NEWS, AUDIO, COMMUNICATIONS AND COMPUTERS

electronics today INTERNATIONAL

OCTOBER 1978

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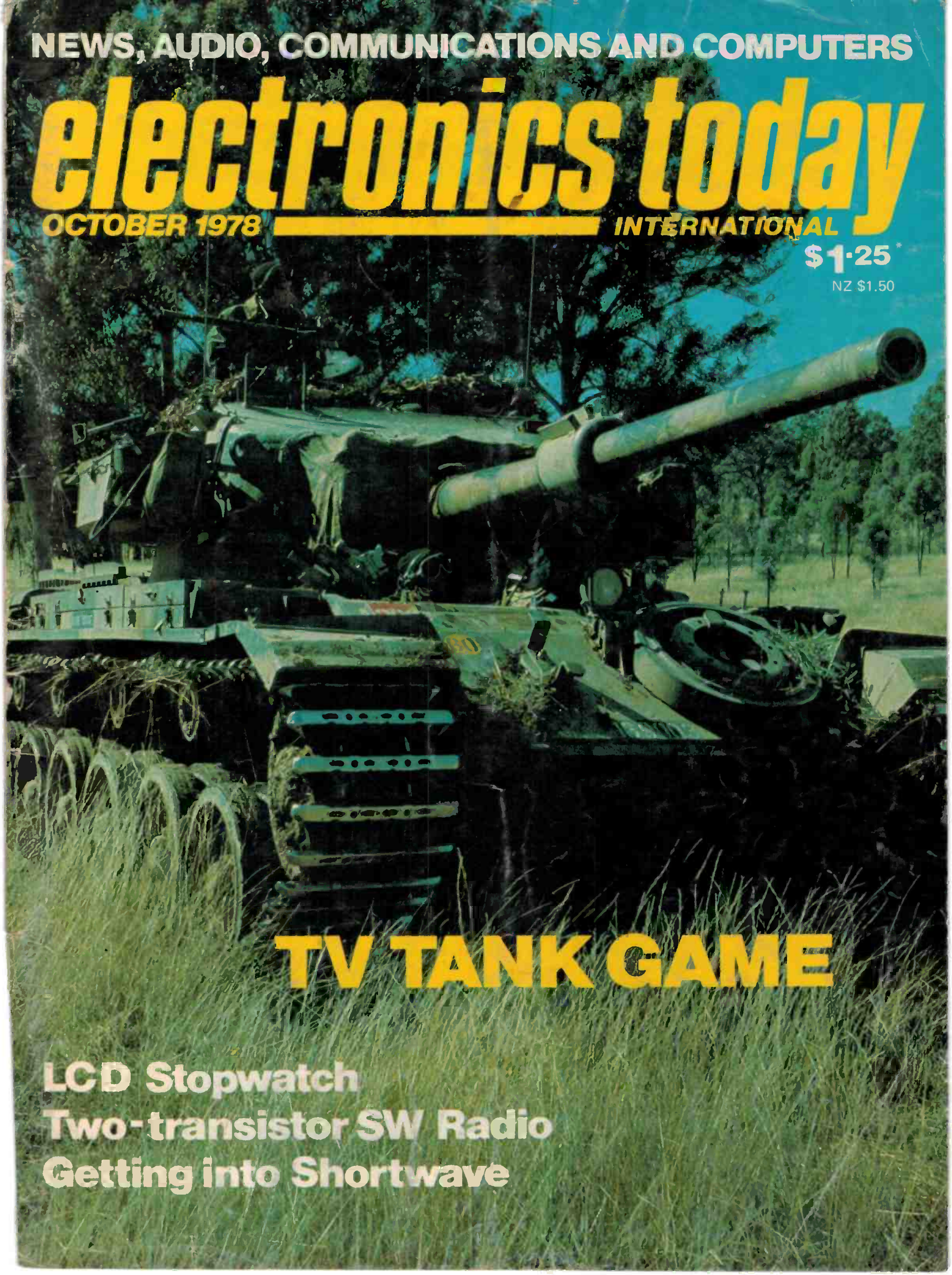

TV TANK GAME

LCD Stopwatch
Two-transistor SW Radio
Getting into Shortwave

The competition don't like the sound of this at all.

For quite some time, other manufacturers have been trying to produce tape with the qualities of the Maxell UD-XL. At the same time, Maxell have been quietly perfecting an even better series.

The UD-XL I and UD-XL II tapes are designed to attain maximum performance at the ferric and chrome position on your tape deck. Whichever tape position you choose, Maxell can give you a better performance.

UD-XL I TAPE, FOR FERRIC (norm.) POSITION (120*us*)

UD-XL I offers an excellent sensitivity of 1 dB higher than even UD-XL. MOL performance is also 1 dB higher over the entire audio frequency spectrum. The result is a new standard in ferric tape, with wider dynamic range and less distortion than ever before.

How does the UD-XL I compare then, with ordinary low-noise tapes?

Sensitivity is higher by 2.5 dB, and MOL performance by as much as 6 dB.

Yet, for all this UD-XL I requires no special bias or equalization. Simply set your tape selector as you normally would at the ferric position – but there the comparison ends.

UD-XL II TAPE, FOR THE CHROME POSITION (70*us*)

UD-XL II tape is such a dramatic improvement on most other tape that can be used in this position, that comparison is really unfair.

For example, if you're familiar with conventional chromium-dioxide tape, you'll know of the associated problems of poor output uniformity – plus low maximum output level and rather high distortion.

UD-XL II tape offers you excellent MOL, sensitivity, and an output improvement of more than 2 dB over the entire frequency range.

Maxell's unique 'Epitaxial' process gives you absolute sensitivity and stability, and no drop-out problems. What's more, the shells are moulded in diamond cut dies, and made to tolerances 5 times greater than the Philips standard. And, like all Maxell tapes, UD-XL II has the 5-second cleaning leader.

In short, if you're recording in the chrome position, you can now achieve all the advantages – with none of the drawbacks.

A prospect we think you'll find very exciting – even if the competition don't.

UD XL II

UD XL I

maxell
simply excellent

For details on all Maxell Recording Tape write to Maxell Advisory Service, P.O. Box 49, Kensington, N.S.W. 2033

WT3/79

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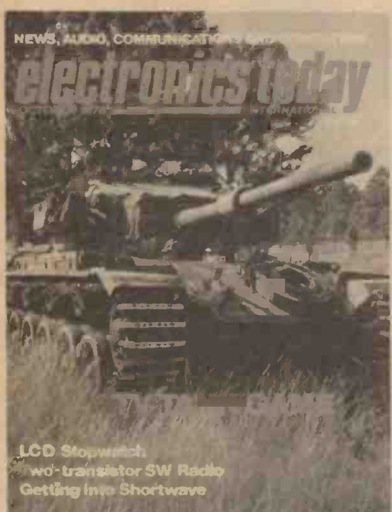
Editorial: Les Bell

Managing Editor: Collyn Rivers

PROJECTS

FEATURES



Cover: All the fun (?) of tank warfare can be yours with our TV Tank Game which is described on page 66. Pic courtesy of Wheels magazine.

NEWS & INFORMATION

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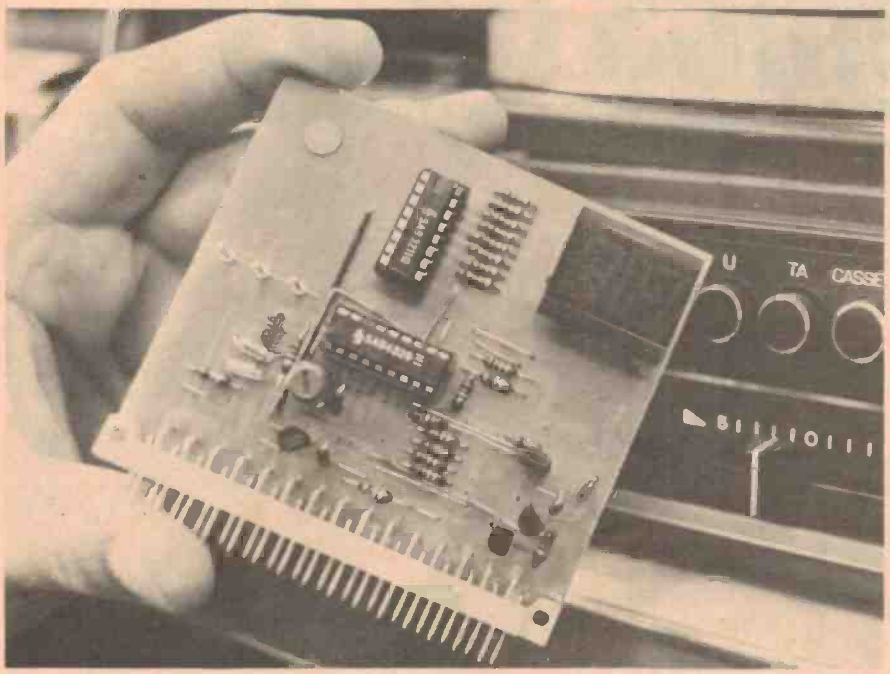
News Digest



New Tasks for IR Light

A new receiver circuit from Siemens now supplements the range of functions of wireless remote control with infrared light: the SAB 4209 offers a fourth analog function of continuous regulation.

The new circuit should be extremely popular with hi-fi addicts. Where it was previously possible to change only three functions such as volume, treble and bass (or colour, brightness and volume) from the depths of an armchair, the balance can now be adjusted without stirring. In other respects, the SAB 4209 circuit is nearly identical with the SAB 3209. A further 30 instructions are however available at the (serial) interface bus. This provision is made for the future requirements of, for example teletext machines.

For further information please contact *Siemens Industries Limited* in Melbourne, Sydney, Brisbane or Perth.

Roof Power

A roof overhead plus the electricity bill paid into the bargain – that's the deal General Electric Co. hopes to offer consumers!. GE are attempting to combine specially developed roof shingles with photovoltaic solar cells. During testing, a hexagonally shaped array of 19 silicon cells supplied by Solarex Corp., bonded to 52 shingles, generated a maximum average of 98 watts per square metre.

Bonded to each rectangular synthetic rubber shingle is a hexagon made of strong, heat-tempered clear glass containing 19 solar cell disks, each with a diamater of 53 mm. An embossed glass cover plate is bonded to the top. The upper half of the hexagons' underside is then bonded to the shingle. The life of the roof is expected to be about 15 years.

Phone Line TV

The Visicom Corp. of PO Box 2058, Cairns, Qld., have been appointed agents for Robot Phone Line TV transmitters and receivers. This system, which uses standard CCTV cameras, monitors and accessories, provides visual and voice communications over any voice grade circuit or radio link. The units are Telecom approved for connection to the phone network and private lines throughout Australia as well as many overseas countries.

Applications for the system include remote surveillance, data exchange, rural education, fast picture transmission and many other uses.

Video information is transmitted in 128 by 128 picture elements, each element coded into one of 16 grey shades, and stored in a 64Kbit memory.

New Radio Terminal from Motorola

The latest in imagination-stretching technology from Motorola is a hand-held microprocessor-based computer terminal which incorporates a radio link with the host computer. The 53-key terminal contains a 2 W FM transceiver which operates in the US's UHF business band. At the other end of the radio link is an RDX1100 control unit which communicates with an IBM mainframe through a conventional data communications link. The hand-held terminal includes a 480-character memory and a 16-character LED display.

Car Antiskids Appearing

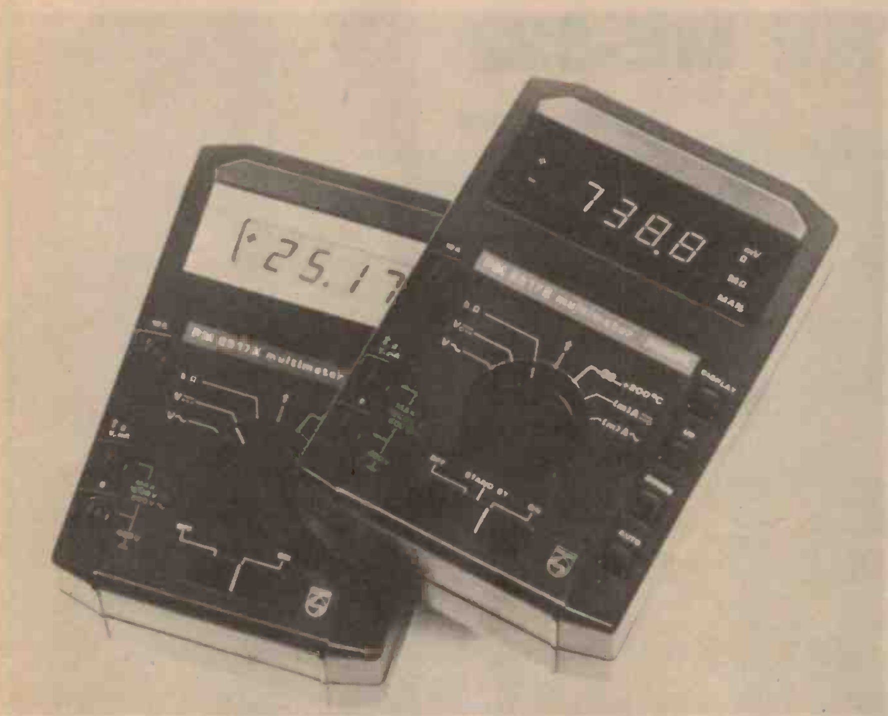
After several years' delay, two German car makers are preparing to introduce antiskid systems on their cars. Daimler-Benz AG will offer it as an option on their top-of-the-line 6.9, and next year BMW will use it. Both companies will use a system developed in cooperation with Robert Bosch GmbH which applies antiskid to all four wheels, not just two as in previous systems.

Analogue Digital Watch

Texas Instruments have done it again. This time the digital watch breakthrough consists of making an LCD display which uses 120 elements arranged in two circular patterns to simulate a conventional 'analogue' watch face. Not only that, but they've designed a multiplexing technique to drive it, and a special I^2L watch chip to work the whole set-up. The use of I^2L allows the top-of-the-line TI watch to feature a clearer display, and a voltage regulator which provides automatic temperature compensation to match the temperature coefficient of the display. The watch is expected to sell for between $275 and $325 in the US, but expect prices to fall sharply as the technology becomes available.

Watch Out HP, TI!

Sharp Electronics has developed what is claimed to be the world's first hand-held scientific computer. The programming language used is tiny FORTRAN, and the machine, which is at the prototype stage, has alphanumeric capabilities. Sharp has no plans to market the unit at present.



Hand-Held DMM

True RMS, autoranging, 0.01% resolution and current range up to 10A are standard features of a new full four digit multimeter from Philips Test and Measuring Instruments. The PM 2517 is available with LED or liquid crystal dispalys and is fully protected against overloading on all ranges.

As well as measuring voltage, current and resistance, the PM 2517 can measure temperature from −60° to +200°C with an optional low cost probe. Other options include data hold which allows the display to be frozen by a switch on the probe.

Careful circuit design with customised LSI circuits for both digital and analogue parts of the multimeter has enabled Philips to produce a high performance instrument in a compact form. Overall dimensions are 172 x 118 x 58mm and weight is only 0.8kg.

Super-dense memory

In the search for ever-larger, ever-cheaper memory systems for large computers, IBM has come up with a new scheme based on the use of tunable-dye laser to induce chemical changes in selected molecules of a storage material. The photo-reactive material is cooled to just a few degrees above absolute zero, and the laser is used to 'burn holes' in the material, each hole representing one bit of data. Storage density can be extremely high, as chemical changes only occur in a very few molecules.

More Bionics

Martin Marietta Corp has developed a new remotely controlled, or 'telechiric' arm for the Marshall Space Flight Center. The arm, which has six degrees of freedom, is controlled by a computer, and follows through pre-programmed sequences of movements.

The design of the control man-machine interface is the really new part of the design – this is handled by a CRT which displays just what the arm is doing and what activity is being conducted, as well as prompting the operator to key in the next movement.

Hi-fi Power Transistors

A range of six new power transistors which are specifically designed for hi-fi output stages and drivers is being marketed in Japan by Matsushita. The 'Super Linear Power Transistors' feature an fT up to 100 MHz and a wide SOAR.

MC6803

Latest word from Austin, Texas, home of Motorola Semiconductors, is of another processor in the 6800 family – the 6803. The 6803 is object code compatible with the 6800, but also includes some new 16-bit instructions – amongst them 8 x 8 bit multiply.

Two versions are available; the MC6803 has an internal clock which divides a 3.58 MHz crystal by 4 for cheapness, while the MC6803E uses an external clock. Otherwise the two chips are identical, with 128 bytes of RAM on-chip, a UART, up to 13 bits of parallel I/O, a 16-bit timer and multiplexed address/data bus. Since there is no ROM on the chip, it would be a good choice for small systems which will be produced in small volume, as well as for hobbyist use.

Data Disco Vision

Hopes that the video disk may prove to be a cheap bulk storage device for computers are nearing fruition. In about six months, we should see the introduction of Draw (Direct Read After Write), a variation on the MCA Disco Vision optical video disk. Around thirty prototypes are now in field trials.

Electronic Popcorn

After electronic yoghourt (ND last month), the latest food to be electrified is popcorn. The US company Amana Radarange has developed a cone-shaped Microwave Popcorn Popper which focusses the field at the bottom of the cone to pop the corn in 3½ mins without oil. Can this be the electronics breakthrough of the decade?

Polish Video Disk

Western engineers usually don't think of Soviet countries as being advanced in comsumer technology, but in fact, since this represents valuable export technology, the Polish company Fonica have developed a capacitive-pickup video disk player. However, the player will probably not go to market until the 30-min playing time is doubled according to a spokesman.

Tone Control IC

Motorola is now sampling a single-chip tone control which uses dc control levels, thus replacing expensive dual-gang post. The IC is mainly intended for car radios, but a version intended for hi fi use will follow.

DON'T MISS THIS HANDHELD DIGITAL MULTIMETER THE ME-522

Specifications

Display: Liquid Crystal Display
Maximum indication: 1999 or -1999
Polarity: Automatic, negative polarity indication.
Zero adjustment: Automatic
Overrange indication: (1) or (-1) is displayed, in the first digit position.
Sampling time: 300 mSec
Battery voltage indication:
Operating temperature: 0 to 40°C (32° to 104°F) less than 80% RH
Accuracy temperature: 23° + 10°C (73.4° + 50°F) less than 75% RH
Power source: Single 9V transistor battery (NEDA 1904 or s —006p)
Power consumption: Approx 15mW
Battery Life: Zinc Carbon 150 to 200 hours.
Insulation voltage: Between the case and the input terminal and external input power jack; AC 1500V for one minute.
Size: 95mm (W) x 155mm (D) x 45mm (H); 3.74in.(W) x 6.10in.(D) x 1.77in.(H)
Weight: 300g (10.56oz) (excluding batteries)
Accessories: Test lead (red) .... 1 pc
Test lead (black) .... 1 pc
Operator's manual .... 1 copy
Battery .... 1 set
Spare fuse (Located battery compartment) .... 1 pc

Electrical Specifications

DC Current Measurement

Range	Accuracy	Resolution	Input R	Voltage drop (in FS)	Circuit protection
200μ A	±(0.8% of rdg+ 1dgt)	0.1μ A	1 K	200m V	20m A for 1 minute
2 m A		1 μ A	100 Ω		60m A for 1 minute
20m A		10 μ A	10 Ω		100m A for 1 minute
200m A	±(1% of rdg + 1dgt)	100μ A	1 Ω		1 A Fuse
1 A		1 mA	0.12 Ω	120m V	

AC Current Measurement

Range	Accuracy	Resolution	Input R.	Voltage drop (in FS)	Circuit protection
200μ A	±(1% of rdg +0.3% of F. S +1dgt)	0.1μ A	1 K Ω	200m V	20m A for 1 minute
2 mA		1 μ A	100 Ω		60m A for 1 minute
20m A		10μ A	10 Ω		100m A for 1 minute
200m A	±(1.2% of rdg +1.3% F. S +1dgt)	100μ A	1 Ω		1 A Fuse
1 A		1 mA	0.12 Ω	120m V	
Frequency response	40 H Z ~ 1 K H Z				

Resistance Measurement

Range	Accuracy	Resolution	Test current	Test power	Circit protection
200 Ω	±(0.25% of rdg +1dgt)+0.2 Ω	0.1 Ω	1 mA	Lo	DC ± 30mA AC30mA for 1 minute
2 K Ω	±(0.25% of rdg +1dgt)	1 Ω	1 mA	Hi	
20 K Ω		10 Ω	100μ A		DC ± 100 V AC100 V rms for 1 minute
200 K Ω		100 Ω	1 μ A	Lo	
20 M Ω	±(0.8% of rdg +1dgt)	10 K Ω	0.1μ A	Hi	

AC Voltage Measurement

Range	Accuracy	Resolution	Input R.	Circuit protection
200m V	±(0.5% of rdg +0.3% of F. S +1dgt)	100μ V	10 M Ω	AC350 V rms for 1 minute
2 V		1 mV		
20 V		10m V		
200 V		100m V		650 V rms for 1 minute
600 V		1 V		
Frequency response	40 H Z ~ 1 K H Z			

DC Voltage Measurement

Range	Accuracy	Resolution	Input R.	Circuit protection
200m V	±(0.25% of rdg + 1 dgt)	100μ V	10 M Ω	DC±500 V or AC350 Vrms for 1 minute
2 V		1 mV		
20 V		10m V		
200 V		100m V		DC±1100 V or AC650 Vrms for 1 minute
1000 V	±(0.4% of rdg + 1 dgt)	1 V		

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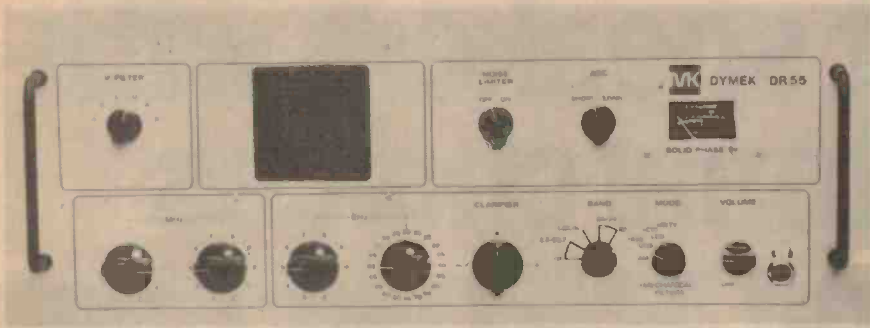
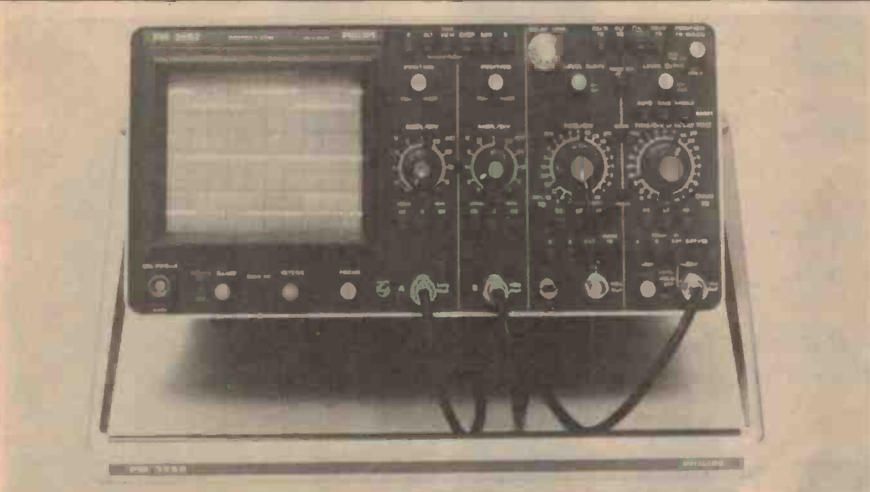


McKay Dymek DR55

The McKay Dymek DR55 is claimed to be the first fully synthesized receiver of its kind available for only US$800.00 in the States.

High level RF front end design and digital phase lock loop tuning make the DR 55 easy to operate and allow frequency changes in a fraction of the time required with conventional mechanically tuned receivers. (It's not so hot for tuning up and down a band, though!) The DRR 55 has many applications in the commercial, governmental and marine areas including WWV monitors for time and frequency calibration, back up service for main receivers and point to point communications.

Ceramic filters are supplied as the standard final selectivity element with optional Collins mechanical filters available for Upper and Lower SSB, CW and RTTY. For more details write *McKay Dymek Company, P.O. Box 2100, Pomona, California 91766.*



New Philips Scope

A compact dual-channel 100 MHz oscilloscope has been introduced by Philips Test & Measuring Instruments. The PM3262 is unique in providing both tirgger-view and alternative timebase operating modes. In addition, the new 'scope features a 5mV sensitivity over the full bandwidth, with a high 2mV sensitivity up to 35 MHz.

Triggering to over 200 MHz and the provision of two external trigger sensitivity settings – "standard" and "double by ten" – enables this oscilloscope to meet the majority of ECL, TTL and other logic measurement needs. Other triggering features include a composite mode for the main timebase.

The trigger-view channel allows exact triggering conditions to be displayed and so allows direct comparisons between trigger and signal. This is particularly useful for such applications as computer or other digital equipment servicing where triggering depends on a clock pulse and relationships between clock and information are important.

Dimensions of the oscilloscope is a compact 316 x 154 x 410 mm (12.45 x 6.06 x 16.21 ins) and it weighs just 9.6 kg (21 lbs).

Operation is possible from a wide range of ac and dc supplies and an optional battery pack is available for field applications. Power consumption is only 45 W and running time from the battery pack is available for field applications. Power consumption is only 45 W and running time from the battery is 3 hours.

Synergistic Beer Drinking

At ETI we're great believers in the concepts of feedback, both positive and negative, and we like to try to apply them to the production of the magazine whenever possible. For example, we use questionnaires to obtain information about the interests of our readers, so that we can try to cater for them in the mag.

But possibly the best form of feedback available to us is simply talking to you, the readers, directly. This way we soon find out if you've got any complaints, and we also get some good ideas from you about what you'd like to see in ETI.

To try to improve our feedback system even further, and have some fun into the bargain, we reckon it would be very productive for us all to get together for a few beers occasionally and so we are introducing a custom which has been called Synergistic Beer Drinking by *Dr. Dobb's Journal of Computer Calisthenics and Orthodontia.* On the first Wednesday of every month, we (that is, the ETI staff) will be found in the evening having a few beers in the *Bayswater Hotel*, in *Bayswater Road, Rushcutters Bay.* If you want to pop in for a chat about what you're doing, or what we're doing, or about what you'd *like* us to do, then we'd be delighted to talk to you. So, let's see you there for a few beers and a bit of a chat.

IC Recording Heads

Remember Exxon Enterprises, the oil giant which initially funded Zilog? Well, they're getting into advanced electronic technology again, this time with a company called Magnex Corp. Magnex are developing a new generation of magnetic recording heads based on semiconductor deposition techniques, in hopes of increasing storage density ten-fold on computer mag disks. Present technology permits densities of 3 Mbits/in^2, but Magnex hope to improve this to over 100 Mbits/in^2.

Now. Two 3-way 40 watt speakers with nine tonal choices

Save about $50 per hour while you assemble them

Even if you didn't know them by number, you probably heard about the Philips AD12K12 MK11 Speaker Kits.

Because they are now a no.1 best-seller.

And here is the compact AD8K30, 8" 3-way compact system, with fine electronic and acoustic components (1" domed tweeters, 5" mid-range, super 8" bass drivers). Brilliant clean sound, with a frequency response closely following the ideal Bruel & Kjaer curve for hi-fi equipment measured in an actual listening room, using the "Third Octave Pink Noise Method".

Plus 9 combination tonal choices to adjust to the acoustics of your own listening-room.

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ETA

PHILIPS **Electronic Components and Materials**

PHILIPS

BA.EL.3

SAW Filters on Lithium Niobate

For some years work has been in progress on integrated filter devices requiring no coils or capacitors. Surface-wave filters are produced in the form of comb-like conductors on the surface of piezoelectric substrates. Siemens has now succeeded in building surface-wave filters on substrates made of lithium niobate. The new device is already being used in picture IF stages in television sets.

In contrast to conventional LC filters, surface-wave filters exhibit a fixed filter characteristic. No alignment is required. As the volume of these filters is so low, compact intermediate-frequency boards can be designed with a greatly reduced number of components. Since the properties of the filters remain unaltered for many years, the highest possible operational reliability is guaranteed. Dependence on the ambient temperature inside a TV set can be ignored. It was originally intended to use a ceramic material with piezoelectric properties as the substrate for the comb-like filter structures. However, the high cost of manufacture and low constancy of this material was not in keeping with the low price level demanded for television sets. $LiNbO^3$ single crystals, in contrast, open the way to economical batch production with optimum filter characteristics and the highest possible frequency accuracy.

The three structure elements of a surface-wave filter – input converter, coupler and output converter – are etched out of an aluminium layer with the aid of a photolithographic process.

When electrical signals are applied to the converter, it emits surface waves in the same cadence in various directions. The coupler picks up a portion of these waves and passes them on to the output converter, which transforms them back into electrical signals. The coupler prevents unwanted waves of differing propagation speeds from reaching the output converter. Further technolgoical measures are required to damp reflected, and thus delayed, waves. The low transfer loss of the filter is the result of the high piezoelectric coupling factor of lithium niobate.

Siemens has a number of the new surface-wave filters in its sales programme. These filters conform with the CCIR Standards B/G and I and the English Standard. The filter OFW 369 is available for antenna converters. Special surface-wave filters are envisaged for the French and U.S. markets. All versions come in a 19 x 16 x 5 mm package with five terminals brought out on one side.

For further information please contact *Siemens Industries Limited* in Melbourne, Sydney, Brisbane or Perth.

ETI/Unitrex Calculator Contest

The August contest must really have stumped a lot of you, as we received what must be an all-time record low number of entries. However, you didn't let us down, and we do have a winner – D. W. Hawke, of Elizabeth South, 5112. He employed the standard method of making up a huge truth table to obtain the solution, which is, of course, that the King cannot unite his kingdom.

Thanks to Mr. I. S. Brown, of Glen Forest, 6071, we have a simpler problem this month. An absent minded teller switched the dollars and cents when he cashed a cheque for Mr. Brown, giving him dollars instead of cents and cents instead of dollars. After buying a five-cent newspaper, Mr. Brown discovered that he had exactly half as much as his original cheque. What was the amount of that cheque?

Seal an empty envelope, write your answer on the back of it, and send it to: Unitrex Calculator Contest (Oct), ETI Magazine, 15 Boundary Street, Rushcutters Bay, NSW 2011. The closing date is Friday, 17th November.

Talking Programmable Calculator

The company who seem to be coming up with a lot of advances in calculators these days is not, as you would expect, TI or HP, but Sharp. Their latest programmable calculator verbally prompts the user, and can be used by untrained staff. The first application programs for the machine are aimed at US auto dealers and will calculate sales, leasing and other financial operations involved in car sales. The machine will even remind the salesman if he forgets something. The conversational calculator weighs just over 20 kg and looks just like a large conventional calculator.

Erratum

An error was made last month in the circuits of the SCR output version of the vari-wiper. As shown, a wire is connected from the supply line to the self parking contacts on the motor. This wire is *not* used for wound field coil motors and should be left out of the circuit.

ETI Staff Vacancy

We are looking for someone to work on ETI's project development staff. Applicants must be capable of, firstly, designing and breadboarding prototype circuits, and secondly, converting the proven circuits into well-built finished projects of the high standard necessary for publication.

Skills required include a good standard of workmanship, both electronically and mechanically. Ability to design pc boards would be an advantage, though limited experience in this area should not deter candidates from applying. A strong background in digital electronics is essential.

The majority of work is design and construction, but it will be necessary to liase with other editorial staff in the presentation of the magazine project article.

The job is in our project development lab at Rushcutters Bay. Salary will depend upon experience and ability, but will be in the region of $12 000.

For further information phone Phil Wait on (02) 33 4282, or write, enclosing a complete resume, to *Staff Vacancy, Electronics Today International, 15 Boundary Street, Rushcutters Bay, NSW 2011.*

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It Goes and GEOS

Two satellites, despite their similar names, fulfil vastly different functions, says Brian Dance.

THERE ARE NOW so many satellites in geosynchronous orbits about the equator that even their names are leading to much confusion. This is particularly true of the GEOS satellites developed by the European Space Agency to measure the electric and magnetic fields in the earth's magnetosphere and the GOES craft (Geostationary Environmental Satellites) which have been developed by the Americans to monitor the weather systems over the western hemisphere.

GEOS Craft

The first GEOS satellite was launched on April 20th, 1977, but unfortunately the American Delta 2914 launching vehicle developed a malfunction during the separation of the second and third stages. It was therefore not possible to place GEOS 1 in its intended geosynchronous orbit, but as much information as possible is nevertheless being gained from the seven experiments on board this craft.

The incorrect orbit of GEOS 1 has resulted in an exposure to radiation of a higher intensity than had been intended and this has degraded the performance of the solar cells on board this craft. In addition, it orbits the earth with a 12 hour period instead of remaining stationary about a point on the earth's surface, but nevertheless it is in radio contact with the ground station in Germany for some eight hours per day.

Shortly after noon on July 14th 1978 a second statellite known as GEOS 2 was successfully launched from the Kennedy Space Centre and attained its correct geosynchronous orbit some 35 000 km above the equator. It was launched just in time to measure the effect of a massive solar flare lasting some 15 minutes. The intensity of this flare was so great that the observatory at Boulder, Colorado advised the USSR that it was felt that there was a considerable risk for the safety of the two Russian astronauts in Salyut 6.

One of the special features of the GEOS craft is their exceptionally high rate of scientific data transmission of some 100 kb/s. This feature, when considered with the fact that continuous communication is obtained between the satellite and the ground station owing to the use of a geosynchronous orbit, means that GEOS 2 will transmit about one hundred times as much data as any European scientific satellite yet launched.

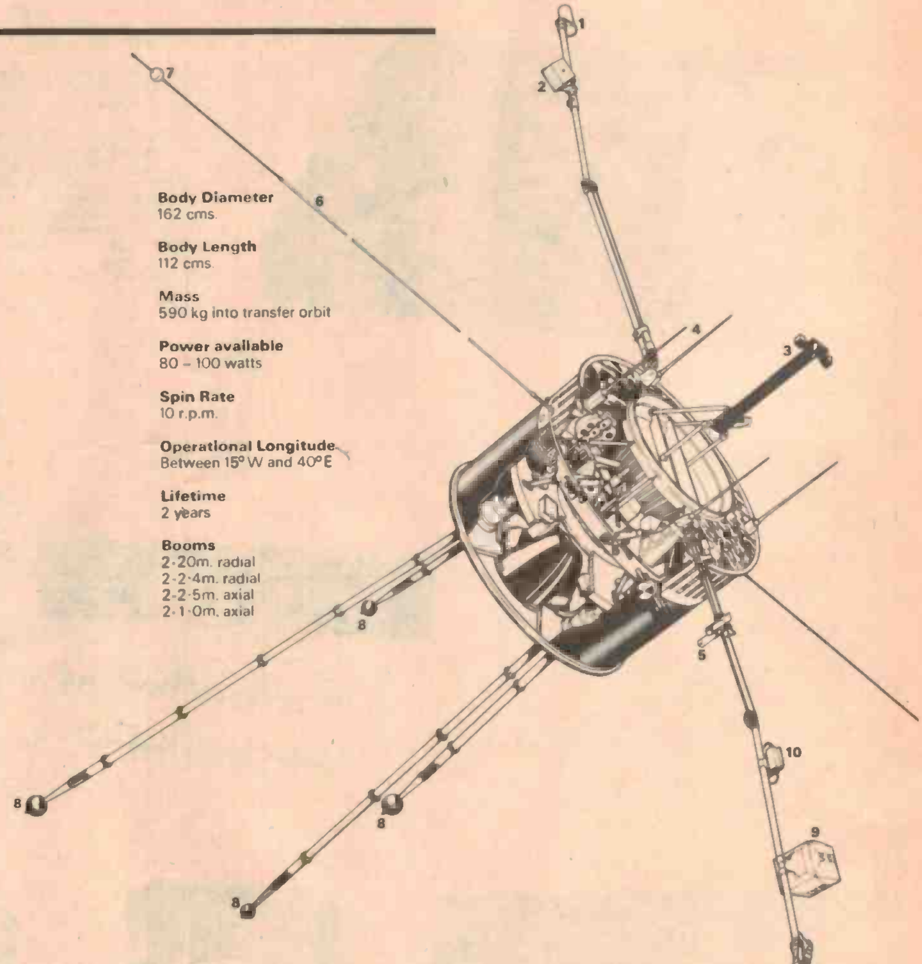


Fig. 1. The GEOS satellite manufactured by British Aerospace, Bristol.

GOES Craft

NASA has just awarded a US $38.8 million contract for three new Geostationary Environmental Satellites (GOES D, E and F) to Hughes Aircraft Company. These new spacecraft will eventually replace the GOES craft already in orbit. GOES D is scheduled for launch in mid-1980 as the first meteorological satellite to be placed in a geosynchronous orbit from the Space Shuttle; it will be positioned 36 000 km over the equator at 75°W longitude directly South of the East coast of the USA. GOES E and F will be launched later in the 1980's.

Each of the GOES satellites will weigh about 820 kg at liftoff and will be 2.16 m in diameter and 4.45 m in length. They will be the US link in a five satellite project, part of the Global Atmospheric Research Programme (GARP) which is scheduled to become fully operational by December 1978 using the GOES satellites which are already in orbit. The GARP project includes the Japanese GMS satellite (also developed by Hughes Aircraft Company), the Meteosat European satellite and the Russian vehicle GOMS which has not yet been launched.

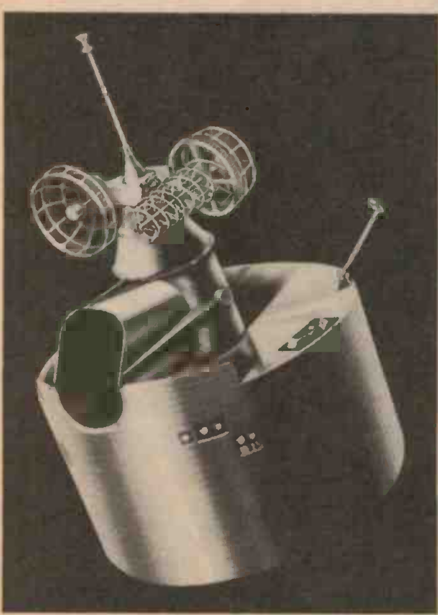
The GARP project has the two primary objectives of improving weather forecasting and gathering data on climatic changes on the surface of the earth. The most important piece of scientific equipment to be carried on board the three new GOES satellites will be a visible and infra-red sensor designed and built at the Santa Barbara Research Centre, California. This sensor will be known as VAS (Visible/Infra-red Spin-Scan Radiometer Atmospheric Sounder) and has been designed to improve the accuracy of short term weather forecasts.

The versatile VAS instrument produces two dimensional images of cloud systems present in various parts of the atmosphere and provides information on their speed and their direction of movement. The VAS equipment also develops temperature and humidity profiles of clear air from the surface of the earth up to an altitude of some 15 km.

The GOES satellites will also contain a Space Environmental Monitoring System consisting of three sensors which monitor solar emission activities to help the planning of aircraft flights and scheduling of communications transmissions.

A Data Collection System on board the GOES spacecraft will be able to receive and relay environmental data sensed by widely dispersed surface platforms (such as river and rain gauges, seismometers, tide gauges, buoys, ships and automatic weather stations). Such platforms transmit data to the satellites at regular intervals when they receive an interrogation signal transmitted by a particular satellite; however, if any platform sensor receives information that exceeds a certain predetermined level, it will immediately transmit the information to a satellite as an emergency measure.

Fig.2. The GEOS satellite which is also a spin craft. Note the S band high gain antenna on the left and the helical UHF antenna on the right, both of which are on the de-spun platform, together with the S band omni-directional antenna projecting upwards along the axis of the craft.



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If you want the condenser microphone sound on stage, Electro-Voice gives you that option.

The PL76 and PL77 condenser cardioid microphones are fast becoming the number one choices of vocalists who want to make the "studio-condenser" sound a part of their act. Both mikes give you condenser performance in a package that competes with dynamic microphone durability. Their gutsy, bass-boosting proximity effect adds presence to any voice. The PL76 is powered by a 4.5 volt battery. The PL77 is similar except that it is also phantom powerable. The "77's" output is 4dB down from the "76's" to allow for more flexibility at the mixing board, and it has a recessed on/off switch that many sound men prefer.

For those desiring the more traditional dynamic sound, the PL91 and PL95 fit the bill perfectly. The PL91, with its mild bass-boost and clear highs is a joy to work with. The PL95, the "pro's choice" in a dynamic cardioid, offers the best gain-before-feedback of any dynamic mike in the business – a test we invite you to make.

Electro-Voice also offers four superb instrument microphones. The PL5 dynamic omni is the mike to use when high sound pressure levels are encountered, as you would find when miking bass drums or amplified guitars, basses or synthesizers.

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E-V's PL9 dynamic omni has one of the flattest frequency response curves in the business – from 40 to 18,000 Hz. And its small size lets you mike instruments you couldn't get near with other mikes offering this performance.

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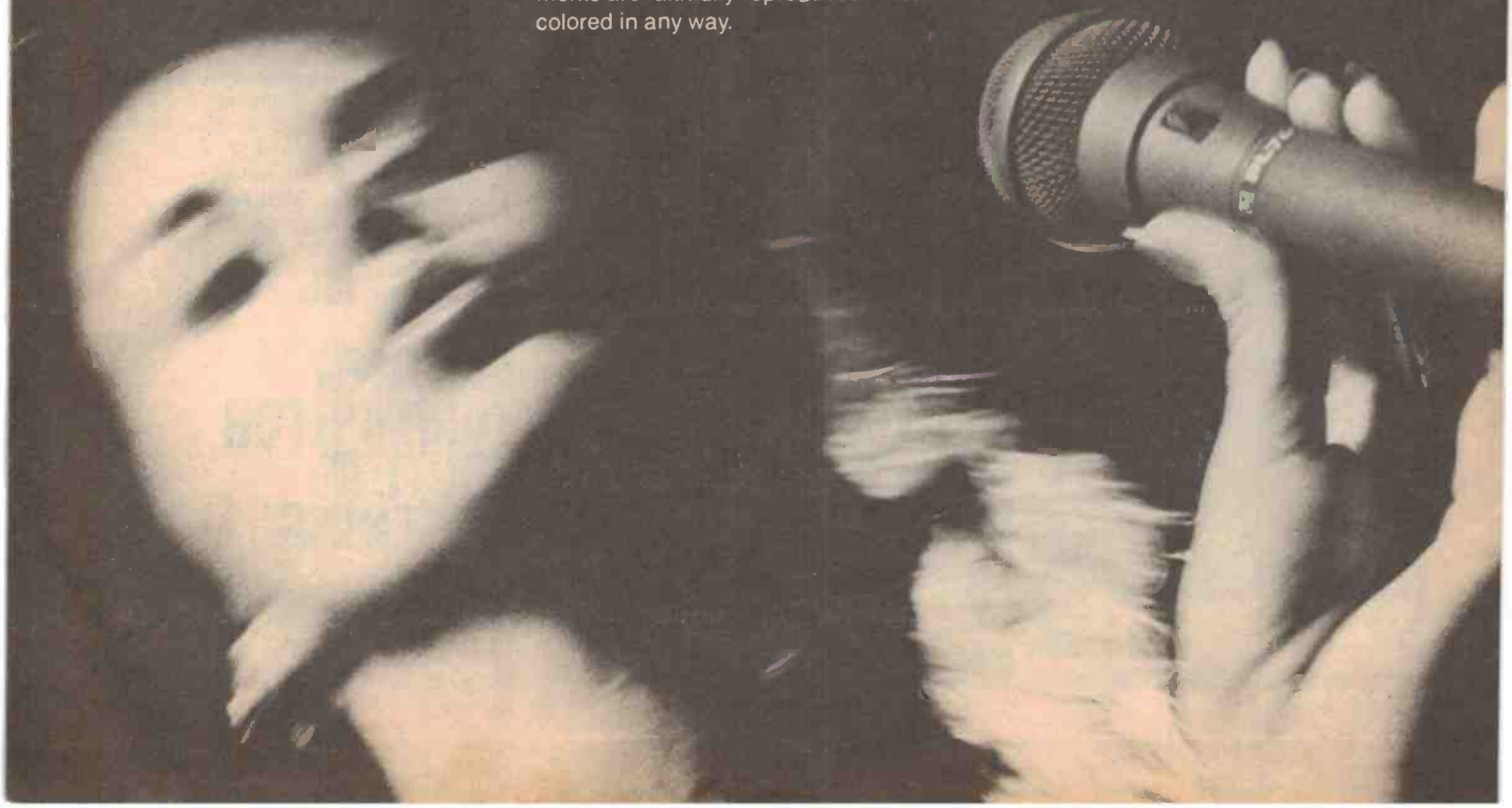

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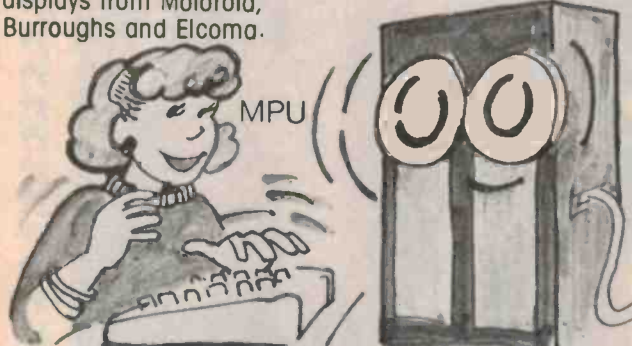

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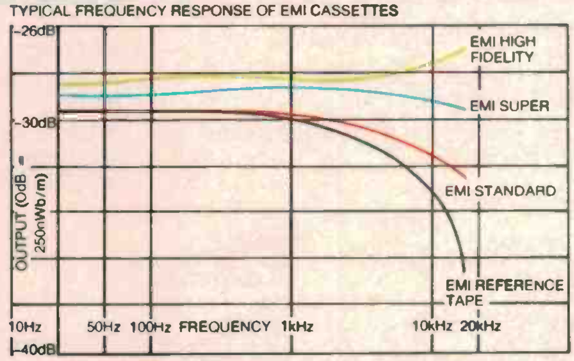

1. Measured using the EMI recommended 2.5dB overbias at 6.3kHZ, derived from the reference batch C521V (the value of bias internationally used by the majority of domestic recorder manufacturers).
   Tape speed 4.76cm/s (1⅞ in/s)
   Track width 0.6 mm
   Record head gap length 2μm
   Replay head gap length 2μm
   Replay amplifier characteristics: 120μsec and 3180μsec
   (In accordance with IEC Publication 94 Edition 3, BS1568 Part 1 and DIN 45513)
2. The Frequency Response is obtained when the record amplifier characteristic has been adjusted to give a flat frequency response (25Hz – 15Hz) from the reference tape batch C521V of –30dB (Ref. 1*).
   **Ref 1. Relative to an RMS Flux of 250nWb/m Tape Width (25mMx/mm) at a frequency of 315Hz (in accordance with IEC Publication 94 Part 2).*

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High Quality Recordings

IN THESE DAYS of splice perfect studio tape recordings, the actual experience of being recorded for posterity is still a sobering trial for even the well conditioned and hardened professional musician.

The renewed interest in the direct cut process highlights the musician's ability to overcome psychological barriers concerning interpretation, techniques and spontaneity. Professionals are reputation conscious and those who commit their art to the direct disc display a sense of adventure and a deep interest in reproducing sound as accurately as possible.

The adventure of direct disc recording is not new. Correspondence from such legendary pianists as Busoni and Paderewski relate their worries concerning condensed interpretation for accommodation onto time-limited playing side. This squeezing of music into exact time lengths and the necessary five or ten seconds rill between each item surely puts a strain on any musician.

For this reason it could appear that even the last province of the jazz musician — improvisation — needs to be fully written before the event. This encroaches into the realm of classical type music where every second is accounted for and a 10% leeway is the maximum. Apparent spontaneity is the life force of any music performance and a reference disc that is continuously replayable without boredom is to be treasured.

It is not surprising that top flight 'real-time' jazz improvisors have never been recorded on direct disc with freedom to improvise. A few wayward thoughts and the whole recording could be overlong or overmodulated.

Strict Improvisation

Perhaps the most audacious, yet strictly disciplined, music improvisation comes from Ali Akbar Khan, the Indian musician, who lives at his college in southern California. This style of music is ideal for direct cut discs as it embraces music of emotional intensity and rhythms on stringed and percussive instruments. In addition, the master Indian musician can present strict improvisations from a few minutes to hours.

Until a few recent issues, the direct cut disc had generally been used as a quality demonstration medium but rarely provided continually enjoyable music. The patchwork quilt of the usual tape-spliced, normally processed disc continues to present the more accurate musical performance.

Direct cut processes do give very fast rise times which, however, may still be limited according to the mixing console used and the sometimes necessary controls in the cutting chain.

Charlie Byrd, CCS8002, (45rpm)

This collection of five pieces for guitar-based quintet is superbly recorded. The musical miscellany contains indiginous rhythms, modern riffs and drum styles.

In particular, Byrd's own composition Old Hymn contains some very fine, indeed fantastic, guitar playing. Passing reference to Villa Lobos' guitar studies is, of course, unavoidable. Watch the levels in this piece as the drum passages can blow unfused speakers.

Virgil Fox — The Fox Touch, Volumes 1 and 2, CCS7001/2

Without doubt, the most exciting and exhilarating of all direct cut discs. Virgil Fox is an old hand at presenting organ music in a colourful manner as many readers will remember from his Heavy Organ Bach recitals for Americas youth. These famous performances were accompanied by blazing clouds of coloured smoke.

This extrovert master musician provides two remarkable programmes of organ music including the famous Bach compositions 'Toccata and Fugue in D Minor', and the 'Toccata, Adagio and Fugue'. Both are on the first disc. Other staggeringly well presented items are blockbusters of Widor, Franck, Dupre, Gigout, Alain and Jongen.

Producer Wodenjak (ex *Sound Advice* publisher) chose well in *Audio's* Bert Whyte, and console circuit designer John Curl (whose initials grace the Mark Levinson JC-1 pre-amplifier). Don't miss these discs. The bass, middle and treble ranges are very powerfully engraved onto normally excellent surfaces.

The organ chosen is a mighty beast whose specifications are unfortunately not included with the discs. This musically inventive pair of discs will test all aspects of the audio system while providing inspiring music.

MXR Digital Delay

Expanding the Boundaries of Creativity

The MXR Digital Delay is a self-contained audio delay line which utilizes sophisticated technology to achieve a new standard of professional quality performance. The culmination of an intensive design program, the MXR Digital Delay is unparalleled in versatility, ease of operation, and creative application.

