THE No1 MONTHLY FOR THE ELECTRONICS & MUSIC HOBBYIST

ELECTRONICS & MUSIC MAKER

PROJECTS, FEATURES, NEWS & REVIEWS IN ELECTRONICS & ELECTRO~MUSIC

JUNE 1981

65p

THE WORDMAKER
ENTER TOMORROW'S WORLD! – MAKE YOUR COMPUTER TALK WITH THIS UNIQUE PROJECT

GUITAR TUNER
NEW, SIMPLE, ACCURATE TUNING SYSTEM FOR GUITARS

MOSFET AMPLIFIER
QUALITY 75 WATT MODULE IDEAL FOR HI-FI

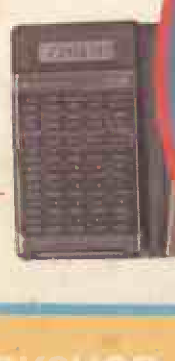
SELECT~A~MATCH
RANDOM DRAW POOLS SELECTION AT A TOUCH!

PLUS
- ✻ FAIRLIGHT COMPUTER MUSICAL INSTRUMENT
- ✻ DAVID VORHAUS AND KALEIDOPHON STUDIO

TWO SPECIAL OFFERS !!

TEXAS TI~38 SCIENTIFIC CALCULATOR

WHITE NOISE III LP



HOME ✻ WORKSHOP ✻ VEHICLE ✻ EDUCATION ✻ COMPUTING ✻ ELECTRO~MUSIC

Apollo I. Its sound quality is as outstanding as its looks. (And makes the price sound ridiculous.)

Three waveband radio and cassette recorder (battery/mains).

BIG SET QUALITY

Big set sound quality from a portable radio/cassette recorder?

That's the remarkable achievement of the Apollo I. It really does have the rich tonal quality you'd only expect in an expensive home unit. On radio or cassette, reproduction is crystal clear even at full volume and over the whole of the tone range. The band change switch gives you the choice of FM, Medium or long wave and a big tuning control provides you with sensitive station tuning, helped by very clear and legible dial markings.

BIG FUNCTION RANGE

Remarkable, too, is the Apollo I's range of functions. In addition to the three band radio and cassette playing capability, it lets you record direct from the radio, record through the built-in condenser microphone, record through an external microphone (not included), and play yourself to sleep with taped music that switches off automatically.

Only £19.95

plus £2.95 p & p

EXTRA 'EXTRAS'

Apollo I has many features you'd hardly expect if it was twice the price. For example: automatic volume control on the built-in microphone, earphone monitoring of recordings, battery or mains operation, provision for remote control, etc.

SENSATIONAL VALUE

Most remarkable thing about Apollo I, though, has to be its price. Any multi-function set would be extremely good value for this kind of money. But the Apollo, with so many 'extras' and such superb quality reproduction, is an absolute bargain. Guaranteed for 12 months.

●Exceptional sound quality ●Battery/mains operation ●Sensitive tuning ●Push button recorder ●Built-in microphone ●Tone control ●Auto recording level control ●Auto stop ●Sleep function switch ●Earphone ●Sockets for external microphone and remote control.

DATA

Output 2W (max), Power consumption 8W, Speaker 4in, 4ohm, Dimensions 11½in x 8in x 3½in (approx), Weight 5lb.

☎ Credit card holders may telephone (0536) 522024 24 hours a day stating card number for immediate attention.

MITRAD 68-70 High Street, Kettering, Northants. NN16 8SY. Tel. (0536) 522024

To Mitrad, 68-70 High Street, Kettering, Northants.

Please send me ____ Apollo I radio/cassette recorder at £19.95 plus £2.95 p & p (£22.90)

Total value of my order £ ____

I enclose cheque/PO made payable to Mitrad. Or debit my

Access/Barclaycard No. ____

Signature ____

Name ____

Address ____

(BLOCK LETTERS PLEASE)

Allow up to 28 days for delivery. Full refund if not completely satisfied. Registered in England No 2554356 Code: 003/MM

ELECTRONICS & MUSIC MAKER

June 1981

100 Pages for the Electronics and Music Hobbyist!

Editorial Offices
282 London Road
Westcliff-on-Sea
Essex SS0 7JG
Tel: (0702) 338878

Advertisement Manager
Terry Day
Classified Manager
Dennis Hill

Advertisement Offices
Electronics & Music Maker
Hillcroft House
16 The Avenue
Highams Park
London E4 9LD
Tel: 01-527 3376

Published by
Maplin Publications
282 London Road
Westcliff-on-Sea
Essex SS0 7JG
Tel: (0702) 338878

Distributed by
Cemas Limited
24 Bridge Street
St Ives
Huntingdon
Cambridgeshire PE17 4EG
Tel: (0480) 63942

Printed by
Eden Fisher (Southend) Limited

Typeset by
Quillset Typesetting

Subscriptions
Rates for 12 issues:
UK & Overseas Surface: £9.90
Europe: £11.64
Airmail: £25.20

Special Offers (Overseas)
LP — extra 56p on price
Cassette — extra 19p on price

CONTENTS

...RAN

...ARD SYNTHESISER

Cabinet size 24.6" x 15.7" x 4.8" (rear) 3.4" (front)

MORE KITS AND ORDERING INFORMATION ON PAGE 55

All projects on this page can be purchased as separate packs, e.g. PCBs, components sets, hardware sets, etc. See our free catalogue for full details and prices.

POWERTRAN ELECTRONICS

PORTWAY INDUSTRIAL ESTATE
ANDOVER, HANTS SP10 3WW

ANDOVER
(STD 0264) 64455

POWERTRAN

...200 100 WATT (rms into 8 ohm) MIXER/AMPLIFIER

...MPLETE KIT ONLY **£49.90** + VAT!

MATCHES THE CHROMATHEQUE 5000 PERFECTLY!

Panel size 19.0" x 3.5" Depth 7.3".

Featured as a constructional article in ETI, the MPA 200 is an exceptionally low priced — but professionally finished — general purpose high power amplifier. It features an adaptable input mixer which accepts a wide range of sources such as a microphone, guitar, etc. There are wide range tone controls and a master volume control. Mechanically the MPA 200 is simplicity itself with minimal wiring needed making construction very straightforward.

The kit includes fully finished metalwork, fibreglass PCBs, controls, wire, etc. — complete down to the last nut and bolt.

POWERT...

TRANSCENDENT DPX MULTI VOICE SYNTHESISER

Another superb design by synthesiser expert Tim Orr published in Electronics Today International

COMPLETE KIT ONLY **£299** + VAT!

Cabinet size 36.3" x 15.0" x 5.0" (rear) 3.3" (front)

The Transcendent DPX is a really versatile 5 octave keyboard instrument. These are two audio outputs which can be used simultaneously. On the first there is a beautiful harpsichord or reed sound — fully polyphonic, i.e. you can play chords with as many notes as you like. On the second output there is a wide range of different voices, still fully polyphonic. It can be a straightforward piano as a honky tonk piano or even a mixture of the two! Alternatively you can play strings over the whole range of the keyboard or brass over the whole range of the keyboard or should you prefer — strings on the top of the keyboard and brass as the lower end (the keyboard is electronically split after the first two octaves) or vice-versa or even a combination of strings and brass sounds simultaneously. And on all voices you can switch in circuitry to make the keyboard touch sensitive! The harder you press down a key the louder it sounds — just like an acoustic piano. The digitally controlled multiplexed system makes practical touch sensitivity with the complex dynamics law necessary for a high degree of realism. There is a master volume and tone control, a separate control for the brass sounds and also a vibrato circuit with variable depth control together with a variable delay control so that the vibrator comes in only after waiting a short time after the note is struck for even more realistic string sounds.

To add interest to the sounds and make them more natural there is a chorus/ensemble unit which is a complex phasing system using CCD (charge coupled device) analogue delay lines. The overall effect of this is similar to that of several acoustic instruments playing the same piece of music. The ensemble circuitry can be switched in with either strong or mid effects. As the system is based on digital circuitry digital data can be easily taken to and from a computer (for storing and playing back accompaniments with or without pitch or key change, computer composing, etc., etc.).

Although the DPX is an advanced design using a very large amount of circuitry, much of it very sophisticated, the kit is mechanically extremely simple with excellent access to all the circuit boards which interconnect with multiway connectors, just four of which are removed to separate the keyboard circuitry and the panel circuitry from the main circuitry in the cabinet.

The kit includes fully finished metalwork, solid teak cabinet, professional quality components (all resistors 2% metal oxide), nuts, bolts, etc., even a 13A plug!

SP2-200 2-CHANNEL 100 WATT AMPLIFIER

The power amplifier section of the MPA 200 has proved not only very economical but very rugged and reliable too. This new design uses 2 of these amplifier sections powered by separate power supplies fed from a common toroidal transformer. Input sensitivity is 775mV. Power output is 100 rms into 8 ohm from both channels simultaneously.

The kit includes fully finished metalwork, fibreglass PCBs, controls, wire, etc. — complete down to the last nut and bolt!

COMPLETE KIT ONLY **£64.90** + VAT!

MICROCHIP ORCHESTRA

Become an instant musician with this revolutionary new product

It's a new kind of musical instrument. A computer controlled synthesiser that helps you create, play and arrange compositions that normally take years of musical training.

A melody, played, or picked out slowly on the keyboard is recorded in a solid state memory. The length and tempo of keystrokes is captured, or you simply reset the entire timing using the unique 'one key play' facility. Then autoplay the tune with one of five instrument sounds and to one of ten rhythm backings or make subtle changes during playback to the melody sound and the percussion pattern.

Even if you have never played an instrument before, you can move to a level of musical ability that you never thought possible.

Digital recording and control

The breakthrough that makes it possible is the development of a dedicated VLSI. This Very Large Scale Integrated circuit contains the digital melody sound synthesiser, rhythm generator and note sequencing memory. As many as a hundred individual notes can be stored, even when the unit is switched off. Record the notes of your music, in real time, or one at a time. If you make a mistake, the delete key lets you edit quickly, using the numerical LCD display reference. On replay, the timing is simply altered to strict tempo or tap out the notes, one at a time, for live performance. Octave Shift lets you move pitch up or down and the Tempo control lets you speed the music up or slow it down. Nothing could be easier. The day of the one fingered musician has arrived!

Create new sounds

The five preset voices for the keyboard, range from percussive piano and guitar to the gliding tones of a fantasy, flute or violin. And in case you find that not enough, you can create your own instrumental sound in the ADSR mode. This gives you direct control over the digital synthesiser enabling the Attack, Decay, Sustain and Release characteristics, as well as vibrato and tremolo intensities to be programmed directly by entering an eight digit number. Over eighty million permutations are available. The possibilities of new sounds are only limited by your imagination.

Auto rhythm

A percussion combo, to complement your melody, is generated by the VLSI. There are ten rhythm patterns under your control. From a strict march to the nuances of a beguine. You can even change patterns mid music, creating a unique accompanying rhythm for your melody. And because the entire synthesiser is locked to the overall Tempo control, when you step this up or down, your recorded melody and the rhythm stay in time. Within a matter of minutes you can produce exciting arrangements to suit the mood of your music.

A personal recording studio

Playback through the built in speaker or take a lead from the output jack to a stereo system and you get a richer, fuller sound. Or connect it to a tape recorder, and mix in the sound of a microphone. Play along with your digital composition and produce jingles, demos or simply realise your undiscovered musical talents.

Create on it, learn on it, even do maths on it. Anywhere. The VL-Tone heralds a new era in personal music.

Try it for yourself

The most remarkable feature of this breakthrough product is it's **£35.95** price, which includes a complete manual, soft vinyl cover and a Song book full of easy to play melodies. The VL-Tone is manufactured by Casio, a world innovator in digital musical and number crunching products. Each unit is backed by their warranty, and also Turnkey's own guarantee of satisfaction; if within two weeks you are not completely delighted with what the VL-Tone can do, return it to us for a prompt and courteous refund.

To order a VL-Tone, send a cheque or money order for £35.95, (which includes VAT, post and packing) or call us with your Visa or Access credit card number.

Discover the sound of the future, by putting a microchip orchestra in your pocket. You can own the most amazing personal music instrument ever made. Order a VL-Tone at no obligation today, and awaken the creative music inside you.

turnkey

8 East Barnet Road, New Barnet, Herts. EN4 8RW. Telephone 01-440 9221.

ELECTRONICS & MUSIC MAKER

Enter the Age of Talking Computers!

It is always exciting for a magazine such as ourselves to produce a new project with an established electronics company. In this way, E&MM can provide designs that utilise the latest technology that normally would only be implemented in commercial products.

This should be of great benefit to our readers and our main project this month is the result of such a venture with Texas Instruments Limited at Bedford.

The 'Wordmaker' has so many applications that I shall await with great interest the suggestions and ideas that come from our readers. In the home, monitoring of information via hidden speakers in rooms — as well as talking games; in the car, warnings can be heard without taking your eyes off the road; in the studio and workshop, electronic control data can be vocally transmitted; and in the factory or office, messages can be announced.

by Mike Beecher, Editor
Electronics & Music Maker.

The electro-musician looking for new sounds to compose with will have plenty of fun 'mis-using' word addresses to create original vocal textures at different speeds.

In these early days of the magazine's growth, we are always looking for areas in electronics, computing and in particular, electro-music that would be of direct interest to our readers.

Our reviews, for instance, aim to provide the design engineer as well as the musician with new specifications and applications of electronic musical instruments — whether player or computer orientated — and the Fairlight CMI should inform you of the state-of-art system at present. There are plenty of developments taking place along the lines of the Fairlight and we shall be looking at these in due course.

Another new feature this month is the review of an electronic music lecture and we invite readers who attend an informative lecture or concert to submit their own summary of the event (along with some photos).

Finally, on a general note, E&MM is now reaching many parts of the world and I must personally give my thanks for the tremendous encouragement and enthusiasm from our readers and from many companies in the electronics and music industries.

Mike Beecher

Letters

Send to: Reader's Letters, Electronics & Music Maker 282 London Road, Westcliff-on-Sea, Essex SS0 7JG.

Dear Sir,
May I first congratulate you on the launch of your new magazine Electronics & Music Maker which fills a long felt need for people like myself who are electronic hobbyists with a strong interest in musical instruments.
A colleague and myself have both started building electronic organs and have completed all the cabinet work and mechanical construction including two 48-note keyboards with contacts.
We have also already made power supplies and amplifiers, but have left all the rest of the electronic circuitry until last because of the rapid advance in technology, and have been at a loss for a choice of suitable ICs.
Now, in the first issues of your new magazine is the answer to all our problems, with the publication of details of this fantastic circuit.
What I wish to know is when the kits become available, will it be possible for us to purchase parts of the kit separately?
For instance: the main circuit board with all components and any other sub-assemblies which I may consider necessary for the completion of my organ.

A. W. Button
Corby, Northants

We have many enquiries each month regarding the Matinée Organ. The following information should be of assistance.
The full kit will be available from Maplin Electronic Supplies, as described in their advertisements, when the complete constructional details for the electronics have been published (expected to be in June). Kit 'packs' will not be available separately, but of course all parts can be bought as individual items. Purchasing the full kit (with or without cabinet) will save a considerable amount of money.
If you are a beginner in electronics construction we suggest you wait until the last article before commencing the project. You will then have a better understanding of what is entailed and can ensure you can tackle all the stages before you start — but we hope that the project is presented so that anyone with some knowledge of soldering can build it.
E&MM's demo cassette No. 1 provides examples of sounds from the prototype version. Two 'full spec' models are now being completed with improved roll-top cabinet and will be shown at the Southend and Hammersmith Maplin shops in due course. A complete demonstration cassette of the Matinée will also be produced.

Dear Editor,
Congratulations on the first two issues of your splendid new magazine — it's just the thing we have all been waiting for.
Congratulations also for the most brilliant concept of a demonstration cassette to go with the reviews and articles in the magazine. This is a major breakthrough and quite unique in my experience — keep it up.
Brickbats and a hearty black mark for your first issue special offers. The BBC record was, of course, magnificent. BUT the nasty Korean-made Pliers and Side-Cutters (worth over £8.00!) You should really be ashamed of such a con. Try as I might I cannot get my Side-Cutters to cut anything! Perhaps there is a mistake and I was sent a dud pair. I hope so — for the sake of all your fans.

B. Saunders
BBC Producer, Berkshire

A new set of Pliers and Cutters is on its way to you. Several thousand sets have been sold without faults.

Dear Editor,
I eagerly awaited your new magazine (in March) and was delighted when it arrived. Many thanks but please don't let computer topics take over! There are quite enough of these in other magazines.
One small point, reference April edition, page 11 Figure 2, you do not list the transistor types — only ICs. What are they please?

K. A. Mason
Bedford

Spectrum Synthesiser: TR3 is a 2N3819, TR4 is a BC182L, TR5 is a BC212L.

Dear Sir,
I was very interested in two of the items presented in your article about the Frankfurt 'Musik Messe' (April issue).
Could you possibly forward to me an address where I might possibly obtain further details about the electronic drum kit — the SDSV from Dave Simmons.
I would also be very grateful if you could provide me with information as to how I might get further details about the DHM 89B2 stereo audio computer.

E. A. Reader
Bedworth, Warwickshire

The Dave Simmons drum kits come from Musicaid, 176 Hatfield Road, St Albans, Herts AL1 4JG, England.
The DHM 89B2 will shortly be reviewed by E&MM and information is available from Publison Audio Professional, 5,7,11 rue Crespin du Gast 75011, Paris.

Dear Sir,
Have a heart!
Your magazine is good, too good; my boyfriend isn't big enough for the two of us and I am the one that's had to leave town.
Yours rejected

Julia Deans
Middlesbrough, Cleveland

Dear Sir
I enjoy your magazine very much, especially the section on computing and particularly Peter Kershaw's series 'Using Microprocessors' which I rate as the best written and most informative material on the subject I have read anywhere.
It is a great pity, however, that Keith Manison's article 'Programming Microcomputers', in the April issue, was mutilated to the extent of becoming unintelligable. I got into difficulties on the second page and became thoroughly confused on the fourth page. I then realised that large chunks of text had been transposed and, with the aid of some experience in computing though not with microprocessors, I got it sorted out and inserted GOTO's at four points to get things in the right order.
There must be many beginners amongst your readers who have been bemused rather than instructed by this otherwise excellent article.

H. P. Evans
South Benfleet, Essex

The error occurred between type proofing and pagenation, and was therefore an unfortunate transposition of two sections that every publisher, including ourselves, tries to avoid.

Dear Mike,
We're still here working on the new album at Conny Plank's Studio, everything is going very well. Brain damage has escalated to the point where it exactly balances with the creative output. We've used the E&MM Syntom on the LP although I'm not so sure you'll pick it out from the rest of the percussion! Thank you for the great piece in the magazine, it was very well done. I wish both you and the magazine all the best wishes for the future.

Warren Cann, Ultravox
Neunkirchen, Köln, Germany

by Raj Gunawardana, Texas Instruments Ltd.

★ E&MM brings you the first major Solid State Speech project for under £100!

★ Promises to have a dramatic impact on state-of-the-art electronics — now, and for generations to come

★ Complete talking library of over 200 words with further expansion space

★ Easy interfacing to a microcomputer through a few lines of BASIC

★ Pitch control has exciting electronic music applications

RECORDED ON CASSETTE NO. 2

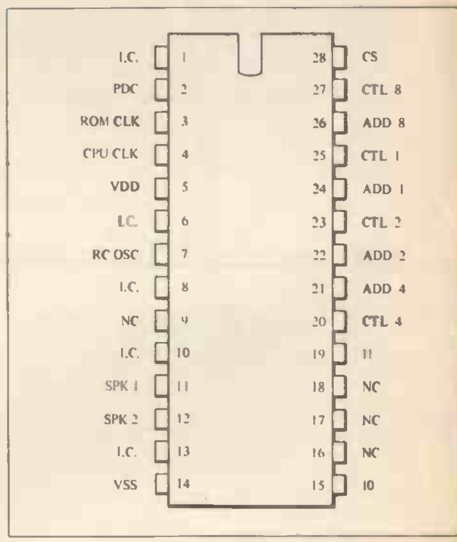


Figure 1. TMS 5100 pin details.

For some ten years Texas Instruments have been developing solid state speech technology with the result that speech can now be produced which faithfully preserves the character of the spoken voice including intonation, accent, dialect, and pitch. Linked to a microcomputer, words can be strung together to make complete phrases and sentences so that voice communication between 'computer' and human becomes possible.

The uses of this project are far-reaching and will be of benefit to almost anyone who uses it. The carefully selected word library has many applications in the home and industry, for telephone, burglar alarms, conversations, messages, games, electronic terms, studio control, speaking clock, temperature indication, calendar, business coding, factory announcements, and accountancy.

This month we shall present the complete building project which can be purchased as a kit and explain how to interface the WORDMAKER board to a microcomputer. Possible interface circuits are included and BASIC programs are also given. It has already been fully tested on the Sharp MZ-80K and Tangerine systems. Further details are provided later for other popular micros and we shall be following this article with additional information on the processes of speech synthesis employed, and readers' ideas for interfacing and use will be welcomed.

The E&MM WORDMAKER Speech Synthesiser is based on the Texas Instruments Voice Synthesis Processor (VSP). This card can be interfaced to any computer system or used as an independent unit. The card comprises the Texas TMS 5100 Voice Synthesis Processor, a memory bank containing the vocabulary and an on-board amplifier.

INSTRUCTION NAME	CTL PINS 8	4	2	1	TOGGLES OF PDC REQUIRED
RESET	0	0	0	X	1 (3 ON POWER UP)
LOAD ADDRESS	0	0	1	X	2
READ and BRANCH	1	1	0	X	1
SPEAK	1	0	1	X	1
TEST BUSY	1	1	1	X	3
READ BIT	1	0	0	X	1
OUTPUT	0	1	0	X	3

X – DON'T CARE

Table 1. The TMS 5100 VSP Command Summary.

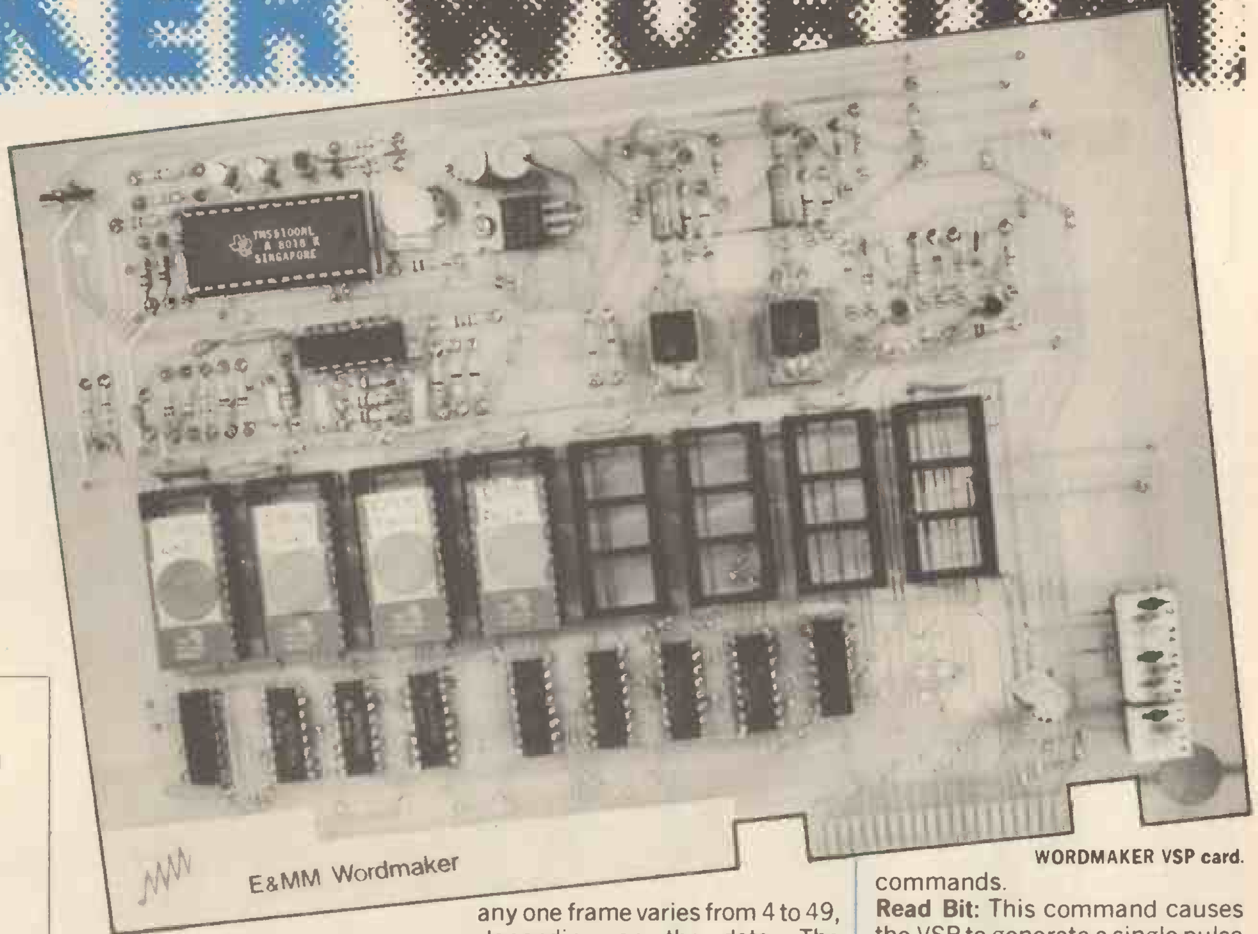
The synthesis method used is called Linear Predictive Coding (LPC). This is a technique developed by Texas which minimises the amount of storage needed for each word. Human speech, like most communication signals, contains a large proportion of redundant information. LPC involves looking at the complete word as a binary data string and removing any redundant data. The coding is then tested to check that the word is spoken satisfactorily. The TMS 5100 contains a 10-pole digital

MAKER WORDM

ATTACK

SWITCH CONTROL TO ZERO

IT IS NOW SEVEN O'CLOCK



WORDMAKER VSP card.

NC — NO INTERNAL CONNECTION
IC — INTERNAL CONNECTION
CS — CHIP SELECT
CTL (1,2,4,8) — CONTROL LINE (1,2,4,8)
PDC — PROCESSOR DATA CLOCK
ADD (1,2,4,8) — ADDRESS/DATA (LINE) TO ROM
I (0,1) — CONTROL LINES TO ROM
CPU CLK — CONTROLLER SYNCHRONISATION (320kHz) CLOCK
ROM CLK — 5100 O/P TO V/S ROM (160kHz)
SP (1,2) — DIFFERENTIAL AUDIO OUTPUT

filter which synthesises the voice; the filter is controlled by the LPC data. For each word sample, the length of the data string written to the TMS 5100 may vary from 4 to 49 bits. The device, therefore, requires quite a high level of 'intelligence'.

The Heart of the System — TMS 5100

The TMS 5100 has five control lines. The command is set up on the CTL lines and executed by toggling the command clock line, PDC.

Table 1 shows the complete list of commands and Figure 1 gives the pin configuration of the IC.

Load Address Command: This command causes the VSP to accept a subsequent nibble (4-bits) of data set up on CTL lines as a speech address segment which is transferred to voice synthesis (V/S) ROM address registers.

Read and Branch: This instructs the VSP to set up appropriate control signals to the V/S ROM, causing it to update its address registers with the contents of the currently addressed pair of bytes.

Speak: On receiving this command, the VSP takes over the control of the V/S ROM and generates pulses on its I/O line to fetch bit serial data from ROM and commences speech. Pulses on the I/O line occur in bursts of a frame interval of twenty-five milliseconds. The number of pulses in any one frame varies from 4 to 49, depending on the data. The timing of I/O pulses for a maximum length of 49 bits, is shown in Figure 2. Details of the data structure will be discussed in a future article.

Test Busy: This command permits the controller to access the TALK STATUS LATCH of the VSP. In operation the command is first set up on CTL lines and the PDC line toggled once. A subsequent toggle of the PDC line enables the Talk Status to be output to CTL1 line. The Talk Status will be high during the execution of speech generation and will be set low on an END OF PHRASE code being encountered. A third toggle of the PDC line is required to return the VSP to a state of accepting new commands.

Read Bit: This command causes the VSP to generate a single pulse on the I/O line and thus read a single bit of data. Each data bit read is input via the ADD8 line to a 4-bit shift register in the VSP. Hence four consecutive read operations are required to completely update the shift register contents.

Output: On receiving this command the VSP is initialised into outputting its buffer contents on to the CTL lines. A second PDC toggle enables the CTL output buffers and a third is required to return the VSP to the command mode. The output command coupled with Read Bit thus allows the controller to access auxilliary data stored in the V/S ROM.

Reset: This command is used to establish known initial conditions in the internal circuitry of the VSP, in readiness for a following sequence of commands. Since the CTL lines convey data as well as commands to the VSP, when previous conditions are not known, it is possible that a command can be conveyed as data. Hence, it is necessary to toggle PDC at least three times, whilst maintaining the Reset command on CTL lines, to ensure correct synchronisation of subsequent commands. Reset can be used in the middle of speech to stop VSP execution.

In the circuit design discussed in this article only the Reset, Test

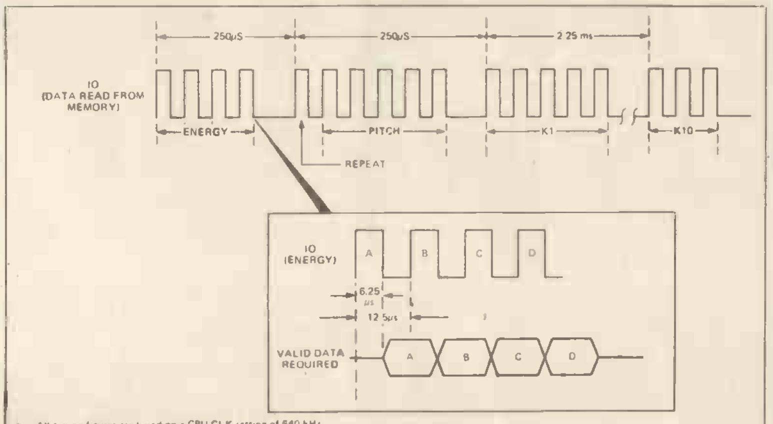


Figure 2. IO Pulse and data input to TMS 5100 in Talk mode.

Busy and Speak commands are used.

Interfacing the VSP Design Considerations

The following requirements have been considered in interfacing the TMS 5100 to a microcomputer to operate as a speech peripheral:

(1) SPEECH DATA MEMORY should have means of serial data output and an auto-incrementing address register for sequential data access.
(2) SPEECH DATA ADDRESS should be pre-setable from the host processor to define current enunciation required.
(3) THE CONTROL INTERFACE should be consistent with device specifications (of TMS 5100).
(4) ALL SIGNAL LEVELS to and from the controller should be TTL compatible.

As far as speech data memory is concerned, two approaches can be made in implementation:

(1) Speech data can be stored externally to the processor in non-volatile memory for stand alone operation.
(2) Speech data can be supplied from within the processor with synchronisation to suit the TMS 5100 timing (see Figure 2).

The circuit discussed in this article takes the first approach, to achieve stand alone operation. Figure 3 shows how the VSP could be interfaced to a microcomputer by implementing a direct data path between the address counter and the controller, instead of via the TMS 5100 CTL lines. This feature avoids the neeed to decode various commands (e.g. Load Address), to maintain a record of command sequences and to build up the contents of the address registers, one nibble at a time.

Speech data memory can, in theory, either be non-volatile or Random Access Memory (RAM). If memory comprises RAM, it would be possible to 'overlay' speech code read out from a slow bulk storage peripheral such as floppy disc or cassette tape. The circuit discussed in this article, however, uses a choice of EPROM types for speech data storage.

Practical Implementation

Figure 4 shows a practical circuit designed in accordance with the architecture discussed. The circuit is designed to be driven from a byte oriented bus and requires a number of control bits to clock data and to monitor VSP busy conditions. Once commanded to TALK, the circuit will operate independently of the processor to generate a single utterance. Concatenation of such utterances has to be carried out by the host processor.

The Control Interface

The control interface comprises four lines named C0, C1, CCLK and BUSY. C0 and C1 are used to set up three commands on CTL2, CTL4 and CTL8 lines, as shown in Table 2. Transistors TR1,

COMMAND	C0	C1
RESET	1	1
TALK	0	1
TEST BUSY	0	0
INVALID	1	0

Table 2.

TR2 and TR3 are used to convert TTL levels to drive voltages suited to the TMS 5100. CCLK is used to clock commands set up on C0 and C1 lines into the VSP. The VSP clock line, PDC, has to change synchronously with the VSP ROM clock line. This is achieved by the use of IC2b as a synchroniser. The CCLK line should therefore be held high for a minimum duration of 6.25 micro-seconds to guarantee that a command would be accepted by the VSP.

The busy line can be used in one of two ways to monitor the end of an utterance. During speech and when the CTL1 line is in a disabled state, the BUSY line will be low, producing a high level only when CTL1 is enabled and subsequent to encountering an END OF PHRASE code. Hence, the host processor can be made to monitor the BUSY line until a high level is detected. Alternatively, more efficient use of the host processor can be achieved by using the positive-going edge of the BUSY signal to generate an interrupt.

Speech Address Buffer/Counter

The address counter comprises four 74LS193 ICs which are 4-bit binary counters with parallel loading capability (IC4-IC7). The starting address is loaded from the data input lines D0-D7, in two stages. Applying a low logic level to LDA1 causes the less significant byte of the counter (IC6 & IC7) to be loaded with data set-up on input lines D0-D7. Applying a low logic level to LDA0 loads the more significant byte of the counter.

Byte address incrementing pulses are derived from IC8 which is programmed as a module 8 counter. IC3b is clocked

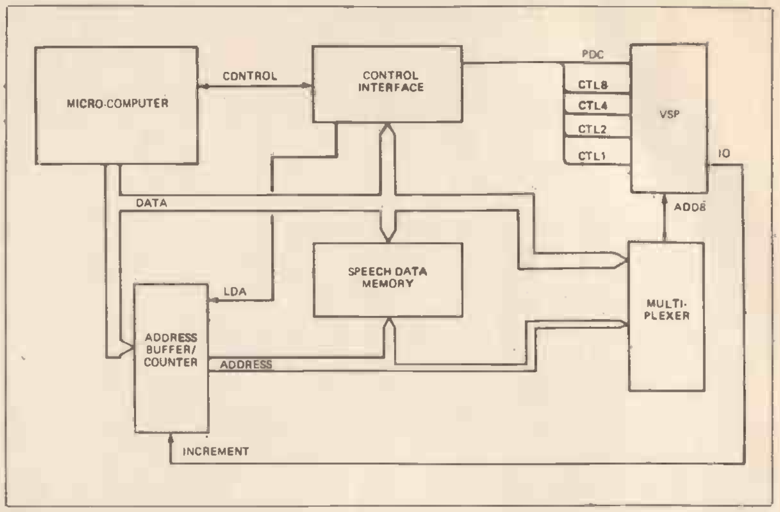


Figure 3. VSP interface.

LINKS USED	IC NO.	SPEECH ADDRESS MAP
LK 2	12	0-7FF (0-2047)*
LK 6	13	800-FFF (2048-4095)
LK 7	14	2000-27FF (8192-10239)
LK 9	15	2800-2FFF (10240-12287)
	16	1000-17FF (4096-6143)
	17	1800-1FFF (6144-8191)
	18	3000-37FF (12288-14335)
	19	3800-3FFF (14336-16383)

*Decimal Values

Table 3. Speech memory address mapping for TMS 2516.

LINKS USED	IC NO.	SPEECH ADDRESS MAP
	12	0-FFF (0-4095)*
LK 1	13	1000-1FFF (4096-8191)
LK 6	14	2000-2FFF (8192-12287)
LK 8	15	3000-3FFF (12288-16383)
LK 10	16	4000-4FFF (16384-20479)
	17	5000-5FFF (20480-24575)
	18	6000-6FFF (24576-28671)
	19	7000-7FFF (28672-32767)

*Decimal Values

Table 4. Speech memory address mapping for TMS 2532.

LINKS USED	IC NO.	SPEECH ADDRESS MAP
LK 1	12	0-1FFF (0-8191)*
LK 4	13	8000-9FFF (23768-40959)
LK 9	14	2000-3FFF (8192-16383)
LK 11	15	A000-BFFF (40960149151)
	16	4000-5FFF (16384-24575)
	17	C000-DFFF (49152-57343)
	18	6000-7FFF (24576-32767)
	19	E000-FFFF (57344-65535)

*Decimal Values

Table 5. Speech memory mapping for TMS 2564.

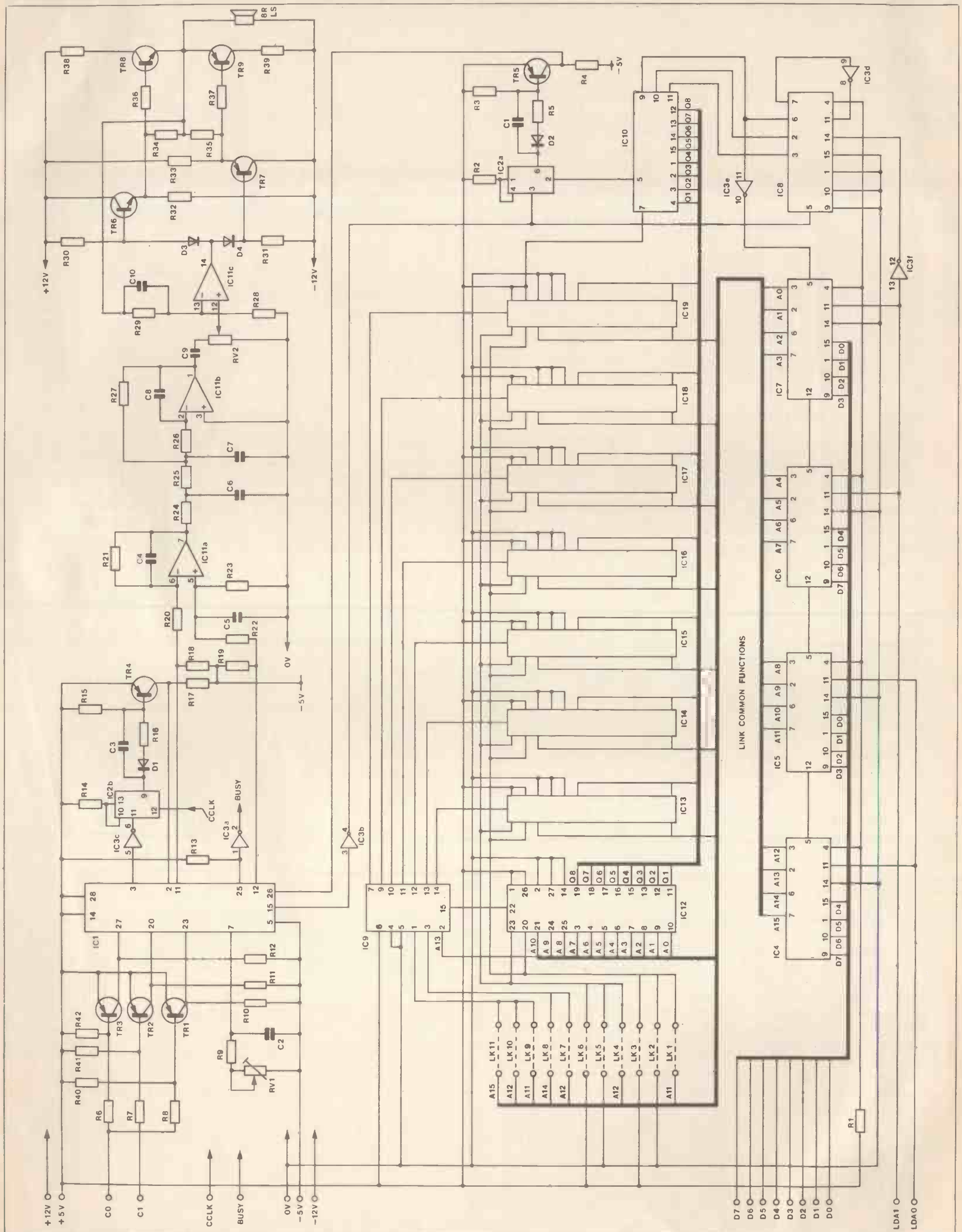


Figure 4. WORDMAKER complete circuit diagram.

with pulses generated by VSP on I/O line. IC3b is used to invert the I/O line and as a buffer to provide greater fan-out capability. This results in IC8 incrementing its contents on the negative edge of the I/O pulse and consequently keeping track of bit-count, at a byte level, for accessing bit serial speech data. At the commencement of speech, speech data is output starting with least significant bit of the first speech data byte. Hence, IC8 is cleared every time a new address byte is loaded into the less significant byte of the address counter. The 16-bit address counter permits a maximum speech memory capacity of 64K bytes. The total capacity of the memory can be expanded by using extra counter stages, if required. A 64K byte memory will store approximately 600 spoken words.

Speech Data Memory

In the circuit shown speech data can be stored in TMS 2516 (16K-bit), TMS 2532 (32K-bit) or TMS 2564 (64K-bit) EPROMs, by wiring an appropriate set of links. Tables 3, 4 and 5 show the links required for each EPROM type and the resulting memory maps.

Serial data is derived by the use of a 74LS151, an eight-to-one line multiplexer. IC10 data input is fed from the data output of EPROMs. The select input of IC10 is obtained from IC8 which maintains a module-8 count which is incremented once, when a single data bit is accessed by the VSP. The output of the multiplexer is conveyed through IC2a which is used as a single-bit 'shift-register' clocked by I/O pulse. The purpose of IC2a is to synchronise serial speech data such that data requested by a particular I/O pulse (see Figure 2) is stored unchanged despite the bit count and the memory address changing as a result of address incrementation.

Audio Signal Conditioning

IC11, a quad-operational amplifier is used to condition the differential audio output of the VSP (SP1 and SP2) into a form suitable for driving a general purpose 8-ohm speaker. IC11a converts the differential push-pull output current into a single-ended voltage output. This signal is then low pass filtered by the active filter comprising IC11b to get rid of any harmonic distortion, generated by the 8KHz sampled output from the D to A converter.

The third-stage of the op-amp is used along with transistors TR6-9, to provide power amplification. The amplifier is capable of producing up to 4.5 Watts of audio power into an 8 Ohm speaker. At

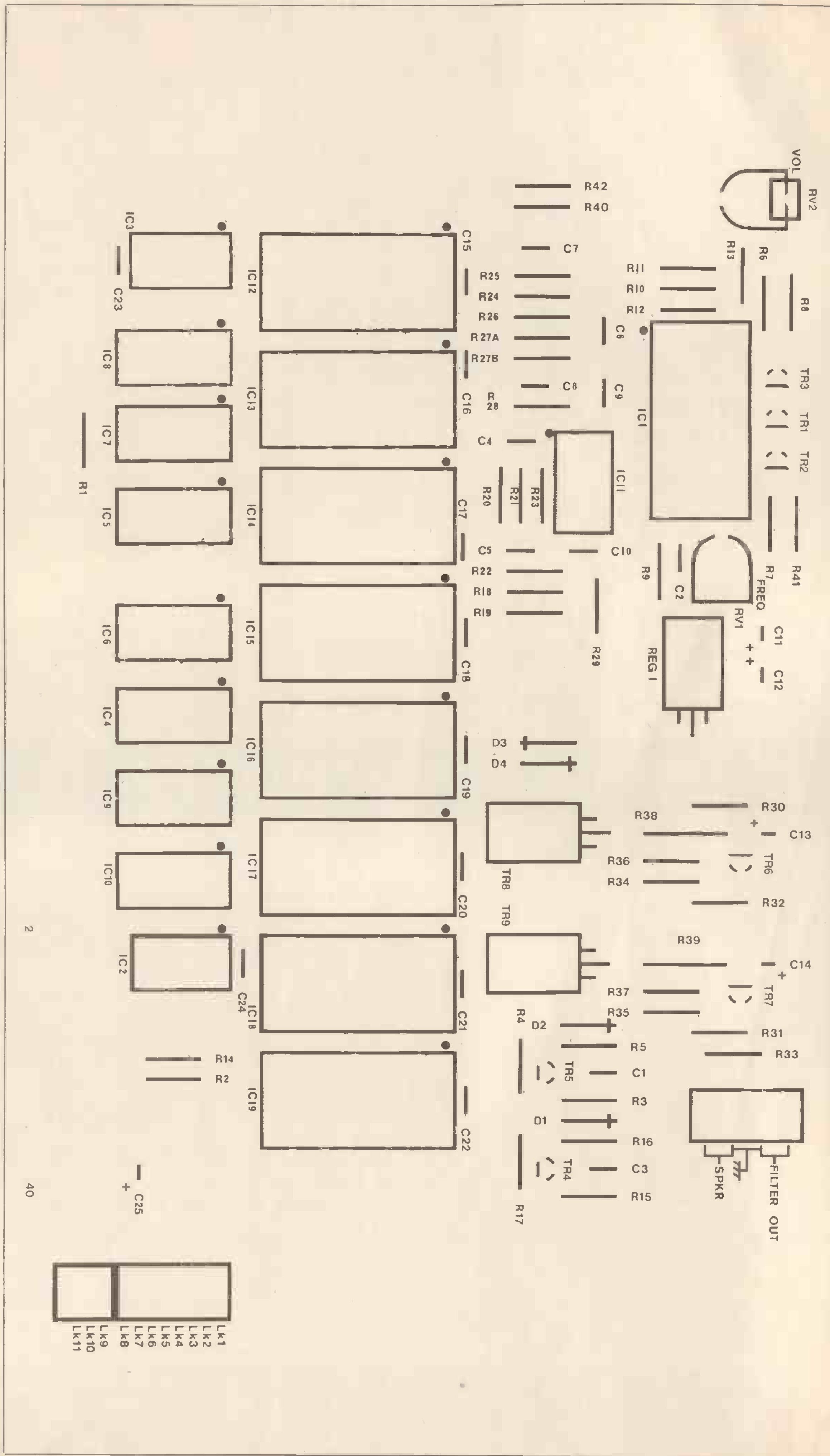


Figure 5. Component overlay.

PERSONAL SERVICE FROM SHARP'S BIG DEALER

SHARP MZ80K 24k £389+VAT
SHARP MZ80K 48k £439+VAT

COMING SOON!

4MHz SUPER CPU — LIGHT PEN — RTTY TRANSMIT/RECEIVE PEN

Write for full details and our latest newsletters

KNIGHTS COMPUTERS

108 ROSEMOUNT PLACE, ABERDEEN
TEL.: 0224 630526

BUILD AND LEARN

Kits which have PROVED themselves!

Forgestone 500 TELETEXT

High quality colour television receiver

NEW INFRA-RED FULL FEATURE REMOTE CONTROL TELETEXT

- ★ Pin diode tuner
- ★ Glass epoxy printed circuit panels
- ★ Full technical construction manual
- ★ Hi-Bri tube
- ★ Eleven integrated circuits
- ★ Ready built and aligned IF module saw type
- ★ High quality components
- ★ Modern cabinets
- ★ All solid state
- ★ Fully isolated and protected power supply
- ★ Diode split L.O.P.T.
- ★ Low consumption
- ★ Also ideal as a FULLY isolated COLOUR MONITOR for Home Computer Systems. R.G.B. or PAL Encoded Video Inputs, with remote switching.

THE ULTIMATE in large screen 22" and 26" television receiver kits. Deluxe full spec. Teletext, 7 channel + VCR. Also video and audio in/out. 6 models in the 500 range.

Buy as you build. All Forgestone Kits are for the constructor of today, sections of the Kit are available separately. Please send stamp for further details of these quality products.

Telephone or Mail Orders accepted on Access/Barclaycard

forgestone colour developments limited

Ketteringham, Wymondham, Norfolk NR18 9RY
Telephone: Norwich (0603) 810453

Some day all power amps will be made this way

THE POWERFET AMPLIFIER

We sell electronic components too................at unbeatable prices. send SAE for lists.

IT GROWS!

+

=

PFA 80
(100W plus into 8Ω)

Elegant Simplicity
Advances in high technology should make life simpler. A cluttered power amplifier board may well perform superbly, but its busy elaboration is an indication that its design is pushing the limit of its component technology.

There are now many first class bipolar power amps on the market. All of them are complex and consequently expensive. Any additional improvements in the areas where they are weak (e.g. H.F. distortion) can only be obtained with yet further complexity and cost.

Only a new technology can provide the sort of "quantum jump" in component performance necessary to reduce the clutter on the board, reduce the cost and make the highest fi once more affordable.

Powerfets
So far 29 semiconductor manufacturers have invested In this new technology. Clearly powerfets are something special.

Their enormous power gains eliminate conventional drive circuitry in power amps, permitting delightfully simple designs. Their freedom from secondary breakdown and their tendency to shutdown when thermally overstressed, result in inherently stable and destruction-proof output stages, not needing protection circuitry. And perhaps best of all, their lack of charge storage make them fast and responsive, producing amplifiers of wide bandwidth and low distortion even at high frequencies.

PFA80/120
The PFA is perhaps the perfect realisation of the classic powerfet amp design. The superb P.C.B. allows the use of either one or two pairs of output devices, providing easy expandability for those starting with the smaller system. (The extra cutput pair of the PFA120 results in lower distortion and improved efficiency, particularly into low impedance loads).

The components used in the PFA have been chosen with extreme care. The lowest noise input devices and lowest distortion gain stage devices were selected regardless of cost. 140V powerfets were cosen against the more usual 120V to give improved safety margins.

Specification	PFA80	PFA120
Bandwith	10hz —	100KHz± 1dB
Output Power R.M.S. into 8Ω	80W (Vs=± 50V)	120W (Vs=± 55V)
THD (20Hz—20KHz)	≤0.008%	≤0.005%
(KHz at rated output)	0.004% typ.	0.002% typ.
SNR	120dB	
Slew Rate	>20V/µS	
Gain	X22	
Rin	30K	
Vs max	±70V	
Cost		
(built)	£15.95	£22.85
(kit)	£13.95	£20.85

PFA 120
(150W plus into 8Ω . 300W INTO 4Ω)

Pre-amp PAN 20
The design is unique. Equalisation is applied after a flat gain stage, resulting in one of the best noise performances available. Superb overload figures are ensured by a front end incorporating a special gain/attenuator control (volume control to you!). The inputs are uncommitted and can be used with any, combination of signal sources in the 1mV to 10V range. RIAA equalisation is provided for mag PUs and space on the board is available for different equalisations.

Specification

B.W.	20Hz-30KHz ± 1dB
THD 'at rated o/p	0.003% typ.
SNR	85dB (ref. 5mV RIAA) 105dB (ref. 100mV flat)
Vs	± 20V
Output	1V (clips at + 20dB)
Cost (built board less controls)	£4.75 2 needed for stereo

Power Amp PAN 1397
A high quality 20W power amp board based on the HA1397. Easily modified for bridge operation, providing high powers from low supply voltages.

Specification

Output power RMS	20W into 8Ω at ± 22V 20W into 4Ω at ± 19V
THD	0.02% at 1KHz 1W to 12W
SNR	90dB
Input	100mV into 50K
Cost (Built)	£5.80

"VAT inc. prices. P&P 40p or 75p with PFA. Power supply components available."

FROM THE POWERFET SPECIALISTS

J. W. RIMMER

Mail order only to – Technical enquiries

148 QUARRY STREET, LIVERPOOL L25 6HQ. Tel: 051 428 2651
367 Green Lanes, London N4 1DY
01-800 6667

E&MM/4

PIN	SIGNAL	PIN	SIGNAL
20	D0	17	GND
22	D1	15	GND
14	D2	13	GND
16	D3	11	GND
18	D4	9	GND
10	D5	39	GND
12	D6	37	GND
24	D7	35	GND
26	LDA0	33	GND
28	LDA1	31	GND
32	C0	29	GND
34	C1	27	GND
36	CCLK	25	GND
38	BUSY	23	GND
1	+12V	21	GND
2	-12V	19	GND
3	+5V	5	GND

Table 6. Edge connector detail.

this power rating, it will be necessary to mount TR8 and TR9 on heatsinks to maintain devices within operating temperature. At reduced power levels, the heat sinking area etched on the PCB should be adequate for normal operation.

Power Supply Requirements

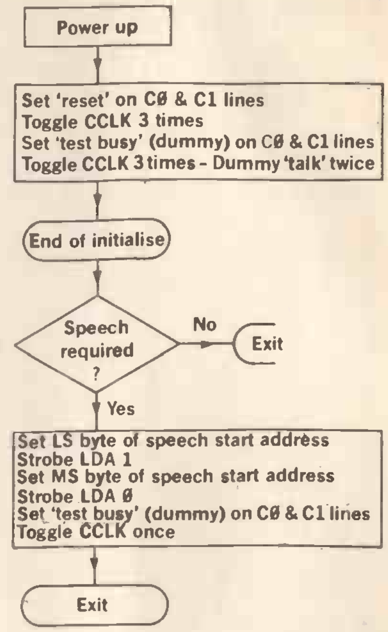
Figure 6 shows the distribution of power supplies in the circuit. The negative 5 volt supply is generated on the PCB, by using REG1 (voltage regulator) and tapping on to the negative 12 volts supply. Typical power requirements (for a board fully populated with TMS 2532 EPROMs) are +5V @ 300mA, +12V @ 50mA, -12V @ 50mA without any audio output.

Speech Data EPROMs

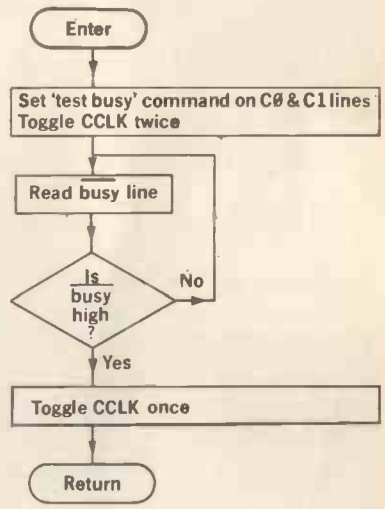
Table 7 gives the speech starting addresses for data in the PROMs provided as parts of the kit. EMM1, EMM2, EMM3 and EMM4 should be plugged into IC sockets IC12, IC13, IC14 and IC15 respectively. The links should be connected according to Table 4 (i.e. same as for TMS 2532 EPROMs). In the kit SPST DIL switches are provided for this purpose.

Construction and Setting Up

Figure 5 shows the component overlay for the circuit. The first step is to fit all the necessary links between the two sides of the PCB (using Track pins or small lengths of wire). Care should be taken when soldering on this board as the tracks are fine and often very close together. The resistors and capacitors can then be fitted, followed by the diodes, soldering both sides where necessary. Next, make all the IC sockets using Soldercon connectors and again solder to both sides of the PCB where necessary. Having completed these stages you can fit the transistors, the voltage regulator (REG1) and IC11. The power transistors (TR8, TR9) and the negative 5 volt regulator should be positioned flat as shown in Figure 5 and bolted on to the PCB to achieve good thermal dissipation.

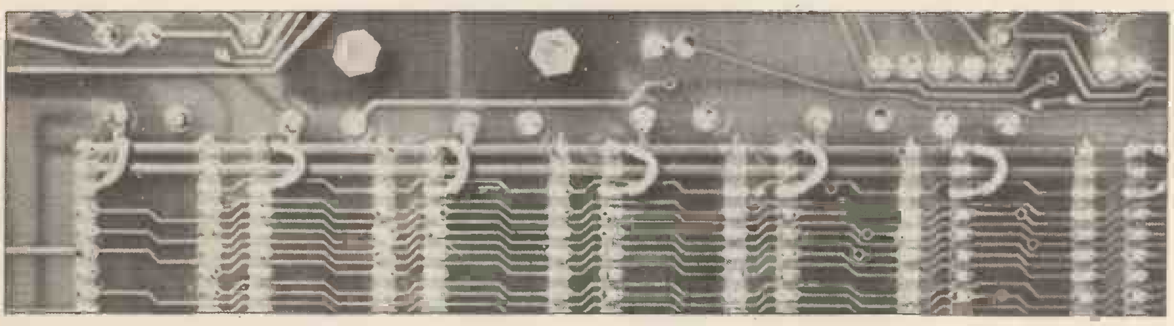


a) Simple Flowchart.



b) Talk with BUSY check.

Figure 7.



Wire links in place for EPROMs supplied.

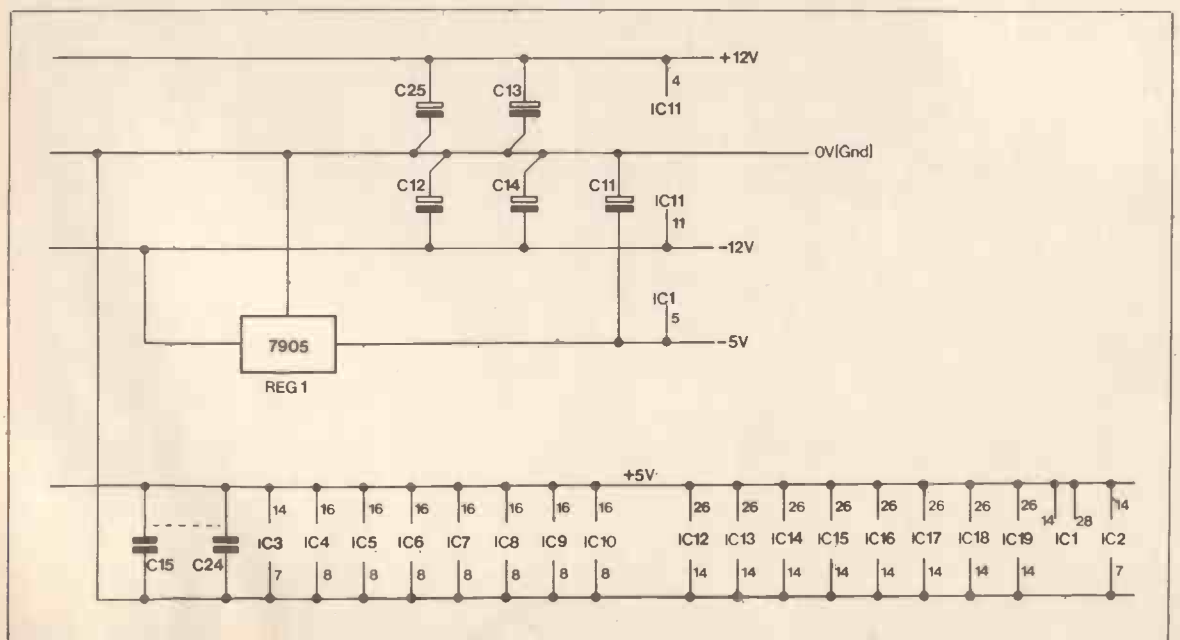


Figure 6. Power supply distribution.

Before you plug in any more ICs, connect a low impedance speaker and power up the card (connection details are shown in Table 6). Check the supply currents and voltages (the current should be approximately 50mA on +12V lines and negligible on the +5V line). Next, check the amplifier is operating. If all is well you can proceed and fit the rest of the components.

The pin numbers given in the circuit diagram are correct for the TMS 2564 only. TMS 2532 and TMS 2516 ICs have 24 pins compared with 28 pins for the TMS 2564. The signal lines match when the lower 24 pins of the 28-pin configuration are used (i.e. pin numbers 1, 2, 27 & 28 are not used).

Note: When using 24-pin packages you must link pin 28 to pin 26 on ICs 12-19 (see photo).

For correct speed of operation the TMS 5100 internal clock frequency should be adjusted

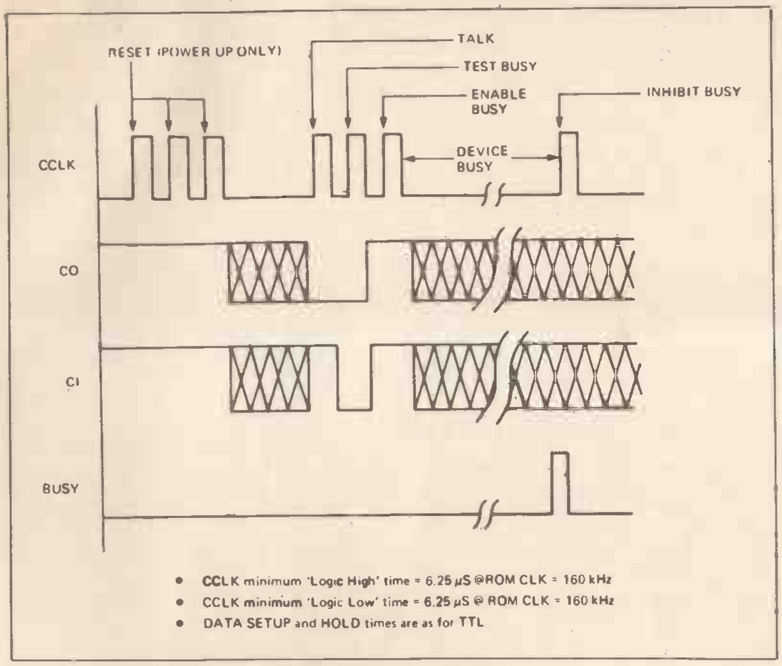


Figure 8. VSP Interface control signal timing.

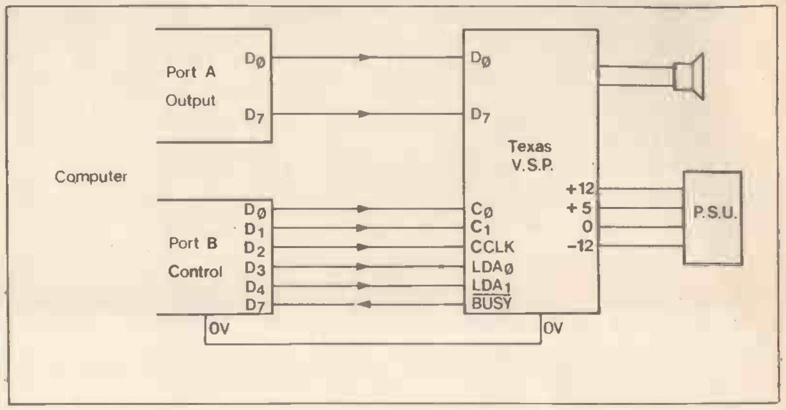
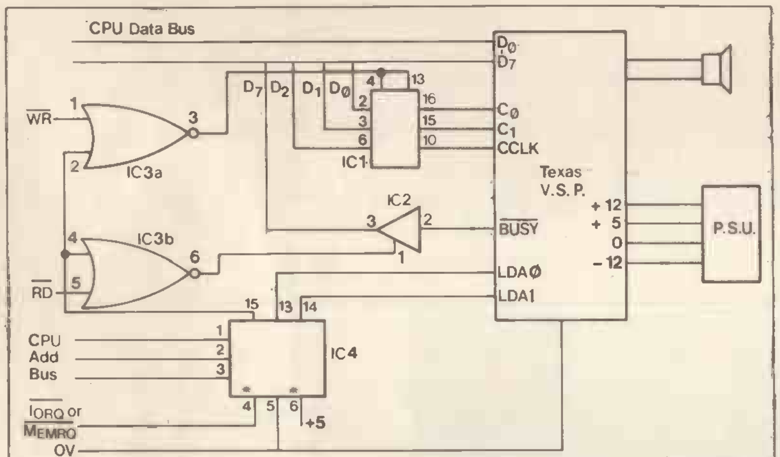


Figure 9. Connection to a standard PIO/PIA Port.



*If the control signals are 'active low' use circuit as shown.
If control signals are 'active high' then connect pin 4 to 0V and the control signal (IORQ or MEMRQ) to pin 6.
IORQ=IN/OUT REQUEST
MEMRQ=MEMORY REQUEST

IC1	74LS75	Pin 5 +ve	Pin 12 0V
IC2	74LS126	Pin 14 +ve	Pin 7 0V
IC3	74LS02	Pin 14 +ve	Pin 7 0V
IC4	74LS138	Pin 16 +ve	Pin 8 0V

Note: Figure 10 circuit design will require careful reference to the addressing data, etc. of your particular micro system. The programming will be different from the Sharp routines in this article.

Figure 10. Purpose-built interface (memory mapped or I/O addressed).

with RV1 to obtain a square wave of period 6.25us (a frequency of 160KHz) at ROM CLK (pin 3) of IC1. The correct adjustment is nominally midway on RV1. If instruments for adjustment are not available, good results can be obtained by listening to the speech output and making the adjustment such that the output sounds 'normal'.

Care should be taken in handling the TMS 5100 which can be damaged by static discharges.

The kit of parts does not contain an edge connector. The RS467-425 20-way, double edge connector is suitable and instead of Veropins for soldering the speaker connections, the screw connector socket (RS423-762) can be used (both available from Radio Spares). A suitable Power Supply circuit diagram for the WORDMAKER is shown in Figure 11.

Now you know all about the E&MM WORDMAKER but is it any use to you? The all-important question is 'Will it interface to my microcomputer?' Well, here is a simple guide to give you some idea. List 1 contains all the popular systems which can be used with available modules. List 2 contains all the popular microcomputers which will drive the WORDMAKER if a simple dedicated interface is used such as the one shown.

LIST 1

Sharp MZ-80K with parallel I/O card and expansion unit
Nascom 1 & 2 as standard
Apple/ITT 2020 with parallel I/O card
Commodore Pet with parallel I/O expansion
Atari 400 & 800 with parallel I/O expansion
Tangerine Micron as standard
Acorn as standard
Video Genie with parallel I/O expansion

LIST 2

MICROCOMPUTER	ADDRESSING MODE
Sharp MZ-80K	I/O mapped
Tandy TRS 80	I/O mapped
Sinclair ZX80/81	I/O mapped
Apple/ITT 2020	memory mapped
Commodore Pet	memory mapped
Atari 400 & 800	memory mapped
UK 101	memory mapped
OHIO Superboard	memory mapped

Using the Wordmaker

Communication with the VSP card is carried out through two ports; one to supply the address of the word-defining data in the V/S ROM, and the other to set the various control functions. There are two preset potentiometers on the card; RV1 controls the speed and pitch of the voice; RV2 controls the volume of the on-board amplifier. All the connections on the board are TTL compatible for easy interfacing (see Figures 9 and 10).

The VSP card is very simple to use and the flowcharts in Figure 7 show the sequence of operations. Figure 8 shows the sequence of commands and the relevant timing. On 'power up' the card must be initialised by setting CØ and C1 to 'RESET' (see Table 2), toggling CCLK 3 times then setting CØ and C1 to 'TEST BUSY' and toggling CCLK a further 3 times. The card is then ready to talk to you. The flowchart in

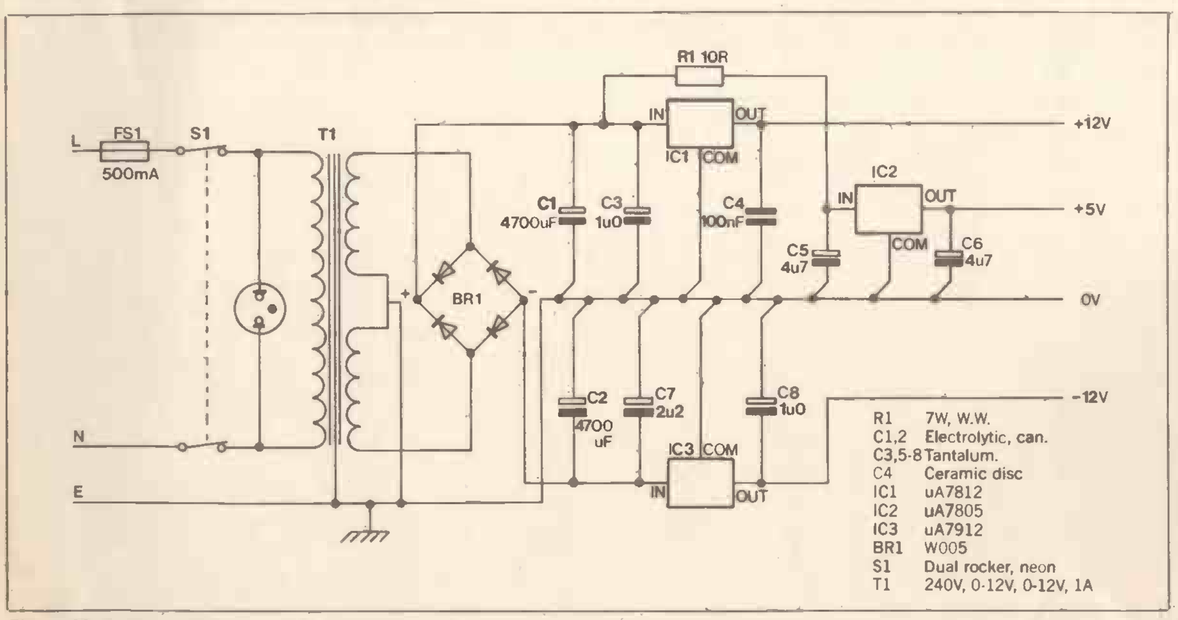
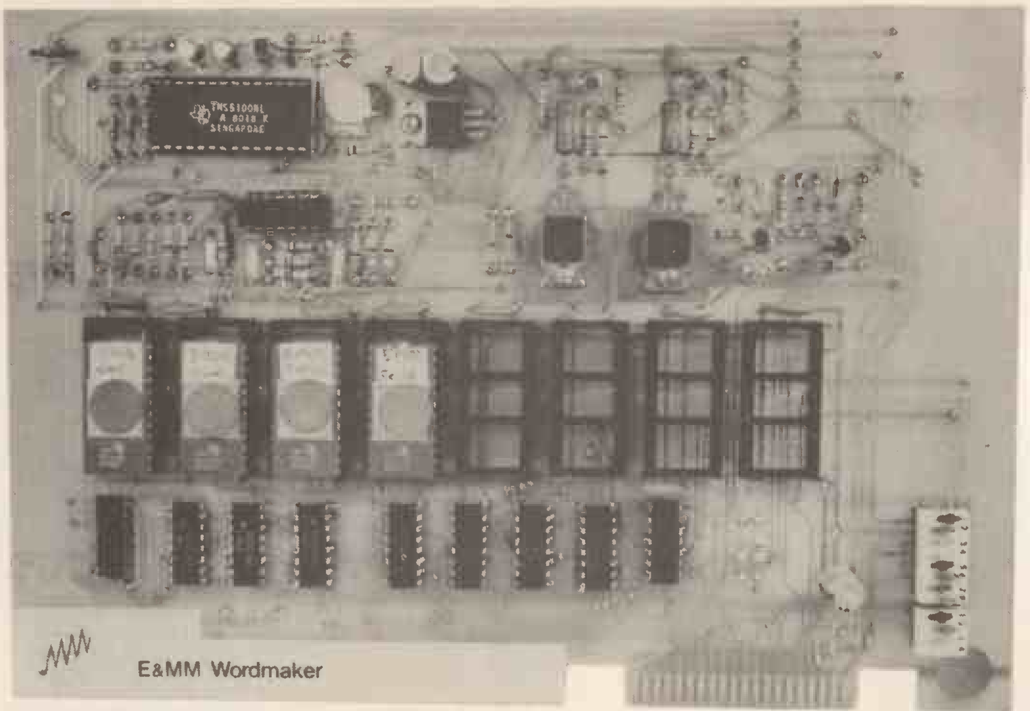


Figure 11. Suggested power supply circuit diagram.

Figure 7(a) also shows a 'dummy test talk' command can be executed in order to avoid an audible click that may be generated prior to commencement of speech. To make it speak the address of the word is written to the card. The two address bytes are latched into the VSP card by taking LDA1 (for LS byte) and LDAØ (for MS byte) low for at least 6.25us (at an oscillator frequency of 640kHz). It is important to note that the LS byte must be loaded first. Having set up the address all we need to do now is send the 'TALK' command on CØ and C1 and toggle CCLK once. Then: Hey Presto, it speaks! If any problems are encountered at this point, a logic probe will be useful for checking that the control and data input lines are providing the correct 'high'/'low' signals via the board connector to the EPROMs and associated logic ICs. Resistor values for R40, R41 and R42 may need changing in



WORDMAKER circuit board.

