to the work on the bit, the odds are that most of it would have evaporated by the time the bit reached the work. This would leave only the molten solder, which would then have to "fend for itself" in trying to produce wetting.

So broadly speaking, it *is* desirable to apply the solder (or more particularly, the flux) mainly to the work, rather than the iron. But in practical soldering, as in many other fields, it's often desirable to "bend the rules" a little. This should become clear in a moment.

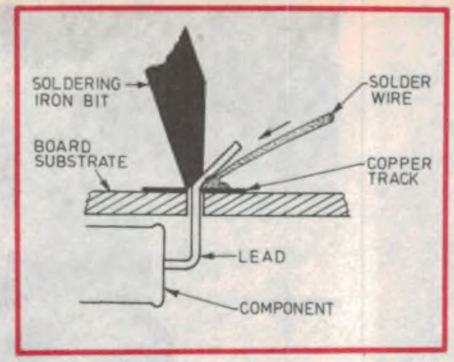


Fig.1: How to solder a component lead to a PCB pad. The iron tip heats the lead and PCB pad directly.

The basic setup when you're making a typical solder joint on a PC board is shown in Fig.1. The tip of the soldering iron bit is applied to the component lead and the PCB pad copper, to heat them up quickly. Then almost immediately the end of the solder wire is applied them both also, to melt it and release the flux as well. The molten flux cleans the surfaces, and it and the solder both spread around the joint by capillary action.

Now this is fine in theory, but often in practice things don't proceed quite this smoothly. The iron tip is either conical or chisel-shaped, and either way it's not ideal for making a good thermal contact with the cylindrical component lead and flat PCB pad simultaneously. This can slow things down — not desirable.

The answer is often just to touch the end of the solder against the tip of the iron, right at the lead and pad. This melts and frees a small amount of solder and flux, allowing them to flow into the joint. And because molten solder is

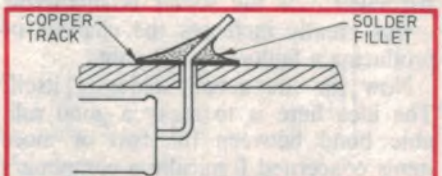


Fig.2(a): With a good solder joint, the solder meets the metal surfaces at a low angle.

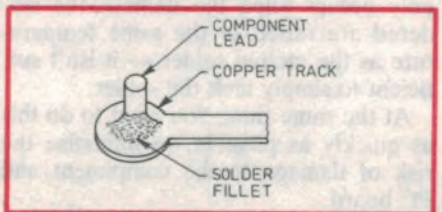


Fig.2(b): Another view of a good joint, showing how the solder forms a smooth fillet all around.

a good conductor of heat, this helps convey the heat from the bit to the metal parts — speeding everything up.

So applying the solder to the iron isn't necessarily a bad thing. In fact it can be positively worthwhile, providing you do it carefully and right at the joint. It's only a no-no when you do it well away from the work, and expect the flux to survive the trip.

Another little point to watch is applying the tip of the iron's bit to the joint in such a way that it will heat up both (or all) of the parts evenly, so that they reach soldering temperature together and quickly — despite differing thermal masses.

For example, a fairly stout component lead generally takes more heat to reach soldering temperature than the usual very thin PCB pad. So to allow for this, you mainly apply the iron tip to the component lead, with just its edge against the copper pad (see Fig.1). In most cases this brings them both up to temperature in the shortest possible time, and again speeds everything up for a better result.

If you don't do this, the time needed to heat up the component lead may be so long that the PCB pad will become overheated and lift from the board — very nasty.

This then is the basic idea of making a good solder joint. Heat all the parts up as quickly as possible, apply the solder/flux, and as soon as the solder has flowed nicely around the joint, remove the iron quickly to allow everything to cool down. Then don't move or otherwise disturb things, until the solder solidifies. This will only take a second or two, in most cases.

How can you tell if you've made a good joint or not? In most cases, you can tell just by looking at it.

A good joint has a smooth solder fillet running all around it, with the solder surfaces meeting those of the component lead and PCB pad at a very small angle — see Fig.2. It is this small angle which shows that the solder has properly "wetted" the other metal surfaces, and bonded to them.

In contrast, bad joints tend to look rough and matted. Very likely they will also have the characteristics of a 'dry' joint – one where the solder hasn't wetted either one surface or the other, or even both. The "dryness" is revealed by a much steeper angle between the solder and metal surfaces, as shown in Fig.3.

If the solder hasn't properly wetted the PCB pad, but only the component lead, you'll get a small spherical blob

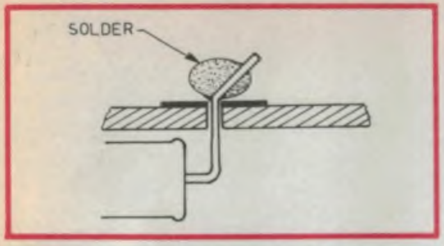


Fig.3(a): One type of dry joint, where the solder hasn't wetted the PCB pad.

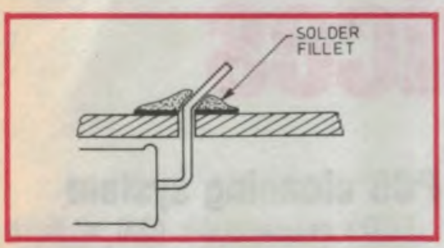


Fig.3(b): Another type, where it hasn't wetted the component lead.

shape rather like that shown in Fig.3(a). Conversely if it hasn't wetted the component lead, but only the PCB pad, you'll get a tiny "groove" around the top of the lead as shown in Fig.3(b). But this can be quite subtle and hard to see, so if you're in doubt it's desirable to reheat and try again — perhaps scraping the metal first to clean it.

Why is a "dry" joint bad? Because where there isn't any wetting, there isn't any true bonding either. Even though the joint may seem firm and secure, and perhaps measure as a very low resistance with your multimeter, it won't stay that way.

Sooner or later (perhaps years later), oxidation will take place and the resistance will rise — possibly going to a full "open circuit". Even more likely is that it will start changing resistance with temperature and vibration, causing all manner of weird and wonderful symptoms.

Sometimes a dry joint can be hard to spot, because the top of the solder can be covered by a thin layer of glassy resin after everything cools. This can make the joint look good, even though it's not.

If you make sure you're using the right tools, clean everything thoroughly and follow the techniques described, you shouldn't produce more than the occasional dry joint. But good soldering takes care, as well as practice. Even experts can make dry joints, if they don't watch what they're doing.

I hope the guidelines given here help you to acquire the skills to make good solder joints, and with a minimum of frustration. EA

Soldering Feature:

New Soldering Products & Services

New range of soldering stations

Cooper Tools' new range of Weller soldering stations are not only housed in new physical form, but have been modified to include new fail-safe features.

Replacement for the very widely used WTCPN is the new WTCPS, featuring the same 'closed loop' temperature control system.

A new addition is the WTCPT "Thermolock" model, featuring the WTL24 soldering iron with plug-in temperature calibration "key". This is designed for production line soldering where a constant temperature is required, controlled to within +/-6°C. The iron features zero voltage switching with colour coded keys for 315, 370 or 430°C temperature control, eliminating tip temperature transients with different tip masses.

Laser trimmed hybrid circuits give the model EC2001D "Temtronic" a proportional temperature control within +/-6°C over the range 175 — 450°C. The EC2001D features zero-voltage switching and an LED "set/read" dual display to set and monitor exact tip temperature.

For micro soldering, the model EC3001D Temtronic has a miniature soldering pencil with a range of new high-mass Weller EPH series tips for improved tip temperature stability. This model features the same hybrid circuitry as the EC2001D and provides precision temperature control to within +/-2°C over the range 40 — 450°C. An LED indicates heating cycle status.

All stations are fitted with a new design detachable soldering iron stand, which can be fitted to either side of the power unit housing or used apart from it for greater flexibility. The new stands also feature wick-fed sponges.

For further information contact Weller distributors or Cooper Tools, PO Box 366, Albury NSW 2640, phone (060) 21 5511.

PCB cleaning system

ECD's programmable 6300 uP batch aqueous cleaning system for PCBs has already had a wide selection of accessories and options to suit particular user requirements. Now to further enhance the performance and utility of the 6300 uP, ECD offers a glass door model with a window to allow visual monitoring of the washing and rinsing cycles.

The new glass door model offers the same high performance as before: monitoring and controlling pre-rinse times, wash times, chemistry concentration, rinse and dry cycles, and others. It also has a built-in printer to furnish hard copy documentation, and can be furnished with any of the other options and accessories, which include a back-saver stand, a dual automatic chemistry feed for saponifier or neutralizer, chemistry level sensors, a convection dryer attachment, a recirculating air oven, a long diffusion assembly, and a conductivity and temperature calibrator.

Batch aqueous cleaning of PCB assemblies, largely through the use of saponifers, is rapidly becoming the process of choice in the industry.

For further details contact sole Australian distributor Meltec, P.O. Box 20, Greenacre 2190 or phone (02) 708 4300.

Large range of soldering equipment

Ersa has long been one of the world's most respected names in solering equipment. In fact it was Ersa who actually patented the first electric soldering iron back in 1928. Since then Ersa has grown to a position where, today, it offers arguably the world's largest single-manufacturer range of soldering equipment.

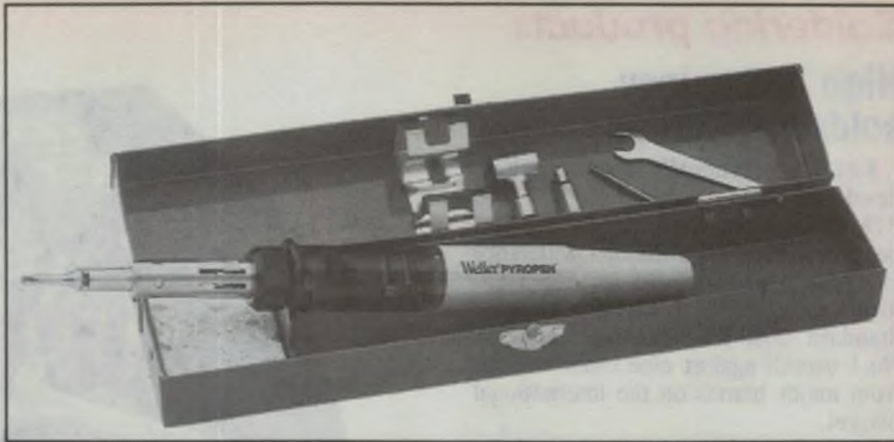
Ersa's range covers soldering irons from 5 watts right through to a massive 750 watts, with over 100 models as well as 10 different models of decoldering irons. On top of this the company offers a very extensive range of static solder baths and wave soldering machines.

Ersa range of wave soldering machines is also very comprehensive, covering soldering widths from 100mm right through to 450mm and comprising a range of over 30 different models. The range covers all budgets, from simple and economical bench top machines right through to full in-line, high volume solder-cut-solder-clean production lines.

Ersa was the first company to develop the two wave principle for SMD back in the mid seventies, during a joint research project with Philips in the Netherlands. The company's range of equipment for SMD work now covers 12 different models of wave soldering machines and 4 separate models of Infrared reflow.

Ersa equipment has been sold and serviced in Australia by Meltec for over 8 years now, having earned an enviable reputation for both reliability and after sales service.

For further information on the Ersa range contact Meltec at 15-17 Beresford Avenue, Greenacre 2190 or phone (02) 708 4300.



Self-igniting Pyropen

Weller has updated its popular WSTA3 Pyropen soldering tool with the new WPA2 self-igniting model. The WPA2 incorporates pushbutton ignition for instant heat and greater convenience in remote, wet, confined or windy conditions.

The new model includes all of the features offered by the previous model. Tip temperature is adjustable from 250° to 500°C. The inbuilt 28cc butane gas tank gives a soldering time of 4 hours at a setting of 2. A gas level window is built into the handle.

A range of 14 Series WPT Weller tips is available for the new model, as used with its predecessor. In addition there are 4 hot blow WHC tips, providing air heated to 650°C.

The WPA2 Pyropen comes in a sturdy metal case with built-in iron stand and sponge, soldering tip and hot blow tip, detachable cable shield, wrench, level and ejector.

Further information is available from Weller distributors or Cooper Tools, PO Box 366, Albury NSW 2640 or phone (060) 21 5511.

High technology soldering station

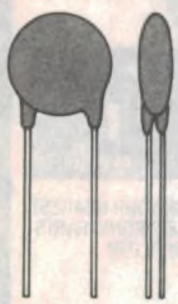
Royel International's new Australian-developed and manufactured T3000 "Thermatic" soldering station has just been confirmed by a major US defence electronics manufacturer as very comfortably meeting US/DOD Defense Standard 2000-1B, and was rated as No.1 overall against nine other stations from major brands on the international market.