Although the MXR Digital Delay is capable of a wide variety of effects, the basic function of the unit is quite straightforward. The input signal is processed through circuitry which delays the signal by a specific amount of time. It is then mixed back with the 'dry' or undelayed signal at the output of the delay. The effect produced will depend upon the amount of delay time chosen. The basic effects that can be obtained by using appropriate portions of the wide delay range provided by the MXR Digital Delay include discrete echoes, vocal doubling, and hard reverberation. In addition to these basic effects, the MXR Digital Delay contains associated circuitry which allows such unique effects as flanging, pitch alterations (vibrato, pitch bending), frequency modulation and infinite (non-deteriorating) repeat-hold.

The MXR Digital Delay employs digital random access memory to produce a time-delayed signal. This technique, derived from computer technology, represents a departure from previous shift register methods. The analog input signal is converted to digital form, stored in the memory circuitry and removed at some designated later time. It is then converted back to analog form and fed to the output.

This method provides the user with the advantages of a wider usable delay range, more precise control of delay time, and preservation of signal quality. The MXR Digital Delay makes available delay times ranging from 0.08msec. to 320msec. (1 second = 1000msec.), fully variable, without excessive noise or mechanical reliability problems. This delay range is expandable to 1280msec., in increments of 320msec., by means of up to three additional plug-in memory boards. These boards are available from MXR and are easily installed by the user.

The MXR Digital Delay is designed for a wide variety of applications including recording, P.A., and amplified musical instruments. The unit is rack-mountable for studio installation, and an optional road case is available for onstage use by the traveling musician.

For more information see your MXR dealer.
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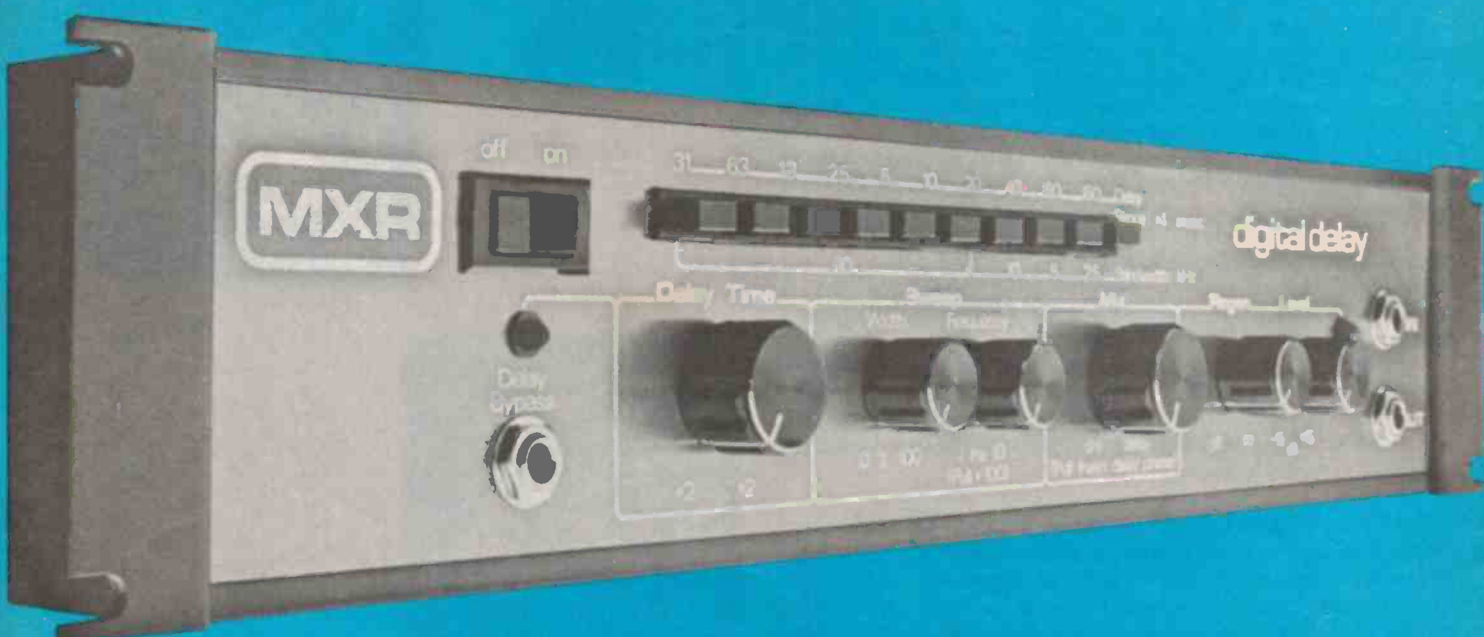
MXR Professional Products Group

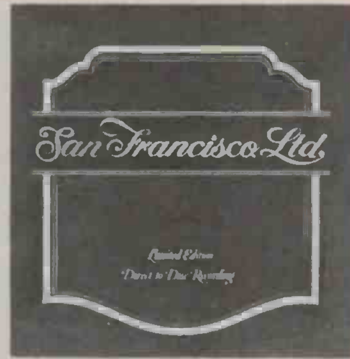


High Quality Recordings

San Francisco Limited, CCS5004, (45rpm)

Apart from the easy gospel style of Terry Garthwaite and her vocal harmonist Willow Wray, this is an enjoyable, real flavour, night-club style disc.

Drum and wind soloists are top notch musicians with more flexibility than normal in the direct cut medium.



Cal Tjader, Huracan, CCS8003, (45rpm)

This apparently distant-miked disc still retains the essence of close-miking with silky treble and throbbing bass. The end of side two has delicate continuous brushing strokes on cymbals; don't mistake this for surface noise or tape hiss.

The composition 'Huracan' has some good low notes.

Peter Appleyard Presents, Salisbury Laboratories SALSD2D001

This Canadian direct cut disc follows modern close miking techniques.

The enormous line-up of percussion instruments is the basis of Appleyard's internationally successful arrangements.

There is something for everyone on this disc. From 'Mambo' to the 'Swinging Shepherd Blues', to the very up-tempo, big band sounds of 'Open the Gates of Love' and 'Night Journey', both by Doc Severinson. These last two are very exciting, driving, full-band expositions with up-front recording styles.

The disc features very tight and controlled acoustics with wide spread but occasional engineering of fades. Most of the music presented has great tension and, considering the instrumental line-up, the results are very smooth even when the rhythmic tension is building towards large climaxes.

World Orchestra of Young Musicians, conductor Pierre Hetu, Musicus MS2-45101, (2 disc set, 45rpm)

Moussorgsky/Ravel: Pictures at an Exhibition.
Richard Strauss: Til Eulenspiegel.
Dvorak: 8th Slavonic Dance.

This auspicious recording of a very young group of musicians has received engineering that varies from excellent to passable. The strings are very well focussed and full-bodied, the brass is natural in timbre.

Slight surface noise intruded during the 'Catacombs', and the strings sound engineered during the 'Great Gate of Kiev'.

This orchestra has received excellent tuition under such inspired personalities as Jean Martinon, Karel Ancerl, Bernstein, Rowicki and Mehta.

Diahann Carroll, Duke Ellington's Orchestra directed by Mercer Ellington, DRC400 (Orinda)

This tribute to Ethel Waters is mentioned as being a digital recording but the cover does not carry information other than a few claims to exceptional technical achievements. The disc was processed at the JVC cutting studio which indicates it was cut at half speed with the resultant trade mark of super clean treble.

The bass sections in Saint Louis Blues do not seem to be as deep as some direct discs but the fullness and cleanliness is well controlled. The vocalist appears suspended in exact focus between the speakers.

In general, a good representation of night club music excellently recorded.

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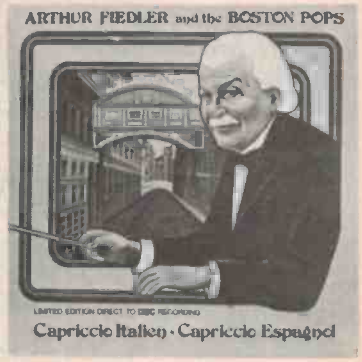
COOPER INDUSTRIES

High Quality Recordings

Organ Sounds from Mount Olivet, ARK1094-S

Careful playing by Diana Lee Metzker underlines the deep bass notes available to high fidelity enthusiasts on this recording. Perhaps the best system test for bass is the Karg-Elert selection which presents notes guaranteed to resonate pickup arms and music systems.

The recording was made by US loudspeaker manufacturer Bob Fulton.



Arthur Fiedler and the Boston Pops, CCS7003

Tchaikovsky and Rimsky Korsakov; Capriccios Italien and Espagnol

Another high quality combination of personality conductor, really top class orchestra and well known music. The dynamic range is wide, the sound is full bodied with some very deep bass notes. A typical direct cut disc, smoothness with good perspectives.

LadyBird, Audio Lab ALJ 1054

Night-club type presentation of well-known items in easy-to-listen-to arrangements.

Very wide spread and separation is a feature of this disc, and piano perspective is slightly removed for once. The double bass is impressively natural and well balanced with the piano, and the electric guitar and drumkit are also recorded with natural acoustic.

Eternal Father, Volume 2, Richardson Records RRS-6

Contains a number of well known hymns and credos sung by the choir of US Naval Academy midshipmen with two organ solos by the resident chapel organist.

The reverberant acoustic occasionally heightens choral effects, giving a pleasing perspective, and the men's voices are very clearly recorded with a slight echo sometimes being returned to the microphone position.

The Langlais organ solo bass notes modulate the treble output.

Wagner and Prokofieff Excerpts, Sheffield Lab 7 and Lab 8

The beautifully produced covers and booklets pre-empt the musicality and realism that is missing from these latest Sheffield discs. Perhaps the subtleties and shadings received in concert halls and opera theatres on normally processed taped performances could not be fully attempted in the direct cut process of Sheffield.

This lack of musical continuity highlights the 'hi fi-ness' of the performances. Acoustic balance is at odds with instrumental sections as each seems to overlay the other; almost as if they are occupying the same seats.

Low frequencies and midrange are powerfully engraved with telling effect. The treble register is often unrealistic and harsh; upper massed strings are thin in tone, especially in their harmonic structure.

As a feat of direct cut engineering these latest Sheffield discs must be recommended for their sonic performances below about 5 kHz, above which feedback control of the cutter head is reduced and where some high frequency limiting is generally applied in tape to disc recordings.

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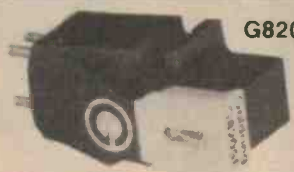

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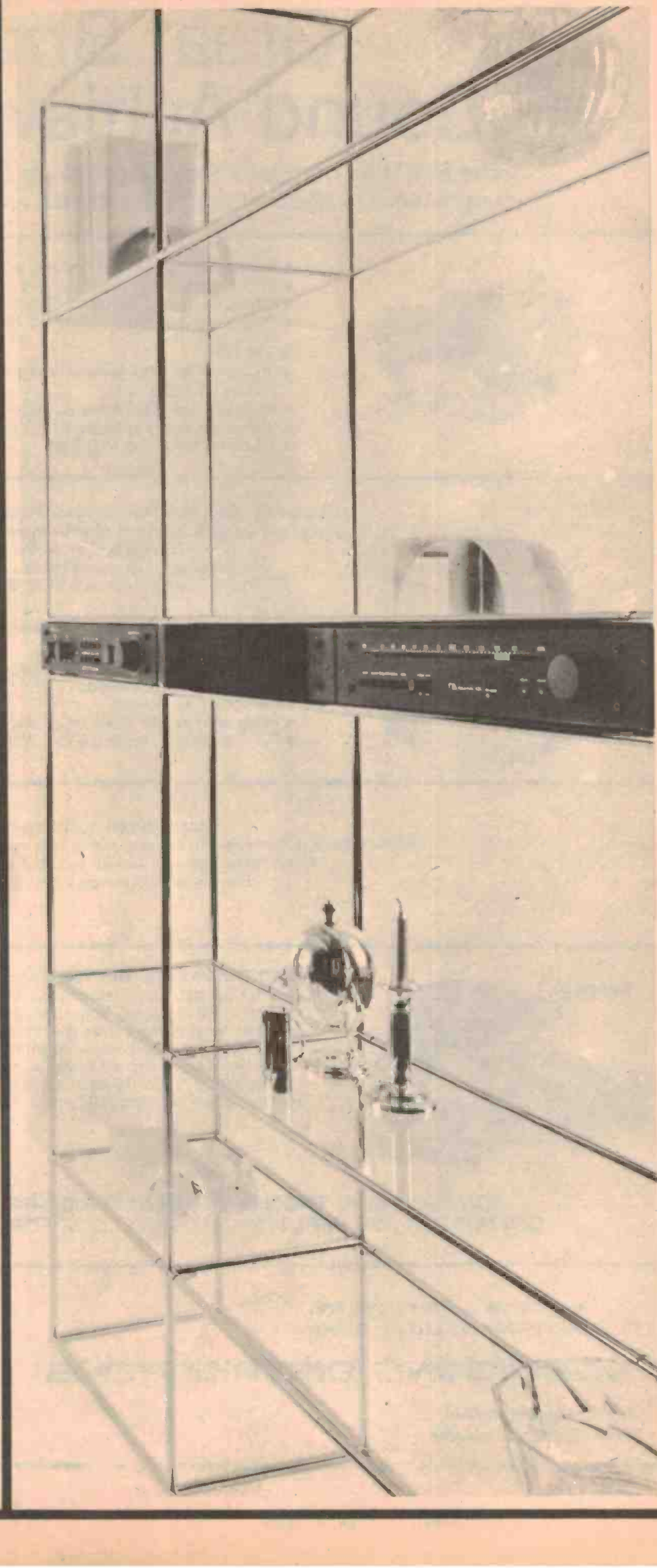

High Quality Recordings

The Spirit of Christmas Brassed, The Annapolis Brass Quintet, Richardson Records RRS-5

Containing thirteen carols, noels and hymns, this record will interest every brass player. The perspective is a fraction flat and occasionally the brass may seem sharp but the transcriptions are very good and excellently played.

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SOUND BRIEFS

Two-speed cassette deck

BIC is marketing a cassette deck operable at either 1 7/8 inches/second or 3 3/4 inches/second. In effect doubling tape speed improves the high frequency response by a factor of two. As the whole of this improved response is not required, BIC say that they have 'exchanged the excess portion for significant improvements in signal/ noise ratio, distortion, dynamic range etc, whilst still providing superior frequency response'.

Such claims cannot be dismissed as advertising hyperbole – BIC are guaranteeing a frequency response of 25 Hz – 22 kHz ± 3 dB at the higher speed.

(BIC's claim to a 'world first' caused tantrums at ETI – our design engineer modified a cassette recorder to run at 3 3/4"/second way back in 1972 as part of a 'fifth wheel' for recording automobile performance data!)

Astrocom/Marlux also attempted to build a two-speed machine some years ago – we're not quite sure what happened to it but the rumour is that Philips would not support the concept. We understand however that BIC's machine has Philip's tacit approval.

Printed Cartridges Soon?

JVC has developed a technique for 'printing' the inductors required for a moving coil cartridge directly onto a tiny wafer substrate which in turn is fixed to the stylus cantilever very close to the stylus tip.

We understand that JVC have no definite marketing plans but a few pre-production devices are said to be around.

Fuji To Compete With 3M's Metafine Tape

Japan's Fuji Photo Film has formally announced that it is about to start manufacturing a metal particle tape the performance of which appears to be similar to 3M's recently announced 'Metafine' product.

Fuji are claiming 7 dB – 12 dB increase in maximum output level (MOL) over chrome tapes, and a 3 – 9 dB improvement over their own FX-II material.

The company says that the new tapes and cassettes will be available as soon as machines are available to use them. This should be almost immediately as Tandberg have just released details of their TD20A open-reel recorder and TCD 340A cassette deck – both of which are fully capable of recording, erasing and playing back the new metal particle tapes (full report this section ETI last month).

Remington and Decca Reissues

Selected recordings from old Remington and Decca catalogues are currently being reissued by a company in California. Anyone interested should contact them directly – Varese International, P.O. Box 148, Glendale, California 91209, USA – mention you heard about it in ETI.

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HX12-3W	35W RMS	20 Hz-22 kHz	$255.00	$345.00	$90.00
HX12-3WA	45W RMS	20 Hz-21 kHz	$235.00	$345.00	$110.00
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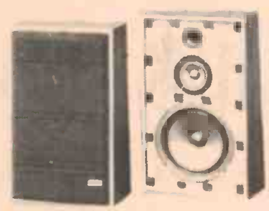
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VCT

Two prior articles on the VCT have appeared in ETI. The first of these was written by Ron Harris who reviewed the history of the VCT and briefly covered potential circuit applications. In the second, by the present author, the internal functioning of the VCT was examined. The purpose of this article is to describe the concept, design and performance of a "discrete" form of VCT which readers may build themselves. By J.E. Morris, Department of Physics, Victoria University of Wellington, New Zealand.

THE CIRCUIT SYMBOL of the voltage-current transactor (VCT) is shown in Fig. 1 with both voltage input and current output terminals floating. In the future it is expected that single chip VCTs (Ron Harris, ETI January 1977) will challenge the familiar op-amp as the universal linear circuit building block. At present, however, these have yet to emerge. In the meantime considerable familiarity with the VCT concept and with its circuit applications may be achieved by building a PCB version using readily available IC transistor arrays.

A single-ended VCT (C.A. Holt, "Electronic Circuits: Digital and Analog" p. 788) is shown in Fig. 2. The floating output version of Fig. 3 corresponds to the circuit discussed before (J.E. Morris, ETI August 1977). In both figures the unfamiliar symbols (boxes) are intended to represent current mirrors. Ideally, the output from the high impedance current scource(s) exactly equals the input current into the low impedance terminal (arrow-head). VCT operation is based upon these current mirrors.

No attempt will be made here to duplicate the earlier explanation of circuit operation which is expected to be reasonable clear from the diagrams (Figs. 2 and 3) anyway). The essential point is that the differential input voltage $V_1 - V_2$ leads to an imbalance in the currents flowing in the two halves of the symmetrical circuit and that this imbalance is translated into a load current I_L. The load is driven by constant current sources (high impedance) and the input impedance is high to minimise input signal loading. With the system of Fig. 3, load current is given by

$$I_L = \frac{2}{3}(V_1 - V_2)/R_{EXT}$$

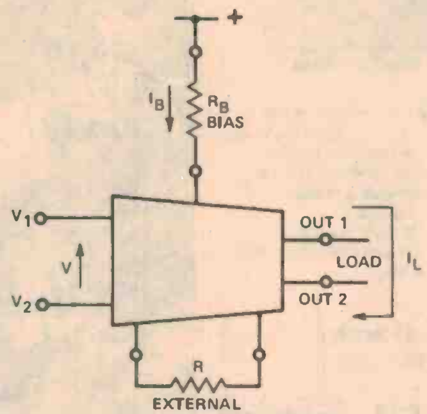


Fig. 1. VCT symbol and external connections.

up to the point where the bias current is exhausted, i.e. for $I_L < \frac{2}{3} I_B$.

Transistor arrays

The original intention of the project described here was to build the current mirrors using perfectly matched transistor arrays in miniature flat IC packages. These were to be mounted on an alumina substrate with printed thick film interconnections in the circuit described in the earlier articles. As is often the case with electronics, however, the realities of the situation dictated a very different course.

In the first place both miniature package arrays and arrays of matched transistors were neither readily available nor acceptably priced! After some searching of the data books, we settled for the RCA arrays CA3084 and CA3086 on the basis of price and availability. (The pin diagrams for these are reproduced in Fig.4). Not all of the components in these packages are used; in particular, the Darlington transistor D in the CA3084 is not employed in the VCT circuit.

The first point to be determined was the effectiveness of these transistor arrays in current mirror circuits. No claim is made for transistor matching in the CA3086 other than the obvious one of thermal matching. In the CA3084, Q_3 and Q_4 are obviously organized as current mirror outputs and Q_1, Q_2 are described as a matched pair. The specifications on Q_1, Q_2 look

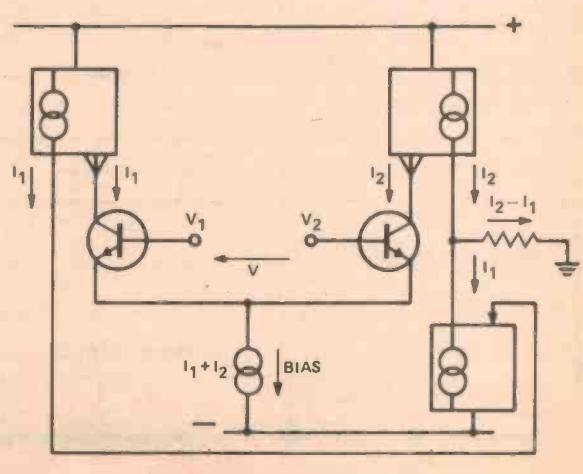


Fig. 2. Single-ended VCT (e.g. CA3080 operational transconductance amplifier.

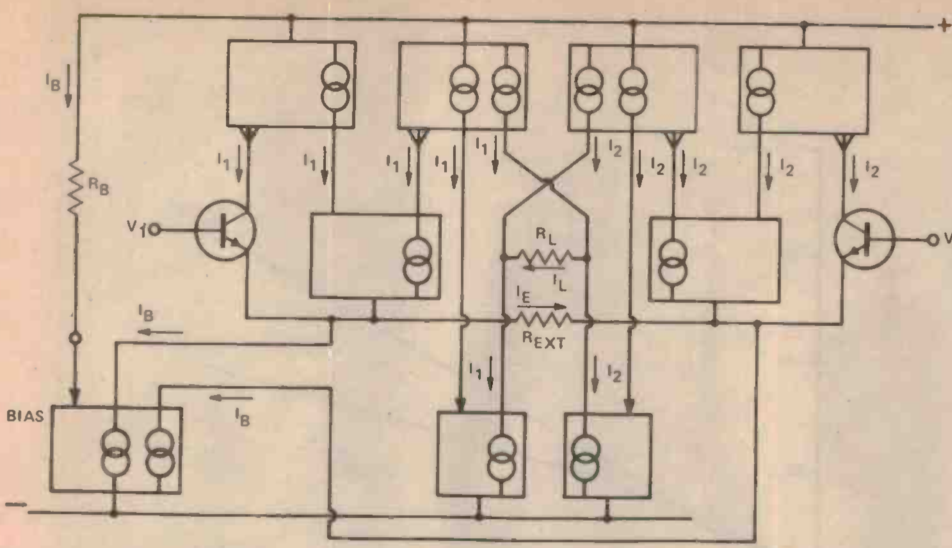
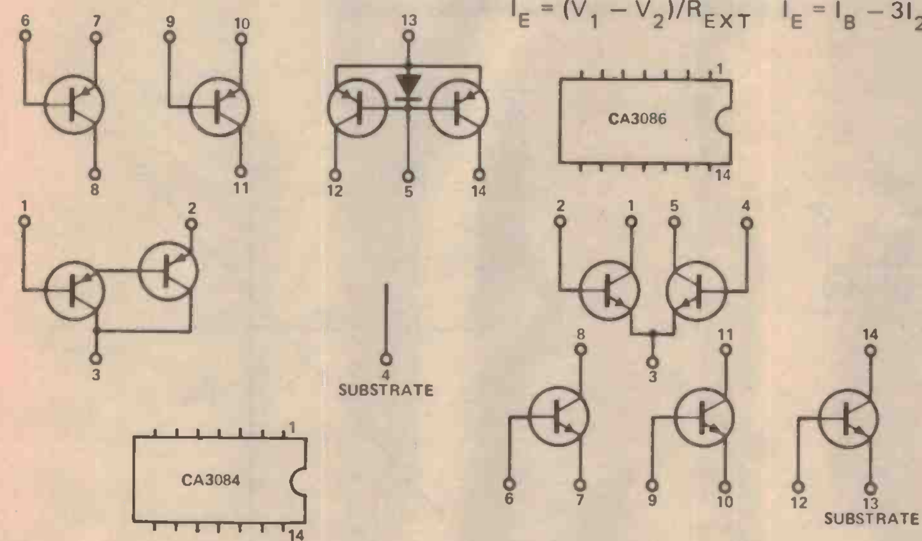


Fig. 3. VCT with floating input.

$I_L = I_1 - I_2$ $\qquad$ $I_E = 3I_1 - I_B$

$I_E = (V_1 - V_2)/R_{EXT}$ $\qquad$ $I_E = I_B - 3I_2$



$I_{12}, I_{14} = I_{13} \mp 15\%$

$I_{12} = I_{14} \mp 10\%$

Q_1, Q_2: for $I_7 = I_{10}$, $V_{BE1} = V_{BE2} \mp 6$ mV (all specs at $I_C = 100\ \mu A$).

Fig. 4. IC transistor arrays — pin connections and CA3084 specifications. (S — substrate connection to most negative point).

impressive and those of Q_3, Q_4 seem rather inadequate (Fig. 4) but in fact for current mirror applications the reverse is true in both cases. To put these specifications into perspective, consider two similar base-emitter junctions where $I_{E1} \quad I_{S1} \exp(e V_{EB1}/kT)$ and $I_{E2} \quad I_{S2} \exp(e V_{EB2}/kT)$. Suppose these two junctions may be regarded as extremely well matched e.g. to ±1 mV in V_{BE} carrying identical currents I_E. Substitution above leads to

$$I_E = I_{S1} \exp(eV_{EB}/kT)$$

$$= I_{S2} \exp(eV_{EB}/kT) \exp(e\, 10^{-3}/kT)$$

and if equal V_{EB}'s are now specified for the current mirror application

$$I_{E2} = I_{S2} \exp(eV_{EB}/kT)$$

$$= I_{S1} \exp(-e\, 10^{-3}/kT) \exp(eV_{EB}/kT)$$

$$= I_{E1} \exp - (e\, 10^{-3}/kT)$$

At room temperature, $kT \quad 1/40$ eV and $I_{E2} \quad 0.96\ I_{E1}$. So a ± 1 mV matching in V_{BE} leads to a 4–5% error in a current mirror application. In this light, $Q_3 - Q_4$ seem to be reasonably matched for the purpose and $Q_1 - Q_2$ less so.

Clearly, the point is best resolved by direct measurement of current mirror performance using the arrays themselves.

Current mirrors

As a first step, the transistors were checked for matching. For the CA3086, all transistors (except possibly the substrate transistor Q_5 whose measurements were later deemed to be suspect) were matched to within a 12 mV spread for a given current up to 500 μA. This figure reduces to a low 1 mV range at 1 mA and increases again with increasing current to about 9 mV at 10 mA. (All measurements at V_{CE} = 3V.) It is only possible to measure terminal characteristics of Q_1 and Q_2 in the CA3084 and from 10 μA to 10 mA, V_{BE} values were matched to within 1 mV.

The performance of the CA3084 current mirror is shown in Fig. 5 and that of a more complex system in Fig. 6. Clearly, the extra components of the more complicated circuit (which are all subject to variations from the nominal device parameters), lead to increased discrepancies in the output current. On the other hand, the simple circuit, (as found within the CA3084 chip, for example,) provides output matching within specification although the absolute level is lower than expected.

With the CA3086 a slightly different measurement technique was employed (Figs. 7 and 8) where transistor gain

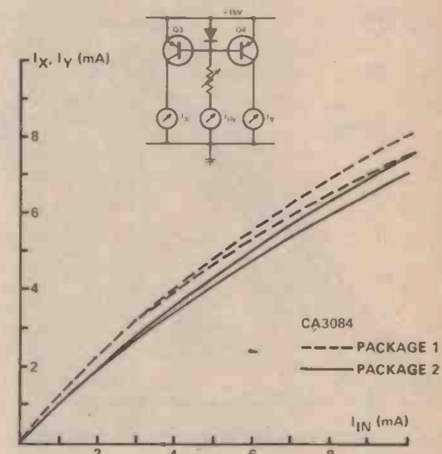


Fig. 5. Elementary current mirror — output matching test.

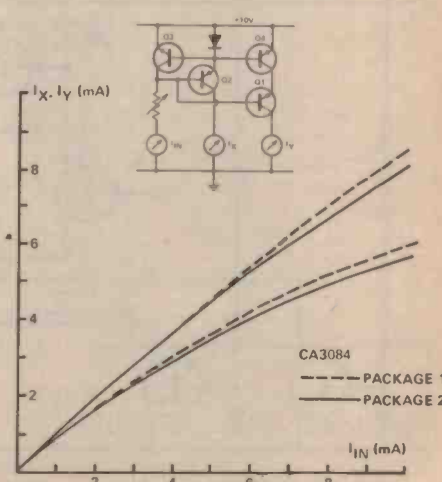


Fig. 6. Complex current mirror — output matching test.

was permitted to vary with V_{CE}. This accounts for the curvatures of the output characteristics in Fig. 7. In Fig. 8, the performance of the more complex system is seen to be clearly inadequate. (The transistors in these two diagrams with base and collector shorted together function as diodes, as does Q_4 in Fig. 6).

The results of this section led immediately to the decision to use only the basic type of current mirror. Both types were examined in the earlier article (ETI August, 1977) and the more complicated form is used in the prototype single chip VCT. The advantage of the complex circuit is that it performs better with low gain transistors but the typical h_{FE} figures of 100 and 40 (for the CA3086 and CA3084 respectively) are expected to be adequate. The problem with the system being developed here is that of poor matching and an

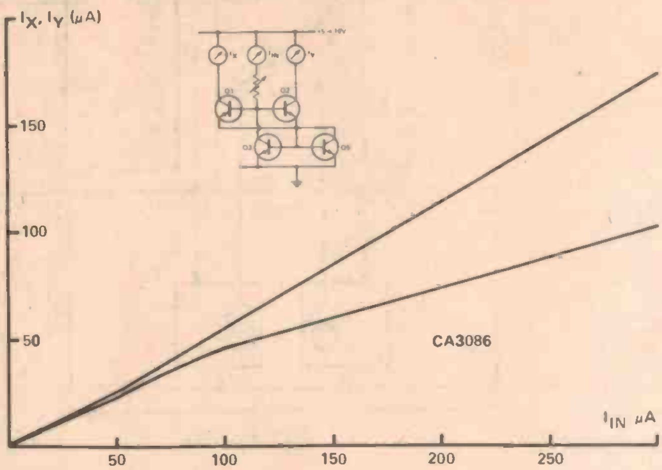


Fig. 8. Complex current mirror — output matching.

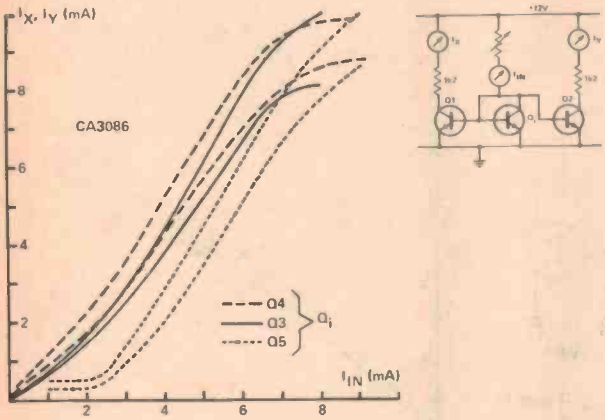


Fig. 7. Elementary current mirror — transistor matching.

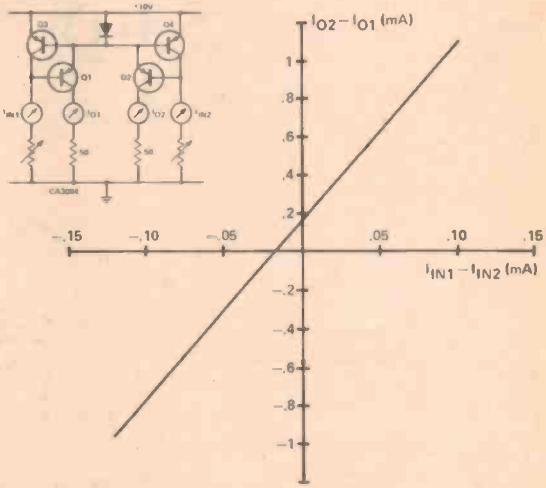


Fig. 10. Effect of linking current mirrors within the VCT.

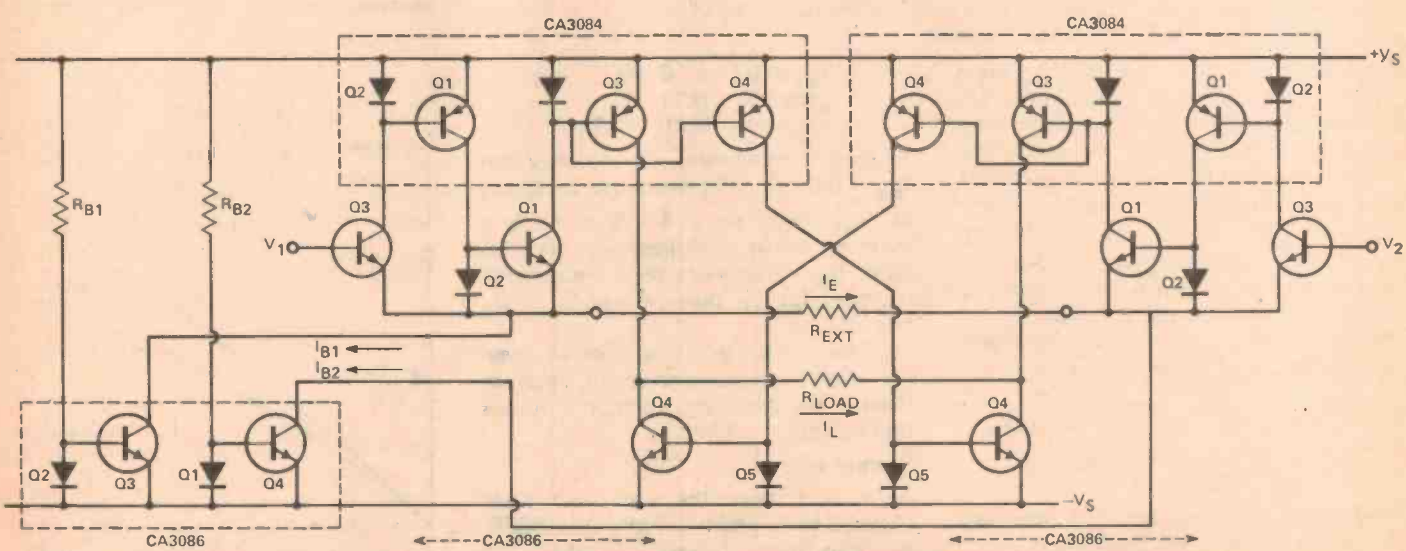


Fig. 9. Simplified VCT design employing IC transistor arrays.

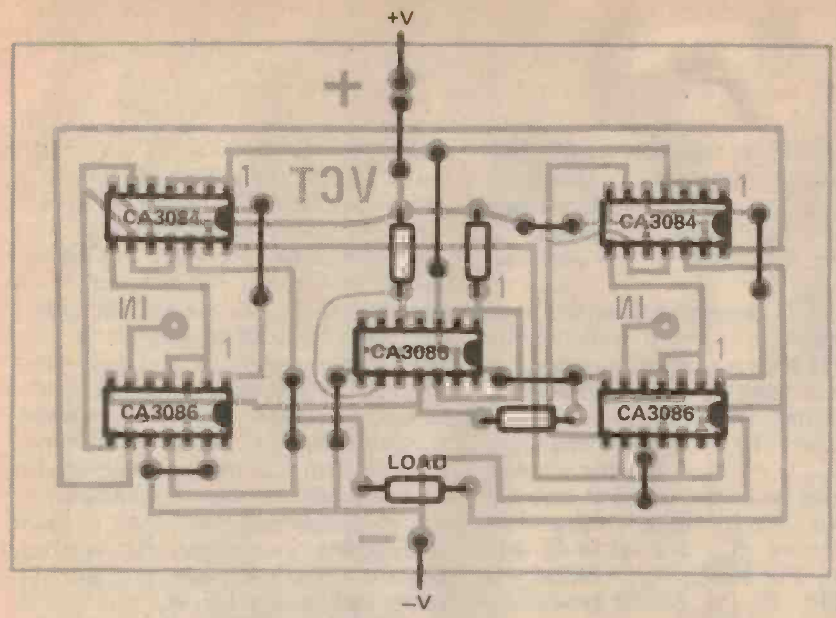


Fig. 11. PCB layout, showing external components, wire links, etc. — view from component side.

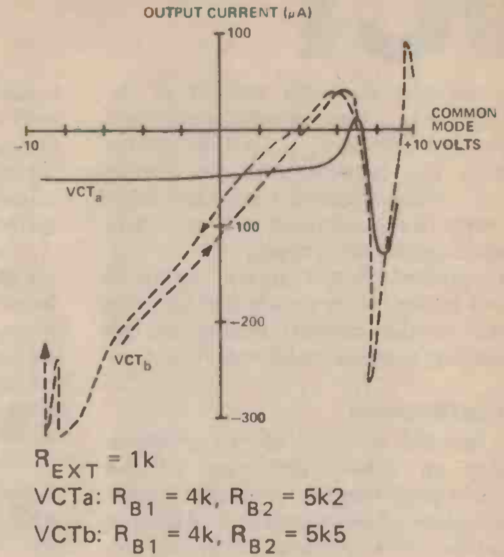


Fig. 12. Common mode signal transfer (V1 = V2).

elementary worst case analysis demonstrates the superiority of a minimal component count.

Discrete VCT

The actual circuit employed is shown in Fig. 9 and differs markedly from the one discussed in the earlier articles. In the first place, the simple current mirror has been used throughout for reasons given above. Second, there is obviously no opportunity to provide current gain by utilising multiple emitter transistors since these are not provided in the arrays. (This is no disadvantage for the purpose of a familiarisation exercise.) The third discrepancy is apparent by comparison of Fig. 9 with Fig. 3. In recognition of device parameter variations and the asymmetry which these will necessarily cause, the bias circuit has been split into two independent sources. In effect, this provides both bias and offset capabilities. Usually one would employ Darlingtons as the input transistors. This step would require an extra CA3086 and has been omitted.

A fifth difference lies with the elimination of any link between the input circuit current mirrors of the two sides. The circuit described in previous articles uses the complex current mirror with diodes shared between the two sides of the VCT. This set-up has been simulated (Fig. 10) and found to be ineffective as a means of compensating for bias imbalance between the two sides. If I_{IN2} is increased,

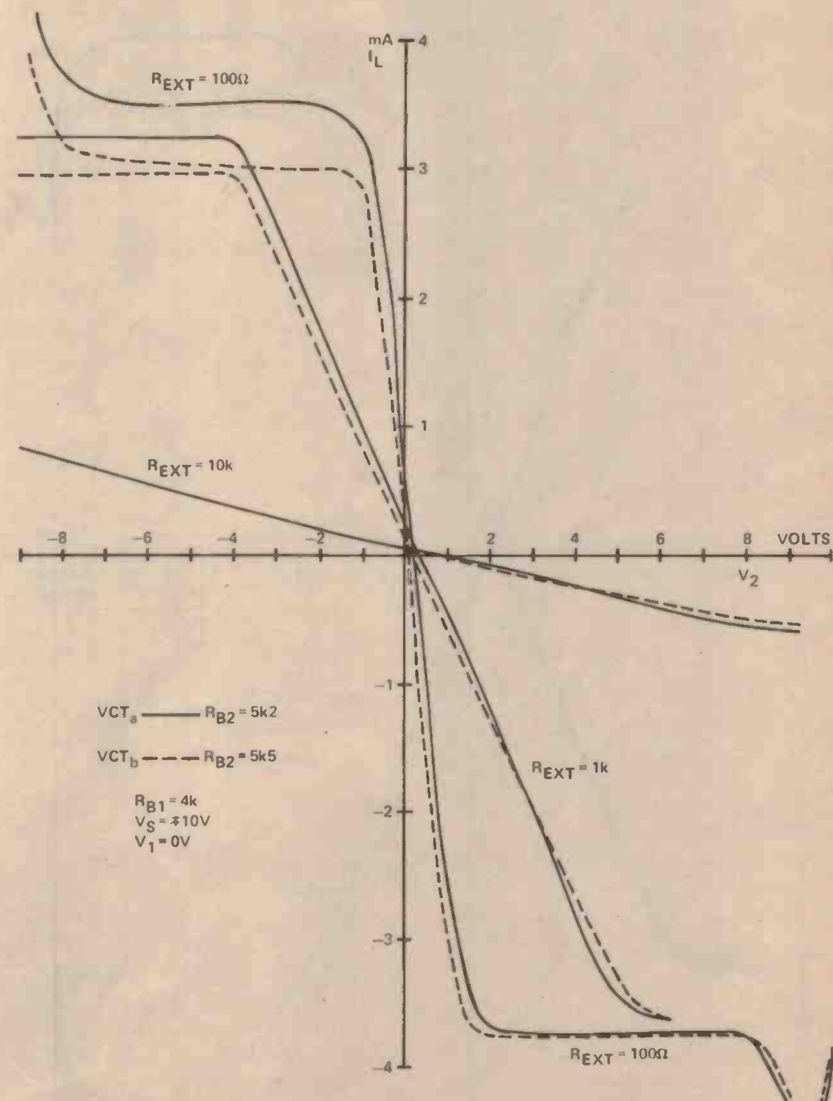


Fig. 13. Transfer characteristics.

for example, the base current of Q_2 and hence I_{O2} increase with a compensating decrease in I_{O1}. A link of this type is not possible with the simple mirror system adopted here, but would not have been employed with the more complicated circuit anyway.

A printed circuit board layout is shown in Fig. 11. No claim is made with regard to the optimal quality of this layout but it seems satisfactory.

VCT performance

It is not the function of this article to present an exhaustive survey of the circuit's performance in varied applications. Many of these have been proposed elsewhere (ETI, January 1977) and the reader is left to try these individually with his own discrete VCT. There are, however a few pitfalls which warrant further discussion. Most of these may be classed as limitations of the non-ideal system.

Two VCTs were constructed and these are identified as 'a' and 'b' from here on. In general, they performed similarly, but there were some significant differences. Unless stated otherwise, below, supply voltages of ∓10 volts were employed with R_{EXT} = 1k and only current monitoring as loads. The first test was to establish bias current levels to achieve a null output. R_{B1} was set to 4k with each unit. For VCTa, R_{B2} = 5k212 and for VCTb, R_{B2} = 5k552 established zero output currents for $V_1 = V_2 = 0V$. Drifts (of the order of 1 µA for VCTa and 40 µA for VCTb) were noted over the next few minutes and R_{B2} was finally set to 5k2 for VCTa and 5k6 for VCTb. In the test for common mode rejection (Fig. 12) the residual offset and the magnitude of short term drift effects are apparent; (output levels must significantly exceed these drifts). As the supply voltages are approached, transistors begin to cut off and this may in turn lead to unpredictable effects depending on the relative parameters of the various devices. The lesson to avoid approaching the supply rails is clear. While the common-mode rejection ratio seems satisfactoty for VCTa (Fig. 12), the curve for VCTb clearly indicates an asymmetry in the circuit, i.e. there is at least one transistor mismatched to its counterpart on the other side; (this mismatch is most likely in a variation of gain with V_{CE}).

Fig. 13 shows the standard transfer characteristics. The slight variations in slope are due to R_{EXT} tolerances and the measured values (VCTa: 1mA/12V and 6ma/7.75V for R_{EXT} = 10K, 1K) exceed expectation slightly (c.f. 1mA/15V, 6ma/9V) due to a small current gain caused by transistor mismatching. This effect also leads to small discrepancies from the expected current limit levels (e.g. $\frac{2}{3}$ x 20V/4K and $\frac{2}{3}$ x 20V/5K2).

The results described in the preceding paragraph were obtained with one input grounded as a matter of convenience. There is a dramatic shift in the offset current when one end of the load is also grounded (Fig. 14) and when both these fixed points are switched to the other side of the VCT. It would seem that the concept of 'floating' input and output require re-examination.

It must be noted that while one might expect the two ends of the floating load to sit at approximately zero volts, it does not take a great deal of device variation to produce extreme deviations from this. In both the circuits built here, two output transistors (Q_4, Q_5 of CA3086, see Fig. 9) were saturated at null output. (With different selection of devices, saturation of CA3084 Q_3 and Q_4 is equally likely). This creates

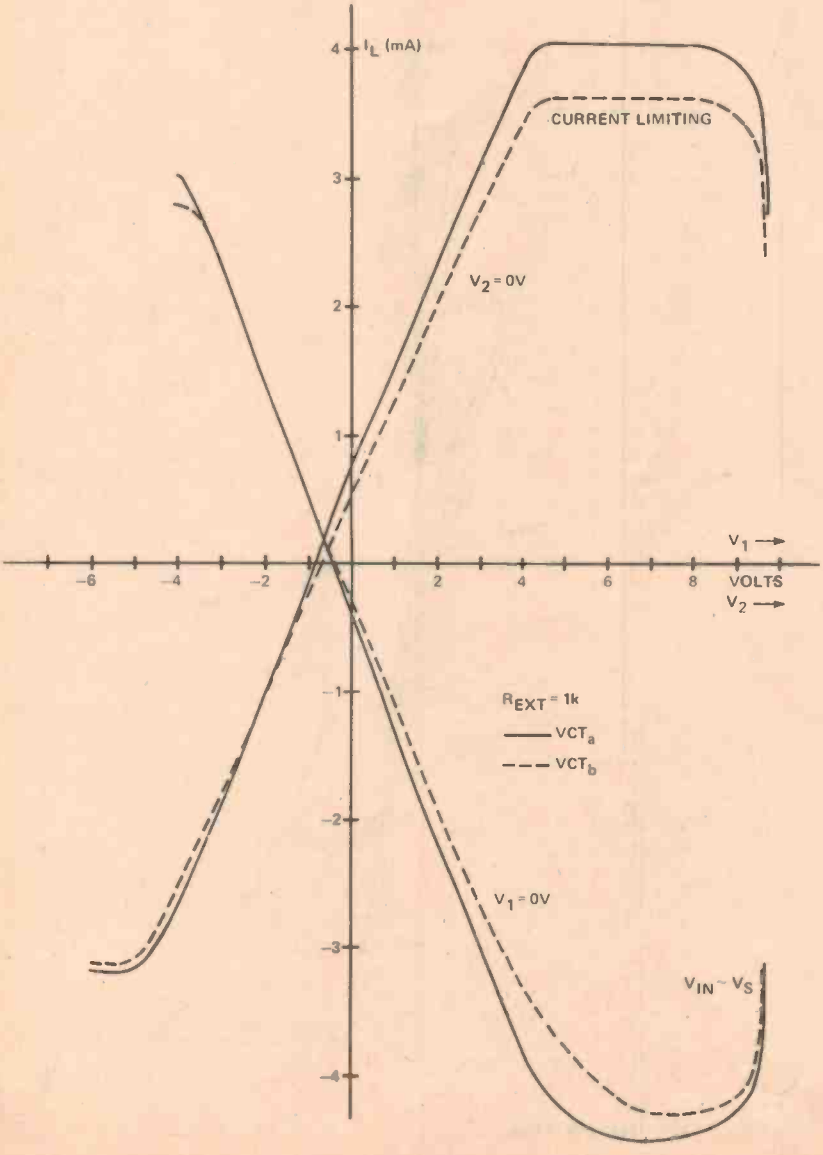


Fig. 14. Transfer characteristics with one end of the load grounded and with corresponding input grounded.

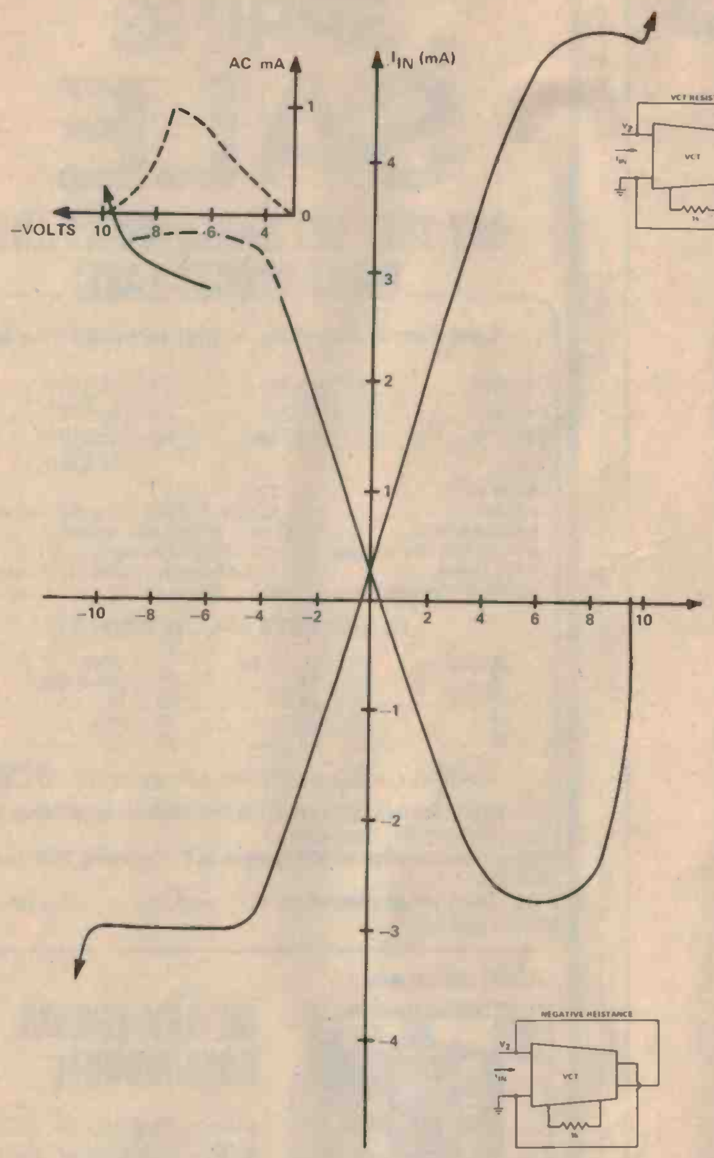


Fig. 16. VCT 'resistors' – positive and negative.

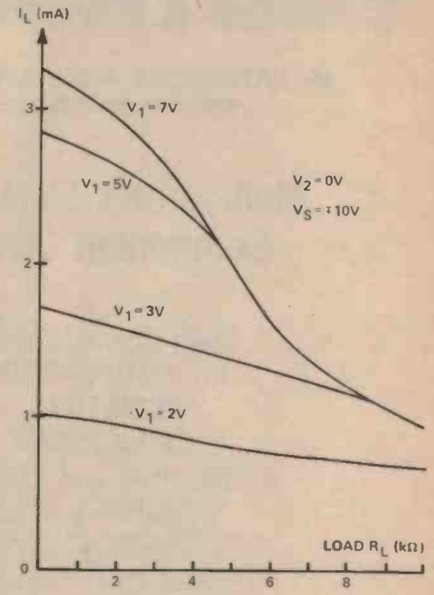


Fig. 15. Effect of output load resistance.

no problems for the floating load unit high frequency or switching applications where performance will be down-graded by transistor saturation. It does, however, mean that the output must be rezeroed if either end of the load is to be tied to a fixed potential as in Fig. 14.