ADDRESS (Hex)	ADDRESS (Decimal)	WORD
EPROM 1		
0000	0,0	AGAIN
0048	72,0	DOWN
0084	132,0	HELLO
00D0	208,0	MESSAGE
0138	56,1	MISTAKE
0198	152,1	NAME
01CE	206,1	NEED
0222	34,2	PLEASE
0262	98,2	PUT
028C	140,2	REPEAT
02CC	204,2	RIGHT
0324	36,3	THANK
036E	110,3	UP
0388	136,3	WANT
03CE	206,3	'S
03E4	228,3	ALL
041A	26,4	AN
0446	70,4	AND
0484	132,4	ANY
04B4	180,4	ARE
04D0	208,4	AT
04F2	242,4	CAN
0522	34,5	DID
0566	102,5	DO
05A0	160,5	DOES
05FC	252,5	FOR
0634	52,6	FROM
0662	98,6	GOT
069C	156,6	HAVE
06DA	218,6	HOW
0724	36,7	IN
0760	96,7	IS
079C	156,7	IT
07B4	180,7	ME
0800	0,8	MUCH
082A	42,8	MY
0856	86,8	NO
0890	144,8	NOT
08C4	196,8	NOW
0906	6,9	OF
0946	70,9	ON
0970	112,9	OR
099A	154,9	OUT
09D6	214,9	THE(E)
0A08	8,10	THE
0A44	68,10	THERE
0A78	120,10	THIS
0A9E	158,10	USE
0AF6	246,10	WHAT
0B20	32,11	WHEN
0B6C	108,11	WHERE
0BB4	180,11	WILL
0C06	6,12	WITH
0C5A	90,12	WOULD
0C94	148,12	YES
0CC6	198,12	YOU
0CF8	248,12	YOUR
0D2E	46,13	A
0D6C	108,13	B
0DA8	168,13	C
0DEC	236,13	D
0E36	54,14	E
0E60	96,14	F
0E94	148,14	G
0EC4	196,14	H
0EFE	254,14	I
0F34	52,15	J
0F80	128,15	K
EPROM 2		
0000	0,16	L
004C	76,16	M
008A	138,16	N
00C2	194,16	O
00EA	234,16	P
0114	20,17	Q
014C	76,17	R
0178	120,17	S
01A0	160,17	T
01F0	240,17	U
021E	30,18	V
0250	80,18	W
0298	152,18	X
02BE	190,18	Y
0300	0,19	ZED
0346	70,19	ZERO
03A4	164,19	ONE
03F6	246,19	TWO
0430	48,20	THREE
0474	116,20	FOUR
04C2	194,20	FIVE
0510	16,21	SIX
054E	78,21	SEVEN
05A4	164,21	EIGHT
05D4	212,21	NINE
061E	30,22	TEN
0652	82,22	ELEVEN
069A	154,22	TWELVE
06F6	246,22	THIRTEEN
0732	50,23	FOURTEEN
0774	116,23	FIFTEEN
0800	0,24	SIXTEEN
086A	106,24	SEVENTEEN
08C2	194,24	EIGHTEEN
08FC	252,24	NINETEEN
0952	82,25	TWENTY
0986	134,25	THIRTY
09B6	182,25	FORTY
09EC	236,25	FIFTY
0A46	70,26	SIXTY
0A7E	126,26	SEVENTY
0AC4	196,26	EIGHTY
0AF0	240,26	NINETY
0B58	88,27	HUNDRED
0BC2	194,27	THOUSAND
0C3E	62,28	EQUAL
0C94	148,28	NUMBER
0D04	4,29	PERCENT
0D54	84,29	AMPS
0D94	148,29	DEGREES
0DF4	244,29	FARAD
0E62	98,30	FREQUENCY
0ECE	206,30	HENRY
0F18	24,31	HERTZ
0F66	102,31	HOURS
EPROM 3		
0000	0,32	MEGA
005E	94,32	MICRO
00D2	210,32	MILLI
010A	10,33	MINUS
0172	114,33	OHMS
01C6	198,33	PLUS
01FA	250,33	POINT
023C	60,34	POWER
0282	130,34	SECONDS
02EA	234,34	TEMPERATURE
0362	98,35	TIME
03AC	172,35	READY
03F0	240,35	SWITCH
043E	62,36	CONTROL
04A2	162,36	WARNING
04EC	236,36	OFF
0530	48,37	CHECK
0566	102,37	BUTTON
05B6	182,37	TELEPHONE
0608	8,38	BUSY
0656	86,38	INVALID
06F6	246,38	MONDAY
0752	82,39	TUESDAY
0800	0,40	WEDNESDAY
0872	114,40	THURSDAY
08D2	210,40	FRIDAY
0938	56,41	SATURDAY
0984	132,41	SUNDAY
09DE	222,41	GOODBYE
0A36	54,42	DATE
0A6A	106,42	LEFT
0A98	152,42	CHANGE
0ADE	222,42	DIRECTION
0B5C	92,43	ENTER
0BA6	166,43	FAST
0C00	0,44	SLOW
0C48	72,44	GO
0C9C	156,44	STOP
0CEA	234,44	HIGH
0D46	70,45	LOW
0D9A	154,45	MOVE
0E10	16,46	RANGE
0E7E	126,46	EXIT
0EBE	190,46	CARDS
0F10	16,47	ATTACK
0F4C	76,47	DESTROY
EPROM 4		
0000	0,48	START
003C	60,48	INSERT
0096	150,48	LOSE
00D0	208,48	WIN
010C	12,49	TRY
0140	64,49	O'CLOCK
0196	150,49	OVER
01D2	210,49	UNDER
0218	24,50	WAIT
0248	72,50	ADDRESS
0294	148,50	LINE
0312	18,51	OPERATOR
037A	122,51	COMPUTER
03E4	228,51	CALL
0428	40,52	INITIALISE
04BC	188,52	INTRUDER
051E	30,53	TEST
0574	116,53	MANUAL
05E8	232,53	AUTOMATIC
064A	74,54	PROCESSING
06C4	196,54	CLOCK
06F4	244,54	GAMBLE
0762	98,55	HOLD
0800	0,56	SHUFFLE
084E	78,56	HARDLUCK
08C8	200,56	ALARM SOUND
08EA	234,56	SHORT TONE
08FE	254,56	PLEASING TONE
0918	24,57	PIE
094C	76,57	PASS
09C2	194,57	POSITION
0A4A	74,58	PUSH
0A80	128,58	PRESENT
0AD6	214,58	GREEN
0B14	20,59	RED
0B4C	76,59	YELLOW

Table 7. E&MM speech data EPROM listing.

Using the WORDMAKER with the Sharp MZ-80K.

```
1 REM E&MM WORDMAKER SHARP MZ80-K
2 REM INITIALISE PORTS
3 REM A=OUTPUT(D0-D7),B=CONTROL(D0= LDA0,D1=LDA1,D2=C0,D3=C1,D4=CCLK)
4 REM 1 Input BUSY also required - use D7 on port B,or an INPUT PORT.
5 REM PA=ADDRESS of PORT A data        PB=ADDRESS of PORT B data
6 INPUT"PORT A ADDRESS";PA
7 INPUT"PORT B ADDRESS";PB
8 FORI=1TO3:A=27:OUT#PB,A:A=A+4:OUT#PB,A:NEXTI
9 FORJ=1TO3:A=24:OUT#PB,A:A=A+4:OUT#PB,A:NEXTJ
10 OUT#PB,24:WL=0:WH=0:GOSUB12:GOSUB12
11 RETURN

12 REM TALK SUBROUTINE
13 OUT#PA,WL:OUT#PB,8:OUT#PB,24
14 OUT#PA,WH:OUT#PB,16:OUT#PB,24
15 OUT#PB,30:OUT#PB,26:OUT#PB,24:RETURN

16 REM SUBROUTINE WITH BUSY CHECK
17 FORI=1TO2:A=28:OUT#PB,A:A=A-4:OUT#PB,A:NEXTI
18 INP#PA,B
19 IFB<128THEN18
20 OUT#PB,28:OUT#PB,24:RETURN
```

Subroutines.

```
21 REM TEST PROGRAM ONE
22 GOSUB 2
23 INPUT"WL";WL
24 INPUT"WH";WH
25 GOSUB12
26 GOTO 23
```

Test Program 1.

```
27 REM TEST TWO
28 PRINT"£"
29 GOSUB2
30 READ WL
31 READ WH
32 GOSUB17
33 GOSUB12
34 GOTO30
35 REM EPROM 1 WORDS:-
36 DATA 0,0,72,0,132,0,208,0,56,1,152,1,206,1,34,2,98,2,140,2,204,2,36,3
37 DATA 110,3,136,3,206,3,228,3,26,4,70,4,132,4,180,4,208,4,242,4,34,5
38 DATA 102,5,160,5,252,5,52,6,98,6,156,6,218,6,36,7,96,7,156,7,180,7
39 DATA 0,8,42,8,86,8,144,8,196,8,6,9,70,9,112,9,154,9,214,9,0,10,68,10
40 DATA 120,10,158,10,246,10,32,11,108,11,180,11,6,12,90,12,140,12,198,12
41 DATA 248,12,46,13,100,13,168,13,236,13,54,14,96,14,148,14,196,14
42 DATA 254,14,52,15,128,15
43 REM EPROM 2 WORDS:-
44 DATA 0,16,76,16,138,16,194,16,234,16,20,17,76,17,120,17,160,17,240,17
45 DATA 30,18,80,18,152,18,190,18,0,19,70,19,164,19,246,19,40,20,116,20
46 DATA 194,20,16,21,78,21,164,21,212,21,30,22,82,22,154,22,246,22,50,23
47 DATA 116,23,0,24,106,24,194,24,252,24,82,25,134,25,182,25,236,25,70,26
48 DATA 126,26,196,26,240,26,88,27,194,27,62,28,148,28,4,29,84,29,148,29
49 DATA 244,29,98,30,206,30,24,31,102,31
50 REM EPROM 3 WORDS:-
51 DATA 0,32,94,32,210,32,10,33,114,33,198,33,250,33,60,34,130,34,234,34
52 DATA 98,35,172,35,240,35,62,36,162,36,236,36,48,37,102,37,182,37
53 DATA 8,38,86,38
54 DATA 246,38,82,39,0,40,114,40,210,40,56,41,132,41,222,41,54,42,106,42
55 DATA 152,42,222,42,92,43,166,43,0,44,72,44,156,44,234,44,70,45,154,45
56 DATA 16,46,126,46,190,46,16,47,76,47
57 REM EPROM 4 WORDS:-
58 DATA 0,48,60,48,150,48,208,48,12,49,64,49,150,49,210,49,24,50,72,50
59 DATA 148,50,18,51,122,51,228,51,40,52,188,52,30,53,116,53,232,53
60 DATA 74,54,196,54,244,54,98,55,0,56,78,56,200,56,234,56,254,56,24,57
61 DATA 76,57,194,57,74,58,128,58,214,58,20,59,76,59
62 REM END OF EPROMS 1-4 WORD DATA
63 COPYRIGHT E&MM 1981
```

Test Program 2 (including complete EPROM data).

order to get the right 'pull-up'.

If you are using the VSP card with a computer system it will probably become necessary at some stage to be able to test when one word has finished so you can start another. If you try and start a word while the VSP is speaking, it will miss the end of the first word and say the next — or it might just stop altogether. Using the 'TEST BUSY' command it is possible to monitor the BUSY line. This is done by setting the 'TEST BUSY' command on C0 and C1 and toggling CCLK twice, then reading the BUSY line. When BUSY goes high you toggle CCLK once more and then initiate the next talk cycle. The BUSY line output (connector pin 38) need not be connected when first testing the board for correct speech operation (e.g. using Test Program 1).

Some Simple Programs

These programs are written in BASIC to run on the Sharp MZ-80K. The port is assumed to be addressed I/O. If you wish to use a memory-mapped system replace all output statements with 'pokes' and input statements with 'peeks'. The programs are written as subroutines to allow them to be easily incorporated into existing BASIC programs (see Subroutines). During the 'Initialise' subroutine, you will need to specify the port address. On the Sharp this is simply two numbers, say 2 and 3.

Test Program 1: By entering the word start address in decimal when prompted, the VSP card will say the word. WL=LS byte, WH=MS byte. This program is a continual loop and to stop use 'escape', 'break' or 'control C' command.

Test Program 2: By entering a string of word start addresses in the DATA line as follows: WL_1, WH_1, WL_2, WH_2 . . ., the VSP card can be made to speak the entered sentence or phrase.

If you use the data list (lines 35-62) the WORDMAKER speaks the whole word library available in correct EPROM order (see Table 7). Note that the 'decimal' Address has the correct numbers for operation instead of a straightforward Hex conversion.

Test Program 3: This program, based on Test Programs 1 and 2, gives some sample sentences and tones which are recorded on our demonstration cassette No. 2. Pauses of varying lengths are easily made by inserting a FOR/NEXT loop at line 28 as shown. Some idea of the musical potential, using varying pitch/clock rates by adjusting RV1 (this can be increased to 100k for greater range), is also given. Exciting possibilities are evident here.

We hope you will find the simple programs helpful in your investigation into the world of talking computers and that you won't spend too many hours talking to your computer as opposed to your family or friends!

Constructional details prepared by Glenn Rogers and Peter Kershaw. E&MM

```
1 REM E&MM WORDMAKER SHARP MZ80-K
2 REM INITIALISE PORTS
3 REM A=OUTPUT(D0-D7),B=CONTROL(D0= LDA0,D1=LDA1,D2=C0,D3=C1,D4=CCLK)
4 REM 1 Input BUSY also required -  use D7 on port B,or an INPUT PORT.
5 REM PA=ADDRESS of PORT A data        PB=ADDRESS of PORT B data
6 PRINT"£"
7 INPUT"PORT A ADDRESS";PA
8 INPUT"PORT B ADDRESS";PB
9 GOSUB22
10 FORI=1TO3:A=27:OUT#PB,A:A=A+4:OUT#PB,A:NEXTI
11 FORJ=1TO3:A=24:OUT#PB,A:A=A+4:OUT#PB,A:NEXTJ
12 OUT#PB,24:WL=0:WH=0:GOSUB14:GOSUB14
13 RETURN
14 OUT#PA,WL:OUT#PB,8:OUT#PB,24
15 OUT#PA,WH:OUT#PB,16:OUT#PB,24
16 OUT#PB,30:OUT#PB,26:OUT#PB,24:RETURN
17 REM SUBROUTINE WITH BUSY CHECK
18 FORI=1TO2:A=28:OUT#PB,A:A=A-4:OUT#PB,A:NEXTI
19 INP#PA,B
20 IFB<128THEN19
21 OUT#PB,28:OUT#PB,24:RETURN
22 REM TEST THREE/SPEECH
23 PRINT"£"
24 PRINT"±±±±±±±E&MM WORDMAKER SPEECH EXAMPLES"
25 GOSUB10
26 READ WL
27 READ WH
28 IFWL=0THENIFWH=1THENFORD=1TO1000:NEXTD:GOTO26
29 GOSUB18
30 GOSUB14
31 GOTO26
32 DATA 8,10,98,35,96,7,196,8,78,21,64,49
33 DATA 0,1,162,36,0,1,200,56,162,36,0,1,188,52,70,9,0,40,0,1
34 DATA 254,56,254,56,34,2,48,37,70,4,40,52,214,9,94,32,122,51,0,1
35 DATA 132,0,0,1,8,10,234,34,96,7,234,44,208,4,240,26,78,21,148,29,234,56
36 DATA 0,1,36,3,198,12,0,1,246,10,180,11,248,12,208,0,108,13,246,19
37 DATA 206,30,70,9,56,41,34,2,0,1,0,1,156,7,96,7,120,10,0,1
38 DATA 240,35,236,36,8,10,60,34,250,33,206,3,70,4,228,51,180,7,70,9
39 DATA 8,10,182,37,254,56,254,56,42,8,148,28,96,7,48,20,48,20,164,21
40 DATA 164,21,78,21,164,21,234,56,234,56,222,41,0,1
41 DATA 234,56,254,56,18,51,0,1,240,35,62,36,212,21,208,4,70,19,0,1
42 DATA 36,3,206,3,0,1
43 REM PROGRAM compiled by Glenn Rogers and Mike Beecher
44 REM COPYRIGHT E&MM 1981
```

Test Program 3.

PARTS LIST

Resistors — all 5% ⅓W carbon unless specified

R1,2,3,5,6,7,8,14,15,16,40,41,42	4k7	(13 off)
R4,9,10,11,12,17,20,21,22,23,25,27A,27B	10k	(13 off)
R13	22k	
R18,19	47R	(2 off)
R26,29	6k8	(2 off)
R28	1k	
R24	12k	
R30,31	8k2	(2 off)
R32,33	2k2	(2 off)
R34,35	82R	(2 off)
R36,37	22R	(2 off)
R38,39	2R2 3 Watt wire wound	(2 off)
RV1	50k cermet preset	
RV2	22k vert. S-min preset	

Note: R27=R27A + R27B

Capacitors

C1,3	100pF polystyrene	(2 off)
C2	68pF polystyrene	
C4,5,8	1nF polystyrene	(3 off)
C6,7	10nF disc ceramic (2 off)	
C9,15-24	100nF disc ceramic	(11 off)
C10	2n2 polycarbonate	
C11,12,25	47uF 25v p.c. electrolytic	(3 off)
C13,14	47uF 16v tantalum	(2 off)

Semiconductors

TR1-5	BC212	(5 off)
TR6	BC183	
TR7	BC213	
TR8	TIP31	
TR9	TIP32	
IC1	TMS5100	
IC2	74LS74	
IC3	74LS04	
IC4-8	74LS193	(5 off)
IC9	74LS138	
IC10	74LS151	
IC11	TL084	
IC12-15	2532 speech coded EPROM	(EMM1-4)
Reg 1	7905	
D1-4	1N4148	(4 off)

Miscellaneous

	Soldercons	
	Veropins	
	Track pins	
LK1-8	Octal SPST DIL switch	
LK9-12	Dual SPST DIL switch	(2 off)

For 80 Column Printers call Micro Peripherals

SEIKOSHA GP80

Probably the world's lowest cost 80 column Impact Printer

**5x7 dot matrix *128 chr set inc £ sign *30 CPS *80 chrs/line or extended chrs *12 chrs per inch *Tractor feed *Up to 8" plain paper with 3 copies *17.25d x 32.8w x 13.2h cms *2.5Kg *Graphics for high resolution*

Dealer Special

SEIKOSHA GP80 (inc. 2000 sheets of paper) . . . £199*

EPSON MX70

High Resolution Graphics at a budget price

Dealer Special

**5x7 dot matrix *80 CPS uni-directional *96 chr set inc £ sign *High Resolution (8x480 dots/line) *80 chrs/line or extended *Tractor Feed *4" to 10" paper with up to 3 copies *Easy head replacement*

EPSON MX70 . . . . £259*

OKI MICROLINE 80

TRS-80 Graphics compatability

**9x7 dot matrix *80CPS uni-directional *80 col. or condensed *Expanded characters *Friction and pin feed *Up to 3 copies*

OKIDATA MICROLINE 80 . . . . £299*

CENTRONICS 737

High quality proportional text suitable for word processing type applications.

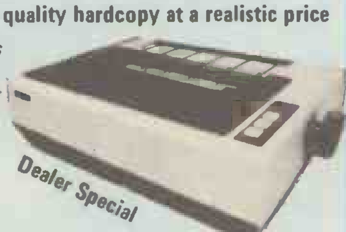
**80 CPS proportional mode *50 CPS mono spaced mode *Nx9 (proportional or 7x8 (monospaced) matrix *96 character set *9½" pin feed or friction *Reverse platen*

CENTRONICS 737 . . . . £349*

EPSON MX80

Correspondence quality hardcopy at a realistic price

**9x9 matrix with true descenders *80 CPS bi-directional with logic seeking *80 column with condensed and enlarged characters giving 40, 66, 80 and 132 chrs/line *Tractor feed *Optional Interfaces for APPLE, PET, TRS80, VIDEO GENI, SHARP, RS232*



Dealer Special

EPSON MX80T	£359*
Friction Modification Kit	£call
Interfaces	£call

EPSON MX80 F/T-1 MX80 F/T-2

This must be the first choice for a truly professional 80 col. printer

**9x9 matrix with true descenders *Friction and Tractor *12 different fonts *40, 66, 80 + 132 column *Single sheet feeding *96 chr set inc 4 Int chrs*

Dealer Special

EPSON MX80 F/T TYPE 1	£399*
EPSON MX80 F/T TYPE 2	£449*
Interfaces	£call
Paper Roll Holder	£call

EPSON MX82

NEW

High Resolution Graphics with 'high gearing'

**9x9 matrix with descenders *Details as MX80T/1 but with high geared high resolution graphics (1152 dots/line)*

Dealer Special

EPSON MX82 . . . . £415*

EPSON MX 85

NEW

A professional screen image printer for Terminals

Dealer Special

**9x7 matrix *80CPS bi-directional with logic seeking *4K Byte FIFO buffer *Asynchronous serial interface *ASCII or Baudot *Friction and Tractor feed *Switchable baud rates (16)*

EPSON MX85 . . . . £call

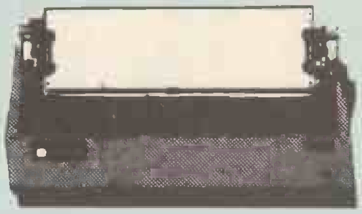
• 1 year guarantee on all printers (except NEC) • Free delivery an all printers** • Best prices and latest models for users, trade and special education discount • Free printout on all machines • • Credit facilities can be arranged and of course Access/Barclaycard accepted •

** DEALER EXPRESS SERVICE - If orders are placed before 11 am Micro Peripherals will deliver the same day within 50 miles of Basingstoke including the London area (a small additional charge will be made)

or 132 Column Printers call Micro Peripherals

OKI MICROLINE 83

Complete with RS232 interface



*9x7 matrix *132 column *Friction and Pin Feed *4 chr sizes *120 CPS bi-directional *96 chr set plus 64 block graphics

OKIDATA MICROLINE 83 . . . . £799*

EPSON MX 100

The ultimate in Matrix Printers

Dealer Special

*Friction *Tractor *136 column *High resolution graphics *22 different chr sizes *7 International chr sets *Up to 254 chrs per line *9x9 matrix * *80CPS bi-directional *True descenders *High geared *High res graphics (1632 dots/line

EPSON MX100 . . . . £575*

ANACOM 150

Fast at a very attractive price

*150CPS bi-directional *Logic seeking *9x9 matrix with descenders *136 column or 80 col *Parallel or serial int.

ANACOM 150 . . . . £799*

QUANTEX 6000P 6000S

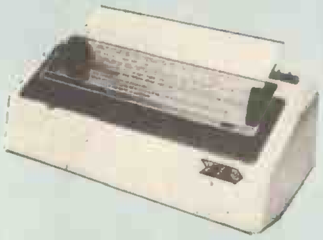
Low cost, compact

*9x9 matrix with descenders *150CPS bi-directional *Logic seeking *136 chrs/line *96 chr set *Exp chrs *Parallel or serial int.

QUANTEX 6000P (Parallel) . . . . £call
QUANTEX 6000S (Serial) . . . . £call

PAPER TIGER 560G

For high quality correspondence quality printing



*160 CPS bi-directional *132 column *High res graphics *2K buffer *Double width chrs *RS232 or Centronics interface *Up to 14.75" paper *Tractor feed *Up to 6 part paper

PAPER TIGER 560G £995*

ANADEX DP9501

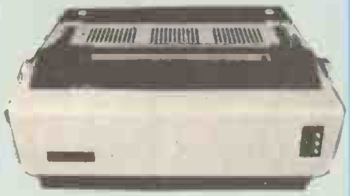
High resolution natrix printer

*11x9 matrix *High resolution graphics *200 CPS bi-directional *X-on/X-off *RS232 interface *4 print densities 10, 12.5, 15 and 16.7 chr per inch

ANADEX DP9501 . . . . £call

VISTA -TEC

Daisy Wheel letter quality



*25CPS *Letter quality *136 column *Proportional spacing *Bi-directional *Diablo compatible *Friction feed

VISTA-TEC £1050

NEC SPINWRITER

Rugged, reliable correspondence quality printer

*55CPS bi-directional *Interchangeable thimbles * Proportional spacing *Tractor option

NEC SPINWRITER 5510 . . . . £call
NEC SPINWRITER 5530 . . . . £call

Micro Peripherals

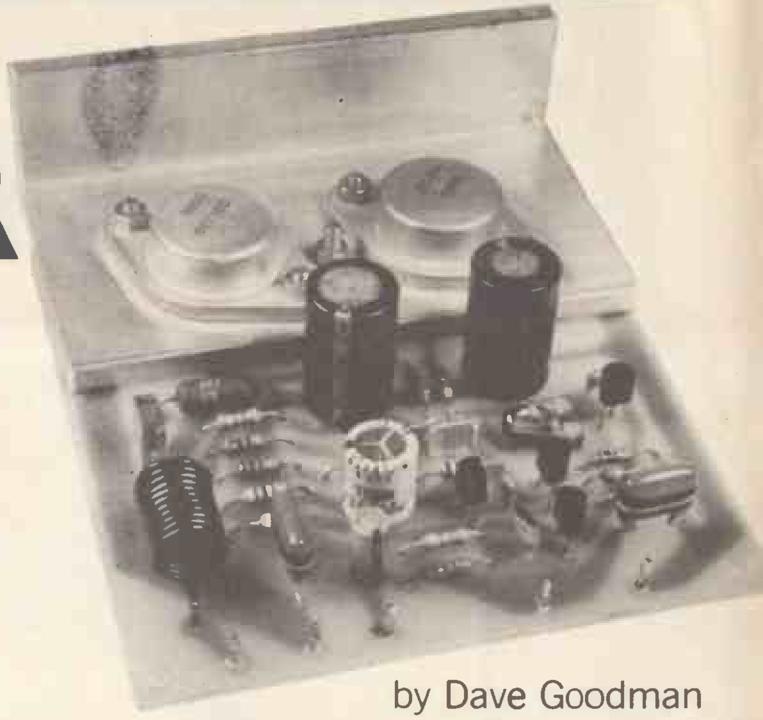
61 NEW MARKET SQUARE, BASINGSTOKE, HAMPSHIRE. Telephone: 0256 56468

ALL PRICES QUOTED ARE EXCLUSIVE OF V.A.T. BUT INCLUDE DELIVERY !!!

- DEALERS ASK FOR DEALER SALES (bona Fide only)
- Educational Establishments obtain special discounts
- Personal cheques welcome
- 12 month guarantee

MOSFET AMPLIFIER

An incredible Hi-Fi Amp that's virtually bomb-proof — like the best valve amps



by Dave Goodman

Specification

Power output:	**>75W RMS into 4Ω** **>50W RMS into 8Ω**
Sensitivity:	**650mV RMS for rated output**
Input impedance:	**47kΩ**
Power supply:	**44-0-44V DC, 2A**
Frequency response:	**20Hz to 20kHz virtually flat** **10Hz to 40kHz ±1dB**
Total harmonic distortion:	**20Hz to 20kHz <0.005%** **1kHz<0.002%**
Signal-to-noise ratio:	**120dB**

Power MOSFETs are a relatively new addition to the range of semiconductor devices available. Small signal MOSFETs have been around for some years, mostly finding uses in high frequency applications, but it was found difficult to make MOSFETs with gate-to-drain voltages greater than 30V (most are rated at 20V), and with high current capabilities, such as would be required in power amps. The high voltages possible with power MOSFETs are achieved by separating the gate and drain layers with a layer of ion implanted silicon dioxide. In addition, a field plate is provided on the source, near the gate. These two measures prevent electric field concentration, which at high voltages would otherwise destroy the gate. The high current capability is achieved by using a comb-shaped structure for the drain and source regions.

Figure 1 shows the connection configuration for the MOSFETs used in this amplifier. Although a TO3 package is used to give excellent heat dissipation, MOSFETs are far superior to bipolar transistors in their response to high temperatures. As a bipolar transistor heats up for a given voltage, the current through it becomes greater; i.e. it has a positive temperature characteristic. If the temperature were allowed to continue to rise thermal runaway would ensue and the transistor would be destroyed. A MOSFET, however, has a negative thermal characteristic. As the transistor becomes hotter, the current tends to decrease, so power MOSFETs are most unlikely to be destroyed due to high temperatures.

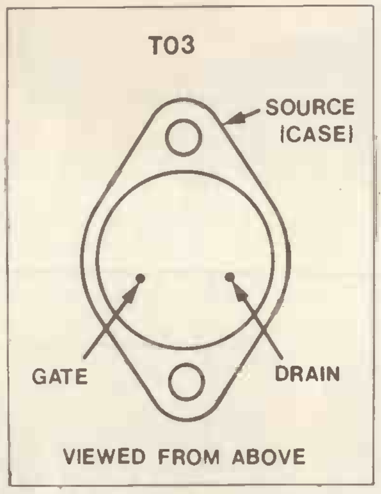


Figure 1. Power MOSFET package.

Power MOSFETs also have a far wider frequency response than bipolar power transistors, so that a very wide and extremely flat frequency response can be obtained, without any complicated circuitry. Figure 3(a) shows the typical output characteristic of a power MOSFET for gate-to-source voltages (V_{GS}) from 1V to 10V in 1V steps. Figure 3(b) shows the remarkably low total harmonic distortion generated by this amplifier. It is scarcely measurable, even with the best test equipment available and certainly far below the minimum audible level.

Circuit Description

TR1 and TR2 form a stable, differential input buffer amplifier, the bias current for each transistor being set to 0.5mA. The 2SA872 transistor is used because it has a very low noise

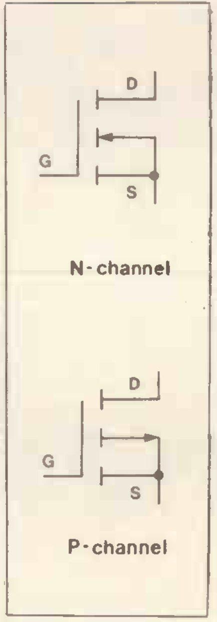


Figure 2. MOSFET symbols.

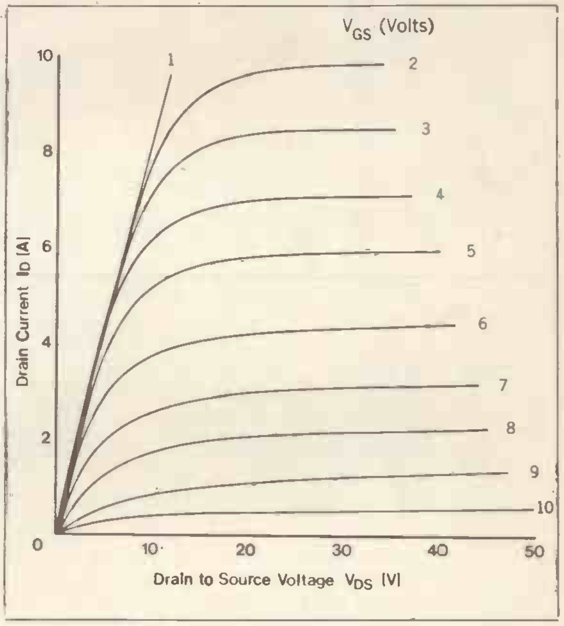


Figure 3(a). Typical output characteristic.

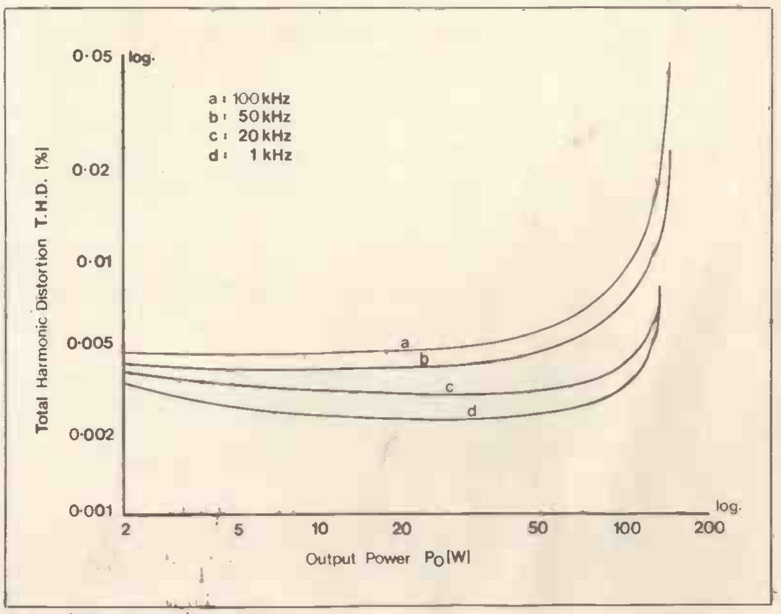


Figure 3(b). Harmonic distortion graph.

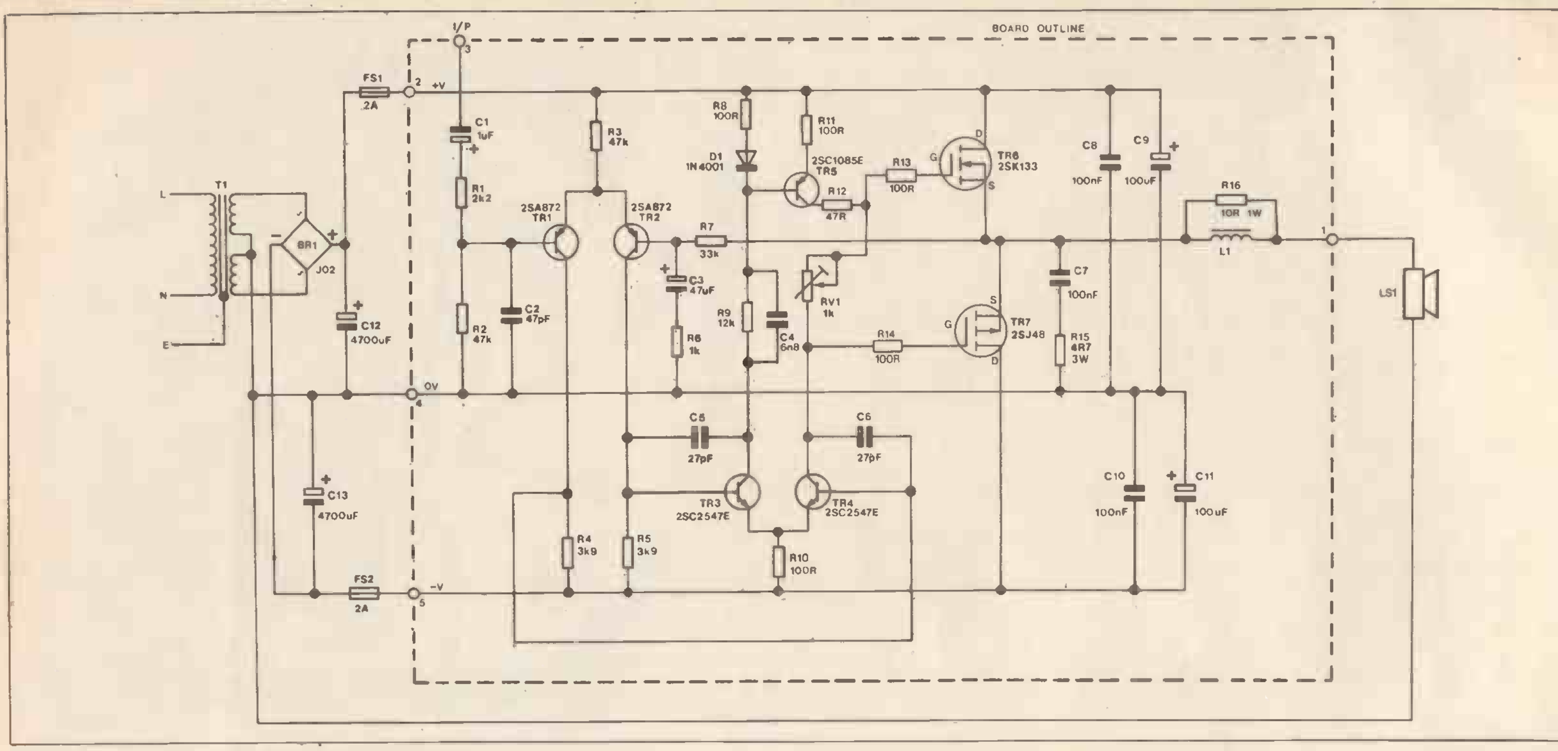


Figure 4. Circuit diagram for single channel amplifier.

output but can handle high voltages. TR3 and TR4 form a 'current mirror' to give a high open-loop voltage gain. TR5 acts as a constant-current load and this low-noise, high-gain, class A amplifier stage is all that is required to drive the power MOSFETs TR6 and TR7. The transistors in the driver stage need to have a high voltage durability, high F_T and low C_{ob}. They also have to supply sufficient power to charge and discharge the gate-to-source capacitance of the power MOSFETs. In this case a bias current of around 50mA is sufficient to ensure adequate power is available at all frequencies and power levels.

The input impedance of the amplifier is set, by R2, to 47k, and C2 bypasses any RF signals present at the input. The amplifier has a gain of 33, and this is set by R7 and R6, via decoupling capacitor C3. R13 and R14 improve the stability at high frequencies by reducing the effective gate load capacitance. C7 and R15 are a Zobel network which, in conjunction with R16 and L1, ensures excellent stability into reactive loads at high frequencies.

Construction

Fit the five Veropins, labelled 1 to 5, to the PCB and solder. Fit and solder diode D1 taking care that it is the right way round. Fit and solder all the resistors *except* **R16**, and all the capacitors, taking care with the polarity of the electrolytic ones, C1, C3, C9 and C11 (refer to Figure 5). Scrape or burn the enamel off one end of the piece of enamelled copper wire and solder it to one lead of R16, close to the body of the resistor. Now wind the wire tightly around the resistor ten times to form L1, as shown in Figure 6. Do not cut the wire, but hold it tightly and scrape off the enamel where it will touch the other lead-out wire of the resistor, then wrap it around the lead and solder. Fit this composite component to the PCB and solder. Fit and solder the preset to the PCB, then the transistors (TR1-5).

Make the heatsink bracket shown in Figure 7. (Note that this is available ready-made, and is included in the kit supplied by Maplin Electronic Supplies Ltd.) The mounting bracket fits to the component side of the PCB as shown in the photograph. Align it with the holes in the PCB and put one bolt through the centre hole from underneath using a 6BA nut, bolt and shakeproof washer. Referring to Figure 8, place a nylon bush in each of the four large holes in the bracket, smear both faces of both mica washers with Thermpath silicone grease and place these in position. Mount the two power MOSFETs, ensuring that TR6 (2SK133) is fitted closest to the coil L1. Put in the 6BA bolts to hold the transistors from underneath and secure them using nuts and shakeproof washers. Solder the bolt heads to the track on the PCB. Finally solder the drain and gate pins to the PCB and re-check all component positions, polarisations and solder joints.

Power Supply

The PSU (T1, BR1, C12 and 13

PARTS LIST

Amplifier

Resistors — all 5% ½W carbon unless specified			
R1	2k2		(M2K2)
R2,3	47k	2 off	(M47K)
R4,5	3k9	2 off	(M3K9)
R6	1k		(M1K)
R7	33k		(M33K)
R8,10,11,13,14	100R	5 off	(M100R)
R9	12k		(M12K)
R12	47R		(M47R)
R15	4R7 3W,W/W		(W4R7)
R16	10R 1W, carbon		(C10R)
RV1	Hor. S-Min. Preset, 1k		(WR55K)
Capacitors			
C1	1uF, 100V, PC, elect.		(FF01B)
C2	47pF, ceramic		(WX52G)
C3	47uF 63V, PC, elect.		(FF09K)
C4	6n8, polycarbonate		(WW27E)
C5,6	27pF, ceramic	2 off	(WX49D)
C7	100nF, polycarbonate		(WW41U)
C8,10	100nF, polyester	2 off	(BX76H)
C9,11	100uF, 63V, PC elect.	2 off	(FF12N)
Semiconductors			
D1	1N4001		(QL73Q)
TR1,2	2SA872	2 off	(QQ30H)
TR3,4	2SC2547E	2 off	(QY11M)
TR5	2SC1085E		(QY12N)
TR6	2SK133		(QQ36P)
TR7	2SJ48		(QQ34M)
Miscellaneous			
L1	Enamelled copper wire, 18swg ¼m		(BL25C)
	T03 mounting kit	2 off	(WR24B)
	Thermpath		(HQ00A)
	Printed circuit board		(GA28F)
	Mounting bracket		(GA29G)
	Pin 2141	5 off	(FL21X)
	Bolt 6BA, ½in.	5 off	(BF06G)
	Nut 6BA	5 off	(BF18U)
	Shakeproof washer, 6BA	5 off	(BF26D)

Power supply

C12,13	4700uF, 63V, Can elect.	2 off	(FF28F)
BR1	Bridge J02		(BL36P)
T1	Transformer, 32-0-32V, 2A		(YK02C)
FS1,2	Fuse, 2A 20mm	2 off	(WR05F)
	Fuseholder	2 off	(RX49D)

Test components

	100R, 5W, W/W	2 off	(L100R)
	Fuse 250mA 20mm	2 off	(WR01B)

Note: A complete kit (LW51F) of all the parts listed under Amplifier is available for just £11.49 inc. VAT and P&P from Maplin Electronic Supplies Ltd. The kit does not include the power supply or test components.

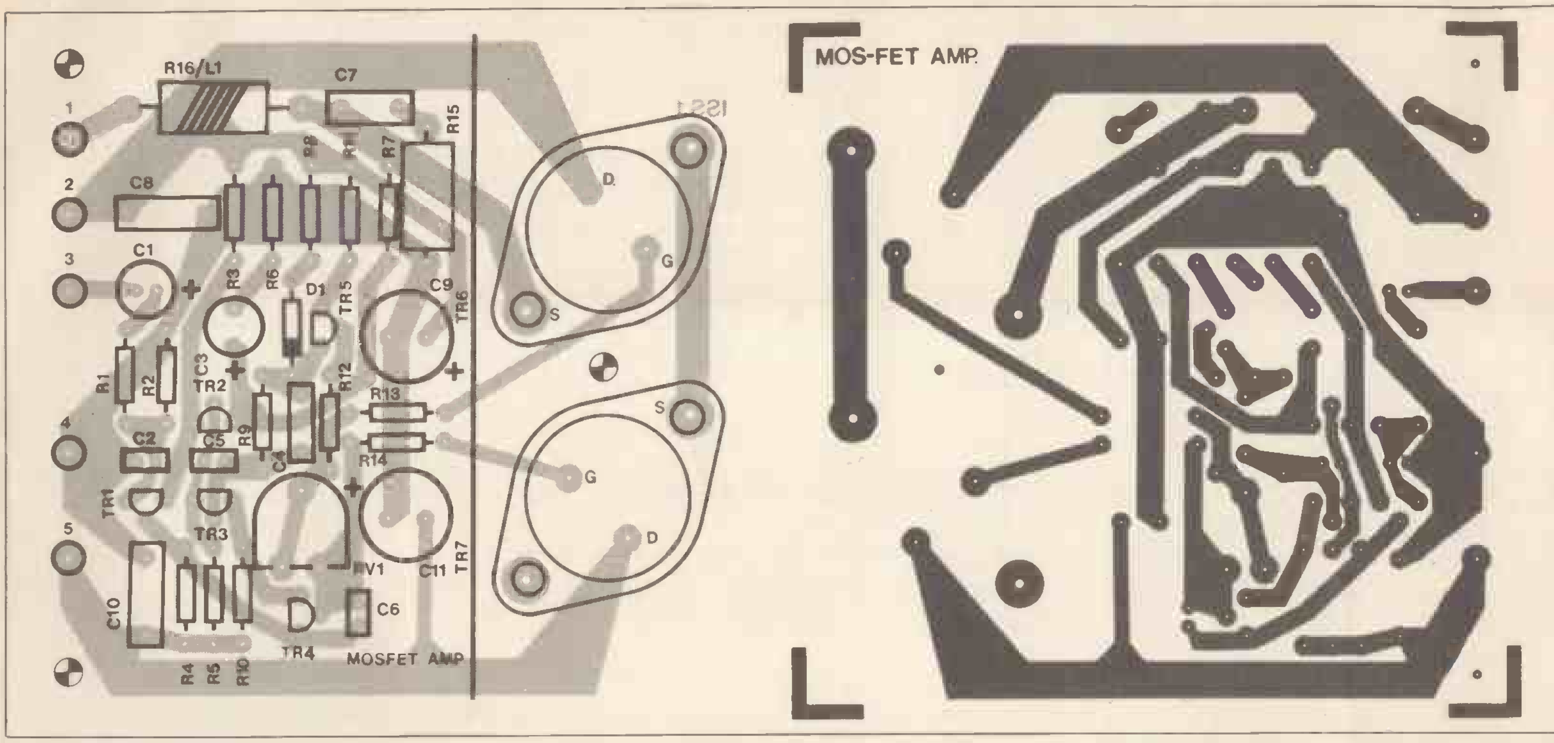


Figure 5. PCB component overlay and track layout

and FS1 and 2) will produce approximately 44-0-44V DC. For a stereo pair use a 4A transformer at 32-0-32V instead of a 2A type. Alternatively, toroidal transformers rated at 35-0-35V could be used, 160VA for a single amp and 300VA for a stereo pair. If the transformer voltage is increased to 40-0-40V and TR6 and 7 replaced by a 2SK134 and 2SJ48 respectively, output powers in excess of 75W RMS into 8 ohms are possible.

Figure 9 shows how simple it is to parallel the output transistors to achieve even higher powers. Using the higher voltage and transistor types just mentioned power levels in excess of 125W RMS into 4 ohms are possible with a 1V RMS input signal if this circuit is used.

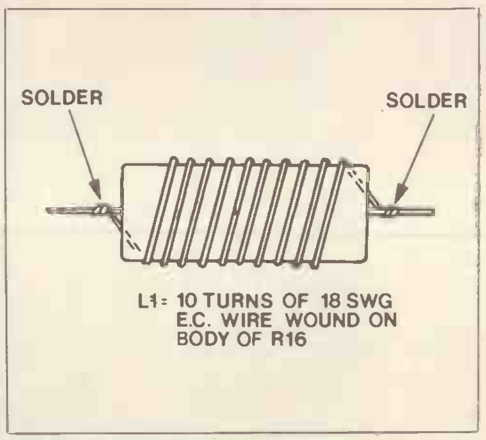


Figure 6. Making the inductor L1.

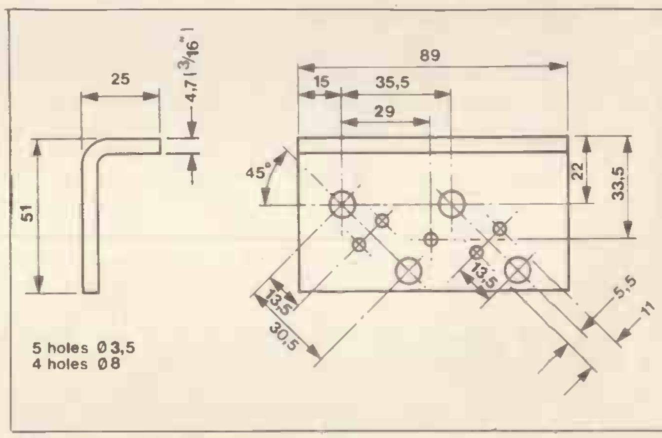


Figure 7. Mounting bracket.

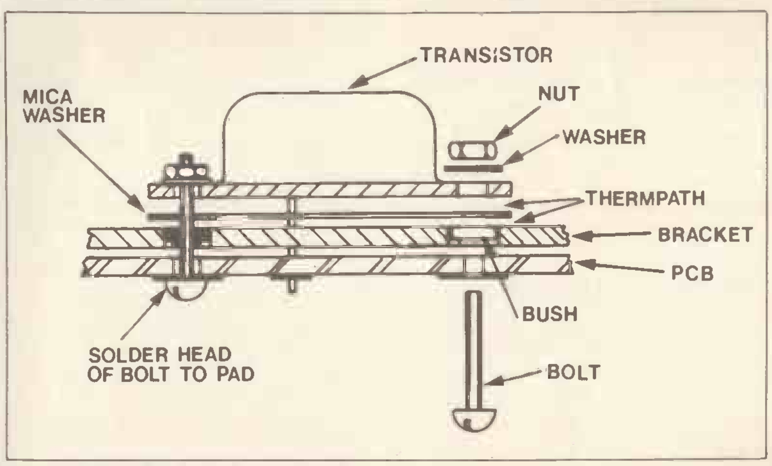


Figure 8. Method of mounting MOSFETs.

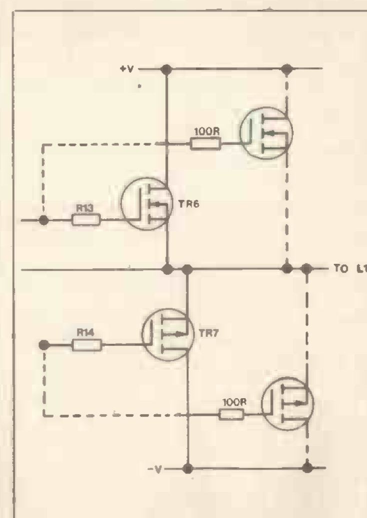


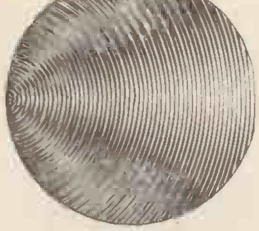
Figure 9. Parallel output connections.

Setting Up

With no speaker connected and fuses not inserted, check that the voltage across C12 is approximately 45V (± 5V) and that the voltage across C13 is the same. Switch off and short C12 and C13 in turn with a resistor (e.g. one of the test resistors). Now connect FS1 and FS2, via 100R 5W resistors, to pins 2 and 5 respectively. Connect 0V to pin 4. Check with a multimeter set to the highest resistance range, that there is no connection between the MOSFET cases and the mounting bracket. Turn RV1 fully clockwise.

Insert 250mA fuses for test purposes as FS1 and FS2 and switch on again. If either fuse blows or any component gets excessively hot switch off immediately. If all is well, connect a DC voltmeter between pin 1 and pin 4. The meter should read about 0V (not more than ± 100mV). Switch off and remove the two 100R resistors. Connect FS2 directly to pin 5 and connect a multimeter switched to about 100mA DC between FS1 and pin 2 (+ve lead to fuse and -ve lead to pin 2). Switch on again and rotate RV1 slowly until the meter reads 50mA. Leave for 10 minutes and re-adjust.

Switch off, disconnect the meter and connect FS1 direct to pin 2. The mounting bracket must now be bolted to a good-sized heatsink or a substantial chassis. Finally, connect a loudspeaker to pin 1. Note that the speaker negative terminal must be returned to the 0V in the power supply and *not* to pin 4 of the amplifier. We recommend making the negative tag of C12 the only 0V point with more than one wire attached. Replace the 250mA fuses with 2A types and connect an input between pins 3 and 4. Note that if you use a toroidal transformer you will have to use antisurge fuses and the test fuses used should be 500mA rating. **E&MM**

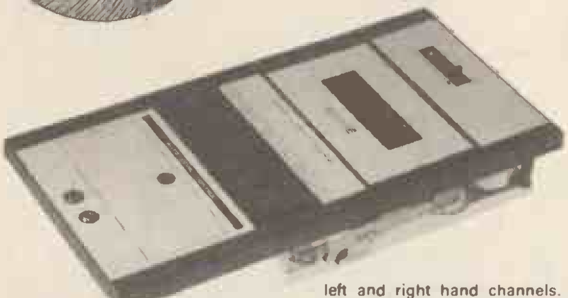


APPROVED thandar STOCKIST

B.K. ELECTRONICS
A SOUND CHOICE

APPROVED thandar STOCKIST

★ PROMPT DELIVERY ★ PRICES INCLUDE V.A.T. ★ AMPLE STOCKS
A PERSONAL SERVICE FROM A SMALL EXPANDING COMPANY



STEREO CASSETTE TAPE DECK MODULE. Comprising of a top panel and tape mechanism coupled to a record/play back printed board assembly. Supplied as one complete unit for horizontal installation into cabinet or console of own choice. These units are brand new, ready built and tested.
Features: Three digit tape counter. Autostop. Six piano type keys, record, rewind, fast forward, play, stop and eject. Automatic record level control. Main inputs plus secondary inputs for stereo microphones. **Input Sensitivity**: 100mV to 2V **Input Impedance**: 68K. **Output level**: 400mV to both left and right hand channels. **Output Impedance**: 10K. **Signal to noise ratio**: 45dB. **Wow and flutter**: 0.1%. **Power Supply requirements**: 18V OC at 300mA. **Connections**: The left and right hand stereo inputs and outputs are via individual screened leads, all terminated with phono plugs (phono sockets provided). **Dimensions**: Top panel 5½in x 11¼in. Clearance required under top panel 2¼in. Supplied complete with circuit diagram and connecting diagram. Attractive black and silver finish.
Price £26.70 + £2.50 postage and packing.
Supplementary parts for 18V D.C. power supply (transformer, bridge rectifier and smoothing capacitor) **£3**.

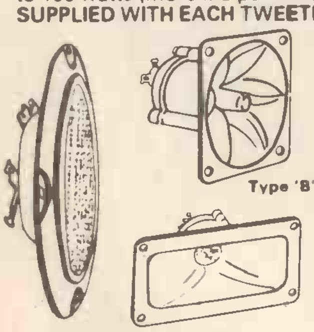
NEW RANGE QUALITY POWER LOUDSPEAKERS (15", 12" and 8"). These loudspeakers are ideal for both hi-fi and disco applications. Both the 12" and 15" units have heavy duty die-cast chassis and aluminium centre domes. All three units have white speaker cones and are fitted with attractive cast aluminium (ground finish) fixing escutcheons.
Specification and Price:–

15" 100 watt R.M.S. Impedance 8ohm 59 oz. magnet, 2" aluminium voice coil. Resonant Frequency 20Hz. Frequency Response to 2.5KHz. Sensitivity 97dB. **Price £32 each.** £2.50 Packing and Carriage each.

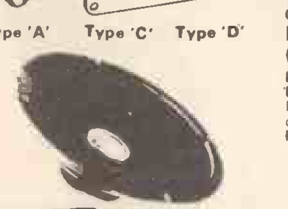
12" 100 watt R.M.S. Impedance 8 ohm, 50 oz. magnet. 2" aluminium voice coil. Resonant Frequency 25Hz. Frequency Response to 4KHz. Sensitivity 95dB. **Price £23.70 each.** £2.50 Packing and Carriage each.

8" 50 watt R.M.S. Impedance 8 ohm, 20 oz. magnet. 1" aluminium voice coil. Resonant Frequency 40Hz. Frequency Response to 6KHz. Sensitivity 92dB. Also available with black cone and black protective grill. **Price £8.90 each.** £1.25 Packing and Carriage each.

PIEZO ELECTRIC TWEETERS – MOTOROLA
Join the Piezo revolution. The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover is **not** required these units can be added to existing speaker systems of up to 100 watts (more if 2 put in series). **FREE EXPLANATORY LEAFLETS SUPPLIED WITH EACH TWEETER.**



Type 'A' 3in round with removable wire mesh. Ideal for bookshelf hi-fi speakers. **Price (Type 'A') £3.45 each.**
Type 'B' 3½in super horn. For general purpose speakers disco and PA systems, etc. **Price £4.35 each.**
Type 'C' 2in x 5in wide dispersion horn. For hi-fi systems and quality disco etc. **Price £5.45 each.**
Type 'D' 2in x 6in wide dispersion horn. Frequency response extending down to mid-range (2000 c/s) suitable for hi-fi systems and quality disco. **Price £6.90 each.**
Post and Packing, all types, 15p each (or SAE for Piezo leaflets).



LOUDSPEAKER
High quality full range 8in loudspeaker. 10 watts RMS, 8ohm. Rolled surround with aluminium centre dome.
Price £3.75 each plus £1 Postage and Packing.

GEC AM/FM STEREO TUNER AMPLIFIER CHASSIS. Originally designed for installation into a music centre. Supplied as two separate built and tested units which are easily wired together. **Note**: Circuit diagram and interconnecting wiring diagrams supplied. **Rotary Controls**: Tuning, on/off volume, balance, treble, bass. **Push-button controls**: Mono, Tape, Disc., AFC, FM (VHF), LW, MW, SW. **Power Output**: 7 watts RMS per channel, at better than 2% THD into 8 ohms. 10 watts speech and music. **Frequency Response**: 60Hz-20kHz within ± 3dB. **Tape Sensitivity**: Output – typically 150 mV. Input – 300 mV for rated output. **Disc Sensitivity**: 100mV (ceramic cartridge). **Radio**: FM (VHF), 87.5MHz – 108MHz. Long wave 145kHz – 108kHz. Medium wave. 520kHz – 1620kHz. Short wave. 5.8MHz – 16MHz. **Size**: Tuner – 2¾in x 15in x 7½ in approx. Power amplifier – 2in x 7½in x 4½in approx. 240V AC operation. Supplied complete with fuses, knobs and pushbuttons, and LED stereo beacon indicator. **Price £23.50** plus £2.50 postage and packing.

JVC TURNTABLE. JVC Turntable supplied complete with an Audio Technica AT10 stereo magnetic cartridge.
★ 'S' shaped tone arm.
★ Belt driven.
★ Full size 12in platter.
★ Precision calibrated counterbalance weight (0-3 grms.)
★ Anti-skate (bias) device. Nylon thread weight.
★ Damped cueing lever.
★ 240V AC operation, (50Hz).
★ Cut-out template supplied.
Size – 12¾in x 15¾in (approx).
Price £28.50 plus £2.50 postage and packing.

MATCHING THREE WAY LOUDSPEAKERS AND X-OVER
BUILD A QUALITY 60 watt SYSTEM

10" 50 watt RMS WOOFER
5" 20 watt MID RANGE
3" 15 watt RMS TWEETER
3 way CROSSOVER

A MATCHING SET of three high quality loudspeakers each fitted with cast aluminium fixing escutcheons and domed black mesh protective fronts. All three units have attractive aluminium centre domes. The escutcheons/mesh fronts are removable to enable a unique choice of baffle board construction. For example, the loudspeakers can be mounted directly on to a veneered board or with the escutcheons removed, they can be conventionally mounted and covered with fabric.
The three way crossover is attached to a mounting panel which incorporates two recessed (black and red) spring loaded loudspeaker terminals. **Price £19.95 + £2.50 P&P.**

B.K. ELECTRONICS
37 Whitehouse Meadows, Eastwood, Leigh-on-Sea, Essex SS9 5TY

VISA

★ SAE for current lists. ★ Official orders welcome. ★ All prices include VAT. ★ Mail order only. ★ All items packed (where applicable) in special energy absorbing PU foam. Callers welcome by prior appointment, please phone 0702-527572.

SELECT-A-MATCH

by William McCarthy

Here's a real 'home' project that gives random selection of football league clubs at a touch!

PARTS COST GUIDE £8.50

Thinking up random numbers is a task that many of us would find tedious, if not difficult! Illustrate this for yourself by quickly writing a dozen or so randon numbers from 1 to 100.

Now look again at these numbers and spot the patterns you have 'inadvertently' produced in this small sample. Group the numbers into decades and see which decade you favour. Note whether even numbers come to mind more than odd.

If the range of numbers to choose from were then reduced to 55 and very many more than 55 selections from this range were made, do you believe you would select each number as frequently as statistics predict?

Tiredness and alcohol do nothing to improve the performance of this task, while 'systems' for selecting allegedly random numbers by relatives' birthdays or throwing darts need no further discussion here!

Enter Select-A-Match, the purpose-built device for picking random numbers without fuss. Not perfect by any means, or even as good as machines like Ernie, but better than man's unassisted brain. Select-A-Match utilises a human function that is less predictable than random number generation, namely the timing of motor control to the hands by the brain.

You may think you can time the movements of your fingers pretty accurately, but without 'cues' for your actions you are lost. The Select-A-Match produces numbers according to a regular pattern but gives no 'cue' as to when a particular number will occur. This it achieves by counting through its repertoire of numbers so rapidly that one would have to be able to react to within about a tenth of a millisecond of a given time to stand a reasonable chance of picking specific numbers. The complete count cycle takes less than 10ms which is certainly well outside the limit of most people's reaction synchronising ability.

Principle of Operation

The two metal screw heads form a touch switch which gates a clock producing an 8KHz output when both are touched together. The train of output pulses are fed into two decade counters with outputs that drive two seven-segment LEDs. The number held in the counters at any time is shown on the double-digit display. While actually being clocked with your finger on the touch switch, the counter output is changing too rapidly for individual characters to be discernable.

The counters are reset to zero each time 56 is decoded from the 7-segment outputs. The significance of this number will be apparent to pools punters! The number 00 is prevented from being displayed, should it occur on release of the touch switch. This is achieved by a detector attached to the seven segment outputs of the counters which introduces an additional pulse into the counter when a zero occurs on the tens output, and

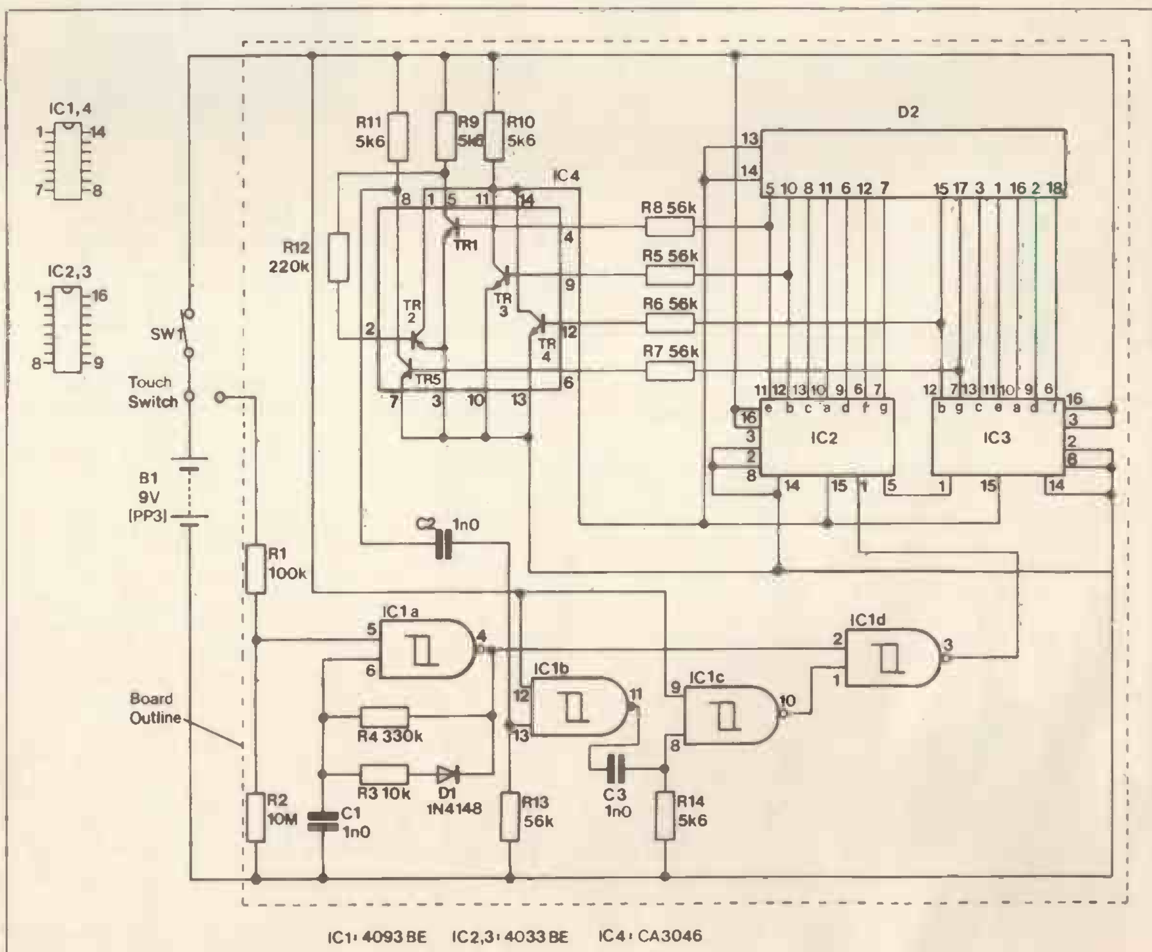


Figure 1. Circuit diagram for Select-A-Match.

this steps the counters on to 01.

Essentially then, the circuit is a 1 to 55 counter, continuously cycling while the touch switch is operated. When the touch switch is released, the number in the counters becomes visible on the display.

Circuit

The circuit diagram of the Select-A-Match is shown in Figure 1. A clock is constructed from gate IC1a, a CMOS Schmitt input quad-NAND gate. While the touch switch is open-circuit (i.e. not being operated), the clock is inhibited by the pull-down resistor R2 on input pin 5 of the clock gate. The resistance of a finger, typically 100k, placed across the touch switch causes the input voltage to rise, enabling the clock to run. The frequency of the clock is set by R4 and C1. A long 'on' compared to 'off' (mark-space ratio) is needed so that negative-going pulses from the zero-suppression circuit NANDed with the clock output in gate IC1d do not interfere with the clock pulses themselves. The required duty cycle is obtained by D1 which allows rapid discharge of C1 through R3, hence the short 'off' period.

The combined clock and zero-suppression pulses are fed to input pin 1 of the units counter, IC2.

The count of 56, used to reset the counters to zero, is decoded from the units counter, IC2, segment outputs e and b, and the tens counter, IC3, segment output b. Segment b is on and segment e is off only when the character 6 is displayed, and 5 is the first character, counting up from 0, in which segment b is off. Taking the complement of segment e of the units display and NORing it with segments b of both displays produces a '0' output when the count of 56 is reached. This 0 is fed to the reset pins of the two counters.

A transistor array, IC4, was used to decode the seven segment data, as the 'on' drive voltages to the LEDs did not exceed the logic 1 threshold voltage of some CMOS inputs. TR1 forms the inverter taking the complement of segment e, while transistors TR2-4 form a 3-input NOR gate.

As the tens counter resets, the tens display goes from 5 to 0, hence segment g goes from on to off. TR5 inverts the output to segment g, which is then fed to the monostable formed by C2, R13 and IC1b, which triggers on the rising edge of the output from TR5. This delay places the pulse from the second monostable, comprising C3, R14 and IC1c out of the way of the front and back edges of the clock pulses. This extra pulse ensures the counter clocks automatically on to 1, should it be stopped at zero.

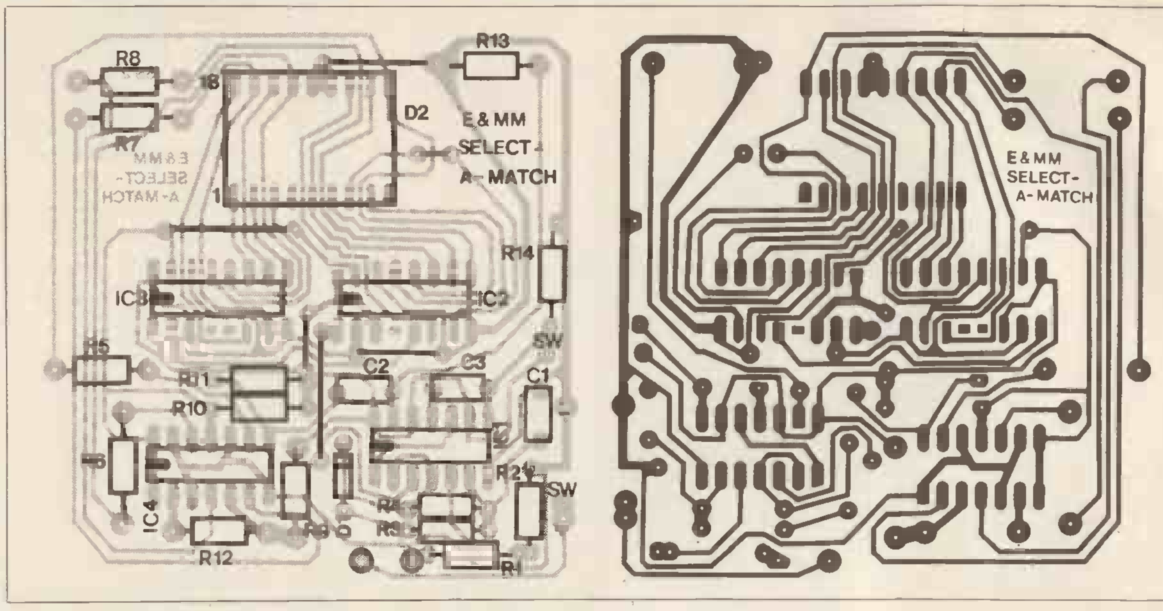


Figure 2. PCB component and track layouts.

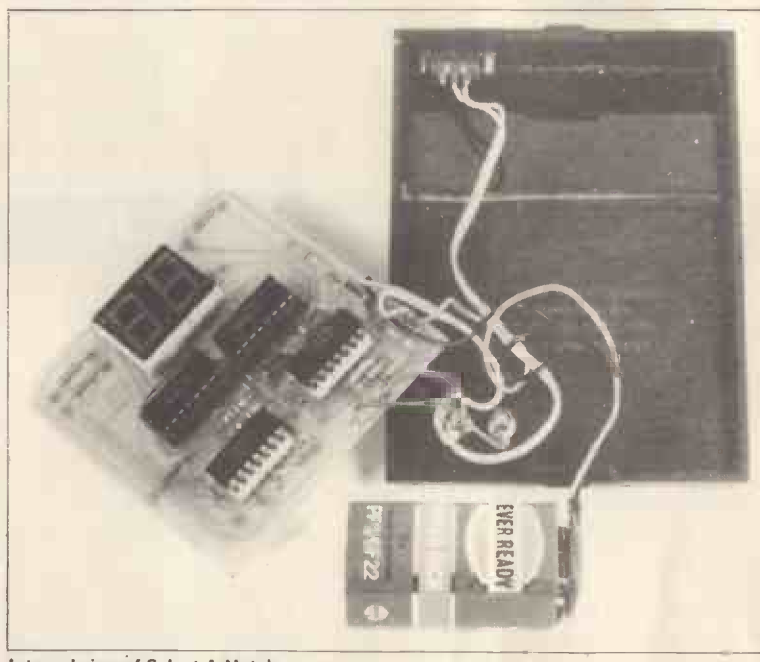
Construction

The printed circuit board, details of which are shown in Figure 2, carries all the components, excluding the touch switch and the battery. Assembly of the board is straightforward, following the normal practice, installing links and terminal pins first, followed by passive components such as IC sockets, resistors and capacitors, and finally the CMOS ICs and display. Use the decimal point as the guide to correct orientation of the LED display.

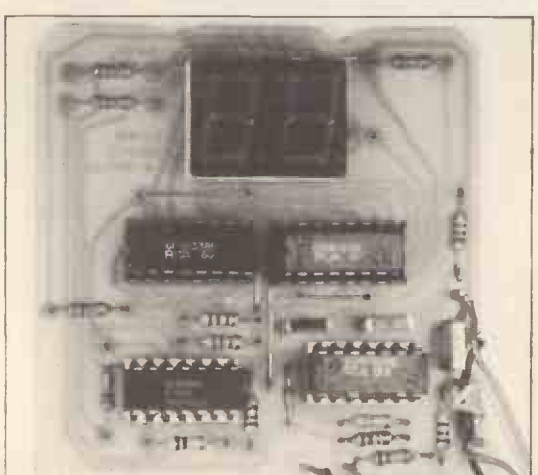
The PCB is a snug fit across the width of the case used, and is held lengthways by the battery placed at the front (see photo). Vertical movement can be restricted by placing a piece of foam between the component side of the board and the case.

The display filter strip should be secured inside the window aperture with a few carefully applied spots of adhesive.

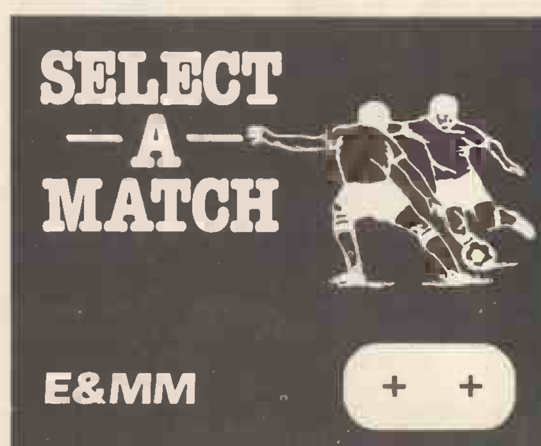
The on/off slide switch is mounted on the rear of the enclosure, using 8BA countersunk screws, locking the nuts with spots of adhesive. The touch switch was simply made by positioning two, chromed M3 panhead screws on 10mm centres at a convenient place (next to the battery) on the front panel. Solder tags should be used to attach the



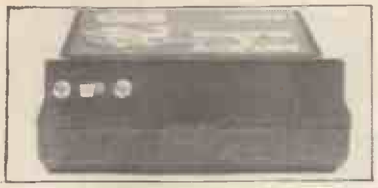
Internal view of Select-A-Match.



Component board completed.



Front panel artwork.



Case rear view.

wires from the PCB to these screws behind the panel and secured with M3 nuts, again locking the nuts with adhesive or locking washers.

