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ELECTRONICS & MUSIC MAKER

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

JULY 1981
65p

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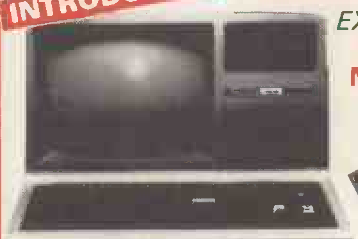

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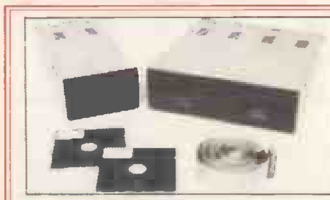

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ELECTRONICS & MUSIC MAKER

July 1981

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NEWS

ETI VOCODER

COMPLETE KIT ONLY £195 + VAT!

Features as a construction article in Electronics Today International this design enables a vocoder of great versatility and high intelligibility to be built for an amazingly low price. 14 channels are used to achieve its high intelligibility, each channel having its own level control. There are two input amplifiers, one for speech either from microphone or a high level source e.g. mixer or cassette deck and one for external excitation (the substitution signal) from either high or low level sources. Each amplifier has its own level control and a rather special type of tone control giving varying degrees of bass boost with treble cut or treble boost with bass cut. The level of the speech and excitation signals are monitored by LED PPM meters with 10 lights - 7 green and 3 red which indicate the level at 3dB steps. There are three internal sources of excitation - a noise generator and two pulse generators of variable frequency and pulse width. Any of the internal sources and the external source can be mixed together. There is a voiced/unvoiced detector which substitutes noise for the excitation signal at the points in speech where the vocal chord derived sounds of the speaker are substituted for by the unvoiced sounds of sibilants, etc. There is a slew rate control which smooths out the changes in spectral balance and amplitude enabling a change of the speech into singing or chanting and other special effects. A foot switch is provided to permit a complete freeze in spectral balance and amplitude whenever required. An LED on this indicates when the freeze is in operation.

An output mixer allows mixing of the speech, external excitation and vocoder output. The majority of the components fit into the large analysis/synthesis board with the rest on 8 much smaller boards with the controls and sockets mounted on them for ease of construction. Connectors are used for the small amount of wiring between the boards.

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

TRANSCENDENT 2000 SINGLE BOARD

Designed by consultant Tim Orr (formerly synthesiser designer for EMS Ltd.) and featured as a constructional article in ETI, this live performance synthesiser is a 3 octave instrument transposable 2 octaves up or down giving sweep control, a noise generator and an ADSR envelope shaper. There is also a slow oscillator, a new pitch detector, ADSR repeat, sample and hold, and special circuitry with precision components to ensure tuning stability amongst its many features.
The kit includes fully finished metalwork, fully assembled solid teak cabinet, filter sweep pedal, professional quality components (all resistors either 2% metal oxide or ½% metal film), and it really is complete — right down to the last nut and bolt and last piece of wire! There is even a 13A plug in the kit — you need buy absolutely no more parts before plugging in and making great music! Virtually all the components are on the one professional quality fibreglass PCB printed with component locations. All the controls mount directly on the main board, all connections to the board are made with connector plugs and construction is so simple it can be built in a few evenings by almost anyone capable of neat soldering! When finished you will possess a synthesiser comparable in performance and quality with ready-built units selling for many times the price.
Comprehensive handbook supplied with all complete kits! This fully describes construction and tells you how to set up your synthesiser with nothing more elaborate than a multi-meter and a pair of ears!

COMPLETE KIT ONLY £168.50 + VAT!

Cabinet size 24.6"

CHROMATHEQUE 5000 5 CHANNEL LIGHTING

This versatile system featured as a constructional article in ELECTRONICS TODAY INTERNATIONAL has 5 frequency channels with individual level controls on each channel. Control of the lights is comprehensive to say the least. You can run the unit as a straightforward sound-to-light or have it strobe all the lights at a speed dependent upon music level or front panel control or use the internal digital circuitry which produces some superb random and sequencing effects. Each channel handles up to 500W and as the kit is a single board design wiring is minimal and construction very straightforward. Kit includes fully finished metalwork, fibreglass PCB controls, wire etc. - Complete right down to the last nut and bolt!

MANY MORE KITS AND ORDERING INFORMATION ON PAGE 42

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

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POW

DJ90 STEREOMIXER as being featured in Electronics Today International - July issue!

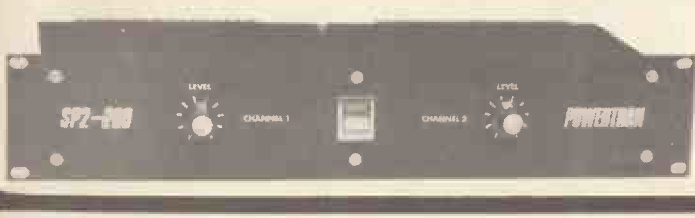
COMPLETE KIT ONLY £97.50 + VAT!

This versatile new mixer, shown fitted to our console, has 2 stereo inputs for magnetic cartridges, a stereo auxilliary (e.g. cassette or jingle machine) input and a microphone input. The decks can be automatically panned either fast or slow and all 3 music inputs can be mixed with slider controls. There is a 5-section graphics equaliser and a beat-lift control. Also there is a voice-over unit (ducking) and an override button for interrupt announcements. The microphone input can be modulated at a variable rate to produce 'growl' effects and there is monitoring of any music input (pre-fade listen) via the stereo headphone socket and a pair of LED PPMs. The kit includes fully finished metalwork fibreglass, PCBs, controls, wire etc. - complete down to the last nut and bolt! The console is shown fitted with two 19" panel units - a Chromatheque 5000 lighting controller and an SP2-200 stereo 100W/channel power amplifier. For a 200W/channel system two SP2-200s could be fitted.
Power supply for mixer with screening metal box **£9.90**+VAT. Console complete with switch panel, lid feet and carrying handles **£69.50**+VAT.
BSR P256 - their latest belt-drive disco turntable **£29.90**+VAT.

POWERTRAN

SP2-200 2-CHANNEL 100 WATT AMPLIFIER

COMPLETE KIT ONLY £64.90 + VAT!



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!

TRANSC

MULTI VO

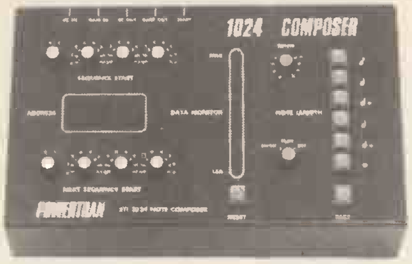
COMPLETE

Cabinet size 36.3" x

SYNTHESISER

15.7" x 4.8" (rear) 3.4" (front)

1024 COMPOSER



COMPLETE KIT ONLY £89.50 + VAT!

Programmed from a synthesiser, our latest design to be featured in Electronics Today International, the 1024 COMPOSER controls the synth. with a sequence of up to 1024 notes or a large number of shorter sequences e.g. 64 of 16 notes all with programmable note length. In addition a rest or series of rests can be entered. It is mains powered but an automatically trickle charged Nickel-Cadmium battery, supplying the memory, preserves the program after switch off.
The kit includes fully finished metalwork, fibreglass PCB, controls, wire etc. – complete down to the last nut and bolt!

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EFFECTS SYSTEM COMPLETE KIT ONLY £49.50 + VAT!

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BLACK HOLE CHORALIZER COMPLETE KIT ONLY £49.80 + VAT!

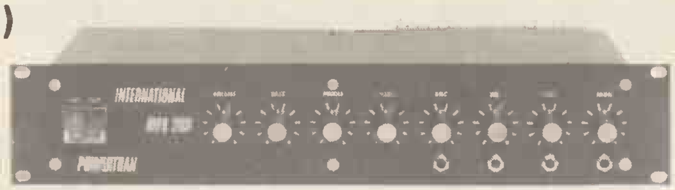
(single delay line system)

De Luxe version (dual delay line system) also available for £59.80 + VAT

Cabinet size 10.0" x 8.5" x 2.5" (rear) 1.8" (front)

The BLACK HOLE designed by Tim Orr, is a powerful new musical effects device for processing both natural and electronic instruments, offering genuine VIBRATO (pitch modulation) and a CHORUS mode which gives a "spacey" feel to the sound achieved by delaying the input signal and mixing it back with the original. Notches (HOLES), introduced in the frequency response, move up and down as the time delay is modulated by the chorus sweep generator. An optional double chorus mode allows exciting antiphase effects to be added. The device is floor standing with foot switch controls, LED effect selection indicators, has variable sensitivity, has high signal/noise ratio obtained by an audio compander and is mains powered — no batteries to change! Like all our kits everything is provided including a highly superior, rugged steel, beautifully finished enclosure.

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



COMPLETE KIT ONLY £49.90 + VAT!

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.

ENDENT DPX

CE SYNTHESISER

KIT ONLY £299 + VAT

5.0" 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 wholr 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 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!

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TEAC Portastudio M-144

At last, affordable multitrack for every musician. TEAC's new Portastudio combines a mixer and multitrack tape recorder in one compact unit. The solenoid, cassette transport runs at twice normal speed and with the built in Dolby system produces remarkable sound fidelity. Precision heads enable four tracks to be recorded with full sel-sync and ping-pong facility. The mixer section accepts any signal with bass, treble, echo send and pan on each channel. These are switched from laying tracks to performing mixdown. The simplified monitoring allows you to listen to the mix you are recording, plus the tracks already on tape. Use the powerful internal headphone amplifier or an external speaker/amp system. Track bouncing, signal processing, memory rewind and varispeed are more facilities that put this remarkable unit on par with what you will get from systems costing many times the price. Just plug in a microphone and a pair of cans and you have your own four track demo setup. **You make the music, Portastudio does the rest.** Full details on request.

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£579 including mike and cans

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Accessit

A unique range of add-on signal processors for PA or studio use. As reviewed in this magazine.

Compressor **£31.97** Variable threshold and speed give scope for effects
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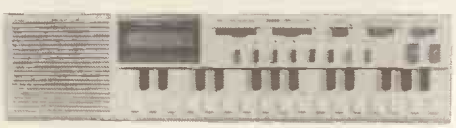
RacKit **£19.55** Mounts three Accessit units to standard 19in rack

Send for the new data folder including specification cards, application notes, review reprints and details of the 21 day free trial offer.

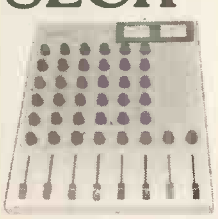
£35.95 Microchip Orchestra



The revolutionary musical instrument that turns you into an instant musician. Order the Casio VL-Tone now, and try **it out at no obligation for 14 days.**

SECK £108.33

Professional Mixer in Kit Form



£152.25 ASSEMBLED

A six input stereo mixer featuring wide range gain, treble, bass, echo, foldback and pan on each channel. For compact PA, keyboards, stage monitoring or recording, the ultra slim design is at home anywhere.

Books

"Are you ready for Multitrack?" explains recording techniques from sound on sound through to eight track, with many pages about The equipment to use. **60p**

"The Multitrack Primer"

from TEAC is a practical guide to setting up a home studio with many tips on wiring, acoustics, mike placement etc. The book is packed with superb illustrations. The best guide around by far. **£3.50**

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ELECTRONICS & MUSIC MAKER

Monophonic Goes Polyphonic!

by Mike Beecher, Editor
Electronics & Music Maker.

A strong German flavour prevails this month with reports on Wersi Electronics, PPG and Kraftwerk. Not surprising really, when you consider the amount of German electronic music available - much of this now coming from specialist recording companies.

During the early 70's many musicians playing organ and piano were tempted away from recording homophonic layers of music in order to exploit the different sounds of the new monophonic synthesisers that were fast appearing. At least a four-track recorder was then required to mix these down to a homogeneous harmonic background.

Of course, many composers kept their existing poly-keyboards close by until the arrival of the polyphonic synthesiser. Meanwhile, forward-looking companies had ensured their products would be able to interface with other instruments through the provision of control voltage and trigger inputs and outputs. Unfortunately, one main difference in this interfacing came with Yamaha and Korg (also EMS), who did not choose, for good reasons, the one volt per octave relationship for CVs and also used differing trigger thresholds. This can be overcome, however, by using linear and logarithmic converters, so the possibility of linking up mono synthesisers of all kinds has existed for some time.

Now we can offer a very cheap way of producing sophisticated polyphonic music through our Alphadac 16 project. An enormous number of control possibilities come from its microprocessor and EPROM and it points to the direction that new musical instruments are taking, from the Casio VL-Tone to the PPG Wave 2 and the Yamaha GS-1.

The electronic drum machine can now be micro-controlled and even the new guitar synthesisers from Roland employ the concept that polyphonic outputs are another step forward.

Joining this polyphonic band come the home computers that have a strong selling potential simply from their music-making qualities.

The Atari 400 and 800 are the latest home computer additions and offer four-part polyphony from a plug-in cartridge.

Now, perhaps we have (besides electronic project construction!) a different theme for the TV, video and computer in our home — Let's Make Music!

Mike Beecher

Readers Letters

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

Dear Editor,
I really liked reading your first issue of Electronics & Music Maker and found it one of the best magazines on the market. I really wish that in one of your future issues you will include a circuit of a colour analyser which is used in colour photographic printing. I am sure many readers would be interested to build one.

I. Calleja
Ta'Xbiez, Malta

What do other readers think?

Dear Sirs,
Having just finished the first, excellent, issue of E&MM, I'd like to seek some advice from the experts - you!
I'm thinking of starting a synth-based band along the lines of G. Numan, John Foxx, New Musik, and I'd like advice on which synth to go for.
Money is a big problem - something in the range up to £200 would be idea. Any ideas?

David Daniells
Chesterfield, Derby

A bit of a tricky question this one, especially since you are somewhat restricted by a lack of funds. However, the first instrument that springs to mind is the WASP. I don't know if you are familiar with this synth, but it will give you almost all the sounds that a much more expensive instrument can product at a fraction the cost. the catch is that the WASP has a touch keyboard, i.e. there are no moving keys, and this can make the WASP a bit tricky to play; but if you only want to be able to play relatively simple lead lines, and produce a wide range of sounds, then this may be just right for you. The WASP would suit the Gary Numan, John Foxx school of synthesists, but wouldn't be too good for the Wakemans, Emersons and Moraz's of this world. Incidentally, EDP, the manufacturers of the WASP have recently introduced a proper keyboard version.
Next up, you could try getting hold of an ARP Axxe, or a Kitten (made by Octave Electronics), these are very similar instruments, and fall within your price bracket (if you shop around, or go for second hand), but they are only single oscillator instruments, and consequently are not so versatile. If I were in your position I would definitely go for a Moog Prodigy, which sells for under £250.00. This really is a monophonic synthesiser with a good history behind it (I understand that it recently became the world's best selling synthesiser ever), and the more recent versions of the Prodigy have control voltage and gate interface sockets on the rear panel, thus enabling the system to be expanded at a later date. The only drawback of the Prodigy is its lack of a noise generator for making 'natural' and percussive effects.
If you really want to sound like Gary Numan/New Musik for £200 then I would suggest a second WASP at £80, and a phase tone MT 30 for around £80, and a phase or chorus pedal. The Casiotone can then be used to give a synth string sound, and the monophonic for the lead lines; but if you are hoping to make a long term investment, then the Prodigy is a better bet, and you can get a string machine or a poly synth later.

Dave Crombie

Dear Editor,
I require a mono play and recording and bias circuit for a reel-to-reel deck taken from a (fairly) ancient HMV 2206. The heads are in good condition, so are the mechanics but the valves are, unfortunately, dead. I intend to use it for effects as detailed in your fabulous magazine, so I only need reasonable quality since I'm not going to use it for music recordings etc. Thanks.

J. R. Walker
Norwich, Norfolk

Any ideas?

Dear Sir,
I would appreciate it if you would answer the following questions: How can I adapt the circuit of the Workshop Power Supply unit in the April issue of E&MM, to enable the unit to give out 0-24 volts at up to 5 amps. Secondly, what changes need to be made to component values? Also could you detail what the new setting up procedure would be?
Finally, can I use the same meter, or do I need to use one with a lower internal resistance?

K. L. Hall, Liverpool

It is not possible for the circuit to handle 5 amps at 25 volts in its present form, because TR1's power rating would be exceeded under short-circuit conditions.
The only way to correct this would involve the use of two transistors in parallel (with emitter resistors) which would preclude the use of the Maplin PCB. If this is done D1 to D4, FS3, T1 should be uprated to 5A types, and R1 changed to 0R1 (use two 0R22 3W wirewound in parallel).
The setting-up procedure is not affected, except that the maximum current should be set at 5 amps. The same meter may be used, but it must of course be scaled to read up to 5 amps, not 2.5.
A more practical solution would be to build two power supplies! This would enable you to set up split rail supplies, in addition to the application you have in mind.

Dear Editor,
Thank you for a most interesting magazine which I have read from the start.
I have a particular interest in the Matinee Organ, for which I have already placed an order and I am looking forward with great anticipation to receiving the kit.
With regard to your Vero Board Project 2, this looks good for an audio probe, but I have noticed that there is no connection between Pin 1 of IC1 and C5 and I would suggest that there should be 4 link wires and not 3 as is quoted in your text. I also note that in the photograph there is an LED shown - what for pray?

D. S. Upton
Powys, Mid-Wales

Yes, it would appear that you are correct and there is a link wire missing from the Vero Project 2 board. This should be added between D-12 and F-12 on the Veroboard, although as C5 is only needed as a precaution against instability, the unit may well function properly without this wire.
The mysterious LED visible in the heading photograph is due to the fact that the 'Metronome' and 'Test Amplifier' photographs were accidentally transposed.

Dear Sir,
Please could you inform me what keyboards Stevie Wonder uses and their approximate prices. Also I soon hope to be starting a two-piece soul group and would like some advice on what keyboard/synthesizer to purchase.
I'm writing this letter after picking up your mag by chance and I can tell you now you've just picked up a regular reader.
Thanking you in advance.

Paul Williams
London E3

After a great deal of research we've managed to track down a list of Stevie Wonder's keyboards, the ones he used on his last tour. Approximate prices are in brackets. Yamaha CS 80 (£3,500), Fairlight CM1 (£13,000), Steinway 7' grand piano, Hohner D6 Clavinet (£400), Fender Rhodes Suitcase 73 (£1,000). He has a host of other instruments dotted around his American homes including a Yamaha CX-1, which used to cost a staggering £50,000.
With regard to your enquiry as to which keyboards/synthesisers you should buy, we hope to be doing a special feature in a forthcoming issue dealing specifically with this subject, so keep your eyes peeled.
The Roland JP8 should be on sale at the end of May for around £2,500, though prices haven't as yet been fixed due to fluctuations in the exchange rates.

Dave Crombie

Dear Editor,
Having just received my third issue of E&MM I, like so many others, must congratulate you on a superb magazine, designed for the every-day enthusiast for whom electronics has been a realm of wonder in the past.
However, I feel it is my duty to request that you ensure total safety to your amateur constructors who will undoubtedly build many of your projects.
From experience I have found that the amateur builder will also be the person who will want to construct for as little cost as possible. With this in mind I would like to draw your attention to Figure 12 of May issue Page 24. The wiring to the mains fuse is such that, should an unshielded fuse carrier be used, with mains switched on at the unit it is possible to be in contact with the supply before the fuse link has been fully inserted. The fuse connections should be reversed.
As the production manager for an electronics company I have to be very aware of the fact that the general public do not always switch off units before checking fuses.

R. D. Baker
Weston Super Mare, Avon

Your comments with regard to the safety aspect of mains powered equipment are noted and Maplin Electronic Supplies are taking appropriate action to correct the error.

Dear Sirs,
You have certainly set a very high standard and maintenance of this, which I am certain, will ensure a long and successful life for this new publication.
It occurs to me that you may have some sort of advisory service.
I am trying to get information on a Compton Melotone organ which I have recently acquired. This appears to be a 'vintage' instrument and is of the electrostatic tone wheel sound generation type. I assume that the instrument is no longer in production and if I could obtain the circuit diagrams and any other technical information it would assist me in the renovation of the instrument. I have attempted to contact Compton but they appear to have moved from their original premises and have amalgamated into Compton Mirfield.

P. Davies
Kirton Lindsey, Lincolnshire

We were fortunate in enlisting the help of Mr. W.F., one of the parents of the electrostatic organ. He started work in 1928 with Leslie Bourn, inventor of the Compton Melotone, and was his assistant for many years. Mr. Davies received a circuit diagram and helpful letter from W.F. which should enable him to renovate the Melotone.
J. & J. Makins of Rochdale bought the Compton Company from the Official Receiver and continued to make electrostatic organs until turning to other methods some six months ago.

Dear Sir,
Let me start off by congratulating you on a superb new magazine that brings my two main hobbies together under one cover.
Yes, you have probably guessed, I have a problem, one that has oft caused me sleepless nights, one I hope you will be able to help me with, or at least point me in the right direction. Let me explain.
I have a Commodore Pet computer, which I can get to play four part music. Four part harmony can be very limiting, so without changing my whole system, I can think of only one way of increasing the number of ports. By recording four ports on to one track of a reel-to-reel, and then recording additional ports on to another track. My problem is 'sync'. How can I record on to the second track at exactly the right place, so that when replaying both tracks together they sound right?
I would be most grateful if you could either help me or put me in touch with someone who could.
I look forward to all subsequent issues of E&MM.
Thanking you in sleepless anticipation,

B. N. Bidgood
London

Synchronization isn't possible unless you're going from one tape recorder to another with a sync track recorded on a non-music track. I'd suggest that you investigate the Micro Technology Unlimited Instrument Synthesis Software Package (obtainable for £30 plus VAT from IJJ Design Ltd, 37 London Road, Marlborough, Wilts SN8 2AA), which, with two D/A boards, will offer stereo synthesis, the 'voices' being distributed between the left and right channels. E&MM will be reviewing this shortly if you'd care to wait before committing yourself!
Dr David Ellis

Dear Sir,
Being a musician and a computer enthusiast at the same time, I'm looking for a device rather like the add-on device for the Casio FX 501-502P. That is, a device that when attached to a micro (ZX-81) produces a monophonic instrument, when given the frequency. Is it possible to hand that over to one of your experts in hope of some design rising to the surface?

D. Parvaz
Henley-on-Thames

Here's an idea for someone to take up — we'll publish the first suitable design submitted.

Dear Sir,
I thought I would just write a short note regarding your new magazine.
Last September my wife and I decided to take up organ playing (from scratch). We bought a fairly cheap model in case we tired of it. Now we have taken it seriously we would like to up rate the organ. Your D-I-Y organ seems to fill the bill admirably. In fact, I enjoy the whole magazine. Good luck with it.

R. A. Clarke
Melton Mowbray, Leics

Dear Editor,
Having seen the first few issues of E&MM I must say that the magazine is superb.
I am eagerly awaiting publication of Alphadac 16. I would like to offer a few suggestions of future issue content.
(1) An interview/equipment review on Tangerine Dream - surely the most important and impressive live performance totally electronic progressive band of the decade.
(2) A feature reviewing amateurs own electronic studios - perhaps with photographs.
(3) One of the major problems with home built synthesis equipment is insurance - the finished product would be extremely expensive to replace with commercially made equipment if stolen and insurance companies require written valuations when dealing with equipment worth over £200 to £300. Would it be possible to produce an official E&MM equipment valuation as a service?

W. J. Philips
Solihull, W. Midlands

Our interviews over the year will certainly try to cover interesting groups or composers who make a valuable contribution to electronic music and from the onset we have welcomed possible features on 'unknown' musicians who have a good studio set-up.
Insuring musical equipment, especially custom-built items, can be expensive and is best left to specialist insurance agencies. Try Entertainment & Leisure (Insurance) Services, PO Box 64, Harrogate, North Yorks, HG2 9ND.

Dear Sir,
I want to commend you on your wonderful magazine. As a student of music in the '30's in Paris I met some of the pioneers of electronic music and became interested in the aspects of 'aperiodic' sounds. When I returned to London in 1935, with some 'radio fiends', we would get some old TRF sets and overload the speakers, producing 'motor boating'. Along with some Theremin type instruments we would produce some very variable sounds. I would add that the results were far more interesting than 'Mr X'! In order to attract musicians to embrace electronic instruments, we will need something more than a singular, monophonic score. Even the old percussion, acoustical efforts of the West African drummers with a trio of kalingas produced a bigger variety of sound, and the kalingas certainly produced a larger 'melodic' effort, one part even producing hyper-phiygian melodic structures. Certainly in the case of folk music we expect diatonic form plus primary chords, but this is 1981, not very far off from the 21st century!

I. J. Gordon
London

Dear All at E&MM,
Without exaggeration, your new magazine is causing me great problems, for since the first issue work here seems to have come to a standstill, the fact of the matter is that once picked up, no one can put it down, and that includes myself. Congratulations, it's a winner.

The Sound Revival Centre
Corsham, Wilts

Dear Sir,
The first four copies of E&MM have been superb, keep up the good work. I have built the Syntom and it has some quite amazing sounds.
I would like to see a project for an AC adaptor with three 9 volt outlets or perhaps one 18 volt outlet as well. This would be useful for controlling three or four effects pedals.

K. Wild
Birmingham

The idea of a battery eliminator for effects pedals has arisen before, but we feel that the extra wiring from power source to effect may cause problems in a 'live performance' environment. However, as we plan several more percussion/trigger effects boxes, a suitable design may be forthcoming.


Good guitars are grown, not made.
Of course, it does help to have advanced construction facilities and some of the finest craftsmen in the world.
But like the great traditional luthiers, we attach unusual importance to the selection and curing of the finest 'soundwoods' available. Such timbers behave as living materials which continue maturing and mellowing even after the guitar is made. The wisdom of working with their natural qualities is the wisdom of Yamaha craftsmen.
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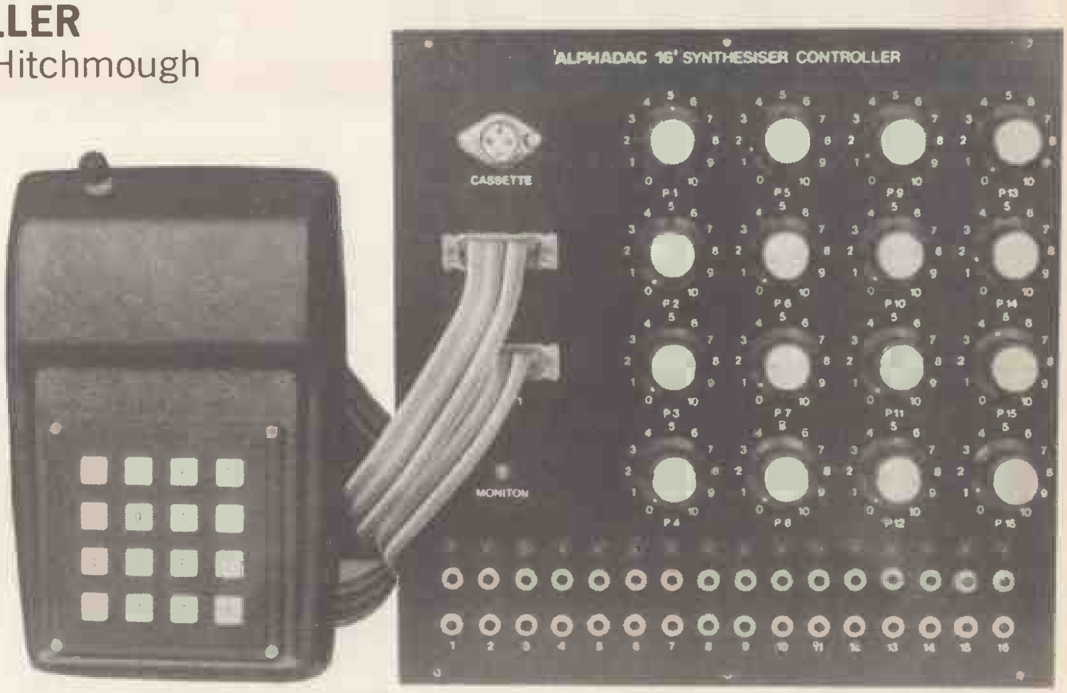
ALPHADAC 16

RECORDED ON CASSETTE NO. 3

SYNTHESISER CONTROLLER

by Charles Blakey and Ken Hitchmough
Digisound Limited

This low-cost micro-based system provides almost unlimited control possibilities for up to 16 monophonic synthesisers played in real time from one keyboard.



Since the introduction of the first voltage controlled synthesiser in the mid-Sixties two major aspects have concerned designers. The first being a polyphonic capability which was realised about ten years later and has since proliferated, although many have a restricted voicing capability. Secondly, and equally important, the ability to achieve real time control over such a versatile instrument without detracting from its capabilities. Recent reviews in E&MM reveal the cost range of such instruments. 'Alphadac 16' is a microprocessor based system which achieves both of these aims with extensive provision for extending the real time control features. Particular advantages are the ease of fitting to most existing synthesisers coupled with the ability of the current control program to greatly enhance the playing capabilities of equipment which only have one or two voices.

General Description

'Alphadac 16' is a multi-option system providing computer management of synthesisers having exponential voltage control response, that is most synthesisers, over a five octave range and up to sixteen voices. It is the versatility of the project which gives it an air of complexity but in reality getting the unit up and running only requires an ability for fine soldering and the use of a voltmeter to calibrate the control voltages. There is only one constraint, namely, that the unit works in conjunction with a digitally encoded keyboard but a suitable encoder is readily available which can be retro-fitted to the majority of popular keyboards. The digital encoder is low in cost and takes the place of the conventional keyboard interface with its resistive divider, sample and hold circuits and gate/trigger generators.

Let us look at two main options. Firstly we recognise that many keyboard players will not wish to get involved in computer programming and also a full computer option will be bulkier and more expensive. So 'Alphadac 16' will operate from a built and tested Controller Card produced by Tangerine Computer Systems and which simply goes into Slot 1 of Alphadac's motherboard. Programs for synthesiser control are provided in EPROMs (permanent memory which may be reprogrammed to incorporate future additions) and the selection of a particular effect is achieved using a sixteen key control pad which may be incorporated into the keyboard case or housed in a separate box adjacent to the keyboard. A single LED provides the necessary communication between the computer and the user. That is all there is to it — in this configuration one does not need to know anything about the operation or programming of computers but at the same time it allows those who so desire to become familiar with micro-processors and could act as a stepping stone to bigger things. 'Alphadac 16' will also operate from a minimum configuration Microtan 65 and Tanex, also produced by Tangerine Computer Systems. Again the keyboard control can be in EPROM and program selection uses the same control pad mentioned above. There are, however, two important differences. First the communication for the latter will be via a video display and, secondly, the Microtan and Tanex may be expanded to give the user the opportunity to write other synthesiser control programs. We can already hear some of you saying 'can Alphadac be used with my present computer'? Well, first the good news, none of the programs for Alphadac use TANBUG (Tangerine's monitor) and so it would be relatively easy to convert the programs to any 6502 based computer such as Apple, Pet, Superboard, Atari and so on. Difficulty may arise, however, in configuring the input/output port to accept the control pad and keyboard signals.

Each control voltage output from Alphadac uses a separate Digital to Analogue converter. At first sight this may seem rather extravagant but it greatly simplifies user programming. More important though is that it allows more compact programs so that several keyboard routines can operate simultaneously and this makes the additional cost well worth while. Six slots are provided on the motherboard and four of these are designated for the D to A converters. Each PCB for the latter contains four D to A converters, portamento selected by computer control on each channel, and four gate generators with LED drivers to indicate which gates are on. The actual number of D to A converters installed will be equal to the number of voices (VCOs, etc.) available, for example if you have three voices then only one PCB need be installed together with three Digital to Analogue converters on this PCB. Others may be added later, if required, up to a maximum of sixteen. We also realise that perhaps only a few users will want to fully expand the system to sixteen voices but the design of the motherboard and the front panel is such that we can install other types of controller into any spare slots. This approach keeps expansion costs low. The control voltage and gate signal for each voice is available from a miniature jack socket on the front panel and also from DIL sockets on the motherboard. We have aimed at giving the user as much flexibility as possible without significantly adding to the cost. For example, as already indicated, each control

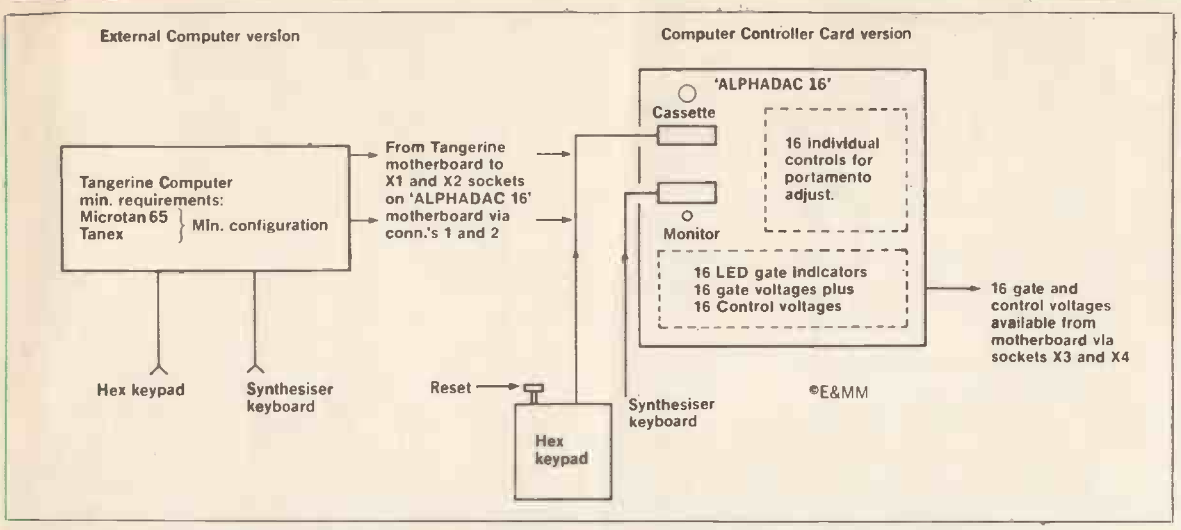


Figure 1. Basic arrangement of 'ALPHADAC 16' with internal computer controller or with external computer.

voltage has its own manual portamento adjustment. Typically, however, we would expect the controller to operate with up to four voices which can be user patched so as to take full advantage of the sound capabilities of the synthesiser and for additional voices to use pre-patched voices. The system will therefore be extended later with an intermediate controller having facility for master control over portamento and all of the other features normally found in polyphonic synthesisers.

Another option is packaging. The block diagram of Figure 1 represents 'Alphadac 16' mounted behind a 9 x 9 inch panel so as to fit in with a range of modular synthesisers. The motherboard and other PCBs could equally well be incorporated into a standard racking system or housed in some other type of portable case.

At the time of publication Alphadac comes complete with a set of keyboard routines in EPROM, called DIGI-1. First of all it is a polyphonic keyboard controller. DIGI-1 can assign control voltages and gates with intelligence, that is, it remembers the keys pressed down on the previous scan and will assign the key to the same voice and avoid note jumping. The memory of keys pressed remains up to the time when the output channel has to be used for another key because you have run out of voices. But polyphonic control is a trivial application for a micro-processor and one can get a better feel for the available power from the short summary below of other programs incorporated into DIGI-1.

a. Tune. Sends the same control voltage plus gate signal to all channels to allow tuning of oscillators and other setting up.

b. Keyboard Split. If selected will split the keyboard at any point determined by the first key you press on the keyboard after selection. Choice of whether top or bottom portion of synthesiser is to be the polyphonic section. The monophonic side may even be used to control a separate synthesiser or a voltage controlled module such as a VCO to obtain special effects.

c. Select Portamento. If the keyboard has been split then portamento may be independently selected for the monophonic and polyphonic sections. The degree of portamento on each voice is manually adjusted.

d. Transpose. Notes may be transposed up or down and at preselected intervals; tones, octaves or any semitone interval up to fifteen semitones. Again independent transpose on either side of a split keyboard is possible.

5. Arpeggiation. Arpeggiation in up or down or hold modes. Staccato and legato modes. Speed up and slow down. These routines are, of course, for the monophonic section but are very effective even with one or two voices and can act as a simple sequencer.

Remember that these facilities are brought into effect by use of the control pad which becomes a supplementary keyboard to bring the effects into play at any time. Furthermore all of the effects (not TUNE obviously) can be in use simultaneously.

Some of the above routines could be achieved by a skilled player using multi-track recording techniques but others are impossible to play manually. So what the micro-processor does is to give a new power to the synthesiser, even one with limited voices, and it begins to combine the voice capabilities of a synthesiser with the playability associated with modern electronic organs.

DIGI-1 occupies just an eighth (or a sixteenth by using larger EPROMs) of the EPROM storage area on the Tangerine Controller Card and so ample room for expansion exists. For a four voice controller the cost is about £50 per voice but thereafter each additional voice will be around £15 and a whole new set of programmes put into the existing EPROM somewhat less than the latter figure. The relatively high initial cost is therefore recovered later by savings in expensive add-ons such as sequencers and other hardware needed to simulate the software capabilities of the 'Alphadac 16'.

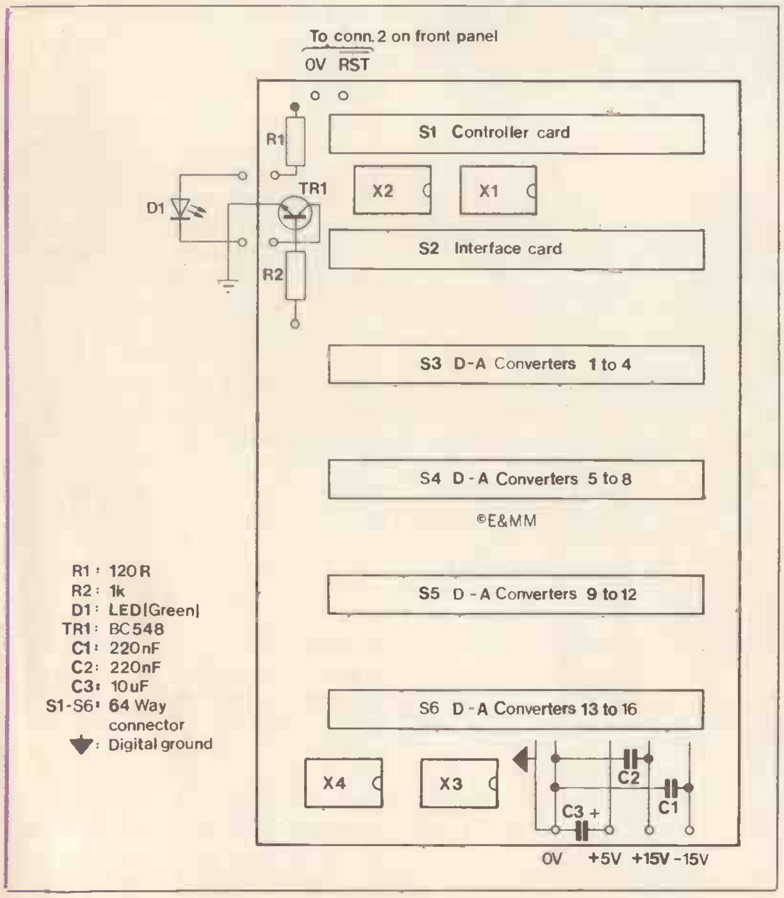


Figure 2. 'ALPHADAC 16' Motherboard.

Circuit

No wiring is required between individual PCBs since they are connected together via a motherboard, illustrated in Figure 2, using 64-way DIN plug and sockets. Slot 1 is for the Tangerine Controller Card, Slot 2 for the interface card, and Slots 3, 4, 5 and 6 are identical, accepting a quad D to A converter PCB. DIL sockets X1 and X2 allow the Controller Card to be replaced by the Microtan 65/Tanex combination which connect to these sockets via the 15-way sockets mounted on the front panel. DIL sockets X3 and X4 are connected to the sixteen available control voltages and sixteen gate signals to facilitate connection of the Alphadac to future extensions. The only other components on the motherboard are inputs for the power supplies, which are ±15V and +5V; the decoupling capacitors C1, C2 and C3; and the common emitter driver for the monitor LED, D1, which is built around TR1, R1 and R2.

A simplified block diagram of the Controller Card is shown in Figure 3. This unit is supplied ready built and tested and fully socketed for easy expansion. The only component that may have to be soldered in later is a crystal for the serial input. The Controller Card has the following facilities: 6502 CPU (supplied); 8K RAM area using 2114's (1K supplied); 8 EPROM area using 2716's although this may be expanded to 16K by using 2732's and changing a link on the PCB (2K EPROM supplied as DIGI-1); two 6522 VIA I/O ports (one required and supplied); a cassette interface; and a 6551 serial input.

Slot 2 accommodates the Interface Card whose circuit is illustrated in Figure 4. In reality this is only part of the inter-facing required, the remainder is on the quad D to A converter PCBs. The part on the latter will, however, be required with any computer and splitting the interface up in this way keeps the motherboard bus versatile so that it may be used to accommodate other types of control card in Slots 3 to 6. The nine inputs (don't worry since two have been ANDed together) to the 8-input NAND gate, IC2, are the most important since they are the six address bits (A4 to A9); the R/$\overline{W}$; the Input/Output (I/O) line; and ø2 from the microprocessor. The combination of these inputs provides a valid WRITE (actually inverted to suit subsequent hardware) signal to allow the keyboard information data bits, D0 to D6 to be converted to analogue outputs for controlling the synthesiser. D0 to D5 are the code bits representing the keys while D6 is a KEY-DOWN signal for the gate information. Bit D7 is a user generated signal to signify that portamento is required. Address bits A2 and A3 determine which of the four possible quad DAC cards are to be addressed while A0 and A1 determine which of the four DAC's, gates and portamentos are selected on the card determined by A2 and A3. These four address bits are simply buffered on the interface card. Likewise the data bits D0 to D7 are buffered. It should be observed that D7 is inverted and the reason for this will be apparent later.

Turning now to the circuit for the quad DAC board, as shown in Figure 5. From the interface card A2, A3 and $\overline{W}$ go to one half of a dual 1 of 4 decoder (IC1a, 74LS139). With the microprocessor program the first address is the highest, that is, A2 and A3 both at logic '1's' and so naturally the last address will be a '0' + '0'. When IC1a is enabled by the $\overline{W}$ signal going low it will respond to the A2 and A3 address bits and if both are high then pin 7 will go low. Notice that pin 7, and the other three outputs are connected to a DIL switch marked S1 to S4. With S1 closed the remaining logic on the quad DAC board is enabled whenever A2 and A3 are both high. The switch is not entirely necessary since we could have inserted a wire link in place of S1 for the quad DAC which goes into Slot 3 and provides the outputs for the first four voices. The switch is nevertheless useful for calibration and enables any quad DAC to go into Slots 3 to 6 by closing S1 to S4 respectively.

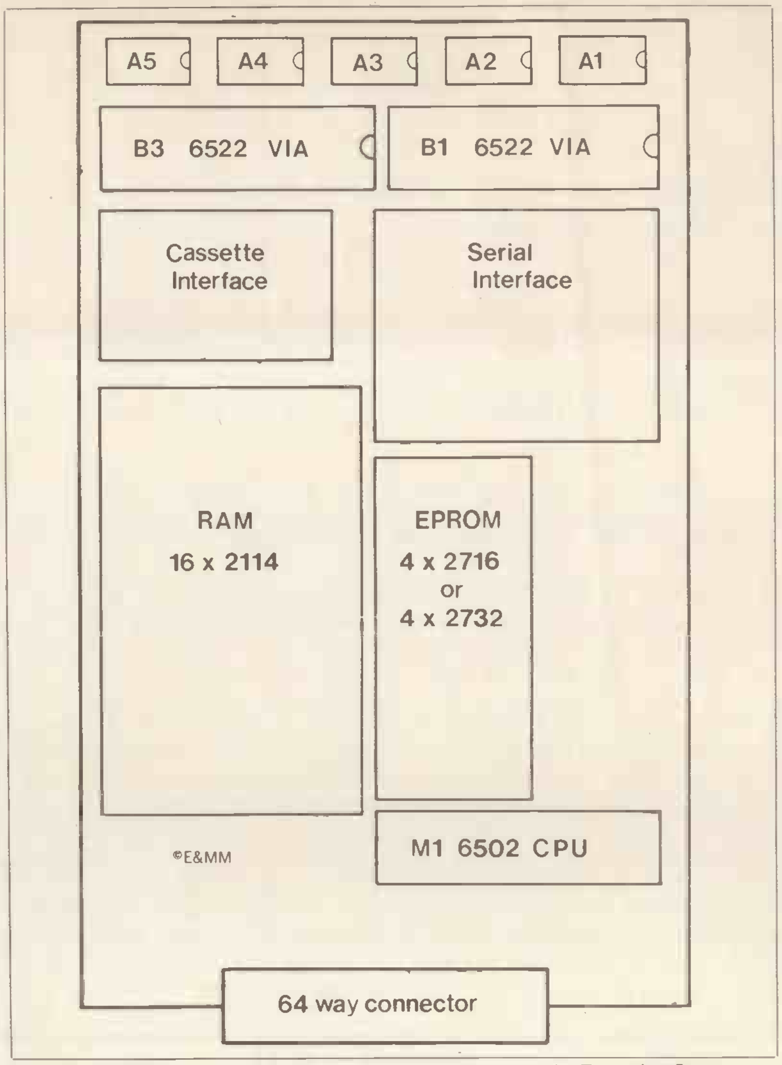


Figure 3. Simplified arrangement of controller card produced by Tangerine Computer Systems.

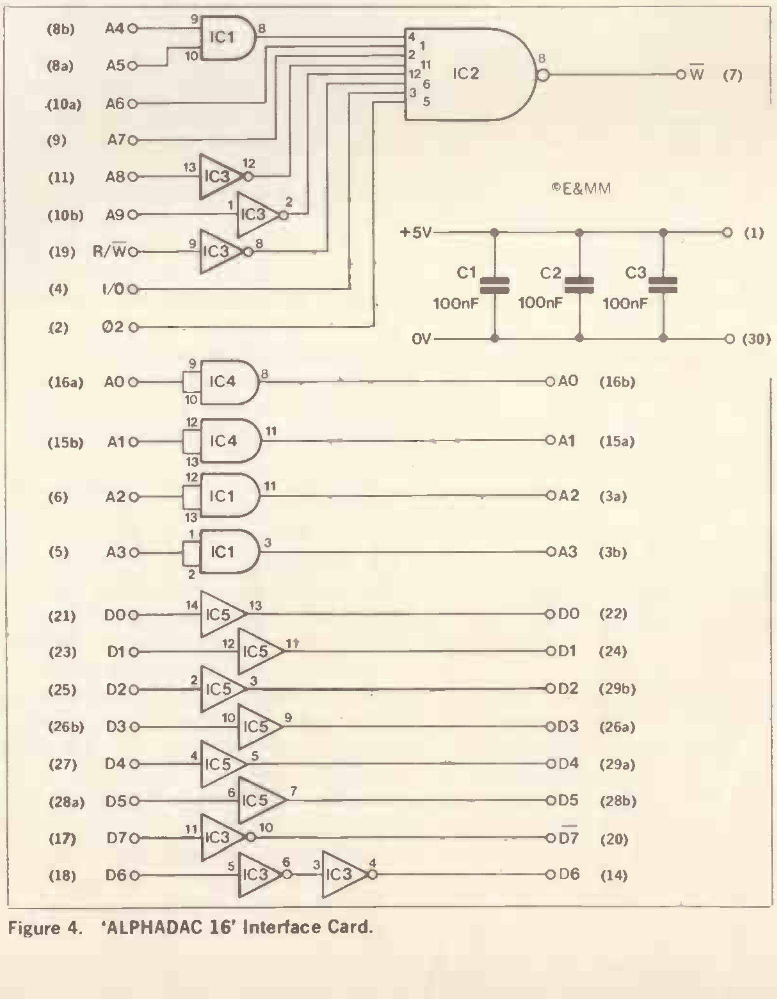


Figure 4. 'ALPHADAC 16' Interface Card.

The $\overline{ENABLE}$ from IC1a (the exit side of S1 to S4) goes to both IC1b and IC2. IC1b operates in a similar manner to IC1a, namely with A0 and A1 high pin 9 goes low and this connects with IC3 which is the D to A converter for Channel 1. The four D to A converters are ZN428E-8's which are microprocessor compatible such that when their $\overline{ENABLE}$ line (pin 4) goes low the converter is transparent to the data bits (D0 to D5 in our case) at the appropriate inputs. Conversely when the $\overline{ENABLE}$ goes high the data bits are latched into the converter. Thus apart from converting the data bits into an analogue voltage the ZN428E-8 also acts as a perfect sample and hold — the output voltage will remain constant for an unlimited period until either the $\overline{ENABLE}$ goes low again and new data is presented or until the power is switched off! The ZN428E-8 also has an internal voltage reference from pin 7 and for IC3 this is connected to the voltage reference input at pin 6. R1 connected to the +5V supply produces the necessary reference current while C12 is a stabilising and decoupling capacitor. The same reference voltage used for IC3 is also connected to pin 6 of the other D to A converters, IC7, 9 and 11, which saves power as well as providing excellent gain tracking between the four converters. Apart from this voltage reference aspect all four D to A converters are the same and so we will just describe the first which is built around IC3, IC4, IC5a and IC6a. The ZN428E-8 is an 8-bit (256 increments) device although we are only using the lowest six bits (64 increments) and thus the nominal maximum output from pin 5 of IC3 will be 0V64, or 10mV for each bit increment. Now to achieve a 1V/octave relationship we require each step to increase by 1V/12 (semitones) = 83.33mV and so pin 5 of IC3 is connected to IC4 arranged as a non-inverting amplifier whose gain is precisely adjustable around the nominal gain of 8.3 by the use of the multiturn trimmer RV1. Trimmer RV2 is used to cancel out the small amount of offset in IC4 while C13 acts as a low pass filter sufficient to remove glitches arising from the D to A converter. It will be apparent that by altering the values of R2, R3 and perhaps RV1 the gain may be altered to suit relationships other than 1V/octave. RV3, C14 and voltage follower IC6a provide a portamento

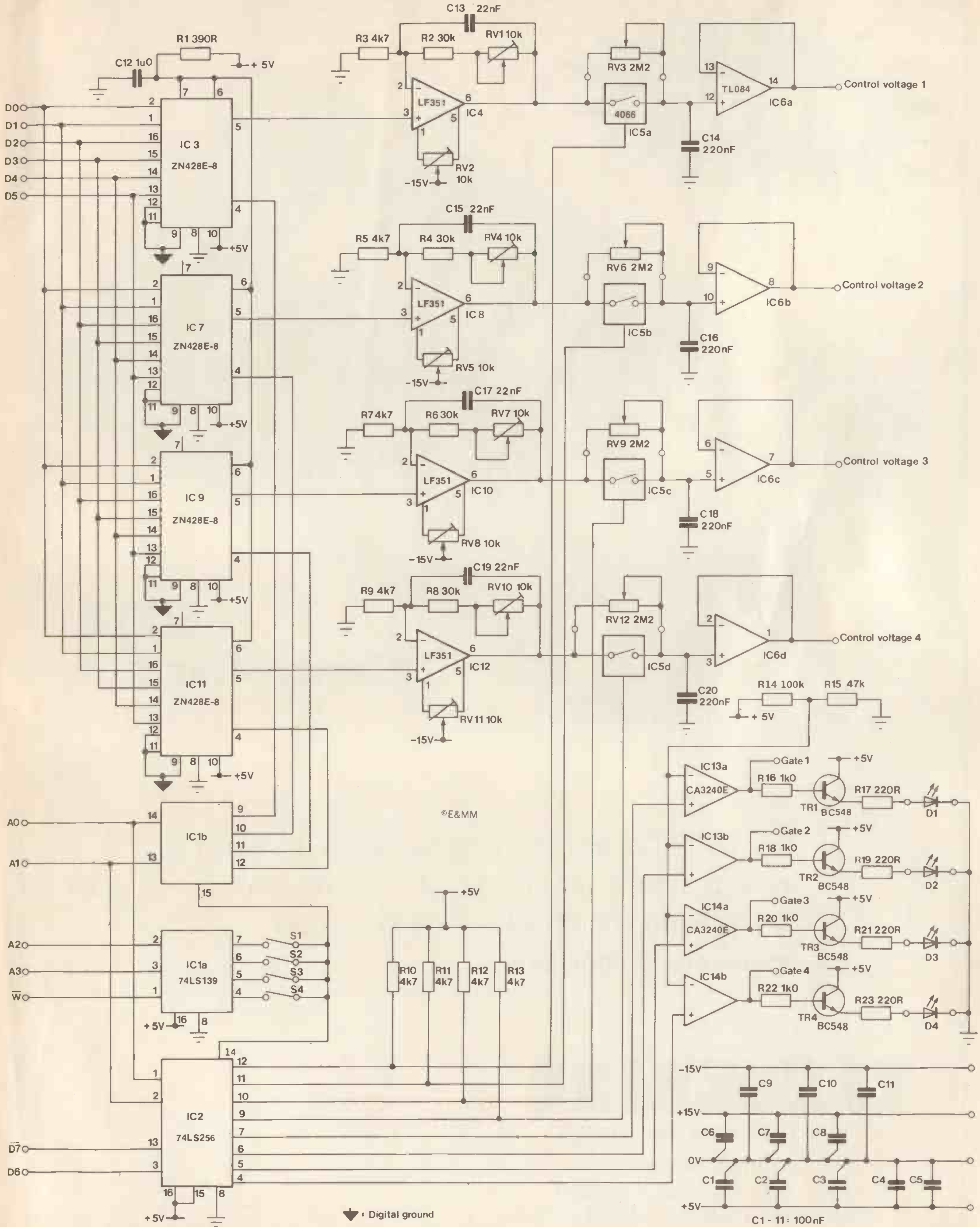


Figure 5. 'ALPHADAC 16' Quad DAC board.

Fully expanded, the 6502 Controller board can provide 16K RAM, 32 I/O lines with handshake, serial I/O port and a cassette interface.

The architecture is identical to the Microtan/TANEX combination, enabling TANBUG V2.3, X Bug and Microsoft BASIC to be used. Furthermore, the O.E.M. can develop software on a Microtan System and transfer the firmwave to the controller board with confidence.

SPECIFICATION

CPU	**6502 (1, 2 or 3 MHz versions)**
Clock	**crystal controlled**
RAM	**1K to 8K Bytes Static**
ROM	**2716 or 2732 up to 16K**
Parallel I/O	**One or Two VIA type 6522 providing up to 32 I/O lines with handshake and 4 sixteen bit counter timers**
Serial I/O	**RS232 Software selectable baud rates**
Cassette I/O	**Software controlled**
Expansion	**32K ROM BOARD, TAN RAM, PARALLEL I/O CARD, SERIAL I/O CARD, HI-RES GRAPHICS**
Price:	**from £60.00 to £120 (includes TANBUG) ex VAT**

For further information call PAUL KAUFMAN on (0353) 3633, 5326, 61460 or simply clip coupon and return.

Please send me full information on the NEW 6502 CONTROLLER BOARD.

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Please enclose 12p stamp — Thank You

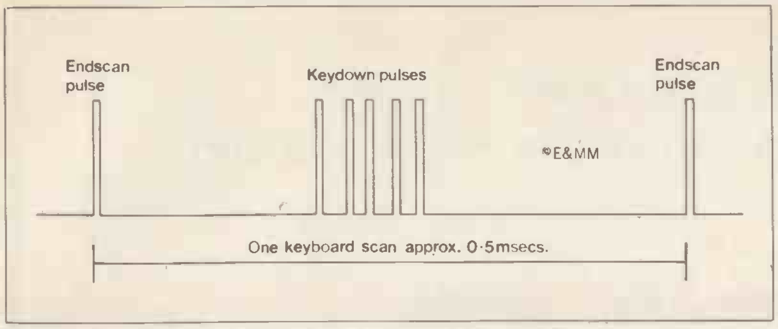


Figure 6. Example of outputs from digitally encoded keyboard.

circuit, i.e., by increasing the resistance of RV3 then C14 will take longer to reach the full voltage and so the rate of glide between notes will increase. A computer controlled facility is provided by IC5a, a voltage controlled switch. When the switch is closed then RV3 is by-passed and no glide will occur since C14 will charge up rapidly. When the switch is opened by the computer then the note will glide at a rate determined by the manual setting of RV3. The control voltage from channel 1 of the Alphadac which connects to the VCO, VCF, etc. is available from the output of IC6a.

Back to the logic circuitry. The $\overline{\text{ENABLE}}$ from IC1a also connects to IC2 (74LS256) which is a dual 4-bit addressable latch. When its $\overline{\text{ENABLE}}$ (pin 14) goes low the outputs will change to the logic status on the data inputs, D6 (gate control) at pin 3 and $\overline{\text{D7}}$ at pin 13. The outputs that change are, however, governed by the same address lines, A0 and A1, used for the D to A converters. When the $\overline{\text{ENABLE}}$ goes high the data is latched within the IC in much the same way as discussed for the ZN428E-8. You will recall that we inverted D7 on the interface card and the reason is simply that the computer outputs a logic '1' when portamento is selected. If this '1' were to pass through IC2 to IC5 then it would put the switch in the ON state and cancel the glide. Since this is the opposite to what we require then we simply invert D7. Resistors R10 to R13 on the portamento lines are pull-ups to ensure correct interfacing between the TTL IC2 and CMOS IC5. Gates are also set by a logic '1' on data bit D6. The gate outputs from IC2 go to a comparator (IC13 and IC14) which will go high on receipt of the logic '1' signal from IC2. The comparator reference voltage is set by R14 and R15. A gate output of about 4V5 comes direct from IC13 and IC14 and is fully short-circuit protected. Provision is made on the PCB board for operating ICs 13 and 14 from the +15V supply so as to give gate voltages of about +13V which suits many other synthesisers. Each gate output is connected to an LED, D1 to D4, via transistor drivers TR1 to TR4 so as to provide a visual indication of the channels which are in use.

Well, that is the hardware side of 'Alphadac 16' but its operation primarily depends on the keyboard electronics, a control pad made up of sixteen keys arranged as a 4 X 4 matrix, and above all on the software called DIGI-1 contained in an EPROM. The keyboard controller, whose electronics cost about £10, consists of two clock driven 8-bit scanners (CD4724's) which examine the keyboard, arranged as an 8x8 matrix, in a sequential manner. Each key up to a practical maximum of 63 therefore has a precisely defined 6-bit code, which is our data bits D0 to D5 discussed above. The scanners are driven by a clock which may be stopped (inhibited) under computer control. Each time a key is found down by the scanner other logic elements output a KEYDOWN pulse which tells the computer to store the value for the key and then carry on doing something else until it receives another instruction. When the scanner completes one scan of 64 steps an ENDSCAN pulse is produced. The computer recognises this pulse as ENDSCAN since the data lines

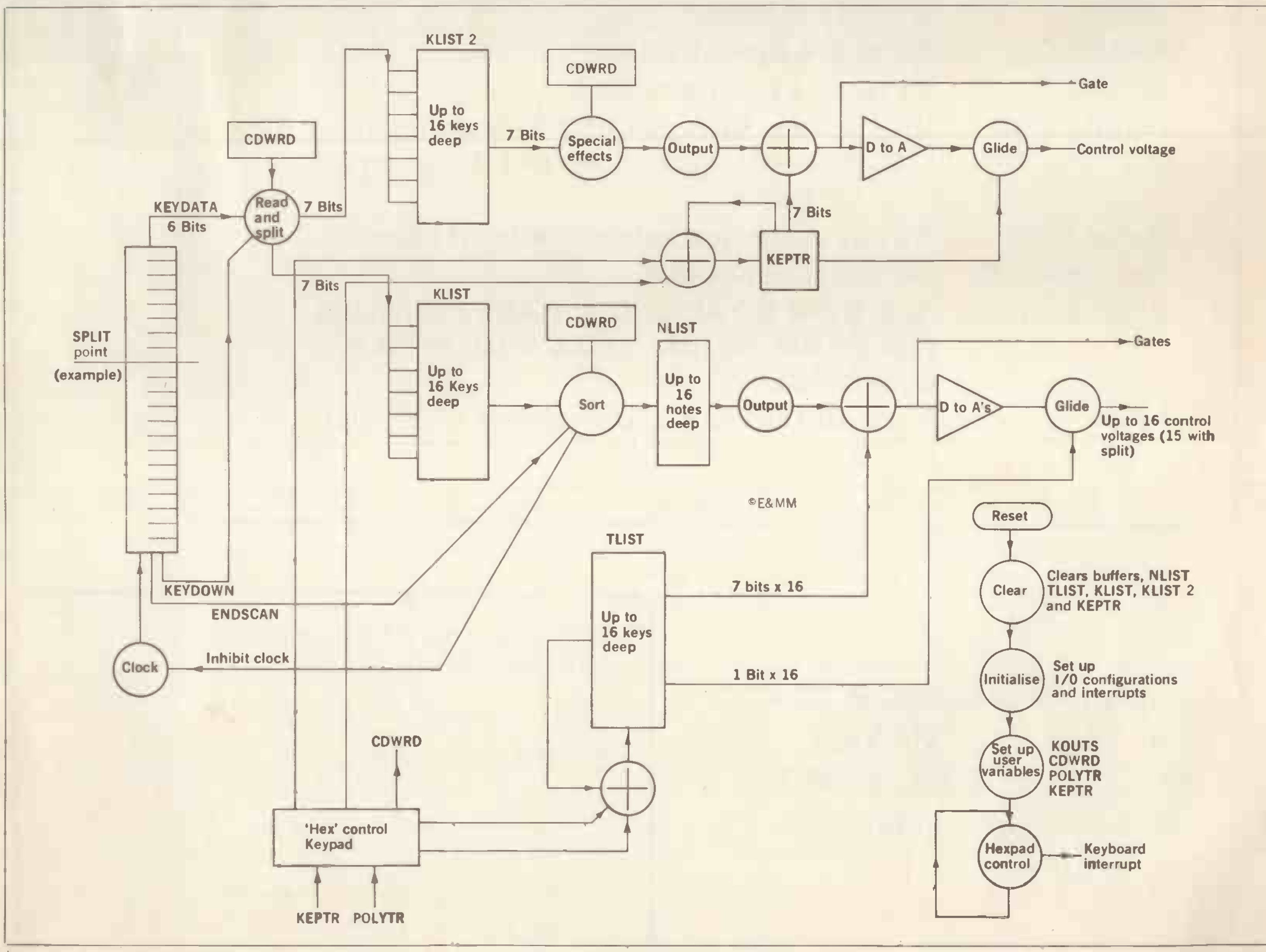


Figure 7. Block diagram of DIGI-1 program.