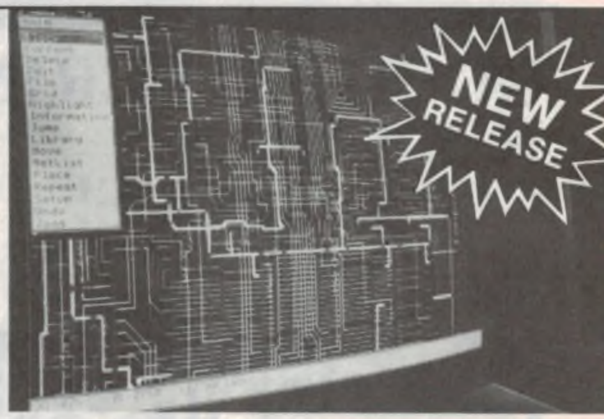
Tip to ground resistance checked out at 0.58 ohms, compared with the spec limit of 2 ohms maximum. Similarly tip to ground potential as 0.4mV, well below the limit of 2.00mV max; idling temperature was +/-3.0ºF, well within the limit of +/-10ºF; and time required to reach soldering temperature from initial power-on was only 28 seconds.

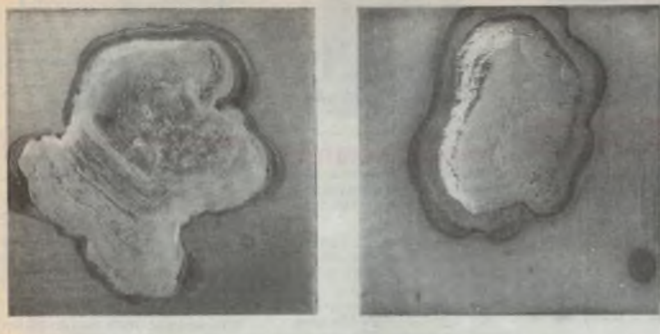
Now available in Australia, the T3000 combines a T300 (3mm tip) soldering iron with a T1000 analog power unit. Also available is the T3050, featuring a digital power unit, capable of displaying both setpoint and control temperatures simultaneously. Models fitted with the T500 (5mm tip) soldering iron are also available, as T5000 and T5050 respectively, and dual-iron models providing both 3mm and 5mm irons as T5300 and T5350.

All models provide accurate electronic temperature sensing and control, electrostatic shields, zero voltage switching for very low RFI/EMI and auxiliary tip ground connectors.

Further information from Royel International, 27 Normanby Road, Notting Hill 3149 or phone (03) 543 5122.







Above: Pictures illustrating the excellent fluxing capabilities of Almit KR-19 (left), compared with a standard solder. Both show the spread of 0.3 grams of solder on identical oxidised copper plates. Almit KR-19 flows to the edge of its flux spread.

High performance resin-cored solder

Almit KR-19RMA/RA solder is an improved formulation, originally developed by manufacturer Nihon Almit at the request of a Japanese automotive instruments manufacturer who had problems in soldering Ni-Cr wire and bimetal. It has now been tested for over 8 years, and is credited with allowing Japanese instrument manufacturing to achieve a zero defects record. It is also said to have made possible automated soldering, as a result of improved flow characteristics.

Tests suggest that Almit KR-19 achieves wetting in about 1.5 seconds, compared with almost 5 seconds for other solder/flux combinations. It also achieves an extremely high spread factor of 96%, due to excellent flow characteristics of its newly developed flux activator.

KR-19 is capable of soldering both stainless steel and Ni-Cr alloy, and other metals which are normally difficult to solder using a standard RMA-type flux. It is available in 60%, 63% and 10% tin alloys, with a choice of wire sizes ranging from 1.6mm dow to 0.38mm. Type RMA (mildly activated flux) flux is also available separately for foaming, brushing, waving or spraying, and meets MIL-F-14256 type RMA requirements.

Further information from Hawker Richardson Mechatronics Division, Unit B, 3-7 Highgate Street, Auburn 2144 or phone (02) 748 3511, or (03) 20 2461.

Improved soldering station

Scope Laboratories has upgraded its model ETC-60L soldering station, giving it tighter temperature control: +/-2°C when idling. The unit now also has improved temperature stability, over a wider range of service temperatures and line voltages, making it particularly suited for Western Australia.

A further feature of the new ETC60L-8FE is a 5-pin screw-type connector used for connection of the iron to the power unit, to prevent accidental unplugging.

Other features of the station are an anti-sieze tip retention system, zero-voltage switching for elimination of EMI and damaging spikes induced at the iron tip, ceramic encapsulation of the heater element for lowest leakage current, and temperature infinitely adjustable from 200 to 470°C. A "floating-earth" model is available with plug-in lead and clip.

Further information from Scope Laboratories, PO Box 63, Niddrie, 3042 or phone (03) 338 1566.

New Products...

PC driven gang/set EPROM programmer

The Logical Devices "Husky" is a gang/set programmer driven directly from an IBM PC via a plug-in card. It uses intelligent and quick pulse algorithms to program as many as four one-megabit EPROMs in less than three minutes.

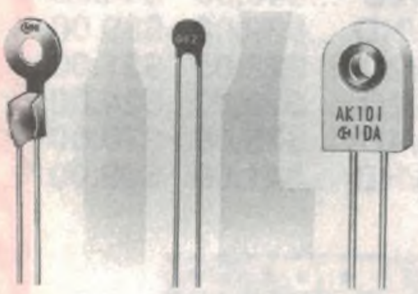
Each of the four 32-pin ZIF sockets supports gang programming of EE-/EPROMs simultaneously with the same data, or sequentially with different data.

Devices supported include most popular CMOS, NMOS and HMOS EE-/EPROMs (as large as 2 meg) and popular CMOS EPLDs. Single chip micros are also supported using an optional 40-pin expansion socket. Similarly, PLCC and PGA devices can be supported by additional socket adaptors.

The advanced software forms an extremely friendly user interface, which can be used under cursor or mouse control.

Husky's advanced design uses an ultra efficient power switching technique to minimise the power load on the PC's power supply. There are no high voltages on the plug-in section of the programmer, eliminating the danger of damaging the PC in case of a programmer malfunction.

Further information from Emona Instruments, 86 Parramatta Road, Camperdown 2050 or phone (02) 519 3933.



Posistor for semi protection

IRH Components, the Australian Distributor for Murata Products, has recently released on the local market a PTC resistor designed to protect high power semis.

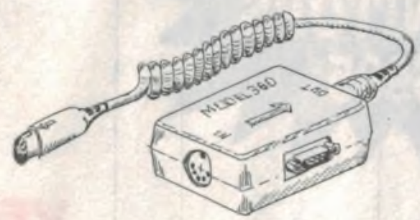
The Murata range of posistors has a logarithmic increase in resistance with a small increase in temperature over the preset detection temperature. The posistors are physically compact and light in construction and therefore have excellent thermal response. Being solid state devices they are immune to mechanical vibration and impact problems.

Their contactless operation prolongs service life and alleviates the RFI problems associated with switching operation of mechanical contacts.

The PTH 487A series of posistors are designed to be attached to power transistors and thyristors via the semi mounting screws, and are connected into circuit to shut the semi down when it exceeds a preset temperature.

The PTH 59F series are disc type Posistors used to detect over temperature in loads supplied via high power output semis.

For further information contact IRH Components, 32 Parramatta Road, Lidcombe 1241 or phone (02) 648 5455.



RS-232 to keyboard T-interface

Unique Micro Design has released "The Wedge", Model 360 RS-232 to keyboard T-interface. It provides a serial port which connects in between the keyboard of a PC, XT or AT and the system unit.

The Wedge converts RS-232 data to appropriate keyboard characters. It is totally transparent to the computer system, which accepts the RS-232 serial input as if it was typed from the keyboard.

The Wedge finds utility in adding serial devices such as bar code readers to a PC system without the need to alter software. When ever the program expects keyboard input, it can accept data from the attached serial device.

Features include:

- Converts RS-232 serial input to PC, XT or AT keyboard format
- Transparent operation
- Small size
- Power supplied via the keyboard connector
- Low cost – RRP $285 including tax
- 12 months warranty

Designed and manufactured in Australia by Unique Micro Design, Unit 2/23 Wadhurst Drive, Boronia 3155 or phone (03) 887 1022.

Scanning AF generator

An Australian designed and manufactured scanning audio frequency generator, Model TX50, has been released by Teletech.

This professional quality instrument is battery operated and fully portable, and serves equally well as a laboratory or field instrument.

The TX50 provides 11 spot frequencies ranging from 50Hz to 15kHz. It operates in two modes: scanning repetitively throughout the range or, at the push of a button, providing a continous tone on any of the designated frequencies. Output levels of +8 and +16dBm are provided.

Applications include line equalisation frequency source, audio amplifier test generator and initial frequency standard.

Further information from Teletech, 61 Betula Avenue, Vermont, 3133, or phone (03) 873 2777.

Solid tantalum capacitors

Kemet T330 Series, polar-type radial lead rectangular Precision Molded Tantalum (PmT) capacitors are primarily designed for applications that demand full use of the premium space available in printed circuitry and high density packaging. The space saving capacitors provide superior packing factor and space utilisation compared with tubular units of the same microcoulomb (CV) rating.

The capacitors employ a rectangular sintered, dry tantalum anode, transfer molded in precision dies with a high impact resistant plastic having excellent electrical, physical and moisture resistant properties. All cases utilise gold colour plastic which permits laser marking with outstanding permanency and legibility. The polarity is indicated by a + sign permanently marked on the case.

T330 Series capacitors are highly reliable and exhibit performance characteristics typical of military test standard. They are available in capacitance values ranging from 0.1 to 220 microfarads in ±20, ±10, ±5% tolerance levels, and in working voltages from 6 to 50 volts. At 85°C the capacitors will operate continuously at full rated voltage.

For further details contact Crusader Electronic Components, 73-81 Princes Highway, St Peters 2044 or phone (02) 506 3855.

AC inverter has "burst power"

The new Magnum 2000 and 4000 Australian-designed and manufactured AC inverters are designed to deliver a massive burst of power for a few seconds. This allows them to be used to operate appliances such as refrigerators, which incorporate a motor and need to draw a high starting current.

The Magnum 2000 is rated at 600VA continuous, but will deliver bursts of up to 2kVA. Similarly the Magnum 4000 is rated at 1250VA continuous but will deliver bursts of up to 4kVA. Needless to say, this requires the use of a "deep cycle" battery with adequate peak current rating. Standby current in both cases is very low, at 250uA.

Features include protection against overload, short circuits, low or high battery voltage, over temperature and reverse battery connection.

Each unit is built in a tough 3mm aluminium chassis and is finished in chip resistant powder coat enamel. The 2000 unit weighs 9.5kg and the 4000 weighs 17kg.

Further information from Austronics, 762a Beaufort Street, Mount Lawley 6050 or phone (09) 370 1050.

IBM PC/XT/AT

Electronic Solutions launched a powerful new I/O board for IBM PCs and compatibles. Features include:

- A parallel printer
- 4 serial communications ports
- A games adaptor port
- A 1.2MB/360K floppy disk controller

Add a mother board and a video board and you've just about got a PC!

The floppy controller can drive either two 1.2MB drives, two 360K drives or one of each density. The serial ports can be configured to be any combination of COM 1: to COM 8:.

The price is an impressively low $399 including tax. For the faint of heart, the board carries a full 3 months warranty and a 14 day money-back guarantee.

For further information contact Electronic Solutions, PO Box 426, Gladesville 2111 or phone (02) 427 4422.

TO3 heatsinks

The Redpoint range of heatsinks has been extended to include 3 pin, 4 pin and 8 pin TO3 configurations.

The range provides for the conventional powerfin type offering up to 8.9° C/W to the shellsink type offering 9.5° C/W. The Redpoint PF range has been desinged to clamp over the TO3 case without distributing the device connections and using almost no additional space.

All Redpoint heatsinks are finished black anodized to maximize heat dissipation.

Further information on the Redpoint range of heatsinks is available from Clarke & Severn Electronics, P.O. Box 129, St. Leonards 2065 or phone (02) 437 4199.

High dB piezo siren

IRH Components has added the type KPE 1100 to its comprehensive range of piezo buzzers and sirens.

The KPE 1100 is ideal for use in the security industry with a sound output of 110dB (min.) at 1 metre with a voltage of 12V DC. The overall operating voltage is 6 to 12V DC with a current drain of 450mA (max) at 12V.