The four constant current sources which comprise the output circuitry lead inevitably to saturation as soon as there is an imbalance between them. In many cases zeroing the output current aggravates the problem. If device selection is contemplated, these are the transistors to consider first.

Variation of load current with load impedance (Fig. 15) suggests that the output impedance is about 40K, substantially below the 60–100 KΩ range expected from the transistor specifications because of saturation. The differential small signal input resistance has been measured at about 35K which is approximately h_{FE} R_{EXT}. This figure would be increased by the use of Darlington input transistors.

Up until this stage, none of the more exotic circuit applications has been discussed. A few remarks should be made, however, in closing. Ideally the output is a constant current and can be used to linearly charge a capacitor, e.g. to provide integration. The constant current sourcing is not perfect however and integrating applications will be limited to frequencies greater than $(2\pi\ R_{OUT}C)^{-1}$. A similar limitation will exist for gyrator performance.

A gyrator was built with the two VCTs but oscillated. The oscillation is believed to originate, however, with the use of inadequate power supplies – another point to note in investigating these circuits – rather than with that circuit itself. Gyrators operate on a negative immitance conversion principle so it is instructive to consider the resistance applications of the VCT in Fig. 16 where the terminal resistances are expect to be $\pm \frac{3}{2}$ R_{EXT}. In the negative resistance case an oscillation region was identified (see inset). If the negative resistance circuit is examined, it clearly provides positive feedback if the driving source (V_2) impedance is not zero.

In closing I wish to acknowledge the assistance of Jock Howie and others with this project.

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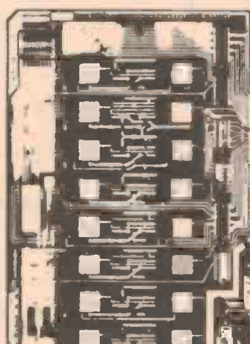

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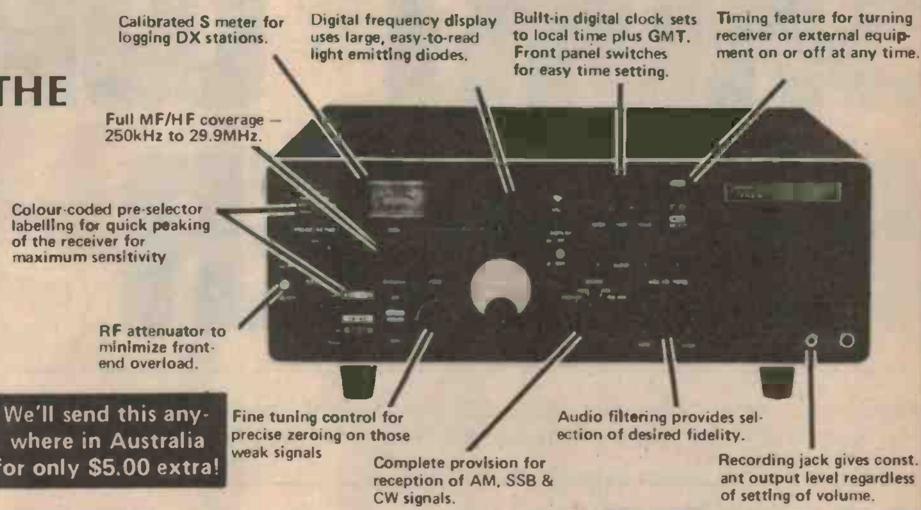

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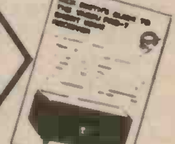

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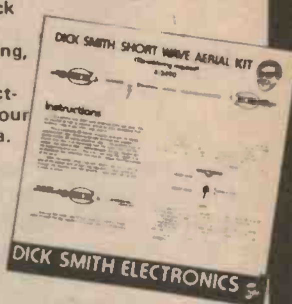

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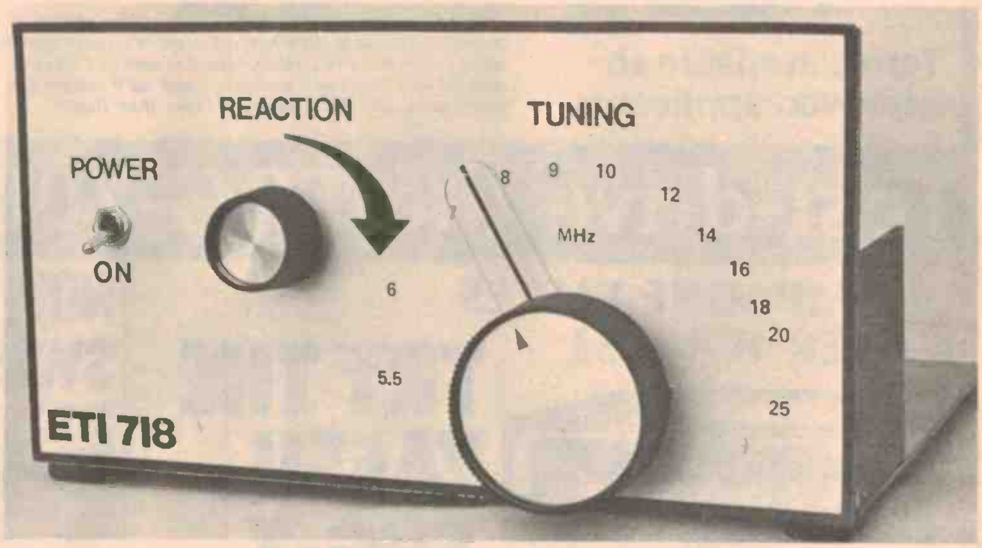
Project 718

SHORT WAVE RECEIVER

Maybe you can't afford a super-radio like some of those mentioned in our other SW Radio article this month, but we've got the answer. . .



APART FROM THE very early sets, which were based upon coherers and other devices you never hear of today, the first radios were very straightforward designs totally unlike today's sophisticated superhets. The early Tuned Radio Frequency (TRF) sets were simply a tuning circuit with some gain and a detector circuit, but later designs used positive feedback, in the form of reaction, to increase the performance. It is still possible to get a lot of fun from sets of this type.

By using modern solid state components a very simple reaction set can be built which offers surprisingly good performance at low cost. The Field Effect Transistor has almost identical performance to the earlier valve and is the basis of this design.

The circuit of fig. 1 uses an MPF 131 dual gate MOSFET as a regenerative detector, followed by a BC548 audio amplifier stage which is capable of driving a crystal ear piece, high impedance head phones, or being fed to the input of an amplifier. The frequency coverage is approximately 5.5 to 25 MHz, or 54 to 12 meters.

This coverage includes many interesting features such as the international broadcast bands at 49, 31, 25, 19, 16, and 13 metres, as well as amateur bands at 40, 20, and 15 metres.

Operation

Satisfactory operation depends on the proper use of regeneration, which unless operated correctly will result in poor performance and interference to neighbouring sets.

Initially, set C1 about half closed and increase the regeneration until a point can be found where signals are heard when tuning. Increasing the regeneration will increase the volume, until a point is reached where a whistle is heard when tuning across a station. The most sensitive point is where this whistle just fails to arise.

Regeneration has to be adjusted in conjunction with the tuning, because the setting of RV1 will change as the set is tuned across the band. The tapping position of the coil also influences regeneration, and may have to be lowered to obtain correct operation on some frequencies. The tapping point found to give the best results will also depend on the length of antenna used. As a starting point, try the middle tap and then move the tapping point up or down the coil to give the strongest signals, while still able to achieve regeneration.

Reception of CW signals is possible by using the regeneration control so the set is just oscillating, while the tuning gang is set so that a beat note is heard. This can also be done for SSB signals but the tuning will be very critical.

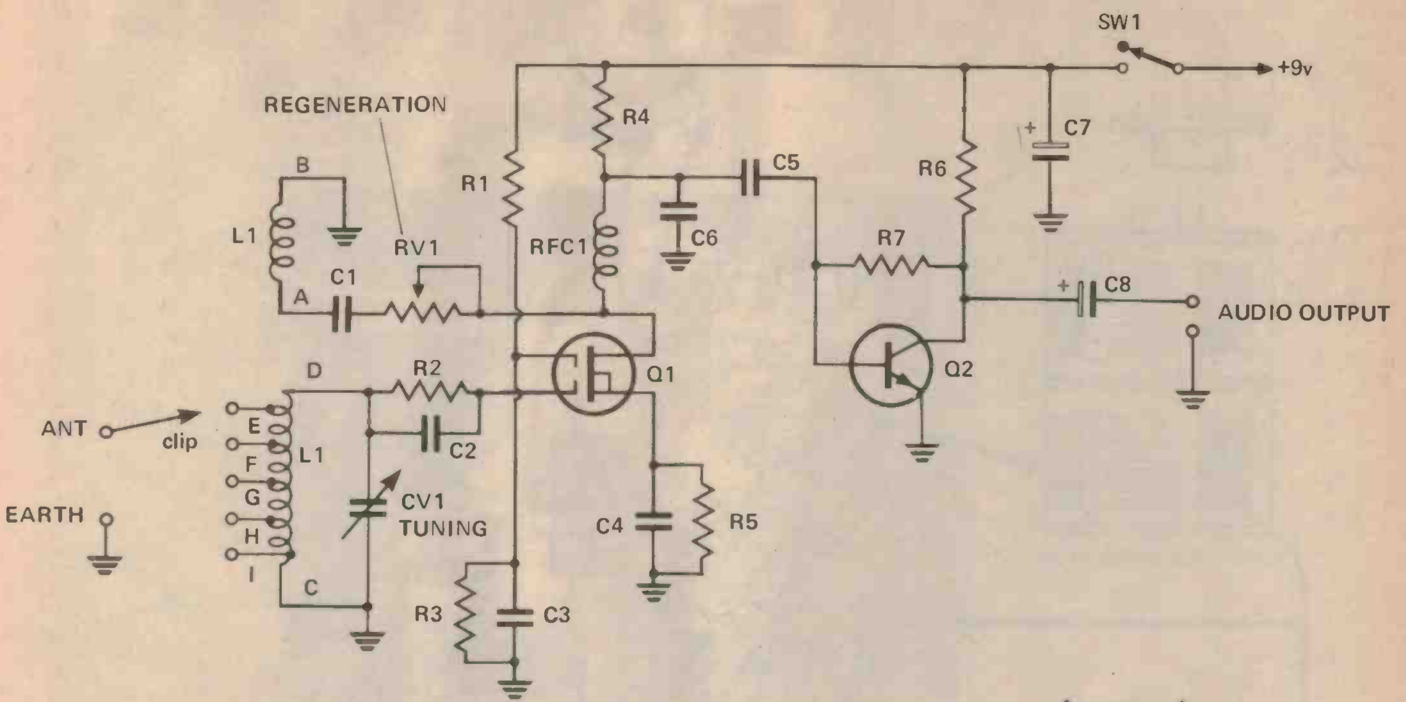
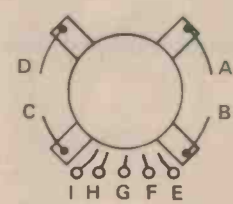


Fig. 1. Circuit diagram of the receiver.



L1
TOP VIEW

HOW IT WORKS – ETI 718

Signals from the antenna are coupled into the tuned circuit (L1, CV1) via the clip lead and the coil taps. The tapping point is varied to give the best match from the antenna to the circuit, yielding the best performance.

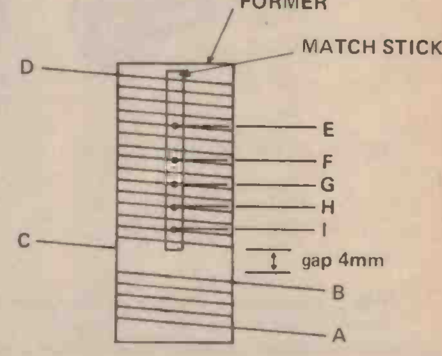
The tuned circuit acts as a filter, only letting the desired frequency through to the FET (Q1), since the tuned circuit resonates at a frequency set by the position of the variable capacitor, (CV1). As the value of the capacitor is varied, so the resonant frequency of the tuned circuit, and the frequency of reception, is varied.

The radio frequency signal at the desired frequency is then fed to the FET (Q1), where it is amplified and appears at the drain. Because the radio frequency choke (RFC1) presents a high impedance (or near open circuit) to radio frequencies the signal passes through C1 and RV1 to the regeneration coil wound on L1. Some of this signal, the amount determined by the setting of RV1, is coupled back to the tuned circuit.

For regeneration to occur, the signal fed back to the input must be the same polarity or 'phase' as the incoming signal. A phase reversal occurs in the FET, so a second phase reversal is necessary. This is achieved by connecting the feedback to the reaction coil upside down (i.e. to the bottom of the winding, and the earth to the top). In this condition of positive feedback the circuit can be made to oscillate.

The feedback signal now passes through the tuned circuit again to the FET, although this time it is 'detected' before it is amplified once more. Detection recovers the audio information from the signal before audio amplification. The radio frequency choke looks like a short circuit to the low frequency audio signal which passes through it. It cannot however pass through resistor R4, but is coupled to the audio amplifier (Q2) via C5, where it is amplified before being fed to the output. Any unwanted RF signal which happens to get through the RF choke is shorted to earth by a small value capacitor (C6).

Maximum circuit gain, and therefore maximum audio output, occurs when the regeneration control is advanced so that the circuit is just not oscillating. This point also yields the best 'selectivity', or the ability to distinguish between close stations.



L1

Table 1 – Coil Winding Details

Reaction coil: 4 turns of 24 B & S enamelled wire, closewound at the base of the former in a clockwise direction.

Tuning coil: 15 turns of 24 B & S enamelled wire, closewound, starting 4 mm above the top of the reaction winding in a clockwise direction. Taps at 2,4,6,8 and 11 turns from the bottom of the winding. Turns which are tapped are raised over a matchstick.

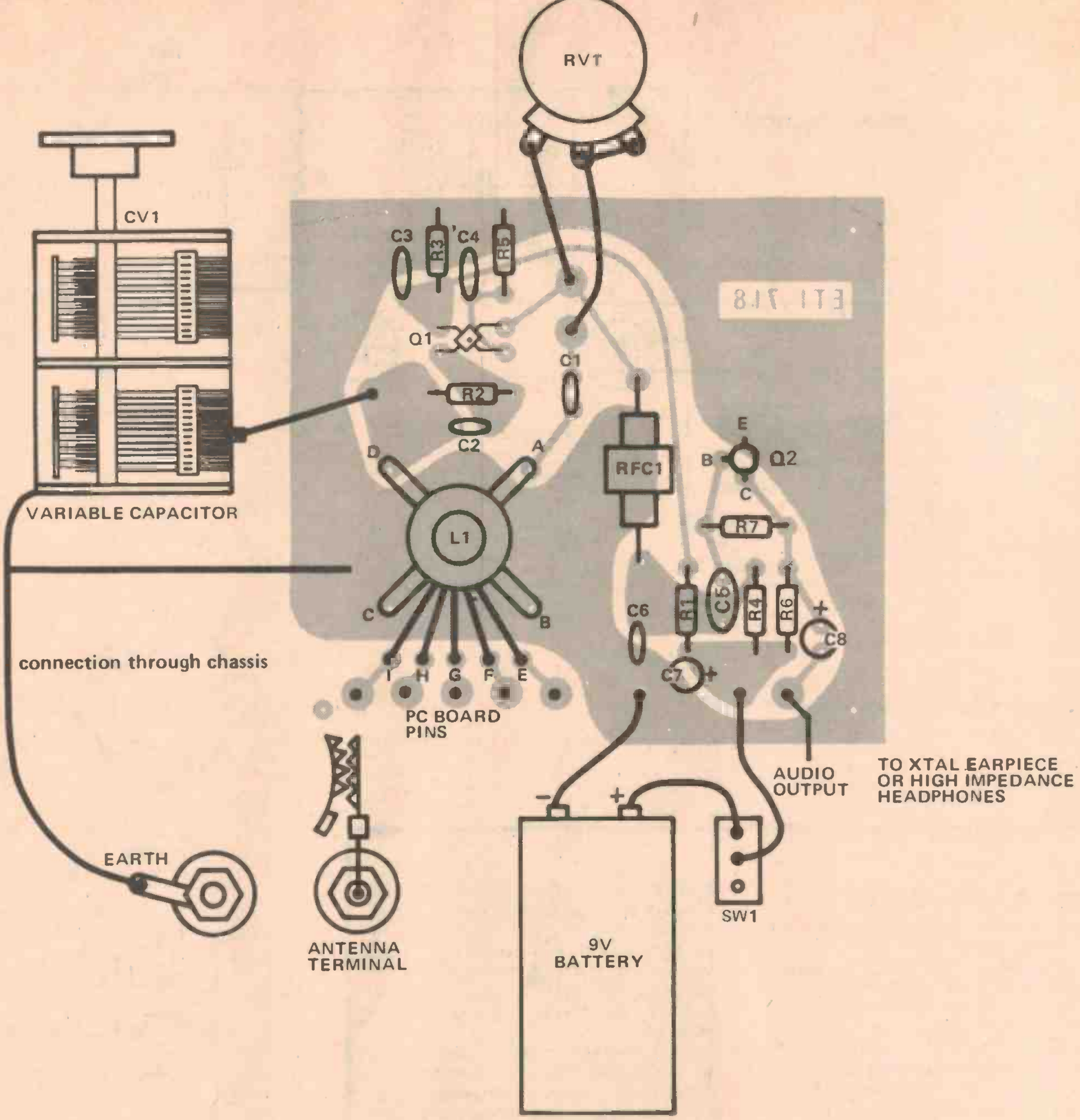


Fig. 2. Component overlay, as seen from the component side of the board. Note carefully the connections to the coil.

PARTS LIST – ETI 718

Resistors all ¼ W, 5%

R1 . . . . 4k7
R2 . . . . 1M2
R3 . . . . 10k
R4 . . . . 2k2
R5 . . . . 1k
R6 . . . . 10k
R7 . . . . 4M7

Potentiometer

RV1 . . . . 2k lin pot

Capacitors

C1. . . . . 10n ceramic
C2. . . . . 270p ceramic
C3,4 . . . . 100n ceramic
C5. . . . . 100n greencap
C6. . . . . 1n ceramic or greencap
C7. . . . . 10µ tantalum 16VW
C8. . . . . 4µ7electro 16VW

Variable Capacitor

CV1. . . . . 415ptuningcapacitor or similar (see text)

Semiconductors

Q1 . . . . MPF131 dual gate MOSFET
Q2 . . . . BC548 or similar

Miscellaneous

pc board . . . . . . ETI 718
pc board pins
coil former. . . . . 12 x 30 mm air cored Dick Smith Cat. No. L-1110
RFC1. . . . . 2.5 mH RF choke Dick Smith Cat. No. L-1824
box to suit . . . . . (see text)
SPST on/off switch
planetary drive, 5 to 1 reduction
length of 24 B&S enamelled wire
9 V battery and battery clip
knobs, rubber feet, crystal earpiece or high impedance headphones, headphone socket

Construction

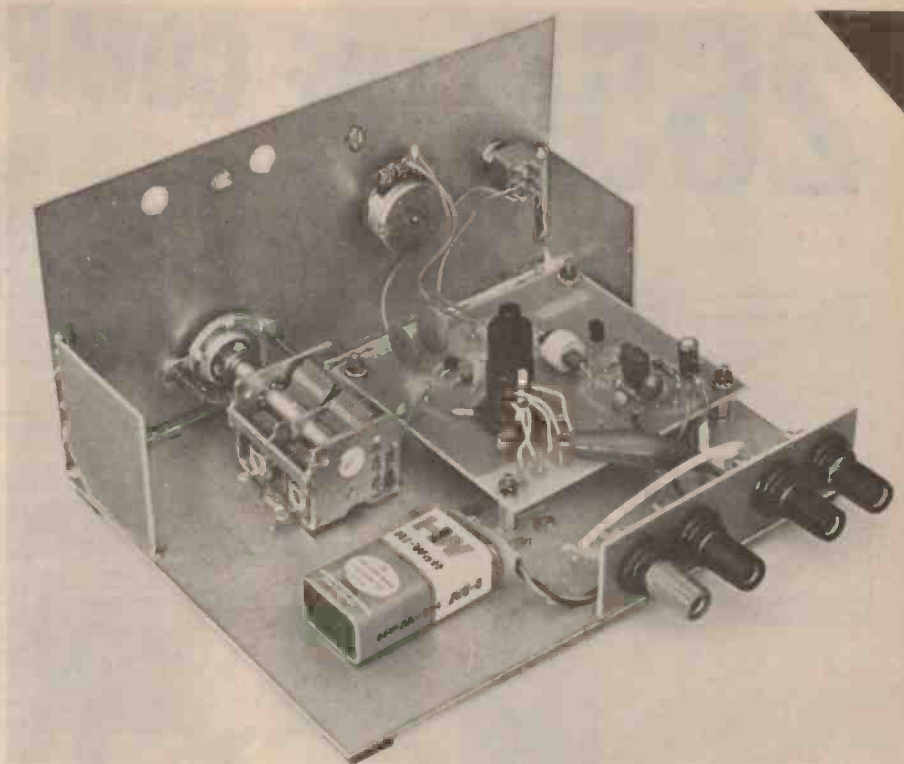
All the components except the tuning capacitor are mounted on a printed circuit board, (see fig. 2). Other types of construction such as vero board can be used but may not offer the same repeatability of results. The coil (L1) is wound separately as in Table 1 and later mounted on the PC board. If the type of former in the parts list is used, the solder lugs on the former will line up with holes in the PC board and the former can then be held down onto the board by its connections. Short lengths of wire are used between the coil taps and the PC board. Printed circuit pins are then soldered into the tapping points and the tap changed by means of the alligator clip from the antenna terminal.

In our receiver we used one section of a second hand dual tuning gang. Most gangs from an old radio will do as long as only one section is used, the lowest frequency of operation depending on the value of capacitance.

The chassis is 175 by 90 mm and 140 mm deep, and is constructed entirely from single sided PC board (copper side inward). This method is both cheap and easy, the front panel being soldered onto the base plate. Squares of PC board are soldered into the ends for rigidity of the front panel.

A planetery drive mechanism is used with the tuning capacitor and is attached to the front panel with two nuts and bolts. A plastic cursor can be cut from a sheet of thin perspex and attached to the outside of the drive mechanism with Araldite to provide a dial pointer.

The regeneration potentiometer and the ON/OFF switch are also mounted on the front panel, with the antenna, earth and output connections mounted on a small piece of PC board at the rear. All wiring should be kept as short as possible, especially to the regeneration control and the tuning capacitor.



Rear view of the completed unit. We used one section of a dual gang tuning capacitor. The terminals from left to right are: Antenna, Earth, and the two output connections.

Antenna and Earth

Although some signals can be heard with a small indoor antenna, an outdoor antenna is much better. The antenna should be as long and as high as practicable, running perhaps from the house to a tall tree or other building. Figure 3 shows a typical antenna installation which will give good results. The leadin from the antenna should be kept as short as possible, so a good position for the set would be close to a window.

An earth is not essential but is generally worthwhile, since it can help to avoid the effects of hand capacity by grounding the metal chassis. The set can be earthed to a water pipe or run to a metal spike driven into the ground.

Performance

The number of short wave signals that can be heard depends upon the time of day, early morning, late afternoon and night being the best. After a few periods of listening at various times you will know what to expect. Using an indoor antenna we were able to receive strong signals throughout the day and the number of stations heard rapidly increased towards dark.

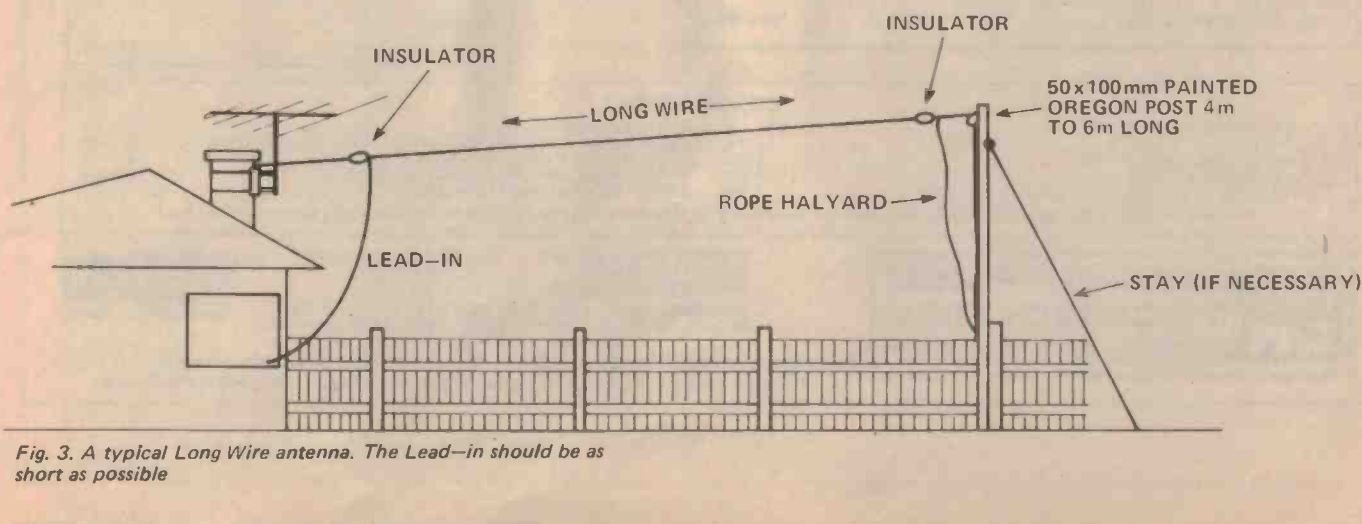


Fig. 3. A typical Long Wire antenna. The Lead–in should be as short as possible

Getting into Short Wave Radio

Your ticket to the world of short wave radio is your receiver, and the way you understand its operation. Here Bob Padula of the Australian Radio DX Club, explains what to look for when buying or operating a radio.

DURING THE PAST two or three years, interest in shortwave radio as a hobby has been marked by a dramatic increase in the numbers of people joining the many DX Clubs around the world. This emergence of shortwave radio as an alternative spare time activity has been associated with the rapid advances in communications receiver design and mass production manufacturing techniques originating in the Asian electronics industry. Contrary to the situation some ten years ago, purchase of a modern, high-quality, multi-band shortwave radio is now well within the reach of most aspiring hobbyists.

The past few years has also been marked by a certain amount of categorization amongst the ranks of shortwave listeners throughout the world, introduced by leading DX groups in Australia and elsewhere, so that the Clubs could more readily determine how they could best serve their memberships. As a result, it is generally accepted that there exists two main categories of shortwave enthusiasts, which, in broad terms, may be defined as:

*Those listeners who wish merely to listen in to foreign broadcasts, in much the same way and for the same reasons that they would tune in to their local broadcasting station. This listener group is generally interested in foreign radio mainly for entertainment, news, music, and perhaps for keeping in touch with the home country. The term "Shortwave Listener", commonly abbreviated to "SWL" is the accepted way of referring to this category of listener.

*Those hobbyists having a more technical involvement in foreign broadcast listening, and who are interested in the study of propagation patterns, frequency usage, scheduling, technical monitoring, and possibly in the compiling of notes for inclusion in reception reports subsequently sent to the stations for verification (QSL) purposes. For this large group of listeners, program content is not of prime importance, as these hobbyists are more concerned with advancing long-distance (DX) reception techniques, and the stations tuned in will consist of a very broad spectrum of those on the air, including those broadcasting in languages other than English. These listeners are generally known as "DXers".

DXers will tend to study the reception of stations operating in all frequency bands, often specializing in DXing the Tropical Bands, such as are used for regional broadcasting in Africa, Asia, and Latin America. The reception of weak signals is important to the DXer, as a challenge to his skill and hobby expertise, whereas the SWL will normally confine his listening to higher powered transmitters beaming programs to his own reception area.

Different Needs

These two listening groups should be kept in mind when discussing how to choose a suitable receiver; whilst some common features will emerge for receivers for both hobbyist groups, the needs of the serious DXer will often be somewhat different to those of the SWL. The situation can be further complicated by the different needs of listeners who may require fully portable equipment, as compared with hobbyists preferring receivers intended for fixed use in the home, and running off a mains supply.

It is of course impossible to recomment a particular receiver, or receivers, that will serve each and every hobbyist satisfactorily; one particular set may have certain shortcomings for a given reception application — the same receiver may be well ahead of others in its class for another style of listening. Overall, the listener must look at his own requirements, and should certainly not rush out and but the set that looks the nicest, has the most colored dials, and perhaps costs the world! The new listener should pay attention to these main factors:

*Whether he wishes to explore serious DXing, or merely pursue general program listening, or possibly some combination of both;

*what he is prepared to spend;

*whether he wants to listen away from home, perhaps whilst on holidays at the beach or in the hills, or from a permanent location back home;

*the fidelity of audio reproduction desired;

*the ease of tuning, controls, and frequency readout that is desired.

Unfortunately, reviews of receiving equipment far too often fail to take into account the somewhat differing needs of the DXer, as compared with the SWL. Most reputable DX Clubs these days publish from time to time realistic reviews of new receivers, written around the general needs of SWLers and DXers. For the new listener, who may not be a member of a DX Club, access to this sort of material is often unavailable, and he may not be aware of what membership of a DX Club can provide. It should be kept in mind that membership of DX Clubs is not confined only to advanced, technically trained and highly skilled listeners, but rather that the Clubs essentially consist of a wide spectrum of listeners, with assorted hobby interests, ranging from the novice SWL through to the advanced, semi-professional DXer. Most hobbyists fall somewhere in between these extremes. However, there is of course a slant towards the encouragement and development of DXing skills and technical expertise, for those who have the capability, motivation, and dedication, but this should not deter the new listener from joining one, or more of the larger DX Clubs.

For some time, the Australian Radio DX Club has recognized the unique problems faced by newcomers to SW listening, and has introduced a special service, for both members and non-members, known as the "Receiver Review Package". This contains a wide variety of brochures, technical specification sheets, and literature made available by receiver manufacturers and distributors, as well as copies of previously published reviews of selected communications sets, originally appearing in the Club's bulletin. Information on availability and cost of this special Package, plus general Club information, is available on request from the ARDXC, Hon. Secretary, PO Box 67, Highett, Victoria 3190, for return postage. New members of ARDXC receive a comprehensive "New Member Kit", including the "Guide to DXing for Beginners", which expands on the information given in this introduction.

A good example of the use of a separate bandspread dial is the Trio Kenwood R300.

Basic Requirements of Receivers

Frequency Coverage

For general DX work, a set offering continuous coverage from 2 MHz through to 30 MHz is essential. Some sets have limited coverage and tune only the major international SW bands — other sets cover only some of the major bands. Such equipment is suitable only for the SWL, and the serious DXer wishing to explore the territory between bands, will need access to frequencies not normally required by the SWL. With the possibility of extensive rearrangements of international frequency allocations for the various radio services emerging from the 1979 World Administrative Radio Conference and new or additional bands being created, many existing sets will be quite inadequate, if designed around the bands as they now exist. With increased sunspot activity, due to the ascent into the new cycle, use of the high frequency 13 and 11 metre bands will be stepped up over the next two or three years, and sets for general SWL work should have coverage of those bands.

Sony's top-line CRF-330K has a digital dial and incorporates a cassette recorder.

Sensitivity

For DX work, good sensitivity is essential. In olden days, before the advent of semiconductors, valve type sets showed a serious drop off in performance above about 17 MHz, and required all sorts of outboard preselectors and preamplifiers to boost the top-end performance. Modern, well engineered sets do not generally exhibit this sort of deficiency, and operate well up to their design limit, which is often around 31 MHz. Good sensitivity refers of course to the ability of the set to detect and respond to weak signals, and is usually specified in terms of microvolts (μV) of input signal to give a standard output. Published data usually gives two sets of figures — one for normal double sideband AM, the other for SSB/CW. Sensitivity of between one and two microvolts will provide adequate performance for the DXer. It is of interest to note that some professional quality receivers have sensitivity figures of 0.25 μV (SSB) and 0.5 μV (double sideband AM), for 30% modulation, and for a 10 dB signal to noise ratio.

The ability of the set to receive a small signal above the noise level is important, and not how well the set can amplify the signal. For the general SWL, superior sensitivity is not so important, as this style of listening usually revolves around stronger signals, and not the weak input levels sought after by the serious DXer. If portability of the set is desired, this means that good sensitivity is mandatory for both the SWLing and DXing applications. Many hobbyists maintain listening whilst travelling, from holiday locations not only in Australia but overseas and perhaps on board ship — an insensitive set coupled to a small antenna under such circumstances is only so much excess baggage!

Careful study should be made of published sensitivity specifications — if the figures show sensitivity figures worse than 4 or 5 μV for 10 dB signal/noise, then the set would have only limited application for the serious DXer.

Selectivity

Most of the current general coverage communications receivers, and the advanced design multi-band portables (and semi-portables) have been engineered around a performance capability of benefit generally only to the SWL. Clearly, manufacturers are looking at the mass market for their dollar return on R & D investment, and it is the SWL group that is of course the largest user of SW radios at the present time. It is for the SWL that modern production and manufacturing methods have been directed in recent years, but it is interesting to note that at least one major Japanese manufacturer has shown a willingness to respond to the requirements of the serious DXer, for future development. Surveys are currently being conducted amongst the large DXing groups within North America on those features thought to be most desirable on equipment designed es-

pecially for the DXer market, and the rapid upsurge of interest in DXing, as opposed to SWLing, in Japan, is also considered to be a key factor in the probable introduction of a relatively inexpensive set designed specifically for the serious DXer.

As a result of this present situation, the selectivity characteristics of many modern, general coverage receivers have been found to be somewhat inadequate for serious work, due to the relatively broad skirt of the overall response curve. The shape factor of the IF response is important when serious DX work is pursued in the crowded bands of today, and many currently available sets are designed to give good audio quality, at the expense of adjacent channel separation. If a set cannot separate stations operating on carrier frequencies 5 kHz apart, the DXer is at a serious disadvantage, as many of the weak signals he will want to listen to lie immediately adjacent to strong international broadcasters. Even strong international stations may not always be heard clearly, if there is another strong station on an adjacent channel, beaming hundreds of kilowatts into the listener's area.

Selectivity figures are usually given as the total bandwidth at the –6 dB point and the –60 dB point. For normal double-sideband (AM) reception, a total bandwidth of about 3 kHz is ideal at the –6 dB point, broadening out to around 10 kHz at the –60 dB point. The selectivity characteristic of this type of design is perfectly satisfactory for most DXing applications, which offers a good overall audio reproduction capability, and with adequate adjacent channel separation of stations 5 kHz apart. A set exhibiting such features was the very popular Trio 9R59 valve type receiver, now superceded, and which has been rated by many serious DXers as one of the best general purpose communications sets ever built in its particular price range.

Many current sets have much broader response characteristics — typically, at the –6 dB point, total bandwidth might be 6 kHz, widening out to about 14 kHz at the –60 dB point. For true communications purposes, bandwidths such as these are too broad for adequate separation of stations on adjacent channels, and whilst satisfactory for general SWLing, are often made the subject of receiver modifications after purchase, by fitting narrower bandwidth filters for specific requirements.

When studying selectivity data as published by manufacturers, care should be taken in properly interpreting it — there is a tendency nowadays to quote merely the bandwidth for SSB reception at the –6 dB point; this will be half the total bandwidth required for satisfactory double sideband AM reception.

More sophisticated receivers, costing upwards of $2000 have superior selectivity features, such as selectable upper or lower sideband, and variable selectivity, to cater for a wide variety of listening requirements. There are many sets, originally manufactured during World War 2, still in regular use, whose selectivity features are superior to those of a lot of the current receivers. For example, the Marconi CR100 series (described by some DXers as the best set ever made) has an inbuilt crystal filter and variable selectivity, ranging from total bandwidths of 6 kHz down to 300 Hz. The well know Hammarlund HQ180 featured variable selectivity and selectable upper or lower sidebands, and there are many other similar sets still in use with this type of useful selectivity characteristic. The Drake SPR-4 is a currently available set featuring switchable variable selectivity; the famous RCA AR88D has five selectivity modes, ranging from 500 Hz to 13.5 kHz at the –6 dB point.

Unfortunately, for the new listener on a limited budget, there is not much he can do about the selectivity characteristics, unless he has some technical training and is able to carry out a modification to improve this aspect of the set's performance. The currently available Yaesu-Msaun FRG7 has proven to be a very popular set for general SWL and DX work, but many users have indicated that its marginally inferior selectivity features have caused them to look elsewhere for a set suitable for serious DXing. In fact, many DXers have added a modification to the FRG7 to sharpen up the selectivity, and at least one receiver distributor in the USA has marketed this mod as an option on purchase.

It is encouraging to note that the latest products emerging from Japan, and in particular the National DR48 and its little brother, the DR28, exhibit selectivity features approaching what is considered to be optimum for the serious DXer. Using ceramic filters, quoted selectivity data for the DR48 and DR28 indicates a bandwidth of 3.4 kHz at the –6 dB point, and 12 kHz at the –60 dB point, which is adequate for most reception applications for the serious DXer, and excellent for the SWL.

Stability

By this is meant the ability of the set to stay tuned to a given frequency after a nominated warm-up period (generally about 15 minutes). In older equipment, drift was often caused by physical shock which meant that the better class set was built like "tanks", making them suitable only for fixed station use. Ageing of valves also required recalibration periodically, and adequate ventilation, coupled with voltage regulators, had to be provided to minimise the effects of temperature change on local oscillator frequencies. Elaborate and expensive compensating networks and the use of negative coefficient components in the local oscillator circuits of valve sets was typical, in order to minimise the effects of frequency change by external conditions.

Modern solid state equipment exhibits far fewer stability shortcomings than the older valve type gear. Drift for modern receivers may generally be less than 100 Hz during any 30 minutes after warmup, and less than 100 Hz for a 10% change in line voltage. Advanced circuitry, such as the synthesized drift cancelling system, is now being used extensively in many modern designs, including several relatively inexpensive receivers.

For reception of SSB signals, stability is very important, to avoid having to have one hand continuously on the controls for the entire listening period! Nothing is worse than to have to continually retune the set in attempting to follow a SSB signal, due to shortcomings in the receiver design, where the signal is constantly dropping out of resolution. Many cheaper multi-band portable SW sets are sadly deficient in this characteristic; though performing well in the general areas of selectivity and sensitivity – their short term drift performance is very poor. This undesirable effect will not normally apply to sets intended for general SWLing, or for general DX work on double-sideband AM signals. It should be noted that some international SW stations are now experimenting with SSB transmissions as part of their normal schedule, and for this reason new purchasers should obtain sets with a capability for this mode of reception, if serious DX work is desired. The very expensive professional quality receivers have exceptionally good long-term drift features, but this type of gear will normally be out of reach for the average SWL or DXer.

Spurious Signal Rejection

The most expensive and elaborate set in the world, having superior sensitivity, selectivity, and stability features will be totally useless if the received signal cannot be separated from a babble of whistles, birdies, and other spurious products. For sets with an IF of 455 kHz, "double spotting" at twice the IF (910 kHz) away from the desired signal is a very real problem, especially at frequencies above about 15 MHz. The effect is due to inadequate selectivity in the RF stages, and causes signals 910 kHz above the wanted frequency to be heard as "double spots", alternatively known as "images". The wanted signal can be tuned in at two spots on the dial, separated by 910 kHz. Additional RF stages were often designed into some equipment used for armed services work, and sets having two RF stages are not uncommon, such as the Marconi CR100 and RCA AR88D. Image-rejection capability is always worse at the high frequency end, and only by very careful attention to design can the rejection ratio be reduced to tolerable levels. On some modern sets, with only one RF stage, the problem can be reduced simply by insertion of an antenna tuning unit in the input to the set from the external antenna. Alternatively, the use of an outboard preselector can often eliminate most of the troublesome double spotting effect on inexpensive receivers. Double-conversion designs have been developed where the first IF is set at a relatively high figure, sometimes around 10 MHz, to provide for good image rejection ratios, followed by a second IF of perhaps 100 kHz for increased selectivity. Some designs have featured triple conversion in an attempt to optimise the conflicting requirements of selectivity and image rejection.

Spurious signals generated within the set have become more common nowadays due to the widespread use of

Sony's ICF-5900W is a very high performance portable.

The FRG-7 is one of the most popular receivers in the world today.

The Standard C6500 is a recent Wadley-loop design.

The R-820 Is Trio Kenwood's general coverage flagship.

solid state devices in the RF stages. In some valve type sets, strong signals could break through and cause overloading due to improper alignment or tuning, or by inadequate attention to design in the RF circuitry. The cross-modulation effects caused in this way appear as unwanted signals superimposed on the desired signal, and can be reduced by attenuating the input signal level, ideally by the use of the receiver's manual gain control, if fitted. Many modern solid state sets exhibit this shortcoming, and often suffer from severe cross modulation problems generated in the RF stages that use bipolar transistors. Close proximity medium-wave stations frequently show up at various points in the SW tuning range, particularly on simpler receivers, and even on some more expensive sets, it is virtually impossible to eliminate this major deficiency, beyond moving one's residence out into the hills! Reduction of the problem when using solid state gear can sometimes be achieved by using properly designed and adjusted filters in the antenna input to the receiver. Very severe cases can sometimes be overcome by fitting an attenuator, and many of the modern sets have such a device already built into the design. Contrary to what might be expected, the use of extra-long outdoor antennas is not recommended for general DX work where local MW transmitters are sited within a few km from the receiver — attempts to use long antennas generally only create even more spurious signal and cross modulation products when solid state gear is operated. Some of the very cheap multi-band portable SW radios are atrocious in their ability to reject strong signals, both SW and from MW stations — often, SW stations can be heard over the MW dial, due to inadequate design attention in the RF and mixer stages. Beware of such equipment, which has no real application for the serious DXer or SWL. If an intended receiver purchase exhibits all sorts of whistles and birdies when used with an antenna of reasonable length (say, about 10 metres long), it would be wise to look elsewhere. Whilst some of these sets may look pretty, with elaborate dials and colored knobs, their overall performance is appalling, and their only value is of a cosmetic nature.

Tuning, Dials, Calibration, Readout

During the early 1940's, the trend was for receivers to have two separate tuning gangs, coupled to separate dials, and electrically in parallel. One was called the "main tuning", the other "bandsspread". When used with switched band changing, and by suitable selection of circuit constants, bandspread tuning was available for any desired portion of the spectrum covered by the main tuning. This tuning arrangement is still used in many current designs, and many recently superceded sets are in widespread use with this dial configuration. It is seen in the popular Lafayette series (both valve and solid state) — HE30, HA230, HA600, HA800, the Trio 9R series (9R59DE, -DE, -DS), the Realistic DX160, and many others. It offers electrical bandspread, sufficient for general DX or SWL work, relatively cheaply and easily, without the introduction of expensive design features. Sets of this type generally have the bandspread dial calibrated for either the major SW bands, or the amateur bands, together with a 0-100 logging scale, and readout to 5 or 10 kHz is achievable, when operated carefully and sensibly. For this to occur, the main tuning dial has to be accurately set to a predetermined frequency, so that the bandspread dial can be read off directly. This is done either by using stations whose frequencies are known, or by internally generated "marker" signals, which are switched from the front panel, perhaps at 5, 10, 50, or 100 kHz intervals. Sets of this nature continue to give reliable service in DX shacks around the world, not only for general DX and SWL work, but also for amateur and utility listening. However, some skill needs to be developed in making sure that the band-edge frequencies are correctly set up before using the bandspread dial, and some familiarity with the SW bands is necessary to establish the starting and end points.

Some sets incorporate mechanical bandspread arrangements, often by using concentric tuning dials, one with a fast tuning rate, the other for slow tun-

The FRG-7000 is the successor to the popular FRG-7.

ing. The famous Eddystone series of communications receivers uses a dial which has a superb gear reduction and movement, allowing direct readout to 5 kHz by use of the inbuilt logging scale.

The serious DXer often uses auxiliary equipment for tuning accuracy, such as the very popular but somewhat archaic Number 10 Crystal Calibrator, which may still be available from disposals sources for around $20 or so. The well known BC221 Frequency Meter is used extensively by serious DXers, but is not so favoured by the general SWL, due to the technical requirement for its proper setting up and use. New BC221's are currently available here in Australia, and represent good value for the money.

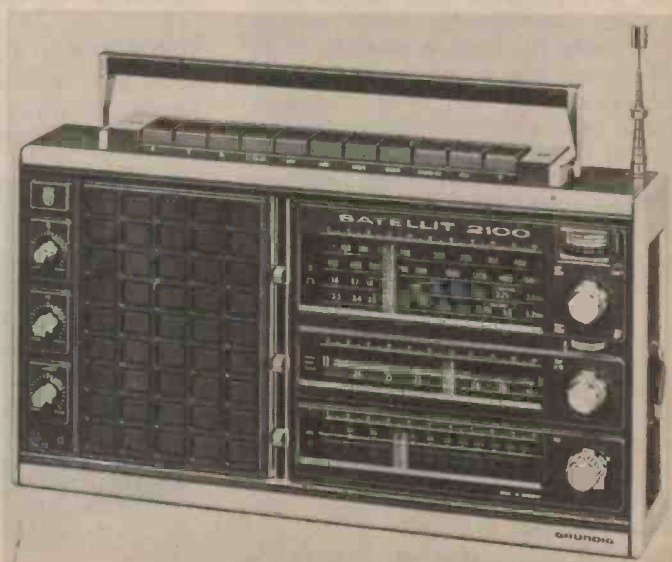
The use of solid state frequency counters, connected across the local oscillator output of the set, arranged to read direct by suitable prescaling circuitry, is perhaps a more worthwhile approach for the SWL without any form of technical background, but good quality, stable counters are prohibitively expensive. The recently introduced DX-555, a combined RF signal generator and digital display frequency counter is seen by many hobbyists as a better solution to the problem, where the output of the generator is connected to the receiver's antenna input and zero-beat with the desired signal. The counter is then read directly. The current price of around $190 may be a deterrent, however, when availability of direct readout receivers for around $300 is now possible.

Over the past year or so, various receivers have appeared on the local scene with quite different circuitry and tuning arrangements. National introduced its portable/compact DR22, then Sony had its portable ICF5900W, and, more recently, National's DR48 was released. Prior to this generation of sets, the Barlow-Wadley XCR30, using the Wadley Loop principle, was probably the first general coverage high quality SW portable set to be made available in quantity at a reasonable price, and offering direct readout down to 5 kHz. No band switching is used – the appropriate 1000 kHz frequency range is selected by a main dial calibrated from 1–30 MHz. A second dial is calibrated at 10 kHz intervals. Another new style receiver that has been available for some time now is the Drake SSR1, incorporating a drift-cancelling system, with claimed readout of better than 5 kHz. The currently available Yaesu-Musen FRG7 has proven to be a versatile type of set for the SWL, but with slightly inferior selectivity features when used for serious DX work, according to some reviewers. It has a similar tuning arrangement to the XCR30, with a claimed readout of 5 kHz.

The very latest receivers are now starting to incorporate digital readout displays, at prices affordable by the average hobbyist. National's DR48 paved the way, selling for recommended retail of $470, and already proving to be a very popular set for both the SWL and serious DXer, but with some shortcomings when tuning the 3–4 MHz range. The very latest National product, the DR28, just released in Australia, is similar in its overall selectivity and sensitivity features to the DR48, but with a different tuning scale, and it also has the same digital display readout as does the bigger set. This is expected to sell for somewhere around the $350 mark, based on overseas prices, and reviewers in the USA have already expressed their enthusiasm for its performance, both as a set for the DXer, and also for the program listener. Now, the digital version of the FRG7, the FRG7000, is starting to become available in this country, but its price tag of $690 may not be a major selling point, when compared with National's DR48.

Previously, digital readout displays have only been available on the most expensive of receivers, but advances in technology, especially in the Asian area, have now made it possible for this feature to be incorporated into relatively inexpensive sets. This form of frequency readout is of course not the ultimate, as various reviewers have suggested, as calibration is often necessary when changing from one band to another, and care is needed in accurately centring the received signal in the pass-band. However, the tuning mechanism used in the DR48 is remarkably free of backlash, using a dual speed concentric geared drive, and should prove to be popular for some time yet. For any receiver, irrespective of mechanical or digital frequency readout, it is essential

The Sony CRF-160 (left) has been popular with SWL's for some years now, while the Grundig Satellit series of receivers is very well known.



The MacKay Dymek DR33 has fully synthesized tuning.

for proper DX or SWL work for the tuning arrangement to be positive and smooth in its operation, with minimal backlash. Some of the older cord drive dials were terrible affairs, and it required virtually a major repair operation for the cord to be replaced, which occured often for some models!

Portable Receivers

Many listeners want to continue their DXing or SWLing whilst on holidays, or when travelling. For this application, compactness, ruggedness, weight, size, tuning accuracy, sensitivity are all primary factors which become important when the receiver is used away from home. Power consumption must also be watched if the set is to be operated on internal batteries, away from commercial mains. Some AC/DC sets can be very greedy on a set of batteries, and this point should be checked out before purchase, if the set is to be operated in that mode. Sets having digital display readouts generally have provision for illuminating the display via a front panel switch, and if the receiver is to be used on internal batteries, it is essential that this cut-off feature be provided. Good sensitivity becomes very important for sets used on holidays, with generally inferior antennas, and particularly if serious DX work is desired. The small size Sony ICF5900W has won many kind words for its performance both as a portable, and as a fixed receiver — its battery consumption is remarkably low, and it gives reasonable results with only a few metres of antenna strung over a nearby tree, or with its own rod antenna. When operated off the mains, it offers adequate performance for small initial cost; being small, it has only a small speaker, which may not be suitable for persons wanting to do SWL work with superior audio reproduction wanted. However, its dial readout is very good, and the set is small enough to carry around as a real portable in the proper sense of the word.

Some users may prefer the National DR22, similar in many respects to the ICF5900W, but having a somewhat more complex tuning mechanism and dial arrangement. This set is also a portable, but many are in use for fixed station operation. The Barlow-Wadley XCR30 has led the race in earlier years as the most popular and best performing SW portable, and should not be overlooked when compared with its newfound Japanese competitors.

Other Features

The final choice of a set is up to the listener! Good sets have an antenna trimmer as standard, for optimum matching to a variety of antenna impedances. Separate gain controls for RF and AF have been standard on communications sets for many years, and the DR22, DR28, and DR48 all have this facility. Separate controls for bass and treble are finding increased use for noisy reception modes, and if properly designed, can offer considerable advantages in digging out weak signals, where serious DX work is desired. For the SWL, these controls would be essential, for adequate audio reproduction. Noise Limiters are also useful, in reducing the effects of pulse type noise, such as caused by car ignition, lightning discharges, and domestic appliances switching transients. Tuning Meters can have some advantages, to indicate the exact position of the signal peak when used with antenna trimmers or outboard preselectors or tuning units.