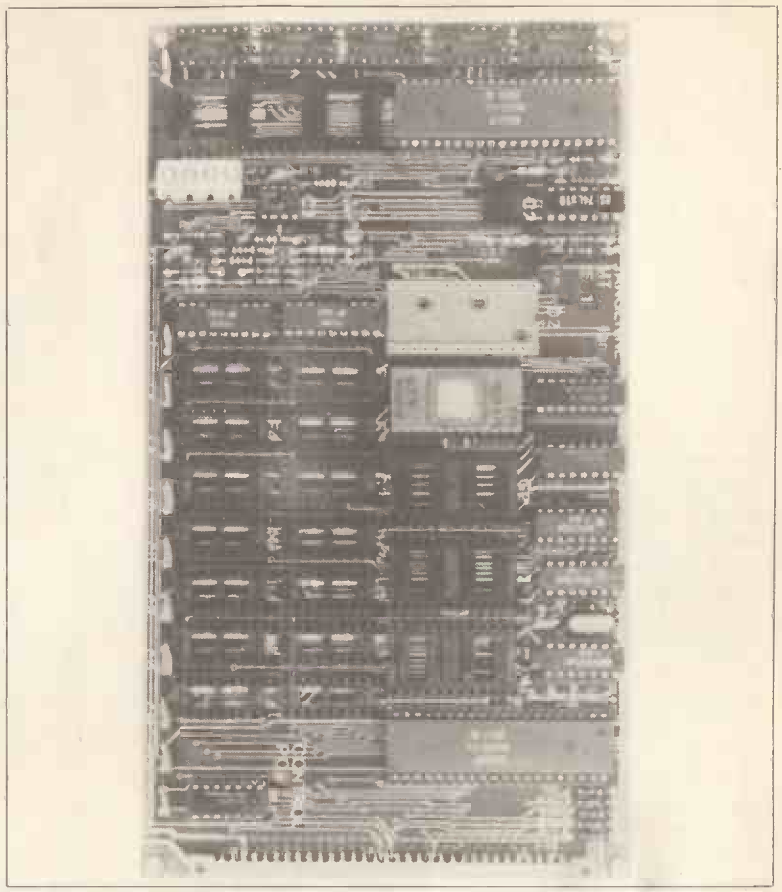
are at zero when it occurs (this is what limits us to 63 keys since zero is an invalid key response). It is a very short pulse but the computer now goes into a routine to decode all of the KEYDOWN pulses it received during the scan and during this time the keyboard scanning stops — but only for such a very short time that it has no aural effect. If we were to hold down, say, five keys then the various strobe pulses going to the computer would look like Figure 6.

Figure 7 is a block diagram to assist in understanding the operation of the computer program. Since the keyboard is counting upwards the data for keys found pressed are entered into a key list (KLIST) in ascending order. We do, however, have an option to split (SPLIT) the keyboard at any point into a monophonic portion and a polyphonic portion and in these circumstances the computer enters data from the mono section into KLIST2 while the poly side goes to KLIST. This housekeeping task is taken care of by CODEWORD (CDWRD). ENDSCAN initiates a SORT routine to put current valid data into NLIST. At the end of each scan data in NLIST is compared with that in KLIST to determine if a note (or notes) stored in NLIST, with or without gates set, has re-appeared in KLIST. If this is the case then it sets on the gate flag and rubs out the key code from KLIST. If a note present on a previous scan is no longer in KLIST the gate flag is removed. This routine assures that notes do not jump about from output to output as they do with simpler algorithms, or many hardware designs, and that they are all re-assigned to the same channel until such times as limited resources, namely, synthesiser voices, causes the channel to be used for another key. The routine also allows correct operation of ADSR's since once the gate flag is removed from NLIST the note will go into its release cycle. NLIST is filled up in sequence so that all notes played, assuming they are all different, find a slot in NLIST until it becomes full. It will be obvious, however, that the maximum number of notes in NLIST should not exceed the number of synthesiser voices otherwise missed notes will occur. Once keys are allocated to NLIST they are erased from KLIST so that the latter only contains information on keys that have just been pressed or were not able to find a home last time due to insufficient space. When a new note does appear in KLIST the routine looks at NLIST to find a space and it does so by choosing the first non-allocated space, for example, one where the gate flag is removed. All of this action: comparing KLIST with NLIST; updating NLIST; removing data from KLIST; and outputting data from NLIST to the hardware takes a matter of microseconds and so the scanner is soon running again looking for new keyboard information.

KLIST and NLIST relate to the 16 channel polyphonic keyboard and additional facilities in the program allow us to transpose notes up or down in real time by pressing keys on the control pad. The transpose interval is preselected at start up (it can be altered in under two seconds by resetting and entering a new transpose value) and may be any interval from one to fifteen semitones per press of the control key. The transpose value is held in TLIST and is added to the NLIST value prior to outputting the data to the digital to analogue converter. Remember though, the keyboard is restricted to six data bits or a little over five octaves and so if we add an octave transpose to the five octave data bit then some funny things will begin to happen and you will likely have a low note and the data bits will spill over and set the glide (portamento) on and perhaps take the gate off. Similar strange things are likely to happen when transposing down from a low note. It is relatively simple to alter the software to prevent this but in practice you should know what note you are on before doing a real time transpose and so the strange effects should only happen when you want them to and we feel sure that some users will put it to good use. Lastly, for the polyphonic mode, another control key allows selection of portamento as described in the section dealing with the quad DAC card.

If SPLIT is selected then one less output is available from the polyphonic side — you only have fifteen left. Also in this event channel 1 output is always allocated for the monophonic side of the keyboard and so the output of NLIST starts at channel 2. The monophonic side of the split point obviously does not require any sophisticated allocation routines and so the monophonic data from the keyboard goes to KLIST2. The monophonic side does, however, still retain portamento select, and transpose, via the data stored in KEPTR, and these are independently controllable, that is, one may transpose up or down both or either of the polyphonic channels and each by different amounts.

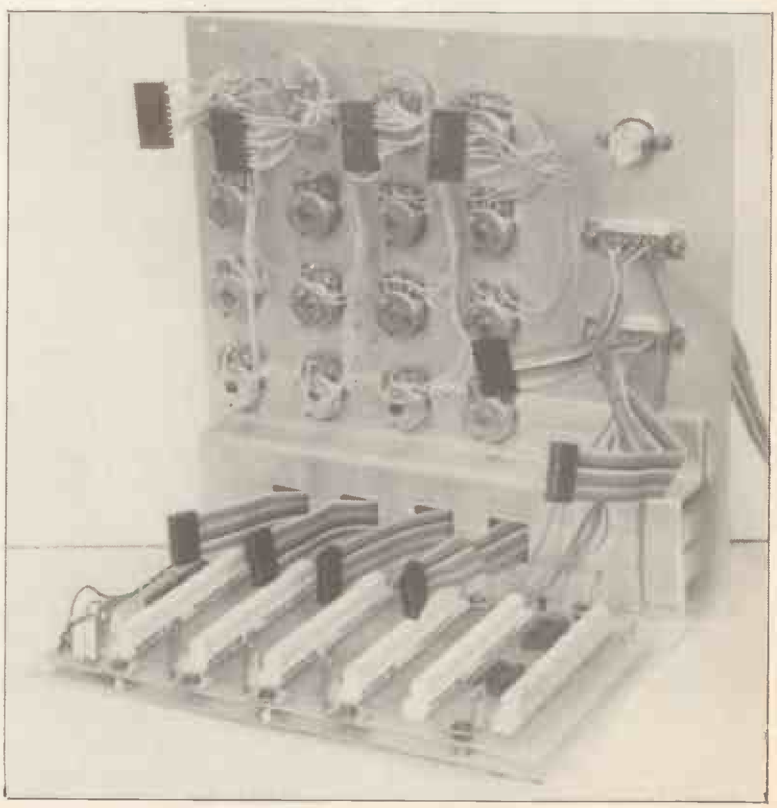
DIGI-1 also contains some SPECIAL EFFECTS for the monophonic channel which may be initialised on start-up of the system. These effects are described in the section dealing with the use of the Alphadac 16.



Tangergine Computer Systems Controller Card.

Construction

These construction notes assume that 'Alphadac 16' is panel mounted, as illustrated, although alterations to suit other methods should be obvious. Likewise to avoid confusion on connection listings only those relating to the installation of the Controller Card version are given. For those wishing to use the recommended external computer then additional construction information is available from Digisound Limited. All PCBs for this project have component overlays printed on



Motherboard and front panel wiring.

and so component placement is not shown here. Special care should be taken with orientation of ICs and the DIN connectors but again these are clearly marked on the PCBs.

Start by installing the components on the quad DAC card (PCB 80-C3) since the completed PCB is required for positioning purposes in the next stage. All links are marked and normally can be made with bare solid wire, such as 1/0.6mm, although insulated wire should be used where "INS. LINK" appears. IMPORTANT: THERE ARE TWO LINKS MARKED INSIDE BOXES, ONE IS MARKED "SP. LINK" AND IS THE LINK TO BE USED FOR A NOMINAL 5 VOLT GATE OUTPUT. THE OTHER IS MARKED "HIGH G LINK" AND IS TO BE MADE ONLY WHEN A NOMINAL +15 VOLT GATE IS REQUIRED IN WHICH CASE "SP. LINK" MUST NOT BE MADE. FAILURE TO OBSERVE THIS MAY RESULT IN COSTLY DAMAGE. Carefully check the foil side of the PCB after construction for excess solder or solder splashes which may make unwanted connections — this is normal practice with any project.

Next install the components on the motherboard PCB (PCB 80-C1) and if you are only going to be using four voices in the immediate future then install: the wire links; DIN sockets in Slots 1, 2, 3 and 4 (4 is for ease of calibrating); the components R1, R2, C1 to C3 and TR1; the power connector PCB plug. Next solder wires to: points marked $\overline{RST}$ and 0V near Slot 1 which are long enough to reach to CONN. 2 on panel; to points marked LED+ and LED 0V long enough to reach the monitor LED; and finally to point marked SKT A1, P11 which has to reach to socket A1 on the Controller Card. After cropping the leads from the underside of the PCB and making the usual check on soldering we are now ready to bolt the PCB to the mounting bracket at points adjacent to Slots 1, 4 and 6 and using nuts as spacers. Plastic nuts and bolts are used at Slots 4 and 6 on the PCB edge nearest the panel to remove the possibility of shorting out a PCB track. First, however, install 'L' brackets at either side of Slots 3 and 5 (plastic bolts at PCB panel edge) with their uprights towards the power supply input. Their precise location can be adjusted later but these brackets will be in front of the component side of the 80-C3 PCBs when the latter are installed in their slots. The PCB can now be put on to the six mounting bolts and spacers and the 'L' brackets installed for Slots 1 and 3. For the Controller Card in Slot 1 the mounting bracket is a shorter type and its upright should face the non-component side of the PCB. In this instance the PCB is secured with a plastic nut and bolt with another nut as an insulating spacer between the bracket and the PCB.

PIN 1 Channel 2 LED	PIN 6 Channel 4 C.V.	PIN 11 Channel 4 gate
PIN 2 Channel 1 LED	PIN 7 Channel 2 C.V.	PIN 12 Channel 2 gate
PIN 3 0V line	PIN 8 Not used	PIN 13 Channel 3 LED
PIN 4 Channel 1 gate	PIN 9 Channel 1 C.V.	PIN 14 Channel 4 LED
PIN 5 Channel 3 gate	PIN 10 Channel 3 C.V.	

Table 1

PIN 1	P1, input	PIN 5	P2, output	PIN 9	P4, output
PIN 2	P1, output	PIN 6	P3, input	PIN 10	Not used
PIN 3	Not used	PIN 7	P3, output		
PIN 4	P2, input	PIN 8	P4, input		

Input and output refer to the side of the voltage controlled switch, IC5

Table 2

PIN NO.	KEYPAD 15-WAY CABLE AND CONN. 2 15-WAY SOCKET	CONN. 2 15-WAY SOCKET TO 14 PIN HEADER TO A2 ON CONTROLLER CARD
1	N.C.	N.C.
2	C1	C1
3	C2	C2
4	C3	C3
5	C4	C4
6	R1	R1
7	N.C.	N.C.
8	N.C.	N.C.
9	R2	R2
10	R3	R3
11	R4	R4
12	N.C.	N.C.
13	N.C.	N.C.
14	0V	N.C.
15	$\overline{RST}$	N/A

Table 3

PIN NO.	KEYBOARD CONTROLLER AND CONN. 1 15-WAY	14 PIN DIL HEADER FROM CONN. 1 TO A1 ON CONTROLLER CARD
1	D0	+5V
2	D1	D0
3	D2	D1
4	D3	D2
5	D4	D3
6	D5	D4
7	N.C.	0V
8	N.C.	0V
9	N.C.	D5
10	0V	N.C.
11	N.C.	TO R2 ON MOTHERBOARD
12	INHIBIT	INHIBIT
13	STROBE	STROBE
14	N.C.	+5V
15	+5V	N/A

Table 4

The DIL socket X5 on the quad DAC board for Slot 3, the first four voices, now connects with the first four sets of LEDs and pairs of jack sockets on the front panel. The 0V line from X5 is used for the ground connection to the LEDs (short lead) and the ground connection of the jack sockets. The jack socket just below the LED should be assigned to the gate output voltage. A length of ribbon cable is used to connect between the X5 DIL header and the panel components. This 13-way cable should be long enough so that the quad DAC card can operate from Slot 3 or Slot 4, but do not make it excessively long. The length can be gauged by offering up the motherboard bracket to the panel with the quad DAC in place. The X5 connections are shown in Table 1.

If more than one DAC card is fitted then the connections between X5 and the panel can be made the exact length for Slots 4 onwards. When all of the connections to the panel have been made then thread the DIL headers through the appropriate holes in the mounting bracket and join the latter to the panel using two or more of the bottom row of potentiometers. For the first quad DAC potentiometers P1 to P4 (equivalent to RV3, 6, 9 and 12 respectively on the circuit diagram) are now wired up to the Molex socket which connects to the DAC card as in Table 2.

Again by temporarily installing the DAC into its slot the wire lengths can be accurately gauged but for the DAC in Slot 3 the wires must be long enough for the DAC to be used in Slot 4. Viewing the potentiometers from the rear and their connections facing upwards the wiper and right hand connection are connected to one wire and the left hand connection to the other wire.

Now make up the control keypad. This may either be installed in the keyboard case or in a separate housing as illustrated. The housing shown allows space for expansion. The keypad should be located close to the bottom lip of this case and by turning the keypad over the hole positions can be marked and then drilled. A slot will have to be cut into the case to allow connections from the keypad to pass through and this is best done by drilling a row of holes of 5 to 6mms. diameter and cutting out the excess plastic between the holes — do this carefully since it is difficult to play keyboards with a bandaged hand! A hole is also required at the rear of the case to accept a 15-way cable. The photographs show the use of flat cable but most constructors will find it more convenient to use round cable. The RESET button is mounted on the top slope of the case at the rear about 20mm. in from the left edge so that it does not interfere with the internal clips. A 6.5mm (or ¼ inch) hole is required for this push-button switch. Finally the case should be fitted with four rubber feet at its extreme corners to prevent it slipping around when in use. The keypad connects to the 15-way socket, CONN. 2, on the panel and the connections are listed in Table 3.

The R and C numbers in Table 3 refer to the markings on the keypad used. Do not cut short any unused wires on the 15-way cable since they will be required at a later date.

If the keypad is installed into the keyboard case then the simplest technique is to also install a 15-way socket as well and to connect up with CONN. 2 using a length of 15-way cable terminated at each end with 15-way plugs.

Now install CONN. 1 which goes to the keyboard controller using 15-way miniature D connectors as above. The sockets are installed on the keyboard and the Alphadac panel and the connections are made using a short connecting lead with a plug at both ends. Behind the panel, CONN. 1 connects with socket A1 of the Controller Card using a 14-pin DIL header. The connections are shown in Table 4.

Next install the monitor LED and connect the remaining wires on the motherboard. The wire at the end of R2 on PCB goes to pin 11 of the DIL header for the A1 socket of the Controller Card, as listed above. The wire at the end of R1 (LED+) goes to the long lead of the monitor LED and that from TR1 collector (LED 0V) to the short lead. The 0V and $\overline{RST}$ wires near Slot 1 go to CONN. 1 connector as listed earlier in order to connect up with the RESET push button switch.

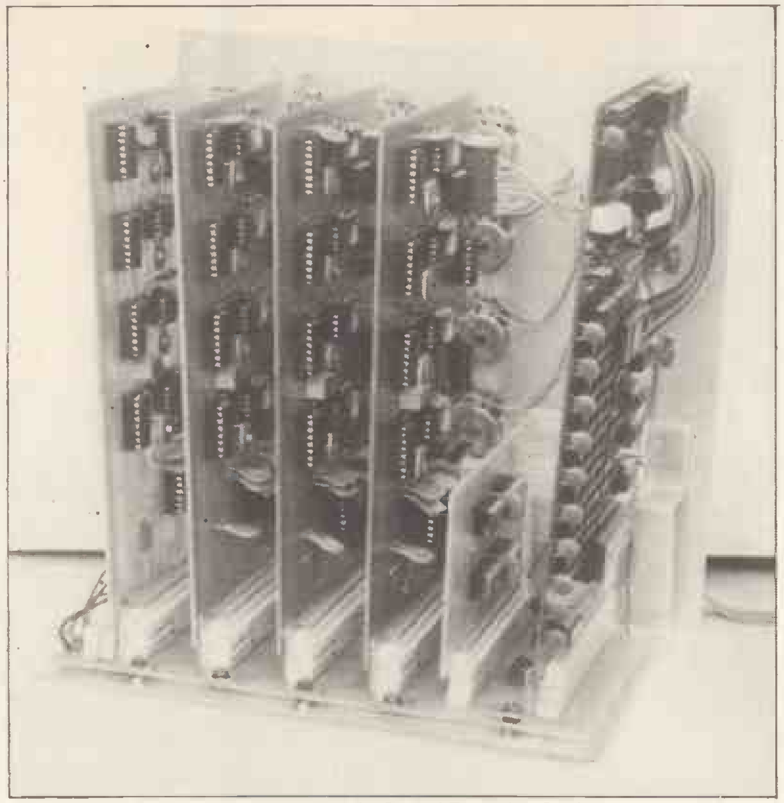
Finally, install the components on the Interface PCB (PCB 80-2). After inserting the DIGI-1 EPROM into socket F2 of the Controller Card we are now ready to go. Install the Controller Card in Slot 1; the Interface Card in Slot 2; and one quad DAC Card into Slot 4 for the calibration step with switch S2 on and the other switches off. Join up the Molex connector from P1 to P4 to the DAC Card and also the DIL header for channels 1 to 4 to socket X5 on the DAC. Power supplies required are ±15V and +5V and the 0V lines for both supplies should be commoned together. Life will be simpler if both power supplies are turned on from the same mains switch but if not then it is good practice to switch the +5V supply on first followed by the ±15V supplies. Likewise the latter should be switched off first followed by the +5V supply.

Operating and Calibrating the Alphadac 16

After switching on the power the first step is to press the RESET button associated with the control pad. With a computer operated system the video would ask four questions and expect the appropriate responses. These are:

A. **VOICES?** That is how many synthesiser voices are you going to use? Press key 1 to F which equals 1 to 15 while pressing key 0 at this time indicates that you have sixteen voices.

B. **CDWRD?** At this stage a CDWRD of 0 or 1 should be entered. Key 1 will indicate that you will require a top split, that is the top section of the keyboard will be used for the monophonic section with a high note priority and its output always going to channel 1 with the bottom portion of the keyboard being polyphonic with up to fifteen more available channels. Pressing key 0 gives a bottom split, the monophonic channel being at the lower portion of the keyboard. Note that the response to this question is preparing the computer for a subsequent control pad response.



Complete synthesiser controller with 4 DACs and Tangerine Card.

In other words you are only informing the computer that when you do select split (see later) it will be top or bottom and until such times as this additional command is given the keyboard will respond solely in the polyphonic mode. In fact CDWRD is more powerful than this and does allow you to enter into various keyboard routines immediately from this start up stage. For simplicity, however, will we stick with the 0 and 1 response to CDWRD and further details of the use of this function are provided with the programme listing.

C. **POLYTR?** Enter the transpose value for the polyphonic channels. Pressing keys 1 to F equal transpose values of 1 to 15 semitones, so for example key C will result in an octave transpose. As with split described above, the transpose will only take place in response to a subsequent control pad response so as to be able to effect the transpose in real time, but you are deciding beforehand the effect you will obtain.

D. **KEPTR?** Enter transpose value that may be required for the monophonic channel. The key values are the same as for POLYTR but note that the monophonic portion of the keyboard (if required) can have a different transpose value.

The computer then expects you to press any button on the keypad to start, so do it now.

Starting up with the Controller Card is just as easy. Press the RESET button at which time the monitor LED will be extinguished and remain off. Then press the control pad keys as though you were responding to the four questions listed above and then press any other key to start. On completion the monitor LED will now flash slowly and it will stay in this condition except when arpeggiation routines are in use at which time it will flash on and off at the arpeggiation rate.

Suppose then we wish to set up for four voices, top split and octave transposes on both polyphonic and monophonic channels. Just press RESET follow by control pad keys 4-1-C-C-C (the last C being the start command). The whole procedure takes less than two seconds. If a mistake is made during setting up, or the monitor LED stops flashing (perhaps a short power failure) or you wish to change the program then press RESET followed by the required keys on the control pad.

Calibration is also straightforward except that close packing of the PCBs restricts access to the quad DACs. In the construction we have recommended installing Slot 4 even though no more than four voices are installed initially. The first DAC is therefore put into Slot 4 as described earlier and using a small screwdriver or trimming tool there is now sufficient space to access the trimmers on the DAC Card. Remember switch S2 should be on and the others off when it is in this Slot. Turn power on, press RESET and press control keys 4-1-C-C-C in sequence. To be sure, now press key 0 on the control pad and adjust trimmers RV2, RV5, RV8 and RV11 so that the output from the respective ICs is exactly zero. The voltage can be measured at the Molex plug on the PCB by connecting up to the appropriate P 'input' as listed earlier, e.g., P2 input at pin 4 of the Molex connector will allow the offset of IC8 to be trimmed out using RV5. Now measure the control voltages from the jack sockets for channels 1 to 4 and use trimmers RV1, RV4, RV7 and RV10 respectively to obtain the required 1V/octave relationship. The initial voltage may be a millivolt or two from zero due to the small offset in IC6 but this should be ignored — trying to trim it out with the presets used above will make matters worse. Calibrate each channel in turn using the following procedure. Press control pad key 4 twice and adjust the appropriate multiturn trimmer to give exactly 2 volts. Press key 4 again and adjust trimmer, if necessary, to obtain exactly 3 volts. Next press key 5 which takes you back to 2 volts and keep pressing keys in the sequence 4-5-4-5-. . . until the values obtained are as close to 2 and 3 volts as you can make them. Pressing key 0 puts you back to zero and repeated pressing of key 4 (up to five times) takes you up in octave steps and so allows you to obtain the best linear response by using the trimmers.

Using the 'Alphadac 16'

There are a large number of effects available in the DIGI-1 program and they should be treated as an aid to playing and not taking full command of the synthesiser. In other words they increase the scope for experimentation to achieve some novel effects. This using section therefore lists the function of the sixteen keys on the control pad.

KEY 0. This is the CLEAR key. It clears all values entered from the keyboard or control pad and can be used at any time if you find yourself in an awkward situation. It does not affect the original program values — only pressing RESET and entering new values can do that.

KEY 1. TUNE. This key outputs the same key code to all channels and puts the gate on. It therefore allows all oscillators to be tuned exactly to each other. Pressing key 0 when tuning is complete puts the keyboard and control pad back into your control.

KEY 2. PORTAMENTO. Sets glide on all polyphonic channels. If glide is off then pressing the key puts it on while if it is already on then pressing key 2 will turn it off. This key will not affect channel 1 if split is in operation.

KEY 3. PORTAMENTO. Operates as key 2 but only on channel 1 when split keyboard is in use.

KEY 4. (POLY) TRANSPOSE UP. Pressing this key will transpose the polyphonic voices up by the interval selected at start-up. It does not affect channel 1 if split is in operation.

KEY 5. (POLY) TRANSPOSE DOWN. As key 4 but the polyphonic section is transposed down by the selected interval. Note that the control pad may be used like a second keyboard and the keys may be pressed in time with the music to give, for example, instantaneous transposition of any part of the music. Remember the strange effects that may occur if you transpose outside of the five octave range of the control bits. To put the keyboard into some other tune range still requires the normal octave shift facility found on most synthesisers.

KEY 6. (MONO) TRANSPOSE UP. As key 4 but operates on channel 1 if keyboard split is in use.

KEY 7. (MONO) TRANSPOSE DOWN. As key 5 but operates on channel 1 in split mode.

KEY 8. SELECT SPLIT POINT. After key 8 on the control pad has been pressed then the first key pressed on the keyboard becomes the split point, that is, the point where the keyboard changes from monophonic to polyphonic. Whether the monophonic section is at the top or bottom portion of the keyboard depends on the program value entered at start-up, as discussed earlier. If you find that the split point is not quite in the right position when you come to play the music then simply press key 0, press key 8 and then press the new note on the keyboard where you require the split to occur. You can, of course, always do a RESET and split the keyboard the other way round. Pressing key 8 again while in the split mode will make the keyboard revert back to polyphonic operation without having to clear other values you may be using.

With the split mode plus the ability to independently select portamento, transpose up and transpose down on each side in real time the playing possibilities become exciting. For example, with a bottom split (key 0 during setting up) channel 1 may be set to a bass guitar sound to accompany yourself on the polyphonic channels. The possibilities are, however, endless since you could also select top split and by transposing the top monophonic section down and the bottom polyphonic section up you would be able to play the bass line with your right hand! Much of the fun comes from experimenting with the effects yourself and learning their musical possibilities but, as other examples, the monophonic channel could be used to control another 1V/octave synthesiser or you may use it to control a separate low frequency VCO (or other voltage controlled module) to obtain dynamic control of modulation and so on.

KEY 9. This key puts you into the arpeggiation mode in the monophonic section of a split keyboard. Up to 16 keys may be held down in this mode and the computer will play each one in turn.

KEY A. Selects UP or DOWN arpeggiation. If the computer is reading up the scale then pressing the key will cause it to read down or vice versa.

KEY B. Pressing this key causes the arpeggiation to reverse direction automatically at the end of each scan of the keys being held down.

KEY C. Selects staccato or legato mode of arpeggiation. Again if you are in the staccato mode then pressing the key puts you into legato or vice versa.

KEY D. Increases the rate of arpeggiation each time the key is pressed.

KEY E. Decreases the rate of arpeggiation each time the key is pressed. When in the arpeggiation routine the monitor LED flashes at the arpeggiation rate.

KEY F. This key will turn the arpeggiation into a sequence which will continue to play even when all keys are released and so

PARTS LIST — MOTHERBOARD (4 VOICES)

Resistors — ¼W 5% carbon film

R1	120R	
R2	1k0	

Capacitors

C1,2	220nF polyester (Plessey Minibox)	(2 off)
C3	10uF 25V tantalum electrolytic	

Semiconductors

TR1	BC548	
D1	SEL1710Y (5mm yellow LED)	

Miscellaneous

64-way A/B DIN sockets	(4 off)
PCB 80-C1	
Sundry mounting hardware	

PARTS LIST — 'ALPHADAC' INTERFACE CARD

Capacitors

C1,2,3	100nF ceramic disc	(3 off)

Semiconductors

IC1,4	74LS08	(2 off)
IC2	74LS30	
IC3	74LS04	
IC5	74LS365	

Miscellaneous

14 pin DIL sockets	(4 off)
16 pin DIL socket	
64-way A/B DIN plug	
PCB 80-C2	

PARTS LIST — ADDITIONAL ITEMS FOR 'ALPHADAC 16'

TANGERINE 'CONTROLLER CARD' or 'MICROTAN 65'/'TANEX'	
Hex. Keypad. 4 x 4 matrix	
Optional case for above. West Hyde VDU PR4.	
Push to make switch	
15-way miniature-D plugs	(2 off)
15-way miniature-D sockets	(2 off)
3.5mm jack sockets	(8 off for four voices)
Panel, mounting bracket, miscellaneous hardware.	

PARTS LIST FOR QUAD DIGITAL TO ANALOGUE CONVERTER BOARD

Resistors — ¼W 1% metal film

R1	390R	
R2,4,6,8	30k	(4 off)
R3,5,7,9	4k7	(4 off)

Resistors — ¼W 5% carbon film

R10,11,12,13	4k7	
R14	100k	
R15	47k	
R16,18,20,22	1k0	(4 off)
R17,19,21,23	220R	(4 off)

Capacitors

C1,2,3,4,5,6,7,8, 9,10,11	100nF ceramic disc	(11 off)
C12	1uF MKH polyester	
C13,15,17,19	22nF polyester (Plessey Minibox)	(4 off)
C14,16,18,20	220nF polyester (Plessey Minibox)	(4 off)

Potentiometers

RV1,4,7,10	10k, 25 turn cermet (Spectrol 64Y)	(4 off)
RV2,5,8,11	10k cermet (Egen 482H20)	(4 off)
RV3,6,9,12	2M2 log. potentiometers	(4 off)

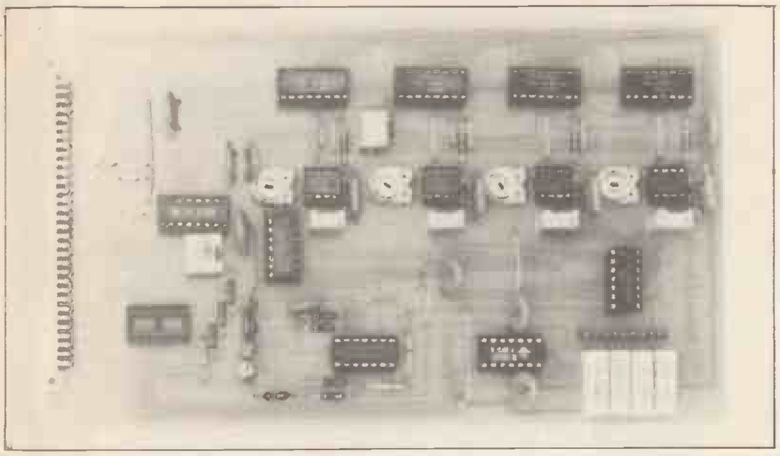
Semiconductors

IC1	74LS139	
IC2	74LS256	
IC3,7,9,11	ZN428E-8	(4 off)
IC4,8,10,12	LF351N	(4 off)
IC5	CD4066B	
IC6	TL084CN	
IC13,14	CA3240E	(2 off)
TR1,2,3,4	BC548	(4 off)
D1,2,3,4	SEL2110R and clips (3mm red LED)	(4 off)

Miscellaneous

Switch, S1 to S4	4-pole SPST lateral DIL	(4 off)
8-pin DIL sockets		(4 off)
14-pin DIL sockets		(5 off)
16-pin DIL sockets		(6 off)
14-pin DIL header		
10-way 0.1 inch Molex connector (plug, cover and pins)		
64-way A/B DIN plug		
PCB 80-C3		

A complete set of parts for a 4-voice controller card version of 'Alphadac 16' as described above, is £193.50 plus VAT. Parts for control of an additional four voices is £50.44 plus VAT. These are available from Digisound Ltd, 13, The Brooklands, Wrea Green, Preston, Lancs. PR4 2NQ. Tel: 0772 683138. Both sets exclude single connecting wire, solder and the four control knobs — the latter being a user choice to match other equipment. It does include the programs in EPROM, keypad, panel, nuts and bolts, special wire (15-way cable and strip type), connectors and DIL sockets, PCBs and all electronic components.

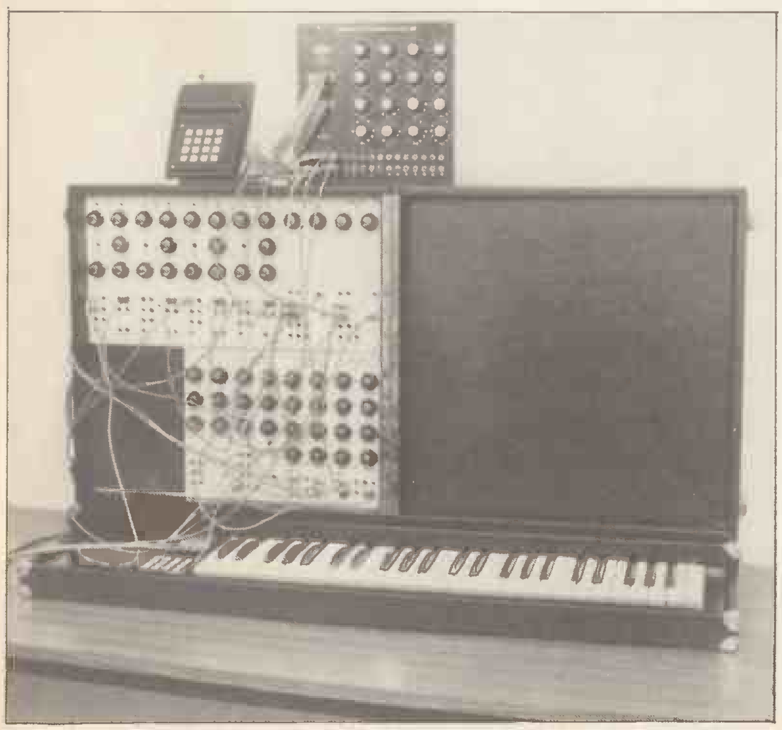


Alphadac 16 Quad DAC board.

provide an automatic accompaniment. One precaution has to be observed, namely, that the notes selected have to be released from the top of the keyboard downwards. This is quite easy to do. But the effect does not end there since pressing any other single key will now take the place of the lowest note that was originally pressed and all of the notes could be replaced by another sequence. Press key F again to stop this mode or key 0 to clear. Remember also that transpose and glide are still available while in the arpeggiation routines.

It is routines such as the arpeggiation techniques which add playability to the synthesiser even when only one or two voices are available. For example, pressing keys 9 and A and holding down a chord in the monophonic section will almost sound like a chord if the scanning rate is fast enough — press key D successively to increase the rate. Another effect could be obtained by connecting channel 2 output (on the polyphonic side) to a second control input on the arpeggiation oscillator (channel 1 monophonic portion) and with this patch pressing one key on the polyphonic side will effect a transpose at various intervals available on the latter portion. It is all good fun but it also has many musical possibilities as well and remember if you get in a muddle while learning then just press key 0 and start again.

Having run out of keys this seems a suitable stage at present to conclude the DIGI-1 program. In later versions, which will be exchanged for DIGI-1 at a small cost, we propose to keep to one control pad and have an external switch which will effectively double its capacity. Likewise other routines such as sequencing will be following on. There is, however, a great deal of music to be made with DIGI-1 and it is best to get to know this program thoroughly now so that you will be able to make the best use of later additions. E&MM



A complete 4-voice synthesiser controlled by Alphadac 16.

SYNWAVE

- * **Sounds from swirling sea to cymbal and wood block**
- * **Easy to build and play**
- * **Dual trigger operation - percussive/external trigger**
- * **Touch sensitive**

Design - Mike Beecher
Development - Robert Penfold

PARTS COST GUIDE £12.25

RECORDED ON CASSETTE NO. 3

The Synwave continues our series of small projects that produce sounds for use in electro-music by percussive control. The minimum number of controls have been selected to give a wide range of 'sea-wave' sounds. In addition, different settings of the controls will produce wind, cymbal and woodblock sounds.

Like the 'Syntom' project featured in our April issue, the unit can be triggered by tapping the case or by striking a drum (on which the Synwave is mounted). These projects are also ideal for triggering from an external source (e.g. a sequencer synthesiser or micro) and thus a second mode of operation can be from an electronic trigger using a positive-going edge of about 7 to 15 volts in amplitude. Interaction of the two modes of use is possible so that complex rhythms can be made from a steady 'external triggered' beat mixed with hand or drum taps providing syncopation.

The four controls are Volume (with on/off switch), for setting output level; Decay - adjusts the time it takes for the sound to die away; Pitch - sets the frequency range of noise from low to high; 'Q' - a resonance control that narrows and highlights the pitch range selected.

Circuit

The block diagram of Figure 1 shows the general arrangement used in the Synwave. An envelope shaper can be operated by either an internal microphone or an external trigger signal, or both. The envelope shaper has a fast attack and slow decay, with the latter being adjustable from less than 100ms to about 5 seconds. The output of the envelope shaper is fed to the control input of a voltage controlled amplifier (VCA) via buffer stage.

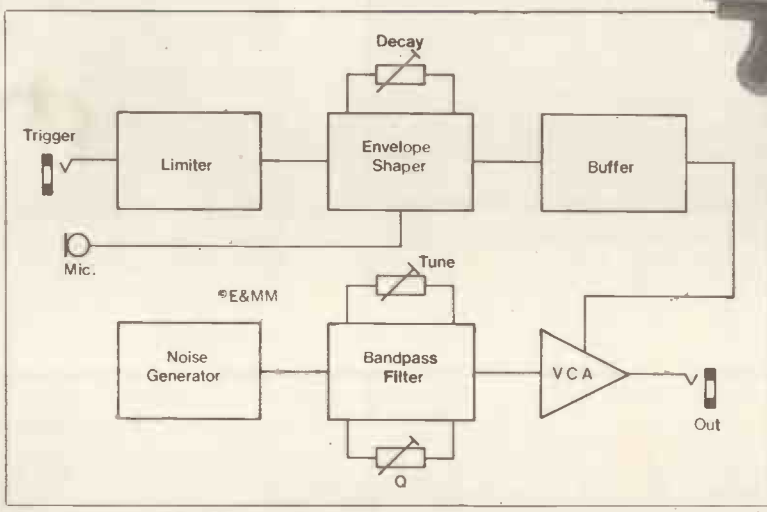


Figure 1. Block diagram of the Synwave.

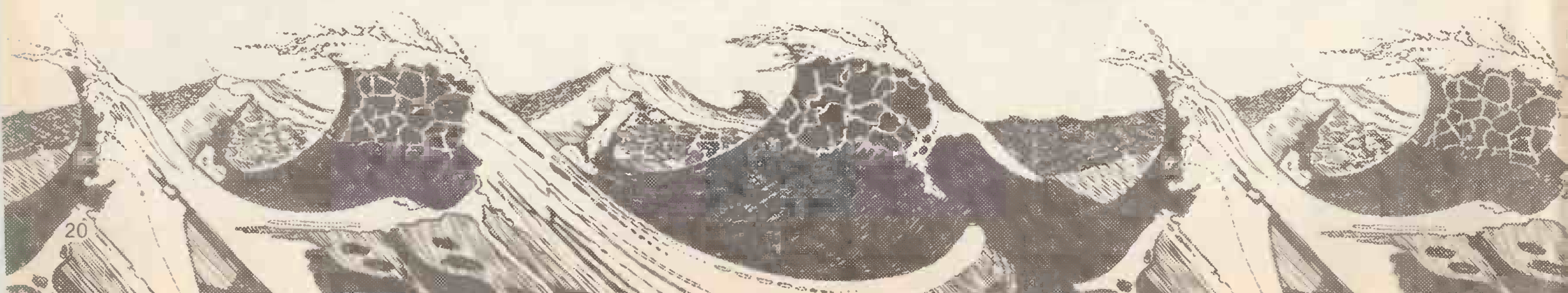
A simple noise generator feeds a bandpass filter which in turn feeds the input of the VCA. The bandpass filter is tunable from a few hundred hertz to more than 10kHz, and therefore gives considerable control over the sound produced by the unit. The bandwidth of the filter can be varied from a very broad response to a very sharp peaky response by means of the Q control, and again, this permits the output sound of the unit to be varied greatly.

If we now consider the full circuit diagram of the Synwave (Figure 2); C1, R1, D1, D2, and R2 process the trigger signal so that on its rising (positive) edge a brief positive pulse of about 7 volts in amplitude is supplied to the base of TR1. TR1 and TR2 form a Darlington pair emitter follower ing the brief input pulse to TR1. R3 and RV1 provide a discharge path for C2, and the setting of RV1 determines the discharge time of C2 (and therefore the length of the output signal).

If crystal microphone X1 is subjected to strong vibrations it will give an output level of several volts peak to peak, and positive going output half cycles will result in C2 being rapidly charged. The output signal level and hence the charge produced on C2 depends on how hard the unit or the drum to which it is attached is struck, and this gives a degree of touch sensitivity.

The signal across C2 must be only lightly loaded or the decay time will be greatly shortened by the charge current leaked away through the loading circuit. TR3 is therefore used as an emitter follower buffer stage which couples the output from C2 to the control input of the VCA. The VCA uses a CA3080 transconductance amplifier, and it gives a level of gain that is proportional to the control voltage. The output signal thus rises rapidly to its peak level, and then decays relatively slowly, in sympathy with the envelope voltage across C2. The output of the VCA is coupled to the output socket by way of volume control RV2. Dual balanced supplies are required by the VCA circuitry and a central 0V rail is effectively produced by R10, R11 and C5.

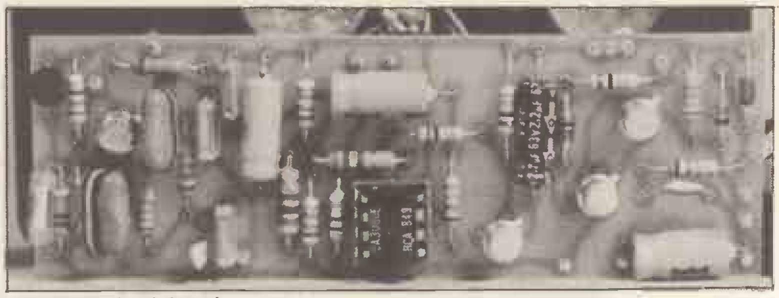
TR5 is used as the noise generator and R18 applies a reverse bias to its base-emitter junction. This junction behaves rather like a Zener diode and like a Zener diode produces noise spikes. This arrangement is preferable to using a Zener diode though, as it gives a higher output at audio frequencies. The high frequency output of the noise generator is



excessive, and so C11 is used to give high frequency attenuation to correct this.

A twin T filter is used as the basis of the bandpass filter, but as a twin T network gives a notch at its centre frequency rather than a peak, the filter network is connected to give negative feedback over a common emitter amplifier. This amplifier features TR4 in a conventional configuration. TR4's emitter circuitry enables a certain amount of negative feedback to be applied to the amplifier and the amount of feedback is controlled by RV4. With the slider of RV4 at or near the lower track connection there is little or no feedback; giving the circuit a high Q value and a narrow, peaky response. Moving the wiper of RV4 towards the upper end of its track gives increased feedback and a consequent reduction in Q together with a broader, flatter response.

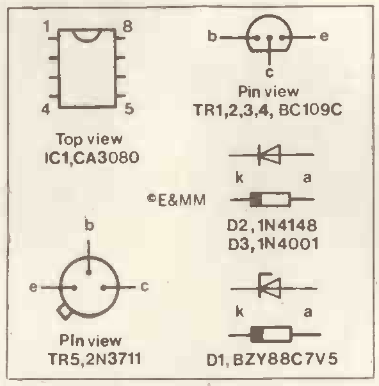
RV3 is part of the twin T network, and varying the setting of this component alters the centre frequency of the filter. Ideally all three resistive elements in the filter should be varied when tuning the filter, but this is not really



Completed circuit board.

practical. This simple system works quite well though, and the only minor drawback is that the Q of the filter varies somewhat with changes in the setting of the pitch control. At some settings of RV3 it may be found that setting RV4 for a very high Q causes the filter to oscillate at its centre frequency. If desired, this can be avoided by adding a resistor of about 150 ohms in value between the positive terminal of C9 and the upper track connection of RV4. However, as this would limit maximum Q available, especially at the highest and lowest pitch control settings, it would reduce the effectiveness of the unit and is not really worth while.

C13 is needed to prevent the filter becoming unstable due to stray high frequency feedback. C4 couples the output of the filter to the input of the VCA. The current consumption of the circuit is only about 1.5mA., or a little higher than this when it is triggered.

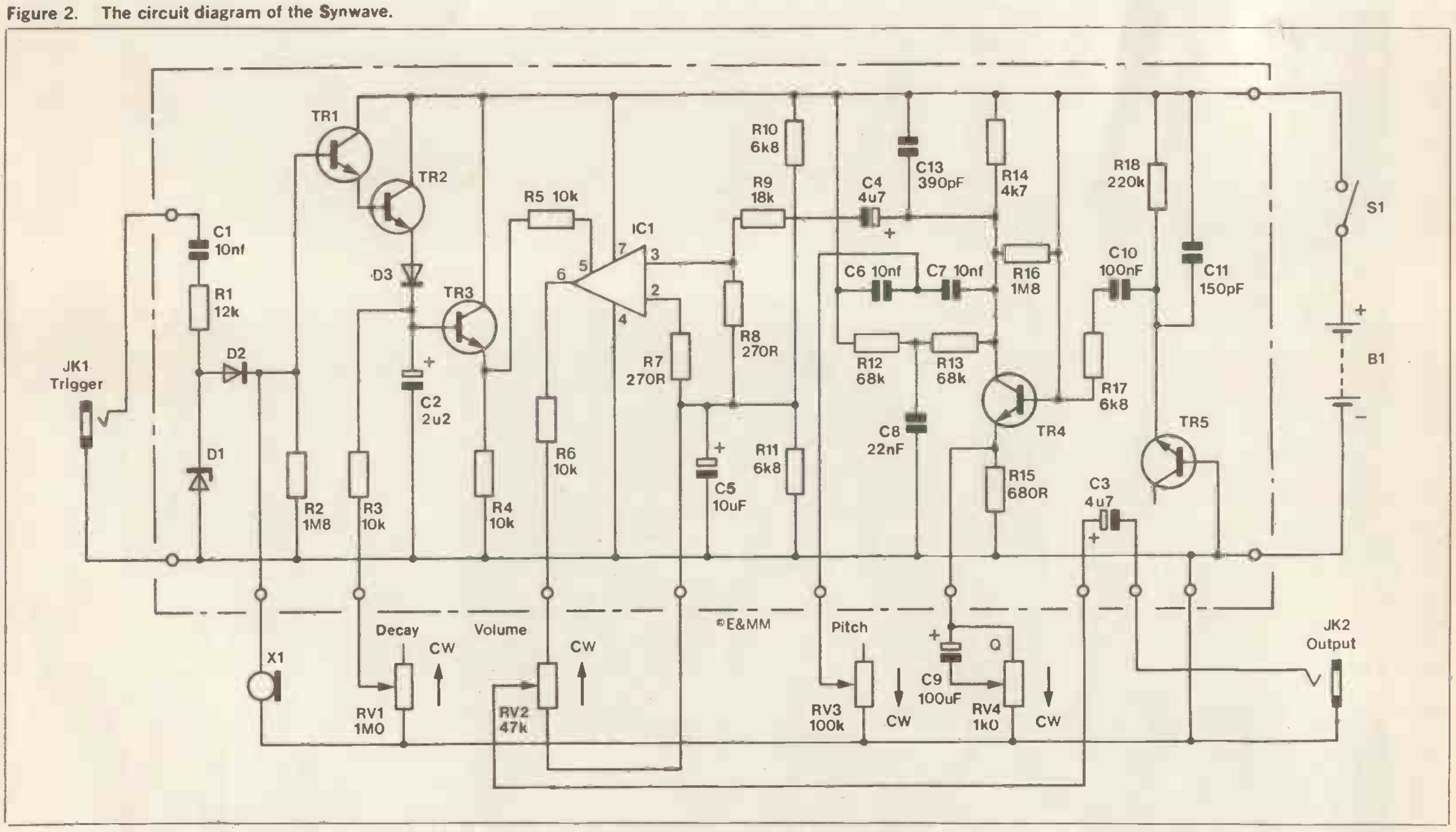


Construction Details

Except for C9 all the resistors, capacitors, and semiconductors are fitted onto a printed circuit board. Fit the semiconductors last, and make quite sure that the electrolytic capacitors and semiconductors are connected the right way round. The printed circuit board fits into the mounting rails of the specified case, but this leaves insufficient room for leads to be taken around the board to the controls, battery clip, microphone, and sockets. This makes it necessary to fit Veropins to the board at the points where it connects to these components, or if preferred, these leads can simply be soldered direct to the copper tracks. Details of the printed circuit board are provided in Figure 3.

The removable lid of the case is used as the rear panel in this application, and the two sockets are mounted on this panel. The front panel is drilled to take the four potentiometers and the microphone is mounted on the right side of the case (as viewed from the front). The microphone is

Figure 2. The circuit diagram of the Synwave.



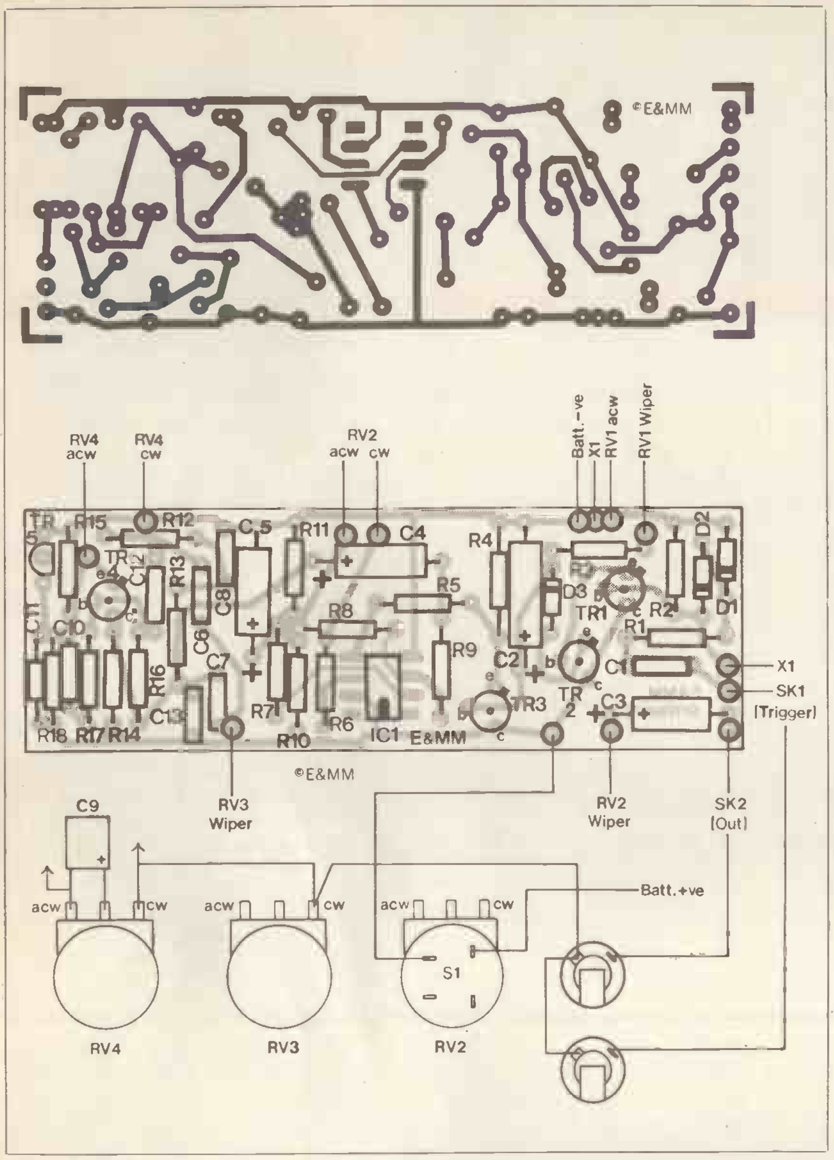


Figure 3. PCB track, component layout and wiring details.

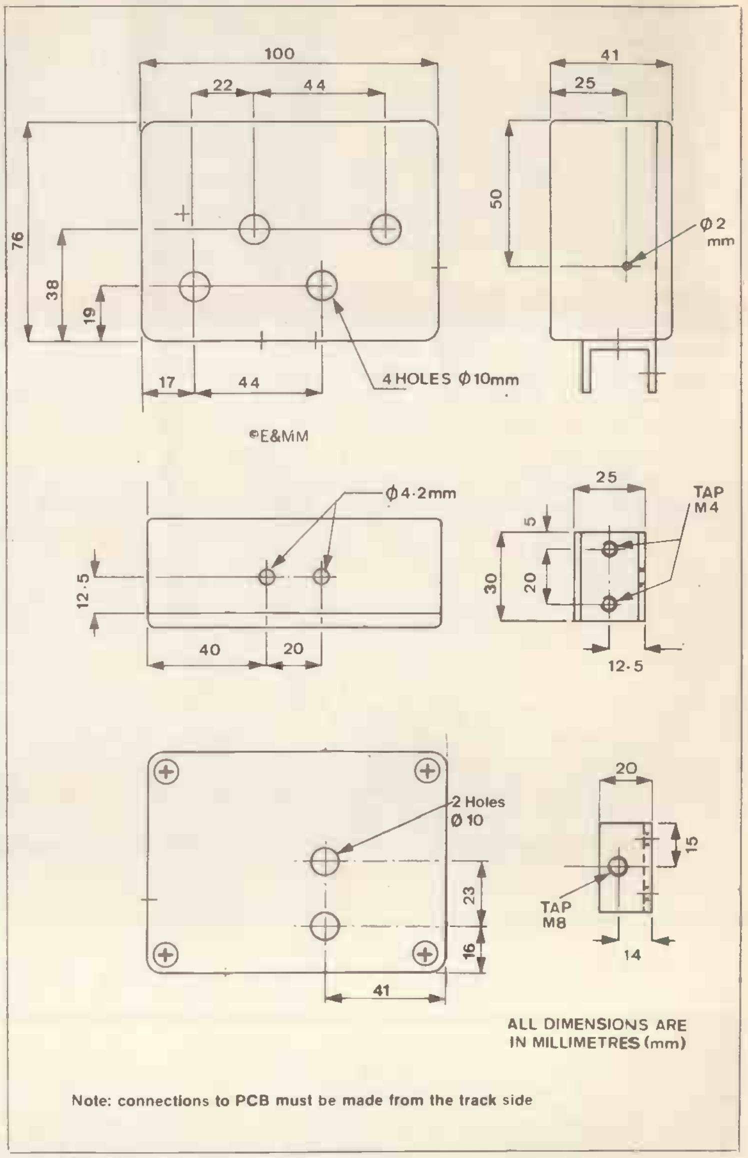
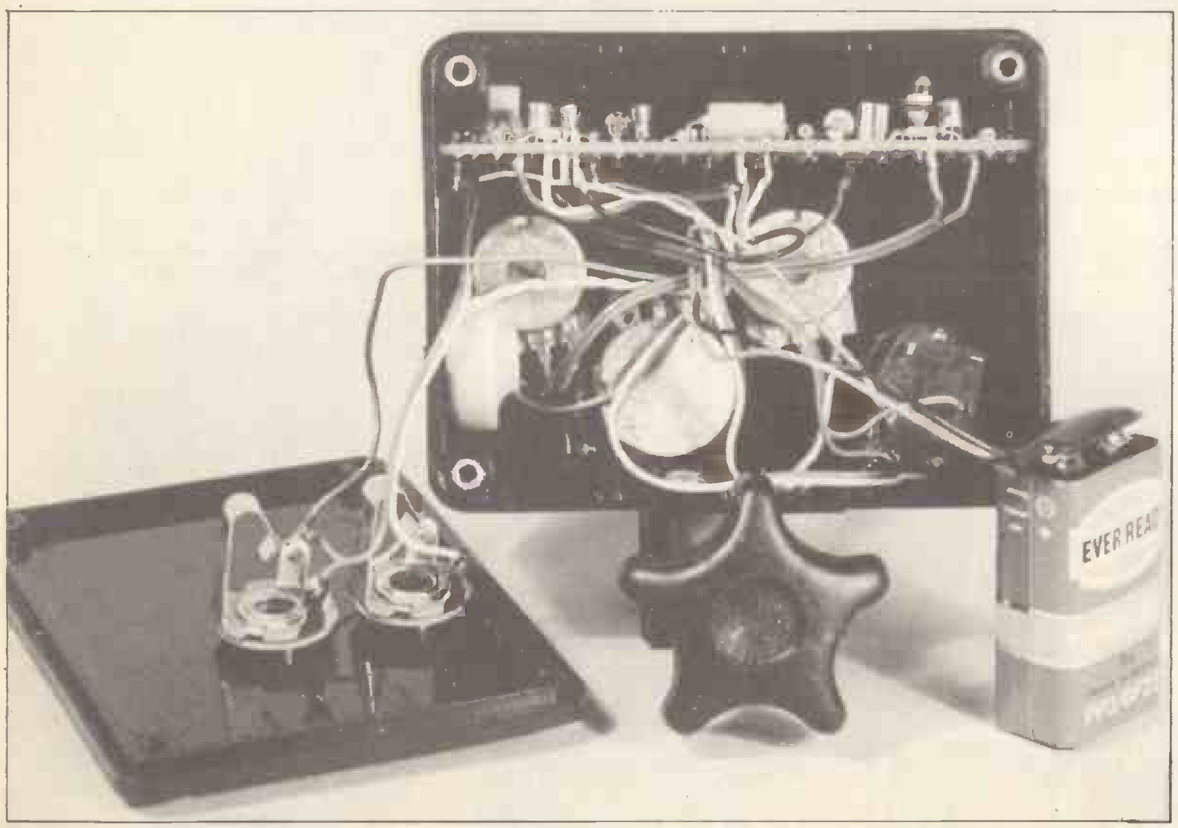


Figure 4. Case and bracket construction.



Synwave with wiring completed and PCB board inserted in case.

actually a crystal earphone having the earpip unscrewed. The small screw at the rear of the earphone is removed, and this is then used to fix the earphone to the case. Figure 4, shows the drilling of the case, and it is advisable to follow this as accurately as possible since there is not a great deal of excess space inside the case and it might otherwise be found that all the parts cannot be fitted into the case.

Next C9 is connected to RV4 and the other wiring to the off-board components is completed. Figure 3 gives details of all this wiring. The printed circuit board fits into the upper set of mounting rails in the case with the component side uppermost. The battery fits vertically into the case in the space between the two sockets and the microphone. A piece of foam material can be glued to the rear panel of the case to keep the battery firmly in place.

If the Synwave is to be fitted onto a drum it is necessary to fit the unit with a mounting bracket. This can consist of a piece of

25mm aluminium channel section which is fixed to the case using a couple of 6mm M4 bolts. A large bolt is used to clamp the Synwave onto the drum, and the bracket is drilled and threaded on one side to take this bolt. A handwheel bolt is ideal for use in this application, but an ordinary type can be used of course. It is advisable to fit a small pad of rubber on the part of the bracket opposite the mounting bolt as this will help to prevent the rim of the drum from becoming scratched when the Synwave is fitted in place.

To complete your project use our smart brushed aluminium panel with electric blue legend and sticky back as shown.

PARTS LIST

Resistors — all ⅓ watt 5% unless specified

R1	12k		(M12K)
R2,16	1M8 (10%)	2 off	(M1M8)
R3,4,5,6	10k	4 off	(M10K)
R7,8	270R	2 off	(M270R)
R9	18k		(M18K)
R10, 11,17	6k8	3 off	(M6K8)
R12,13	68k	2 off	(M68K)
R14	4k7		(M4K7)
R15	680R		(M680R)
R18	220k		(M220K)
RV1	1M lin. pot.		(FW08J)
RV2	47k log. pot. with switch		(FW65V)
RV3	100k lin. pot.		(FW05F)
RV4	1k lin. pot.		(FW00A)
Capacitors			
C1	10n ceramic plate		(WX77J)
C2	2u2 63V axial electrolytic		(FB15R)
C3,4	4u7 63V axial electrolytic	2 off	(FB18U)
C5	10u 25V axial electrolytic		(FB22Y)
C6,7	4n7 polycarbonate	2 off	(WW26D)
C8	10n polycarbonate		(WW29G)
C9	100u 10V PC electrolytic		(FF10L)
C10,12	100n polyester	2 off	(BX76H)
C11	150p polystyrene		(BX29G)
C13	390p ceramic plate		(WX63T)
Semiconductors			
IC1	CA3080, 8-pin, DIL		(YH58N)
TR1,2,3,4	BC109C	4 off	(QB33L)
TR5	2N3711		(QR34M)
D1	BZY88C7V5		(QH11M)
D2	1N4148		(QL80B)
D3	1N4001		(QL73Q)
Miscellaneous			
X1	Crystal earpiece		(LB25C)
SK1,2	Mono jack socket (open type)	2 off	(HF91Y)
	Case MB2		(LH21X)
	Handwheel bolt		(YL23A)
	M4 6mm bolts		(BF33L)
	Printed circuit board		(GA35Q)
	PP3 connector		(HF28F)
B1	PP3 battery		
	1mm Veropins		(FL23A)
	Knobs	4 off	(YG40T)
	Knob cap blue		(QY01B)
	Knob cap grey		(QY03D)
	Knob cap red		(QY04E)
	Knob cap yellow		(QY06G)
	Front panel		(BX99H)

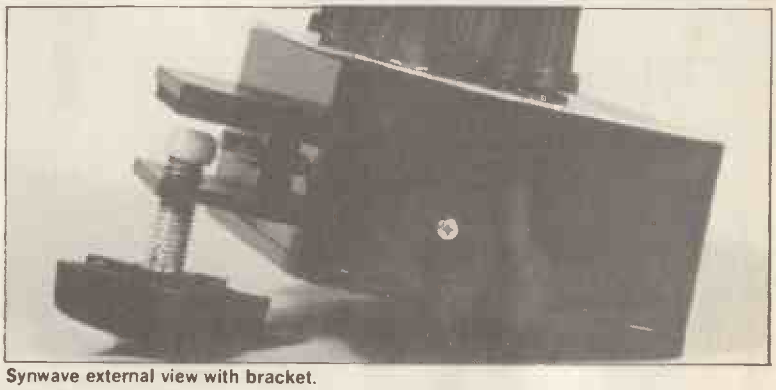
Testing and Use

Connect the Synwave to an amplifier via SK2 and switch on with the Volume control set to midway. Set Decay to maximum, Pitch to minimum and Q to midway. Give the unit a sharp tap or use a suitable trigger signal (applied to SK1) and a 'seawave' should be heard.