The siren has a frequency sweep between 1500 to 3500Hz. Termination is by flexible leads and it is flange mounted.

For further information contact IRH Components, 32 Parramatta Rd, Lidcombe 2141 or phone (02) 648 5455.

New Arista catalog

Well-known independent accessory importer and distributor Arista Electronics is about to produce its brand-new 1988-89 Catalog, following the excellent response to its previous edition.

The new Catalog will include Recommended Retail prices this year for the first time, for the benefit of consumers. It will include details of over 150 new products which have been added to the company's range, including loudspeaker systems and stereo headphones for CD-quality sound reproduction.

Watch for the new Arista catalog, which will be included as a bonus insert in next month's *Electronics Australia*!

New Products...

Mobile SC7000 scanner

Captain Communications has just released the high performance Saiko SC7000 scanner. The scanner offers performance and facilities normally associated with much more expensive units.

Frequency range is unusually comprehensive, covering:

- HF band inc CB Band 26.0 – 30.00MHz
- VHF Lowband 68.00 – 88.00MHz
- Airband 118.00 – 138.00MHz
- VHF Highband 138.00 –178.00MHz
- UHF band 380.00-512.00MHz

A very comprehensive display shows mode, channel, frequency and channel step. Search functions are very comprehensive and work in 5, 12.5 or 25kHz steps. Sensitivity is a high 0.5uV, an excellent figure for a wideband scanner. Scanning can be through up to 50 memory channels. Delay function, channel blockout and priority channel are all provided.

Input/output facilities include 12V power, antenna and speaker.

For further information contact Captain Communications, 28 Parkes Street, Parramatta 2150 or phone (02) 633 4333.

Low cost EPROM programmer

The compact, lightweight Advantest TR4943 EPROM programmer can be used for debugging microprocessor systems, for programme development and research and in checking ROM contents. It handles devices up to 512K bits.

A highly versatile complement of nine data editing functions is presented in easy-to-understand menu fashion, on a 16 character by 2 line LCD. Eight types of translation formats are accommodated and such features as serial input/output for remote control of key functions and improved printer output speed via a Centronics parallel input/output interface are standard.

Used in combination with the Advantest TR49403 debugging RAM unit, ROM emulation is also possible.

Further information from AWA Distribution, 112-118 Talavera Road, North Ryde 2113 or phone (02) 888 9000.

UV EPROM eraser

Now available from US manufacturer Bytek International is the BUV-3 family of low cost, high eficiency UV EPROM erasers offering features usually only found in higher priced EPROM erasing equipment.

Housed in rugged steel enclosures to ensure long, trouble-free operation in a production environment, these units offer sale and virtually maintenance-free service without adjustment. The rated average life of the UV lamp is approximately 6 months of continuous operation, and the built-in UV glow indicator replaces the normally unreliable conventional pilot lights and add-on UV lenses.

The BUV-3 features a full 10" wide drawer with an integrated handle capable of holding up to thirty 24-pin chips at a time. A conductive foam pad protects the chips from possible electrostatic charge build-up. An interlock feature on the drawer protects the operator from accidental exposure to short wave ultraviolet energy.

Further information is available from Parameters, Centrecourt, 25-27 Paul Street North, North Ryde 2113 or phone (02) 888 8777.

Capacitors and mains filters

Rifa has been appointed sole Australian distributor for Evox capacitors and mains filters from Finland.

Evox is already well known in Europe as a supplier to the telecommunications, industrial and consumer markets where its reputation for quality at competitive prices is well established.

The Evox range includes polyester, polycarbonate, polypropylene and polystyrene capacitors in various mounting styles including surface mount.

An extensive range of mains interference filters is also available, covering 1 to 10 amps with a wide range of international approvals. Custom filters can also be designed.

Further information is available from Rifa, P.O. Box 95, Preston 3072 or phone (03) 480 1211.

New portable PC

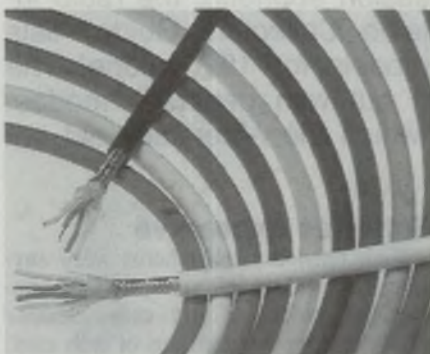
Epson Australia has released the PX-16 Portable Computer, a versatile PC-compatible machine for commercial, industrial and scientific applications.

The PX-16 has been designed to offer the user maximum flexibility in system configuration, offering a choice of keyboards, screen units, cartridge interfaces, expansion interfaces and disk drives. Based on the V20 CPU (8088 compatible), it comes with standard 256Kb main RAM which is expandable to 1.4Mb.

The 512Kb system ROM includes MS-DOS V3.2, GW-Basic and utilities. It also provides three 512Kb mask ROMs and three 128Kb EPROMs as application ROMs.

All standard and modular feature of the PX-16 are configured within an A4 size footprint. The PX-16 comes with built-in ports for a disk drive, a parallel printer, an RS-232C communication, and a bar code reader.

For further information contact Epson sales offices in each state.



Soft, flexible mike cables

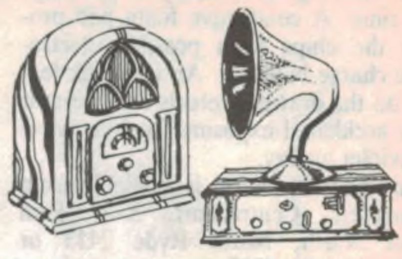
Belden Wire and Cable has designed a new range of microphone cables in matte finish jackets of brown, red, green, orange, yellow, blue, violet, grey, white, ivory, chocolate brown, translucent and black.

Belden 1192A Brilliance cable is composed of four color-coded (blue-whitblue-white) 24 AWG stranded bare copper conductors to round out the cable's appearance and to provide needed flexibility. EMI/RFI interference is blocked with an overall tinned copper braid shield that provides 96% coverage.

In actual use, Brilliance cables have two conductors; that is, the two blue conductors are joined to form one conductor and the two white conductors combine to form the second conductor. Connecting the cable in this fashion lowers the possibility of induced noise and allows for a nominal capacitance of 39.2pF/ft. They are available in 500, 1000 and 2500ft put-ups and also a 1000ft package for easy installation.

For additional information, contact Belden Electronics, P.O. Box 322, Clayton 3168 or phone (03) 240 0448.

Vintage Radio



by PETER LANKSHEAR

Early receiver developments: 1925-30

Last month we progressed to the mid 1920's, where the radio receiver had become reasonably easy for the non-technical operator to use. In the pre depression euphoria, the radio industry boomed. McMahon's "Radio Collectors Guide" lists nearly 950 different American models for 1926 alone! The British market too was booming but with generally modest models, including crystal sets – which the Americans did not take seriously.

With the notable exception of some RCA superhets, the TRF receiver was virtually universal in the USA by the mid 1920's, with more variations in cabinet styling than circuitry. However, despite the lively market, there was a serious shortcoming still to be satisfactorily overcome. Dependant on battery power, radios were fiddling and expensive to operate.

The majority used the ubiquitous 201A triode, with a filament rating of 5 volts at .25 amperes. This was far in excess of the capabilities of dry cells, and the then-standard 6 volt car battery was commonly used. This generally went flat at the wrong time, needed frequent trips to be charged. Consequently home chargers were popular, a common practice being for the battery to be trickle charged when the receiver was not in use.

There was no question of running directly heated filaments from mains power. Hum made AC completely unusable, and the components necessary for practical mains operated DC supplies did not exist. In short, filament supplies were most unsatisfactory.

Some receivers did use low consumption UX199 type 60mA dry cell operated valves, but even these needed a bank of six large No. 6 cells. In some moderately successful RCA receivers, the filaments of 199 valves were connected in series and lit from rectified and filtered mains current.

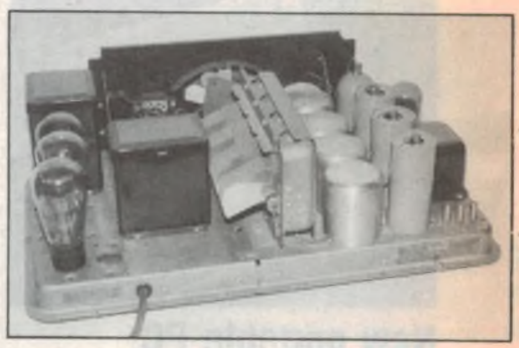
Batteries expensive

High tension requirements were anything from 90 to 180 volts, initially supplied by blocks of dry cells. Smaller sized batteries were groups of cells comparable with modern type D. The "super" 45 volt batteries cost 30 shillings each, so that a set of three would have been something like $100 in today's money! Furthermore, a working wage was proportionately far smaller than today. Next time you pay $5 or so to repower that ghetto blaster, give a thought to great grandfather and his battery bill.

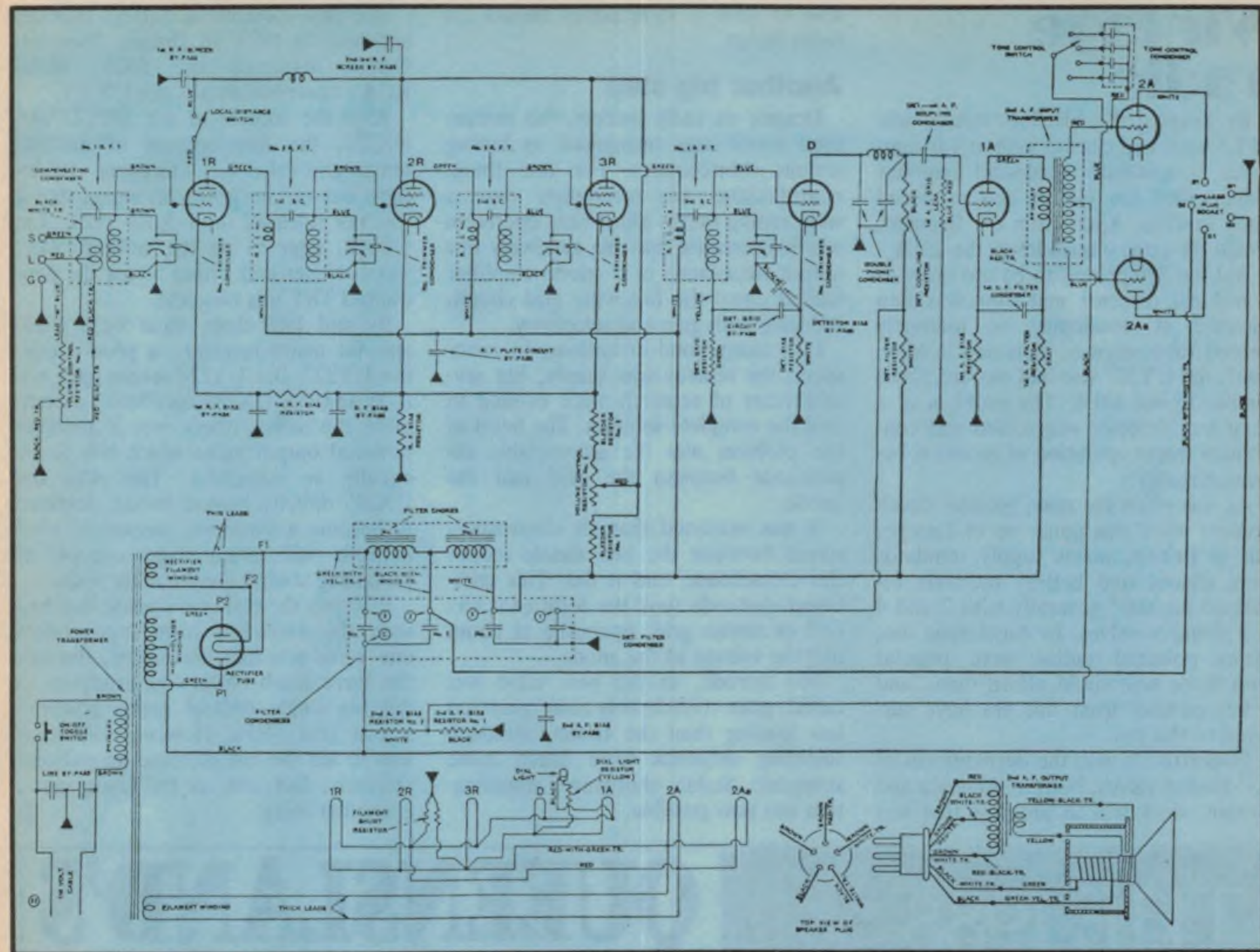
One alternative was for HT batteries to be assembled from small lead acid cells. Whilst these supplies had excellent characteristics, they were initially very expensive and there were the same objections as with lead acid filament batteries.