To add the finishing touch to your project, use the front panel drawing supplied. E&MM

PARTS LIST

Resistors — all 5% ⅓W carbon

R1	100k		(M100K)
R2	10M		(M10M)
R3	10k		(M10K)
R4	330k		(M330K)
R5,6,7,8,13	56k	5 off	(M56K)
R9,10,11,14	5k6	4 off	(M5K6)
R12	220k		(M220K)
Capacitors			
C1,2,3	1n0 polycarbonate	3 off	(WW22Y)
Semiconductors			
D1	1N4148		(QL80B)
D2	Double digit common cathode display		(BY68Y)
IC1	4093BE		(QW53H)
IC2,3	4033BE	2 off	(QW23A)
IC4	CA3046		(QH26D)
Miscellaneous			
	14 pin DIL socket	2 off	(BL18U)
	16 pin DIL socket	2 off	(BL19V)
	PP3 9V battery		
	PP3 connector		(HF28F)
	Case		(HY25C)
	M3 pan head screws		(BF51F)
	M3 nuts		(BF58N)
	M3 solder tags		(LR64U)
	8BA countersunk screws		(LR00A)
	8BA nuts		(BF19V)

ELECTRONIC GAMES
COLOUR CARTRIDGE T.V. GAME
SEMI-PROGRAMMABLE T.V. GAME
+ 4 Cartridges + Mains Adaptor
Normal Price £73
NOW REDUCED TO: £39.50 inc VAT
DATABASE T.V. GAME
FULLY PROGRAMMABLE CARTRIDGE T.V. GAME
14 Cartridges available
Normal Price £87.86
NOW REDUCED TO: £59 inc VAT
ATARI T.V. GAME
The most popular T.V. Game on the market with a range of over 40 cartridges including SPACE INVADERS with over 112 games on one cartridge. £98.90 inc VAT
SPACE INVADERS
Hand-held Invaders Games available £19.95
+ Invaders Cartridges available to fit ATARI/RADOFIN/ACETRONIC/PHILIPS G7000
+ Cartridges also available for MATTEL/TELENG/ROWTRON/DATABASE/INTERTON
CHESS COMPUTERS
We carry a range of over 15 different Chess computers:
Electronic Chess £29.95
Chess Traveller £49.95
Chess Challenger 7 £79.00
Sensory 8 £119.00
Sensory Voice £259.00
SPECIAL OFFERS:
VOICE CHESS CHALLENGER Normal Price £245 NOW £135.00
SARGON 2.5, BORIS 2.5 Normal Price £273.70 NOW £199.95
All prices include V.A.T.
TELETEXT
ADD-ON ADAPTOR £199 inc VAT
THE RADOFIN TELETEXT ADD-ON ADAPTOR
Plug the adaptor into the aerial socket of your colour T.V. and receive the CEEFAX and ORACLE television information services.
THIS NEW MODEL INCORPORATES:
· Double height character facility
· True PAL Colour
· Meets latest BBC & IBA broadcast specifications
· Push button channel change
· Unnecessary to remove the unit to watch normal TV programmes
· Gold-plated circuit board for reliability
· New SUPERIMPOSE News Flash facility
SPEAK & SPELL
Normal Price £49.95
NOW REDUCED TO: £39.50 inc VAT
Teach your child to spell properly with this unique learning aid. Fully automatic features and scoring. Additional word modules available to extend the range of words.
ADDING MACHINE OLYMPIA HHP 1010
Normal Price £57.21
NOW REDUCED TO: £34 inc VAT
Uses ordinary paper! No need to buy expensive thermal paper!
Fast add listing PRINTER CALCULATOR 2 lines per second, 10 digit capacity. Uses normal adding machine rolls. Battery or mains operated.
(Mains adaptor extra)
24 TUNE ELECTRONIC DOOR BELL
Normal Price £19.70
NOW REDUCED TO: £12.70 inc VAT
Plays 24 different tunes with separate speed control and volume control. Select the most appropriate tune for your visitor, with appropriate tunes for different times of the year!
MATTEL T.V. GAME
The most advanced T.V. game in the world. 20 cartridges available. Add-on KEYBOARD coming soon to convert the MATTEL to a home computer with 16K RAM, fully expandable and programmable in Microsoft Basic. Other accessories will be available later in the year. £199.95 inc VAT
THE OLYMPIA — POST OFFICE APPROVED
TELEPHONE ANSWERING MACHINE
WITH REMOTE CALL-IN BLEEPER
£135 inc VAT
This telephone answering machine is manufatured by Olympia Business Machines, one of the largest Office Equipment manufacturers in the U.K. It is fully POST OFFICE APPROVED and will answer and record messages for 24 hours a day. With your remote call-in bleeper you can receive these messages by telephone wherever you are in the world. The remote call-in bleeper activates the Answer/Record Unit, which will at your command repeat messages, keep or erase them, and is activated from anywhere in the world, or on your return to your home or office. The machine can also be used for message referral, if you have an urgent appointment, but are expecting an important call, simply record the 'phone number' and location where you can be reached. With optional extra bleepers (£13 each) this facility can be extended to colleagues and members of the family. Using a C90 standard cassette you can record as many as 45 messages. The announcement can be up to 16 seconds long and the incoming message up to 30 seconds long.
The machine is easy to install and comes with full instructions. It is easily wired to your junction box with the spade connectors provided or alternatively a jack plug can be provided to plug into a jack socket. Most important, of course, is the fact that it is fully POST OFFICE APPROVED.
The price of £135 (inc. V.A.T.) includes the machine, an extra-light remote call-in Bleeper, the microphone message tape, A/C mains adaptor. The unit is 9¼"x6"x2½" and is fully guaranteed for 12 months. The telephone can be placed directly on the unit — no additional desk space is required.
OLYMPIA
FOR FREE BROCHURES – TEL: 01-301 1111
Silica Shop
TO CHISLEHURST
CO-OP
HIGH STREET
MAIN ROAD
SIDCUP HILL A211
TO FOOTSCRAY
ONE WAY STREET
CINEMA
POLICE STATION
TO ELTHAM
HATHERLEY ROAD
STATION ROAD
ELM ROAD
FARADAY AVENUE
SIDCUP STATION
NOTE: The top of Hatherley Road is one way only. Please enter from Sidcup High Street
Express 48hr delivery service available
· CALLERS WELCOME Demonstrations daily at our Sidcup shop
· 2 YEAR GUARANTEE All goods are covered by a full year's guarantee and many are further covered by our exclusive Silica Shop 2 year Guarantee
· MONEY BACK UNDERTAKING If you are unsatisfied with your purchase and return it within 7 days we will give you a full refund
· AFTER SALES SERVICE Available on all machines out of guarantee
· CREDIT FACILITIES
SILICA SHOP LIMITED Dept. E&MM4
1-4 The Mews, Hatherley Road, Sidcup, Kent DA14 4DX
Telephone: 01-301 1111 or 01-309 1111
SILICA SHOP

BI-PAK The Professional approach

TRANSISTORS

AC107	26
AC125	30
AC126	22
AC127	22
AC128	20
AC128K	37
AC132	26
AC141	26
AC141K	40
AC142	26
AC142K	40
AC176	24
AC176K	40
AC187	25
AC187K	40
AC188	25
AC188K	40
ACY17	50
ACY18	50
ACY19	50
ACY20	50
ACY21	50
ACY22	50
AD130	75
AD140	70
AD142	85
AD143	85
AD149	70
AD161	40
AD162	40
AD161/162 M/P	80
AF114	50
AF115	50
AF116	50
AF117	50
AF118	65
AF124	50
AF125	50
AF126	50
AF127	50
AF139	38
AF239	42
AL102	1.90
AL103	1.80
ASY26	50
ASY28	50
ASY29	50
AU104	1.90
AU110	1.90
AU113	1.90
BC107	10
BC107A	11
BC107B	11
BC107C	12
BC108	10
BC108A	11
BC108B	11
BC108C	12
BC109	10
BC109A	11
BC109B	11
BC109C	12
BC113	16
BC114	17
BC115	18
BC116	19
BC116A	20
BC117	20
BC118	17
BC119	28
BC120	35
BC125	25
BC126	30
BC132	18
BC134	18
BC135	18
BC136	20
BC137	20
BC138	28
BC139	32
BC140	25
BC141	28
BC142	25
BC143	25
BC144	40
BC145	46
BC147	09
BC148	09
BC149	09
BC150	20
BC151	22
BC152	20
BC153	25
BC154	19
BC157	10
BC158	10
BC159	10
BC160	26
BC161	38
BC167	11
BC168	10
BC169	10
BC169C	11
BC170	09
BC171	09
BC172	09
BC173	09
BC174	15
BC175	35
BC177	14
BC178	14
BC179	14
BC180	12
BC181	10
BC182	10
BC182L	10
BC183	10
BC183L	10
BC184	10
BC184L	10
BC186	15
BC187	18
BC207	11
BC208	11
BC209	12
BC212	10
BC212L	10
BC213	10
BC213L	10
BC214	10
BC214L	10
BC225	26
BC226	36
BC237	13
BC238	14
BC239	15
BC251	15
BC251A	16
BC261	18
BC300	30
BC301	28
BC302	29
BC303	28
BC304	28
BC307	13
BC327	12
BC328	13
BC337	13
BC338	13
BC384	14
BC440	30
BC441	30
BC460	32
BC461	32
BC477	20
BC478	20
BC479	20
BC546	10
BC547	10
BC548	10
BC549	11
BC550	14
BC556	14
BC557	13
BC558	13
BC559	14
BCY30	80
BCY31	80
BCY32	85
BCY33	80
BCY34	80
BCY70	14
BCY71	15
BCY72	15
BCZ10	70
BCZ11	70
BCZ12	70
BD106	50
BD115	50
BD116	50
BD121	65
BD123	65
BD124	75
BD131	35
BD132	35
BD131/132 M/P	80
BD133	40
BD135	35
BD136	35
BD137	35
BD138	36
BD139	38
BD140	38
BD139/140 M/P	80
BD155	50
BD175	60
BD176	60
BD177	68
BD178	68
BD179	75
BD180	75
BD185	68
BD186	68
BD187	75
BD188	75
BD189	78
BD190	78
BD195	90
BD196	90
BD197	95
BD198	95
BD199	99
BD200	99
BD201	80
BD202	80
BD201/202 M/P	1.70
BD203	80
BD204	80
BD203/204 M/P	1.70
BD205	80
BD206	80
BD207	80
BD208	80
BD222	47
BD225	47
BD232	85
BD233	65
BD234	65
BD235	55
BD236	58
BD237	65
BD238	65
BD239A	50
BD240A	50
BD239A/240A	1.00
BD240	45
BD241	45
BD506	38
BD508	38
BDX32	2.20
BDY11	1.30
BDY17	1.80
BDY20	80
BDY55	1.40
BDY56	1.60
BF115	25
BF117	50
BF118	75
BF119	75
BF121	50
BF123	60
BF125	50
BF127	60
BF152	25
BF153	25
BF154	22
BF155	35
BF156	28
BF157	28
BF158	28
BF159	28
BF160	28
BF162	24
BF163	30
BF164	50
BF165	50
BF167	24
BF173	24
BF176	36
BF177	24
BF178	25
BF179	30
BF180	30
BF181	30
BF182	30
BF183	30
BF184	22
BF185	22
BF186	26
BF187	26
BF188	32
BF194	10
BF195	10
BF196	12
BF197	12
BF198	15
BF199	16
BF200	30
BF222	90
BF224	20
BF240	17
BF241	18
BF244	28
BF257	30
BF258	30
BF259	35
BF262	60
BF263	60
BF270	36
BF271	31
BF273	36
BF274	38
BF324	35
BF336	34
BF337	34
BF338	38
BF371	26
BF457	37
BF458	37
BF459	38
BF594	30
BF595	28
BF596	28
BFR39	24
BFR40	25
BFR41	25
BFR50	25
BFR52	25
BFR62	24
BFR79	28
BFR80	28
BFW10	55
BFX29	25
BFX30	30
BFX84	24
BFX85	26
BFX86	26
BFX87	26
BFX88	26
BFX90	55
BFY50	20
BFY51	20
BFY52	20
BFY53	20
BFY90	80
BIP19	38
BIP20	38
BIP 19/20 M/P	80
BRY39	39
BSX19	20
BSX20	20
BSX21	21
BSY95	13
BSY95A	13
BU105	1.60
BU105/02	1.95
BU204	1.40
BU205	1.40
BU208	1.90
BU208/02	2.25
GP300	40
MJ480	95
MJ481	1.05
MJ490	95
MJ491	1.15
MJ2955	90
MJE340	50
MJE370	55
MJE371	60
MJE520	45
MJE521	65
MJE2955	90
MJE3055	65
MJE3440	52
MP8113	52
MPF102	60
MPF104	35
MPF105	35
MPSA05	20
MPSA06	20
MPSA55	20
MPSA56	20
NO120	18
OC19	85
OC20	1.85
OC22	1.50
OC23	1.50
OC24	1.35
OC25	1.00
OC26	1.00
OC28	90
OC29	95
OC35	90
OC36	90
OC41	20
OC42	22
OC44	24
OC45	20
OC70	24
OC71	15
OC72	24
OC74	26
OC75	30
TC76	35
OC77	50
OC79	40
OC81	22
OC810	24
OC82	24
OC82D	30
OC83	26
OC84	38
OC139	80
OC140	80
OC169	80
OC170	80
OC171	80
OC200	46
OC201	95
OC202	1.20
OC203	85
OC204	90
OC205	1.15
R2008B	2.50
R2010B	2.60
TIC44	29
TIC45	35
TIP29	30
TIP29A	55
TIP29B	42
TIP29C	44
TIP30	38
TIP30A	40
TIP30B	42
TIP30C	44
TIP31	38
TIP31A	40
TIP31B	42
TIP31C	44
TIP32	38
TIP32A	40
TIP32B	42
TIP32C	44
TIP41A	44
TIP41B	46
TIP41C	48
TIP42A	44
TIP42B	46
TIP42C	48
TIP2955	60
TIP3055	50
TIS43	22
TIS90	20
TIS91	22
TIS92	22
UT46	20
ZTX107	10
ZTX108	10
ZTX109	10
ZTX300	12
ZTX301	12
ZTX302	16
ZTX303	16
ZTX304	20
ZTX330	15
ZTX500	13
ZTX501	12
ZTX502	16
ZTX503	12
ZTX504	25
ZTX531	25
ZTX550	25
2N388	36
2N388A	56
2N404	20
2N404A	24
2N524	40
2N527	50
2N598	40
2N599	46
2N696	24
2N697	24
2N698	30
2N699	32
2N706	10
2N706A	12
2N707	48
2N708	14
2N711	30
2N717	30
2N718	25
2N718A	50
2N726	29
2N727	29
2N743	20
2N744	20
2N914	20
2N918	30
2N929	20
2N930	18
2N946	40
2N1131	24
2N1132	24
2N1302	25
2N1303	28
2N1304	28
2N1305	28
2N1306	35
2N1307	35
2N1308	40
2N1309	40
2N1599	35
2N1613	28
2N1711	30
2N1889	45
2N1890	45
2N1893	40
2N2147	75
2N2148	70
2N2192	38
2N2193	38
2N2194	38
2N2217	25
2N2218	25
2N2218A	28
2N2219	28
2N2219A	30
2N2220	20
2N2221	20
2N2221A	22
2N2222	20
2N2222A	20
2N2368	18
2N2369	14
2N2369A	14
2N2411	25
2N2412	25
2N2646	47
2N2711	22
2N2712	22
2N2714	22
2N2904	24
2N2904A	26
2N2905	24
2N2905A	26
2N2906	18
2N2906A	20
2N2907	20
2N2907A	22
2N2923	15
2N2924	15
2N2925	15
2N2926G	10
2N2926Y	09
2N2926O	09
2N2926R	09
2N2926B	09
2N3010	20
2N3011	20
2N3053	22
2N3054	45
2N3055	42
2N3402	21
2N3403	21
2N3404	29
2N3405	42
2N3414	16
2N3415	16
2N3416	29
2N3417	29
2N3614	1.00
2N3615	1.05
2N3616	1.05
2N3646	09
2N3702	09
2N3703	09
2N3704	09
2N3705	09
2N3706	10
2N3707	10
2N3708	09
2N3708A	09
2N3709	09
2N3710	10
2N3711	10
2N3771	1.40
2N3772	1.60
2N3773	2.20
2N3819 (FET)	18
2N3820 (FET)	45
2N3821 (FET)	60
2N3823 (FET)	60
2N3903	12
2N3904	12
2N3905	12
2N3906	12
2N4058	12
2N4059	14
2N4060	14
2N4061	12
2N4062	12
2N4220 (FET)	35
2N4284	28
2N4285	28
2N4286	28
2N4287	28
2N4288	28
2N4289	28
2N4290	28
2N4291	28
2N4292	28
2N4293	28
2N4860 (FET)	60
2N4923	65
2N5135	10
2N5138	10
2N5172	14
2N5194	56
2N5245	40
2N5294	50
2N5296	50
2N5448	12
2N5457 (FET)	32
2N5458 (FET)	32
2N5459 (FET)	35
2N5551	36
2N6027 (P.U.T.)	34
2N6121	70
2N6122	70
2N6289	70
2S301	50
2S302	43
2S302A	43
2S303	56
2S304	71
2S305	80
2S306	80
2S307	80

DIODES

AA119	08
AA120	08
AA129	09
AAY30	09
AAZ13	15
AAZ17	15
BA100	10
BA102	20
BA144	09
BA148	15
BA154	12
BA155	14
BA156	14
BA173	15
BA248	16
BB104	30
BAX13	07
BAX16	08
BY100	22
BY101	22
BY105	22
BY114	22
BY124	22
BY126	11
BY127	12
BY128	16
BY130	17
BY133	21
BY156	08
BY164	51
BY176	75
BY206	30
BY210/600	09
BYZ10	45
BYZ11	45
BYZ12	40
BYZ13	40
BYZ16	41
BYZ17	36
BYZ18	36
BYZ19	36
OA5	60
OA10	35
OA47	08
OA70	08
OA79	10
OA81	10
OA85	10
OA90	07
OA91	07
OA95	07
OA182	13
OA200	08
OA202	08
IN34A	07
IN60	06
IN914	04
IN916	05
IN4148	04
IS44	05

74 SERIES TTL

7400	14
7401	12
7402	12
7403	12
7404	13
7405	13
7406	28
7407	28
7408	20
7409	20
7410	13
7411	20
7412	22
7413	30
7414	50
7416	28
7417	28
7420	14
7421	32
7422	24
7423	28
7425	28
7426	30
7427	28
7428	34
7430	14
7432	28
7433	36
7437	30
7438	30
7440	15
7441	60
7442	60
7443	1.00
7444	1.00
7445	90
7446	90
7447	65
7448	65
7450	15
7451	15
7452	15
7453	15
7454	15
7460	15
7470	32
7472	28
7473	32
7474	30
7475	44
7476	35
7480	48
7481	95
7482	70
7483	68
7484	95
7485	95
7486	28
7489	1.95
7490	36
7491	75
7492	50
7493	36
7494	75
7495	65
7496	65
74100	1.10
74104	50
74105	50
74107	32
74110	46
74111	60
74118	95
74119	1.20
74121	36
74122	46
74123	60
74124	60
74136	65
74141	60
74144	2.50
74145	80
74150	1.00
74151	65
74153	65
74154	1.00
74155	70
74156	70
74157	70
74160	90
74161	90
74162	90
74163	90
74164	1.00
74165	1.00
74166	1.00
74167	2.30
74174	90
74175	80
74176	85
74177	85
74180	90
74181	2.30
74182	85
74184	1.35
74190	1.00
74191	1.00
74192	95
74193	1.00
74194	90
74195	90
74196	95

CMOS

CD4000	18
CD4001	19
CD4002	20
CD4006	92
CD4007	22
CD4008	80
CD4009	40
CD4010	48
CD4011	22
CD4012	22
CD4013	45
CD4014	84
CD4015	84
CD4016	42
CD4017	80
CD4018	85
CD4019	45
CD4020	99
CD4021	1.05
CD4022	95
CD4023	23
CD4024	70
CD4025	20
CD4026	1.50
CD4027	48
CD4028	80
CD4029	1.00
CD4030	55
CD4031	2.00
CD4034	1.95
CD4035	1.20
CD4036	3.30
CD4037	95
CD4038	1.15
CD4040	95
CD4041	78
CD4042	78
CD4043	88
CD4044	88
CD4045	1.50
CD4046	1.10
CD4047	95
CD4048	65
CD4049	45
CD4050	45
CD4052	80
CD4054	1.25
CD4055	1.25
CD4056	1.35
CD4068	25
CD4069	25
CD4070	29
CD4071	25
CD4072	25
CD4081	26
CD4082	26
CD4085	90
CD4093	70
CD4501	28
CD4502	1.20
CD4503	70
CD4506	70
CD4507	60
CD4508	2.95
CD4510	99
CD4511	1.15
CD4516	1.10
CD4518	1.00
CD4520	1.00
CD4528	1.10
CD4531	1.50
CD4561	1.00

VOLTAGE REGULATORS

MVR7805-MVR7824	all 59p Ea.
MVR7905-MVR7924	all 63p Ea.
78L05-78L24	all 28p Ea.
79L05-79L24	all 55p Ea.
LM309K	1.25
UA79MGHC	2.50
LM320 15v 12v, 15v 24v	95p Ea.

74 LS SERIES TTL

74LS00	13
74LS01	13
74LS02	15
74LS03	15
74LS04	15
74LS05	22
74LS08	21
74LS09	21
74LS10	20
74LS11	22
74LS12	26
74LS13	34
74LS14	50
74LS15	34
74LS20	18
74LS21	26
74LS22	32
74LS26	38
74LS27	35
74LS28	35
74LS30	18
74LS32	22
74LS33	34
74LS37	28
74LS38	28
74LS40	25
74LS42	55
74LS47	72
74LS48	80
74LS49	90
74LS51	24
74LS54	28
74LS55	28
74LS63	1.40
74LS73	30
74LS74	30
74LS75	38
74LS76	42
74LS78	46
74LS83	68
74LS85	75
74LS86	38
74LS90	38
74LS91	1.10
74LS92	68
74LS93	58
74LS95	95
74LS96	1.10
74LS107	40
74LS109	70
74LS112	38
74LS113	68
74LS114	38
74LS122	68
74LS123	60
74LS124	1.60
74LS125	45
74LS126	45
74LS132	60
74LS136	50
74LS138	60
74LS139	68
74LS145	1.15
74LS147	2.00
74LS148	1.60
74LS151	70
74LS153	68
74LS155	65
74LS156	80
74LS157	60
74LS158	60
74LS160	85
74LS161	75
74LS162	1.00
74LS163	90
74LS164	90
74LS165	1.20
74LS166	1.70
74LS168	1.80
74LS169	1.80
74LS170	2.50
74LS173	95
74LS174	95
74LS175	95
74LS181	2.70
74LS183	2.80
74LS190	95
74LS191	95
74LS192	95
74LS193	95
74LS194	95
74LS195	85
74LS196	1.00
74LS197	85
74LS221	1.00
74LS240	1.60
74LS241	1.60
74LS242	1.60
74LS243	1.60
74LS244	1.50
74LS245	2.20
74LS247	1.20
74LS248	1.20
74LS249	1.20
74LS251	1.20
74LS253	90
74LS257	90
74LS258	1.10
74LS260	85
74LS259	1.50
74LS261	4.00
74LS266	72
74LS273	1.65
74LS275	3.50
74LS279	85
74LS280	2.40
74LS283	85
74LS290	90
74LS293	1.00
74LS295	1.90
74LS298	1.50
74LS299	3.50
74LS323	3.50
74LS324	1.90
74LS325	3.00
74LS326	3.20
74LS327	3.10
74LS348	1.80
74LS352	1.50
74LS353	1.50
74LS365	45
74LS366	55
74LS367	62
74LS368	80
74LS373	1.45
74LS374	1.45
74LS375	1.10
74LS378	1.20
74LS386	75
74LS393	1.10
74LS395	2.00
74LS398	2.70
74LS399	2.00
74LS390	1.40
74LS670	2.50

COMPUTER I.C.s

2114L-3	2.40
2708	3.50
2516/2715-5v	4.90
4116	2.25

LINEAR I.C.'s

CA270BE	95
CA280Q	95
CA3011	98
CA3014	1.75
CA3018	65
CA3020	1.75
CA3028	80
CA3035	2.30
CA3036	1.00
CA3042	1.60
CA3043	1.85
CA3046	70
CA3052	1.60
CA3054	1.10
CA3075	1.50
CA3080	65
CA3081	1.50
CA3085	95
CA3089	2.00
CA3090	3.60
CA3123E	1.50
CA3130E	90
CA3140E	48
LF351N	55
LF353N	88
LF356N	90
LM301A	25
LM304	1.60
LM308	75
LM311	65
LM317H	2.50
LM318H	1.95
LM324	48
LM337T	1.35
LM339N	65
LM348N	80
LM380	85
LM381	1.45
LM382N	1.20
LM384	1.45
LM386	85
LM387	1.10
LM3915	2.20
LM3916	2.45
LM1458	42
LM3900	58
LM3909N	70
LM3914N	2.20
LM3911N	1.20
MC1304	1.90
MC1310P	1.45
MC1312	1.70
MC1350	1.20
MC1352	1.40
MC1469	2.70
MC1496	90
NE555	20
NE556	55
NE565	1.20
NE566	1.50
NE567	1.70
72702	46
UA703C	25
UA709C	25
72709	46
709P	35
UA710C	40
72710	30
UA711C	32
72711	32
UA723C	45
72723	45
UA741C	24
72741	24
741P	17
UA747C	60
72747	60
UA748	35
748P	35
SN76013N	1.60
SN76023N	1.65
SN76110	1.50
SN76115AN	1.90
SN76660N	90
TAA550B	35
TAA621	2.00
TAA661B	1.50
TBA120B	70
TBA540	1.40
TBA641A	2.20
TBA800	85
TBA810S	95
TBA820	70
TBA920Q	2.50
TCA270S	1.40
ZN414	90

SILICON RECTIFIERS

200mA	
IS920 50v	06
IS921 100v	07
IS922 150v	08
IS923 200v	09
IS924 300v	10
1 Amp	
IN4001 50v	04½
IN4002 100v	05
IN4003 200v	06
IN4004 400v	06
IN4005 600v	07
IN4006 800v	07
IN4007 1000	08
1.5 Amp	
IS015 50v	09
IS020 100v	10
IS021 200v	11
IS023 400v	13
IS025 600v	14
IS027 800v	16
IS029 1000v	20
IS031 1200v	25
3 Amp	
IN5400 50v	11
IN5401 100v	12
IN5402 200v	14
IN5403 300v	15
IN5404 400v	16
IN5405 500v	17
IN5406 600v	18
IN5407 800v	22
IN5408 1000v	25
6 Amp	
BYX38-300	45
BYX38-600	60
BYX38-300R	45
BYX38-600R	60
10 Amp	
IS10/50 50v	30
IS10/100 100v	35
IS10/200 200v	40
IS10/400 400v	50
IS10/600 600v	60
IS10/800 800v	70
IS10/1000 1000v	85
IS10/1200 1200v	95

THYRISTORS

1 Amp — TO39 CASE	
THY1A/50v	34
THY1A/100v	38
THY1A/200v	42
THY1A/400v	50
THY1A/600v	65
THY1A/800v	78
BT101/500R	80
BT102/500R	80
BT106	1.25
BT107	93
BT108	98
2N3228	70
3 Amp — TO66	
THY3A/50v	35
THY3A/100v	37
THY3A/200v	40
THY3A/400v	50
THY3A/600v	60
THY3A/800v	75
5 Amp — TO64	
THY5A/50v	36
THY5A/100v	45
THY5A/200v	50
THY5A/400v	57
THY5A/600v	60
THY5A/800v	75
5 Amp — TO66	
THY5A/50v	36
THY5A/100v	45
THY5A/200v	50
THY5A/400v	57
THY5A/600v	60
THY5A/800v	75
2N3525	77
BTX30/50L	40
BTX30/400L	70
BT116	1.50
C106D	38
BTY79/400R	95
5 Amp — TO220 PLASTIC	
THY5A/50vP	35
THY5A/100vP	45
THY5A/200vP	47
THY5A/400vP	50
THY5A/600vP	60
THY5A/800vP	70
10 Amp — TO48	
THY10A/50v	45
THY10A/100v	50
THY10A/200v	55
THY10A/400v	60
THY10A/600v	80
THY10A/800v	1.10
16 Amp — TO48	
THY16A/50v	65
THY16A/100v	80
THY16A/200v	90
THY16A/400v	1.20
THY16A/600v	1.50
THY16A/800v	2.00
30 Amp — TO49	
THY30A/50v	1.30
THY30A/100v	1.50
THY30A/200v	2.95
THY30A/400v	4.00
THY30A/600v	4.20

TRIACS & DIACS

2 Amp — TO39	
TR12A/100v	30
TR12A/200v	42
TR12A/400v	50
10 Amp — TO48	
TRI10A/100v	55
TRI10A/200v	80
TRI10A/400v	90
4 Amp — TO202	
TR14A/400v	48
8 Amp — TO220	
TR18A/400v	64
10 Amp — TO220 PLASTIC	
TRI10A/400P	85
6 Amp — TO220	
TR16A/100v	45
TR16A/200v	52
TR16A/400v	60
12 Amp — TO220	
TRI12A/400v	70
DIACS	
BR100	20
D32	20

ZENER DIODES

400W 1 3V-39V	all at 8p
1 3W 1 3V-100V	all at 15p
10W 1 3V-100V	all at 35p

BRIDGE RECTIFIERS

1 Amp RMS	
BR1/50v	20
BR1/100v	22
BR1/200v	25
BR1/400v	29
2 Amp RMS	
BR2/50v	35
BR2/100v	40
BR2/200v	44
BR2/400v	50
BR2/1000v	65
6 Amp RMS	
BR6/50v	75
BR6/100v	80
BR6/200v	88
BR6/400v	95

– new extended 1981 range

AL30A 10w R.M.S.
AUDIO AMPLIFIER MODULES

£4.16

AL60 25w R.M.S.
AUDIO AMPLIFIER MODULE
25 Watts RMS

£5.15

SPM120 STABILISED POWER SUPPLIES
SPM120/45
SMP120/55
SMP120/65

£6.38

AL80 35w R.M.S.
AUDIO AMPLIFIER MODULE

£8.07

S450
STEREO FM TUNER
Fitted with phase lock-loop

£25.56

Stereo 30
COMPLETE AUDIO CHASSIS

7+7w R.M.S.
£21.09

GE100 Mk2.
10 CHANNEL MONOGRAPHIC EQUALISER
£23.00


AL120 50w R.M.S.
AUDIO AMPLIFIER
(With integral heat sink and short-circuit protection).

£13.14

AL250 125w R.M.S.
POWER AMPLIFIER

£19.60

SPM80
STABILISED POWER SUPPLY

£4.84

VPS30
REGULATED VARIABLE STABILISED POWER SUPPLY

£7.60

MONO PRE-AMPLIFIERS

MM 100. Supply voltage 40-65v inputs: Tape, Mag P.U. Microphone Max output 500mv. £12.43

MM 100G. Supply voltage 40-65v inputs: 2 Guitars. Microphones Max output 500mv. £12.43

PA100
STEREO PRE-AMPLIFIER

£17.65

PA200
STEREO PRE-AMPLIFIER

£18.24

STA5. 5 watts per channel Stereo Amplifier. Kit consisting of: 2xAL20 amplifiers, 1xPA 12 pre-amplifier, 1xPS12 power supply, 1x2036 transformer and necessary wiring diagram £19.52

STA10. 10 watts per channel Stereo Amplifier. Kit consisting of: 2xAL30 amplifiers, 1xPA12 pre-amplifier, 1xPS 12 power supply, 1x2036 transformer and necessary wiring diagrams. £20.63

STA15. 15 watts per channel Stereo Amplifier. Kit consisting of: 2xAL60 amplifiers, 1xPA100 pre-amplifier, 1xSPM80 power supply, 1x2034 transformer, 2xcoupling capacitors for 8 ohms 470mfd 30v and necessary wiring diagram. £36.76

STA25. 25 watts per channel Stereo Amplifier. Kit consisting of: 2xAL60 amplifiers, 1xPA100 pre-amplifier, 1xSPM120/45 power supply, 1x2040 transformer, coupling capacitors for 8 ohms 470 mfd 45v, 1xreservoir capacitor 2200mfd 100v and necessary wiring diagram. £40.50

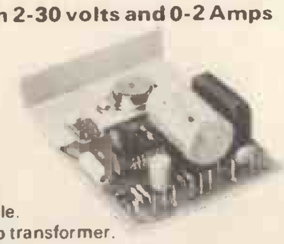
STA35. 35 watts per channel Stereo Amplifier. Kit consisting of: 2xAL80 amplifiers, 1xPA200 pre-amplifier, 1x2035 transformer, 2xcoupling capacitors 470mfd at 50v for 8 ohms, 1xreservoir capacitor 2200mfd 100v and necessary wiring diagram. £45.76

STA50. 50 watts per channel Stereo Amplifier. Kit consisting of: 2xAL120 amplifiers, 1xPA200 pre-amplifier, 1x2041 transformer, 2xcoupling capacitors 1000mfd 63v, 1xSPM 120/65, 1xreservoir capacitor 3300mfd 100v and necessary wiring diagram. £59.89

STA100. 100 watts per channel Stereo Amplifier. Kit consisting of: 2xAL250 amplifiers, 1xPA200 pre-amplifier. 2xSPM 120/65 power supplies, 2x2041 transformers, 2xcoupling capacitors 1000mfd 100v and necessary wiring diagram. £84.68

Stabilised Power Supply Kit
Variable from 2-30 volts and 0-2 Amps

VPS30



Kit includes:
1 – VPS30 Module.
1 – 25 volt 2 Amp transformer.
1 – 0-50v 2" Panel Meter.
1 – 0-2 Amp 2" Panel Meter.
1 – 470 ohm wirewound potentiometer.
1 – 4K7 ohm wirewound potentiometer.
Wiring Diagram Included.

KIT £20 + VAT

HARDWARE IN PACKS OF 25.

839	0BA 1" Bolt	0.70
840	0BA ½" Bolt	0.40
842	2BA 1" Bolt	0.35
843	2BA ½" Bolt	0.30
844	2BA ¼" Bolt	0.32
845	4BA 1" Bolt	0.28
846	4BA ½" Bolt	0.20
847	4BA ¼" Bolt	0.18
848	6BA 1" Bolt	0.24
849	6BA ½" Bolt	0.18
850	6BA ¼" Bolt	0.20
851	0BA Solder Tags	0.20
852	2BA Solder Tags	0.16
853	4BA Solder Tags	0.14
854	6BA Solder Tags	0.12
855	0BA Full Nut	0.42
856	2BA Full Nut	0.26
857	4BA Full Nut	0.18
858	6BA Full Nut	0.18
859	0BA Washer	0.12
860	2BA Washer	0.09
861	4BA Washer	0.09
862	6BA Washer	0.09

FUSE HOLDERS

506	20mm Chassis Fuse Holder	0.14
507	1¼" Chassis Fuse Holder	0.14
508	1¼" Car in line Fuse Holder	0.12
509	20mm Panel Fuse Holder	0.26
510	1¼" Panel Fuse Holder	0.32

FUSES:
Quick Blow 20mm:

611	150mA	0.06
612	250MA	0.06
613	500MA	0.06
614	800MA	0.07
615	1 Amp	0.06
616	1.5 Amp	0.07
617	2.0 Amp	0.06
618	2.5 Amp	0.06
619	3.0 Amp	0.06
620	3.15 Amp	0.07
621	5.0 Amp	0.06

Semi Delay: 20mm

622	100MA	0.07
623	250MA	0.07
624	500MA	0.07
625	1 Amp	0.07
626	1.6 Amp	0.07
627	2 Amp	0.07
628	2.5 Amp	0.07
629	3.15 Amp	0.07
630	5.0 Amp	0.07

Quick Blow: 1¼"

631	250MA	0.06
632	500MA	0.06
634	800MA	0.06
635	1 Amp	0.06
636	1.5 Amp	0.06
637	2.0 Amp	0.06
638	2.5 Amp	0.06
639	3 Amp	0.06
641	4 Amp	0.06
642	5 Amp	0.06

PS12 POWER SUPPLY MODULE

Power supply for AL20A-30A, PA12, S450 etc.

Input A.C. Voltage 15-20V.
Output D.C. Voltage 22-30V approx. (Dependent upon input.)
Output Current 800mA maximum.
Dimensions 60x43x26mm.

£1.65

PA12
STEREO PRE-AMPLIFIER

£8.55

MPA30
MAGNETIC CARTRIDGE PRE-AMPLIFIER

£3.27

BP124 SIREN ALARM MODULE

American Police screamer powered from any 12 volt supply into 4 or 8 ohm speaker. Ideal for car burglar alarm, freezer break-down, and other security purposes.

ONLY £3.85 5 WATTS –

Transformers are not included with power supplies.
SPM 120 Range also require reservoir and output capacitors.

BP124. 5 watt 12v max. – Siren Alarm Module. £3.85

GE100MK11. 10 channel mono-graphic equaliser, complete with sliders and knobs. £23.00

VPS30. Variable regulated stabilised power supply 2-30v 0-2 amps £7.60

PS250. Consists – 1 capacitor & 4 diodes for constructing unstabilised power supply for AL250 to 125 watts 2.90

TRANSFORMERS

2034. 1.7 amp 35v. Suit SPM80. £4.90
2035. 2 amp 55v £6.65
2036. 750mA 17v. Suit: PS12. £2.85
2040. 1.5 amp 0-45v-55v. Suit: SPM120/45. SPM120/55v. £6.45
2041. 2 amp 0-55v-65v. Suit: SPM120/55. SPM120/65v. 3.46
2039. 1 amp 0-20v. Suit Stereo 30. £3.50
2043. 150mA 15-0-15v. Suit: SG30. £1.60

ACCESSORIES

139. Teak Cabinet. Suit: Stereo 30, 320x235x 81mm. £7.00
140. Teak Cabinet. Suit: STA15, 425x290x 95mm. £9.50
FP100. Front Panel for PA100 & PA200. £1.80
BP100. Back Panel for PA100 & PA200. £1.60
GE100FP. Front Panel for one GE100MK11. £1.75
2240. Kit of parts including Teak Cabinet, Chassis, Sockets and Knobs etc. (To house STA15 Amplifier). £19.95

Full data sheets are available FREE on request, please enclose a S.A.E.

Access and Barclaycards accepted — just telephone our Orderline — Ware (STD 0920) 3182. All prices exclude VAT, add 50p postage per order. Terms: C.W.O., cheques, Postal Orders payable to Bi-Pak at address below.

BI-PAK
SEMICONDUCTORS

Dept. EMM 4 P.O. BOX 6, WARE, HERTS.
Tel: Ware (STD 0920) 3442. Telex: 817861.
Giro No. 3887006.
Visit our shop at: 3, Baldock St, Ware, Herts.

STOP! PRESS!

CB ACCESSORIES

105	Adjustable Aerial Gutter Mount	£3.00
106	CB Mobile Antenna	£9.50
1340	Mobile or CB Mike 600 ohms	£4.98
1341	Mobile or CB Mike 250 ohms	£6.00
1715	PL 259 Plug	£0.40
1716	SO239 Socket 4 hole fixing	£0.38
1717	SO239 Socket single hole fixing	£0.40
1718	PL258 Double Ended Female Coupler	£0.40
1719	NC555 Reducer for PL259 (Small)	£0.16
1720	NC556 Reducer for PL259 (Large)	£0.16
1721	M359 Right Angle Coupler PL259 SO239	£0.75
1722	M358 T Connector Female-Male-Female	£0.85
1723	NC563 Inline Coupler PL259 x 2	£0.60
1724	BNC15 50 ohm standard plug	£0.64
1725	BNC1502 Chassis mounting socket	£0.75
1726	BNC1503 Chassis mounting socket single hole fixing	£0.70
1727	BNC1520 BNC male to SO239 female	£0.85
1728	BNC1521 BNC female to PL259 male	£0.85

THE MATINÉE ORGAN

A complete electronic organ to build at low cost

PART 4: Interwiring, setting-up and Pedalboard circuitry

Last month we showed in Figure 22 the interwiring details. This month we describe how to achieve the results shown.

Interwiring

Take the seven wires coming from the power supply PCB, cut the blue and white wires to a length of 1.2m and the remaining five wires to 1m. Strip and tin the wires, terminate to the socket contacts and fit into the five- and six-way housings as shown in Figure 25. Check again that the wires are connected to the correct pins on the power supply.

Cut 2m from the length of yellow wire, then cut that in half, and twist the two lengths together. Cut 80cm off the length of screened cable and terminate these three wires on the socket contacts as shown in Figure 26. Push the contacts into the six-way housings as shown in Figure 25. Connect the free ends of the two yellow wires to the two tags on the spring line marked "input" (it does not matter which way round they are connected). Prepare the other end of the screened cable and connect it to the tags on the spring line marked "output". The screen must be connected to the terminal that is already connected to the metal case.

Cut two 1.5m lengths of violet hook-up wire and 1.5m of screened cable and connect to the four-way housing as shown in Figure 27. Connect the other ends to the swell pedal and glide switch as shown in Figure 28.

Cut a 50cm length from the orange, yellow and violet wires and connect them to one of the three-way housings and the two LEDs as shown in Figure 29.

Cut 30cm off the end of the 4m length of 2-core mains cable (at present connected to the PSU), then cut off a further 70cm and connect one end of each length to the headphone socket as shown

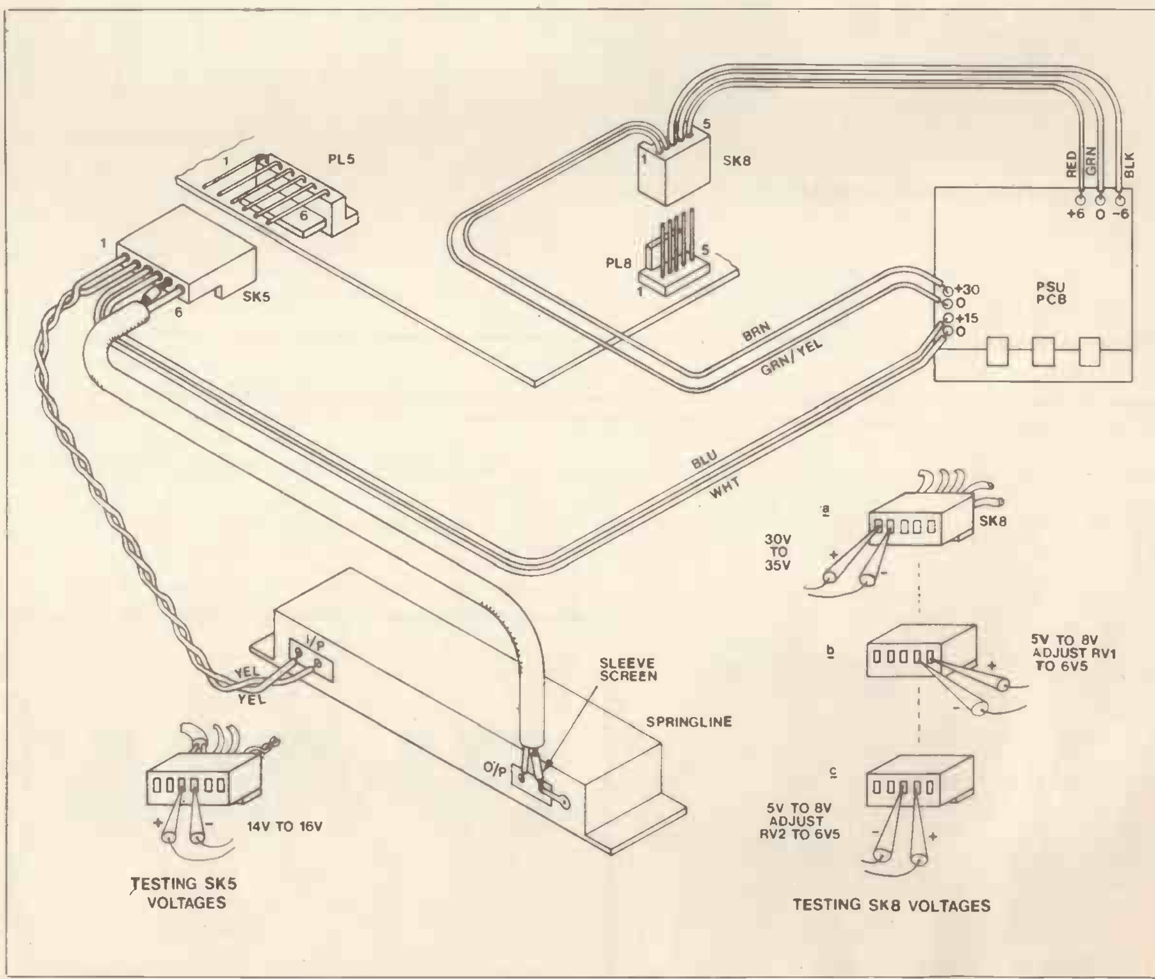


Figure 25. Wiring for springline, PSU and socket housings.

in Figure 30. Connect the two resistors R604 and R605. To the other end of the 30cm piece connect the two-way housing. The remaining cable is connected to the loudspeaker with the brown wire connected to the tag nearest the red dot on the speaker chassis.

Cut 1.5m off the 3m length of 2-core mains cable (still connected to the PSU) and connect one end of this piece and the end of the piece from the PSU to push-on receptacles, after sliding the covers back over the wires, as shown in Figure 31. Temporarily connect these to the mains switch. Referring to Figure 12, connect the other end of the cable to the 3-way terminal block, connecting the green wire from the PSU to the third terminal. Connect the 3-core mains cable to the other side of the block as shown in Figure 12. Do not connect to the mains yet.

With reference to Figure 23, link together all the top, left-hand tags of the pedalboard switches with the strapping wire. Then link together all the lower, left-hand tags of the pedalboard switches. Referring now to Figure 32, identify which wire number is which in the 15-way jumper that has a plug already connected at one end. Separate wire number 1 from the ribbon by carefully cutting along the groove between that wire and the next. Once started, it can be pulled back by hand. Pull back for exactly 50cm then cut 45cm off this wire and terminate at the tag shown in Figure 23. Separate wire 2 and then wire 3 to the same distance as wire 1 and terminate, then work through the remaining twelve wires separating back each wire only as far as required for each connection.

Now connect the remaining lengths (just over 1.3m each) of the orange, yellow and violet wires to the remaining three-way housing as shown in Figure 32 and connect the other ends to the pedalboard as shown in Figure 23. Connect the orange wire to the centre, right-hand tag of the extreme right-hand switch then cut 15cm off one of the wires cut from the ribbon jumper and link that tag to the centre right-hand tag of the third switch from the right.

This completes the wiring.

Setting-up the Power Supply

Ensure that the covers are completely covering the tags on the mains switch and take care with the mains terminal block, the fuseholder and the transformer primary tags whilst testing is in progress. Insert the fuse FS1 into the fuseholder in the power supply chassis. Ensure that the two sockets on the ends of the wires from the power supply are NOT connected to the main PCB. Connect the 13A plug to the other end of the 3-core mains cable. Plug into the mains supply and switch on.

Set a multimeter to a DC voltage range higher than 40V, take the five-way socket and place it with the locating lugs down and the wires entering from the rear. (The brown wire should be on the left). Switch on the organ mains switch; the neon in the switch should light. With thin-tipped probes or with pieces of wire connected to the probes, connect the meter positive probe to the left-hand socket and the negative to the socket next to it. The meter should read between 30V and 35V. If this voltage is not correct, switch off immediately and re-check all wiring and the polarity of all relative components.

If all is well, move the meter positive lead to the right-hand socket and the negative lead to the socket next to it. Switch the meter to the 10V DC range (or next highest range) and check that the meter reading is between 5 and 8 volts. Adjust RV1 on the PSU PCB with the trimming tool until the meter reads 6.5V. Remove the negative lead and replace it with the positive lead. Put the negative lead in the centre socket. The meter should read between 5V and 8V. Adjust RV2 on the PSU PCB until the meter reads 6.5V.

Take the six-way socket and place it with the locating lugs down and the wires entering from the rear. (The centre wire of the

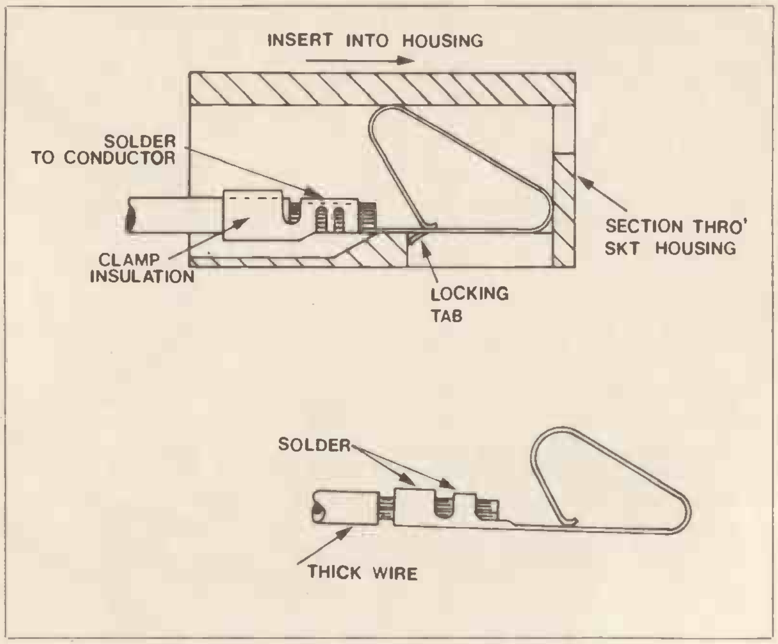


Figure 26. Socket contacts and housing details.

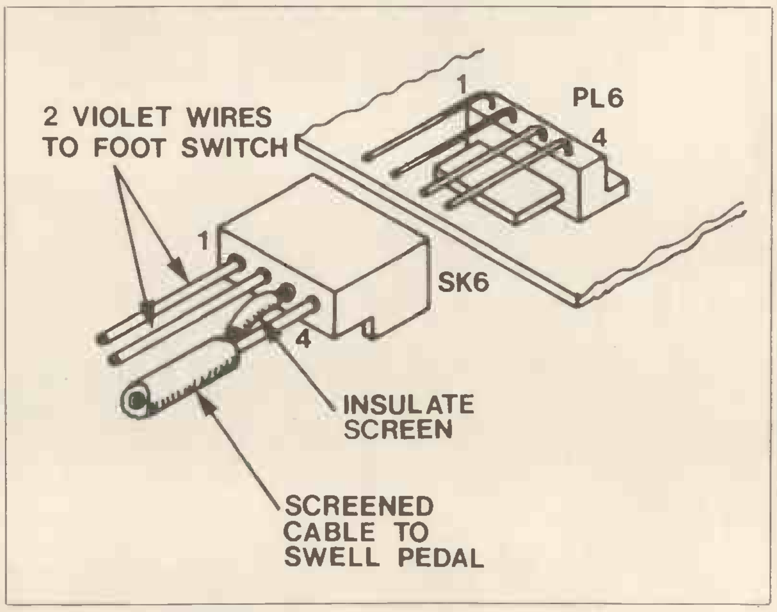


Figure 27. Four-way housing.

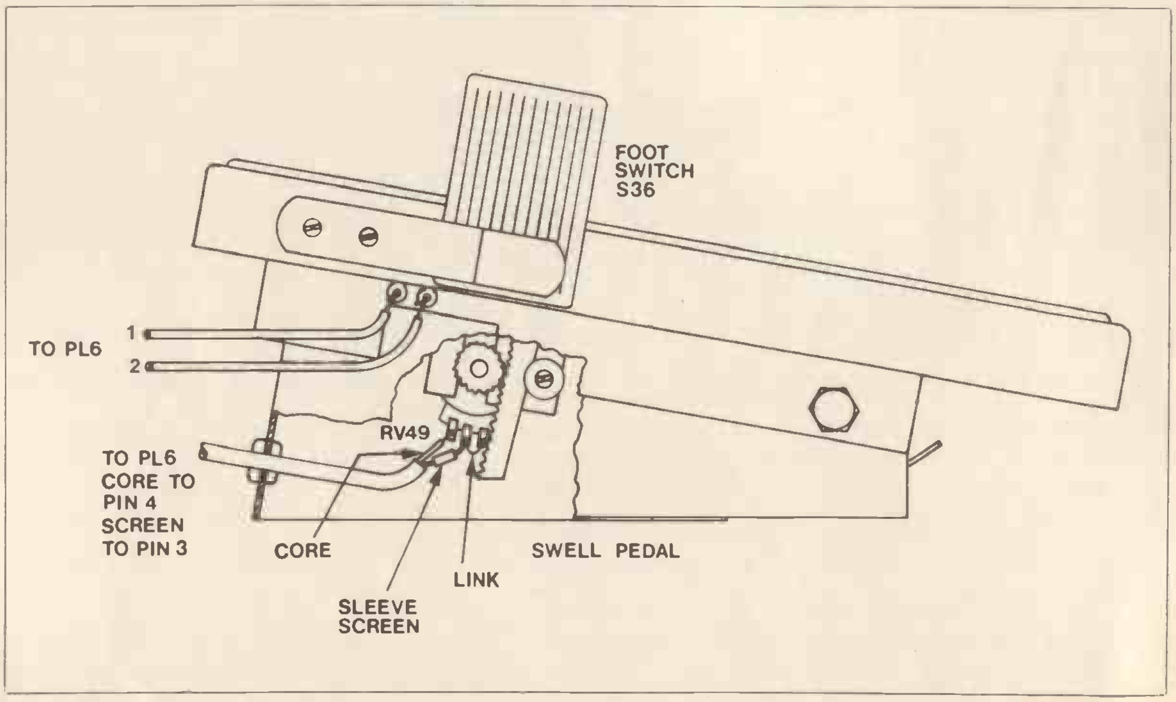


Figure 28. Swell pedal and glide switch.

screened lead should be on the left). Switch the meter to a DC voltage range above 15V and connect the positive lead to the third socket from the left and the negative one to the third from the right. The meter reading should be between 14V and 16V. Switch off.

Setting-up the Main PCB: Supply Rails

Note that in the following instructions the front of the PCB is the edge with the latchswitches under it. Connect the two sockets from the PSU to their plugs on the main PCB, SK8 with its locating lugs towards the centre of the PCB and SK5 with the locating lugs downwards. At this stage there should be no other sockets connected to the main PCB and ICs 1, 4, 24 and 44 should not be plugged in.

Switch on and switch the meter to the 10V DC range (or next highest range). Connect the meter negative lead to the metal of the pot mounting bracket and the positive to the positive end (nearest front of board) of C216 on the extreme left-hand edge of main PCB. The meter should indicate between 5.5V and 6.5V. Connect the meter positive lead to the pot mounting bracket and the negative one to the negative end (nearest the rear of the board) of C216. The meter should indicate between 5.5V and 6.5V. Switch off.

Unpack the remaining four ICs taking care to avoid touching the pins. Plug them in as shown on the legend on the PCB and on the identification chart supplied with the kit. Note that all the ICs on the main PCB have pin 1 either to the rear of the board or to the left-hand side (except IC24). Ensure that all drawbar slide pots are at minimum i.e. towards the rear of the board and that all switches are released or off, except any one rhythm switch and the presets cancel switch.

Connect the two jumper cables to the keyboard PCBs, ensuring that the cable leaves PLA towards the centre of the PCB, not as shown in Figure 22. Connect the other ends to the main PCB making sure that the cables come off the sockets towards the rear of the PCB as shown in Figure 22. Plug in the 15-way connector on the end of the cable from the pedalboard with the cable coming off downwards. Plug in the other four sockets. When you are certain that they are all correctly connected, switch on.

Connect the meter negative lead to the pot mounting bracket and the positive to the positive end of C216. Adjust RV1 on the PSU PCB until the meter reads exactly 6V. Connect the meter positive lead to the pot mounting bracket and the negative to the negative end of C216. Adjust RV2 on the PSU PCB until the meter reads exactly 6V.

Setting-up the Main PCB: General

Leave all the drawbar slide pots at minimum and set the meter range to 2.5V DC (or next highest above). With reference to Table 4, adjust each preset shown as follows. Connect the meter positive lead to the pot mounting bracket and the negative one to the test point shown in the table. With no keys pressed note the voltage reading as accurately as possible. Press any key on the manual indicated in the table and adjust the preset shown in the table until the voltage is identical to the one noted previously. Set all seven presets in turn.

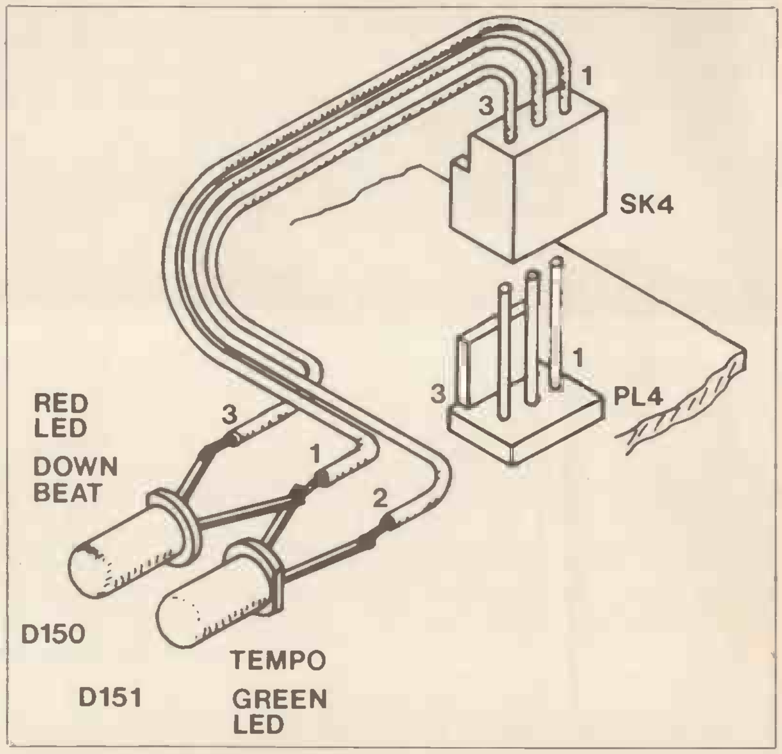


Figure 29. Downbeat and tempo LED wiring.

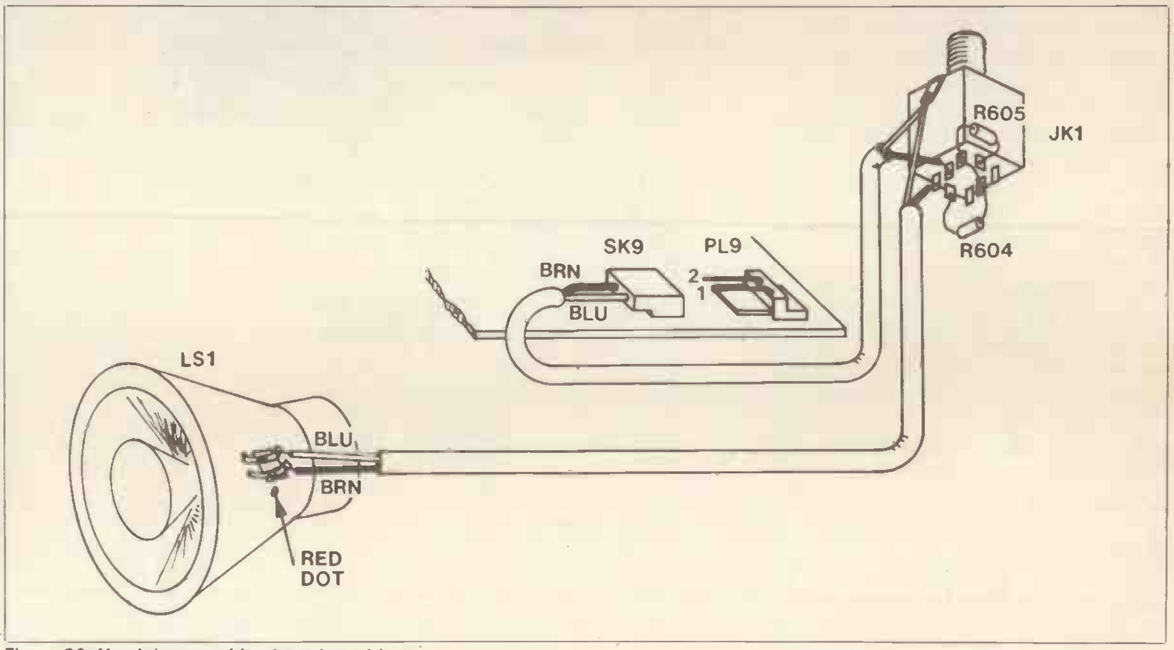


Figure 30. Headphone and loudspeaker wiring.

Test Point	Preset	Button pressed	Manual
TP1	RV35	Presets cancel	Upper
TP2	RV36	Presets cancel	Upper
TP3	RV45	Accordion	Upper
TP4	RV16	Presets cancel	Lower
TP5	RV14	Presets cancel	Lower
TP6	RV15	Presets cancel	Lower
TP7	RV13	Presets cancel	Pedalboard

Table 4. Setting-up VCA's

Advance the Bass Guitar drawbar RV12 and advance the master volume RV50. Press any pedal on the pedalboard and adjust RV1 on the main PCB for the cleanest attack that gives the most realistic sound.

Reset RV12 and advance the pedals 8ft. Flute drawbar (RV10). Play a note repeatedly on the pedalboard and adjust RV2 on the main PCB to set a fast or slow attack for the most pleasing sound.

Reset RV10 and advance the 8ft. Flute drawbar for the upper manual (RV38). Adjust the manual balance control (RV46, 47) if necessary, then play middle A. RV32 should now be adjusted to set the pitch of the entire organ. The frequency for middle A should be exactly 440Hz and may be set with pitch pipes available from most music shops or from the tone on E&MM demo cassette No. 1. Alternatively, the preset may simply be set to its centre position. Another alternative for early risers is the 440Hz tone broadcast by Radio 4 before programmes start each day (about 5.50 a.m. except Sundays).

Play A again and adjust RV31 so that when the glide switch S36 is pressed, the tone drops to Ab.

Select Vibrato (S20) and Vibrato Delay (S21), pull vibrato depth (RV30) fully forward and vibrato rate (RV28) half way. Adjust RV29 to give the delay you prefer. Reset S20, S21, RV28 and RV30.

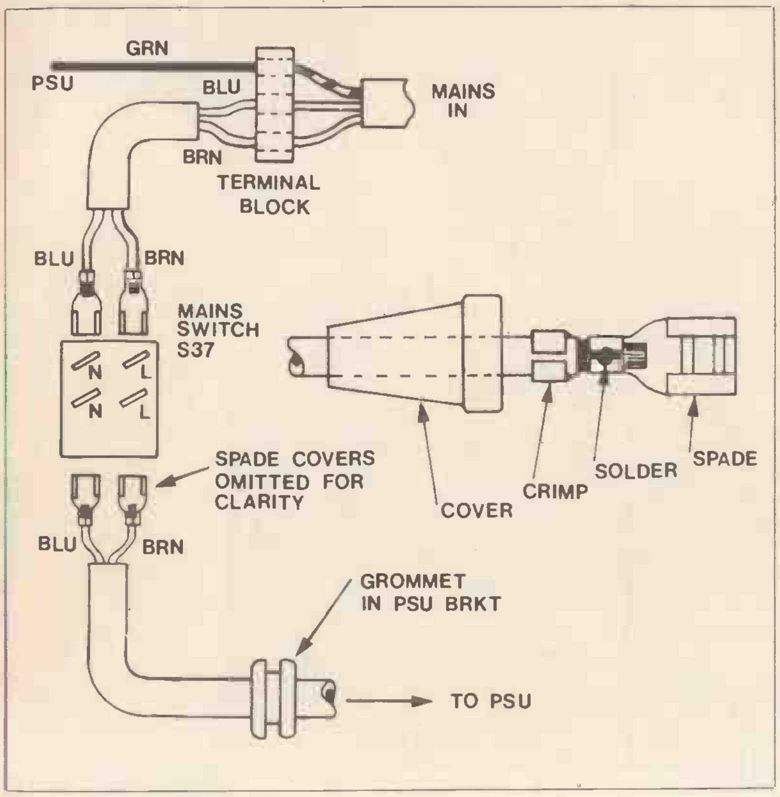


Figure 31. PSU mains cable wiring.

Set the swell pedal roughly central, play a chord on the upper manual then press manual wah (S35) and wah on/off (S34); adjust RV48 for the same volume. Reset S34 and S35.

Press rotor on/off (S17), play a chord and adjust RV52 slowly until the best effect is achieved. Switch to fast rotor (S18) and the effect will accelerate slowly just like a real "Leslie". Reset S18 and the rotor will decelerate slowly. Reset S17.

Setting-up the Main PCB: Rhythm Generator

Set RV19, 20, 21, 22, 23, 24 and 25 fully clockwise and RV26 and 27 fully anticlockwise. Advance the rhythm level RV18, select Waltz, rhythm start S22 and adjust tempo RV51 for a reasonable speed. Adjust RV19 for the best sounding bass drum. Adjust RV25 to a point just before it starts to oscillate. Set RV27 half way. Adjust RV26 for the best snare drum sound, then re-adjust RV27 for the best cymbal and snare sound.

Select Reggae, set RV21 fully anti-clockwise and adjust RV20 until the best low bongo sound is achieved. Readjust RV21 to improve the tone, then slowly adjust RV20, 21 relative to each other for the best sound.

Select Disco, set RV22 fully anticlockwise and adjust RV23 until the best conga sound is achieved. Then re-adjust RV22 to improve the tone. RV22 and 23 should then be slowly adjusted relative to each other to obtain the best sound.

Select Cha-cha and adjust RV24 for the best clave sound. Note that in this rhythm, high bongo (RV25), low bongo (RV20) and conga (RV23) form a run and may be re-adjusted to obtain a pleasing downward frequency progression. The long and short cymbals do not require adjustment and the high bongo is set when the snare drum is set. The organ is now completely set-up.

Pedalboard Circuit

The heart of the pedalboard circuit is the M147 integrated circuit which provides five octave-related outputs for any one of 13 different notes. As with all 13-note pedalboards, the output is monophonic, that is only one note can be played at any one time. However many pedals are pressed, the M147 only outputs the frequencies appropriate to the lowest pedal pressed — in other words it gives priority to the left.

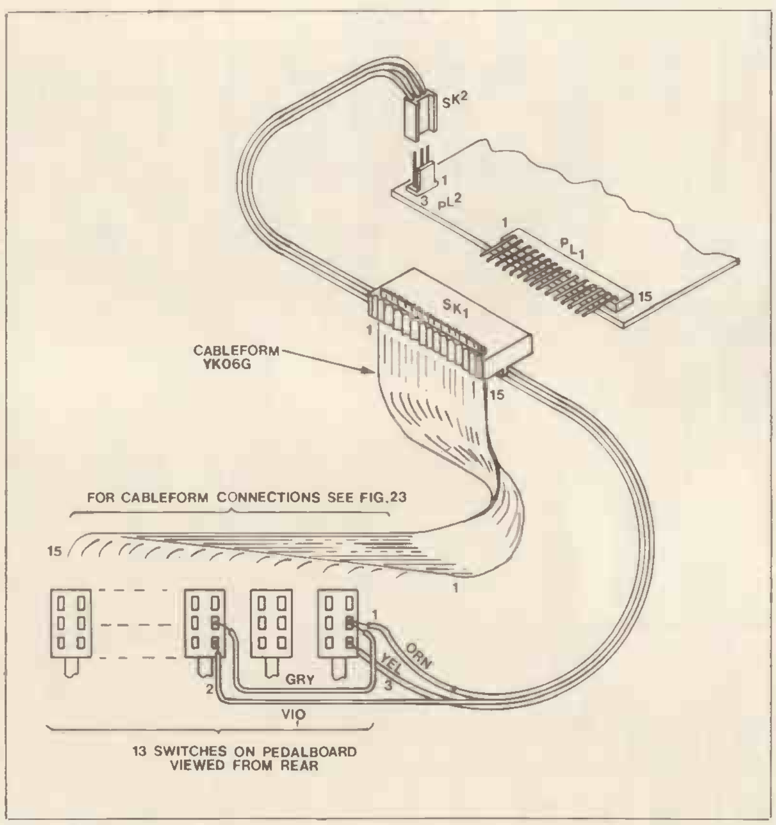


Figure 32. Pedalboard wiring.

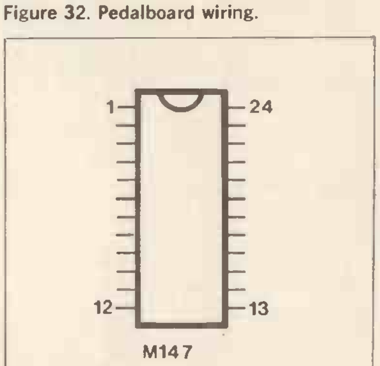


Figure 33. M147 pin details.

The master frequency 500,060Hz from IC37 pin 13 (Figure 2) is connected to pin 17 of the M147. Since this pin can also accept 2MHz, the mode switch in the IC is set to accept 500kHz by connecting pin 19 to +6V.

When the pedals are normal, the thirteen key line inputs to the IC are connected to +6V, but when depressed, that pedal input is connected to -6V. The M147 detects the transition and if the pedal is to the left of any previously pressed pedal or if releasing a most left pedal makes a higher one the new most left pedal, the frequencies appropriate to that pedal are output on pins 20 to 24. The output of pin 23 is exactly double the frequency (or one octave higher) than pin 24, whilst the output of pin 22 is one octave higher than pin 23 and so on, though the 1ft and 2ft outputs are not used in the Matinee.

1.	+6V
2.	Trigger percussion pulse
3.	Low C
4.	C#
5.	D
6.	D#
7.	E
8.	F
9.	F#
10.	G
11.	G#
12.	A
13.	A#
14.	B
15.	High C
16.	Trigger sustain level
17.	Master frequency input
18.	-6V
19.	Mode select
20.	1 foot
21.	2 foot
22.	4 foot
23.	8 foot
24.	16 foot

Table 5. M147 Pin functions

This output now remains on even if the pedal is released, unless a new pedal now becomes the most left pedal pressed or until a new pedal is pressed. Each output has a pull-down resistor to -6V (R4, 5 and 6) and is then fed through IC2, the auto/manual switch. When in manual mode, the three footages are connected straight through to the filters but in automatic mode, they are disconnected and the automatic bass output from the lower manual, M108, is connected through instead.

The square wave from the 16ft output is connected through the low-pass filter formed by R17, 18, 19, C6 and 7 to form a flute sound. The output is taken via C5 to the level control drawbar RV9. The square wave from the 8ft output of the M147 is connected through the low-pass filter formed by R20, 21, 22, C8 and 9 to form a flute sound also. The output is taken via C10 to the level control drawbar RV10. There is also an input to this filter coming via R215 from the automatic bass when IC2 is switched to automatic.

The outputs of RV9 and 10 are mixed together by R141 and 142 and fed to the signal input, pin 14, of IC3, the bass VCA. The control input, pin 16 of this IC, is fed from the bass envelope shaper. Pin 16 of the M147 provides a low DC level whenever any pedal is pressed and this level is fed to the input of the bass envelope shaper

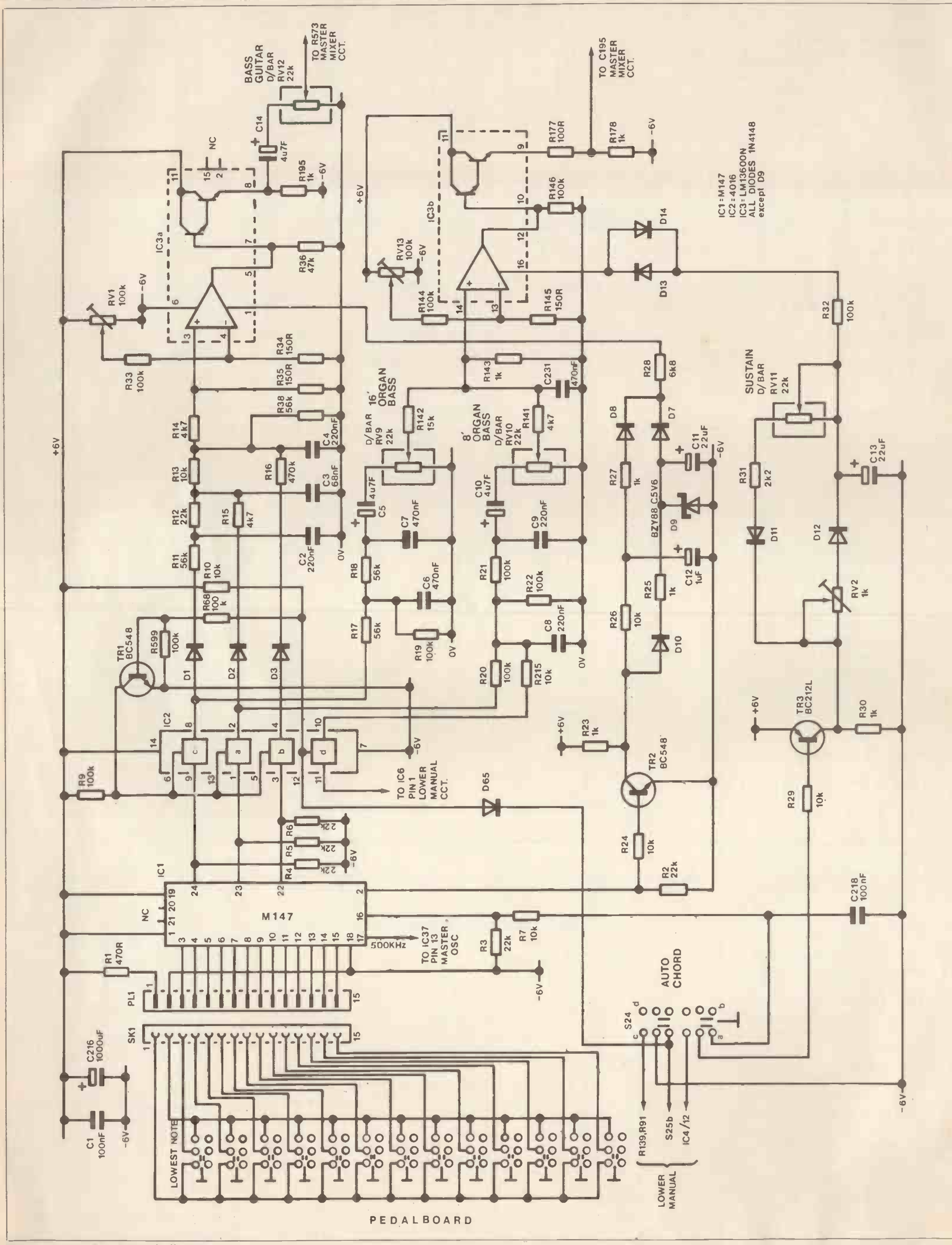


Figure 34. Pedalboard circuit diagram.

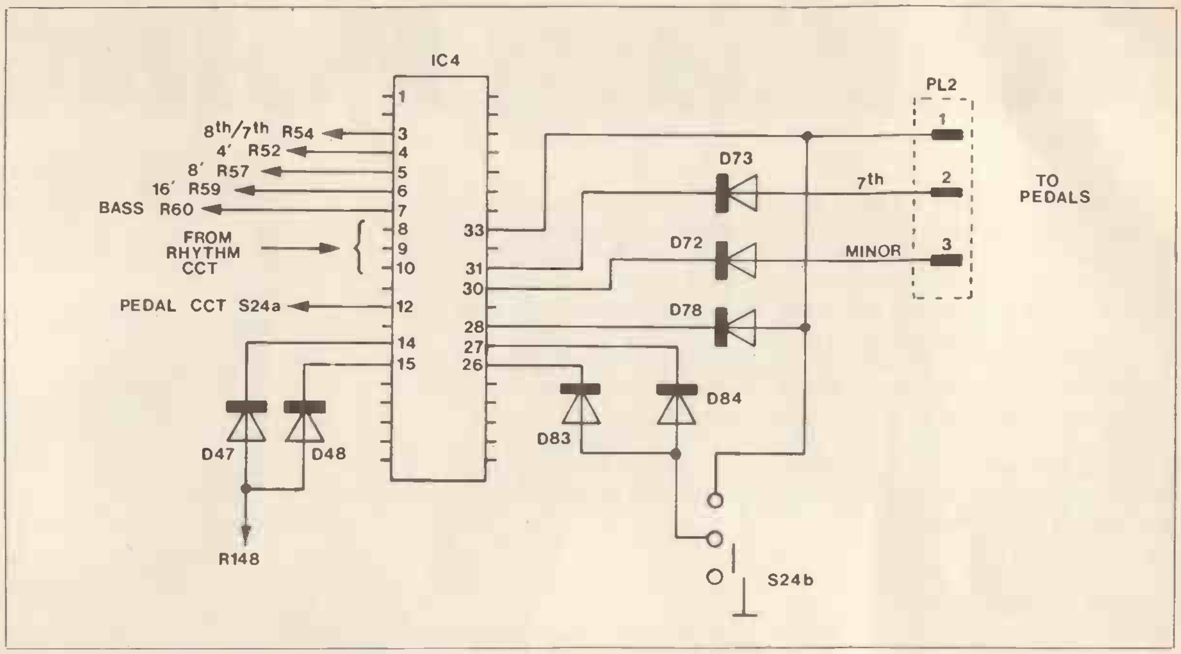


Figure 35. Lower Manual M108 connection details.

when the organ is in manual mode. In automatic mode the input comes from the TDB output of the M108 and this changeover is carried out by S24A.