Using short Decay and high Pitch and Q, the woodblock sound can be obtained. Cymbal effects require high Pitch and Q with slightly longer Decay.

In addition, the Q control can put the filter into oscillation and Pitch will then vary the frequency. Of course, this effect may not be desirable, especially as the volume increases substantially, and is simply removed by reducing the Q control or inserting a resistor as mentioned earlier.

A little experimentation with the controls will soon give an idea of the wide range of useful effects that can be produced. **E&MM**



Synwave external view with bracket.

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BARCLAYCARD VISA

SEMICONDUCTORS

AC126	0.22	BC109B	0.10	BC212	0.09	BD140	0.30
AC127	0.22	BC109C	0.11	BC212L	0.09	BD159	0.65
AC128	0.28	BC114	0.11	BC213	0.09	BD166	0.46
AC128K	0.28	BC116A	0.12	BC213L	0.09	BD179	0.72
AC141K	0.34	BC117	0.19	BC214	0.09	BD182	0.70
AC142K	0.30	BC119	0.24	BC214L	0.09	BD201	0.83
AC176	0.22	BC125	0.12	BC237	0.09	BD202	0.65
AC176K	0.31	BC140	0.31	BC238	0.09	BD203	0.78
AC187	0.26	BC141	0.25	BC251A	0.12	BD204	0.70
AC187K	0.28	BC142	0.21	BC252A	0.15	BD222	0.45
AC188	0.22	BC143	0.24	BC258A	0.39	BD223	0.48
AC188K	0.37	BC147	0.09	BC300	0.30	BD225	0.46
AD142	0.90	BC148A	0.09	BC301	0.30	BD233	0.35
AD143	0.82	BC148B	0.09	BC303	0.26	BD234	0.35
AD149	0.70	BC149	0.09	BC307	0.09	BD236	0.45
AD161	0.39	BC157	0.10	BC327	0.10	BD237	0.30
AD162	0.39	BC158	0.09	BC337	0.10	BD238	0.33
AD161/2	1.04	BC159	0.09	BC338	0.10	BD410	0.55
AF124	0.34	BC160	0.28	BC461	0.30	BD434	0.55
AF125	0.32	BC161	0.28	BC478	0.20	BD437	0.50
AF125	0.32	BC170B	0.10	BC547	0.10	BD438	0.60
AF127	0.32	BC171	0.08	BC548	0.10	BD517	0.60
AF139	0.42	BC171A	0.10	BC549A	0.08	BD520	0.65
AF150	0.42	BC171B	0.10	BC550	0.07	BDX32	1.50
AF239	0.42	BC172	0.09	BC550B	0.07	BF115	0.35
AU106	2.06	BC172B	0.10	BC557	0.07	BF127	0.24
AU107	1.75	BC172C	0.10	BC557B	0.07	BF158	0.18
AU110	2.00	BC173B	0.10	BC558	0.07	BF160	0.27
AU113	1.48	BC174	0.09	BD115	0.30	BF167	0.24
BC107	0.10	BC174A	0.09	BD116	0.52	BF173	0.22
BC107A	0.10	BC182	0.09	BD124B	0.56	BF177	0.38
BC107B	0.10	BC182LB	0.10	BD131	0.32	BF178	0.26
BC108	0.10	BC183	0.12	BD132	0.35	BF179	0.34
BC108A	0.10	BC183L	0.09	BD133	0.40	BF180	0.29
BC108B	0.10	BC184LB	0.09	BD135	0.30	BF181	0.29
BC108C	0.10	BC204	0.10	BD136	0.30	BF182	0.29
BC109	0.10	BC208B	0.13	BD137	0.30	BF183	0.29
				BD138	0.30	BF184	0.28
				BD139	0.32	BF185	0.28

BF194	0.11	BFX84	0.26	TIP29C	0.42
BF195	0.11	BFX85	0.28	TIP30A	0.46
BF196	0.11	BFX86	0.30	TIP30C	0.43
BF197	0.11	BFX88	0.25	TIP31C	0.42
BF198	0.10	BFY50	0.21	TIP32B	0.40
BF199	0.14	BFY51	0.21	TIP32C	0.42
BF200	0.30	BFY52	0.25	TIP33B	0.55
BF241	0.15	BFY56	0.48	TIP41C	0.45
BF256	0.28	BFY90	0.77	TIP42C	0.47
BF256/LC	0.28	BR100	0.19	TIP47	0.65
BF257	0.28	BR101	0.30	TIP2955	0.84
BF258	0.25	BRC4443	0.85	TIP3055	0.66
BF259	0.26	BT106	1.00	TIS91	0.20
BF271	0.26	BT108	1.22	2N2219	0.28
BF273	0.13	BT116	1.20	2N2905	0.40
BF336	0.34	BU105	1.22	2N3054	0.59
BF337	0.29	BU108	1.69	2N3055	0.59
BF338	0.32	BU124	1.00	2N3702	0.12
BF355	0.37	BU126	1.22	2N3703	0.12
BF362	0.38	BU204	1.55	2N3704	0.12
BF363	0.31	BU205	1.30	2N3705	0.12
BF371	0.20	BU208	1.39	2N3706	0.12
BF394	0.19	BU208A	1.52	2N3708	0.12
BF457	0.23	BU208/02	1.89	2N5294	0.38
BF458	0.23	BU326A	1.42	2N5296	0.48
BF459	0.36	BU407	1.24	2N5298	0.52
BF595	0.23	BU500	1.75	2N5496	0.66
BF597	0.25	MRF477	10.00	2N6107	0.68
BF639	0.28	MJ3000	1.98	2SC1172Y	2.20
BFR39	0.23	MJE340	0.40	2SC1306	1.25
BFR40	0.28	MJE520	0.48	2SC1307	1.85
BFR41	0.28	R20088	1.70		
BFR79	0.28	R2010B	1.70		
BFR80	0.28	R2322	0.58		
BFR81	0.28	R2323	0.66		
BFT42	0.28	R2540	2.48		
BFT43	0.27	R25404	2.80		
BFW92	0.85	RCA16334	0.90		
BFX29	0.30	TIP29	0.40		

INTEGRATED CIRCUITS

LA4031P	2.70	SAS670S	1.60	TBA120S	0.70	TCA270	1.10
LA4400	4.15	SAS580S	2.85	TBA120AS	0.70	TCA270S	1.10
MC1327P	0.95	SAS590S	2.85	TBA120SB	0.70	TCA270SQ	1.10
MC1330P	0.76	SL480	1.40	TBA120SQ	0.70	TCA800	2.15
MC1349P	1.20	SL490	1.96	TBA120U	1.00	TCA940	1.65
MC1350P	0.76	SL901B	4.35	TBA395	1.50	TDA440	2.20
MC1351	1.00	SL917B	6.25	TBA396	0.75	TDA1004A	1.85
MC1352P	1.00	SL1310	1.80	TBA440N	2.55	TDA1170	1.95
MC1495	3.00	SL1327	1.10	TBA480Q	1.25	TDA1190	2.15
MC14011BCP	0.32	SL1327Q	1.10	TBA510	1.65	TDA1327	1.70
MC14013BCP	0.70	SL1430	1.09	TBA510Q	1.65	TDA1327Q	1.70
MC14049BCP	0.43	SL1431	1.37	TBA520	1.10	TDA1352B	1.43
ML231B	1.75	SL1432	1.37	TBA520Q	1.10	TDA1412	0.85
ML232B	1.75	SN76003N	1.65	TBA530	1.10	TDA2020	2.45
ML236	5.35	AC76013N	1.15	TBA530Q	1.10	TDA2030	2.80
ML237	1.95	AC76023N	1.15	TBA540	1.25	TDA2522	1.95
ML238	4.20	SN6023N	1.45	TBA540Q	1.35	TDA2523	1.95
ML239	2.10	SN76033N	1.65	TBA550Q	1.46	TDA2530	1.54
ML920	4.12	AC76033N	1.65	TBA550Q/E	1.45	TDA2532	2.40
ML922	3.29	SN76110N	0.89	TBA560C	1.45	TDA2540	2.15
ML926	1.65	SN76131N	1.30	TBA560CQ	1.45	TDA2541	2.15
ML928	1.65	SN76226ND	1.55	TBA570	1.00	TDA2560	2.15
SAA1025	7.20	SN76227N	1.05	TBA641-B11	3.15	TDA2581	1.25
SAA1124	5.00	SN76532N	1.40	TBA720AQ	2.45	TDA2590	2.95
SAS560S	1.60	SN76533N	1.30	TBA750	1.85	TDA2591	2.95
		SN76544N	1.30	TBA750Q	1.85	TDA2593	2.95
		SN76650N	1.05	TBA800	0.89	TDA2600	2.95
		SN76660N	0.60	TBA810S	1.35	TDA2611A	1.95
		SN76666N	0.70	TBA810AS	1.35	TDA2640	2.50
		SW153	2.74	TBA820	1.45	TDA2690	1.35
		TA7205AP	1.95	TBA920	1.65	TDA3950	2.50
		TAA550	0.25	TBA920Q	1.65	UPC566H	2.95
		TAA570	1.80	TBA950-2X	2.35		
		TAA661B	1.20	TBA990	1.49		
		TAA700	1.70	TBA990Q	1.49		
		TBA120B	0.70				

THERMISTOR

VA1104	0.52
VA8650	0.45

SPECIAL PRICES WHILE EXISTING STOCK LASTS

TBA550Q	1.00	BC252A	0.10
TCA270Q	0.65	EN91/2D21	0.65
TDA2541	1.50	PY500A	1.20
BDX32	1.00	PL519	2.25
BU208	1.00	PCF808	1.20

NEW BRANDED VALVES

A1714	14.00	E82CC	1.50	ECH83	0.78
A1998	11.50	E83CC	1.50	ECH84	0.93
A2087	11.50	E83F	2.50	ECL80	0.66
A2134	9.00	E86C	[illegible]	ECL82	0.58
A2293	7.20	E88C	[illegible]	ECL83	1.13
A2521	15.00	E88CC	2.60	ECL84	0.74
A2900	10.90	E130L	13.00	ECL85	0.74
ACP	3.00	E180F	5.25	ECL86	0.74
AC/HL/DD	3.00	E182CC	4.50	EF22	2.50
AC/PEN	3.50	E280F	19.50	EF37A	3.60
AC/SP3	4.50	E283CC	8.25	EF39	2.00
ACVPI	3.50	E810F	8.25	EF40	1.20
ACVP2	1.50	EA50	1.00	EF41	1.25
AR8	0.70	EAA91	0.60	EF42	1.95
ARP12	0.70	EABC80	0.56	EF50	1.50
ARP34	2.00	EAC91	0.90	EF55	2.25
ARP35	1.50	EAF42	1.40	EF71	1.50
ARP37	1.00	EB41	2.30	EF80	0.48
AU3	1.50	EB91	0.52	EF83	3.50
B36	1.85	EBC33	1.00	EF85	0.48
B729	1.85	EBC41	0.85	EF86	0.70
BT5B	33.00	EBC81	0.86	EF89	0.75
BT17A	95.00	EBC89	0.85	EF91	1.22
CBL31	2.00	EBC90	0.75	EF92	5.00
CIK	14.00	EBC91	0.75	EF93	0.65
C3JA	10.00	EBF80	0.55	EF94	0.55
D3A	30.00	EBF89	0.70	EF95	0.78
DAC32	1.20	EC52	0.70	EF96	0.65
DAF91	0.45	EC86	1.00	EF97	0.95
DAF96	0.65	EC88	1.00	EF183	0.56
DC90	1.20	EC90	0.46	EF184	0.56
DCX4/1000	5.00	EC91	3.00	EF731	0.80
DD620	1.20	EC92	0.80	EH90	0.65
DET10	6.00	EC93	0.80	EK90	0.65
DF33	1.20	ECC33	4.00	EL32	0.95
DF91	0.45	ECC40	2.30	EL33	2.50
DF92	0.60	ECC81	0.55	EL34	1.54
DF96	0.65	ECC82	0.55	EL34 Mullard	2.45
DF97	1.50	ECC83	0.60		
DH63	2.20	ECC84	0.60	EL36	1.60
DH77	0.90	ECC85	0.60	EL37	9.00
DK91	0.90	ECC88	0.65	EL38	4.50
DK92	1.20	ECC91	0.65	EL41	1.50
DK96	1.00	ECC189	0.78	EL81	2.05
DL92	0.60	ECC803S	1.50	EL82	0.58
DL94	1.20	ECC804	0.40	EL84	0.60
DL96	1.00	ECC807	1.30	EL85	3.85
DLS10	9.00	ECC808	2.00	EL86	0.90
DLS16	10.00	ECF80	0.65	EL90	0.82
DM70	1.10	ECF82	0.60	EL91	6.00
DM160	1.50	ECF86	1.50	EL95	0.70
DY80	1.20	ECF802	1.20	EL360	9.00
DY86/87	0.55	ECF804	6.00	EL504	1.40
DY802	0.60	ECF812	1.20	EL509	2.60
E55L	14.00	ECH3	2.50	EL821	7.00
E80CC	4.75	ECH35	1.50	EL822	8.25
E80F	6.25	ECH42	1.00	EM1	4.00
E81CC	3.90	ECH81	0.58	EM4	4.00

EM80	0.70	OA3	3.00	QQV03-10	2.50
EM81	0.70	OB2	0.65	QQV03-20A	12.25
EM84	0.70	OC3	1.05	QQV06 40A	13.95
EM85	0.85	OD3	1.15	QQZ06-40A	45.25
EM87	1.10	OM4	1.00	QS150/45	7.00
EMM803	2.50	OM5B	3.60	QS1200	3.15
EN32	14.00	OM6	2.00	QS1209	1.50
EN91	0.95	PABC80	0.50	QS1212	3.20
EN92	4.00	PC86	0.80	QV03-12	3.50
ES1500	115.00	PC88	0.80	QV05-25	1.75
EY51	0.80	PC92	0.85	QY3-125	30.50
EY83	1.50	PC97	0.95	QY4-250	52.15
EY84	8.00	PC900	0.85	QY4-400	60.85
EY86/87	0.50	PCC84	0.45	QY5-500	99.00
EY88	0.60	PCC85	0.54	R1	1.50
EY500A	1.50	PCC88	0.80	R2	1.50
EZ41	1.20	PCC89	0.80	R3	1.50
EZ80	0.56	PCC189	0.80	R10	4.00
EZ81	0.56	PCC806	0.80	R12	0.80
EZ90	0.46	PCE82	0.80	R16	12.00
G1/371K	30.00	PCF80	0.70	R17	2.00
G55/1K	8.00	PCF82	0.60	R18	8.00
G120/1B	8.00	PCF84	0.65	R19	1.20
G150/2D	4.00	PCF86	1.20	R20	1.20
G180/2M	7.00	PCF87	0.40	RG1-125	3.50
GC10B	9.00	PCF200	1.35	RG1-240A	11.75
GC10D	9.00	PCF201	1.35	RG3-250A	11.75
GC104B	9.00	PCF800	0.40	RG4-1000	10.00
GN4	4.00	PCF801	0.92	RK-20A	12.00
GN10	15.00	PCF802	0.72	RPL16	12.00
GN24	1.50	PCF805	1.80	RR3-1250	65.00
GRD7	9.00	PCF806	0.60	RV120/350	1.50
GS10C	12.00	PCF808	1.48	S11A	1.50
GT1C	13.50	PCH200	1.10	S130	2.50
GU50	11.50	PCL81	0.60	S130P	3.00
GXU1	13.50	PCL82	0.74	SP41	4.00
GXU50	12.50	PCL83	2.00	SP42	2.50
GY501	1.20	PCL84	0.76	STV280/40	8.00
GZ30	0.85	PCL85	0.80	STV280/80	23.00
GZ32	0.85	PCL86	0.76	T41	2.00
GZ33	3.25	PCL200	1.60	TP25	1.50
GZ34	2.20	PCL805	0.80	TT11	1.50
GZ37	4.00	PD500	2.95	TT21	14.50
HL41	2.00	PEN4DD	1.50	TY2 125A	45.00
HL42DD	2.00	PEN25	1.50	TY4-350	90.00
HL92	1.80	PEN45	1.80	TY4 500A	41.50
HL133/DD	1.50	PEN46	1.50	U10	1.50
HP6	1.50	PENA4	2.50	U15	1.50
HY90	1.00	PFL200	1.13	U17	1.50
KT61	3.50	PL33	0.75	U18 20	2.00
KT66 USA	4.95	PL36	1.05	U19	11.95
KT66 UK	9.00	PL81A	0.74	U22	1.00
KT77	5.00	PL82	0.60	U25	0.68
KT88 USA	6.00	PL83	0.62	U26	0.90
KT88 UK	11.50	PL84	0.65	U37	12.00
KTW61	1.50	PL500	1.12	U41	0.70
L63	1.00	PL504	1.20	U191	0.70
M8079	6.00	PL508	1.48	U193	0.65
M8083	3.25	PL509	2.30	U281	1.00
M8100	2.85	PL519	2.60	U282	1.00
M8137	2.85	PL802	2.50	U291	0.60
M8162	3.85	PL820	3.00	U301	0.60
M8196	3.25	PT4	4.00	U309	0.60
M8225	1.20	PT15	4.50	U801	0.80
ME1400	4.00	PY31	0.60	UABC80	0.65
ME1402	4.50	PY32	0.60	UAF42	1.00
ME1403	10.00	PY33	0.60	UBC81	1.00
ME1501	14.00	PY81	0.65	UBF80	0.60
MH4	2.10	PY82	0.55	UBF89	0.60
MH41	2.10	PY83	0.70	UBL21	1.20
MS4B	5.00	PY88	0.74	UC92	0.80
MU12	1.50	PY500A	1.35	UCC84	0.70
MU14	1.50	PY800	0.65	UCC85	0.60
N18	1.00	PY801	0.65	UCH21	1.20
N78	8.90	PZ30	0.60	UCH41	1.20
NR14	9.00	QB3 300	30.50	UCH42	1.20
NR73	3.50	QE03 10	3.20		
NU3	1.50	QP25	1.00		
NU17	1.50	QQE06 40	13.95		
NU18	1.50	QQV02-6	10.50		
OA2	0.60				

UCH81	0.65	2C51	0.80	6BL8	0.65	6SK7	0.80	20P5	1.15
UCL82	0.76	2B7	1.50	6BR7	3.75	6SL7GT	0.72	25A6G	0.90
UF41	1.15	2D21	0.95	6BR8A	1.20	6SN7GT	0.69	30	2.85
UF42	1.15	2D21W	2.00	6BS7	3.30	6SS7	1.50	30C1	0.70
UF80	0.80	2K25	10.00	6BS8	1.88	6U56	1.50	30C15	0.40
UF86	1.10	3A/147J	7.50	6BU6	2.00	6U8	0.60	30C17	0.40
UF89	1.10	3A/167M	10.00	6BU8	1.15	6V6GT	0.90	3C18	1.80
UL41	1.85	3A2	3.00	6BW4	1.30	6W4GT	1.00	30F5	0.95
UL84	0.78	3A3A	3.00	6BW6	4.50	6X4	0.60	30FL1	0.95
UU5	1.50	3A4	0.60	6BW7	0.75	6X5GT	0.60	30FL2	0.95
UU6	3.50	3AW2	3.35	6BW8	4.00	7B7	1.40	30FL12	1.10
UU7	3.75	3B2B	5.00	6BX7GT	2.00	7D6	1.40	30FL14	1.85
UU8	3.75	3D6	0.50	6BZ6	2.00	7H7	1.50	30PI13	0.80
UY1N	0.90	3W4GT	2.50	6BZ8	0.95	7S7	2.00	30PL14	2.25
UY85	0.70	4-125A	35.00	6C4	0.45	7Y4	1.00	35A5	1.20
UY224	2.50	4-250A	38.00	6C6	0.50	8D8	2.75	35W4	0.70
V914	2.00	4-400A	40.00	6C8G	1.25	8FQ7	0.75	35Z3	1.85
VLS631	13.00	4CX250B	26.60	6C11	2.50	9BW6	1.20	35Z4GT	0.69
VP41	1.50	4CX350A	39.00	6C15	2.50	10C1	5.50	40KD6	2.80
VP133	2.00	5A-170K	5.25	6C18	2.50	10C2	0.70	41	0.80
VR75/30	3.00	5A/206K	9.00	6C31	1.50	10D2	1.25	431U	1.25
VR101	1.50	5B-254M	14.50	6CB5	1.50	10F1	0.75	50C5	0.95
VR102	1.50	5B-255M	14.50	6CB6	1.50	10F9	0.75	50CD6G	1.15
VR105/30	1.05	5D6	4.00	6CD6GA	4.00	10F18	0.60	52KU	0.85
VR150/30	1.15	5D21	15.50	6CF6	1.50	10GK6	1.96	57	0.85
VT25	5.00	5D22	38.00	6CG8A	1.00	10P14	2.50	75C1	1.20
VT120	1.15	5R4GB	2.00	6CH6	7.00	11E2	15.50	80	1.40
VT138	4.25	5U4G	0.85	6CL6	1.50	12A4	2.50	84	0.86
VU39	1.50	5U4GB	1.50	6CZ5	2.00	12AC6	0.88	85A1	5.40
VX6120	5.00	5V4G	0.85	6DC6	2.00	12AD6	0.80	85A2	1.20
VX9133	5.00	5Z4G	0.85	6DW4	1.20	12AE6	0.85	89	1.20
W25	0.65	6/30L2	0.70	6EA8	0.80	12AG8	1.50	90C1	1.69
W61	1.50	6A/203K	9.00	6F1	2.00	12AH7GT	0.85	90CG	10.85
W63	0.70	6A6	1.50	6F6G	2.00	12AH8	5.50	92AG	9.00
W77	5.00	6A8G	1.50	6F8G	1.50	12AT6	0.59	92AV	9.00
W107	0.70	6AB7	0.60	6F12	1.30	12AT7	0.55	15082	1.50
W142	1.15	6AB8	0.66	6F14	1.00	12AT7WA	1.60	15083	3.90
W147	2.00	6AC7	1.00	6F22	0.70	12AU6	0.60	150C4	1.50
W727	0.65	6AF4A	1.20	6F23	0.48	12AU7	0.55	155UG	25.00
W729	1.00	6AG7	1.20	6F24	1.25	12AV6	0.90	1858T	1.50
X24	1.00	6AH6	1.00	6F25	1.25	12AX7	0.55	257A	6.00
X65	0.86	6AJ7	1.00	6F26	0.48	12AX7WA	1.50	408A	4.00
X66	0.85	6AK6	2.00	6F28	1.25	12AY7	4.00	708A	5.00
X719	0.58	6AL5	0.62	6F33	8.50	12AZ7A	1.50	715A	6.00
XG5 500	19.50	6AM4	2.50	6FG5	1.50	12B4A	1.60	715C	15.50
XR1-1600A	29.00	6AM5	6.00	6FH5	1.50	12BA6	0.75	717A	1.50
XR1-6400A	128.00	6AM6	1.30	6FN5	1.50	12BE6	1.05	801A	2.00
YL1020	29.00	6AN5	2.00	6FL2	1.50	12BH7	0.95	803	16.00
YL1060	15.00	6AN8A	2.50	6GH8A	0.80	12BL6	0.70	807	1.09
Z63	1.00	6AQ5	0.82	6GK5	1.00	12C8GT	0.70	808	3.00
Z77	1.20	6AS5	1.50	6GK6	1.00	12E1	16.50	811A	9.00
Z303C	9.00	6AS6	3.50	6H2N	0.70	12GN7	3.25	813	11.30
Z502C	12.00	6AS7G	4.50	6H3N	0.70	12HG7A	3.25	833A	47.85
Z504S	13.50	6AT6	0.80	6H6	1.00	12J5GT	0.48	2050A	3.90
Z700U	1.00	6AV5GTA	1.50	6HF5	4.50	12J7GT	0.70	4212E	230.00
Z749	0.48	6AU6	0.55	6HG8	1.50	12K5	1.00	5557	19.50
Z759	9.00	6AV6	0.72	6HZ6	1.00	12K7GT	0.80	5636	3.00
Z803U	12.50	6AW8A	2.50	6J5GT	0.75	12Q7GT	0.50	5642	5.00
ZC1040	8.00	6AZ8	1.80	6J6	0.55	12SA7GT	1.00	5651	1.75
ZM1001	5.00	6B10	2.50	6J7	0.70	12SJ7	0.60	5670	3.50
ZM1020	4.00	6BA6	0.50	6J7GT	1.00	12SL7	1.50	5687	8.15
1AC6	1.20	6BA7	3.75	6JE6	2.10	12SN7GT	1.85	5749	2.00
1B3GT	1.00	6BA8A	3.50	6JS6C	2.55	12SR7	0.70	5751	1.50
1B5	2.50	6BE6	0.50	6K4N	1.00	12U7	1.50	5763	3.20
1D5	1.00	6BD6	1.00	6K7	0.70	12Y4	0.60	5814A	2.75
15G	1.00	6BH6	1.60	6KD6	3.95	13D3	3.20	5842	6.50
1L6	1.50	6BJ6	1.05	6L1	2.50	13D7	3.20	6080	4.20
1LA6	1.00	6BK4	2.75	6L6GC	1.75	13D8	3.20	6080WA	5.00
1U5	1.00	6BN4	1.25	6L6GT	1.10	14S7	1.00	6146	4.20
1X2B	1.15	6BN6	1.30	6L7	0.55	15D2	1.00	6146A	4.45
2A3	3.00	6BN7	3.50	6L15	1.50	17JZ8	1.60	6146B	4.45
2AS15A	11.00	6BN8	0.85	6L17	1.50	18D3	1.60	6201	1.20
2C39A	19.00	6BQ5	0.60	6L18	0.60	19AQ5	0.70	6267	0.70
		6BQ6GA	2.00	6LD3	0.85	20A2	4.00	6870	11.50
		6BQ7A	0.72	6P1	0.60	20D1	0.70	7025	1.50
				6P15	0.60	20D4	1.75	7032	2.00
				6P25	2.50	20F2	0.75	7318	9.00
				6P28	2.00	20L1	0.95	7360	7.50
				6LD20	0.60	20P1	0.55	7551	4.50
				6SA7GT	1.00	20P3	0.50	7558	11.50
				6SH7	1.50	20P4	1.05	7591A	2.35

DIODES

AA119	0.08	BY179	0.63	IN4001	0.04
BA102	0.17	BY199	0.28	IN4002	0.04
BA115	0.13	BY206	0.14	IN4003	0.04
BA145	0.17	BY208 800	0.33	IN4004	0.05
BA148	0.17	BY210 800	0.33	IN4005	0.05
BA154	0.06	BY223	0.90	IN4006	0.05
BA155	0.13	BY298 400	0.22	IN4007	0.06
BA156	0.15	BY299-800	0.22	IN4148	0.02
BAX13	0.04	BYX10	0.20	IN4448	0.10
BAX16	0.06	BYX55/600	0.30	IN5401	0.12
BB105B	0.30	BYX71/600	0.60	IN5402	0.14
BB105G	0.30	OA47	0.09	In5403	0.12
BY126	0.10	OA90	0.05	IN5404	0.12
BY127	0.11	OA91	0.06	IN5406	0.13
BY133	0.15	OA95	0.06	IN5407	0.16
BY164	0.45	IN914	0.03	IN540R	0.16
BY176	0.85			ITT44	0.04
				ITT2002	0.11

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4 Watt	4R7 1KB	0.13
	2K2 6KH	0.16
	10K	0.22
7 Watt	R47-4K7	0.14
	5K6-12K	0.15
	15K-22K	0.18
11 Watt	1R-10K	0.18
	15K	0.21
17 Watt	1R-10K	0.24
	15K-22K	0.25

BASES

B7G	0.15
B7G Skirted	0.30
B8G	0.70
B9A	0.15
B9A Skirted	0.30
B10B	0.16
B13B	0.50
8 Pin DIL	0.20
14 Pin DIL	0.22
14 Pin DIL/Q	0.30
16 Pin DIL	0.30

ZENER DIODES

BZX61 0.15

6V2 7V5 8V2 9V1 10V 11V 12V 13V 15V 16V 18V 20V 22V 24V 27V 30V 33V 36V 39V 47V

BZY88 0.07

2V7 3V 3V3 3V6 3V9 4V3 4V7 5V1 5V6 6V2 6V8 7V5 8V2 9V1 10V 11V 12V 13V 15V 18V 24V 27V

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by Robert Penfold

Voltage Regulators

As we have already seen in this series, a 9V battery has an output voltage that is nominally 9 volts but which is likely to vary between about 9.5 volts and 7.5 volts in practice, as the battery voltage tends to fall as the battery becomes exhausted. In many applications the fact that the supply voltage falls by about 2 volts during the working life of the battery is of little or no real consequence but there are occasions when a stable supply voltage is essential.

We have also seen how the voltage provided by a power source can vary due to variations in the load current, and the consequent voltage drop due to the internal resistance of the power source. Once again, this lack of voltage stability is often of little or no significance but sometimes it can cause malfunctions in circuits.

This month we shall consider some simple voltage regulator circuits and devices and the use of ordinary silicon diodes as voltage regulators will be considered first.

Diode Regulators

In last month's article we saw how the current flowing through a silicon diode is practically zero until the forward bias reaches about 0.6 volts, and how only a very small increase in the bias voltage is then sufficient to produce a very high current flow (see Figure 3 of Starting Point Part 4). This characteristic enables a diode to be used in a simple voltage regulator circuit of the type shown in Figure 1.

Here D1 is forward biased from the input supply via R1, and a little over 0.6 volts (say nominally 0.65 volts) is developed across D1 and fed to the output. If the input voltage rises for some reason, the current flowing through R1 and D1 rises, causing D1 to conduct more heavily. This effective reduction in the resistance of D1 prevents the voltage developed across this component from more than marginally increasing, and most of the increased input voltage is developed across R1. If the input voltage should decrease for some reason, less current flows through R1 and D1, and D1 conducts less heavily. This effective increase in the resistance of D1 results in the output voltage only decreasing marginally, with most of the decrease in the input voltage being reflected in the voltage drop across R1.

This stabilising effect also operates if the output current varies. A higher output current flow tends to tap-off some of the current that would otherwise have passed through D1, and its resistance therefore increases. This rise in resistance largely compensates for the decrease in load resistance at the output (bearing in mind that D1 and this load resistance are connected in parallel), and little change in output voltage results. If the output current is reduced, D1's resistance decreases and the output voltage remains virtually constant.

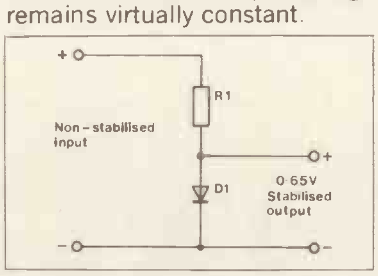
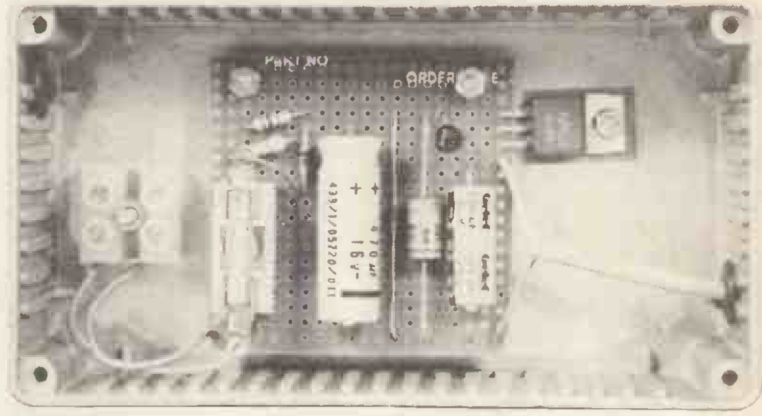


Figure 1. Silicon diode used in a simple shunt stabiliser circuit.

This type of regulator is known as a "shunt" regulator, and certain conditions must be met if it is to function effectively. Obviously the input voltage must be higher than the required output voltage. In fact the minimum input voltage must be high enough to give a current flow through R1 and D1 that is at least as high as the maximum output current that is required. If this is not the case, it is likely that R1 and the load will form a potential divider that takes the output voltage below the threshold voltage of D1, rendering D1 ineffective.

The required value for R1 is calculated using Ohm's Law, after first deducting 0.65 volts from the minimum expected input voltage to find the minimum expected voltage across R1. The maximum acceptable value for R1 is then equal to this voltage divided by the maximum output current required. A lower value is acceptable of course but this would make the current consumption of the circuit much higher than is really necessary if the value used was to be well below the calculated maximum acceptable value.

An obvious drawback to using a voltage regulator of the type shown in Figure 1 is that only a single output voltage of 0.65 volts is available; this is far too low to be of any use in most applications. One way of achieving higher and additional output voltages is to connect diodes in series, as shown in the circuit of Figure 2. This type of circuit operates in the same way as the basic circuit of Figure 1 but the threshold voltage of the series network of diodes is equal to the sum of the threshold voltages in the network. Thus in the circuit of Figure 2 there are three diodes, and the nominal output voltage is 3 x 0.65 volts, or 1.95 volts in other words.



Car Cassette Power Supply.

Of course, this type of circuit is

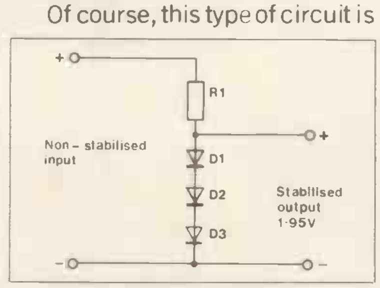


Figure 2. Example of a multiple diode shunt stabiliser circuit.

still rather limited with regard to the maximum output voltage that can be attained, since an impractically large number of diodes would be needed in order to achieve output potentials of more than about 3 volts.

Amplified Diode

A transistor can be used in a simple low voltage shunt regulator using the arrangement shown in Figure 3, which is usually termed an "amplified diode" arrangement. The transistor used must be a silicon type and not germanium.

As we discovered last month, a silicon transistor does not conduct between its emitter and collector terminals until a forward bias of about 0.6 volts is applied to its base-emitter junction. The base-emitter bias voltage only needs to exceed this threshold level slightly in order to make the device conduct heavily between the emitter and collector terminals.

If we assume that R2 and R3 have the same value, then about 1.2 volts will be needed at the collector of TR1 before this device begins to conduct, since R2 and R3 provide half the collector potential to the base of TR1. A slightly higher collector voltage is sufficient to bias the device hard into conduction, giving the "avalanche" effect needed to give stabilisation of the output voltage.

With R2 and R3 at the same value the nominal output voltage is 1.3 volts, but this can be reduced by making R2 lower in value, the minimum voltage available being 0.65 volts with R2 at zero. TR1 is then effectively being used as a silicon diode regulator. Higher voltages can be obtained by making R2 higher in value so that a higher collector voltage is needed before the base terminal is brought to the 0.6 volt

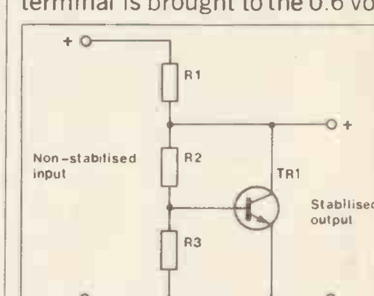


Figure 3. An 'amplified diode' regulator circuit using an NPN transistor.

threshold level. However, the higher the output voltage is made, the less efficient the circuit becomes and this type of circuit is not normally used if an output voltage of more than about 3 or 4 volts is required.

Zener Diodes

Higher output voltages can be obtained using a special type of diode known as a "Zener" diode. This is used in exactly the same way as a silicon diode or an amplified diode, as can be seen from the circuit of Figure 4 (which also shows the circuit symbol for a Zener diode).

Note that the Zener diode is connected with the opposite polarity to a silicon diode employed as a shunt regulator. As a Zener diode is basically just an ordinary silicon diode, it will give an output voltage of only about 0.65 volts if it is connected with the wrong polarity. In the circuit of Figure 4 the Zener is reverse biased, but it will still conduct as the input voltage will exceed the reverse breakdown voltage of the component. At this breakdown voltage the resistance of the device suddenly drops from a figure of typically many hundreds of megohms to just a few tens of ohms, giving the avalanche effect and the required stabilisation of the output voltage.

Normal silicon diodes usually have quite high reverse breakdown voltages and the exact breakdown voltage will vary considerably from one device to another, it will even vary considerably between two devices of the same type. Zener diodes are designed to breakdown at relatively low voltages, and are marked with a value that indicates the breakdown voltage, usually with a tolerance of 5% on

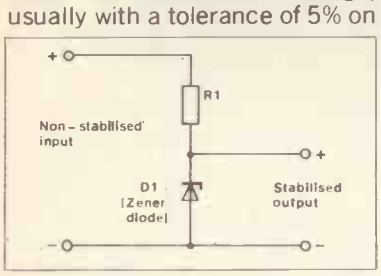


Figure 4. Zener diode shunt regulator circuit.

this figure. As the voltage developed across a Zener diode varies slightly with changes in the current passing through the device, the Zener voltage is usually specified at a certain current (5mA for instance, in the case of the popular BZY88 series of Zener diodes). The voltage developed across lower voltage Zeners (i.e. 5.6 volts and less) tends to vary significantly with changes in the current passing through the device, and these are not really suitable for use in circuits where a very high degree of stabilisation is required.

Zener diodes are available with operating voltages of between about 2.7 volts and 60 volts or so. Due to the lack of Zeners having operating voltages below about 2.7 volts there is little alternative to using an amplified diode or silicon diodes when such a voltage is required. Even at potentials of around 3 volts, where suitable Zeners are available, it is more common for silicon diodes or an amplified diode to be used as the latter are more efficient in general.

Series Regulators

A serious drawback of the shunt regulator in many applications is the fact that they have a constant current consumption that is at least as high as the maximum output current required. The regulator thus consumes a high current even if only a fairly modest output current is needed for the majority of the time, a high output current being required only occasionally and intermittently. This can lead to an unnecessarily short battery life in battery powered equipment and can result in the generation of substantial amounts of heat in medium and high power circuits.

This problem can be overcome by the use of a series regulator. As the name implies, this is connected in series with the load rather than in parallel with it and has a resistance which is self-adjusting to give a voltage drop that maintains the output voltage at the required level. Thus a perfect series regulator would not consume any current as the input current would be the same as that required by the circuit fed from the output of the unit. Practical series regulators do not quite achieve this, but usually have a current consumption marginally above that required by the load.

Figure 5 shows the simplest series regulator configuration. R1, D1 form a straightforward shunt regulator of the type described earlier, but the output is taken via a transistor which is connected in series with the load. TR1 is used in what is generally called the "emitter follower" mode but is sometimes given the alternative name of "common collector" mode.

TR1 does not provide any voltage gain from the input at its base to the output at its emitter, there is in fact a small voltage drop of about 0.6 volts or so from the base to the emitter (assuming a silicon device is used); this being the base to emitter voltage needed to bias the device into conduction. The output is therefore stabilised at about 0.65 volts below the operating voltage of D1.

Although TR1 provides no voltage amplification, it does of course give current amplification and only a small base current will be drawn by the shunt regulator even if a substantial output current is taken from TR1's emitter terminal. For example, if TR1 has a current gain of one hundred and the shunt regulator can provide an output current of 1mA, an output current of 100mA could be drawn from the emitter of TR1 before the 1mA output capability

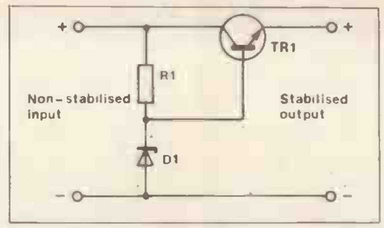


Figure 5. Simple series regulator using an emitter follower stage.

of the shunt regulator became exceeded and the output voltage dropped significantly. The circuit would then consume a current equal to the output current drawn from the unit, plus the 1mA required by the shunt regulator section of the unit. A shunt regulator with no series element would need to have a continuous current drain of at least 100mA.

Where very high output currents are required (a few hundred milliamps or more) it is quite common for the circuit configuration of Figure 6 to be employed. This is basically the same as the arrangement of Figure 5, but the output of the emitter follower stage is fed to the input of a second emitter follower. The two transistors form what is called a "Darlington Pair", and together they effectively form a single transistor having a current gain equal to the product of the current gain of the two devices. This enables high output currents to be obtained with good regulation and only a low current through shunt regulator part of the circuit.

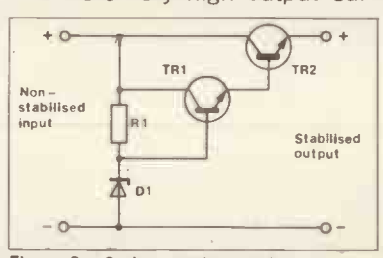


Figure 6. Series regulator using a Darlington pair.

Car Cassette Power Supply

The construction project for this month is a simple voltage regulator circuit that enables a cassette recorder or radio which requires a 6V supply to be powered from a 12V car battery. This method of powering a radio or cassette unit that is to be used in a car or boat eliminates the need to buy expensive batteries which tend to be short-lived, especially in the case of cassette units. The unit can easily be modified to give an output potential of 7.5 or 9 volts if required, as will be explained in detail later.

In this application, where a well stabilised output is not required (bearing in mind that the voltage provided by a battery varies considerably during its life-span), it may seem that a voltage dropper resistor in series with the supply is all that is required. This is not in fact the case. The voltage dropped across this series resistor would depend on the supply current, as we know from Ohm's Law, but the supply current is an unpredictable quantity and may well vary considerably from one instant to the next. A voltage regulator circuit is therefore required.

The circuit diagram of the car cassette power supply unit is shown in Figure 7. R1, D2 form a shunt stabiliser circuit having a nominal output potential of 7.5 volts. Zener diodes tend to give the output voltage that contains small, rapid, and random changes in voltage. This "noise" is obviously undesirable and is smoothed out by C2.

TR1 is the emitter follower buffer stage, and this is a Darlington device (i.e. two transistors connected as a Darlington pair and contained in a single package). The emitter of TR1 connects to the output by way of R2, which forms part of a simple current limiting circuit. The pur-

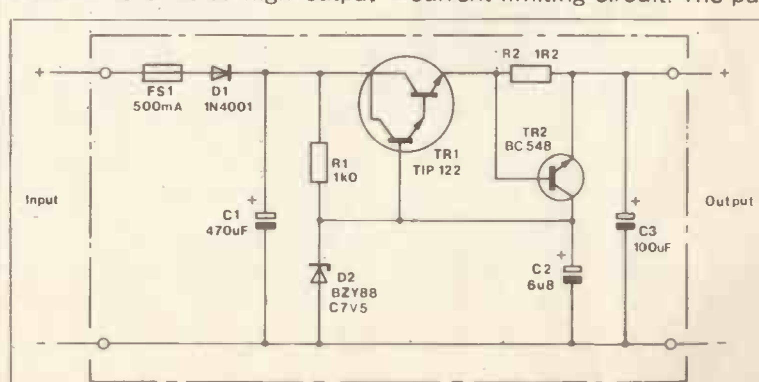


Figure 7. Circuit diagram of the car cassette power supply.

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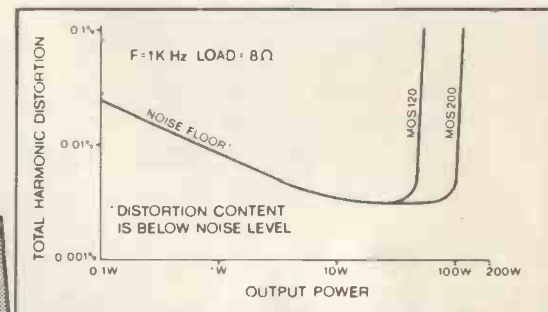
MOS200	120W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£33.46 + £5.02



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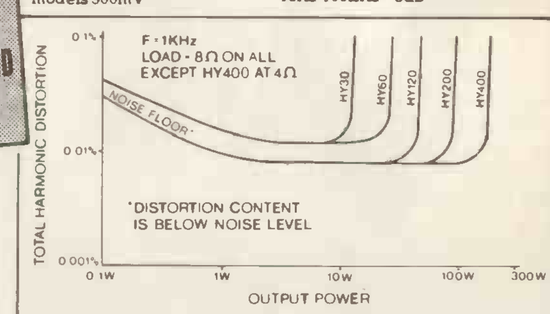
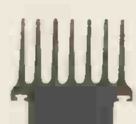
HY60	30W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£8.33 + £1.25
HY120	60W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£17.48 + £2.62
HY200	120W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£21.21 + £3.18
HY400	240W into 4Ω	0.01%	15V/μs	5μs	100dB	£31.83 + £4.77



Load impedance all models 4Ω – ∞ Input sensitivity all models 500mV
Input impedance all models 100KΩ Frequency response all models 15Hz-50KHz – 3dB



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pose of this circuit is to limit the maximum output current of the unit to a safe level in the event of a short circuit or serious overload at the output.

If the output current is about 0.5 amp or less, the voltage developed across R2 will only be about 0.6 volts (1.2 ohms x 0.5 amps = 0.6 volts), and TR2 will therefore have no significant effect on the circuit as this voltage is insufficient to bias it into conduction. There will be a small voltage drop across R2 that will reduce the output voltage when high supply currents are being drawn, but this voltage drop is not high enough to be of any consequence; this is something that happens with batteries as well due to their internal resistance.

If the current drawn from the unit should go much above 500mA the voltage developed across R2 will be sufficient to switch on TR2. This then tends to tap off some of the current through R1, sending it to the negative supply rail through the load connected across the output. This tends to pull the base terminal of TR1 lower in voltage, and thus reduces the output voltage as well. This gives the required current limiting action and, even with a short circuit across the output, an output current of only about 550mA would flow since TR2 would reduce the output voltage to practically zero.

FS1 protects the unit against damage if a short circuit should occur across the non-stabilised input for some reason. D1 simply protects the unit by blocking the supply if the input should be inadvertently connected with the wrong polarity. The 12 volt supply of a car is often polluted with a fair amount of electrical noise, these noise spikes are smoothed out by C1, C3 so that they do not appear at the output.

Output Voltage

The output voltage of the unit under low-load conditions is equal to the 7.5 volts across D2 minus about 1.3 volts (0.65 volts x 2) dropped between the base and emitter of TR1, i.e. about 6.2 volts. This drops to a little under 6 volts under high-load conditions, this range of voltages is similar to those provided by 6 volt dry batteries under similar conditions.

If an output voltage of 7.5 volts is needed, this can be accomplished by changing D2 for a 9.1 volt component (a BZY88C9V1). For a 9 volt output D2 can be changed to a 10 volt Zener (a BZY88C10V). Although this will give an output voltage which is slightly less than that provided by

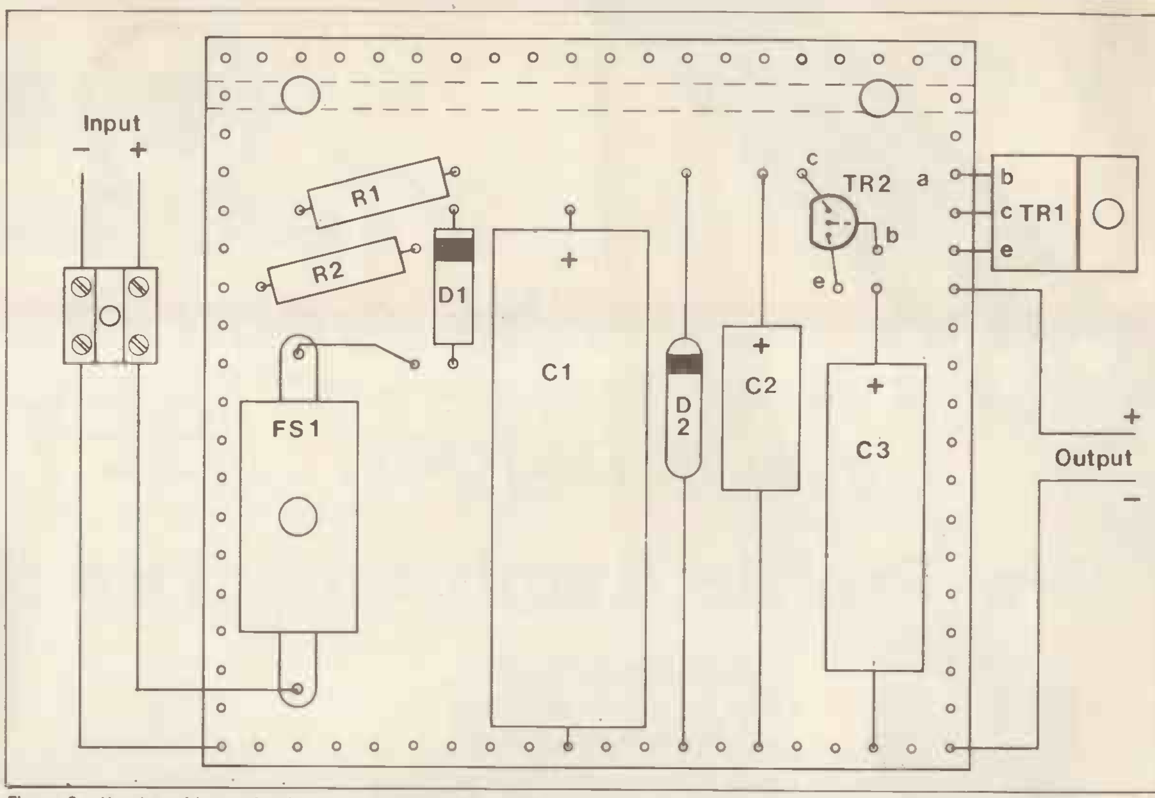

Figure 8. Veroboard layout for the car cassette power supply.

new, 9 volt, dry batteries, the output potential of about 8.7 volts is still well within acceptable limits.

Construction

The suggested component layout is shown in Figure 8 and is based on a 0.1in. matrix Veroboard which has 19 copper strips by 20 holes. No cutting of the Verotrack is required. Construction of the board is carried out in the usual way but note that FS1 is mounted in a chassis mounting fuseholder; the latter is fitted on the component panel using a short M3 or 6BA bolt and fixing nut.

Under some circumstances TR1 has to dissipate a few watts of power, and the consequent heat generated will destroy the device unless some heatsinking is provided to enable it to lose this heat in the surrounding air at a suitably fast rate. A simple way of providing the necessary heatsinking is to build the unit in a metal case, then bolt TR1 to the case so that it acts as the heatsink. The prototype is housed in a diecast aluminium box (Maplin type DCM5004) but any metal case of similar dimensions (120 x 65 x 40mm) should be suitable.

In order to find the correct position for the mounting hole for TR1, first mount the completed component panel on the base panel of the case using M3 or 6BA fixings with 6.35mm spacers over the bolts in order to keep the connections on the underside of the board out of contact with the metal case. The leadout wires of

PARTS LIST

Resistors			
R1	1k, ⅓ watt 5%		(M1K0)
R2	1R2, ½ watt 5%		(S1R2)
Capacitors			
C1	470u, 25V, axial		(FB73Q)
C2	6u8, 63V, axial		(FB21X)
C3	100u, 25V, axial		(FB49D)
Semiconductors			
TR1	TIP122		(WQ73Q)
TR2	BC548		(QB73Q)
D1	1N4001		(QL73Q)
D2	BZY88C7V5 (see text)		(QH11M)
Miscellaneous			
	Box, type DCM5004		(LH71N)
	Veroboard 0.1in. matrix		(FL08J)
FS1	500mA, 20mm, quick-blow		(WR02C)
	20mm, chassis-mounting fuseholder		(RX49D)
	Connector block		(HF01B)
	Insulating set for TR1		(WR23A)
	Power plug of appropriate type		
	Wire		(BL09K)
	Bolt 6BA, 1 inch		(BF07H)
	Nut 6BA		(BF18U)
	Spacer 6BA, ¼ inch		(FW34M)
	Grommet small		(FW59P)

TR1 are then carefully formed so that the metal pad on the underside of the component fits flat against the base panel of the case. The position of the mounting hole is then marked using TR1 as a template. The component panel is then removed so that the mounting hole for TR1 can be drilled safely.

One end of the case is drilled to take the input lead and the other end drilled to take the output lead. The input lead is taken to the component panel by way of a two-way terminal block. These blocks are normally only sold in twelve-way strips, it is therefore necessary to cut a two-way block from one of these using a modelling knife. The terminal block is mounted on the base panel of the case beside the component panel using a 25mm 6BA or M3 bolt and matching fixing nut.

The output lead is terminated in a power plug of the type appropriate to the equipment to be supplied by the unit, be careful to connect the plug with the correct polarity. Normally the outer connector is negative and the inner connector is positive but it would be advisable to check this point with the operating manual for the equipment used with the unit, if this is possible.

When finally fitting the component panel and TR1 into place, TR1 should be fitted with an insulation set so that its heat-tab (which connects internally to its collector terminal) is electrically isolated from the case). The insulating set consists of a mica washer, which is placed between TR1 and the case, and a plastic bush which fits over the mounting bolt and into the fixing hole of TR1 so that the bolt is insulated from TR1.

As the case is electrically isolated from the supply circuit, and assuming that any exposed metalwork on the equipment supplied by the unit is also electrically isolated (which is invariably the case), the unit is suitable for use with both negative and positive earth systems.

The quiescent current consumption of the unit is only a few milliamps. This is not sufficient to warrant the fitting of an on/off switch or disconnecting the unit when it is not in use. **E&MM**

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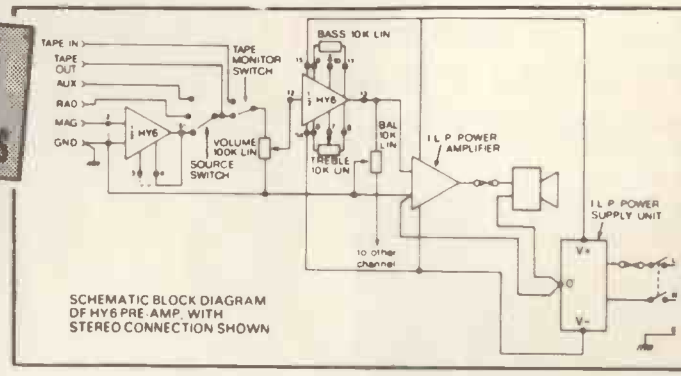

SCHEMATIC BLOCK DIAGRAM OF HY6 PRE-AMP. WITH STEREO CONNECTION SHOWN

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PSU70 for use with 1 or 2 HY120's	£15.92 + £2.39 VAT
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PART 5: Cabinet construction; lower manual and rhythm generator circuits

If you wish to make your own cabinet, cutting details and requirements are given in Table 6. Construction details are shown in Figure 36. Fix the swell pedal to the baseboard before starting to put the panels together. The cabinet can now be completed except for the top and the back. The ready-made cabinet comes complete with a roll-top that runs in plastic guide slots fitted into routed out slots in the cabinet sides. The roll-top and guide slots are available separately for those who wish to make their own cabinet but since few constructors have access to routing machinery, it is not easy to fit and we have not shown details in the construction drawing.

If you use the guide slots you will need to cut off the forked end 465mm from the closed end and let them into the sides of the cabinet. Also, the dropped front of the top will need to be shortened. Alternatively, another inner side-piece could be fitted, on whose edge the roll-top would run and in this case it will be necessary to widen the whole cabinet slightly. However, if you feel the roll-top is essential, we strongly recommend using the ready-made cabinet.

Fixing the Organ in the Cabinet

Install the trim and housing around the swell pedal, then fix the pedalboard and bolt the loudspeaker to the baffle board. If making your own cabinet, this is a suitable time to fit the grille cloth. Remove the transformer fixing bolts and place the PSU module in position on the base. Mark the four holes and drill through the base using a 4mm or 5/32in. drill. Note that these are the only four fixings that are not provided in the ready-made cabinet due to variations in the transformer frame size.

Screw down the terminal block as shown in Figure 12. Fix the P-clip to the 3-core mains cable and screw down near the terminal block. Fix the reverb spring-line, using the rubber couplings, either to T-nuts fitted in the ready-made cabinet or as shown in Figure 36.

Place the keyboard roughly in position. Remove the screws supplied with the keyboard assembly from where they are fitted in the top of the keyboard cheek mounting supports. Placing the keyboard cheeks in position now determines the exact position for the keyboard. Carefully remove the cheeks, screw down the keyboard and refit the cheeks screwing down from above. Hinge up the top keyboard and remove the screws in the frame. Place the keyboard separator in position and screw up.

Push the mains switch into the pre-cut hole in the side cheek and carefully reconnect the wires. Fix the metalwork (supplied with cabinet kit), as shown in Figure 37. The screws into the sides of the cabinet should not be tightened to allow for adjustment when the PCB and front panel are in position.

Since describing the main PCB construction in Part 3 we have discovered that it is much easier to put the drawbars together before soldering the slide pot to the PCB. Put the M3 bolts through the frame after placing one of the special 4BA washers under the head of the bolt through the slot as shown in Figure 38. Hold the unit upside-down and place four of the special washers on each bolt; then place the slide pot upside-down over the bolts, align and screw up. Now solder the whole assembly to the main PCB.

Snap the latchbuttons onto the latchswitches. S16, 24 and 33 are red, S22, 23, 34 and 35 are grey, S26 and 27 are white and the remainder are black. Cut the shafts of the rotary pots to 22mm long. Bolt the PCB onto the metalwork, then pull the covers off the rocker tablets S17 to 21 to enable the front panel to be fitted.

Fit the LED holders to the front panel then snap the LEDs into the clips from behind. The red LED fits in the 'Downbeat' hole and the green LED in 'Tempo'. Push the drawbars fully back, then fit the front panel and bolt up to the metalwork. Carefully re-align the metalwork frame then remove the front panel and PCB and tighten up the end screws.

Re-fix the main PCB and reconnect all the cables. Bolt the headphone socket to the front panel, then refit the front panel. Replace the covers on the rocker tablets. S17 and 18 are grey, S19 is orange and S20 and 21 are red. Push the three knobs onto the shafts of the rotary pots. Double-check that all plugs and sockets are correctly connected. If using the ready-made cabinet kit, fit the roll-top as described in the instructions supplied with the kit. Fix the top and the back to the cabinet. The Matinée organ is now completed.

Lower Manual Circuits

Figure 39 is the circuit diagram of the lower manual. In Part 4 we described the circuits around the lower manual M108 and this is now continued. There are eight signal outputs from the M108, all connected to quad op-amps IC5 and 6 that are used to raise the signal levels. The footages are connected through CMOS switches, IC8 and 10 to the appropriate flute and string fil-

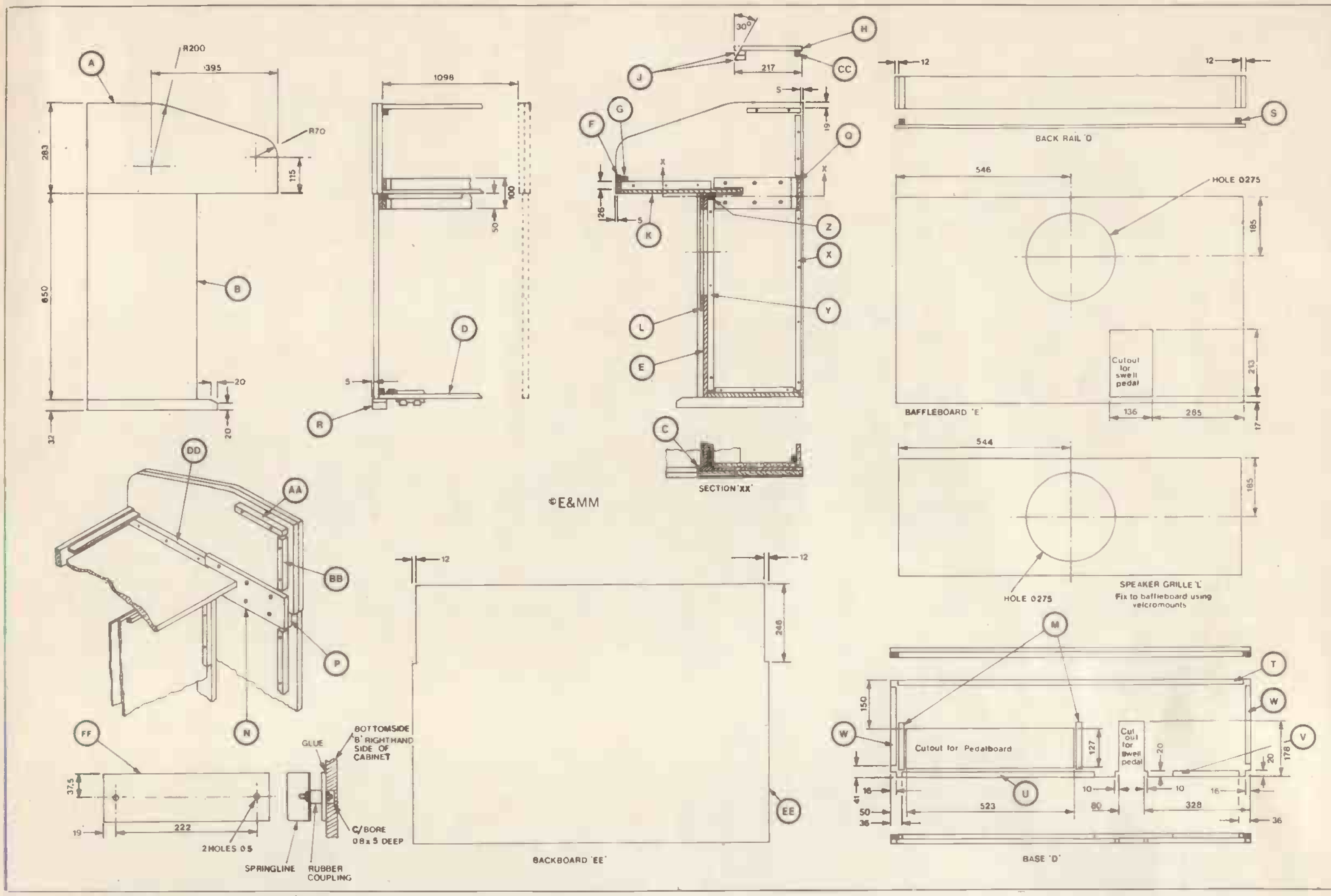

Figure 36. Cabinet construction details.