In Europe and Britain, the situation was little different. There, as well as in the US, considerable effort was put into developing mains operated HT supplies.

Fortunately, mains supplies for the modest HT current demands were a practical proposition and compact units often called "B eliminators" or "power packs", containing a transformer, recti-



Top: The Atwater Kent model 70 8-valve screen grid TRF receiver in its console, dating from 1930. It had a massive 12" moving coil speaker. Above shows the classy nickel-plated chassis, with its 4-gang tuning capacitor and thorough shielding. The inverted tray-type chassis became standard for valve receivers and other equipment.



The circuit of the model 70. TRF receivers like this are still capable of performing well.

fier and smoothing circuits soon appeared. A typical supply was the subject of the March *EA* mystery picture.

Three different types of rectifier were used. The most primitive was the "slop jar" or more politely, the electrolytic rectifier. These consisted of small jars containing a borax solution and a pair of pure aluminium electrodes. These were capable of rectification and were the parent of the electrolytic capacitor.

More conventional were metal oxide rectifiers, but they most successful used valve rectifiers, both cold cathode and thermionic. One of these valves, the UX213, evolved into the UX280 described in a previous article.

Chokes, resistors and paper capacitors were used in "eliminators" for filtering and voltage taps. The capacitors were rarely more than a couple of microfarads, which could result in instability in receivers designed for well regulated battery supplies. For all that, the basic concept of the mains HT supply was sound and the eliminator became popular.

Indirectly heated valves

Although operating costs were reduced with mains powered HT, the filament supply situation remained messy and untidy. The real need was for valves that were not dependent on DC heating.

Hum is generated by direct AC heating because the constantly changing potential difference along the length of the filament modulates the electron stream, and thin filaments have insufficient thermal capacity to maintain a constant temperature during the current cycle. The solution was, of course, the *unipotential cathode*, comprising a metal sleeve or tube heated internally by an insulated filament.

Although research had started about 1920, the first heater type valves marketed in the US are credited to F.S. McCullough, who in 1925 produced his 410 – with electrical characteristics similar to the 201A, but with a terminal block on top to take the 3 volt heater wiring. These valves could be plugged into standard UX 4-pin sockets and with a twisted pair of heater wires linking the tops of the valves, ready conversion of existing radios was possible.

Other small manufacturers were producing various styles of AC valves, with Arcturus making some with carbon heater elements!

These developments were by small firms, and soon Westinghouse was investigating AC valves for RCA. Rather than working on an indirectly heated cathode, their first efforts were concentrated on directly heated cathode valves. Why this apparently retrograde research was undertaken when indirectly heated valves were already in existence has not been explained. Even in those days, the activities of Big Business were convoluted and it is likely that the directly heated cathode promised quicker results and possibly fewer legal wrangles.

By keeping the filament voltage low at 1.5 volts and current high at 1.05 amperes, a reasonably successful amplifier valve called the UX226 was produced early in 1926. Apart from the filament, it had the same electrodes as the 201A.

But the 226 proved to be too noisy as a grid leak detector, and effort was then directed at developing an indirectly heated valve anyway. Released in May, 1927, the UY227 also had characteristics similar to the 201A. The problem of a hum free detector was solved and convenient mains operation of receivers became a reality.

As was often the case, parallel development work was going on in Europe, but in Britain, mains supply standards were chaotic and battery receivers remained popular, generally with 2 and 4 volt filament valves. In Australasia too, mains powered radios were popular with those who could afford them, and a fair number from this era have survived to this day.

Concurrently with the development of AC heated valves, both in America and Britain, work was in progress that was also to have a tremendous impact on radio design.

Another big step

Despite its early success, the neutralised triode was recognised as having serious shortcomings. For one thing, neutralisation was incomplete over a wide tuning range. Shortwave operation was unsuccessful and the relatively low output impedance of a triode amplifier loaded down the following grid circuit, reducing both gain and selectivity.

Like many good inventions, in retrospect, the remedy was simple, but several years of research were needed to find the complete solution. The heart of the problem was the unavoidable capacitance between the grid and the anode.

It was reasoned that an electrostatic screen between the two should reduce this capacitance, and it did. This additional electrode took the form of a second or *screen* grid, operating at about half the voltage of the anode.

The tetrode, as the new valve was called, gave considerably more gain and less loading than the triode, although shielding demands were much more stringent. Stable shortwave amplification was now possible.

The first commercial battery tetrodes appeared in 1927. In Britain, Marconi-Osram marketed the S625, whilst RCA's contribution was the UX222.

With the success of the UY227 and UX222, the development of an AC screen grid valve was a foregone conclusion. But various problems meant that it was not released until April 1929. The UY224, later to be the stalwart 24A, was a winner and within a year the neutralised TRF was obsolete.

By mid 1929 then, there were available for mains receivers, a good triode, the UY227, the UY224 screen grid tetrode and the UX280 rectifier. To complete the series, there was a medium powered output valve which was to be equally as successful. This was the UX245 directly heated triode, destined to become a favourite, frequently used in push pull output stages capable of producing several good quality watts.

1930 was the end of a decade that had seen the evolution from regenerative one valve sets like the Grebe, through the three knob battery neutrodynes to the big single control mains powered screen grid TRFs. However 1930 was also to see the last of these magnificent receivers. But that, as the saying goes, is another story.

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Walking through a Radio Transmitter

This month we take an overall look at a broadcast radio studio and station, see a general view of its circuits, the form the signals take and where they come from. A short trip into the fascinating ideas of Amplitude Modulation completes the story.

by BRYAN MAHER

The speech and music you hear on your radio receiver all starts at the station studio in a microphone, record player or tape player. The speech signal begins as pressure waves in the air between the announcer and the microphone. Inside the microphone these air waves vibrate a very thin diaphragm.

There are many types of microphone; "ribbon", "moving coil", "capacitor", "crystal" are four common types. In the moving coil microphone the thin diaphragm has a tiny coil attached, surrounded by a small permanent magnet. As the air pressure waves from the announcer's mouth cause the thin diaphragm to vibrate, it moves the coil in the magnetic field, so generating a tiny voltage, between 10 and 100 microvolts. This tiny voltage is an audio frequency electrical signal which is amplified by a preamplifier.

At the announcer's console this signal may be switched to further studio amplifiers and amplified to a fair sized audio voltage signal. Alternately the announcer can switch in or out the various record-playing turntables, tape and cassette players, landlines or outside broadcasts coming in via microwave links. Fig.1 gives a symbolic idea of the arrangement.

In big stations a control engineer may perform these signal selections. The final chosen program is amplified in the studio to a fairly high voltage level so it can be sent to the transmitter, sometimes many kilometres away. Program is conveyed to the transmitter via either landline or microwave link. Either way the program is an electrical voltage signal corresponding to the sound pressure air waves originating at the announcer's mouth, or to the wavy shape of the grooves in an LP record, or the magnetisation pattern on a magnetic tape in the studio.

On arrival at the transmitter, these program signals (the "audio") is fed to a large high power audio amplifier called "the modulator". In Amplitude Modulated (AM) transmitter stations, the modulator is very high powered – in many cases, perhaps 5 kilowatts (kW), and up to 50kW in the case of some very high power ABC broadcast stations.

Crystal Oscillator

In another part of the transmitter, as indicated in Fig.2, the "oscillator section", a quite separate circuit generates a sine wave electrical signal at a high frequency, a "radio-frequency" (RF). We call this section the "RF oscillator".

Of course, gentle reader, you remember all you have read previously about sine waves, RF frequencies and tuned circuits. Well, the oscillator section in this case uses a special type of tuned circuit called a *crystal*, which is not the usual inductor-capacitor combination. Rather it is a solid slice of ceramic-like quartz (silicon dioxide) crystal, either natural or manufactured.

Carefully made slices of such crystals have a peculiar property called the "Piezoelectric effect". By this the crystal slice can be made to expand and shrink rhythmically (in a microscopic way), and in so doing a small high frequency voltage is generated between its faces.

The important thing about this property is that any particular slice of crystal can do this action at one and only one frequency. Thus it is an electro-mechanical equivalent to a tuned circuit.

From this unique frequency of a

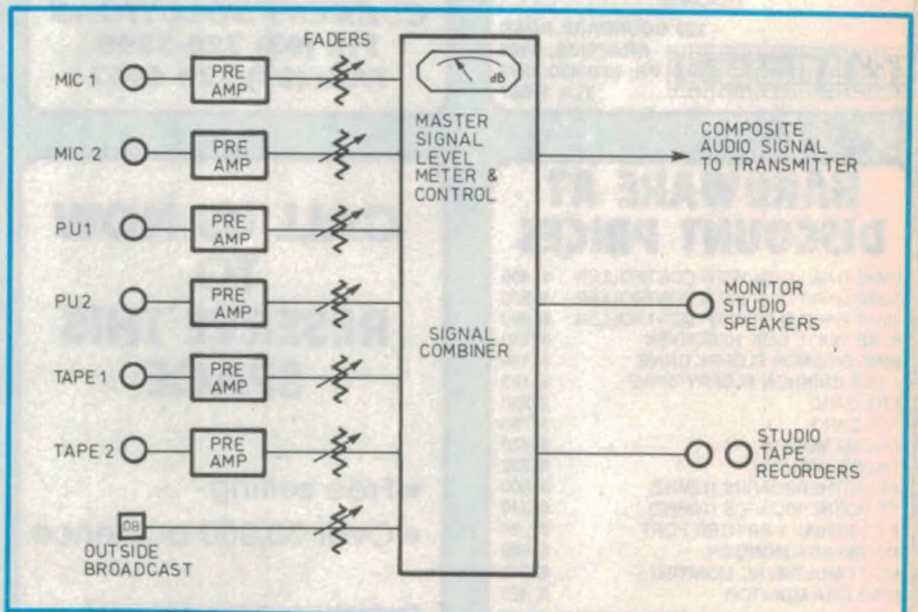


Fig.1: Simplified block diagram of a small radio station studio, showing the flow of audio signals.

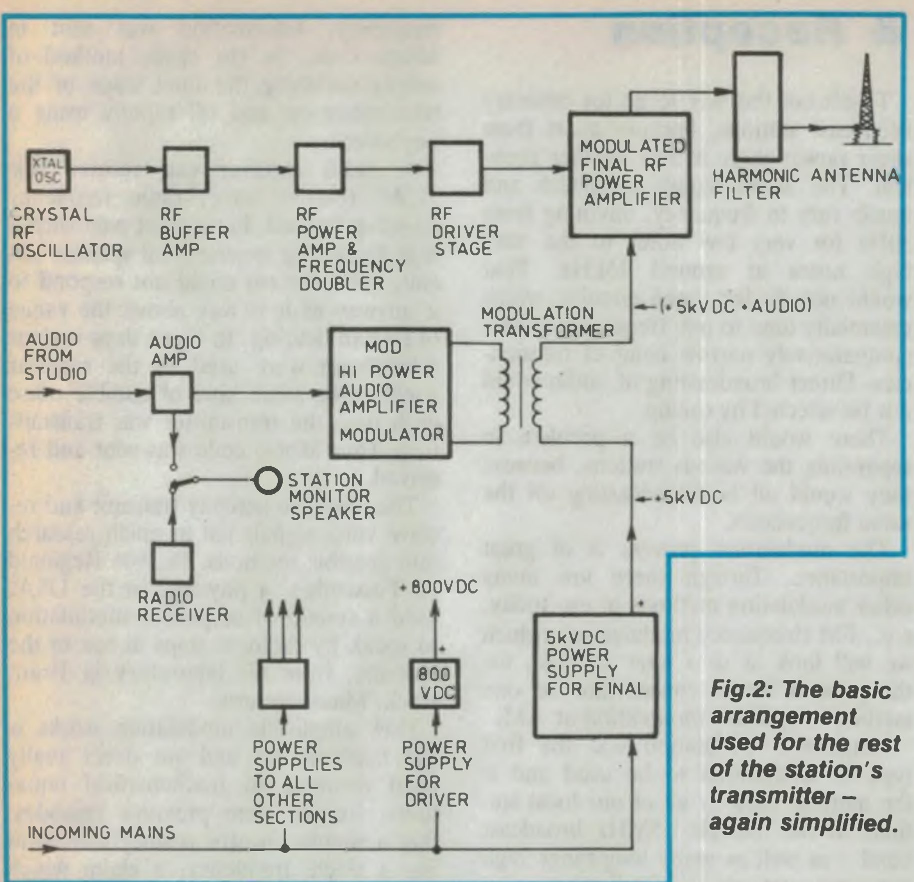


Fig.2: The basic arrangement used for the rest of the station's transmitter – again simplified.

particular slice of crystal is derived the "carrier" or centre frequency of a broadcast radio station. The extreme stability of the crystal frequency sets the stability of the whole transmitter's final output frequency. The crystal oscillator output is amplified, possibly frequency multiplied by two, three or some fixed whole number, and finally used to drive the transmitter final output stage.