In manual mode, the level from the M147 switches TR3 on and C13 now charges via D12 and RV2 at the rate set by RV2. This provides a positive going output from the envelope shaper which turns up the gain of IC3b. When all pedals are released, pin 16 of the M147 goes high turning TR3 off. C13 now discharges, via R30, 31, RV11 and D11 at a rate set by the sustain drawbar RV11. The output of the envelope shaper is now negative-going and this gradually closes the VCA until there is no further sound (remember that the tone outputs of the M147 remain on even when no pedal is pressed). As in all VCAs in the organ, a preset (in this case RV13) is connected via a resistor to pin 13(4) of the VCA to remove any DC offset present at the output when the VCA is keyed.

All three footages from IC2 are connected via D1, 2 and 3 to the bass guitar filter, a complex low-pass filter-mixer consisting of R11 to 16 and R38 and C2, 3 and 4. This produces a characteristic bass guitar sound. The output of this filter is fed direct to pin 3, the signal input of IC3a, the bass guitar VCA. The control voltage to pin 1 comes from the bass guitar envelope shaper.

When any pedal is pressed, a negative pulse around 10ms long, from pin 2 of IC1, is connected via R24 to TR2 causing it to switch off momentarily which charges C11 via R25 and D10, and C12 via R26. C12 rapidly discharges again whilst C11, whose charge does not rise as high as C12 because of D9, discharges more slowly. This produces the early "thud" and longer sustain characteristic of a bass guitar. The output of the VCA is fed via RV12, the bass guitar level control.

Lower Manual M108

The M108 in the lower manual is used in both the "single" and "split" modes. In future we shall refer to the "single" mode as the manual mode and the "split" mode as the automatic mode. The keyboard connections are identical to the upper manual, but the functions associated with octave bar 6 differ as follows. Pin 24 of the M108 (IC4) is not connected and this allows the outputs of the rhythm generator to be active low. Pin 26 and 27 go via D83, 84 and S24B, the auto/manual switch. When this switch is not operated, the manual and 49-note keyboard modes are selected. When the switch is operated, automatic and split-keyboard modes are selected. Pin 28 is permanently locked on by D78 so that when a one-finger chord is released, the whole chord remains on in order to provide an output during sustain time.

Pins 30 and 31 are connected via D72 and 73 to the pedalboard keys low C and D. In automatic mode, depressing low C changes a major chord to a minor chord and depressing D changes a major chord to a 7th chord. Pressing both together would generate a minor 7th chord. The counter-melodies and bass runs are also changed accordingly.

The manual mode functions of the M108 in the lower manual are the same as those for the upper manual. However, in the lower manual the M108 is used in its automatic mode as well and the following pins are used. In the manual mode, pins 4, 5 and 6 are the footage outputs for the lower half of the lower manual but in the automatic mode they and pin 3 become the four notes of an 8ft chord.

Pins 8, 9 and 10 are the input from the rhythm generator. After decoding the M108 generates a bass line which is output on pin 7. Pin 11 is not used in the Matinée. The output from pin 12 changes level whenever the code into pins 8, 9 and 10 changes and is used to initiate the bass envelope shaper.

In manual mode pin 15 gives a DC level when any key is pressed, but in automatic mode any key pressed on the lower half of the manual gives a DC level from pin 14. In the Matinée we do not need these two signals separately so these two pins are linked together via D47 and D48.

In Part 5, we shall describe the construction of the cabinet and explain how everything fits in. Ready-made cabinets (in flat-pack form) will also be available at this time from Maplin Electronics Supplies Ltd. We shall also continue our description of the lower manual and rhythm generator circuits. **E&MM**

PARTS LIST

Resistors — all 5% ⅓W carbon unless specified

R1	470R		(M470R)
R2,3,4,5,6,12	22k	6 off	(M22K)
R7,10,13,24, 26,29,215	10k	7 off	(M10K)
R9,19,20,21, 22,32,33,68, 144,146,599	100k	11 off	(M100K)
R11,17,18,38	56k	4 off	(M56K)
R14,15,141	4k7	3 off	(M4K7)
R16	470k		(M470K)
R23,25,27,30 143,178,195	1k	7 off	(M1K)
R28	6k8		(M6K8)
R31	2k2		(M2K2)
R34,35,145	150R	3 off	(M150R)
R36	47k		(M47K)
R142	15k		(M15K)
R177	100R		(M100R)
RV1,13	100k Hor. S-min. preset	2 off	(WR61R)
RV2	1k Hor. S-min. preset		(WR55K)
RV9,10	22k Lin. Drawbar white	2 off	(BR42V)
RV11	22k Lin. Drawbar blue		(BR98G)
RV124	22k Lin. Drawbar green		(BR99H)
Capacitors			
C1,218	100nF disc ceramic	2 off	(BX03D)
C2,4,8,9	220nF polycarbonate	4 off	(WW45Y)
C3	68nF polyester		(BX75S)
C5,10,14	4u7, 63V, axial electrolytic	3 off	(FB18U)
C6,7,231	470nF polycarbonate	3 off	(WW49D)
C11,13	22uF, 10V, axial electrolytic	2 off	(FB29G)
C12	1uF, 63V, axial electrolytic		(FB12N)
C216	1000uF, 16V, axial electrolytic		(FB82D)
Semiconductors			
IC1	M147		(YY91Y)
IC2	4016BE		(QX08J)
IC3	LM13600N		(YH46U)
TR1,2	BC548	2 off	(QB73Q)
TR3	BC212L		(QB60R)
D1,2,3,7,8,10, 11,12,13,14,65	1N4148	11 off	(QL80B)
D9	BZY88C5V6		(QH08J)
Miscellaneous			
S24	4-pole latch switch		(FH68Y)
PL1	15-way, Rt-angle, minicon plug		(BH67X)
	24-pin DIL socket		(BL20W)
	13-note pedal board		(XB18U)
SK1	Pedalboard cableform		(YK06G)

Starting Point

by Robert Penfold

As it is hoped this series will show, it is within the capabilities of practically anyone to gain a good basic understanding of electronics. For those whose main interest is electronics construction, design, or servicing, it is probably best to concentrate mainly on the characteristics of the various components and the way in which they are employed in practical designs, rather than on the detailed theory of their operation. This approach is used in this series, and it should enable even absolute beginners to quickly and easily grasp an understanding of electronic circuits. Each part of the series will be accompanied by a simple constructional project which will demonstrate the practical application of the theory that has been covered, as well as being a useful and worthwhile piece of equipment in its own right.

Semiconductors

There are a number of devices that come into the semiconductor category, the two most common being transistors and diodes. These are the only semiconductor components we will be concerned with for the time being and we will deal with the diode first as this is the simpler of the two.

A diode, or rectifier as higher power types are often called, has the property of only allowing a current flow in one direction. This property is demonstrated in the circuit of Figure 1, which also shows the circuit symbol. D1 blocks any current flow through R1, but D2 conducts and allows a current to flow through R2. In terms of conventional current flow, the arrowhead formed by part of the diode symbol indicates the direction in which the component conducts.

It is obviously important to identify the two terminals of a diode so that it can be connected with the correct polarity; the usual method is a band marked round the body of the component at the end having the cathode leadout wire, as shown in Figure 2. Unfortunately, there are a small number of diodes which have the band marked round the anode end of the component for some reason; thankfully these are only encountered rarely. There are also a few diodes which have the polarity marked by having the diode circuit symbol on the body of the component (the band may also be included).

An ideal diode would have no resistance when forward biased (i.e. passing a current) and infinite resistance when reverse biased (opposing a current flow). Alternatively, a low forward resistance and extremely high reverse resistance would be very acceptable but practical diodes do not even provide this. The reverse resistance of germanium diodes is usually quite high; being typically a few hundred kilohms or more. Silicon diodes are better in this respect, having a typical reverse resistance of hundreds, even thousands, of megohms. It is in the forward direction that the performance of semiconductor diodes leaves much to be desired.

The problem with a forward biased semiconductor diode is that it does not conform to Ohm's Law. When subjected to small voltages it has an extremely high resistance of perhaps many megohms or more, whereas with a high voltage applied to the device its resistance may well be just a few ohms or even less. The resistance of a silicon diode falls sharply at

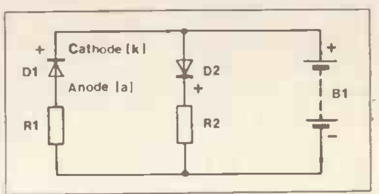


Figure 1. Diode effect on current flow.

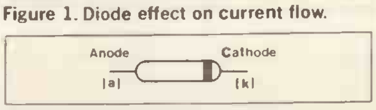


Figure 2. Typical diode markings.

a forward voltage of approximately 0.6 volts (referred to as the threshold voltage) as shown in the graph of Figure 3. In practice this means that a diode of this type will not work properly if it is subjected to low voltages, and when used at higher voltages, there is a voltage drop of about 0.6 volts across the device when it is forward biased.

For circuits where a diode has to process fairly low voltages, a germanium device is preferable since germanium diodes have a lower and less sharply defined forward threshold voltage, and give a typical voltage drop of only 0.1 to 0.2 volts. This must be offset against the disadvantage of the lower reverse resistance. Germanium diodes are also relatively easily damaged by heat and must be treated carefully when they are being soldered into a circuit.

Diodes and other semiconductor

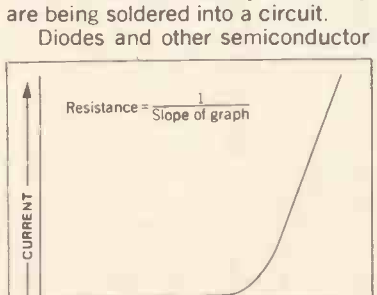


Figure 3. Forward characteristic of typical silicon diode.

devices do not have values like resistors and capacitors, but are given type numbers such as 0A90, 1N4148, etc. The type numbers tell you little or nothing about the characteristics of a device and it is necessary to refer to the data sheet for the device concerned in order to obtain this information.

The two main parameters of a diode are its maximum reverse voltage and its maximum safe forward current. If the reverse bias voltage applied to a diode is too high, the device will break down and exhibit a very low resistance. It is also quite likely that the device will be destroyed. The reverse breakdown voltage is usually quite high; being typically between 50 and 1000 volts.

The maximum forward current that a device can handle safely is often determined by the ability of the device to dissipate the heat generated by the power wasted in the component due to its forward voltage drop (i.e. its forward resistance). This enables most diodes and rectifiers to handle currents in the order of hundreds of milliamps or more, but there are some types which can only handle currents up to a few tens of milliamps in safety.

Transistors

A transistor is an 'active' device, which means it is capable of providing amplification, whereas resistors, capacitors, and diodes cannot, and are termed 'passive' components. A transistor also differs from the other components we have considered so far in that it has three terminals rather than two. These are termed the 'base', 'emitter', and 'collector'. There are two main types of transistor, the NPN type and the PNP. These names refer to the types of semiconductor material used in the devices, and the way that they are arranged. Here we are not concerned with the complex internal structure and operation of semiconductor devices and will concentrate on the properties and uses of these components. The main practical difference between NPN and PNP transistors is that they operate with the opposite supply voltage polarity. Figure 4 shows the circuit symbols for both types of transistor, the only difference between the two being the direction of the arrow in the emitter part of the symbol.

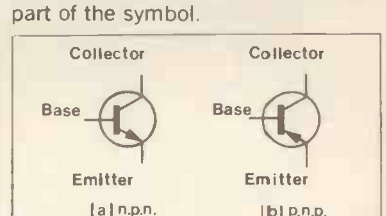


Figure 4. a) NPN transistor symbol. b) PNP transistor symbol.

Figure 5 shows a simple circuit that demonstrates the amplifying capability of a transistor. If S1 is in the open position, the battery is connected across the series combination of ME2 and the collector-emitter terminals of TR1. ME1, RV1 and the base terminal of TR1 are effectively eliminated from the circuit.

Under these conditions the transistor would ideally pass zero current but it will in fact pass a small 'leakage' current. For a silicon transistor this current will normally be very low, and is usually less than one microamp. Germanium transistors tend to have much higher leakage currents than this, and germanium power devices sometimes have leakage currents of tens of milliamps. The high leakage current is one of the reasons that germanium transistors have now been superseded by silicon devices, and most germanium transistors are now in fact obsolete.

If S1 is now closed, a current will

flow through S1, ME1, RV1, and the base-emitter terminals of TR1. The base-emitter junction of TR1 acts very much like a forward biased diode, thus for a silicon device there will be a base-emitter voltage of about 0.6 volts. The current flowing into the base of TR1 can be varied by means of RV1, and ME1 will register the actual current flow.

The base current flowing into the device has the effect of causing an increased collector-emitter current to flow and this current is monitored by ME2. The important point to note here is that the collector current will increase by an amount which is greater than the base current and varying the base current causes a roughly proportional change in the collector current. In other words, if RV1 is adjusted for a base current of (say) one microamp, the collector current registered on ME2 might be 100 microamps. If RV1 is then adjusted for a base current of two microamps, ME1 would register a collector current of approximately 200 microamps. The transistor is therefore producing a DC current gain (often abbreviated to h_{FE}) of 100 times.

The current gain of a transistor is not constant, but varies to some extent with changes in collector current and, to a lesser extent, with changes in collector voltage. In general the gain of a transistor increases as collector current increases, although at high collector currents the current gain may well drop slightly. Current gain also tends to increase slightly with increased collector voltage, but is almost independent of it at values above approximately one volt. At collector voltages below one volt the current gain falls considerably, as can be seen from the graph of Figure 6 which shows a typical collector current versus collector-emitter voltage curve for a fixed base current.

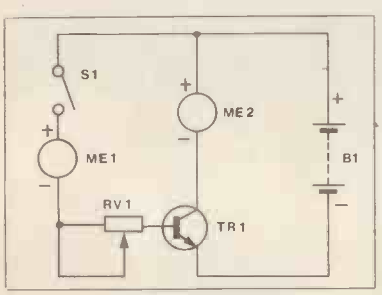


Figure 5. Simple current gain demonstration circuit.

Parameters

We have already considered two parameters of transistors — leakage and DC current gain. Leakage will normally be specified at a particular collector to emitter voltage since it increases with rising collector to emitter voltage. Since current gain is to some extent dependent upon both collector current and voltage, it will normally be quoted at specific values for both quantities.

Transistor data usually includes a number of other parameters, and some of the more important ones are listed and explained below:

V_{CE} max. Maximum collector to emitter voltage. If this rating is exceeded the collector to emitter current will greatly increase and the device will be almost instantly destroyed.

I_C max. The maximum safe collector current for the device.

Ptotal The maximum power that the device can dissipate without overheating and being destroyed.

V_{EB} max. The minimum *reverse* voltage that will cause the base emitter junction to break down and pass a significant current. The device will not be harmed provided the current flow is limited to a safe level.

V_{CB} max. The maximum collector to base voltage the device can withstand without becoming damaged.

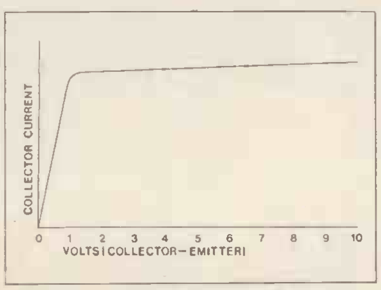


Figure 6. Collect current, collector-emitter voltage relationships.

Transistor Tester

Our construction project for this month is a transistor tester based on the circuit shown in Figure 5 and described earlier. With this configuration it is possible to have the meter calibrated direct in terms of current gain. For example, if we use a meter having a full scale value of 10mA in the ME2 position, and adjust RV1 for a base current of 1mA, a transistor having a gain of (say) 5 would give a meter reading 5mA, similarly a transistor having a gain of 10 would give a reading of 10mA on ME2. Thus ME2 gives a direct indication of gain and the full-scale value can be changed by altering the base current. A base current of 100uA (0.1mA) for instance would necessitate a current gain of 100 in order to give full scale deflection of the meter. In a practical circuit ME1 could be omitted, and RV1 could be replaced with a series of switched resistors which would give the required base currents at the supply voltage in use.

This type of circuit is not without drawbacks, two very obvious ones being that the test device is not being measured at specific collector voltages or currents as these both vary according to the meter reading obtained. Component tolerances and variations in the supply voltage also affect accuracy to some extent but despite these limitations, a simple tester of this type gives a useful indication of the current gain of the test transistor, and is an extremely useful item of test gear to have in the workshop.

The unit described has five ranges: 0 to 10, 25, 100, 250 and 1000, and is suitable for testing both NPN and PNP types.

The Circuit

The full circuit diagram of the tester is shown in Figure 7. The purpose of S2 is simply to switch the supply polarity to suit PNP or NPN components, as required. S1 selects a resistor that gives the appropriate base current for the measuring range selected, in some cases it is necessary to use two resistors in parallel to obtain the required value.

ME1 is a moving coil meter, and a meter of this type must be supplied with a current of the correct polarity or there will be a reverse deflection of the pointer. Additional poles on S2 could be used to switch the polarity of the meter to suit the mode of operation (NPN or PNP) but a simpler alternative is to use diodes to provide this switching automatically.

With the unit in the PNP mode the emitter terminal of the test device is positive and the other supply rail is negative. D3 and D2 therefore channel a current through the meter with the correct polarity while D1 and D4 are reverse biased and play no active part in the circuit. When the circuit is switched to the NPN mode the supply polarity is reversed, it is then D1 and D4 that supply the current path for the meter, again with the correct polarity, while D2 and D3 become reverse biased and have no effect on the circuit.

The four diodes form what is known as a 'bridge rectifier', this is a type of circuit that is frequently found in practical electronic designs.

R8 is included to limit the maximum current that can flow through the meter and the transistor being tested, to a safe level. The maximum current flow is high enough to take the meter beyond its full-scale value so that the meter needle is forced against the upper end stop, but the degree of overload is insufficient to damage the meter even if it should be sustained for a considerable length of time. If it is not possible to obtain full-scale deflection of the meter even with the collector and emitter sockets short-circuited, the battery voltage is too low and a new battery should be fitted to the unit.

Construction

The tester is built into an ABS Console Case type M1005, and is styled to match the High Impedance Voltmeter project which was described in Part 2 of this series. The meter is mounted on the upper part of the front panel with SK1 to SK3 closely grouped beneath it. The meter requires front panel hole some 38mm in diameter and this can be cut using a coping saw or a very small round file. A simple alternative is to make a ring of small holes, positioned as close together as possible, round the inside of the required cutout. The central piece of metal can then be punched out and a large half-round file used to smooth and enlarge the cutout as necessary. S1 is mounted on the upper right-hand part of the front panel and S2 is fitted below it.

No component board is used in this unit as the diodes and resistors are mounted direct on to the meter, sockets and switches. Insulated wires are used to complete the wiring (a method sometimes known as hard wiring). Figure 8 shows full wiring details.

This is quite easy and straight-

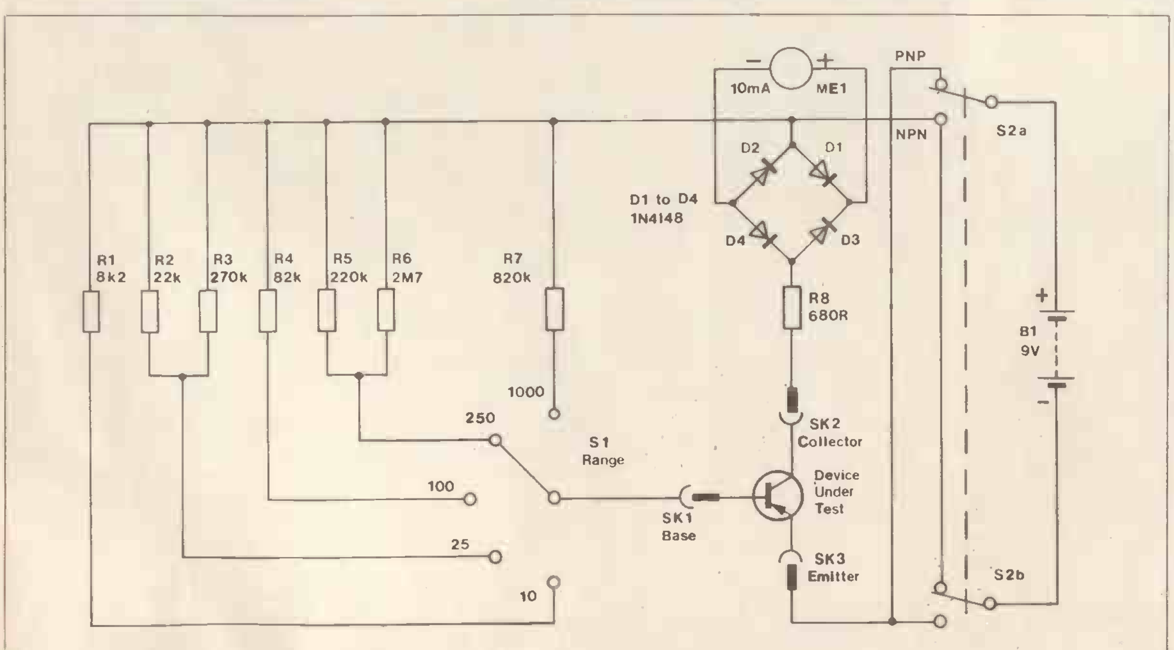


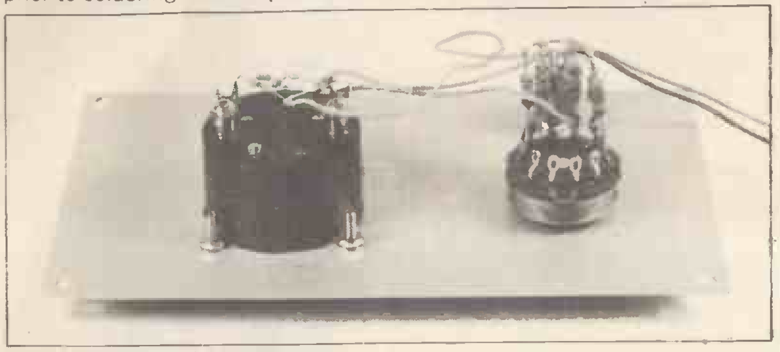
Figure 7. Transistor tester: circuit diagram.

forward provided the component leadout wires are trimmed to length and generously tinned with solder prior to soldering them in place. It is also a good idea to coat the tags of the sockets, switches, and meter with solder before wiring components to them. Be careful to connect the four diodes with the correct polarity. The wiring is completed using six connecting wires which are multistrand, PVC covered connecting wire.

After checking the wiring thoroughly to eliminate errors, the unit is ready to be tested. S2 should be set to the appropriate mode before connecting a transistor to the unit, and initially only the collector and emitter leads should be connected. Most devices will plug directly into the three sockets but some devices (mainly power types) will need to be connected to the unit via a set of three test leads. Each lead consists of a short length of insulated wire having a 1mm plug at one end and a crocodile clip at the other. The leads can be of different colours for easy identification. When only the emitter and collector leads are connected there should be no noticeable deflection of the meter if a silicon transistor is being tested and only a slight deflection if the device is a germanium type.

With the base lead also connected into circuit, S1 is adjusted to find a range that gives a strong but less than full scale deflection of the meter, a gain reading can then be taken.

E&MM



Internal view of transistor tester.

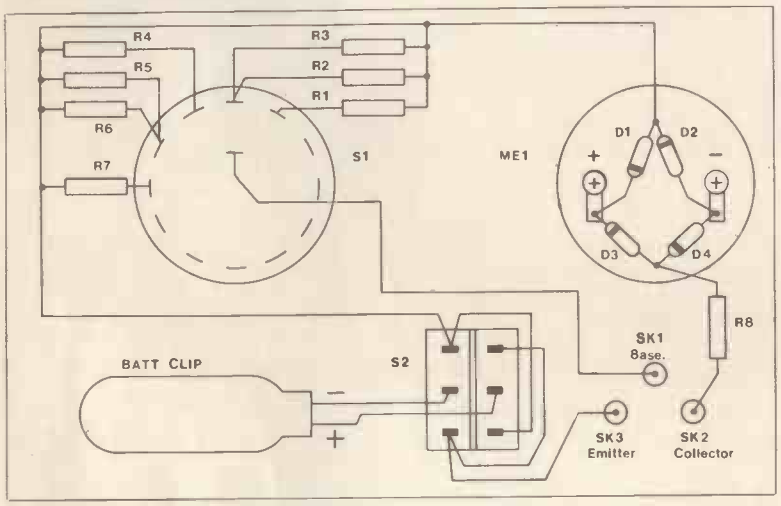


Figure 8. Transistor tester: wiring diagram.

PARTS LIST

Resistors			
R1	8k2 ½W 2% oxide		(X8K2)
R2	22k ½W 2% oxide		(X22K)
R3	270k ⅓W 5% carbon		(M270K)
R4	82k ½W 2% oxide		(X82K)
R5	220k ½W 2% oxide		(X220K)
R6	2M7 ⅓W 5% carbon		(M2M7)
R7	820k ½W 2% oxide		(X820K)
R8	680R ⅓W 5% carbon		(M680R)
Semiconductors			
D1-4	1N4148	4 off	(QL80B)
Miscellaneous			
S1	Switch 1 pole 12-way (adjustable)		(FH42V)
S2	Switch DPDT Sub-min. toggle, centre off		(FH05F)
ME1	Meter, panel, 2in., moving coil 10mA. f.s.d.		(RW96E)
	ABS Console Case M1005 or similar		(LH63T)
	Knob K7B		(YX02C)
	Socket 1mm.	3 off	(WL60Q)
	Plug 1mm.	3 off	(WL58N)
	Crocodile clip	3 off	(HF24B)
	Connector PP3		(HF28F)
	Battery PP3		
	Connecting wire (1m)		(BL07H)

FREE OUR CURRENT BARGAIN LIST WILL BE ENCLOSED WITH ALL ORDERS.

TRANSMITTER SURVEILLANCE *
Tiny, easily hidden but which will enable conversation to be picked up with FM radio. Can be made in a matchbox — all electronic parts and circuit. £2.30.

RADIO MIKE *
Ideal for discos and garden parties, allows complete freedom of movement. Play through FM radio or tuner amp. £6.90 comp. kit.

SAFE BLOCK
Mains quick connector will save you valuable time. Features include quick spring connectors, heavy plastic case and auto on and off switch. Complete kit. £1.95.

LIGHT CHASER
Gives a brilliant display — a psychedelic light show for discos, parties and pop groups. These have three modes of flashing, two chase patterns and a strobe effect. Total output power 750 watts per channel. Comlete kit. Price £16. Ready made up £4 extra.

FISH BITE INDICATOR
Enables anglers to set up several lines then sit down and read a book. As soon as one has a bite the loudspeaker emits a shrill note. Kit. Price £4.90.

6 WAVEBAND SHORTWAVE RADIO KIT
Bandspread covering 13.5 to 32 metres. Based on circuit which appeared in a recent issue of Radio Constructor. Complete kit includes case materials, six transistors, and diodes, condensers, resistors, inductors, switches, etc. Nothing else to buy If you have an amplifier to connect it to or a pair of high resistance headphones. Price £11.95.

SHORT WAVE CRYSTAL RADIO
All the parts to make up the beginner's model. Price £2.30. Crystal earpiece 65p. High resistance headphones (gives best results) £3.75. Kit includes chassis and front but not case.

RADIO STETHOSCOPE
Easy to fault find — start at the arial and work towards the speaker — when signal stops you have found the fault. Complete kit £4.95.

INTERRUPTED BEAM
This kit enables you to make a switch that will trigger when a steady beam of infra-red or ordinary light is broken. Main components — relay, photo transistor, resistors and caps etc. Circuit diagram but no case. Price £2.30

OUR CAR STARTER AND CHARGER KIT has no doubt saved many motorists from embarrassment in an emergency you can start car off mains or bring your battery up to full charge in a couple of hours. The kit comprises: 250w mains transformer, two 10 amp bridge rectifiers, start/charge switch and full instructions. You can assemble this in the evening, box it up or leave it on the shelf in the garage, whichever suits you best. Price £11.50 + £2.50 post.

GPO HIGH GAIN AMP/SIGNAL TRACER. In case measuring only 5¼in x 3¾in x 1¼in is an extremely high gain (70dB) solid state amplifier designed for use as a signal tracer on GPO cables, etc. With a radio it functions very well as a signal tracer. By connecting a simple coil to the input socket a useful mains cable tracer can be made. Runs on standard 4½v battery and has input, output sockets and on-off volume control, mounted flush on the top. Many other uses include general purpose amp, cueing amp, etc. An absolute bargain at only £1.85. Suitable 80ohm earpiece 69p.

NEW KIT THIS MONTH!
CB RADIO — Listen in with our 40-channel monitor. Unique design ensures that you do not miss sender or caller.
Complete kit with case and instructions only £5.99.

8 POWERFUL BATTERY MOTORS
For models, Meccanos, drills, remote control planes, boats etc. £2.50.

WATERPROOF HEATING WIRE
60 ohms per yard, this is a heating element wound on a fibre glass coil and then covered with p.v.c. Dozens of uses — around water pipes, under grow boxes in gloves and socks. 23p per metre.

COMPONENT BOARD Ref. W0998
This is a modern fibreglass board which contains a multitude of very useful parts, most important of which are: 35 assorted diodes and rectifiers including 4 3amp 400v types (made up in a bridge) 8 transistors type BC107 and 2 type BFY-51 electrolytic condensers. SCR ref 2N 5062, 250uf 100v DC and 100uf 25v DC and over 100 other parts including variable, fixed and wire wound resistors, electrolytic and other condensers. A real snip at £1.15.

FRUIT MACHINE HEART. 4 wheels with all fruits, motorised and with solenoids for stopping the wheels with a little ingenuity you can defy your friends getting the "jackpot". £9.95. + £4 carriage.

4-CORE FLEX CABLE
White pvc for telephone extensions, disco lights, etc. 10 metres £2, 100 metres £15. Other multicore cable in stock.

MUGGER DETERRENT
A high-note bleeper, push latching switch, plastic case and battery connector. Will scare away any villain and bring help. £2.50 complete kit.

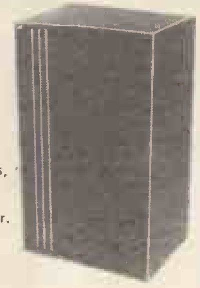
EXTRACTOR FANS

Mains operated — ex. Computer.
5" Woods extractor £5.75 Post £1.00.
6" Woods extractor £6.90 Post £1.25
6" Plannair extractor £7.50 Post £1.00
4" x 4" Muffin 115v. £4.50 Post 50p.
4" x 4" Muffin 230v. £5.75 Post 50p.

PUSH BUTTON G.P.O. TELEPHONES
FOR £25 (quickly recoverable in saved time) you will improve your image and efficiency with this push button desk telephone, ex. G.P.O. thoroughly reconditioned, can be yours in a few days, if you send today.

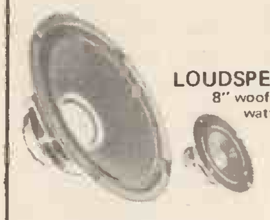
*(Not licenceable in the U.K.)

SUPER HI-FI SPEAKER CABINETS



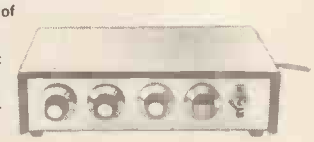
Made for an expensive Hi-Fi outfit — will suit any decor. Resonance free cut-outs for 8" woofer and 4" tweeter. The front material is carved Dacron, which is thick and does not need to be stuck in and the completed unit is most pleasing. Colour black. Supplied in pairs, price £6.90 per pair (this is probably less than the original cost of one cabinet) carriage £3.50 the pair.

LOUDSPEAKERS



8" woofer and 4" tweeter, 4 ohms 35 watts power rating £6.90 per pair. Ditto but 8 ohms, £11.50 per pair. Post £2.00.

3 CHANNEL SOUND TO LIGHT KIT



Complete kit of parts for a three-channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two-tone metal case and has controls for each channel, and a master on/off. The audio input and output are by ¼" sockets and three panel mounting fuse holders provide thyristor protection. A four-pin plug and socket facilitate ease of connecting lamps. Special snip price is £14.95 in kit form or £19.95 assembled and tested.

THIS MONTH'S SNIP

UNIVAC KEYBOARD Model No. FI 308-00

Has 57 encoded key switches and 10 mini toggle switches. As well as a P.C.B. with many IC's etc. These keyboards are in very good condition. Price only £11.50 + post £2.00. Well worth it for the switches alone.

POCKET AUDIO COMPONENT TESTER

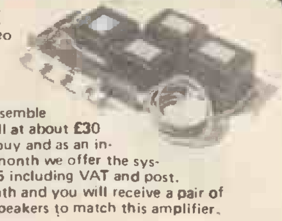
With it you can quickly test diodes, rectifiers, transistors, capacitors, check wiring and p.c. boards for open circuits, find the anode and cathode of a diode or rectifier and whether a transistor is PNP or NPN, which are the base collector and emitter connections. Condensers, if bad give a continuous signal but if good, give intermittent signals of varying length depending on their value. The test current is very low (2uA) and the voltage only 1.4v, so it is also possible to check MOS devices, as well as sensitive transistors with out fear of damaging them. The unit is supplied complete with internal battery, which should last many months. Price £3.45p.

MINI-MULTI TESTER Deluxe pocket size precision moving coil instrument, Jewelled bearings - 2000 o.p.v. mirrored scale.
11 instant range measures: DC volts 10, 50, 250, 1000.
AC volts 10, 50, 250, 1000.
DC amps 0 — 100 mA.

Continuity and resistance 0 - 1 meg ohms in two ranges. Complete with test prods and Instruction book showing how to measure capacity and inductance as well. Unbelievable value at only £6.75 + 50p post and insurance.

FREE Amps range kit to enble you to read DC current from 0 - 10 amps, directly on the 0 - 10 scale. It's free if you purchase quickly, but of you already own a Mini-Tester and would like one, send £2.50.

MULLARD UNILEX



A mains operated 4 + 4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost anyone. In easy to assemble modular form this should sell at about £30 — but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only £16.75 including VAT and post.
FREE GIFT — buy this month and you will receive a pair of Goodman's eliptical 8"x 5" speakers to match this amplifier.

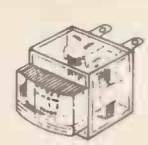
VENNER TIME SWITCH

Mains operated with 20 amp switch, one on and one off per 24 hrs. repeats daily automatically correcting for the lengthening or shortening day. An expensive time switch but you can have it for only £2.95. These are new but without case, but we can supply plastic cases (base and cover) £1.75 or metal case with window £2.95. Also available is adaptor kit to convert this into a normal 24hr. time switch but with the added advantage of up to 12 on/offs per 24hrs. This makes an ideal controller for the immersion heater. Price of adaptor kit is £2.30.

DELAY SWITCH

Mains operated — delay can be accurately set with pointers knob for periods of up to 2½hrs. 2 contacts suitable to switch 10 amps — second contact opens a few minutes after 1st contact. £1.95.

LEVEL METER



Size approximately ¾" square, scaled signal and power but cover easily removable for rescaling. Sensitivity 200 uA. 75p.

STEREO HEADPHONES

Japanese made so very good quality. 8 ohm impedance, padded, terminating with standard ¼" jack plug. £2.99 Post 60p.

BRIDGE RECIFIER

1 amp 400v 30p each.
10 for £2.50. 100 for £20.00

TIME SWITCH BARGAIN
Large clear mains frequency controlled clock, which will always show you the correct time + start and stop switches with the dials. Comes complete with knobs. £2.50.

LAST MONTH'S SNIP — STILL AVAILABLE

And it still carries a free gift of a desoldering pump, which we are currently selling at £6.35p. The snip is perhaps the most useful breakdown parcel we have ever offered. It is a parcel of 50 nearly all different computer panels containing parts which must have cost at least £500. On these boards you will find over 300 IC's. Over 300 diodes, over 200 transistors and several thousand other parts, resistors, condensors, multi-turn pots, recifiers, SCR, etc. etc. If you act promptly, you can have this parcel for only £8.50, which when you deduct the value of the desoldering pump, works out to just a little over 4p per panel. Surely this is a bargain you should not miss! When ordering please add £2.50 post and £1.27 VAT.

MAINS MOTORS Precision made as used in record players, blow heaters, etc. Speed usually 1,400. All have ample spindle length for coupling fan blade, pulley, etc. Power depends on stack size. 5/8" stack £2.00; ¾" stack £2.50; 7/8" stack £3.00; 1" stack £3.50; 1½" stack £4.50. Add 25% to motor cost to cover postage, and then add 15% VAT.

YOUR LAST CHANCE FOR THIS BARGAIN

100 twist drills, regular tool shop price over £50, yours for only £11.50. With these you will be able to drill metal, wood, plastic, etc. from the tiniest holes in P.C.B. right up to about ¼". Don't miss this snip — send your order today.

MAGNETIC LATCH

Low voltage (4 - 8 volt AC/DC operation Only £1.50 each.

TAPE PUNCH & READER

For controlling machine tools, etc, motorised 8 bit punch with matching tape reader. Ex-computers, believed in good working order, any not so would be exchanged. £17.50/pair. Post £3.00.

J. BULL (Electrical) Ltd.

(Dept. EM), 34 - 36 AMERICA LANE,
HAYWARDS HEATH, SUSSEX RH16 3QU.

J. BULL (Electrical) Ltd — Established 25 years. MAIL ORDER TERMS: Cash with order -- please add 60p to all orders under £10, to offset packing, etc. ACCESS & BARCLAYCARD WELCOMED. Our shop is open to callers. BULK ENQUIRIES INVITED. Telephone: Haywards Heath (0444) 54563.

CIRCUIT MAKER

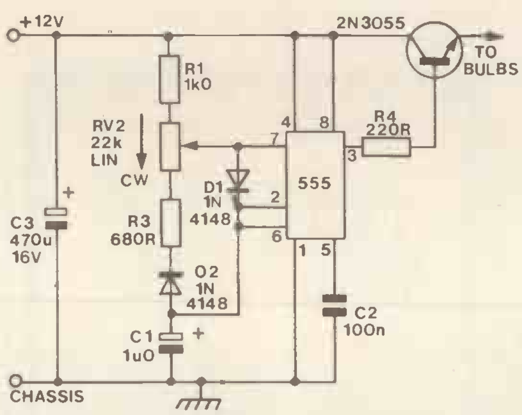
One of the nice features about a magazine such as this is the way readers can contribute, thus presenting their ideas to a large number of people. Each contribution may be a full feature or constructional article describing some piece of electronic, electro-musical equipment, or more probably, a short piece containing the circuit diagram and a short piece of explanatory text. It is thus our intention to set aside pages in each issue for 'Circuit Maker', a feature dedicated to short ideas, mostly sent in by readers.

Dashboard Light Dimmer

Recently made cars have very well lit dashboard instruments and these are generally a great asset. Under certain circumstances however, a minimum amount of light is desirable, particularly in fog or on motorways. Some cars have some form of light dimmer fitted; the circuit below can be added simply to any which don't, provided that all the dash bulbs run from a common supply wire. This can be checked on the circuit diagram of the car, it is usually fairly easy to identify the correct wire. Do check that the sidelights have not been included in the dimmer circuits since the dashboard lights are often part of the same circuit — the effect of dimming the sidelights can be imagined!

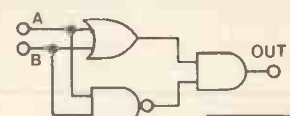
The dimmer works by applying a variable mark/space ratio square wave to the bulbs via 2N3055 power transistor. This technique is more complex than a simple voltage dropper circuit but it means that the 2N3055 does not need a heatsink to dissipate large amounts of waste power. The basic square wave is derived from a 555 timer connected as an astable, the output of which feeds the power transistor. The timing period is determined by the charge time (via D1, R1 & RV2) and the discharge time (via D2, R3 & RV2) of the 1uF capacitor. It is obvious that if the variable resistor is turned fully clockwise the charge time will be long, and the discharge time short, thus the 555 output will be high for a long period relative to the off period and the bulbs will be bright. As the variable resistor is turned anti-clockwise the charge rate will decrease as the discharge rate increases reversing the situation so that the bulbs become dimmer as the on time becomes less. The values chosen do not allow the bulbs to be turned right off for safety reasons.

Considerable decoupling must be added since a car is a very noisy environment, and the capacitor on pin 5 of the 555 must not be left off under any circumstance.



Ex-Or Synthesis

Exclusive-or is one of the most powerful logic functions, and although it forms the central function of any arithmetic unit frequent other uses in control are often realised. Usually only one such gate is required at a time and buying four in a standard integrated circuit is needlessly expensive, particularly since they are four or five times more costly than the standard gates. In view of this it is worth examining the way the EX-OR function can be synthesised from standard gates, which may be available as surplus from the main design anyway. The simplest combination is shown, although many others exist. It is interesting to note that some parts of this circuit can be replaced by discrete diode gates, thus enabling a very economical replacement.

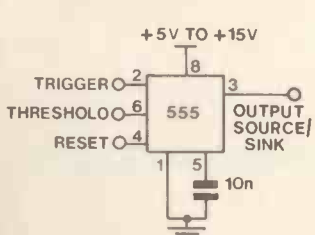


A	B	OUT
0	0	0
0	1	1
1	0	1
1	1	0

The 555 - a Power Latch

The 555 timer is a well known design block, finding frequent use in monostable and oscillator circuits. It can also be used as a high power latch, with flexible trigger arrangements allowing interface to logic or analogue signals. The function table of a 555 in this mode is shown. A negative pulse on pin 2 sets the output high, whereas a negative pulse on pin 4 resets the output to the low state. The output can also be reset by the application of a positive pulse to pin 6. Pin 4 has priority, and if pin 4 is held low, the levels on 2 & 6 are ignored; the output will remain low. Pin 2 also has priority over pin 6, although in this case a low on pin 2 will allow the output to follow the inverse of pin 6. The output always goes high when pin 2 is low and pin 6 floating. Any unused inputs should be connected to their inactive logic level.

The most convenient feature of the 555 in this mode is the ease with which it can be interfaced to external circuits, and in some cases will be more compact than a couple of transistors. The 555 will sink or source up to 200 mA, although the actual output voltage will fall away from the relevant rail as the load becomes more severe.



PIN	PULSE	NAME	O/P
2		TRIGGER	
6		THRESHOLD	
4		RESET	

FUNCTION TABLE

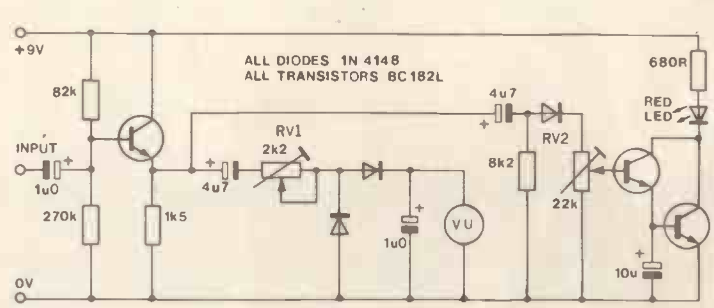
VU meter with peak indicator

Glenn Rogers, Wickford

The metering on most tape recorders and mixers leaves much to be desired, and it is often useful to replace the circuit. The addition of a peak LED is also desirable, particularly for mixers where overload of a PA is often the result of a VU meter with a slow response time. This circuit was designed for this purpose, and is very simple and cheap to add. The input signal is buffered and fed to two separate stages for the VU meter and peak LED. The sensitivity of each stage can be set independently, and for absolute accuracy a signal generator should be used.

A steady sine wave input at peak level should be applied and RV1 adjusted until the meter reads 0dB. Increase the input until the meter reads +5dB and adjust the second preset until the LED just lights. Other peak LED levels may be used if required, although +5dB is a good compromise.

The circuit consumes about 15 mA at 9 volts with the LED on, and many times less with the LED off.



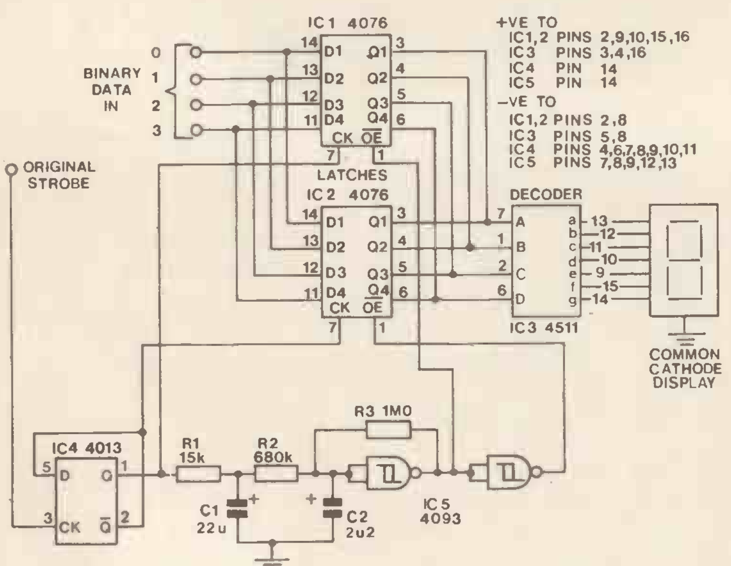
Slow Fade for 7-Segment Displays

The number displayed on a seven-segment indicator is usually derived from four binary lines, which are latched into a decoder. Once a new number is required the signals on the lines are changed and the decoder latch strobed. This gives an instantaneous change which can be disturbing — for example a bright clock in a dim room.

A much smoother display can be obtained by cross fading from one number to the next, even on the same indicator, and for a minutes clock a change over a one second period is ideal. This design, which is only intended to demonstrate the technique, is for one display only although the same control unit could be used for several displays with the addition of extra buffers.

The cross fade is achieved by storing both the numbers on latches and then switching between the latches with a fast variable pulse width clock. One latch is enabled when the clock is high, the other when low, and so by slowly altering the clock waveform from all space to all mark an apparent crossfade is obtained. The incoming data bus is connected to two 4076 CMOS quad D-type latches. These have a three state output, and thus provided that both latches are not enabled at the same time the outputs can also be connected together. These outputs are then connected to the decoder. The original decoder latch strobe is connected to the clock line of a further D-type flip flop which changes state as every strobe. The latch of the decoder should be permanently enabled. Assume the Q output of the control flip flop is low. The next strobe pulse will toggle the flip-flop and the Q output will go high, loading data latch IC1. This strobe pulse will not affect the data already on latch IC2 because the latches are +ve edge triggered. At the same time the 22uF tantalum capacitor starts to charge via R1, releasing the oscillator built around the Schmitt trigger. The mark/space ratio of this oscillator is dependent on the amount of current sourced or sunk by R2, which is in turn dependant on the voltage across C1. This means that the oscillator will start with a high output which will gradually change to a low output with a sliding mark/space ratio. The oscillator output is then inverted to provide two polarities of drive which are directly fed to the data latch enables. The data strobed onto IC1 slowly appears on the display as the IC2 data dims. The next piece of data obviously reverses the procedure, leaving the system in the first state with Q low.

Problems will occur if the display is multiplexed; ideally the data should be latched before the multiplexer and even then care must be taken to ensure that the multiplex frequency is not near the fade frequency, or the display cross-fade will look very odd indeed.



Speaker Jack Sockets

Ron Levy, Shoeburyness

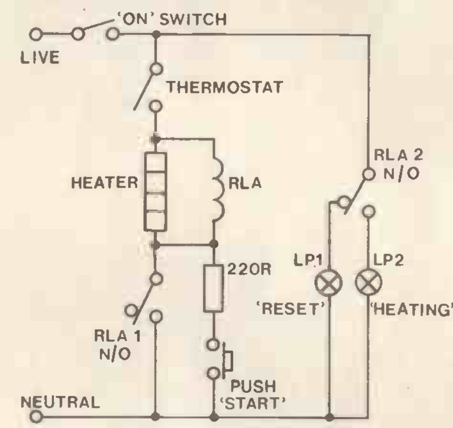
It is very unwise to use the more expensive jack sockets which have metal inserts for PA and instrument speaker cabinets because the metal fixing bezel may short out the jack plug as it is inserted or removed, damaging the power amp or blowing a fuse. Normally this does not matter since the amp will be switched off, but this precaution is often overlooked in the blind panic which occurs after it is found that something does not work.

Immersion Heater One-Shot

An immersion heater can be an expensive problem, particularly when left on by mistake all night. The addition of a relay and a pushbutton switch will produce a 'one shot' facility where pressing the switch will apply power to the heater until the internal thermostat opens (as the tank of water reaches the maximum temperature). The heater will not then come on again, even if the tank cools, until the start switch is pressed again and thus it is impossible to leave the heater on for more than one heat cycle without taking deliberate action. If the tank is hot when the start switch is pressed nothing happens.

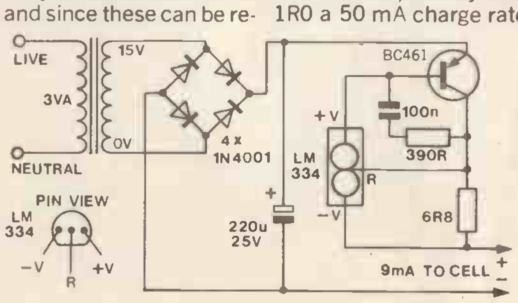
This effect is achieved by connecting the coil of a mains relay across the heater, and then connecting one of the normally open relay contacts in series with original heater return. Note that the circuit may need to be inverted if the original system was wired differently. The start switch is connected across the relay contacts, and serves only to provide a circuit path to initially close the relay, which then latches as the relay contacts themselves close (assuming the thermostat to be closed). When the thermostat opens, the relay will open, and thus the circuit will not be completed again unless the pushbutton is pressed again. The 220R resistor limits the current through the switch. Two lamps for monitoring purposes may be added if the relay has any spare contacts, these indicating heating and reset.

It is a good idea to check that the relevant connections can be accessed before buying the parts. Care should be taken, live mains and possibly water are involved — a particularly lethal combination.



Ni-Cads for Effects Pedals

One of the complaints heard most often about guitar effects pedals is that they use batteries at a high rate, and with PP3's costing over 50p the expense is considerable. For the cost of about 10 such dry batteries it is possible to buy a Nickel Cadmium equivalent, and since these can be recharged after use the extra cost is quickly recovered. A typical PP3 equivalent will stand up to at least 300 full charge/discharge cycles, and will generally last far longer if treated properly. Ni-Cad batteries need charging at a constant current, about 10 mA for a PP3 size; a full charge will then be obtained over 20 hours. They should not be charged for more than 20 hours however, or damage is likely to occur. A simple charger circuit is shown. The power supply follows the typical pattern of mains transformer, bridge rectifier and capacitor. The 10 mA constant current is derived using a three terminal current source, the LM334. This is connected to the external PNP pass transistor since 10 mA is the absolute maximum current allowed by the current source on its own. The 6R8 resistor determines the final current, and by reducing this to 1R0 a 50 mA charge rate is obtained in which case the pass transistor should be fitted with a heatsink. In order to ensure stability under all conditions an RC network is connected across the pass transistor.



A few points about Ni-Cad batteries should be noted. Firstly, they are supplied nearly discharged and must be charged before use. Most importantly, the battery must never be shorted because the high currents that flow will cause internal damage. Finally, it is not a good idea to run a Ni-Cad completely flat since they sometimes refuse to recharge, replacement being the only solution.

GUITAR TUNER

by Clive Button

A low cost 'commercial' tuner that gives rapid accurate tuning for electric and acoustic guitars in a new simple way.

Many guitarists, especially beginners, experience difficulty in tuning their instruments. Even when using traditional 'pitch pipes' this can still be a problem if the string is out of tune by more than a semitone or two. I know from teaching basic guitar at evening classes that, with ten or twelve people trying to 'tune up' at the same time, the task is made almost impossible. There are of course electronic guitar tuners available and many are extremely good. Unfortunately, they also carry a rather high price tag. For this reason the Guitar Tuner described here was designed, the objectives being to produce a guitar tuner as quick and simple as possible to use, with a price closer to the old faithful 'pitch pipes' than to its commercially produced, electronic counterpart.

The system is extremely simple, using just two LED's, one for 'sharp' and one for 'flat'. To tune the selected string simply adjust both LED's to the same brightness and you're in tune. The accuracy of the device is quite sufficient to tune your guitar as well as can be done by ear alone, and remains at the set pitch with the battery voltage down as far as 8 volts (the unit being powered by only one PP3).

Circuit

Before looking at the circuit operation it is best to consider the requirements of the unit i.e. the frequencies we have to deal with. These are shown, for the six strings of the guitar, in Table 1. By the use of a frequency to voltage converting stage these are changed to DC voltage levels, which can be compared with reference voltages produced from a chain of high stability, close tolerance resistors, which are fed from a stabilised voltage supply. The frequency-to-voltage conversion is achieved by the single LM2917 chip (IC2).

The output of this device follows the expression: $V_{out} = f_{in} \times V_{cc} \times R_{11} \times C_5$ which is a linear relationship between the input frequency (f_{in}) and the output voltage (V_{out}), see Figure 1. Vcc is the internally stabilised voltage, between 7.3 and 7.5V, produced by the internal Zener of IC2, see circuit diagram, Figure 2. From the above expression, values of R11 and C5 are chosen to provide suitable output voltage changes for the guitar frequencies. The calculated voltages are also shown in Table 1.

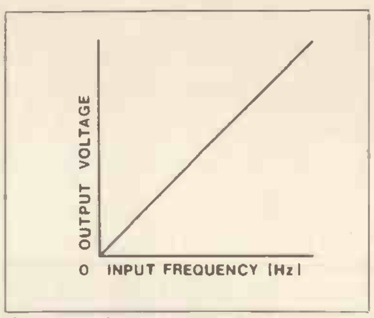


Figure 1. Frequency-to-voltage converter characteristic.

Now to the circuit itself. As we only need to deal with frequencies between 82.4 and 329.6Hz, the input is filtered by the high-pass combination of C5, R11, which attenuates frequencies below 72Hz and thus helps eliminate any mains hum pick-up. The low pass combination of C2, R2 attenuates frequencies above 338Hz, reducing the effect of harmonics and spurious noise etc. above this

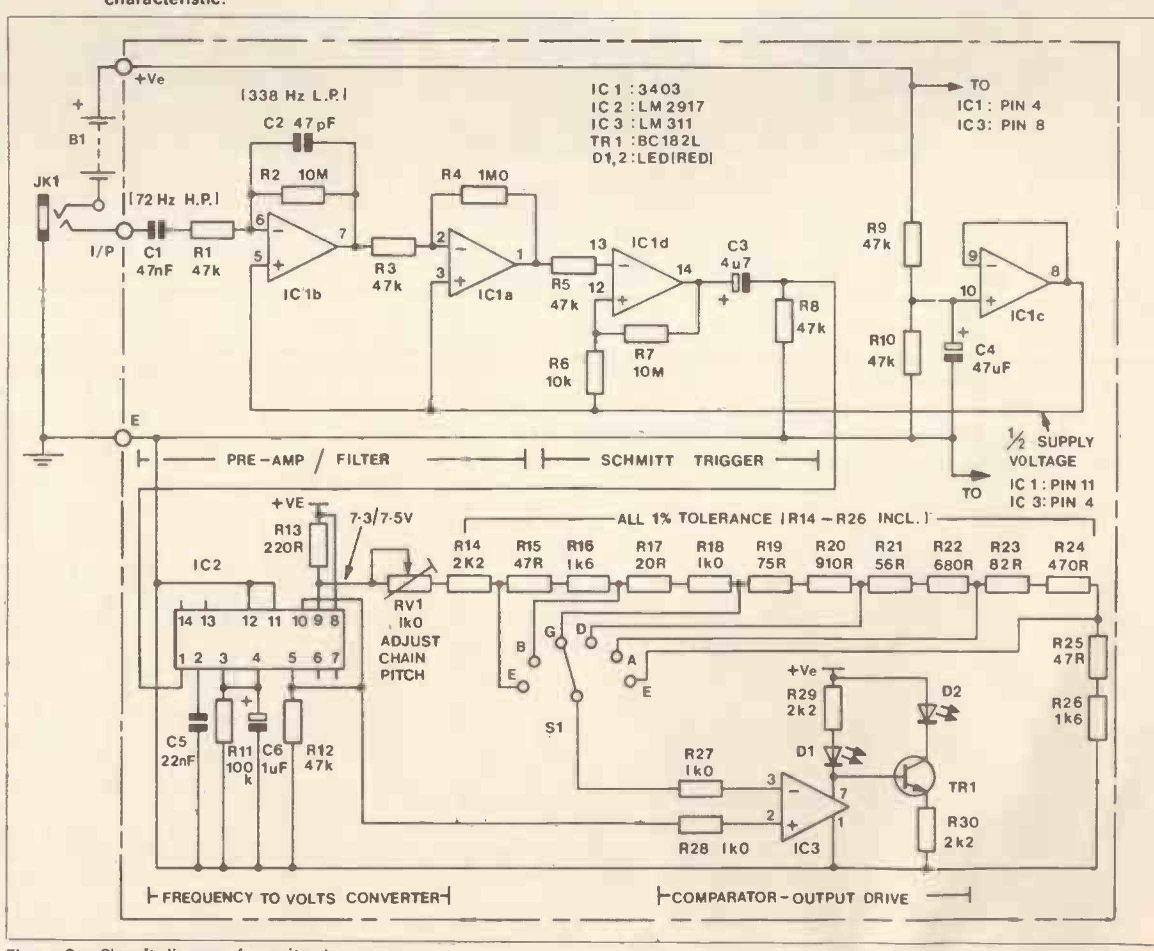


Figure 2. Circuit diagram for guitar tuner.

frequency. The chosen values of R1,R2 set the gain of the first stage at 200. This high gain is tolerable because the effects of clipping of the signal are relatively unimportant in this circuit.

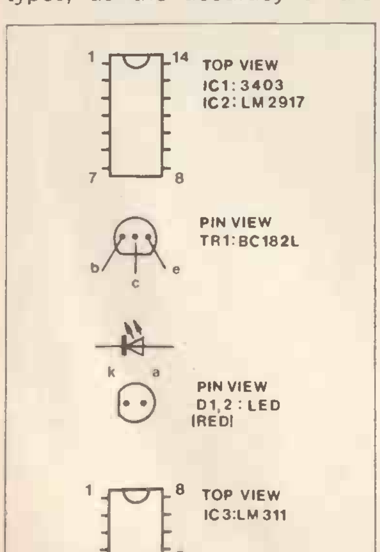
The next stage produces a gain of 20, such high gain being required to produce a strong signal even though the decay of the string is fairly rapid. This stage is followed by a Schmitt trigger to give a clean square wave at the input frequency; a square wave that will remain virtually constant until the guitar string has ceased to vibrate. This square wave is coupled to the input of IC2, the frequency-to-voltage converting stage, the fourth op-amp in IC1 being used solely to supply a mid-point voltage for biasing the rest of the circuit.

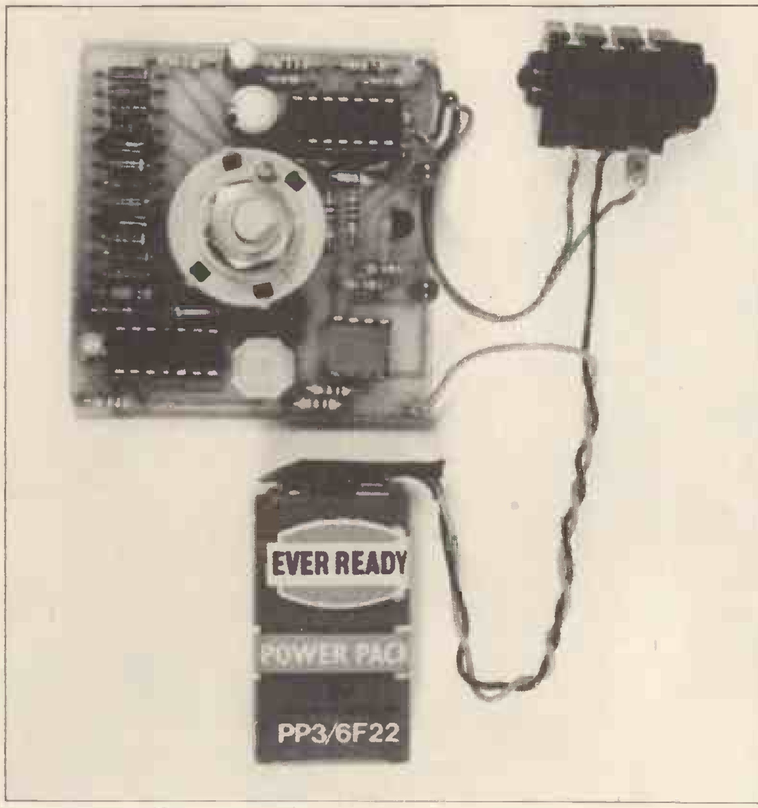
IC2 generates the linear conversion from frequency to voltage which remains linear over a fairly wide temperature range. Use is also made of its internally stabilised voltage supply (pin 9). Any variation in the stabilised voltage, whether caused by supply variation or temperature change, will effect the IC's output slope and the reference slope equally, and thus produces no noticeable effect on the unit's performance.

Note	Frequency (Hz)	F-V Output (volts)
E	82.4	1.360
A	110.0	1.815
D	146.8	2.422
G	196.0	3.234
B	246.9	4.074
E	329.6	5.438

Table 1. Calculated values of frequency-to-voltage converter output.

The reference chain comprises a series of resistors, the values of which have been chosen to give a voltage division equal to the intervals between the guitar strings. The resistors must be high stability, close tolerance types, as the accuracy of the





Internal view of guitar tuner.

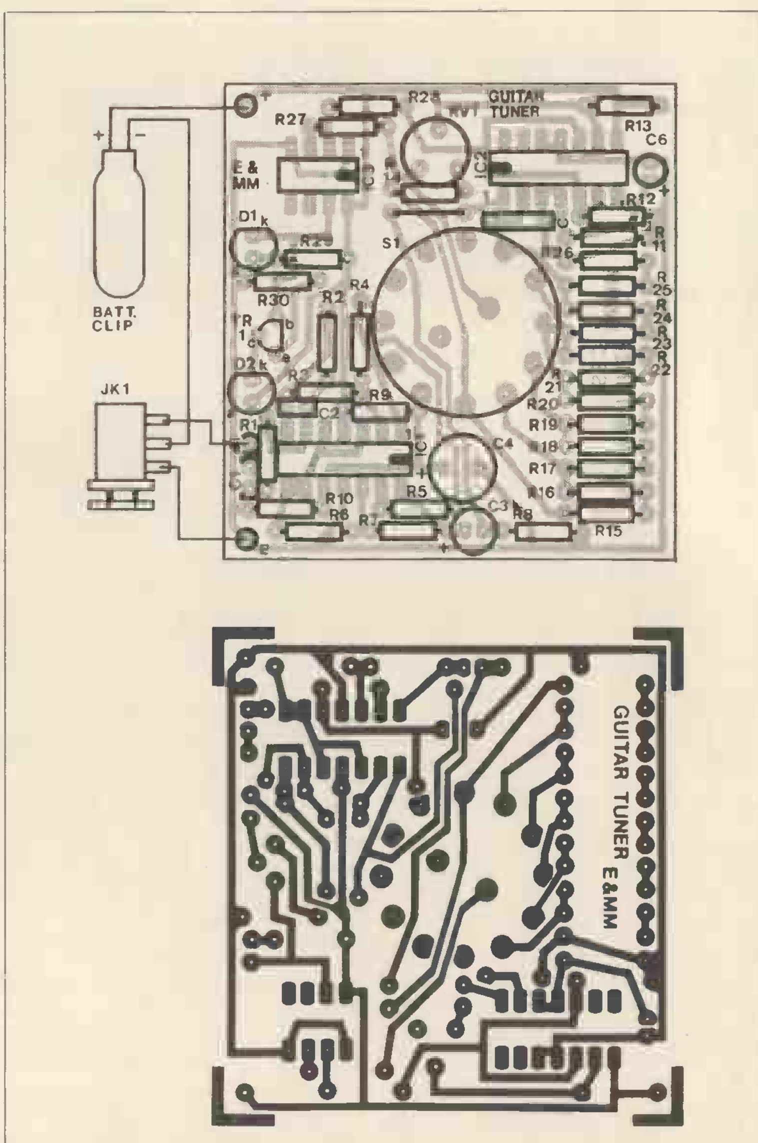


Figure 3. PCB Track layout and component overlay.

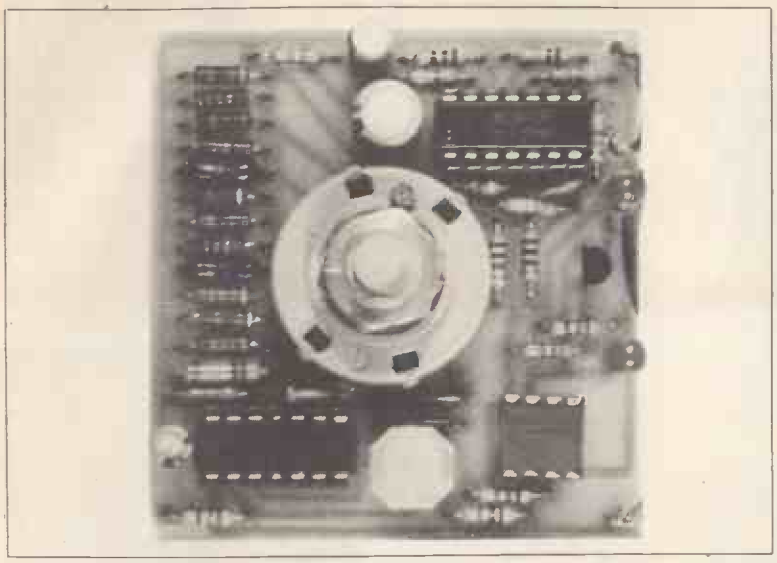
Tuner is entirely dependent upon the accuracy of the reference chain. Most of the resistance values in the chain are fairly small and any slight variations from their actual values will not significantly affect the overall accuracy.

There are however two 1k6 resistors (R16, R26) in the chain; 1% resistors could vary by as much as ±16 ohms from their required values (though they probably won't vary by more than 2 or 3 ohms) and this would adversely affect the accuracy, so it is preferable to select these, or at least check their actual values before connecting them in circuit. The voltages derived from this chain are selected by the six-way switch (S1) and compared with the voltage produced by IC2. This comparison is performed by IC3, with its own output directly driving D1, the LED which indicates that the note is flat. The 'sharp' LED (D2) is driven by a separate transistor (TR1).

Construction

Figure 3 shows the PCB and component overlay. Fit all the resistors to the PCB taking care to get the 1% ones in the correct places. Next, fit the capacitors, observing the polarity of the electrolytic types. The preset (RV1) and the three IC's can now be fitted, noting the position of pin 1 in each case. The LEDs stand up above the PCB, the base of each LED body being ½in. (13mm) above the board. It may help here to cut two pieces of insulation from some suitable gauge wire, each half an inch in length, and slide these over the legs of the LEDs to give the correct lead lengths. LED polarity is indicated by a flat on the body, next to the cathode connection, and this must be carefully observed. The last thing to fit to the PCB is the switch and for this the connecting lugs have to be cut off the switch contact tags, just below the circular end-pieces to allow them to be inserted through the board and soldered into position. The switch body then serves as the PCB support when it is finally fitted into the box.

Mark out and drill the holes in the box section, as shown in Figure 4. If this is done accurately, the switch bush and LEDs should fit neatly through the box front. Fit leads, about two inches in length, from the jack-socket to the board input connections and bend the tags of the jack-socket flat against its body. Connect the battery negative lead to the centre contact of the jack-socket and the positive lead to the board connection. With the battery connected,



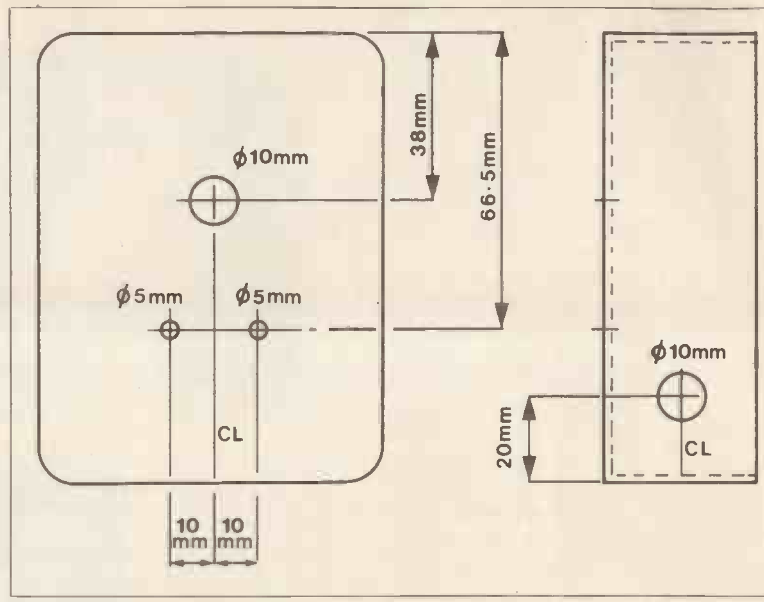


Figure 4. Drilling details.

and before fitting the board into the box, the unit can be set-up as detailed below. Finally the unit can be completed by fitting the board, jack-socket and battery into the box, as shown in Figure 5.

Even though the unit will remain at the set pitch for battery voltages as low as 8V, it is advisable to use the Duracell type battery, as its full voltage is maintained for 90% of its useful life, thus ensuring good results for some considerable time. An added advantage is, should you run it flat, it will not leak.

Setting-up

After construction the unit will have to be adjusted to concert pitch i.e. A = 440Hz. This has to be done using a pitch source of known accuracy, be it a keyboard, audio-oscillator or whatever. It is best to set the chain from the top 'E' by selecting this on the switch, injecting the note of E (329.6Hz) at the input and adjusting the preset until both LEDs are at the same brightness, which will automatically ensure that all six notes are set at the correct pitch.

An added feature can be incorporated by bringing the preset control out to the front panel. The unit could then be used for tuning to pitches other than A = 440Hz, which would be useful if you are playing on a keyboard that is slightly sharp or flat. This would be done by feeding in a note from the keyboard, adjusting the tuner to this and in turn using it to tune your guitar.

Operation

As explained earlier, for correct tuning of the selected string both LEDs will appear to be at the same brightness level. We now want to find the best way of doing this. First, when the guitar lead is plugged into the unit, and before a string is struck, the LED indicating string 'flat' will be illuminated. Now select the appropriate string note (e.g. bottom E) on the switch and, with the guitar's volume control at maximum, strike the string; then either LED may light, showing 'flat' or 'sharp', (this will be true however far the string is out of tune). If the 'flat' LED stays lit, then wind the string up as quickly as you like until just the 'sharp' LED is illuminated indicating that the required note has just been passed.

Now detune the string (i.e. 'flat' LED lights) and gradually bring the string back up until the two LEDs come to the same brightness; the string is now in tune. It is always better to come up to the required note as this makes sure that any slack in the gearing of the machine-head is taken up and avoids any chance of the string slipping down out of tune again.

No doubt while carrying out the above operation the string will probably have to be picked more than once to maintain an input to the Tuner. This is more applicable to the higher pitched strings, as their vibrations die away more quickly, although once used to using the unit, you will find that all strings can be brought into tune with just one pick. On the initial pick of the string you will probably notice that the sharp LED will first light momentarily and then go out. This is due to the rich harmonic content of a plucked string and can be minimised by picking the string on or around the twelfth fret, thus ensuring a strong fundamental vibration along the string's length, giving a quicker and longer-lasting reading on the LEDs. Incidentally, this is also true when using any other guitar tuning device.

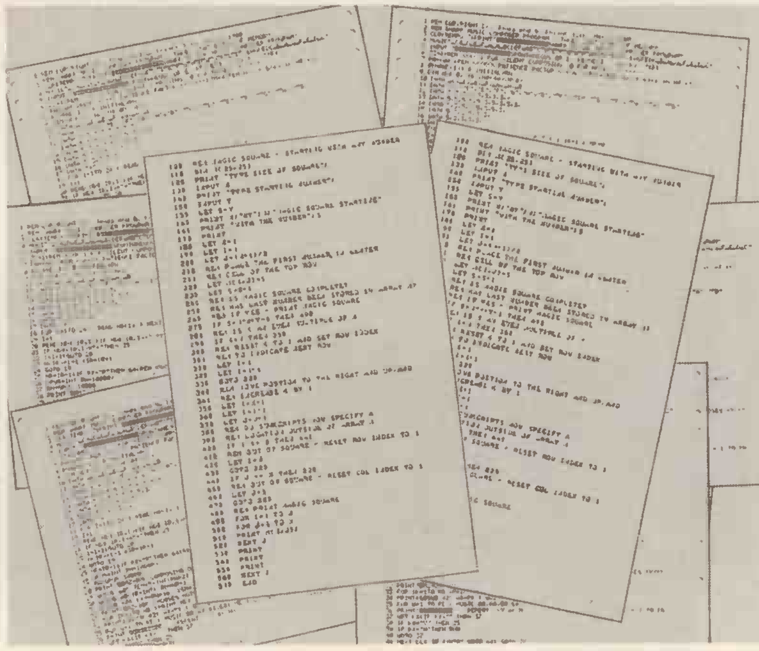
It is not necessarily ideal to have a strong signal output from your guitar pick-up. Some guitars will give a clearer indication on the LEDs for several seconds when the string is hardly audible. An added advantage is that you will quickly detect an old string, that will be prone to slipping out of tune, by the Tuner's inability to hold the brightness of both LEDs without wavering.