Part	Name	Material	Size (mm)	Qty
A	Topside	15mm Chipboard	595 x 283	4
B	Bottomside	15mm Chipboard	650 x 340	2
C	Thickening Strip	15mm Chipboard	650 x 50	2
D	Base	15mm Chipboard	1122 x 305	1
E	Baffle Board	15mm Chipboard	1092 x 650	1
F	Front Rail (1)	15mm Chipboard	1098 x 56	1
G	Front Rail (2)	15mm Chipboard	1098 x 22	1
H	Top	15mm Chipboard	1098 x 220	1
J	Top Front Runner	15mm Chipboard	1098 x 35	2
K	Keyboard Shelf	12mm Chipboard	1098 x 380	1
L	Speaker Grille	6mm Plywood	1088 x 370	1
M	Pedalboard Spacer	6mm Plywood	150 x 20	2
N	Side Joint	12mm Plywood	267 x 100	2
P	Side Thickening Strip	12mm Plywood	267 x 50	2
Q	Back Rail	15mm Plywood	1098 x 100	1
R	Foot	Hardwood	405 x 32 x 43	2
S	Batten	18mm Square	100	2
T	Batten	18mm Square	1080	1
U	Batten	18mm Square	600	1
V	Batten	18mm Square	205	1
W	Batten	18mm Square	244	2
X	Batten	18mm Square	579	2
Y	Batten	18mm Square	626	2
Z	Batten	18mm Square	1050	1
AA	Batten	18mm Square	172	2
BB	Batten	18mm Square	190	2
CC	Batten	18mm Square	1056	1
DD	Batten	18mm x 26mm	285	2
EE	Backboard	3mm Hardboard	1122 x 814	1
FF	Springline Mount	6mm Plywood	260 x 75	1

Table 6. Cabinet Cutting List.

MISCELLANEOUS PARTS LIST FOR CABINET

Front panel		(XY94C)
Metalwork mounting kit		(XY95D)
Spring clip	4 off	(BF15R)
End cheek set		(XY96E)
Keyboard separator		(XY97F)
Swell pedal housing and trim		(XY98G)
Rubber coupling	2 off	(FB98G)
Self-tapper No. 8 x ½ in. (for fixing metalwork to cabinet)	4 off	(BF69A)
Bolt 4BA 1 in. (for PCB mounting)	8 off	(BF04E)
Spacer 4BA ¼ in. (for PCB mounting)	8 off	(FW31J)
Nut 4BA (for PCB mounting)	8 off	(BF17T)
Panel screw 4BA ½ in. (for metalwork)	8 off	(BF14Q)
Bolt 2BA 1 in. (for speaker)	4 off	(BF01B)
Nut 2BA (for speaker)	4 off	(BF16S)
Bolt M4 25mm (for swell pedal and pedalboard)	8 off	(BF50E)
Nut M4 (for swell pedal and pedalboard)	8 off	(BF57M)
Self-tapper No. 4 x ⅜ in. (for swell pedal housing)	6 off	(BF65V)
Wood screw No. 10 x 1 in. (for fixing frame to shelf)	4 off	—
P-Clip ¼ in.		(LR45Y)
Velcromount	4 off	(HB21X)
Music stand		(XG01B)
Roll top		(XY99H)
Roll top guides (pair)		(XG00A)

Note: The above parts are only required if you are constructing your own cabinet. The cabinet kit (XY93B) supplied by Maplin Electronic Supplies Ltd. is complete and no other parts are required if this is used.

ters. These each have two inputs mixed together in the manual mode, except for 8-foot from IC4 pin 5 which does not require the CMOS switch. In automatic mode, the footages from the upper half of the keyboard (IC4 pins 16, 17 and 18) are cut off by the CMOS switches, and IC4 pins 3, 4, 5 and 6 now become four notes of an 8-foot chord when one key is pressed in one of the two lower octaves of the keyboard.

The 16-foot and 4-foot from the lower half of the keyboard are disconnected from their filters and the four notes of the chord are combined in R84, 85 and 86 and mixed together in IC9. The output of IC9 in automatic mode is connected through a CMOS switch into the 8-foot string and 8-foot flute filters. The note on the original 8-foot line is mixed with the other three notes at the input to the 8-foot string and 8-foot flute filters.

In the manual mode the lower manual circuits are much the same as for the upper manual. The 4-foot flute filter is built around IC11a, 8-foot flute around IC11b, 16-foot flute around IC11d, 4-foot string around IC12 and 8-foot string around IC13. In the manual mode the outputs of the flute filters are connected through the mixer IC11c to the flute VCA, IC15. The 8-foot string filter is connected to its VCA

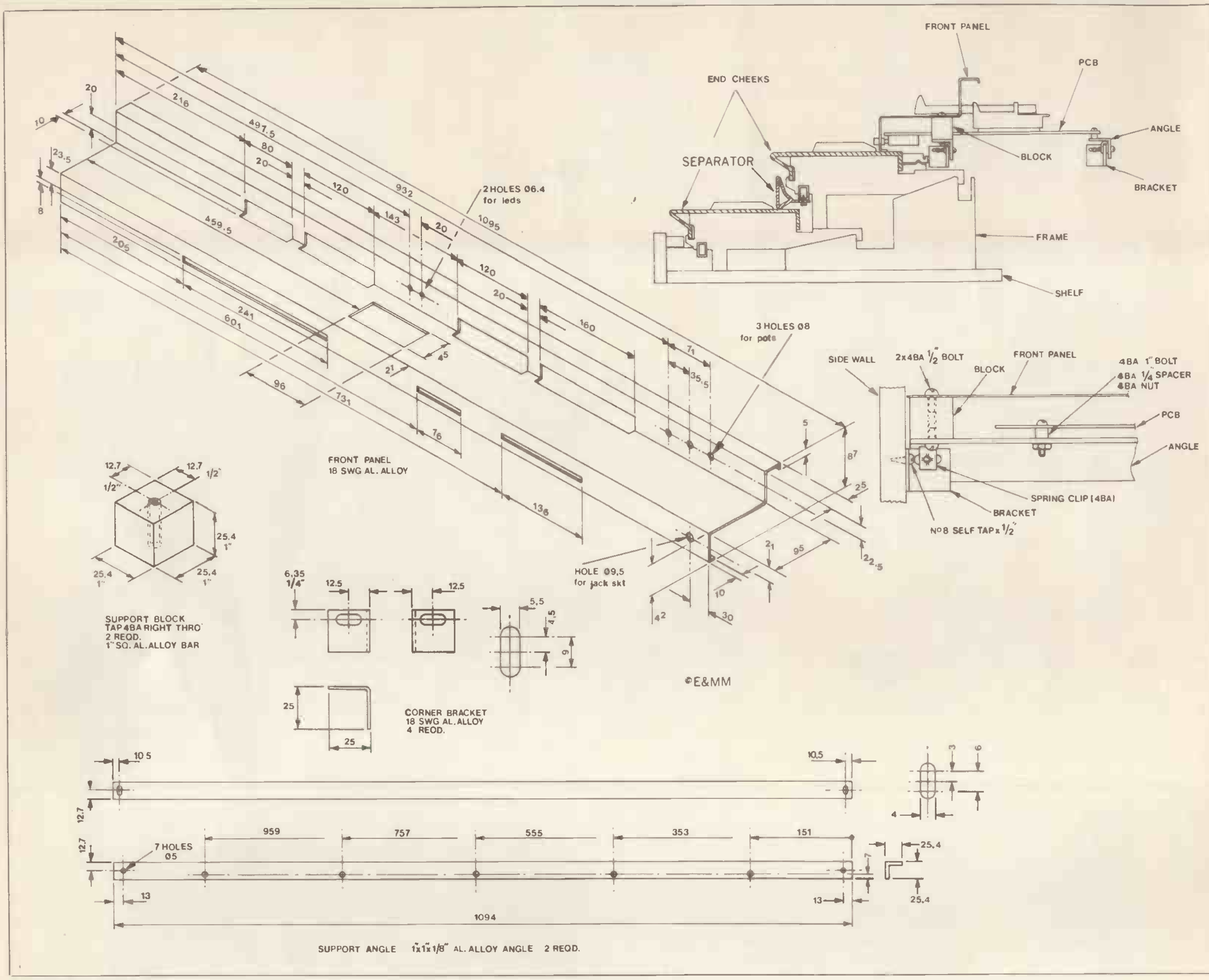

Figure 37. Metalwork.

IC14b and the 4-foot string filter is connected to its VCA, IC14a. In the automatic mode the 4-foot string VCA becomes the countermelody VCA and the 8-foot string VCA becomes the vamp VCA when the vamp button is pressed.

In the manual mode all three VCAs are controlled by the flute envelope shaper (TR5 and 6 and associated circuitry) which is itself controlled by KPS. If memory is pressed, the KPS signal is overridden by an earth on the cathode of D53 which pulls TR5 on permanently and the last keys pressed sound indefinitely. When the vamp button is pressed, all three VCAs are controlled from the vamp envelope shaper TR9 and 10. However, the vamp only plays when keys are pressed and the rhythm unit is switched on.

When KPS is high (all keys released), both the vamp and countermelody envelope shapers are inhibited to prevent pulses from the rhythm generator triggering them. When KPS goes low or memory button is pressed, the bias is removed from D55 and 66 and the pulses from the rhythm generator are now able to trigger the envelope shapers.

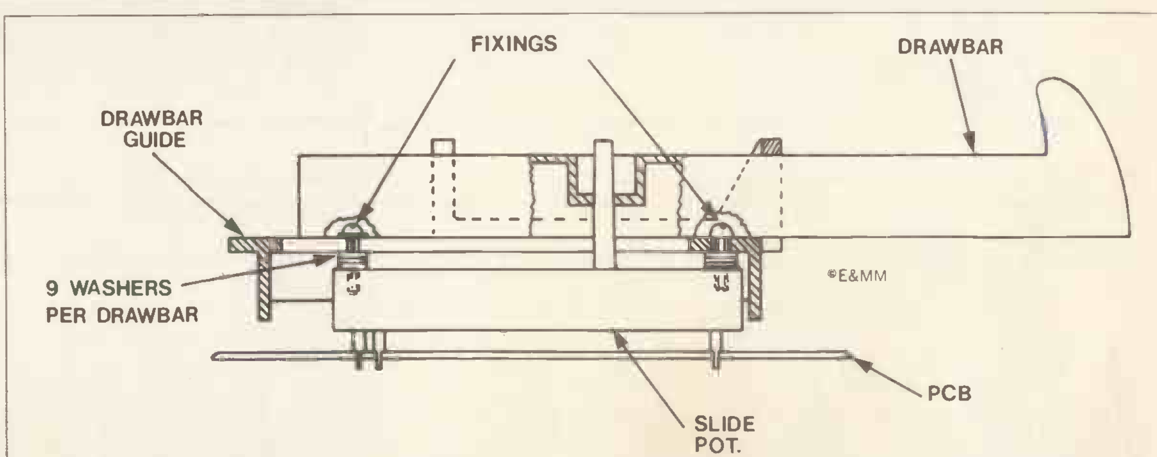

Figure 38. Drawbar assembly.

With the "auto" button pressed, the flute envelope shaper is still controlled by KPS as is the 8-foot string envelope shaper. However, the 4-foot string VCA is now controlled from the countermelody envelope shaper, TR7 and 8. The countermelody is generated from the four notes of the chord produced by IC4. These are switched through to the mixing resistors R69 to 72 by IC7 under control individually of four outputs from the rhythm unit. From the mixing resistors, the countermelody is fed to the 4-foot string filter and thence to the 4-foot string VCA.

If the auto and vamp buttons are both pressed, the flutes and 8-foot string VCAs come under control of the vamp envelope shaper whilst the 4-foot string remains under the control of the counter-

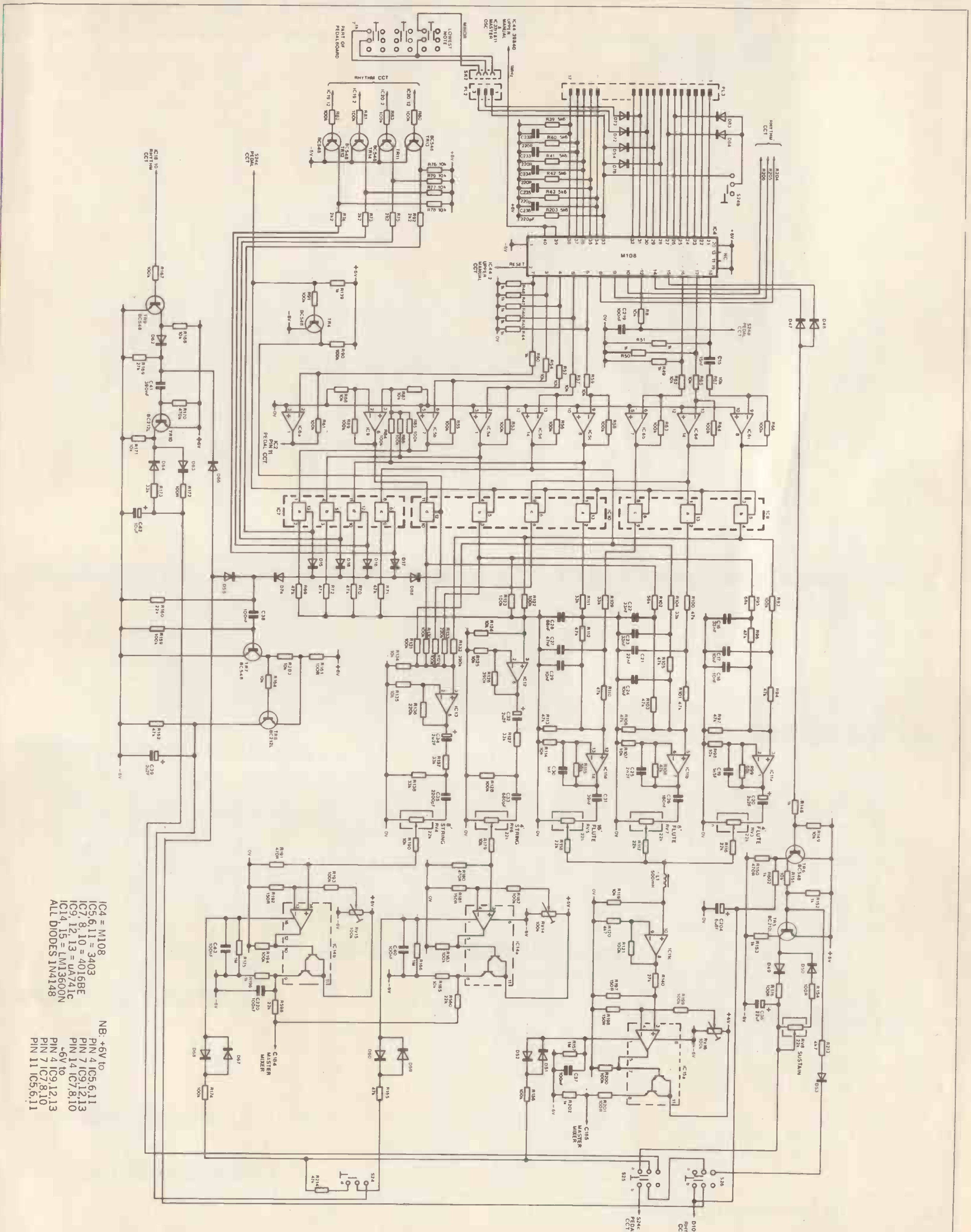

Figure 39. Circuit diagram of the lower manual.

BI-PAK The Professional approach

TRANSISTORS

Type	Price
AC107	25
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
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BC182L	10
BC183	10
BC183L	10
BC184	10
BC184L	10
BC186	15
BC187	18
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BC226	36
BC237	13
BC238	14
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BC251	15
BC251A	16
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BC337	13
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BC478	20
BC479	20
BC546	10
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BC549	11
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BC556	14
BC557	13
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BC559	14
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BCY31	80
BCY32	85
BCY33	80
BCY34	80
BCY70	14
BCY71	15
BCY72	15
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BD116	50
BD121	65
BD123	65
BD124	75
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BD132	35
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BD133	40
BD135	35
BD136	35
BD137	35
BD138	36
BD139	38
BD140	38
BD139/140 M/P	80
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BD178	68
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BD180	75
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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
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BD238	65
BD239A	50
BD240A	50
BD239A/240A	1.00
BD240	45
BD241	45
BD506	38
BD508	38
BDX32	2.20
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BDY17	1.80
BDY20	80
BDY55	1.40
BDY56	1.60
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BFR62	24
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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
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MPSA56	20
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OC23	1.50
OC24	1.35
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OC35	90
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OC44	24
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OC70	24
OC71	15
OC72	24
OC74	26
OC75	30
TC76	35
OC77	50
OC79	40
OC81	22
OC81D	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
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TIC45	35
TIP29	30
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TIS92	22
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ZTX303	16
ZTX304	20
ZTX330	15
ZTX500	13
ZTX501	12
ZTX502	16
ZTX503	12
ZTX504	25
ZTX531	25
ZTX550	25
2N38B	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
2N221A	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
2N29260	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

Type	Price
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

Type	Price
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

Type	Price
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
CD451D	99
CD4511	1.15
CD4516	1.10
CD4518	1.00
CD4520	1.00
CD4528	1.10
CD4531	1.50
CD4561	1.00

VOLTAGE REGULATORS

Type	Price
MVR7805-MVR7824	all 59p Ea.
MVR7905-MVR7924	all 63p Ea.
78LO5-78L24	all 28p Ea.
79LO5-79L24	all 55p Ea.
LM309K	1.25
UA79MGHC	2.50
LM320 15v 12v, 15v 24v	95p Ea.

74 LS SERIES TTL

Type	Price
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

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

LINEAR I.C.'s

Type	Price
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
LM324N	48
LM337T	1.35
LM339N	65
LM348N	90
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

Type	Price
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
IS10/100 1000v	85
IS10/1200 1200v	95

THYRISTORS

Type	Price
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

Type	Price
2 Amp — TO39	
TR12A/100v	30
TR12A/200v	42
TR12A/400v	50
10 Amp — TO48	
TRI110A/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

Type	Price
400W 1.3V-39V	all at 8p
1.3W 1 3V-100V	all at 15p
10W 1 3V-100V	all at 35p

BRIDGE RECTIFIERS

Type	Price
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

£21.09 7+7w R.M.S.

GE100 Mk2.
10 CHANNEL MONOGRAPHIC EQUALISER

£23.00

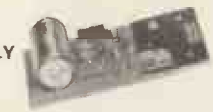
AL120 50w R.M.S.
AUDIO AMPLIFIER
(With integral heat sink and short-circuit protection).

£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

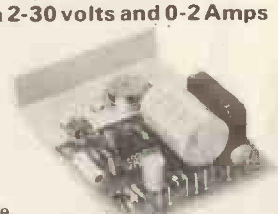
STA35. 35 watts per channel Stereo Amplifier. Kit consisting of: 2xAL80 amplifiers, 1xPA200 pre-amplifier, 1x2035 transformer, 2xcoupling capacitors 470mfd at 50v for 8 ohms, 1xreservoir capacitor 2200mfd 100v and necessary wiring diagram. £45.76

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

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509	20mm Panel Fuse Holder	0.26
510	1¼" Panel Fuse Holder	0.32

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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
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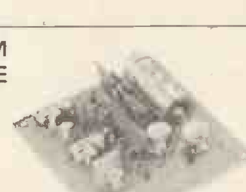

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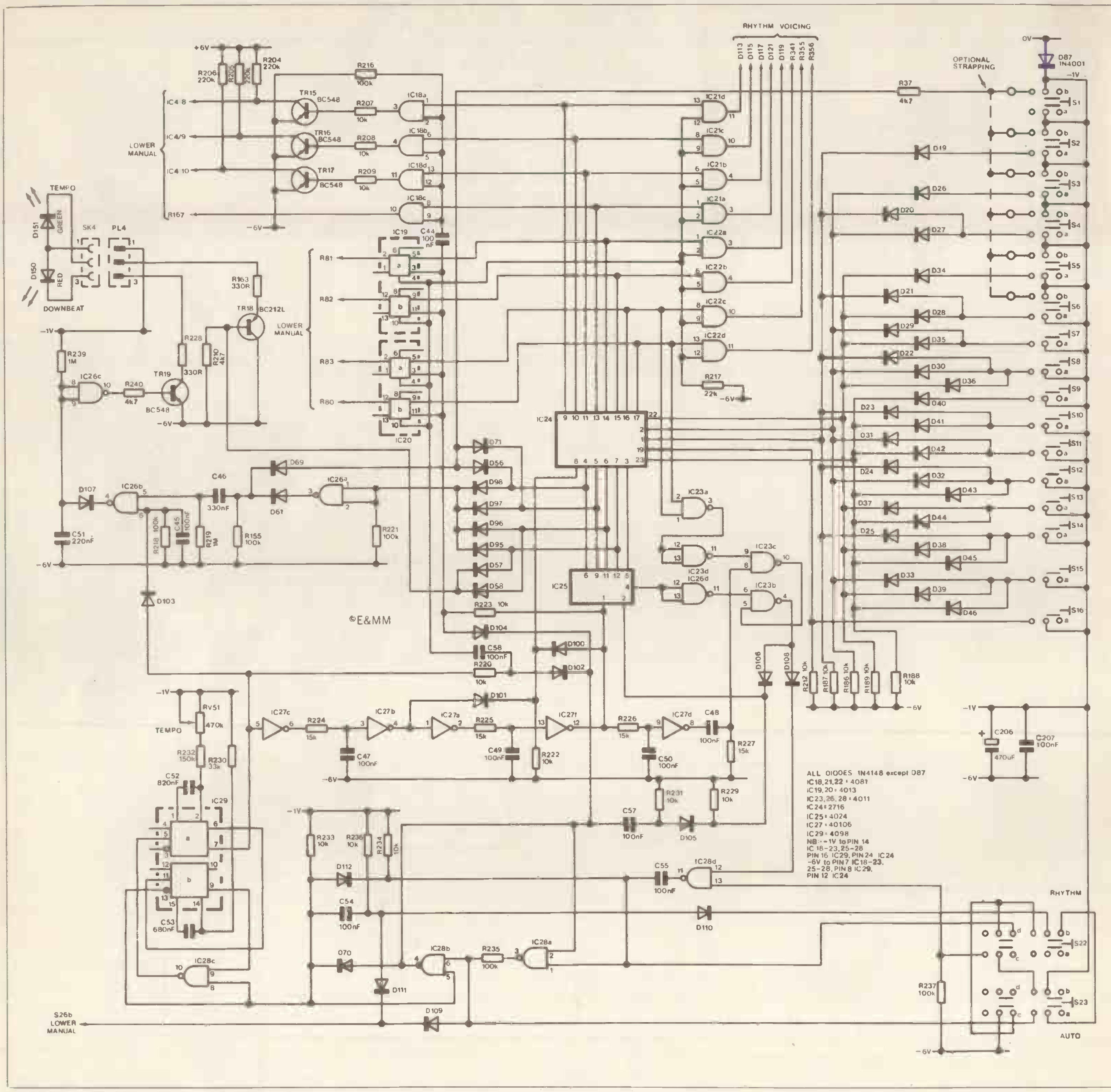


Figure 40. Circuit diagram of the rhythm unit.

melody envelope shaper.

The vamp envelope shaper is triggered by positive-going pulses from the rhythm unit. These pulses turn TR9 on and C41 charges through R169. Whilst C41 is charging, TR10 is turned on. When the input pulse is not present, TR9 turns off, C41 discharges through D62 and then TR10 turns off. Thus we now have a pulse at the junction of D63 and 64 of the length we require and at the required level. C42 now determines the attack and decay of the envelope in the same way as the other envelope shapers we have described previously.

The rhythm unit has four of its outputs connected via R80 to 83 to TR11 to 14 which act as level shifters and inverters. When a negative-going pulse occurs on one or more of these lines, the transistor turns on and drives the appropriate CMOS switch in IC7 which connects one or more of the notes of the automatic chord through to the countermelody VCA.

At the same time, any pulse is also fed through D15 to 18 and D74 to trigger the envelope shaper. The resultant positive-going pulse turns TR7 on during the charge time of C38 and the collector of TR7 going low turns on TR8 which charges C39. When the pulse goes off, C39 discharges via R162 which sets the discharge time. This envelope shaper is a high speed version of the others in the organ, designed to respond to rapid input control signals, retriggering each time.

As the rhythm generator can be used in manual mode, the countermelody must be inhibited when auto is not selected and this is achieved by preventing the cathodes of D15 to 18 from going high which stops the CMOS switches in IC7 from turning on. The 'auto/manual' switch S24 when in auto mode presents a -6V level to the junction of R91, 139. In the manual mode, this -6V is not present and R139 pulls the junction of R91, 139 to +6V which turns on the CMOS switches in IC8 and 10a, b and c. This also turns on TR4, via R91 which turns off IC10d and this turns the automatic chord lines off. The collector TR4 being low provides the -6V that allows D88 to conduct and turn off the countermelody also.

Rhythm Unit Circuits

The circuit diagram of the rhythm unit is shown in Figure 40. All the rhythms consist of two bars of up to 32 counts total and

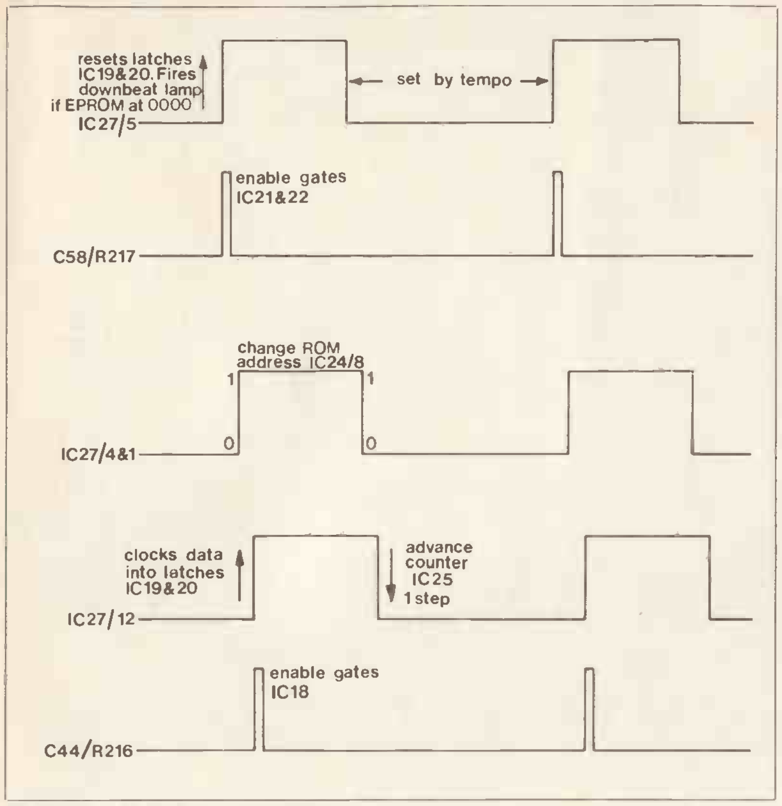
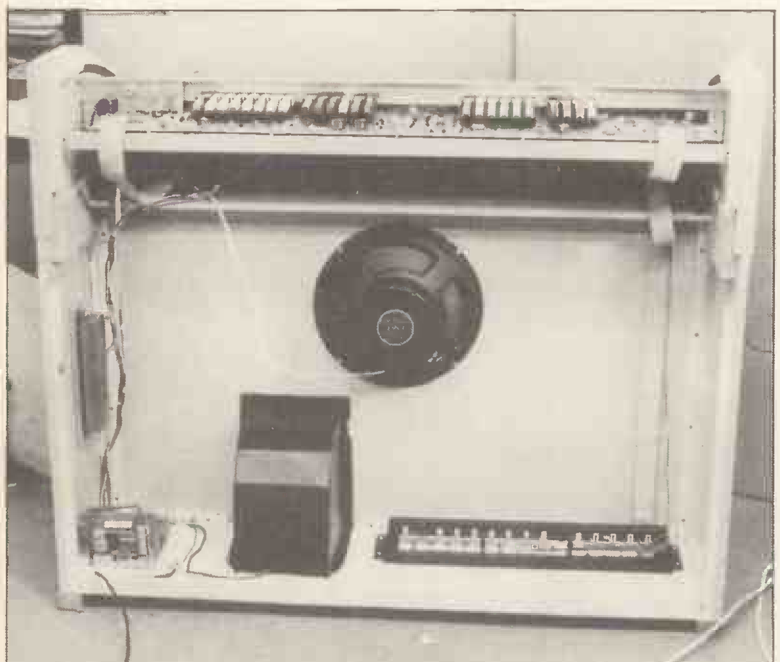


Figure 41. Rhythm unit timing chart.



Rear view of cabinet with parts installed.

at each count, any of the 16 outputs can be enabled. Four of these outputs provide a continuous level until changed (countermelody), whilst the remainder simply provide a pulse at the appropriate time. The information is stored in a pre-programmed 16K EPROM. As the EPROM has only 8 output lines, for each count the EPROM is addressed twice.

IC29 is a dual monostable that provides the clock pulses from which the rhythm generator is timed. The timing consists of a fixed duration high period set by C53 and R230 and a variable duration low period set by C53 and R232 and the tempo control RV51. The output is from pin 7. IC27 provides high impedance points to allow the timing circuit to function correctly.

Referring to Figure 41, positive transitions of the clock pulse first enable all the gates in IC21 and 22 during the charge time of C58, thus transferring the information standing on the outputs of the EPROM to the outputs of the gates. Second, they reset the four countermelody latches IC19 and 20 and third, enable IC26b which we shall describe later.

The leading edges are also inverted by IC27c, a Schmitt trigger, and delayed by R224 and C47 to allow time for the above operations to take place. After the delay, IC27b further inverts the signal and the positive levels are applied to IC24 pin 8. This is the least significant address line of the EPROM and allows the second set of 8 bits to be made available at the outputs of the EPROM.

By this time all the gates in IC21 and 22 have been disabled and the positive-going transition at IC27b output has been inverted by IC27a. The signal is now delayed by R225 and C49 and inverted again by IC27f. This positive-going transition enables all the gates in IC18 during the charge time of C44 and clocks the four latches in IC19 and 20. This is also connected to the input of IC25, a 7-stage ripple counter.

The positive-going pulse at the output of IC27f is delayed by R226 and C50 and inverted by IC27d. It is turned into a pulse by R227 and C48 and applied to IC23 pin 8. When the clock goes negative, the least significant address line of the EPROM returns low and this negative transition steps IC25 which moves the EPROM to its next address ready for the next positive-going clock pulse.

IC25 addresses the five next least significant address lines for each of the 32 possible counts. The four next address lines are directly coded from the rhythm selection switches via the diode matrix D19 to 46. These lines are normally held low by R186 to 189, but go high via the diodes when selected. S16 switches the most significant address line to select the second set of 15 rhythms.

Two methods are needed to reset the counter to count one (count one is the downbeat of the first bar, bearing in mind that there are two bars in each rhythm) so that a rhythm can be any length to generate unusual time signatures such as 5/4 time. A reset always occurs if the counter reaches maximum and for rhythms requiring fewer steps a non-valid output option (short and long cymbals together) is coded. This corresponds to pins 16 and 17 of the EPROM being high simultaneously.

Thus the output of IC23a goes low, is inverted by IC23d and applied to IC23c, the other input of which is only high for a short period after the counter has returned the least significant address low and moved the counter to the next EPROM address. So, if a reset is required after count 24, for example, the non-valid output option must be coded in count 25. This all happens very quickly, whilst the delay set by the tempo control occurs and ensures that the next beat is the downbeat.

If the output of IC23c goes low or pin 4 of IC25 goes high, thus indicating the end of 32 counts, then after an inversion by IC26d, the output of IC23b goes high and resets IC25 via D106 and IC28d is enabled.

When S22, the rhythm start/stop switch is pressed, S22B connects a low level via S23C normal, to the cathode of D110 which pulls the junction of R236 and C54 low. The pulse produced by C54 charging pulls pins 5 and 8 of IC28 low, resetting the clock and causing the start/stop latch IC28a and b to change over giving a high on pin 4. This removes the -6V that has been inhibiting the output gates and latches via D102 and 104 and allows the rhythms to sound. It also resets the counter IC25, so that rhythms always start on the downbeat of the first bar.

If S22 is released and S23, the auto start/stop switch is pressed, the -6V is removed from IC28 pins 5 and 8 as before. This allows the clock to run, but as pin 6 of IC28 is held high by KPS from IC4, the start/stop latch remains at stop. When a key on the lower manual is pressed, KPS goes low and the start/stop latch changes over. The pulse produced by C54 in this case, ensures that the clock starts in the right phase.

When the keys are released, KPS goes high which allows the high from R236 via D110 to turn the start/stop latch off. This ensures that the rhythm starts on the downbeat of the first bar when a key is pressed, stops when released, yet allows the tempo and downbeat lamps to flash even when the rhythm is not sounding, so that the tempo may be set prior to playing.

If S22 and S23 are both pressed, the rhythm starts when you press a key, but does not stop when the keys are released until a pulse via C55 from IC28d pulses IC28 pin 1 low and sets the start/stop latch to stop. This occurs at the end of the second bar as previously described.

The downbeat and tempo LEDs are controlled by the output from the counter IC25. The downbeat LED always flashes on the first count. The second flash occurs halfway through the count (except for 5/4 time) which can be either 24 or 32 counts. For unusual time signatures the second flash does not occur in the right place but we considered this was relatively unimportant compared with the facility of being able to generate unusual time signatures. The second flash therefore occurs at count 13 or count 17. This is selected by the strapping behind the first six rhythm switches S1 to 6. The unit

LOWER MANUAL PARTS LIST

Resistors - all 5% ⅓W carbon unless specified

R8,52,54,57,59,62, 65,67,76-79,87,88, 98,107,114,119, 124,125,134,135, 149, 151,164,168, 171,179,185,190, 202,283	10k	32 off	(M10K)
R39-43,203	5k6	6 off	(M5K6)
R44-51,60,139,148, 152,153,196,602	1k	15 off	(M1K)
R53,55,56,58,61, 63,64,66,80-86, 89-91,93,121-123, 128-131,156,159, 167,174,182,183, 193,194,199,200	100k	36 off	(M100K)
R69-72,94,96,97, 100,101,103,105, 106,108,110,112, 113,162,165,214	47k	19 off	(M47K)
R73-75,92	2k2	4 off	(M2K2)
R95,99	68k	2 off	(M68K)
R102,115	56k	2 off	(M56K)
R104,109,111,127, 137,138,173	33k	7 off	(M33K)
R116-118,160,560, 598	22k	6 off	(M22K)
R120,213	390k	2 off	(M390K)
R133,136	220k	2 off	(M220K)
R140,169	27k	2 off	(M27K)
R150,180,191	470R	3 off	(M470R)
R154,161,172,176, 201	100R	5 off	(M100R)
R157,166,175	1M	3 off	(M1M)
R170	470k		(M470K)
R181,192,197,198	150R	4 off	(M150R)
RV3-7	Drawbar white, 22k lin	5 off	(BR42V)
RV8	Drawbar blue, 22k lin		(BR98G)
RV14-16	Hor S-min preset 100k	3 off	(WR61R)

Capacitors

C15	15nF polyester		(BX71N)
C16,22,23	33nF polyester	3 off	(BX73Q)
C17,18,24,29	10nF polyester	4 off	(BX70M)
C19	1n5 polycarbonate		(WW23A)
C20,32,34,39	2u2 63V axial, elect.	4 off	(FB15R)
C21	22nF polyester		(BX72P)
C25	2n2 polycarbonate		(WW24B)
C26	180nF polycarbonate		(WW44X)
C27	47nF polyester		(BX74R)
C28	68nF polyester		(BX75S)
C30	1nF polycarbonate		(WW22Y)
C31	39nF polycarbonate		(WW36P)
C33	680pF ceramic		(WX66W)
C35	2n2 polystyrene		(BX30H)
C36	22uF 10V axial, elect.		(FB29G)
C37,40,43	100nF polyester	3 off	(BX76H)
C38	100nF polycarbonate		(WW41U)
C41	390nF polycarbonate		(WW48C)
C42	10uF 25V axial, elect.		(FB22Y)
C204	6u8 40V axial, elect.		(FB20W)
C219,220	100nF disc, ceramic	2 off	(BX03D)
C232-236	220pF ceramic	5 off	(WX60Q)

Semiconductors

D15-18,47-55,59,60, 62-64,66-68,72-74, 78,83,84,88	1N4148	28 off	(QL80B)
TR4,6,7,9,11-14	BC548	8 off	(QB73Q)
TR5,8,10	BC212L	3 off	(QB60Q)
IC4	M108		(YY90X)
IC5,6,11	3403	3 off	(QH51F)
IC7,8,10	4016BE	3 off	(QX08J)
IC9,12,13	uA741C	3 off	(QL22Y)
IC14,15	LM13600	2 off	(YH64U)

Miscellaneous

L1	Choke, 500mH 40R		(HX24B)
S25,26	Latchswitch, 2-pole	2 off	(FH67X)
PL2	Minicon latch plug, 3-way		(BX96E)
PL3	Minicon plug, 17-way		(BH64U)
SK2	Minicon latch housing, 3-way		(BX97F)
SK3/SKB	Jumper cable, 17-way		(BX98G)
	Minicon terminal	3 off	(YW25C)
	DIL socket, 40-pin		(HQ38R)
	Veropin 2141	2 off	(FL21X)

RHYTHM UNIT PARTS LIST

Resistors - all 5% ⅓W carbon unless specified

R37,210,240	4k7	3 off	(M4K7)
R155,216,218,221, 235,237	100k	6 off	(M100K)
R163,228	330R	2 off	(M330R)
R186-189,207-209, 212,220,222,223, 229,231,233,234, 236	10k	16 off	(M10K)
R204-206	220k	3 off	(M220K)
R217	22k		(M22K)
R219,239	1M	2 off	(M1M)
R224-227	15k	4 off	(M15K)
R230	33k		(M33K)
R232	150K		(M150K)
RV51	Pot lin 470k		(FW07H)

Capacitors

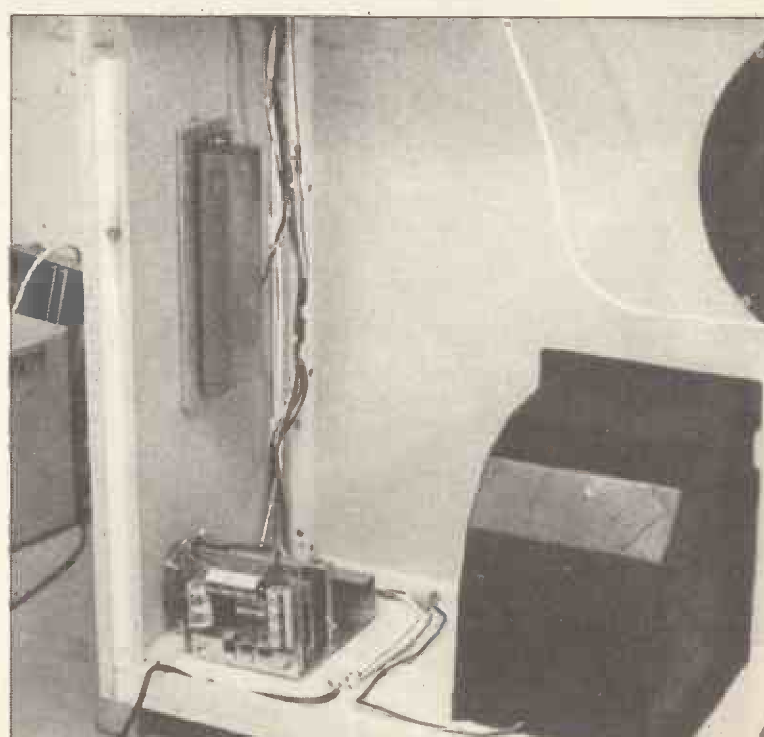
C44,45,47-50,54, 55,57,58	100nF polycarbonate	10 off	(WW41U)
C46	330nF polycarbonate		(WW47B)
C51	220nF polycarbonate		(WW45Y)
C52	820nF polycarbonate		(WW52G)
C53	680nF polycarbonate		(WW51F)
C206	470uF 6.3V axial, elect.		(FB70M)
C207	100nF disc, ceramic		(BX03D)

Semiconductors

D19-46,56-58,61, 69-71,95-98, 100-112	1N4148	52 off	(QL80B)
D87	1N4001		(QL73Q)
D150	LED Red		(WL27E)
D151	LED Green		(WL28F)
TR15-17,19	BC548	4 off	(QB73Q)
TR18	BC212L		(QB60Q)
IC18,21,22	4081BE	3 off	(QW48C)
IC19,20	4013BE	2 off	(QX07H)
IC23,26,28	4011BE	3 off	(QX05F)
IC24	2716/M2		(QY15R)
IC25	4024BE		(QX13P)
IC27	40106BE		(QW64U)
IC29	4098BE		(QX29G)

Miscellaneous

S1-16	Latchswitch, 2-pole	16 off	(FH67X)
S22,23	Latchswitch, 4-pole	2 off	(FH68Y)
PL4	Minicon latch plug, 3-way		(BX96E)
SK4	Minicon latch housing, 3-way		(BX97F)
	Minicon terminal	3 off	(YW25C)
	LED clip, clear	2 off	(YH54J)
	DIL socket, 24-pin		(BL20W)
	Veropin 2141	6 off	(FL21X)



Mounting of springline and power unit.

is set for 32 counts if no connection is made and for 24 counts if a connection is made.

The count is decoded by D95 to 98 for the 32 count rhythms and D56 and 71 for the 24 count rhythms. The seventeenth count is pins 6, 9, 11 and 12 of IC25 going low together, which allows the input of IC26a to go low via R221. Pin 3 of IC26 now goes high, thus pulsing the input of IC26b high. If this corresponds with a high on pin 6 of IC26, pin 4 goes low thus removing the high from the input of IC26c which produces a high that turns on TR19 via R240 and this turns on D150 via R228. The length of this flash is determined by the charge time of C51 and R239.

The thirteenth count is pins 6 and 9 of IC25 going high simultaneously which means that the cathodes of D56 and 71 are allowed to go high via R37 and the 24-count strap. This positive-going transition is connected via D69 to C46 as in the previous case. In this case, however, the discharge time for C46 exceeds the maximum length of time possible between counts 13 and 17 and thus the flash that would have occurred at count 17 is inhibited.

The tempo LED, D151, is triggered by pins 11 and 12 of IC25 going low together, thus allowing the cathodes of D27 and 28 to be pulled low via R210, thus turning on TR18 which causes the green LED to flash via R163.

The four latches in IC19 and 20 hold the countermelody information for each count of the rhythm. IC18c provides the vamp output to the vamp envelope shaper and IC18a, b and d provides the outputs to control the bass codes of the M108. TR15 to 17 act as inverters and level shifters. The M108 recognises this negative logic 3-bit code and internally latches it and produces a bass note and bass envelope trigger pulse TDB. The automatic bass output from IC4 pin 7 is amplified by IC6a and fed to IC2 pin 11 (see Figure 34).

Since all the CMOS in the rhythm unit is designed to run at +5V relative to -6V it is necessary to generate a -1V rail (which effectively becomes +5V). This is achieved by feeding the 0V through D87 which drops about 1V. This rail is smoothed by C206 and 207.

In the final part, next month, we shall describe the rhythm generator voicing, the audio mixing stages, the wah, rotor sound, reverb and power amp circuits to conclude the circuit descriptions. We shall also list any amendments and errors that have occurred in the series and give some playing instructions. E&MM

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MAPLIN

CIRCUIT MAKER

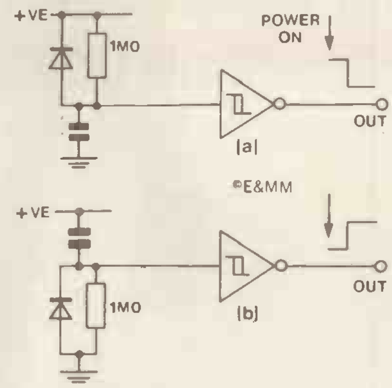
Readers contributions can be an original feature or constructional article describing electronic or electro-musical equipment which is ideally a complete building block that will aid the circuitmaker. All ideas and circuits presented for publication should have been proved before submission and should include a circuit diagram and explanatory text.

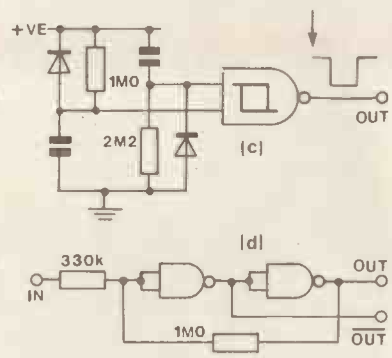
Logic Power-Up Resets

It is often necessary to ensure that a logic circuit powers up in some predetermined state, and simple circuits can be added to achieve this. Indeed, on many occasions the reset circuit can be designed around spare gates in the main circuit.

The most simple circuit holds any reset lines high for a period after power is applied, after which the resets are taken low (a). The circuit is based around a Schmitt trigger, which generates a clean switching signal from a slowly rising, or noisy, input signal. In this case a slowly rising voltage is obtained from an RC network, connected directly to the gate inputs and the supply rail. As power is applied the voltage on the capacitor starts to rise until the threshold of the trigger is reached, at which point the gate output goes low. This inversion is simply due to the fact that most logic Schmitt triggers are derivations of the traditional gates, in this case an inverter.

This circuit may be improved with the addition of a diode as shown. Without the diode the capacitor may not discharge during a short power supply break, and thus a reset would not be generated. The diode allows the capacitor to discharge to the power rail as it collapses, and thus a reset will always be generated if the power drops long or low enough to corrupt the logic states.





ALL DIODES 1N4148 / CAPACITORS 100n

A reset of the opposite sense (from low to high as for TTL) can be obtained by transposing the resistor and capacitor (b). In this case however the diode is essential, preventing the destruction of the gate at power down, since without the diode the gate input would be taken to -5 volts due to charge stored on the capacitor. The diode also provides response to momentary power collapses.

Some reset circumstances, particularly with shift registers, require that a proper high-low-high clock sequence is generated, perhaps to strobe a load input. This can be obtained by combining the two above reset circuits (c). In this case the type (a) RC network should have the lower time constant. At power up, one gate input is high, the other low. The NAND output is thus high. Both capacitors start to charge, but the integrator (type (a)) reaches the threshold of its input first, thus both inputs are high, and the output drops. As the other network charges, the other input to the gate falls, and hence the output returns to the high state where it remains.

If a proper Schmitt trigger is unavailable (often no other use will be found for the rest of the Schmitt gates in a package), a discrete trigger can be made from any two inverting gates, including NAND, NOR or simple inverters. These should be connected in series, with a positive feedback resistor connected as (d). This resistor provides a current flow to help 'snap' the trigger over quickly once it starts to change state referred to as hysteresis action. These form of triggers do have advantages over their single gate counterparts. Firstly, both polarities of reset are available without need for further inverters, and secondly, the degree of positive feedback, and hence the threshold voltage, can be chosen simply by altering the feedback resistor.

In the circuits shown the values are chosen for CMOS logic, making use of the high gate input impedances. The circuits may be used for TTL, but it is necessary to reduce the values of all the resistors to 1k and increase the capacitors accordingly.

Syntom Trigger Input

The Syntom drum synthesiser, described in the April '81 issue of E&MM, is a very versatile instrument capable of producing a wide range of useful effects. In its original form, however, the unit can only be triggered by way of the internal microphone, no trigger input for use with a synthesiser being provided.

Fortunately, it is quite easy to add a trigger input to the Syntom, and a simple method for doing this is given here. The trigger signal must be a positive pulse between 3 and 15 volts in amplitude, and have a duration of a few milliseconds or more.

Figure 1 shows the small additional circuit required to provide the trigger input. TR2 has its collector and emitter terminals connected across the input of the main Syntom circuit and effectively feeds a small, negative pulse to this input if it is switched on briefly. Due to the high gain of the amplifier at the input of the Syntom, this small input pulse is sufficient to send the output of IC1 fully positive, and thus activate the envelope shaper and other circuits (see Figure 1 of the original article).

TR2 will in fact be switched on if a positive input pulse of adequate amplitude is applied to JK2. C5 ensures that TR2 is only pulsed on briefly regardless how long the input pulse may happen to be. R30 is a current limiting resistor which protects the base-emitter junction of TR2.

Construction

As there is very little excess space inside the Syntom unit, it is strongly recommended that the method of construction described here is followed precisely or it may be found that the additional components cannot be accommodated inside the unit.

Start by mounting the input jack on the rear panel in the position shown in Figure 2. Note that with the addition of this socket there is not enough space for the battery to fit horizontally across the rear of the unit so it must be fitted vertically into the case, as close to the microphone as possible.

The other components are mounted on a small piece of 0.1in. matrix Veroboard which measures 5 strips by 7 holes. The component layout is shown in Figure 3. There are no breaks in any of the copper strips and the leadout wires of TR2 should be trimmed quite short so that the component panel is as compact as possible.

A Veropin or a short piece of thick, non-insulated wire is soldered to the board at the point where it must connect to JK1. When this pin or wire is soldered to the appropriate tag of JK1, it should be found that the board is held firmly in place. Be careful to position the board where it will not come into contact with the jack plug when inserted into JK1.

The other two leads from the component panel are then wired in place; these can conveniently connect to the Syntom printed circuit board at the two pins which connect to XI but be careful to connect the leads the right way round. After connecting the earthing lead from JK1 to JK2, as shown in Figure 3, the unit is ready for testing and use.

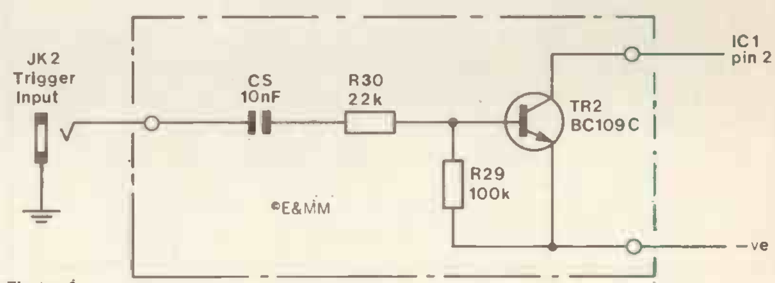
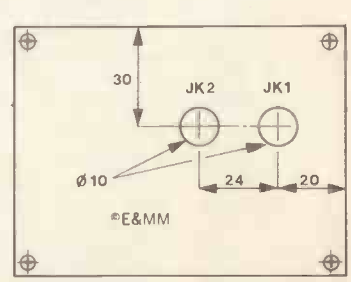


Figure 1



All dimensions in millimetres

Figure 2

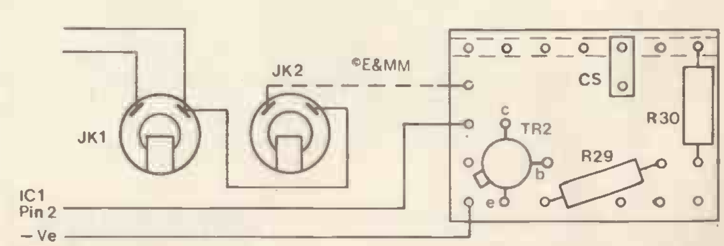


Figure 3

Audio Cassette auto-cue

Ray James, Hayes, Middlesex

One of the main disadvantages of music on cassette instead of record is the difficulty encountered when trying to find a particular track. It would therefore be useful to be able to select a required track and then wind/rewind to it, the tape stopping automatically at the required position.

One method of doing this is to code information onto the tape between tracks and detect these codes during winding. This involves complicated modifications to the cassette mechanism and is impractical for the home constructor.

Another method, which forms the basis of this design, is to use the tape counter on the cassette deck as a reference and index all the tracks on the tape. A required track can then be found by setting the counter value of that track on a set of switches and comparing this value with the tape counter during a fast wind, stopping the wind when the numbers are equal.

The circuit design here was intended as an add-on for the JVC/Tandberg cassette mechanism although it could be employed with any mechanism provided that a stop solenoid is available. Furthermore, the provision of an electronic counter and display to replace the mechanical counter means that construction becomes much easier because a sloping window for the original counter is not required; indeed a very attractive unit could be made by locating the counter in the meter area.

The circuit (shown below) works by counting the pulses derived from the reed switch on the mechanism. The number of pulses is divided by 6 using IC2 and fed to a three-digit bcd counter (IC3,4,5). The output from this counter is compared with the settings on a bcd switch when they are equal, the a=b output of the comparator goes high and energises the stop solenoid by means of the Darlington transistor. A three digit display is connected to the counter; this consists of three 74LS47 decoder drivers and three common anode displays.

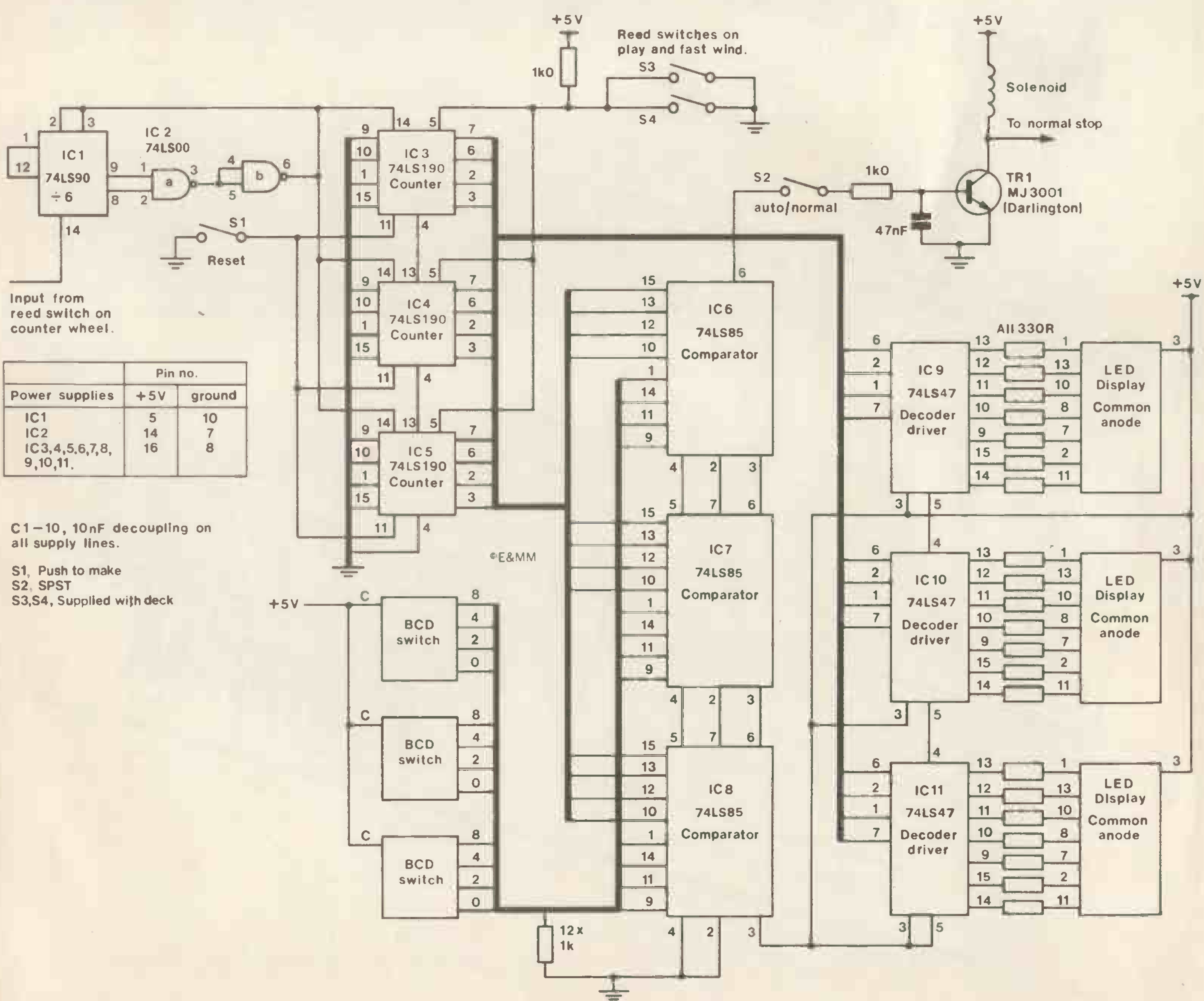
The direction of the counter is determined by the logic level on the up/down line, which in turn depends on the operational key pressed. Obviously an up count is required for play and fast wind, this corresponds to a logic low and is achieved by connecting two reed switches in parallel, one on each key. In addition, the automatic function is disabled simply by switching off the drive to the stop solenoid if required.

The accuracy of the system is adequate to cue most album tracks, an error of 0.4 inch of tape being typical, this equates to a mere 250ms.

Operation

The tape should be rewound and the counter reset by pressing the reset switch which zeros the counter. The tape is wound onto any required points and the counter reading noted for future use. When this is done any number may be set on the bcd switches and wind or rewind pressed accordingly. Naturally if the direction chosen is wrong the tape will wind to the end without automatically stopping.

NOTE: Some readers may not be familiar with the 'bus' type of drawing used in the diagram. Diagrams for logic circuits such as this generally have large numbers of wires all following the same path, and to simplify the drawing they are all drawn as a single line, with an accompanying label to state how many wires are in the line. It is convention to mark all pins with the wire name or number at both ends, though in many circumstances the bus structure is quite clear in itself. For example in the diagram IC4 pin 2 is indicated as going to IC7 pin 12 by virtue of their relative positions.



Power supplies	Pin no. +5V	Pin no. ground
IC1	5	10
IC2	14	7
IC3,4,5,6,7,8,9,10,11.	16	8

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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.

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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
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POLY 13	Pots, Switches for master control board	£11.80
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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
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POLY 25	Construction manual	£1.50
	Total cost for individually purchased packs for single voice instrument	£355.15
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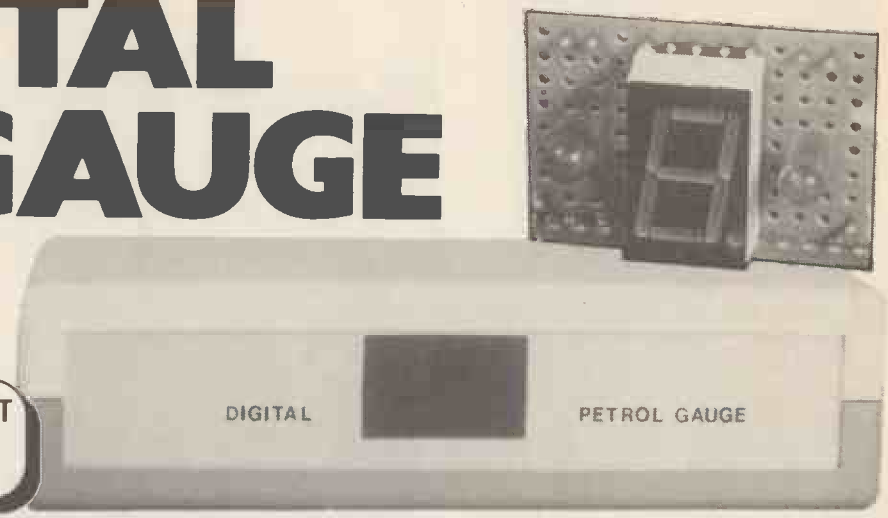


'The needle's in the red again. Not to worry, it's not right anyway — at least a gallon left.' Two miles later, 'Blast! Out of petrol. The gauge says empty too!' Famous quotes of the average motorist. From these two comments it is apparent that the only relevant part of the average petrol gauge is the low zone. So to satisfy this requirement we feature a useful fuel indicator with digital readout and critical level indication.

The unit, in fact, gives a digital display of the percentage amount of fuel remaining, a full tank representing 100% and producing a readout of 9 until 10% of the fuel has been used at which point the display changes to 8. Thus there is a 10% safety factor built into the gauge. When the indicator goes to 0 (i.e. you're down to 10% fuel), two red LEDs start to flash warning you it is time to buy more fuel. When both the display and the LEDs extinguish, the tank is virtually empty and you've got your last chance to get to a garage!

Circuit

The circuit diagram for the petrol gauge is shown in Figure 1. The input voltage for the circuit is derived from the car's petrol tank sensor which, in conjunction with R4, forms a potential divider producing virtually 0 volts with a full tank and about 5 volts when the tank is empty. To divide this input range into the ten divisions required, the National LM3914N bargraph IC is used. This IC contains a buffer input stage, a potential divider chain, comparators, and a precise 1.2 volt reference source.

The outputs of the LM3914N are capable of sinking the current and voltage applied to them and thus act as zero voltage switches. To encode the outputs of IC1 into signals capable of being displayed on a common anode, seven segment display they are passed through a diode matrix (D1 to D47).