Maintenance

Some good used gear is often available through the classified advertisement pages of the local papers, or via ETI. Care is necessary when buying such equipment, as maintenance can be a difficult problem, if the listener has no technical background or access to proper servicing facilities. Such gear should always be accompanied by a circuit, at the very least, and if possible, some sort of operator's manual. Valve sets still give reliable service where DX or SWL is tuned, but some valves are starting to become a little hard to get, when it is considered that the original components are often still in use, many dating back to the early 1940's. These sets need periodical alignment, and unless the hobbyist has adequate facilities for undertaking this work, or knows someone who would be willing to look after it for him, he would be well advised to steer carefully when intending purchase of older secondhand equipment.

With new sets, it is necessary to ensure that the manufacturer/distributor combination maintains proper service

The Realistic DX-300 has just been released, and features digital readout.

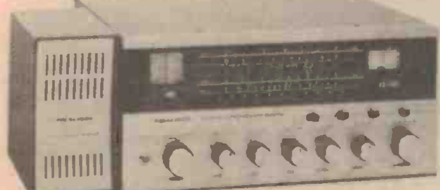
The National DR28 is one of the new receivers to feature digital frequency indication.

facilities, and that some form of warranty is available on purchase. Whilst the failure rate of solid state gear is extremely low, maintenance will be needed at some stage or another, if only to replace a single transistor, and ready access to a service centre is essential, for equipment which may cost around $400 or more.

Conclusion

It is quite impossible to nominate any particular set as being ideal for a given reception application. Sets designed for portable work invariably display some shortcomings when used for fixed station use — equipment intended for good overall audio reproduction, such as the SWL would want, would not be suitable in many respects for the serious DXer. A set giving continuous coverage from 3–30 MHz might sacrifice some performance features and dial readout accuracy, whereas a receiver intended

The Realistic DX-160 offers bandspread tuning.



Typical of portable radios is Sony's ICF-5800L.

for use only in the international SW bands would offer superior features in the dial and readout areas. No hard and fast rules can be given — the final choice is the listener's, dependent on his own needs how much he is prepared to pay. Many new listeners have been attracted by glossy advertising brochures without really bothering to study what was contained in them — they have rushed out and paid many hundreds of hard earned dollars for a fancy receiver, only to find that it wasn't all that they thought it would be. Some homework is absolutely essential — all receivers have different performance characteristics, and careful study of the available literature is well worth the time taken. If the new listener is not a member of a reputable DX Club, it would be in his interests to join, if only for a year, to see what receivers are being used, as there are generally some rather forthright opinions about equipment expressed in the pages of DX Club bulletins! If a brochure or literature about a desired set is unavailable, it may not be worth going any further; be wary of rash and unsubstantiated promotional claims about specific performance features, particularly where insufficient technical information supports the comments. If a member of a DX group, whether it be amateur, DX, or SWL, the new listener should make contact with others who have some experience, and who will be able to discuss the relative merits and demerits of currently available equipment.

Receivers in general use

The list which follows shows the most popular receivers in use here in Australia for DX and SWL purposes. The information is based on an analysis of equipment operated by ARDXC members, and where possible, an indication is given as to whether the receiver is suited to serious DXing, or for the general SWL. The list is not meant to be complete, and equipment is not shown in any particular order of merit. Models no longer available are shown in brackets.

Barlow-Wadley XCR30
(Drake SPR4, SSR1)
(Eddystone EC10, 680, 840C, 830/7)
(Lafayette HE30, HA230, HA600, HA600A, HA700, HA800, HA800A)
(Marconi CR100)
National Panasonic DR22, DR28, DR48 (Note: DR48 also known as RF4800)
(RCA AR88D)
Realistic (SX190, DX160
Selena B-212 (suitable for SW only)
(Selena B-206)
Sony ICF5900W, ICF5800, CRF160
(Trio JR60, ER202, 9R59DE, 9R59DR, 9R59DS)
Trio-Kenwood R-300 (QR-666)
(Vega 250)
Yaesu-Musen FRG7 — the most popular receiver currently in use for both DXing and SWLing.

KENWOOD

1.8-28MHz SSB TRANSCEIVER

TS-520S SERIES

TS-520S/VFO-520S/SP-520

Antenna Coupler

Frequency range	6 amateur bands from 1.8 to 29.7 MHz
Input Impedance	50 ohms
Output Impedance	50 to 500 ohms, unbalanced
Through power	200 Watts maximum
Wattmeter	
Type	Through-line wattmeter
Frequency range	1.8 to 29.7 MHz
Measurable RF power	Up to 20/200 Watts, switched
Kinds of RF power	Forward & reflected power, switched
Impedance	50 ohms
Accuracy	Better than /-10 percent of full sacle

The SP-820 has built-in selectable tone filters to attenuate high and/or low frequencies. You can switch between 2 different receiver sources. Headphones may also be used in conjunction with the filter network.

TRIO-KENWOOD (AUSTRALIA) PTY. LTD.
31 Whiting Street, Artarmon, Sydney. NSW. Australia. 2064. Tel: (02) 438-1277.

Interstate Distributors:

VIC: Vicom Imports Pty Ltd (03) 699-6700
QLD: Mitchell Radio Co (07) 57-6830
SA: International Communications Systems P/L (08) 47-3688
WA: Willis Trading Co. (09) 321-7600
TAS: Advance Electronics (003) 31-5688
NT: R.J. Klose (089) 81-8704

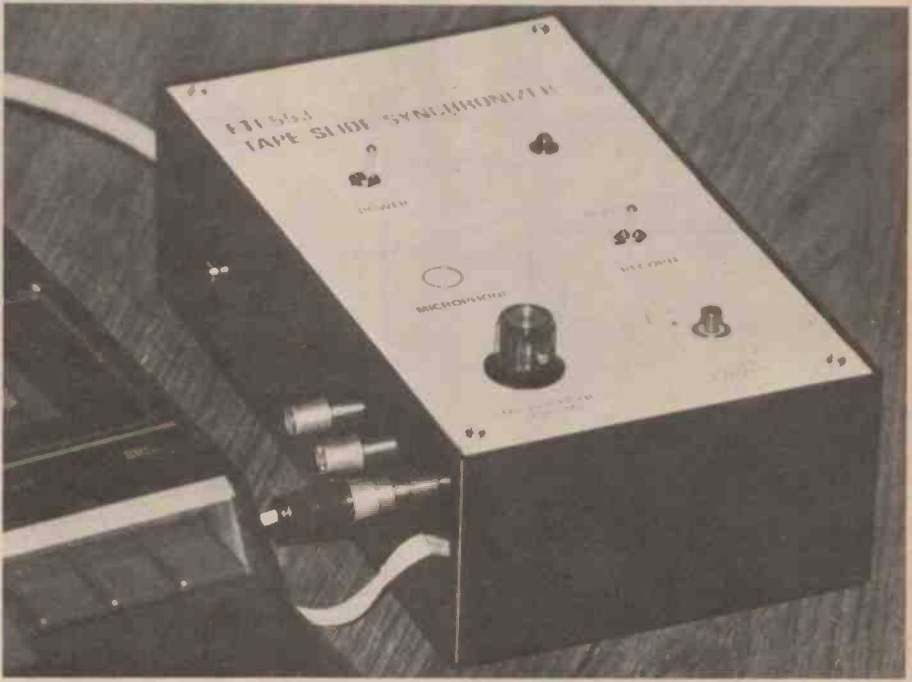
PS Did you know Kenwood are to release a new solid state 30W PEP HF Mobile Transceiver TS-120 with full 10M coverage, digital display and noise blanker in OCTOBER — watch for further details.

TAPE SLIDE SYNCHRONIZER

This unit will let you tape record a commentary for your slide show, so you can even give a talk without being there. . .

WHEN PUTTING ON a slide show for your friends or a business meeting, it is usually necessary to have some commentary with it. If it is a one-time presentation this is no problem, but if the show is to be repeated or if you simply want to be able to recall good memories a couple of years later then a tape recording of the commentary is ideal. The problem now is to keep the slides changing in synchronization with the commentary, without having to record that obtrusive phrase 'change slide now' onto the tape.

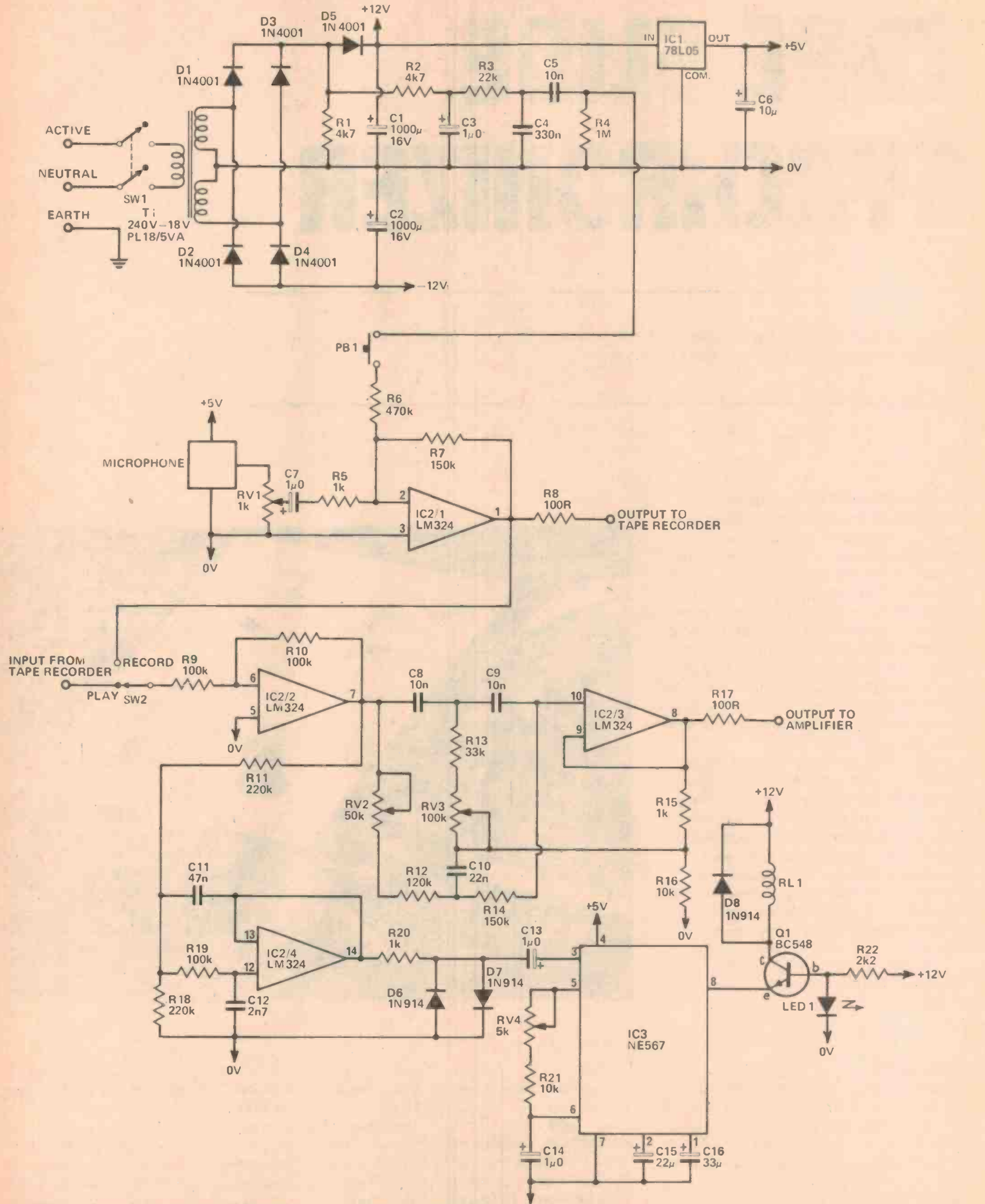
This unit allows a control tone (100 Hz) to be recorded on the tape along with the normal voice recording; when replayed the tone will activate a relay which will change the slide while a notch filter removes the tone so it is not heard through the speaker. We published a similar design some six years ago which recorded the tone on the second channel of a stereo recorder. While this worked well, a stereo recorder is not always available, and this design allows an economical mono recorder to be used.



Construction

Assemble the pc board with the aid of the component overlay in fig. 1. With the 240 V wiring it is better not to use pc pins but solder the wires directly onto the pcb. A covering of epoxy glue over the tracks leading to the transformer will help to prevent accidental contact.

We built the prototype into a large plastic box with the controls on the front panel and the tape recorder/ amplifier connections on the rear. The wiring of the front panel is given in fig. 3. We used an electret microphone insert mounted just behind the front panel. A plastic Scotchcal was used with a 25 mm dia. hole behind to allow the panel to vibrate and transmit the sound to the microphone. However the noise of the relay operating could be heard on the tape and therefore an external microphone is recommended. A socket can be mounted on the front panel in the microphone position.



The pc board pattern for this project is printed on page 112.

HOW IT WORKS – ETI 553

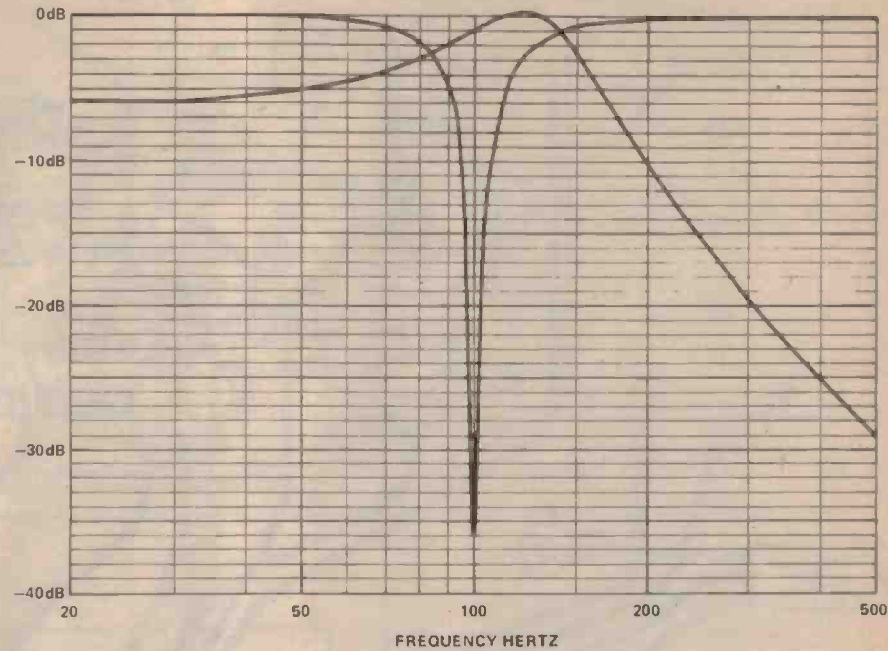
With this unit, unlike our previous design, we record a 100 Hz tone burst on the same channel as the speech whenever we require a slide to be changed. The tone is derived by full wave rectifying the output of the transformer and filtering out the harmonics by R2,3/C3,4.

Pressing the slide change button mixes this tone with the output from the microphone which is amplified by IC2/1. This combined output is recorded on the tape.

In the record mode SW2 connects the output of IC2/1 to the buffer amplifier IC2/2. In the playback mode it connects the output from the tape recorder to the amplifier. The output of this amplifier is split into two paths. One of these is through a 100 Hz notch filter to IC2/3 effectively removing the 100 Hz tone without much change to the rest of the spectrum. This is used to drive an amplifier/speaker system.

The other path for the signal after IC2/2 is via a low pass filter IC2/4. This removes frequencies above 150 Hz and has a response as shown in fig. 3. When the 100 Hz tone occurs, this filter passes it, rejecting speech frequencies, and it is passed to IC3. This is a phase locked loop tone decoder and its output on pin 8 turns on when the correct frequency tone is received. The output stage of this IC is an open collector npn transistor which can sink but not source current. With no incoming tone this transistor will be off, preventing any emitter current in Q1, hence turning it off also. The voltage on the base of Q1 in this case will be set at 1.6 V by LED1. When a tone occurs the output of the IC will saturate to about 0.6 V, forward biasing Q1, turning it on, and closing the relay. The current in R22 is now bypassed into the base of Q1, giving about 1.2 V on the base. This is too low for the LED to conduct and it will go out.

The power supply is simply full wave rectified and filtered for IC2, and a 5 V regulator is used for the PLL IC and the microphone amp.



Using the Unit

With this unit a separate amplifier/speaker system is needed. Also the slide projector must have a remote change button using normally open contacts. Connection has to be made between these contacts and the relay in the unit. Check that these wires are isolated from the 240 V mains and if not be very careful with the connections.

Connect the unit to the tape recorder and projector, assemble the slides in the correct order and switch on. With the record/playback switch in the record position and the recorder set to record, commence the commentary, changing slides with the button on the unit. The high level input on the recorder should be used and the microphone level pot set to give the correct recording level.

When playing back simply set the record/playback switch to playback and replay the tape.

Adjustments

Set the unit up to record and with all trimpots at the centre of their travel and the microphone level at minimum, hold the slide change button down. Probably some 100 Hz signal will be heard on the output of the amplifier. Alternately adjust RV2 and RV3 to minimise this signal. It should be necessary to wind up the volume of the amplifier to finally adjust for a minimum level.

The other adjustment is of the phase locked loop centre frequency. With the push button pressed slowly rotate RV4 until the relay either opens or closes. If it closes, continue to rotate it until it drops out then bring the pot back to the half way point. If the relay opened, reverse the rotation to find the other point at which it opens and leave RV4 midway between these two points.

Check the operation of the relay when pressing the button. There should be about half a second delay before it closes.

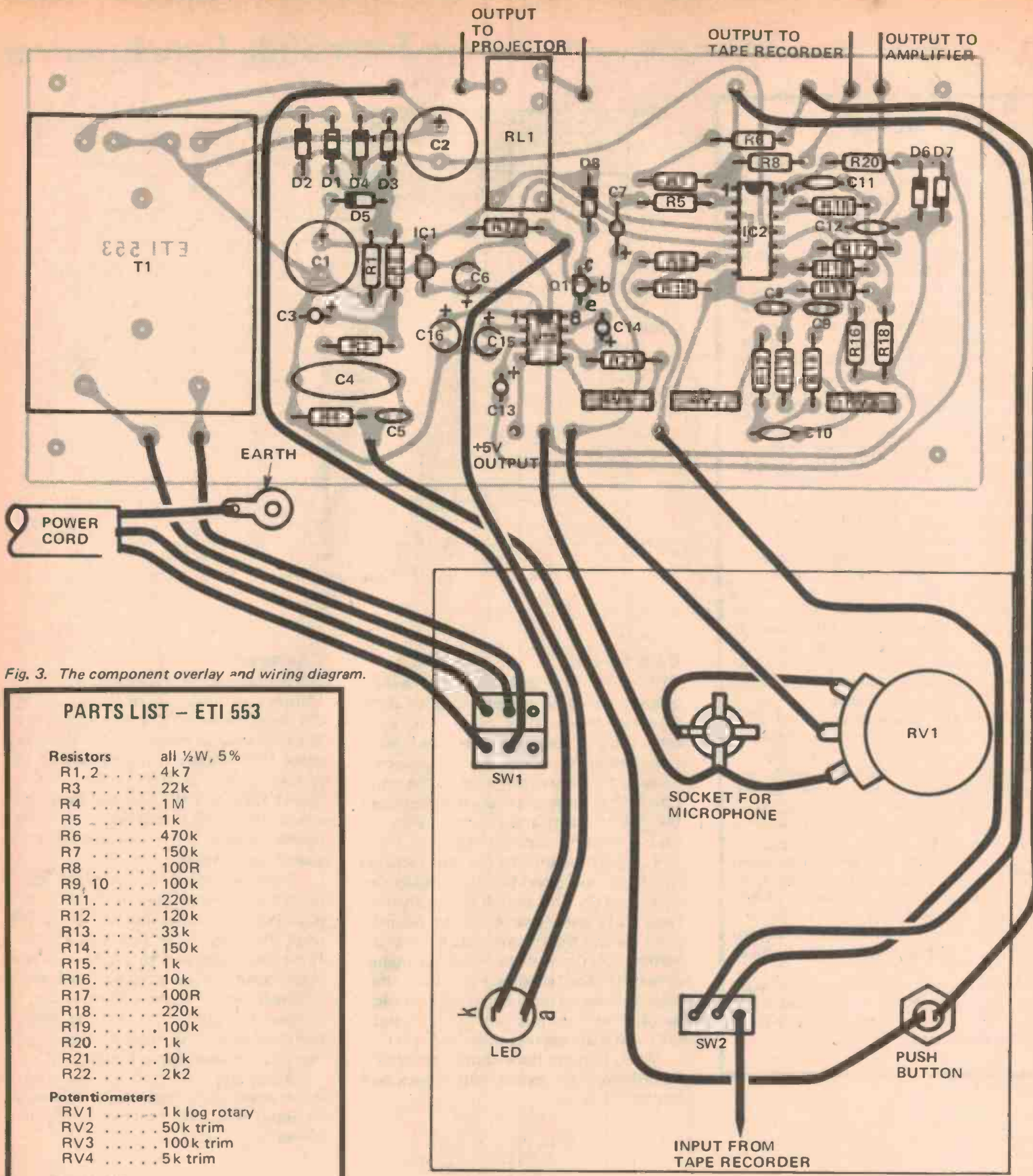


Fig. 3. The component overlay and wiring diagram.

PARTS LIST – ETI 553

Resistors all ½W, 5%

R1, 2 . . . . . 4k7
R3 . . . . . . 22k
R4 . . . . . . 1M
R5 . . . . . . 1k
R6 . . . . . . 470k
R7 . . . . . . 150k
R8 . . . . . . 100R
R9, 10 . . . . 100k
R11 . . . . . . 220k
R12 . . . . . . 120k
R13 . . . . . . 33k
R14 . . . . . . 150k
R15 . . . . . . 1k
R16 . . . . . . 10k
R17 . . . . . . 100R
R18 . . . . . . 220k
R19 . . . . . . 100k
R20 . . . . . . 1k
R21 . . . . . . 10k
R22 . . . . . . 2k2

Potentiometers

RV1 . . . . . 1k log rotary
RV2 . . . . . 50k trim
RV3 . . . . . 100k trim
RV4 . . . . . 5k trim

Capacitors

C1, 2 . . . . . 1000µ 16V electro
C3 . . . . . . 1µ0 25V electro
C4 . . . . . . 330n polyester
C5 . . . . . . 10n polyester
C6 . . . . . . 10µ 25V electro
C7 . . . . . . 1µ0 25V electro
C8, 9 . . . . . 10n polyester
C10 . . . . . . 22n polyester
C11 . . . . . . 47n polyester
C12 . . . . . . 2n7 polyester
C13, 14 . . . . 1µ0 25V electro
C15 . . . . . . 22µ 10V electro
C16 . . . . . . 33µ 10V electro

Semiconductors

IC1 . . . . . . 78L05
IC2 . . . . . . LM324
IC3 . . . . . . NE567 (8 pin)
Q1 . . . . . . BC548
D1–D5 . . . . 1N4001
D6–D8 . . . . 1N914
LED

Miscellaneous

PC board ETI 553
Relay 12V 280Ω
Transformer 240V–18V (PL18/5VA
Two toggle switches
One push button switch N/O
Box to suit
3 core flex and plug
Output sockets etc.

RADIO PARTS

ESTABLISHED OVER 35 YRS . . . NOW CARRYING IN EXCESS OF 12,000 LINES . . .

VOLTAGE REGULATORS

LM300H T05 Voltage Regulator $3.60
LM304H T05 Negative Regulator 2.83
LM305H T05 Voltage Regulator 1.07
LM309H T05 5 Volt Regulator 2.61
LM309K T03 5 Volt Regulator 2.74
LM317T T0220 3 Terminal Adjustable Regulator 3.19
LM317K T03 3 Terminal Adjustable Regulator 4.59
LM320T T0220 Neg. 1 Amp Regulators, 5, 6, 8, 12, 15, 18, 24 volt 2.74
LM320K T03 Neg. 1 Amp Regulators 5, 6, 8, 12, 15, 18, 24 volt 5.04
LM323K T03 Pos. 3 Amp — 5 Volt Regulator 7.09
LM340T T0220 Pos. 1 Amp Regulators 5, 6, 8, 12, 15, 18, 24 volt 1.59
LM340K T03 Pos. 1 Amp Regulators 5, 6, 8, 12, 15, 18, 24 volt 4.02
LM723CH T05 Voltage Regulator 1.20
LM723CN 14 Pin Dil Voltage Regulator 0.71
Prices include sales tax.

OPERATIONAL AMPLIFIERS/BUFFERS

LH0002CN 10 pin dil Current Amp 7.29
LH0042CH T05 low cost FET Op Amp 5.69
LM301H T05 Op Amp 0.69
LM301A 8 pin dil Op Amp 0.41
LM302H T05 Voltage Follower 3.83
LM307H T05 Op Amp 1.15
LM307N 8 pin dil Op Amp 0.66
LM308N 8 pin dil Op Amp 1.10
LM318N 8 pin dil Op Amp 3.17
LM324N 14 pin dil low power quad Op Amp 1.10
LM343H T05 high voltage Op Amp 8.13
LM348N 14 pin dil quad 741 Op Amp 1.50
LM349N 14 pin dil wide-band decompensated quad 741 Op Amp 2.30
LM358N 8 pin dil low power dual Op Amp .. 0.97
LM709CH T05 operational amplifier 1.10
LM709CN 8 pin dil Op Amp 0.82
LM741CH T05 operational amplifier 0.61
LM741CN 8 pin dil Op Amp 0.41
LM747CN 14 pin dil dual Op Amp 1.15
LN1458N 14 pin dual Op Amp $0.82
LM3900N 14 pin dil quad amp 0.94
LM4250H T05 Programmable Op Amp 2.32
Prices include sales tax

VOLTAGE COMPARATORS

LM311N 8 pin dil voltage comparator 0.89
LM319N 14 pin dil high speed dual comparator 4.54
LM339N 14 pin dil low power low offset voltage quad comparator 0.92
LM360H T05 high speed differential comparator 5.23
LM361H T05 high speed differential comparator 3.83
LM393N 8 pin dil low power low offset voltage dual comparator 1.25
LM710H T05 voltage comparator 0.94
LM711H T05 dual comparator 0.94
Prices include sales tax

AUDIO, RADIO AND TV CIRCUITS

LN370N 14 pin dil AGC/Squelch amp 5.48
LM371H T05 integrated RF/IF amp 4.02
LM372H T05 AM IF strip 4.78
LM373H T05 AM/FM/SSB IF AMP/detector .. 6.18
LM374H T05 AM/FM/SSB IF video amp/detector 5.07
LM375N 14 pin dil oscillator and buffer with TTL output 5.74
LM377N 14 pin dil dual 2 watt audio amp ... 3.06
LM378N 14 pin dil dual 4 watt audio amp ... 3.24
LM379S 14 pin in line dual 6 watt audio amp 6.45
LM380N 14 pin dil audio power amp 1.73
LM381N 14 pin dil dual preamp $2.87
LM381AN 14 pin dil low noise dual preamp 4.59
LM382N 14 pin dil low noise dual preamp ... 2.23
LM384N 14 pin dil 5 watt audio power amp 2.55
LM386N 8 pin dil low voltage audio power amp 1.40
LM387N 8 pin dil dual preamp 2.63
LM388N 14 pin dil 1.5 watt audio power amp 1.72
LM1303N 14 pin dil stereo preamp 1.68
LM1304N 14 pin dil FM multiplex stereo demodulator 2.04
LM1305N 14 pin dil FM multiplex stereo demodulator 2.04
LM3065N 14 pin dil television sound system 1.61
Prices include sales tax.

FLUKE 8020A

Specifications:— Sensitivity: 3½ Digit Liquid Crystal Display (10 Meg all ranges); Dimensions: 180 x 86 x 45 mm; Power Requirement: 9 Volt Battery e.g. 216 Eveready (Further information available upon request). $205.28 including sales tax

DOMINION PRO SERIES. HIGH QUALITY REGULATED POWER SUPPLIES

11 to 16 volts adjustable. Ideal where long continuous use and excellent regulation are required. All supplies are totally short-circuit proof.

NG3 3.5 amps — $49.00 including tax. For CB, hobbyists, experimenters, school, etc. Input 240V AC, Output 11 to 16V DC, Regulation 0-3.5A 20mV. Ripple at 3.5 amps-4mV. Dimensions: 3¾ wide x 4½" deep x 6" high. Weight approx 5 lb.

NG7 6 amps — $57.00 including tax. High power single side band CB radios, service bench repairs, 2-way radio base supplies. Input 240V AC, Output 11 to 16V DC, Regulation 0-6A 30 mV. Ripple at 6 amps-4mV. Dimensions: 5" wide x 5¼" deep x 6" high. Weight approx 8 lb.

NG12 12 amps — $115.00 including tax. Heavy duty model. Ideal for operating high power linear amps, hybrid 2-way radios, etc. Input 240V AC. Output 11 to 16V DC, Regulation 0-12A 10mV. Ripple at 12 amps-1.5mV. Dimensions: 10" wide x 5¼" deep x 6" high. Weight approx 16 lb.

Manufactured by Radio Parts Group. Trade enquiries welcome.

MULTIMETERS

TMK VF4

Specifications:— Sensitivity: 2K Ω /Volt DC, 2K Ω /Volt AC; DC Voltage: 0.25V, 2.5V, 10V, 50V, 250V, 1000V; AC Voltage: 10V, 50V, 250V, 1000V; DC Current: 0-500 μA, 10MA, 250MA, 10A. Resistance: x1, x10, x100, x1K, (6,60,600,6K Centre Scale); Capacitance: 500 μF to 1 μF (in two Ranges); Decibels: —15 to plus 32dB (in four Ranges); Dimensions: 145 x 95 x 45 mm. $21.27 including tax.

TMK TP5SN

Specifications:— Sensitivity: 20K Ω /Volt DC, 8K Ω /Volt AC; DC Voltage: 0.5V, 5V, 50V, 250V, 500V, 1000V; AC Voltage: 10V, 50V, 250V, 500V, 1000V; DC Current: 0-50 μA, 5MA, 50MA, 500MA; Resistance: x1, x10, x100, x1K (60, 600, 6K, 60K Centre Scale); Capitance: 50 μF to 0.1 μF (in two Ranges); Decibels: —20 to plus 36dB; Dimensions: 135 x 95 x 40 mm. $25.18 including tax.

TMK200

Specifications:— Sensitivity: 20K Ω /Volt DC, 10K Ω /Volt AC; DC Voltage: 0.6V, 6V, 30V, 120V, 600V, 1200V; AC Voltage: 6V, 30V, 120V, 600V, 1200V; DC Current: 0.06MA, 6MA, 60MA, 600MA; Resistance: 0-10K Ω, 100K Ω, 1M Ω, 10M Ω; Capacitance: .002 μF to 0.2 μF Decibels: —20 to plus 63dB; Dimensions: 130 x 90 x 35 mm. $27.91 including tax.

TMK500

Specifications:— Sensitivity: 30K Ω /Volt DC, 13K Ω /Volt AC; DC Voltage: 0.25V, 1V, 2.5V, 10V, 25V, 100V, 250V, 1000V; AC Voltage: 2.5V, 10V, 25V, 100V, 250V, 500V, 1000V; DC Current: .05MA, 5MA 50MA 500MA, 12A; Short Test: Internal Buzzer; Decibels: —20 to plus 56dB; Dimensions: 160 x 85 x 70 mm. $41.22 including tax.

NEW "SOLDER-EATER" DE-SOLDERING BRAID (1.8m)

in cassette package. For standard PCB — Part No. 213. For miniature PCB — Part No. 214. $1.60 each (exempt).

SINCLAIR PDM35

Specifications:— Sensitivity: 3½ Digit LED Display (10 Meg Input DC); DC Voltage: 1MV to 1000V (Four Ranges); AC Voltage: 1V to 500V (40 Hz-5 kHz); DC Current: 1 MA to 200 MA (Six Ranges); Resistance: 1 Ω to 20 Meg Ω (Five Ranges); Dimensions: 153 x 76 x 39 mm; Power: 9 volt Battery (e.g. 216 Eveready). $61.89 including sales tax

LIFE PANEL METERS

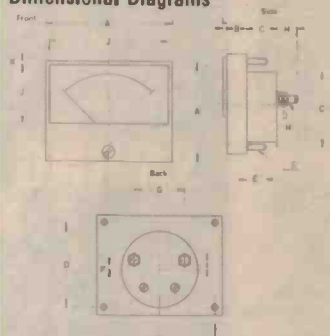
VT1 SERIES:
Ranges available: 0-50uA, 50-0-50uA, 0-100uA, 100-0-100uA, 0-200uA, 0-500uA, 0-1mA, 0-5mA, 0-10mA, 0-100mA, 0-500mA, 0-1A, 0-5A, 0-15A, 0-15V, 0-50V, DC, Plus 0-300V AC. All one price $7.36 ea. incl. sales tax.

VT2 SERIES
Ranges available: 0-50uA, 50-0-50uA, 0-100uA, 100-0-100uA, 0-200uA, 0-500uA, 0-1mA, 0-5mA, 0-10mA, 0-100mA, 0-500mA, 0-1A, 0-5A, 0-15A, 0-15V, 0-50V DC. All one price $6.90 ea. incl. sales tax.

VT3 SERIES:
Ranges available: 50-0-50uA, 100-0-100uA, 0-200uA, 0-5mA, 0-10mA, 0-100mA, 0-500mA, 0-1A, DC Plus 0-300V AC. All one price $6.44 ea. incl. sales tax.

VT4 SERIES
Ranges available: 0-50uA, 50-0-50uA, 0-100uA, 100-0-100uA, 0-200uA, 0-500uA, 0-1mA, 0-5mA, 0-100mA, 0-500mA, 0-1A, 0-5A, 0-50V DC Plus 0-300V AC. All one price $5.98 ea. incl. sales tax.

Dimensional Diagrams



MODEL	VT-1	VT-2	VT-3	VT-4
A	86	78	56	46
A1	78	66	51	44
J1	50	42	31	26
C1	69	55.5	46	37.5
C	24	25	24.5	23.5
8	14	12	10.7	10.5
E1	13	13	10	10
E	3	3	3	2.3
H1	5	5	4	4
H	4	4	3	3
D	57	47.5	28	32.5
D1	57	48	(2 studs)	33

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INTRODUCTORY KIT: 8002 KA.
Contains: 1 sheet of each of Metal/Plastic/8007 Film, 1 litre 8500 developer, 1 can 3900 Gloss Clear, 1 ML3 Applicator Block, 1 box ML4 Developer/Pads, 1 Sensitivity Guide, Full Instructions. $52.90 Incl. sales tax.

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(all prices include sales tax) **8500 Developer:** 1 litre, $4.60 ea. **ML3 Applicator Blocks:** $4.60 ea. **ML4 Developer Pads:** 100 sheet roll, $4.03 per roll. **3900 Gloss Clear Coat Aerosol:** 368 grm, $6.90 ea. **3930 Matte Clear Coat Aerosol:** 368 grm, $6.90 ea. **8019 Protective Overlay Film:** 10" x 12", 10 sheets, $12.08, 12" x 24", 5 sheets, $14.38. **10 S.G. Sensitivity Guide:** $7.48 ea. **P.A. 1 Squeegee Applicator:** 40c ea.

Further information available on request.

Note: Metal & Plastic Label and Exposure Film in 600 x 900 mm and 600 x 1200 mm sizes will be available in single sheets at a later date.

Trade enquiries welcome

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PARTS FOR NEW KITS

TANK TV GAME (See Octuber ETI)

Complete kit, including instructions	Cat K-34/5	$39.50
SEPARATE PARTS:		
PCB (only)	Cat H-8620	$3.85
AY-3-8710 IC	Cat Z-6856	$17.50
Fully built RF modulator	Cat K-6040	$3.00
Fully built audio modulator	Cat K-6042	$4.50

MODEL TRAIN CONTROLLER (See October EA)
Not produced as a kit – all parts available from stock:

PCB only	Cat H-8355	$3.75
Zippy box	Cat H-2752	$3.75
2N3055 transistor	Cat Z-2145	$0.95
2N3053 transistor	Cat Z-2130	$0.80

VARI WIPER Mk 2 (See September ETI)
Not produced as a kit – most parts available from stock:

Relay	Cat S-7125	$4.80
C106Y1 SCR	Cat Z-4315	$1.00
2N2646 (DS2646) unijunction	Cat Z-1786	$1.20

UNIVERSAL MOVIE MIXER (See September E.A.)

Complete kit, including instructions	Cat K-3492	$49.50
SEPARATE PARTS:		
PC Board (only)	Cat H-8354	$2.95
50k A curve 45mm slider pot	Cat R-1980	85c
Knobs to suit slider pot	Cat H-3780	40c

FET INPUT AC-DC VOLTMETER (See September E.A.)
Not produced as a special kit – all parts available ex stock:

PC Board only	Cat H-8353	$2.75
1mA MRA 658 Panel Meter	Cat Q-2060	$12.50
Fabricate your own meter scale using the Scotchcal process:		
8005 black Scotchcal photo sensitive aluminium	Cat H-5694	$6.00
CA-3140 FET op-amp	Cat Z-5417	$2.50

DIGITAL DIAL (See September E.T.I.)
Not produced as a special kit – most parts available ex stock.
PC Boards:

ETI 550	Cat H-8619	$2.20
ETI 591 A/B (suit special Dick Smith LT-303 7 segment displays	Cat H-8617	$4.00
ETI 591C (suits yellow H/P 5082-7663 displays)	Cat H-8618	$1.80
ICM 7217A up-down counter IC	Cat Z-5416	$16.00
5082-7663 yellow 10.9mm 7 segment display	Cat Z-4160	$4.50
LT-303 red 7.6mm 7 segment display	Cat Z-4103	$1.50

LIGHT SHOW CONTROLLER
Not produced in kit form – most components normal stock.

UPGRADED 40/200MHz FREQ. COUNTER (See August E.A.)
Same style as previous kit, but new circuitry means it is easier to build, set up and is more sensitive. Basic counter is 40MHz – by adding a single 95H90 IC the range is extended to 200MHz.

Complete kit for 40MHz, inc. instructions.	Cat K-3437	$99.50
95H90 IC to extend range to 200MHz	Cat Z-5360	$12.50
SEPARATE PARTS:		
PC Boards (set of two top quality boards)	Cat H-8346	$8.50
MC-10116L IC (triple differential amplifier)	Cat Z-5415	$1.95
MM 5369M IC (oscillator – divider)	Cat Z-5781	$3.50
74C926 IC (4 digit counter)	Cat Z-5414	$12.00
3.579545MHz crystal (new low price!)	Cat K-6031	$3.00
LT-303 7 segment display	Cat Z-4103	$1.50

All other components are normal stock lines at all of our stores

PHOTO TACHOMETER (See August E.A.)
Although we do not produce a full kit for this project, all parts are normal stock lines at all of our stores

PCB (only)	Cat H-8352	$1.80
FPT100 phototransistor	Cat Z-1950	$2.00

UTILITY TIMER (See August E.A.)
Again, not produced as a special kit – all parts are normal stock lines

PCB (only)	Cat H-8345	$3.50
6V Buzzer	Cat L-7009	$1.75
Zippy box case	Cat H-2753	$1.95

NEW 10 GAME TV GAME KIT (See July E.A.)

Complete kit, including instructions	Cat K-3491	$49.50
SEPARATE PARTS:		
PCB (only)	Cat H-8344	$3.95
Fully built RF modulator	Cat K-6040	$3.00
Fully built audio modulator	Cat K-6042	$4.50
AY-3-8600 IC	Cat Z-6852	$15.00

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Hitel Hi Fi	145 Queen Street St Marys NSW. Ph 623-4442
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Rivercom	9 Copland Street, Wagga NSW. Ph 21-2125
Brian Bambach Electronics	68 William Street, Gosford NSW. Ph 24-7246
Capital Coast Elect.	Unit 11, Commercial Centre, Ford St, Moruya NSW. Ph 74-2545
GCG Communications	385 Mulgrave Rd, Cairns QLD. Ph 54-1035
The Elect. Hobby Centre	1045 Gold Coast Hwy, Palm Beach, QLD. Ph 34-1248
Premier Sound	239 Musgrave St, Rockhampton, QLD Ph 27-4004
Sumner Electronics	97 Mitchell Street, Bendigo VIC. Ph 43-1977
Aero Electronics	123A Bathurst St, Hobart TAS. Ph 34-8232
Devon Electronics	45 Ashburner St, Devonport TAS. Ph 24-4216
A.E.Cooling	Town Centre, Peoples St Bldg, Elizabeth, SA. Ph 255-9196
Hutchesson's Communic.	5 Elizabeth Street, Mt Gambier, SA. Ph 25-6404
Altronics	105 Stirling Street, Perth WA. Ph 328-1599.
BP Electronics	11 Duke Street, Albany WA. Ph 41-2681

Project 811

TV TANK GAME

'Fun for all the family', is the phrase that comes to mind — but you can have even more fun by building it yourself!

MANY DIFFERENT types of TV games have appeared over the past few years, however few continue to hold the player's interest as long as this one. The 'TV Tank Game' has been designed for two players, each of whom has a completely steerable tank with forward and reverse speed control, clockwise and anticlockwise rotation and a firing button. The tanks are also provided with delays on the movement and firing as well as variable speed to add realism. Anti-tank barricades and mines have been placed in the battlefield to retard the progress of each tank across the screen. The score is kept for each tank above the battlefield and the object of the game is to score as many direct hits on the enemy as possible. The first player to score 16 hits wins the game.

The heart of the game is the AY-3-8710 integrated circuit which is designed to operate from a battery supply with a minimum of components. All the game functions are provided by this IC.

Tank Control

When the forward or reverse button is pressed, the tank will move in the selected direction at low speed. If the button is held down, medium speed will be selected after half a second, and high speed half a second after that. Releasing the button at any speed will cause the tank to continue at that speed. To stop the tank the button for the opposite direction is pressed momentarily.

Rotation either clockwise or anti-clockwise is possible when the tanks are moving or stationary.

Firing

Shells can be fired approximately once every four seconds and refire requires release and re-operation of the button. Attempting to fire during the four second delay time will give the firing sound effect, but a shell will not actually be fired.

Rotating the tank while the shell is in flight will cause the shell to follow a curved trajectory in the direction of rotation — even around barriers. The range of the shell is approximately two thirds of the screen depth or width, depending on the firing angle. Gunfire sounds accompany the firing and shell burst sounds are produced when a shell reaches the end of its range or hits a barrier, border or the enemy tank.

Barriers

Barriers can be of two different types. There are 22 fixed terrain barriers on the battlefield and provide protection from shells. Tanks cannot pass through these barriers when the interaction is selected. Six mines are distributed on the battlefield which, when hit, cause a tank to explode and become stationary with its gun inactive for a period of 2 to 4 seconds. The mine then vanishes for the remainder of the game. A mine being hit scores for the enemy tank.

Explosions

Explosion patterns are produced when a shell is at the end of its range or when the shell makes contact with a barrier. A tank will explode and fragment momentarily when it hits a mine or is hit by a shell. Suitable explosion sounds are produced when a tank hits a mine or is struck by a shell.

Engine Sounds

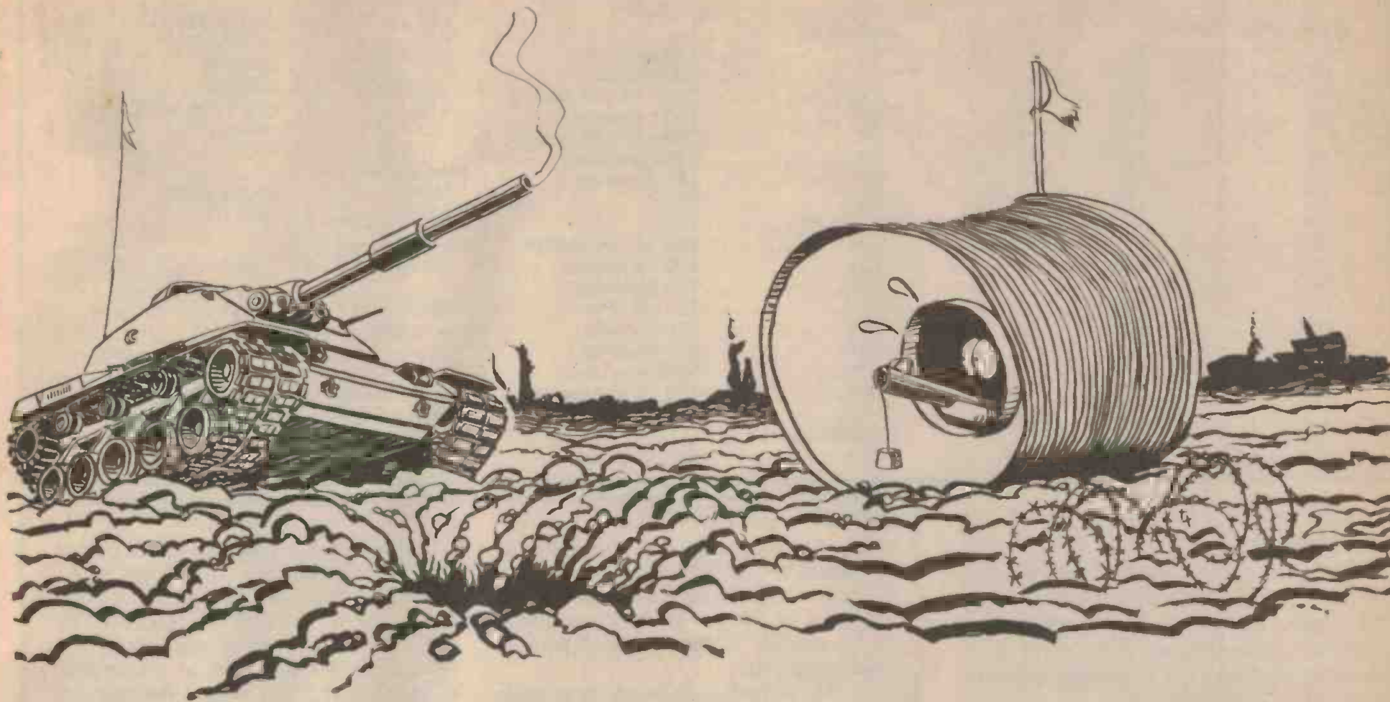
Four engine sounds are produced, one for each of the speeds and one for the stationary position.

Scoring

Separate scores, one white and one black, are placed above the battlefield for each player. A player's score is incremented when his tank scores a hit on his opponent or his opponent's tank hits a mine. The game ends when one player scores 16, at which time the score flashes.

Reset

The game is reset and the scores are set to zero when the reset button is pushed. The mines are replaced and the tanks are reset to their starting positions.



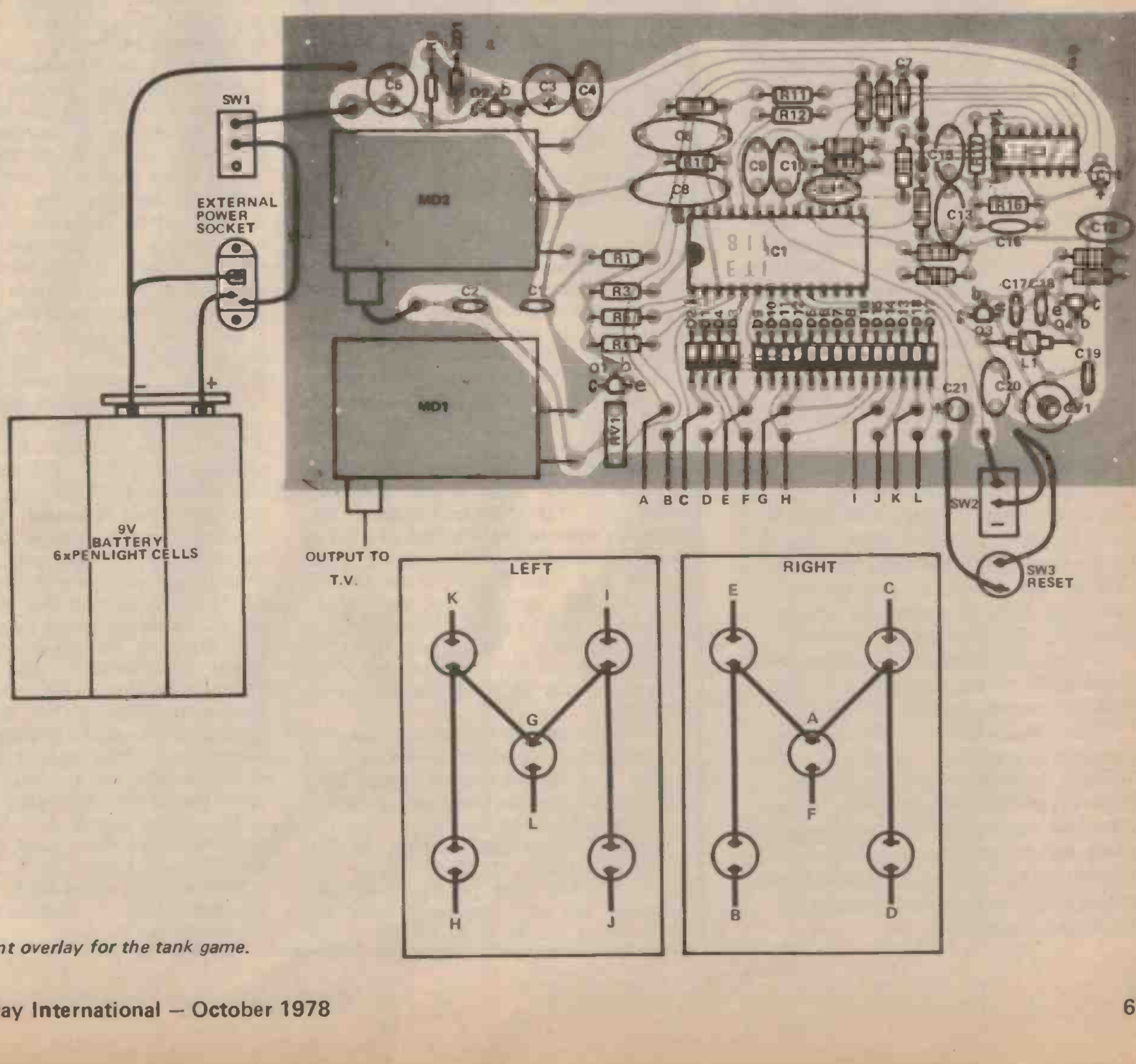


Fig. 1. Component overlay for the tank game.