It is also possible to use the Tuner for correct pitching of acoustic guitar strings, by plugging a microphone into its input. However, a small pre-amp may be needed to boost the microphone output in order to obtain a sufficiently good reading. **E&MM**

PARTS LIST

Resistors — all 5% ⅓W carbon unless specified			
R1,R3,R5,R8 R9,R10,R12	47k	7 off	(M47K)
R27,R28	1k0	2 off	(M1K)
R29,R30	2k2	2 off	(M2K2)
R2,R7	10M	2 off	(M10M)
R6	10k		(M10K)
R4	1M0		(M1M)
R13	220R		(M220R)
R11	100k 1% ½W		(T100K)
R16,R26	1k6 1% ½W	2 off	(T1K6)
R15,R25	47R 1% ½W	2 off	(T47R)
R14	2k2 1% ½W		(T2K2)
R17	20R 1% ½W		(T20R)
R18	1k0 1% ½W		(T1K0)
R19	75R 1% ½W		(T75R)
R20	910R 1% ½W		(T910R)
R21	56R 1% ½W		(T56R)
R22	680R 1% ½W		(T680R)
R23	82R 1% ½W		(T82R)
R24	470R 1% ½W		(T470R)
RV1	1k Cermet, preset		(WR40T)
Capacitors			
C1	47nF Minidisc		(YR74R)
C2	47pF ceramic		(WX52G)
C3	47uF 63V PC elect.		(FF03D)
C4	47uF 25V PC elect.		(FF08J)
C5	22nF Carbonate		(WW33L)
C6	1uF 100V PC elect.		(FF01B)
Semiconductors			
TR1	BC182L		(QB55K)
D1,D2	LED, red	2 off	(WL27E)
IC1	3403		(QH51F)
IC2	LM2917		(WQ38R)
IC3	LM311		(QY09K)
Miscellaneous			
JK1	Jack socket stereo, plastic type		(HF92A)
S1	Rotary switch, SW6B 2 pole 6-way		(FF74R)
	Knob M3		(RW90X)
	PP3 Clip		(HF28F)
	ABS Box MB2		(LH21X)
	Printed circuit board		(GA24B)
	Front Panel		(YL26D)
	14-Pin DIL socket	2 off	(BL18U)
	8-Pin DIL socket		(BL17T)

Software



Welcome to the Software page — not another one I hear you groan! I am sure that we are all fed up with the never ending supply of Space Invaders and Star Trek Mk 6 version 10, so, therefore, my policy for this page will be one of hints and tips both discovered by myself, my colleagues and, of course, yourselves. This does not mean that program listings will not be presented on this page, but it is hoped that some more useful programming techniques will be featured rather than enormous listings for one specific machine.

If you wish to send me any material for inclusion on this page there are certain things you can do to help both myself and the readers. Firstly, please try and include some kind of flow chart, it doesn't have to be a masterpiece but even a very basic flow chart is invaluable to somebody looking at a program for the first time. Hand in hand with this please use plenty of REM statements or place an explanation beside the relevant coding on your listings. For those of you not sending listings but hints and tips on a particular machine or a programming technique then send in your text written as neatly as possible on alternate lines or if possible typed, double line spaced with 1" margins. It will help if all items for inclusion on this page are marked for my attention at our E&MM editorial address.

Date Verification

Many times during the development of software for small businesses, I find myself in need of a 'date verification' routine. This used to be a real chore and many different approaches were tried. Whilst discussing this problem with a member of the South East Essex Computer Society this routine came to light on one of his discs. Its exact origin is not clear but much of the coding has been converted by Paul Nikiel so as to improve the efficiency of the routine. It is shown listed here as a short basic program but of course would normally be used as a sub-routine in a much larger program. The routine is listed in a standard basic form and so long as your machine can handle logical, functions it should not produce any problems.

This module is one of the shortest I have seen and has proved invaluable. It can be slotted into a program in many ways depending on how your date is input.

Line 10 accepts your date and line 20 splits the date into its various parts i.e. date, month and year all in two-digit form. These lines need not necessarily be used, for lines 30-70 are the main routine and as long as your date information is fed in using the relevant variables, it will work with any date input system. DD should be set to date, MM should be set to month and YY should be set to year. Obviously lines 50 and 60 can be tailored to display the messages you require and line 70 would normally be the return of your sub-routine.

Positioning Points

A common use for many home systems is mathematical or scientific calculations. These programs often produce floating point numbers (containing decimal points) and the output from these programs can be displayed more neatly if all the decimal points are placed one beneath the other. Unfortunately most home computers do not include Print Using in their BASIC language and therefore output formatting can become a little difficult. The following routine simulates one of the BASIC Print Using instructions. It will take numbers stored as strings and calculate where the decimal point is located. Having obtained this information it is then reasonably easy to print out all these numbers neatly on to the screen with decimal points located one beneath the other.

```
10 INPUT"Please input the data in the form
   DD.MM.YY.......":A$
20 DD=VAL(LEFT$(A$,2)):MM=VAL(MID$(A$,4,2))
   :YY=VAL(MID$(A$,7,2))
30 X=(DD<1)+(DD>31)+(DD*MM*YY<>INT(DD*MM*YY))
   +(MM<1)+(MM>12)+(YY<50)+(YY>99)
40 Z=(MM=4)*(DD>30)+(MM=6)*(DD>30)+(MM=9)*
   (DD>30)+(MM=11)*(DD>30)
45 X=X+Z+(MM=2)*(DD>29)+(MM=2)*(YY/4<>INT(YY/4))
   *(DD>28)
50 IF X THEN PRINT"Date invalid ........":GOTO 70
60 PRINT "Date valid.........."
70 END
```

Date Verification program.

```
10 DIM A$(9)
20 FOR I=0 TO 9:INPUT A$(I):NEXT I
30 FOR I=0 TO 9
40 T=LEN(A$(I))
50 FOR Z=1 TO T
60 IF MID$(A$(I),Z,1)="." THEN PRINT TAB
10-Z);A$(I):Z=T+1:GOTO 90
70 NEXT Z
80 PRINT TAB(10-Z);A$(I)
90 NEXT I
```

Decimal point alignment program.

Again this routine would probably be included in a program as a sub-routine. Line 10 dimensions a string array ready to accept any 10 numbers, line 20 allows you to input your numbers into the string array. As in the previous routine these two lines will almost certainly be different when used in your program, but as long as the number that you require printed is stored in A$ the rest of the routine will work. Line 30 sets up a loop which will print out the 10 numbers you have stored. Line 40 sets T equal to the length of A$ and line 50 sets up another loop to travel from the first character of A$ to the last character of A$. Line 60 calculates where the decimal point is positioned in the string. When the decimal point is located it then calculates a tab and prints the string in the correct position. Line 70 is the next for line 50, line 80 catches any integers that may have fallen through the loop. Line 90 returns to line 30 for the next string to be worked on.

Although this routine would appear very obvious to some, I have found that many people who use their machines purely for mathematical and scientific purposes often have problems with string handling and may work almost exclusively with numbers without examining the possibilities available to them if they convert their integer or floating point numbers into strings.

Program prize

From time to time on this page I will set a problem, to which there will be no fixed solution but will encourage you to approach the problem your way. The writer of the best solution to this problem will receive a computer book and will have his or her solution printed during the following months.

The best solution will not necessarily be the shortest or most efficient code. I will be looking for ease of input/output, input protection and error handling, combined with code efficiency. Above all it must be friendly to the user and give pointers if he or she makes mistakes.

It is almost certain that most of our readers will supply solutions in BASIC, so it is unfair to try and judge these against other languages, however, if anybody presents a solution in another language, this may well be published if a flowchart or explanation is provided with the program listing. This will give many of our readers an insight into other languages and may well prove to be a worthwhile comparison.

Your mission this month is to write a program that will accept resistor values and convert these to colour codes and visa versa.

The main thing to remember is that not all values of resistors are easily available; that's all the help you are getting. Good luck!

Graham Daubney **E&MM**

USING MICROPROCESSORS

Peter S. Kershaw B.Sc.

The aim of this series of articles is to teach by example the basic principles of microprocessor hardware and software to the level at which the reader will be able to understand, modify and even design microprocessor-based projects.

This month we look at the Z80 instruction set in more detail and some important new concepts.

Addressing Modes

There are many ways of specifying the source and destination of data in an instruction. No processor can offer all possible addressing modes but those available on the Z80 are illustrated in Table 4. Many instructions employ two addressing modes, one for the data source and one for the destination. Of course, it is not necessary to remember the names of the addressing modes, just those which are available for the processor concerned. In fact different manufacturers often refer to the same addressing modes by different names.

When writing software it should be borne in mind that instructions involving indexed addressing are long (3 or 4 bytes) and slow to execute. Thus many of these more advanced features of the Z80 are rarely used.

Subroutines

Consider a program in which it is necessary to read three ASCII numbers, x, y and z, from a keyboard, calculate (x + yz) and then output it to a display (Figure 7). It can be seen that much of the code is repeated three times. This is obviously a considerable waste of program space. For this reason a *subroutine* is used to fetch the data. When it is necessary to input data the subroutine is branched to or *'called'*. At the end of the subroutine the data is in the accumulator and execution returns to the main program. As the subroutine may have been called from anywhere in the main program it must be told where to return to. Thus, when a CALL instruction is executed the current value of the program counter (PC) is saved before jumping. At the end of the subroutine this address is reloaded into the program counter. If a fixed memory location is used to save PC, then it is not possible to nest subroutines (CALL one from another), as the original return address would be overwritten. A method used in some minicomputers is to save PC, in a location reserved for this purpose, at the start of the subroutine. However, this will not work for subroutines stored in ROM.

The Stack

Most processors support a 'stack'. This is an area of memory usually located downwards from the top of the available RAM, in which return addresses and other program data are stored. Data is *pushed* onto the stack and *pulled* or *popped* from it. To initialize the stack, SP (stack pointer) is loaded with the top-of-RAM address (Figure 6a). When a CALL to a subroutine is encountered, the current program counter contents are loaded into (SP-1) and (SP-2). The stack pointer is then decremented (Figure 6b). Where registers used in the main program are needed in subroutines, their contents may be saved on the stack (Figure 6c) and restored to the registers at the end of the subroutine. In the Z80 only *register pairs* can be saved. At the end of the subroutine the registers and program counter are restored (Figure 6d).

Note that there is no way for the processor to tell where the data on the stack originated. Thus:

```
PUSH BC
POP  DE
```

will result in the data in BC being loaded into DE via the stack. A suitable program would therefore look like this:

```
   .    .
   .    .      SUB  PUSH BC
   .    .           PUSH DE
   .    .           PUSH HL
CALL SUB              .  .
   .    .           POP  HL
   .    .           POP  DE
   .    .           POP  BC
   .    .           RET
   .    .
   .    .
   .    .
```

Clearly, if many levels of 'nesting' are used (ie a subroutine calling a subroutine calling a subroutine, etc) the stack may become very long. You should therefore ensure that there is adequate room for the stack without overwriting other program or data areas. Sometimes the stack is used to store intermediate program data, particularly in 're-entrant' subroutines (subroutines which can CALL themselves). However, very great care must always be taken to ensure that, whichever program path is followed, every PUSH has a corresponding POP.

The eight restart (RST) instructions are identical to CALLS to certain addresses between 0000H and 0038H. They save time and memory for frequently-used subroutines.

Interrupts

It is often necessary for a microprocessor to respond to an external event which is not synchronised with the program, e.g. a key depression, electrical overload indication, a real-time clock, etc. As an example, consider a microcomputer connected to ten computer terminals and processing data from them. One way to collect data from the terminals is to 'poll' them. This means asking each terminal in turn whether it has any data. However, if the polling is done too infrequently data may be missed, and if it is done too often the microcomputer has too little time for anything else.

'Interrupts' provide a much better solution. The CPU examines its interrupt inputs during each instruction cycle. If an interrupt is active, the CPU responds by branching to an interrupt handling routine (rather like a subroutine CALL).

The Z80 has two interrupt inputs: non-maskable (NMI) and maskable (INT). The CPU will respond to a negative edge on NMI by storing the program counter contents on the stack and branching to memory location 0066H. NMI is most often used when a very fast response to an event is required, such as for storing essential data on disk when a power failure is imminent. For very fast response, instead of pushing the registers at the start of the NMI routine an exchange is performed with the alternate register stack (see Part 2). The non-maskable interrupt is only acknowledged if the interrupt-enable flip-flop is set (by an Enable Interrupt instruction). Note that NMI has *priority* over INT, i.e. NMI can interrupt the INT routine, but not vice-versa. The response to an enabled maskable interrupt depends upon which of three interrupt modes has been set:

Mode Zero — In this mode the interrupting device can place any instruction on the data bus and it will be executed by the CPU. Most commonly this is a single-byte restart instruction as this is easy to arrange in hardware, but multiple-byte instructions are also permissible. The timing of the data on the bus must be synchronised to signals generated by the CPU.

Mode One — The CPU responds by executing a restart to 0038H.

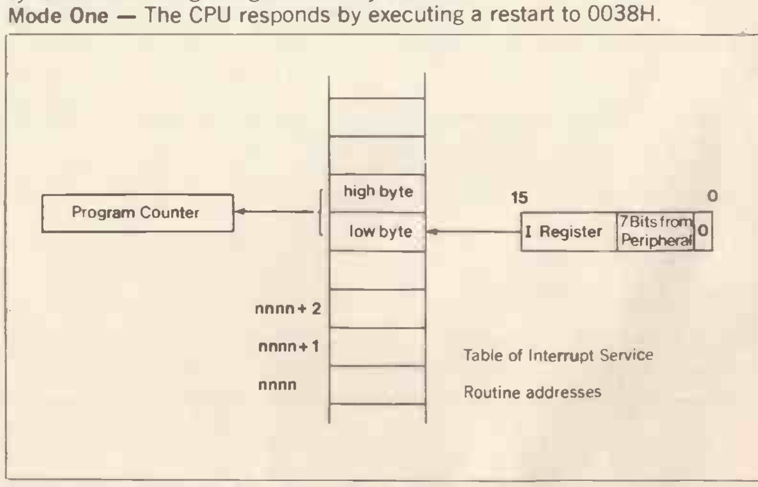


Figure 5. Vectored interrupt response (Mode 2).

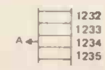
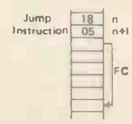
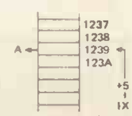
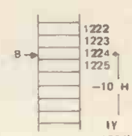
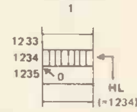
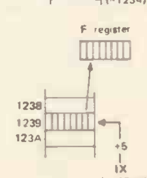
Addressing Mode	Example	Symbolic Representation	Description
Immediate	LD A, 23H	A ← 23	Loads the 8-bit immediate value 23(hex) into register A.
Immediate Extended	LD HL, 1234H	HL ← 1234	Loads the 16-bit immediate value 1234 into register pair HL.
Extended	LD A, (1234H)		Loads the byte stored at location 1234 into register A.
	LD HL, (1234H)		Loads the 2 bytes stored at locations 1234 and 1235 into HL. Note that the order of the bytes is reversed.
Register Indirect	LD A, (HL)		Loads register A from the address Pointed to by HL.
	JMP (HL)	PC ← HL	Causes program execution to jump to the address stored in HL
Relative	JR 05H		Adds the 8-bit, 2's complement value 5 to the current value of the program counter (which is pointing to the next instruction).
	JR -10H		Causes a backward jump.
Register	LD A,B	A ← B	Loads register A with the data in register B (B is unchanged).
Implied	CPL	$A \leftarrow \bar{A}$	Complements (inverts each bit) of the accumulator. The accumulator (reg. A) is the **implied** operand.
Indexed	LD A, (IX+5)		Loads register A with the data in the address which is found by adding 5 to the contents of the index register IX.
	LD (IY-10H), B		Stores the contents of register B in the address which is found by adding -10H (2's complement) to the contents of index register IY.
Bit	SET 3,A		Sets bit 3 of register A to '1'.
	RES 7, (HL)		Resets (to '0') bit 7 of the memory location pointed to by the HL register pair.
	BIT 1, (IX+5)		Copies bit 1 of the data in the location pointed to by IX+5 into the Zero flag in the F register. Other flags are also affected.
Modified Page Zero	RST 32 (see 'The Stack')		Allows single-byte addressing of 8 locations between 0000H and 0038H

Table 4. Z80 Addressing modes.

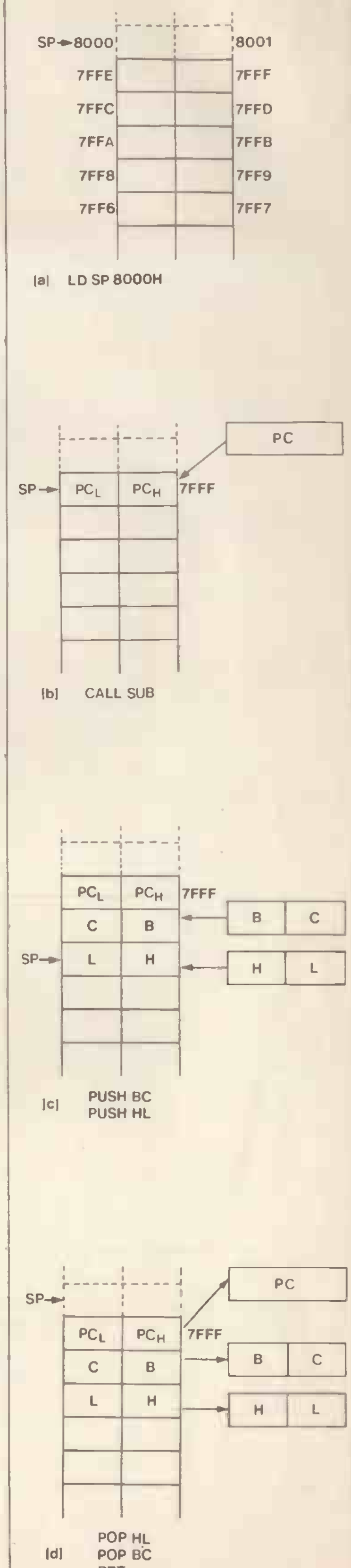


Figure 6. Stack operations.

Mode Two — This is the *vectored* interrupt mode. The interrupting device places a single byte on the data bus (the Least Significant Bit (LSB) must be zero). This is used as the least significant address byte. The most significant byte is obtained from the I register. The address formed by these two is then used as a pointer to the memory location which holds the interrupt-routine address. Normally a table is maintained in memory, containing up to 128 interrupt service routine addresses (see Figure 5).

Thus in interrupt mode 1 for the example above, when a terminal has data available it interrupts the CPU. This causes a jump to the interrupt handler at 38H. The interrupt handler then polls the terminals until it finds the source of the interrupt. At the end of the interrupt handler the RETI (return from interrupt) instruction is executed. In addition to the functions of the RET instruction, RETI enables non-maskable interrupts and provides control signals to special Z80 interface components. The implementation of interrupt-based systems will be

Instruction Type	Mnemonics	Description
Data Movement	LD	8- or 16-bit loads from one register or memory location to another.
	LDI, LDIR, LDD, LDDR	Copy blocks of data from one area of memory to another.
	PUSH, POP	Special loads for stack manipulation.
	EX, EXX	Exchange registers within main register set, or between main and alternate sets.
Arithmetic	ADD, ADC	Add, Add with carry.
	SUB, SBC	Subtract, Subtract with carry (borrow).
	INC	Increment (add 1).
	DEC	Decrement (subtract 1).
Logical	AND	8-bit logical AND (bit-for-bit).
	OR	8-bit logical OR.
	XOR	8-bit logical Exclusive OR.
AF register-pair manipulation	DAA	Decimal Accumulator Adjust (for decimal arithmetic).
	NEG	Negate A (2's complement).
	CMP	Complement each bit of A.
	SCF	Set carry flag.
	CCF	Complement carry flag.
8-bit compare	CP	Compare accumulator with register or memory.
	CPI, CPIR, CPD, CPDR	Search a block of memory for a specific byte.
Rotates and shifts	RL,RR	Rotate left/right arithmetic
	RLC,RRC	Rotate left/right logical
	RLD,RRD	Rotate BCD digit between accumulator and memory location pointed to by HL
	SLA	Shift left arithmetic
	SRA	Shift right arithmetic
	SRL	Shift right logical
Bit Manipulation	BIT	Test one bit in register/memory.
	SET	Set one bit in register/memory.
	RES	Reset one bit in register/memory.
Jumps	JP	Conditional/unconditional absolute program jumps.
	JR	Conditional/unconditional relative program jumps.
	CALL,RST	Subroutine jumps.
	RET	Return from subroutine.
	DJNZ	Decrement B, relative jump if not zero (used for program loops).
Input/Output	IN	Single-byte input from peripheral.
	OUT	Single-byte output to peripheral.
	INI,INIR, IND, INDR	Multiple-byte input.
	OUTI,OTIR, OUTD,OTDR	Multiple-byte outputs.
Interrupt Control	IM0,IM1,IM2	Set interrupt mode.
	EI,DI	Enable/disable maskable interrupts.
	RETI	Return from maskable interrupt.
	RETN	Return from non-maskable interrupt.
Miscellaneous Instructions	NOP	No operation.
	HALT	Halt program execution.

Table 5. Summary of Z80 instruction set.

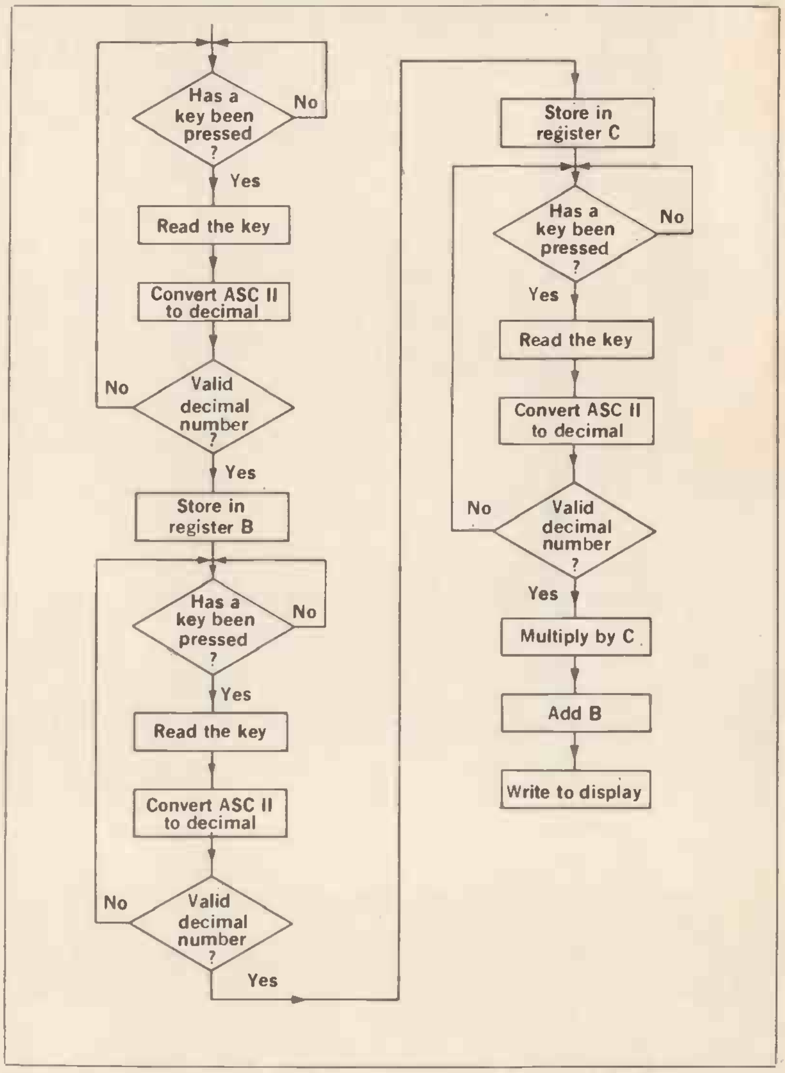
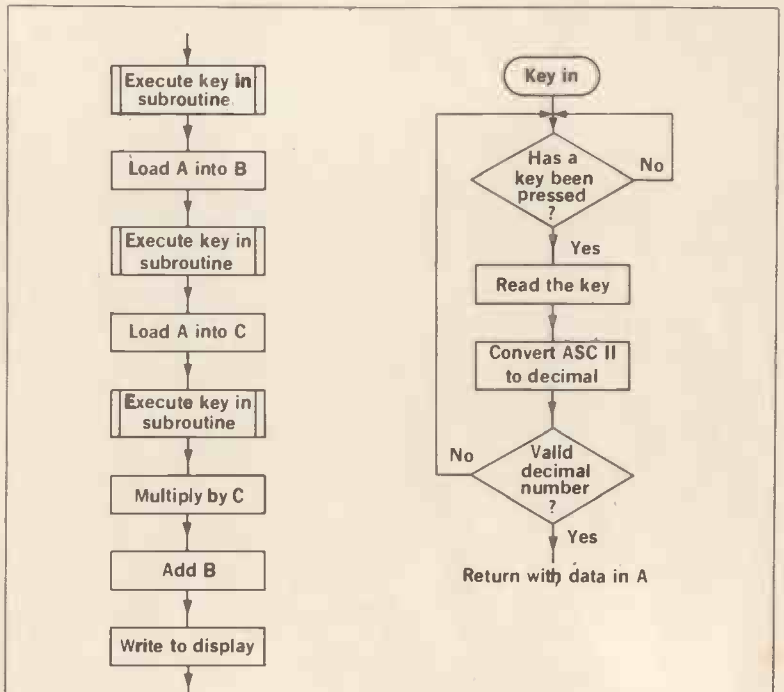


Figure 7. A program to read 3 numbers (x y z) from a keyboard and display x + yz.



(a) Program. **(b) Key in subroutine.**

Figure 8. The program of Figure 7 written using a subroutine to obtain decimal data from the keyboard.

illustrated in more detail later in this series.

Z80 Instruction Set

We are now in a position to understand all the available Z80 instructions. These are outlined in Table 5. Use this to familiarise yourself with the types of operations supported by the CPU.

Next month we will tackle the first complete design exercise based upon a Z80 microprocessor.

E&MM

BASICALLY BASIC

Graham Hall, B.Sc.

This regular series will attempt to teach BASIC to those who would like to use it for any home, business, scientific or musical application, but have no previous programming experience.

BASIC commands

A BASIC *command* is an instruction executed by the computer immediately. Unlike BASIC *statements*, commands do not require line numbers and are not included in programs. If you have used a computer to execute a BASIC program you would have already encountered the BASIC command called 'RUN'. In response to the RUN command the computer 'reads' the program, sorts the statements into sequential order and checks for any mistakes. Provided this is completed successfully the computer will then execute the program. Now we will look at some of the other BASIC commands which are useful when constructing a program. The description will be general, and you should refer to the operator's 'user manual' for the computer being used in order to find out the commands available on your machine.

The NEW command

When you type in the individual statements of a BASIC program, they are stored in the computer memory. The NEW command is used before you start to enter a new program. It erases the program storage section of the memory, thus ensuring that there are no unexecuted statements left around from previously created programs.

The LIST command

The LIST command instructs the computer to display on the VDU terminal the statements of the program currently stored in the computer memory. The statements are displayed in their proper sequence; that is with the lowest numbered statement first (this may not have been the order in which they were typed into a computer). When writing large programs, the LIST command is useful in order to check that the statements have been typed into the computer correctly. LIST may be used at any point in the series of program lines, without affecting the operation of the program itself.

Some versions of BASIC used on personal computer systems incorporate a 'hard copy device', such as a printer, have an additional list command which directs the program listing to the hard copy device, instead of the screen.

The SAVE command

The SAVE command is used to transfer a program to a permanent storage device. A permanent storage area is somewhere other than the computer's main memory, which can hold a large number of programs or data, and which will retain the information, even when the computer is switched off. The permanent storage devices used with a personal computer are usually 'floppy discs' or magnetic tape cassettes. When a program is stored it is kept in a 'file'. The file is given a unique name, by which the program can be identified.

The LOAD (or OLD) command

The LOAD command is used to retrieve programs in files from an external storage device. In order to do this the file name is specified, together with the LOAD command. For example, to retrieve the file called 'PROGRAM' from a magnetic tape drive, type 'LOAD PROGRAM'. This transfers the contents of the file 'PROGRAM' to the main memory for re-use. You could then use the LIST command to display the contents of the main memory.

BASIC prompts

A 'prompt' is a command which the BASIC Language Processor prints on the terminal to request information or instructions. You are probably already familiar with the BASIC prompt 'READY' which appears on the terminal after any BASIC command has been executed. It signifies that the computer is waiting for you to input a BASIC command or program.

The PRINT statement

We have already used the PRINT statement in a BASIC program to display character strings and the values of variables. Now we will look at some more ways to use the PRINT statement, including its use as a 'direct statement', or command which is executed immediately.

To use PRINT as a command, its prefix line number is omitted. For example, the command

PRINT "HELLO"

immediately displays the word HELLO on the computer terminal (note that the RUN command is not required in order to produce the output).

Now try typing the command

PRINT "4 + 3"

The output to the terminal is:

4 + 3. This is as expected because the characters enclosed in quotation marks are printed literally. To get the computer to arithmetically evaluate the expression '4 + 3' and to print the answer, the quotation marks are omitted. So, the command

PRINT 4 + 3

produces the output:

7.

Thus, we can use BASIC like a desktop calculator.

You can also control how the PRINT statement formats its output. For example,

PRINT "4 + 3 = "; 4 + 3

gives the output:

4 + 3 = 7.

This is because the semicolon means 'print the next item on the same line as the previous one'. Each item is called an 'argument'.

If the semicolon is replaced with a comma, the output is spaced out:

PRINT "4 + 3 = ", 4 + 3

gives the output:

4 + 3 =   7.

The comma is called a 'delimiter'.

The number of spaces between the first argument and the second will depend on the type of computer being used. Usually one line on the terminal is divided into 5 sections (called fields), of 14 character positions each. If more than five arguments, separated by a comma, are placed in a PRINT statement, or command line, each argument is output to its own field, until the five fields are filled. The remaining arguments are printed on the next line. For example,

PRINT "1", "2", "3", "4", "5", "6", "7"

gives the output:

```
1      2      3      4      5
6      7
```

(Note: a comma is *not* needed after the last argument.)

It is also permissible to use semicolons and commas in the same PRINT statement or command line. For example,

PRINT "4 + 3 = ", 7; "IS THE ANSWER"

gives the output:

4 + 3 =   7 IS THE ANSWER

If the PRINT statement is used without an argument a blank line is output to the screen. For example,

```
10  PRINT  "OUTPUT A"
20  PRINT
30  PRINT  "BLANK LINE"
RUN
```

results in:

```
OUTPUT A

BLANK LINE
```

Expressions and operator hierarchy

Last month we looked at simple expressions involving one arithmetic operator. Now we shall examine how BASIC evaluates expressions which have different combinations of arithmetic operators.

BASIC evaluates expressions according to certain rules that determine the order in which arithmetic operations are performed. Consider the expression,

5↑2-6/3*2+1

First BASIC 'scans' the line from left to right and performs any exponentiation operation (↑) encountered. In the computer the expression has become:

25-6/3*2+1

Again the line is scanned from left

to right and any multiplication or division operations are performed in the order in which they are encountered. The expression is reduced to:
25-4+1

On the final scan from left to right, subtraction and addition operations are performed in order. This gives the answer: 22. A computer may be used to evaluate the expression by typing in:
PRINT 5↑2-6/3*2+1

The order in which BASIC performs operations can be changed by using parenthesis (brackets) within the expression. If the expression above was changed to:
5↑2-6/3*(2+1)

BASIC evaluates the contents of the parenthesis first, reducing the expression to:
5↑2-6/3*3

The next scan performs the exponentiation, reducing the expression to:
25-6/3*3

Next the multiplication and division are performed giving:
25-6

Finally the answer is the result of the subtraction: 19.

Note that although the actual numbers in the two forms of expression were identical, use of parenthesis changed the order of evaluation, which changed the answer from 22 to 19. If the parenthesis contain more than one operation, the contents will still be evaluated according to the rules previously stated. Table 1 summarises the order in which BASIC performs operations.

A more complicated expression could contain parenthesis within parenthesis (this is called 'nesting'). For example:
16/(5+21/ (3+8/2))
⑤ ④ ③ ②①

The numbers inside the circles show the order in which the operations are performed.

The number of open parenthesis and close parenthesis must be identical, otherwise BASIC will display an error message.

HIGHEST PRIORITY	
( )	: parenthesis
↑	: exponentiation
*,/	: multiplication, division
+,-	: addition, subtraction
LOWEST PRIORITY	

Table 1 Operation Hierarchy

Error Messages

Error messages, also called 'diagnostics', may be displayed by the computer at any stage of a program's creation. There are two categories of error: errors in logic and errors in syntax. Syntax errors are format, or typing errors, which are usually detected after a statement has been typed and the 'RETURN' key pressed. For example,
10 IF N = 5 GOTO 100
but the program has no line 100. This is an 'illegal' instruction, so an error message will be displayed. The line must be corrected before the program can be executed.

So far the kinds of error discussed have been 'fatal' — that is they prevent the program from compiling and executing. However, it is possible for the computer to compile a BASIC program with errors in it. Depending on the error, it may cause an error message to be output when the program is being executed and terminate the RUN. An example of such an error is the evaluation of an expression involving division by zero (an operation which is not allowed in BASIC). The computer would output a message resembling:
?WARNING — DIVISION BY 0 AT LINE 50

The error must be found and corrected before the program will run correctly.

The most difficult errors to detect are those which do not terminate the program execution but cause unexpected or incorrect results. These are 'logic errors' and are due to errors in the program design. The computer has no way of determining when they occur. This is where methodical program design methods using flow diagrams to show program operation become invaluable, since this is often the only way to detect logic errors.

A BASIC program

The following program illustrates some uses of the statements introduced so far. The program outputs to the terminal a temperature conversion table. It uses the formula:
F = 9/5C + 32 where F = degrees F
C = degrees C
For converting degrees Celcius (Centigrade) to degrees Fahrenheit. The use of the IF THEN and the GOTO statements to implement a 'loop' was described last month.

```
 10  REM CONVERT CELCIUS TO FAHRENHEIT
 20  REM IN STEPS OF 5 DEGREES CELCIUS
 30  PRINT "TEMPERATURE CONVERSION TABLE"
 40  PRINT "---------- ---------- -----"
 50  PRINT
 60  PRINT "CELCIUS", "FAHRENHEIT"
 70  LET C=0
 80  PRINT C, 9/5*C+32
 90  IF C=100 THEN GOTO 999
100  LET C=C+5
110  GOTO 80
999  END
```

The program is executed by typing the BASIC command RUN and will display the calculated values on 24 lines of the VDU. Try using the other BASIC commands described earlier so that you become familiar with their function. E&MM

COMPUTING NEWS

SHARP LANGUAGE TRANSLATOR

Sharp have recently introduced a pocket calculator sized language translator which has had a very successful trial marketing period in both Japan and America. Language modules are available for translating to or from French, German, Spanish, Japanese — katakana style, and Japanese — Roman style. Two language modules can be fitted at a time allowing for example translations between English and German, English and French, or even French to German. The style and layout of the keyboard is similar to Sharp's hand held personal computer and the display is a 23 digit LCD dot matrix which scrolls if the translated sentences exceed the length of the display. 14 keys have special symbols depicting aeroplanes, buses, a fork and knive — these remind the user that there are 152 of the most used sentences stored in each module. Pressing the aeroplane button allows the user to search through phrases like 'When is the next flight,' 'Please make a reservation,' etc. and these are displayed in English and can be translated at the press of a button. There are 1,750 words in each language and it is possible to search through these and translate a word you cannot even spell correctly — the memory is scanned for similar words. Individual words, phrases or complete sentences can all be translated quickly and even if you can't pronounce the sentence the translator can simply be held up and shown. It handles homographs (words which have two meanings) in a very clear manner e.g. if you try to translate the word light it will ask whether you mean 'not dark' or 'not heavy.' The unit takes just over 1mA and the battery lasts for 700 hours. Operators used to a QWERTY layout will find the ABCD keyboard layout slow at first but the unit certainly works well and will prove popular with travellers and students.

ITT OWNERS GET A BITE OF THE APPLE

Ever since the ITT 2020 first appeared its users have had to suffer with those dreaded lines created when using Apple pictures on their machines (for those unaware of this problem, it is caused because the ITT contains a ninth bit in its hi-res pages that Apple pictures don't account for). This problem has now been overcome by Computech Systems who offer a conversion program for ITT users.

You read your high resolution picture as usual, then BRUN CAI (Convert Apple to ITT of course!), the blank lines are then removed and a normal picture will be displayed. The only problem you are left with is slightly different proportions, due to the higher resolution of the ITT's 360 pixels in the X direction.

Further details from Computech Systems on 01-794-0202. E&MM

Micromusic

A series that focuses on using the popular microcomputers for making music.

Music Composer Program

Graham Knight

The previous issues of Electronics and Music Maker have described how the Sharp MZ-80K microcomputer can be programmed to play music. Regular readers will recall that the MZ-80K can be programmed from BASIC over a three octave range with the user selecting the note pitch and length. Using this simple programming method almost any notes can be transposed to play BASIC e.g. MUSIC 'CDEFGAB¯C' will play the scale of C major. Examples have already been published in E&MM of complete tunes with multiple tempos and a wide variety of notes which can be programmed in just a few lines of BASIC.

The computer can also be programmed to generate its own music and the program published this month incorporates this interesting feature. The program is quite short, taking only 2503 bytes of memory and can therefore be run on any MZ-80K regardless of its memory size. This program is longer than those previously published, so care and time must be taken to ensure that it is entered correctly. Remember that it is possible to enter a part of the program and save that section on to a cassette if you run out of time to enter the whole program at once. It is then easy to load this first section at a later date and then enter the remaining lines to complete the program. It is in any case good practice to save sections of the program as you enter them — there is nothing more frustrating than entering a 300 line program and to see it disappear in front of you because another member of the family has accidentally unplugged the micro! In the writer's home area there tends to be a few dips in the mains supply every other day which does not normally bother the Sharp but if the break is more than just a flicker and lasts more than a second then all the entered lines will disappear. Saving sections as you enter them is an excellent insurance against losing entire programs due to momentary mains failures.

The Composer Program generates music, either spontaneously creating tunes with the tempo, timing and range entirely selected by the micro or creating music to parameters set by the user. The program plays the scales in line 4 the moment it is run and then requests the user to enter S for a spontaneous tune or R which allows the user to select the tempo etc. If the user enters S, the MZ-80K takes a few seconds to silently compose a tune from the data in lines 11 to 17, select an Opus number, and will then print this on the screen along with the note durations it has chosen. A graphic display then shows the range of notes which are played and at the end of the piece the user has the option of hearing it again or going on to another composition. The spontaneous tunes are produced by the lines of the program which ensures that the notes are melodic and harmonically related to a certain degree.

The user can also set the parameters for the tune by selecting R and entering his requests. The screen display will ask for a tempo between one and seven (the fastest), a rhythm between one and five and the number of repetitions of a phrase. One further parameter can be set by the user and this number controls the effect — entering between one and six will create musical tunes, 7 to 19 selects electronic sounding tunes and numbers above 20 produce what can only be described as very modern 'cosmic' effects. Once the above selections have been entered on the keyboard the MZ-80K composes the music in a few seconds keeping to the parameters chosen by the user. The musical composition is again drawn graphically on the screen and then played through the speaker. The tunes thus created can be repeated over and over again and if a slow tempo number is selected it is quite easy to follow the notes played on the display.

It is hoped that users get a great deal of fun from this month's program and some recorded examples are given on E&MM demo cassette No. 2. Correspondence suggests that many readers were amused by the range of sounds effects detailed in issue 1 and several letters have commented on the morse tutor described in issue 2. A forthcoming article will also describe a light pen which can be used to draw on the screen and to play notes from music shown on the MZ-80K screen. **E&MM**

```
1 REM COPYRIGHT Dr. James and G. Knight
2 REM SHARP MUSIC COMPOSER PROGRAM - TAKES 2503 BYTES OF MEMORY
3 CLR:TEMPO 7:PRINT"■■■■■■■■■■■■■■■SHARP MZ-80K MUSIC COMPOSER PROGRAM"
4 MUSIC"_C4_D_E_F_G_A_BCDEFGAB¯C¯D¯E¯F¯G¯A¯B¯A¯G¯F¯E¯D¯CBAGFEDC_B_A_G_F_E_D_C"
5 INPUT "■■■■■■■■■■■■■■■■SPONTANEOUS OR BY REQUEST (S or R)? ";R$
6 ZZ=1:REM XXXX 1 FOR SILENT COMPOSING, 0 FOR NOTES XXXXXX
7 PA=600 :REM XXXXXX PATIENCE FACTOR XXXXXXX:JM=4:REM No of bars in A$ etc
8 RN=RND(1): R INITIAL=RN
9 DIM ND$(8, 16),N$(40),N(8)
10 DATA _C,_D,_E,_F,_G,_A,_B
11 DATA "C","D","E","F","G","A","B","¯C","¯D","¯E","¯F","¯G","¯A","¯B"
12 DATA 3,3,3,3,3,3,3,3,/
13 DATA 5,5,5,5,5,3,5,3,3,3,/
14 DATA 5,3,5,3,5,3,5,3,/
15 DATA 5,3,3,5,3,3,/
16 DATA 5,3,3,3,3,/
17 DATA "*"
18 FOR I=1TO 24 : READ N$(I) : NEXT I : IR=1 : NR=0
19 I=1
20 READ ND$(IR,I):IF ND$(IR,I)="/"THEN23
21 IF ND$(IR,I)="*"THEN 25
22 I=I+1:GOTO 20
23 N(IR)=I-1 :IR=IR+1
24 GOTO 19
25 NR=IR-1:IF R$="R"THEN 64:REM XXXXX MZ-80K CHOOSES OPUS NUMBER XXXXXX
26 OPUS=INT(RN*10000)
27 RN=OPUS/10000
28 PRINT"■■MZ-80K COMPOSING OPUS #";OP
29 GOSUB 60: TEM=5+INT(RN*2)  : RE=2
30 GOSUB 60:IR=INT( RN*NR+1 ):DM=2 :TEM=6 :REM XXXXXX MZ-80K COMPOSES XXXXX
31 GOSUB 60: K=9+RN*10  :SM=2 :XX=0
32 PRINT"■MZ-80K CHOOSES NOTE DURATIONS ";: NB=N(IR)
33 FOR IK=1TO NB :PRINT ND$ (IR,IK);: NEXT IK
34 PRINT:GOSUB 42: A$=P$ : GOSUB 42:B$=P$ : TEMPO TEM
35 FOR U=1 TO RE : MUSIC A$,A$,B$,B$: NEXT U: MUSIC N$(8)+"9"
36 PRINT"■■■■■■■■■     REPEAT  (Y or N) ?                  ":FOR LL = 1 TO PA
37 GET K$:IF K$="" THEN 37
38 IF K$="Y" THEN 35
39 IF K$="N"THEN RUN
40 GOTO 37
41 NEXT LL: IF R$="R" GOTO 64: GOTO 26
42 P$=""
43 FOR J=1 TO JM : NB=N(IR) : FOR I= 1 TO NB : DK=0
44 GOSUB 60:R=RN :IF R<.3 THEN DK =DM : IF R>.7 THEN DK = -DM
45 GOSUB 60:R1=RN:GOSUB 60:R2=RN
46 K=K+(R1-R2)* 2+DK :K=INT(K+.5) : IF K=KK THEN 45: KK=K
47 IF K>21 THEN K=21
48 IF K<1 THEN K=1
49 IF K>15 THEN K=K-1
50 IF K<6 THEN K=K+1
51 GOTO 55: REM XXXXXXXX BYPASS ROUTINE XXXXXX
52 GOSUB 60:IF (RN<.3)* (ABS(K-8)<1.5) THEN K=8
53 GOSUB 60:IF (RN<.3)* (ABS(K-16)<1.5) THEN K=16
54 GOSUB 60:IF (RN<.3)*(ABS(K-12)<1.5) THEN K=12
55 XX=XX+1 : Q$=N$(K)+ND$(IR,I) :SET XX,40 -K
56 IF ZZ=1THEN 58
57 MUSIC Q$
58 P$=P$+Q$: NEXT I: XX=XX+2 : NEXT J: XX=XX+2
59 RETURN
60 Z= (RN+1.1):Z=Z↑6 : RN=Z-INT(Z)
61 RETURN
62 RN=RL :GOTO28
63 REM XXXXX USER  REQUESTS XXXXXX
64 INPUT"■■Select tempo  (1-7) ";TEM
65 IF TEM >7 THEN FOR A=1TO10:MUSIC"C1_B3":NEXT:USR(62):GOTO 64
66 INPUT"■■■Select rhythm (1-5) ";IR
67 IFIR>5 THEN MUSIC"_B2R_BR_BR_BR":PRINT"■■■■■■■■■■■■■■■■■■■■          ":GOTO66
68 INPUT"No. of repetitions? ";RE
69 INPUT"Effect no.(1-6 musical 7-19 electronic -  20 + cosmic )? ";DM
70 DM=DM-1 :REM 'THIRD' IS TWO STEPS
71 GOTO 31
72 FOR N=18440 TO 19000
73 IF PEEK(N)=13 THEN PRINT N,PEEK(N+1) ;PEEK(N+3): NEXT
```

RECORDED ON CASSETTE NO. 2

EXPANDABLE POLYPHONIC SYNTHESISER

Cabinet size 31.1" x 19.6" x 7.6" rear 3.4" front

COMPLETE KIT ONLY

£320.00 + VAT!
(single voice)

Plug in extra Voices — Kit price £52 + VAT (£48 — + VAT if ordered with kit)

TRANSCENDENT POLYSYNTH

By brilliant design work and the use of high technology components the Polysynth brings to the reach of the home constructor a machine whose versatility and range of sounds is matched only by ready built equipment costing thousands of pounds. Designed by synthesiser expert Tim Orr and being featured in Electronics Today International, this latest addition to the famous Transcendent family is a 4 octave (transposable over 7½ octaves) polyphonic synthesiser with internally up to 4 voices making it possible to play simultaneously up to 4 notes. Whereas conventional synthesisers handle only one at a time.

The basic instrument is supplied with 1 voice and up to 3 more may be plugged in. A further 4 voices may be added by connecting to an expander unit, the metalwork and woodwork of which is designed for side by side matching with the main instrument. Each voice is a complete synthesiser in itself with 2 VCOs, 2 ADSRS, a VCA and a VCF (requiring only control voltages and a power supply, the voice boards are also suitable for modular systems). One of these voices is automatically allocated to a key as it is operated. There are separate tuning controls for each VCO of each voice. All other controls are common to all the voices for ease of control and to ensure consistency between the voices.

Although very advanced electronics the kit is mechanically very simple with minimal wiring, most of which is with ribbon cable connectors. All controls are PCB mounted and the voice boards fit with PCB mounted plugs and sockets. The kit includes fully finished metalwork, solid teak cabinet, professional quality components (resistors 2%, metal oxide or metal film of 0.5% and 0.1%), nuts, bolts, etc.

Kit also available as separate packs

Pack		Price
POLY 1	Pair of PCB's for multiplex cct. K.B. contacts	£9.50
POLY 2	IC's IC sockets, Rs, Cs, for multiplex cct.	£8.20
POLY 3	Superior quality keyboard	£32.25
POLY 4	Contacts and bus bars	£12.00
POLY 5	Double sided plated through PCB for digital control and pitch/gate generator cct.	£17.25
POLY 6	Rs, Cs, heat sink for fitting to Pack 5	£10.50
POLY 7	IC's IC sockets, diodes for fitting to Pack 5	£31.30
POLY 8	Double sided mother board (for plug-in voices)	£18.90
POLY 9	Rs, Cs, connectors for mother board	£14.10
POLY 10	IC's IC sockets, Trs, heat sinks for mother board	£13.10
POLY 11	PCB for master controls (left of section marked VOICES)	£18.80
POLY 12	IC's IC sockets, diodes, Trs, Rs, Cs for master control PCB	£9.30
POLY 13	Pots, Switches for master control board	£11.80
POLY 13	Pots, Switches for master control board	£11.80
POLY 14	PCB for VOICE controls	£6.80
POLY 15	Pots, switches, diodes, Cs for VOICE PCB	£4.80
POLY 16	PCB for plug in voice	£8.20
POLY 17	Rs, Cs, presets, connectors for one voice	£16.30
POLY 18	IC's, IC skts, diodes for one voice	£27.50
POLY 19	Transformer 0-120-240, 17-0-17, 0-7.7	£6.30
POLY 20	Pitch bend control	£3.90
POLY 21	Misc parts e.g. jack sockets, knobs, mains switch etc.	£13.00
POLY 22	Ribbon cable, ribbon cable connectors, mains cable	£8.45
POLY 23	Fully finished metalwork and fixing parts	£25.60
POLY 24	Solid teak cabinet	£25.80
POLY 25	Construction manual	£1.50
	Total cost for individually purchased packs for single voice instrument	£355.15
	Special kit for 4 voice expander kit including connectors	£295.00

ADSR IC CEM 3310	£4.00
VCO IC CEM 3340	£6.00

ICs and details of all packs in our FREE CATALOGUE

POWERTRAN

ALL PRICES VAT EXCLUSIVE

PRICE STABILITY: Order with confidence. Irrespective of any price changes we will honour all prices in this advertisement until August 31 1981 if this month's advertisement in Electronics & Music Maker is quoted with your order. Errors and VAT rate changes excluded.

EXPORT ORDERS: No VAT. Postage charged at actual cost plus £1.00 handling and postal documentation.

U.K. ORDERS: Subject to 15%* surcharge for VAT. No charge is made for carriage. *or at current rate if changed.

MANY MORE KITS ON PAGES 2 & 3

OUR CATALOGUE IS FREE! WRITE OR PHONE NOW!

POWERTRAN ELECTRONICS

PORTWAY INDUSTRIAL ESTATE ANDOVER, HANTS SP10 3WW

ANDOVER (STD 0264) 64455

Quote E&MM on all enquiries

SECURICOR DELIVERY: For this optional service (U.K. mainland only) add £2.50 (VAT inclusive) per kit.

SALES COUNTER: If you prefer to collect your kit from the factory call at Sales Counter Open 9 a.m. — 12 noon, 1—4.30 p.m. Monday-Thursday.

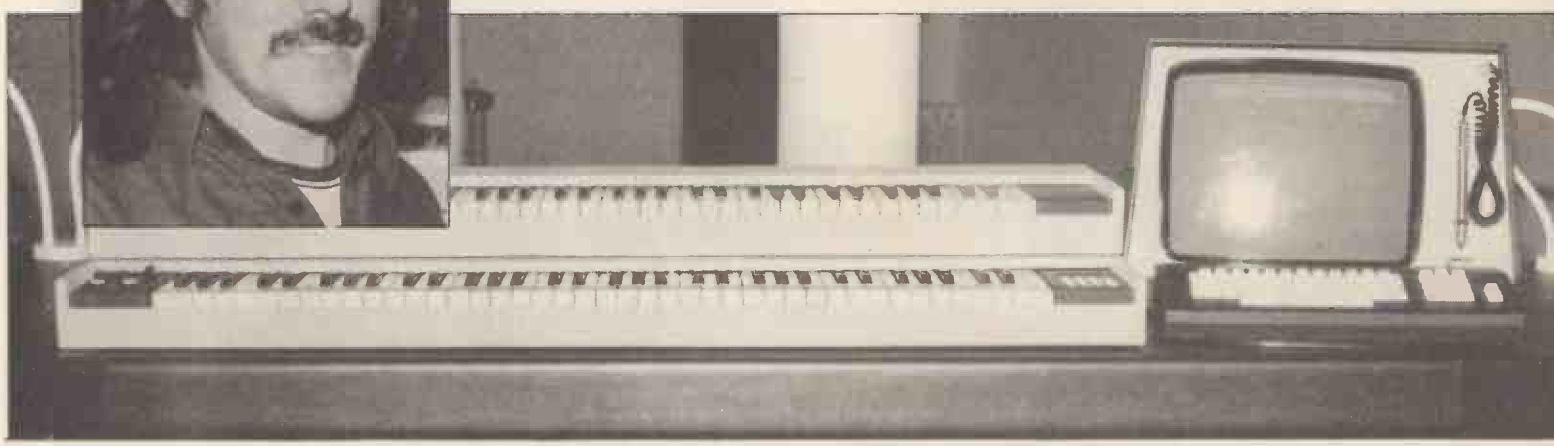
INSTRUMENT REVIEW

Each month we review the latest Electro-Music Equipment — from synthesisers to sound reproduction and effects!

E&MM's special in-depth reviews look at what's new in the world of commercial music — a vital updating for both electronics designers and musicians.

The Fairlight Computer Musical Instrument

Peter Vogel



It's a source of fascination to me that those countries which are virtually kept "in Coventry" with respect to the big, wide world so often seem to produce innovations that leap ahead from competitors. Maybe this proves that geographical isolation enforces the pecking order, or, as Darwin might have put it: if one bird gets a big beak, then they all want one. At least this seems true in Australia; not only for the kangeroo, but also for the Fairlight Computer Musical Instrument. Whilst kangeroo steak may be an acquired taste, the Fairlight CMI certainly isn't; indeed, it's positively addictive — but first of all you've got to catch one, and they're still comparatively rare and expensive creatures.

The development of the Fairlight CMI really started about six years ago, when, as far as Australia was concerned, microprocessors were only just appearing on the market. At that stage, the development team consisted of Peter Vogel and Kim Ryrie who spent a year designing a logic-controlled polyphonic analogue synthesiser which turned out to be rather similar to the Prophet in terms of programmability. This design was ceremoniously scrapped because they suspected that development in America would by now have overtaken them. This was being hyper-critical, actually, as the Prophet was still very much in the pipeline (Sequential Circuits actually brought out the first Prophet 5 in 1977). Instead, they decided to go for a fully digital system and teamed up with Tony Furse, a computer engineer working in Sydney. He had actually prototyped a system which used two minicomputers and some digital oscillators, but the equivalent of note files were inputted on paper tape which meant that it took twenty minutes to load-up five minutes-worth of music! This system produced some impressive results but was very expensive and not at all commercially viable.

The three of them therefore formed Fairlight Instruments with the express purpose of developing a completely digital system. The first real product of this trio was the QASAR M8, an eight waveform channel, polyphonic system designed using TTL and dual-microprocessor control, with each waveform channel providing up to 128(!) harmonics. One of the two processors controlling the M8 system handled user interaction with the system (video graphics terminal with light pen, music keyboard, touch-sensitive controls, etc.). The second processor controlled the waveform-generating hardware and calculated each waveform from given harmonic amplitudes and phase specifications. This system was never really widely distributed, though it was installed in the School of Music in Canberra, Australia. This first system attracted a lot of interest from composers working in the School of Music and word-of-mouth did the rest in spreading interest in it all over the world. It wasn't until about two years ago that the current version of the system started in the design stage and it only took about six months to get from design to the prototype. The new Fairlight CMI incorporates all of the capabilities of the QASAR M8 system but uses MOS Large Scale Integration technology extensively and incorporates many features that were not possible on the original M8 system. It is also much smaller and less expensive than the original system.

The CMI package consists of the computer section containing all the processing and memory cards as well as two 8" floppy disc drives; a six-octave music keyboard (with the provision for an optional 'slave' keyboard) with a keypad at the right-hand side of the keys; and an alphanumeric keyboard and graphics display unit. The care that has gone into

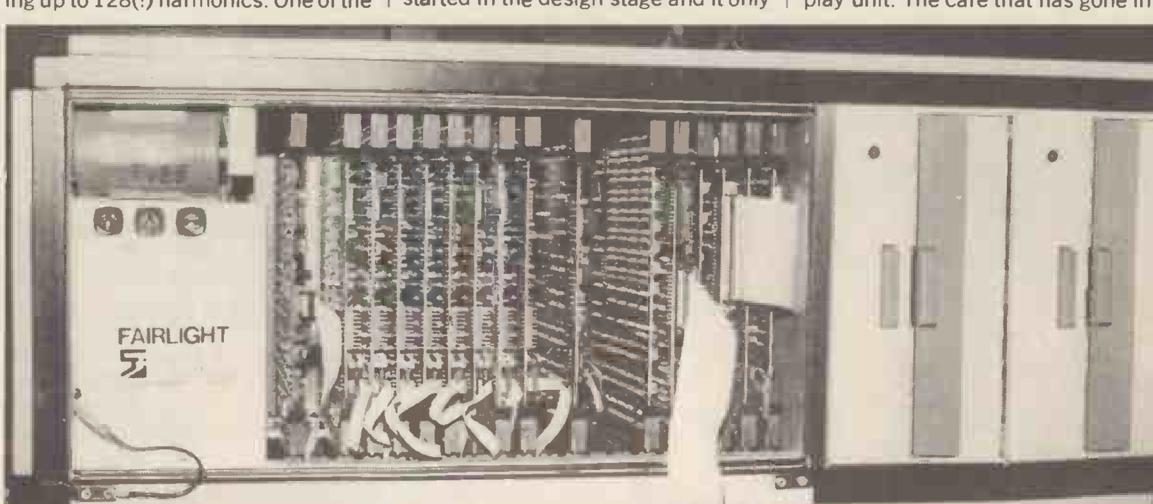


Figure 1. CMI Computer Section.

the design of the CMI is evident right down to the really common-or-garden hardware; for instance, the VDU is a particularly high resolution device that Fairlight had to design to enable the best operation of the light pen facility in drawing waveforms and so on. The important thing to realise about the system is that the sound generation is totally digital, and, after digital to analogue conversion, each of the eight independent output channels is the result of real-time control and keyboard data imposed on a waveform held in 16K of RAM. This is rather different to the system used by Mountain Hardware in the Apple Music System, where digital oscillators are instructed to synthesise waveforms according to a table of instructions.

The Computer Unit

Looking inside the main unit (see Figure 1), it's apparent that the configuration of modules is that of a considerably more dedicated processor system than other micro-systems. The first section on the left is the PSU, and the really large capacitors in it help to prevent the potentially catastrophic effects of mains fluctuations, which can be a real threat on stage!

The first circuit card is a master control card which controls the eight voice channels. Each voice card consists of 16K of RAM dedicated to the waveform memory plus a D/A converter outputting to an audio connector at the front of the card. All the voice cards connect with a motherboard bus at the back of the unit for bi-directional data transfer and addressing.

Figure 2. Keyboard keypad controls.

The next card along is the light pen controller which interfaces the light pen to the computer. Next to that you find the 64K RAM card, though there is room for two more memory cards if it becomes necessary in the future. Altogether, the system has 208K of RAM plus a megabyte of disc. Moving along, we find the CPU control card which has the serial interface for the keyboard and optional printer as well as a parallel interface for other control purposes. There's also a couple of kilobytes of ROM for start-up and booting the system disc.

The next card is the central processor module which has two 8-bit processors connected back-to-back, the two 6800s operating on alternate phases of the clock, so that they can communicate through common areas of memory without time-consuming 'interrupting' (switching a CPU from one task to another). This allows the throughput of data in the CMI to be comparable to minicomputers, even though the actual technology is based on cheap microprocessors. According to Peter Vogel, this dual-processor configuration (known as QASAR) is the key to making the CMI viable as a musical instrument.

Next to this module is the floppy disc controller which controls the two 8" disc drives and operates via direct memory access (DMA) for very high speed transfer of data. The disc drives are the only pieces of hardware not custom-made for Fairlight, and are in fact Japanese double-sided drives of normal IBM format holding half a megabyte each. The disc on the left is the operating system disc which contains all the programs and holds something like 200K of object code for loading into the system as it's required. The other disc is a user disc which contains the sound library built up by the user.

As new software facilities are developed, so Fairlight can send out a new system disc with which to replace the old one.

Moving back to the card area of the main unit, the next module that we can see is the graphics controller. The graphics system is memory-mapped with additional dedicated RAM giving an exceptional 512 x 256 points of resolution. The module also has a good deal of hardware for high-speed vectoring so that the maximum potential of drawing on screen with the light pen is achieved.

The Music Keyboard

The music keyboard is a standard six-octave design with one contact per note moving between two bus bars, the time taken to travel this distance providing key velocity information. The analysis of where the keys are at is performed by another 6800 processor, actually in the keyboard itself, dedicated solely to scanning and calculating key velocities. The entire keyboard-scanning and velocity-sensing cycle takes two milliseconds to complete, which is very fast by any standards (the Lowrey MX1 does the same in five milliseconds). At the right-hand end of the keyboard (see Figure 2) there's a keypad and small

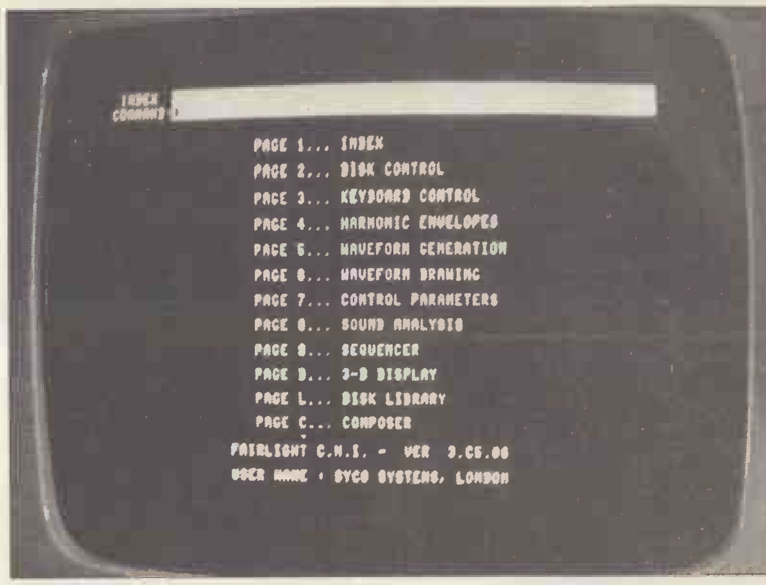


Figure 3. Page 1 Index.

alpha-numeric display. This enables the system to be used on stage with only the keyboard in sight and the computer off stage in the wings. The keypad relays simple commands to the main unit and the alpha-numeric display enables the computer to send error messages back to the user.

In practice, the keyboard is usually split into registers with a different voice or group of voices assigned to each register. The optional slave keyboard is purely a convenience and allows the user to allocate one sound to one keyboard and the rest to the slave.

Additional real-time expression is available from the master keyboard and includes three faders, two switches and a socket for a footswitch. A typical configuration of control parameters, selected from software, might provide a sustain pedal, key-velocity control of level, and keyboard fader control of vibrato. Unfortunately, the faders don't do justice to the rest of the instrument and are as uncomfortable to play as those on the cheapest of monophonic synthesisers. With the industry standard of the Moog modulation wheel, you would have thought that Fairlight could have used something similar to implement analogue user-control.

The CMI Functions

The various functions of the CMI are grouped into twelve categories, which are characterised by twelve different display formats known as 'display pages'. Page 1 (Index) provides the 'menu' of available pages (see Figure 3) and is used in conjunction with the light pen to select other pages. Page 2 (Disc Control) is a directory of all the current files on the user disc (see Figure 4). The functions, 'delete', 'load' (selected in the photo and therefore white) and 'transfer', can be applied to any file on the disc (in this case, file 10, 'Demos'). 'Delete' removes a file that is no longer wanted, 'load' loads a particular file into the instrument so that you can play it, and 'transfer' copies that file on to a different disc. Various suffixes are attached to each file name: '.VC' tells the user that 'Piztwang', for example, is a voice file containing the data needed to generate a sound, i.e., the dynamic waveform and amplitude data; '.CO' is a file holding control parameters which may be linked with voice files; '.IN' signifies an instrument file that describes the whole configuration of the instrument, and, in the case of 'Demos', includes five different voice files and associated

Figure 4. Page 2 Disc Control.

control files; '.SQ' files contain data entered from the keyboard or using the music composition language (see later) as sequences which can be 'played back' to order. Below the directory of files there's a feature enabling the user to select the register to which the voice files/control files are to be assigned. There are five registers, A to D, which correspond to different allocations of the six octaves available on the keyboard. However, until the number of output channels allocated to register A has been reduced from its default value of eight, by using Page 3 to allocate the 'Nphony', no other registers other than A can exist. The number displayed in 'free space' indicates how many of the 128-byte sectors of the disc remain unused and therefore available for the construction of files.

Page 3 (Keyboard Control) enables the operator to sort out the allocation of output channels to various sections of the keyboard as well as 'mapping' the keyboard for us in real-time playing and with sequence files. By allocating a voice to more than one channel, one is setting the 'Nphony' or degree of polyphony for a particular voice. The way the voices are assigned to the keyboard is determined by the keyboard map at the bottom of Page 3 (see Figure 5). The array of keyboard maps represent eight six-octave keyboard channels, and each octave in the map is occupied by a letter, A-H, which identifies the register (and therefore the voice) activated by playing the keyboard within that octave. The main keyboard is represented by keyboard map 1 whilst the slave keyboard is allocated the second. Keyboard maps 3-8 are used only by the sequencer or by the music composition language, both of which allow the creation of sequence files that can 'play' any of the eight keyboard channels. Looking at the first map, you can see that the first voice, 'Piztwang', occupying register A, is allocated to five octaves of the keyboard, and the second voice, 'Saxy', is allocated to the top octave.

Figure 5. Page 3 Keyboard Control.

'Octav', 'S/T' and 'Fine' are tuning offsets: 'Octav' sets the starting octave of a register in relation to the music keyboard, with a total range of nine octaves available from the CMI; 'S/T' and 'Fine' provide coarse and fine pitch adjustments to the registers with which they're associated. These extra tuning adjustments give the same effect to the sound as slight detuning of oscillators in a conventional analogue system and supposedly make the sound 'more natural', where naturalness, at least in human terms, is equated with something less than the perfection offered by the computer. There's nothing like being second best! In addition, there's a 'scale' function which enables the user to select the tuning of the keyboard. The default values of 12th root of 2.00 (simply a mathematical expression to determine pitch increments within the octave and between octaves) gives the standard Western tuning, i.e., equal division of the octave into twelve semitones. Applying an alternative expression of 24th root of 2.00 gives a quarter-tone scale.

Leaving aside a few pages (for reasons that will become apparent soon), we come to Page 7 (Control Parameters). This page really adds the finishing gloss to the output of the CMI, by way of specifying control options like attack and decay speeds, vibrato speed and depth, overall level, and a low-pass tracking filter for final tone adjustment.

The key velocity data calculated by the 6800 processor in the keyboard can be used to regulate attack time and the overall sound level. There's also a constant time facility which makes glissando and portamenti work according to a calculation of the distance over which the notes have to travel, which means that the notes in a chord all arrive simultaneously rather than travelling in step with one another. This is a splendid feature and comforting to those of us that have struggled with recalcitrant ribbon controllers on a Poly-Moog or CS80 trying to get slides to work musically!

A further control option is the 'slur' function which does precisely what it says and adds legato by preventing the reattack of notes until the hands have left the keyboard.

Stepping through to Page L (Disc Library), this gives direct access to the disc file directory from the 16-key keypad on the music keyboard which provides one-finger commands for the loading of voice and instrument files. These display pages take care of the relatively non-creative side of the CMI; the rest are all involved in the primary function of the CMI, the actual synthesis of sound.

CMI Creativity

There are four areas of the CMI concerned with creating music: firstly, a variety of techniques are provided for the synthesis of waveforms; secondly, there's the ability to sample real sounds and recreate them with the addition of new pitch data entered from the music keyboard; thirdly, eight individual parts can be 'recorded' as sequences and then 'played back'; fourthly, advanced software enables the use of a music composition language rather than the music keyboard for input of music data.

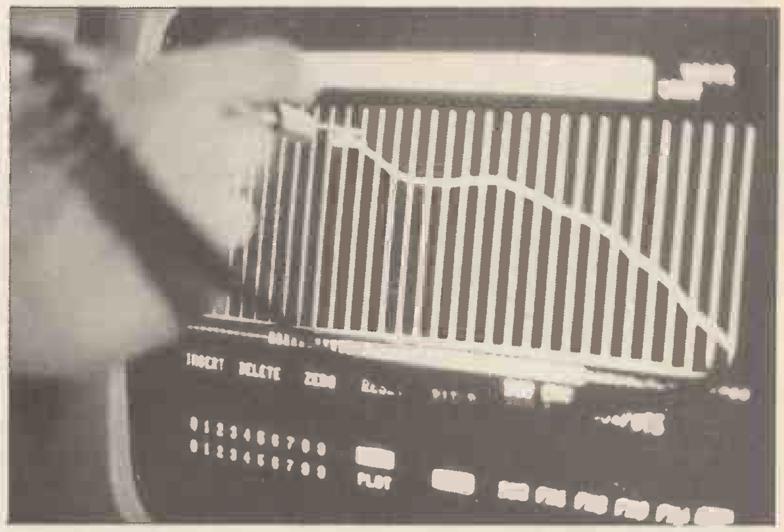


Figure 6. Page 4 Time Profiles.

Page 4 (Time Profiles) provides the real clue to the remarkable ability that the CMI has in creating complex waveforms, with an internal animation or micropolyphony that is achieved, not by frequency modulation or filter sweeping, but instead by actually describing an individual amplitude envelope for every harmonic. If we start by looking at the photograph of Page 4 (Figure 6), you'll see that the display is divided by vertical lines; these represent thirty-two waveform segments that can be varied in duration.

There are three types of information necessary to construct a waveform for loading into a voice file: firstly, the harmonic profile is drawn, where each harmonic from the fundamental to the 32nd is plotted separately on the screen using the light pen and thereby builds-up a waveform memory for each of the thirty-two segments; secondly, an energy profile is drawn, where the overall change in amplitude is plotted over the thirty-two segment cycle and forms the amplitude ramping data; thirdly, a duration profile is constructed in the same way, but this time the amplitude plotted for each segment determines the duration of each segment with a minimum duration of one cycle of the segmental waveform. The display actually only shows up to eight harmonics simultaneously as any more would be extremely messy and time-consuming for the computer, but even this number is daunting enough to decipher in monochrome; colour would be a valuable feature here. So far, so good, but all we've done is to draw a picture of a sound. If we then hit the 'Compute' command with the light pen, the system then computes the dynamic waveform and amplitude variations which will then characterise the voice. The point of all these manipulations is to get a sound where the harmonics are varying dynamically over part or all the time that a key is depressed, a far remove from the static sound that you get with harmonic drawbars on an organ.

It's obviously no easy thing to construct meaningful waveforms, and there's a terrific temptation to put everything bar the kitchen sink into the waveform memory first time round. What you quickly realize, though, is that the most interesting and/or useful sounds are derived from simple additive synthesis using, say, harmonics 1, 4 and 10 only. A glance through the series of papers by Moorer *et al.* (1977 onwards) in the Computer Music Journal, entitled 'Lexicon of Analysed Tones', really reveals the importance of the dynamic fluctuation of harmonics in the 500 to 2,000 Hz band in determining the quality of sound to human ears. The CMI enables you to take account of this in a way that no other system approaches at the present time. As the only limitation on its basic sound quality that I've heard is a slight tendency for hiss to build-up as notes die away, I'd presume that harmonic data entered from the 'Lexicon' would produce a perfectly identifiable trumpet, violin, or whatever; it would be interesting to test this out, though I wouldn't like to hazard a valued judgement on such an exercise! However, the sound of the CMI cannot be perfectly 'natural', for, unlike the average acoustic instrument, the same waveform memory is accessed regardless of pitch. Now, using the same waveform throughout the range of a synthetic stringed instrument doesn't seem to impair drastically the authenticity of the sound in comparison with the real thing, but, with wind and brass instruments, an accurate synthesis of all pitches would require extremely complex waveform variations to take account of the way in which the harmonic array changes according to the register of the instrument. Quite honestly, though, the capacity to program or predict different harmonic profiles according to different registers can get somewhat academic, but some variation, perhaps implemented by a linear prediction algorithm to vary the amplitude of key harmonic components over a particular range, could be useful. This variation of sound from one register to another is an important psychological factor in the perception of music and intuitively used by composers when scoring with the dark and forboding chalumeau register of the clarinet or the warm and velvety first half-octave of the flute. But, as well as timbral variation, it's also important with many instruments that the bottom register makes itself felt with more of a vengeance by virtue of greater sustaining power. The CMI doesn't seem to offer this as an option and I find that curious. There are a few more functions to consider in association with Page 4: firstly, a 'loop' facility which enables the operator to select a group from one to thirty-two adjacent waveform segments that are then repeated *ad infinitum* during the voice generation as long as a key is depressed; secondly, recent software has added a three dimensional waveform plot (Page D) that shows the beginning of the waveform at the bottom of the screen (see Figure 7) and the temporal transformation of harmonic levels as the waveform plot moves 'into' the screen. Page 5 (Waveform Generation) provides an additional method of manipulating harmonic information. Thirty-two special graphic controls (equivalent to analogue faders) displayed across the screen provide amplitude control of the thirty-two harmonics. The light pen or alphanumeric keyboard is used to manipulate the graphic sliders for each of the thirty-two segments making up the waveform (as on Page 4). This is obviously a very accurate way of constructing waveforms but rather time-consuming and more suited to synthesis in the calm atmosphere of an electronic music studio than for the average over-worked musician struggling to meet deadlines.