Each segment of a seven segment display is given a code letter, as shown in Figure 2, which also contains a table detailing which segments must be lit to produce each of the ten digits. Where a tick is shown in this table, a diode must be connected between the appropriate IC output and the segment required. Each segment is therefore given a bus-

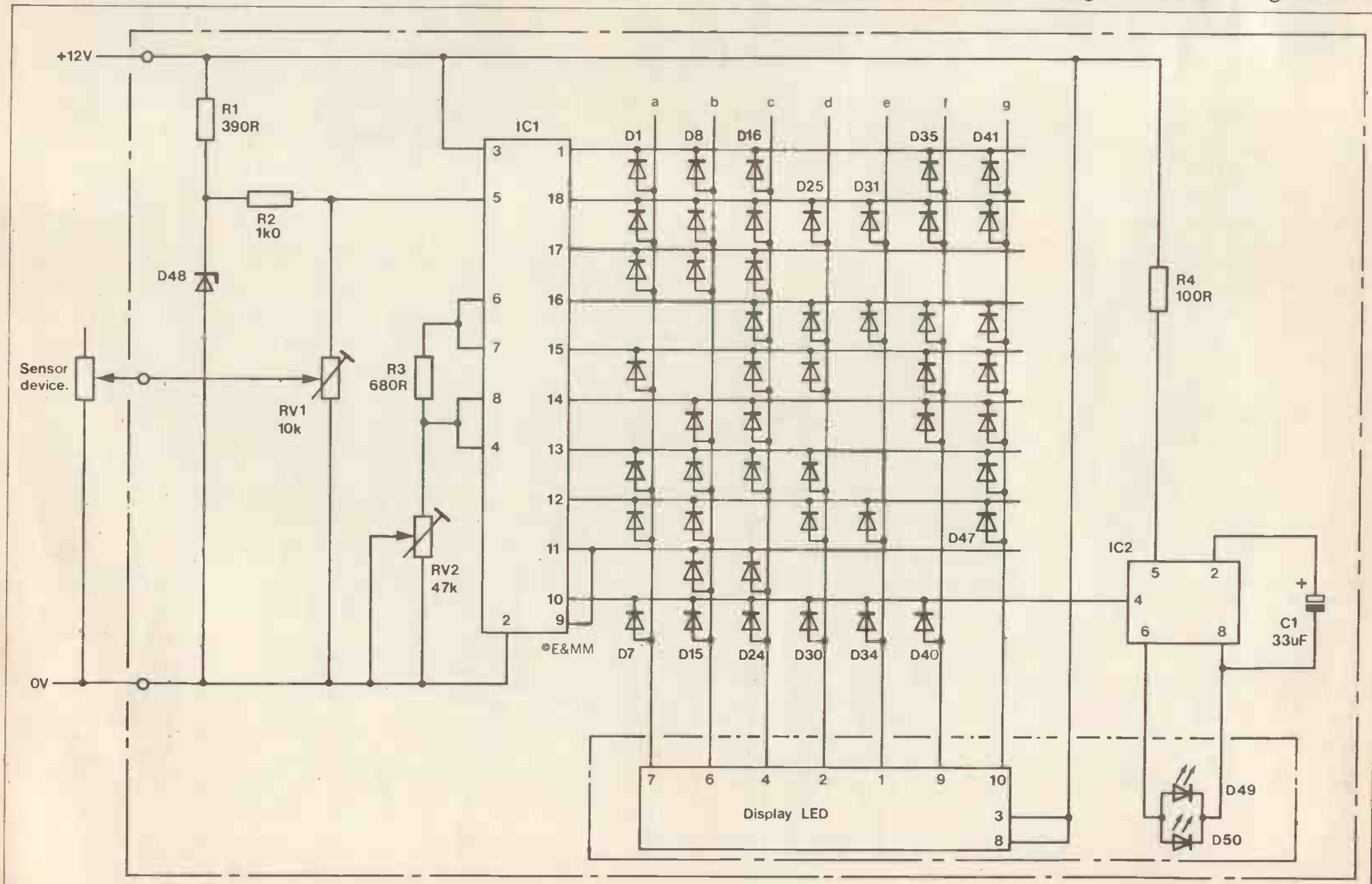
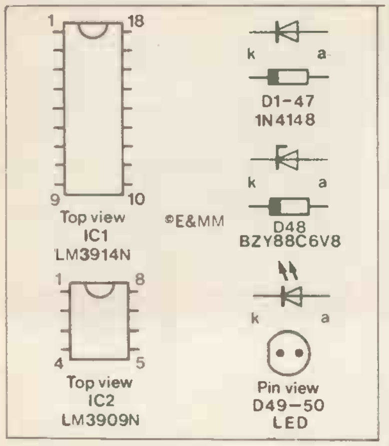


Figure 1. Circuit diagram for digital petrol gauge.



Display number	Segments A	B	C	D	E	F	G
0	✓	✓	✓	✓	✓	✓	X
1	X	✓	✓	X	X	X	X
2	✓	✓	X	✓	✓	X	✓
3	✓	✓	✓	✓	X	X	✓
4	X	✓	✓	X	X	✓	✓
5	✓	X	✓	✓	X	✓	✓
6	X	X	✓	✓	✓	✓	✓
7	✓	✓	✓	X	X	X	X
8	✓	✓	✓	✓	✓	✓	✓
9	✓	✓	✓	X	X	✓	✓

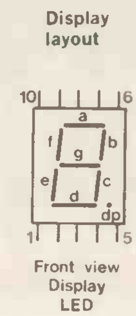


Figure 2. Display segment connection.

bar to which the diode anodes are connected, the diode cathodes going to the appropriate output pin bus-bars.

The output from IC1 pin 10 also goes to the 0 volt pin of IC2. IC2 is the National LM3909N LED flasher device which, when enabled, flashes the two LEDs to give the low level warning.

The input level from the sensor can be adjusted by means of RV1, while RV2 sets the internal voltage reference of IC1. Adjustment of these two components is dealt with later. R3 and D48 stabilise the supply to the sensor circuits so that variations in the supply voltage do not cause changes in the number displayed by the unit. It is not necessary to stabilise the supply to IC1 as its internal circuits provide any necessary stabilisation.

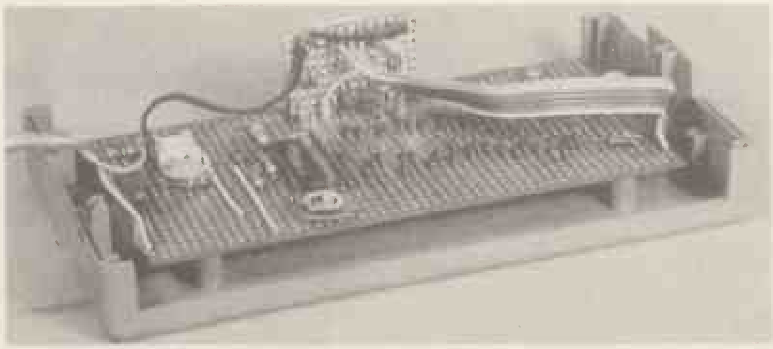
Construction

Most of the components are fitted onto a 0.1in. pitch Veroboard panel measuring 24 strips by 50 holes. This is a standard size in which the board is sold. Figure 3 shows the component layout of this board. The two mounting holes are 3.3mm in diameter.

The seven segment display and the two LED indicators are mounted on a separate, smaller board, shown in Figure 4. Veropins are fitted to this board at the points where it connects to the main panel. A couple of extra pins are fitted to the board and these are soldered to two matching pins fitted on the main board, so that the display panel is mounted at right angles to the main board. The diagrams and interior photograph of the unit should clarify the method of mounting and eliminate any problems that may arise.

Ribbon cable can be used to wire the two boards together and will give a neat finish. However, ordinary connecting wire can be used if preferred.

The specified Verocase makes a convenient housing for the project since the main component board will fit onto the front pair of mounting pillars of this case, using the mounting screws provided with the case. The front panel of the case requires a rectangular display window to be cut out at the appropriate place. This cut-out can be made by



Component board and display board mounting.

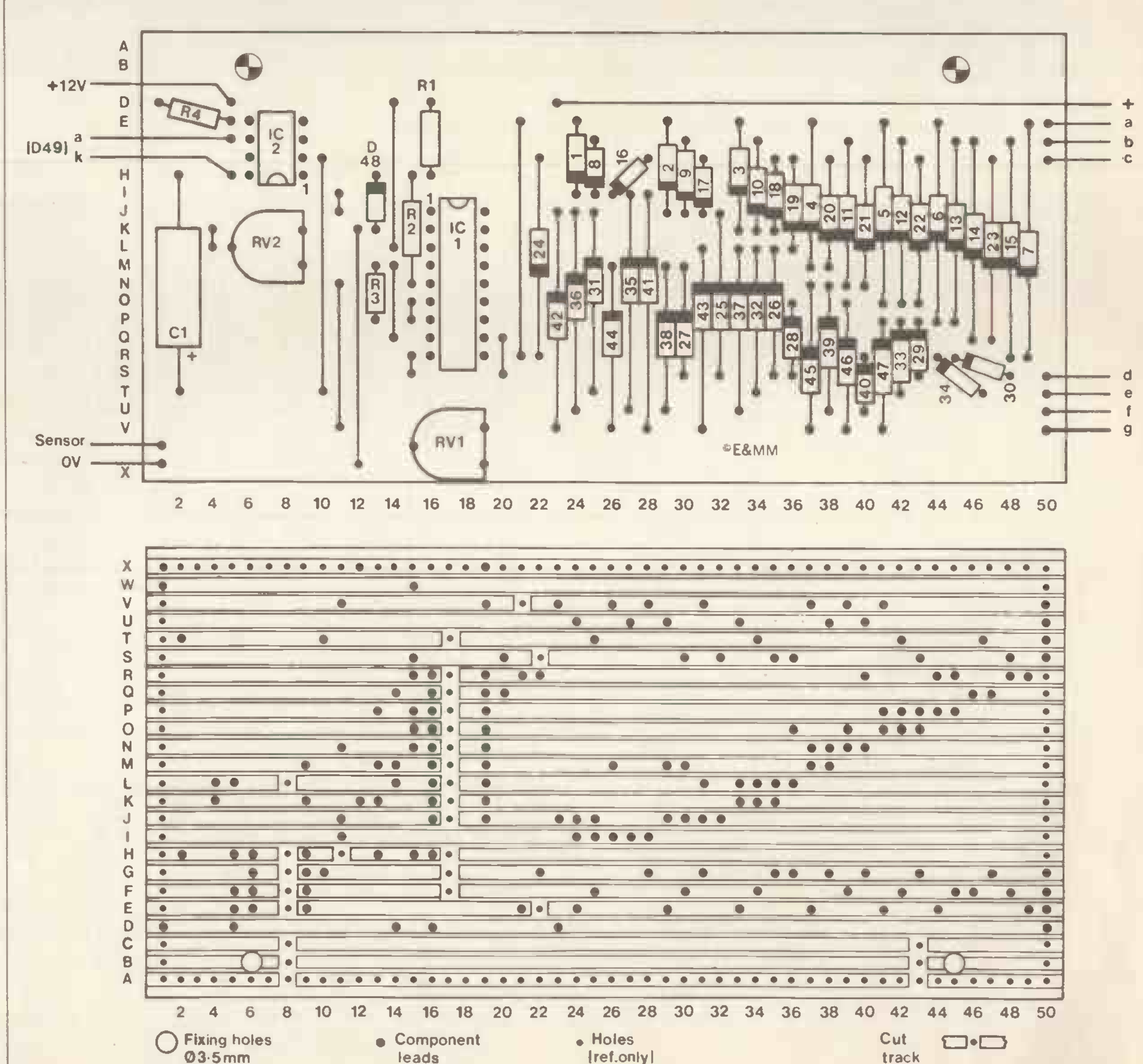


Figure 3. Wiring details and main board layout.

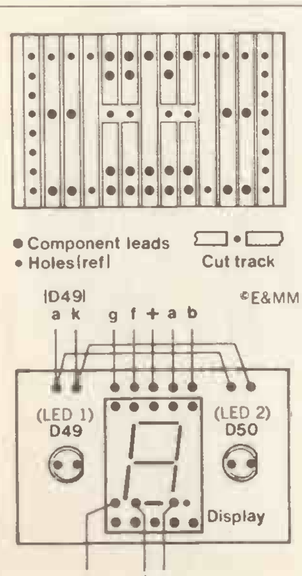
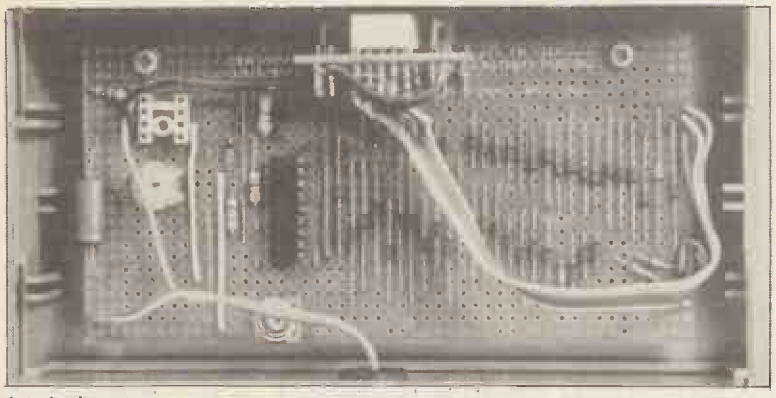


Figure 4. Display board details.



Interior layout.

drilling a hole about 10 or 12mm in diameter and then filing it out to the required size and shape. A piece of red display filter is then glued in place behind the cut-out. The rear panel of the case needs a single hole to be drilled in it to take the supply and input leads. It is advisable to fit this hole with a grommet to protect these leads.

Setting Up

Connecting the unit to the car is fairly straightforward. After consulting the car workshop manual, carefully remove the existing petrol gauge; connected to it should be three cables. With the ignition switched on identify these three leads using a voltmeter. One should indicate 12 volts, one 0 volts, and one between 0 and 5 volts. Connect the 12 volt lead to the 12 volt supply lead of the replacement unit, the 0 volt lead to the 0 volt supply lead, and the remaining lead to the input/sensor lead. The original petrol gauge must be disconnected or the digital petrol gauge will not work properly. Next fill the petrol tank (which will probably cost you more than the gauge has cost to construct), and switch on the ignition.

Adjust RV2 until the voltage at pin 8 of IC1 is between 0 and 0.5 volts and adjust RV1 until the display reads 9. Alternatively the unit can be set up with the tank almost empty, as long as the sensor lead measures approximately 5 volts.

RV2 should be adjusted as before, but RV1 should be adjusted until the display reads 0 and the two LEDs are flashing. Ultimately, however, setting up RV1 is a matter of trial and error, to set the zero display at your desired level.

Keep an eye on the unit as the petrol level falls, and adjust the unit when the desired critical level is reached. Remember, as the petrol level falls, the sensor voltage rises.

Mounting

The unit, once completed and set up, can be mounted in one of two ways: as a complete unit, when it should be mounted where the display will be shielded from sunlight (otherwise it could become illegible), or with the display board mounted away from the main unit.

The display board is then connected to the main board using a suitable length of ribbon cable. The use of a case for the main component board is still recommended but the display window is obviously replaced by a slot for the ribbon cable. The case is then mounted in any convenient position that is dry, oil free, and away from the heater.

E&MM

PARTS LIST

Resistors — all 5% ⅓W carbon.

R1	1k2	(M1K2)
R2	100R	(M100R)
R3	390R	(M390R)
R4	1k	(M1K)
RV1	10k Hor. S-min. preset.	(WR58N)
RV2	47k Hor. S-min. preset.	(WR60Q)

Capacitors

C1	33uF 16V Axial	(FB35Q)

Semiconductors

D1-47	1N4148	47 off	(QL80B)
D48	BZY88C6V8		(QH10L)
IC1	LM3914		(WQ41U)
IC2	LM3909		(WQ39N)
LED1-2	LED red.		(WL27E)
X1	Display Type 1. ½in.		(FR39N)

Miscellaneous

Filter red.	(FR34M)
ABS Box MB1	(LH20W)
DIL socket 8 pin	(BL17T)
DIL socket 18 pin	(HQ76H)
Ribbon cable 10 way 1 metre	(XR06G)

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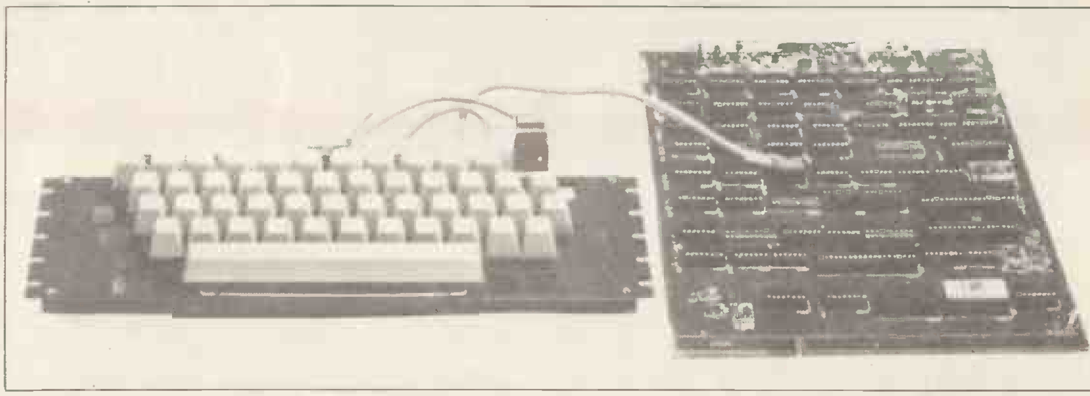


How to play tunes without any extra hardware except an audio amplifier and speaker

by Don Finlay

Programming in machine code is difficult, so they say. But why do I find it so addictive? Once I start to work out a problem, it occupies my mind in every spare moment. It is like the challenge of a good puzzle, but much more satisfying because the solution is useful and leads on to other things. After building a Nascom 1, I spent a great deal of time in devising programs for playing tunes with controllable waveforms, using a little extra hardward. Even on Christmas Day, I was sitting down with a pencil and paper in a few odd moments!

This Nascom is being developed to control equipment in the Electronic Music Studio of The City University, where music students are given experience in recording and compositional techniques. It has 32K memory; a 16-channel analogue output board to 12-bit precision; 2K Tiny BASIC (surprisingly useful for controlling the analogue output board); ZEAP assembler; V&T Electronics cassette deck, about to be installed; and a PIO board on order. One of the things we hope to do soon is 'place' sounds accurately in a multi-speaker environment, using the analogue board to control a bank of VCA's. There are many other ways we could use the equipment, the main difficulty being to find enough time and manpower to build and develop hardware, and write software.

Although some personal computers have an optional tune-playing routine using a squarewave signal from just one line of an output port, I have never seen one for the Nascom. When the Scamp was launched, several years ago, I collected some information on a music program for a hand-held 'toy' which was demonstrated. It completely flummoxed me at the time, as there was far too much jargon for a beginner to take in at the meeting (what *were* these 'flags' they kept talking about?) and the music program wasn't explained. Yet it is the only simple tune program I have managed to acquire.

Probably this will cause a flood of letters from readers saying I haven't done a proper search, and these routines are available all over the place, for any system. If so, I'm sure E&MM will be pleased to publicise them!

Here, then, is my method of playing tunes on a Nascom 1, devised in some more spare moments (over Easter!) before assembly. It goes without saying that machine code is essential, for both speed and timing. There is plenty of room even in the 4K version, as the playing routine occupies only 54 (hex) bytes, and tunes can be fitted into the remaining RAM taking only 2 bytes per note.

The playing routine, as shown in the listing, starts at 0E00. It may be better to move it to 0F00, making room for a longer tune sequence from 0C50; I didn't use this because the ZEAP assembler uses 0F00 onwards, making the task a little easier than my earlier efforts, which were all hand-assembled. If this move is made, the two CALL instruction bytes at 0F1D and 0F30 must be changed from 0E to 0F. All other jumps are relative, so need no alteration. The £ sign in the listing indicates that the number which follows is hex, as required by ZEAP. Most assemblers use a following H, but one soon gets used to this alternative. I have omitted the line numbers which ZEAP incorporates, and typed the listing by hand as I wasn't able to get the use of a printer at the time of writing this article.

Anyone who wants just to use the routine can type in the second column of the listing at the addresses indicated in the first column. Then a 'tune table' needs entering at 0C50. A sample tune is shown in Table 1; this has slight relevance to an event due to take place in July. The tune table consists of pairs of bytes, the first in each pair being a duration code and the second one a note frequency code.

Also needed, of course, is connection to an audio amplifier, earpiece or headphones. The program produces identical squarewaves on all lines of Port 4, so any one of these may be connected through a volume control (a 5-volt squarewave is a very large signal) to the amplifier or high-impedance 'phones.

Finally, the program will run when executed from 0E00, and return to the Nascom monitor afterwards.

Usually people like to write their own tunes, so the codes for notes and their durations have to be looked up from Table 2. The duration is entered

```
0E00  3E0F              LD A,£0F        ;        EXECUTION ADDRESS
0E02  D306              OUT (06),A      ;        SET PIO FOR OUTPUT
0E04  21500C            LD HL,£0C50     ;        START OF TUNE TABLE
0E07  1E00     DURATN   LD E,00
0E09  56                LD D,(HL)       ;        DURATION INTO DE
0E0A  7A                LD A,D
0E0B  FEFF              CP £FF          ;        TEST FOR END CODE
0E0D  CA8602            JP Z,£0286      ;        IF SO, GO TO MONITOR
0E10  23                INC HL
0E11  4E                LD C,(HL)       ;        HALF-PERIOD INTO C
0E12  7E                LD A,(HL)       ;        ALSO INTO A
0E13  FE00              CP 00           ;        TEST FOR PAUSE CODE
0E15  282E              JR Z,PAUSE      ;        IF SO, JUMP
0E17  3EFF     CYCLE    LD A,£FF        ; 7
0E19  D304              OUT (04),A      ;11      SET OUTPUT HIGH
0E1B  CD3C0E            CALL DELAY      ;17
0E1E  00                NOP             ; 4      START OF 47-CYCLE
0E1F  00                NOP             ; 4      BALANCING DELAY
0E20  00                NOP             ; 4
0E21  00                NOP             ; 4
0E22  00                NOP             ; 4
0E23  00                NOP             ; 4
0E24  00                NOP             ; 4
0E25  00                NOP             ; 4
0E26  00                NOP             ; 4
0E27  00                NOP             ; 4
0E28  3E00              LD A,00         ; 7      END OF DELAY
0E2A  3E00              LD A,00         ; 7
0E2C  D304              OUT (04),A      ;11      SET OUTPUT LOW
0E2E  CD3C0E            CALL DELAY      ;17
0E31  EB       TEST     EX DE,HL        ; 4      DURATION INTO HL
0E32  ED42              SBC HL,BC       ;15      SUBTRACT HALF-PERIOD
0E34  EB                EX DE,HL        ; 4      STORE DURATION
0E35  3802              JR C,NXTNTE     ;12(7)   NEW NOTE
0E37  18DE              JR CYCLE        ;12      TEST TAKES 47 CYCLES
0E39  23       NXTNTE   INC HL          ;        POINT TO NEXT DURATION
0E3A  18CB              JR DURATN
0E3C  7E       DELAY    LD A,(HL)       ; 7
0E3D  0601     LOOP2    LD B,1          ; 7      OUTER LOOP
0E3F  10FE     LOOP1    DJNZ LOOP1      ; 8(13)  INNER LOOP
0E41  3D                DEC A           ; 4
0E42  20F9              JR NZ LOOP2     ;12(7)   LOOP OF 31
0E44  C9                RET             ;10
0E45  1B       PAUSE    DEC DE          ; 6
0E46  7B                LD A,E          ; 4
0E47  B2                OR D            ; 4
0E48  00                NOP             ; 4      START OF 36-CYCLE DELAY
0E49  00                NOP             ; 4
0E4A  00                NOP             ; 4
0E4B  00                NOP             ; 4
0E4C  00                NOP             ; 4
0E4D  00                NOP             ; 4
0E4E  00                NOP             ; 4
0E4F  00                NOP             ; 4
0E50  00                NOP             ; 4      END OF DELAY
0E51  20F2              JR NZ,PAUSE     ;12(7)   TOTAL 62
0E53  18E4              JR NXTNTE
```

Listing of tune-playing routine for a Nascom 1. Figures in the remarks column show the number of cycles taken by the instructions.

first. Values given are approximate, since the duration varies with the note for unavoidable reasons explained later. I have shown the values I used in the sample tune; those at the left form a basis for notes formed of minim, crotchet, quaver, semiquaver and demi-semiquaver, for instance, with their dotted versions at the right. The first note in the sample tune has 30, indicating a duration of about ⅜ second, and 59, indicating the note F above middle C.

0C50	30	59	10	5F	30	6A	10	5F
0C58	20	59	20	4F	20	46	10	59
0C60	10	00	20	42	20	46	20	4F
0C68	20	59	20	5F	20	6A	20	5F
0C70	20	78	30	59	10	5F	30	6A
0C78	10	5F	20	59	20	4F	20	46
0C80	20	34	10	3A	30	46	30	4F
0C88	10	46	80	59	FF			

Table 1. Coding of a sample tune. Each note is coded by one byte for duration, followed by one for frequency. The end is signalled by FF.

There's Method In It

For those who would like to know how the program was devised, here is my approach.

We start by assuming that a squarewave signal is required, i.e. the line is set high and low for equal times alternately. This uses the OUT instruction in a Nascom system. To get the required frequency, we must arrange to have a controlled time delay between the OUT's. In the absence of an external timer chip and interrupt system, this has to be done by software loops, requiring knowledge of how long each instruction takes. The OUT instruction itself takes 11 cycles of clock frequency, or 5½ microseconds.

At this stage, where we start to look at Z80 instructions, it is necessary to be aware of the range of instructions, what they will do, and the timing. I have found a Zilog booklet, giving the instructions in condensed form, immensely helpful here, but the manufacturers' programming manual gives more detail, as do several books on Z80 programming. One strange-looking instruction which is very useful is seen at address 0E3F of the listing: DJNZ LOOP1. This decrements the B register and gives a jump if not zero. The mnemonic doesn't obviously relate to the B register - you just have to know this. The jump would take 13 cycles, but no jump, i.e. program continues, takes only 8.

To get a variable delay, we enter a number into a register and subtract 1 at regular intervals. When the result is zero, the delay is ended. So the B register is often used for this purpose. As it turns out in this case, it is better to use it as an inner timing loop with the main count-down in an outer loop, because if we increment the number initially loaded into B we get an extra 13 cycles of delay, whereas using any other register would take longer. The outer loop here counts down using the accumulator, which is loaded first with the frequency code.

Since the delay is proportional to this code, good resolution and accurate frequency generation require it to be as large a number as possible. Hence we try to use FF hex, or 255 decimal, or near to it, for the longest half-cycle period, which is at the lowest frequency we are to use. (256 is possible, but we reserve the maximum code of 00 to indicate a pause. Why does 00 give a maximum delay? I leave the reader to spot this.) My note table was chosen to span three octaves up from C at 130.8Hz, which has a corresponding periodic time of 7645 microseconds. If we now divide 7645 by 255 we get the length of time to be occupied by the counting loop. A greater length means the divisor is reduced, spoiling the resolution; but a smaller length means we can't get the full period at the lowest frequency. So 7645/255 is in fact a minimum, and it comes to almost exactly 30. We should aim, then, at getting a counting loop as near as possible to 30 microseconds per cycle; but since these will be used twice in every cycle in the countdown, we need 30 'T cycles' (Z80 clock cycles) in each half-period, with the Nascom 1's 2-MHz clock.

The loop shown between addresses 0E3D and 0E42 takes 31 cycles, as can be seen by adding the four cycle lengths for these instructions. The DJNZ line is a little luxury which enables a single change in the previous line to slow down the tune, although it also reduces the pitch. I found this very useful in checking my sample tune, which I loaded with one or two errors; changing 0E3E from 1 to 3 made it play more slowly, and I was able to spot the errors more easily. This change added 26 cycles to the delay loop.

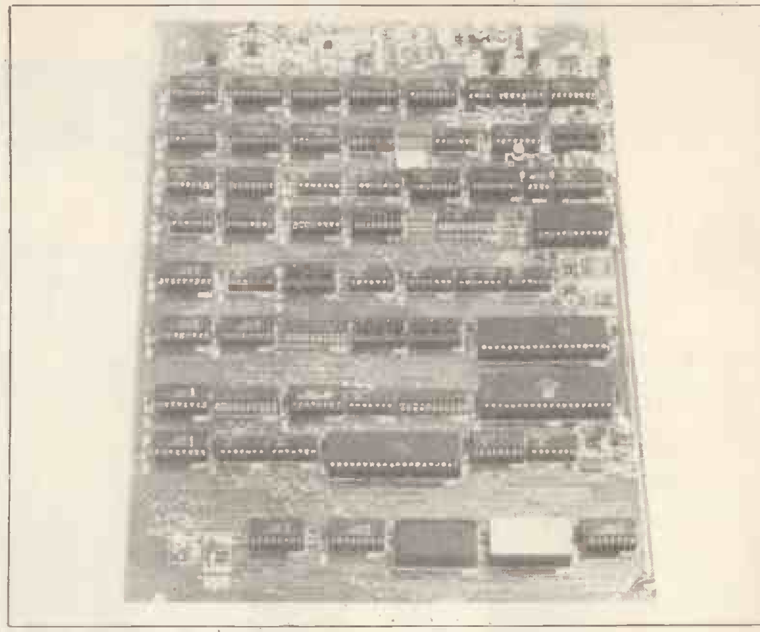
Loading A at the beginning of DELAY, and returning from the subroutine, take an extra 7 and 10 cycles respectively, so the total delay is 17 + 31*n cycles, where n is the note frequency code.

Having got the note sounding, we need a method of deciding when to end it. One possible method is to decrement a counter by 1 after each cycle, but this would mean a different delay code for each note frequency, and would be very trying to enter. The Scamp system I mentioned earlier did this, in order to shorten and simplify a ROM program in a device not intended for flexibility.

There is a simple alternative. Each cycle lasts for 31*n microseconds, ignoring a small (we hope) extra time for loads and tests which we will check later. So let us subtract n from the duration code after every cycle; we have then subtracted effectively the length of the cycle from the code, measured in 31-microsecond units. The duration code must then be simply the number of 31-microsecond periods required. Since we need a large number, to get notes of about a second in length, the duration code is made the high-order byte 'd' in a 16-bit number with low-order byte zero. Then d*256*31 is the duration in microseconds. For example, 30 hex gives 380928, or 0.38 second. Duration is loaded into the Z80's register pair DE at programme steps 0E07 to 0E09.

The subtraction routine is done at TEST. To do a 16-bit subtraction, we must use the HL pair - but this is also used as a pointer to the tune table and we have to save its previous contents. What a beautiful instruction EX DE, HL turns out to be! It not only gets DE into HL but saves the pointer in DE until we are ready to swap back. It couldn't be more tailor-made for the job. All this takes 47 cycles, however, so we waste 47 cycles in the first half-cycle to preserve our squarewave, although we needn't really do so as squarewaves aren't all that interesting.

The true half-cycle time can be calculated now, allowing for 35 cycles



Nascom 1 microprocessor board.

NOTE.	b	CODE NAT	#
C		1B	
B	1F	1D	
A	23	21	1F
G	28	26	23
F		2B	28
E	31	2E	
D	37	34	31
C		3A	37
B	42	3E	
A	4A	46	42
G	54	4F	4A
F		59	54
E	64	5F	
D	71	6A	64
C		78	71
B	87	7F	
A	98	8F	87
G	AB	A1	98
F		B5	AB
E	CB	C0	
D	E5	D8	CB
C		F3	E5
PAUSE		00	

DURATIONS (APPROXIMATE)

80	1 sec	C0	1½ sec
40	½	60	¾
20	¼	30	⅜
10	⅛	18	3/16
08	1/16	0C	3/32

FF 'END OF TUNE' CODE

Table 2. Composer's aid: note codes are shown against standard musical notation, and a possible set of duration codes is given. Pause is signalled by 00 in the note code position, and end of tune by FF in the duration code position, in the tune table.

to output high or low and call delay; 47 for test or balance; and delay itself, 17 + 31*n. The total is 99 + 31*n, giving a full-period time of 99 + 31*n microseconds. The required values of n for the different frequencies are calculated from equating this formula to the period time. The result is about 3 less than the number of 31-microseconds loops in the period, and leads to the values in Table 2.

Pauses are as important in music as sounds. To simplify coding, it is best to use the same duration code for a pause as for a note. Since every subtraction in the note routine corresponds to n*31 microseconds, we need a 31-microsecond loop in PAUSE, i.e. 62 T-cycles, and count this down by ordinary decrements instead of subtractions. Note another quirk of the Z80: decrementing DE doesn't set any flags, so we have to test for zero by ORing D and E.

We can now check the inaccuracies caused by the load and test parts of the cycle. At the top of the musical scale, we have a large number of cycles in a given duration, so the duration is extended more than at the bottom by the fixed 99 microseconds per cycle. Taking extremes: top C, with duration 30 hex for example, will have INT (48*256/27) cycles, i.e. 455 cycles, each of which takes 99 + 27*31 = 936 microseconds, giving a total duration of 425880 microseconds. Bottom C, on the other hand, with the same duration, will have only 50 cycles of 7632 microseconds, giving a total of 381600 microseconds, which is about 10% less. The error is not noticeable for most purposes; if it proves to be, it is still easier to make a small adjustment to a duration code than to have a different one for every note.

For convenience in a first approach, I have classified code 30 as giving ⅜ second in the duration table. This is slightly low compared with the figures I have just shown, but is within about 2% at the bottom end of the range.

Next?

Finally, we may be stimulated into thinking how to alter and improve things. Can we alter speed without altering pitch? At step 0E32, the duration code is decremented. We could decrement faster by repeating this instruction, more than once if wanted, and this would speed the playing. I haven't tried it because it means reassembling the following program. And inserting a counting loop round this instruction slows the basic program. We could also write a program to multiply or divide all the duration codes in the tune table. We could experiment with pulse waveforms. We could have a sequence table, which plays several tunes or parts of tunes in the order specified. We could interact with BASIC to make loading even easier, generate random sequences, or compose. And so it goes on. Is anyone else hooked?

E&MM

Micromusic

Atari Music Composer Cartridge

The Atari Music Composer is a plug-in ROM for use with Atari computer systems. The cartridge can be used with either the 400 or the 800 personal computer, and in both cases it replaces the BASIC cartridge. Facilities for saving your compositions enable both disk-based and cassette-based systems to be used, and obviously the amount of memory the system has governs the length of your composition.

Our cartridge was tested on the Atari 800 with 48K of memory, providing the facility to store up to 13,880 notes. The number of notes available for composing, with a given memory capacity, is as follows:

48K: 13,880
32K: 9,784
16K: 1,592

These figures were obtained after the disk operating system had been loaded

The 21-page manual provided is in four parts: a general description, a sample session, a description of the music file structure and a quick reference guide. The manual assumes you have some musical knowledge, but not that you are used to using a keyboard. Each keyboard entry is explained step by step. This, combined with printed examples of computer responses and screen displays, means that anyone unfamiliar with keyboards should have very little problem. Although a difficult item to write a manual for, we felt that the description of the various functions and commands left much to be desired.

Choosing the Menu

The programs contained in the ROM are menu driven. In other words, you are given a list of options to choose from. This, in most cases, leads to a further sub-menu, from which parameters can be set. When the cartridge is inserted into the machine you immediately enter the main menu. This lists the sub-menus (Figure 1). The options available are outlined below:

EDIT MUSIC. This leads to a sub-menu (Figure 2), the first item of which is PHRASE. This resembles a phrase in music, in that it groups notes into sections. However, unlike a musical phrase, it does not denote accents or context, but rather enables you to move sections of music around in your arrangement. There are 9 different phrases available.

METER. This sets the time signature, which defaults to 4/4 unless told otherwise. Since there are no accents available this is of limited use, but combined with another function, CHECK MEASURES, it becomes impossible to exit from a bar that does not contain the correct number of notes.

KEY SIG. You can write in any key by simply typing the number of #'s or b's needed. Accidentals may also be written in as they occur.

TEMPO. This is programmable between 1 and 9, 1 being the fastest.

Having set these parameters it is now possible to proceed and write the first phrase. Two musical staves are displayed on the screen - the treble and bass clefs. This is because there is a choice of pitch which ranges over 3 octaves.

For the purposes of writing you are provided with a cursor, which may be moved horizontally back and forth. Thus enabling you to delete or insert notes in the required position. Also displayed are: an indication of the phrase you are in, the bar number, the number of notes free, and an entry prompt. An example of how easy it is to enter notes is given in Figure 3.

After setting the measure of bar number, the notes are entered as follows: the first letter is the note required N, F or S will denote natural flat or sharp respectively. Then you need the octave numbers. 3 to 6 are valid, and after one note has been entered you stay in that octave unless you specify otherwise. Next is the length of note required, which ranges from W for a 'whole' note or breve, down to T for a 32nd note or demisemi quaver. Lastly, if the note is tied or dotted you must type in T or '.' respectively. Rests are entered as R, plus desired length.

As each note is entered the notes of that measure are played, which is a help if you are composing, but can be a hindrance if you are simply entering notes from sheet music. Once composition of the phrases is complete, you can proceed to the ARRANGE MENU.

ARRANGE MENU. The first thing asked for is which of the 4 voices you wish to arrange. After entering the relevant number you are presented with the heading ARRANGE VOICE (plus the number you entered) and a list of line numbers from 1 to 20 on the left hand side of the screen (Figure 4). One of these numbers is a different colour from the rest. This represents the cursor and can be moved vertically using normal cursor controls, thus allowing deletion or insertion of lines. At the bottom of the screen you are presented with a row of 8 letters: C,D,G,M,P,S,T,V. If M is selected the full ARRANGE MENU is displayed (Figure 5). The functions provided are: COUNT. This enables you to set up a loop and is used in conjunction with GOTO; DISPLAY can be used to show the notes on the screen as they are played; GOTO enables you to jump back and forth in your arrangement and can be used with COUNT for repeating passages a specified number of times; PLAY PHRASE is self explanatory, and is accompanied by a number from 1 to 9 denoting the phrase you wish to be played; STOP, as in all other menus, exits to the next menu; TRANSPOSE allows you to transpose a phrase up or down, in semitone steps. Numbers from -36 to +36 are valid, but have to be used with some caution, as it is possible to transpose music out of the 3 octave range. If this happens the machine

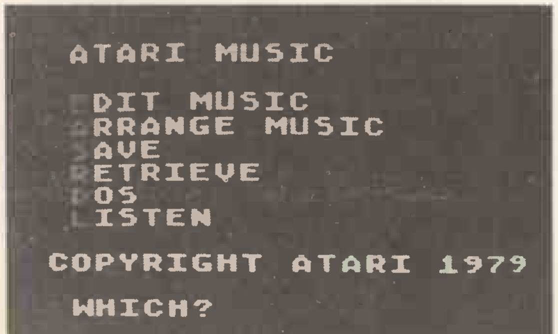


Figure 1. Main MENU.

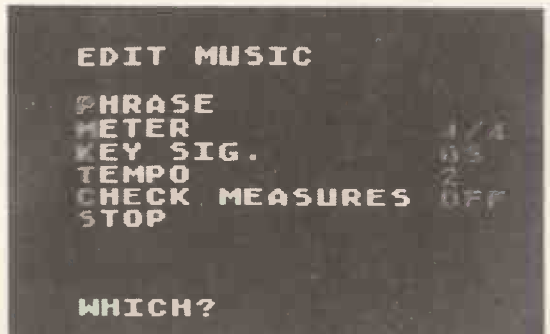
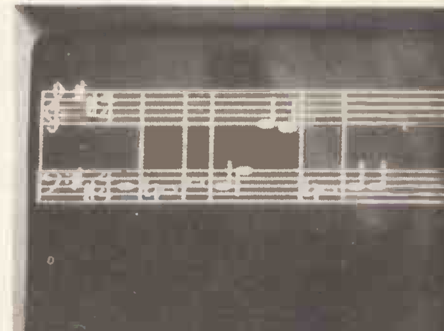


Figure 2. EDIT MUSIC.



Bass Clef music.

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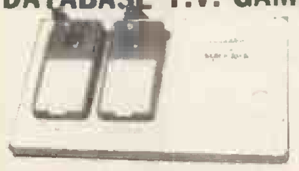

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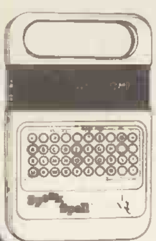

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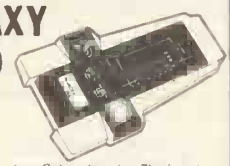

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The machine is easy to install and comes with full instructions. It is easily wired to your junction box with the spade connectors provided or alternatively a jack plug can be provided to plug into a jack socket. Most important, of course, is the fact that it is fully POST OFFICE APPROVED.

The price of £135 (inc. VAT) includes the machine, an extra-light remote call-in Bleeper, the microphone message tape, A.C. mains adaptor. The unit is 9¾"x6"x2½" and is fully guaranteed for 12 months. The telephone can be placed directly on the unit — no additional desk space is required.

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SILICA SHOP

Figure 3. Entering Music.

will do the best it can; VOLUME. This is adjustable between PP and FF.

This set of instructions provides a very powerful, high level music programming language. A sample arrangement for one voice is shown below.

```
1 DISPLAY
2 VOLUME MF
3 COUNT 3
4 PLAY PHRASE 1
5 GOTO 4
6 TRANSPOSE 12
7 COUNT 12
8 PLAY PHRASE 2
9 GOTO 8
```

The next items on the main menu are SAVE and RETRIEVE. Upon entering the SAVE menu (Figure 6), the first thing to do is enter a file name. Having done this you will be asked WHICH? At this point the following options are open to you: save EVERYTHING, ALL PHRASES, ALL VOICES, PHRASE X (a particular phrase), VX (a particular voice). RETRIEVE offers you the same facilities.

Files saved using the Music Composer can be used from BASIC and a comprehensive breakdown of the file structure is given in the manual provided. The details are too complex to describe in a review, but basically each file is made up of four sections. Each record starts with a header byte enabling you to locate the starting point. A phrase record contains pitch and duration values for a given phrase. The voice record is the actual program for playing one of the four voices. There is also a miscellaneous information record in which the time signature, tempo and key signature are stored.

The DOS instruction in the main menu is for use with disk-based systems and when selected, returns control of the machine to the disk operating system, thus enabling use of all usual DOS commands. This command is non-destructive and on exiting the disk operating system, using option B which is RUN CARTRIDGE, you will find your composition intact.

LISTEN enables you to hear everything from the arranged programs.

Making Music

Having explained the functions provided we shall now relate our experiences of using the cartridge. We decided to approach this review in two ways. From the point of view of users with little or no musical knowledge we thought a good test would be to enter sheet music and for those of you who are musically adept or more adventurous, we composed a 24-bar piece of original work.

In order to enter sheet music it is obviously necessary to identify the notes their duration, and symbols such as rests and sharps, flats, etc. With a little patience and a prompt table, those with no musical knowledge should be able to master this in a short period of time. The manual is also very useful here as it lists note durations, octave spacings and symbols.

After a quick trip to a local music shop we had our eager hands on some popular music for piano. We found the best approach was to initially number the bars and then write the code for each note immediately beneath it. At this point we assigned each of the four voices in the music to a phrase. We then typed each phrase in turn, only to realise that many sections of each phrase (the verses and choruses) were repeated and we should have split the phrases up further and then used the ARRANGE facility to play them in the correct order. This entails more time spent on planning, but much time is saved at the keyboard and the possibility of typing errors is reduced.

Upon listening to the result it was obvious that we had made a number of errors. Some of these, such as a note in the wrong octave, were quickly located and we found the cursor controls very effective for correcting these errors. Other errors were harder to find. The answer is to take your time and get it right in the first place. Although most sheet music can be entered, the machine has difficulty in coping with some aspects, not least of which is the lack of emphasis on individual notes. This can make some music sound noticeably different. Triplets, some turns and some trills are not possible and obviously rallentando, crescendo, diminuendo and glides etc. are out.

For our second test we entered a four-part composition having phrase one as the melody line, phrase two as the first harmony, phrase three as an arpeggio rhythm and phrase four as bass. We changed things as we went along, replacing a triplet with a single note, for example, and altering notes which though musically correct, sounded slightly wrong on the computer when the four phrases were played together. This, we suspect, is because all the voices have the same timbre. CHECK MEASURES proved to be invaluable as it is easy to forget the step to the next bar when concentrating on writing the notes, and when you try to exit the error message MEASURE TOO LONG is displayed so the error may be corrected almost as soon as it is made.

Conclusions

Considering that this is the cheapest way of generating computer music, we feel the 'Music Composer' represents outstanding value for money. The emphasis is more on fun than on serious music making though for anyone who has always wished to know something about music, but has been put off by text books and terminology, this could be a fun way to learn. As a classroom teaching aid it would definitely hold a student's attention, without too much teacher involvement. For the professional musician it promises much, but you may soon find yourself restricted by this particular composer's limitations. However it is, after all, written for a home computer system. And no doubt more sophisticated programs and peripherals will become available in due course.

We wish to thank Ingersoll Ltd. for the loan of a cartridge, and a pre-production Atari 800.

Tony Search
Graham Daubney
E&MM

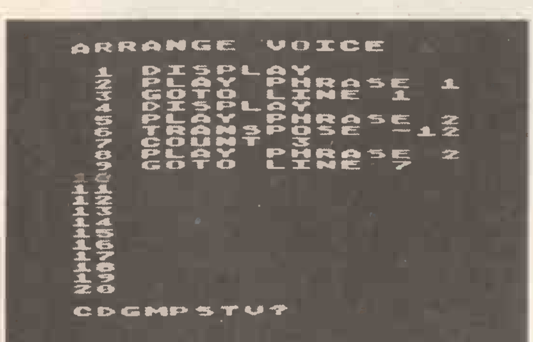

Figure 4. ARRANGE VOICE.

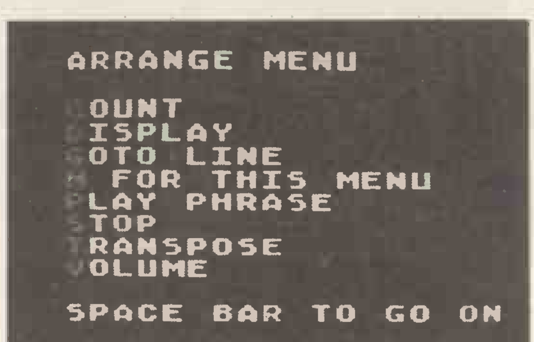

Figure 5. ARRANGE MENU.

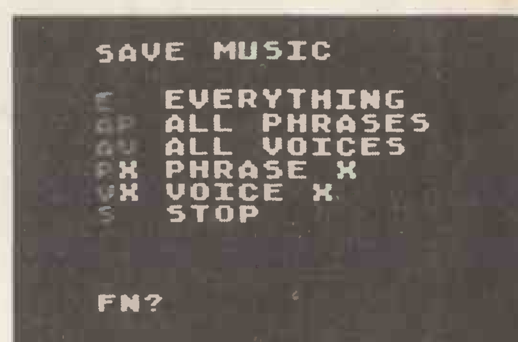

Figure 6. SAVE MUSIC.

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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.

The IF Statement

So far in this series the IF statement has been used to compare a variable with a constant to test for equality. Different actions can then be taken depending on the result of the comparison. For example, the statement:

```
20 IF C=10 THEN GOTO 50
```

Compares the contents of the variable C with the constant 10. If C contains a value of 10, program execution branches to line 50; otherwise it continues with the statement immediately following line 20. Thus a conditional branch has been made according to the value of C.

The '=' symbol in the above statement is being used as a 'relational operator' (the 'comparison relational operator'). It is one of six relational operators in BASIC. Table 1 shows the six symbols used to represent relational operations. Using these symbols with the IF THEN statement makes it possible to determine relationships such as relative size. For example, the statement:

```
20 IF C>10 THEN 50
```

Compares the contents of the variable C with the constant 10. The branch to line 50 occurs when C contains a value which is greater than 10.

The IF statement can also be used to compare two variables or two expressions. For example, the following statement compares the result of two expressions:

```
50 IF B↑2>4*A*C THEN GOTO 10
```

(NOTE: the IF statement can send program execution back to a previous line as well as ahead.)

Some versions of BASIC allow the GOTO part of the statement to be omitted so that only the line number branched to is specified. For example:

```
10 IF C=A THEN GOTO 90   is the same as:
10 IF C=A THEN 90
```

for some versions of BASIC.

IF statements can contain executable statements other than the GOTO statement. For example:

```
10 IF B↑2>4*A*C THEN PRINT "ROOTS ARE REAL"
```

(This statement could be used as part of a program dealing with 'quadratic equations'.)

> RELATIONAL OPERATOR — a symbol used in the BASIC language to determine a relationship of relative size between:
>
> i) two variables,
> ii) a variable and a constant,
> iii) a variable and an expression,
> iv) an expression and a constant,
> v) two expressions.
>
> For example, the relational operator 'less than' (<) can be used as follows:
>
> 10 IF A<0 THEN PRINT "NEGATIVE"

Multiple Statements on a Line

Each numbered line of a BASIC program requires a minimum amount of space in computer memory. Most versions of BASIC allow you to have more than one statement on a single program line, thus saving memory space because the total number of program lines is reduced. In a line containing more than one statement, a special character called a 'separator' is used between the statements. The separator enables the computer to distinguish each new operation. The symbol used as a separator varies according to which version of BASIC is used. The most commonly used symbols are a backslash (\) or a colon (:). You should consult the relevant operator user manual to check for the correct separator.

The following program uses colons as separators:

```
10 LET X=4 : LET Y=5 : LET Z=6
20 PRINT : PRINT X*Y+Z
30 END
```

Three numbered statement lines have been saved by using more than one statement on a line. Line 10 assigns a constant to each of three variables. Line 20 outputs a blank line and then the result of an arithmetic expression involving the three variables. To make the program more readable it is a good idea to put a space each side of the colon, although space often becomes vital when fitting statements on a line and may not allow this. The computer ignores the space when it 'reads' the program.

Multi-statement lines are especially useful when used with IF statements. Earlier we saw that if the condition specified in an IF statement is not fulfilled, the program ignores that statement line and continues execution at the next numbered line. Thus, using an IF THEN multi-statement line the execution of more than one statement can depend on the result of a comparison. For example:

```
10 IF F>0 THEN PRINT "F IS POSITIVE" : GOTO 50
```

The computer will print the message and branch to line 50 if the condition 'F>0' is true, but neither will be executed if the condition is false.

As you write more BASIC programs you will find that multi-statement lines help to organise a program and increase the usefulness of the IF statement. Also the memory space saved will enable larger programs to be written using the same amount of memory. This is important when memory space is limited.

The INPUT Statement

Already we have examined how an assignment can be made to a variable by using a LET statement. The 'data' which is to be assigned to a variable is specified when the program is typed into the computer. There are several other methods for informing the computer of the value of variables. One of them is the INPUT statement. The INPUT statement allows the computer user to assign values to variables while the program is running and to change that data each time the program is run.

Consider the following program:

```
10 LET A=3
20 LET B=4
30 PRINT A*B
40 END
```

Lines 10 and 20 use the LET statement to assign constants to the variables A and B. The variables are then operated on, and the result printed by line 30.

Now let us use the INPUT statement to assign this data when the program executes:

```
10 INPUT A,B
20 PRINT A*B
30 END
RUN
```

When the program is run it asks you to input to the terminal the values to be assigned to A and B. Your input is requested by a question mark (?) prompt. For example, when you type the RUN command the program prints: ? Program execution then stops and waits for you to type values for A and B. When more than one number is to be input each number is separated by a comma. So, to assign 3 to A and 4 to B type after the question mark prompt: 3, 4

After you type the values and the RETURN key the program will continue to run automatically, and in this example will print the result of A multiplied by B which is 12. When the program is run again different values for A and B can be specified.

If you do not type enough values for the number of variables in the program another prompt is output and so on, until a value has been typed for each vacant variable. If you type the RETURN key instead of a value in response to the prompt, BASIC assumes the value to be zero. If the input character is non-numeric it will be rejected by the computer and an error message will be output to the terminal. (The actual message displayed will depend on the version of BASIC you are using.) The computer will then output the prompt again to allow you to type in the correct input. Later in this series we will show how BASIC enables strings of characters to be input to a program.

It is good programming practice to output a message using the PRINT statement before an INPUT statement requests data. This message will remind the program user of what the INPUT is to be used for. For example, the previous program can be modified as follows:

```
10 PRINT "INSERT VALUES FOR A AND B"
20 INPUT A,B
30 PRINT A;"*";B;"=";A*B
40 END
```

Some versions of BASIC allow the INPUT statement itself to contain the reminder, if the reminder is enclosed in quotation marks. For example:

```
10 INPUT "INSERT VALUES FOR A AND B";A,B
20 PRINT A;"*";B;"=";A*B
30 END
```

The semicolon between the reminder message and the two variables causes the program to print the message and the question mark prompt on one line as follows:
INSERT VALUES FOR A AND B?
Your input should follow after the string and prompt. After you type the RETURN key, the answer appears on the terminal.

Statement Review

The following BASIC program contains examples of BASIC statements and techniques discussed so far in this series:

```
10 REM—NUMBER GUESSING GAME
20 LET X=37 : REM—NUMBER TO BE GUESSED
30 PRINT "I'M THINKING OF A NUMBER FROM 1 TO 100"
40 PRINT "GUESS MY NUMBER"
50 INPUT "YOUR GUESS";G
60 IF G<X THEN PRINT "TRY A BIGGER NUMBER" : GOTO 50
70 IF G>X THEN PRINT "TRY A SMALLER NUMBER" : GOTO 50
80 PRINT "THAT'S RIGHT! YOU GUESSED MY NUMBER"
90 END
```

The program is composed of the following lines:

line 10 — The REM statement allows you to insert comments into your program. All the characters following the REM statement on the same line as shown are ignored by the computer.

line 20 — The LET statement declares the variable 'X' and assigns to it the constant 37. The colon is a 'separator' symbol which enables more than one statement to be written on a single numbered line.

lines 30 and 40 — The two PRINT statements issue a message on the terminal.

line 50 — The INPUT statement outputs a reminder message followed by a question mark prompt. In answer to the prompt you type a single numeric value followed by the RETURN key. This value is stored in the variable 'G' and is used later in the program.

lines 60 and 70 — These are multi-statement comparison lines. If the comparison succeeds, a message is printed and a conditional branch is made to line 50

line 80 — The PRINT statement outputs the message in quotation marks to the terminal. The only way program execution can reach line 80 is if the value you type in for G is the same as the value assigned to X (because line 60 or 70 re-directs program execution back to line 50 if G is less than or greater than X respectively).

line 90 — The END statement signifies program completion.

Later in this series we will examine automatic features of BASIC called 'functions'. Functions are built into the BASIC language in order to perform frequently needed operations. Two BASIC functions can be combined and used in the above program so that each time the program is run the program itself generates a number between 1 and 100 for the user to guess. The two functions needed are the 'RND' and 'INT' functions.

If line 20 is replaced with the new line:

```
20 LET X=INT(100*RND(1))+1
```

the value assigned to X will be different each time the program is run.

You may wish to try and modify the program so that it prints out how many guesses the user tried in order to get the correct number. Also it would be a good idea if the program repeated automatically until it receives a special 'terminator', instead of typing 'RUN' each time a number is to be guessed. For example, if you type a negative number as your guess the program will stop. The modified program will be given in next month's BASICALLY BASIC.

Mathematical Symbol	BASIC Symbol	Example	Meaning
=	=	X=Y	X is equal to Y
<	<	X<Y	X is less than Y
≤	< =or=<	X<=Y	X is less than or equal to Y
>	>	X>Y	X is greater than Y
≥	> =or=>	X>=Y	X is greater than or equal to Y
≠	<> or><	X<> Y	X is not equal to Y

Table 1. BASIC Relational Operators and examples of their use.

USING MICROPROCESSORS

Peter S. Kershaw B.Sc (Eng.)

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.

Part 5 A Design Example

This month we present a hardware design example. A simple car computer has been chosen, as it has most of the standard requirements of dedicated processor applications. ROM, RAM, interrupts and analogue and digital I/O. This is not intended to be a constructional project - there are many better ways of achieving the same result. The Z80 has been used only because the previous articles have been based upon it. At each stage of the design, the options available are discussed in detail.

Specification

The first stage in any design is the specification of the required performance characteristics. These should include the facilities offered, input and output tolerances, power supplies available, etc. All facilities which may be required should be included - it is much easier to remove some than to add them later. Similarly with tolerances, it is better to err on the side of accuracy. The following is a provisional specification for the car computer:

Facilities and tolerances:

Instantaneous speed	(0-99 mph ±2)
Instantaneous mpg	(0-99 mpg ±5%)
Average speed	(0-99 mph ±2)
Average mpg	(0-99 mpg ±5%)
Total distance	(0-99 miles ±1)
Total fuel used	(0-9.9 gallons ±0.2)

Inputs:
- Magnetic induction transducer (magnet mounted on front wheel)
- Fuel flow rate transducer (proportional d.c. voltage output)
- Pushbuttons: mode set (6), system reset

Output:
- Seven-segment LED displays

Power:
- 12v DC @ 500 mA

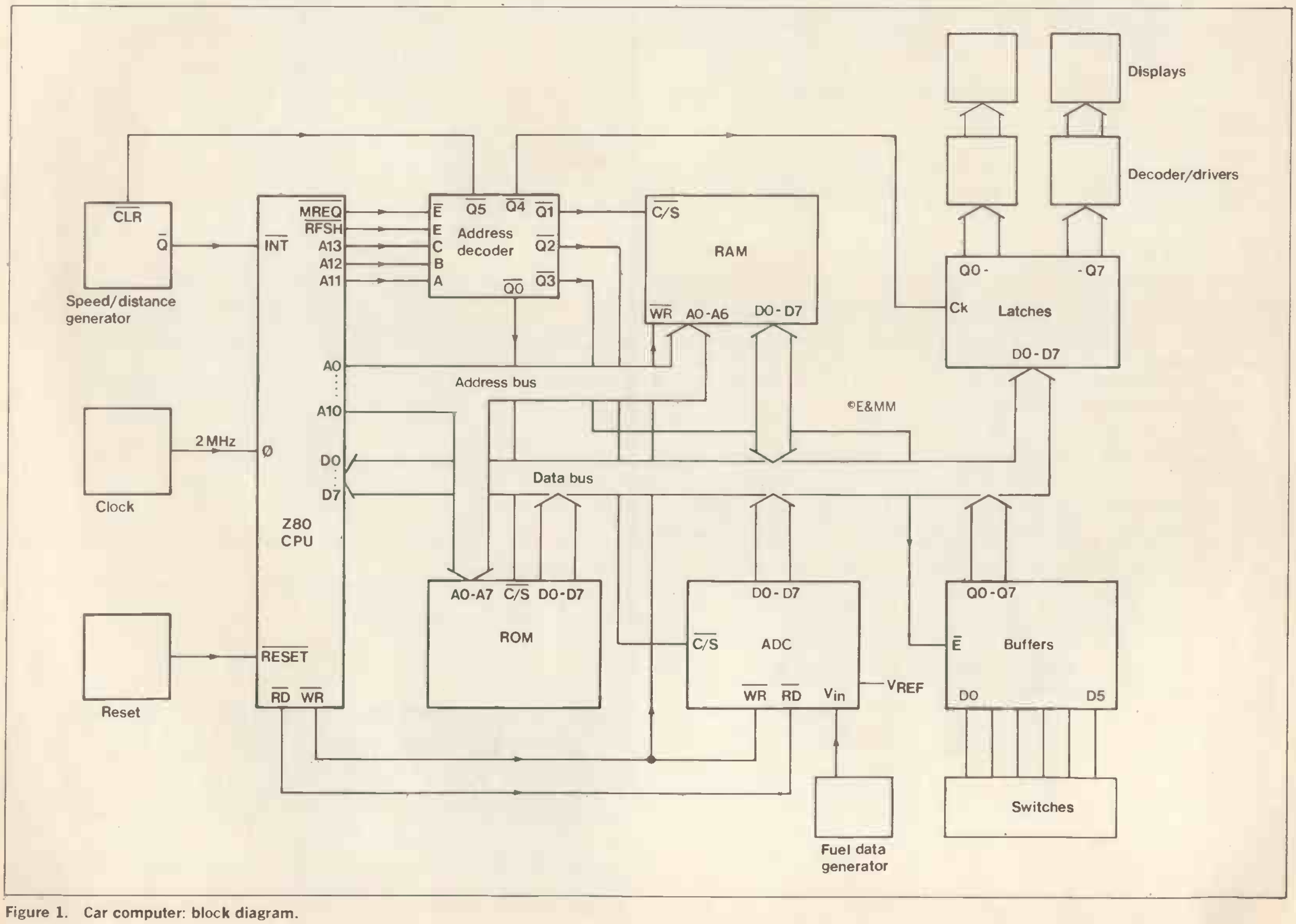

Figure 1. Car computer: block diagram.

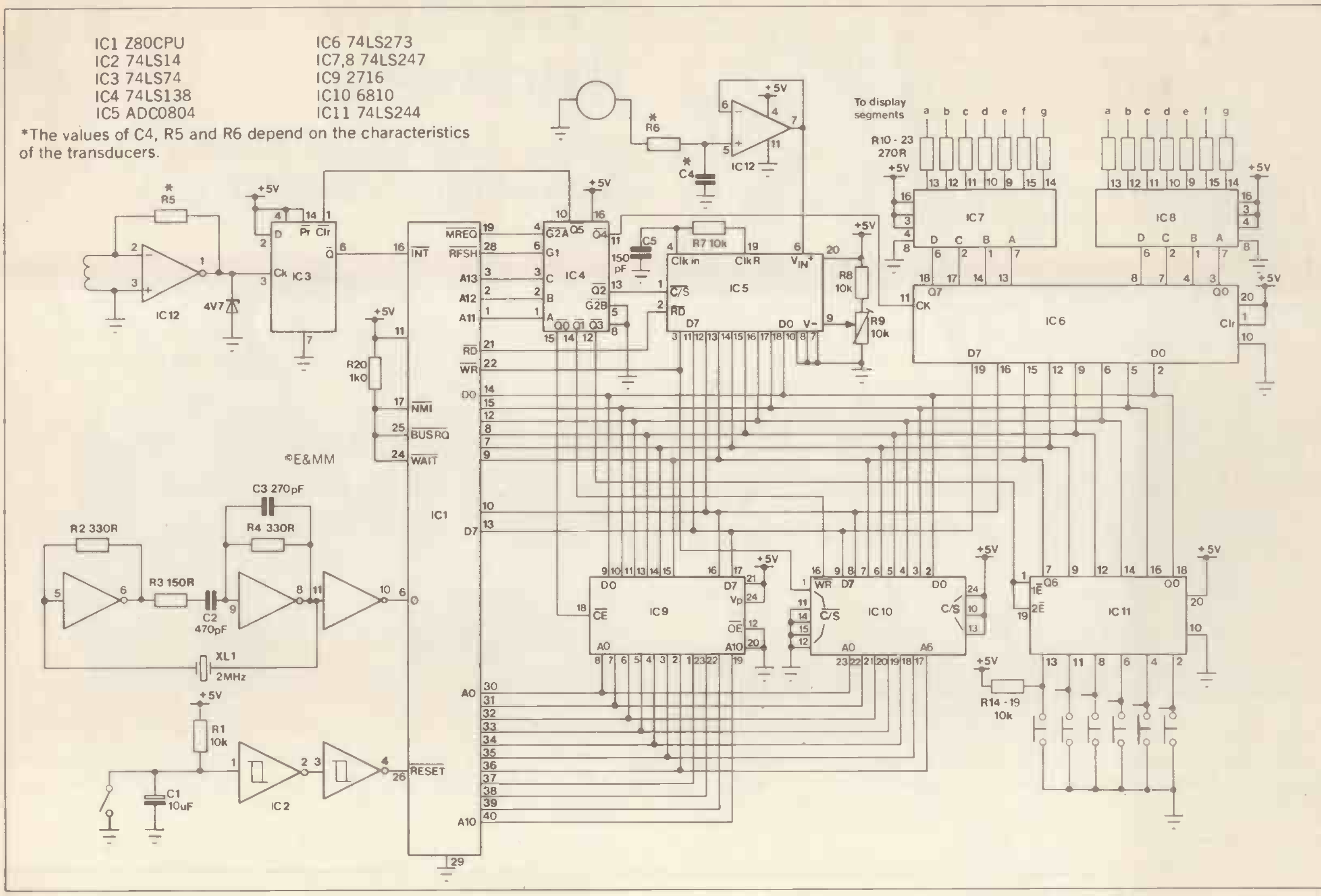

Figure 2. **Car computer: complete circuit diagram.**

In addition, for a real application size, weight and cost would be specified. Note that during a substantial design project these specifications may change several times as new requirements and new problems arise.