PARTS LIST – ETI 811

Resistors all ¼ W 5%

R1	1k
R2	270R
R3	10k
R4	1k5
R5	2k2
R6	100R
R7	1M
R8	10k
R9	18k
R10	1M
R11,12	4M7
R13	10k
R14	4M7
R15	47R
R16	10k
R17	22k
R18	4k7
R19	100k
R20	470R
R21	100k

Potentiometer

RV1	1k lin mini trimpot

Capacitors

C1	1n0 ceramic
C2	100p ceramic
C3	100μ 16 VW electro
C4	100n greencap
C5	100μ 16 VW electro
C6	270n greencap
C7	10n greencap
C8	270n
C9 - C13	100n
C14	25μ 16 VW electro
C15	100n greencap
C16	47n greencap
C17	10n ceramic
C18	33p ceramic
C19	47p ceramic
C20	100n greencap
C21	4μ7 16 VW electro

Variable Capacitor

CV1	60p trimmer

Semiconductors

IC1	AY-3-8710
IC2	4001BCN
Q1 - Q4	BC549
D1 - D18	1N914
ZD1	7V5 400 mW zener diode

Modulators

MD1	1082 AUS
MD2	UM1263

Miscellaneous

SW1,2	SPDT miniature toggle switches
SW3 - SW13	SPST push buttons
pc board	ETI 811

28 pin IC socket, six way AA size battery holder, battery clip, length of 75 ohm coax, Belling Lee-type plug, RCA plug, external battery socket, length ribbon cable, plastic box 195 x 113 x 60 mm, two plastic boxes 80 x 53 x 29 mm.

Construction

The printed circuit board is housed in a plastic box with a metal top panel for the reset, power and interaction switches. Ribbon cable is used for the connections from the two small control boxes to the main unit.

Firstly, mount the components onto the pc board with the help of the overlay in fig. 1. Note that the overlay is viewed from the component, or fibreglass, side of the board. The capacitors C3, C4, C14 and C21 are electrolytics and must be inserted in the correct polarity. The transistors, diodes and the two ICs must also be correctly positioned.

It is recommended, though not essential, that sockets be used for the two ICs. If a 28 pin socket is not available for the main IC, Molex or Soldercon connectors can be used instead. Cut the connector strip into two lengths of 14 pins and solder them into the board. By carefully flexing the connecting strip back and forth, it can be removed, leaving only the pins. The IC can now be carefully inserted.

The two modulators are also mounted on the pcb and a short length of wire is used to connect the output of MD2 to the pcb track. To attach this, remove the cover of MD2 and pass the wire through the centre of the output connector and solder it to the connector's internal solder terminal.

To simplify assembly, all the external connections to the pcb are to pc pins soldered into the board.

Once assembled, the pcb can be mounted into the box. A 15 mm hole is drilled in the back and the output socket of MD1 mounted through it (see photo). Holes are also drilled for the external power socket, and the ribbon cable to the control boxes. Four small holes are drilled in the base and the pc board mounted on spacers.

HOW IT WORKS – ETI 811

Most of the operations in this game are performed by the main IC. Since it would be much too complex to describe the operation of this IC, we shall concentrate on the external circuitry required for it to operate correctly.

A TV picture is made up by a single beam of electrons hitting a phosphorescent screen which is scanned in horizontal lines, with each successive line just under the previous one. By varying the intensity of the beam the brightness of the screen can be varied. With the Australian system each horizontal line takes 64μS (i.e. 0.000064S) and every 312½ lines the beam reverts back to the top of the screen; the second "frame" fits between the first set of lines making up the total picture of 625 lines. So that the TV knows when to start the scan and to start each line, a series of pulses must be provided together with the picture information.

A pulse is needed every 20ms to give this synchronisation. These pulses are negative-going and the line sync is 4μs long while the frame sync is 250μs long. the IC gives the combined sync on pin 18. To simplify the design only 312 lines are used per frame, however this is accepted by the TV set.

All the internal timing pulses for the IC are derived from a high frequency oscillator, (4.09 MHz). Transistor Q4, together with the tuned circuit L1 – CV1, forms a Colpitts oscillator giving a distorted sine wave output at its emitter. Because this waveform is not square enough to feed to the IC, it is fed to Q3, a class C amplifier. The output from this amplifier is still not square but has a fast rise time which the IC requires for correct operation.

The movement of the tanks is controlled by the switches SW4 to SW13 which feed strobed control signals from pin 4, (tank 1 strobe), and pin 24 (tank 2 strobe), via D1-18 to the IC.

Video information appears at five different outputs of the IC. These are: pin 2 – background, pin 3 – composite blanking, pin 18 – composite sync, pin 27 – right player tank, pin 28 – left player tank.

Because each output contains a part of the total information they have to be added together. This is done by a video mixer (R2 to R5) and the output of this mixer is fed to a buffer stage (Q1). The voltage of the waveform at the emitter of Q1 is 0.6V lower than at the base but has a lower impedance suitable to drive the modulator, (MD1). The TAB pot (RV1) controls the signal level to the modulator and is used to set the background grey level.

The video modulator contains its own oscillator running at the frequency of the TV channel used for the display. The video information is superimposed onto this carrier and fed to the TV set via the output socket and the 75 ohm cable.

So far we have only explained the operation of the video and timing circuits. Outputs are also provided for sound effects of tank engines, shell firing and explosions. These outputs appear at: pin 20 – explosion and gun fire, pin 21 – tank 1 motor sound, pin 23 – tank 2 motor sound, pin 25 – gunfire envelope and pin 26 – explosion envelope.

The output of gunfire and explosions continually appears at pins 25 and 26 and is fed to two sections of a NOR gate package, IC2/2 and IC2/3. Pin 20 is then held down to 0V each time a firing or explosion sound is wanted, which causes a pulse of sound envelope to appear at the output of the NOR gate. The motor sounds from each tank from pin 23 and pin 21 are added together, fed to IC2/4 and the resultant sound from this NOR gate added to the firing and explosion sounds. The sound is then shaped by IC2/1, the pitch being varied by the selection of R16 and C16. Audio is then coupled to the sound modulator (MD2), which is a 5.5 MHz modulated oscillator which provides the 5.5 MHz sound subcarrier for the video modulator, (MD1).

The power supply is a conventional series regulator using a zener diode (ZD1) and a series transistor (Q2). The voltage at the emitter of Q2 is about 0.6V below the zener voltage. Resistor R6 supplies the bias current for the zener.

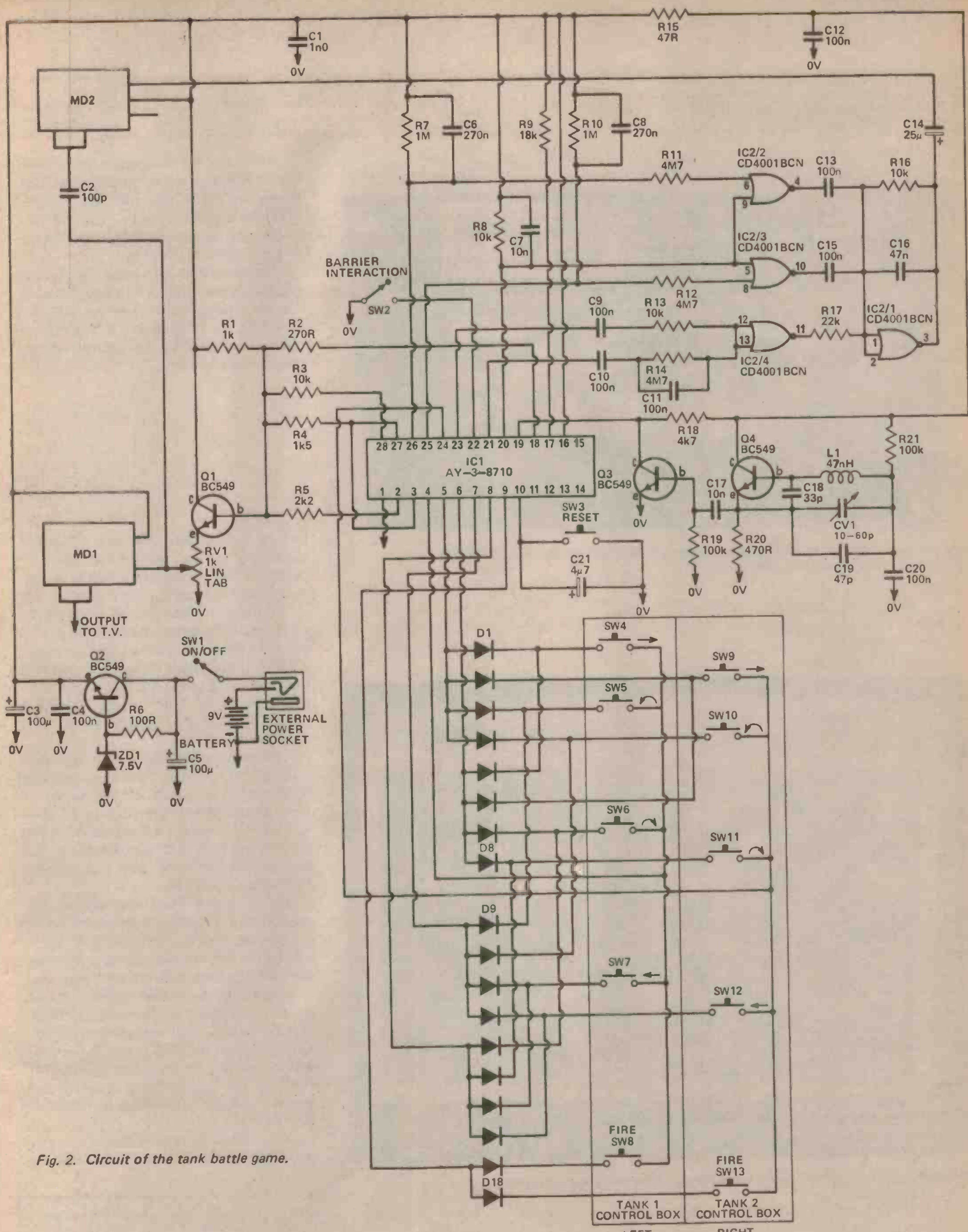
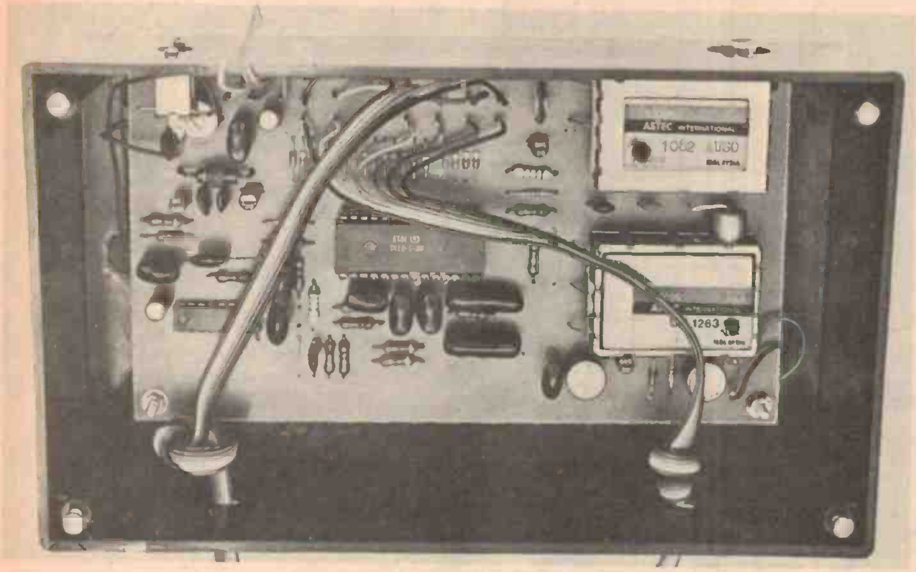
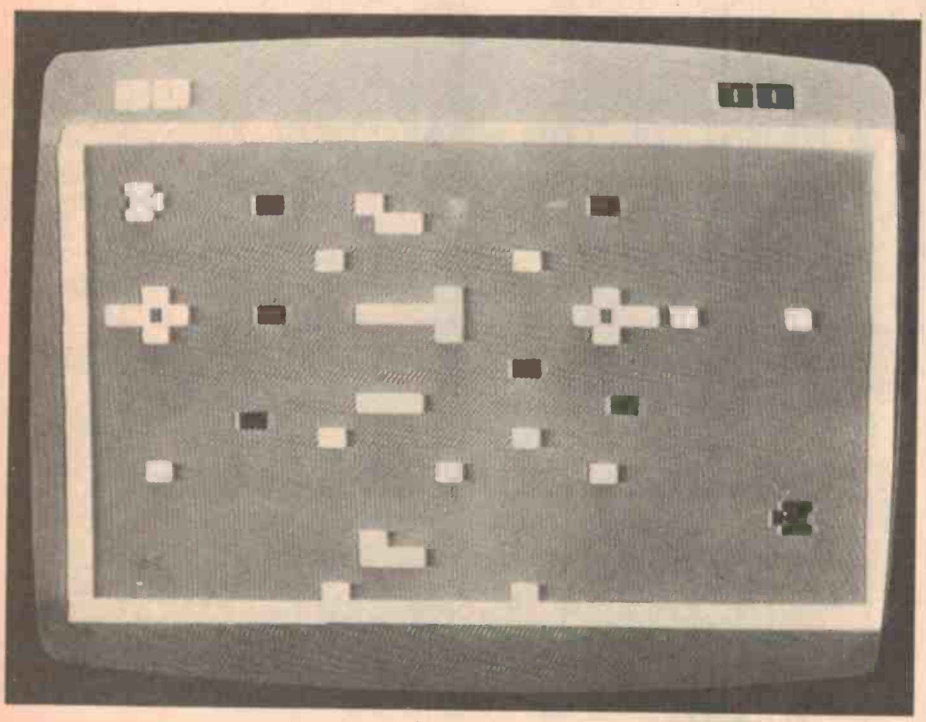


Fig. 2. Circuit of the tank battle game.



The completed unit. Note the position of the pcb flush against the rear of the box so the output connector can pass through it.



The battlefield as it should appear on the screen after the setup adjustments.

After the three switches have been assembled on the front panel they can be connected to the unit with about 150 mm lengths of wire. The battery holder can be placed inside the box in any convenient position.

The next step is to assemble the two control boxes and drill a hole in each for the ribbon cable. The switches are wired to the pc board, via the ribbon cable, as shown by the figures on the component overlay.

Setting Up

Before turning the unit on, doubly check that all the components are in the correct positions and that the transistors, diodes and ICs are the right way round.

Connect the unit to the TV set with a length of 75 ohm coaxial cable. If your set does not have a coaxial input a balun transformer may be necessary to match the 75 ohm output from the game to the 300 ohm input of the television. Set the trimpot RV1 to about mid-range.

When the unit is turned on and the television is tuned to the channel number stamped on the top of the video modulator (MD1), the picture on the screen will probably be unsynchronised. By turning CV1 with a screwdriver, the picture should 'lock' and the battlefield should appear.

By adjusting the trimpot RV1 in conjunction with the brightness control on the set, the background grey level can be set for the best picture. Hitting the reset button will initiate the game.

Next, adjust the fine tuning control on the television so the sound effects can be heard. The sound modulator (MD2) has an internal preset adjustment which can be used in conjunction with the fine tuning control to achieve the correct sound. However, this should not be necessary.

This concludes the setting up — your game should now be ready for play.

A complete kit of parts for this project will be available from Dick Smith Electronics.

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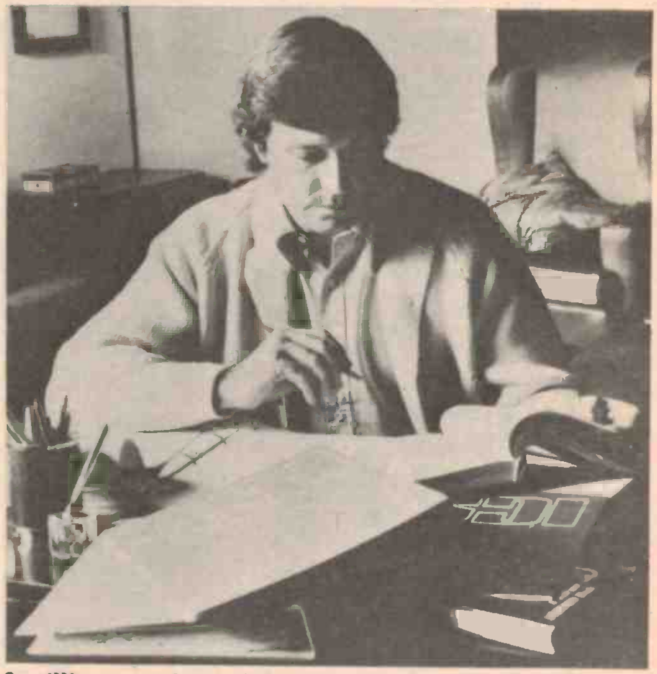

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DIGITAL STOPWATCH

When we couldn't get hold of a stopwatch chip that would do the things we wanted, we designed our own stopwatch from scratch. . .

THE SURVEY we conducted last year on the requirements for a sports timer revealed a requirement for, basically,a good stopwatch. As most stopwatches are used in outdoor sports, it is not really practical to use an LED display. The power requirement of this type of display, if it is to be seen in daylight, is very high for portable use. We therefore decided to wait for the appearance of economical LCD displays before commencing our design.

While the stopwatch described here is not particularly small, it can be easily hand held, and uses a large display which is easily readable 3 - 4 m away, even in strong daylight. It can easily be remotely operated, either by mechanical switches or electronic control circuits.

SPECIFICATION – ETI 590

Display	6 digit LCD, 12.5 mm high
Maximum reading	59 minutes 59.99 seconds
Resolution	0.01 seconds
Readability	Up to 5 metres in dim light bright sunlight
Accuracy	Can be calibrated– crystal controlled
Modes	Normal, lap and total
Size	140 x 57 x 32 mm
Battery	9 V (216)
Battery life	
on	1 to 2 months
off	shelf life

Design Features

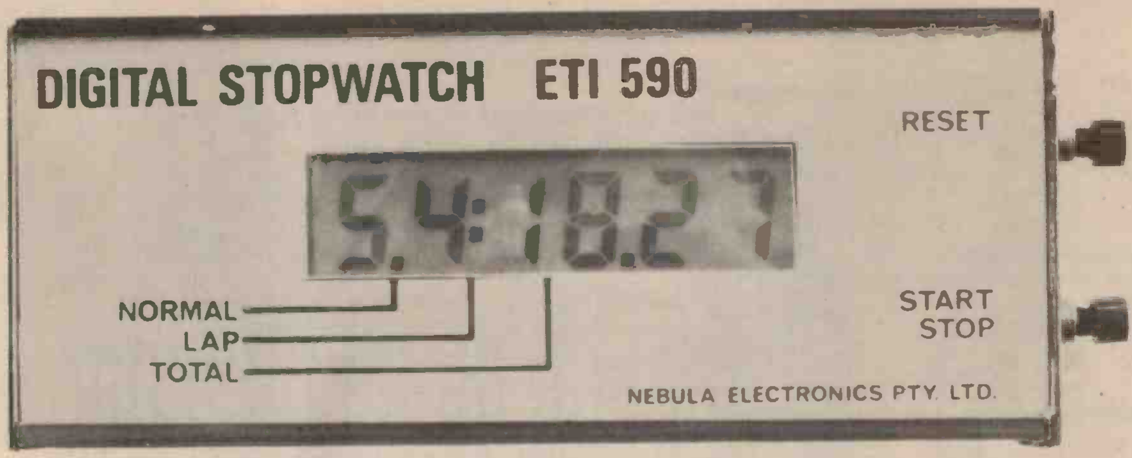
The display we are using is a large (12 mm high) six digit liquid crystal unit. We chose a resolution of 0.01 s, giving a maximum display of 59 min, 59.99 s. We looked around for a single IC which would do all the work, but the only devices we could locate are designed for LED displays. Driving an LCD display usually requires an ac signal with an average dc component across the display of zero. This requirement prevents the display multiplexing as used in most special stopwatch ICs.

The low power consumption of the display indicated that CMOS should be used in the design, thus keeping the total supply current to less than 750 μA.

When deciding what stopwatch modes to provide, we were limited by the package count, as we are using standard CMOS ICs and not a custom LSI chip. We finally settled on the three commonest modes using a single memory.

Initially we did not think that a power switch would be necessary, but the supply current was higher than we expected, giving only about two months continuous use. We also originally used a slide switch to set each of the three modes, but the cost of these two switches and the space required made us look for an alternative method.

To delete a power switch, the supply current has to be reduced to less than 10 μA, so by checking where the 750 μA was going we found that the biggest power consumption was in the 4060 oscillator. Stopping the oscillator



dropped the current but as the output of this IC drives the backplane of the display, stopping it will cause damage to the display.

The method we chose for on/off switching was to remove power to all but three of the ICs in the off mode. To replace the mode switch we used analogue switches and three of the unused decimal points as indicators. Mode selection is performed by holding the reset button pressed while pushing the start/stop button. In the 'fourth' mode, two decimal points will come on, and if both buttons are released the display will turn off. Holding the button closed will turn off. Holding the reset button closed will bring the display back and pressing the start/stop button will move it into mode one.

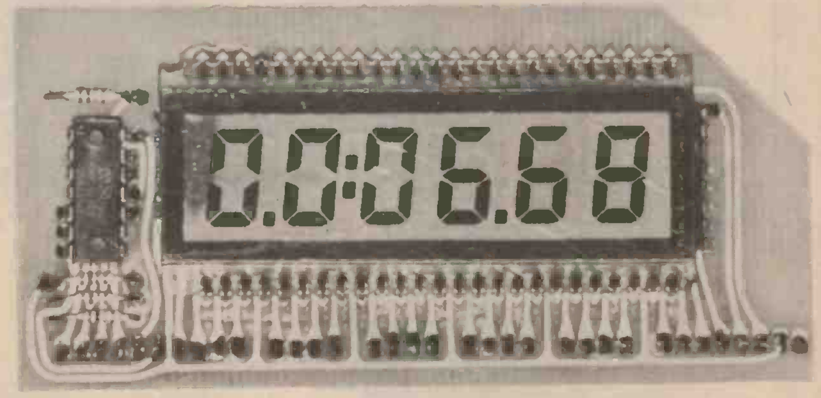


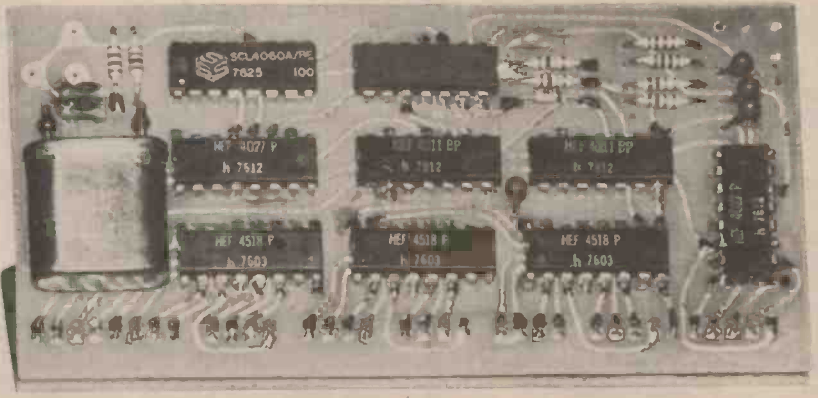
Photo showing the display board with the display board in position. Note that IC2 – IC7 are under the display. Note also that the display is a custom type and will only be available from Nebula Electronics, 15 Boundary St., Rushcutters Bay, 2011.

Calibration

For normal use this is not required and a 33p capacitor is used for C2. Our prototype was about 0.1s slow in one hour. If greater accuracy is required CV1 can be used along with a 15p capacitor for C2. If so check the time over a one hour period, record the error, then turn CV1 slightly one way and recheck. Continue until the accuracy is within your limits. Due to the manual operation of the pushbuttons the longer the timing period the more accurate will be the calibration.

External operation

As the watch is simply operated by normally open pushbuttons any number can be paralleled or the leads extended. If electronic operation is required it is preferable that the output stage of that unit be open circuit NPN transistors. It an external voltage pulse is used, it should be between 6 and 9 volts high. It may be necessary to remove or reduce C3 and C4. Remember when designing your interface that the output should normally be high and the timing occurs on the negative going edge.



The logic / control card.

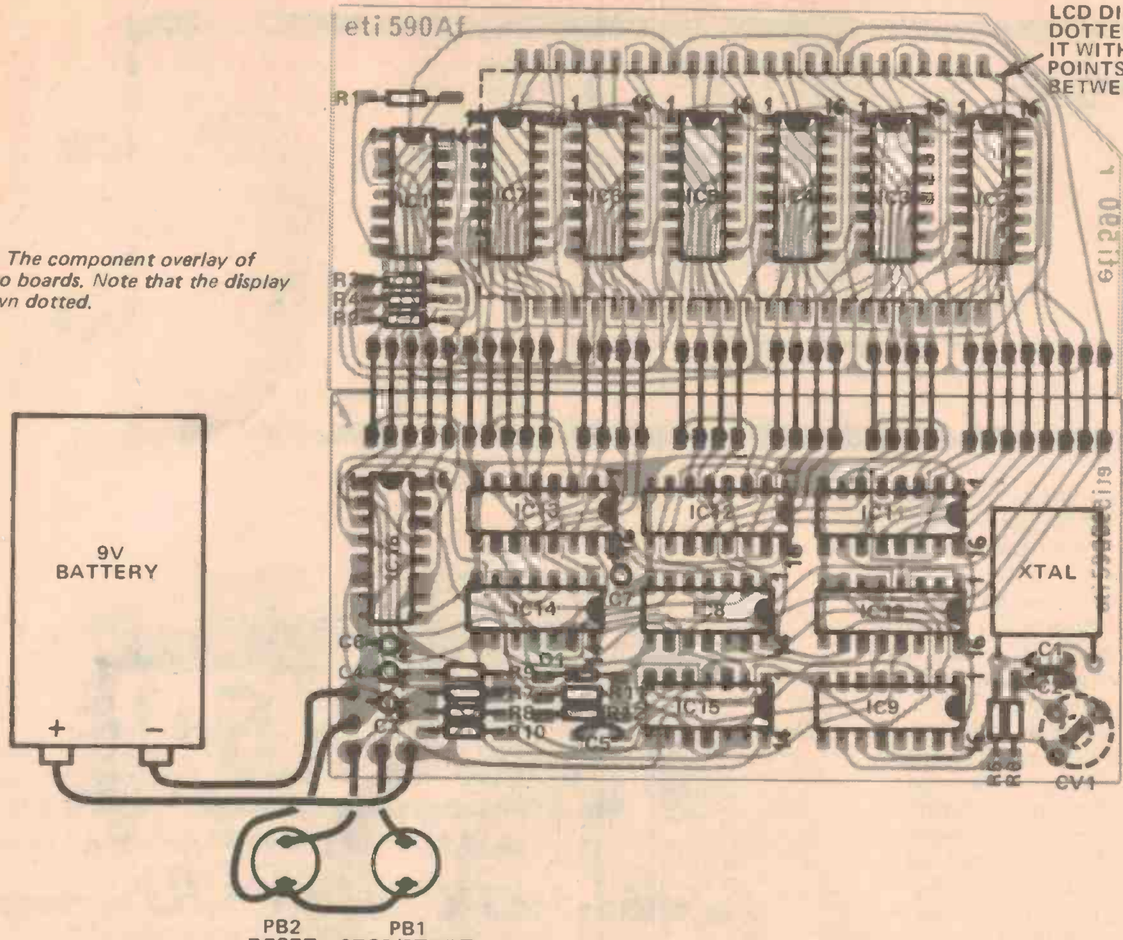


Fig. 2. The component overlay of the two boards. Note that the display is shown dotted.

PARTS LIST – ETI 590

Resistors	all ¼W, 5%
R1–R4	100k
R5	4M7
R6	1k
R7	47k
R8	1k
R9	47k
R10	1k
R11, 12	100k
Capacitors	
*C1, 2	33p ceramic
C3, 4	1µ0 tantalum
C5	330p ceramic
C6, 7	1µ0 tantalum
Variable Capacitor	
*CV1	2–30p trim (optional)
Semiconductors	
IC1	4016 quad switch
IC2–IC7	4056 decoder
IC8	4011 two input NAND
IC9	4060 oscillator-divider
IC10	4027 J K flip.flop
IC11–IC13	4518 dual decade counter
IC14	4011 two input NAND
IC15	4093 quad schmitt trigger
IC16	4027 J K flip flop
D1	IN914 diode

Miscellaneous
PC boards ETI 590A, 590B
LCD display (Hamlin 3918 315)
Two push buttons
Batteryclip
Case to suit

*If CV1 is used reduce C2 to 15 pf.

Construction

With a circuit of this complexity it is virtually essential that the pcbs be used. These boards are double sided and many components have to be soldered on both sides. As a result, sockets cannot be used on the ICs (not that there's room for them anyway!). A small soldering iron with a fine tip is needed to solder the IC pins on the top of the board.

Before starting assembly, inspect the pc boards for any breaks or unwanted joins in the tracks as they are thin in places and it will be difficult to find a break later if it is under an IC! Start assembly with the display board (ETI 590A) inserting the ICs first and soldering them in. Ensure that they are oriented correctly and that they are sitting as close as possible to the pc board. It is recommended that the soldering iron tip be earthed to prevent damage to the ICs. After soldering the ICs in on both sides add the resistors and solder them in.

Now carefully examine the board for any bad solder joints before proceeding. The display is now added (do not remove the protective cover yet) such that it sits over the top of the ICs with the decimal points closest to the connector (the as yet unused row of holes along the edge of the board). The segments of the display can be seen if it is held at an angle to the light. The display should be sitting right on top of the ICs, as the leads are not too long. It should now be soldered into this position — be careful as the display is glass, and is both delicate and expensive!

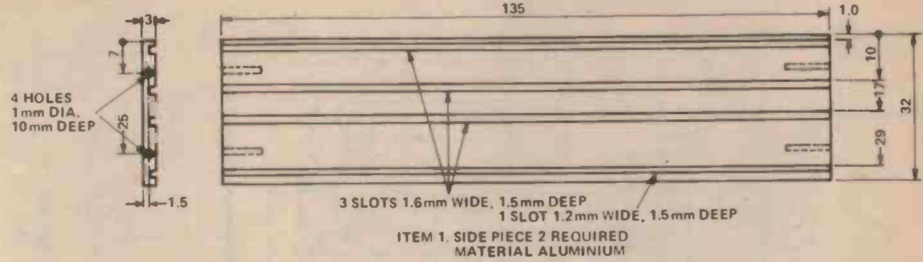
The second board can now be assembled similarly. Glue a small (about 20 mm square) piece of thin card on to the pc board to insulate it from the crystal, before gluing the crystal into position.

For normal use, the crystal frequency is probably accurate enough with simply a 33 pF capacitor for C2. The prototype was within 0.1 s over a one hour timing period. The crystal can be trimmed by reducing C2 to 15pF and adding CV1. This adjustable capacitor is fitted to the *non*component side of the board and the corner of the display board is cut off to provide clearance for it.

The two boards can now be joined together by sitting them back to back, separating them by 7 - 10 mm, then 'sewing' them together with a long piece of tinned copper wire (see photo). Now solder these links on the front surface of the display board, and bend the two boards apart to enable the three pads which are used to be soldered. Before soldering the control board on, the boards must be spaced correctly. This can be done by using the two side pieces of the box as a guide. Only the component side of the control board need be soldered. Once the boards have been soldered the excess leads can be cut off. The battery clip can now be connected along with the pushbuttons.

The operation of the unit can now be checked. When the battery is first connected the display may or may not come on depending on the mode. Pressing either button should bring the display on and it should be possible to step through the modes using the start/stop button while holding the reset button closed. Check that the unit operates in each mode.

The case can now be assembled. The case can be etched slightly in a caustic soda solution if desired, and then painted to give a good finish.



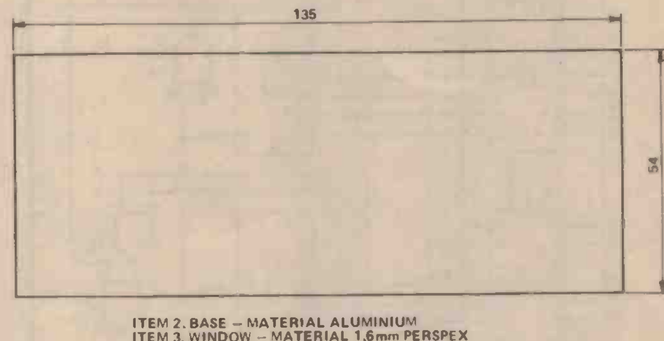
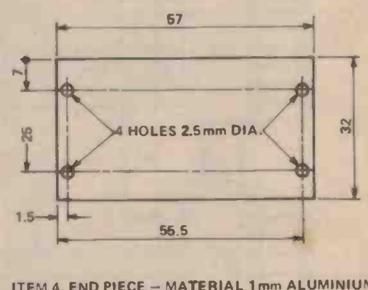


Fig. 3. The details of the metalwork used for the protype.



A complete kit of parts for this project is available from
Nebula Electronics Pty. Ltd.
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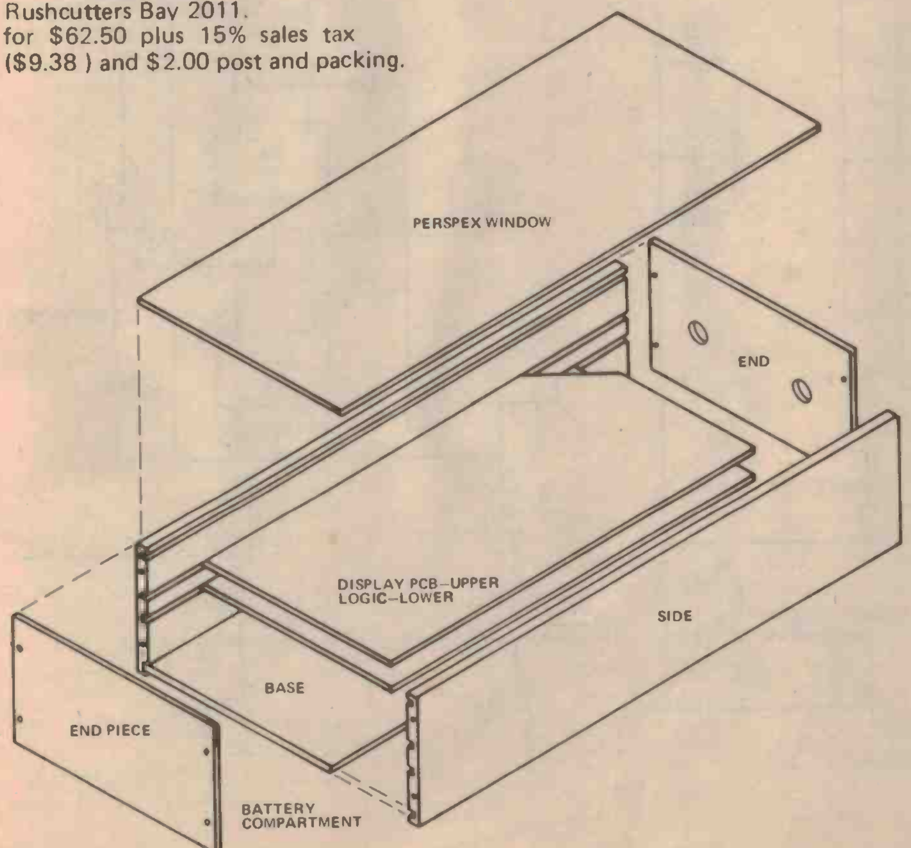
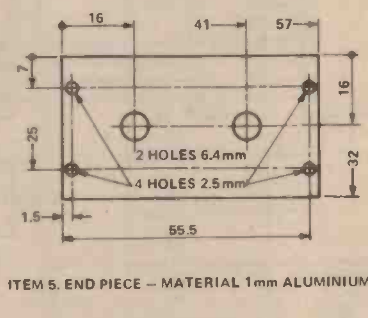
Rushcutters Bay 2011.
for $62.50 plus 15% sales tax ($9.38) and $2.00 post and packing.





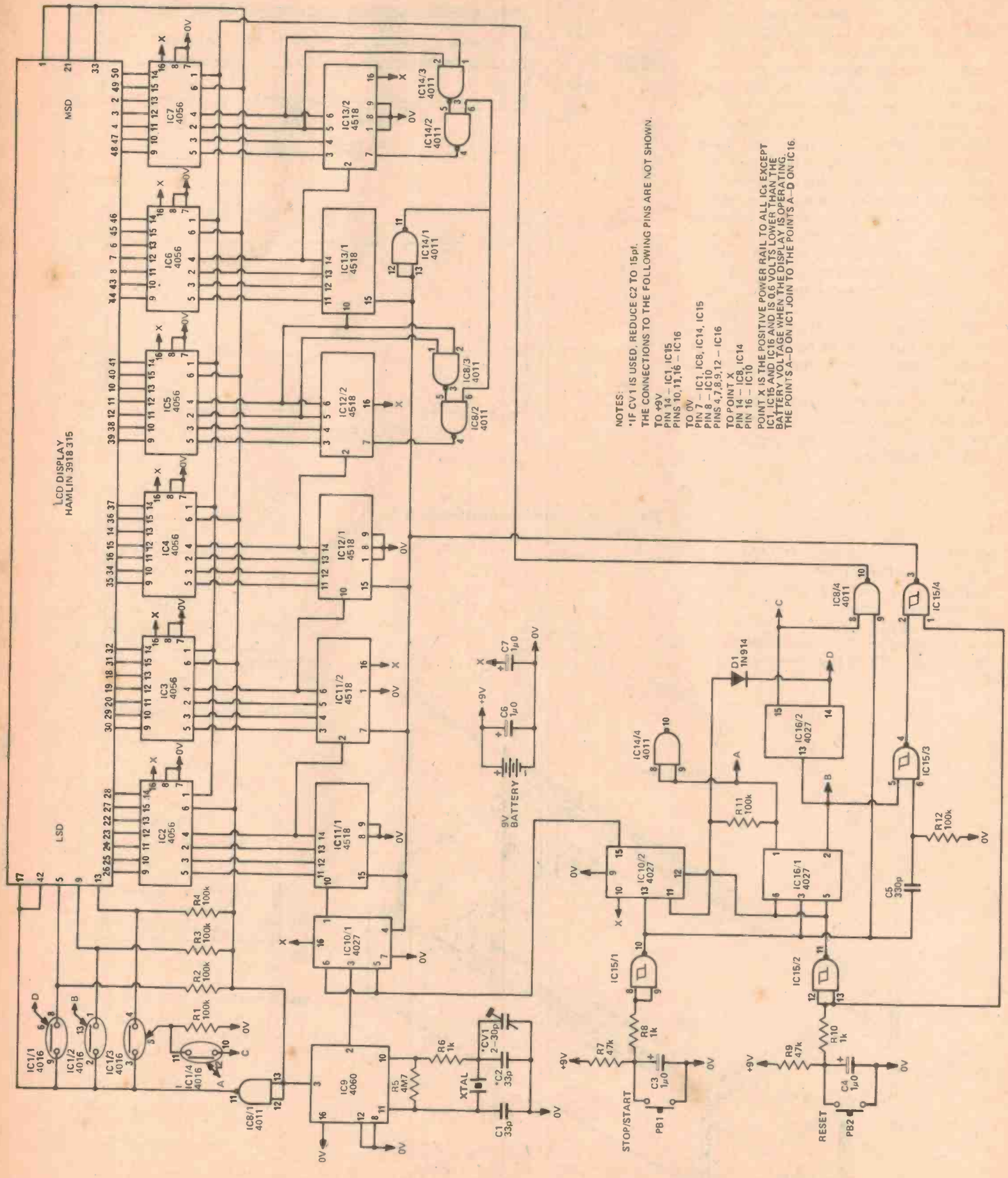


Fig. 1. The complete circuit diagram of the stopwatch.

HOW IT WORKS – ETI 590

Let's start in the middle. IC9 is a crystal oscillator and divider, which, using a 1.6384 MHz crystal, gives 200 Hz on pin 2 and 100 Hz on pin 3. If necessary the crystal frequency can be adjusted by CV1, but normally a 33 pF capacitor for C2 will be accurate enough. The 200 Hz output is divided by 2 in IC10/1 if pins 5 and 6 of that IC are high. The resulting 100 Hz drives IC11/1 which divides by 10, IC11/2 and IC12/1 which also divide by 10, IC12/2 which, due to IC8/2 and IC8/3, divides by 6, IC13/1 (divide by 10) and finally IC13/2 (divide by 6). This is a total division by 360 000, giving an output (not used) from IC13/2 of one hour.

The BCD outputs from each of these dividers is decoded by IC2 - IC7 which are the display decoder/drivers. These ICs need the backplane frequency as an input so that the outputs will either be in phase (display off) or out of phase (on). Also included on these ICs are the latches required to hold a steady display while counting continues.

Keeping It Under Control

Two push buttons are used, one for start/stop and the other for reset. Both are debounced and buffered by schmitt triggers. If the reset button is pressed the reset input to IC10/2 (pin 12) goes high, forcing the Q output (pin 15) low. This stops IC10/1 from dividing, which stops the display. The reset button also places a low on pin 1 of IC15 causing the reset line of the counter to go high, resetting the contents to zero.

Before going any further we had better explain the mode control. This is done by IC16 which is connected as a divide by four counter. If the reset button is pressed a high will be applied to the J-K terminals of IC16/1 and if the start/stop button is now pulsed, each pulse will advance the counter by one. The A-D outputs for the four modes are given below:

	A	B	C	D
Mode 0 (off)	0	1	0	1
Mode 1 (normal)	1	0	0	1
Mode 2 (lap)	0	1	1	0
Mode 3 (total)	1	0	1	0

These modes are selected sequentially with mode 0 following mode 3. Now back to the operation of the main circuit.

In mode 1 we have a '1' on pin 11 IC10 (K input), due to the mode selector, as well as a permanent '1' on the J input. In this mode, the start/stop button will alternate the output of IC10/2 on each press, enabling and disabling IC10/1.

Also in this mode there is a low on pin 9 of IC8/4, forcing the output high. This opens the latch in the decoder ICs and the contents of the counters will be continuously displayed. Counting is therefore alternatively started and stopped by the start/stop button without resetting. If the reset button is pressed the counters are reset and IC10/2 forced into the stop condition.

In mode 2 (lap timing) we have a low on pin 11 of IC10/2, and a high on pin 9 of IC8/4. If the reset button is pressed the counters are reset to zero and IC10/2 is forced into the stop condition. Pin 10 of IC15/1 will be low (push button open) and this signal on pin 8 of IC8/4 will force pin 10 high, thus opening the latches. Zero will be displayed. Pressing the start/stop button will toggle IC10/2 into the start mode, allowing the counters to be advanced. If the button is held pressed the high on the input of IC8/4 is lost and the latches are closed. The result is that although the counters are being advanced the display will still read zero. Releasing the button will cause the display to immediately update to the correct reading and continue to follow the counting.

If the start/stop button is again pressed IC10/2 will not be affected as the J-K inputs are 1,0 and not both high. However, while the button is depressed the latches are closed and the time until the button was pressed will be displayed. Also at the instant the button is depressed a positive pulse of about 25 µs is generated by C5/R12 and as the other input of IC15/3 is high, this pulse results in a 25 µs wide negative pulse on pin 4 of that IC. This resets the counter ICs (via IC15/4) back to zero, although this cannot be seen as the latches are closed. Releasing the button will allow the display to update to the time from the last press. In this mode the result is that the time between presses of the start/stop button is displayed for as long as the button is held down.

In mode 3 the operation is identical to mode 2 with the exception that the reset pulse due to C5/R12 is disabled by a low input on pin 5 of IC15/3. The result of this is that the time displayed is the total since the first press of the start/stop button.

The mode indication is done by IC1; depending on the status of the mode counter one of IC1/1, IC1/2 and IC1/3 will be on. In mode 0 both IC1/1 and IC1/2 will be on.

Power? The astute reader may have noticed that the 9 V supply only goes to IC1, IC15 and IC16! The input protection on CMOS ICs consists of diodes to the power rails, and if any input is taken above the supply rail the protection diode will conduct; if there is enough energy and the load on the power supply is very light the power supply voltage will rise. If there is no power supply and an input is taken to +9 V the power supply will rise to about 8.4 V. Care has to be taken not to damage the protection diodes, however. Getting back to this circuit, in mode 1, the high output on point A (IC16/1) will supply current to the rest of the ICs via the protection diodes in IC14/4. In modes 2 and 3 it is supplied via IC8/4. In the off mode there is no path unless one of the push buttons is depressed. In this case it is supplied via IC10/2 or IC8/4. The current in the off state was measured as about 20 nA, mainly being leakage in C6.

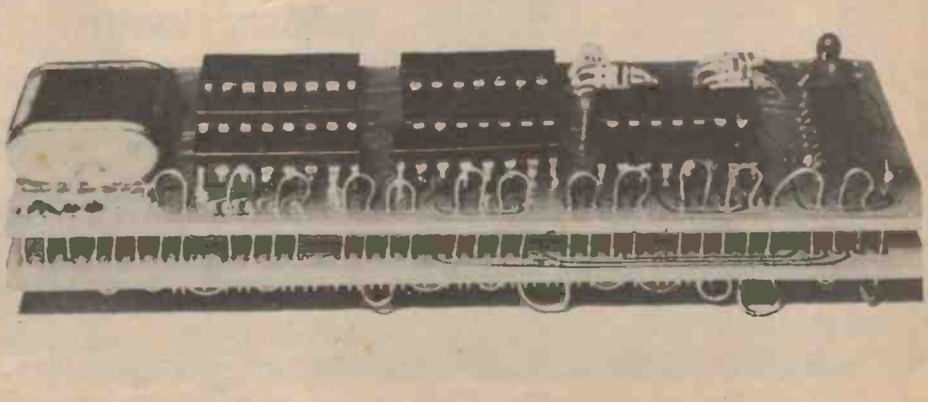


Photo showing how the two boards are wired together. After soldering the loops any excess should be cut off.

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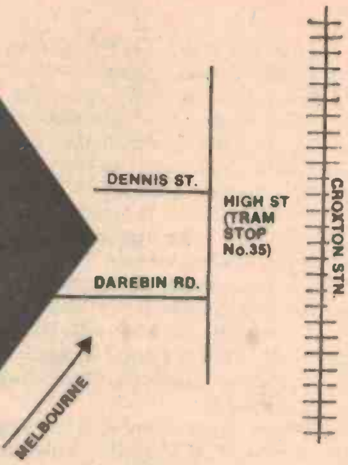

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ETI 071	$1.40
ETI 072	$1.80
ETI 083	$1.80
ETI 084	$1.70
ETI 085	$1.30
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ETI 135	$1.90
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1 watt carbon		
1 ohm to 1M	8c	7c
5 watt		
1 ohm to 100 ohm	.40	.35

TANTALUMS Resin Dipped

	1-9	10-99
.1, .15, .22, .33, .47, .68uF (all 35V)	.25	.20
1uF 35V	.25	.20
2.2uF 25V	.23	.20
2.2uF 35V	.25	.20
3.3uF 25V	.25	.20
4.7uF 35V	.25	.22
6.8uF 35V	.30	.25
10uF 16V	.25	.23
10uF 35V	.30	.28
15uF 16V	.30	.25
15uF 35V	.50	.45
22uF 16V	.38	.35
47uF 16V	.65	.60
68uF 16V	1.20	1.10
100uF 6.3V	.70	.65

MINIATURE TRIMPOTS

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0.1 watt, .1" spacing		
100, 250, 500, 1K, 2K, 5K, 10K,	.20	.17
25K, 50K, 100K, 250K, 500K, 1M	.20	.17

I C SOCKETS

0	1-9	10 up
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14 Pin DIL	.33	.30
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10 uF	25v	PCB	0.09	0.08
10 uF	50v	PCB	0.10	0.09
22 uF	16v	PCB	0.08	0.07
22 uF	35v	PCB	0.10	0.09
33 uF	16v	PCB	0.09	0.08
33 uF	50v	PCB	0.11	0.10
47 uF	16v	PCB	0.10	0.09
47 uF	35v	PCB	0.12	0.11
100 uF	10v	PCB	0.11	0.10
100 uF	16v	PCB	0.12	0.11
220 uF	25v	PCB	0.15	0.14
470 uF	16v	PCB	0.17	0.16
1000 uF	25v	PCB	0.38	0.36
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KITS

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TTL

7400	.28
7401	.28
7402	.28
7403	.28
7404	.37
7405	.37
7406	.50
7407	.50
7408	.34
7409	.34
7410	.30
7411	.37
7413	.54
7414	1.03
7416	.60
7417	.60
7420	.30
7422	.30
7426	.45
7427	.45
7430	.30
7432	.43
7437	.50
7438	.50
7440	.30
7441	1.50
7442	.70
7447	1.25
7448	1.25
7450	.35
7451	.35
7453	.35
7454	.30
7460	.35
7470	.65
7472	.45
7473	.60
7474	.65
7475	.65
7476	.45
7480	1.25
7483	1.25
7485	1.45
7486	.65
7489	1.20
7490	.75
7491	1.00
7492	.75
7493	.75
7494	1.10
7495	.95
74100	2.45
74107	.65
74121	.60
74123	1.10
74132	1.25
74150	1.80
74151	1.10
74153	1.10
74154	1.70
74157	1.10
74160	1.55
74164	1.55
74165	1.55
74173	2.75
74175	1.65
74180	1.35
74192	1.40
74193	1.40
74221	1.50
74367	1.40

74LS

74LS00	.30
74LS01	.30
74LS02	.30
74LS03	.30
74LS04	.35
74LS05	.35
74LS08	.30
74LS09	.30
74LS10	.30
74LS11	.30
74LS12	.30
74LS14	1.20
74LS20	.30
74LS21	.30
74LS27	.30
74LS28	.40
74LS30	.30
74LS32	.33
74LS37	.45
74LS38	.45
74LS40	.30
74LS42	1.20
74LS73	1.20
74LS74	.50
74LS75	.70
74LS78	.50
74LS85	1.50
74LS86	.50
74LS90	1.20
74LS92	1.20
74LS93	1.20
74LS95	1.50
74LS109	.50
74LS113	.55
74LS114	.55
74LS138	1.20
74LS151	1.20
74LS154	1.60
74LS157	.90
74LS163	1.20
74LS164	1.30
74LS174	1.00
74LS175	1.00
74LS191	1.20
74LS192	1.20
74LS193	1.20
74LS194	1.20
74LS195	1.20
74LS196	1.20
74LS221	1.20
74LS253	1.85
74LS279	.65
74LS365	.80
74LS367	.80
74LS368	.80

CMOS

4000	.25
4001	.25
4002	.25
4006	1.40
4007	.25
4008	1.25
4011	.25
4012	.25
4013	.55
4014	1.35
4015	1.20
4016	.50
4017	1.40
4018	1.40
4019	.75
4020	1.60
4021	1.40
4022	1.60
4023	.25
4024	.90
4025	.40
4027	.80
4028	1.25
4029	1.90
4030	.40
4040	1.30
4041	1.25
4042	1.25
4043	1.50
4044	1.50
4046	1.95
4049	.60
4050	.60
4051	1.20
4052	1.20
4053	1.20
4060	2.65
4066	1.00
4068	.40
4069	.35
4070	.40
4071	.40
4072	.40
4073	.40
4074	.40
4076	1.85
4077	.40
4078	.40
4081	.40
4082	.40
4510	1.50
4511	1.50
4518	1.50
4520	1.45
4528	1.20
4555	1.20
14553	7.50
14584	1.25
74C00	.40
74C02	.40
74C04	.40
74C08	.40
74C10	.40
74C14	1.90
74C48	2.55
74C73	1.20
74C75	1.20
74C76	1.35
74C90	2.25
74C93	2.25
74C175	1.85
74C192	2.25
74C193	2.25

LINEAR

301	.40
307	.65
308	1.35
311	.85
324	1.35
339	.90
349	2.25
356	1.65
380	2.00
381	2.00
382	2.00
386	1.95
555	.35
556	.85
565	1.95
566	2.50
567	2.65
709	.75
723(VR)	.55
741	.35
747	1.25
3900	.90
3909	1.25

VOLTAGE REGS.