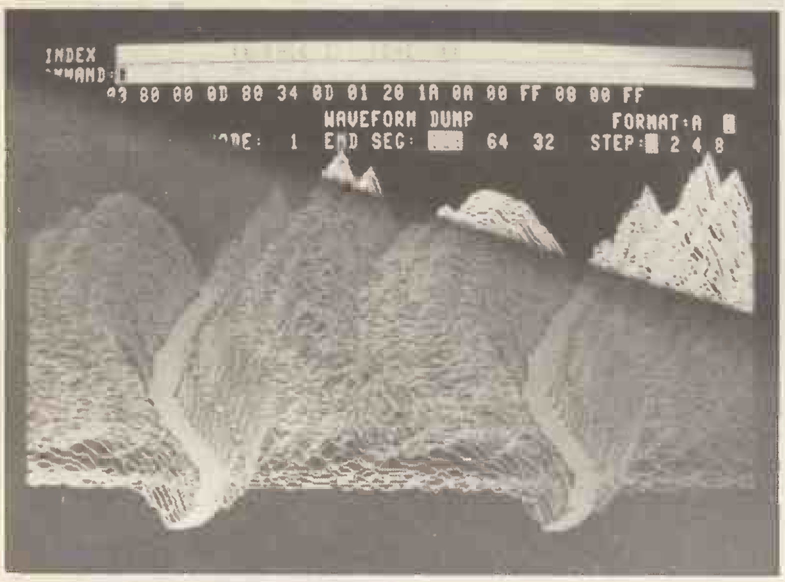


Figure 7. Page D 3-Dimensional waveform plot.

The next technique for waveform construction is to be found on Page 6 (Waveform Drawing). The ability to input waveforms directly into waveform memory by drawing waveshapes on the screen with the light pen must constitute the CMI's most remarkable feature. Selecting the 'Plot' function allows every twist and turn of the light pen to be entered; with 'Join' selected instead, it's possible to draw the waveshape as a series of dots (and therefore very quickly) with the computer filling in the gaps with straight lines. The reason why this facility is so clever is because it enables the operator to construct waveforms that change more or less dramatically from one harmonic complement to another. If one wanted, say, a triangle wave that turned into a square wave, then, using the previous harmonic profile technique, it would be necessary to work out all the harmonics of both the triangle and square waves as well as trying to fathom out what comes in between. It's obviously much easier just to draw the waveshapes and leave the CMI to do the rest. Furthermore, each different waveshape can be assigned to particular groups of the thirty-two segments, and, if a sudden jump between waveforms is not required, then a 'Merge' function can be selected which will calculate intermediate waveforms and interpolate them between those just drawn. There's also the facility to select a group of segments and reverse their order with respect to the rest of the cycle, thereby producing various permutations of 'backward' sounds.

The next creative area is provided by Page 8 (Sound Analysis). This is the facility that has attracted most attention from the media and rock musicians and some almost unbelievable sounds can be heard on our demonstration cassette No. 2. The sampling operation of an external audio source involves an A/D conversion with variable sampling rate and the direct loading of a particular 16K waveform memory. The sampling rate can be varied between 2 and 30 KHz and a compromise has to be made between the required bandwidth of the sample (approx. 0.5 × sample rate in KHz) and the required duration of the waveform sample (approx. 16.4 ÷ sample rate). In practice, the sampling procedure requires a considerable amount of skill in choosing the right sampling rate together with the best combination of digital filters (high-pass to remove signals below the fundamental pitch of the input signal, low-pass to remove upper harmonics that may lead to aliasing with the sample frequency).

It's also important to check that the sample isn't clipped during the A/D conversion, and a level control plus an amplitude plot of the signal enables this to be controlled. The real trick to successful sampling is to get exactly one cycle of the waveform into the memory, and this in turn requires an accurate knowledge of the pitch of the digitised signal (if it has one) and a very good interpolation routine for knitting the cycles together. Once this has been done, the stored waveform can then be used as an ordinary voice file and played via the keyboard. However, as there's no harmonic analysis program in the CMI, it's not possible to do anything else to the waveform other than change pitch and apply simple control parameters from Page 7. Analysis and alteration of the sampled waveform would offer great potential for musique concrête techniques, but, as it stands, I think it's a facility likely to remain a source of choirs of cats or chords of kisses (I kid you not) at worst and a rather exotic Mellotron at best.

Moving to Page 9 (Sequencer), we come to another really excellent CMI feature. The sequencer allows up to thirty minutes of data from a real-time keyboard performance to be recorded as a sequence file on the user disc, which can then be replayed to reproduce the original performance. If the original keyboard information is octophonic then this will be assigned to the eight keyboard channels as represented in the keyboard maps on Page 3.

At the other extreme, eight monophonic 'tracks' can be stored on disc and then 'merged' together creating an octophonic output with different voices resulting from eight separate lines of real-time keyboard playing. A click track is provided and an external sync input to the CMI allows the sequencer to be synchronised from an external audio tone so as to facilitate the overlaying of sequences with a multitrack tape recorder.

Finally, we arrive at Page C (Composer). The Fairlight Music Composition Language (MCL) provides a means of inputting musical data from the alpha-numeric keyboard, storing the data on disc as sequence files, and replaying them via chosen keyboard channels.

To simplify data entry much use is made of defaults, and includes pre-specified values for beat units, gaps between notes, keyboard octave, transposition, key velocity and key selection. Notes are specified by the following parameters: pitch (note name with accidental prefix if necessary); velocity (key velocity specified for use in conjunction with Page 7); time (note duration up to the start of the next note and expressed as an integer or fraction of the beat unit); gap (time between the key release and start of the next note). Repeats are also enterable to minimise keyboard entries. Recent software allows Page 7 control parameters to be added as part of a sequence file plus the entry of visual cues in a part to assist the operator in building up a score.

Each piece produced from the MCL may consist of up to eight parts, and each part may access up to thirty-two different sequence files holding 1 to 2000 notes. Getting to grips with the MCL takes time and a spot judgement would be premature. Whilst it offers great flexibility in use, and is certainly a significant evolution in terms of music languages, I'm not convinced that the way of visually presenting the inputted data is as efficient as the input process itself. The problem lies in visualising relationships between notes, something that's easy and natural to stave-reared musicians but frustratingly difficult with the MCL. I think most composers would have real problems building-up a complex score with the MCL unless they first wrote out the music in conventional notation and then translated it to MCL, and that seems a waste of time. There's a touch of arrogance in Fairlight's assertion that 'such techniques (more or less conventional music notation) are not as practical as they are visually appealing' and they should watch out for a backlash from those composers that are quite satisfied with a traditional 'music composition language'.

Conclusions

All in all, the Fairlight CMI is a remarkable system, and, even though £15,000 is no small sum, the price reflects very fairly the capabilities of the CMI. So far, about sixty systems have been sold around the world, of which fifteen appear to be in the UK. Most of them are in commercial recording studios which seems the wrong place for an instrument that is a complete composition, production and recording system in its own right. It's also arguable that rock music is not the area of music most likely to benefit from the facilities offered by the CMI, as the instrument is worthy of far more than being a glorified bank of presets and demands patience and time to get the best out of it. As a state-of-the-art commercial digital synthesis system, the CMI is likely to remain a reference point for some time to come. Fairlight Instruments are committed to basing future software development on the demands of users, but I fear that changes may reflect its application in commercial music rather than the more truly creative use of it in the much wider spectrum of contemporary music in general. I hope I'm proved wrong.

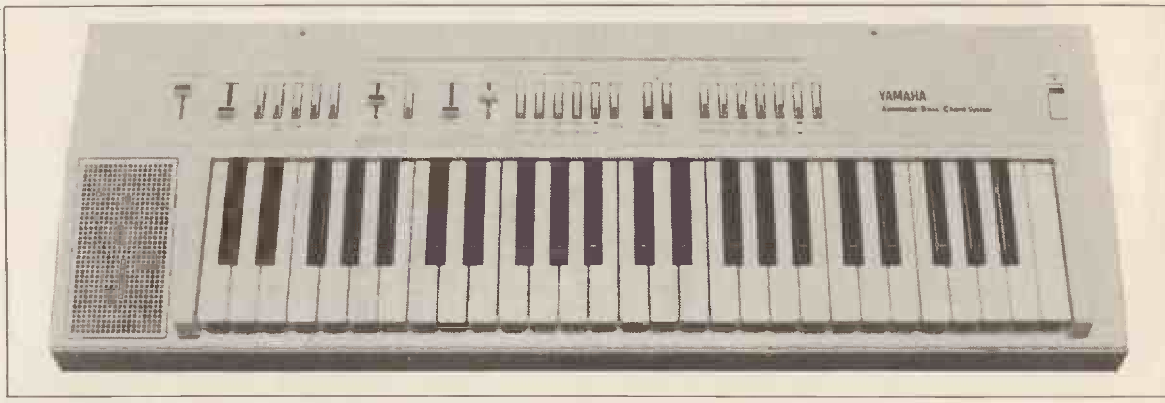
Written by Dr David Ellis.
Based on Mike Beecher's interview with Peter Vogel.

RECORDED ON CASSETTE NO. 2

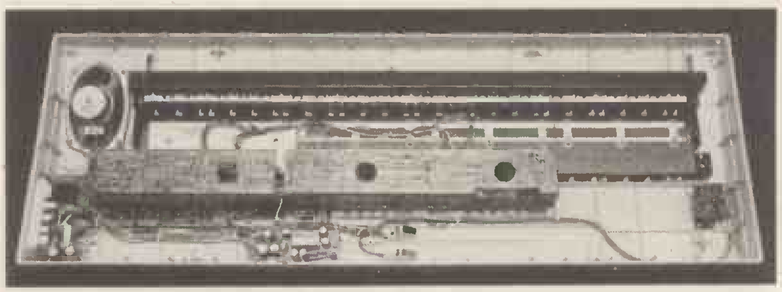
E&MM

INSTRUMENT REVIEW

The Yamaha PS20 Portable Keyboard



Yamaha PS20



Internal view of the PS20

The PS20 and the smaller PS10 are, literally, Yamaha's great white hopes for the future. The PS range employs the PASS system of voice production to achieve its range of sounds at a very reasonable price.

Whilst on the subject of money matters, the PS20 will be available in the shops at below £299.00, and the PS10 under £199.00.

Getting back to the PS20 itself, the casework is pretty stunning: it is made out of vacuum-formed high-impact 'whitish' plastic and looks very modern. The big selling point that Yamaha are trying to ram home is that it is a go-anywhere keyboard, and I have to admit that that is exactly the case.

The instrument has a '3-way power system'. This is a clever bit of design, enabling the PS20 to be run off the mains, a set of batteries, or a 12-volt car battery. This is achieved by using different power packs that fit snuggly into a recess on the underside of the instrument. Each power pack has the same terminals that plug into the main body of the machine, but with different input facilities. One pack contains transformer and regulating circuitry, and with a cable running to the mains. A second houses a set of six 1½-volt batteries, whilst a third system plugs into the car cigarette lighter socket and transforms the dirty 12-volt supply into a clean 9-volt one.

The keyboard that Yamaha use is built in one of their own factories in Hamamatsu, Japan. It has a particularly nice feel to it and there is absolutely no mechanical contact noise to be heard: the key mechanisms are also well-protected against dust, etc. As with most instruments these days, the keyboards are based on the key of C, i.e. the keyboard covers 4 octaves (49 notes), from C to C. Several instruments use 3½-octave keyboards, but these normally go from F up to C. It is very seldom that you come across and F to F instrument.

The PS20 uses an interesting new control switch mechanism. It could be considered to be a cross between a push button latching and a rocker switch with a bit of tablet thrown in for good measure. These switches, which make up 85% of the control mediums, are long thin plastic wedges sprung at one end, and they latch when pressed. This latching is cancelled by pressing another switch from the same bank. At the tip of each switch is a coloured inset which enables the switches to be coded.

The controls are split up into various sections, so, working from left to right on the photograph, the first bank is marked 'Orchestra'. These switches provide the basic voicings for the instrument. The PS20 will play up to ten notes simultaneously and independently (i.e. no shared envelopes, etc.). However, if the Automatics (bass and/or chords) are being used, then less notes are available. For example, during ABC (Automatic Bass Chords) playing, which we shall come to forthwith, the bass takes one note, the chords four, the arpeggiator one, leaving just four for the melody orchestral voices.

Yamaha have put two voices on each switch, so, if that switch is down, one of two voicings may sound: as to which depends on a master up/down switch. This, to my mind, is messy, and makes quick changes awkward. I would have far sooner seen a separate switch for each voicing, and put up with the extra couple of pounds it would have cost.

The actual timbre and character of the individual sounds wasn't, I felt, all it should have been. Yamaha claim that they can produce a perfect sound with this PASS system — if some of these sounds are perfect representations of the orchestral instruments after which they are labelled, then either I, or they, need our ears examining.

What this system has done, in the case of the PS20, is to enable what are pretty ordinary instrument voicings to be made available on a very low-cost instrument. The PS20 is an economic breakthrough, not an aural one.

Perhaps I should inform you of the

The voicings available are: Organ 1 — a basic pipe organ sound; Organ 2 — quite good, with a percussive bite to the attack; Trumpet — fair, but, in my opinion, not round and full-bodied enough; Strings — some funny harmonics are present in the lower octaves, otherwise a bit flat; Clarinet — traditionally a square wave, but, in this case, there seemed to be some overtones present that weren't quite right; Oboe — good, nice and reedy; Piano — probably the best of the presets, and better than most electronic simulations; Harpsichord — poor; Accordion — slightly too rich in harmonics; and Vibraphone — a nice warm sound with a slow modulation. Overall, the presets are good, especially when bearing in mind the price.

The rhythm unit employs a similar means of selection, two patterns per switch with a master. The rhythms Yamaha have incorporated include March, Disco, Waltz, Rock, Tango, Swing, Rhumba and Samba. A nice feature about this section is the 8-bar Variation facility, which introduces a fill every eighth bar. There is also Synchro Start, which is activated by any of the bottom 19 notes of the keyboard. The patterns themselves are well arranged; however, some of the percussion voicings, in particular the snare and bass drums, are a bit dubious.

The Arpeggiator has two possible variations on a theme, the theme being either the chord fingered on the lower section of the keyboard, or the automatically generated chord produced by Yamaha's single chord generator. And the variation is either a rising and falling arpeggio, or just a rising one.

Finally, we come to the ABC section, which, in fact, is similar to the automatic section of most present-day home organs. It consists of an automatic chord generator, which can produce a major chord from any of the notes played on the lower section of the keyboard. Yamaha have developed a tidy system for selecting minor and seventh chords of this root note. The minor is obtained by pressing any white note below this root. How do you get a minor seventh? No prizes for working that one out. All the other favourites are there: Fingered Rhythmic Chord, Memory, Multi Bass (a different bass pattern), and they all go to make the PS20 a versatile, all-in-one instrument.

Of course, to be a portable, go-anywhere keyboard, the PS20 has to have its own amp and speaker, and it has. You can see from the internal shot, that the speaker (elliptical 4" x 2½") isn't going to fill the Albert Hall, but, for domestic use, the sound it produces is quite adequate, and surprisingly full. There are also line outputs (phono plugs!) and a headphone output (jack) on the side of the instrument.

Internally, as you would expect from a Japanese company, construction is excellent. The keyboard switches and diodes are mounted on SRBP circuit boards, whilst all the major circuitry is on glass boards. The switches are directly mounted to the boards, and, overall, an impression of quality and ruggedness pervades. None of the chips are socketed, but, since most of them are Yamaha custom jobs, replacing them is going to be a service department job, should the instrument fail. The PASS technology makes modifications to the instrument a tricky and very limited possibility; however, there is plenty of room inside the case of the PS20 if it was felt that signal modifiers (e.g. graphic eq) were warranted and these could be installed into the body of the instrument with room to spare.

The PS20 is a very nice instrument. Some of the sounds are a bit dodgy, but, at the price, you can't grumble. I think that this is only the first in a long line of new products from Yamaha that are designed to shift the musical instrument market towards that of consumer electronics, and, along with Casio, whose new Casiotone CT-401 is making a bid for the same market, I think that electronic keyboard instruments are going to become increasingly cheaper and accessible.

Dave Crombie **E&MM**

WILMSLOW AUDIO
The firm for Speakers

EVERYTHING IN STOCK FOR THE SPEAKER CONSTRUCTOR! BAF, LONG FIBRE WOOL, FOAM, CROSSOVERS, FELT PANELS, COMPONENTS, SPEAKER STANDS & BRACKETS ETC., LARGE SELECTION OF GRILLE FABRICS (send 22p in stamps for fabric samples).

HI-FI DRIVE UNITS

AUDAX HD12.9D25	£8.75
AUDAX HD11P25EBC	£7.50
AUDAX HD20B25H4	£14.95
AUDAX HD13D34H	£12.95
AUDAX HD24S45C	£21.95
AUDAX WFR15S	£23.95
CHARTWELL CEA205 pair	£61.25
COLES 4001	£7.65
COLES 3000	£7.65
COLES 3100	£7.95
COLES CE2000 6½"	£14.95
CELESTION HF1300 II	£12.50
CELESTION HF2000	£12.50
DALESFORD D10 tweeter	£8.45
DALESFORD D10 ferrofluid	£8.95
DALESFORD D30/110	£11.25
DALESFORD D50/153	£12.25
DALESFORD D50/200	£12.25
DALESFORD D100/250	£29.95
DALESFORD D300	£35.75
DECCA London Horn	£79.95
ELAC 6NC204 6½"	£7.50
ELAC 8NC298 8"	£8.95
EMI type 350, 13" x 8", 4 ohm	£9.45
EMI 14A/770, 14" x 9", 8 ohm	£19.50
ISOPHON KK8/8	£8.15
ISOPHON KK10/8	£8.45
JORDAN WATTS Module	£24.95
JORDAN WATTS Module Mk III	£28.50
JORDAN WATTS HF kit	£10.50
JORDAN 50mm unit	£33.50
JORDAN crossover pair	£34.00
KEF T27	£9.45
KEF B110	£12.25
KEF B200	£13.50
KEF 8139	£27.75
KEF DN12	£9.40
KEF DN13	£6.75
LOWTHER PM6	£63.00
LOWTHER PM6 Mk I	£67.75
LOWTHER PM7	£99.00
PEERLESS KO10DT	£10.95
PEERLESS DT10HFC	£10.50
PEERLESS KO40MRF	£13.60
RICHARD ALLAN CG8T	£13.50
RICHARD ALLAN CG12T Super	£29.50
RICHARD ALLAN HP8B	£20.75
RICHARD ALLAN LP8B	£14.50
RICHARD ALLAN HP12B	£33.50
RICHARD ALLAN DT20	£9.95
RICHARD ALLAN DT30	£10.75
SEAS H107	£9.95
SEAS H211 ferrofluid	£10.95
SHACKMAN ES units pair	£136.00
SHACKMAN ES units with cabs. pair	£170

PA GROUP & DISCO UNITS

CELESTION G12/50TC	£19.50
CELESTION G12/80CE	£24.50
CELESTION G12/80TC	£23.75
CELESTION G12/125CE	£42.00
CELESTION G15/100CE	£37.95
CELESTION G15/100TC	£38.50
CELESTION G18/200	£64.75
CELESTION POWERCEL 12/150	£66.00
CELESTION POWERCEL 15/250	£88.00
FANE CLASSIC 45 12"	£13.95
FANE CLASSIC 55 12"	£15.50
FANE CLASSIC 80 12"	£19.75
FANE CLASSIC 85 15"	£26.00
FANE CLASSIC 150 15"	£37.95
FANE CLASSIC 125 18"	£43.95
FANE CLASSIC 175 18"	£47.95
FANE GUITAR 80L 12"	£26.25
FANE GUITAR 80B/2 12"	£27.25
FANE DISCO 100 12"	£28.75
FANE PA85 12"	£26.75
FANE BASS 100 15"	£39.00
FANE CRESCENDO 12E 12"	£57.50
FANE CRESCENDO 15E 15"	£74.50
FANE CRESCENDO 18E 18"	£94.75
FANE COLOSSUS 15E 15"	£99.95
FANE COLOSSUS 18E 18"	£107.00
FANE J44	£6.90
FANE J73	£10.90
FANE J104	£15.95
FANE J105	£23.95
GAUSS 3181A 10" 150 watts	£115.00
GAUSS 4281 12" 300 watts	£146.00
GAUSS 4581 15" 300 watts	£162.00
GAUSS 4583A 15" 400 watts	£162.00
GAUSS 4882 18" 400 watts	£220.00
GOODMANS 8PA	£5.05
GOODMANS PP12	£22.50
GOODMANS DI12	£25.50
GOODMANS GR12	£24.95
GOODMANS 18P	£48.45
GOODMANS HIFAX 50HX	£21.85
GOODMANS HIFAX 100HX	£24.50
McKENZIE C12100GP	£24.45
McKENZIE C12100TC	£24.45
McKENZIE C12100 BASS	£24.45
McKENZIE C12125GP	£39.95
McKENZIE C12125TC	£39.95
McKENZIE GP15	£35.10
McKENZIE TC15	£35.10
McKENZIE C15 BASS	£59.60
MOTOROLA PIEZO HORN 3½"	£8.50
MOTOROLA PIEZO HORN 2" x 6"	£12.25
RICHARD ALLAN HD8T	£20.25
RICHARD ALLAN HD10T	£21.75
RICHARD ALLAN HD12T	£29.75
RICHARD ALLAN HD15	£52.75
RICHARD ALLAN HD15P	£52.75
RICHARD ALLAN ATLAS 15"	£77.00
RICHARD ALLAN ATLAS 18"	£96.00

WILMSLOW AUDIO

KITS FOR MAGAZINE DESIGNS etc.

Kits include drive units, crossovers, BAF/long fibre wool etc. for a pair of speakers

Carriage £3.95 unless otherwise stated

Practical Hi-Fi & Audio PRO9-TL including felt panels and level controls	£152.75 carriage £5.00
Hi-Fi Answers Monitor	£146.00
Hi-Fi News State of the Art	£189.00
Hi-Fi News Midiline	£99.75
Hi-Fi News Miniline	£49.00
Hi-Fi News Tabor with J4 bass units	£66.00
Hi-Fi News Tabor with H4 bass units	£70.00
Hi-Fi for Pleasure Compact Monitor	£116.00
Hi-Fi for Pleasure E.C.M. including felt panels, foam etc.	£77.50 carriage £5.00
Popular Hi-Fi Jordan System 1	£125.00
Popular Hi-Fi Mini Monitor	£77.00
Popular Hi-Fi Round Sound including complete cabinet kit	£74.00
Practical Hi-Fi & Audio BSC3	£65.00
Practical Hi-Fi & Audio Monitor	£180.00
Practical Hi-Fi & Audio Triangle	£120.00
Practical Hi-Fi & Audio DBS4	£85.00 carriage £5.00
Everyday Electronics EE20	£29.50
Everyday Electronics EE70	£150.00 carriage £5.00
Wireless World T.L. KEF	£125.00
Wireless World T.L. RADFORD	£190.00

Building speakers is easy with the new WILMSLOW AUDIO FLAT PACK CABINET KITS!

SPEAKER KITS

SPEAKER KITS Prices Per Pair Carriage £3.95 unless otherwise stated

COLES NIMBUS KIT mounted on baffle	£69.00
DALESFORD SYSTEM 1	£54.00
DALESFORD SYSTEM 2	£57.00
DALESFORD SYSTEM 3	£104.00
DALESFORD SYSTEM 4	£110.00
DALESFORD SYSTEM 5	£142.00
DALESFORD SYSTEM 6	£95.00
DALESFORD 'D' KIT including cabinet	£79.95
KEF Reference 104aB kit	£133.00 plus £5 carriage
KEF Cantata kit	£199.00 plus £5 carriage
LS3 Micro Monitor kit	£76.00
LOWTHER PM6 kit	£132.75
LOWTHER PM6 MK I kit	£139.95
LOWTHER PM7 kit	£199.00
RADFORD Studio 90	£181.00
RADFORD Monitor 180	£243.00
RADFORD Studio 270	£309.00
RADFORD Studio 360	£450.00
RICHARD ALLAN Tango Twin	£55.50
RICHARD ALLAN Maramba	£77.50
RICHARD ALLAN Charisma	£111.00
RICHARD ALLAN Super Triple	£102.50
RICHARD ALLAN Super Saraband II	£159.95
RICHARD ALLAN RA8 kit	£62.75
RICHARD ALLAN RA82 kit	£98.75
RICHARD ALLAN RA82L kit	£108.00
SEAS 223	£42.50
SEAS 253	£67.00
SEAS 403	£79.95
SEAS 603	£134.95
WHARFEDALE DENTON XP2 kit	£31.45
WHARFEDALE SHELTON XP2 kit	£40.40
WHARFEDALE LINTON XP2 kit	£56.20
WHARFEDALE L60 kit	£52.50
WHARFEDALE L80 kit	£72.00
WHARFEDALE L100 kit	£87.00
WHARFEDALE E50 kit	£129.00
WHARFEDALE E70 kit	£160.00
WHARFEDALE E90 kit	£249.50

WILMSLOW AUDIO BA1 sub bass amplifier/crossover kit ..... £37.95 plus £1 carriage

CARRIAGE & INSURANCE

Tweeters/Crossovers	70p each
Speakers:	
4" to 6½"	90p each
8" to 10"	£1.10 each
12", 13" x 8", 14" x 9"	£2.00 each
15"	£3.00 each
18"	£5.00 each
Speaker Kits	£3.95 pair
Mag. Design Kits	£3.95 pair

unless otherwise stated

ALL PRICES INCLUDE VAT AT 15% AND ARE CORRECT AT 12/4/81

SEND 50P FOR 56-PAGE CATALOGUE 'CHOOSING A SPEAKER' (or price list only free of charge) Export catalogue £1 or $3 U.S.

Tel: 0625-529599 for speaker drive units, kits, PA equipment, mail order enquiries, and all export enquiries.
Tel: 0625-526213 for Hi-Fi equipment and complete speaker enquiries.

Lightning service on telephoned credit card orders!

SWIFT OF WILMSLOW
The firm for Hi-Fi
5 Swan Street,
Wilmslow, Cheshire.

WILMSLOW AUDIO
The firm for Speakers
35/39 Church Street,
Wilmslow, Cheshire.

Line Inputs

After amplifying and buffering our tape and disc sources, the next task is routing, mixing crossfading and balancing the music sources. This Zenlike task is as much the heart of a DJ's individuality as the speed and stress of his repartee. There can be no dogmatic rules here. Casual rock DJ's á la Radio Caroline turn off one turntable, read out the biography of the band, take a bite out of a sandwich and then proceed with the show. Heavy metal DJ's crossfade relentlessly and with ever increasing gusto, whilst Soul and Disco-Funk operators double-beat, blend and seque.

Figure 1 depicts the *basic* layout of a typical UK broadcast console; although it appears similar to a mixing desk in that the level of each source can be set individually, this is a deceptive view, for instead of mixing all the signals, all we wish to do is to *butt* two of them together, with perhaps a little mixing at the moment of changeover. At the output of each input amplifier is a three-position switch: Post Office style lever switches are recommended here for their positive action.

Assume a record is playing on turntable one. S1 will be on and the signal will be routed to the audience via the sound system. If we're not using any taped material, then S3 and S4 will be in the mute position. Meanwhile, S2 will be in the cue position, and we'll be able to cue up the record on turntable two via the monitor 'phones.

Records can vary greatly in level — if the disc on turntable one is a twelve inch single and the record on two is an album, there may be 6-8dB difference in level. Instead of equalising the levels at the moment of changeover, we can set disc two at the appropriate level by switching the VU meter (or PPM) between the cue and live positions on S5 to compare the average levels of both discs. Channel two fader can then be adjusted to give a meter reading similar to the record in progress. Because of the need to equalise levels, especially in broadcast work, the normal position of the faders should be about three-quarters up to allow adjustment in both directions together with sufficient track below the knob to allow long, smooth fade-up and down strokes. The three-quarters position naturally causes a notional loss of level which is compensated for by adjusting the volume control at the output of the console. Disc two is now cued up and when disc one finishes, S2 is quickly flicked over to on whilst the channel one fader is swiftly pulled down. S1 is then moved to cue, and the cueing up process is repeated.

This is just one way of using this very flexible arrangement. Alternatively, disc two could be brought in on the channel fader whilst one is faded out — or any other combination of switch and fader controlled changeovers, including the use of monitor 'phones to detect the end of a soporific intro', swiftly jumping in on the lever switch when the music livens up. In general, switched changeovers give tight, broadcast style programming and are ideal when the music is for presentation

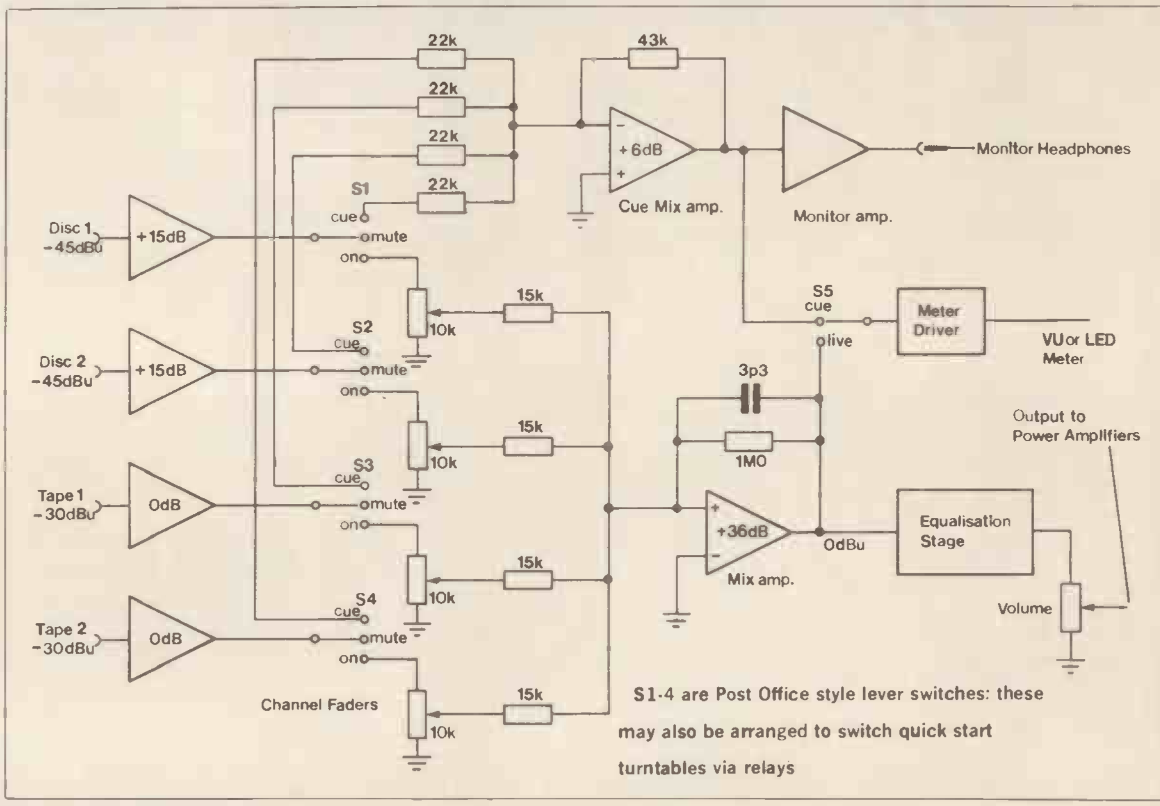


Figure 1. Basic UK broadcast console layout.

rather than participation.

Faded changeovers provide a range of smooth effects, characteristically *á la Disco* from the subtlety of the Soul session, where you *feel* the music change to the heavy Rock show, where you simply *hear* it change. Though versatile, the broadcast style disco console demands a lot of skill from the DJ.

Figure 2 shows an alternative arrangement, using a single fader, which commutes between disc (or tape) signal sources in a single stroke — hence a crossfader. S1 and S2 allow either the tape one or disc one input to follow music emanating from either of the number one inputs, and vice versa.

Although inherently simple to use, skill is still necessary to achieve useful results. As the fader traverses the centre position, the level falls abysmally, and it's normally necessary to ride the volume control, raising it at this point to give a smoother transition. Alternatively, this dead spot can be used to inject brief repartee, whilst for a hard driving Rock show, the fader moves so swiftly that the dip in level is inaudible.

Rapid transitions can also be achieved using switches, but however rapidly it's shunted across, the crossfader is always smoother and has the advantage that it can be operated by a single finger or an unemployed elbow whilst the hands are frantically occupied with other controls. The crossfader then is ideal for the Rock DJ, though it can be used by almost anyone (Simon Bates used one of mine quite happily!) and the results are purely a function of the DJ's skill, in the same way that a gifted photographer can capture evocative scenes with a very ordinary camera.

Although the broadcast arrangement (Figure 1) is best suited for Soul DJ's who frequently want to double beat, some may covet the crossfader

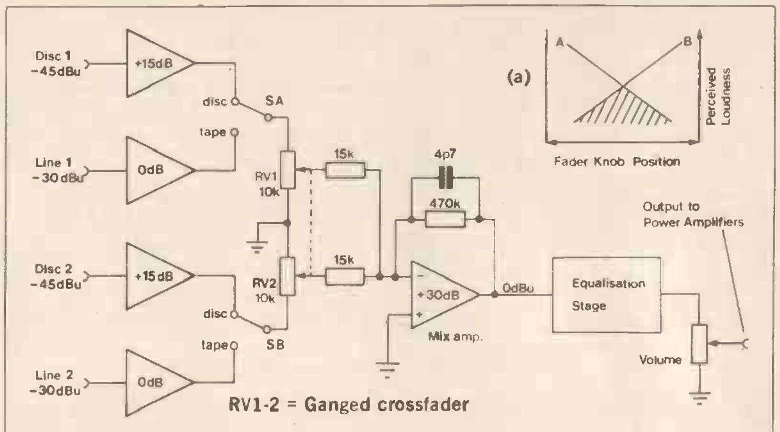


Figure 2. Standard crossfader.

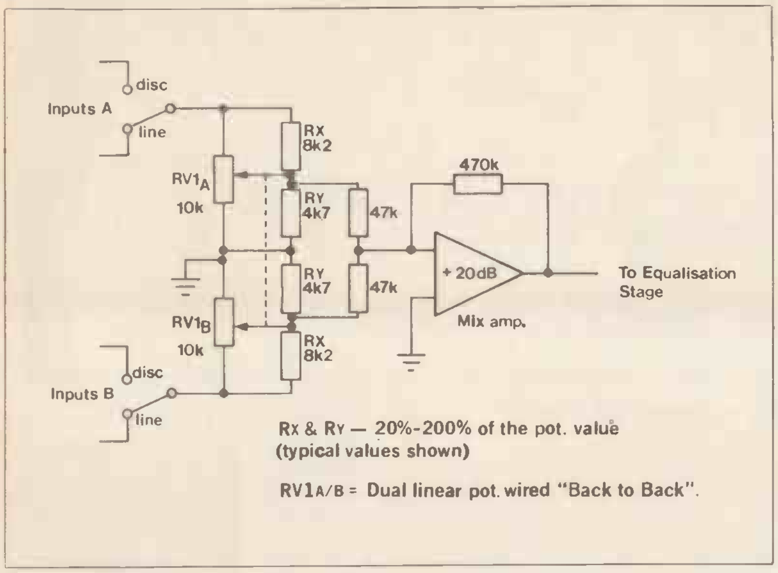


Figure 3. Crossfader with modified taper.

for its simplicity; though the 'hole in the middle' effect shown in Figure 2(a) appears to render it unsuitable. Figure 3, however, shows how the crossfader can be tweaked to remove the dip in level around the fader's central position using linear pots tweaking resistors RX and RY. Because the ideal crossfader response is a tenuous idea in the mind of a DJ, we cannot easily plot a graph of a desirable fader characteristic, so the values of RX and RY have to be determined by trial and error. As a guide, their values usually lie within 20 to 200 per cent of the fader value. Whilst this trick overcomes the limitation of the crossfader shown in Figure 2, it is less satisfactory from the viewpoint of equalising levels.

Like the broadcast arrangement, the crossfader shown in Figure 2 *can* be used to equalise the levels; reducing the level of disc one slightly will make two audible, but rarely to a significant degree. However, the crossfader shown in Figure 3 must be kept hard over otherwise events on the other turntable (such as cueing up) will be plainly audible to the audience. So it's necessary to anticipate major changes in level, using the metering or past experience, and deftly adjust the volume control immediately after crossfading.

Finally, on club consoles, it can be useful to have a foolproof method of crossfading. Figure 4 shows the elements of an automatic crossfader operated by flicking switch S1. Simultaneously, the appropriate turntable is started (via a relay and S1c). Once started, the turntables are locked on by latching the relays. Once the new disc is underway, the other turntable can be stopped by touching SA or SB which unlatch their respective relays. Note that SA (for example) only takes effect when S1 is set at 'fade to B', therefore if hit accidentally, they cannot abort a record in progress. RC networks known colloquially as 'snubbers' are wired across these switches and the relay contacts to attenuate switching clicks.

This arrangement allows the boss or another member of the club staff to stand in for a skilled DJ who's just phoned in to say that his car has been engulfed by a monster snowdrift on the M62. The crossfade speed can be preset for acolytes to produce a tolerable performance, albeit monotonous. The automatic crossfader is also a gift for the skilled DJ who wishes to concentrate on the audience and his own showmanship rather than subtle juxtapositions of musical texture.

Voiceover

The best music — whether Debussy, Mingus or Motorhead is an arcane and powerful language that transcends the ethos of rational thought, so it's not unnatural to feel anger welling when a (nameless!) radio DJ natters senselessly over a note that is trying hard to form a chord — a record you want very much to hear.

In a sense, certain radio DJ's have set a bad example, for whilst voiceovers *can* be used creatively (viz: rapping), they are certainly unwelcome if their content is out of sympathy with the music or the mood of the occasion. Mainstream Rock records are very definitely discrete entities, but soul and disco material is very amenable to sympathetic voices. It's even possible to make administrative announcements over laid back soul without disturbing the atmosphere at all — given a suitably accented voice.

The onset of acoustic feedback frequently limits the DJ's microphone gain setting to a level below or just above the ambient level of the music, yet for the minimum intelligibility, your vocals must be 10-15dB above the mean SPL of the music. The obvious solution is to attenuate the music whilst talking, by turning down the volume control. However, this requires considerable dexterity and sobriety if for any reason both hands are already occupied.

The classic alternative is the microphone activated autofader or 'ducking' circuit. Lamentably, this

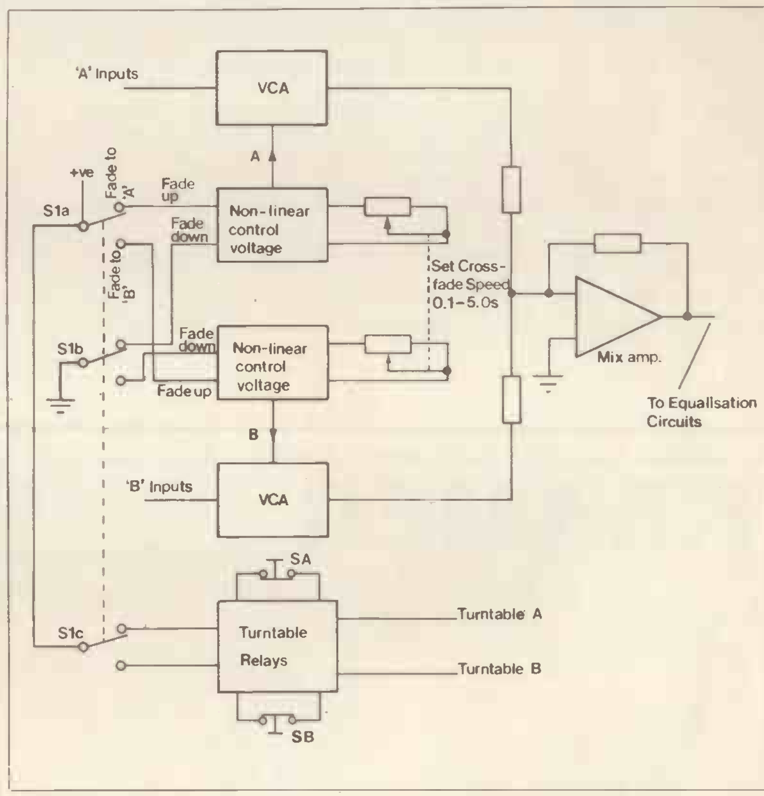


Figure 4. Automatic crossfader.

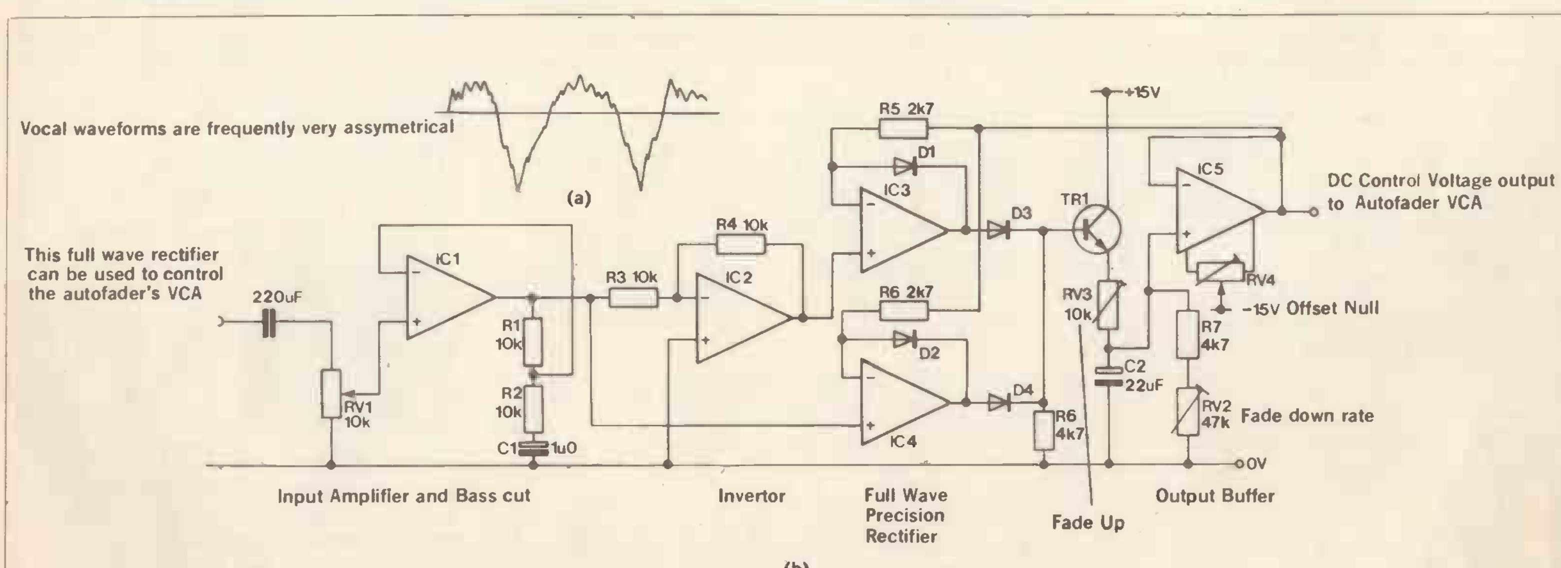


Figure 5. a) Sample speech waveform.
b) Full-wave rectification control circuit for autofader VCA.

gizmo owes its popularity more to a common desire to emulate radio DJ's than to any real expedience. Perhaps the best known aberration of the autofader is its predisposition to *pump* the music even whilst the circuit's sensitivity to the DJ's vocals is barely sufficient. The autofader works well in the broadcast studio because any monitoring is at low levels or on headphones. Once the music level approaches or exceeds the DJ's vocal level as *heard by the microphone*, the music attempts self-attenuation, once attenuated, it stops attenuating itself, the level rises and once again, it begins to act on itself — hence the pumping effect. Whilst close miking can help, there is no easy solution to this problem. Screaming into the microphone will also help the autofader to differentiate between your own voice and ambient Hazel O'Connor, but a raised voice is subtly different in character to a quiet one, and isn't necessarily sympathetic to your own performance or the music!

Another problem is the idiosyncrasies of DJ's vocal chords! An exciting voice full of character is really a voice full of distortion, and the result is a highly assymetrical waveform (Figure 5(a)); note the very large negative peaks. This assymetry is not a problem in itself, but the vast majority of autofaders derive their control voltage from only one-half of the microphone signal; usually the positive half. This being so, the sensitivity control will have to be set at

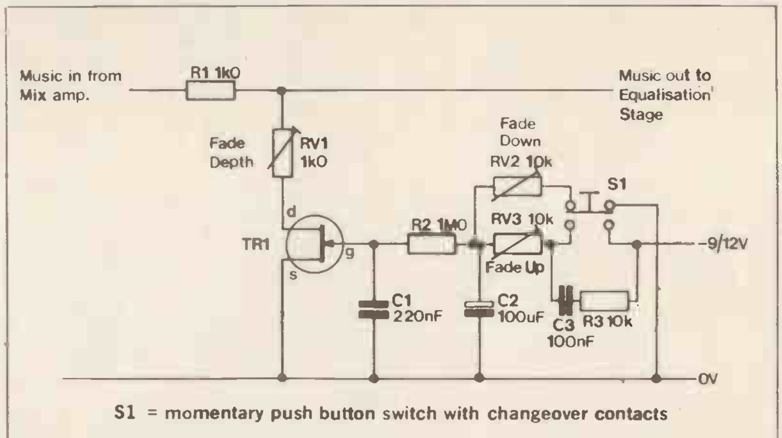


Figure 6. Switched 'ducking' circuit.

a much higher level than strictly necessary if the DJ has a voice with negative assymetry as in Figure 5(a). This aggravates pumping. If the DJ's voice produces large positive peaks, then the sensitivity control can be set at a low level, but if another DJ with negative assymetry uses the autofader, he will find it a little insensitive. The symmetry is also dependent on microphone phasing.

Figure 5(b) shows a full-wave rectifier circuit which alleviates the assymetry syndrome; the DC control voltage is derived from both the positive *and* negative peaks in the vocal waveform. Although the autofader *can* be used successfully if the music is quiet or your microphone is abnormally insulated from the ambient SPL, when Rock music is reproduced at its live levels of 105-125dB, one begins to appreciate that the autofader is passé.

An elegant alternative is the switched 'ducking' circuit (Figure 6). When S1 is in its normal position, the gate of TR1 is earthed and presents a high resistance across its drain-source terminals. Provided this impedance is much greater than R1, and the value of R1 is much less than the input impedance of the next stage, no attenuation will occur. When S1 is moved to fade, C2 charges via RV3 and a rising negative potential appears at the gate of TR1. The FET responds by lowering its source-drain resistance (ideally to a terminal value about one tenth of R1) and the music signal is progressively attenuated over a period of say half a second.

When the announcement finishes, S1 is returned to its normal position, C2 discharges via RV2, the negative voltage on the gate of TR1 returns slowly towards 0V and the music fades up. C1, C3 and R3 prevent switching glitches and other unwholesome noises.

Although the fade up-down characteristic is audibly non-linear, it is normally acceptable, and the circuit can be improved by using a ramp voltage carefully matched to the $V_{gs}/R_{DS\text{-}on}$ parameter of the FET in place of the simple CR network. The beauty of this circuit is that like the microphone activated autofader, it needs no hands to operate it — only a footswitch and a co-operative, well trained foot!

Alternatively, if panel mounted, the switch can easily be stabbed at by a spare elbow if your hands are fully occupied. Yet more adventurous, the switch can be placed on the microphone's body: This is ideal for possessive DJ's who like to clasp their microphones. With a little practice and ingenuity, the switched ducking circuit can possess all the attractions of the autofader without pumping and capricious sensitivity.

In Part 3 we will look at the art of fading and mixing signals. E&MM

HI-FI

Jeff Macaulay

This month a look at a simple home assembly speaker and the latest rash of noise reduction systems. First, the speakers. If you have £100 or so to spend on a speaker system you will have a reasonable amount of choice.

The best speakers in this price range are the mini speakers. If however your wallet will not stretch even that far, you will have problems obtaining anything approaching hi-fi.

One possible alternative is to build your own speakers. Unless you are a reasonable craftsman though your efforts might not be appreciated by the (female) members of your family. One way round this problem is to obtain a ready made cabinet in which to place your drive units. Unfortunately it is difficult, and usually expensive, to find what you want. Assuming that you have got this far, for good results a crossover unit specially designed for the speakers in hand must be obtained.

Now it is certainly true that there are a few complete speaker kits on the market that include the woodwork ready made, but not many. I had these problems myself recently when trying to produce a pair of high quality speakers with a total budget of £60.

After looking around I found a pair of drive units that sounded good together with a matching, ready built, 12dB/octave crossover, specially designed for use with the speakers. The next problem was the cabinets.

As I don't count woodworking as my greatest talent, I decided to see if I could find a suitable, ready built alternative. My luck was in, J. Bull of Haywards Heath (who advertise in this magazine) stock a very nice pair of cabinets. Coming complete with an attractive sculptured foam front to boot for only £6.90 a pair, plus £3 post and packing, the cabinets are ready cut for an 8 inch woofer and 4 inch tweeter. This was just what I required.

It took about an hour to complete the speaker system from scratch. Because all the parts were ready made, all I had to do was drill two 4BA clearance holes in the back baffle to take the crossover board and mark out the mounting holes for the drive units. The flying leads from the crossover are fitted with push-on terminations which fit the drive units. A roll of BAF wadding half a metre long was inserted into the cabinet and lastly the drive units were screwed into place with ½ inch, round-head, self-tapping screws. The resulting sound quality was a revelation for such an inexpensive pair of speakers and easily outperformed the £100 competition in my local Hi-Fi emporium.

The Do-It-yourself speaker kit.

Being curious, I measured the frequency response with a capacitor microphone out of doors and found it flat within 3dB between 60Hz and 20kHz. Power handling is some thirty watts continuous but plenty of SPL can be generated with a ten watt amplifier. These are 'fast' speakers, the transient response is extremely good. They will also transmit plenty of detail when the signal is of good quality. Interested readers can obtain the drive units from Bewbush Audio, 10, Sycamore Close, Langley Green, Crawley, Sussex.

A kit containing two woofers, dome tweeters, crossovers and wiring instructions for a pair of these speakers will set you back £40 plus £2 postage and packing. In total, including the BAF wadding and cabinets, a pair should cost about £55.

On to other matters. There seems to be a battle royal brewing on the noise reduction front. One of the thorns in the side of Japanese audio manufacturers is the fee they have to pay to Dolby for the use of their noise reduction system. Obviously, if a viable alternative could be produced a lot of money would be saved. Against this background several interesting alternative systems have been developed, each claiming to be the ultimate solution to cassette noise problems.

Most of the systems are based on the compander, the technical term for a compressor/expander system. On record, the dynamic range of the signal is compressed. In this way the low level passages which are most prone to noise are raised above the noise threshold. Similarly, on replay, the signal is expanded back to its original dynamic range. If this is done properly the signal is much improved. In fact the Dolby system works in this manner providing an 8dB improvement above 1kHz.

Unfortunately Dolby operates by detecting the signal amplitude and compressing accordingly. Thus when tapes of widely differing maximum output levels are played on the same machine, the system produces what can only be politely described as unsatisfactory reproduction.

Certainly the noise is reduced but the treble is massacred as well. Quite a few friends of my acquaintance prefer the sound from a cassette better with the Dolby left out. Try it some time!

One of the main drawbacks of the compander system is that when low level signals are played back a pumping sound can be heard. This is due to the fact that there isn't sufficient treble content to mask the hiss in some parts of the signal. The only commercial system that overcomes this problem is DBX. This literally cuts the dynamic range of the signal in half on record and doubles it on replay. Treble pre-emphasis is used on the input signal to ensure that this part of the signal is always above the noise level.

Telefunken's Hi Com system is the most successful of the new systems if the published information is to be relied on. Claimed noise reduction approaches 30dB above 1kHz. An advantage of the system is that it is obtainable on a single chip. If it were taken up by the large manufacturers mass consumption would reduce the cost to an acceptable level. Aurex, another compander system, claims a noise reduction of 20db. This is a system I have actually heard and it certainly works as described. However pumping effects are evident on some material and in my experience this makes the sound tiring to listen to over a long period.

As you may imagine, Dolby have not taken this potential competition lying down and have entered the fray with two new systems of their own.

Dolby C is the name of their latest offering which works by cascading two companders in series, each giving a 10dB improvement in signal to noise ratio. The frequency at which the system starts to operate has been lowered from about 1kHz to 375Hz. Otherwise the system is similar to, and completely compatible with, the normal Dolby B systems currently available. The difference is a 20dB improvement in S/N overall and a claimed reduction in midband distortion.

The other new noise reduction system from Dolby is the HX system. This operates in an entirely different way to the companders and only operates on record. All tape recorders need a bias voltage applied to the record head to prevent distortion due to the hysteresis of the tape. This bias takes the form of an ultrasonic signal and for a good recording its amplitude must be matched to the tape type used. Too little bias and the high signals are apparently boosted with respect to the bass and midrange. Too much and the bass and midrange will be recorded at a higher level than the top.

Now it so happens that the response to high frequency signals of normal tapes drops for large amplitude signals. Dolby's solution is to lower the bias on high level, high frequency passages of music so that these are recorded with their natural balance.

The NAD 6040 is the only cassette player available at the present time with this facility built in. It qualifies as a noise reduction system only in that it allows a signal to be recorded at a higher level.

Lastly, Tandberg have come up with a similar system to HX which alters the treble pre-emphasis on record and restores the balance on replay. Details of this system are scanty and it has yet to be incorporated on any deck available in the UK. **E&MM**

Guide to Electronic Music Techniques

Editing

Lawrence Casserley

Last month I gave a general rundown of tape techniques for 'musique concrete' and suggested a few experiments. Now I would like to expand on one of the areas that often gives people the most trouble. There is nothing terrifyingly difficult about editing, but it can seem daunting until you've had a bit of practice.

If you're going to do much tape work then it's worth getting yourself the right sort of kit for it. While there are various fancy splicing machines on the market, there is no substitute for the good old EMI block. If you can't get one anywhere else, you can get the ¼" tape splicing block by post from Turnkey Ltd., 8 East Barnet Road, New Barnet, Herts for £3.80 including post and packing. Turnkey also supply splicing tape, leader tape, chinagraph pencils and single-edge razor blades, all of which you will need (don't try to use ordinary razor blades if you value your fingers!). You will also find a ruler useful.

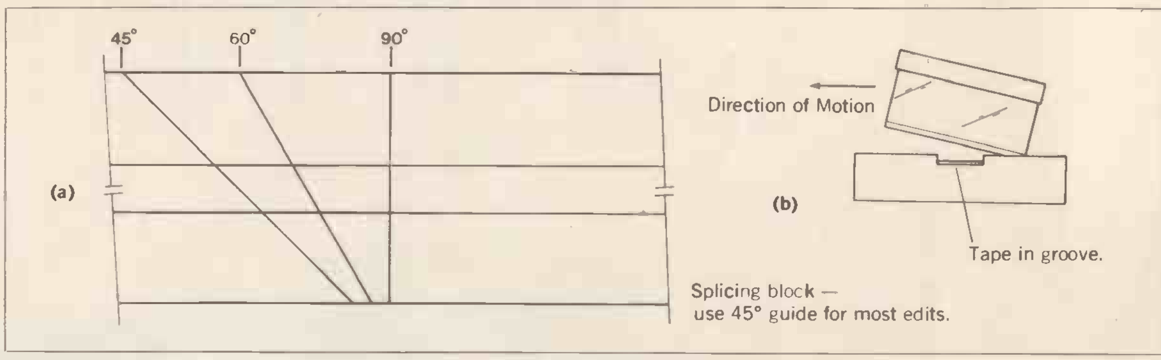


Figure 1.

Time in seconds	1/10	1/8	1/6	1/5	1/4	3/10	1/3	3/8	2/5	1/2	3/5	5/8	2/3	7/10	3/4	4/5	5/6	7/8	9/10	1
TAPE SPEED 15	1½	1⅞	2½	3	3¾	4½	5	5⅝	6	7½	9	9⅜	10	10½	11¼	12	12½	13⅛	13½	15
7½	¾	15/16	1¼	1½	1⅞	2¼	2½	2 13/16	3	3¾	4½	4 11/16	5	5¼	5⅝	6	6¼	6 9/16	.6¾	7½
3¾	⅜	15/32	⅝	¾	15/16	1⅛	1¼	1 13/32	1½	1⅞	2¼	2 11/32	2½	2⅝	2 13/15	3	3⅛	3 9/32	3⅜	3¾

(length in inches)

Table 1. Chart of time vs. length of tape in inches.

Having got your kit assembled, how do you go about it? Let us take a specific example. Suppose you have recorded a number of sounds in succession (it doesn't matter what they are for the moment) and you want to isolate two of them and then join them together. It is always a good idea to record sounds at the highest available speed as it makes editing much easier — a quarter inch of tape lasts 1/15th second at 3¾ inches per second (which can be quite a lot), 1/30th second at 7½ and 1/60th second at 15; 1/10th second (a significant amount) takes up 1½ inches at 15, ¾ inch at 7½ and ⅜ inch at 3¾ — little bits of tape are less terrifyingly little at higher speeds!

Particularly when starting, try and keep the lengths of tape as large as possible by selecting higher speeds. First, you will need to get the tape in contact with the playback head without engaging the capstan. The arrangements for this vary on different machines and I discussed this in last month's article. Get the tape in approximately the right position for the beginning of the sound you want and, grasping a spool in each hand and keeping the tape fairly taught across the heads, rock it back and forth, and if you have chosen the right spot you should hear the sound starting and stopping. For your first attempts, use a sound with a very clear attack (e.g. a percussive sound, piano or guitar) and move onto the trickier ones when you have a bit more experience. You will find it easier to locate the sound if you keep the tape moving quickly in each direction and try to get the attack in the middle of the swing. Start with a wide swing from side to side and gradually narrow it down, keeping the movements quick and the attack in the centre of the swing, and gradually "home in" on the sound until you have it exactly on the head. You will find that you need to practice a bit to get the hang of it, but after a little while it will become quite easy.

When you think you have found the sound and the tape is at rest with the attack exactly on the head, carefully mark the back of the tape with your chinagraph pencil.

Make sure you know which is the playback head and mark the tape exactly in the middle of the head. If it is difficult to get at the head itself, find another fixed point (a tape guide, for example) that is more accessible, measure the exact distance from the head and make a mark on your splicing block exactly the same distance from the cutting guide; when you put the tape into the block, put the mark on the tape in line with the mark on the block and your cut will be in the right place. When you've marked the tape, run it back and forth a few more times to make sure you've got the right spot and then move on and do the same thing at the end of the sound.

Don't make each cut as you find the correct spot, as it is difficult to find the next one with one end of the tape loose. When you have found both ends you can make the two cuts at once and splice the main tape back together. It is a good idea to gently pull the tape clear of the deck before cutting (the Revox B77 has a block mounted for this purpose on its deck). Always keep your hands clean when handling tape as moisture and grease can affect reproduction.

If you have an EMI block you will see that there are three cutting guides, at 45°, 60° and 90° to the direction of the tape (see Figure 1(a)) For general use the 45° guide is the one to use, the others will be useful occasionally when you are working with very small bits of tape or very sharp transitions from one sound to another. When cutting the tape, don't push the razor blade down on to the tape, but rather, holding it at a slight angle and making sure it is in line with the guide, slide it gently across the tape and you will get a clean cut (Figure 1(b)) When making a splice put the two ends of tape into the block and gently butt them up together so that there is no gap between them but no overlap either; cut off about an inch of splicing tape and, making sure it is not overlapping the edges of the tape and that the join is in the middle of the splicing tape, press it firmly onto the back of the tape (always make sure the tape is in the block oxide-side down) then gently pull the tape out of the block. Take the piece you have cut out, lay in on a clean surface, and mark it with the chinagraph so that you know (a) which sound it is, and (b) which direction it goes in, otherwise the only way to find out is to splice it into another tape and play it, but this is obviously time consuming. Now go on to find your second sound in the same way.

If you are extracting a whole series of sounds and the rest is 'rubbish' (e.g. silence or the pieces of tape containing clicks from switching the tape recorder in and out of record mode) you can go through and make all the marks, then go back and cut them all out afterwards, but do make some mark to show which are the parts you want, otherwise you can end up with a beautifully edited tape of silence and a pile of sounds in the rubbish bin!

And that brings up another point — wherever possible make a copy of your original material to edit, and keep the 'master' (i.e. your original tape), so if you make a hash of it you won't have to re-record the material. Also, if you want to use the same material again in a different way, you've still got it.

Having extracted your two sounds, you can join them together. In order to play them you will need to put 'leader' tape at the beginning and end. Make sure you use enough — it is annoying to have the tape come off the spool and have to be re-threaded every time you rewind a tape, and it's not *that* expensive. I always allow at least six or seven feet. If you want a silence between the two sounds you can put in another piece of leader. As there is a direct relationship between the length of a piece of tape and the time it takes to play it, you can easily calculate the right length, measure it and cut it. Table 1 is a handy chart to help with this.

All this may seem rather long-winded just to join two sounds to one another! Editing seems a bit like that at first; you spend what seems like hours producing two seconds of sound that you're not very happy with and wonder if it's all worth it, but if you persevere and don't get discouraged if you make a few mistakes, or your tapes fall apart, or you're not sure if that's what you wanted anyway, you'll find it suddenly gets much easier. Like most skills it has to be practised — you develop a rhythm and many of the awkward aspects become automatic — before you know it you've developed a very useful and powerful technique for manipulating sounds.

A final hint. It always pays to be well organised. Develop a system that works for you. If you always lay your kit out in the same way you won't spend most of the time hunting for the razor blade; and if you always mark your sections of tape carefully and have a note-book handy to keep track of what they all are and what you've done, you'll be less likely to get in a complete muddle and will save yourself a lot of time in the end. There's nothing more aggravating than contemplating a pile of identical lengths of tape and not having the faintest notion what they all are. I know — I've done it! Good luck and have fun. Next month I'll talk about microphone techniques for musique concréte.

E&MM

WORKING WITH VIDEO

Andrew Emmerson

Earlier in this series I talked about the glittering world of video in the United States — where everything is cheaper and better of course. Or is it? Certainly video is cheaper, and there's a wider selection of video equipment and films on tape. But television programming is pretty diabolical (in general) and even the quality of the 525 line NTSC picture is not as good as our European systems, but we will not pursue that for the moment. Anyway, it is very entertaining to read the American video magazines and see what's currently on offer over there. With luck we may spot trends which will be repeated over here in months to come, while other novelties are worth mentioning out of curiosity. So remember, you read it here first, folks!

Starting with something in the novelty category, there are the new video cassettes with allegedly three dimensional capability. Straight back to the 1950s, this, and the first 3-D release is, appropriately, 'Creature from the Black Lagoon'. MCA has put the cassettes on sale and is offering free special glasses with every tape. What the rest of the family do while you watch with your special glasses is not clear, especially as they have no National Health scheme on which to fall back! Somehow I don't see this sort of thing catching on in Britain but it's certainly a novel idea.

Another feature unlikely to be copied over here is multi-speed video recording , and I am not speaking of special effects. What I mean is that virtually all home video recorders in the USA now offer a half speed and/or third speed facility which enables you to record double or three times the amount of programme on a normal tape. Thus on to a two hour blank tape you could record six hours of programmes. The only snag is that the picture and sound quality are degraded somewhat, though not sufficiently to stop consumers enjoying this facility. To be honest, I have not personally seen the results, so I cannot comment on the quality from first-hand experience but suffice to say multi-speed is now virtually a standard feature on VCRs in the USA. And despite the rude remarks about the American TV system I ought to say that a well recorded American VHS or Beta tape produces a picture which is subjectively little worse than the best European ones.

A feature in the USA scene which will be repeated over here is the arrival of receiver-monitor TVs aimed at the domestic user. Receiver-monitors have been around for years in the professional area and have proved their worth there. The receiver portion is just like any other TV set but the monitor facility enables you to connect a video input direct. Thus, if you want to test a camera you can plug its output straight into the monitor without first going through the modulator in the video recorder. With less intermediate processing you should (and do) get a better picture. The same applies to replay of video tapes — by connecting the *video out* of a VCR to the *video in* of the monitor you can view the tapes exactly as they are, without possibly losing the fine detail and colour effects. There are many other uses for video monitors in video production and home computer users have been looking out for low-cost, colour monitors for years. Receiver-monitors at realistic prices are now appearing on the US market; there is a large screen offering from General Electric and a six inch portable model from JVC. Interestingly, JVC have seen fit to launch the same set (in a PAL/SECAM version) on the UK market and I have in fact bought one. At a discount price of around £225 it offers an incredible range of facilities: battery/mains operation, PAL or SECAM colour, video and audio in *and* out, VHF and UHF tuner, and no less than three European sound standards, covering the systems used in the UK, western Europe and the East bloc. This makes it useful for monitoring foreign TV programmes when conditions are up and it has very useful applications in my particular speciality, amateur TV transmission. The only things the JVC CX-610UK doesn't handle are NTSC (the American system) and French TV.

However, I am straying from my roundup of what's new on the US scene. Here's another development sure to be repeated over here, the user-friendly camera. Nice as they are, some of the new super-cameras baffle you with all the controls. The latest offering from Toshiba enables, it is claimed, high quality home video movies to be produced even under the most taxing circumstances. Two things make this possible. One is the highly sensitive Univicon 2 tube which is said to halve the amount of light required for good pictures. An automatic shut-off is incorporated to protect the tube in extreme bright light. The other incredibly clever feature is *automatic* continuous focussing, using a CCD (charge coupled device) chip. This apparently senses the light spectrum frequencies of the scene when you focus on an object. If the object moves out of focus the CCD senses the error as a plus or minus value and operates a servo motor on the lens to compensate and correct it. The series of compensatory movements are said to be undetectable visually. Price is around £650, including electronic viewfinder and 6X zoom lens.

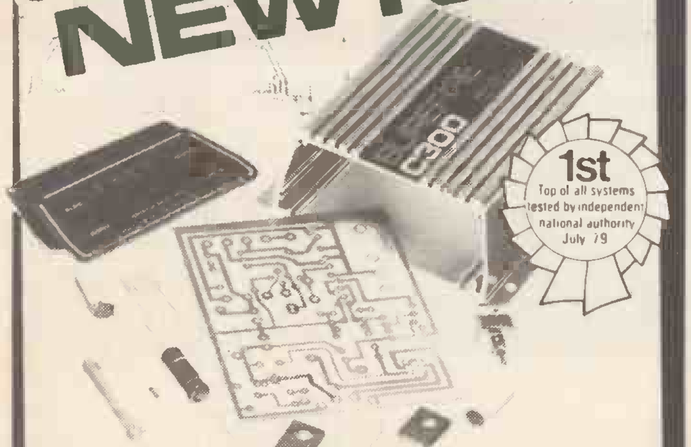
Home telecine devices abound in the US market now. They are designed to enable you to convert movies and slides to the video format and offer an optical method of coupling a projector straight into a video camera. In this way you avoid the problems of trying to shoot the projector screen with a camera and adjusting the light levels. Needless to say this rough and ready method just described produces rough and ready results. Unfortunately it is arguable whether low-cost accessories produce significantly better results, which may be why these gadgets are not so popular in the European market. To achieve professional results (without smeary images, bars across the picture and grotty sound) you need professional equipment costing several thousand pounds. You need a high-quality camera, a variable speed projector and a proper telecine lens multiplexer. There are several agencies offering film to tape transfer or you could use the facilities at JVC's Video Information Centre in London. Avoid low-cost, 'back street' outfits — they will rip you off.

Finally, we come to a field neglected over here but well catered for in America, video furniture. (There's a marketing idea!) In America you can buy attractive, real wood trolleys designed to carry a colour TV, video recorder and a few dozen tapes. (By comparison, all I have seen over here are very 'industrial' looking trolleys or foul chipboard cabinets with 'plastic teak' veneer.) But best of all new products in the USA is the Videnza and this is definitely my favourite! 'You can store up to 100 VHS or Beta video cassettes in Pyramid Manufacturing's Videnza cabinet', says the write-up. Half the tapes are always accessible; the other half are locked out of sight behind a false back. (Not a false bottom!) When a key is inserted, the hidden shelves swing into view. Cost is $219 and now I know how to store my exotic and rare collection of 'artistic' tapes!

See you next month. **E&MM**

2 SUPERB NEW KITS!

NOW WITH PLUG-IN COMPUTER CIRCUIT BOARD



C300/ES200

high performance electronic ignition, to add power, economy, reliability, sustained smooth peak performance, instant all weather starting, to your car.

Surefire has sold in its thousands in ready made form from big name accessory firms, but it is now available in quality kit form to fit all vehicles with coil ignition up to 8 cylinders.

ES200. A high performance inductive discharge ignition incorporating a power integrated circuit (special selection) electronic variable dwell circuit (maximises spark energy at all speeds) pulse processor (overcomes contact breaker problems). Coil governor (protects coil). Long burn output. Negative earth only. Compatible with all rev counters.

C300. In it's ready built form (C3000) it came top of all systems tested by an independent national authority July '79. A high energy capacitive discharge ignition incorporating a high output short circuit proof inverter, top grade Swedish output capacitor, pulse processor circuit, transcient overload protection. Fast rise bidirectional output ideal for fuel injection, sports carburation, oily engines. Compatible with most rev counters. (Low cost adaptors available for rare cases. Application list enclosed with each kit. Note Vehicles with Smiths Jaeger rev. counters code RV1 on dial will require adaptor type TC1).

What's in the kits. Surefire's own precision anodised aluminium extruded case P.C. mounted security changeover switch, static timing light. Special selection Motorola semi conductors, Capacitors, resistors etc. selected after 5 years experience. Glass fibre pcb, solder, complete down to last washer.

Fully illustrated comprehensive instructions and full technical back up service.

SUREFIRE ELECTRONIC IGNITION

DEPT. E&MM/4

Suretron Systems (UK) Ltd.
Bayer Buildings, Lower Bristol Road, Bath, BA2 3EF. Tel: Bath (0225) 332317

Name

Address

Phone order with Access Barclaycard VAT and P & P inc — Quantity required

ES200: Neg ⏚	£13.95		
C300: Pos ⏚	£17.95		
C300: Neg ⏚	£17.95		
Tacho Adapt. TC1	£3.90		

I enclose chq PO's
£
Chq No

3 CHANNEL SOUND/LIGHT CHASER

LB31000SLC £32.70

A high performance sound to light system which automatically switches to a chase when the music ceases. Super sensitive with an anti-interference circuit. The unit will operate from practically any amp and control up to 1,000W/channel. 5Hz to 70K. Controls: bass / mid treble / master sensitivity / chase speed.

STEREO DISCO MIXER/PREAMP

LBPA3
M — Magnetic
C — Ceramic

£33.70
Magnetic or ceramic deck versions — please state

All the requirements of a stereo disco preamp on one board, left and right deck mixers/tone controls/mic. mixer/tones/mic. auto fade over decks/and P.F.L. The unit can be used with either LB100/150/250.

Full set of pots — £8.63

3 CHANNEL SOUND/LIGHT

LB31000SL

£22.70

All the advantages of the SLC without chase. Controls: bass/mid/treble/master sensitivity.

LBPA2 £17.20
A four channel mixer and tone stage for mics, guitars, etc. Can be used with any LB amps. Set of pots £2.74.

LBPA1 £19.50
A stereo hi-fi preamp and tone storage for mag. p.u. / tape / tuner, etc. Set of pots £3.27.

2/4/8 CHANNEL CHASER

LB81000LC

£28.00

An all logic chaser system for use with up to 8 channels at 1,000 watts each. Facilities include foot-switch trigger and module cascading (16, 24, 32 channel, etc.), chase speed and re-cycle delay.

3-WAY ACTIVE CROSSOVER

LBACO1 £17.90

LBPSU1 £7.20

Bass/mid/treble active crossover with stage booster! Available with crossover points of 200 or 300Hz, and 2K or 3KHz (please specify) LBPSU1 supply for LBACO1 (1 or 2).

POWER AMPLIFIERS

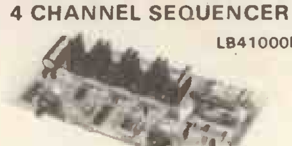
Tough dealing power amps for use in sound systems. Open/short circuit protection and fused. Heavy gauge heatsinks and rugged o/p devices (all operate down to 4 ohms).

25W RMS	100W RMS	150W RMS	250W RMS
20Hz to 60K	5Hz to 25K	5Hz to 25K	5Hz to 25K
0.07% THD	0.1% THD	0.1% THD	0.1% THD
96DB S/N	110DB S/N	110DB S/N	110DB S/N
LB25	LB100	LB150	LB250
£11.20	£19.70	£29.20	£43.50

Note all models are available with either 500mV or 775mV sensitivity. Please state when ordering.

4 CHANNEL SEQUENCER

LB41000LS



£19.20

A 4 channel sequence generator for banks of lamps up to 1,000W per channel. Two speed controls, cross effect to provide settings between seconds and rapid burst.

LBRLD1 £6.20

A de-thump unit for use with any LB power amps

1 AND 3 CHANNEL DIMMERS

LB31000LD

LB31000LD £16.20

Single channel version LB11000LD £7.20

Power dimmer units for the theatre/stage applications up to 1,000W per channel, with on board suppressing. The unit is also available without rotary pots for use with sliders — LB31000LD (no pots) £15.00 Sliders 75p each

POWER AMP POWER SUPPLIES

LB25PS	LB100PS	LB150PS	LB250PS
£11.20	£16.20	£19.00	£26.50
P/P £1.20	P/P £1.40	P/P £1.70	

FOR GUITARS P.A. & DISCO

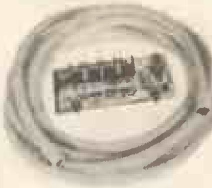
PIEZO HORNS £5.75 P/P 50p

CELESTION LOUDSPEAKERS
(ALL STANDARD CONE 8 OHMS)

G10-50	G12-65	G12-100	G15-100
(10in 50W)	(12in 65W)	(12in 100W)	(15in 100W)
£14.70	£20.70	£26.45	£36.45
P/P £1.70	P/P £1.70	P/P £1.70	P/P £2.00

ROPE LIGHTS/DRIVER

LB41000LC-S £24.20



4 colour Ropes Red/yellow/green/blue 6-metre length

ROPE LIGHTS £45.40

A four channel chaser up to 1,000W per channel, with a sound trigger facility. The music input signal modulates the speed of the chase giving an excellent sound/light effect. The unit will control up to 10 ropes with chase speed and trigger level control.