Hardware Design

It is usual to design the hardware of a microprocessor-based project first. However, the software requirements should be borne in mind even at this stage. (In fact, it is often software requirements which determine the choice of processor).

System Timing

One of the first things to notice is that some form of real-time reference is required to measure speed. We could use a Counter-Timer Circuit (Z80-CTC) which contains counters which may be clocked externally or from the system clock. We would then count, say, the number of wheel revolutions in one second. However, this reduces the accuracy at low speeds. For example, at 10 mph there are only 2.51 revs/second (assuming a wheel diameter of 56 cm). Alternatively, we could count the number of clock cycles between wheel revolutions. The time for one revolution varies from 39.8 ms at 99 mph to infinity at 0 mph. When stationary, in fact, the count will never be terminated, and this must be taken into account in the software.

Instead of using a CTC, we could set up a software counting loop, using the system clock as our reference. Provided the time spent computing is very small compared with the time spent counting, or the computing time is somehow compensated for, this method can be quite accurate enough. Even at maximum speed, the time per revolution (39.8 ms) is very long compared with the time required for computation (probably less than 1 ms). This timing method saves the cost of the CTC and its associated wiring.

A block diagram of the car computer is shown in Figure 1. The output from the induction coil is amplified by an op amp. This signal is then used to set a D-type flip-flop. This causes a maskable interrupt to the CPU. When the interrupt has been serviced, an address is read (or written to) which causes Q_1 to go low. This then clears the flip-flop, removing the interrupt.

Memory

The amount of ROM required can only be estimated at this stage, but the smallest standard EPROM available is the 2708 (1k x 8). However, this requires +12v and -5v supplies. Thus, the 2716 (2k x 8) which runs from a single +5v supply is used. In assessing the amount of RAM required, we must remember that a stack will be required for interrupt servicing and subroutines. But the software will be quite simple and the intermediate data storage requirement is small, so a 6810 (128 x 8) should be adequate.

Input and Output

There are as many ways of implementing I/O as there are applications. In this instance we may choose between octal latches and buffers and LSI I/O chips. Devices like the Z80-P10 (Peripheral Input/Output) or the Intel 8255 PPI (Programmable Peripheral Interface) offer flexibility and facilities such as interrupt generation, bidirectional ports and 'handshaking'. These devices may be more expensive than TTL chips but they offer a considerable saving in space and wiring. In this application, however, we only need six input lines. These can be provided with an octal buffer (74LS244).

It is worth mentioning here that whereas most microprocessors have special support chips for I/O, displays, etc many of these devices are usable with almost any processor. Thus, even though the range of Z80 support chips is quite small there are many devices which can be used from families such as 8080 and 6800. The designer should always try to keep abreast of new developments in microprocessor support.

Address Decoding and Control

Address lines A_{11}, A_{12} and A_{13} are decoded to select particular devices. As with most microprocessor components, inputs and outputs are active low. Thus, when A,B & C are low, Q_0 goes low (active) and the ROM is selected. Two other signals are applied to the address decoder: $\overline{MREQ}$ and $\overline{RFSH}$. $\overline{MREQ}$ goes low when a valid memory address is on the address bus. With the Z80, there are two circumstances where this occurs. One is where a memory location is being read or written to. The other is where a dynamic memory refresh address is being supplied. This is done automatically each time an opcode is being decoded. When a valid refresh address is present, both $\overline{MREQ}$ and $\overline{RFSH}$ go low. As we are not using dynamic RAMs, we can gate out these addresses by applying $\overline{RFSH}$ to the decoder, as shown in Figure 1.

Note that the I/O is addressed as if it were memory (i.e. it is memory-mapped). This has been done simply because the address decoding is there so no further circuitry is needed to derive the appropriate chip select signals. The Z80 does, however, generate $\overline{IORQ}$ which is similar to $\overline{MREQ}$, but can only address 256 I/O port addresses. It can be seen that, whilst A_0-A_{10} are applied to the ROM, the RAM sees only A_0-A_6. This means that any address given to the RAM is independent of A_7-A_{10}. Thus, the block of RAM may be addressed starting at 0800, 0900, 0A00..... Similarly, since A_{14} & A_{15} are ignored entirely, the whole of memory space is repeated 4 times. A memory map (showing only the first occurrence of each device) is given in Figure 3.

For the analog-to-digital (A/D) conversion, a device has been chosen which interfaces directly to the processor bus. A fairly common and cheap alternative is to use a D/A converter and a comparator. This and other conversion techniques will be discussed in more depth in a later article.

The 7-segment displays are driven by decoder/drivers from a single 8-bit port. It would have been possible to drive each segment directly using two seven-bit ports and performing the encoding of the segments in software. However, standard 74LS273 latches cannot provide the necessary current to light the LEDs and high current devices are more expensive and impose a greater load on the data bus. The switch outputs are applied to a tri-state buffer. These will be read regularly to check for a switch closure.

Bus Loading

The Z80 data and address bus outputs can each drive several LSTTL inputs. The loading imposed by the devices on the bus can be found from manufacturers' data sheets. If the buses are too heavily loaded, or if they are taken off the main circuit board, they should be buffered using unidirectional or bidirectional tristate octal buffers, as required.

Clock

A clock frequency of 2 MHz has been chosen as it is suitable for the standard 2.5 MHz Z80 and does not place severe demands on any of the other devices. In general, the timing of memory devices and peripherals should be checked to see that they will operate correctly under the design conditions. For memory devices, the access time is particularly important. This is the time taken for valid data to be available on the output pins after the chip select becomes active, assuming a stable address.

Timing charts in the Mostek Z80 technical manual show that 1½ clock cycles are available for an opcode fetch (OCF) cycle (i.e. when reading an opcode from the ROM), and 2 clock cycles are available for a normal data read or write. These times are reduced slightly by internal delays, but clearly the standard memories with access times of 450 ns or less will be adequate with a 2 MHz clock. Ways of using fast CPUs with slow memories will be discussed at another time. An I/O cycle is half a clock cycle longer than a memory read/write. This enables MOS I/O devices (such as the Z80-P10) to operate at full speed. Thus, when working near full speed, these devices should be configured as I/O ports rather than memory-mapped.

System Reset

Finally, the combination of C_1 and R_1 causes the RESET pin of the CPU to be held low until the 5v supply has settled. This is called 'power on reset'. The manual reset button can be pressed at any time, causing a restart to location ØØØØH. If dynamic RAMs are used, the reset has to be synchronised to the clock, for which additional circuitry is required.

A complete, detailed circuit diagram is shown in Figure 2.

Better Hardware Solutions

For small applications such as this, single-chip microcomputers are often used. These contain a microprocessor and combinations of ROM, RAM, I/O ports and timers. The ROM is normally mask programmed by the manufacturers. This is only economically feasible for very large quantities.

If the car computer is to be left on when the car is stationary, a low power CMOS processor and liquid crystal displays would drain far less current from the car battery. For example, the Motorola MC146805E2 is a CMOS processor with:

* 112 bytes of on-chip RAM
* 16 bidirectional I/O lines
* Programmable timer
* Automatic power-on-reset
* On-chip oscillator

It consumes 20 mW at the full clock speed of 5 MHz (compared with 750 mW for the Z80 at 2 MHz), and less than 1 mW in its special standby mode. This device would therefore be far more suitable for an application such as this.

Some multifunctional devices are also very useful for reducing the chip count. For example, the new Mostek MK3886 'Combo Chip' contains a serial I/O port, two timers, three interrupt channels and 256 bytes of RAM. Thus, the complete processing requirement for many applications could be met simply by a Z80 CPU, a Combo Chip and a ROM.

Next month we will look at the design of hardware and software for a digital music keyboard. E&MM

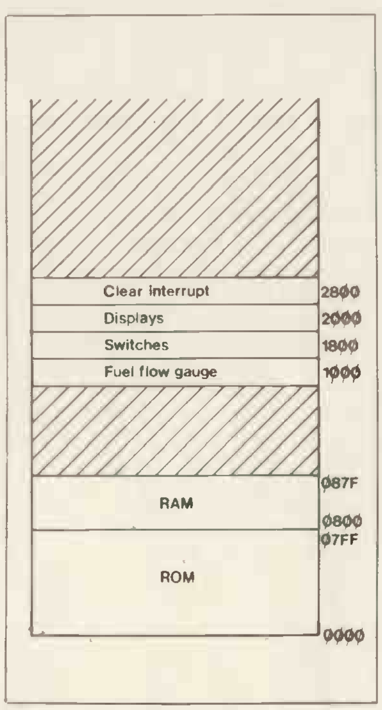

Figure 3. Memory map (not to scale).

Hot Wiring your GUITAR

Adrian Legg

Series/parallel and pick-up phase reverse

Series/parallel is an alternative feature to coil tap that is included in quite a few production guitars using humbuckers, and a useful item it is too. The difference between the two is simple. Both will give the normal series coil humbucker sound in one position, but where the coil tap cuts out one of the coils, probably by one of the methods I've shown so far, the parallel setting alters the coil wiring so that effectively, instead of a humbucker, you have two single coils operating in parallel. Each coil has its own output and earth, though the pair still use the same magnetic field, and remain out of phase, so are still humcancelling. This gives a thinner, more toppy sound than series, but is still not absolutely the sound of a single coil pick-up or a tapped humbucker.

The most common set-up requires a three or four conductor and shield humbucker, and an on/on DPDT switch. Where the overall phase of the pick-up is not going to be reversed after the series/parallel switch, a three conductor and shield type will do. But where phase reverse is required, then the in-phase earth end of the coils has to run via the series/parallel DPDT to an on/on DPDT cross-wired so that in reverse phase, this earth-end of the coils will become the output end. Figure 1 shows a four conductor pick-up linked to a series/parallel DPDT, and on from there to a phase reverse DPDT. This set-up can easily be extended to include a coil tap, either partial or complete, by running a wire from terminal 6 of the series/parallel DPDT to any of the earth type taps I've shown so far.

Obviously, the most sensible one to go for in a control situation beginning to get complicated would be the tone control spare leg tap. Where phase reverse is not required, the wiring would be as in Figure 2. I use here for convenience the colour codes as used on Dimarzio and Velvet Hammer four-conductor pick-ups. The extra tap here would operate when the DPDT was set to series. Parallel would be unaffected. This gives you an interesting A-B comparison facility on the DPDT between parallel and tap, and the opportunity to draw your own conclusions about the relative values of the two.

The interesting point about phase reverse in conjunction with an earth-type tap, either via the series/parallel DPDT, or direct tapped from the coils link, is that phase selection determines which coil is tapped. Figure 3 shows phase reverse in conjunction with a tone control earth-type tap. In normal phase, coil 2 will be turned off, and in reverse phase, coil 1 will be turned off. In my experience, this extra range of tone is of most use on the bridge pick-up. There are taps where this does not apply but they're for another time. Note that in Figure 3, both the black and the white wire run to the tone control, the series link is achieved from 0-9, when there is sufficient resistance to prevent the link between the coils shorting to earth. As before, from 9-10 the tap operates.

Beware when dealing with multiconductor and shield production "custom" pick-ups. Schecter and Lawrence humbuckers for example, are normally wired for phase reverse and tap as in Figure 4, so series/parallel switching is not possible without rewiring the conductors. Others, like the earlier Dimarzio Dual Sound, were wired as in Figure 5 for series/parallel and/or tap, but not for overall phase reverse. In the latter case though, one could always tap out coil 2, and reverse phase on coil 1 only to get an out-of-phase mix with another pick-up. More about coil phase reverse later on. The reason that you cannot reverse overall pick-up phase on the latter type of three conductor and shield is simply that in reverse phase, the shield would become the output, and if that didn't simply earth out somewhere along the line, it would be horribly noisy. These Dual Sounds are wired four conductor nowadays, and the simplest way to get all the options is to rewire a humbucker with less than four conductors up to four, using a single separate shield to earth the pick-up base and hardware.

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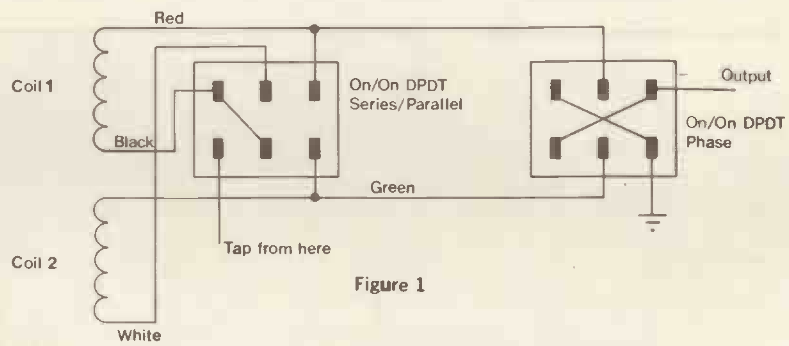


Figure 1

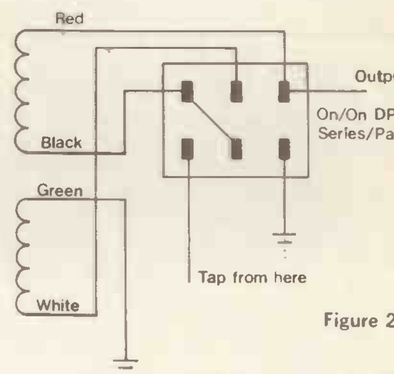


Figure 2

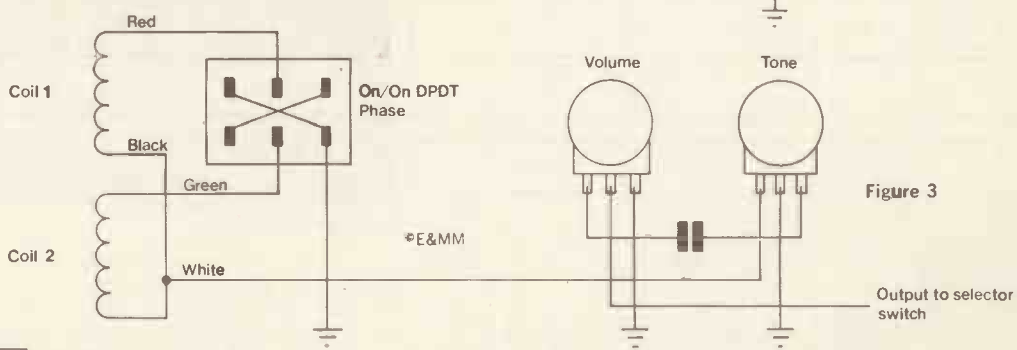


Figure 3

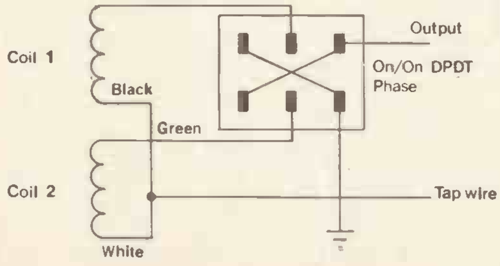


Figure 4

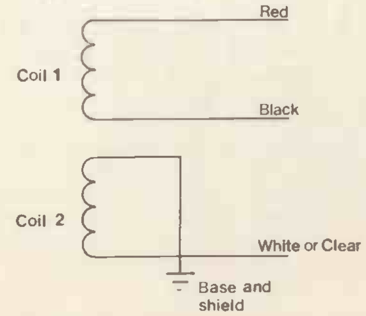


Figure 5

GOING SOLO

An insight into the background and musical equipment that brought about Duncan Mackay's Electronic Music LP 'Visa'

RECORDED ON CASSETTE NO. 3

Duncan Mackay.

There is no lack of musical experience in the life of Duncan Mackay, for he learnt the violin from the age of three and through the encouragement of his late father, who was a Professor of Music, continued playing until he was fifteen. His father then started lecturing at the University in Port Elizabeth, South Africa and here Duncan took the LTCL and LRSM examinations on the violin.

His keyboard experience began with the church organ whilst at university and it also gave him the opportunity to play jazz three times a week (Jimmy Smith style) on an old Hammond M100 organ. He started teaching music for six months but this was something he couldn't cope with at all, so by chance he got a job as keyboard player with a jazz group from Brazil. Having worked for some time in Rio in his early twenties he then came back to work in Rhodesia and finally returned to England seven years ago, planning to join up with Ginger Baker. This association didn't work at all and he started working with John Hiseman with what was to become Collisseum II.

Duncan's music making in these days brought little income until Steve Harley came along from Cockney Rebel and offered him £50 a week. He remained with Cockney Rebel until four years ago and when Rebel split up he stayed with Steve for another year as musical director. Then came the move to 10cc during which three albums were made, including 'Bloody Tourists' and 'Look Now'. During that time he still worked with Steve Harley and nearly a year ago they completed an LP entitled 'Score'. This was quite different from his 'Visa' record, with its 'thousand-notes-a-minute', very orchestral, dramatic music and unusual time signatures.

'Score' came from Duncan wanting to do something outside of Cockney Rebel, with the title coming from the music holding all the elements of a good film sound track. It was recorded at Scorpio Studios and certainly couldn't have been recorded in his present studio, for it used numerous live percussion and keyboards. Coming just before the advent of polyphonic keyboards, the music required an enormous amount of time spent multi-tracking monophonic synthesiser tracks layer by layer and turned out to be an expensive album to produce. The album was not as big a success as it should have been, for it contained plenty of interesting ideas. Shortly after 'Score', Duncan left EMI to join a new record company, Edge Records.

How Visa Started

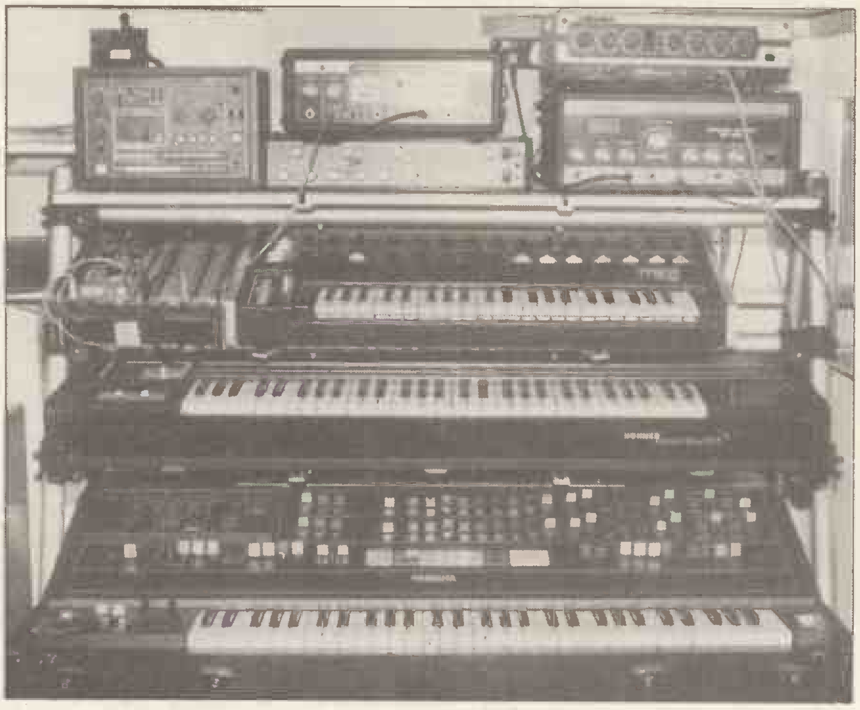
Duncan took all the music he had recorded on two-track Revox to Edge management who recognised it had good potential for an album. When discussing the cost of going into an eight-track studio to make the recording, Duncan suggested that the company loaned him a mixing desk and an eight-track recorder as down payment on the album. "This enabled me to record the entire album in the studio at home using my own equipment in addition. But having spent years in recording studios where there was usually an engineer to help out, it was quite a daunting experience to begin the LP entirely on my own knowing that it had to be completed in six weeks!"

The main mixing desk.

Although the mixing desk (an Allen & Heath Modular 3, 16 into 8) had limited EQ facilities, it was sufficient since most synthesisers had their sounds shaped before being direct injected into the desk. Because it had only three 'sends', extra junction boxes were made to switch these outputs to various effects boxes, without having to change jacks around.

Duncan dislikes untidy wiring in studios, and, needless to say, spent a lot of time moving the equipment around until he was satisfied. Part of the solution has been to use several patch boxes around the room to minimise the amount of extra wiring needed. To hold the keyboards, he uses a Roland rack which although quite expensive at around £100 is ideal for angling each piece of equipment exactly as required.

He prefers to use reverberation and other effects on individual tracks, rather than at the final mix-down stage and feels that this adds greater depth and spatial effect to the stereo field. He added, 'You have to be careful not to add too much reverberation, otherwise the sound can become swamped - but it does allow you to listen carefully to your monitor mix and get a good impression of what you are building up'. We reminisced



The main keyboard rack with echo and drum units above.

The Hammond Leslie unit (centre).

on the difficulties of making an 8-track demo and then going into a 24-track studio to try and recreate the original version. It was obviously easier and cheaper to put the whole album together in his own purpose-built studio. "With more time available, making electronic music often brings situations when you might be changing the controls slightly and getting an effect you couldn't possibly have thought up". He remembers setting up a drum pattern on the Compu-Rhythm which by chance had some echo added and sounded so good that it was kept for the final track.

Stereo recorders and various effects units.

Recording Equipment and Effects

The multi-track tape machine used was a Brenell Mini-8 with Vari-speed and remote control. The amps in the studio are Quad 405's fed into a pair of JBL speakers (Decade 36 3-way speakers set for flat response), although he has tucked away a pair of Auratones which he likes as additional reference speakers (even though the bass needs boosting!).

The mixing desk sits in front of what used to be an old fire-place, conveniently positioning it sufficiently away from the monitor speakers. The sound of the room is already fairly dry from the carpeting and curtains, so no special equalising was needed even at the mastering stage. Noise reduction is not used - instead the Brenell recorder receives fairly high signals that can peak into the 'red' frequently without producing distortion, thus eliminating one additional step in the chain that could affect the final sound. "The only time I like using dbx is when I am recording piano and I like to play it back without it to get a really bright penetrating 'honky-tonk' effect".

Although Duncan's Hammond is capable of giving him a great organ sound through its tone cabinet on the album, he used a Roland VK1 through a 'Sound Dimension' unit that really spreads out the sound. There are two Revox tape recorders (both A77's) and one is used for the mix-down and the other for tape echo and back-up copies. There is also a Technics M04 cassette tape machine that is useful for recording any make of tape with correct bias and equalisation and its 'search facility' helps to locate tracks quickly. For more complex echo effects there is a Yamaha E1010, Roland Space Echo RE150 and also the DC30. Each of these produces a different kind of echo along with an early solid-state Roland unit, the Digital Chorus. Other effects come from the Roland 'Sound Dimension D', a Phase Shifter - the SPH323, and a Bell Flanger - the BF20 stereo version. The Eventide Clockworks Harmoniser has pride of place next to an old Yamaha tuning scope which is very useful for tuning the Clavinet.

Echo and other effects are controlled occasionally from foot pedals and the former especially is operated from a 'push-to-make' rather than an 'on/off' switch to give more accurate echo timing. We mustn't forget Dave Simmons' Clap-Trap too which adds extra percussive sounds.

In the photographs you might also spot an instrument that excited both of us - the Roland Auto Harp, which is simply the traditional auto harp with piezo pick-ups under each string. We both agreed the sound it produces was unobtainable even from guitars and added interesting chordal and arpeggio effects.

Duncan points out, 'It is important to listen to recordings in various environments - even the car stereo is useful for evaluating if there is too much bass and so on'. Next to his Leslie unit there is a rack of equipment from his old 10cc days and space for some Kepex noise gates which help to keep the background noise of the Clavinet down in recording.

Onto Keyboards

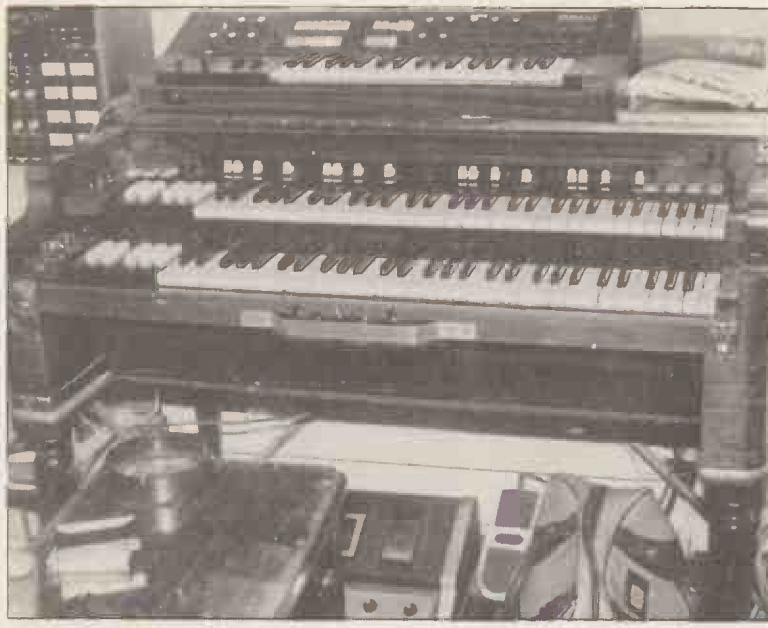
Looking at the impressive array of keyboards, we started with the Hammond B3 and its accompanying Leslie unit which has a 200W Gauss bass speaker and JBL horns, 'Rarely used these days', comments Duncan 'and certainly never played as loud as it could be'. The Hammond was bought in Cape Town for £400 brand new from an old lady who had been left it in a relative's will and was first discovered ornating her living room with a table cloth over it and pictures on top!

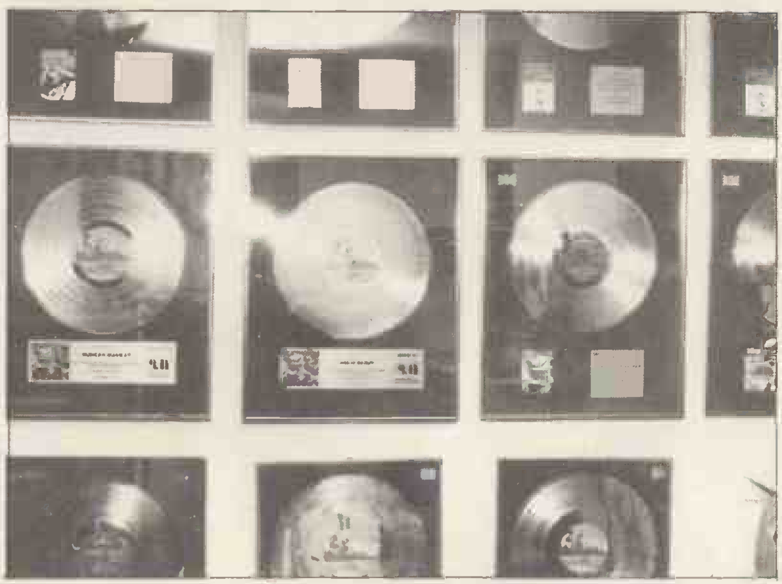
Under the main rack is the Yamaha CS80 which provides most of the harmony and polyphonic textures on 'Visa'. This has been modified to take two extra memories and the string sounds have also been improved. A firm favourite is the Hohner Clavinet, which is sent through the Digital Chorus, helping to add a great deal of clarity to the sound. "I use the Multi-Moog quite a lot for sequencing — its touch-sensitive action helps to accent notes - and operates with the Roland system 100 sequencer. The latter's Channel A is used for note control and Channel B for filter control and rests are inserted by simply closing the filter."

On the top part of the rack is a Roland TR78 Compu-Rhythm which has its bass drum sound beefed up by a Moog Equaliser. 'I find the pad for entering rhythms impracticable, so I use the writing switch which is much more accurate, although you have to keep removing jacks for normal operation'. The drum sounds go through the Space Echo which gives further syncopation to the rhythms and these are very evident on the 'Visa' album! Throughout the LP the percussion is always intended to sound electronic - listen to the nice phased cymbal on the second track. Duncan only occasionally uses his Moog Taurus pedal for penetrating synthesiser bass: "This really comes from my time with 10cc and playing jazz in Africa when I gigged with just a drummer". His church organ experience obviously gives him an interest in playing pedals and he plans to reinstate a two-octave pedalboard with his Hammond shortly. The Yamaha CS15D shown on the top of the Hammond will have been donated since as a prize in a competition promoting 'Visa'.

Writing the Music

During composing, the music was often written down in traditional notation, without detailing all the synthesiser and mixer settings. No physical tape editing is done as Duncan prefers to collect on a Revox numerous sounds that he experiments with, from which he will extract parts afterwards that he likes


The original Hammond B3!


Just a few of Duncan's gold, silver and platinum disc awards.


The Brenell 8-track recorder


How to keep your cables tidy!

- in fact, that is how all of the 'Visa' pieces were written. Talking about the reasons for writing 'Visa', Duncan mentioned his initial dislike for drum machines had recently changed and prompted him to do a lot of experimenting with them. "I'm still continuing to write music in the vein of 'Score', but it's just not commercially viable at the moment. It was challenging to produce 'Visa', for everything was created in my studio from beginning to end. The excitement of composing electronic music for me came from the manipulation and interfacing of controls as well as the composing of the music and the record was intended to be pleasing and enjoyable to listen too, rather than contain exciting innovative ideas."

Its directness and catchy melodies should appeal to the whole family and points to the important developments that are taking place in providing cheaper synthesisers for everyone to play easily and have fun with.

What this album will prove to many people is that acceptable music can now be written in a good home studio set-up and should inspire the many hundreds of people who now enjoy,recording their own music to continue their experiments. Surprisingly, the whole of the 'Visa' LP was recorded by simply filling the eight tracks of the recorder and mixing these down into stereo. When 'Visa' is performed at a concert, Duncan uses one other keyboard player and backing tapes.

Certainly 'Visa' is a big step for Duncan and it contains the personality of the composer through its warmth and directness, its neat and precisely organised rhythmic and melodic counterpoints. Like many electronic music composers, his next album promises to be different again. His latest release is a single which is not on the album, titled 'Sirius 3 Mark II'. It's more in the dance vein and shows yet another side of his composing. Meanwhile, he continues to compose film sound tracks, jingles, play most of the music for Kate Bush and looks forward to plenty of solo dates this year.

Mike Beecher **E&MM**

You can listen to Duncan playing his studio keyboards on our E&MM Demo Cassette No. 3.

We are also offering his 'Visa' LP to E&MM readers for only £3.49 inc. post, packing and VAT. Send your cheque to 'Maplin Publications', 282, London Road, Westcliff-on-Sea, Essex, SS0 7JG.

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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.

PPG Wave 2

8-Voice Polyphonic Digital Synthesiser with 8-Track Digital Sequencer

RECORDED ON CASSETTE NO. 3

PPG have been designing and building synthesisers in Germany for several years but, to date, have not made them available elsewhere. Their range of instruments covers monophonic models through to the complex 360 Wave Computer and the company in particular specialises in digital synthesiser technology.

The Wave 2 combines new digital microprocessor circuits with accepted analogue control synthesis and thus aims to overcome the complexity often inherent in computer based systems through its analogue settings and realtime keyboard. The result is an instrument that sounds quite unlike other performance synthesisers, producing complex digital waveforms that can be filtered to produce a vast range of sounds.

System Design

Rather than produce an instrument following the conventional sine, triangle, sawtooth and squarewave basic sound sources, PPG designed the Wave 2 with banks of waveforms that are digitally produced. They are contained in 30 'Wavetables' which are accessible through a numerical keypad linked to an LCD 80-character display.

This innovative idea solves the problem of many programmable synthesisers — their inability to show the control settings of memorised sounds. Hence, information on all controls can be displayed and through the keypad can be used to update and change the preset sounds.

There are 5 separate displays available for indicating the main panel functions, digital routing and control, oscillator tuning, analogue control settings (on a scale from 0 to maximum 63) for both channels A & B, and Sequencer/Arpeggio functions.

Each of the Wavetables contains 64 different waveforms. These are programmed at the factory and stored in part of the 24K EPROM memory making a total of 1920 in all available. The rest of the EPROM space holds the control information for sending data to and from the main 6809 microprocessor. Some Wavetables have a reasonably smooth transition through their 64 waveforms whilst others have very dramatic changes that contain strongly accentuated and very different harmonic structures — it is with these latter Wavetables that the Wave 2 makes some unique sounds.

Eight oscillators all receive the waveform control information that sets the basic waveform structure, filter and VCA action, which therefore shapes the required harmonic structure. The keyboard then takes any eight notes played and sets each oscillator's basic pitch. As soon as you change waveforms all eight voice synthesisers are reshaped identically to sound the same. Selection of the waveforms is made from the Analogue section on the left half of the front panel either manually, using the 'Partial Wave Numbers' (PWN) control or automatically, with an ADSR envelope.

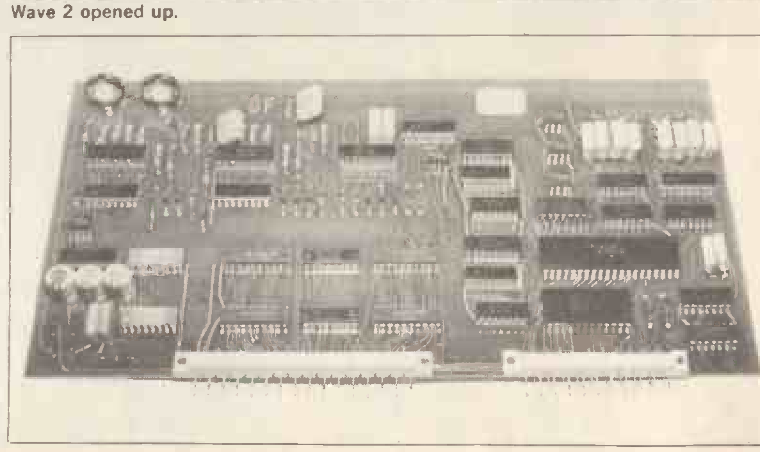
All the digital information is entered with the numerical keypad and 'display select' buttons on the right half of the panel.

There are two other important design concepts on the Wave 2. First, the relatively low number of analogue controls is achieved through a triple-sharing system that lets you select the panel mode to allocate a specific routing for each set of functions. Second, the notes played on the keyboard can be stored in the 12K RAM memory of an 8-track digital recorder in numerous ways for simultaneous or individual playback.

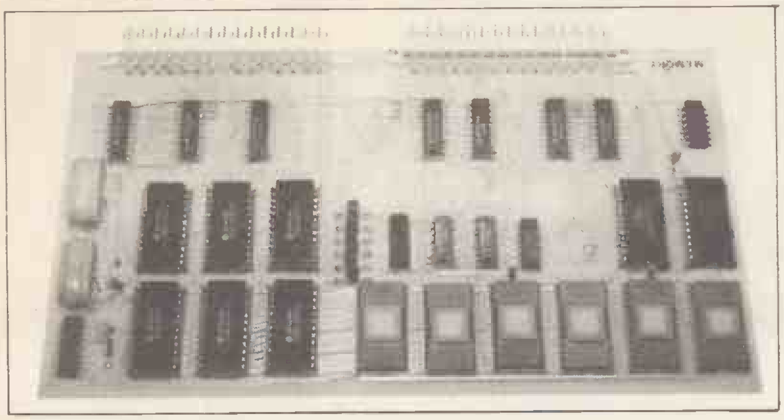
Live Performance

On powering the instrument, you immediately have access to a total of 100 programmable stereo sounds. Thirty of these (and possibly more in production models) are supplied factory preset although the user can reprogram all of them if he wishes.

Wave 2 opened up.



Dual oscillator, filter, VCA board.



Memory board.

The Wave 2 might be considered at this stage just like another programmable polyphonic instrument with program numbers punched in on the numerical keypad. But it is also like an analogue synthesiser and if you want to change any of the settings you simple move the desired control in the analogue section. This gives great potential for continually updating sounds during performance, with memory storage at any time.

Analogue Controls

In the 'Multiple Function Analog Control Panel' from left to right, we start with a Master Tune for adjusting the pitch of all oscillators simultaneously ± semitone to other instruments and a Master Volume output.

Next there are two ADSR generators: Envelope 1 and 2. In the first of the 3 panel modes, indicated by LEDs in the Panel Function section and selected from a 'Display Select' button, Envelope 1 can be used independently for the Low Pass Filter and the PWN. Envelope 2 controls the VCA shape (or loudness). The maximum Attack time is 14 seconds with Decay and Release lasting up to 30 seconds.

Switching to second panel mode, the top controls now determine LFO parameters for setting a delay before the LFO operates, Waveform (continuously variable through triangle, sawtooth, reverse sawtooth and square wave), intensity of modulation and LFO speed.

The LFO can be selected by viewing the LCD display and inserting a '1' instead of an '0' after two code letters representing modulation of pitch, partial wave numbers, filter frequency and VCA, with LFO triggering able to give sequential running of the oscillators. What was Envelope 2 now becomes Envelope 3 and has Attack, Decay and Depth controls for EG pitch changes. Although the adjustments made in each panel mode are held whilst you set your sound up, in order to retain the complete synthesiser 'preset' you must then put it in a program from 0 to 99, using Data Transfer, otherwise the sound will be lost on selection of another program. Data Transfers can be done in 9 different ways allowing update of certain sections of information.

Analogue panel 3 mode now assigns the original 8 controls of Envelope 1 and 2 as volume level outputs for the eight tracks of the sequencer/arpeggio digital recorder in the instrument. The LFO speed control now adjusts the sequencer master clock rate.

At first, this jumping around from one mode to another appears slightly confusing, but of course, all the information can be seen as numerical values for each setting on the LCD display. In performance, switching from one panel mode to the next is simply a touch of a button. I like this method, because you can focus on the LCD display rather than peer back and forward over numerous controls.

The output of the standard Wave 2 instrument is stereo and for each program there are outputs A and B. It can also be supplied with 8 individual outputs from its sequencer. The 'Group' button (in Display Select) chooses either or both channels and is indicated on the main display and on the two Panel Function LEDs. So you can produce two completely different sounds (based on the same Wavetable) from the same program.

Exciting possibilities come from this truly stereo programming. Selection of VCA envelopes will simulate panning from one channel to another and echo, with individual change of one channel only giving de-tune, chorus and complex tonal effects.

Multiple Function Digital control section.

Panel Display showing Analogue control settings.

Keyboard and Tuning

Using the keyboard select modes you can specify (counting from the left) from which note the split point should be to put channel A and B on each half.

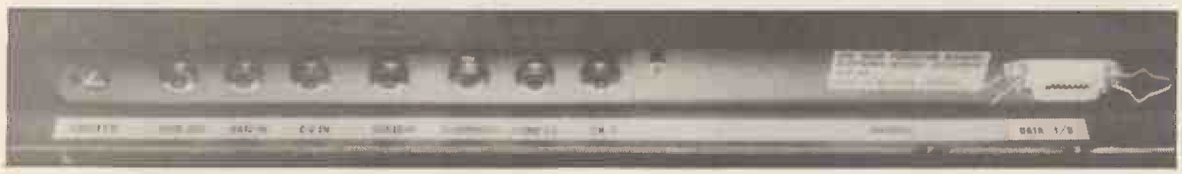
Besides the full keyboard in 8-note polyphonic mode, there are 8 other modes that give choice of oscillators on each channel, choice of the number of oscillators on each note and keyboard split. This makes utmost use of the 8-note system — you can achieve rich string effects from 4 oscillators on two monophonic notes using key split or play top solos to left hand chords just as easily.

Other uses for the keyboard (highest note played) voltage are: 'Keyboard Follow' opening the filter up the keyboard over 7 increasing amounts, loudness balance at low and high ends and particularly interesting, its control of PWN, being able to select individual waves on each note or produce whole sweeps of partials from note jumps.

Locating and modifying all information on the display is done by moving a cursor to the data e.g. SPLIT 10, and then typing a new number. There's a clear perspex spring-loaded wheel for pitch-bends (up or down 4 semitones) on the left of the keyboard that's usefully angled towards the player. I would have preferred at least an octave jump here.

Each oscillator can be adjusted in 4 'micro' steps from -1 to +2 for rich 'chorus' and de-tuning effects. A further instruction (shown on the display along with micro tuning)

Multiple Function Analogue control section.

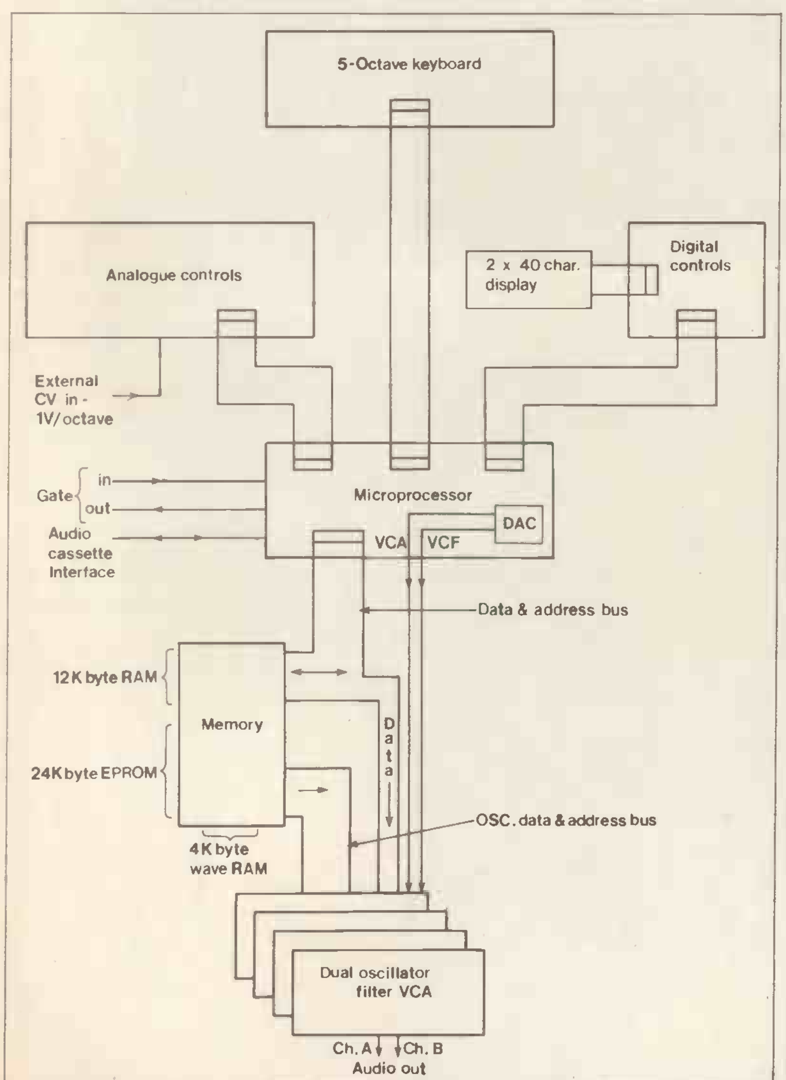


Rear panel sockets.

enables the pitch of individual oscillators to be stated as a number which is the semitone count from the bottom note e.g. '12' is 1 octave up, '31' is 2 octaves and a fifth up. All eight oscillators are therefore capable of wide parallel interval playing from one or more notes (Ravel 'Bolero' style!).

Two types of control from finger touch operate. First, there is the 'electric piano' kind of touch sensitivity that generates a control voltage dependent on the velocity of a pressed key. This will open the filter or increase the volume on faster touch playing.

The second type is pressure sensitivity, the control voltage being derived from the action of a firmly pressed key. A little disappointing, in terms of mechanics, as the whole keyboard droops with the key(s) depressed (memories of the EMS Polysynthi here!) yet it does its job of altering (individually or collectively) the filter, partial wave numbers, loudness and LFO modulation intensity.



Block diagram PPG Wave 2.

Partials and Extras

If you play big chords on a particularly dramatic wavetable, the sound can be very dense and somewhat overpowering. This is where the ability to select one or more waveforms of a Wavetable is very useful. It's done by adjusting the 'Env. 1 Wave' control which really sets the number of waveforms heard in sequence from 1 to 64 at attack, decay, sustain (holding one waveform) and release times. Aurally, a sweep at varying speeds from one waveform to the next is heard, starting from the point set by the PWN control (e.g. ½-way is waveform 32). If a start is selected from say, waveform 50, then provided the ADSR carries on after 64, the table skips back to 1.

Here's another plus — the effect will convince you that echo and reverberation are present on long releases!

Every wavetable has triangle, sawtooth and pulse waveforms available as the basis of standard analogue synthesis. These occur usually at the end of the PWN sweep where waveforms are more widely separated on the control's movement. The Low Pass filter present can further modify a partial wave using its Cut-Off and Emphasis (resonance) controls.

'Test and Cancel' is an unusual facility that checks oscillators, so that if a problem should arise, the particular board can be located and 'cancelled' — ideally a safety feature to get you out of trouble on stage.

The rear panel has a data in/out socket for micro connection, control voltage in, gate in and out, headphones, sustain switch, and cassette 5-pin Din interface socket. All the program information can be dumped onto a standard mono cassette (it takes about one minute). Instruction 1 dumps the program data, 2 dumps the sequencer tracks, 3 loads from cassette and 4 will verify a dump.

The Sequencer

The addition of an 8-track digital recorder in the Wave 2 must make it a really attractive proposition and it can be used to record up to 10 sequences and/or arpeggio effects. A sequence can only be recorded by entering each of the eight possible layers one at a time in monophonic fashion. The big advantage here is the possibility of recording 8 melodies using completely different synthesiser sounds. Alternatively, arpeggios that rise, fall or do both on a chosen chord, have random selection or continuously moving groups of notes, and have a specified number of notes in a loop taken from your chord are easily done using a keypad instruction.

A sequence can run from 0 to 99 times (the latter makes it a continuous repeat). Further layers would be played whilst hearing previous tracks. Provided memory is available (no running indication of this on the present model), up to 10 'labelled' sequences on up to eight tracks can be recorded. Routing can be changed while the sequence is running as well as in single step mode.

Needless to say, numerous editing features and modes of operation are available, with updating of pitch, filter, waves and EG filter control at the mixdown stage possible (Panel mode 3). A total of 2000 events can be recorded and an optional expansion card will bring this up to 6000 events in all.

Conclusion

Because the Wave 2 is micro-based and software controlled it can easily be updated. Here lies its main strength although the purchaser will want the instrument to be versatile and fully operational when he buys it.

There were one or two 'bugs' in the system that I am informed will definitely not be in the production model and, like any other powerful control processor, has to be used with some thought to achieve its full potential. Jittering can occur if you stop PWN between two waves although in practice your ear would make you move on to a complete wave. Two nice features are auto-cursor movement from one data point to the next and the LCD display has a useful control that adjusts the 'output angle' to suit your position during performance. Wave 2's sequencer would be very versatile indeed if it could record realtime polyphonic music as well as single melodies and the initial click track needs to be a 'click' and not its present 'note' which clashes with your key notes. Another interesting extra that could be implemented is to have mixer settings remembered as you adjust them during your sequence realtime playback — but of course you have to stop somewhere! As the instrument stands it presents a new concept of sound synthesis in the studio or on stage. If you don't believe me, listen to its special sounds on E&MM's Demo Cassette 3!

Mike Beecher **E&MM**

The Wave 2 has been competitively priced at £3232.16 including VAT and comes in a black metal cabinet with electric blue front panel (Length 92cm, Depth 55cm, Height 17cm). It is obtainable in the UK from Desert Distributors, 6 Erskine Road, London NW3. Tel: 01-586 0357.

Guide to Electronic Music Techniques

Microphone techniques for 'Musique Concrete'

Lawrence Casserley

I've already talked about how to manipulate sounds on tape and these ideas apply to any sounds that you might want to use. Now I want to talk about ways of getting the sound you want from acoustic sources.

In order to do this it is necessary to convert acoustic energy into electrical energy by means of some form of microphone. There are many different types of microphone and they can be used in many different ways.

Microphones can be divided into two broad classes - air mics and contact mics. Air mics detect variations in voltage that can then be recorded and/or manipulated electronically. There are various categories of air microphone and it is worth knowing a bit about them. First, they can be divided according to the method of energy conversion. The two you are most likely to encounter are dynamic (or moving coil) and capacitor (used to be called condenser). A dynamic mic is effectively the inverse of a speaker - a diaphragm which is moved by pressure waves in the air is attached to a coil which moves with the diaphragm in a magnetic field thereby generating current in the coil. A capacitor microphone, on the other hand, uses the diaphragm as one plate of a capacitor with a charge on it. As the diaphragm is moved by the air, the distance between the two plates and therefore the capacitance, changes causing a change in the voltage across the capacitor. As the capacitor must have a charge on it, and because, for technical reasons, most capacitor mics contain a preamp it is necessary for them to have some form of power supply, which may make their use more complicated. Apart from that, you mostly won't need to worry all that much about the different types. If you don't understand why these two approaches work you'd better bone up on basic electronic theory; there are a number of good books available and Robert Penfold's articles in E&MM will help.

A more important consideration is the polar diagram, or directional characteristic, of the microphone. The two characteristics you are most likely to encounter are omni-directional and cardioid. An omni-directional mic is equally sensitive to sound from all directions, while a cardioid mic has a roughly heart-shaped characteristic with a null at the rear of the mic and the most sensitive point at the front (Figure 1). This is the most commonly used directional characteristic and this type of mic will usually be the most useful to you. Generally we are concerned with recording a particular sound from a particular source and we want to direct the most sensitive point of the microphone towards it.

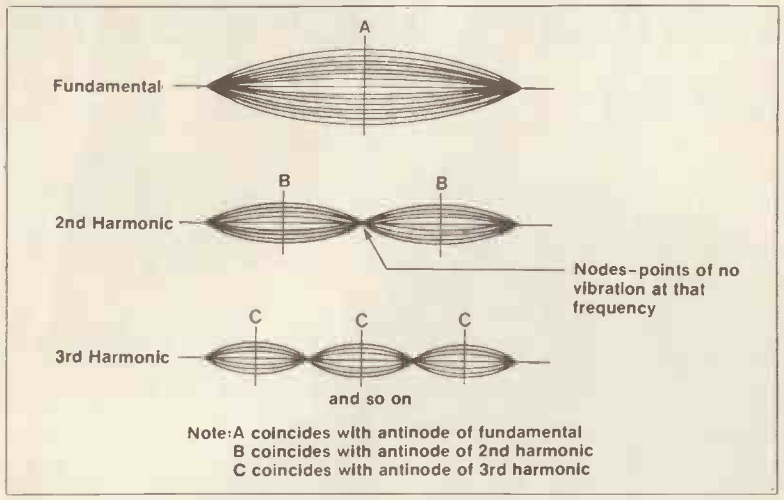


Figure 2. Modes of vibration of a string.

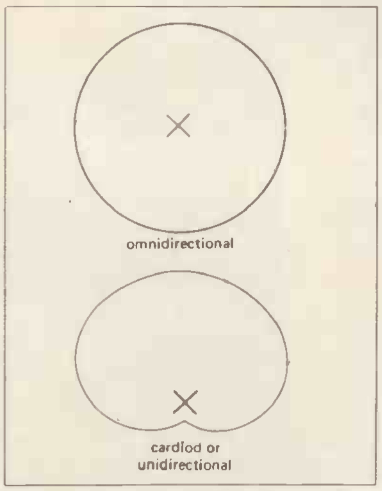


Figure 1. Microphone Polar diagrams.

Contact mics also come in different types. There are two common types. The first is not really a contact mic at all, but a magnetic pickup which senses the movement of a metal object within its magnetic field. This is the type of pickup used on electric guitars and similar instruments and can be useful for some applications provided the vibrating body is metal. Magnetic pickups are mounted close to the vibrating object whilst contact mikes detect vibrations directly. The most common method for achieving this is to use a piezo-electric crystal which produces a small output voltage when stressed. The vibrations of the sound-producing object to which the mic is attached produced stresses in the crystal, thus generating a waveform analagous to the vibrations.

The other point to note about microphones is impedance. Most professional microphones are low impedance (200 ohms or less), but cheaper microphones and most contact microphones are usually of much higher impedance and some domestic tape recorders only accept high impedance mics. The most important point is to get the impedance matched or else you will get hum, noise and/or overload problems. Also, if you are using high impedance mics (particularly contact mics, which sometimes have a very high impedance) keep the leads as short as possible in order to reduce hum and other interference.

Finally, before talking about what you can do with your microphones, a few comments about what microphones to use.

There are a number of mics available in what is usually called the semi-professional range. I'll first mention a couple which I have found useful for this sort of work. For a dynamic mic the AKG D190 is hard to beat for price vs. performance, giving a lot of the quality of a really professional mic for about £50. A "cheap" capacitor mic is the Calrec 652 (which I use quite a lot) which is a similar price to the D190 but, of course, you'll need a power supply, which is extra. It's worth trying some of the electret mics (a cheaper form of capacitor, usually powered by a small battery in the mic itself). There are a number of types available at various prices.

For contact mics there are various types ranging from a few pounds up to hundreds. Many of the very cheap ones are apt to fall apart unless you are extremely gentle with them, so may prove a false economy, but there are several in the £10-£20 range that are worth looking at. I use a number of Schaller mics which are really sold as acoustic guitar pickups, but can be attached to all sorts of things and they are fairly robust. Also Coloursound do a range of pickups that are worth looking into. In the more expensive range there is a new capacitor contact mic by DI Tapes Ltd. (at 107 Park Street, London, WIY 3TA) which was designed as a piano pickup and sells for about £50. This mic is very sensitive and has a good frequency response (often a problem with the cheaper models). There is also an extensive range of contact mics by Barcus Berry at various prices. Lastly, there are all sorts of odd pickups that can be bought very cheaply on the surplus "junk" market and it is worth getting some of these to experiment with; and, don't forget, amazing things can be done with dismembered telephone receivers! (To cover myself I must advise you not to use Telecom property!!)

Using microphones

The one really important problem with mics is where do you put them - how close to the sound source? - which part of the source should they point at? There are no fixed rules for this - just experiment until you get the sound you want; but it will help to have some idea of the principles involved. The most important thing to realise is that a vibrating body does not vibrate in the same way all over and therefore does not produce the same sound from all parts.

Let us take a simple example; a vibrating string will have a number of modes of vibration (Figure 2) corresponding to the different harmonics; placing a mic over different parts of the string will emphasise different harmonics and, therefore, alter the timbre. Electric guitars with more than one set of pickups exploit this principle to get different tone colours. But if we have a moveable pickup or an air mic we can take the idea further by running it along the vibrating string. If we are over the middle of the string (Point A in Figure 2) all the odd harmonics, and especially the fundamental, will be emphasised and all the even harmonics will be at a nodal point and, therefore, de-emphasised. At point B, the second harmonic and its odd multiples (6, 10, 14, etc.) will be emphasised; at point C the third harmonic and its odd multiples (9, 15, 21, etc.) will be emphasised; and so on, with the fundamental getting progressively weaker as we move toward the end of the string. While other vibrating bodies tend to be more complex than a string, the same principles apply, and the best bet is to experiment by moving the mic over the surface - indeed you may want to use the filtering effect of moving the mic while you are recording.

Another matter to consider is the distance of the mic from the point of excitation (hammer striking object, bow scraping string, etc.). If the mic is very close to the point of excitation the noise made at this point will be emphasised, while if the mic is further away the characteristic resonance of the vibrating body will be emphasised.

All these points apply to both air and contact mics, but remember that contact mics, because they are actually attached to the vibrating object, may affect the way it vibrates and, therefore, the sound it makes. This should be taken into account, particularly on small or light objects, or if you are trying to get a long resonance (the extra weight of the contact mic will tend to damp out resonances more quickly).

Remember that we can use the mic as part of the whole process of making the sound we want to hear; it is not just a mechanical device, but can be used as a creative instrument — all it needs is imagination and a willingness to experiment. **E&MM**

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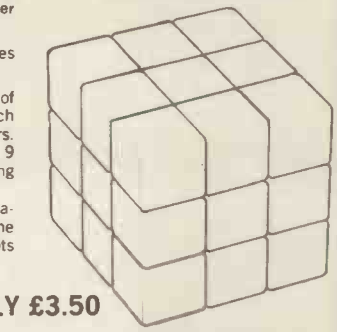

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SOUND ON STAGE

Ben Duncan

Thin Lizzy

Power, loudness and power amplification

Regrettably, there is nothing very tangible in the relationship between amplifier power, sound level and perceived loudness; this is something many musicians are painfully aware of, after having parted with lots of cash for a casually described 'megga-wattage' which didn't live up to expectations! Broadly speaking, a tenfold increase in sound level or amplifier power corresponds to a mere doubling of loudness to our ears. Thus doubling the power of your instrument amps can be expensive yet disappointing. All other factors being equal, the increase in loudness will be very subtle indeed. But variations in the methods by which amplifier watts are measured, together with the effects of loudspeaker impedance, efficiency and dispersion pattern can all work together to make, say, a nominal '100 watts' sound impossibly loud or puzzingly mute.

These are objective, measurable effects; others are subjective, but equally real. Colouration (the emphasis of certain frequencies) in the speakers and distortion can suggest immense loudness, whilst clean, uncoloured sound rarely seems loud enough. The general result is that amplifier watts should be taken with a generous pinch of salt; the loudness your ears perceive is always the final arbiter! When a good valve amplifier is overdriven, it produces a distorted sound that is both immense *and* palatable. Apart from their ability to add ethereal ambience, emotion and warmth to the guitar, valve amplifiers of any given rating invariably seem louder than equally powerful transistor counterparts. The reason lies partially in psychoacoustics — the characteristic distortion of the valve amplifier simply *sounds* loud — but also in the conservative nature of valve amplifier power ratings. Additionally, the output power of any amplifier is at least doubled by gross overloading, and in good valve amplifiers, this potential extra power is musically acceptable and thus usable, whilst in transistor amplifiers, it is usually very discordant and 'ear-ripping'. As a result, a carefully chosen 30 to 100 watts of valve amplification is adequate for playing loud, raunchy music *almost anywhere*! It's not surprising that valve amplifiers are the quintessential sound of Rock . . .

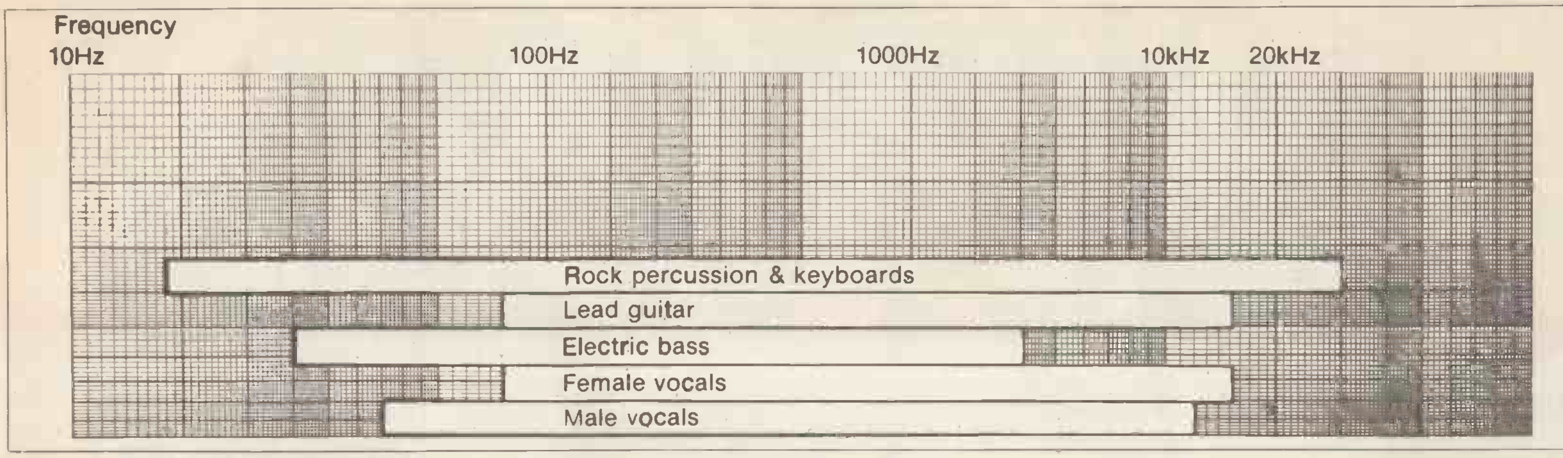
In creative hands, a handful of transistor amplifiers can exhibit 'musical' overload characteristics similar to good valve amplifiers but in general, transistor amplifiers produce tinny, harsh, brittle, metallic effects when they are overdriven; they sound either crystal clear or extremely obnoxious. This doesn't mean that the transistor amplifier is useless — merely that different techniques are needed to coax music out of it. Or, to look at it another way, the transistor amplifier suits some types of music better than the valve amp. In general, transistor amplifiers have to be played clean at levels *well below overload* to avoid the generation of unpleasant sounds. This means that the potential of full power isn't available, and adequate power ratings will be *at least three times* those indicated above for valve amplifiers, ie: 100 to 300 watts for lead guitar.

The transistor amplifier is best suited to clean styles of playing and is therefore very acceptable on bass or guitar work demanding a clinical, sterile feel, whilst the harsh, ear-ripping characteristics were well suited to the punk idiom of '76-'79. However, acceptable distortion can be introduced via FX circuits and the speakers in order to extend the versatility of the instrument and make it sound louder without discomfort. Neither type of amplifier is inherently 'the best', there are good and bad examples of each. It's only that one is better suited to *your* music, *your* skill and *your* guitar. In short, the best amplifier is the one you can develop a relationship with.