309	2.25
317	3.50
323	8.25
325	2.60
723	.55
7805	1.30
7806	1.30
7808	1.30
7812	1.30
7815	1.30
7818	1.30
7824	1.30
7905	2.25
7912	2.25
7915	2.25
78L05	.50
78L12	.50
78L15	.50
79L05	.85
79L12	.85
79L15	.85

OPTO

FND507 C/A	1.70
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IN5625 5A 400V	45c

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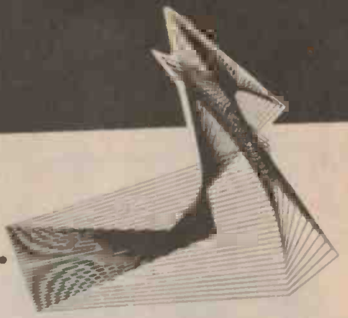
PRINT-OUT

ETI's COMPUTER SECTION



NEWS

Earom now Eeprom

Now that you've learnt that Earom stands for Electrically Alterable Read Only Memory, forget it – Jedec's subcommittee JC-42 has voted in favour of the term Electrically Eraseable Programmable Read Only Memory (Eeprom), as a title for the device. We're not too struck on this personally – it sounds like the term for a 2708-type EPROM.

First 16 K Static RAM

The latest milestone in memory technology has been passed by Texas Instruments, who have announced the world's first 16 K static RAM. Organised as 2 K x 8, the TMS4016 is pin compatible with the 2716 EPROM, thus making for extremely flexible memory board design. Samples of the IC will be available in September, with production scheduled for the year's end.

LSI–11 Now Microprogrammable

The Digital Equipment Corp. LSI-11 and LSI-11/2 microcomputers can now be microprogrammed, that is, users can define their own instruction sets. DEC will mask program user-supplied microcode into 512 x 22 bit ROMs, enabling the processors to provide special functions such as FFTs or emulation of other processor instruction sets.

Pseudo-static RAM

Mostek are being very cunning. Although dynamic RAMs are larger by a factor of four and cheaper than static RAMs many memory system designers steer away from them, to avoid problems associated with refresh circuitry. What Mostek have done is to put the refresh counters on a new memory chip itself, so that when the memory is not being accessed, it will automatically refresh itself. The 2K x 8 RAM has a 100 ns access time and is designed for 5 V operation. Sample quantities of the 4816 are due in November.

Another Printer Driver

In order to use the ETI 641 Printer with the Assembler we run at work, we've had to write a short printer driver program which we reproduce here. It's fairly straightforward, the only odd feature being the way it filters out line feed characters (012Q) which would otherwise be printed. The program was printed on the 641 itself – we could have done an assembly listing, but it looks rather confusing, as each line 'wraps' around twice. The program is written in 8080 code, by the way.

```
*PRINTER DRIVER
            AORG 001:000Q
            SORG 001:000Q
PRINT       CPI  012Q
            RZ
            PUSH PSW
LOOP        IN   031Q
            CPI  177Q
            JZ   LOOP
            POP  PSW
            OUT  31Q
            RET
```

Paratronics 150

In order to keep the project lab at ETI fully up to date, we've just taken delivery of a Paratronics Model 150 S-100 compatible logic state analyser. This will be used in the development and debugging of our forthcoming computer projects, and we like to think of it as an example of the kind of effort we're putting into coming up with the best projects anywhere.

COMPUTER CLUB DIRECTORY

Sydney: Microcomputer Enthusiasts Group, P.O. Box 3, St. Leonards, 2065. Meets at WIA Hall, 14 Atchison St., St. Leonards on the 1st and 3rd Mondays of the month.

Melbourne: Microcomputer Club of Melbourne, meets at the Model Railways Hall, opposite Glen Iris Railway Station on the third Saturday of the month at 2 p.m.

Canberra: MICSIG, P.O. Box 118, Mawson, ACT 2607 or contact Peter Harris on 72 2237. Meets at Building 9 of CCAE, 2nd Tuesday of month at 7.30 p.m.

Newcastle: contact Peter Moylan, Dept. of Electrical Engineering, University of Newcastle, NSW 2308. (049) 68–5256 (work), (049) 52–3267 (home).

Brisbane: contact Norman Wilson, VK4NP, P.O. Box 81, Albion, Queensland, 4010. Tel. 356 6176.

New England: New England Computer Club, c/- Union, University of New England, Armidale, NSW 2351. (New club; not restricted to students)

Auckland: Auckland Computer Club, P.O. Box 27206, Auckland, N.Z.

Computer clubs are an excellent way of meeting people with the same interests and discovering the kind of problems they've encountered in getting systems 'on the air'. In addition, some clubs run hardware and software courses, and may own some equipment for the use of members. Try one – you'll like it!

If your club is not listed here, please drop us a line, and we'll list you. The same applies if you are interested in starting a club in your area. Also, if established clubs know their programme of forthcoming events, we can publicise them.

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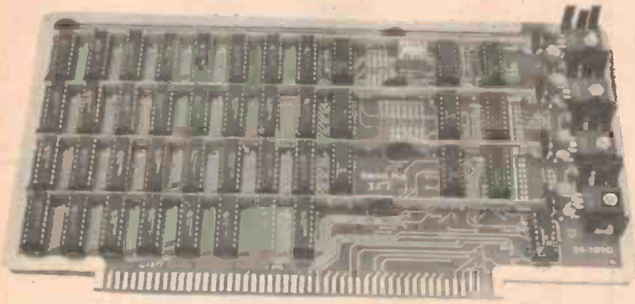

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PRINT-OUT

Comprehensive Z-80 Driver for the ETI 640 VDU

The following program which was contributed by R.J. Long of Kenmore, Qld, handles all the facilities available on the ETI 640 VDU — flashing characters, black on white characters, extended graphic characters (i.e., printing control characters) and chunky graphics.

The program is written specifically for the Z-80, but the assembler has flagged the unique Z-80 codes (with a 'Z' in the left column and a '?' after the op-code) so that 8080 users can adapt the appropriate instructions. Extensive use has been made of bit testing and setting, relative jumps, block moves and 16-bit subtraction. No attempt has been made to minimise the space occupied by the program — rather it uses subroutines extensively so that all functions are self-contained modules.

Modes of Operation

The VDU can be set to any of the following modes:

1) Normal
2) Flashing
3) Black on white
4) Extended graphics
5) Chunky graphics.

Normal Mode

In this mode the VDU simulates a normal TTY, with some extra features. The cursor is a flashing black on white character. The following control characters are recognised:

a) Carriage return — moves the cursor to the front of the line.
b) Line Feed — moves the cursor down one line. After the cursor reaches the bottom line the text on the screen will be scrolled up.
c) Backspace (^H) — moves the cursor back one character. Does not destroy the characters that it passes over. The cursor does not move backwards past the front of the line.
d) Forward Space (^I, the TAB character) — moves the cursor forwards. Does not proceed past the end of the line.
e) Vertical Feed (^K) — moves cursor up. Scrolls the text downwards when it reaches the top line.
f) Form Feed (^L) — clears the screen and positions the cursor at the top left of the screen.
g) Home (^Q) — moves the cursor to top left of screen without clearing the screen.
h) Bell (^G) — rings the TTY bell. Does not print anything on the screen.
i) Cursor Off (^U) — turns the cursor on or off.

Flashing Mode

This mode is enabled with the control S (^S) character. All characters after the ^S will flash, until another ^S is received, which will then cancel the flashing mode.

Black on White

This is enabled with ^R. All characters following this are then displayed as inverse video, Another ^R cancels the mode.

Extended Graphics

When in this mode (^E) the control characters are displayed as the extended graphic symbols available in the character ROM. Because ^E sets and clears this mode the graphic character corrrespon-ding to it cannot be displayed.

Chunky Graphics

This mode is set and cleared with ^T.

Mode Priority

The extended graphics characters and chunky graphic symbols can be made to flash if S is transmitted before the ^E or ^T. Once in extended or chunky graphics mode the flashing cannot be cancelled until the graphics mode is cancelled.

Similarly, the extended graphics symbols can be black on white and/or flashing, if BOW and flashing are set before entering the extended graphics mode. Chunky graphic symbols cannot be made black on white.

Speed Control

Normally, when the text is being displayed on the screen by, say, listing a program, it appears (and disappears!) too quickly to read easily. There is a memory location (DELVAL, at FE58) which controls the amount of delay which is introduced after each character is processed. The initial value is 0 = fastest (least delay). The value of the location can be changed (by your monitor, or POKE'd from BASIC) to slow the display. 'FF' will give a speed equivalent to about 60 characters per second.

Implementation of the program

The program has been assembled to execute a FC00. If you have an assembler than it can be reassembled at any location you desire.

The routine expects to receive the character in the 'C' register. It returns with the character in the accumulator.

Mr. Long writes: My monitor (the TDL Zapple monitor) has a feature which allows the user to assign the console device to a 'user defined' device and all CALLs to the console input and output routines by-pass the usual monitor I/O routines and are directed to locations above F800. In these locations we insert jumps to the soft-ware which handles the 'user defined' device. In this case, the normal TTY port is used for input, so the instructions in the user defined jump vectors jump back to the routine in the monitor which handles the input. These locations are at F800, and F818 for the I/P status of the TTY port. For the output we jump to this VDU driver from location F803. The 'list' device also jumps to the VDU driver.

When the bell character is received the VDU driver which then jumps to the normal TTY routine in the monitor, so that the bell on the TTY can be rung.

'The assembler I have used is the TDL Z-80 relocating assembler. The double equals (==) makes the associated identifier a constant, so that it cannot be redefined.

'The labels that are preceded by '. .' are 'local' labels, which do not create ambiguity with identical labels which are separated by ordinary labels. The label '%LABL' in the macro is a local label which is automatically generated by the assembler to avoid clashes between local labels when the macro is invoked more than once between global labels.

'The op-codes are generally those of the 8080, with additional ones for the Z-80 instructions. They are not Zilog or Mostek mnemonics.

'Note that the 16 bit values are listed with the high byte first rather than the usual low byte first. Of course the assembler generates code with the low byte first.'

The program is copyright but may be copied by individuals or clubs for non-commercial purposes.

```
TDL Z80 RELOCATING ASSEMBLER VERSION 2.2
ETI VDU 640 Z-80 driver
Written by R.J. Long.  August 1978


                        ;
                        ; ETI VDU 640 Software controlled VDU driver.
                        ;
                        ; This driver simulates normal TTY scrolling
                        ; as well as providing the VDU features such as
                        ; flashing , inverse video and chunky graphics.
                        ;
                        ; (C) Copyright 1978 by:R.J. Long.
                        ;                         19 Cedarleigh Rd.,
                        ;                         Kenmore.
                        ;                         Qld. 4069
                        ;
                        .I8080           ; Flag unique Z80 instructions.
                        ;
FC00                    BASE    == 0FC00H      ; Locn. of this program
F490                    ZTTYO   == 0F490H      ; Locn. of TTY O/P routine
                                               ;    in monitor.
F61F                    ZTTYI   == 0F61FH      ; Monitor TTY I/P routine.
F520                    ZTSTS   == 0F520H      ; Status of TTY I/P.
E800                    MEM     == 0E800H      ; Start of VDU memory.
0400                    OFFSET  ==   400H      ; Offset of control bits.
                        ;
003F                    LL      ==    3FH      ; Max. line length (0-63).
000F                    LINES   ==    0FH      ; No. of lines (0-15).
                        ;
                        ; Recognised control characters:
                        ;
0008                    BSCH    == 08H  ; Backspace.
0009                    FSCH    == 09H  ; Forward space.
000D                    CRCH    == 0DH  ; Carriage retn.
000A                    LFCH    == 0AH  ; Line feed (cursor down).
000B                    VFCH    == 0BH  ; Vert. feed (cursor up).
000C                    FFCH    == 0CH  : Form feed (clear screen).
0011                    HMCH    == 11H  ; Home (w/o clear) (^Q)
0007                    BELLCH  == 07H  ; Bell.
0015                    CURCH   == 15H  ; Turn cursor on/off.
                        ;
                        ; Characters to set or clear modes:
                        ;
0005                    EXTCH   == 05H  ; Ext. graphics mode (^E)
0012                    BOWCH   == 12H  ; Black on white (^R)
0013                    FLSCH   == 13H  ; Flashing (^S)
0014                    CHKCH   == 14H  ; Chunky graphics (^T)
                        ;
                        ; Bits in mode register (Reg. E)
                        ;
0000                    EXGBIT  == 0    ; Ext. graphics
0001                    BOWBIT  == 1    ; Black on white.
0002                    FSHBIT  == 2    ; Flashing.
0003                    CHKBIT  == 3    ; Chunky graphics.
                        ;
                        ; The following bits are also in the 'mode' register
                        ; and are used to reset the cursor properly.  For
                        ; example if a character was flashing before the cursor
                        ; was passed over it (by forward space) then that
                        ; character will stay flashing after the cursor leaves.
                        ; Similarly for black on white.
                        ;
0004                    AFSBIT  == 4    ; Already flashing.
0005                    ABWBIT  == 5    ; Already black on white.
0006                    CURBIT  == 6    ; If set turn cursor off.
                        ;
                        ; Bits in the character to set its mode.
                        ;
0007                    BOW     == 7    ; In main memory.
0000                    FLASH   == 0    ; In control section of memory.
0001                    CHUNK   == 1    ; "    "       "    "    "
                        ;
                        ; The following macro inverts the specified bit.
                        ;
                        .DEFINE FLIP [THEBIT,%LABL]=
                        [
                                BIT     THEBIT,E
                                JRZ     %LABL
                                RES     THEBIT,E
                                JMP     EXIT
                        %LABL:  SET     THEBIT,E
                                JMP     EXIT
                        ]
                        ;
                        .PABS
                        ; The following jump vectors are used by the Zapple
                        ; monitor when in the 'user defined mode'. That is the
                        ; mode which is used so that the output comes to
                        ; this VDU driver and not the normal TTY.
                        ;
  F800                          .LOC    0F800H
  F800    C3 F61F                       JMP     ZTTYI    ; Use normal TTY I/P.
  F803    C3 FC00                       JMP     VDUCO    ; Use this driver for O/P.
                                ;
  F815                          .LOC    0F815H
  F815    C3 FC00                       JMP     VDUCO    ; For List output.
  F818    C3 F520                       JMP     ZTSTS    ; TTY I/P status.
                                ;
  FC00                          .LOC    BASE
  FC00    C3 FC06               VDUCO:  JMP     BEGIN    ; Jump over vectors.
  FC03    C3 F490               TTYOUT: JMP     ZTTYO
                                ;
  FC06    C5                    BEGIN:  PUSH    B        ; Save registers.
  FC07    D5                            PUSH    D
  FC08    E5                            PUSH    H
  FC09    3A FE55                       LDA     LC       ; Get all variables and keep in
                                                         ;   the registers.
  FC0C    47                            MOV     B,A
  FC0D    3A FE56                       LDA     CC
  FC10    57                            MOV     D,A
  FC11    3A FE57                       LDA     MODE
  FC14    5F                            MOV     E,A
  FC15    2A FE59                       LHLD    CURSOR
  FC18    79                            MOV     A,C      ; Get the character.
Z FC19    CB5B                          BIT     ?CHKBIT,E        ; Chunky graphics set?
Z FC1B    200E                          JRNZ    ?CHUNKY  ; Yes
  FC1D    FE20                          CPI     ' '
  FC1F    DA FC34                       JC      CONTRL   ; A control char.
                                ;
  FC22    CD FCF7               NORMAL: CALL    CLRCSR   ; Clear cursor.
  FC25    CD FD48                       CALL    NORM     ; Process normal character.
  FC28    C3 FCD9                       JMP     EXIT
                                ;
  FC2B    FE14                  CHUNKY: CPI     CHKCH    ; Cancel chunky mode?
Z FC2D    20F3                          JRNZ    ?NORMAL  ; No. Just put into memory.
Z FC2F    CB9B                          RES     ?CHKBIT,E        ; Reset bit.
  FC31    C3 FCD9                       JMP     EXIT
                                ;
Z FC34    CB43                  CONTRL: BIT     ?EXGBIT,E        ; Ext. graphics set?
Z FC36    2809                          JRZ     ?..L1    ; No.
  FC38    FE05                          CPI     EXTCH    ; Yes - do we reset?
Z FC3A    20E6                          JRNZ    ?NORMAL  ; No.
Z FC3C    CB83                          RES     ?EXGBIT,E
  FC3E    C3 FCD9                       JMP     EXIT
  FC41    FE05                  ..L1:   CPI     EXTCH    ; Do we set ext. graphics?
Z FC43    2005                          JRNZ    ?..L2    ; No.
Z FC45    CBC3                          SET     ?EXGBIT,E        ; Yes.
  FC47    C3 FCD9                       JMP     EXIT
  FC4A    FE14                  ..L2:   CPI     CHKCH    ; Set chunky graphics?
Z FC4C    2005                          JRNZ    ?..L3    ; No.
Z FC4E    CBDB                          SET     ?CHKBIT,E
  FC50    C3 FCD9                       JMP     EXIT
                                ;
  FC53    CD FCF7               ..L3:   CALL    CLRCSR
  FC56    FE0D                          CPI     CRCH     ; Carriage return?
Z FC58    2006                          JRNZ    ?..L4
  FC5A    CD FD8A                       CALL    CR
  FC5D    C3 FCD9                       JMP     EXIT
  FC60    FE0A                  ..L4:   CPI     LFCH     ; Line feed?
Z FC62    2006                          JRNZ    ?..L5
  FC64    CD FD9C                       CALL    LF
  FC67    C3 FCD9                       JMP     EXIT
  FC6A    FE12                  ..L5:   CPI     BOWCH    ; Set/clear BOW?
Z FC6C    200E                          JRNZ    ?..L6
                                        FLIP    [BOWBIT]         ; Yes, and exit.[
Z FC6E    CB4B                  +       BIT     ?BOWBIT,E
Z FC70    2805                  +       JRZ     ?..0001
Z FC72    CB8B                  +       RES     ?BOWBIT,E
  FC74    C3 FCD9               +       JMP     EXIT
Z FC77    CBCB                  +..0001: SET    ?BOWBIT,E
  FC79    C3 FCD9               +       JMP     EXIT
                                +]
  FC7C    FE13                  ..L6:   CPI     FLSCH    ; Flash?
Z FC7E    200E                          JRNZ    ?..L7
                                        FLIP    [FSHBIT][
Z FC80    CB53                  +       BIT     ?FSHBIT,E
Z FC82    2805                  +       JRZ     ?..0002
Z FC84    CB93                  +       RES     ?FSHBIT,E
  FC86    C3 FCD9               +       JMP     EXIT
Z FC89    CBD3                  +..0002: SET    ?FSHBIT,E
  FC8B    C3 FCD9               +       JMP     EXIT
                                +]
  FC8E    FE07                  ..L7:   CPI     BELLCH   ; Bell?
Z FC90    2006                          JRNZ    ?..L8
  FC92    CD FC03                       CALL    TTYOUT   ; Send to TTY.
  FC95    C3 FCD9                       JMP     EXIT
  FC98    FE08                  ..L8:   CPI     BSCH     ; Backspace?
Z FC9A    2006                          JRNZ    ?..L9
  FC9C    CD FDAD                       CALL    BS
  FC9F    C3 FCD9                       JMP     EXIT
  FCA2    FE09                  ..L9:   CPI     FSCH     ; Forward space?
Z FCA4    2006                          JRNZ    ?..L10
  FCA6    CD FDB3                       CALL    FS
  FCA9    C3 FCD9                       JMP     EXIT
  FCAC    FE0C                  ..L10:  CPI     FFCH     ; Form feed?
Z FCAE    2005                          JRNZ    ?..L11
  FCB0    CD FDCC                       CALL    FF
Z FCB3    1824                          JMPR    ?EXIT
  FCB5    FE0B                  ..L11:  CPI     VFCH     ; Cursor up?
Z FCB7    2005                          JRNZ    ?..L12
  FCB9    CD FDBA                       CALL    UP
Z FCBC    181B                          JMPR    ?EXIT
  FCBE    FE11                  ..L12:  CPI     HMCH     ; Cursor home?
Z FCC0    2005                          JRNZ    ?..L13
  FCC2    CD FD95                       CALL    HOME
Z FCC5    1812                          JMPR    ?EXIT
  FCC7    FE15                  ..L13:  CPI     CURCH    ; Turn cursor on/off?
Z FCC9    200E                          JRNZ    ?EXIT    ; Ignore other control char.
                                        FLIP    [CURBIT][
Z FCCB    CB73                  +       BIT     ?CURBIT,E
Z FCCD    2805                  +       JRZ     ?..0003
Z FCCF    CBB3                  +       RES     ?CURBIT,E
  FCD1    C3 FCD9               +       JMP     EXIT
Z FCD4    CBF3                  +..0003: SET    ?CURBIT,E
  FCD6    C3 FCD9               +       JMP     EXIT
                                +]
                                ;
                                ; The exit routine saves all variables back in
                                ; memory, retrieves the registers and puts a delay
                                ; in to reduce speed of display (variable).
                                ;
```

PRINTOUT

```
Z  FCD9   CB73       EXIT:   BIT    ?CURBIT,E     ; Turn cursor on?
Z  FCDB   2003               JRNZ   ?..L1    ; No.
   FCDD   CD FD19            CALL   SETCSR   ; Turn cursor back on.
   FCE0   78         ..L1:   MOV    A,E
   FCE1   32 FE57            STA    MODE
   FCE4   7A                 MOV    A,D
   FCE5   32 FE56            STA    CC
   FCE8   78                 MOV    A,B
   FCE9   32 FE55            STA    LC
   FCEC   22 FE59            SHLD   CURSOR
   FCEF   E1                 POP    H
   FCF0   D1                 POP    D
   FCF1   C1                 POP    B
   FCF2   CD FE45            CALL   DELAY
   FCF5   79                 MOV    A,C      ; Return the char. to A reg.
   FCF6   C9                 RET
                     ;
                     ; This subroutine clears the cursor from the
                     ; current position. If the character was already
                     ; flashing and/or black on white (as indicated
                     ; by the bits in Reg. E) then the character is left
                     ; as flashing and/or BOW.
                     ;
   FCF7   CD FD39    CLRCSR: CALL   ADDOFF   ; Point to bits in control
                                             ;    section of memory.
Z  FCFA   CB63               BIT    ?AFSBIT,E     ; Already flashing?
Z  FCFC   2804               JRZ    ?..L1    ; No.
Z  FCFE   CBA3               RES    ?AFSBIT,E     ; Reset mode bit.
Z  FD00   1802               JMPR   ?..L2    ; Leave flashing.
Z  FD02   CBA6       ..L1:   RES    ?FLASH,M      ; Stop flashing.
Z  FD04   CB4E       ..L2:   BIT    ?CHUNK,M      ; Is current character
                                             ;    chunky?
Z  FD06   2804               JRZ    ?..L3    ; No.
   FD08   CD FD3F            CALL   DECOFF   ; Yes. Can't be BOW so point
                                             ;   to normal memory and retn.
   FD0B   C9                 RET
   FD0C   CD FD3F    ..L3:   CALL   DECOFF
Z  FD0F   CB6B               BIT    ?ABWBIT,E     ; Already BOW?
Z  FD11   2803               JRZ    ?..L4
Z  FD13   CBAB               RES    ?ABWBIT,E     ; Yes.
   FD15   C9                 RET
Z  FD16   CBBE       ..L4:   RES    ?BOW,M   ; No, stop BOW.
   FD18   C9                 RET
                     ;
                     ; This subroutine sets up the cursor by turning
                     ; on the flashing and BOW (inverse video).
                     ; Also checks if the character that was there
                     ; was flashing or BOW. If so sets bits in the 'mode'
                     ; register (Reg. E) so that CLRCSR
                     ; can reset the character properly.
                     ;
   FD19   CD FD39    SETCSR: CALL   ADDOFF
Z  FD1C   CB46               BIT    ?FLASH,M      ; Is character flashing?
Z  FD1E   2802               JRZ    ?..L1    ; No.
Z  FD20   CBE3               SET    ?AFSBIT,E     ; Yes, so remember it.
Z  FD22   CBC6       ..L1:   SET    ?FLASH,M      ; Make it flash anyway.
Z  FD24   CB4E               BIT    ?CHUNK,M      ; Chunky?
Z  FD26   2804               JRZ    ?..L2    ; No.
   FD28   CD FD3F            CALL   DECOFF   ; Yes, can't be BOW.
   FD2B   C9                 RET
   FD2C   CD FD3F    ..L2:   CALL   DECOFF
Z  FD2F   CB7E               BIT    ?BOW,M   ; Is character BOW?
Z  FD31   2802               JRZ    ?..L3
Z  FD33   CBEB               SET    ?ABWBIT,E     ; Yes, remember it.
Z  FD35   CBFE       ..L3:   SET    ?BOW,M   ; Inverse video.
   FD37   C9                 RET
                     ;
                     ; Routine adds OFFSET to the current cursor
                     ; position so that the control bit section can
                     ; be looked at.
                     ;
   FD38   C5         ADDOFF: PUSH   B
   FD39   01 0400            LXI    B,OFFSET
   FD3C   09                 DAD    B        ; CURSOR := CURSOR + OFFSET
   FD3D   C1                 POP    B
   FD3E   C9                 RET
                     ;
   FD3F   C5         DECOFF: PUSH   B        ; Inverse of DECOFF.
   FD40   01 0400            LXI    B,OFFSET
   FD43   B7                 ORA    A        ; Clear carry.
Z  FD44   ED42               DSBC   ?B; CURSOR := CURSOR - OFFSET
   FD46   C1                 POP    B
   FD47   C9                 RET
   FD48   71         NORM:   MOV    M,C      ; Get the character.
Z  FD49   CB53               BIT    ?FSHBIT,E     ; Make it flash?
Z  FD4B   280A               JRZ    ?..L0    ; No.
   FD4D   CD FD38            CALL   ADDOFF   ; Yes.
Z  FD50   CBC6               SET    ?FLASH,M
   FD52   CD FD3F            CALL   DECOFF
Z  FD55   1808               JMPR   ?..L1
   FD57   CD FD38    ..L0:   CALL   ADDOFF   ; Stop flashing.
Z  FD5A   CBA6               RES    ?FLASH,M
   FD5C   CD FD3F            CALL   DECOFF
Z  FD5F   CB5B       ..L1:   BIT    ?CHKBIT,E     ; Make it chunky?
Z  FD61   2010               JRNZ   ?..L2    ; Yes, bypass BOW.
   FD63   CD FD38            CALL   ADDOFF   ; No, so ensure it's not.
Z  FD66   CB8E               RES    ?CHUNK,M
   FD68   CD FD3F            CALL   DECOFF
Z  FD6B   CB4B               BIT    ?BOWBIT,E     ; Make it BOW?
Z  FD6D   280C               JRZ    ?..L3    ; No.
Z  FD6F   CBFE               SET    ?BOW,M   ; Yes.
Z  FD71   1808               JMPR   ?..L3
   FD73   CD FD38    ..L2:   CALL   ADDOFF
Z  FD76   CBCE               SET    ?CHUNK,M
   FD78   CD FD3F            CALL   DECOFF
                     ;
                     ; Now check if at end of line. If so perform
                     ; CR/LF sequence.
                     ;
   FD7B   3E3F       ..L3:   MVI    A,LL     ; Line Length.
   FD7D   BA                 CMP    D        ; At end of line?
Z  FD7E   2803               JRZ    ?..L4    ; Yes. New line.
   FD80   14                 INR    D        ; No. CC := CC+1
   FD81   23                 INX    H        ; CURSOR := CURSOR+1
   FD82   C9                 RET
   FD83   CD FD8A    ..L4:   CALL   CR
   FD86   CD FD9C            CALL   LF
   FD89   C9                 RET
   FD8A   C5         CR:     PUSH   B
   FD8B   0600               MVI    B,0      ; Clear B.
   FD8D   4A                 MOV    C,D      ; Put CC into Reg. C.

   FD8E   B7                 ORA    A        ; Clear carry.
Z  FD8F   ED42               DSBC   ?B       ; CURSOR := CURSOR-CC
                                             ;   (HL := HL-BC)
   FD91   C1                 POP    B
   FD92   1600               MVI    D,0      ; CC := 0
   FD94   C9                 RET
                     ;
   FD95   1600       HOME:   MVI    D,0      ; CC := 0
   FD97   42                 MOV    B,D      ; LC := 0
   FD98   21 E800            LXI    H,MEM    ; Top left of screen.
   FD9B   C9                 RET
                     ;
   FD9C   3E0F       LF:     MVI    A,LINES
   FD9E   B8                 CMP    B        ; LC = LINES? (On last line?)
Z  FD9F   2004               JRNZ   ?..L1    ; No.
   FDA1   CD FDE3            CALL   SCROLL   ; YES.
   FDA4   C9                 RET
   FDA5   04         ..L1:   INR    B        ; LC := LC+1
   FDA6   C5                 PUSH   B
   FDA7   01 0040            LXI    B,LL+1   ; (B will be 0, C will be LL+1)
   FDAA   09                 DAD    B        ; CURSOR := CURSOR + LL
                                             ;   (HL := HL+BC)
   FDAB   C1                 POP    B
   FDAC   C9                 RET
                     ;
   FDAD   AF         BS:     XRA    A        ; Clear A.
   FDAE   BA                 CMP    D        ; At front of line?
   FDAF   C8                 RZ              ; Yes, finish.
   FDB0   15                 DCR    D        ; CC := CC-1
   FDB1   2B                 DCX    H        ; CURSOR := CURSOR-1
   FDB2   C9                 RET
                     ;
   FDB3   3E3F       FS:     MVI    A,LL
   FDB5   BA                 CMP    D        ; At end of line?
   FDB6   C8                 RZ              ; Yes.
   FDB7   14                 INR    D        ; CC := CC+1
   FDB8   23                 INX    H        ; CURSOR := CURSOR+1
   FDB9   C9                 RET
                     ;
                     ; Moves cursor up one line.  When cursor
                     ; reaches the top line then scrolls down.
                     ;
   FDBA   AF         UP:     XRA    A
   FDBB   B8                 CMP    B        ; At top line?
Z  FDBC   2004               JRNZ   ?..L1    ; No.
   FDBE   CD FE14            CALL   DSCRLL   ; Yes, scroll down.
   FDC1   C9                 RET
   FDC2   05         ..L1:   DCR    B        ; LC := LC-1
   FDC3   C5                 PUSH   B
   FDC4   01 0040            LXI    B,LL+1
   FDC7   B7                 ORA    A
Z  FDC8   ED42               DSBC   ?B       ; CURSOR := CURSOR-LL
   FDCA   C1                 POP    B
   FDCB   C9                 RET
                     ;
                     ; Clear screen by filling with blanks. Also
                     ; clears control bit section of memory.
                     ;
   FDCC   C5         FF:     PUSH   B
   FDCD   D5                 PUSH   D
   FDCE   E5                 PUSH   H
   FDCF   21 E800            LXI    H,MEM    ; Start of memory.
   FDD2   11 E801            LXI    D,MEM+1  ; Destn. of 1st blank.
   FDD5   01 07FF            LXI    B,2*OFFSET-1     ; Length to shift.
   FDD8   3620               MVI    M,' '
Z  FDDA   EDB0               LDIR   ?; DO IT!!!
   FDDC   E1                 POP    H
   FDDD   D1                 POP    D
   FDDE   C1                 POP    B
   FDDF   CD FD95            CALL   HOME     ; Set up cursor.
   FDE2   C9                 RET
                     ;
                     ; Scrolls up by shifting all lines
                     ; up by 1 then blank filling the bottom
                     ; line. Does the same for the control bits in
                     ; upper memory.
                     ;
                     ; Does this by shifting the first character of
                     ; second line to first position in first (top)
                     ; line, then incrementing pointers.
                     ;
   FDE3   C5         SCROLL: PUSH   B
   FDE4   D5                 PUSH   D
   FDE5   E5                 PUSH   H
   FDE6   21 E840            LXI    H,MEM+LL+1        ; Start of 2nd line.
   FDE9   11 E800            LXI    D,MEM    ; Start of top line.
   FDEC   01 03C0            LXI    B,OFFSET-(LL+1) ; Length.
Z  FDEF   EDB0               LDIR?
   FDF1   21 EC40            LXI    H,MEM+OFFSET+LL+1 ; Now the control bits

   FDF4   11 EC00            LXI    D,MEM+OFFSET
   FDF7   01 03C0            LXI    B,OFFSET-(LL+1)
Z  FDFA   EDB0               LDIR?
   FDFC   21 EBC0            LXI    H,MEM+OFFSET-(LL+1) ; Clear last line.
   FDFF   3E20               MVI    A,' '
   FE01   0640               MVI    B,LL+1   ; Line length.
   FE03   77         ..L1:   MOV    M,A
   FE04   23                 INX    H
Z  FE05   10FC               DJNZ   ?..L1    ; Repeat until done.
                     ;              ;Clear last line of control bits.
   FE07   21 EFC0            LXI    H,MEM+2*OFFSET-(LL+1)
   FE0A   0640               MVI    B,LL+1
   FE0C   77         ..L2:   MOV    M,A
   FE0D   23                 INX    H
Z  FE0E   10FC               DJNZ   ?..L2
   FE10   E1                 POP    H
   FE11   D1                 POP    D
   FE12   C1                 POP    B
   FE13   C9                 RET
                     ;
                     ; Similar to SCROLL, but scrolls down.  Starts
                     ; by shifting last character of 2nd last line into
                     ; last character of last line.
                     ;
   FE14   C5         DSCRLL: PUSH   B
   FE15   D5                 PUSH   D
   FE16   E5                 PUSH   H
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PRINTOUT

```
   FE17   21 E8BF             LXI    H,MEM+OFFSET-(LL+1)-1
   FE1A   11 EBFF             LXI    D,MEM+OFFSET-1
   FE1D   01 03C0             LXI    B,OFFSET-(LL+1)
Z  FE20   EDB8                LDDR?
   FE22   21 EFBF             LXI    H,MEM+2*OFFSET-(LL+1)-1
   FE25   11 EFFF             LXI    D,MEM+2*OFFSET-1
   FE28   01 03C0             LXI    B,OFFSET-(LL+1)
Z  FE2B   EDB8                LDDR?
   FE2D   21 E800             LXI    H,MEM
   FE30   3E20                MVI    A,' '
   FE32   0640                MVI    B,LL+1
   FE34   77           ..L1:  MOV    M,A
   FE35   23                  INX    H
Z  FE36   10FC                DJNZ   ?..L1
   FE38   21 EC00             LXI    H,MEM+OFFSET
   FE3B   0640                MVI    B,LL+1
   FE3D   77           ..L2:  MOV    M,A
   FE3E   23                  INX    H
Z  FE3F   10FC                DJNZ   ?..L2
   FE41   E1                  POP    H
   FE42   D1                  POP    D
   FE43   C1                  POP    B
   FE44   C9                  RET
                       ;
                       ; Causes a delay so that the speed of the display
                       ; can be reduced so that it is more readable.
                       ; The value in location DELVAL can be changed to
                       ; change the speed. 'FF' is slowest.
                       ;
   FE45   3A FE58      DELAY: LDA    DELVAL
   FE48   FE00                CPI    0
   FE4A   C8                  RZ                  ; No delay.
   FE4B   C5                  PUSH   B
   FE4C   47                  MOV    B,A
   FE4D   E3           ..DEL: XTHL   ; Waste time.
   FE4E   E3                  XTHL
   FE4F   E3                  XTHL
   FE50   E3                  XTHL
Z  FE51   10FA                DJNZ   ?..DEL
   FE53   C1                  POP    B
   FE54   C9                  RET
                       ;
                       ;
   FE55   00           LC:     .BYTE  0           ; Line Count.
   FE56   00           CC:     .BYTE  0           ; Character Count.
   FE57   00           MODE:   .BYTE  0           ; Mode of operation.
   FE58   00           DELVAL: .BYTE  0           ; Value for delay.
   FE59   E800         CURSOR: .WORD  MEM         ; Cursor position.

***** SYMBOL TABLE *****

ABWBIT 0005    ADDOFF FD38    AFSBIT 0004    BASE   FC00
BEGIN  FC06    BELLCH 0007    BOW    0007    BOWBIT 0001
BOWCH  0012    BS     FDAD    BSCH   0008    CC     FE56
CHKBIT 0003    CHKCH  0014    CHUNK  0001    CHUNKY FC28
CLRCSR FCF7    CONTRL FC34    CR     FDBA    CRCH   000D
CURBIT 0006    CURCH  0015    CURSOR FE59    DECOFF FD3F
DELAY  FE45    DELVAL FE58    DSCRLL FE14    EXSBIT 0000
EXIT   FCD9    EXTCH  0005    EF     FDCC    FFCH   000C
FLASH  0000    FLSCH  0013    FS     FDB3    FSCH   0009
FSHBIT 0002    HMCH   0011    HOME   FD95    LC     FE55
LF     FD9C    LFCH   000A    LINES  000F    LL     003F
MEM    E800    MODE   FE57    NORM   FD49    NORMAL FC22
OFFSET 0400    SCROLL FDE3    SETCSR FD19    TTYOUT FC03
UP     FDBA    VDUCO  FC00    VFCH   0008    ZTSTS  F520
ZTTYI  F61F    ZTTYO  F490