NEW - MINI MODULES - NEW

Ingeniously designed mini pre-amplifier building blocks for use in music and PA applications. You choose the type and number of units you require for your particular system and mount each module via its control direct onto your panel.

LBMM1 Pre-amp for mics, guitars etc.
LBMM2 Mixer for up to 6 LBMM1/2/3/4/5
LBMM3 Bass/boost/cut for either LBMM 1/2/3/4/5. LBMM4 Mid-boost/cut for either LBMM1/2/3/4/5. LBMM5 Treble boost/cut for either LBMM1/2/3/4/5. LBPSU1 + 15V supply for up to 12 modules. LBPSU + 15V regulated for up to 50 modules
MM1 £4.50; MM2 £5.20; MM3 £5.70; MM4 £5.70; MMS £5.70; PSU1 £7.20; RPSU £14.50.
Discount on MM1/2/3/4/5 10 to 24 – 20%. 25 + -30%.

L & B ELECTRONIC MODULES

PROFESSIONAL ENGINEERING BY PROFESSIONALS

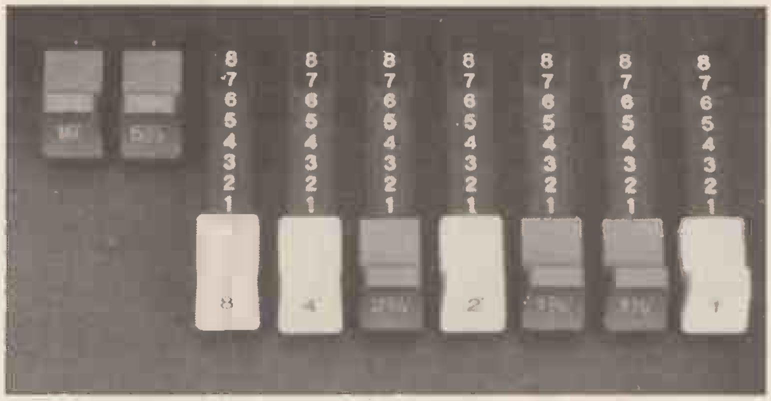
45 Wortley Road, Croydon, Surrey CRO 3EB. Tel: 01-689 4138

Each module is manufactured from the highest quality components, fully tested, supplied with a connection and circuit diagram and guaranteed for twelve months.
All prices shown are VAT inclusive. Please include 50p post/packing except where individually stated. To mail order send cheque/P.O./registered cash or Access number. C.O.D. service £1 extra. For the new Autumn catalogue send 50p (full spec. shown).
Please note this company has no connection with LB Electronics of Hillingdon

Organ Talk

Ken Lenton-Smith

THE DRAWBAR SYSTEM



If imitation is a form of flattery, the Hammond Organ Company must be pleased to note how drawbars have increasingly been fitted to other makes of organs — even the home-constructed variety—over the years. Of course, manufacturers borrow each others ideas freely and even Hammond is in this category, but the drawbar system has been in use for 45 years and is still very popular.

Despite the system having its limitations, the modern instrument may well incorporate drawbars as part of the many facilities available. As there is a tendency for the newcomer to 'grab a handful' of drawbars without knowing the principles on which they are based, this article will attempt to provide a better understanding of their use.

In the very early days of modern science, Robert Hooke discovered that musical tones could be created by holding a piece of card against a cogwheel. Doubling the speed of the revolving wheel raised pitched by an octave, a discovery he made in 1618. Over two centuries later, other scientists were experimenting with toothed wheels, magnets and electric motors and at the beginning of the present century, the Telharmonium was playing music to telephone subscribers in New York, its tones derived from alternators.

Tone-wheel

Laurens Hammond, a man of greatly inventive mind, had developed a number of ideas - electric motors, stereo movies, a radio power pack and electric clocks - before turning his designing to music and the organ. His first organ appeared in 1935 and worked on Hooke's principle but used an electromagnet in front of the toothed wheel.

A single Hammond tone-wheel generator produces a very good sine wave, but the sound of a pure waveform is uninteresting to the ear. Consequently Laurens Hammond decided to provide additional pitches so that harmonics could be added to the fundamental. However, rather than using tabs or drawstops, he decided upon individual volume controls for each pitch: these were engraved with numbers from 0-8 for setting the required harmonic content of a given timbre. He named these 'drawbars' or 'tonebars', the classic Hammond system having sets of nine drawbars.

The CTV screen's phosphors are of three primary colours only (red, green and blue) but mixtures of these will give an almost infinite number of hues. In the same way, the primary or fundamental tones available from each drawbar are mixed: with *nine* primary musical colours, the variations again are almost infinite. During the last decade, the Hammond mechanical generator was replaced by LSI devices, but sine waves are still produced and mixed as hitherto.

Harmonics

The drawbars are related to each other harmonically and for the system to work properly the waveforms must be pure sine. The set of nine drawbars have coloured knobs for controlling these harmonics of the fundamental and appear as in Figure 1.

Brown	Brown	White	White	Black	White	Black	Black	White
Sub Octave	Sub Third	Fundamental	2nd	3rd	4th	5th	6th	8th

Figure 1

If all of the nine drawbars are pulled out to their fullest extent (i.e. set to 8 in each case), the registration is written down as:

88 8888 888

The nine figures are split into three groups partly to make the registration easier to read. A more important reason for this grouping is to remind the user that:

88 —the first group of two Brown drawbars controls the sub-octave content of the timbre.
8888—the central group sets the basic tone.
888 —the top three drawbars add brilliance.

Brown drawbars give sub-octave sounds, white denotes *consonant* (even) harmonics and black *dissonant* (odd) harmonics. The second brown drawbar provides 5⅓' pitch, which is dissonant, but its use adds a sub-octave character because of difference frequencies it provides when other pitches are in use.

Basic Tone

Drawbars in the central group have their own characteristics. Taking each in turn we find that:

00 8000 000 (the first white drawbar) adds fundamental power to all unison 8' sounds but requires the addition of other drawbars to establish a sense of pitch. Reducing volume allows the upper harmonics to be more incisive.

00 0800 000 adds brightness and clarity without brilliance. At low volume it imparts a delicate effect to any tonal family.

00 0080 000 is dissonant, adding Quint tone necessary for strings and woodwinds. If too powerful will thicken the registration.

00 0008 000 provides brilliance and aids the sense of pitch definition.

Using just these four drawbars, we can try a few permutations. If the sound is pleasing but too loud, a 'mini' version of the same registration is obtained by pushing each drawbar in by the same number of notches. Given a good amplifiation system, quiet registrations are often more effective than *fortissimos:*

00 7656 000 8' Diapason
—mainly consonant with some third harmonic.
00 8020 000 8' Tibia Clausa
—fundamental with some third harmonic content.
00 4763 000 8' Oboe Horn
—weak fundamental.
00 8888 000 8' Tuba
—loud and fairly bright.
00 8740 000 8' Horn
—a very smooth registration.
00 8605 000 Flute Chorus
(consonants only).

Brilliance

The top group of three drawbars adds 'seasoning' to the central group, as shown in these examples:

00 6888 000 8' Trumpet becomes 00 6888 543
00 8888 000 8' Tuba becomes 00 8888 866
00 2354 000 8' Salicional becomes 00 2354 321
00 7373 000 8' Clarinet becomes 00 7373 430

Lastly, we can add small quantities of the first two brown drawbars for sub-octave and chorus registrations:

52 8888 542 Full Great
34 3576 421 String Chorus
47 5430 000 16' Oboe Horn
64 3322 000 16' Diapason

Artists like Jimmy Smith and Groove Holmes took to the Hammond because of the 'dirty sound' that it could produce — aided by the use of plenty of 5⅓' drawbar and percussion of second/third harmonics. Hammond's old B-3 organ was so popular in this respect that an almost identical LSI version of the tonewheel model was produced recently — the B-3000. Drawbar registrations do not necessarily need to be imitative and the 'blues' player might well use registrations (with or without soft percussion) such as:

68 0800 006 88 8800 000
66 0880 000 88 8000 008

An extra black drawbar with red spot is sometimes encountered on Hammond organs. This controls a mixture of tenth and twelfth harmonics, giving extra 'fizz' to any registration.

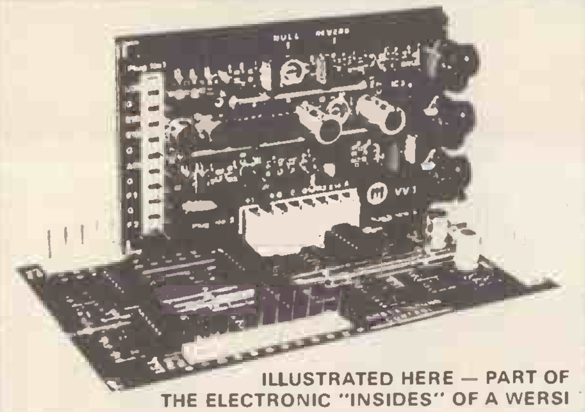
It is worth noting that settings which involve plenty of dissonant harmonics are best reserved for solos whilst accompaniments and block chords should employ consonant harmonics mainly. Where reverse colour presets are fitted (the lowest octave of a six octave keyboard), Hammond usually preset these so that accidentals (white keys) give solo voices and the naturals (black keys) more consonant voices intended for chords. This is a reminder that dissonant harmonics must be used with care — depending on the type of music being played!

Writing down any favourite tone-colour discovered is well worth while as otherwise its registration will soon be forgotten. Yes . . . I know what I said earlier about grabbing drawbars! With an understanding of the principles, memorising the *pattern* made by the protruding drawbars will help when making quick changes in registration. In effect, the pattern is equivalent to a bar graph/frequency spectrum, allowing the player to see the harmonic content at a glance. In very general terms the patterns will be:

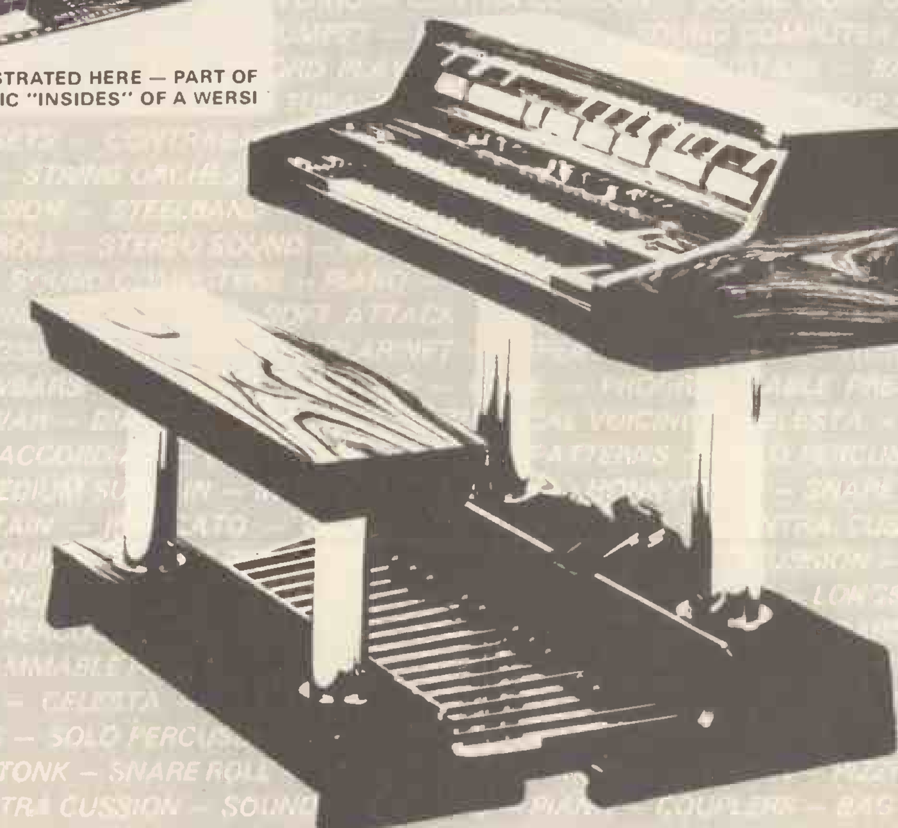
Not all drawbar systems will conform to the specification mentioned but the same ideas can be applied provided that pure waveforms (perhaps described as 'Flute') are being processed. In strict theory, nine Hammond drawbars will give at least 80 million different timbres — according to the blurb. I'll settle for far les than this, but it should be possible to hear the effect of tiny changes in registration if the instrument is worth its salt and the reader not too senile!

E&MM

Create One Yourself!



ILLUSTRATED HERE — PART OF THE ELECTRONIC "INSIDES" OF A WERSI



Aura and WERSI Show You How

Create one of Wersi's electronic organs by building it yourself from an easy to build kit. Create a perfect match in decor by picking a spinet or console in contemporary or traditional styling. Create your own personalized instrument by picking just those features that fit your playing style.

Create your own custom electronic organ by having WERSI build it for you. Create the keyboard instrument that exactly fits your needs in styling and features. Create a lifetime investment with WERSI's unique updating system which allows you to ADD new features in the future,

Want to know more about WERSI? AURA SOUNDS are the first company to successfully market WERSI Organs and kits in the U.K. Our technical telephone support service is second to none. There's a friendly welcome and free demonstration at our three showrooms. Fill in the coupon and enclose a cheque/P.O. for £1.00 payable to AURA SOUNDS LTD. FOR IMMEDIATE ACTION TELEPHONE 01-668 9733 24 HOUR ANSWERING SERVICE, QUOTING ACCESS/BARCLAYCARD NUMBER.

AURA SOUNDS LTD.
14-15 Royal Oak Centre, Brighton Road, Purley, Surrey. Tel: 01-668 9733
17 Upper Charter Arcade, Barnsley, Yorkshire. Tel: (0226) 5248
1729 Coventry Road, Sheldon, Birmingham. Tel: 021-707 8244

Please send me the full colour WERSI Catalogue. I enclose cheque/P.O. for £1.

NAME ______________________

ADDRESS ______________________

Send to Aura Sounds Ltd., 14/15 Royal Oak Centre, Brighton Road, Purley, Surrey.

E&MM/4

WERSI AND AURA SOUNDS — THE WINNING COMBINATION

Hot Wiring your GUITAR

Adrian Legg

Continuing with the taps, firstly this month, I shall assume that you feel you have a beautiful guitar and that sticking nasty little switches in it will spoil it. Fear not, you can still extend the tonal range by using the existing tone control(s) to operate an earth type tap or an 'alternative hot' tap.

You can use any one tone control to tap any one pick-up. You cannot, however, use one tone control to tap two pick-ups, as the tap wiring will mix one coil from say pick-up 1 with the normal mix of coils from pick-up 2 when operated solo; so you won't be able to get a solo humbucker sound unless you replace the tone pot with a tandem pots unit and operate them separately on the one shaft. That's for another time though.

To operate a complete earth-type tap on one pick-up, the tone control and tap wire must be wired as shown in Figure 1, which assumes that the pick-up and control system is one of a pair on something laid out like a Les Paul. From 0-9 on the tone control (which will still function as a normal tone control as well) the pick-up will give the normal series coils humbucker sound, but from 9-10, coil 2 will be earthed out via the tap wire, giving a single coil sound from coil 1, whose earth reference is also provided by the tap wire.

Figure 2 shows the necessary wiring modifications to operate a partial tap in the same manner, here the tone control uses the same capacitor for partial tap and normal tone operation. The effect is the same as the partial taps explained last month. The 9-10 on the tone control will take out the treble frequencies from coil 2, allowing the treble from coil 1 to dominate the sound, which will be thicker than that for a complete tap. In both partial and complete tap, there is no particular need to screen the tap wire, as at no point is it used as hot. However, Figure 3 shows a way of wiring a tone control tap where the tap wire becomes an alternative hot. Here, unless the guitar is already thoroughly screened, the tap wire should be screened to help minimise the extra noise that will come from dropping out the humbucking propensities of the pick-up when tapped. The diagram assumes the same guitar layout as before, but in this instance, from 0-9, the humbucker sound will come out and at 9-10, the signal will be taken from *coil 2* via the tap wire and link wire 'a'. Coil 1 will not sound, and there is no useful partial tap to be had here.

This style of tapping leads me to another type of switchable tap that also selects signal either from the whole series coils system, or from halfway through. This method again requires good screening. Figure 4 shows how a SPDT switch will give either series or single (coil 2 operates, coil 1 is cut), and normally an on/on would be used immediately after the pick-up and before the controls. If you are completely rewiring a guitar, or maybe building from scratch, a point worth remembering is that if this type of tap is applied to both or all pick-ups, the use of an on/off/on SPDT switch cuts out the need for a pick-up selector switch, since each pick-up can be switched on, in either series or single mode, independently. Alternatively, an on/on DPDT switch could be used to tap both pick-ups simultaneously in a two-pick-up guitar, though I would suggest that this cuts some attractive mixing possibilities.

Generally speaking, deciding which coil you are going to cut out will have an important bearing on the tone. In the bridge position, using the coil furthest from the bridge as hot will give a warmer sound than using the one nearest the bridge. If you prefer the sound of the coil nearest the bridge, perhaps you should consider the use of parallel coils instead of a tap, the coil nearest the bridge will tend to dominate the sound anyway. You might also be better off with the hum-cancelling properties of parallel out-of-phase coils which a complete tap eliminates altogether, or a partial tap eliminates partially. The same also applies to the fingerboard pick-up to a large extent. Personally, I must say that for a long time I have preferred the sound, both on solo pick-ups and mixes, of tapped humbuckers to parallel coils and, as far as the bridge is concerned, am quite happy with a partial tap via a .033uF capacitor cutting out top from the nearest coil to the bridge on a close-in sited pick-up. I have also found a reasonably convincing 'out-of-phase' Strat sound can be obtained from a partial tap operated on the rear coil (nearest bridge) of a pick-up sited further forward. I find the top edge that a tap gives sounds less constricted than parallel coils and it is possible to be much more specific about harmonic content. Variation in harmonic content can have a drastic effect (good and bad) in an out-of-phase mix of one sort or another though and for this reason, as well as the odd studio type situation, where hum becomes a problem sometimes, I believe firmly in retaining the option of parallel coils as a switchable facility but as a back-up option rather than a primary option.

I leave you with a point Jeff Baxter raised recently: that different guitars can have different things to say to the player, and offer different musical possibilities. I agree, but also believe that the tonal possibilities in a guitar can be exploited so that it might have as much to say to you as half a dozen others, and without the problems of coping physically with a variety of scale lengths, neck shapes, fingerboard cambers and so on. Changing from one guitar to another for the sake of the sound can play hell with your technique when it is at full stretch, but turning a switch one way or another affects your concept of your music at that moment without changing anything for your hands. **E&MM**

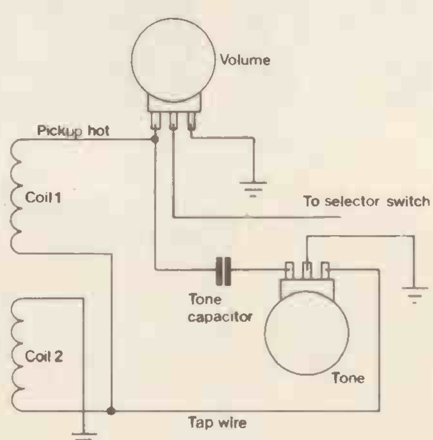


Figure 1

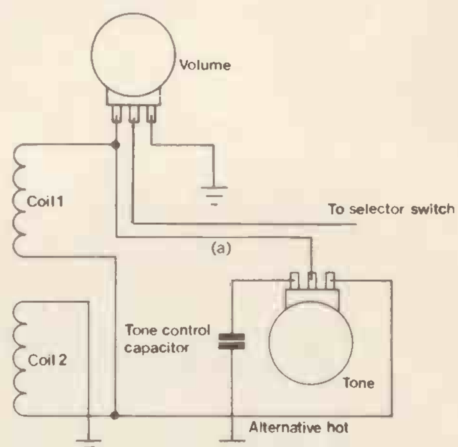


Figure 3

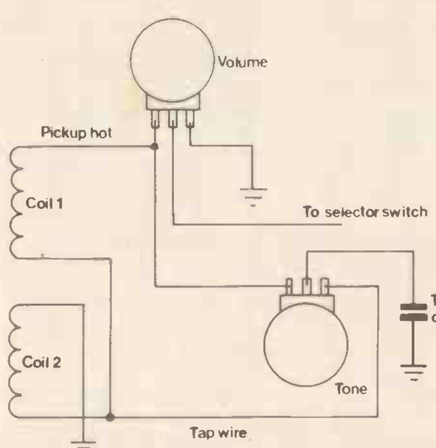


Figure 2

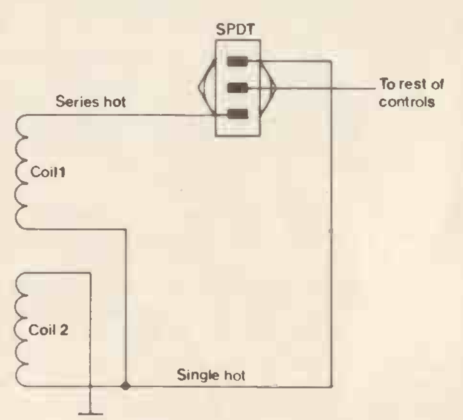


Figure 4

DAVID VORHAUS & KALEIDOPHON STUDIO

RECORDED ON CASSETTE NO. 2

David Vorhaus' Kaleidophon Studio is situated on the top floor of a house in busy Camden High Street, London and the control room window commands a panorama of Camden Town rooftops. A suitably elevated position, you might think, for a studio specialising in electronic music, but no pie in the sky. Apart from the BBC Radiophonic Workshop, Kaleidophon is really the only studio dedicated to electronic music in London. In fact, the studio stems from "radiophonic" origins, as David explained to me: 'after doing physics and psychology at Aberdeen, I came to London to do my postgraduate degree and also played double bass in the Morley College orchestra. By chance I went to a lecture on electronic music at Morley in 1968 given by Brian Hodgson, Delia Darbyshire and Peter Zinovieff. It seemed to me that they really knew what they were talking about and convinced me that that was what I should be doing. Brian and Delia were both connected with the Radiophonic Workshop and we decided to set up this studio together.'

The studio now contains a fascinating array of gear, ranging from weird and wonderful Vorhaus designs to the latest computer technology in the form of the Fairlight CMI, which David says he bought as an investment as well as believing it to be the instrument of the future. In fact, his model was the first in the country, but, as that was only six months ago, he still considers himself a beginner when it comes to using it. Even so, he has already produced an Alka-Seltzer commercial entirely on the Fairlight and is currently working on an all-Fairlight album. His track record is pretty impressive and includes one album on the Island label ('Electric Storm'/White Noise 1, 1969) which sold 100,000 and proved to be one of the most long-lived records from that company, an album on the Virgin label ('Concerto for Synthesiser'/ White Noise 2, 1974), and a recent release on the Pulse label ('Re-entry'/ White Noise 3, 1980).

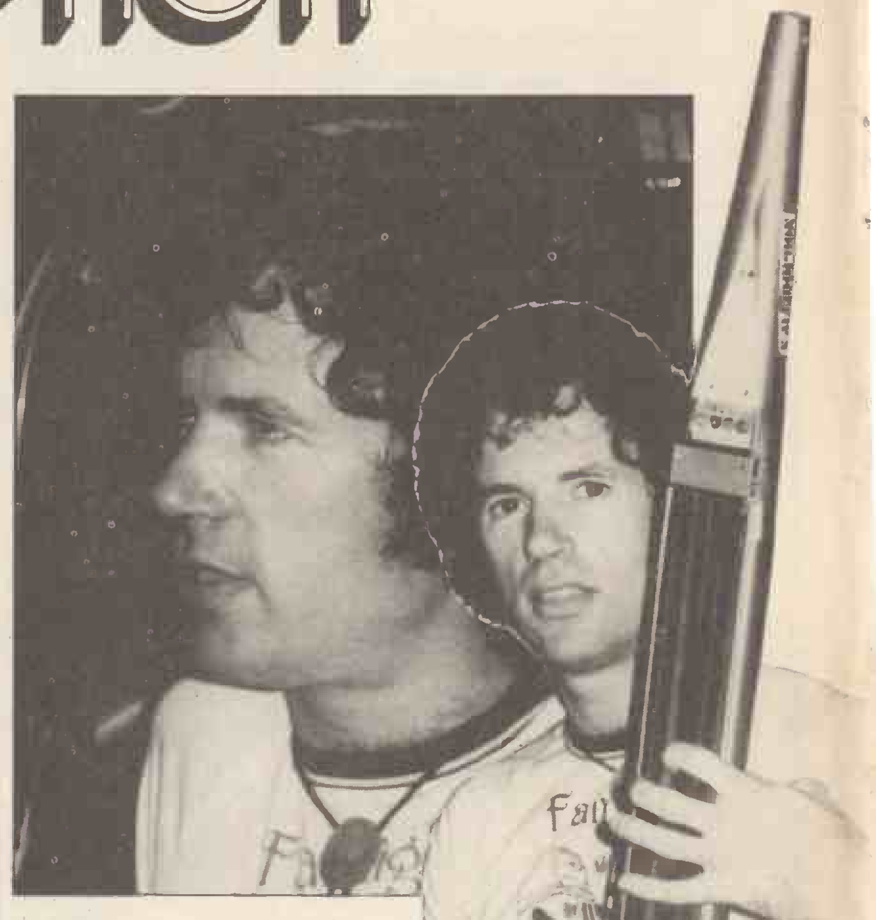
I wondered why there had been such large gaps between releases — David certainly couldn't be accused of jumping on the bandwagon! 'Yes, for all of them there have been five-year gaps and it was really to give the field a chance to change. What I really don't want to do with White Noise is to produce a new album just like the previous one. I like to feel that I'm exploring the musical possibilities of the latest technology.'

David describes his music as having a strong element derived from 20th century classical music, in particular, composers like Stravinsky, Bartok and Shostakovich, but there's always an underlying movement derived from rock and jazz, or what David calls 'the Black influence'.

I asked him about the significance of the album titles, White Noise 1, 2 and 3. 'My first album was one of the first electronic albums in this country and it's really a matter of continuity calling them White Noise albums. The second was really the first album devoted to synthesisers, and a heavier work, probably suited to the instrument in the sense that synthesisers then couldn't get nearly as rich sounds as with earlier electronic techniques.' Other activities have included writing library music for Keith Prowse Music, which, as well as paying the rent (an honest man, David!), he also finds very enjoyable. 'It provides a very welcome contrast to the tension of doing solo work,' said David, 'where it's often rather difficult to find the necessary self-discipline in the initial stages of putting it together.'

As well as Kaleidophon being David's personal studio, it is also thrown open to members of the public wishing to avail themselves of his unique expertise. An outside engineer would doubtless be somewhat confused by the unusual mixing desk (for instance, all EQ is performed by a separate EQ bank rather than having individual EQ in each input module), but there's nothing lacking in the quality of its output, and at £22 per hour this must be the cheapest 24-track studio anywhere!

Considering his experience of working with groups and musicians from the other side of the mixing desk, I asked him what he thought of the state of music-making in this country. 'This country was once the tops for exploring new avenues in music, and



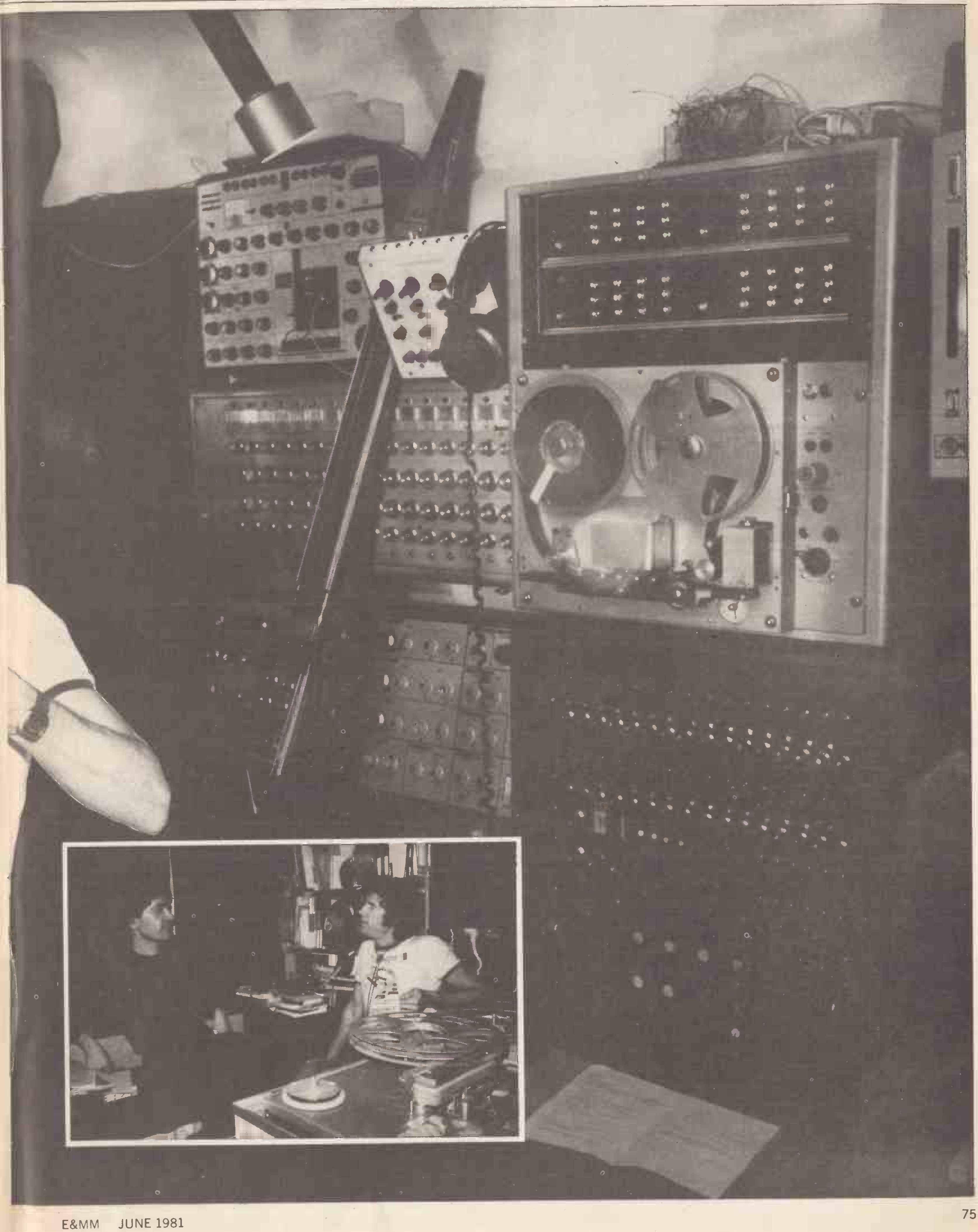
though there are still a lot of people doing this in their own ways, it's no longer the main stream. In certain respects we're going through the Dark Ages in music. All one can really hope is that, to put it in economic terms, the slump is bottoming-out.'

I've noticed that a number of the more experimental musicians, Brian Eno, for instance, are forced to leave Britain to seek support for their creative work elsewhere. 'To a certain extent that's true; Britain is a bad place for creative work, but you've got to watch for the snag in thinking that moving is the answer to the problem.'

We both agreed that the 'problem' lay in the Catch 22 situation facing the contemporary creative artist: if there's no demand for left of main stream music, then record companies won't release it; if there's no opportunity for release of such material, creativity will be starved (literally) and so there'll be nothing to demand in the first place.

'I think that good musicians are still as good as ever, but I think they will generally be concerned with playing their instruments rather than high tech. Actually, amongst the musicians I respect, none of them are particularly technology-conscious. Peo-

David Vorhaus with his Kaleidophon.



ple like Fred Frith, for instance. And people that are very technology-conscious, particularly consumer commodity technology-conscious, don't seem able to produce good music.'

I wondered whether he thought that the development of electronic music was looking rosier than other forms. 'No, but as far as the hardware is concerned things are happening faster than ever before, particularly in the digital field. As far as the actual technology is concerned we're really just leaping ahead, but we've still got to learn to walk and run.'

Mind you, on the production side, it must be a good thing if the mystique of 'studios' can be eradicated by high technology allowing the equivalent of studio sophistication in your own home. 'Yes, well it already is as compared with ten years ago and in some respects this is going ahead too fast. It's really a matter of the standard of musicianship. It's all very well bringing it into the home, but you've got to study your instruments in quite a lot of detail before you're going to be able to do anything usefully. If you think of a rich language with a lot of words, then there's a lot of learning to do before you're able to express yourself in it. The only way you can learn something quickly is if you restrict yourself to a 20-word language. This is the point about bringing studio-quality music into the home; the technology is one thing, it's just like playing records, but, as far as playing music is going to go, it's not nearly as important as the actual standard of musicianship and composition. The new Lowrey organ is the best demonstration of this. After all, you can buy this instrument for exactly the same price as the Fairlight (£15,000) and it brings the equivalent of a big orchestra right into your home which you can play and get a big brass sound, note-perfect, without knowing a damn thing! The technology is already there, but it almost makes musicianship redundant. I mean, musicians might as well split and leave this planet.'

Whilst all that's true, I think such technology will ultimately provide at an economic price the potential for electronic music-making at the fingertips of a vast number of people. Whilst, at present, commercial music occupies the listening time of 95% of the public, paradoxically such music puts musicianship to the bottom of the list. If more and more people actually start to create music rather than just passively soaking it up, then perhaps commercial music will be forced to reappraise its stance on musicianship and the public will demand more from their music than instant aural gratification.

'Well, exactly. The technology can provide instant gratification but it isn't the way to use it. Somehow we've got to think of a way of reversing the regression that seems to be happening to music.'

Returning to present-day technology, aside from such commercial standards as the Prophet 5 and Mini-Moog, Kaleidophon also boasts the very first VCS3 synthesiser (serial no. 001) made by EMS (Peter Zinovieff's company), now getting on for ten-years-old and still as reliable as

ever. That's British workmanship for you... However, it's for two of his own designs that the name of David Vorhaus is most likely to ring bells in any reader's head. A few years back, he and his studio were featured in a BBC TV programme on the development of electronic music. Whilst most of the programme did little more than reveal the cameraman's fascination for tinkling ivories in the same way as coloured liquids dripping into and out of test-tubes in popular science programmes, the undoubted high spot was David demonstrating two inventions, the 'Maniac' and the 'Kaleidophon' (from which the studio gets its name). Maniac stands for 'MultiphasicANalogue InterActive Chromataphonic' and, like its title, is an impressive piece of hardware resplendent with a multitude of pots and LED's. Essentially, the device is a multiple sequencer with a maximum sequence length of 64 steps, each of which initiates two control voltages and therefore provides duophonic operation. Remember, that's each step; the entire Maniac can actually play up to six synthesisers at the same time, and all in counterpoint with each other! The long sequence can be programmed to divide off into factors of 64, e.g. 4 x 16. Each of these shorter sequences can be used to trigger the others by using various control options such as the 'end out' of one triggering the clock of another. One of its most endearing features is a switch marked 'Time Warp Navigator' which automatically syncs any sequence running over a 16-note 4/4 bar length by triggering reset when the sequences are used in their interactive capacity, or 'jamming together', as David puts it!

The Kaleidophon, on the other hand, is specifically an instrument for musicians rather than the knob-pusher, and offers remarkably flexible control of pitch and timbre in an ergonomically-pleasing package.

'I planned with the Kaleidophon to make an instrument that one could learn to play quickly very well and be a sort of virtuoso. It's turned out to be a much better instrument, expressionwise, than I originally conceived, but it's a failure in its initial purpose as something that would be quick to learn. I guess this shows up a more general principle that with anything that is really extensive and expressive it takes a long time to learn the language.'

The Kaleidophon looks something like some of the more outrageous guitar designs, at least as far as the neck is concerned. The technique of pitch selection is borrowed from the guitar, which is sensible, but the 'strings' in this case are made of conductive plastic rather than gut or metal. The model shortly to be in production (and E&MM have been promised the first off the production line for review!) uses four strings which can be tuned in fourths (as with electric bass or double bass) or fifths (as with other stringed instruments). With a useful range of 6 octaves and monophonic operation, the Kaleidophon is designed to be used as a lead instrument with much of its extraordinary versatility derived from various pitch selection options and joystick timbre control.

'I think one thing that'll have to be emphasised about the Kaleidophon is that it's not exactly the same as a bass or anything else. The fretless bass is perhaps the most similar, but you can't expect to just pick it up and play it like a virtuoso. It's a big advantage being a string player, as the fingering in principle is the same, but the action is totally different.'

The Kaleidophon now has an international reputation, for in 1979 it won one of three prizes awarded for new electronic instruments at the Ars Electronica festival held in Linz, Austria. The other two prizes went to the Lyricon and the Fairlight CMI, so it's in good company!

Finally, I asked David about his future plans. 'Well, I'm planning to move to Australia for half of the year, but also planning to stay here and run the studio. I'm planning immediately to explore the Fairlight really intensively and do a Fairlight album, because it's going to take doing an album to realise the whole range of possibilities of the instrument, and it's going to be very frustrating, I know that!'

Dr. David Ellis E&MM

America

Ian Waugh

Many new products coming onto the market do not necessarily herald new advances in technology. Manufacturers will often find a better, more efficient or economical way of incorporating existing technology into new products: the sort of thing which may make you wonder why no one thought of it before. To someone, somewhere, it will be just what they've been looking for.

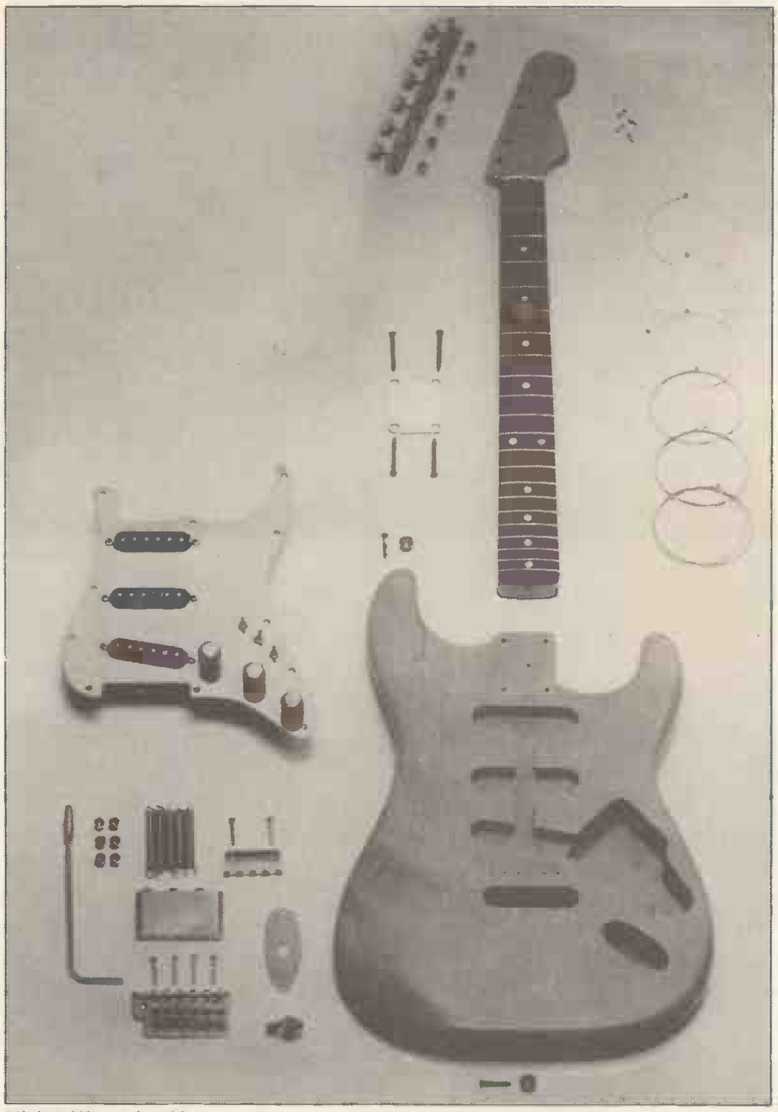
Electro-Voice have a new microphone, the PL80, intended for vocals. It has a shock mount to reduce handling noise and an Acoustifoam blast filter to reduce popping. Made from aluminium and diecast zinc it is enclosed in a dent-resistant Memaflex grille screen. Retail price around $199.95.

DeArmond have announced their model 260 Acoustic Guitar Pickup which is designed to be mounted in the soundhole of any flat-top guitar. It is claimed that the sounds reproduced are of recording studio quality that can only be obtained by using a condensor mike. It uses a piezo magnetic sensor and is coated with a scuff-proof epoxy finish. Recommended retail price is $59.95.

Mighty Mite Musical Products, Inc. have the answer for anyone wanting to make their own guitar. They will supply complete guitar kits containing every part necessary to make a custom guitar, including the neck, body and strings. Brass is the dominant feature of the hardware and five different kit packages: 'Strat,' 'Tele,' 'P/Bass,' 'Jazz Bass,' and 'Les Paul' are available.

Tuners seem to be dropping out of manufacturers lists and into the shops as if the ear has gone out of fashion. The Music People have a tuner for acoustic guitars which works on the strobe principle. You can only tune to the standard guitar tuning: E, A, D, G, and B. You place a little window under the string and twang it. If the string is out of tune you will see a double image (lay off the rye) and you tune it until it becomes a single string. Retail price is $41.50.

Acoustyx have their Mark II digital tuner (I never saw their Mark I) which is crystal based and has a LED display. It covers a 4½ octave range with an accuracy of ± 0.1Hz. It is activated by the insertion of a jack plug. A carrying case is available but without, it retails at $159.95.



Mighty Mite guitar kits

JIG are distributing the Justina Quartz Tuner (made by Zen-On of Japan) which incorporates 'advanced LSI circuitry'. Accuracy is to within $^1/_{100}$ of a semi-tone. It has a built-in microphone, a stand, an extra large meter and a battery-check switch. Retails at $79.95.

Musico describe their new 'instrument-controlled synthesiser' as being capable of taking any instrument and making it sound like anything else. It is called the Resynator and principally follows the notes you play both tonally and dynamically and uses this information to control various parameters of sound. Front panel controls appear straightforward and are selected to give a wide choice of modulation control from your input sound. Incorporating microcomputers, this could be something keyboard players and guitarists could share.

Ibanez have concocted a package aimed primarily at guitarists but also useful in the studio. It consists of four units linked together and rack mountable. The UE-400 (they must have a computer thinking up names for new products) consists of a compressor, phaser, distortion unit and a chorus/flanger. Their order in the sequence of effects can be altered and remote switching is possible via a footboard. FET switches ensure clean switching and other effects can be hooked into in the form of a pre-wired pot which is the system. AC powered, the UE-400 retails at $545.

Torres Guitars have a tone control designed for retrofit in electric guitars and allows the guitarist to remove midrange frequencies without affecting highs or lows. It retails at $30.00.

There is a lot of news for guitarists this month. It is amazing how many bits and pieces you can add to your 'axe'. A volume preset unit called the Sly Box is available from the company of the same name. It allows you to preset a softer volume for rhythm passages without altering amp settings. A red LED indictes a signal straight through the Sly Box and a green LED indicates the signal is being attenuated. At a retail price of $29.95, here is yet another button for your floor.

Goldline have a small Real Time Analyzer called the ASA-10 (that computer must be working overtime!) which gives an LED display of the characteristics of a sound to enable you to adjust your parametric equalizer with ease. The display can be frozen to show the characteristics of a sound at any particular time during its duration. At $239.95, this affordable unit could find itself in many places running to a budget.

Next month: one or two more goodies for the guitarist plus a new drum machine which does everything but buy a round. Come to think of it, our drummer doesn't do that either. And he does take up a lot of room on stage. Let me see how much that unit costs . . .

Companies and manufacturers mentioned:

Electro-Voice, 600 Cecil Street, Buchanan, MI 49107; DeArmond, 1702 Airport Highway, Toledo, OH 43609; The Music People, Box 648, West Hartford, CT 06107; Acoustyx from Highland Corporation, Precision Drive, North Springfield, VT 05150; JTG, 1808 West End Avenue, Nashville, TN 37203; Musico, 1225 N. Meridian Street, Indianapolis, Indiana 46204; Ibanez, P.O. Box 469, Bensalem, PA 19020; Torres Guitars, 14567 Big Basin Way, Saratoga, CA 95070; Sly Box, 566 Humboldt, Denver, CO 80218; Goldline, Box 115, West Redding, Conn. 06897.

Mighty Mite Musical Products, Inc.
4809 Calle Alto, Camarillo,
California 93010

E&MM

WERSI

THE CRÊME DE LA CRÊME OF ELECTRONIC ORGANS

Easier to own than you think!

Believe it or not WERSI organs were designed for those who wanted to build their own organ but never conceived it possible. The WERSI concept is to make assembly an automatic step-by-step procedure. NOW even the humblest do-it-yourselfer can construct a WERSI organ — experience isn't necessary, just the desire to own an organ which is technically brilliant and is guaranteed to produce the world renowned WERSI sound.

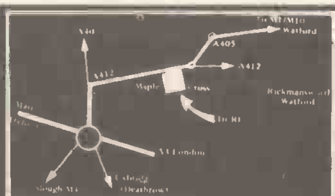
Perhaps you have toyed with the idea but are still hesitant about taking the plunge — Electro-Voice are WERSI specialists and whilst giving you the opportunity to see, hear and play the complete range of WERSI instruments at any one of our fully equipped showrooms, we will be more than happy to discuss in full the advantages of building your own organ.

Seeing plus hearing equals believing, so, why not come along to one of our studios and meet one of our resident demonstrators who will be delighted to demonstrate any instrument. Additionally, talk with one of our engineers who will show you one of the WERSI kit-pack systems. (Electro-Voice customers are guaranteed full after sales service plus engineering support).

WERSI . . . one of the world's most desirable instruments — easier to own than you thought!!

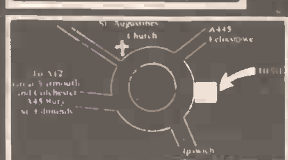
P.S. Home construction offers you the bonus of saving at least 60% of the completed instrument price

Head Office & Showroom:
Maple Cross Industrial Estate,
Denham Way,
Rickmansworth, Herts.
Tel: (Rickmansworth) 75381



Nottingham:
389 Aspley Lane,
Nottingham
Tel: (Nottingham) 296311

Ipswich:
486 Felixstowe Road,
Ipswich, Suffolk
Tel: (Ipswich 0473) 710051



electro voice SALES Ltd.

the voice of WERSI!

Name ....
Address ....
....
Tel. ....

☐ Please send me the 104 page catalogue. I enclose £1 to cover postage and handling.

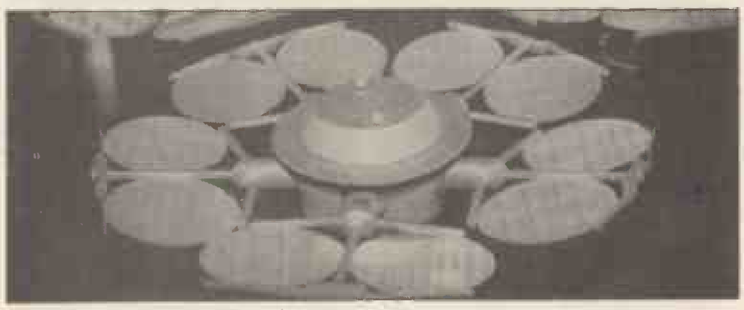
Send to: **Electro Voice, FREEPOST, Rickmansworth, Herts RD3 6FP.**

E&MM/4

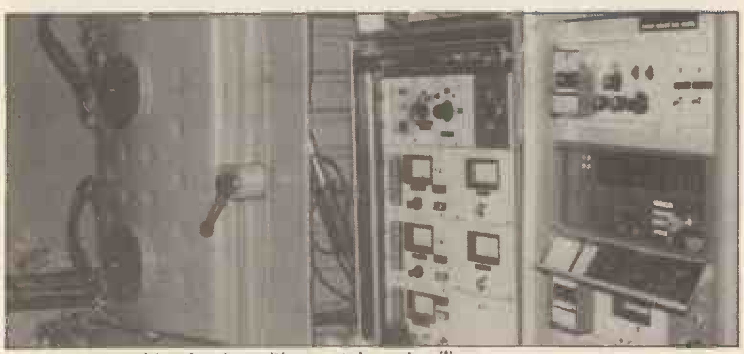
Colour graphics system allows analysis of complex integrated circuit chip layout.

Using a light pen to inspect and modify circuits and IC layouts.

Electron Microscope for inspecting and verifying IC production.
Inset: A highly magnified photo of connection points on a silicon chip.



Pure silicon slices ready for processing.



Evaporator machine for depositing metals on to silicon.

INDUSTRY PROFILE

Texas Instruments Limited

The Texas Instruments story began in 1930 with Clarence Kaccher and Eugene McDermott setting up a company called Geophysical Service Incorporated. They had to design and build their own equipment and relied heavily on electronics technology. During World War II, GSI built military equipment for locating submarines.

In 1951 Texas Instruments was formed and was the first company to produce commercially available silicon transistors and these rapidly replaced earlier germanium devices. GSI was still retained as a subsidiary for seismic research and development.

In 1956, Texas used their advanced scientific computer for oil exploration, enabling a new type of 3-dimensional geophysical survey.

Today, Texas employs over 89,000 people and has more than 50 plants in 19 countries. When TI's plant at Bedford opened in 1957 it was the first extension of the company outside the USA. It is the UK headquarters for Texas Instruments and Geophysical Service International. In 1970 a new factory started operation at Plymouth and is now one of the main plants within the EEC manufacturing integrated circuits.

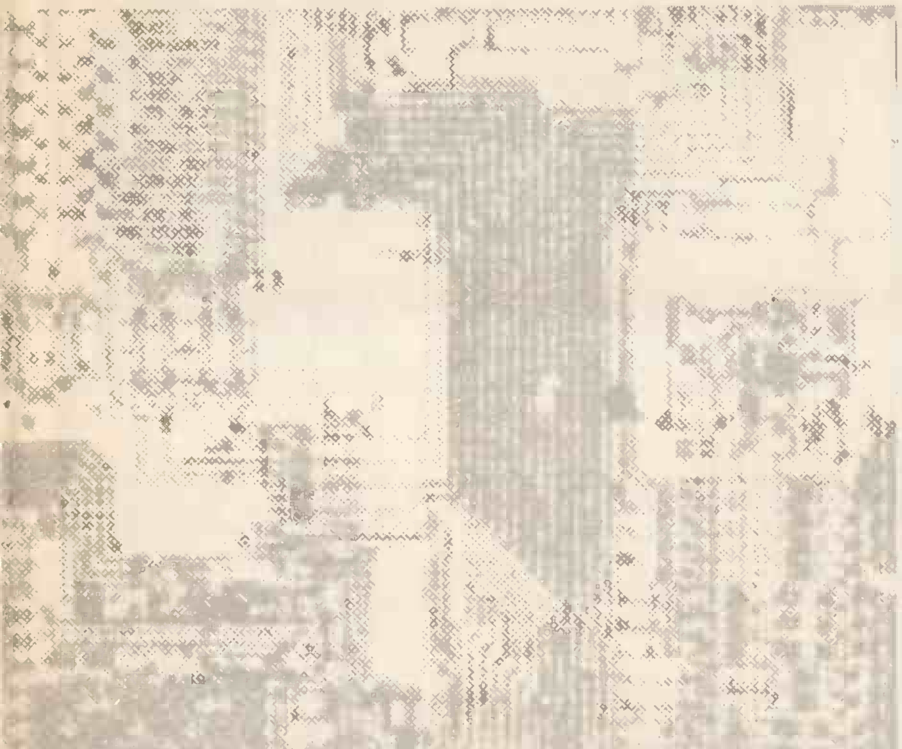
The 'IC' was a Texas innovation, invented in 1958 by research engineer Jack Kilby. An IC is basically an electronic circuit containing a large number of individual components, mainly transistors, on a silicon chip of wafer-thin silicon. Silicon itself is the second most abundant element on the earth's surface, occurring naturally in quartz or as common sand. It is refined to an ultra-high state of purity and then formed into a single cylindrical crystal, several inches in diameter, from which the thin circular wafers are sliced. Each slice will yield dozens of IC chips and complex fabrication techniques allow hundreds of thousands separate transistors to be fitted into a total area of quarter of an inch square.

By 1971 Texas had produced the first single chip microcomputer which enabled their advanced calculator products to become pocket sized.

TI Semiconductor Division established a large circuit design facility in Bedford. Here the specification is decided and the circuit designs and logic diagrams are produced. This is then analysed by computer to evaluate how well the circuit will perform. A functional layout is made that adapts the logic to the silicon chip and this is digitized and stored in the computer which allows design changes to be made as necessary and finally assembles all the circuit elements into a complete layout. The computer tape now holds all the information on the circuit geometries so that the chip is completely described in digital form. This information can be rapidly transmitted to an area where electron beam equipment will place the circuit patterns on to slices of silicon which are then processed and tested.

Finally, the processed slices are split into individual chips and assembled in finished packages at the highly automated plant in Plymouth.

In Bedford, a team of over 50 soft-



ware and applications engineers spend their time solving customers' problems. New products like Zero One — micro electronic control of several trains running on a single track — developed for Hornby model train sets, and the superb speech synthesis card which is featured as our main project this month.

High voltage power transistors are designed and manufactured at Bedford while opto-electronic devices and a whole range of linear, digital, bipolar and MOS electronic circuits are also produced by other Texas companies.

The three main areas of development for Texas are in semiconductors, consumer electronics and distributed computing systems. The latter allows the end-user direct access to computer facilities, relying on low cost, flexible computer terminal and storage systems. The Digital Systems Division of TI at Bedford produced the portable 'bubble memory' computer, storing large amounts of data even without power connected.

The production, administration and communication of the company obviously benefit from its computer systems and a satellite based global communications network — the largest private on-line system in the world.

Microprocessors are used in sophisticated robots which assemble low cost calculators and take over the tedious job of connecting the tiny bond wires in ICs.

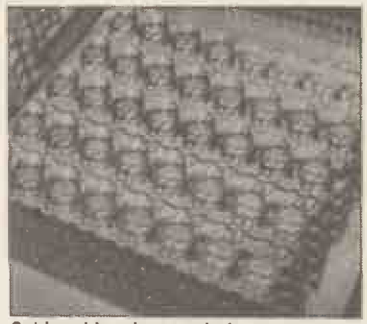
Consumer electronics is a rapidly growing area and all started in 1954 with the first commercial transistor 'Regency' radio. But the single chip pocket calculator in the early '70's bought the biggest step forward, with Texas producing low cost scientific and business designs such as the first solid-state analogue watch and a wide range of learning aids including the popular 'Speak and Spell' instrument which uses an IC to synthesise the human voice. Speech synthesis is also used in a new language translator and in TI's home computer (which also makes music!).

Government radar and laser guidance systems along with airport surveillance, marine communications, infra-red scanning, space probe research and industrial control products all make up the wide scope of Texas Instruments.

It is hard to describe in a few words the tremendous activity that goes on at the Bedford plant. My visit proved very informative and Chris Followlel, responsible for hobbyist consumer relations, was at liberty to show me all the relevant factory departments, despite the 'restricted area' notices!

Gathered under one immense roof in the design/software applications building are many highly qualified engineers and this forms just one part of the large plant area built up around a central quadrangle. Efficiency and productivity are definitely key words for any TI employee and the promise of 'equal opportunities' for promotion is also a major factor in the company's success and to enable the Bedford company to beat the recession, managing director Robb Wilmot has instigated 'people and assett effectiveness' programs, to increase the

Encapsulation of power transistors takes place in this zero humidity environment unit.



Soldered headers ready for encapsulation.

Special rig for testing LSI devices such as this 16-bit CPU — the TMS 9900.

This computer controlled (human aided!) machine grades transistors.

IC testing equipment that fully checks internal operation.

Electronic speech development equipment.

Educational study room for staff to update on latest Texas developments.

Engineer working with TI components on a TV application.

One of the many computer software and development areas.

The TI-99/4 Home Computer for business and leisure.

Talking learning aids, calculators, as well as watches are large volume consumer products.

productivity per employee.

Most of the staff are graduate trained in scientific and computing subjects and the senior engineers are definitely orientated to sales and marketing as well. Since Texas net sales exceeded £1772 million in 1980, it is indeed encouraging that the company's interests can extend right down to the practical hobbyist market, where profits must be insignificant.

The whole atmosphere seems conducive to good research and development, with groups of engineers sited in 'cubicle' sections that give a surprisingly quiet background noise in the building. Many engineers spend much of their time working on projects that require travelling to the company concerned. Mike Lloyd, in charge of TI implementation of our WORDMAKER, certainly ensured that the project kept to its deadlines, despite a business trip to Belgium.

At present, the Bedford factory areas produce power transistors and a new 'clean room' will soon be completed for maintaining the high quality required in manufacturing silicon based components.

The future looks good for Texas, and with the combined development of home computer and general consumer products, we can look forward to further innovative ideas from this large company.

Mike Beecher — E&MM

RECORD REVIEWS

GAMES
by SYNERGY (Larry Fast)
Passport PB6003

Games is the fourth solo album from Larry Fast, recording under the name of Synergy. Fast is probably better known in America than in England (where his records are often difficult to obtain) and his expertise in synthesiser playing and programming has been sought by Barbara Streisand, Hall and Oates, Boz Scaggs, Ian Lloyd, John Tropea, Peter Gabriel and Nektar.

The Synergy albums have a characteristic style which is the result of the sounds and timbres used and Larry's compositional technique. Many sounds are string-derived and there is the characteristic use of flute-like and brass lead voices along with swirling, tinkling arpeggios and punctuating drum fills (all electronic and exceedingly deceptive). The themes are all highly melodic and tend to develop rather than repeat as the music progresses. The music has, in fact, been *orchestrated* for synthesisers and a veritable master of such orchestration is Mr Fast.

Contributing to the characteristic sound is the equipment in the Synergy studio. Larry believes that the purchase of more and more modules quickly reaches a point of diminishing returns and is content to work with the Moog and Oberheim equipment which is the backbone of the studio. A Sequential Circuits' Prophet 5 was also used on Games and other equipment from PAiA, 360 Systems, Musitronics and MXR. Important additions were the inclusion of an Eventide Harmonizer and a Delta-Lab DL-2 Acousticomputer, used as 'ambient enhancement devices'. An Apple II computer functioned mainly as a sequence editor and as Larry has recently become more involved with computer/synth packages they may be more evident on future albums.

The tracks on Games were composed in blocks between other commitments and Larry admits to the fragmentary nature of the pieces so the LP as a whole does not exhibit a single 'character'. This is more evident when compared to his Cords album which seems to have a greater coherence.

The first track on side one (or 'Program 1' as Larry calls it), Delta 2, consists of 'remnants' of compositions left over from the Electronic Realizations for Rock Orchestra LP. Admitting the fragmentary nature of Games it was felt that this could be the last opportunity to use these pieces, hinting that future albums would be conceived at a stretch.

Track two, Delta 4, and track four program 2, Delta 3D, were culled from an experimental digital synthesis sequencer program at Bell Laboratories, New Jersey. They consist of a rapid, almost random, violin-like voice bouncing about in a well-constructed harmonic framework backed by shifting layers of strings. You can hear the bow scraping across the strings on the solo lines. Very reminiscent of the violin sound on Vivaldi by Curved Air.

Track three, Delta 1, is described by the composer as 'an electronic cultural mirror' reflecting the pop and rock trends of the late '70's. Beginning with a heavy rock drum beat under a sequenced bass line, the rhythm has a conventional disco feel to it but the lead lines and chord changes are not quite so conventional.

Program 2 consists of six tracks, Delta 3A-F, which were, with the exception of 3D (as mentioned above), composed during the soundcheck periods of the Peter Gabriel '78 tour. The themes are slightly more abstract and given less time in which to develop than those on program 1 but they are all as full of the Synergy hallmarks as the other pieces.

All recording was initially done on an MCI JH-110/8 one inch recorder in the Synergy Studio and later transferred to 2in. 24 track for final mixing and overdubbing. The individual pieces are coded and numbered as each 8-track piece is begun which explains the out of sequence numbering on the LP.

Perhaps because of the fragmentary nature of the album, it does not seem to reach the melodic standards of some of his other work but even on these grounds it is impossible to criticise the compositions. Games is a must for anyone interested in electronic music and to anyone actively engaged in electronic composition (in the 'popular' field) — listen and learn. Highly recommended! Ian Waugh

City of Fear
by FM
Passport PB6004

In keeping with current trends in music an album entitled 'City of Fear' should really contain 40 minutes of heavy guitar, drums and vocals all mixed at 0dB, and thus it

was placed on the turntable with a certain amount of trepidation. Any nasty thoughts about it proved totally groundless since FM play electronic rock, and quite pleasant it is too.

FM are a three piece Canadian band, using acoustic and electronic percussion (Martin Deller), synthesisers and bass (Cameron Hawkins) and acoustic and electric mandolin and violin (Ben Mink). These latter instruments make an unusual contribution to the sound, although sometimes they are fed through so much effect that a guitar would have done just as well. All of the tracks feature vocals written by Cameron Hawkins and these hold the music together well, besides giving it a sense of purpose. As far as I can tell this is the band's third album, the others being 'Black Noise' and 'Surveillance'. Interestingly though, Ben Mink did not appear on Black Noise, his place taken by 'Nash the Slash'.

The sound produced tends to rock (reluctant use of the word 'progressive'), in that the drums form the base for nearly all the music in direct contrast to many other similar electronic bands where the drums merely fill in behind the main themes. The record opens with the interestingly named 'Krakow' which starts with a solid drum and bass line with mandolin and synth slowly coming forward to give a build up which suddenly breaks as the vocals come in, accompanied by string sound and a quiet tympani. The rock theme and vocals then combine before breaking to their respective sections again. In this way the track is typical of the album which has lots of contrast between gentleness and solid rhythm breaks on drums and bass. The title track attracts attention because of a very smooth, almost classical synth opening moving towards an expected, if not predictable, break with the much fuzzed mandolin. The strength of this piece is mainly derived from several recurring synth themes throughout.

'Nobody at all' is tucked away at the end of the second side. This is one track that is smooth in its build up from simple piano and vocals to include bass and drums, which leave again soon after. It is a pity that this is tucked away rather than put in the middle of the album because it would have been an admirable contrast; stuck at the end it does seem an afterthought.

The production is by Larry Fast and is generally tight, with some excellent use of effects, especially on the vocals. The sound produced is clean, with some particularly nice drums on 'Nobody', although the snare on the rest of tracks is rather weak. The bass end of the sound is very full, and without much treble to balance it left me wishing I had a bass control available.

An album which will appeal more to the rock orientated person rather than those listening for the electronics, but one which is well worth a listen. Chris Lare

Ravel
by Tomita
RCA RL 13412

Probably the world's best known engineer of Electronic Synthesiser Sound, Japan's Isao Tomita is certainly one of the most productive studio synthesists. This L.P., his seventh to be released in the U.K., continues the very distinctive 'Tomita sound' which he introduced in 1974 with the very successful "Snowflakes Are Dancing". Since his Debussy recordings Tomita has performed electronic interpretations on various classical works from composers including Mussorgsky, Stravinsky, Holst and Prokofiev. On this recording he features four compositions from Ravel. Side One reveals more of Tomita's ability for creating quiet, floating atmospheres in 'cathedral' acoustics with his relaxed engineering of "Daphnis And Chloe: Suite No. 2" and "Pavan For A Dead Princess". "Bolero" opens Side Two, building towards some of the best groove-cut bass I've ever heard — definitely a contender for checking out your speaker response. I've listened to Dutch, U.S., Japanese and U.K. pressings of the L.P. and all but the Jap version have a high frequency whistle at the beginning of "Bolero", so if you have acute ears and good tweeters it

may be worth spending the extra pounds on a Jap import copy. The "Mother Goose Suite" fills the remainder of Side Two, displaying two definitive Tomita styles from soundscapes to farmyard noises.

The sleeve, a beautiful Japanese illustration featuring some multi-coloured feathered birds, lists some forty-five items of equipment. I sometimes wonder whether Tomita feeds a score into his computer and assembles the sounds in the same way his fellow workers produce his equipment on factory conveyor belts. I know some classical devotees sense a lack of feeling in Tomita's electronic realisations but they should be pleased that his recordings have at least introduced a wider audience to classical music.

If you've enjoyed Tomita's previous recordings you'll probably like this one. Certainly an L.P. I would recommend as an introduction to the 'Tomita sound'. I just wish he would use his genius and vast compliment of equipment to experiment with some original and non-classical works. More concerts too!
Dave Townsend

NEW PRODUCTS

TAPE-HEADS AND TAPES

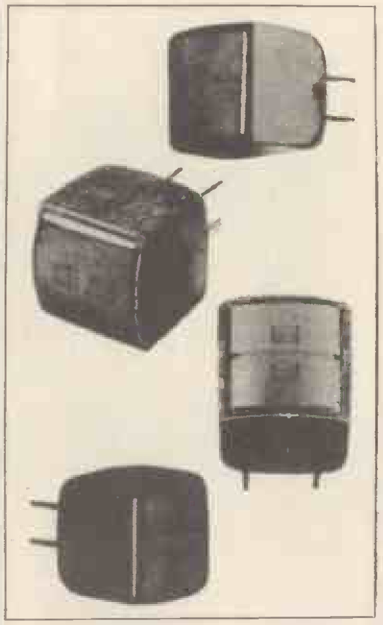
Monolith Electronics Co. Ltd. have recently introduced a new range of record/replay and erase heads for 'reel-to-reel' tape transports.

Designated the 'R' series, the new range is designed for use with ¼ inch tape and includes heads for full and half-track mono and stereo as well as 4, 6 and 8 channel.

The 6 and 8 channel heads are available to order, with customer specified values of inductance, resistance, recording current, playback level, bias and erase conditions.

Low frequency response characteristics are claimed to be excellent due to the hyperbolic contour of the heads. Nominal head gaps are 2.5um for the record/playback heads and 2 x 127um for erase heads. Dimensions of the heads are 12.7mm x 12.7mm x 16.5mm deep and individual mounting assemblies are available for all heads in the range.

Also from Monolith comes a new concept in light-coded tapes for tape transport control.



The coding is achieved by the removal of oxide from standard tapes to form precise and accurately coded light 'windows' in the tape, thus enabling existing light detectors and control circuits within the transport to respond with, for example, 'end of tape' message in telephone answering machines or data storage applications.

The windows can be ordered as either circular holes or rectangular slots and may be situated anywhere along the length of the tape according to customers requirements.

The coded tapes are available in reel-to-reel or cassette format, the cassettes being assembled in either screwed or press-fit bodies as required. Cassette sizes C1 to C120 are available and all tapes can be supplied with or without leaders.
The Monolithic Electronics Co. Ltd., 5/7 Church Street, Crewekerne, Somerset.

PREMIER SOUND

Multivox have recently announced the release of the Premier VM44 sound system.

Designed with ease of use and versatility in mind, the VM44 system consists of a power mixer and two extension speakers. The mixer features four independent channels providing bass and treble controls as well as reverb and volumn.

Separate high and low impedance inputs on each channel permit the use of microphones or instruments, with overall control of the four channels provided by master volume and master reverb.

The VM44 delivers 50W RMS into 8 ohms at 1% THD from its internal power stage and also has an effects loop and a fine output jack.

The extension speakers consist of a special design 12 inch speaker and a piezo tweeter.

NICE AND EASY

To make life easy for the loudspeaker constructor, Wilmslow Audio now offer flat-pack cabinet kits for many popular designs including the new Wharfedale E50, E70 and E90 kits.

All panels are accurately cut to size and baffle boards have the necessary speaker apertures cut and rebated where required.

The cabinets when assembled may be painted, stained, or finished with iron-on veneer.

The company also claims to have the largest selection of speaker drive units and kits available anywhere.

Wilmslow Audio Ltd are now in new premises at 35/39 Church St., Wilmslow, Cheshire, and new touch-control, customer-operated demonstration facilities enable prospective kit buyers to listen before purchase.

MORE SCOPE

A new range of 'scopes' has recently become available from Crotech Instruments Ltd. The range consists of four mains powered and two battery powered 'scopes. Single and dual beam versions are available, the most sophisticated offering component testers and up to eight triggering modes.

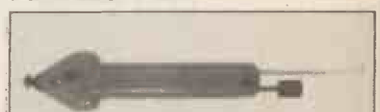
All mains operated models incorporate regulated power supplies, ensuring that the quoted specification is maintained over a 10% variation in supply voltage or any change in supply frequency between 47 and 65Hz.

The two battery operated models include a battery saving circuit that switches off the internal converter after 10 minutes operation, thus minimising unnecessary drain on the batteries if the instrument is left switched on while not in use.

Re-setting of the battery saver is simply a matter of depressing a reset button located on the front panel. The high sensitivity and modern design of the trigger circuits results in the

stable display of low amplitude signals at frequencies higher than the quoted specification. For example, the 3131 Dual Trace 15MHz 'scope will trigger reliably up to 35MHz on signal amplitudes in the region of 5mV. For further information contact: Grotech Instruments Ltd., 5 Nimrod Way, Elgar Road, Reading, Berkshire RG2 0EB.

DOUBLE-SIDED BOARD PINNING TOOL



Harwin Engineers, the originators of strip form track pins, have announced a new hand-tool for the quick and easy insertion of their pins into double-sided printed circuit boards.

The new tool feeds out the strip form track pins, exposing them one at a time so they are ready to be located in the PCB.

When correctly placed, the pin is broken off the strip, leaving it in place in the hole, ready for soldering. At the press of a button, the tool exposes another pin and the process is repeated in the next hole.

In addition to making pin insertion quicker and easier, the new tool ensures consistent results and keeps the pins clean prior to soldering.

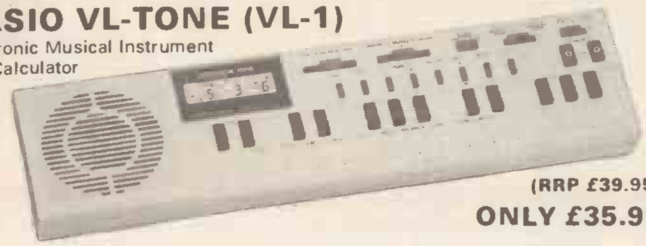
Harwin Engineers SA, Fitzherbert Road, Farlington, Portsmouth, Hants PO6 1RT.

BECOME AN INSTANT MUSICIAN NO EXPERIENCE NECESSARY

Create your own music with a VL-TONE. You combine the sound, rhythm and tempo and the VL-TONE plays it back . . . beautifully!

CASIO VL-TONE (VL-1)

Electronic Musical Instrument and Calculator



(RRP £39.95)

ONLY £35.95

VL-1: Utilises Very Large Scale Integrated circuit advanced technology. This complete 29-note synthesiser records and plays back. The octave shift switch expands the range of the keyboard to almost 5 octaves.
Preset sounds: Piano, Violin, Flute, Guitar, Fantasy and ADSR (sound wave that can be varied in over 80 million ways).
One key play: Record a melody. The notes are replayed in correct sequence simply by tapping the replay key and duration and tempo can be varied.
Auto play: ONE-KEY or MANUAL playing can be recorded and will be played back in the form of a melody.
Auto rhythm: 10 built-in rhythms with variable tempo and balance, can be incorporated in manual playing or added to your recording.
Facilities: LCD numerical display shows pitch, including sharps and programming information. Built-in amplifier and speaker. Output jack. Pitch control.
Calculator: 8 digits, +, −, x, ÷, square roots, %, constants and full memory.
Power source: Four AA size batteries or AC adaptor **(price £5).**
Dimensions: 30mm x 300mm x 75mm (1⅛" x 11¾" x 3").
This compact, battery powered lightweight (438g, 15.4oz) can be played anywhere.

Available now

OTHER CASIOTONE KEYBOARDS

MT-30 Polyphonic, 22 instruments over 3 octaves. Battery/mains (RRP £115) **£95.**
CT-301 Polyphonic, 14 instruments over 4 octaves. 8 x 2 rhythm accompaniments. Vibrato, delayed vibrato. Pitch control. Output jacks. AC only (RRP £285) **£245.**
CT-401 As CT-301 but with Casio Auto Chord for one finger or auto accompaniment. Plays major, minor and seventh chords with bass. Integral sustain and hold. (RRP £345) **£295.**

THESE SPACE INVADERS WILL ALARM YOU — The price won't

CASIO'S MOST AMAZING WATCHES EVER

Display: Hours, minutes, seconds, am/pm, day and date. 12 or 24 hour format.
Auto Calendar: Day, date, month, year.
Alarm: 24 hour, with "On" symbol.
Hourly Chimes: Time signal every hour, on the hour. Easily switched on or off.
Professional Stopwatch: Lap times etc, from 1,000th second to 24 hours.
Dual Time: Second time zone.
Calculator: 8 digits, four functions, with constants and display symbols.
FINGER-TOUCH KEYBOARD.
DIGITAL SPACE INVADER GAME/with sound effects and scoring.
Water resistant case. Mineral glass.
CA-90: 46 x 36 x 10.55mm. Black Resin.
CA-901: 40.5 x 35.2 x 10.5mm. Metal.

CA 901 (RRP £34.95)
ONLY £29.95

The random digital invaders attack from the bottom right and move across the display. Every time you tap AIM your missile number, top right, progresses by 1. When your missile number coincides with an invader, tap FIRE and tha spaceship will disappear, adding to your score. The game is over if 3 of the 16 spaceships in an encounter penetrate your defences.
There are 2 stages, each stage having 9 encounters. In stage 1 the game speeds up with each encounter and in stage 2 the invaders attack from a closer position. After stage 2 the game reverts to stage 1 but the score, displayed after each encounter, is incremental.

CA 90 (RRP £29.95)
ONLY £24.95

A CLASSIC IN ITS TIME

Battery powered, with integral stand. Ideal for car, caravan, boat, domestic or office use, or as a pocket watch (leatherette pouch with window included).