As a potential amplifier purchaser, listen to, or better still, try out as many models as you can — preferably with your own guitar or bass, and bear in mind that the sound of a 'head' (separate) amp will be profoundly influenced by the speakers it's tested with, amongst other factors. It's all too easy to end up with a bland and unsympathetic beast of an amplifier simply because it was demonstrated with a particularly good guitar and speaker cabinet! Find the point(s) where the amplifier overloads, and listen to how the sound changes above and just below the overload point. Is it a useful and potentially musical sound? Or does it rip your ears and shatter windows? If you ever intend to practise with the amp at low levels, then *listen* to the amp at these levels. The sound may be different, but again, is it a *useful* sound? Above all, talk to other guitarists, and visit your local group gear shop and try different types of guitar amps with different wattage ratings.

Speakers — an introduction

Two types of speakers are used in conjunction with electro-musical instruments. The first, akin to the hi-fi speaker, is primarily a reproducer, which aims to convert electrical waveforms into facsimile air vibration.



Frequency range of Rock instruments and vocals.

These 'reproduction' speakers are most useful for keyboards and are the foundation of the best PA systems. We'll look at this type of speaker later in the series, particularly as it concerns the bass player. Meanwhile, speakers intended for the guitarist and for vocals PA provide the antithesis of pure reproduction — again they are part of the instrument. Like the amplifier, the speaker can be driven hard to subtly mould the nature of a valve amp's distortion, giving a slight 'edge' to the sound for instance. In conjunction with a transistor amplifier, the speaker's distortion can be dominant at average levels, and helps to give 'roundness', 'punch' or 'bite' to an otherwise neutral sound. Some speakers feature metallic centre domes to enhance the upper harmonics of the guitar; these are best avoided with transistor amps, which tend to emphasise these harmonics naturally. Whilst the centre dome will certainly give extra bite, it will also exaggerate the tinny, metallic sound generated by the amplifier to a fatiguing degree. In this case, a speaker with a conventional paper tweeter cone is preferable.

The prime requirements for guitar and vocal speakers are an efficient mid-range response and a power capacity that's about twice that of the amplifier. The second requirement arises because guitarists invariably overload their amplifiers, and in this case, the power output will be well in excess of the amplifier's nominal rating. Hence it's a sensible and well proven rule of the thumb to allow a 100% power margin for guitar speakers. Although a modern 12 inch driver will often meet these requirements, in the past, high power drivers weren't readily available, if at all, and it was necessary to use several 12 inch or 10 inch drivers to achieve a sensible power capacity, eg: the traditional 4 x 12 cabinet. At the same time, guitarists discovered the unique musical properties of overdriving these marginally rated speakers with valve amplifiers. As a result, another school of thought has arisen — rate your speakers to match the power capacity of the amplifier, enjoy the music and pray that they don't blow up! Fortunately, this philosophy works, *provided* you're using the right speakers, preferably the ones that the manufacturer supplied. The secret here is essentially a case of causing the cone to produce distortion without burning out the voice coil.

Term		Definition
Head	—	an amplifier discrete from the speaker cabinet.
Combo	—	a combined speaker and amplifier.
Slave	—	a discrete power amplifier without tone controls, usually driven with the 'line level' signal from the guitar amplifier.
Loudspeaker		known variously as a driver, a cone driver, a chassis speaker, a horn-loaded driver, etc, when the essential sound generating component is referred to.
Loudspeaker		known variously as a 'cab', cabinet, enclosure, column, direct radiator speaker, horn-loaded speaker, horn, baffle or reflex — when a complete loudspeaker system is being discussed.
Direct radiator	—	also known as an *infinite baffle*, this type of speaker cabinet is the commonest to be found on stage; the driver is visible and couples directly with the air.
Column speaker	—	a specialised form of direct radiator, where several drivers are arranged in a line to control the sound dispersion.
Horn-loaded loudspeaker	—	also known as in various guises a horn, 'bin', 'bullet' or 'lens', the driver is usually hidden and couples with the outside air via some form of expanding tube.

Table 1. Glossary of technical terms

The overall result is that no hard and fast rules can be laid down for guitar and vocal speakers — the 4 x 12 inch, 2 x 10 inch and even 4 x 8 inch are all broadly similar and equally valid approaches. The only definite proviso is that driver(s) with a diameter greater than 12 inches will rarely provide sufficient 'top' and should be avoided; 10 inch and 12 inch speakers are the traditional choice for guitar and vocals rendition, and not without good reason! For bass, the frequency response requirements are shifted down by around two octaves. 'Top' becomes unimportant, whilst the overriding need for good low bass response governs the cabinet size. The traditional sound of the electric bass puts great emphasis on the low notes, as if to mimic its cousin, the double bass. Because the ear is insensitive to low bass, high sound levels are essential for them to become audible. In the double bass, this is achieved by the sheer size of the vibrating panels. Likewise, for the electric bass, to make the bottom notes audible, a large area of speaker cone is called for, together with a high-power amplifier. Thus the traditional 60's bass sound was usually achieved with 24, 18 or 15 inch drivers, singly, in multiples, or by horn loading, which can achieve the same results with a smaller driver, together with a number of other advantages, though at greater cost.

However, the bass has few interesting sounds to offer when the harmonics are suppressed in this manner. The bass becomes much more expressive when the harmonics are emphasised; something that the funky bass players of the '70's extolled. To make these harmonics audible, one can simply use a mid-range speaker in conjunction with the large diameter bass speakers to boost the upper octaves, or, alternatively, use 12 inch drivers. These have a natural response which extends into the upper register of the bass but to achieve audible bass (simultaneously), a large cone area is also required — hence 4 x 12 inch drivers again, which elegantly combines good 'top end' response with an area (and hence bass response) more than equal to two 15 inch drivers. Finally, unlike the guitar, a heavily thumbed bass readily causes speaker cones to bang against their end stops. As this is potentially much more disastrous than the voice coil overheating that can occur in guitar speakers, it's good practice to rate speakers intended for electric bass at *four times* the amplifier's nominal power capacity.

For vocals, the power and frequency response requirements are much the same as the guitar speaker's. Hence 8, 10 or 12 inch speakers, used in multiples to provide adequate power handling capacity. Although a peaky, coloured response will give a useful 'pokey' vocals sound that is just about capable of cutting through wailing guitars, it may aggravate tendencies to feedback, 'howling round' before you can raise the volume control to the sound level you require. Unfortunately, this problem can only be totally avoided by using microphones and speaker systems with a flat, uncoloured response. Nonetheless, it's wise to steer clear of exceptionally coloured vocals speakers unless you can be sure they can be wound up to workable levels in practice. Vocals speakers also profit from special enclosure techniques, again to avoid premature feedback. The traditional column speaker, although much maligned, is excellent from this point of view. Containing between four and eight 12, 10 or 8 inch speakers in a vertical array, the typical column provides a well defined and *'forward'* dispersion pattern, the idea being to keep the sound away from the microphone and the ceiling, from where it's likely to be reflected back to the stage. In many respects, a well designed column speaker is the ideal vocals speaker, short of a very expensive tri-amplified, horn-loaded system. In comparison with the currently trendy scaled down (and therefore compromised) models of large scale PA rigs, a pair of good columns exhibit the fine balance of delicacy and incisive 'punchiness' that is the hallmark of good mid-range and hence a good vocals speaker. Best of all, secondhand columns are available cheaply, being ostensibly 'out of fashion'.

When choosing a speaker cabinet, remember that you will have to carry it around! Today, there is rarely any intrinsic merit in owning a huge speaker stack, unless as a heavy metallist you demand an impressive and machismo stage set up; a well designed and sensibly small speaker enclosure can be just as loud and efficient as the monsters of the '60's. Again, listen to the sound of the speaker; a good cabinet will tend to produce a useful and acceptable sound without requiring much prompting from the amplifier's tone controls. Then stand back from the cabinet and try to judge how well the sound will *project* from a stage. Projection is all-important — don't forget that your audience *also* has to hear you! In particular, the low notes have a habit of disappearing as you move away from vented (reflex loaded) bass cabinets.

For many people, loudspeakers are as much a journey of self-discovery as the music they convey. You will only find the perfect speaker when you cease to be creative. Since the speaker is a part of your instrument, it deserves to be changed and toyed with as much as your guitar and your own ideas and feelings about music.

E&MM

WORKING WITH VIDEO

Andy Emmerson

This month we look at video discs, what they do, what they don't do, how they do it if they do it and how they will affect you.

It is easy to draw parallels between video discs and video tapes on the one hand and audio discs and tapes on the other. Some of these comparisons are valid, others are misleading. Audio discs are simpler to manufacture than tapes because the process is a relatively straightforward moulding/stamping operation as opposed to the long-winded business of recording a piece of tape, cutting it to length and assembling it inside a complex housing. The action of making a video disc is a far more expensive and precise activity than making an audio disc but it is still more straightforward than making a tape. It is also a faster process than making a tape: tapes are still made in 'real time'. In other words, if you are producing a two hour film it will take you two hours to copy the film from the master recording and additional time to finish the assembly. This time factor alone restricts the number of video cassettes that can be produced. Video discs can be produced as fast as the machine can turn them out and this should therefore make them a cheaper item to make, all other factors being equal.

Continuing our comparison, audio discs are replay-only devices, whereas with cassettes you can make your own recordings. Exactly the same applies in video - but video discs have not yet appeared in this country - we only have tapes. Whereas records outsell musicassettes this is not yet the case in video and it may never turn out that way. However, given the choice of video tape or disc, which would you choose?

The first point to appreciate is that the quality of reproduction offered by video discs and tape is not the same. Many people find the quality of reproduction of a home video recorder perfectly adequate but most would admit that broadcast TV is better. Video *discs* on the other hand promise pictures and sound every bit as good as broadcast TV, with the promise of full hi-fi sound (even stereo in some cases) or a selectable foreign language soundtrack. The *price* of video discs and their players should be less than that of tapes and video recorders, say a third or a half cheaper. All sorts of 'trick' features will be standard such as slow motion, perfect freeze frame, reverse, fast scan and random access. The contents of the disc can even be still

The Philips LaserVision (formerly VLP) video disc system, which will be launched in the UK in mid-1981. Designed for the modern home, LaserVision produces high-quality pictures and sound on any domestic colour television set. The player can simultaneously be connected to a hi-fi system for full stereo sound.

LaserVision (formerly VLP) is capable of a multitude of functions, all at the touch of a button and with no wear to the disc. These include freeze frame, varying slow motion speeds in both forward and reverse and rapid forward and reverse search, enabling any section of the disc to be found in seconds.

An exciting range of disc albums will be available when LaserVision is launched, including top feature films such as Alien, Star Trek — The Motion Picture and Saturday Night Fever.

pictures, up to 54,000 on one side! You could put an encyclopedia on a disc and access any individual page at random in less than 15 seconds.

With all these marvellous features there must be a couple of snags. Experience in the USA has shown picture quality to be variable due to poor disc pressings, though this can obviously be cured by better quality control. One side of a disc cannot contain a complete film, so you will have to interrupt your viewing to turn over, but this is not really a problem. No, the only real drawback with these devices is that *they cannot record!!* This is a serious disadvantage for the majority of video enthusiasts who use their video machines to 'timeshift', that is to record a favourite programme while they are away from home or even while watching another programme. Hopefully, some of the people who read this column are interested in things more creative such as shooting their own material, but once again this is something you cannot do with videodiscs. Even if films on video disc turn out to be as cheap as, say, £10, the cost of the special player (say £250 to £400) is likely to outweigh the attractions of the pre-recorded programmes. Some people will of course be able to afford both tape and disc machines, and market research indicates that people who are already into video (i.e. existing VCR owners) have a greater interest in owning both systems than people who don't have a VCR. On the other hand, three out of five VCR owners expressed no interest in video discs.

Later this year video disc equipment will come on to the UK market and it will be interesting to see if these predictions are fulfilled. In any case, the increased competition and awareness in video will benefit all video enthusiasts. It is extremely likely that the arrival of video discs will force down the cost of video tapes, both blank and pre-recorded, and machines may well become cheaper. The VCR manufacturers may even retaliate with a low-cost replay-only machine!

Finally, we ought to take a quick look at how video discs work. There is (predictably) more than one format and the three formats are (also predictably) totally incompatible. So discs made for one system will not be playable on machines of other types and considering the deals which manufacturers will make to sign up exclusive material for their own system this will probably reduce your choice of programmes, more so than with tape.

The three systems are known as VHD, Laservision and Selectavision. VHD is promoted by JVC and in this country by Thorn-EMI, so it seems set to enjoy the same success as their VHS system. The records are grooveless and the actual information is recorded by laser in minute pits. These are played back by a capacitance-sensing stylus which glides over the recorded surface. The stylus is guided not by grooves but by rows of even smaller pits on either side of the programme track. The disc itself is 10.2 inches in diameter and made of high-quality, conventional PVC, like an audio disc. To prevent contamination, the record must be handled in a protective sleeve.

System two was invented by Philips and is known as the Philips/MCA/Pioneer Laservision system. In this system the recorded information exists in the form of microscopic pits on the surface of a silvered disc, twelve inches in diameter. The silvered layer has its own built-in protective plastic surface - this avoids contamination from dust and all but the deepest of scratches. The pits are scanned optically, using a miniature laser. Again, there are no grooves.

The third system, Selectavision, is the property of the American RCA organisation and unlike the other two systems will not be available in Europe for some time. It lacks several of the impressive features offered by the other two systems because it has opted for a simpler but more restrictive method of operation. Like VHD it also senses capacitance variations as an electrode passes over microscopic pits in the disc surface. But, unlike VHD, the pickup travels in a physical groove which simplifies player technology but prevents freeze framing. The disc is also 12 inches in diameter and must be protected in a special sleeve.

Over the next few months you will hear a lot of claims and counter claims about discs and their merits - use this guide to form your own opinions. **E&MM**

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 3¼in 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.

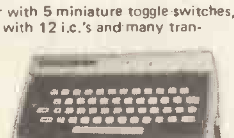
FRUIT MACHINE HEART. 4 wheels with all fruits, motorised and with solenoids for stopping the wheels with a little ingenuity you can defy your friends getting the "jackpot". £9.95. + £4 carriage.

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.

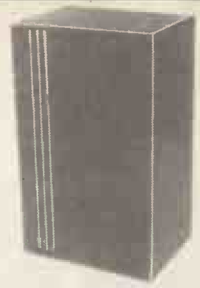
EXTRACTOR FANS — Mains Voltage
Ex-computer, made by Woods of Colchester, ideal as blower; central heating systems, fume extraction etc. Easy fixing through panel, very powerful 2,500 rpm but quiet running. Choice of 2 sizes, 5" £5.50. 6" £6.50. post £1 per fan.

KEYBOARD BARGAIN
50 computer type keys, together with 5 miniature toggle switches, all mounted on a p.c.b. together with 12 i.c.'s and many transistors and other parts, in a case but the case may be cracked or otherwise damaged.
£11.50 + £2 post. This is far less than the value of the switches alone. Diagram of this keyboard is included if you request it, or it is available separately. Price: £1.



*(Not licenceable in the U.K.)

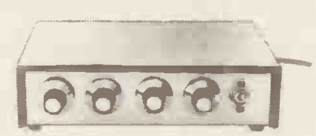
SUPER HI-FI SPEAKER CABINETS
Made for an expensive Hi-Fi outfit — will suit any decor. Resonance free cut-outs for 8" woofer and 4" tweeter. The front material is carved Dacron, which is thick and does not need to be stuck in and the completed unit is most pleasing. Colour black. Supplied in pairs, price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



Vu METER SNIP.
Approximately 1 5/8" square, suitable for use as a recording level meter power output indicator or many similar applications. Full vision front, cover easily removable if you wish to alter the scale. Special snip price £1.00, or 10 for £9.00.

MOTORISED DISCO SWITCH
With 10 amp changeover switches. Multi-adjustable switches all rated at 10 amps, this would provide a magnificent display. For mains operated 8 switch model £6.25, 10 switch model £6.75, 12 switch model £7.25.

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.



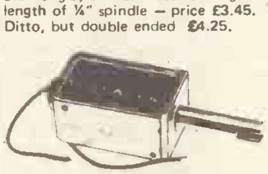
FLUORESCENT TUBE INVERTER
For camping — car repairing — emergency lighting from a 12v battery you can't beat fluorescent lighting. It will offer plenty of well distributed light and is economical. We offer Phillips inverter for 12" 8 watt miniature tube for only £5.25. (With tube and tube holders as well.

THIS MONTH'S SNIP

½ PRICE CABLES! Flat P.V.C. covered mains cables — for lighting and power instalations.

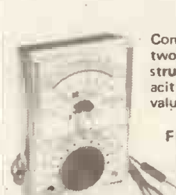
SIZE	TYPE	100 Mtres	CARRIAGE
1.5mm	Single	£ 3.95	£2.00
1.5mm	Flat twin	£ 6.50	£2.50
1.5mm	Flat three core & E	£ 9.85	£3.00
6mm	Single	£ 7.50	£2.50
4mm	Flat twim	£11.50	£3.50
6mm	Flat three core	£34.50	£4.50
16mm	Twin & E	£65 + £9.75	£10.00

12v MOTOR BY SMITHS
Made for use in cars, these are series wound and they become more powerful as load increases - they will in fact burn themselves out if overloaded to stopping point. Size 3½" long by 3" dia. These have a good length of ¼" spindle — price £3.45. Ditto, but double ended £4.25.



SOLENOID WITH PLUNGER
Mains operated £1.99
10 – 12 volts DC operated £1.50.

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.

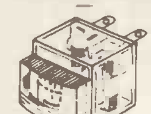


FREE Amps range kit to enble you to read DC current from 0 - 10 amps, directly on the 0 - 10 scale. It's free if you purchase quickly, but of you already own a Mini-Tester and would like one, send £2.50.

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"x5" speakers to match this amplifier.

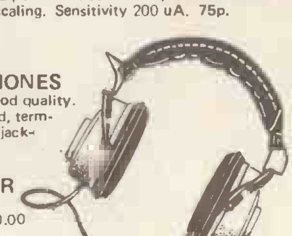
VENNER TIME SWITCH
Mains operated with 20 amp switch, one on and one off per 24 hrs. repeats daily automatically correcting for the lengthening or shortening day. An expensive time switch but you can have it for only £2.95. These are new but without case, but we can supply plastic cases (base and cover) £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

BURGLAR ALARM CONTROL PANEL
Contains labelled connection block, latching relay, test switch and removable key control switch. Simplifies the whole installation, all you have to do is to take wires to pressure pads and to alarm bell. Price £7.95, with complete diagram.

PRECISION MAINS OPERATED CLOCK
For only £1.99. Sounds unbelievable but that's what you can have if you send your order right away. The clocks which have large clear dials were made by the famous Smiths Company for use with domestic cooker/switch, brand new and guaranteed.

12V SUBMERSIBLE PUMP
Just join it to your car battery, drop it into the liquid to be moved and up it comes, no messing about, no priming, etc. and you get a very good head. Suitable for water, paraffin and any non-explosive non-corrosive liquid. One use if you are a camper, make yourself a shower. Price: £8.50.

POPULAR 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.

MINI MONO AMP on p.c.b., size 4"x 2" approx. Fitted volume control and a hole for a tone control should you require it. The amplifier has three transistors and we estimate the output to be 1 W rms. More technical data will be included with the amplifier. Brand new, perfect condition, offered at the very low price of £1.15 each, or 10 for £10.00.

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INSTRUMENT REVIEW

THE WERSI PIANOSTAR

The Pianostar will come as quite a surprise to the many people who have built Wersi organ kits over the years. Having established a high reputation in the organ world, it is an ambitious new direction for the company to take and in many respects they have succeeded in producing an upright piano that looks and more importantly feels like the traditional acoustic piano. But what is equally important is its innovative extras that take conventional piano principles and stretch the tonal and control possibilities to make the Pianostar suitable for many modern styles as well as classical music.

All this is a lot to expect from one instrument that has refined its electronics (without the use of microprocessors) to fit a remarkably small space. From the photographs, virtually all the electronics can be seen installed on one main rack. Ribbon cables and prewired connectors have done away with all tedious wiring and, apart from the two main dual speaker systems, foot pedals and main amplifier in the base, the whole piano has little to put together.

Except for the keyboard frame, of course, which forms the heaviest and undoubtedly the most critical item for the advanced pianist. A lot of attention has gone into the correct weighting of each key and its smoothness of action. The keys are pleasing to play, although Wersi are planning to update the existing keyboard with a further improved action developed in Italy for production kits. Keys have a firm feel and at first, seem to bounce back too much and prove difficult to manipulate trills. A good playing technique can produce acceptable classical music. It is easy to move from acoustic grand piano to Pianostar and say, "I told you so - not a bit like a 'real' piano". But so much of your decision probably comes from the evaluation of whether or not it's a typical piano 'sound' and Wersi have certainly tried to get this and more. For the player, other factors are important and keyboard sensitivity, harmonic modulation and dynamics should be as critical as tonal excellence.

Dynamic range is certainly as good, if not better (lacking mechanical noise except on very low output volume setting) than an acoustic instrument. Control of keys at pp levels is adequate, although equal sensitivity from one note to the next relies on careful mechanical contact setting-up. This is much improved on the usual 'velocity sensitive' configuration by the use of two 'rest' and 'operate' bus-bars for the key contact instead of two further contacts that often move out of line after a time, producing erratic note volumes.

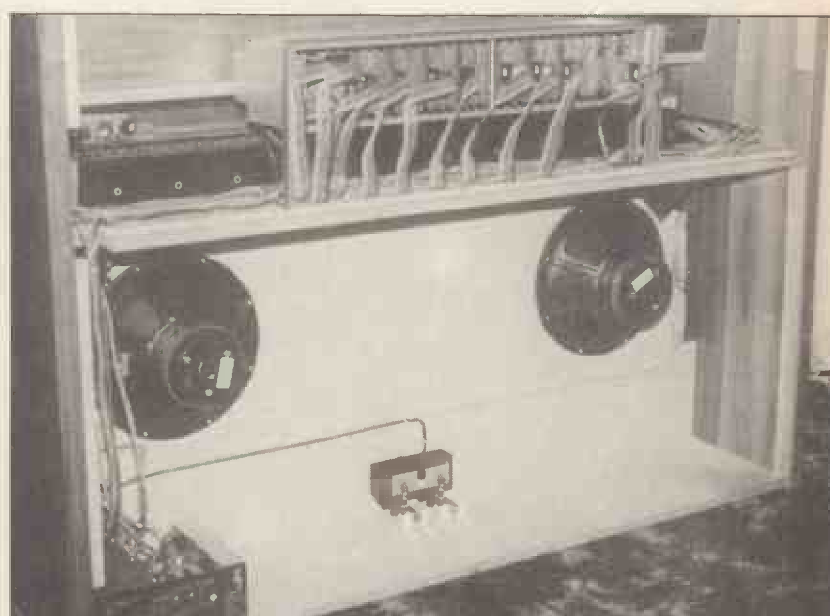
Pianostar S2000

Circuit Design

The Pianostar sounds are derived from a voltage controllable high frequency oscillator operating at about 1MHz. A correction frequency is fed via a top octave synthesiser IC and 16 to 1 line multiplexer. This frequency is differentiated and rectified, with the resulting DC voltage controlling the final HF pitch output. The multiplexer selects one of the 12 TOS frequencies from the BCD 4-bit code of the Transposer, enabling the whole piano to be tuned instantly to any interval. A Pitch control matches tuning over several semitones to other instruments and Vibrato, Hawaii and Slalom all function by sending appropriate control voltages to the HF oscillator.

The HF signal is then passed to a pre-scaler section that divides the basic frequencies for the 12 notes of each octave on Channel 2. It also goes via a programmable fractional divider before another frequency divider produces the notes for Channel 1. This enables Channel 1 to be de-tuned against Channel 2 at calculated intervals up to a perfect 5th. Electronic keying of the fully polyphonic keyboard ensures clean production of all the pitches.

Dynamic volume and envelope shaping are set at this stage, with the latter dependent upon Banjo and Sustain switches and the speed of transition of the key contact from the 'rest' bus-bar to the 'operate' bus-bar.

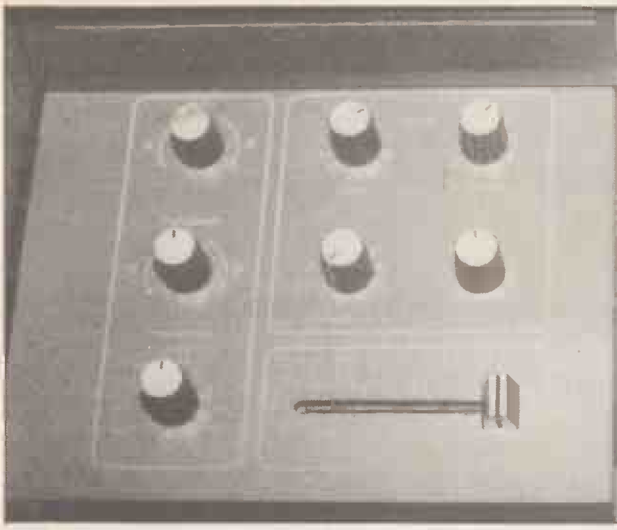


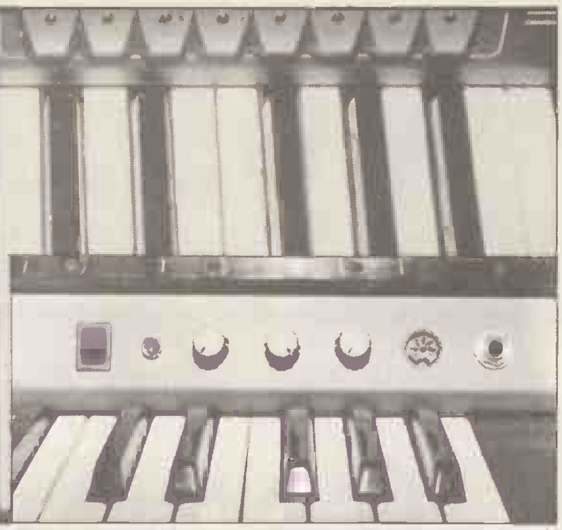
Back removed showing the electronics.

The critical resistor for sustain time is chosen for each key to match the decay of equivalent piano strings. At this point, too, comes the control logic (through CMOS gates) for switches, sustain and pedals.

Both channels then go through their individual filter sections containing two types of circuitry. The first filter accepts the 'raw' signals produced by the keying circuits and shapes the preset voices. The second filter produces a sine wave from keyed frequencies to make the 'Stage Piano' voice. One active filter is used on octaves 1, 2 and 3 with separate filters on the rest.

The channel outputs are finally treated by separate VCFs before going to pre-amps containing volume and tone controls (also noise gates). The S2000 takes these signals to two


Left hand controls.


Right hand controls.


Envelope shape board taken from mounting rack.

hybrid amplifier modules and a relay is used to effect switching to headphones.

Performance Features

Playing the Pianostar for the first time at Wersi's superb showrooms in Germany, I was immediately impressed by its stereo image received. The wide spacing of the speakers that are powered by 2 x 100 Watt amplifiers gave a surround sound stereo piano that was truly exciting. The maximum power output seemed overrated but did give enough bass to shake the ceiling at home and would be plenty for regular gigging in restaurants and hotels.

Like the best electric pianos, it uses two-oscillator tuning to achieve its harmonic modulation similar to a piano's vibrating strings. But it uniquely provides de-tuning at set degrees from a single control. Besides giving the very slight pitch differences required for de-tuning to produce the superb stereo 'chorus-like' effect, without which the notes sound dull, it also enables automatic tuning for each preset as well as interval separation of the third, fourth and fifth between the left and right channels. The potential of these larger intervals is great with solo monophonic playing, especially jazz, but its use in polyphonic music is restricted to bell-like effects and complex note clusters for the more avant-garde experimentalist.

Coupled with instant pitch transposition for putting a piece into any key - ideal for accompanying trumpets, clarinets and saxophones with music all in the same pitch - the 'Slalom' slider gives polyphonic glide down an octave and 'Hawaii', at the touch of the left foot pedal, gives that well-known semitone glide up to the note. In addition, this pedal can operate Vibrato (slow/fast, heavy or light) while the right pedal gives the expected sustain.

An interesting feature, situated with these controls at the left end of the keyboard, is filter control. A low pass filter can be modulated using its Speed control to give a continuously changing tonal effect set by Resonance, Frequency Cut-off and Amplitude (depth of modulation) controls. At slow speeds this creates deep swirling qualities associated with polyphonic synthesisers and at higher speeds produces tremolo and wah-wah, that can be made to 'bubble' at maximum Resonance and Speed. A button also selects 'Keyboard follow' for the filter, opening it up on progressively higher notes and interesting on a sequence of low to high chords for its sudden tonal changes. A combination of vibrato and filter modulation on piano tones gives some pleasant vibraphone effects.

There are eight presets that produce distinctive percussive tones: the Rock Piano is bright on top but thinner on bass; the Stage Piano is the most mellow and nearest to classical piano except in the lowest registers which tend to be lacking in bright harmoncis; the Kinura has boosted high harmonics to give a great punchy and penetrating sound; Banjo is really banjo - even the action of the piano seems different (through envelope keying) - but you'll have to do strumming yourself by rapid reiteration (hard work!); Harpsichord and Cembalo (the latter couples two octaves of Harpsichord) are very authentic; Honky-Tonk puts the de-tuning to maximum use (incidentally, all de-tuning is set appropriately for each preset on normal 'automatic' setting) for all pub piano enthusiasts; and Piano gives a brighter overall sound compared with Stage Piano.

During playing, it's better to stick to one preset for classical music choosing Stage Piano or Harpsichord more frequently than the rest, but for modern music the choice of tones (including mixed combinations of presets) make the instrument very satisfying to play.

Each preset button has an LED indicator built in and a similar set of buttons control Octave coupling as well as Hawaii, Vibrato and VCF.

Finally, the right hand controls provide total Volume setting for the built-in amp/speaker system or stereo headphones, Bass boost and Tape playback level, with on/off switch, 5-pin Din record/playback for stereo tape and headphone jack socket close by. The tape facility is ideal for electronic music recording and also allows you to play along with any accompaniment.

The cabinet is factory made with a well polished wood veneer finish and tasteful speaker cloth. No castors though - you have to slide its quite heavy weight on glide buttons. You'll never open the lid to see inside, for the whole of the back's thick hardboard panel unscrews instead. The electronics construction has been well thought out, with the main rack section and the keyboard sliding out for easy access. Circuit boards with clear legends take components supplied in labelled packs and the assembly manuals have enough information for all but the most inexperienced constructor.

A portable version, the Pianostar T2000, is also available without amps and speakers. The keyboard range is reduced from seven octaves to six and the cabinet is finished in black rexine and a heavy moulded plastic material. This version measures 26 x 52 x 112 cms and comes with stand and separate pedal unit, whilst the upright model is 102 x 58 x 145 cms.

Conclusion

Probably the best way to make a final assessment is to try the Pianostar yourself at one of Wersi's showrooms or listen to it being played by their expert German demonstrator, Hady Wolff on E&MM's Demo Cassette No. 3.

My criticisms are few - low notes tend to be a little woolly on Stage Piano, which is generally a very usable rich sound; the lowest octave with non-piano presets like Cembalo (using added low octave) is best avoided and, in any case, would not be part of the range of its original instrument. Slight transformer buzz was completely solved by reseating it in its case and the only playing problem was in avoiding transient clicks from preset buttons by switching them when keys are released (and sustain off).

The upright piano model S2000 kit represents best value at £1,273.00 (inc. VAT) with complete cabinet and built-in amplification. The portable T2000 is £1,225.00 (inc. VAT) with 5 Watt stereo monitor, headphone, and preamp outputs. Ready made prices are £2,102.00 and £2,038.00 respectively.

The instrument gives a lot of pleasure by virtue of its variety of sounds and will be an ideal compliment for any lounge, be it a family living room or hotel, and a versatile electronic instrument for professional or home recording studios.

Mike Beecher E&MM


Pianostar T2000

Organ Talk

Ken Lenton-Smith

FRANZ IN CONCERT

The virtuoso performer and Wersi demonstrator Franz Lambert toured the U.K. some weeks ago and I was among a party from E&MM that attended his first concert here - at the Fairfield Halls, Croydon.

Programmes were not available so I surmise that Franz changes his programme according to location and as the mood suits him. After the show at Croydon he was to perform at eight other centres and, as the Franz Lambert Fan Club tends to follow him in his travels, he may well like to leave his choice of programme wide open. Certainly, he gave his Croydon audience a very wide range of music - possibly with the accent on serious music. The audience in the Fairfield Halls appeared to be a mixture of his fans and organ lovers generally, not forgetting representatives of the Press!

The tour had been organised by Aura Sounds of Purley and the concert we attended was - with one minor criticism - a well-staged, interesting and exciting occasion. Sitting ready on stage were the Galaxy and Helios organs with the new Pianostar electric piano between them. On each side of the stage were percussion kits: timpani, gong, bells, bongos, glock and other traps occupied one side, the other having a full rhythmic kit including synth drums.

Rather unusually, the two Wersi organs were back-on to the auditorium but a large, angled mirror behind the instruments allowed the concert-goers a back view of the organist. Additionally, a remote-controlled colour TV camera was directed on the keyboard and its signal shown on eight monitors at the sides of the stage. These viewing aids gave the audience the opportunity to see the rapid changes in registration continuously taking place.

Six 100W speaker cabinets were ranged along the back of the stage and this gave more than ample volume on the louder passages and appeared to be set to accentuate the lower frequencies. It certainly did justice to the Galaxy, though the Helios lacked the same level of reverberation. I appreciate that each hall has its own acoustic characteristic, which alters with an audience in place: this was, of course, the first of a series of concerts and subsequent performances may well have seen alterations to the PA arrangements.

Franz Lambert and his percussionist, Kurt Bong, arrived on stage and the Galaxy was used to open the show with a Fanfare - of Trumpet Voluntary flavour, with timpani. It was not possible, because of the oblique view afforded by the CCTV, to be precise about the registrations used: in any case, Wersidata was no doubt in constant use (a random access preset system fitted to these organs). Thus I can only give a general indication of the tones the organist used.

Franz Lambert

An ABBA number in rock tempo followed, mainly using third harmonic percussion, after which the tempo slowed for a 'cascading strings' melody. The Galaxy is a three-manual instrument with just about all the facilities one could wish for and, from the moment the concert began, the organist was demonstrating not only his own prowess but also the capabilities of the organ itself.

After the applause for the first session had died down, a German compère addressed the audience - and here I must make a criticism. Broken English through a rather bassy, reverberated amplification system is extremely difficult to follow. He also addressed Franz Lambert in German across the stage and even a smattering of that language was no help at all. Bearing in mind that Franz plays in the USA, I would respectfully suggest that this brilliant organist speaks at least one English phrase - and possibly changes his compère when away from home! I was reminded of the occasion when I first tried out an early Wersi organ and was completely at sea because every control was labelled in German.

Returning to the performance itself, Dvorak's 'Ninth Symphony' began with synthesised strings and the well-known theme became a cor anglais solo (well-known, that is, to lovers of Hovis!). The reprise was in polyphonic brass with string accompaniment. Today's organ having become orchestral rather than solely imitative of its pipe counterpart, instruments like the Galaxy offer great scope to the more seriously-inclined musician in re-arranging the classics. This appears to be Franz Lambert's strong point, the Ninth Symphony being executed with exquisite expression.

'Japanese Lantern' was evocative of Geisha Girls and cherry blossom. Phased strings with 5⅓' tone added set the theme in rubato tempo, changing into heavy swing in organ tone for the final choruses. The location was then changed by Tchaikowsky's 'Capriccio Italien', heralded by a mournful trumpet with strings as backing against a slow bolero rhythm.

To prove to the many organists in the hall just how it should be played, 'Tico Tico' was the next offering. Franz chose to register in straight 'electronic organ tone', no doubt because from the era of Ethel Smith this is how we have always been used to hearing this famous samba. Kurt Bong also capitalised on this number with a very lively solo in the percussion department. I guess that 'Tico Tico' elated the non-players in the audience, but left the practical musicians somewhat downhearted! Despite a raging tempo, the organist's keyboard technique was faultless and breathtaking.

Cat Stevens' 'Morning Has Broken' began with chimes, which appeared to be a percussed flute mixture with odd harmonics, the tune being played by a most realistic oboe. The theme was repeated by the 'string orchestra' in a grand and expressive manner. 'Elizabethan Serenade' was registered in woody flute harmony with white noise for the accompaniment, the melody in synthesised strings.

Moving over to the Helios organ, a selection from the European Hit Parade was played with rock backing by Kurt who had also moved over to his rhythmic kit. This medley allowed liberal use of the synth drums but for the most part Franz kept his registration in organ tone.

'Flight of the Bumble Bee' was another of the organists special arrangements, combining a brilliant demonstration of the man and his instrument. Franz managed to register his organ so that an incisive and insistent bee gyrated round the hall.

A swing medley, mainly based on 'C Jam Blues' was to follow and was much in the style of Jimmy Smith - with percussed third harmonic prominent. This part of the performance modulated into 'Sweet Georgia Brown' with the solo taken on a *very* windy jazz flute: although there was probably too much white noise added, the effect was interesting nevertheless.

Returning to the Galaxy, Franz and his percussionist prepared to play 'If I Could Be a King', making great play of the fact that they were turning to sheet music - to the amusement of the audience. This arrangement employed brass, horn, string and harp arpeggios: the latter, and indeed many of the solo voices, are a great credit to Wersi's engineers.

"Gemutlichkeit" was how the compère introduced Franz Lambert's 'Nutties Selection' (I translate this as giving a feeling of satisfaction or well-being). This part of the programme was a rock and roll romp for both performers - mostly Country & Western numbers that are well-worn but allowed the use of banjo, train whistles and plenty of corn!

Lennon and McCartney compositions, surely among the best to emerge in the last couple of decades of popular music, were used in the penultimate medley. A boisterous version of 'She Loves You' gave way to a plaintive oboe solo of 'Yesterday': that particular sound, which must be synthesiser based, is total realism on the Wersi organ. 'Michelle' was also in haunting vein, the solo being taken by trombone with a string backing. A rollicking version of 'Yellow Submarine' was followed by the breathy flute being used again for 'Hey Jude'. This selection ended as it began with 'She Loves You' - but not before Kurt had taken a drum solo lasting several minutes, lambasting everything within reach including the synth drums!

The final part of the show was another of the organist's special arrangements - 'Sabre Dance' by Khachaturian, expertly played on the Galaxy. This began with a lament played on rolling strings, then turned to Baroque organ style in counterpoint. The theme was prestissimo in organ tone with a fair amount of dissonant harmonics: the full dynamic range of the organ was brought into play and the performance can only be described as scintillating.

The audience would not let the artists leave the stage until two encores had been heard - a fast gallop, followed by a slow number on the electric piano. No doubt Franz finds it advisable to wind his audience down before it emerges into the world of reality again.

This concert was highly enjoyable, combining first class musicianship and instruments. It was also proof of the change in character of the entertainment organ in recent years into an orchestra at the fingertips.

Few organists ever achieve the expertise shown at this concert, but anyone interested in electronic music can build a Wersi organ.

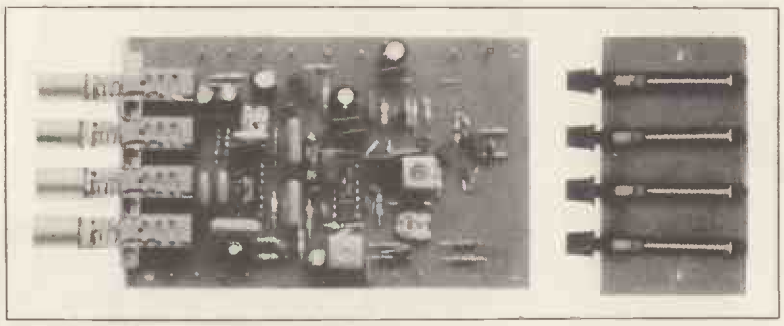
Some readers may not be aware of the existence of a club that consists of organ builders, working both to their own designs and on kits. The Electronic Organ Constructor's Society is a non profit-making organisation which was founded twenty years ago. The Society holds regular meetings in London, Manchester and elsewhere and publishes The Electronic Organ Magazine which it circulates to a world-wide membership.

Details of membership may be obtained by sending a stamped, addressed envelope to Ralph Purdy (Membership Secretary), 11 The Avenue, Station Road, Billericay, Essex CM12 9HH.

E&MM

HI-FI

Jeff Macaulay



Bi-Pak FM main board and tuning panel.

Something Old? Something New?

Sony have taken out a patent on a speaker system. Nothing new in that you may think but there you'd be wrong! This speaker is the first of a new generation of 'digital' speakers.

To understand how it works though, we have to understand how audio signals can be digitally encoded.

Sound consists of a pressure wave that travels in air. If a suitable transducer, a microphone, picks these signals up, its output will consist of an electrical voltage whose amplitude will rise and fall in sympathy with the pressure wave (the sound) that impinges on it. If this signal is examined on an oscilloscope, a complex ever-changing voltage level will be seen. Conventional audio equipment operates with amplified levels of this original voltage.

There is, however, another way in which this signal can be encoded. Before describing this in detail it will be as well to define just what we are trying to encode. Sound levels in a live concert can vary by a ratio of 10,000:1 in amplitude. This is known as the signal's dynamic range.

The frequency range that must be covered extends from 20Hz to 20kHz, a thousand to one ratio. Digital recording works by sampling the waveform at a very high frequency and encoding its instantaneous amplitude.

Now computers cannot count in tens like us, they only know two numbers, 0 and 1. 1 represents a high voltage level and 0 an absence of voltage.

At first sight this seems extremely limiting but in fact a computer can count quite easily with just these two levels. In our conventional number system (decimal) large numbers are represented by thousands, hundreds, tens and units, i.e. powers of ten. The computer equivalent uses powers of two (binary). For example, consider the computer number 1001100. Note that only 0 and 1 appear. The key to translating this back to a decimal number is shown below:

2^6	2^5	2^4	2^3	2^2	2^1	2^0
64	32	16	8	4	2	1
1	0	0	1	1	0	0

Note that the number is read from left to right and contains 1-64, no 32's or 16's, one 8, one 4, no twos and no 1's. By adding up what we have we find that the number is 64+8+4=76. Notice that instead of tens, hundreds, etc. (i.e. powers of ten) each column advances by a power of two.

Our music signal has a dynamic range of 10,000:1 and to encode any of the possible levels between these limits we must be able to count up to 2^{14}, 16,384. Now each of our columns contains a bit of information which is either 0 or 1, so we can say that each of our samples requires 16,384 bits of information. Having settled this, all that has to be established is the sampling rate.

Luckily this can be readily determined because of the work of a gentleman named Nyquist who showed that the maximum frequency that can be completely recovered when modulated on a carrier is exactly half that of the carrier. So to encode our highest frequency audio signal we need a carrier of 40kHz minimum.

Our digitally encoded signal then consists of a 14-bit binary code that changes 40,000 times per second. The most successful commercial digital recording equipment, the Soundstream, uses a 16-bit code and a sampling rate of 50kHz.

Once in digital form, the program has to be translated back to analogue in order for it to be heard, which raises the natural question 'Why bother in the first place?' The answer is simple. For a start, once the signal has been recorded in digital form, it won't deteriorate in any way. No compression is required since the full dynamic range can be accommodated; and last, but by no means least, the S/N ratio is greatly improved.

Unfortunately the problem of converting the digital code back to analogue form remains. At present this is done with D/A converter chips and the resulting signal is then recorded on a conventional analogue disc. All this brings us back to where we started with Sony's new speaker.

The innovative idea behind this system is to dispense with moving coil speakers and conventional amplifiers and replace them by compressed air drivers. Basically a tank of compressed air is fed via electromechanical valves to 'Horns' which vent into the listening room. There are 14 of these horns and the control for the air flow valves is obtained directly from the incoming digital 'word'.

When a logical one is applied to the valve it opens for the duration of the pulse allowing air to enter the horn. If things are arranged so that the air pressure pulse produced at the horn connected to the most significant digit is 2^{14} times stronger than that at the least significant digit, then the combined pressure valve produced by the horns will be an exact replica of the input before it was digitally converted. In other words, the whole system operates as a powerful digital to analogue converter without the need for a separate amplifier.

A fascinating idea and one which we will all no doubt hear more of in years to come. It is not altogether new though.

At the turn of the century, a mechanical amplifier using compressed air was invented, which worked on similar principles. The 'drive unit' consisted of a slotted, fixed plate with a comb which was free to slide across it. Compressed air was blown through the plate and the comb was mechanically linked to the record stylus. As the stylus moved the comb across the fixed plate, the air pressure varied in sympathy with the groove modulations producing sound. The device was coupled to an acoustic horn to provide amplification.

Commercial versions of this equipment were on sale in 1906 and for reasons that are somewhat obscure, it was named the 'Autexaphone'.

A commentator of the time reported that the sound could be heard for two or three miles in calm weather which must have meant a hefty SPL was being generated.

The analogy to an electronic amplifier can be more readily appreciated if one remembers just how these work. A conventional amplifying device modulates an external power source, a DC supply. This modulation is controlled by the input signal. Thus an amplifier functions as a copying device. In the air driven speaker, the pressurised air is analogous to the DC supply. The input signal is the mechanical movement of the comb and the output is modulated air pressure changes (sound).

Hi-Fi, Lo-Cost

There are several ways one can acquire a decent hi-fi system. The most obvious (and expensive) is to trail around hi-fi stores and, after listening to various combinations, part with your well earned cash. Another way, is to assemble the projects featured in this and other magazines. A third, very much underestimated method, is to assemble a stereo system from ready made modules, many of which are excellent in value and performance.

One such module I have recently come into contact with is an interesting example of this approach. Bi-Pak have established an excellent reputation over the years for the reliability and performance of their amplifier modules so it was with great interest that I received the new S453 FM tuner module.

Like it's predecessor, the S450, this module consists of two PCBs, one of which holds the guts of the tuner, and the other the four 100k multiturn presets which control the varicap tuning.

Also in common with the S450, tuning is accomplished by means of four pushbuttons. Although this means that only four FM stations can be selected, this isn't a major drawback. For those who wish to experiment it is not too difficult a problem to add further stations by using a separate switch bank.

One of the great things about this tuner is its small size, the large PCB is only 125 x 80mm. The tuning PCB is 45 x 80mm. Adding the unit to an existing installation is simple since the unit requires a supply voltage between 18-25V and has a current consumption of 45mA. In many cases a suitable supply rail will already be available and the tuner can then be run via a simple network consisting of a dropper resistor and decoupling capacitor.

So much for the mechanics. Now, how does it sound? To find out I built the module together with a simple PSU into a Verocase in which it was a fairly tight fit. After the usual debugging exercise, in my case the elimination of an earth loop, I was most impressed with the performance. While it is not the most sensitive tuner that I have ever tested, adequate stereo reception of all the major stations with good signal to noise ratio was obtained. Stereo separation was extremely good (Bi-Pak quote 30dB). What is more important though is a tuner's ability to produce a good stereo sound stage with the subtle depth of effects intact. This the tuner can do. Technically the unit employs a discrete front end with an IC limit/demodulator stage. Stereo decoding is carried out by the ubiquitous PLL IC. Stereo operation incidentally can be bypassed by fitting an external switch.

In conclusion, a fine product which can be recommended for those who wish to obtain a good tuner and are prepared to do some mechanical work themselves. The price is £19.53 exclusive of VAT and should be available during August from Bi-Pak Limited. **E&MM**

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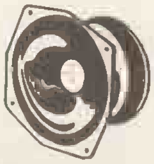

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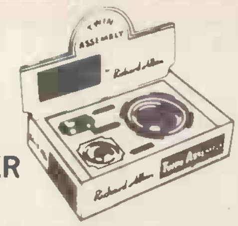

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Advanced Music Synthesis

So it's a good programme?

Dave Bristow

Whilst it is essential to understand the mechanics and logic of the instrument you play, the end product, making music, should be the prime consideration. There is only one way of monitoring progress to this goal, and that is by ear - so for the short time it takes to read this article, unplug the mental oscilloscopes and warm up the ears and fingers!

There is more to synthesis than good programming; the sound has to be delivered and it is this area which is often neglected by both players and manufacturers. It is easy to become infatuated with the novelty and wide variety of sounds available from synthesisers without developing their musical potential and it seems to me that manufacturers are taking too long to design and produce good key-board-actions for otherwise good synthesisers, by which this potential can be realised.

During the course of my consultancy and demonstration work for Yamaha, I find myself at many European Trade Fairs where all makes of synths. are on show and technology rules supreme! TV displays, computer interfaces and illuminated panel indicators are surrounded by rows of faders and buttons, yet, midst all this sophistication, there will probably be a 4 (or maybe 5) octave keyboard, F to F, badly sprung, the action of which is similar to any department store chord organ!

Design began to improve with the Yamaha CS80, and the GSI action is even better but these are the exception rather than the rule. However, despite the manufacturers' slowness to meet our needs in this area, there are still techniques which keyboard players need to develop in order to utilise fully synthesisers currently on the market, and to enable them to deliver carefully programmed sounds with maximum effect. These are: control of the various means of expression and the use of differently tuned oscillators requiring some harmonic investigation. These skills are as much part and parcel of the modern synthesists' technique, as programming and should not be overlooked, so I should like to consider them in more detail.

Playing Technique

Most monophonic or duophonic synthesisers seem to function in such a way that any release time set on the envelope generator controlling the VCA or VCF has to be allowed to complete before the successive note will operate according to the programmed attack time. As most of many workable solo synthesiser sounds in the woodwind, reed, brass and string area require a very small release time (this is just as important to the musical nature of the sound as the gentle attack time), a playing technique needs to be developed in which each key is released before the next is depressed, even in legato playing. This way, each note will have the full benefit of the envelope programming and the front of the notes will not 'clip'. Pianists do not normally play legato in this manner and it takes some practice to develop this technique, but the rewards in the form of more authentic imitative and musical sounds are well worth the effort. Even grace notes should be played in this way - set up a brass sound on a monophonic synth. and compare normal legato playing with "every note released" legato. The difference will be very noticeable, the careful playing giving more credibility to the programme. Tapping the fingers on a table, ensuring that each one is lifted before the next one taps, will help develop this 'push and release' finger-style approach to the synthesiser keyboard and significantly broaden its musical potential.


Dave Bristow and Gary Luenberger at the Yamaha test studio, Japan.

Some polyphonic synthesisers (the ones I use are the CS80 and the new GS1) have independent pressure sensors on each key to control volume, timbre, LFO modulation etc. In order to maximise the potential of this refinement, it is necessary to develop a controlled *"after pressure"* in all fingers of both hands, which for most keyboard players is a novel requirement. The skill is very easily developed by resting the fingers and thumb on a firm surface (as if on the keys of a piano) and pressing each one down firmly in turn, without ever lifting them from the surface. Although this facility is only available on a few synths, the effect is very good, allowing inside or top single lines to be brought out in a chordal movement.

Generally, introducing LFO modulation or VCO, VCF and VCO control is done via mod-wheels, pitch wheels, levers and ribbons, and foot-pedals. Competent use of these controls requires practice and thought. The 'click' of self-centring pitch wheels is not always too apparent and the fingers need to be sensitive to the position of the wheels. It is important to know the pitch span (i.e. 1 tone, 3rd interval, octave) of any pitch device, and whether it has a linear or logarithmic effect in order that musical bends can be consistent and thus make a pitch bend of a given interval instantly. The use of LFO modulation is also very important. For instance, the introduction of LFO modulation on a flute sound should have more effect on the timbre (VCF) and amplitude (VCA) than on the pitch (VCO), whereas, with a violin sound, modulation should mainly effect the pitch (VCO). Choosing the correct speed, depth and area of influence (VCO, VCF or VCA) enables LFO modulation to be carefully incorporated into programmes or introduced during playing via wheels, levers, or pedals, or pressure on the keys and will bring an instrumental performance to life, broadening its musical value.

Another area that should be explored, and is unique to synthesists, is the possibility of obtaining 2 or more notes from one key, where more than one VCO per note is provided with the instrument. This effect is of course more interesting where duophonic or polyphonic instruments are concerned and it can be rewarding to investigate the harmonic possibilities through combining specific pitches. The best interval to begin with is the fifth, this being the first different harmonic in the series. For instance, playing a major third interval with the two oscillators for each note tuned apart, will sound a major 7th chord - a minor 3rd interval will be a minor 7th.

The only note which brings in an out-of-scale 5th is B. Two note combinations of any other notes will sound interesting and give useful harmonies directly related to the root key. Playing more than two notes requires more investigation of course, but if your instrument has this facility then it should not be ignored. The relative volumes of the two oscillators is also an important factor - if one is significantly lower than the other, then there is an effect of "ghost" harmonies, not unlike the effect of harmonics on a Hammond seeming to change the mood of any given chord. This is another musical area waiting to be explored, but don't expect the instrument to produce it alone - choose the right notes, and be aware of the extra combination of notes you are producing by detuning the oscillators.

I hope that the tone of this article expresses my belief that the synthesist is more important than the synthesiser and that the correct interpretation of a sound and good playing of the keyboard is every bit as important as the logical construction of the programme. Generally, programming is considered to be part of the synthesist's job as a musician but this need not necessarily be so. Over the last eighteen months, I have been involved with the development and presentation of Yamaha's latest polyphonic synthesiser, the GS1, and in the case of this instrument, programming and playing have become completely separated. The instrument has presets (although these can be interchanged from a voice-card library system), all the programming being done at the factory. In order to present the instrument with my band at the Frankfurt Trade Fair last February, I spent some days programming suitable voices at the factory, but after this, during the shows, no alteration to the voices was possible. The result was an enforced freedom from knob twiddling and button pushing that I found totally relaxing, and this coupled with an 88-note keyboard and an action like a grand piano, enabled me to concentrate 100% on the delivery of the music - and that's what it is all about.

Programming the GS1 was, I must admit, quite an experience but one I would rather relate on another occasion, leaving you to think about your skills as a synthesiser player and performer rather than a synthesiser programmer. And I would like to ask the manufacturers generally this question: Do your synthesisers as musical instruments, have the qualities that these skills will ultimately demand? **E&MM**

America

Ian Waugh

As promised last month, a few more goodies for the guitarist plus more info about the ultimate drummer . . . I didn't realise Jane Fonda played drums . . .

Guitarists first. MXR have an Effects Loop Selector made from die-cast aluminium which allows the guitarist to choose between two effects systems while running into a single amplifier. The unit requires no separate power unit and a circuit is included to minimise 'pop'. It can also be used to choose between speaker or amp arrangements and retails at $25.

A similar unit is available from Roger Eddy at $24.95. You pays your money . . .

The Think Tank has been working overtime at Whirlwind Music and come up with the 'ultimate' guitar lead. Called the Constrictor — known in the trade as the 'augmented cord' — it consists of 20 inches of coiled lead attached to 10 feet of straight lead. The 20 inches extends up to 10 feet, too, giving a total lead 20 feet long which should not get snarled around your feet. Made from cured neoprene cable by Belden, the Constrictor is designed to pass signals with the minimum of cable noise.

New from Stars Guitars is their Star Grinder which is a distortion unit designed for retrofit in electric guitars. A pot allows a mix between straight and distorted guitar and an optional bypass switch is available. A single 9-volt battery is required and the unit should fit most control cavities.

The HF-4 Hot Foot Active Gain Pedal from Polyfusion runs from a 9-volt battery which is activated by plugging in a cord. The volume output level is adjustable from unity (input and output signal) to 12dB (four times original power). It has a high impedance input and low impedance output. The tension on the pedal's movement is adjustable. The HF-4 sells for $99.95 from BKL.

Fast-Fret from Kenyon is an applicator stick designed to clean and lubricate guitar strings. It is applied by rubbing the applicator along the strings. Excess can be wiped off with the cloth supplied; the solution does not harm guitar finishes and it is non-toxic.

Linn LM-1 Drum Computer.

There are literally dozens of 'small' amps on the market designed either for use in small rooms or as practice amps. Most of them will give good quality output at low levels. The latter are much more common and the Zeus model 8401 (has *everyone* got a computer working on new product names?) is one of many worth considering. It provides 1 watt of clean power and 2.5 watts of overdriven signal from its internal speaker. Tone and volume controls are included and the preamp can add up to 21dB of boost to the guitar's signal. The entire unit is only 7½" x 3" x 1¾", is housed in an aluminium case and is powered by 8 small batteries (an AC adapter can be used). It costs $64.95.

For those who think nostalgia ain't what it used to be, Echoplex have re-introduced their tape echo with tubes. Their EP-6T uses the same basic circuitry as the original EP-2 but has a PCB. After many years of solid-state construction the new unit is deemed to fulfil a long-felt demand. It is available to special order (6-8 weeks) from Market Electronics.

The Peavey EQ-27 has, would you believe, 27 frequency bands each spanning ¼ octave. All 27 slide controls have centre dents and provide for + 15dB boost and cut. All inputs and outputs have transient, over-voltage, and short-circuit protection. The voltage regulator protects against power variations. The unit has a bypass switch and is rack-mountable.

. . . Talking about drummers . . . The PAiA Programmable Drum Set now has improved memory circuitry which allows the 'save' mode to hold rhythm patterns for over a year while battery life for normal operation has been extended to several hundred hours.

Right! This is it! Introducing the LM-1 from Linn Electronics. This sophisticated, yet easy to operate machine, contains actual drum sounds recorded digitally in its computer memory. It holds up to 100 drumbeats and these are programmable in real time. Drums include snare, bass, hi-hat, cabasa, tambourine, two congas, two tom-toms, cowbell, clave and hand claps. Programming features include automatic error correction, programmable dynamics, flams, rolls, build-ups, open and closed hi-hat, etc. Special timing circuitry is included to give a 'human' feel to the drumming and all time signatures are possible (including the one our drummer plays after a bottle of rye and a Pepsi). The LM-1 has versatile editing facilities and rhythm patterns can be linked together into complete song formats. All programmed parts can be retained in the memory when power is switched off and programmed data can be stored on cassette. Other features include a 13 output stereo mixer with volume, pan and separate outputs for each drum. The pitch of each drum can be individually adjusted and the unit can be used to overdub on tape and sync to almost anything. The bad news is the price — $5,500. Not too expensive, really, when you consider the flexibility of the unit but possibly other manufacturers will see a market here and introduce their own models. It doesn't *look* quite as pretty as Jane Fonda but then if looks were important our drummer would be peeling potatoes. This is certainly a unit to look at, especially for electronic music composers and enthusiasts. Warren Cann of Ultravox is reviewing this for us.

Next month we'll give guitarists' pockets a rest and see what else is going on in America.

Companies and manufacturers mentioned:

MXR Innovations, 740 Driving Park Ave., Rochester, NY 14613, also Atlantex Music Ltd, 34 Bancroft, Hitchin, Herts SG5 1LA;

Roger Eddy, 1330 Miles Ave., Pacific Grove, CA 93950;

Whirlwind Music Inc., P.O. Box 1075, Rochester, NY 14603;

Stars Guitars, 818 Folsom St., San Francisco, CA 94107;

BKL International Distributing, Box 248, Neptune, NJ 07753;

Kenyon International, Box 10185, El Paso, TX 79992;

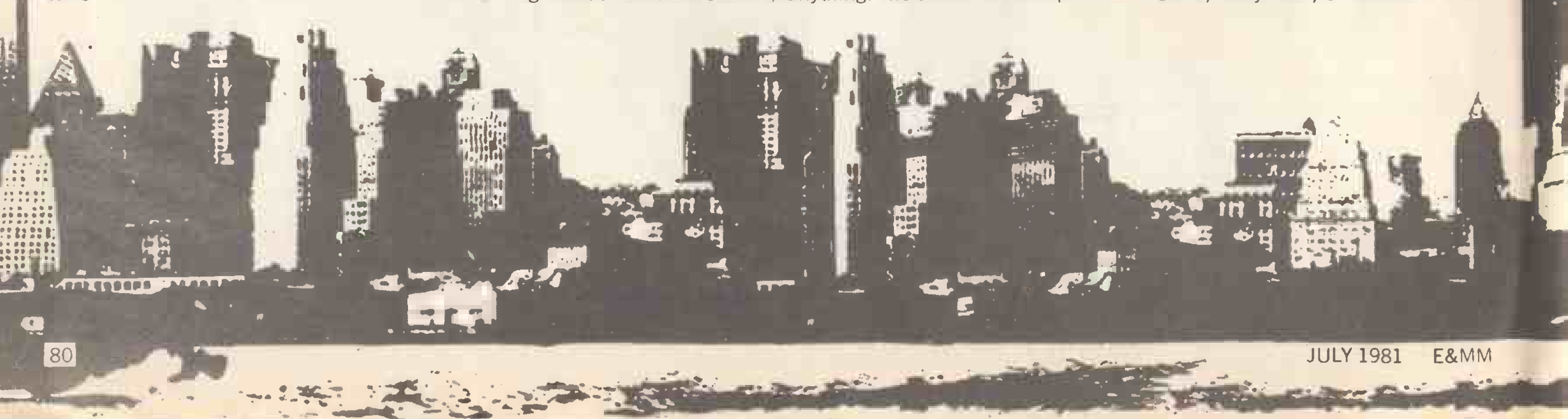
Zeus Audio, 511 S. Palm Ave., Alhambra, CA 91803;

Market Electronics, 38367 B Apollo Parkway, Willoughby, OH 44094;

Peavey Electronics, 711 A St., Meridian, MS 39301;

PAiA Electronics, 1020 W. Wilshire Blvd., Oklahoma City, OK 73116;

Linn Electronics Inc., 3249 Tareco Drive, Hollywood, CA 90068. **E&MM**



RECORD REVIEW

Computer World
by Kraftwerk
EMC 3370

Earlier this year, EMI Records (UK) signed Kraftwerk and here is their first LP release for this company, which is just in advance of the group's first UK tour since 1976.

The concept of the album is that it IS the Computer World, and its titles range from 'Computer Love' to 'Home Computer' and 'It's More Fun to Compute'.

For many people, Kraftwerk create in their music an impression of robot composers sitting rigidly at vast banks of controls. This 'robotic feel' seems to have been the group's trade mark since the No. 1 success of 'Autobahn' (single and album) in 1974 on the Vertigo label. The double album 'Kraftwerk' preceded this although it really contained more sound effects rather than pure electronics. Other records have been 'Ralf and Florian' (named after Ralf Hutter and Florian Schneider who make up the present group with Wolfgang Flur and Karl Bartos), 'Radio Activity' (1975), 'Trans-European Express' (1977) and 'The Man Machine' (1978) with the latter three on the Capitol label. Two Vertigo compilation albums may also be of interest 'Exceller 8' (1975) and the recent 'Elektrokinetik'.