Many of the stages following the crystal oscillator, and the final stage itself, use capacitor-inductor tuned circuits. This is possible and quite convenient, as each stage in this section of the transmitter is dealing with only one fixed radio frequency.

Transmitter final

In many AM (amplitude modulated) transmitters the final output stage, Fig.3, becomes the "meeting place" of the stable RF carrier frequency (derived from the crystal) and the amplified audio signal (derived from the microphone or record player at the studio). This process of "meeting" is called "modulation" and done in a special circuit which causes the amplitude of the constant frequency RF carrier to rise and fall at the slower rate of the varying audio frequencies.

The circuit shown in Fig.3 depicts a "plate modulated high-power class C final RF amplifier". MOD is the audio modulator, a high power audio frequency (AF) amplifier. V1 is a valve or vacuum tube, forming the high power RF final power amplifier. This raises the RF signal to the full station output power level, perhaps 2kW or up to 100kW according to the power limit for that station as specified by Government regulation.

In small transmitters V1 could be a large high power high frequency transistor, or even a power FET (field effect transistor). However in large transmitters V1 is a valve (vacuum tube) because no high frequency transistors capable of kilowatts of power have yet appeared in the market place.

V1 operates in class C, which means it is a non-linear amplifier which conducts in short, sharp, high-current bursts, only on the positive peak of the grid input RF cycle. T1 is a tuned RF air-cored transformer consisting of the primary, L1 (tuned by C1), while L2 is the step-down-ratio secondary.

This tuned circuit C1-L1 is called the "final tank circuit" because of the way the large valve V1 "dumps" big lumps of energy into the tuned circuit once each cycle. The dumped energy then circulates between C1 and L1, back and forth in a complete sinewave motion, as we discussed last month.

A little of this energy is lost in heat in the small resistance of the coil and cables, but a rather larger proportion is carried away from the tuned transformer by the secondary winding L2, to be coupled via the filter L3 to the station transmitting antenna. At the antenna 90% or more of the incident electrical energy is turned into electric and magnetic fields, which travel away from the transmitting antenna through the air to everybody's home, including your abode. This energy radiation away from the transmitter antenna is the radio-fre-

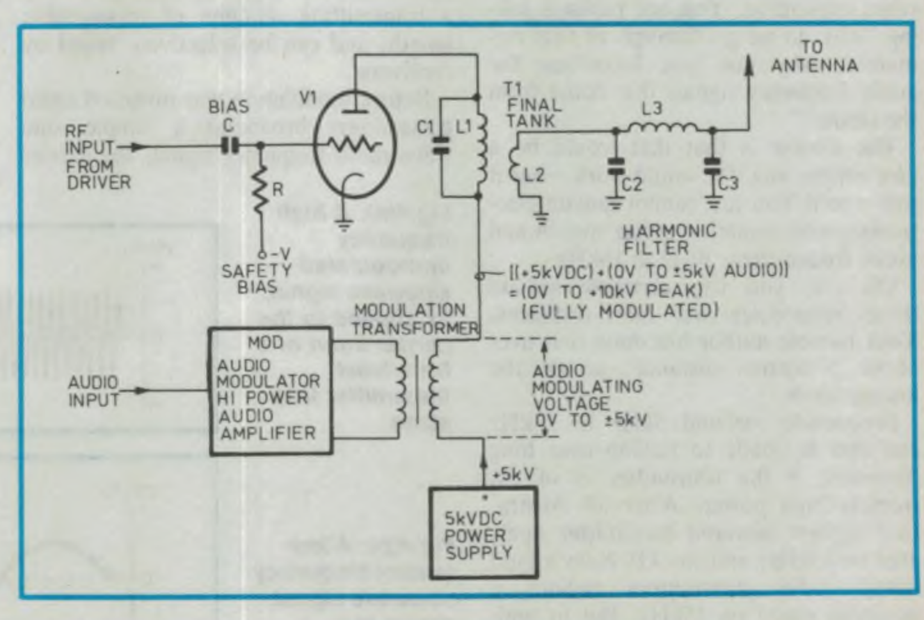


Fig.3: Simplified diagram of a small plate-modulated Class C final RF amplifier, as used in a broadcast frequency radio station transmitter.

quency electro-magnetic radiation we discussed in the first chapter of this saga.

In contrast to the large amount of energy continually being drained from the tank circuit C1-L1 by the antenna, there is a still-larger quantity of energy always circulating within the tank, back and forth between C1 and L1 in the manner which all readers of long memory will remember from last month's episode.

Quality factor "Q"

We give a name to the ratio of the energy continually circulating within the tank to the energy lost by the tank every cycle. We call this quantity the *quality* of the loaded tank coil-capacitor combination. Using the symbol "Q" to represent this factor, we define it as:

$$Q = \frac{\text{Tank circulating energy}}{\text{Energy drained away each cycle}}$$

As Q is a ratio of energies, Q itself is a dimensionless number. Typical values of Q for a large tank circuit, loaded by the transmitting antenna, are in the range from 8 to 12. This means that if a station is transmitting say 10kW from its antenna, anything up to twelve times this amount of power is continually stored in the coil-capacitor energy interchange action within the tank circuit. That's a large amount of circulating power!

Why modulation?

The purpose of modulation needs some explaining. You are perhaps asking "why do we go through all that rigmarole, why not just broadcast the audio frequency signals that come from the studio?"

The answer is that that would be a nice simple way if it would work – but it just won't! You just cannot radiate electro-magnetic radiation at the speech and music frequencies, 30Hz to 16kHz.

Oh yes, you can certainly radiate these frequencies over short distances. Your humble author has done that over about 5 metres distance, across the lounge room.

Frequencies around 5kHz to 20kHz can also be made to radiate over long distances, if the transmitter is of extremely high power. After all Australia's highest powered transmitter operates on 45kHz, and the US Navy's land based radio transmitters radiate a powerful signal on 15kHz. But in both cases the power needed approaches the megawatt level.

That's not the way to go for ordinary broadcast stations, because apart from sheer power there is also another problem. The audio signals of speech and music vary in frequency, anything from 30Hz for very low notes to the very high notes at around 15kHz. That would not do for tuned circuits, which essentially tune to one frequency or to a comparatively narrow band of frequencies. Direct broadcasting of audio could not be selected by tuning.

There would also be a problem in separating the various stations, because they would all be broadcasting on the same frequencies.

The modulation process is of great importance. Though there are many other modulation methods in use today, e.g., FM (frequency modulation), which we will look at in a later episode, for the present let us concentrate on one method: *amplitude modulation* or AM.

Amplitude modulation was the first type of modulation to be used and is the method used by all of our local stations in the 500kHz-1.5MHz broadcast band – as well as many long-range high frequency stations like Radio Australia, the BBC and Voice of America.

Amplitude modulation

In amplitude modulation the idea is that the station actually broadcasts a high frequency RF signal called the "carrier", of extremely accurate and stable frequency derived from the crystal oscillator. Being a high frequency it transmits well over long distances using a transmitting antenna of manageable length, and can be selectively tuned by receivers.

Before modulation was invented radio transmitters broadcast a simple sine wave radio frequency signal, the carrier frequency. Information was sent in Morse code, by the crude method of simply switching the final stage of the transmitter on and off rapidly using a key switch.

A radio receiver can receive this "CW" (carrier wave) radio frequency signal quite well, but cannot pass such a high frequency to your loud speaker circuit, and your ear could not respond to it anyway as it is way above the range of human hearing. In those days various subterfuges were used so the receiver could make some kind of audible noise each time the transmitter was transmitting. Thus Morse code was sent and received.

The desire to actually transmit and receive voice signals led to much research into possible methods. In 1906 Reginald A. Fessenden, a physicist in the USA, used a system of amplitude modulation to speak by radio to ships at sea in the Atlantic, from his laboratory in Brant Rock, Massachusetts.

How amplitude modulation works is not hard to see and we don't really need recourse to mathematical equations. Recall, from previous episodes, that a simple sine (or cosine) waveform has a single frequency, a claim which cannot be made by any other waveform. Also keep in mind three facts:

1. We need a high radio frequency to transmit over long distances with practical antennas.
2. We need low frequencies to transmit voice and music (because voice and music are in the range 30Hz to 20kHz.
3. To transmit voice and/or music we somehow have to combine (1) and (2).

Sinewave audio

The carrier signal is always a sine waveform, but the audio signal of voice and music can be, and usually is, a very complex waveform. To make explana-

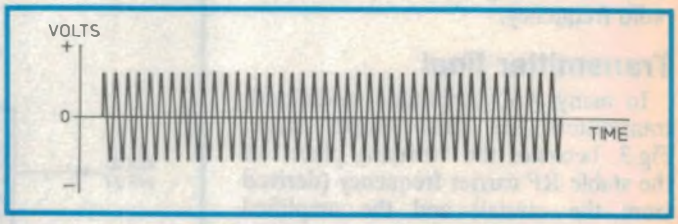


Fig.4(a): A high frequency unmodulated sinewave signal, as applied to the carrier input of a broadcast transmitter final stage.

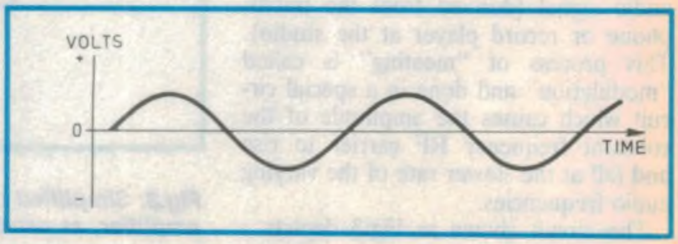


Fig.4(b): A low (audio) frequency sinewave signal, drawn to a different time scale for clarity.

tions simpler, first let us consider how we would transmit an audio frequency sine wave, such as we hear sometimes on the ABC as the hourly time signal.

Fig.4(a) shows the high frequency unmodulated RF carrier signal, a sine wave, and Fig.4(b) shows an audio sine wave signal. We recall from past reading that if a sine waveform is passed through any linear circuit, it comes out as a sine wave. The same is true if two sine waves at two different frequencies, such as those in Fig.4 are passed through any linear circuit: you just get out two different sine waveforms added. That's not what we want, of course. We want somehow to combine them.

The only thing left to do is to pass the two waveforms in Fig.4 through a non-linear circuit. Now that's something else again!

The mathematicians can show that when two sine waveforms, (such as the RF carrier and our audio frequency sine wave) at two different frequencies are passed through a suitable non-linear circuit, the output contains up to seven components, as follows:

1. The original RF sinewave.
2. Harmonics of the original RF sinewave.
3. The original audio sinewave.
4. Harmonics of the original audio sinewave.
5. A new signal, being a sinewave at a frequency equal to the *sum* of the RF frequency plus the audio frequency. Call this new frequency the *upper sideband* (abbreviated USB).
6. Another new signal, a sinewave whose frequency is the *difference* between the RF frequency and the audio frequency. Call this new frequency the *lower sideband*, or LSB.
7. Possibly a DC level.

As the tank circuit C1-L1 in Fig.3 is tuned to the carrier RF frequency, the audio frequency (being so different) does not appear in the output. Because of the tuning of the tank C1-L1, and the presence of the filter C2,C3 and L3, the harmonics mentioned above are also suppressed.

Sideband power

The tuning of the tank C1-L1 is wide enough to admit both the LSB and the USB, as well as the carrier. Therefore the signal as sent to the antenna contains the carrier together with the two sideband frequencies.

The relation between the amplitudes of RF carrier and original audio waveform is called the modulation percentage, denoted by "M". The amplitude of the audio waveform (as measured across the secondary of the modulation transformer T2), can be anything from zero (M=0), up to the same voltage as the RF carrier (M=1), but not greater.

TABLE 1
Amplitudes and powers in amplitude modulation (for sine wave audio frequencies)

Modulation index M	Carrier power	Amplitude of each sideband relative to carrier amplitude	Power in each sideband	Total sideband power	Total transmitted power
100%	10kW	0.5	2.5kW	5kW	15kW
50%	10kW	0.25	625W	1.25kW	11.25kW
25%	10kW	0.125	156.25W	312.5W	10.3125kW

The mathematics also shows that for the case of 100% modulation, i.e., M=1, the amplitude of each sideband frequency in our example is half that of the carrier. Because power is proportional to voltage squared (and because the square of 1/2 is 1/4), it follows that in our example each sideband frequency carries one quarter as much power as the carrier.