90 ERRORS WERE DETECTED *****
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HEX DUMP

```
FC00  C3 06 FC C3 90 F4 C5 D5 E5 3A 55 FE 47 3A 56 FE
FC10  57 3A 57 FE 5F 2A 59 FE 79 CB 58 20 0E FE 20 DA
FC20  34 FC CD F7 FC CD 48 FD C3 D9 FC FE 14 20 F3 CB
FC30  9B C3 D9 FC CB 43 28 09 FE 05 20 E6 CB 93 C3 D9
FC40  FC FE 05 20 05 CB C3 C3 D9 FC FE 14 20 05 CB DB
FC50  C3 D9 FC CD F7 FC FE 0D 20 06 CD 8A FD C3 D9 FC
FC60  FE 0A 20 06 CD 9C FD C3 D9 FC FE 12 20 0E CB 4B
FC70  28 05 CB 8B C3 D9 FC CB CB C3 D9 FC FE 13 20 0F
FC80  CB 53 28 05 CB 93 C3 D9 FC CB D3 C3 D9 FC FE 07
FC90  20 06 CD 03 FC C3 D9 FC FE 08 20 06 CD AD FD C3
FCA0  D9 FC FE 09 20 06 CD B3 FD C3 D9 FC FE 0C 20 05
FCB0  CD CC FD 18 24 FE 0B 20 05 CD BA FD 18 1B FE 11
FCC0  20 05 CD 95 FD 18 12 FE 15 20 0E CB 73 28 05 CB
FCD0  B3 C3 D9 FC CB F3 C3 D9 FC CB 73 20 03 CD 19 FD
FCE0  78 32 57 FE 7A 32 56 FE 7B 32 55 FE 22 59 FE E1
FCF0  D1 C1 CD 45 FE 79 C9 CD 38 FD CB 63 28 04 CB A3
FD00  18 02 CB 86 CB 4E 28 04 CD 3F FD C9 CD 3F FD CB
FD10  6B 28 03 CB AB C9 CB BE C9 CD 38 FD CB 46 29 02
FD20  CB E3 CB C6 CB 4E 28 04 CD 3F FD C9 CD 3F FD CB
FD30  7E 29 02 CB EB CB FE C9 C5 01 00 04 09 C1 C9 C5
FD40  01 00 04 B7 ED 42 C1 C9 71 CB 53 28 0A CD 38 FD
FD50  CB C6 CD 3F FD 18 08 CD 38 FD CB 86 CD 3F FD CB
FD60  5B 20 10 CD 38 FD CB 8E CD 3F FD CB 4B 29 0C CB
FD70  FE 19 08 CD 38 FD CB CE CD 3F FD 3E 3F BA 29 03
FD80  14 23 C9 CD 8A FD CD 9C FD C9 C5 06 00 4A B7 ED
FD90  42 C1 16 00 C9 16 00 42 21 00 E8 C9 3E 0F B8 20
FDA0  04 CD E3 FD C9 04 C5 01 40 00 09 C1 C9 AF BA C8
FDB0  15 28 C9 3E 3F BA C8 14 23 C9 AF B8 20 04 CD 14
FDC0  FE C9 05 C5 01 40 00 B7 ED 42 C1 C9 C5 05 E5 21
FDD0  00 E8 41 01 E8 01 FF 07 36 20 ED B0 E1 D1 C1 CD
FDE0  95 FD C9 C5 D5 E5 21 40 E8 11 00 E8 01 C0 03 ED
FDF0  B0 21 40 EC 11 00 EC 01 C0 03 ED B0 21 C0 EB 3E
FE00  20 06 40 77 23 10 FC 21 C0 EF 06 40 77 23 10 FC
FE10  E1 D1 C1 C9 C5 D5 E5 21 BF EB 11 FF EB 01 C0 03
FE20  ED B8 21 BF EF 11 FF EF 01 C0 03 ED B8 21 00 E8
FE30  3E 20 06 40 77 23 10 FC 21 00 EC 06 40 77 23 10
FE40  FC E1 D1 C1 C9 3A 58 FE FE 00 C8 C5 47 E3 E3 E3
FE50  E3 10 FA C1 C9 00 00 00 00 00 E8
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Fast Fourier Transforms

You may have heard of Fourier Analysis, but more often than not explanations of what this is all about are drowned in mathematics. E.J. Hughson describes how it's done electronically.

MUCH OF ELECTRONICS is concerned with the processing of signals of some sort or another. It is only natural then, that a lot of effort has gone into analysing these signals. On one hand one must know certain basic things about the signals in order to be able to build useful circuits. On the other hand, investigating signal properties with no particular applications in mind, has led to various useful results that later helped to simplify, improve or introduce new circuit designs. The field of study concerning signals is known, naturally enough, as "Signal Analysis".

In order to go deeply into some of the theory in this field, some pretty heavy math must be employed. However, it is quite easy to understand the majority of the material intuitively, and besides, that's a much more entertaining approach.

Think of a Signal . . .

How do most of us think of signals? Probably "signals" conjures up images of a scope with a waveform on it. Let's use this waveform as an example — suppose it's a 1kHz triange wave. What characteristics does this waveform have? It is a voltage (say) varying up and down periodically, thus it has an "instantaneous amplitude" at any instant in time. This is what we see on the scope, an amplitude versus time graph. We can also say that the waveform has a characteristic we call frequency. Most of us use the term frequency to mean the basic frequency of repetition of the entire waveform. Why this distinction? Here's where a theoretical concept must be just accepted if we're not to get submerged in abstraction.

Fourier Analysis

It is convenient to think of a *sine* wave as the "purest" waveform, and use this kind of wave as a basis for study of other waveforms. It has been found possible to make any other kind of waveform from a combination (sum) of sinusoidal waves of various frequencies and amplitudes. This is analogous to being able to combine the three basic colours of light, green, red, blue to form other colours.

In fact we have cheated a little bit; we should correct the above to say that any kind of waveform can be made from combinations of sine *and cosine* waves of various frequencies and amplitudes, a cosine wave being simply a sine wave but one quarter wave ahead.

Ok, so what? The next step is to introduce a graph of amplitude versus frequency. Figure 2 is an example in which we plot the "frequency content" of a sine wave of amplitude 1 and frequency 1kHz. There is only one point on the graph, because as we said before, a sine wave is considered to be "pure" or only one frequency.

So how about our triangle wave? What does its frequency content look like? Figure 3 shows that the frequency content is quite complex.

The graph shows that htere is a large content of the fundamental frequency, with decreasing content of odd order harmonics.

The process of converting the "time" waveform to the "frequency" graph is called the Fourier Transform. The reverse process is called the Inverse Fourier Transform.

In the case of a repetitive waveform (such as the triangle wave) the Fourier Transform yields a frequency content graph which has non-zero points only at multiples of the fundamental frequency. Thus, a series of numbers may be used rather than a graph to represent this information. For the triangle wave, the series is:

.81 x (1kHz sine — .09 x 3kHz sine) + .032 x (5kHz sine) — .017 (7kHz sine) + . . .

For a 1kHz, ±1V square wave the series is:

1.27 x (1kHz sine) + 424 x (3kHz sine) + .255 x (5 kHz sine + . . .

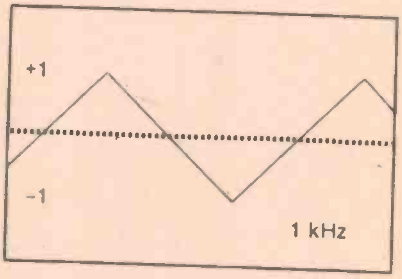


Fig. 1. Scope trace showing triangle wave

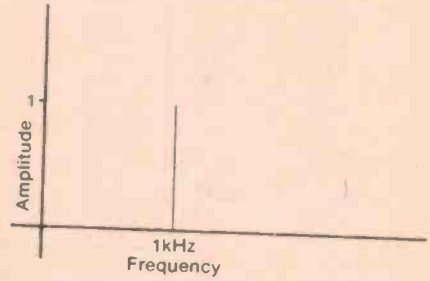


Fig. 2. Amplitude vs. frequency plot of 1KHz sine wave

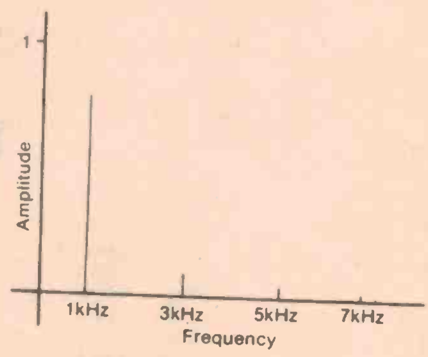


Fig. 3. Amplitude vs. frequency plot for triangle wave.

On the other hand, you are no doubt already familiar with frequency plots of noise, and particularly audio equipment response curves, which are nothing more than the frequency content graphs of the output with "all frequencies" fed in. (Fig. 4.) Note that the frequency plots in this example are continuous rather than just the odd point here and there.

Doing It

A picture of actually doing the transform is shown in Fig. 5. The "transformer" could be a person with a piece of paper working out the graph or more usefully a machine doing the work. Suppose a computer was used to do the task on an input waveform, how would it do it?

Automatic Transform

If an analog waveform is sampled at regular intervals, we get what is called a discrete time series — discrete because it is a series of separate points and time series because we have something changing with time. Figure 6 shows a sampled sine wave displayed on an oscilloscope.

If we were to measure the level of each of the points we would get a series of numbers. If we do this electronically using analog-to-digital conversion we get a series of digital numbers representing the discrete time series. OK so far? It is this set of digital samples which a Fourier Transform (or "Discrete" FT in this case) takes and turns into information directly showing the frequency or harmonic content of all signals which make up the original time series. The technique shows any components from DC to half the sampling frequency. (It is not possible to obtain any frequencies higher than this since it would contradict a fundamental rule concerning sampled waveforms, established by Nyquist.)

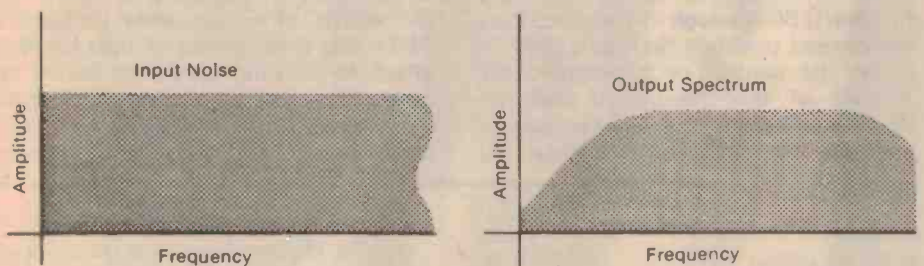


Fig. 4. Noisy amplitude vs. frequency spectra

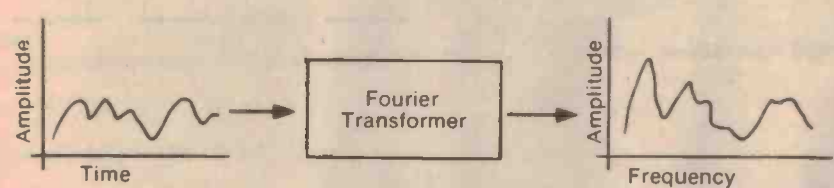


Fig. 5. The transform process

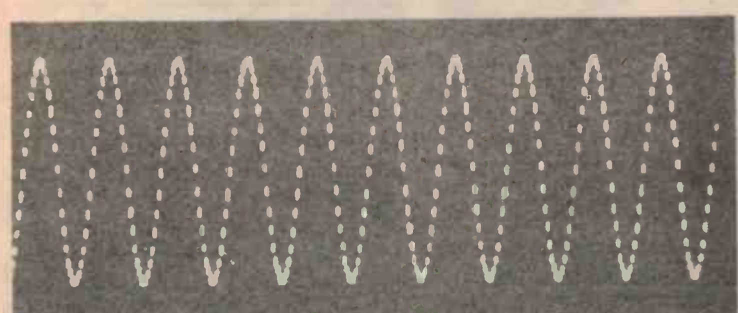


Fig. 6. Analog sine wave sampled at intervals

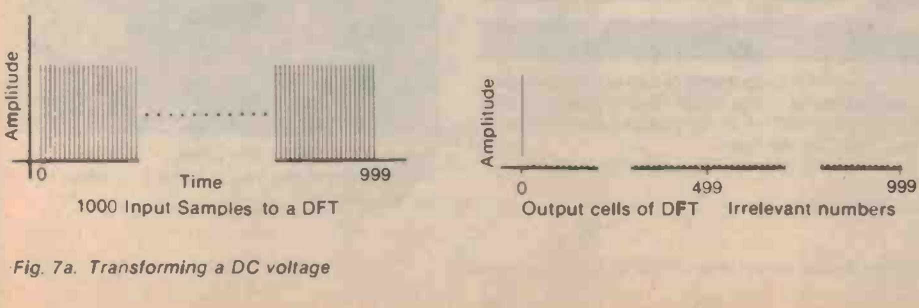


Fig. 7a. Transforming a DC voltage

Adding New Frequencies And Filtering

If the output numbers undergo an inverse DFT we get a series of numbers outputted which represent the original waveform.

By taking a waveform and analysing it using a DFT, then performing an inverse DFT on the output we can arrive back at the original waveform. A filter can be made by performing an inverse DFT only on those numbers representing the frequencies which are required.

Similarly, by adding numbers to represent new frequencies before performing an inverse transform extra frequencies will be present in the output time series (and after digital-analog conversion, in the output waveform).

The DFT does not work on analog or continuous information: only on a set of numbers representing the instantaneous values of a portion of a waveform. The result is a set of numbers corresponding to the frequency content of the waveform. Not only does DFT give us each frequency present in the original waveform, it also gives the relative phase and amplitude of each frequency component.

By performing a power calculation on the output frequencies a power spectrum may be obtained. Of course the more numbers or samples which are input to the DFT, the more information is available at the output. However, for a fixed set of numbers is outputted.

Interpreting The Numbers on the Output

To illustrate how outputted numbers are interpreted consider a DFT performed on a portion of a time series containing 100 samples. The 1000 numbers inputted will have various arithmetic operations performed on them and 1000 numbers (known as frequency cells) will be outputted. Of these 1000 cells only the first 500, representing the frequency range, will have any real meaning.

For example, suppose all input numbers representing samples from an anolog-to-digital converter are the same. (This would mean that a constant DC voltage would have had to have been applied to the converter.) Of the 1000 numbers obtained by the forward transform, only the first would have a value other than zero, since this first number is reserved for the DC content of the input series and all the energy of the input is in the form of DC. (See Fig 7a).

Suppose now the output of an analog-to-digital converter is being sampled at 1000 samples/sec, also suppose a sine wave of 1Hz is applied to the input of the converter. One thousand numerical samples or one second's worth of data is collected. If these 1000 numbers are used as the input of a Fourier Transform, then of the 500 numbers output, the first will have zero value (DC) but the second, reserved for frequency of 1Hz, will have maximum value (Fig 7b). All others will have zero value also.

If the frequency of the sine wave inputted to the converter is now increased to 2Hz and the 1000 samples at 1000/sec are collected, the Fourier Transform processor output will consist of zeroes in all 500 numbers except the third corresponding to 2Hz (Fig 7c). The output numbers are the cells, cell 0 to cell 499 in this case being reserved for frequencies of 0 (DC) to 499Hz. Figure 7 gives a graphic representation of these inputs and outputs. (NB, since the output cells are numbered starting from zero so also are the input samples, for clarity.)

Cell Number And Frequency

The example given above assumes a sampling frequency of one thousand per second so that with a 1000 point transformer the cell numbers automatically correspond to the frequencies they represent in the input time series. It is of course, not always practical to have the sampling frequency tied to the number of samples in the DFT as rigorously as this. But it is a very simple matter to obtain the actual frequency to which a cell output corresponds. This is obtained by the following relationship:

Frequency corresponding to Cell Number (1st cell = 0)

$$= \frac{\text{Cell No.} \times \text{Sampling Frequency}}{\text{No. of points in FFT}}$$

The outputs depicted by Figure 7 are of course idealized. In practice slight errors will occur due to the finite number of bits used in the arithmetic of the calculation.

As so far discussed, the Discrete Fourier Transform both forward and reverse has been put in terms of numbers which are inputted, the calculation process and numbers outputted. The calculation process is very involved and tedious but could be carried out by a computer or even a hand calculator (if you had the time and patience). To perform a 1000 point transform, it would require over 2 million discrete calculations, tedious indeed!

Fast Transform

The Fash Fourier Transform technique is able to reduce the calculations of a similar size transform to about 22,000 which is a significant reduction in the number of calculations and hence the amount of computer time. (Still a little much for the average pocket calculator, however!) So although digital computers can be used to obtain the results of FFTs under the control of a program, the amount of time needed to load the samples into the machine, to access and compute the data and to output the results makes even a general purpose digital computer an impractical signal analyser.

For this reason, analysers using dedicated hardware capable of only performing FFTs are a far more practical proposition. Such analysers are capable of taking an analog wave form input performing analog-to-digital conversions on it, sampling accordingly, loading the desired number of samples into a dedicated FFT calculator and presenting the results to some display for presentation. See Fig. 8.

The instruments using FFT analysers usually come complete with accumulators and memories so that frequency spectra may be integrated and compared to each other. Integrating (or summing) the results of continuously computed FFTs over some period of time has the effect of showing up signals buried in noise. No matter how deeply the signal is buried the cell or cells which the signal occupies will eventually build up over

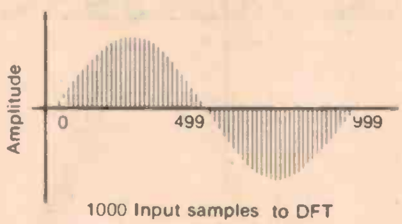
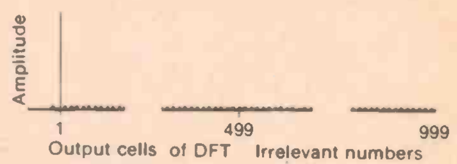


Fig. 7b. Transformation of 1Hz sine wave.



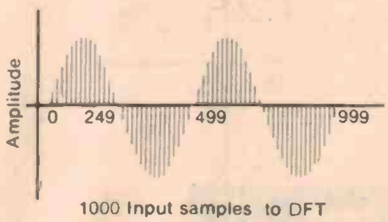
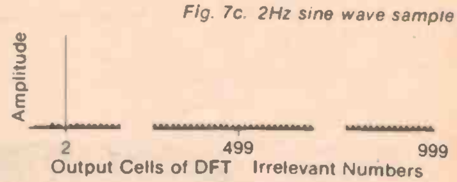
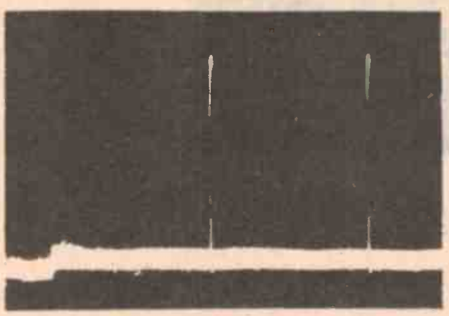
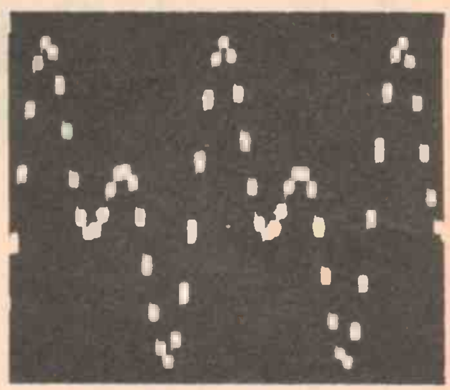


Fig. 7c. 2Hz sine wave sample





Displayed FFT output with two cells only present, corresponding to the series input. Note lines are same height and the second twice as far from zero frequency as the first.



Original sampled times series — two sine waves with one twice the frequency of the other, both same aplitude.

Fig. 9. Actual inputs and output of a FFT processor

all the other cells where the noise will be randomly distributed. This technique is now used, for example, in submarine detection where the noise from the vessel is discriminated over the sea noise by continuous integration of FFT results.

Figure 9 illustrates a sampled wave form consisting of 2 sine waves of equal amplitude and the display results of an FFT performed on a set of numerical samples taken from the time series. The display has its own amplitude graduations and the two lines represent the energy in the cells corresponding to the frequencies of the 2 sine waves. (Note no other lines appear as all other cell values are zero). The display is produced by continuously outputting the cell numbers from FFT result to a digital-to-analog converter and including the amplitude graduations.

The Mathematics

This article is not the place to consider the in depth mathematical theory necessary to fully understand the processes which form part of the Fourier transform. Numerous books and technical articles now exist on the subject. However the basic operation and its adaptability to digital hardware is quite easily understood.

One major constraint on an FFT processor is that the number of samples inputted to it cannot be varied completely. With most processors, the number of samples in fact have to be a power to 2, e.g., 32 or 54 or 256 or 1024. The more samples taken then the larger the range of frequencies which can be determined or alternatively the narrower the band width between cells. However, the calculation process takes longer. In practice sample blocks of 512, 1024, 2048 are amongst the most commonly chosen as these offer a compromise between frequency range and computation time.

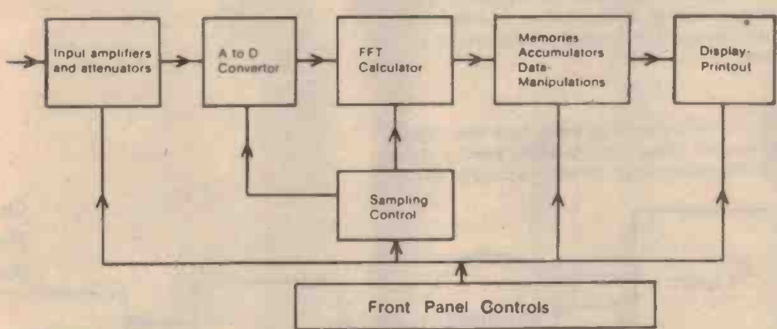


Fig. 8. Typical FFT Analyser basic functions

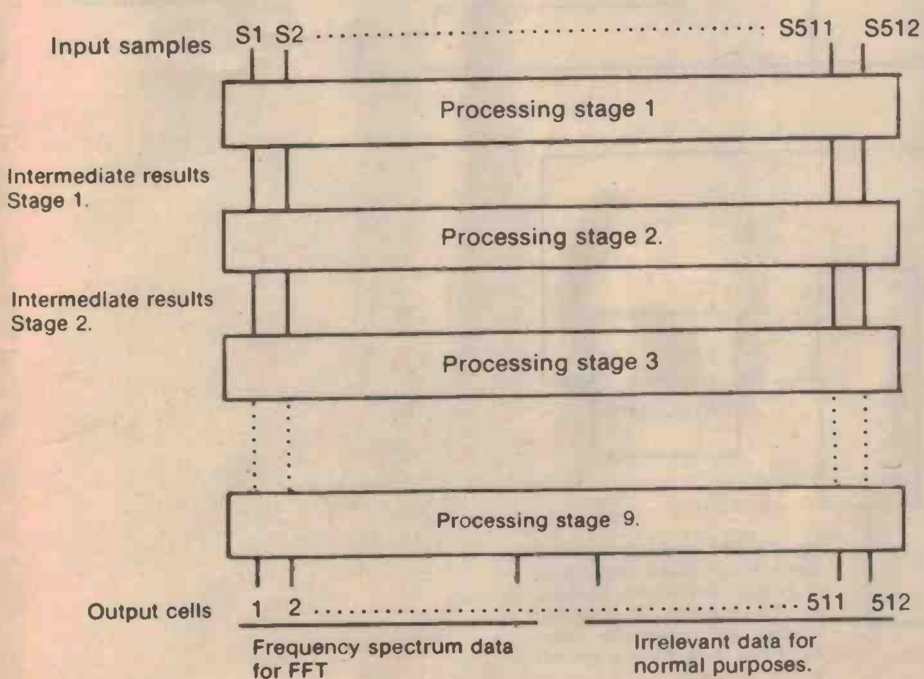


Fig. 10. FFT Processing stages for 512 point transform

Essentially in the case of a Forward Transform the samples from the time series are loaded into a buffer and combinations of samples are added and subtracted from each other, multiplied by trigonometrical values usually looked up from a Read Only Memory. This process is repeated using different combinations of samples and trigonometrical values. The number of processing stages is related to the number of samples, eg, if 2048 samples were inputted, then 11 processing stages are needed. (22^{11}=2048). If 512 samples were inputted, then 9 stages are required, etc. This is illustrated in outline by Fig. 10.

The advantage over the old 'conventional' method of computation is that with the conventional method the number of stages of calculation equals the number of samples. In a 512 point transform the process would be 512/9 or approximately fifty-five times shorter by using an FFT. In a continuous process where FFTs are being continuously computed, obviously a very real saving is made in terms of result presentation.

As mentioned earlier the FFT processing idea lends itself very easily to a dedicated machine and the idea of pipeline processing is used in most of these. Pipeline processing is used where a number of calculations in series are performed and where an unacceptably long delay result for the computing of an answer before the next inputs are applied. Figure 11 shows an arrangement where this is likely to happen.

In this example an adder precedes a multiplier followed by another adder. With no pipelining, no further inputs can be supplied until enough time is allowed for the results of previous input numbers to be stored away. However with a pipeline processor, (Fig. 12) latches are included in strategic places allowing sets of numbers to follow each other as though they were coming down a pipe. Thus after the first set of results have trickled through the latches, a much faster throughput of numbers will result.

This type of arrangement is very suitable in FFT processors since a large throughput of samples with much number crunching takes place.

Present & Future FFT Analysers.

Essentially an FFT processor (which is the heart of modern spectrum analysers, voice print identifiers, etc) usually consist of a memory which stores the samples and intermediate results and a processor which computes intermediate results. The total samples are stored internally in the memory and when the FFT process begins, the samples are taken in pairs, arithmetically operated on to form intermediate results and stored ready for the next level of processing. Two memories are sometimes used where samples and results are alternately read from one memory through the pipeline processor into the the other memory, where they are ready for the next level of processing. This technique saves still more time in computing FFTs. See Figure 13.

This article has only touched onto the now very broad field of FFT processing technology. The approach lends itself easily to band shifting, frequency zoom effects and other features made relatively easy with a digital system.

Until the 1970s few people knew of Fourier Transforms. At best the term would evoke a feeling of something obscure, very mathematical and having few, if any practical applications. But in recent years a whole new world of applications has been unleashed.

FFT techniques are today used for a variety of applications including extraction of signals burried deep in noise, sonar processing, spectrum analysis of compex waveforms, voice print analysis and the digital synthesis of music. Research is finding still more uses, such as in the oral synthesizing interface of talking computers. Some day you may be able to phone a computer and hold an intelligent conversation with it, obtaining such things as account balances, travel reservations, etc, with tonal expressions no different from those of a helpful person!

With the advent of bubble memories and the ever decreasing size but increasing complexity of micro circuits, it appears that the FFT processing field will expand to a point where it will soon be a part of every day life, a truly big step forward from just 10 years ago when the technique was not even heard of.

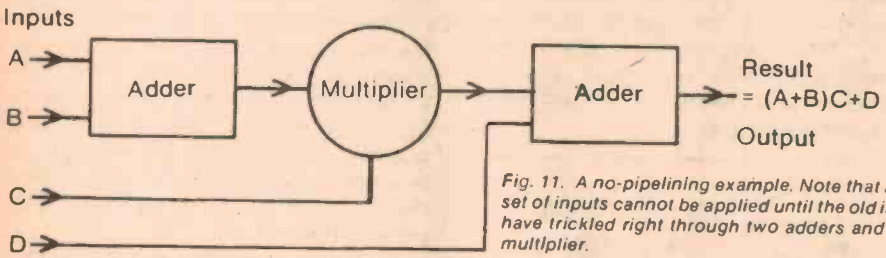
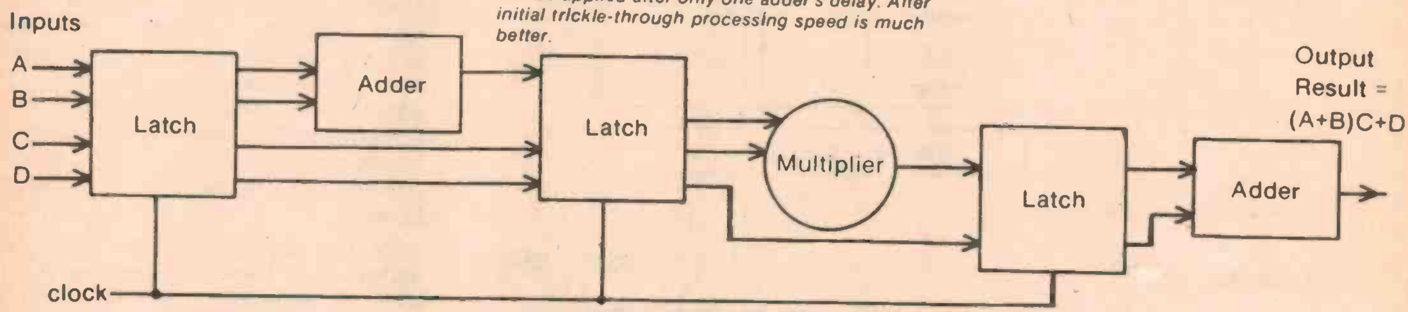


Fig. 11. A no-pipelining example. Note that a new set of inputs cannot be applied until the old inputs have trickled right through two adders and a multiplier.

Fig. 12. Pipelining arrangement, here new inputs can be applied after only one adder's delay. After initial trickle-through processing speed is much better.



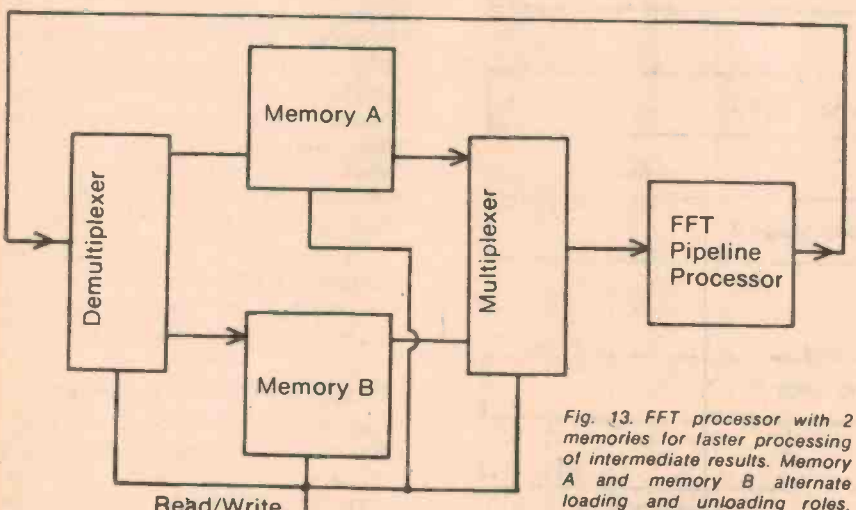


Fig. 13. FFT processor with 2 memories for faster processing of intermediate results. Memory A and memory B alternate loading and unloading roles. Input and output paths are not shown for clarity.

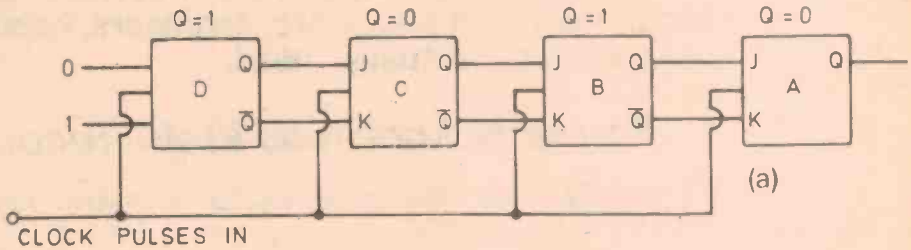
DIGITAL ELECTRONICS BY EXPERIMENT part 8

A SHIFT REGISTER is a set of flip-flops, each of which can be set by its PRESET terminal to store a 1 or 0, so that the whole set stores a "word" (complete number). For example, four flip-flops could store numbers such as 0101, 1000, 1101, and so on. In addition, we can apply clock pulses to all of the flip-flops and so cause the stored numbers to shift from one flip-flop to the next in line on each clock pulse; several designs make this possible in either direction (right-left shift).

Fig. 2 shows an example of this in action. We start with the number 1010 stored, so that LEDs on the B and D outputs will be lit. The input of the first flip-flop is connected with J=0; K=1, so that at the clock pulse its Q output will change to zero. The two outputs of the first flip-flop, however, are connected to the J and K inputs of the next flip-flop in line (compare the Johnson counter, which is very simply obtained from a shift register). With J=1 and K=0 on the second flip-flop, from the outputs of the first, the clock pulse will cause the output of flip-flop C to change from 0 to 1. Similarly, with Jb=0, Kb=1, flip-flop B is forced to change from 1 to 0, and flip-flop A is forced to change from 0 to 1. The effect is as if a zero had been forced in at the left-hand side and has caused all of the stored numbers to shift one place along.

A Simple Shift Register

Use the two 7476 J-K flip-flops (Fig. 2) on your blob-board to make up a four-stage shift register. Connect the clock inputs to one of the spare pads of the blob-board, and run a line from this pad to the output of the slow oscillator or the debounced switch. Blob short connecting wires from each Q output to the next J input, and from each Q output to the next K input. Blob a wire from Ja to the earth line, leaving Ka floating. Connect the reset pins to a reset line (a spare blob-pad) and then to the reset switch so that pressing the reset switch will earth the reset pins. Finish off by connecting LEDs and



CLOCK PULSE	QD	QC	QB	QA
0	1	0	1	0
1	0	1	0	1
2	0	0	1	0
3	0	0	0	1
4	0	0	0	0

(b)

Fig 1. A shift register made up from J-K flip-flops. (a) Arrangement of the flip-flops. (b) Truth table, showing the effect of clock pulses.

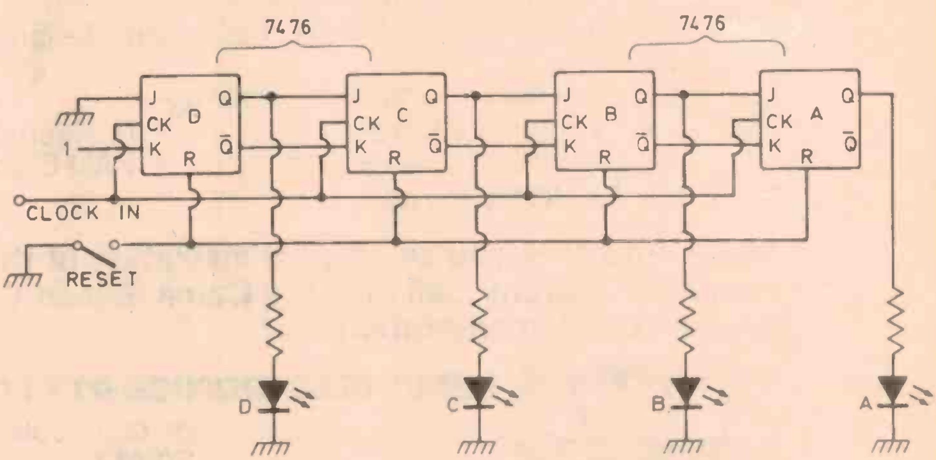


Fig 2. Connections of 7476 flip-flop to form a shift register on the 8-IC Blob-board.

resistors so that the state of each Q output can be read.

Now switch on. One or more of the LEDs may light, but can be extinguished by using the reset switch. Now set up a number by using the preset terminals. By temporarily bridging from each preset pin to earth, using a wire bridge, set two of the flip-flops to 1, preferably so that 1010 is stored. Next apply clock pulses and observe what happens; this is easier to follow if the debounced switch is used.

Now switch off, and disconnect Ja from earth. Connect Ja to Qd and Ka to $\bar{Q}$d. Switch on again, reset, and set to a display of 1010 again. Now apply clock pulses. What happens? Can you see the possible applications for storing a sequence of operations, such as a traffic lights sequence?

Types of Shift Register

The shift register made up using 7476s can be used as a PISO or SIPO type. PISO means parallel in, serial out, the information is set up on each flip-flop, perhaps at the same time, and is read out in sequence, one digit for each clock pulse. In a SIPO shift register (serial in, parallel out), a number of clock pulses equal to the number of flip-flops is applied at the same time as a varying signal (0 to 1) applied at the input J-K terminals, starting with an empty register. With the register filled, the voltages at the Q terminals can be read (using LEDs for example) in parallel. Each type is important; we need numbers in parallel form for operations such as addition, but in serial form for transmitting down a single wire, or for recording on tape. We can, of course, have SISO (serial in-serial out) and PIPO (parallel in- parallel out) shift registers, and a set of flip-flops can be arranged to act in any one of these ways.

The 7494 Shift Register

This has been chosen as one example (Fig. 3) of the very wide variety of shift registers that are available. Like most integrated shift registers, it is constructed using the clocked S-R type of flip-flops, but the action is the same as that of our J-K flip-flop model; the schematic of the IC is shown in Fig. 4. Four flip-flops are used, with a common clock to each, and a clear input which will reset each flip-flop. A serial input is also available.

The interesting feature of the 7494, however, is the gated parallel inputs labelled 1A, 2A, 1B, 2B and so on. These act through a set of gates on the preset inputs of the flip-flops, so that they are independent of the clock

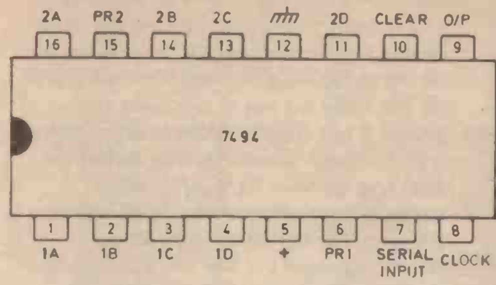


Fig 3. Pinouts of the 7494

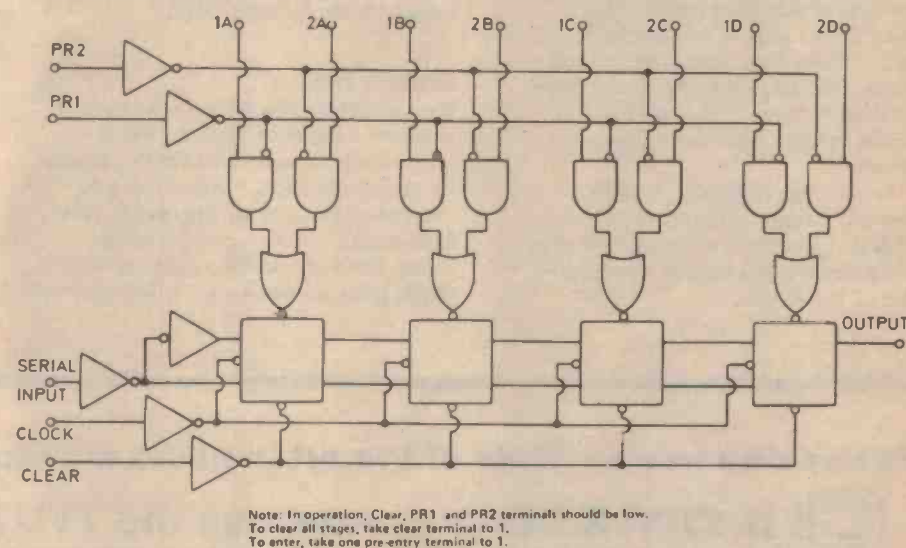


Fig 4. Schematic diagram of the 7494 shift register. Compare the number of flip-flops gates and inverters in this single chip with the number of packages needed to make this from 7400's and 7476's.

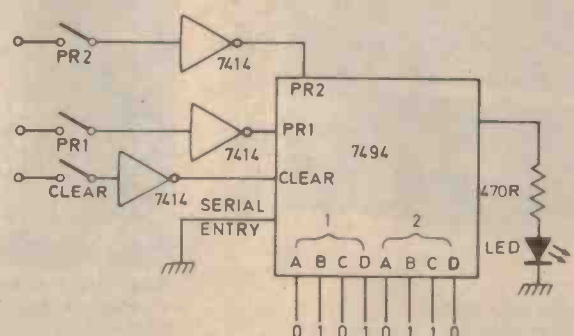


Fig 5. Connecting up the 7494 on the blob-board. Note that inverters have to be used on each switched line, as the preset and clear lines must be held at logic 0 for normal operation.

pulses. The gating is arranged so that either one or the other set of inputs can be "read" into the register. For example, imagine that the inputs with the 1 prefix are each connected to a signal input, 0 or 1, and that the inputs with the prefix 2 are each connected to another set of signals. We can use the pins marked preset 2 and preset 1 now to select which set of inputs is chosen and placed in the register.

Imagine that preset 1 is at logic 1 and the preset 2 is at logic 0. Because of the inverters connected to the preset inputs, all the inputs with the 1 prefix are gated through to the OR gates which control the flip-flop presets. Because all the inputs with the 2 prefix are gated out, there will be no input from these gates. The opposite process takes place if preset 2 is at logic 0 and preset 1 is at logic 1. Note that these inputs must be operated so that both do not enter at the same time. The inputs should remain at logic zero during normal operation.

The output from the register is from pin 9, and will consist of one bit, 0 to 1, for each clock pulse fed in to the clock input, and at the leading edge of the clock.

Blob-board Work

Connect the supply lines to the 7494, +5V to pin 5 and earth to pin 12. Now blob a connecting wire from the output of the debounced switch to clock input of the 7494 on pin 8. Connect the preset 1 pin (pin 6) to an inverter whose input is from a push-button switch so that this pin can be momentarily earthed; leave the other preset entry pin (pin 15) earthed. Now set up signals to enter on the 1-set of inputs, A, B, C, D on pins 1, 2, 3 and 4. For example, we can connect pins 1 and 3 to logic 1, and pins 2 and 4 to logic 0, so setting up the number 1010. This will be entered when the PR1 pin is momentarily set to 1 by the inverter and switch, and the flip-flops will be set up to the number 1010.

Detector Work

We can detect this only at the output, since we cannot connect to the Q outputs of the intermediate flip-flops, by connecting an LED and limiting resistor to the output pin, pin 9. Now blob a connection from the serial input, pin 7, to earth, so that as each clock pulse arrives a zero is fed into the first stage of the register. This ensures that the register stores 0000 after four clock pulses.

One Clock

Now switch on, and press the enter switch briefly. Use the clock switch to apply four clock pulses, and note the output on each pulse. The contents of the register should now be 0000, so that further clock pulses will not produce any "1" output. Another entry can be made by pressing the entry switch at any time. By connecting the second set of entry pins, and using the second pre-enter (PR2) pin, we can enter another number. Connect up the second set of entry pins (16, 14, 13, 11) to give another number, and connect up the PR2 (pin 15) terminal to the output of another spare inverter. Connect another push-button switch between the inverter input and the earth line, and try out the circuit again, entering the second number (after clearing) by pressing the enter switch momentarily. Check that this number is then read out at the output when the register is clocked.

CB COMMUNICATIONS

Minister Announces Changes

The Minister for Post and Telecommunications, Mr Tony Staley, announced a number of changes that would affect the CB radio service at the official opening of the second National Citizen's Radio Association National Convention held last month over 1st – 4th September.

The Federal Government would introduce changes to the Act and Regulations to establish the Citizen's Band Radio Service as a separate service, removing it from the category under which it is now operated – the Land Mobile Radio Service (Class C).

Mr Staley, in announcing these decisions, said that the rules and regulations for mass broadcasting, professional telecommunications and commercial land mobile services were inappropriate for CB.

Mr Staley also announced that regulations would shortly be introduced that would allow any owner of CB equipment to cover up to five sets on one licence for a single fee.

The two emergency channels, channel 5 on both 27 MHz and UHF, were announced as being reserved for the volunteer emergency services (such as CREST) and for travellers' assistance.

The Government is also planning to increase the number of UHF channels from 40 to 80 following the WARC conference next year. They are also looking at ways of restricting the import of non-licensable equipment and the sale of transmitting equipment to unlicenced persons.

The Minister also announced plans to call a meeting of manufacturers, retailers and CB'ers representatives to examine technical standards and performance specifications for CB equipment, particularly for use on UHF.

The restrictions on 'gain' antennas were to be revised and HF beams would be allowed in certain areas (mainly country), UHF gain antennas being given the OK.

In the discussion session following his speech at the opening of the NCRA Convention, Mr Staley said that the new RB14, amended as per the above suggestions and the pertinent W & T Regulations, would be pushed through as soon as possible and he hoped that the P & T Department would exercise 'administrative discretion' in the intervening period with regard to operators who may be running illegal installations under the new regulations but who would be quite legal under the foreshadowed changes.

Well, it seems that CB'ers have been granted a few concessions along the lines they have been clamouring for over the last twelve months, as foreshadowed at the first National Convention of the NCRA in September last year. It has taken some time and the changes are not what you'd call 'sweeping', but it is progress. More changes may come next year following the WARC 79 conference. It's going to be an interesting time.

NCRA Convention

The NCRA's second National Convention, held at Wrest Point in Hobart, was rather a flop as far as attendance goes. There was little to attract the 'ordinary' CB'er, apart from the Hotel, Casino and local tourist attractions, and there were even insufficient delegates to raise a quorum at the National Assembly!

Nevertheless, it was a great bun fight and both the NCRA and CREST (who held their National Convention simutaneously) managed to plough through their administrative work and get around to addressing themselves to some of the questions facing the CB Service and their respective organisations.

Harvey Milne, Director of President Electronics (Aust.) requested leave to address the National Council of CREST, which he was granted. In his address he told the Council that they should set themselves up as an organisation in their own right, separate to the NCRA and to foster more authority in the organisation. He said 'CREST should be prepared to work more closely with the industry in order to provide the sort of service the community requires'.

'At the present time, CB is regarded as somewhat of a toy and the emergency service provided by CREST is critical to the future of CB in Australia'. He said that CREST should 'clean up the image' of CB. He reminded them that the emergency service CREST provided was one of the major reasons why CB was legalised last year. Mr Milne urged CREST to reorganise their aims and to cut out the politics and get on with the job! Having berated them he then donated six Washington base station transceivers – no strings attached!