This latest album has been recorded at Kraftwerk's Kling Klang Studio in Dusseldorf. At the same time, the Kling Klang studio was being modified to be transportable on tour. Giant video screens have been specially made for the visuals, but for now it's the music that remains our focal point.

The title of the main track 'Computer World' introduces a musical phrase that dominates the whole LP. In the Key of E minor here, it has the notes G\D\B/E (the diagonals indicate an upward or downward movement of pitch).

Kraftwerk don't often name on LPs the equipment they use, probably because a lot of it's custom built. No particular synthesiser sound is evident, although the sequencer controlled melodies usually have dry percussive pizzicato string tones at centre stereo, enabling a repeated echo of the sequence to be heard in syncopation at the left hand stereo position.

The only words sung on the record are on 'Computer World' and 'Computer Love'. Any other speech either comes from vocoder treated human voice as in 'It's More Fun To Compute' or as computer processed speech. The rather limited vocabulary of their speech board is evident on the opening track with the words 'address, numbers, money, people, time, travel, pre-ignition and entertainment', (perhaps they've not seen E&MM's Wordmaker yet!)

Repetition plays a major part in the music of Kraftwerk and is very evident on 'Computer World'. The use of simple harmony is another element that either attracts you through its simplicity and 'primitive' flavour or, through its lack of development and same dynamic level throughout, may not inspire you. And the question that most of the 'still inspired' listeners ask is, 'Did it really take three years to put this LP together'? Surely not, so perhaps we should regard the purpose of it is to set an 'image' for the future. Certainly, computer speech and musical calculators are here to stay and the whole feeling of automated music comes from the open and simply structured pieces.

The E minor harmony of 'Computer World' has one change to G minor for the words 'Interpol and Deutsche Bank' (using the melody G/A/Bb Bb\A F/G\D).

'Pocket Calculator' is amusing to listen to and utilises interjections from Casio and Texas calculators in between 'I'm the operator with my pocket calculator . . .' Placement of sounds is not important in the music, but a dominating syncopated repeated Ab note catches attention at stereo centre whilst the bass line holds on to octave Bb's. Against the bass comes Ab harmony that often sounds like a suspended 4th chord when the melody 'Ab/C/FF\Ab/C/EbEb\D' appears.

'Numbers' uses one to eight count speech in various languages over

repeated random sampled notes and deep grunting bass riff. Some panning is noticeable and timed echo too. This piece runs into 'Computer World' again using instruments only except for a fade out on jumbled computer speech running at fast clock rate.

'Computer Love' has the 'Computer World' theme in G minor. This piece builds up nicely and has an interesting electronic drum rhythm. In fact, the best feature of this record in terms of electronic music is its subtle use of electronic drums — the phased/flanged cymbal is unusual and the clarity of the 'bubbling melodies' that occasionally appear makes them effective. The simple harmony does pay off as well, with the G minor chords receiving a strong C vocal note that holds the listeners' attention. Only one new melody appears on notes 'D/G\F\D\C\Bb/C/D/G—\D'.

'Home Computer' has the most in it for me and is cleverly put together on a 'C/Eb\Bb/Db' bass that introduces a 'Dr. Who glass harmonica' solo sound. Despite the one chord basis (C minor), the sequences are well thought out and are controlled from rising ramp waveforms. One contrasting four-note motiv (Ab/Bb/Eb\D) leads to ring modulated oscillator sweeps and flanging is prominent on drums which hold the music together.

'It's more fun to compute' really shows off Kraftwerk's electronic cymbal and suitably emphasises that their music although simply built-up (using C/Eb\Bb/Db\C—C\Bb G/D\C— sustained melodies throughout C minor harmony) can be effective.

Their tour commences on June 15th in Manchester with dates all over the UK ending in London on July 3rd. We all wait to see whether Kraftwerk in person will actually appear on stage or whether as their record implies will be replaced by the 'Computer World'.

Mike Beecher
Dave Townsend

E&MM

BOOK REVIEWS

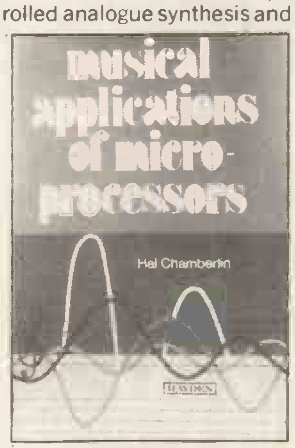
Musical Applications of Microprocessors

by Hal Chamberlin
Published by Hayden Book Co Inc.
Price £14.85

Here's a book that is truly for the E&MM 'Electro-Musician' of the future. I haven't stopped reading it since I picked it up (some time ago I must confess!). Its 600 pages are packed with the most up-to-date information on making electronic music through your micro and it really does give practical examples that will give you numerous building blocks for experiment.

Although many computer music techniques have been developed since the 1960's, their widespread use in electronic music production and their possibilities of interfacing with commercial and kit synthesisers are only just being realised. This is not to say that we shall have to wait a little longer for computer music composition to become feasible for the 'ordinary' musician working with limited financial resources. In fact, the hardware is available, as this book proves, and all the reader needs in addition is an understanding of BASIC, machine code and peripheral interfacing.

The first section of the book covers background material, analogue and digital musical synthesis principles as well as introducing specific micro-systems from Z-80 to 6502. The second section deals with computer-controlled analogue synthesis and the

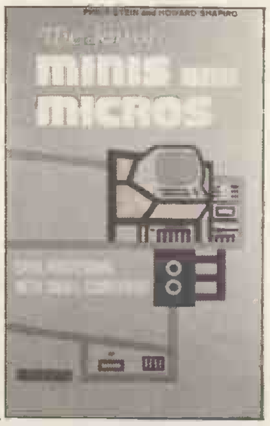


final part has digital synthesis and sound modification.

In particular, it teaches the reader the vital controlling and interfacing techniques needed to link your Pet, Sharp or popular micro to input/output ports and shows practical ADC and DAC circuits as well as possible keyboard matrix scanning systems. (This month's 'Alphadac 16' uses this type of application.)

The book uses minimal mathematical theory and maximum circuit examples and/or sample programs — from organ interfacing to percussion generation. Finding the answers to using the electronics is the stumbling block for many musicians and this superbly written book with accurate wave diagrams and circuits will be a tremendous help.

Mike Beecher



The Joy of Minis and Micros

by Philip Stein and Howard Shapiro
Published by Hayden Book Company Inc.
Price £5.95

An odd title but a book full of constructive advice, easily digested wit and many a true word on the faults that can accompany the sort of computer destined for the consumer market.

The book is typically American in format using an abundance of clichés, puns and sheer lunatic headings to introduce each section, but it is this kind of informal approach that lends itself so well to a subject that has become over-rated and over-publicised.

At last here is a book purposely written for those who do not own a micro-computer. A book which aims to resolve the computer's usefulness or role and if necessary advise against purchasing such a unit without even an inkling of what to do with it when you have bought it.

The subjects covered are:— Do you or don't you need a mini-computer? What about main frames or micro-computers? How to pick the right mini-computer? (and it is here that such considerations as which language do you require or do you need time sharing, are considered). Hooking it up with the rest of the world (I think they mean interfacing). But what are you going to use it for? And a very brief chapter on how does it work?

It is 100 per cent devoid of any form of illustration which judging by most American books is another point in its favour. From a software point of view, there is very little unexplained, however, I must underline the fact that it is only a preliminary guide to the subject and at no point goes into deep or gory detail.

The main text is preceded by an incredible 20 verse poem, the purpose of which is quite obscure — even having read the book. Nonetheless, my advice is if you are thinking of purchasing a home computer some time in the near future then this is certainly as good a volume as any to choose in an effort to start you off in the right direction.

Nigel Fawcett

Electronics Pocket Book

by E. A. Parr
Published by Newnes Technical Books
Price £5.60

The fourth edition of this popular reference book has been completely rewritten in an attempt to cope with an electronics technology that progresses at an astonishingly rapid rate. Since making its first appearance eighteen years ago, the book has seen the simple germanium transistor technology of those days grow into the sophisticated microprocessor chip systems of today. Indeed, one is reluctant to produce a reference book these days for fear it will be outdated before even leaving the printers' press. I must give full marks to Mr Parr for achieving considerable success in producing a book that is up to date yet retains some of the more 'old fashioned' techniques upon which the technology is still based.

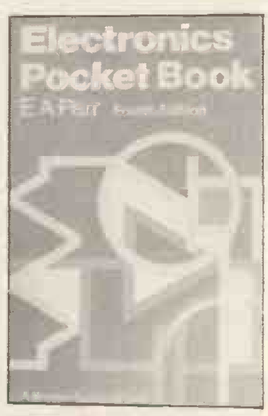
In his preface, the author states the book's unchanged philosophy of 'a non-mathematical presentation of the many varied topics covered by electronics'. This I found, generally, to be so. Although no claims are made for completeness (and indeed who would be so bold as to try to write a complete book of electronics today) I found the wide range of topics covered quite surprising.

The various sections dealing with, for example, basic atomic structure, electronic components, simple circuits to more advanced computer circuits, power supplies etc., are concisely presented but perhaps, a little too brief in parts.

Nice to see Teletext and Prestel mentioned but disappointing to find no reference to glass-fibre optics as a communication means — currently being introduced by British Telecom and undoubtedly the data transmission medium of the future. The usual reference data section is included at the end of the book.

Summarising: A book of use to the student and enthusiast as well as of possible use to the designer for quick reference. However, for detailed information, reference elsewhere would be required.

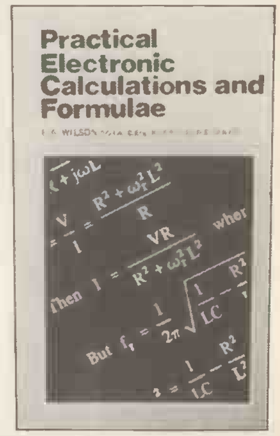
Anthony M. Ball



Practical Electronic Calculations and Formulae

by F. A. Wilson
Published by Bernard Babani
Price £2.25

Almost invariably the books that are reviewed in the various electronic periodicals consist of project books, teach yourself books or theory books. Whether you are a newcomer to the subject, a budding amateur or even a fully fledged professional, it is virtually impossible to remember or recall all the mathematical calculations and formulae required to bring your various electronic designs to a fruitful conclusion. There are many publications that cover this aspect of electronics and



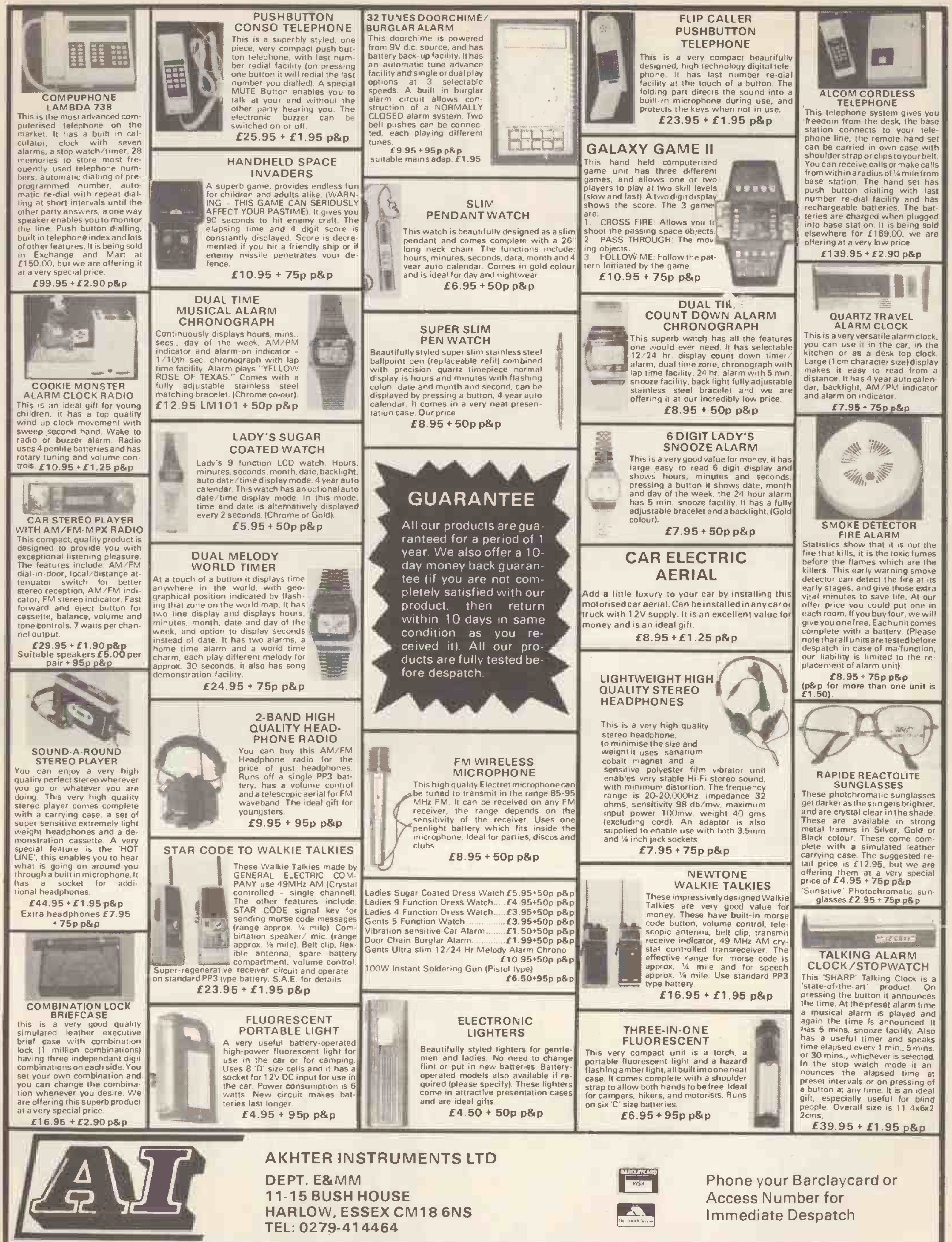
make very handsome items of support documentation to compliment the other books on your bookshelf but in my opinion F. A. Wilson's "Practical Electronic Calculations and Formulae" stands out on its own. It is an excellent book and has been compiled to suit all levels of technical knowledge. If the arithmetic involved is likely to be too advanced then maximum use has been made of tables and graphs.

It is primarily a reference book and has been divided into six sections: Units and Constants, Direct Current Circuits, Passive Components, Alternating Current Circuits, Networks and Theorems, and Measurements. You will notice that these sections follow the format applied to teach-yourself or elementary theory books on electronics.

The amateur should never feel that having to refer to books such as this is indicative of his not being able to grasp the subject fully. The fact is professionals always make good use of reference books because the more involved one becomes in electronics, the more confusing and similar the methods of calculation become.

It would be impossible for me to give a brief outline of the contents or even to precis the subjects covered within the text - it quite simply covers the lot. Every symbol, every constant, every unit of mensuration is there for those who have never quite been able to grasp those complicated formulae involving vectors, time lag and phase difference, which are so common in AC theory, this is the book for you as I have never seen a better approach to or explanation of this very difficult area.

Nigel Fawcett


COMPUPHONE LAMBDA 738
This is the most advanced computerised telephone on the market. It has a built in calculator, clock with seven alarms, a stop watch/timer, 28 memories to store most frequently used telephone numbers, automatic dialling of preprogrammed number, automatic re-dial with repeat dialling at short intervals until the other party answers, a one way speaker enables you to monitor the line. Push button dialling, built in telephone index and lots of other features. It is being sold in Exchange and Mart at £150.00, but we are offering it at a very special price.
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This doorchime is powered from 9V d.c. source, and has battery back-up facility. It has an automatic tune advance facility and single or dual play options at 3 selectable speeds. A built in burglar alarm circuit allows construction of a NORMALLY CLOSED alarm system. Two bell pushes can be connected, each playing different tunes.
£9.95 + 95p p&p
suitable mains adap. £1.95
FLIP CALLER PUSHBUTTON TELEPHONE
This is a very compact beautifully designed, high technology digital telephone. It has last number re-dial facility at the touch of a button. The folding part directs the sound into a built-in microphone during use, and protects the keys when not in use.
£23.95 + £1.95 p&p
ALCOM CORDLESS TELEPHONE
This telephone system gives you freedom from the desk, the base station connects to your telephone line, the remote hand set can be carried in own case with shoulder strap or clips to your belt. You can receive calls or make calls from within a radius of ¼ mile from base station. The hand set has push button dialling with last number re-dial facility and has rechargeable batteries. The batteries are charged when plugged into base station. It is being sold elsewhere for £169.00, we are offering at a very low price.
£139.95 + £2.90 p&p
HANDHELD SPACE INVADERS
A superb game, provides endless fun for children and adults alike. (WARNING - THIS GAME CAN SERIOUSLY AFFECT YOUR PASTIME). It gives you 90 seconds to hit enemy craft. The elapsing time and 4 digit score is constantly displayed. Score is decremented if you hit a friendly ship or if enemy missile penetrates your defence.
£10.95 + 75p p&p
SLIM PENDANT WATCH
This watch is beautifully designed as a slim pendant and comes complete with a 26" long neck chain. The functions include: hours, minutes, seconds, data, month and 4 year auto calendar. Comes in gold colour and is ideal for day and nightwear.
£6.95 + 50p p&p
GALAXY GAME II
This hand held computerised game unit has three different games, and allows one or two players to play at two skill levels (slow and fast). A two digit display shows the score. The 3 games are:
1. CROSS FIRE: Allows you to shoot the passing space objects.
2. PASS THROUGH: The moving objects.
3. FOLLOW ME: Follow the pattern Initiated by the game
£10.95 + 75p p&p
COOKIE MONSTER ALARM CLOCK RADIO
This is an ideal gift for young children, it has a top quality wind up clock movement with sweep second hand. Wake to radio or buzzer alarm. Radio uses 4 penlite batteries and has rotary tuning and volume controls. £10.95 + £1.25 p&p
DUAL TIME MUSICAL ALARM CHRONOGRAPH
Continuously displays hours, mins., secs., day of the week, AM/PM indicator and alarm-on indicator - 1/10th sec. chronograph with lap time facility. Alarm plays "YELLOW ROSE OF TEXAS." Comes with a fully adjustable stainless steel matching bracelet. (Chrome colour).
£12.95 LM101 + 50p p&p
SUPER SLIM PEN WATCH
Beautifully styled super slim stainless steel ballpoint pen (replaceable refil) combined with precision quartz timepiece normal display is hours and minutes with flashing colon, date and month and second, can be displayed by pressing a button, 4 year auto calendar. It comes in a very neat presentation case. Our price
£8.95 + 50p p&p
DUAL TIME COUNT DOWN ALARM CHRONOGRAPH
This superb watch has all the features one would ever need. It has selectable 12/24 hr. display count down timer/alarm, dual time zone, chronograph with lap time facility, 24 hr. alarm with 5 min. snooze facility, back light fully adjustable stainless steel bracelet and we are offering it at our incredibly low price.
£8.95 + 50p p&p
QUARTZ TRAVEL ALARM CLOCK
This is a very versatile alarm clock, you can use it in the car, in the kitchen or as a desk top clock. Large (1cm character size) display makes it easy to read from a distance. It has 4 year auto calendar, backlight, AM/PM indicator and alarm on indicator.
£7.95 + 75p p&p
LADY'S SUGAR COATED WATCH
Lady's 9 function LCD watch. Hours, minutes, seconds, month, date, backlight, auto date/time display mode. 4 year auto calendar. This watch has an optional auto date/time display mode. In this mode, time and date is alternatively displayed every 2 seconds. (Chrome or Gold).
£5.95 + 50p p&p
6 DIGIT LADY'S SNOOZE ALARM
This is a very good value for money, it has large easy to read 6 digit display and shows hours, minutes and seconds, pressing a button it shows date, month and day of the week, the 24 hour alarm has 5 min. snooze facility. It has a fully adjustable bracelet and a backlight. (Gold colour).
£7.95 + 50p p&p
GUARANTEE
All our products are guaranteed for a period of 1 year. We also offer a 10-day money back guarantee (if you are not completely satisfied with our product, then return within 10 days in same condition as you received it). All our products are fully tested before despatch.
CAR STEREO PLAYER WITH AM/FM-MPX RADIO
This compact, quality product is designed to provide you with exceptional listening pleasure. The features include: AM/FM dial-in-door, local/distance attenuator switch for better stereo reception, AM/FM indicator, FM stereo indicator. Fast forward and eject button for cassette, balance, volume and tone controls. 7 watts per channel output.
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Suitable speakers £5.00 per pair + 95p p&p
DUAL MELODY WORLD TIMER
At a touch of a button it displays time anywhere in the world, with geographical position indicated by flashing that zone on the world map. It has two line display and displays hours, minutes, month, date and day of the week, and option to display seconds instead of date. It has two alarms, a home time alarm and a world time charm, each play different melody for approx. 30 seconds, it also has song demonstration facility.
£24.95 + 75p p&p
CAR ELECTRIC AERIAL
Add a little luxury to your car by installing this motorised car aerial. Can be installed in any car or truck with 12V supply. It is an excellent value for money and is an ideal gift.
£8.95 + £1.25 p&p
SMOKE DETECTOR FIRE ALARM
Statistics show that it is not the fire that kills, it is the toxic fumes before the flames which are the killers. This early warning smoke detector can detect the fire at its early stages, and give those extra vital minutes to save life. At our offer price you could put one in each room. If you buy four, we will give you one free. Each unit comes complete with a battery. (Please note that all units are tested before despatch in case of malfunction, our liability is limited to the replacement of alarm unit).
£8.95 + 75p p&p
(p&p for more than one unit is £1.50).
LIGHTWEIGHT HIGH QUALITY STEREO HEADPHONES
This is a very high quality stereo headphone, to minimise the size and weight it uses sanarium cobalt magnet and a sensitive polyester film vibrator unit enables very stable Hi-Fi stereo sound, with minimum distortion. The frequency range is 20-20,000Hz, impedance 32 ohms, sensitivity 98 db/mw, maximum input power 100mw, weight 40 gms (excluding cord). An adaptor is also supplied to enable use with both 3.5mm and ¼ inch jack sockets.
£7.95 + 75p p&p
SOUND-A-ROUND STEREO PLAYER
You can enjoy a very high quality perfect stereo wherever you go or whatever you are doing. This very high quality stereo player comes complete with a carrying case, a set of super sensitive extremely light weight headphones and a demonstration cassette. A very special feature is the 'HOT LINE', this enables you to hear what is going on around you through a built in microphone. It has a socket for additional headphones.
£44.95 + £1.95 p&p
Extra headphones £7.95 + 75p p&p
2-BAND HIGH QUALITY HEADPHONE RADIO
You can buy this AM/FM Headphone radio for the price of just headphones. Runs off a single PP3 battery, has a volume control and a telescopic aerial for FM waveband. The ideal gift for youngsters.
£9.95 + 95p p&p
FM WIRELESS MICROPHONE
This high quality Electret microphone can be tuned to transmit in the range 85-95 MHz FM. It can be received on any FM receiver, the range depends on the sensitivity of the receiver. Uses one penlight battery which fits inside the microphone. Ideal for parties, discos and clubs.
£8.95 + 50p p&p
RAPIDE REACTOLITE SUNGLASSES
These photchromatic sunglasses get darker as the sun gets brighter, and are crystal clear in the shade. These are available in strong metal frames in Silver, Gold or Black colour. These come complete with a simulated leather carrying case. The suggested retail price is £12.95, but we are offering them at a very special price of £4.95 + 75p p&p
'Sunsitive' Photochromatic sunglasses £2.95 + 75p p&p
STAR CODE TO WALKIE TALKIES
These Walkie Talkies made by GENERAL ELECTRIC COMPANY use 49MHz AM (Crystal controlled - single channel). The other features include: STAR CODE signal key for sending morse code messages (range approx. ¼ mile) Combination speaker/mic. (range approx. ⅛ mile). Belt clip, flexible antenna, spare battery compartment, volume control. Super-regenerative receiver circuit and operate on standard PP3 type battery. S.A.E. for details.
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Gents 5 Function Watch £3.95+50p p&p
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Door Chain Burglar Alarm £1.99+50p p&p
Gents Ultra slim 12/24 Hr Melody Alarm Chrono £10.95+50p p&p
100W Instant Soldering Gun (Pistol type) £6.50+95p p&p
NEWTONE WALKIE TALKIES
These impressively designed Walkie Talkies are very good value for money. These have built-in morse code button, volume control, telescopic antenna, belt clip, transmit receive indicator, 49 MHz AM crystal controlled transreceiver. The effective range for morse code is approx. ¼ mile and for speech approx. ⅛ mile. Use standard PP3 type battery.
£16.95 + £1.95 p&p
TALKING ALARM CLOCK/STOPWATCH
This 'SHARP' Talking Clock is a 'state-of-the-art' product. On pressing the button it announces the time. At the preset alarm time a musical alarm is played and again the time is announced. It has 5 mins. snooze facility. Also has a useful timer and speaks time elapsed every 1 min., 5 mins. or 30 mins., whichever is selected. In the stop watch mode it announces the alapsed time at preset intervals or on pressing of a button at any time. It is an ideal gift, especially useful for blind people. Overall size is 11 4x6x2 2cms.
£39.95 + £1.95 p&p
COMBINATION LOCK BRIEFCASE
this is a very good quality simulated leather executive brief case with combination lock (1 million combinations) having three independant digit combinations on each side. You set your own combination and you can change the combination whenever you desire. We are offering this superb product at a very special price.
£16.95 + £2.90 p&p
FLUORESCENT PORTABLE LIGHT
A very useful battery-operated high-power fluorescent light for use in the car or for camping. Uses 8 'D' size cells and it has a socket for 12V DC input for use in the car. Power consumption is 6 watts. New circuit makes batteries last longer.
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ELECTRONIC LIGHTERS
Beautifully styled lighters for gentlemen and ladies. No need to change flint or put in new batteries. Battery-operated models also available if required (please specify). These lighters come in attractive presentation cases and are ideal gifts.
£4.50 + 50p p&p
THREE-IN-ONE FLUORESCENT
This very compact unit is a torch, a portable fluorescent light and a hazard flashing amber light, all built into one neat case. It comes complete with a shoulder strap to allow both hands to be free. Ideal for campers, hikers, and motorists. Runs on six 'C' size batteries.
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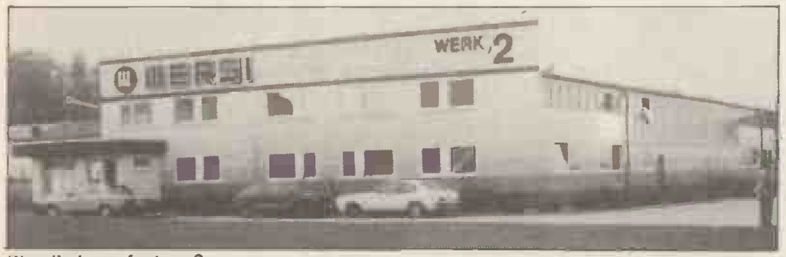
INDUSTRY PROFILE

Wersi Electronics

Wersi main showrooms, factory and offices in Halsenbach.



Wersi's large factory 2.


IBM computer system for administration and customers orders.

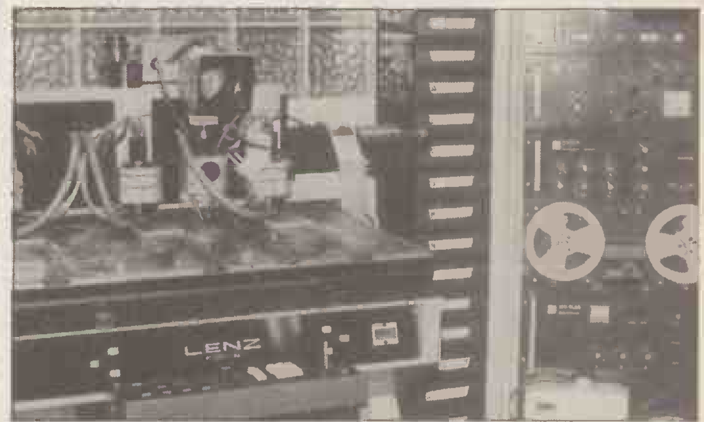
The story of the German Company of Wersi Electronics began in 1968 when the priest from St. Goars on the Rhine asked a well known young electronics expert in the town, Reinhard Franz, to repair his electronic organ. Wilhelm Franz, his older brother, quickly recognised the potential of setting up a business in the field of electronic music. They both worked intensively on the idea of developing an electronic organ with the newest technology down in the cellar of their parent's house in Werlau. Soon the first Wersi organ was made and in 1969, the Company premises were established in the small town of Halsenbach near the Lorelei Rock on the river Rhine.

Here, the team of young engineers produced electronic organs as do-it-yourself kits with easy-to-follow assembly manuals. The idea of building a home electronic organ not only appealed to the German public, but quite unintentionally from the outset brought the Wersi kits to many people who initially could not play, as well as to the enthusiastic hobbyist and professional musician.

The last ten years have seen the continued development of the company, with a second factory built in 1974 for constructing the cabinets and larger mechanical parts. A third factory is now being erected to cope with the increased production and marketing of Wersi kits to many parts of the world.

Wersi now employs over 300 people and has nine retail outlets in the Federal Republic of Germany, nine distribution offices in Europe and the USA as well as ten worldwide representatives. In the UK, two companies provide the personal service that is needed for kit sales and after-sales advice: Aura Sounds Ltd. in Purley, Barnsley and Birmingham; Electro-Voice Sales Ltd. in Rickmansworth, Nottingham and Ipswich. In many respects, their commitment to customers is a long standing one, for the larger kits are often built over a considerable period of time.


Screen printed etch-resist circuit boards.



Computer controlled PCB drilling speeds production.


Legends are screen-printed by Wersi.


Plastics moulding plant with (inset) a finished item.

Factory 2 main cabinet construction areas.

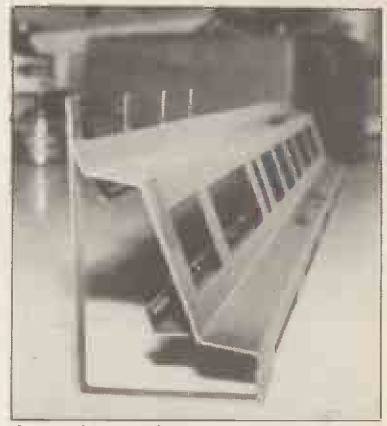
Selecting suitable wood veneers for cabinets.

Preparing rexine covered cases.

Varnishing speaker cabinets.

Factory made wiring harnesses save a lot of construction time.

Putting components into labelled bags.



A complex metal part.

Component packing department.

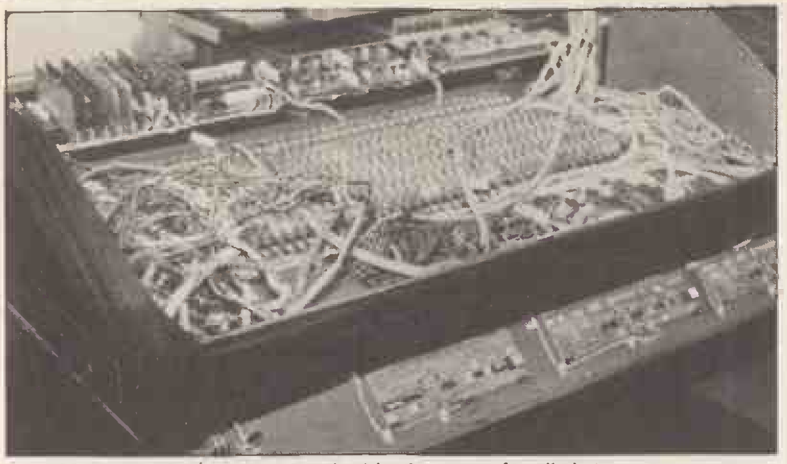
For the future, Wersi plan to sell more of their kits in Africa, South America and Australia. Reinhard Franz has only just returned from promoting his products in Tokyo at the first German 'Musik Messe' in Japan, where organ kits seem to be unheard of.

Today Wersi offers a whole range of kits for electronic music making, from the portable 'Entertainer' single-manual organ at £250 to the huge 'Galaxy' organ costing £7,546. The concept of the Wersi kit is to provide modules that are built individually with little or no electronic knowledge. All the small component parts come in separate numbered packs that are referred to in the step-by-step instructions. These modules are then easily wired together through factory prepared multi-wire harnesses, thus eliminating one of the biggest chores in organ construction. Finally, nearly all of the cabinets are hand-made at their second factory in Halsenbach.

In terms of sound and materials, the Wersi organ and range of speakers, mixers and sound processors represent high quality although the proof of this was best shown to me when I visited their German showrooms and factories recently.

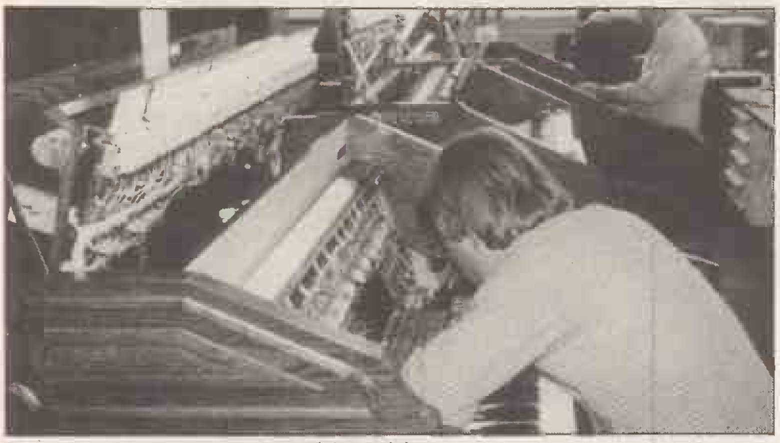
The friendly hospitality of the German company was more than evident during the whole of our two day visit (accompanying me was Arthur Griffiths of Aura Sounds Ltd). In the main factory we visited the drawing office, component packing departments, circuit board manufacture and despatch areas. At the second factory was the huge cabinet assembly plant and large component storage including ready-made instruments which have 'laser-assisted' component board assembly. Here too, are the research and service departments. Finally, we returned to the sales offices and showrooms.

One of the most important criteria for the company's success in its attention to the supply of best quality components. All electronic and mechanical parts are tested thoroughly. Often, special grade ICs from Texas, Motorola, Phillips and others are prepared for Wersi to

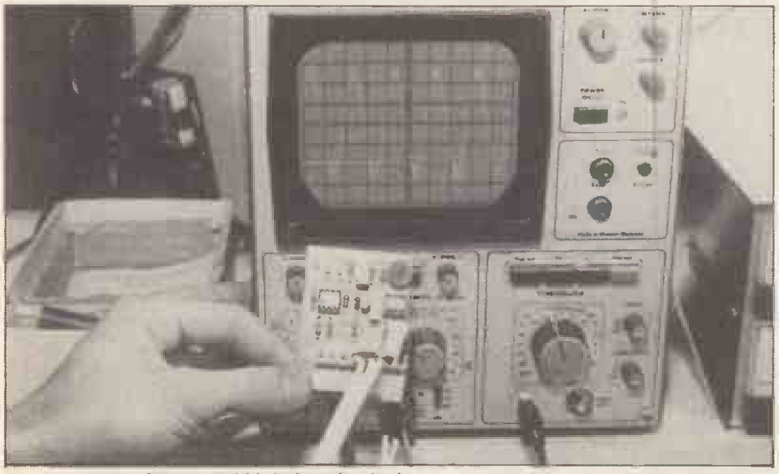


A large organ kit during assembly with wiring harnesses installed.

The improved keyboard mechanism for the Pianostar.



Easy access to all parts makes servicing quicker.



The new Noise Gate board kit being checked.

Development boards for cymbal and side drum.

ensure that the specification of their kits is maintained.

From the start, integrated circuits were used in kit designs, one of the first chips being ITT's SHA110 device. The full organ range was restructured from the beginning of 1977, covering 1 to 3 manual concert instruments that utilise TTL, CMOS and LSI technology. In all, some 45 patents exist for the circuitry including the 'Sound Computer' which enables up to 64 registration switch settings on the organ to be electrically programmed with EAROMs (Electrically Alterable Read Only Memory) for instant recall at the touch of a button. Literally every switch and tab on the organ from sustain, delay, vibrato to Leslie speaker has a DC control voltage to enable this. Microprocessors will certainly become part of Wersi organ technology for facilitating control of rhythms, voicing and registration.

The electronic keying circuitry is also patented and produces clean sounds from multiple registration and virtual silence otherwise (better than 65dB over the whole instrument at full volume) plus variable attack and sustain — a joint development by Wersi and Texas Instruments.

Wersi's chief engineer, Wilfried Dittmar (also a classically trained organist!) and his team often produce add-on extras to the standard kits that immediately up-date the models. Recent additions include a 'breathy' flute stop with noise filter control, a stereo noise gate that shuts down outputs in between playing, a realistic metallic cymbal, improved snare-drum and the Pianostar S2000 (reviewed this month).

Features such as 13 harmonic drawbars, rhythm tempo presets, drum break emphasis, key click, arpeggios, glissandos, contracussion, multi-preset registration, polyphonic octave slide, transposition, slalomatic, full auto-accompaniment, string orchestra and electronic rotating baffle effects all help to make the Wersi organ as commercial as possible.

Wersi developments include original circuit board mounting stop tabs with self-cleaning contacts, BBD chorus and choir effects, power amps, cabinet construction allowing highest option kits to be implemented at a later date, sine (cascaded filtering) plus square and sawtooth waveforms simultaneously providing basic sound sources, sealed pedal contacts, and MOS-LSI tone generators normally silent until pressed.

As the photographs will show, most of the organ kit main parts are produced in the Wersi factories including circuit boards, woodwork, plastics, metalwork, wiring harnesses, panel and tab legending and even the manual printing. All this attention to quality that Wersi provides comes at a price — the first 2-manual with pedals organ kit, the Cosmos, costs £1,499 and the popular Helios costs around £3,500. Still, if you buy the Galaxy ready-assembled it's £20,450! The Toccata and Classica instruments are for the church organist and the Combo portable should interest the gigging musician. Many of the instruments were ably demonstrated by Hady Wolff in the immaculate showroom, extracts of which are on E&MM's Cassette No. 3.

At the end of our tour I spoke to Horst Hoppe, the Chief Sales Manager. He stressed their need for more manufacturing and storage space and talked about their planned 400-seater auditorium for demonstration concerts as well as a second-hand organ shop. Visitors frequently come to the showrooms and concert tours in many countries are given by Franz Lambert, Kurt Prina and Jimmy Smith, with Klaus Wunderlick also a frequent Wersi performer. French assembly manuals are now complimenting the German, English, Dutch versions already available.

Arthur Griffiths, Mike Beecher and Wersi Managing Director Reinhard Franz

I'll leave the last word to Herr Hoppe who commented 'Much to my own personal regret, there are no magazines similar to E&MM here in Germany. I think there should be great interest in this magazine and like E&MM, we specialise in the field of electro-music and see a great opportunity to offer kits for the layman, giving them many possibilities for enjoying their leisure hours by building their own musical instrument.'

Mike Beecher **E&MM**

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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).

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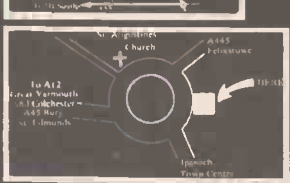

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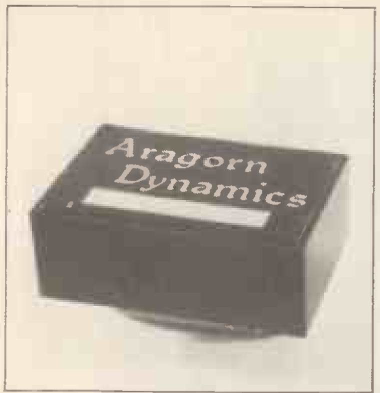
NEW PRODUCTS



EXPONENTIAL VOLTAGE TO FREQUENCY CONVERTER

Turner Electronics Ltd, have recently developed a voltage to frequency converter for use in applications where the requirement of a wide, stable exponential frequency range is of prime importance. The Aragorn VF01 encapsulated module also operates in a linear mode with minimal change of external components.

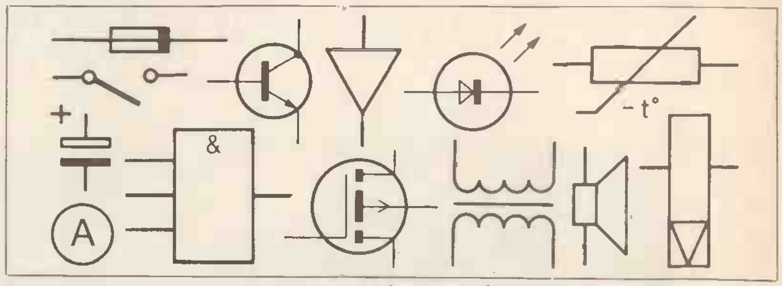
The proven operational frequency range lies between 0.1Hz and 200kHz with a possible maximum of 500kHz at a slightly degraded spec. Accuracy in the linear mode is better than 0.1% central to 6 decades and in the exponential mode, better than 0.1% over 5 decades. Power supply requirements are +15 volts. The module measures L 45 x W 30 x H 21mm. with 0.040 inch diameter, gold plated pins on a 0.1 inch grid pattern.

For further information and prices contact:
Turner Electronics Ltd., Unit B2, Old Barn Lane, Kenley, Surrey, CR2 5AT.

STANDARDS FOR EDUCATION

The British Standards Institution has recently released a booklet containing 270 symbols and an A1 size wall-chart showing 160 symbols from BS3939 for use in schools and colleges.

The 20 page, A4 booklet containing the 270 selected symbols includes a page of general notes on symbols and diagrams, two examples of circuit layout, 28 general, qualifying, supplementary and unclassified symbols, 28 symbols for conductors and connecting devices, symbols for resistors, capacitors, inductors and transformers, rotating machines, transducers, measuring instruments,



relays and contact units, valves and tubes, semiconductors, logic elements etc.

The wall chart contains 160 of the more common symbols taken from the booklet. Copyright subsists in all BSI publications, but teachers and lecturers are permitted to duplicate pages of the booklet for their own and students use within the one educational establishment.

The package (designated PD7303) costs £6.00 + VAT and is available from:
BSI Sales Department, 101, Pentonville Road, London, N1 9ND.

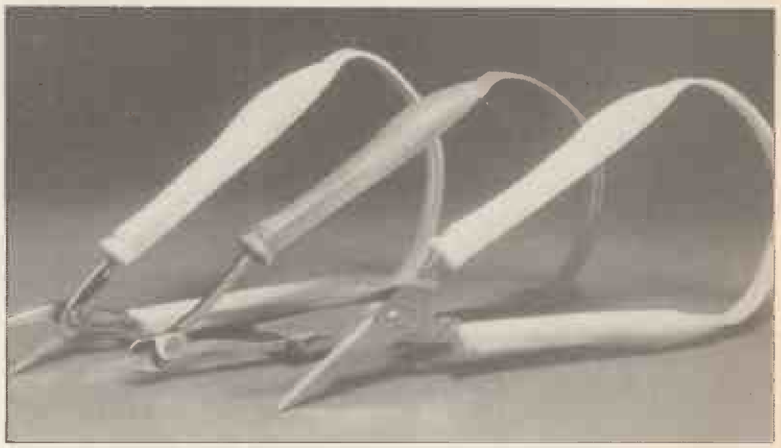
MINIATURE HANDTOOLS

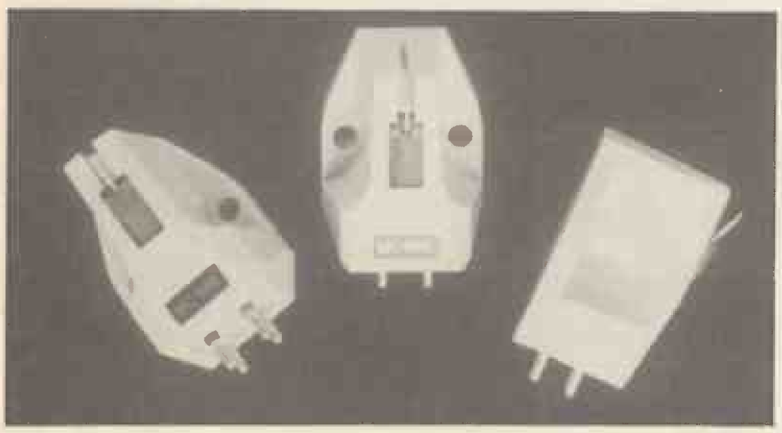
Tele-Production Tools Ltd., the Westcliff based manufacturer of handtools and production aids have recently released a set of three new 'Easi-Grip' miniature handtools designed for use in electronics and fine modelling.

The set consists of miniature carbon steel side cutters, fine nosed stainless steel tweezer-pliers and a serrated stainless steel scissor (shear for cutting fine wires, boards, foil, etc).

All are fitted with ergonomically styled self-opening handles and are fingertip operated to ensure fine control and ease of operation.

The tools weigh around 40gms each and cost £3.75 each including postage, packing and VAT or £10.00 for the set of three.
Tele-Production Tools Ltd., Stiron House, Electric Avenue, Westcliff-on-Sea, Essex, SS0 9NW.





MOVING CORAL

Coral of Japan have released a new high output, low impedance, moving coil cartridge designed as a direct replacement for moving magnet types.

Designated the MC88E, the cartridge features: Coral's one-point suspension system, a magnesium-aluminium alloy cantilever, a specially shaped armature and an output impedance of less than one twentieth of that of a moving magnet design.
MCA88E Specification:

Output voltage:	2.5mV (1kHz, 5cm/sec)
Channel balance:	1.2dB
Channel separation:	25dB (1kHz)
Frequency response:	20Hz-60kHz
Tracking force:	2+0.2g
DC resistance:	47k Ohm
Stylus tip:	0.3 x 0.7mm

The cartridge will cost around £30 and is being distributed by:
Videotone Ltd.,
98, Crofton Park Road, London, SE4.
Telephone 01-690 8511

PROFESSIONAL WHARFEDALE

Wharfedale, best known for domestic hi-fi loudspeakers, have launched their first purpose-built professional speaker, the E90 PRO.

Designed for high power, high quality PA use, the 300 Watt rating of the E90 and its hi-fi quality reproduction should ensure its welcome to night clubs, small concert halls, and discos.

The E90 PRO is suitable for amplifiers from 30 to 300 Watts with a sensitivity of 95dB per watt at one metre, and features two, 250mm computer-optimised, low - inertia, moving-coil bass drivers, two 100mm high-flux moving-coil, mid-range drivers and a 25mm compression drive horn-loaded tweeter.

Protection against misuse is provided by thermal circuit breakers which make it virtually impossible to overload the E90 PRO, and with mobile discotheque use in mind, the speaker is fitted with castors and recessed grab handles.

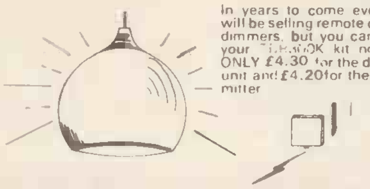
The price for the E90 PRO is around £495 each and the speakers will be available at hi-fi shops, music dealers and sound installation specialists throughout the UK.

For further information contact the Marketing Department, "E90 PRO" Wharfedale, Highfield Road, near Idle, Bradford, West Yorkshire. Tel. 0274 611131.

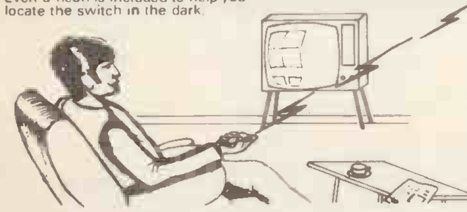
TK Electronics • COMPONENTS • KITS • PROJECTS

KIT

Our new TDR300K Touch Dimmer Kit will ensure that you are. Based on our highly successful TD300K touch controlled dimmer kit, the TDR300K incorporates an infra red receiver, enabling the lamp brightness to be varied and switched on or off by touch or remotely by means of a small hand held transmitter. The complete kit, which includes easy to follow instructions will fit into a plaster depth box and the plastic front plate has no metal pads to touch, ensuring complete safety. Even a neon is included to help you locate the switch in the dark.

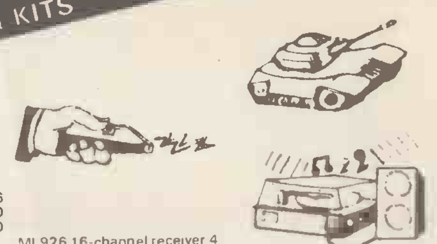


In years to come everyone will be selling remote control dimmers, but you can have your TDR300K kit now for ONLY £4.30 for the dimmer unit and £4.20 for the transmitter.



For the more athletic of you the TD300K Touchdimmer kit is still available at 6.50 and the TDE/K Extension kit for 2-way switching etc is £2. DON'T FORGET to add 50p P&P and 15 VAT to your total purchase.

REMOTE CONTROL COMPONENTS & KITS



LD271 1R Emitting diode	.36
SFH205 Photodiode Detector	.90
SL480 1C Pulse Amp	1.70
SL490 32 Command Encoder/transmitter	2.40
ML922 10-channel receiver + 3 analogue outputs	4.20
ML926 16-channel receiver 4 latched binary outputs	1.40
Clip-on Plastic Reflector for 1R LEDs, increases range	.20

ML925. A decoder designed for model/toy control providing a 2-speed drive motor and three position latched steering system or a vehicle with momentary action steering and a third motor, eg. gun turret, winch, etc. Outputs also available for other facilities such as horn, turn indicators, headlights etc. 2.10

To make things EVEN EASIER, we have designed several new kits:—

MK6 - Simple Infra Red TRANSMITTER. A Pulsed infra red source which comes complete with a hand held plastic box. Requires a 9V battery. 4.20

MK7 — Infra Red RECEIVER. Single channel, range approximately 20 ft. Mains powered with a triac output to switch loads up to 500W at 240V ac, but can be modified for use with 5 to 15V dc supplies and transistor or relay outputs. 9.00

"Special Price" MK6 and MK7 together. Order as RC500K. 12.50

MK8 — Coded Infra Red TRANSMITTER. Based on the SL490, the kit includes 2 1R LEDs measures only 8x2x1.3 cms and requires a 9V (PP3) battery. 5.90

MK9 —4 Way KEYBOARD. For use with the MK8 kit, to make a 4-channel remote control transmitter. 1.90

MK10 — 16-Way KEYBOARD. For use with the MK8 kit to generate 16 different codes for decoding by the ML928 or ML926 receiver (MK12) Kit. 5.40

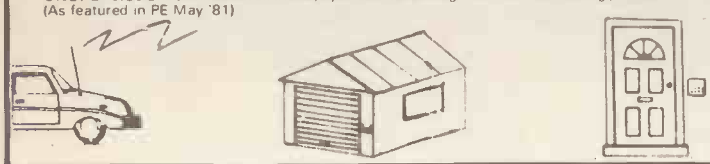
MK11 — 10 On-Off Channel 1R RECEIVER with 3 analogue outputs 0-10V) for controlling such functions as lamp brightness, volume, tone, etc. Other functions include an on/standby output and a toggle output, which may be used for sound muting. Based on ML922 decoder 1C. Includes its own mains supply. 12.00

MK12 — 16 Channel 1R RECEIVER. For use with the MK8 kit with 16 on/off outputs which with further interface circuitry, such as relays or triacs, will switch up to 16 items of equipment on or off remotely. Outputs may be latched or momentary, depending on whether the ML926 or ML928 is specified. Includes its own mains supply. 11.95

MK13 — 11-Way KEYBOARD. For use with MK8 and MK11 kits. Transmits programme step + and analogue + and (3), mute normalise analogue outputs and on/standby 4.35

PROJECT

Whatever kind of door you have, our New Electronic Combination Lock will enable you to open it easily but make things very difficult for unwelcome visitors. The unit, which comes complete with a 10-way keypad, requires an easily remembered four digit code to be entered before the door can be opened, while the intruder has over 5,000 combinations to choose from. The code can be easily changed by means of a pre-wired plug and a momentary or latched output version can be made. The kit has even more uses in a car where it may be used to disable the ignition. Another useful feature is the Save Button. This stores the combination number, enabling the car to be used by authorised persons such as garage personnel without disclosing the code. The complete kit measures 7x6x3 cms deep and consumes a mere 40uA when not in use and will drive a 5V to 15V (750mA) solenoid or relay coil (not supplied) directly. So why not treat your door to a new lock for ONLY £10.50 and think about all the keys you can lose or forget without ever locking yourself out. (As featured in PE May '81)



DISCO LIGHT KIT

Each unit has 4 channels (rated at 1KW at 240V per channel) which switch lamps to provide sequencing effects, controlled manually or by an optional opto isolated audio input.

DL1000K
This kit features a bi-directional sequence, speed of sequence and frequency of direction change being variable by means of potentiometers. Incorporates meter dimming control. **£14.60**

DLZ1000K
A lower cost version of the above featuring undirectional channel sequence with speed variable by means of a preset pot. Outputs switched only at mains zero crossing points to reduce radio interference to minimum £8.00. Optional Opto Input DLA1 60p

24-HR CLOCK APPLIANCE TIMER KIT

Switches any appliance up to 1KW on and off at preset times once per day. Kit contains: AY 5-1230 1C, 0.5" LED display, mains supply, display drivers, switches, LEDs, triac, PCBs & full instructions.

CT1000K Basic Kit	£14.90
CT1000KB with white box (56×131×71mm)	£17.40
Ready Built	£22.50

DVM THERMOMETER KIT

STAR BUY

ONLY £13.50 +VAT

NEW RIDICULOUS LOW PRICE FOR DVM/THERMOMETER KIT

Based on ICL7106 DVM chip and a 3½ digit liquid crystal display. This kit will form the basis of a digital multi-meter - only a few additional switches and resistors required (details supplied) or make a sensitive digital thermometer (-50° to 150°C) reading to 0.1°C. The basic kit has a sensitivity for full scale of 200mV, automatic polarity and runs from a 9V PP3 battery.
At this price you can use this kit in place of moving coil meters in virtually any application from bathroom scales to bicycle speedometers - the possibilities are endless.

MINI KITS

These kits form useful subsystems which may be incorporated into larger designs or used alone. Kits include PCB short instructions and all components.

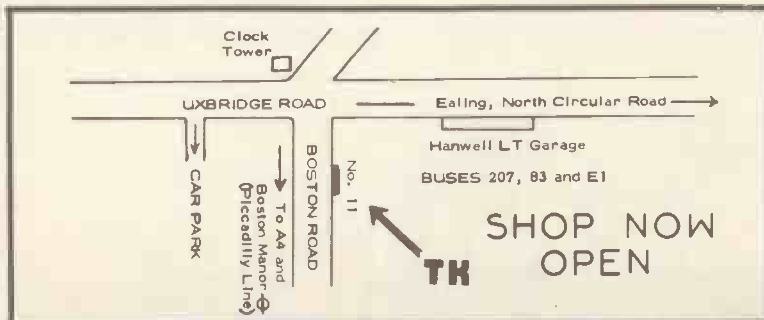
MK1 TEMPERATURE CONTROLLER/THERMOSTAT
Uses LM3911 1C to sense temperature (80°C max) and triac to switch heater 1kW £4

MK2 SOLID STATE RELAY
Ideal for switching motors, lights, heaters, etc from logic Opto-isolated with zero voltage switching. Supplied without triac. Select the required triac from our range. £2.60

MK3 BAR/DOT DISPLAY
Displays an analogue voltage on a linear 10-element LED display as a bar or single dot. Ideal for thermometers, level indicators, etc. May be stacked to obtain 20 to 100 element displays. Requires 5-20V supply. £4.75

MK4 PROPORTIONAL TEMPERATURE CONTROLLER
Based on a new zero voltage switch 1C, this kit may be wired to form a 'burst fire' power controller, enabling the temperature of an enclosure to be maintained within 0.5°C. Thermistor failure causes output to switch off. Temperature range ambient to 90°C. 3KW £5.55

MK5 MAINS TIMER
Based on the ZN1034E Timer 1C this kit will switch a mains load on (or off) for a preset time from 20 minutes to 35 hours. Longer or shorter periods may be realised by minor component changes. Maximum load 1KW £4.50



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We also supply a wide range of components including INTEGRATED CIRCUITS, MINI TRANSFORMERS, CMOS, LEDs, VOLTAGE REGULATORS, DISPLAYS, VMOS POWER FETS, TRIACS, DIL IC SOCKETS etc etc.

EVENTS

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 24th — PERCUSSION & ELECTRONICS, Programme - 1. Indifferent Affair - Charles Barber. 2. First performance of new work - Nicholas Wilson. 3. A film improvision - Mark Limbrick. 4. Study for solo snare drum - Jeffery Wilson. Venue: Royal College of Art, Kensington, London. Admission 50p. Commences 1.00 pm. Also June 26-29 as below.

June 26th — St Martins School of Art, Charing Cross Road, London.

June 28th — New Half Moon Theatre, London. Commences 8.00 p.m. Admission £1.00.

June 29th — Brady Centre, London. Commences 8.00 p.m. Admission £1.00.

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 — NANN 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 — FLUTE & ELECTRONICS, British Music Information Centre, Stratford W1. To mark Teleman's 300th Anniversary. Simon Desorgher on Flute, Lawrence Casserley on Electronics performing Telemann Canonic Sonata for flute and electronics. Commences 7.30 p.m.

June 30th — LEEDS ELECTRONICS EXHIBITION, Dept. of Electrical & Electronic Engineering, Leeds University.

July 8th-12th — AUDIO VISUAL EQUIPMENT EXHIBITION, World Trade Centre, Singapore. Further information from Bob Hackett, European Sales Manager, ITF International, Ratcliff House, Blenheim East, Solihull, W. Midlands. Tel. 021-705-6707.

July 15th-18th — NATIONAL FESTIVAL OF MUSIC FOR YOUTH, Fairfield Hall, Croydon. Tickets £1.50 (60p under 19) at the door.

July 19th — SUSSEX MOBILE RALLY, Brighton Race Course - Trade stands dealing in all forms of electronics, including amateur radio, microprocessors, components and C.B. Entrance 50p (with free lucky draw ticket). Commences 10.30 a.m.-6.00 p.m.

July 29th-31st — MICRO COMPUTER SHOW, Wembly Conference Centre, London. Aimed at both the hobbyist and trade. Tickets £1.50 on the day or three for £1.00 from Online Conferences Ltd, Argyle House, Joel St, Northwood Hill, Middx. (cash and S.A.E. required with order).

Aug. 29th-Sept. 5th — NATIONAL HOME ELECTRONIC ORGAN FESTIVAL, Pontins Tower Beach, Prestatyn, North Wales. The programme for this residential event will include: daily concerts by "star" organists - teach-in sessions - sheet music and book sales - exhibitions and demos by leading manufacturers - synthesisers, rhythm units and rotary speakers. Accommodation from £78 for two people. Ring (07456) 2244.

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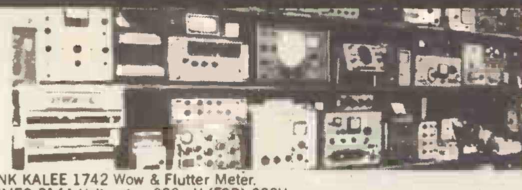

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Demo Cassette No. 1 (March/April issues) contains:
1. The sounds of the Matinée Organ. 2. Musical extracts played on the Yamaha SK20 Synthesiser reviewed last month. 3. Examples of the basic waveforms and effects discussed in 'Guide to Electronic Music Techniques'. 4. Music and sound effects played on the Sharp MZ-80K Microcomputer. 5. Warren Cann demonstrates the Syntom Drum Synthesiser. 6. The PAIA8700 Computer/Controller. 7. Frankfurt Music Fair: the Yamaha GS-1, Electro-Harmonix Clockworks Controller.
Cassette Price: £2.45 inc. VAT and p&p.

Demo Cassette No. 2 (May/June issues) contains:

1. Tim Souster 'feature' examples from his electronic music studio. 2. Electronic Dream Plant: Adrian Wagner plays the Wasp/Spider and some of his music. 3. Lowrey MX 1 Electronic Organ — the essential music complement to the review! 4. Apple Music System — polyphonic computer music. 5. E&MM Word Synthesiser — speech from our friends in Texas. 6. Fairlight Computer Musical Instrument review — because of its price, very few have heard this amazing instrument. 7. Sharp 'Composer' and 'Morse' programs. 8. Yamaha PS20 keyboard — a complete piece on this portable play anywhere instrument. 9. Vero projects: Radio/Metronome/Oscillator 10. Some extraordinary sounds from the creative David Vorhaus.
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Demo Cassette No. 3 contains from this issue: 1. The unique sounds of the new PPG Wave 2 synthesiser. 2. Synwave sea effects and other sound possibilities. 3. Wersi Pianostar — the versatile kit instrument demonstrated by German demonstrator Hady Wolff, who also shows some of the special sounds from the Wersi organ range. 4. Musical examples of the immense possibilities from the Alphadac 16 synthesiser controller. 5. Atari's new Music Cartridge programming 4-part compositions. 6. Duncay Mackay makes creative sounds from his 'Visa' LP keyboard set-up.
Next month's issue will also list further examples for Demo Cassette No. 3.
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ADVERTISERS INDEX

CORRIGENDA

The following errors and omissions have been noted in previous issues of E&MM and are brought to your attention:

APRIL ISSUE

Page 30. Figure 2. R6, 7 and 8 should read R8, 6, 7.

MAY ISSUE

Pages 32 and 34. Test amp and Metronome pictures transposed.
Page 33 Figure 2. C5 should be connected to pin 1 of IC1 by wire link from D12 to F12.
Page 45 Figure 6. R3 should go to E1 not F1 as shown.

JUNE ISSUE

Page 13. Wire links shown on Wordmaker PCB have now been replaced by extra tracks on component side of PCB.
Page 64 Figure 6. C2 is shown reversed, S1 is shown reversed. Col 3, sentence beginning 'When S1 is in its normal position . . .' should read: When S1 is in its normal position, the gate of TR1 is negative biased and the device presents a high resistance across its drain — source terminals.
Page 83. City of Fear and Synergy sleeve photos transposed.
Page 84 Col 3 Line 9 should be line not fine. Col 4 Line 36 should be Crotech not Growtech.

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