So the total sideband power carried by the two sideband frequencies amounts to half the power of the original carrier. In other words the total transmission, at 100% modulation percentage and sine wave audio, is one-and-a-half times more powerful than the RF carrier alone. This extra power is provided by the audio modulator, in the case of the circuit Fig.3.

We talk glibly about the carrier, upper and lower sideband frequencies as if they were three separate and distinct frequencies. We list examples of their relative amplitudes and powers in Table 1. But where is the audio? The relative frequencies appear as Fig.6, for a carrier of 1.0MHz and sinewave audio at 800Hz. For speech or music Fig.6 would be much more complex. Some readers are no doubt grumbling that they have been tricked – "Can't see any audio frequencies in Fig.6!" So where is the voice and music contained? The answer is:

1. The carrier conveys no information, except the fact that the station is transmitting ("on the air") and a measure of its strength.
2. All the audio information – speech, music and other sounds – is conveyed by the lower sideband.
3. All the audio information – speech, music and other sounds – is also conveyed by the upper sideband.

Now that all our readers are happy again, you are perhaps wondering why we transmit what appears to be three signals, when either the LSB or the USB alone carries all the information?

Why full AM?

Good question indeed! And that question has given rise to a host of alternative methods of modulation, like single sideband (SSB) – of which you probably have heard from friends or CB (citizen's band) devotees.

The answer to your question is that, in the case of local broadcast and many overseas stations, full AM (i.e., carrier + LSB + USB) are all transmitted because:

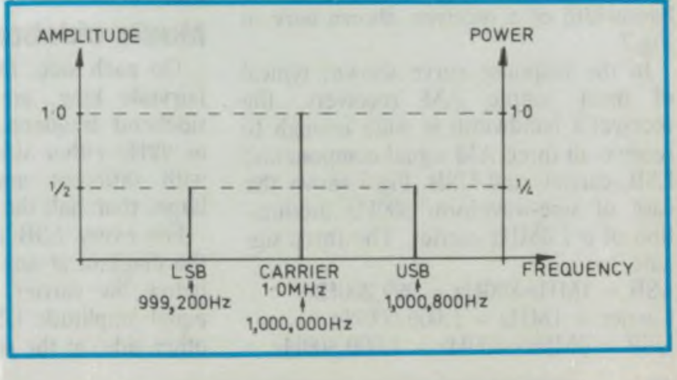


Fig.6: A frequency domain graph of a 1MHz RF carrier fully amplitude modulated by a 800Hz audio sinewave signal.

1. That's the way it was first done, and millions of receivers designed for this method are in use.
2. This system results in the simplest (hence most economical) radio receivers.

It is true that with AM the station seems to be wasting some power, but this full AM system results in easy radio receiver design for low price mass production receivers. At least that was the reason years ago.

Today, using some of the extremely complex, small and low priced integrated circuits that abound in the market place, manufacturers can produce very complicated and powerful radio receivers capable of receiving two or more types of modulation. And these receivers can be sold to you at a lower price than early simple AM receivers of past years. That's progress!

So you may well wonder is there any good reason why full AM, with its apparently wasteful attitude to transmitted power, should not be replaced by other more efficient modulation systems? The truth is that today many local broadcast stations are changing to the FM modulation system and perforce changing their frequencies up to the VHF band around 100MHz. But that's another story for another day.

What about those international AM stations like Radio Australia, the BBC, Voice of America, Deutschland Speigel, etc? Why do they continue to use AM (which some unthinking people call old-fashioned)? The answer becomes clear when we consider one more aspect of all modulation systems. That is the matter of *bandwidth*.

Bandwidth

Firstly let us make the point that to use the system simplicity of full AM, our simple receiver must be capable of receiving and amplifying the carrier and LSB and USB simultaneously. Recall in an earlier discussion we talked of the bandwidth of a receiver, shown here in Fig.7.

In the response curve shown, typical of most simple AM receivers, the receiver's bandwidth is wide enough to receive all three AM signal components: LSB, carrier, and USB. Fig.7 shows the case of sine-waveform 800Hz modulation of a 1.0MHz carrier. The three signals
LSB = 1MHz-800Hz = 999,200Hz
Carrier = 1MHz = 1,000,000Hz
USB = 1MHz+800Hz = 1,000,800Hz

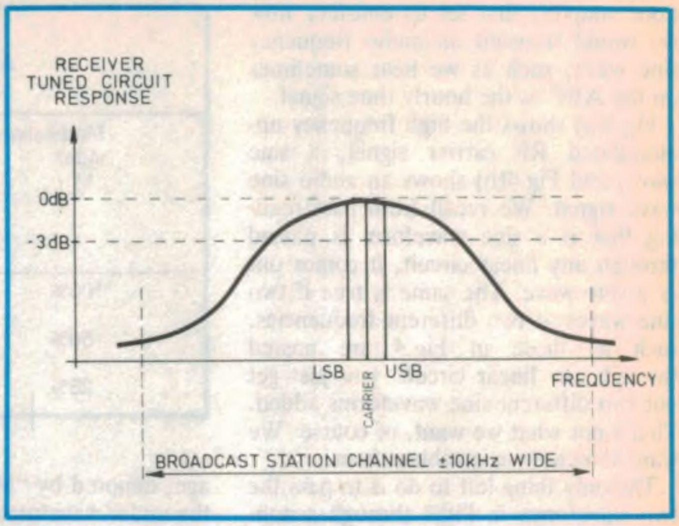


Fig.7: The RF tuned circuits of a receiver respond well to all sidebands within the station bandwidth of +/-10kHz.

are all received and amplified almost equally by the receiver, whose bandwidth extends +/- 9000Hz each side of centre.

Fig.7 is for single frequency 800Hz sine waveform modulation (a handy test signal, but a rather boring sound conveying neither program nor information). Now let's make another perfectly true, very general, though cryptic statement:

No single-frequency transmission can convey any information, intelligence or program, except the fact that the station exists, and its strength.

So to convey any type of information or program at all, we must use more than one frequency. This implies that all programs broadcast will consist of a range of frequencies. If you want to send speech, you will use the range of modulation frequencies from about 300Hz to about 3000Hz. For music the range of audio modulation frequencies used will be much wider, using any or all of the frequencies from as low as 50Hz up to 9kHz.

Thus any sketch of the sideband frequencies used in a live or recorded AM broadcast would look more like Fig.8. Here we see the carrier or centre frequency as a constant amplitude signal, the largest amplitude of all in the figure.

Music sidebands

On each side, like courtiers of some fairytale king, are a whole range of sideband frequencies, extending as far as 9kHz either side of the carrier. All with different amplitudes, but none larger than half the carrier amplitude.

For every LSB frequency we see in the diagram at any particular frequency below the carrier, we can identify an equal amplitude USB frequency on the other side, at the same frequency above the carrier. The whole bunch of LSB's are as a mirror-image of the set of USB's, "mirrored in the carrier".

The only reason why the sidebands stop at 9kHz either side of the carrier is that the whole broadcast frequency scale is divided into 20kHz channels, each channel allotted to a different radio station. To avoid "adjacent-channel" interference, sidebands more than 9kHz from the carrier are filtered down in amplitude towards zero at 10kHz either side of the carrier, as Fig.8 shows.

To receive all that speech and music faithfully, our receiver must receive all of that "mess" – all the LSB frequencies and all the USB frequencies, and (of course) the carrier.

Frequency & time domains

Figs.6,7 and 8 are all drawn "in the frequency domain", i.e., with *frequency* as the horizontal axis of our graph. These figures are graphs showing all the frequencies of all the signals that occur sometime (not necessarily together) within some reasonable range of time.

If we were to look at such a signal on a cathode ray oscilloscope (CRO) what would we see? The picture we would see is "in the time domain", meaning that we see the changes in the signal voltage as *time* progresses – ordinary real time in seconds, milliseconds or microseconds. This is shown in the CRO picture of Fig.9, which as you can see is very different from the frequency domain graphs.

Time-domain pictures, as shown on a CRO, are single snapshots of the voltage changes which occur almost instantaneously, or at least in a tiny interval of time. We use the CRO to "freeze a short segment of time" (in true science fiction style) so we can inspect the voltage excursions which occurred. Then after a few milliseconds we see the next

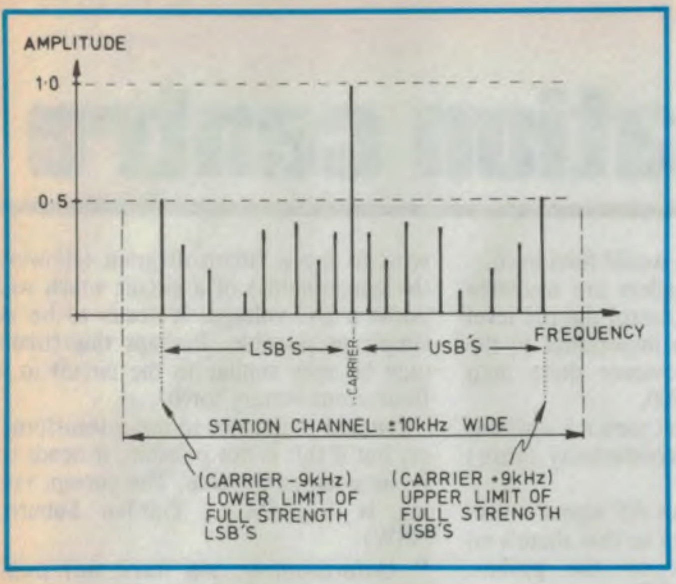


Fig.8: Inside the standard broadcast channel bandwidth of 20kHz, sidebands within +/-9kHz of the carrier are transmitted at full strength while those outside this range are attenuated by filters.

snapshot, repeating the process to make a "moving" picture.

In the time domain Fig.9 we do not see three frequencies as shown in the frequency domain diagrams of Figs.6 and 7. Rather we see, in the time domain, the composite voltage diagram.

The modulated waveform

Any signal has only one voltage value at any one moment of time. The time domain diagram on a CRO shows that voltage as a vertical height above or below a zero line for each moment. We see, as in Fig.9, that the signal voltage rises and falls at carrier frequency, but the amplitude of such carrier signal cycles is continually changing at a slow rate – the audio modulation rate.

The AM modulation circuit, Fig.3, is effectively a *multiplication* circuit where the amplitude of the audio signal modifies the positive supply voltage feeding the final RF amplifier. By this action, and the fact that the final RF amplifier stage is non-linear, the output waveform, Fig.9, is the product of the RF signal cosine function multiplied by the modulating signal.

Whenever the modulating signal is large and positive, the RF signal is large on both positive and negative swings. Whenever the modulating signal is large and negative, the RF signal is small on both positive and negative parts of its cycle.

Fig.9 is a picture of a high frequency RF signal, so such a signal transmits well over long distances and can be tuned by L-C circuits at both transmitter and receiver.

Notice that the modulating signal does not appear in Fig.9 directly, but does appear by implication, as the shape of the envelope formed by just the positive peaks of the RF cycles is a picture of the complete modulating signal. As well, the envelope formed by just the negative peaks of the RF signal is also a picture of the whole modulating signal.

Postscript

For those readers overcome with mathematical enthusiasm, yes you can explain all the above mathematically.

Recall that we commented earlier on the function-multiplication effect of the non-linear stage Fig.3. For your delight here are the equations in brief.

From Fig.9 we see that modulated output consists of the steady carrier added to the "wavy" part. The wavy part is the product of the modulating signal and the carrier Cosine function. So the total modulated output is:

Carrier + (modulating signal x carrier Cosine function)

Using:

Vo = total modulated output voltage
Vc = peak voltage of carrier alone
$Pi = 3.1416$
fc = carrier frequency
Vm = peak voltage of modulating audio signal alone
fm = audio modulation frequency
t = time in seconds
M = modulation percentage

We have:

$$Vo = Vc.\mathrm{Cos}(2\,Pi\,fc\,t) + Vm.\mathrm{Cos}(2\,Pi\,fm\,t).\mathrm{Cos}(2\,Pi\,fc\,t)$$

But by our definition of modulation percentage,

$$Vm = M.Vc$$

$$Vo = Vc.\mathrm{Cos}(2\,Pi\,fc\,t) + M.Vc.\mathrm{Cos}(2\,Pi\,fc\,t).\mathrm{Cos}(2\,Pi\,fm\,t)$$

Let us call that equation (3).