Apparently the message struck home. Motions from the National Councils of both CREST and NCRA brought about a joint sitting at which they voted to constitutionally separate the organisations.

In other developments at the Convention: channel 4 on 27 MHz is now to be known as the 'highway channel' and the UHF highway channel is to be channel 40. The question of 'Dealer's' and 'Demonstrator's' licences is to be looked into as it appears that the requirements and restrictions on these licences are presently open to wide interpretation. The NCRA is looking closely into the design and distribution of membership cards.

Elections saw no radical changes to the faces 'up front'; you can read more about the whole shebang in the October issue of CB Australia.

The Reace RC-1000 transceiver monitoring instrument provides continuous indication of power output, SWR and modulation percentage. With three power ranges up to 1000 W, the RC-1000 is claimed to be good up to 150 MHz. Further details from Just CB's at 546 Whitehorse Road, Mitcham, VIC 3132.

AMATEUR COMMUNICATIONS

New Kenwood Rig

Kenwood will shortly release in Australia their latest, low-power, economy, all-band transceiver – the TS-120V.

Designed to suit those on a limited budget, this rig should be particularly attractive to Novices as it has many of the features of the 'big' rigs and meets the power requirements – and should retail at a very competitive price.

The TS-120V is an all solid-state transceiver featuring digital frequency display with readout to 100 Hz plus an analogue dial with a 25 kHz per turn tuning rate. It covers all bands 80 to 10 metres (including all of the 10m band), plus 15 - 15.5 MHz for WWV time/frequency signals. The receiver incorporates both RIT tuning and IF shift. A crystal calibrator is also included providing calibration markers every 25 kHz. Transmitter power input is quoted as 30 watts PEP on SSB.

The transceiver may be powered from 13.8 Vdc (nominal) or a matching 240 Vac mains power supply, type PS-20. The transceiver itself measures a compact 241 mm wide, by 94 mm high and is 235 mm deep.

The TS-120V is distributed in Australia by *Trio-Kenwood (Australia) P/L* of *31 Whiting Street, Artarmon NSW 2064*. Phone (02) 438-1277.

Giant Bargain Sale

A sale and auction of surplus stock of spares, samples, shop-soiled returns and some new equipment, donated by Dick Smith Electronics, will be held at the NSW Division Wireless Institute Centre on Saturday 28 October.

The entire gross proceeds will go to the WIA's Federal Education Scheme for the benefit of Youth Radio work throughout Australia.

There will be over $30,000 worth of equipment (at normal retail prices) including multimeters, antennas, speakers, transceivers, transformers and a large selection of assorted components.

The sale will be held at the *Wireless Institute Centre, 14 Atchison Street, Crows Nest* commencing at 12 noon on the date mentioned. Any unsold items will be auctioned later in the afternoon.

We are advised that everything must go – there will be no reserve at the auction!

Join in, get yourself some bargains and help support the training of future radio amateurs. Don't forget – 12 noon, Saturday 28 October at 14 Atchison St, Crows Nest NSW.

Videocassettes on Ham Radio

The WIA will shortly have available a number of videocassettes – two suitable for PR purposes, the third being the now famous G6CJ "Aerial Circus", a highly entertaining and instructive programme. One of the PR videotapes is a collection of the ARRL publicity films, in colour, with sound. The second, also in colour and with sound, is a recording of the programme that appeared on Melbourne Channel 7 TV's "This Week Has 7 Days" programme. The latter is particularly suited to showing to general Australian audiences, such as at local 'publicity' displays etc.

All programmes are on standard U-matic cassettes.

The G6CJ Aerial Circus tape is copyright and we are advised that it will only be loanded out to well-recommended WIA divisional or club officers. The WIA Federal Videotape Coordinator is John Ingham VK5KG. Interested persons can obtain details on the conditions of loan of the videotapes from him (QTHR)

Baghdad on the Air

The club station of the Scientific Welfare Centre, YI1BGD, located in Baghdad, is now operational on 14 MHz (only). It was established following representation to the Yugoslavian government by the Yugoslavian Amateur Radio Society.

Ten Metre Beacons

For those operators currently exploiting the upsurge in good ionospheric conditions to work the DX available on 28 MHz, and who may want to improve their 'yield', here is a list of currently operational beacons:–

28202.5 kHz	0500-0600Z 1500-1600Z	9J2BBB, Lusaka
28205 kHz	24 hours	DLOIGI, West Germany
28207.5	"	N4RD, Florida
28210	"	3B8MS, Mauritius
28215	"	GB3SX, Crowborough
28220	"	5B4CY, Limassol
28225	"	VE3TEN, Ottowa
28230	"	ZL2MHF, Mt Climie
28235	"	VP8BA, Bermuda
28245	"	A9XC, Bahrain
28250	"	KC4 , Palmer Station, Antartica

More 44 MHz TEP Reports

On 8th April this year Ray Cracknell, ZE2JV in Rhodesia worked 5B4AZ and 5B4WR in Cyprus on 144 MHz, the distance being around 5,900 km. Again on the 10th April, ZE2JV worked 5B4WR, signals being reported around strength one and two with doppler flutter. 5B4WR was also reported heard that day by ZE2JE.

The following day, 11 April, ZS6LN in South Africa heard the 5B4CY two metre beacon on Cyprus. Distance between the two stations is 6,340 km. Then, on 12th April ZE2JV worked SV1AB over a distance of 6,275 km with signals reported again around the strength one to two.

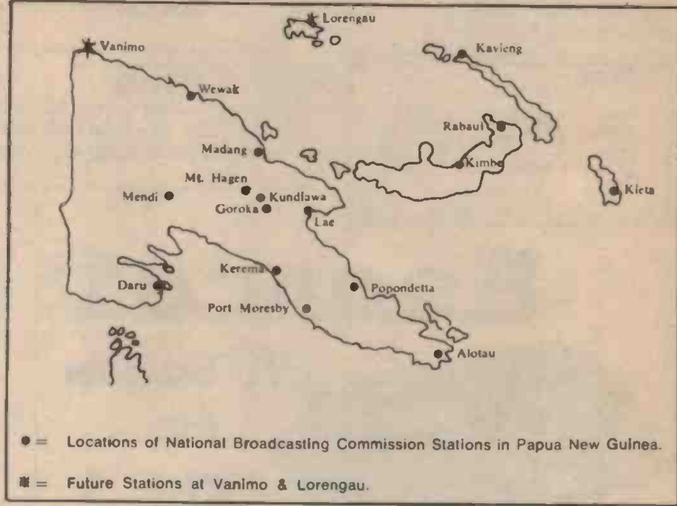
It is interesting to note that CW was used for all contacts. The reporting of these transequatorial contacts completes evidence of TEP in the three major TEP zones of the world on frequencies above 100 MHz and should significantly add to the data on this unusual and highly interesting mode of ionospheric propagation.

Novice Band Expanded

The Novice allocation in the 80 metre amateur band was increased as from 8-8-78, the Novice segment now encompassing 3525 kHz to 3625 kHz.

SWL COMMUNICATIONS

Compiled by Peter Bunn, on behalf of the Australian Radio DX Club (ARDXC).



All times are in Greenwich Mean Time (GMT), add 10 hours to convert to Australian Eastern Standard Time. All frequencies are in kiloHertz.

New Transmitters For Gabon

Radio-TV Gabonaise has recently been conducting test transmissions from Moyabi using new 500 kilowatt units. Victor Goonetilleke of Sri Lanka reports that monitored announcements indicate tests are currently scheduled between 0700 and 1900 and 15300 kHz (for Europe), 9650 kHz (for the Middle East), 7200 kHz (to West Africa), and on 6030 kHz for Congo and Zaire. Victor reports that only 6030 kHz was confirmed as on the air, with French language programming until 1800 sign-off. Reports of these test transmissions are sought, and should be sent to: C.I.A.C.M., Post office box 270, Franceville, Gabon.

Monte Carlo

Trans World Radio at Monte Carlo has a daily English service on 7105 from 0625 until 0800. From October 29, this service will be broadcast one hour later on the same channel. A special service on Saturdays is heard 0940-0955 on 9610, which is on air for the weekly DX program entitled "DX Special".

Indian Regional Stations

Reception of Asian stations is generally best during our summer months. Several Indian regionals which should provide reliable signals in coming months include All India Radio at Hyderabad on 4800, and All India Radio at Calcutta on 4820. Reception is currently noted from approximately 1403 in East Australia, with a relay of the English news from Delhi broadcast at 1530.

New Frequency For Chile

The Voice of Chile at Santiago has introduced a new outlet for foreign language programs. Chile now uses 17865 kHz, and Bob Padula advises of reception of English news at 2215 on this channel. Other frequencies currently used by the Voice of Chile in the 16 metre band include 17715, 17790, and 17800 kHz. Languages used, in 30 munute blocks, include English, French, Spanish, Italian, Arabic and Russian. Meanwhile, Chile's Home Service program, in Spanish, continues to give reliable reception nightly from sign-on at 1100 until past 1300, on 6190 kHz. Interference is present early in the transmission from a Venezuelan station, Ecos del Torbes, which also uses 6190 kHz, but the Venezuelan station's signal fades out soon after 1130.

World Radio and Television Handbook

The Australian Radio DX Club will be helping DXers in Australia to receive their copy of this invaluable publication when the 1979 edition becomes available. The ARDXC co-ordinates bulk ordering of the Handbook, with persons able to receive their copy direct from the publishers in Denmark, by registered airmail to their home address. For further information, write to the DRDXC Secretary at the address given in this column.

New Outlet For Port Moresby

The National Broadcasting Commission, Port Moresby, has been observed during August on the new frequency of 4785 kHz, replacing 4890 kHz. This may be only a temporary move for Port Moresby, as the station also shifted temporarily from 4890 kHz during June, to 4760 kHz. Port Moresby gives good reception between 0730 and 1400 on the 60 metre band. Morning sign-on is at 1950.

Finland

A schedule to hand from Radio Finland in Helsinki, indicates services in September and October for the Far East and Australia in English are broadcast daily from 0930-1000 on 21495. On Saturdays and Sundays, also on 21495, the special "Radio Finland in its Sunday Best", featuring high-lights of the week on Radio Finland as well as special programs, is aired between 0800 and 0930. For students of languages, a recent innovation is the Monday program entitled "Starting Finnish".

The Voice of the Andes

Radio HCJB, at Quito in Ecuador, currently has broadcasts scheduled for our area between 0600 and 1130 using 11900 and 6130 for English services, while a transmission between 0700 and 1030 on 9745 is also directed to the South Pacific region, in English. Use of the 13 metre band continues during September and October, with programs on 21480, between 1630 and 2200, and including English between 1700 and 1800, and again from 1900-2030.

COMMUNICATIONS

Sri Lanka

Adventist World Radio (Asia) broadcasts programs via the facilities of the Sri Lanka Broadcasting Corporation in Colombo. Programs in English, according to latest information, may be heard between 0330 and 0400 on 9720 and 15425, between 1430 and 1550 on 6075, 9720 and 15425, and from 1330 until 1345 on 6075, 9720, 15425 and 4940. The first two segments (0330-0400, and 1430-1500) are broadcast on Sundays only, while the program at 1330 is only broadcast on Saturdays. The Saturday service includes an interesting segment entitled "Your Radio Doctor".

German Regional Stations

A schedule to hand from the German commercial broadcaster, Suddeutscher Rundfunk (Stuttgart) indicates the following schedule for broadcasts via its shortwave transmitter at Muhlacker, which operates on 6030. Monday to Friday 0356-2315; Sundays: 0455-2310; Saturdays: 0356-0000.

Another German regional broadcaster is RIAS (Radio in the American Sector) which operates on 6005 from transmitters at Berlin (20 kilowatts) and at Munich (100 kilowatts). The Munich transmitter is on the air 1730-0315, while the Berlin transmitter is in use between 0325 and 1730. The Munich transmitter provides reliable signals currently between 1730 and 2200, with programs in German.

and a local language, and include a good variety of local music and songs. This is an example of the special weekend programs maintained by several African broadcasting stations. Other stations with similar schedules are Radio Mali which operates on weekends only operates on weekends only from 0800 sign-on using 7110, and Radio Ivory Coast, which uses 7215 from sign-on at 0600. Reception of both these stations should improve as our summer approaches, corresponding to the onset of the northern winter.

Oman

For some years, the BBC has operated a mediumwave relay station on Masirah Island off the southern coast of Oman, for broadcasts to the Asian region. Recently, shortwave facilities have also been added to this relay site. Advice received from the station indicates that World Service programs of the BBC, all in English, will be aired via the Masirah relay station according to the following schedule until the first week in November: On frequencies of 11780 and 15310, 0700-0815, on 17770 between 0900 and 1300, on 1530 between 0900 and 1515, on 7250 from 1600 until 2030 and on 7140 between 0000 and 0230, while transmissions of the World Service will be carried on both 9590 and 11955 between 0300 and 0330.

USA

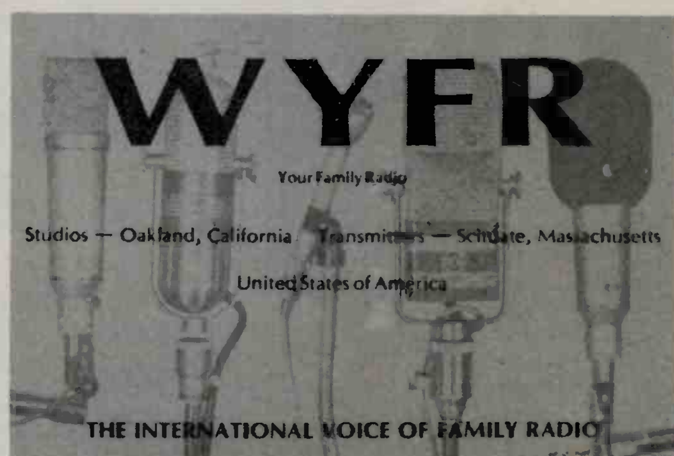
The Family Radio network, station WYFR, with studios in Oakland, California and transmitters located at Scituate (Massachussets) and Okeechobeee (Florida), has special

Holland

Radio Nederland will again be making extensive use of their relay facilities at Bonaire in the Netherlands Antilles, for broadcasts to Australia and New Zealand during period S-78, which concludes on November 5. English is carried by the Bonaire relay for Australia and New Zealand between 0730 and 0825 daily on 9770 and 9715, with English continuing on 9715 until 0925. English for South and East Asia is carried by the Madagascar relay station for Radio Nederland programs between 1430 and 1525 on 21480 and 17855.

Italy

Radio-television Italiana (RAI) has a daily English service for Japan and the Far East between 2200 and 2225, on 11905, 9710 and 5990. There is no English program specifically for Australia, however the above transmission generally offers reliable reception, particularly on the former channel. RAI places strong emphasis on services in Italian for Australian audiences however with two transmissions daily. The morning service for Australia is on the air between 2050 and 2130 on 11800, 9575, and 7290. The evening program is aired between 0830 and 0930 on 21690, 17780, 15330, 11810, and on 9580, according to the RAI schedule which is effective until the beginning of November.



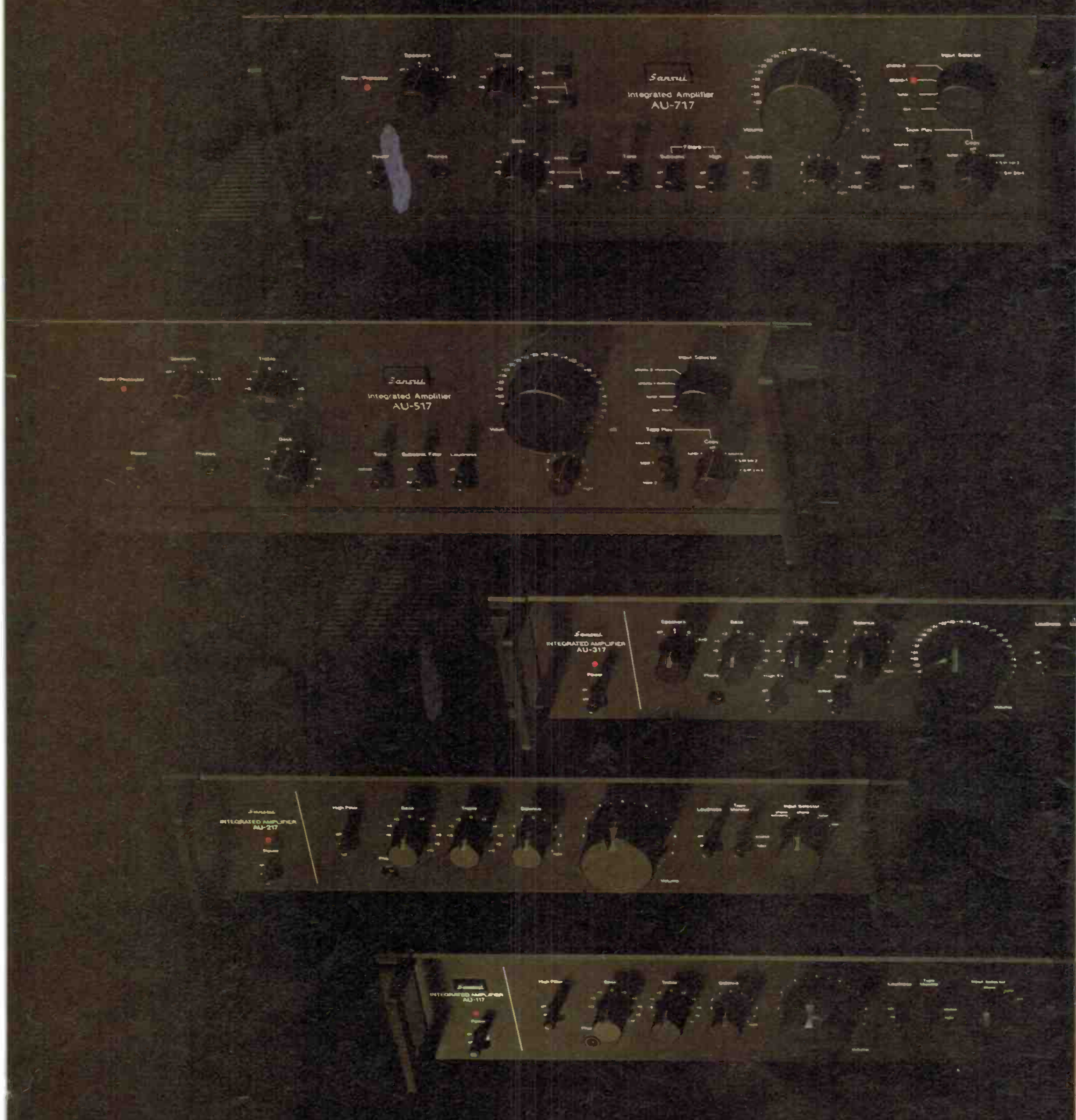
Guinea

Radiodiffusion Nationale, which also identifies on-air as "La Voix de la Revolution", is currently noted with a special Sunday program from sign-on at 0600 until approximately 0850, on 9650. Programs are in both French

weekend programs in English, beginning at 1230. Between 1230 and 1400, these programs are broadcast on 15110 and 17785, continuing between 1400 and 1500 on 17785 and 21525. Weekday programs include English 2000-2200 on 17845 and 15440.

The Australian Radio DX Club (ARDXC) is a non-profit body with headquarters in Melbourne. For further information regarding shortwave radio and DXing, please write to the General Secretary, PO Box 67, Highett, Victoria 3190 enclosing a 30c stamp.

Specs with a purpose!
Sansui's new amplifiers

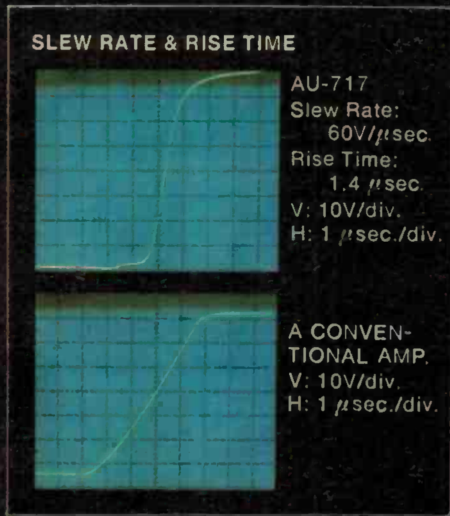


Sansui's all-new integrated amplifiers have absolutely astounding specifications. Compare them with any others in their class, and Sansui comes out far ahead. But what really makes Sansui's new amplifiers so superior is that all these great specs have a single purpose — outstanding sound quality.

Take response speed, for example. Your amplifier doesn't move, but it does respond. The more rapid its response, the cleaner and the more accurate the sound. That's why the AU-717, for example, features an advanced DC power amplifier design. Sansui's DC amplifier eliminates all capacitors in the signal path and even in NFB loop so amplification is direct without coloration and phase delay. Response is astoundingly rapid — the proof is in the ultra-high (60v/μsec.) slew rate and ultra-rapid rise time (1.4μsec).

But Sansui didn't strive for such outstanding specs just to be able to print impressive figures. On the contrary, Sansui research showed that to achieve accurate reproduction and reduce signal loss, lightning-fast response was essential.

In addition, special circuits were incorporated to achieve new levels in stamping out TIM (transient inter-modulation distortion), a type



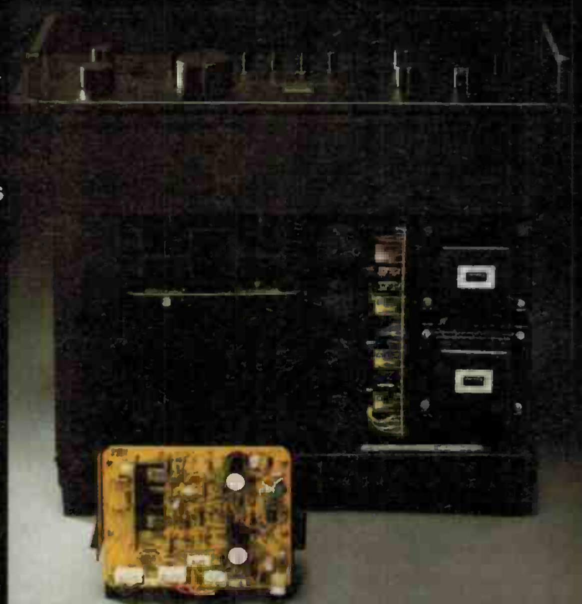
of distortion that is now receiving high priority. Still another important benefit of Sansui's DC amplifier is the ultra-wide frequency response from zero (DC) to 200,000 Hz.

The final result is music with a purity and clarity that must be heard to be believed. All the dimensions of complex musical sounds — the wide dynamic range, the sudden pulsive signals, the nuances of barely perceptible but critical overtones in the ultra-high frequencies — all these are now crystal clear, all are proof of Sansui's new levels in superior sound quality. Impressive power is 85 RMS watts per channel, 20 — 20k Hz, and total harmonic distortion at rated output is 0.015%. That means it can be considered non-existent as far as the human ear is concerned.

Keep in mind that though the AU-717 is special, it's not special for Sansui. Each and every amplifier on the left-hand page embodies the same Sansui commitment to outstanding sound quality. All controls have been carefully thought out and designed for their specific purposes. Sansui has no place for gadgets and gimmicks in its dedication to the ultimate in hi-fi.

The AU-517 and AU-317 also feature the same DC power amplification as the AU-717, and offer 65 and 50 RMS watts respectively. The AU-217 and AU-117 offer 30 and 20 RMS watts respectively, but are not to be under-rated. In fact, they represent exceptional values in low distortion and true hi-fi performance.

Sansui for specs with a purpose — outstanding musical quality.



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Reasonable abbreviations, such as 25 Wrms, count as one word.

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Every effort will be made to publish all adverts received — however, no responsibility for so doing is accepted or implied.

Adverts must relate to electronics or audio — general adverts cannot be accepted.

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THANKS FOR THE COPIES, BOB WILLIAMS, BUT I LOST YOUR ADDRESS SO THAT IS WHY I'M USING "MINI-MART" AGAIN, S. JAY.

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PCB's

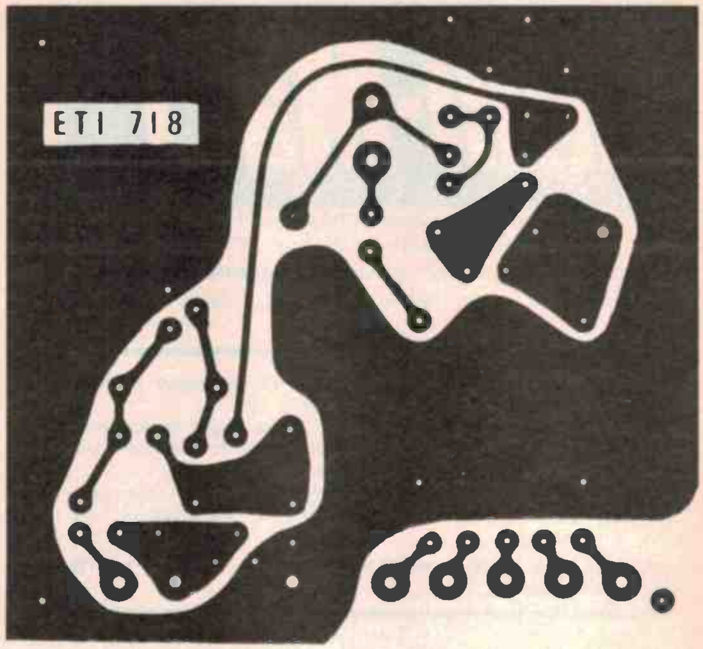
Using ETI PCB Artwork

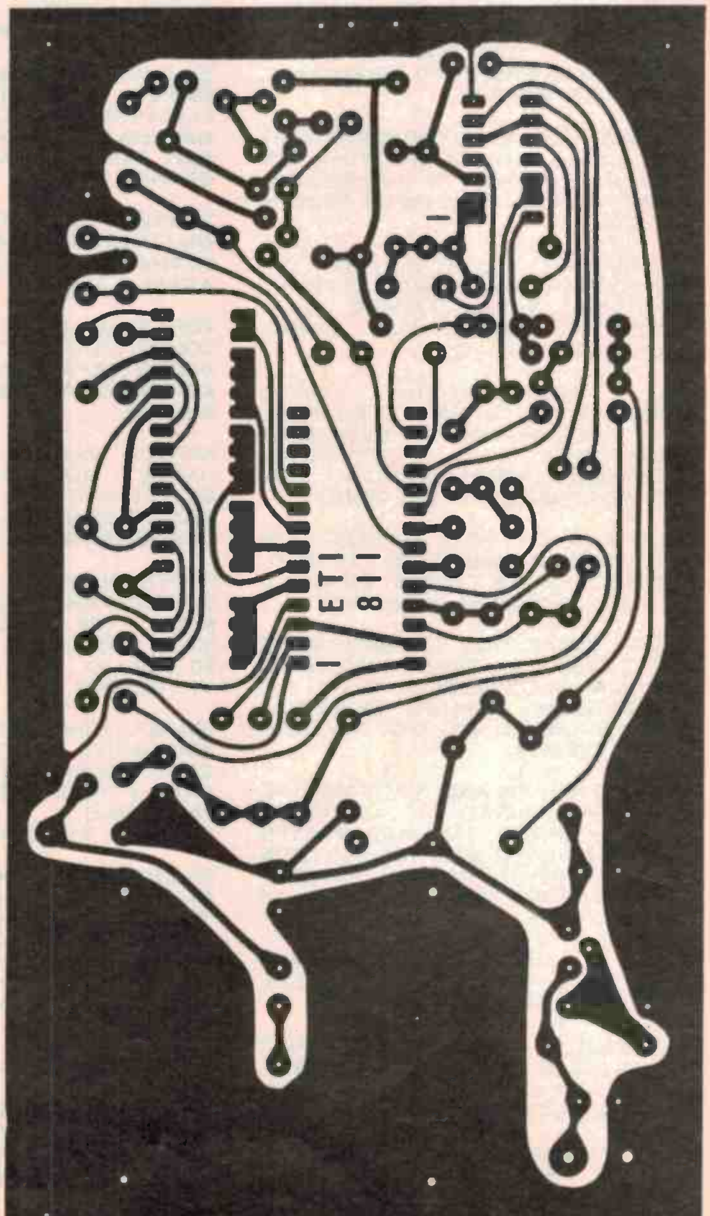
This method can be used to make negatives of ETI artwork from October 1977 on, provided the reverse of the page is printed in blue. The film used is Scotchcal 8007 which is UV sensitive and can be used under normal subdued light.

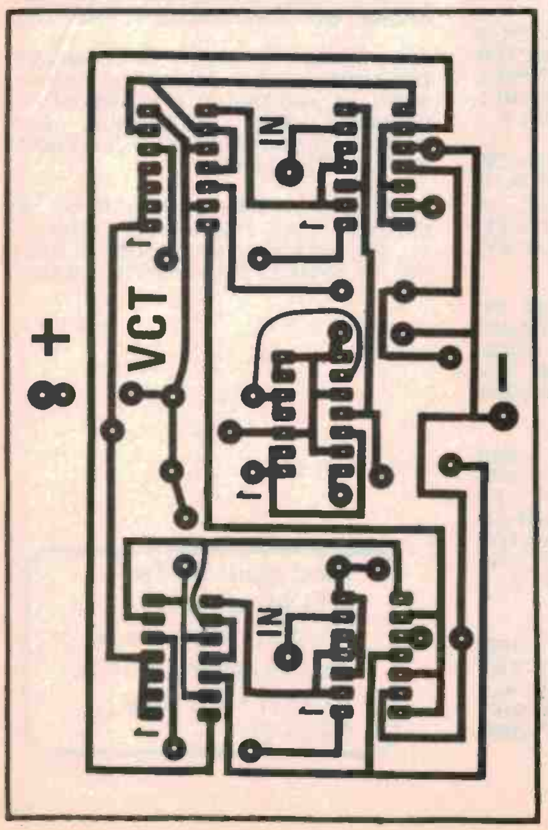
Cut a piece of film a little larger than the PC board and expose it to UV light through the magazine page. The non emulsion side should be in contact with the page. This surface can be detected by picking the film up by one corner - it will curl towards the emulsion side. Exposures of about 20 minutes are normally necessary.

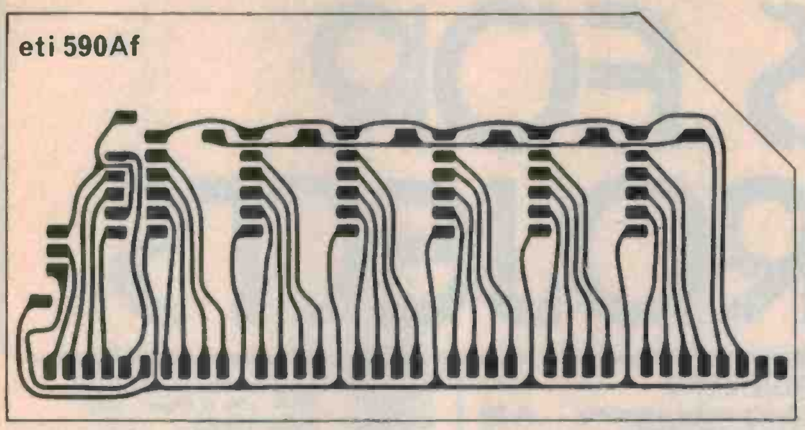
The film can now be developed by placing it emulsion side up on a table, pouring some Scotchcal 8500 developer on the surface and rubbing it with a clean tissue.

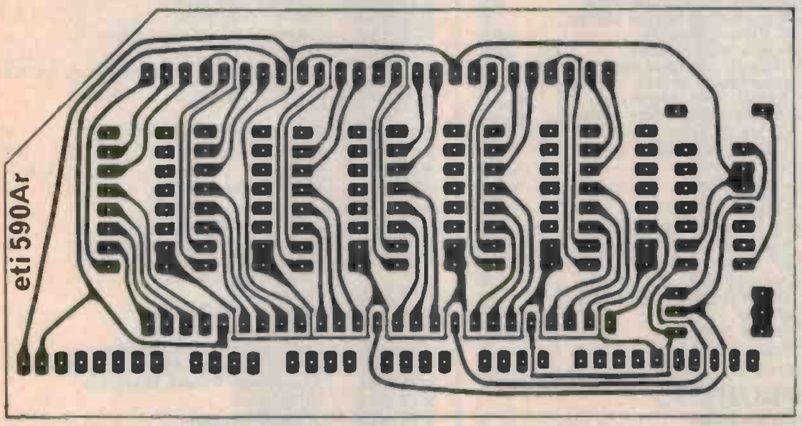
Further information on Scotchcal and PCB manufacture can be found in the September and December 1977 issues of ETI. Please note also, that occasionally pressure on space may unfortunately prohibit the printing of blue type behind all PCB's, in which case the reader must resort to more conventional photographic techniques for PCB manufacture.

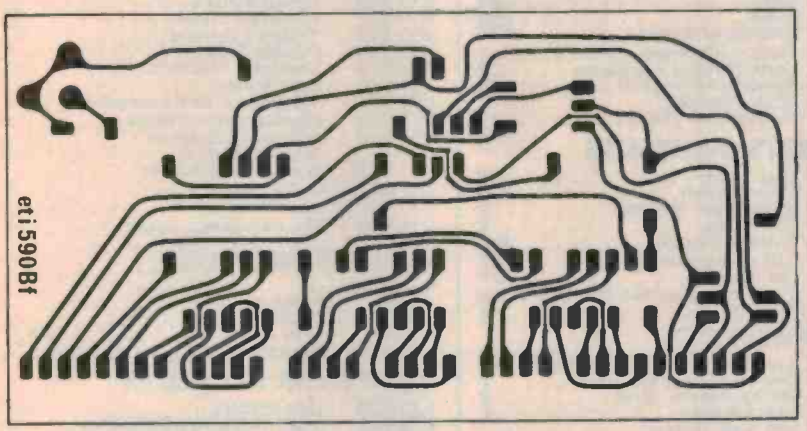


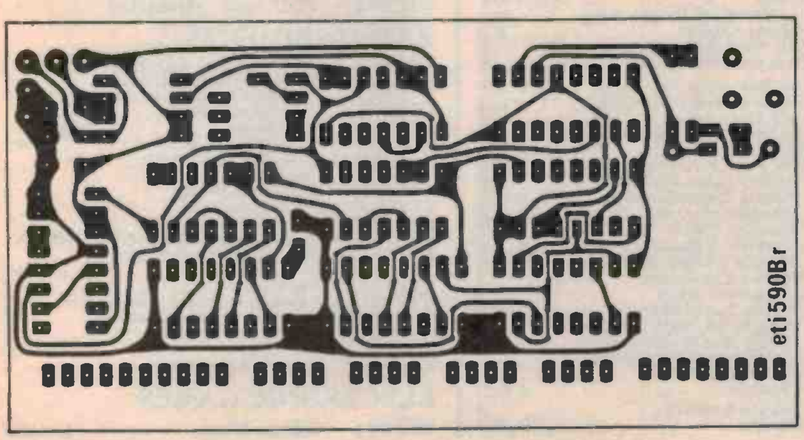


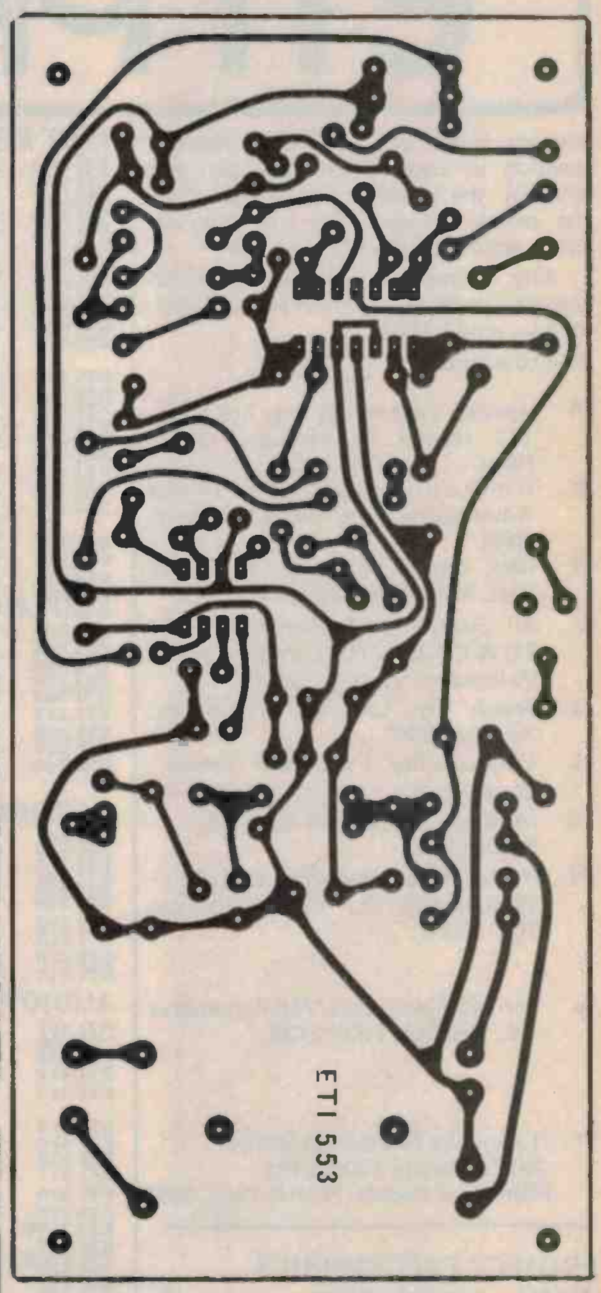



eti 590Af


eti 590Ar


eti 590Bf


eti590Br


ETI 553

KITS FOR ETI PROJECTS

We get many enquiries from readers wanting to know where they can get kits for the projects we publish. The list below indicates the suppliers we know about and the kits they do.

Any companies who want to be included in this list should phone LES BELL on 33-4282.

Key to companies:

- **A** Applied Technology Pty. Ltd. 109 - 111 Hunter St, Hornsby. 2077. NSW.
- **C** Amateur Communications Advancements, PO Box 57, Rozelle, NSW.
- **D** Dick Smith Pty. Ltd. of Crows Nest, NSW. (see Ads. for address).
- **E** All Electric Components (formerly ED & E Sales), 118 Lonsdale Street, Melbourne, Victoria, 3000.
- **J** Jaycar Pty. Ltd. 405 Sussex St., Sydney 2000.
- **L** Delsound Pty. 1 Wickham Terrace. Queensland.
- **M** Mode Electronics. PO Box 365, Mascot 2020.
- **N** Nebula Electronics Pty. Ltd. 15 – 19 Boundary St., Rushcutters Bay 2011. NSW.
- **P** Pre-Pac Electronics. 718 Parramatta Rd., Croydon NSW 2132.
- **T** Townsville Electronics Centre. 281E Charters Towers Rd, Rising Sun Arcade, Hermit Park. 4812

PROJECT ELECTRONICS

ETI 041	Continuity Tester	DS
ETI 043	Heads or Tails	DATSE
ETI 044	Two-Tone Doorbell	DATSE
ETI 045	500 Second Timer	DS
ETI 047	Morse Practice Set	DS
ETI 048	Buzz Board	DS
ETI 061	Simple Amplifier	DATS
ETI 062	Simple Amplifier Tuner	DSE
ETI 063	Electronic Bongo's	DS
ETI 064	Intercom	ATS
ETI 065	Electronic Siren	DS
ETI 066	Temperature Alarm	ADTSE
ETI 067	Singing Moisture Meter	DS
ETI 068	Led Dice	ADSE
ETI 072	2-Octave Organ	DS
ETI 081	Tachometer	E

TEST EQUIPMENT

ETI 102	Audio Signal Generator	E,DS
ETI 105	Lab Power Supply	E
ETI 107	Widerange Voltmeter	E
ETI 108	Decade Resistance Box	ES
ETI 109	Digital Frequency Meter	E
ETI 111	IC Power Supply	ES
ETI 112	Audio Attenuator	ES
ETI 113	7-Input Thermocouple Meter	P,E
ETI 116	Impedance Meter	ES
ETI 117	Digital Voltmeter	E,AS
ETI 118	Simple Frequencv Counter	E,AS
ETI 119	5V Switching Regulator supply	ETS
ETI 120	Logic Probe	L,ES
ETI 121	Logic Pulser	L,ES
ETI 122	Logic Tester	ES
ETI 123	CMOS Tester	ES
ETI 124	Tone Burst Generator	ES
ETI 128	Audio Millivoltmeter	L,ES
ETI 129	RF Signal Generator	L,ES
ETI 130	Temperature Meter	E
ETI 131	General Purpose power supply	E,N
ETI 132	Power Supply	NSE
ETI 133	Phase Meter	E
ETI 134	True RMS Voltmeter	E

SIMPLE PROJECTS

ETI 206	Metronome	T
ETI 218	Monophonic Organ	ET
ETI 219	Siren	ET
ETI 220	Siren	ET
ETI 222	Transistor Tester	ETS
ETI 234	Simple Intercom	T
ETI 236	Code Practice Oscillator	E
ETI 239	Breakdown Beacon	E
ETI 240	High Powered Emergency Flasher	E

MOTORISTS' PROJECTS

ETI 301	Vari-Wiper	ET
ETI 302	Tacho Dwell	ET
ETI 303	Brake-light Warning	E
ETI 305	Car Alarm	E
ETI 309	Battery Charger	P,E
ETI 312	CDI Electronic Ignition	P,ET
ETI 313	Car Alarm	E,DT
ETI 316	Transistor Assisted Ignition	E
ETI 317	Rev. Monitor	E

AUDIO PROJECTS

ETI 401	Audio Mixer FET Four Input	E
ETI 406	One Transistor Receiver	T
ETI 408	Spring Reverb. Unit	E
ETI 410	Super Stereo	E
ETI 413	100 Watt Guitar Amp	P,L,J,DT
ETI 413	x 200 Watt Bridge Amp	SE
ETI 414	Master Mixer	E,J
ETI 416	25 Watt Amplifier	E
ETI 417	Amp Overload Indicator	E
ETI 419	Guitar Amp Pre-Amp	P.E.DT
ETI 420	Four-channel Amplifier	L,E
ETI 420E	SQ Decoder	E
ETI 422	International Stereo Amp	SL,D
ETI 422B	Booster Amp	E
ETI 422	50 Watt Power Module	E
ETI 423	Add-on Decoder Amp	E
ETI 424	Spring Reverberation Unit	SL,E
ETI 425	Integrated Audio System	E
ETI 426	Rumble Filter	E
ETI 427	Graphic Equaliser	SL,E,J
ETI 429	Simple Stereo Amplifier	E
ETI 433	Active Crossover	J
ETI 435	Crossover Amp	J
ETI 438	Audio Level Meter	L,ES
ETI 440	Simple 25 Watt Amp	L,E
ETI 441	Audio Noise Generator	L,ES
ETI 443	Compressor-Expander	E.J.
ETI 444	Five Watt Stereo	ES
ETI 445	Preamp	J,E,D
ETI 446	Audio Limiter	J
ETI 447	Phaser	E,J
ETI 449	Balanced Mic Preamp	JE
ETI 480	50 W. 100 W Power Amp	A
ETI 480P	Power Supply	DAT
ETI 481	12V to 40V DC Inverter	E
ETI 482A	Preamp Module	AE
ETI 482B	Tone Controller	AE
ETI 484	Compressor Expander	E
ETI 485	Graphic Equalizer	JSE
ETI 480	50W. 100W Power Amp	ADBE

MISCELLANEOUS

ETI 502	Emergency Flasher	E
ETI 503	Burglar Alarm	ET
ETI 505	Strobe	L,E,D
ETI 506	Infra-Red Alarm	E
ETI 509	50-Day Timer	E
ETI 512	Photographic Timer	E
ETI 513	Tape Slide/Synchroniser	E
ETI 514	Flash Unit — Sound Operated	E
ETI 515	Flash Unit — Light operated	E
ETI 518	Light Beam Alarm	ET
ETI 525	Drill Speed Controller	E
ETI 528	Home Burglar Alarm	P,ET MS
ETI 529	Electronic Poker Machine	E
ETI 532	Photimer	E
ETI 533	Digital Display	L,E,AS
ETI 534	Calculator Stopwatch	A,D
ETI 539	Touch Switch	E
ETI 540	Universal Timer	ES
ETI 541	Train Controller	ET
ETI 543	Double Dice	A
ETI 544	Heartrate Monitor	AE
ETI 546	GSR Meter	E
ETI 547	Telephone Bell Extender	E
ETI 548	Photographic Strobe	E
ETI 549	Induction Balance Metal Locator	E
ETI 581	Dual Power Supply	E
ETI 582	House Alarm	E
ETI 583	Gas Alarm	ME
ETI 586	Shutter Speed Timer	E

ELECTRONIC MUSIC

ETI 601		
4600	Synthesiser	J
3600	Synthesiser	J
ETI 602	Mini Organ	E,A,D
ETI 604	Accentuated Beat Metronome	E

COMPUTER PROJECTS

ETI 630	Hex Display	AE
ETI 631	VDU Keyboard Encoder	AE
ETI 632	VDU 1 k x 8 Memory Card	AE
ETI 633	VDU Sync Generator	AE

RADIO PROJECTS

ETI 701	TV Masthead Amplifier	E,D
ETI 702	Radar Intruder Alarm	DE
ETI 703	Antenna Matching Unit	E
ETI 704	Crosshatch/Dot Generator	L,A,D,ES
ETI 706	Marker Generator	ES
ETI 707	Modern Solid State Converters	C,E
ETI 708	Active Antenna	E
ETI 709	RF Attenuator	E
ETI 710	2 metre Booster	C,E
ETI 711B	Single Relay Remote Control	AE
ETI 711C	Double Relay Remote Control	AE
ETI 711R	Receiver	AE
ETI 711AR	Remote Control Transmitter	AE
ETI 711DR	Remote Control Decoder	AE
ETI 712	CB Power Supply	E
ETI 740	FM Tuner	AE
ETI 780	Novice Transmitter	E

ELECTRONIC GAMES

ETI 804	Selecta-Game	O,A,DS

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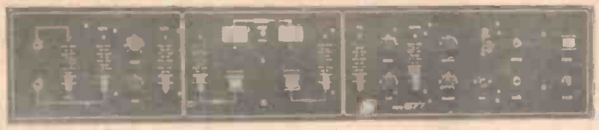

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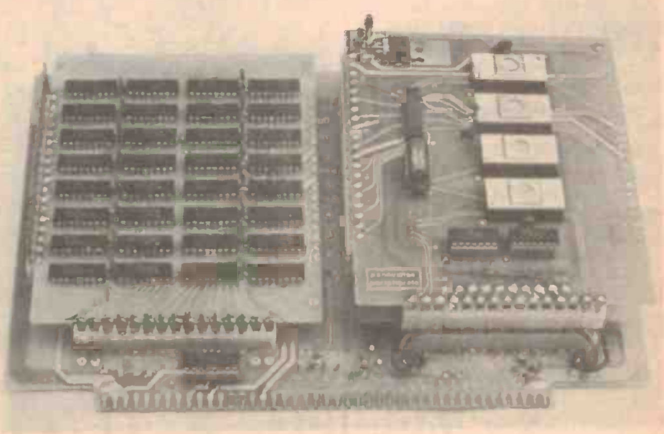

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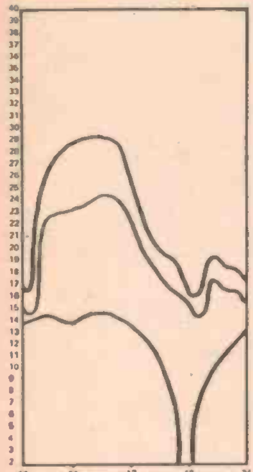
predictions

Ionospheric Predictions for the month of November

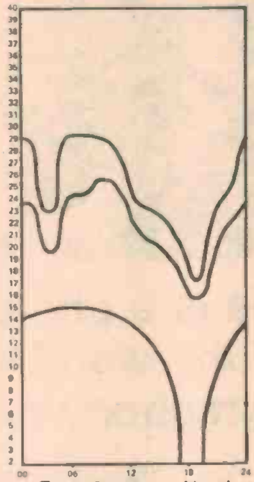
THESE PREDICTION GRAPHS have been prepared courtesy of the Ionospheric Prediction Service Division of the Department of Science.

Any enquiries about these predictions should be directed to ETI, not to the Ionospheric Prediction Service.

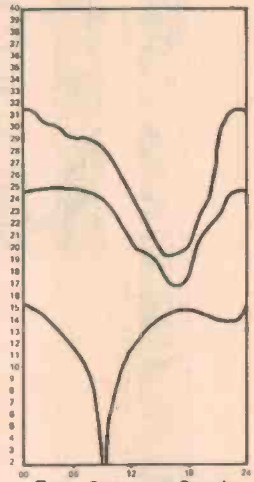
The graphs indicate the maximum usable frequency (MUF) on HF circuits between various centres in Australia and selected points overseas. For less than 50% of the days of the month the highest frequencies propagated will be at least as high as the uppermost curve. Between 50% and 90% of the days of the month the MUF will be at least as high as the curve beneath the upper curve. The absorption limiting frequency (ALF), which affects the lowest frequencies that will be propagated, is indicated by the lower curves on the graphs.



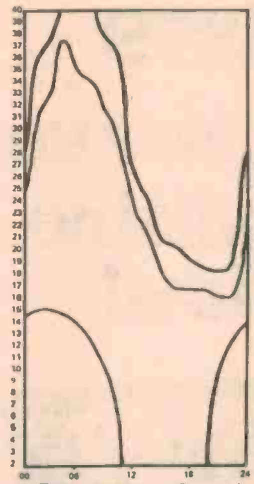
East Coast — South Africa (also serves South Central)



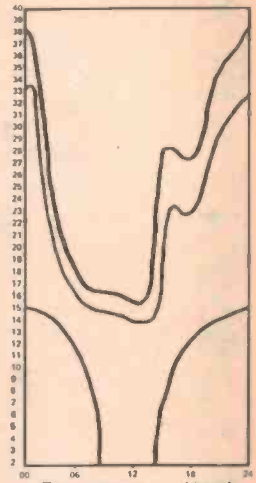
East Coast — North Africa (also serves South Central)



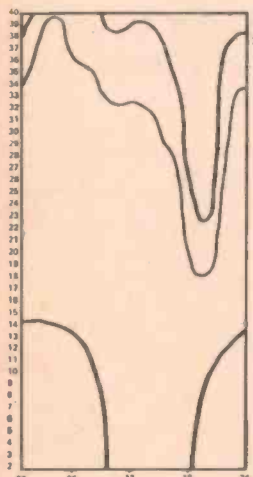
East Coast — South America (also serves South Central)



East Coast — Central USSR (also serves South Central)



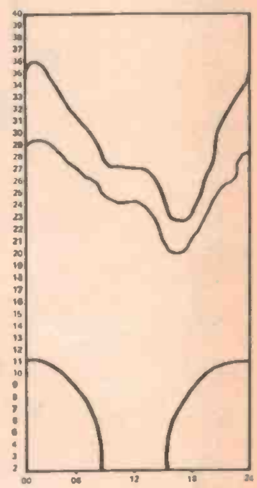
East Coast — North America (also NE and South Central)



East Coast — Japan (also serves NE and South Central)

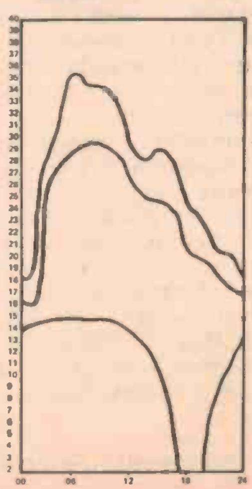
SWL and AMATEUR COMMUNICATIONS

East Coast — South Pacific

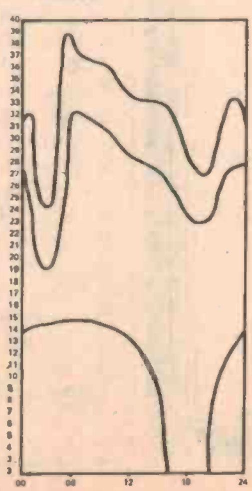


East Coast — Europe (Short Path)

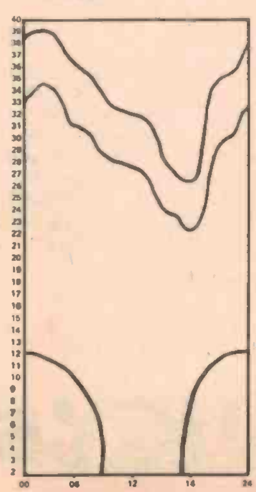
North East — South Africa



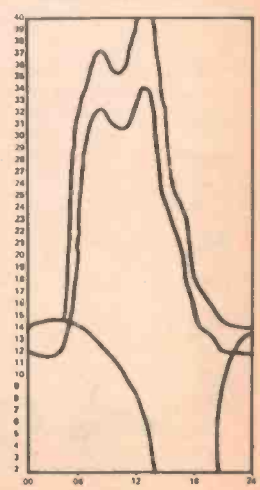
North East — North Africa



North East — South Pacific (also serves South Central)

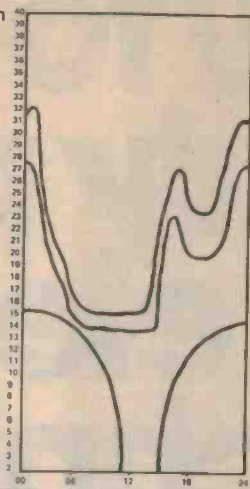


North East — Europe (Short Path)

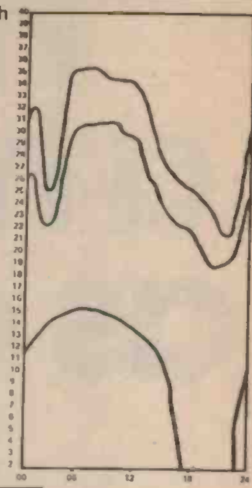


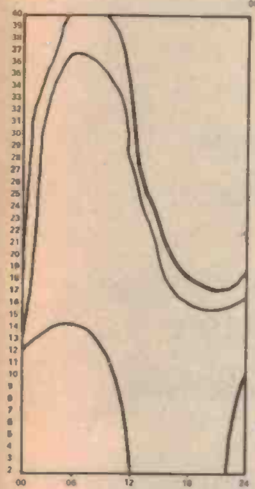
South Central — Europe (Short Path)(also West Coast)

West Coast — North America

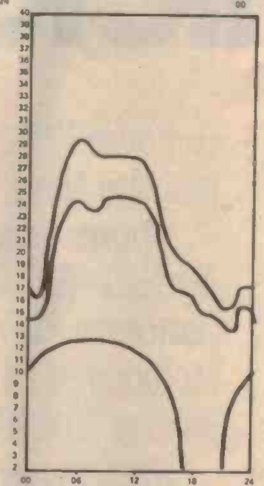


West Coast — North Africa

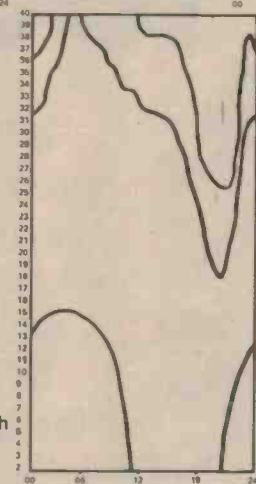




West Coast — Central USSR



West Coast — South Africa



West Coast — Japan

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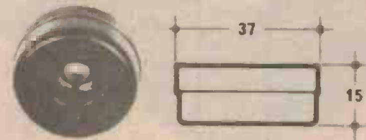

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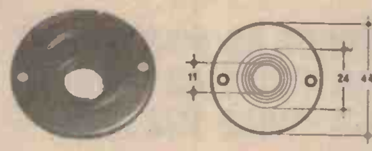

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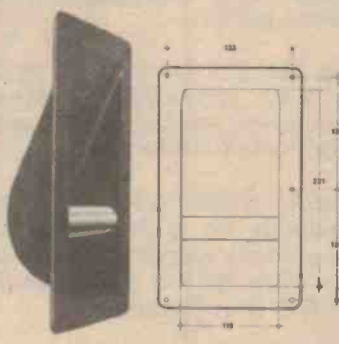

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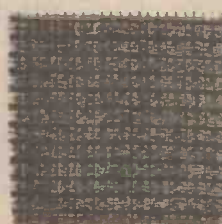

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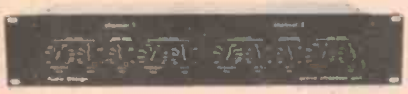

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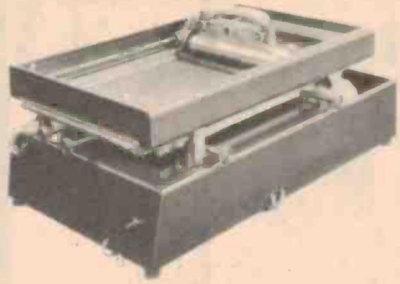

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Ideas for experimenters

These pages are intended primarily as a source of ideas. As far as reasonably possible all material has been checked for feasibility, component availability etc, but the circuits have not necessarily been built and tested in our laboratory. Because of the nature of the information in this section we cannot enter into any correspondence about any of the circuits, nor can we produce constructional details.
Electronics Today is always seeking material for these pages. All published material is paid for – generally at a rate of $5 to $7 per item.

Gated 123 Oscillators

The action of two distinct types of gated oscillator is shown in Fig. 1. Type A stops immediately the inhibit signal goes low, and starts immediately it goes high. (Hence fractional output pulses may be produced.)

Type B finishes its current pulse before stopping when the inhibit signal goes low and like A starts immediately it goes high.

A is used when an oscillator has to be synchronized using pulses shorter than the output pulse and B is used when a number of whole pulses are required (the inhibit signal is obtained from the output of a counter).

It can be quite difficult to achieve a type A oscillator that starts up without jitter using TTL. The circuit of fig.2 shows how an SN74123 may be used to construct both types. A type A

Continued

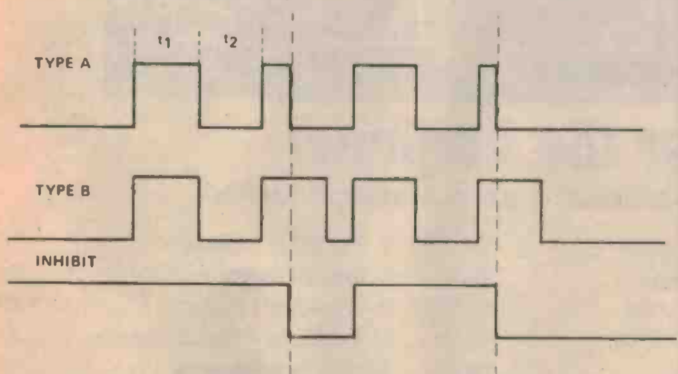


Fig.1. Left– operation of the two types of oscillator with respect to the inhibit signal.

Fig.2. Right– connection to a 74123 to obtain both type of gated oscillator.

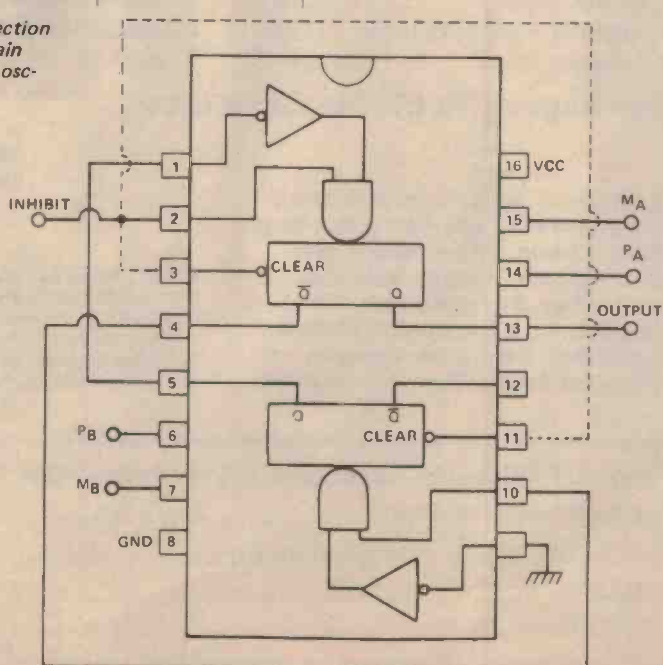
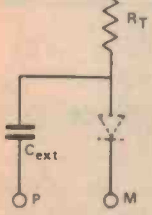


Fig.3. Below– arrangement of the timing components.



oscillator is obtained if the dotted connections are left out. The times t_1 and t_2 are set by the usual timing components see fig.3 – the diode is needed if Cext > 1000p (across PA – MA and PB – MB respectively). The times may be calculated using:–

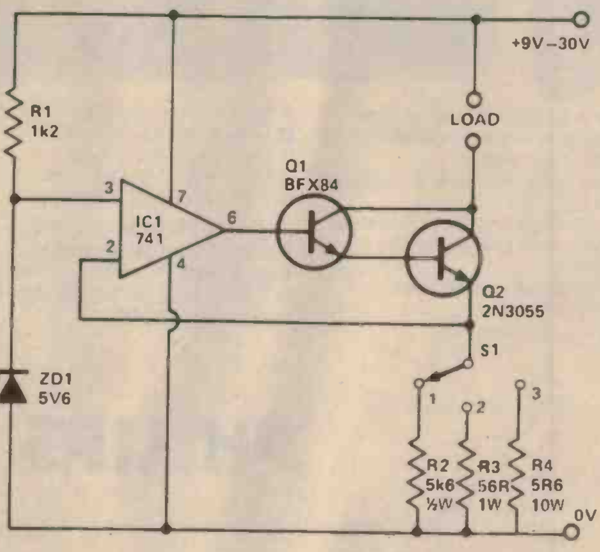
$$t = 0.32R_T C_{ext} (1 + 0.7/R_T)$$

if the diode is not required and

$$t = 0.28R_T C_{ext} (1 + 0.7/R_T)$$

otherwise.

R_T is in kilo-ohms, Cext is in picofarads, t is in nanoseconds and the max value of R_T is 20K.



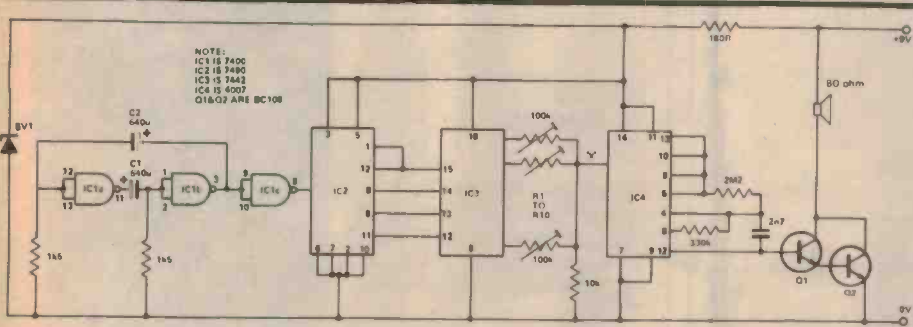
Constant Current Source

The circuit shown will provide 3 preset currents which will remain constant despite variations of ambient temperature or line voltage.

ZD1 produces a temperature stable reference voltage which is applied to the non inverting input of IC1.

100% DC feedback is applied from the output to the inverting input holding the voltage at Q2's emitter at the same potential as the non inverting input.

The current flowing into the load therefore is defined solely by the resistor selected by S1. With the values employed here, a preset current of 10mA, 100mA or 1A can be selected. Q2 should be mounted on a suitable heatsink.



Musical Tone Generator

This circuit provides a means of generating a series of up to ten musical notes.

The 7400 oscillator produces pulses at about 1 second intervals. These pulses, after being buffered are fed to a decade counter which produces a BCD output. The output is fed to the 7442 which produces a decimal output. Each output is taken to a preset forming a potential divider. The VCO senses the voltage at point 'a' and changes the frequency of the output tone. Careful adjustment of the presets can give a reasonable range of notes. The length of each note as well as the time between notes can be varied by changing the timing components in the 7400 oscillator.

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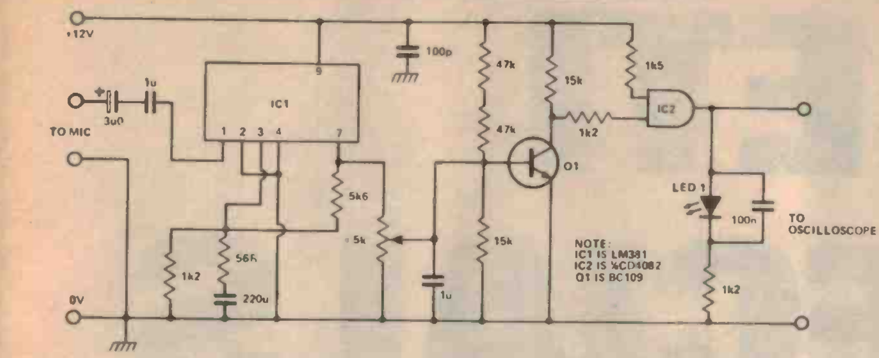
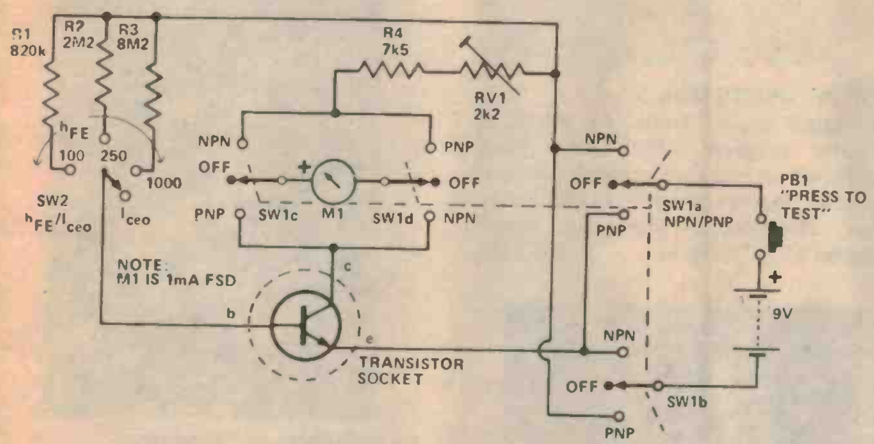


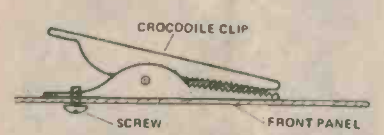
Morse Code On The Oscilloscope

The circuit enables morse code to be displayed as dots and dashes on an oscilloscope screen. By speaking into a microphone, saying 'dit' and 'dah' as appropriate, short and long pulses appear on the screen in a format similar to that of written morse.

One half of an LM381 and a BC109 are used to amplify the signal from the microphone, which is then clipped into digital form by the AND gate. The output from the circuitry is fed to an oscilloscope set to 2V/cm and 5ms/cm, set to trigger on the start of a 'dit'.

Input to the circuit can be from a microphone, or tape recorder. If words are recorded onto the tape with the microphone and then played back via the circuit, practice at reading morse is possible.





Transistor Tester

This transistor tester works by injecting a known current into the base of the transistor under test, and measuring the collector current. The values of R1, R2 and R3 give a base current of 10, 4 and 1μA which gives a FSD on the meter for transistors with a gain of 100, 250, and 1000 respectively. Since the gain of the transistor is proportional to its I_C, the gain can be easily deduced from the reading on the meter. Leakage current is measured by leaving the base open circuit.

SW2 reverses the polarity of the battery and the meter to allow the testing of both NPN and PNP transistors. R4 and RV1 protect the meter from excessive currents, and do not affect the reading on the meter. RV1 should be adjusted so that the meter needle just touches the end stop when the collector and emitter terminals are connected together.

A simple transistor socket can be made by mounting three crocodile clips as shown in the diagram.

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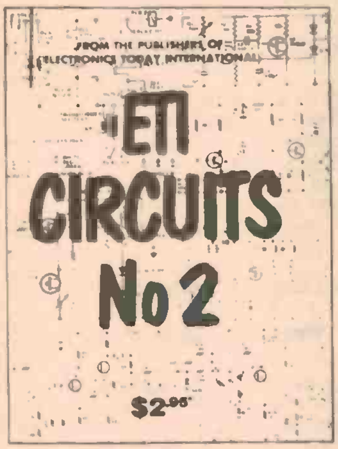

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