PQ-20 ALARM CLOCK
(RRP £14.95)
ONLY £12.95

Large LC Display of full digital time. Symphonic alarm (Mozart, No. 40), or buzzer, with snooze facility. Hourly time signal option. Integral speaker and amplifier. Rapid setting. Accuracy +/− 15 secs/month. One lithium battery lasts approx. 12 months. Dims: 9.3 x 108 x 48mm. (⅜ x 4¼ x 1⅞"). 53g (1.9oz).
MA-1 Battery Alarm Clock
Similar to PQ-20 but has blue LC Display, nightlight, 3 position volume control. 3 AA batteries last 15 months approx. Dims: 43 x 115 x 76mm (1¾ x 4½ x 3 inches). Ivory coloured case. (RRP £11.95) **ONLY £9.95**

OUR BEST SELLING SCIENTIFIC

CASIO FX-3500P

Statistical regression and integrals. Non-volatile memories and stores. 38 functional (non-volatile) steps. 2 programme storage capability. Unconditional and conditional jumps. One independent, 6 constant (non-volatile) memories. 18 pairs of parentheses, nestable in 6 levels.
61 built-in functions, Including: Integrals (Simpson's rule). Linear regression, logarithmic regression, exponential regression, and power regression. Hyperbolics, sexagesimal and co-ordinates conversions. 10 digit mantissa or 10 + 2 exponent. Two silver oxide batteries give approximately 1,000 hours continuous use with power-saving automatic cut-off, with data and memory protection. Dims: 9/32 x 2⅞ x 5¼ inches. Supplied with leatherette wallet.

ALL THIS FOR ONLY £22.95

SUMMER TIME!

Now is the time to buy a **Sports Watch** for your holidays and outdoor activities. These models (except HV027) are **WATER RESISTANT TO 100 METRES** and suitable for swimming, snorkelling, sailing and most other outdoor sports.
SEIKO DUAL DISPLAY
Analgue display of time with sweep second hand. Independent digital display of time (12 or 24 hour format); day/date calendar; 24 hour alarm function; hourly time signal; 1,100th second stopwatch. Instant setting. Luminous dial. 2 year battery life. Battery life indicator. Stainless steel case. HARDLEX glass. **JET 088.** Black outer bezel. 100 metre W/R case 36 x 40 x 9mm approx.

JET 088
100 METRE WATER RESISTANT
SAVE £35!
ONLY £94.50

HV 027
WATER RESISTANT A BEAUTIFUL SPORTS WATCH
SAVE £17!
ONLY £72.50

CASIO ALARM CHRONOS

W-100
Black resin case/strap
£19.95*

W-150
All stainless steel
£32.50*

W-150C
S/S case resin strap
£25.95*

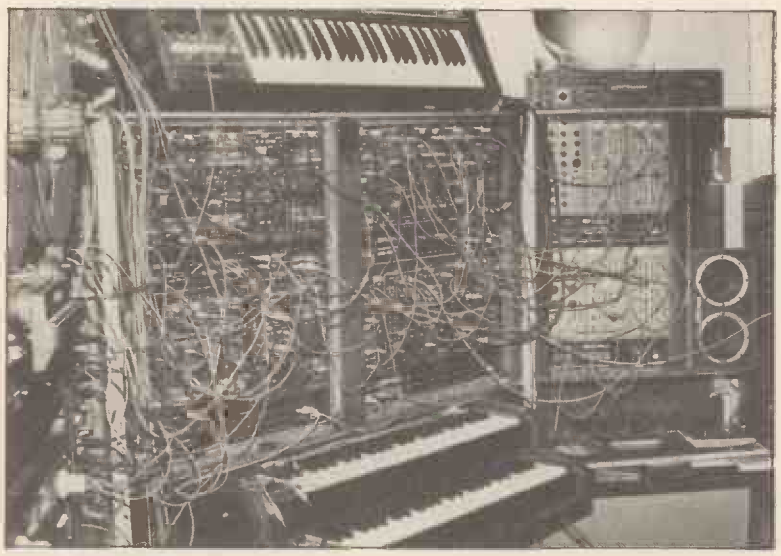
Full time (12 or 24 hour) and calendar display. Half-hourly time signal option. Alarm. 1,000th second stopwatch. Lap timing. Countdown alarm timer with repeater memory function. Time is always visible regardless of display mode. Nightlight. 9.65mm thick case. Mineral glass face. Amazing 5 year battery life.

Price includes VAT and P&P. Send your company order, cheque, P.O. or phone your ACCESS or BARCLAY CARD number to

TEMPUS

Dept E&MM/4, FREEPOST, 164-167 East Road, Cambridge CB1 1BR
Tel: 0223 312866

MUSIC MAKER EQUIPMENT SCENE



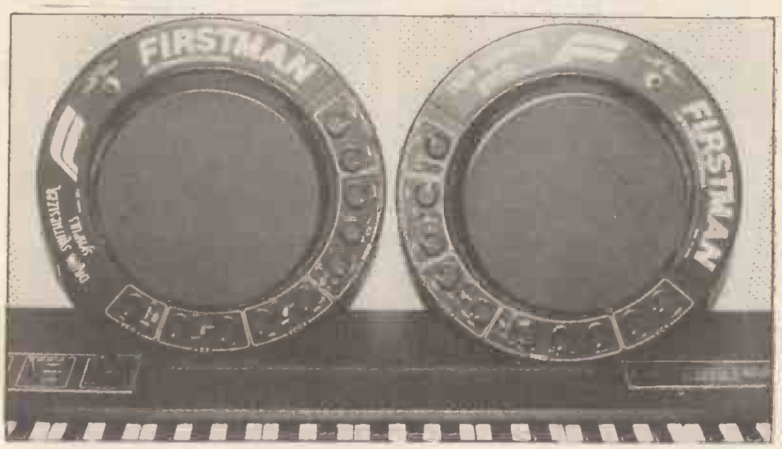
The Roland Studio.

The NOVATRON Double Manual Mk V (with cover removed). Yes, you are right — this is the successor of the original Mellotron! Unfortunately, due to a mix-up somewhere along the line, the latter name was sold to an American. This version and the 400SM Single Manual model are the only instruments now being made and are still in the 'unique' category, producing sounds from tapes that have the actual recorded instrument. All kinds of effects are available to order (e.g. Paul McCartney had bagpipe phrases from 'Mull of Kintyre' put on to different keys), although the most popular sounds are brass, strings, flutes and the impressive choir.

From Streetly Electronics Ltd, 338 Aldridge Road, Streetly, Sutton Coldfield B74 2DT, West Midlands, England.

FIRSTMAN INTERNATIONAL SYN PULS/SD-1. This drum synthesiser has its controls positioned round the circular solid foam pad. The synthesiser has five sections: VCO-1; VCO-2 which doubles as an LFO; VCF; VCA; and SWEEP which is used to give changes in pitch and tone— the harder you beat the pad the larger the variation. The Synpuls is powered by two 9V batteries.

From Firstman Corporation, 1, Hachimancho, Higashikurume-Shi, Tokyo, Japan.



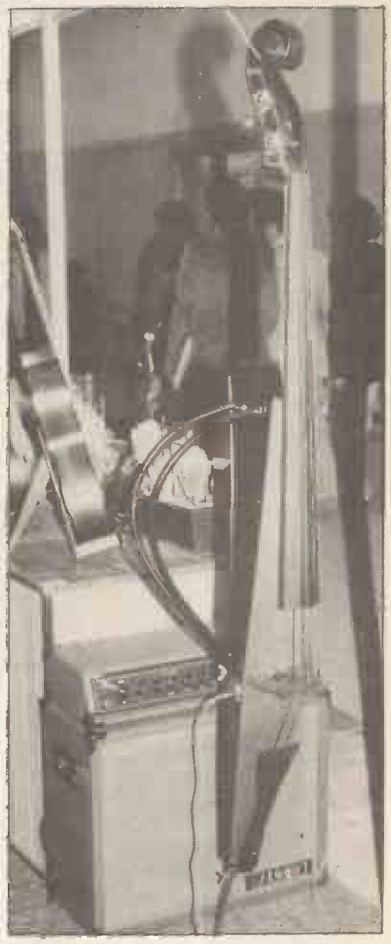
'AUDIOS" EFFECTS UNIT. **This is a state-of-the-art, all purpose effects unit. The scope of effects and sound 'experiences' that it is capable of creating stretches from barely audible texture alterations to full orchestral sound generated by one vocal solo. The three main sections are a sound storage memory, a transposer and a time delay unit. The Audios is stereophonic and some of the possibilities are: phasing, flanging, hyperflanging, sound storage for transposed playback, pinpointed memory recall by program keys and pedals, sound depth enhancement, different delay times for each channel, vibrato, double stereo phasing, pre-programmable transposition intervals, natural vibrato by pre-selectable attack-decay, and concise setting of transposition intervals and delay times through the 4-digit digital display. Rather impressive!**

From R. Barth KG, Grillparzerstr. 6a, D2000 Hamburg 76, W. Germany.

SEQUENTIAL CIRCUITS POLY-SEQUENCER. This sequencer, available as a separate unit or as an addition to the Prophet-10, was designed to be simple to use, but no compromises were made in its capability or flexibility. The sequencer records up to six 'real time' sequences; the exact notes and timing being recorded (total storage capability is over 2,500 notes). The facilities include editing, single-stepping, external clock and transposition. There is also an internal 'Mini' digital cassette to store the sequences on! One of the most attractive features is the possibility of setting up automatic program changes in a sequence allowing note groups to be linked in specific sequences.
From Sequential Circuits, 3051 North First Street, San Jose, CA 95134.

OBERHEIM OB-Xa. The Oberheim OB-Xa programmable polyphonic synthesiser represents the latest step in Oberheim's philosophy of 'evolutionary product development'. The OB-Xa is an expansion of the OB-X with programmable split keyboard and doubling option, which allows the synthesist to play two different sounds on each section of the keyboard. By selecting different program combinations and mixing them with the balance control, many new complex sounds are possible. The OB-Xa has an additional four-pole filter and modulation facilities. It is supplied with 32 different preset sounds and 8 split/double combinations. As with the OB-X, it is available in four, six or eight voice configurations.
From Oberheim, 1455 19th Street, Santa Monica, California 90404.

"SOUND AROUND" from Lemon Studio Sound. Lemon Studio Sound have provided a different approach to the instrument amplifier. The Sound Around cabinet has an internal 200 Watt amplifier with direct and effects input channels plus a bass speaker and horn on all four sides! The dimensions are a modest 55 x 42 x 42 cm.
From Lemon Studio Sound, Haselweg 13, 75 Karlsruhe, Germany.



VAN ZALINGEN BASS. This acoustic, electronically amplified string-bass claims advantages over its traditional counterpart by virtue of its special construction. The slim shape makes it more portable and musical characteristics offer easy to play high notes, no 'wolf' tones, equal volume for the whole instrument range and yet still retaining the acoustic double-bass sound.
From Alpha Musical Instruments, Kruisbroeksestraat 7, P.O. Box 212, 5280 AE, Boxtel, Holland.

HH P73 ELECTRONIC PIANO. Many of the electronic pianos arriving on the market in recent years have not been well received by discerning musicians. HH have tried to put 'life' into the sound by use of advanced computer technology. The P73 contains a microprocessor which produces rich complex voicings and the tonal structure of each note is modified throughout its duration as in an acoustic instrument. The piano has five different voices: Piano 1 'Normal Piano', Piano 2 'Stage Piano', Piano 3 'Jazz Piano', Piano 4 'Grand Piano' and Clavichord. The output is in stereo with panned tremolo and a 'space' control which combines phasing and chorus effects. The piano is complete with a sturdy case, legs and a dual footswitch for sustain and volume boost.
From HH Electronic, Viking Way, Bar Hill, Cambridge CB3 8EL, England.

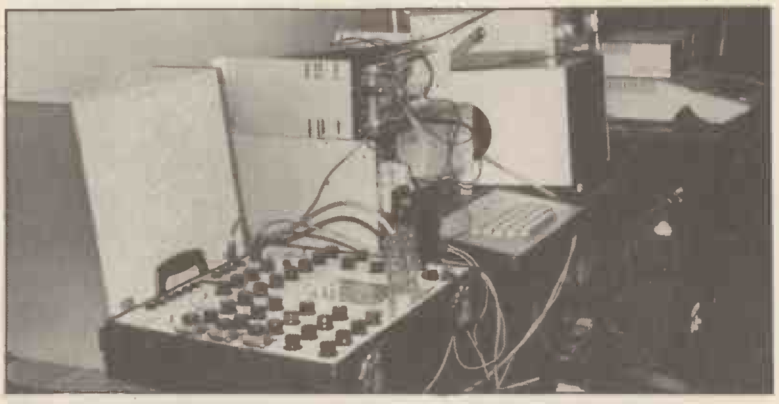
Electronics and Music in Harmony

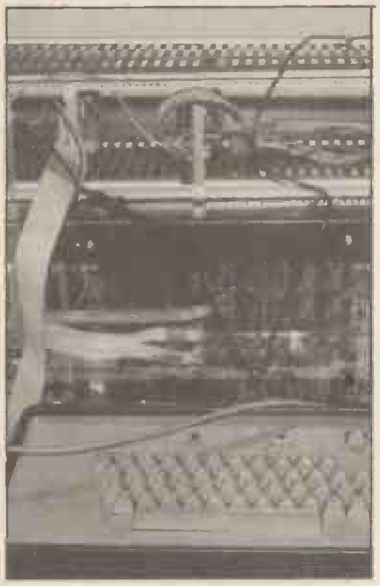
Lectures at the Institute of Electrical Engineering, P. Conway (Leeds Polytechnic), D. Finlay (City University), K. Jones (City University)

Who would have thought that the invention of the thermionic valve in 1906 would lead to such advanced developments as complex music synthesisers and computers, less than 60 years afterwards. This lecture demonstrated the contribution that electronics has made to music, from early musical devices to one of the latest computer music systems.

Paul Conway, from Leeds Polytechnic, presented a technically biased description of analogue techniques used for sound synthesis. Any musicians present without a mathematical background, would have been bewildered by his quick delve into Fourier analysis and descriptions of early electro-mechanical methods of generating sounds. Fortunately some of the technical descriptions of effects, such as pitch and amplitude modulation, were demonstrated using a Crumar 'Performer' polyphonic synthesiser.

The next lecture was given by Don Finlay from City University, London. Don began by briefly describing how the invention of the digital computer had made possible a new field of music synthesis. However, it is only recently with the cheap processing power of microprocessors, that the individual can experiment. Using a 'look-up table' in the computers memory and a digital to analogue convertor, a Nascom 1 microprocessor was used to give a very close approximation to a sine wave — the basic 'building block' of sounds. More complex waveforms can be synthesised by combining, in different proportions, sine waves which are multiples of the fundamental frequency (this is called additive synthesis). The sound of conventional instruments can be synthesised by changing the harmonic content of a waveform with time. This is the principle used in the new Fairlight CMI reviewed this month. The limitations are the amount of memory available and the speed at which the computer can perform the computations.





Another approach to music synthesis with computers is the control of external hardware, such as a synthesiser: the memory size of Mr Finlay's Nascom 1 was only 4k; consequently he constructed a 9-channel multiplexed system to enable the micro to control 9 v.c. functions of an analogue synthesiser. This was demonstrated using the Nascom 1 to play a melody in 3-part harmony.

The 'piece de resistance' of the evening's lectures was the sophisticated Apple Music System. Kevin Jones, a research fellow at City University, has been working with the Apple to study stochastic composition techniques. Essentially the system consists of special hardware and software which connects to an Apple II microprocessor. Using system subroutines written in BASIC the composer is able to 'construct' his compositions aided by high resolution colour graphics. Kevin had the audience captivated by one of his compositions called 'Turtle Soup', a computer-generated 9-part canon. The combination of the nine parts is randomly chosen by the computer to give an intricate changing collage of sound. To enhance the music the computer graphics are used to display each of the separate parts as it changes pitch. Unfortunately there was not time for the full capabilities of the Apple Music System to be discussed. Nevertheless, the lecture pointed to the microprocessor's increasingly important contribution to the expanding field of electronic music.

As the latest technology makes new music systems and devices commercially available, it becomes increasingly important that lectures such as this can be attended by the general public. Only then will electronic music and the techniques required for its composition, become a medium for contemporary composers as well as home experimenters.

Graham Hall **E&MM**

emas

The Electro-Acoustic Music Association of Great Britain was inaugurated in January 1979 and held its first Annual General Meeting in May of that year. On an Arts Council initiative, a survey of electronic music studios in the UK was carried out by Simon Emmerson during 1977 and 78; this was followed up by a series of meetings and a weekend conference in York in 1978. Directors of studios, composers and technicians met to discuss mutual problems and decided that the formation of a national group to promote the interests of this area of music was essential. The UK was in many respects behind in the provision of facilities for research and composition and the greatest effort would be needed to catch up — both in hardware and in actual studio experience.

While EMAS roots lie in a relatively 'elitist' tradition of serious music composition, most members are fast becoming aware that there cannot be a divide between 'traditional' electronic music studios and more advanced 'popular' studios. The weight of investment and development is now firmly with the latter.

It is therefore essential that the experience of sounds which comes naturally to the studio composer should be allied with the new technologies in the development of the studios of the 1980's — microprocessors and digital recording especially. EMAS holds that there are many interests in common between all aspects of *electro-acoustics*, from sound recording, montage, mix-multitrack works, to pure abstract electronics. EMAS has already organised concerts and a computer music conference, and administers a Sound Equipment Pool for concert hire. In forthcoming issues I want to set the scene and describe some of the composition studios found throughout the country who are members of EMAS.

But first a short history. Electronic Music studios have most commonly grown up in two types of institution: in Radio Stations or in Universities (or other institutes of Higher Education). The former tended to be the case on the continent of Europe, big studios were developed in the ORTF (Paris), the West Deutscher Rundfunk (Cologne) and RAI (Milan). In America, however, richly endowed universities tended to be the centres for such work: Columbia, Princetown, Colgate, Stanford and a host of others. Britain, sadly, fell between the two approaches: while the Radiophonic Workshop at the BBC has a great history of radiophonic achievement since its inception, it has rarely had the resources to allow 'free composition'.

Few University Music Departments had the foresight to establish studios when money was to be had, leaving it until quite recently to battle for a few crumbs for the necessarily expensive technology. Nonetheless, perseverance has produced quite a number of small, efficient studios in universities in Britain which we shall examine. Another very important development has been in much more open and democratic studios based on 'continuing education', colleges and arts centres. I shall be looking at two such (at least): West Square (part of Morley College) in London and Spectro Arts in Newcastle. Even universities are now lowering their drawbridges to allow more access to visiting composers and I hope to report on an EMAS scheme for bursaries and a prize — financed by the Performing Right Society — in a future issue.

In the long run this network of rather uncoordinated activity might be brought together so that one could encourage composers from any background through a chain of possibilities: 'Evening class — advanced study bursary — full scale composition', using facilities in his region of the country — and as we shall see London does not necessarily dominate the composition studio scene! I have visions of a microprocessor controlled information network (anyone read Ivan Illich?) which would enable anyone to find out the facilities available and to contact other musicians and engineers, simply by dialling into his terminal.

Simon Emmerson
Hon. Sec. EMAS
72 Hillside Road, London N15 6NB

EVENTS

May 12th-14th	INTERNATIONAL MICRO ELECTRONICS EXHIBITION, Exhibition Centre, Bristol. Aimed at industry and business. Free tickets from Euro Fairs Ltd, 9 Park Place, Clifton, Bristol BS8 1JP.
May 22nd	THE EXPERIMENTAL MUSIC GROUP present a music theatre piece which deals with 'Exploitation' particularly in the field of advertising. Venue, Royal College of Music, London. Tickets available on the night.
May 26th	ELECTRONIC MUSIC STUDIO. Informal concert featuring work by Royal College of Music students. Venue, Royal College of Music, London. Tickets available on the night.
June 1st-4th	OPTO-ELECTRONIK EXHIBITION, Exhibition Centre, Munich. Further information from ECL (Exhibition Agencies) Ltd, 11 Manchester Square, London W1M 5AB.
June 15th-19th	INTERNATIONAL COMMUNICATIONS, ELECT'L & ELECTRONIC COMPONENTS EXBN., Milner Park, Johannesburg, South Africa. Further information from ECL (Exhibition Agencies) Ltd, 11 Manchester Square, London W1M 5AB.
June 18th	THE TWENTIETH CENTURY ENSEMBLE — Royal College of Music Conductors — Edwin Roxburgh, Lawrence Casserley. The programme includes works for instruments plus electronics. Cristobal Halffter — Variaciones sobre la Resonancia Lineas y Puntos/de un Grito. Heinz Hollifer — Pneuma (all first UK performances). Tickets on the door.
June 23rd-26th	INTERNATIONAL WORD PROCESSING EXHIBITION. Wembley Conference Centre, London. Tickets from Business Equipment Trade Assc., 8 Southampton Place, London.
June 26th/27th/28th	BROMLEY FAMILY & TRADE EXHIBITION, Norman Park, Orpington, Kent. Tickets available half price from EXPLAN, Exhibition Promoters, International House, Cray Avenue, Orpington, Kent.
June 27th/30th	NAMM INTERNATIONAL MUSIC EXHIBITION — McCormick Place, Chicago, USA. Special travel arrangements may be made with British Airways (01-821 4544), Trade Fairs and Exhibition Bureau.
June 27th/July 4th	KEYBOARD AND ELECTRONIC MUSIC FESTIVAL, to be held at the London Musicians' Collective, in conjunction with the October Gallery. If you wish to participate, contribute or perform, please post tapes, videos, cassettes to: Ken Guntar, C/O October Gallery, 24 Old Gloucester St, Queen Square, London WCL. Closing date 20th May 1981.
June 30th	LEEDS ELECTRONICS EXHIBITION, Dept. of Electrical & Electronic Engineering. Leeds University.

We shall be pleased to publish news of forthcoming electronic and electro-music exhibitions, clubs, also special electronic music concerts.

CANCELLATIONS	Audio Visual & Television Fair, Birmingham — May 10th-17th. Hobby Electronics, Bristol — May 29th/30th/31st.

SUBSCRIBE!

to ELECTRONICS & MUSIC MAKER — the No.1 Monthly for the Electronics and Music Hobbyist

For 12 issues:

UK and overseas surface £9.90
Europe £11.64
Airmail (excluding Europe).....£25.20

Overseas payments including Republic of Eire should be covered by Bankers draft in pounds sterling.

Subscriptions normally commence from the current issue of E&MM.
Back copies can be obtained from E&MM at £1 each inc. postage.

E&MM Subscriptions Dept., Maplin Publications
282 London Road, Westcliff-on-Sea, Essex SS0 7JG

E&MM Subscriptions Dept., Maplin Publications, 282 London Road, Westcliff-on-Sea, Essex SS0 7JG.

Please send me the next 12 issues of Electronics & Music Maker. I enclose a cheque/postal order* for £9.90/£11.64/£25.20* made payable to Electronics & Music Maker.

**DELETE AS APPROPRIATE*

PLEASE PRINT

Name ....

Address ....

....

E&MM6/81

BOOK REVIEWS

Microphones in Action

by Vivian Capel
Published by Fountain Press
Price £5.00 in softback

It is always hard to write a book about a continuously changing field, in this case microphones. The writer may play safe and keep to the theory ignoring all the 'real' items, thus leaving the reader no wiser about what to use for an application, or include up to the minute technology that quickly becomes dated. Vivian Capel succeeds admirably in the first part of his book, illustrating the theory with plenty of photographs of actual microphones showing commercial application of the theory. Indeed, the whole theory section (which occupies the first 7 chapters) is excellent. It is clearly laid out and for the most part the text is easy to read, although the small size of some of the data tables will require a careful eye.

With the theory out of the way, methods of connecting up microphones are considered. Again the explanation is lucid and accompanied by diagrams that illustrate the text well. I would have preferred to have seen more circuit diagrams at this stage since most of the explanation stops at the block diagram stage leaving the reader to search elsewhere for suitable circuits.

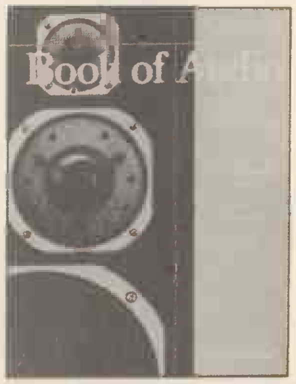
The second part of the book deals with actually using a microphone to make a recording, and opens with a description of reverberation and room styles leading to some of the problems which occur. A chapter entitled 'Choosing The Right Microphone' may well lead the reader to believe that suggestions of the best microphone for certain jobs will be made, and to a limited extent this is true. The type of microphone required is suggested, leaving the reader to thumb through the first half of the book for an example. It is also a pity that 'pop groups' are dismissed in 8 lines. Moving on to actually using the microphones and interesting points start to emerge, but not much mention is made to tricks of the trade, such as rolling off the bass when recording acoustic guitars to obtain a 'clean' sound. Most sort of applications are covered with several pictures to demonstrate the technique involved. 'Pop groups' are again glossed over and a few words, for example, about the miking up of a drum kit would not be out of place since the methods are very interesting.

All in all however, this is a good book for the beginner, and the experienced user who wishes to become more acquainted with the theory. Provided that the main interest is not with 'pop groups' (which are hardly mentioned) the book is worth reading.
Chris Lare

Newnes Book of Audio

Edited by K. G. Jackson
Published by Newnes Technical Books
Price £4.95

When a book comprises a compendium of manuscripts written by different authors, there is a real danger that the outcome will be simply a collection of disjointed articles that just happen to reside between two covers.



In no way does the Newnes Book of Audio fall within this category, being well presented and with good continuity throughout. Each author compliments his literary 'bed-mates', referring freely to other sections but avoiding duplication.

The seven authors, each established experts in their own fields, have managed to paint a comprehensive picture of the audio scene both from an equipment and application viewpoint. Although written in easy-to-understand language, suitable for beginners, the book still holds some areas of interest for the enthusiast.

Divided into ten sections, with six additional items of background interest, the whole field of audio, with particular reference to hi-fi, is explored both in general and technical terms. Line diagrams and photographs are liberally used and complement the text.

Each section of the book covers a distinct area of the world of audio taking one through recorders, disc reproduction, tuners, aerials, amplifiers, microphones and loudspeakers. Of special interest are sections on the making of recordings (a neglected art), mobile audio systems and a synopsis of hi-fi generally.

I found the book to be well written and illustrated, easy to read and interesting although it is probably of more use to the newcomer and raw amateur than to the established enthusiast. Certainly valuable to a buyer considering a new set-up and who is confused by the abundance of equipment now available.
Anthony M. Ball

International Transistor Equivalents Guide

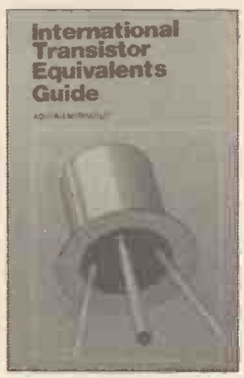
by Adrian Michaels
Published by B. Babani Ltd.
Price £2.95

Ever since the transistor became generally available at an economic price the problem of finding substitutes has been with us. Today, with equipment being supplied from world wide sources, the vast array of semi-conductors presented to one is, to say the least, daunting. The chances of a particular transistor being readily at hand is not good and the search for substitutes difficult.

The International Transistor Equivalents Guide goes a long way to solving this problem with equivalent and near-equivalent devices being listed for over one hundred manufacturers. Using alpha-numeric sequence, the identification of a particular device is quick and easy. Included are a selection of substitutes for most of the popular, user-orientated modern transistors likely to be encountered.

The tables list concisely type number, material type, polarity, manufacturer and an indication of the application the device is most suited to. Equivalents are sub-divided into European, American and Japanese types.

It must be realised that direct equivalents are not always possible and that electrical and mechanical



characteristics might differ somewhat between manufacturers. Indeed, there is occasionally slight variation between devices having the same type number. With this in mind and where circuits having critical parameters are involved, it would be wise to consult manufacturers' specifications before making a substitute.

I do feel that this book will be a valuable addition to the bookshelf of all those taking an active interest in electronics and will augment the various transistor data books that are available.
Anthony M. Ball

Electronic Synthesiser Projects

by M. K. Berry
Published by B. Babani Ltd.
Price £1.80

This book contains about ten separate building-brick type projects, discounting power supplies. The accompanying circuit descriptions are reasonably informative but certainly not over-detailed. I would prefer to see just a bit more detail, particularly as there are one or two configurations which might cause problems if taken at face value, the key trigger switches on the 'Keyboard and Sample and Hold' being a particular example.

On the plus side these projects are all cheap to build and readily available components have been used wherever possible without sacrificing circuit simplicity.

Subjects covered include a single

chip synthesiser based on the Texas SN76477N I.C. Various analogue delay line applications utilising the TDA1022 bucket brigade I.C. plus assorted, active, low-pass filters. The effects available from the delay circuits include phasing, flanging-vibrato, reverberation and echo.

One chapter of the book is devoted to sequences including construction details of an analogue sequencer and a description of its application. Although digital sequencers are mentioned in some detail there is no accompanying project which I feel is a unfortunate omission.

Two voltage controlled oscillator circuits are covered in reasonable detail and a keyboard interface is also included.

The final project in the book is an ADSR type envelope generator for amplitude control. With these building bricks connected together, the contructor should end up with a fairly good synthesiser. I am very surprised that there is no voltage control filter circuit in the book. Although it is obviously impossible to cover all aspects of the subject, this really is a curious omission.

With so few books on this subject it is impossible to make comparative judgement. However, over all this is a well balanced book with sufficient detail for the majority of home constructors.
Martin Christie

TEACH-IN FOR THE 80's

ELECTRONICS CONSTRUCTION KITS

Electronics assembly is fast becoming the most fascinating and educational hobby for beginners of all ages.
Monthly constructional projects, appear in most of the magazines in the hobbiest electronics field, with basic technical principles and symbols explained in great detail.
The sheer simplicity of these projects are a must for all beginners. Start with a hobby that could become a worthwhile career.
Our kits come complete with all parts as specified.
*ALL PROJECT KITS ARE SUPPLIED WITH CASES
(except items marked *).
All kits come complete with items; plus Texas IC sockets where required, also Veroboard connecting wire, etc.

Listed below is a selection of the many projects available.
Reprints are available at 40p extra.

Audio Effects Unit	ZB122	Oct. 80	£12.25
Phone Call Charge Jogger	ZB121	Oct. 80	£6.90
Darkroom Controller	ZB123	Oct. 80	£17.25
Bicycle Alarm	ZB124	Oct. 80	£9.25
Precision Parking Pad	ZB73	Sept. 80	£3.50
Lights Failure Monitor	ZB77	Sept. 80	£3.75
TTL Power Supply Unit	ZB78	Sept. 80	£9.50
Duo-Deci Timer	ZB75	Sept. 80	£8.50
*TTL Logic Probe	ZB76	Sept. 80	£3.25
Bedside Radio	ZB74	Sept. 80	£14.25
Auto Lighting-Up Warning	ZB71	Aug. 80	£5.65
Audio Millivoltmeter	ZB70	Aug. 80	£17.75
Weather Centre (Electronics only)	ZB72	Aug. 80	£47.50
Brakesafe Monitor	ZB68	Aug. 80	£7.50
Cricket Game	ZB69	Aug. 80	£14.95
Zener Diode Tester	ZB79	July 80	£5.00
Signal Tracer	ZB80	July 80	£5.00
General Purpose Amplifier	ZB81	July 80	£6.00
Voltage Converter	ZB82	July 80	£4.75
Autowaa	ZB83	July 80	£19.25
A.F. Signal Generator	ZB84	July 80	£20.00
Courtesy Light Delay	ZB85	July 80	£5.25
Auto Phase	ZB86	July 80	£19.25
Battery Voltage Monitor	ZB64	May 80	£4.80
Lights Warning System	ZB63	May 80	£3.60
Autofade	ZB66	May 80	£10.25
*Dual Line Game	ZB65	May 80	£25.00
Audio Tone Generator	ZB67	May 80	£3.50
*Pre-tuned 4-Station Radio	ZB62	May 80	£14.00
Gas Sentinel	ZB61	April 80	£27.00
Automatic Level Control	ZB60	April 80	£8.00
Cycle Direction Flasher	ZB59	April 80	£14.50
Cable and Pipe Locator	ZB54	March 80	£3.75
Stereo Headphone Amplifier	ZB57	March 80	£15.25
Doorbell Register	ZB58	March 80	£3.60
Five Range Current Limiter	ZB53	March 80	£4.50
Kitchen Timer	ZB55	March 80	£12.75
Touch Switch	ZB56	March 80	£9.00
Micro Music Box	ZB45	Feb. 80	£17.00
Simple Short Wave Receiver	ZB44	Feb. 80	£18.00
Morse Practice Oscillator	ZB43	Feb. 80	£6.00
Slide/Tape Synchroniser	ZB42	Feb. 80	£11.50
Spring-Line Reverb Unit	ZB49	Jan. 80	£22.50
Mains on/off Timer	ZB48	Jan. 80	£30.00
Power Supply 3-9V	ZB47	Jan. 80	£4.50
Loft Alert	ZB46	Jan. 80	£33.00
Lightcall	ZB103	Dec. 79	£6.25
Burglar Alarm	ZB51	Dec. 79	£5.00
Baby Alarm	ZB40	Nov. 79	£8.50
Opto Alarm	ZB41	Nov. 79	£5.00
Radio Tuner MW/LW	ZB108	Nov. 79	£14.75
3-Function Generator	ZB52	Nov. 79	£25.00
One Armed Bandit	ZB33	Oct. 79	£21.00
Lights-on Reminder	ZB34	Oct. 79	£4.60

Signal Level Indicator	ZB36	Oct. 79	£4.50
High Impedance Voltmeter	ZB35	Oct. 79	£14.50
Universal Oscillator	ZB37	Oct. 79	£3.50
Chaser Light	ZB4	Sept. 79	£17.50
Lower Power Audio Amplifier	ZB3	Sept. 79	£3.75
Simple Transistor Tester	ZB2	Sept. 79	£5.50
Varicap MW Radio	ZB1	Sept. 79	£8.50
Quiz Referee	ZB12	Aug. 79	£4.75
Touch-on Pilot Light	ZB10	Aug. 79	£2.00
Trailer Flasher	ZB9	Aug. 79	£3.00
Swanee Whistler	ZB8	Aug. 79	£3.50
Electronic Tuning Fork	ZB7	Aug. 79	£3.90
Power Supply 9V	ZB6	Aug. 79	£3.25
Warbling Timer	ZB5	Aug. 79	£5.80
Water Level Indicator	ZB111	July 79	£4.50
Dolls House Lights Economiser	ZB107	July 79	£4.50
Darkroom Timer	ZB17	July 79	£2.50
Soldering Iron Bit Saver	ZB13	July 79	£9.25
Voltage Splitter	ZB15	July 79	£3.25
Conference Timer	ZB14	July 79	£38.00
Electronic Canary	ZB19	June 79	£4.50
Tremolo Unit	ZB18	June 79	£10.00
Meter Amplifier	ZB21	June 79	£3.50
Quad Simulator	ZB22	June 79	£8.00
Short Wave Converter	ZB25	May 79	£13.75
Electronic Dice	ZB24	May 79	£13.50
Intruder Alarm	ZB23	May 79	£23.00
Shaver Inverter	ZB26	April 79	£8.00
Touch Bleeper	ZB27	April 79	£3.25
Choke Warning Device	ZB28	April 79	£7.50
Transistor Tester	ZB100	April 79	£4.00
One Transistor Radio MW/LW	ZB104	March 79	£7.25
Time Delay Indicator	ZB98	March 79	£4.00
Micro Chime	ZB96	Feb. 79	£12.00
Lights Reminder for Car	ZB32	Jan. 79	£4.50
Headphone Enhancer	ZB101	Jan. 79	*£4.00
Solid-State Roulette	ZB95	Jan. 79	£18.25
I'm First	ZB105	Jan. 79	£3.70
Continuity Tester	ZB115	Jan. 79	£4.30
Fuzz Box	ZB106	Dec. 78	£5.00
Vehicle Immobiliser	ZB110	Dec. 78	£5.00
Audio Effects Oscillator	ZB109	Nov. 78	£3.50
Tele-Tel	ZB94	Nov. 78	£17.80
Radio MW/LW	ZB116	Oct. 78	£7.00
Sound to Light	ZB112	Sept. 78	£7.00
R.F. Signal Generator	ZB93	Sept. 78	£20.50
Guitar Tone Booster	ZB117	Sept. 78	£5.00
A.F. Signal Generator	ZB119	Aug. 78	£10.00
Quagmire	ZB120	July 78	£9.50
Tele-Bell	ZB118	June 78	£12.25
Weird Sound Effects Generator	ZB113	March 78	£3.50
Catch-a-Light	ZB102	March 78	£6.00
Chaser Light Display	ZB97	Feb. 78	£22.00
Car System Alarm	ZB92	Feb. 78	£4.50

PERSONAL CALLERS PLEASE RING TO CHECK AVAILABILITY OF KITS
ALL PRICES INCLUDE POST PACKING AND 15% V.A.T.

MINI I.C. RADIO OCTOBER '80 ZB126	£10.35
DUSK/DAWN RELAY OCTOBER '80 ZB125	£7.45
SOUND TO LIGHT ZB127 NOV. '80	£19.00
GUITAR PRACTICE AMPLIFIER ZB128 NOV. '80	£16.85
REACTION TESTER ZB129 NOV. '80	£10.25
PRECISION TIMER ZB130 NOV. '80	£21.00
TRANSISTOR TESTER ZB131 NOV. '80	£8.00
SOIL MOISTURE MONITOR ZB132 NOV. '80	£5.00

OTHER THAN STATED, PRICES ON APPLICATION

CALLERS BY APPOINTMENT ONLY
HOURS: Mon-Fri 9.00-5.30 p.m. Sat. 9.00-4.30 p.m.

T. POWELL

ADVANCE WORKS, 44 Wallace Road
London N1. 01-226 1489

HOURS
MON FRI. 9 5.30 PM
SAT. 9 4.30 PM

ORDERS
ADD 30p POST/PACKING
ADD 15% VAT TO TOTAL

Minimum telephone Orders £5.00
Minimum Mail Order £1.00

BITS & PIECES

by Mark Space "SOUNDS GOOD"

Ears should be kept akimbo for some of the newest American albums, of which Garland Jeffreys' 'Escape Artist' (Epic), with his beat ballad/reggae formula brings together such stalwarts as Lou Reed; members of Springsteen and The Rumour; and reggae/dub specialists Big Youth and Linton Kwesi Johnson. An EP ('Miami Beach'), that comes with the album puts a spotlight on American race-relations. Altogether a live sound, indeed.

Another American offering, though with a touch of the Anglo's, is the collaboration between Brian Eno and David Byrne resulting in the experimental 'My Life in the Bush of Ghosts', (Polydor). This recipe takes voices from various sources (radio chat shows, Lebanese Mountain Singers, etc.), spices them with the sound of synthesisers and other instruments, and then simmers the whole over a percussive stove. Like most experiments, sometimes it does and sometimes it doesn't; but present results show future promise.

San Francisco has produced more experimental musionics by way of Tuxedomoon's 'Desire' (Pre/Charisma), which ranges from the hypnotic to the weird.

For those who find 'experimental' a 3 x 4-letter word and take their rock neat, the Stray Cats have the right-shaped bottle. Their album, unconfusingly labelled 'Stray Cats' (Arista), shows them in great form as leaders of the new rockabilly phase — with plenty of solid rock and R&B styles thrown in — but preserving a modern face with offerings like 'Storm the Embassy'.

Spare a tear for those sons of Wigan, the Moonlove, whose electronic affinity with such as Gong (and, perhaps, Tangerine Dream), have made them invisible men to the heavy-metal-hungry Wiganites, despite the acclaim accorded to the group by *die Jungen Volk* on the Continent. Alas, a prophet is ever without humour in his own country; so the Moonlove must rest content with the other kind of prophet and continue making their Marks in Germany until the wheel of fashion turns again.

Sadly, box-office popularity seems to depend more upon trends than virtuosity. But some virtuosity commands perennial recognition, as the Climax Blues have demonstrated ever since 1970. Peter Haycock, the guitarist, deserves a wider public to appreciate his performance; whilst the relaxed expertise and natural rhythm of the group goes a long way towards reviving the flagging faith of rock fans.

Of all the Muses it is smiling Terpsichore who draws her devotees from the widest age-span of mortals. Take just two modern examples, Mark Shakespeare and George Allum.

Mark, currently concert organist for Electro-Voice Limited, had played the Blackpool Tower, given a solo performance at the London Palladium, and won a national competition by the time he was fourteen years of age. Recently he has released three LP's and achieved his seventeenth year.

George, a member of Phillip Wachsmanns' Avantegarde Workshop at the City Lit, gave a recital of electronic music of his own composition during a South Bank concert. His piece, 'Dawn/Evening', took its place alongside a Debussy piano-piece, a violin and piano sonata by Mozart, and a duet from Act I of Verdi's 'Simone Boccanegra'. Young George has lived in Westminster for every one of his seventy years ——.

The fame of John Chowning's work in the synthetic reproduction of vocal tones has spread far from the Stanford University of California at which he is Professor of Music, and a founder member of the Center for Computer Research in Music and Acoustics where significant advances in this field have been made.

There can be no disputing the fact that the use of computers in composing and performing music is an important, vast and unexplored area of development. In some quarters the opinion is already held that the computer-generated sounds of the future will be better than those produced by human means. If this is true there will be little encouragement for future Rubensteins or Galways if their highest praise is to be told that their performance was 'nearly as good as a Computer, old man!'

A scrutiny of the various reports on computer-acoustic activities will reveal the Adspeak techniques of the PR-men at work, aided and abetted by enthusiastic Jargoneers. 'Natural' and 'Artificial' — with their emotional overtones of 'good' and 'not-so-good' — have been banished and 'Concrete' and 'Synthesised' installed in their places. Now we can only choose whether or not to listen to the 'synthesised song of a nightingale', the 'concrete song of a nightingale', or — worst of all — the 'song of a concrete nightingale'.

Ignoring the semantics and academic hassles of computer-acoustics, Richard Burgess and his band, Landscape, concentrate on using these new techniques to extend their range of emotion-communication. Their latest album, 'From the Tearooms of Mars to the Hellholes of Uranus', (RCA), gives a bright pointer to the pop potential latent in computer music. By taking past styles of music and projecting them into a futuristic setting the richness of the new sounds has been vividly demonstrated for the benefit of those who will follow after.

Modestly decrying his abilities as an electronics expert and a musician, Richard Burgess insists that his motivation is to provide entertainment. Just how well his motivations function can be seen by the demands on his skill made by Landscape; the Shock dance troupe; the Spandau Ballet; and a raft of complex-programming side projects.

Right now a 35-minute B-movie, based on 'Tearooms of Mars' and featuring the Shock, is a positive gleam in the Burgess eye; but enthusiasts must bear their souls in patience. E&MM

EDUCATION

Electronics & Music Maker looks to the future by choosing projects that use up-to-date technology and features that inform its readers of the latest developments in electronics and electro-music.

Education in its broadest sense is therefore one of the key aspects of this magazine.

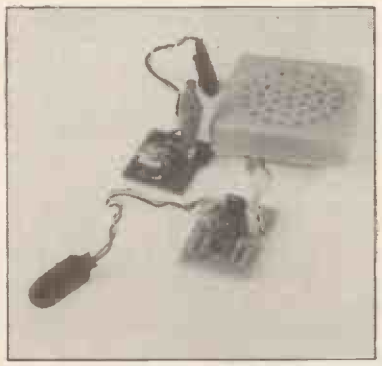
It is also exciting that it will be read by teachers and pupils alike through its wide circulation in this country and many subscriptions abroad.

Chip Shop Kits

While there are a number of publications catering for beginners to electronics construction, there seems to be very few electronic kits for beginners currently available. The range of twenty inexpensive kits very recently introduced by Electroni-Kit Ltd (who are well known for their "Denshi" multi-project kits) is therefore a welcome step which should help to fill this gap. Known as 'Chip Shop Kits', the new range consists mainly of single project kits, although a few are '2 in 1' kits that enable two separate projects to be constructed. These are not solderless kits and each project is built on a printed circuit board, but a soldering kit (Kit No. 2) and a tool kit (Kit No. 3) are included in the 'Chip Shop' range.

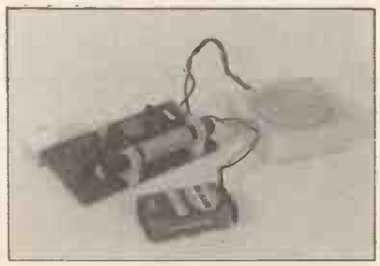
Three 'Chip Shop' kits have been investigated by E&MM with the help of some willing youngsters, and our findings for each are given below.

Kit No. 5: Morse Code Trainer & Siren Oscillator.



Kit No. 13: Light Sensitive Alarm & Electronic Lamp.

Kit No. 19: 4 Transistor Radio with parts unpacked.



The completed Transistor Radio with ferrite aerial.

(19) 4 Transistor Radio

At first sight the circuit for this kit looks like a four transistor push-pull audio amplifier of the type using two transformers, fed from the coupling winding of a ferrite aerial! A closer scrutiny of the circuit shows that the input and driver transistors are biased virtually to saturation and cut off respectively, and therefore provide the rectification needed for AM demodulation. A filter capacitor across the primary winding of the driver transformer provides the RF filtering. A simple circuit of this type is obviously not going to give a level of performance equal to a superhet design, but TRF designs of this type can combine good usable performance and low cost.

The instructions for this kit are clear and concise, and there were no problems in building the set. It was a little disconcerting to find a length of fine wire coming from the driver transformer, but a resistance check on this component revealed that it was in working order. There is no case supplied with the kit, but there is a plastic moulding which fits over the front of the speaker and protects the delicate diaphragm.

The performance of the finished receiver was a little disappointing to say the least. Only the MW band is covered, and no stations were reproduced from the loudspeaker at acceptable volume. In a strong reception area the ferrite aerial may be adequate, but in most places the use of an additional wire aerial will be necessary. The instructions deal with the use of an external antenna, and using one of these does give improved volume. However, loading on the ferrite aerial reduces its selectivity, and station separation suffers as a result.

Although this is an excellent kit in many respects, it is badly let down by the performance of the finished article.

(5) Morse Code Trainer & Siren Generator

The kit was sensibly packed and the components were readily identifiable. The instructions were reasonably explicit but there were two points which could be disconcerting to beginners and (or) young constructors:—

1. The text refers to specific colours of wire (in this case blue) whereas the kit was supplied with orange wire.
2. The constructor is told to connect the positive battery lead to earth, but it is a negative earth circuit.

Another disappointing omission is that having made the board up and having connected the external components (i.e. loudspeaker and switches) there are no suitable holes in the case for the switches to fit into. This tends to irritate younger constructors. Furthermore, even an experienced constructor would have considerable difficulty in fitting all the items into the case.

Nevertheless, the finished kit does give a feeling of achievement and is worth the outlay. All in all a good buy both for educational purposes and as a useful present for 10-15 year olds with an interest in electronics.

(13a) Light Sensitive Alarm (13b) Electronic Lamp

This kit comprises two completely separate projects — a 'light-sensitive alarm' and an 'electronic lamp'. We are informed that the kit is aimed at 'teenagers and adults', but 'intelligent 10 to 12 year olds should have no difficulty in completing the project'.

As with the other kits, everything required for completion is included except the PP3 battery and a soldering iron. Sufficient solder is included, but there are no cases to house the completed projects and the boards are not tinned to keep the kit price as low as possible. The instructions give details of the resistor colour codes so that identification is easy; transistors and capacitors are identified by their markings, but a complete beginner might possibly have difficulty in distinguishing between these and the light dependent resistor (LDR), but careful study of the instructions should prevent mistakes.

The instructions are clearly set out in a logical order and are easy to follow. Construction is straightforward and is aided by the clear diagrams. It would be almost impossible, for example, to connect the transistors the wrong way.

Advice on soldering technique is sound, but is slightly lacking as far as the complete beginner is concerned. We are told to 'keep the bit well tinned', but there is no explanation as to what this means. No mention is made of the possibility of heat damage to components! On the whole the beginner would be well advised to refer elsewhere for soldering technique (e.g. Beginners Guide To Building Electronic Projects by R. A. Penfold; Bernard Babani (publishing) Ltd., £1.25, which also contains other useful tips for the beginner). There is no substitute for practice, however.

The light-sensitive alarm is of fairly general appeal. It emits a reasonably loud tone (which could rapidly become nauseating!) when exposed to light. The possible applications of the device are numerous, quite apart from the possibilities as a gimmick, which might appeal to young constructors. The same cannot be said of the electronic lamp which merely lights up a rather dim neon lamp. It does illustrate important electronic principles, but there would be very little demand for this project on its own.

The 'How it works' explanations give a general idea of what is going on inside the circuits, but in order to fully understand the principles involved a reasonable knowledge of electronics is obviously required. Beginners would once again need to enquire elsewhere for a full understanding.

On the whole the kit is reasonable value at a price of £5.00. It would appeal especially to 'intelligent 10-12 year olds' to whom it would be convenient to purchase such items in complete-kit form.

Conclusions

For their price, the 'Chip Shop' kits offer a lot of fun for the newcomer to building electronics projects — especially for young enthusiasts aged 10 or over. Although the limitations of the kits may deter some adults, no doubt they will be popular, and with continued improvement to detail will become a most useful range of educational electronics kits.

'Chip Shop' kits are distributed by Electroni-Kit Ltd., Rectory Court, Chalvington, Hailsham, E. Sussex, and should be available in hobby and electronics stores throughout the country. **E&MM**

CLASSIFIEDS

APPOINTMENTS - SERVICES - SALES - WANTS

All types of Kits constructed (Maplin, Wersi, etc.). Competitive prices.
For quotation Ring Newtown (0686) 28646.

MAPLIN M.E.S. 53 organ with mixer and 32 note pedal section. This instrument has only recently been completed and an opening concert has been given on it. 2 61 note keyboards, drawbars, 32 note pedal etc. £2.000 or nearest offer (including amplification and 4 x 12" speakers in cabinet).
Tel: Mansfield 52023.

STUDIO HIRE

8 TRACK STUDIO INCLUDING SYNTHESISERS, FREE TEA and a handy musician/engineer, £20 per 6-hour session. Ideal for composers, synthy players etc.

For full details catch DAVE on WATFORD 39347.

FOR SALE

MAPLIN Electronic Organ Model 53 2 manuals and pedals, in HAND-BUILT Wooden console but completely without electronics.
Would suit electronic engineer wishing to build an organ to his own specification without carpentry capabilities.
Price: Subject to negotiation.
Telephone: Horley (02934) 3698.

Roland JP-4 Jupiter Synth (new) List **£1,889**
Roland RS-505 Paraphonic Synth/Strings (new) List **£1,229**
Roland MP-700 Piano c/w amplifier (used) Last list **£1,586**
Roland EP-09 Piano, self amplified (new) List **£399**
Roland Revo 250 watt reverb keyboard amp/tremolo cabinet with 18" Pioneer speaker (new) Last list **£995**

All in mint condition. Total cost over £5,500. Accept **£2,600** the lot or will split for sensible offers.

KEYBOARDS, The Headrow, Leeds 1
Telephone (0532) 468939

ELECTRONICS & MUSIC MAKER

TECHNICAL EDITOR

Additional staff are needed to join our editorial team to help us produce projects, features, news and reviews that make E&MM the No. 1 monthly for the electronics and music hobbyist.

We require immediately a TECHNICAL EDITOR having practical experience of electronic project design and construction, with responsibility for preparation of submitted projects for publication.

In addition, you will work with our projects team in researching and developing new designs for E&MM.

The salary for this important position will be commensurate with age and experience.

Please write, enclosing detailed C.V. to: The Editor, 282 London Road, Westcliff-on-Sea, Essex SS0 7JG.

CLASSIFIED ADVERTISEMENTS

Attach your copy to this form and send to:
ELECTRONICS & MUSIC MAKER, Advertisement Dept., Hillcroft House, 16, The Avenue, Highams Park, London, E49LD.

Name ....

Address ....

....

Remittance value.....................................**enclosed**

SPECIAL INTRODUCTORY OFFER
Only £4.00 per single column centimetre for a Semi-Display. Cheques payable to Maplin Publications.

This size Adv. 1 cm single column £4.00

This size Adv. 3 cm x 2 columns £24.00

This Adv. size 8 cm single column £32.00

This size Adv. 2 cm single column £8.00

This size Adv. 4 cm x 2 columns £32.00

This size Adv. 3 cm single column £12.00

NEXT MONTH — July Issue

on sale at your newsagent from June 15th

'ALPHADAC 16' SYNTHESISER CONTROLLER

This low-cost micro-based system provides almost unlimited control possibilities for up to 16 monophonic synthesisers played in real time from one keyboard.

SYNWAVE

Continuing our series of exciting, easy to build and operate trigger/percussion instruments, the SynWave will give you sounds from swirling sea to cymbal and woodblocks.

HEXADRUM

A six-tone touch sensitive 'electronic bongo' drum that is an ideal electro-music instrument for educational and studio use.

CAR DIGITAL PETROL GAUGE

Get an accurate indication of petrol in your tank down to the last drops.

DUNCAN MACKAY FEATURE

Now an established soloist and composer in his own right, Duncan Mackay discusses his work since 10cc, including his latest LP.

Plus all our regular articles covering Electronics, Computing and Electro-Music.

ADVERTISERS INDEX

CORRIGENDA

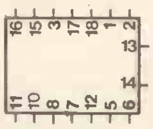
The following errors and omissions have been noted in previous issues of E&MM and are brought to your attention:

MAY ISSUE:

Page 7. Noise Reduction Unit. In Figure 2, C30 should read C20.

Page 10. Noise Reduction Unit. In the Parts List C29 and C30 should be 10nF (not 200uF). Also C31 and C32 should be added to C6, 8 etc.

Page 11. Car Digital Tachometer. In Figure 1 the pin connections for D3 are as follows:



Page 54. Using Microprocessors. 1001 under Table 3 should read 1101
D D

This issue: Price change for MES advertisement on page 26. YK02C is now £11.95 not £12.95; YK07H is now £20.95 not £21.45.

THE SPECTRUM SYNTHESISER

The remaining constructional articles for this project have been unfortunately delayed due to unpredicted circumstances.

We intend to publish the final parts as soon as possible without modification to material already printed.

The Editorial staff apologise for any inconvenience that may have been caused to our readers.

PRICE COST GUIDE
Starting Point £12.50.
Guitar Tuner £10.25.

NEW REDUCED PRICES

8K £399
16K £449 } + VAT
32K £499

RRP £795 for 32K

The PEDIGREE PETS Very popular for home & business use. 8K Microsoft Basic in ROM. 8K Pet 32K & 16K with new improved keyboard. All with green screen

Cassette Deck £55 extra   Full range of software available

Interface PET IEEE — Centronics Parallel

Decoded **£77.00** + VAT

We give a full one year's warranty on all our products.

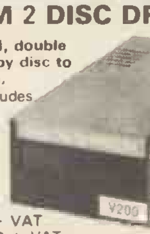
SPECIAL SCOOP GET YOURSELF A PRINTER FOR YOUR PET AND SAVE A FORTUNE

only **£299** + VAT

Interface Cards for Apple, Pet, TRS80, Nascom and Compukit — £49 + VAT

Full Pet Graphics including cables. Ready to go. **EX-STOCK.**

NASCOM 2 DISC DRIVES



Add a powerful, double density, mini floppy disc to your Nascom system.

- Disc Controller Card (includes Nasbus 6 S100 interface
- Will control 4 Drives.
- CPM operating system.
- Extended Disc Basic Compiler.
- Power supply included

One Disc System — **£499** + VAT
Additional Disc Unit — **£299** + VAT

NASCOM 2 GAMES TAPE

featuring Space Invaders and Android Nim, Re-numbering program and other goodies!

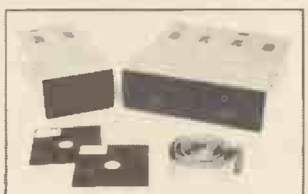
£7.50 + VAT

NEC SPINWRITER

only **£1350** + VAT

NEC's high quality printer uses a print "thimble" that has less diameter and inertia than a daisy wheel, giving a quieter, faster, more reliable printer that can cope with plotting and printing (128 ASCII characters) with up to five copies, friction or tractor fed. The ribbon and thimble can be changed in seconds. 55 characters per second bidirectional printing — with red/black, bold, subscript, superscript, proportional spacing, tabbing, and much, much more.

TEAC DISK DRIVES



- TEAC FD-50A has 40 tracks giving 125K Bytes unformatted single density capacity.
- The FD-50A can be used in double density recording mode.
- The FD-50A is Shugart SA400 interface compatible.
- Directly compatible with Tandy TRS80 expansion interface.
- Also interfaces with Video Genie, SWTP, Heathkit, North Star Horizon, Superbrain, Nascom, etc, etc.
- Address selection for Daisy chaining up to 4 Disks.
- Disks plus power supply housed in an attractive grey case.

Single Disk Drive **£225** + VAT   Double Disk Drive **£389** + VAT

COMP POCKET COMPUTER GREATEST BREAKTHROUGH YET

£79.90 + VAT

COMPUTER POWER THAT ONCE FILLED A ROOM CAN NOW BE CARRIED IN YOUR POCKET!

● Programs in BASIC ● "QWERTY" Alphabetic Keyboard ● 1.9K Random Access Memory ● Long Battery Life.

Computer power that once filled a room can now be carried in your pocket! It's easy to load with ready-to-run software from cassette tape (interface and recorder optional) or program it yourself in easy-to-learn BASIC. 24-character liquid crystal readout displays one line at a time. Special feature is advanced non-volatile memory allows you to power on and off without losing the contents of memory. Note: Memory must be transferred to tape before changing batteries. Automatic statement compaction squeezes every ounce of memory space. Features power-off retention of programs and data. Powerful resident BASIC language includes multiple statements, math functions, editing, strings, arrays and much more. Multiple program loading capability subject to RAM availability. Carrying case and batteries included.

FANTASTIC FOR FILE HANDLING ACULAB FLOPPY TAPE

The tape that behaves like a disc, for TRS-80 LEVEL 2.

only **£169** + VAT

The Aculab Floppy Tape for the TRS-80 and Video Genie is a highly reliable digital storage system that provides many of the advantages of floppy disks at less cost. Automatic debounce routine for the Level 2 keyboard.
Connects directly to TRS-80 Level 2 Keyboard. Operating and file handling software in ROM. 8 commands add 12 powerful functions to Level 2 BASIC.

THE VIDEO GENIE SYSTEM

Ideal for small businesses, schools, colleges, homes, etc. Suitable for the experienced, inexperienced, hobbyist, teacher, etc.

EG3000 Series WITH NEW EXTRA KEYS!

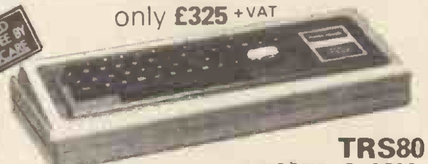
16K **£279** + VAT

● 16K user RAM plus extended 12K Microsoft BASIC in ROM ● Fully TRS-80 Level II software compatible ● Huge range of software already available ● Self contained, PSU, UHF modulator, and cassette ● Simply plugs into video monitor or UHF TV ● Full expansion to disks and printer ● Absolutely complete — just fit into mains plug.
The Video Genie is a complete computer system, requiring only connection to a domestic 625 line TV set to be fully operational; or if required a video monitor can be connected to provide the best quality display. 51 key typewriter style keyboard, which features a 10 key rollover. Supplied with the following accessories:- ● BASIC demonstration tape; ● Video lead; ● Second cassetee lead; ● Users manual. ● BASIC manual; ● Beginners programming manual. Write useful programs in the BASIC computer language yourself.

VIDEO GENIE EXPANSION BOX NOW IN SHOP

TRS80 LEVEL 2 16K

only **£325** + VAT



Fully converted to UK T.V. Standard. Comes complete with easy to follow manuals. UK Power Supply — Cassette Leads — Sample tapes. Special box to enable you to plug into your own TV. Recommended for first time-buyers. Just plug in and go   Full Range of Software Available

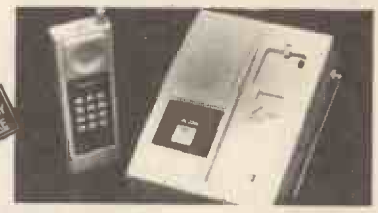
Interface to Centronics Parallel for TRS80 **£75.00** + VAT

TRS80 32K EXPANSION INTERFACE

only **£295** + VAT

Expand your TRS80 by 32K.
32K Memory on board. Centronics parallel port. Disk controller card. Real time clock. Requires Level II Basic. Interface for 2 cassette decks, complete with power supply

YOU NEED NEVER MISS AN IMPORTANT CALL AGAIN TWO CORDLESS TELEPHONE SYSTEMS — DIRECT FROM USA



THE ALCOM only **£147** + VAT

Base station connects to your telephone line. Remote handset clips to your belt and gives you push-button dialling — Bleeps when call arriving — Nicad rechargeable batteries. Charger in base unit.

LOW COST TELEPHONE ANSWERING MACHINE only **£99.95** + VAT

Microprocessor controlled answering machine. Plug into your phone line. Records any phone call messages. Remote bleeper enables you to listen to your messages from anywhere in the world. Uses standard cassettes. Comes complete with mains adaptor, microphone, remote bleeper, base unit, cassette with 30 sample pre-recorded messages.

COMMERCIAL EXPANDABLE ● COMPLETE TRS 80 · MODEL II

64K 1-Disk Model II **£1995.00** + VAT

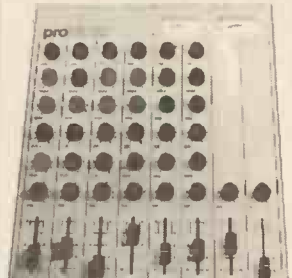
RRP £2250.00

The Model III is now in our showroom

This new unit from the world's most successful micro company is now available immediately with software.
The basic unit comes complete with 64 thousand characters (bytes) of Memory. The built in 8" Floppy disc adds another ½ million extra characters including the disc operating system. More disc expansion is now available.
The Model II is a complete unit with a full keyboard including a numeric pad and 12" screen which gives 24 lines of 80 characters. The computer is supplied with both the disc operating system and the Level III Basic.
A full self test routine is written into the power up procedure to eliminate incorrect operation. Both serial and parallel expansion sockets are standard. A printer is a plug-in operation.
Both hardware and software necessary to talk to a mainframe are included. Terminal usage is very possible. With the addition of CPM2 you can operate with COBOL, FORTRAN, MBASIC, CBASIC in which languages are many other applications packages i.e. accounting, payroll stock etc.

CP/M2	**£95.00**	M BASIC	**£155.00**
CIS COBOL	**£400.00**	FORTRAN	**£220.00**
C BASIC	**£75.00**	WORDSTAR	**£255.00**

COMP PRO MIXER



Professional audio mixer that you can build yourself and save over £100.

Only **£99.90** plus VAT for **complete kit.** Plus FREE power supply valued at £25.00

FULL RANGE OF ACCESSIT AUDIO ADD-ONS

Learn more about our products - Send £1 & S.A.E. for 1981 Spring Catalogue

NOBODY CAN GET NEAR OUR PRICES EXCEPT OUR CUSTOMERS

FREE 10 C-12 CASSETTES WITH ORDERS OVER £100.00 — ENCLOSE THIS COUPON WITH ORDER

NOBODY CAN GET NEAR OUR PRICES EXCEPT OUR CUSTOMERS

Learn more about our products - Send £1 & S.A.E. for 1981 Spring Catalogue

RRP £540 only **£399** + VAT

ANADEX DP8000

EXTENDED GUARANTEE BY COMPUCARE

Super Quality — Low cost printer. Tractor Feed with full 96 ASCII character set. Accepts RS232C at band rates between 100 and 9600 and Parallel Bit data.
Attaches either directly or through interfaces to Pet, Apple, TRS80, Sorcerer, Nascom, Compukit etc.

EUROPE'S FASTEST SELLING ONE BOARD COMPUTER

COMPUKIT UK101

★ 6502 based system — best value for money on the market. ★ Powerful 8K Basic — Fastest around ★ Full Qwerty Keyboard ★ 4K RAM Expandable to 8K on board. ★ Power supply and RF Modulator on board. ★ No Extras needed — Plug-in and go. ★ Kansas City Tape Interface on board. ★ Free Sampler Tape including powerful Dissassembler and Monitor with each Kit. ★ If you want to learn about Micros, but didn't know which machine to buy then this is the **machine for you.**

40 pin Expansion Jumper Cable for Compukit expansion £8.50 + VAT

Build, Understand and Program your own Computer for only a small outlay.

KIT ONLY **£149** + VAT
NO EXTRAS NEEDED

Available ready assembled, tested & ready to go **£199** + VAT

NEW MONITOR FOR COMPUKIT UK101
● In 2K Eprom 2716 ● Allows screen editing ● Saves data on tape ● Flashing cursor ● Text scrolls down **£22.00** + VAT
Special Bonus SAVE £22. New Super Monitor inc. in each kit or sold separately for **£22** + VAT.

FOR THE COMPUKIT	
Assembler/Editor	£14.90
Screen Editor Tape	£1.90

All Prices exclusive VAT

Memory Upgrade (4K)	£15.90
Game Packs	
1. Four Games	£5.00
2. Four Games	£5.00
3. Three Games 8K only	£5.00

Super Space Invaders (8K)	£8.50
Space Invaders	£5.00
Chequers	£3.00
Real Time Clock	£3.00
Case for Compukit	£29.50

EXTENDED GUARANTEE BY COMPUCARE

THE NEW ANADEX DP9500 and DP9501 A PROFESSIONAL PRINTER

- Bi-directional printing
- Up to 220 chars/line with 4 print densities
- 500 char buffer
- RS232C and Centronics Parallel interface built in
- Full software control of matrix needles allowing graphics capability
- 200 chars/sec ● Adjustable width tractor feed.

DP9500 — ONLY **£795** + VAT
DP9501 — ONLY **£845** + VAT

THE ATARI VIDEO COMPUTER GAMES SYSTEM

£83.00 VAT

Atari's Video Computer System now offers more than 1300 different game variations and options in twenty Game Program™ cartridges!
Most Cartriages only £13.90 + VAT
Prices may vary with special editions Basic Maths, Airsea Battle, Black Jack, Breakout, Surround, Spacewar, Video Olympics, Outlaw, Basketball, Hunt & Score*, Space War, Sky Diver, Air Sea Battle, Codebreaker*, Miniature Golf.

Extra Paddle Controllers — **£14.90** + VAT
*Keyboard Controllers — **£16.90** + VAT

SPACE INVADERS NOW IN STOCK £25

HITACHI PROFESSIONAL MONITORS

9" — ~~£129~~ **£99.95**
12" — ~~£199~~ **£149**

● **Reliability** Solid state circuitry using an IC and silicon transistors ensures high reliability. ● **500 lines horizontal resolution** Horizontal resolution in excess of 500 lines is achieved in picture center. ● **Stable picture** Even played back pictures of VTR can be displayed without jittering. ● **Looping video input** Video input can be looped through with built-in termination switch. ● **External sync operation** (available as option for U and C types) ● **Compact construction** Two monitors are mountable side by side in a standard 19-inch rack.

ENGLISH COLOUR TV/ AMERICAN NTSC COLOUR MONITOR

Suitable for Apple, Atari and Texas 99/4 **£295** + VAT

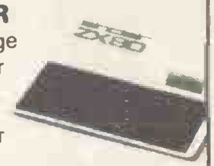
8MHz Super Quality Modulators	£4.90
6MHz Standard Modulators	£2.90
C12 Computer Grade Cassettes	10 for £4.00
Anadex Printer Paper — 2000 sheets	£25.00
Floppy Discs 5¼" Hard and Soft Sectored	£3.50
Floppy Disc Library Case 5¼"	£3.50
Verocases for Nascom 1 & 2 etc.	£24.90
Keyboard Cases	£9.90

MEMORY UPGRADES

16K (8 x 4116) **£17.90** + VAT
4K Compukit (8 x 2114) **£17.90** + VAT

SPECIAL OFFER

We will part exchange your Sinclair ZX80 for any of our products.



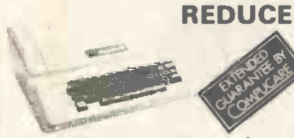
Refurbished ZX80's — fully guaranteed
Refurbished MicroAces — **£69.90** + VAT
(Supply dependant upon stocks).

NEW TV GAME BREAK OUT

Has got to be one of the world's greatest TV games. You really get hooked. As featured in **ETI**. Has also 4 other pinball games and lots of options. Good kit for up-grading old amusement games.
MINI KIT — PCB, sound & vision modulator, memory chip and de-code chip. Very simple to construct. **£14.90** + VAT
OR PCB **£2.90** MAIN LSI **£8.50** Both plus VAT

We have one of the largest collections of Computer Books under one roof, along with racks of software for the **PET** and **TRS80**.
Come and see for yourself.

WE ARE NOW STOCKING THE APPLE II AT REDUCED PRICES



16K **£549**
32K **£579** + VAT
48K **£599**

Getting Started APPLE II is faster, smaller, and more powerful than its predecessors. And it's more fun to use too because of built-in features like:
● BASIC — The Language that Makes Programming Fun. ● High-Resolution Graphics (in a 54,000-Point Array) for Finely-Detailed Displays. ● Sound Capability that Brings Programs to Life. ● Hand Controls for Games and Other Human-Input Applications. ● Internal Memory Capacity of 48K Bytes of RAM, 12K Bytes of ROM; for Big-System Performance in a Small Package. ● Eight Accessory Expansion Slots to let the System Grow With Your Needs.

You don't need to be an expert to enjoy APPLE II. It is a complete, ready-to-run computer. Just connect it to a video display and start using programs (or writing your own) the first day. You'll find that its tutorial manuals help you make it your own personal problem solver.

NOW OPEN

OUR ***NEW***

SHOWROOM & SALES CENTRE AT
311 Edgware Road,
London W2.
Telephone: 01-262 0387

APPLE DISC II

Disc with Controller **£349** + VAT
Additional Drives **£299** + VAT

● Powerful Disk Operating Software Supports up to 6 drives ● Name Access to Files for Ease of Use ● BASIC Program Chaining to Link Software Together ● Random or Sequential File Access to Simplify Programming ● Dynamic Disk Space Allocation for Efficient Storage ● Individual File Write-Protection Eliminates Accidental File Alterations ● Loads an 8K Byte Binary Image in 6.5 sec. (1.2 sec. in Pascal) ● Storage Capacity of 116 Kilobytes (143K Bytes with Pascal) on Standard 5¼" Diskettes ● Powered Directly From the APPLE (Up to 6 Drives) for Convenience and High Reliability ● Packaged in Heavy-Duty, Colour-Coordinated Steel Cabinet

A SELECTION OF APPLE INTERFACES ARE NOW AVAILABLE AT OUR NEW SHOWROOM.

COMP SHOP INC.
"Europes Largest Discount Personal Computer Stores"

Delivery is added at cost. Please make cheques and postal orders payable to **COMPSHOP LTD.**, or phone your order quoting **BARCLAYCARD, ACCESS, DINERS CLUB** or **AMERICAN EXPRESS** number.
CREDIT FACILITIES ARRANGED — send S.A.E. for application form.

MAIL ORDER AND SHOP:
14 Station Road, New Barnet, Hertfordshire, EN5 1QW *(Close to New Barnet BR Station — Moorgate Line).*
Telephone: 01-441 2922 (Sales) 01-449 6596 Telex: 298755 TELCOM G
OPEN (BARNET) — 10am - 7pm — Monday to Saturday

NEW WEST END SHOWROOM:
311 Edgware Road, London W2. Telephone: 01-262 0387
OPEN (LONDON) — 10am - 6pm — Monday to Saturday

IRELAND: 80 Marlborough Street, Dublin 1. Telephone: Dublin 749933
COMPSHOP USA, 1348 East Edinger, Santa Ana, California, Zip Code 92705. Telephone: 0101 714 5472526

BARCLAYCARD VISA · AMERICAN EXPRESS · DINERS CLUB INTERNATIONAL

COMP COMPUTER COMPONENTS
(Part of the Compshop Ltd. Group)

FREE 10 C-12 CASSETTES WITH ORDERS OVER £100.00 — ENCLOSE THIS COUPON WITH ORDER

MAPLIN make it easy...

in SOUTHEND
284 London Road
Westcliff-on-Sea
Essex
Tel: (0702) 554000
(Closed Mondays)

in HAMMERSMITH
159-161 King Street
Hammersmith
London W6
Tel: 01-748 0926
(Closed Mondays)

For personal service visit one of our stores.
Our new store at Hammersmith is conveniently situated near the end of the M4 and the North and South Circular Roads.
There is excellent street parking on meters a few steps away and Hammersmith Underground Station is nearby. Call in and see us soon.

in our CATALOGUE
320 big pages packed with data and pictures of over 5,500 items

Over 100,000 copies sold already!
Don't miss out on your copy.
On sale now in all branches WH Smith price £1.
In case of difficulty check the coupon below.

by MAIL ORDER
A fast service
You can rely on

- Same day service on in-stock lines
- Very large percentage of our stock lines in stock
- All prices include VAT
- Large range of all the most useful components
- First class reply paid envelope with every order
- Quality components—no rejects—no re-marks
- Competitive prices
- Your money is safe with a reputable company

On price, service, stock, quality and security it makes sense now more than ever to make MAPLIN your first choice for components every time!

make it easy... with MAPLIN

The Maplin Matinée
Amazing value for [redacted] plus £99.50 for cabinet if required
£299.95

Easy to build, superb specification. Comparable with organs selling for up to £1,000. Full construction details in Electronics & Music Maker commencing March, 1981 issue. Back numbers available.

Post this coupon now.
Please send me a copy of your 320 page catalogue. I enclose £1.25 (incl. 25p p&p). If I am not completely satisfied I may return the catalogue to you and have my money refunded. If you live outside the U.K. send £1.68 or 12 International Reply Coupons.

Name ____________________
Address ____________________

MAPLIN ELECTRONIC SUPPLIES LTD.

All mail to: P.O. Box 3, Rayleigh, Essex SS6 8LR. Tel: Southend (0702) 554155 Sales: (0702) 552911