Notice the product of Cos functions above.

We can see in Fig.9 that $Vc(1 + M)$ is the maximum amplitude, and the term "1 + M" can appear in the equations thus:

$$Vo = Vc.\mathrm{Cos}(2\,Pi\,fc\,t).(1 + M.\mathrm{Cos}(2\,Pi\,fm\,t))$$

From trigonometry remember that

$$\mathrm{Cos}(a + b) + \mathrm{Cos}(a - b) = 2\,\mathrm{Cos}(a)\,\mathrm{Cos}(b)$$

Substituting this trig equality into equation (3) we have:

$$Vo = [Vc.\mathrm{Cos}(2Pi\,fc\,t)] + [1/2\,M.Vc.\mathrm{Cos}(2Pi(fc + fm)t)] + [1/2\,M.Vc.\mathrm{Cos}(2Pi(fc - fm)t)]$$

In this, the final equation, the term in curly brackets is the carrier, the first term in square brackets is the USB and the second term in square brackets is the LSB.

Notice that each sideband amplitude is half the carrier amplitude (when M = 100%), and that the sideband frequencies are given by (fc + fm) and (fc - fm) respectively, as we asserted non-mathematically before. QED (which I'm told means "quite enough done"!)

Next time we will consider how this signal, so carefully modulated, can be demodulated in your radio receiver.

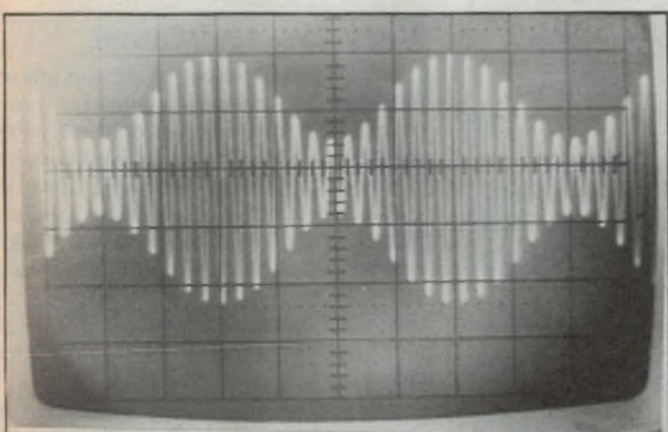


Fig.9: Time domain picture of an amplitude modulated high frequency signal, taken from a CRO screen.

Information centre

Commodore interface

Could you tell me if you have described any simple interfacing projects suitable for the Commodore 64/128 (B.J., Orbost, Vic).

• ***We have not published any interfacing projects specifically for the Commodore 64 and 128 machines. However in our March 1988 issue, we published an article entitled "Connect your PC to the outside world". We're curently developing a more elaborate unit, which you might also find of interest.***

Soil conductivity

For some time now I've been searching for a circuit for a conductivity meter as used by hydroponic gardeners.

Do you know of any previously published circuits? If not, would it be possible to consider this as a future project?

There are several makes available in NZ, some analog and others digital, but at $200-300 they are too dear for the home gardener.

The ideal meter would have maximum and minimum settings (adjustable) which would drive a relay which in turn would operate a solenoid valve. This would allow the gardener to go on holiday while the garden would feed itself.

Such automatic feeders are available here too (they also control the pH level but pH is of far less importance to the home gardener). However these auto units cost around $1200.

On the back of one meter I saw was the following: 1 cf.(conductivity factor) unit = 100 mS.

I also understand an AC signal is necessary between probes so that there's no buildup or erosion on the probes. (T.J.S., Manapouri, NZ)

• ***Unfortunately, to this date we have not published a circuit such as the one you describe. However, we will keep the idea in mind for a possible future project.***

Lighting system

At the moment I am designing a circuit which incorporates a push-bike dynamo lighting set with rechargeable batteries. As part of that circuit it is necessary to step-up a DC voltage so that it can be regulated correctly. I have found it difficult to obtain information on how to do such a thing. Someone suggested that I obtain the circuit from a battery-powered flourescent torch and adapt that in the circuit. Could you please send to me a circuit diagram (showing the components) of a circuit which will boost a DC voltage. It needs to be as simple as possible. Perhaps this circuit may be very similar to the circuit in a flourescent battery torch.

I would prefer not to use a transformer, but if this is not possible, it needs to be as small as possible. The current rating is 1-2A.(M.V., Garden Suburb, NSW).

• ***Unfortunately, we have not published a circuit suitable for such a purpose. You'd need to use a small DC-DC convertor, with a suitable transformer, switching transistor(s) and output rectifier system.***

Circuit idea.

Some months ago I built a 16k memory expansion for my son's VZ-300, so far I have found it impossible to get to run propertly. The fault seems to be incorrrect memory addressing.

The circuit used came from your May 1987 magazine, in the Circuit and Design Ideas section.

Could you please tell me if any alternations or corrections were made to the circuit you published. My son is hoping to try and run Stan Blaster, which needs the extra memory, and at present is not pleased with a Dad who can't build things that work. (J.B., Nowra, NSW).

• ***Sorry J.B., but items published in the Circuit and Design Ideas section are presented "as is", directly as sent in by readers. As we note each month, we're not in a position to provide any further help with them.***

Very low resistance.

Have you published (or do you intend publishing) a circuit diagram (or project) for the measuring of extremely low resistance. I was thinking of a 4 wire instrument capable of measuring down to 100 micro ohms, that could be used on printed circuit boards with a fairly high degree of accuracy. Could you also tell me what are "Kelvin needle probes" as described in the Toneohm 700 PCB fault tracer on page 108 of the April edition. (J.O'N, Cooma. NSW)

• ***As yet we have not published a project of this kind. However, we will***

What was it?

This month's mystery item is another early version of a component that is still in use today, although you mightn't find it too easy to recognise. Today's equivalents cost about 50 cents, but back in 1929 the component shown would cost you anything from 7 shillings and sixpence to twice that figure, depending on its electrical value. This would correspond to something like $50 in today's money. *Answer next month)*

September's mystery item

The mystery item last month was a Magnavox Dynamic – an early version of the "powered loudspeaker", or power amplifier and loudspeaker combination.

Based on one of the first *electrodynamic* or moving coil loudspeaker units, it included both a power amplifier stage to boost the output from a headphone-type radio receiver, and a mains-derived power supply.

Unlike today's models, early moving coil loudspeakers didn't employ a permanent magnet to provide a magnetic field around the voice coil – at the time, permanent magnets simply weren't good enough for the job. They used a large electromagnet instead, known as the *field coil*. Often this was connected into the power supply of a receiver or amplifier, where it not only received DC current for excitation, but also doubled as a filter choke. It's likely that this arrangement was used in the Magnavox Dynamic.

keep this idea in mind for a possible future project. We're not too sure just what Kelvin needle probes are – perhaps the experts at Emona Instruments can explain.

60-60 amplifier

I have finished building the Playmaster 60/60 Amplifier. When testing it I found that I could not set the quiescent current. The voltage across the 560 ohm 5W resistors used for setting the quiescent current continues to rise and will not stay at 11.2V.

I have read your May 1987 feedback on the 60/60 Amp and have not been supplied with the wrong value of high frequency compensation capacitor. I have earthed the heatsink; also Q12 has been swapped for an MJE340 already.

Could you please give any reasons for this problem? It is in both channels. (J.F., Sutherland, NSW).

• The problem with your amplifier seems to indicate thermal runaway. This may be confirmed by heating and cooling the amplifier while monitoring the quiescent curent.

If this problem exists afer the May 87 modifications have been implemented, we must look for other factors. They are:

- ***insufficient heatsinking compound between the semiconductors and heatsinks.***
- ***inadequate cooling from a steel, rather than aluminium, box.***
- ***the possibility of supersonic oscillation, as detected by the probe shown on p66 of the May 87 issue.***

NOTES AND ERRATA

ROBOT BOOK: In the August 1988 issue, we published a letter from a Mr G.A., of Tauranga NZ, enquiring about a book by David Heiserman called "How to Build Your Own Self-Programming Robot". Due to our fire we've lost Mr G.A.'s original letter, with his full name and address, but if he cares to contact Bob Barnes of RCS Radio Pty Ltd., at 651 Forest Road, Bexley NSW 2207 or phone (02) 587 3491, Bob has kindly offered to help with further information. Thanks, Bob!

Letters

continued from page 7

press. One can only hope that the makers of the various dry batteries will act to protect their interests and in so doing advise the consumer of the unique suitability of their cells for the great majority of battery operated equipment.

Phil Allison,
Sydney, NSW.

Common emitter amps

I am writing with regard to the article "Designing Common Emitter Amplifiers" which appeared in the June issue of EA. The article is quite informative but it contains an error.

The problem occurs on p132 in the middle column, in the calculations for C2. There seems to be some confusion about RE, Re and re, although I am pretty sure that in this instance Elmo Jansz is referring to Re, the emitter resistor that is bypassed by C2.

In the article the equation for C2 is given as

$$C2 = 10/(2\pi.50.10^3)$$

which in a more general form can be written as

$$C2 = 10/(2\pi.f.Re)$$

where f is the lowest frequency of operation, and Re is the emitter resistor. This I believe, is not correct.

From reference to "Integrated Electronics" by Millman and Halkias, I suggest the correct expression is

$$C2 = 1/(2\pi.f.re)$$

To make sure I lashed up the circuit using a BC109 and the components as described in the article (C2 = 47uF), and found that the low frequency 3dB point was in fact approximately 130Hz, not 50Hz as was intended in the design. This is exactly what my equation for C2 (above) predicts.

I believe that a few other points should have been made in the article as well. First, it is essential that the supply line must have a fairly low impedance over the range of frequencies the amp will be expected to cover (i.e. some supply bypassing may be necessary).

Second, amplifiers which have the emitter effectively grounded to signals, such as this one, can only handle about 10mV peak-to-peak (or 3.5mV RMS) input before significant distortion occurs.

Third, I feel that some mention should be made about the effect of collector current on gain and input impedance. And fourth, some follow up article(s) should discuss emitter followers, differential pairs and perphaps some other related topics.

On another matter I would like to register my intense dislike of the current practice of not numbering every page. I find it very frustrating opening the magazine in the middle of a six page ad not knowing where I am nor where I should go. The July issue is not too bad with approximately 70% of the pages numbered, but I do find it difficult, like walking into a dark room with only a flashlight! EA is not the only culprit nor the worst, but I wish you could do better.

That should be enough griping. I thank you for your time.

Phil Denniss
Dept. of Plasma Physics
University of Sydney, NSW

Comment: Thanks for the clarification, Phil. We have already published an article by Elmo Jansz on emitter followers, in the February 1984 issue. Numbering every page of an issue is often difficult, due to the habit of many advertisers in "bleeding" their copy out into the space normally used for our pagination lines.

Forum

continued from page 43

will necessarily help the understanding of circuit theory. I can easily imagine a situation where it could do the exact opposite, and very effectively.

By the way, I note that in Mr Van der Zwan's final paragraph he writes that our use of the SAA/IEC standards would be a significant step *towards the standardisation* of electrical drawing practice. So even he obviously realises that the standards haven't achieved true status as yet. This is contrary to his assertion earlier that we should be "adhering to the recognised standard symbol language".

Where does this all leave my original article, and *EA's* current use of circuit symbols in general?

Well, with the benefit of hindsight I guess I could have shown a few of the rectangular symbols so beloved of the SAA/IEC, and this probably wouldn't have made things more confusing. But I don't regard it as a major omission, by any means. The article mainly deals with the symbols that are currently used most widely, and that was my intention – because this would provide newcomers with the greatest help.

As I explained on the very first page of the article itself, there's enough similarity between the symbols used throughout the world, that once you're fairly familiar with one dialect, you can usually find your way around most others. I'm sure this will extend even to the dialect currently favoured by the SAA and IEC. Unless or until that particular dialect becomes a lot more popular, I don't believe we'd be doing our readers a favour by adopting it as *EA's* standard. It seems to me we're better off sticking to our current "non-standard" symbols, because on the whole they're more widely used.

But what do YOU think? Drop me a line to let me know your views, as well.

Finally this month, a note about last month's topic of oxygen-free copper and its use in hifi equipment.

Although I wrote then that I hoped to have some authoritative information on the subject this month, from at least one company's design people in Japan, that hasn't been possible. Perhaps they've been too busy, but so far there's been no response. I'm still hoping to get the information, though, and I'll pass it on to you as soon as I do.

Frankly Frank

continued from page 38

Commissioner, even if supplied with all sorts of warrants and portable photocopiers as in a recent example in Sydney, cannot serve a writ on an immaterial tax fiddler. Our software evangelist also cannot be caught in unforeseen situations with young female humans, either.

It occurs to me that our intelligent program is in all conceivable ways directly analogous to a dis-embodied spirit – an angel, demon, fire or other elemental, poltergiest, doppleganger, mban sidhe (Banshee for those who who only speak in anglice) – or doctors who charge the "Most-Common-Fee".

You will easily be able to identify whether your intelligent program is malign or not. Look at the object code and if the sequence 110, 110, 110 recurrs, watch your step and read up the words of St John on Cyprus. I wonder what the good man might have been drinking as he wrote about the pale horse, the seven horned beast and the whore of Babylon. Of course our man might have been careless when he stirred the mushrooms in to his lunchtime salad, or since it was a long time before science he may have smoked a bit of the old Hash.

My telephone just rang. When I picked it up I got the long-distance tones and then a man speaking French-Canadian French spoke. Either that or Francois Villon was calling from Fat Margot's bar and grill. Has it started I pondered – is the International Telephone system now a creature in its own right, and does it plan to get its own back on us for the way we overwork it?

Paranoia may be distressing, but it is probably a survival characteristic in the 1980s.

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.

RADIO, TELEVISION and HOBBIES

October 1963

Australian Doctor Develops New X-Ray System: Broken bones can be set in one-quarter the usual time with only one-hundredth the X-ray energy, by using new electronic techniques pioneered by an Australian experimental surgeon and his associates.

During a visit to the United States of America to exchange technology with engineers of Raytheon Company, Dr George Berci explained how his team from the University of Melbourne had worked for two years to build the "stored telexray" system to aid surgeons in setting fractures.

Starting with an X-ray tube, the information is amplified by an image intensifier for a brighter picture. This is then viewed by a vidicon television camera tube. Systems now in use do this, Dr Berci explains, but present a picture only while illuminated by X-ray energy and the patient and surgical team must be exposed to X-rays continuously.

Key to Dr Berci's unique system is a storage tube developed by Raytheon Company. The tube receives the picture of the broken bone from the TV camera and "freezes" it on a fine mesh within the tube. The picture is then displayed on several television monitors in the operating room, beside the surgeon and others who need immediate progress reports.

Wireless Weekly 3d

October 1938

Sydney Sees Television Sets: The Sydney public was given a foretaste of sight broadcasting recently when two television sets, brought from England by the British General Electric Co., were shown in a window of Farmer and Company's Market Street store.

Each day for the past week or two large crowds have gathered outside the window to see the apparatus, which which consists of two of the models now being manufactured on a commercial scale in England, together with a cathode ray tube and photographic reproductions of actual television broadcasts.

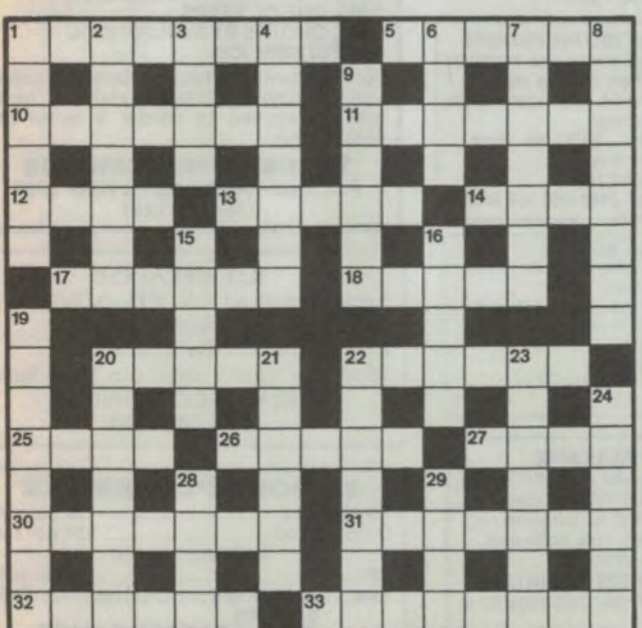
As there is no television transmission in Australia, the effect is simulated by projecting a sub-standard motion picture on the television screen of one of the receivers.

The object of the display is to give Sydney people a realistic impression of the service enjoyed by listeners and "lookers" in England and on the Continent, and it forms a splendid medium for wide-appeal publicity.

CROSSWORD

ACROSS

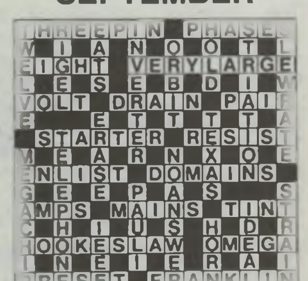
1. Electronic game control. (8)
5. Home entertainment item. (6)
10. Masters mould them .(7)
11. Said of area not tested for clandestine bugs. (7)
12. Illuminated emergency sign. (4)
13. Auxiliary component for computer. (4)
14. Musical instrument digital interface. (4)
17. Drives. (6)
18. Rid program of faults. (5)
20. Follows beam to beacon. (5)
22. Replay recorded segment. (6)
25. Hire (TV etc). (4)
26. Semiconductor where holes are major carriers. (1-4)
27. See this when you face the phone. (4)
30. Critical occasion at Cape Kennedy. (4-3)
31. Said of an alarm that's not set. (7)
32. Brand of soldering iron. (6)
33. Phosphor does this on the screen. (8)



DOWN

1. Interfered with radio signal. (6)
2. Element with atomic no.39. (7)
3. Shapes of simple aerials. (4)
4. Service with heavy duty. (7)
6. Television & Electronic Services Association. (4)
7. Winding a tape. (7)
8. Image-forming tube. (8)
9. Sent discrete signals. (6)
15. Nobel Prizewinner & atomic physicist, Enrico ----. (5)
16. Meaning of super in SHF. (5)
19. Excessive input to calculator. (8)
20. Quantity of digits! (7)
21. Begin trip to TV repairer? (3,3)
22. Insulation fault. (7)
23. Puzzling problems. (7)
24. Current-inducing parts of fans. (6)
28. Computer instruction. (4)
29. Region of lower registers. (4)

SOLUTION FOR SEPTEMBER



EA marketplace EA marketplace

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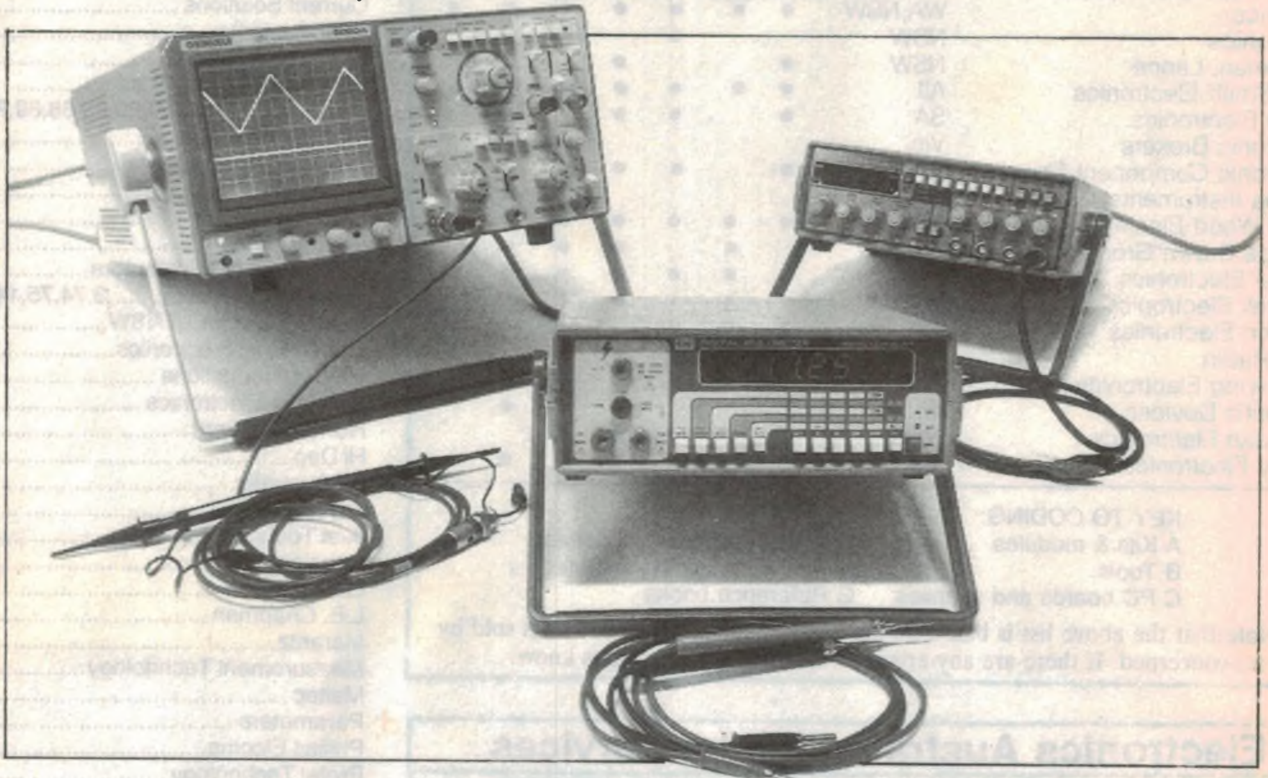

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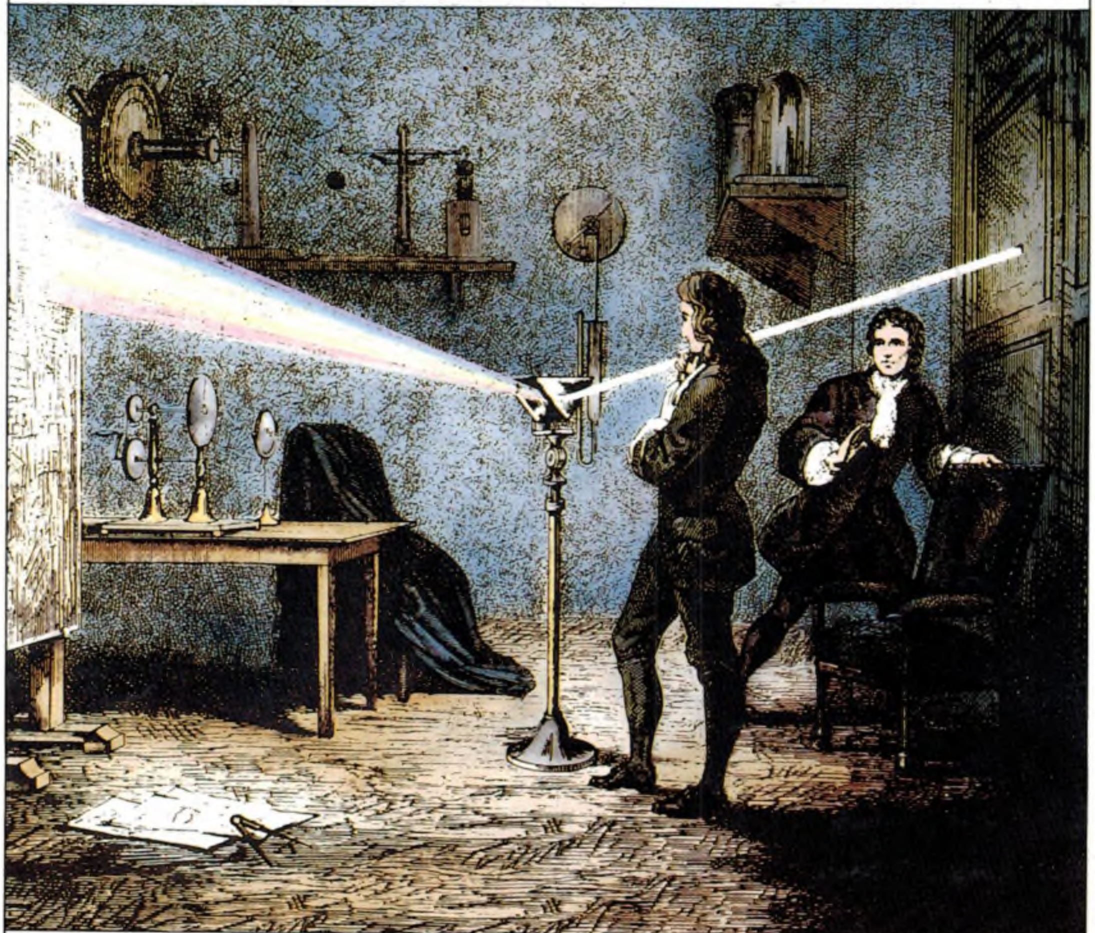

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