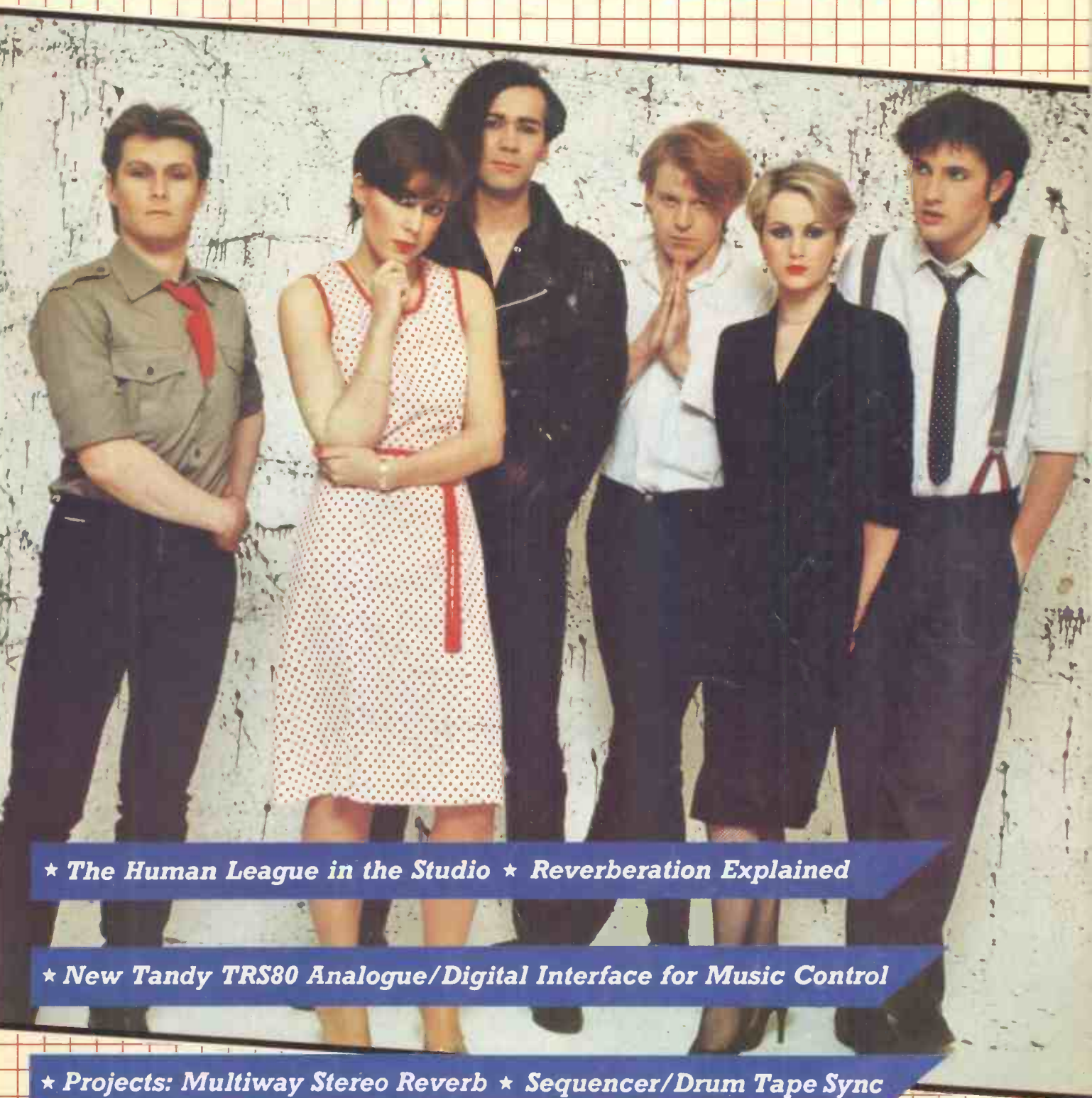
Electronics &
Music Maker

APRIL 1982 75p



★ The Human League in the Studio ★ Reverberation Explained

★ New Tandy TRS80 Analogue/Digital Interface for Music Control

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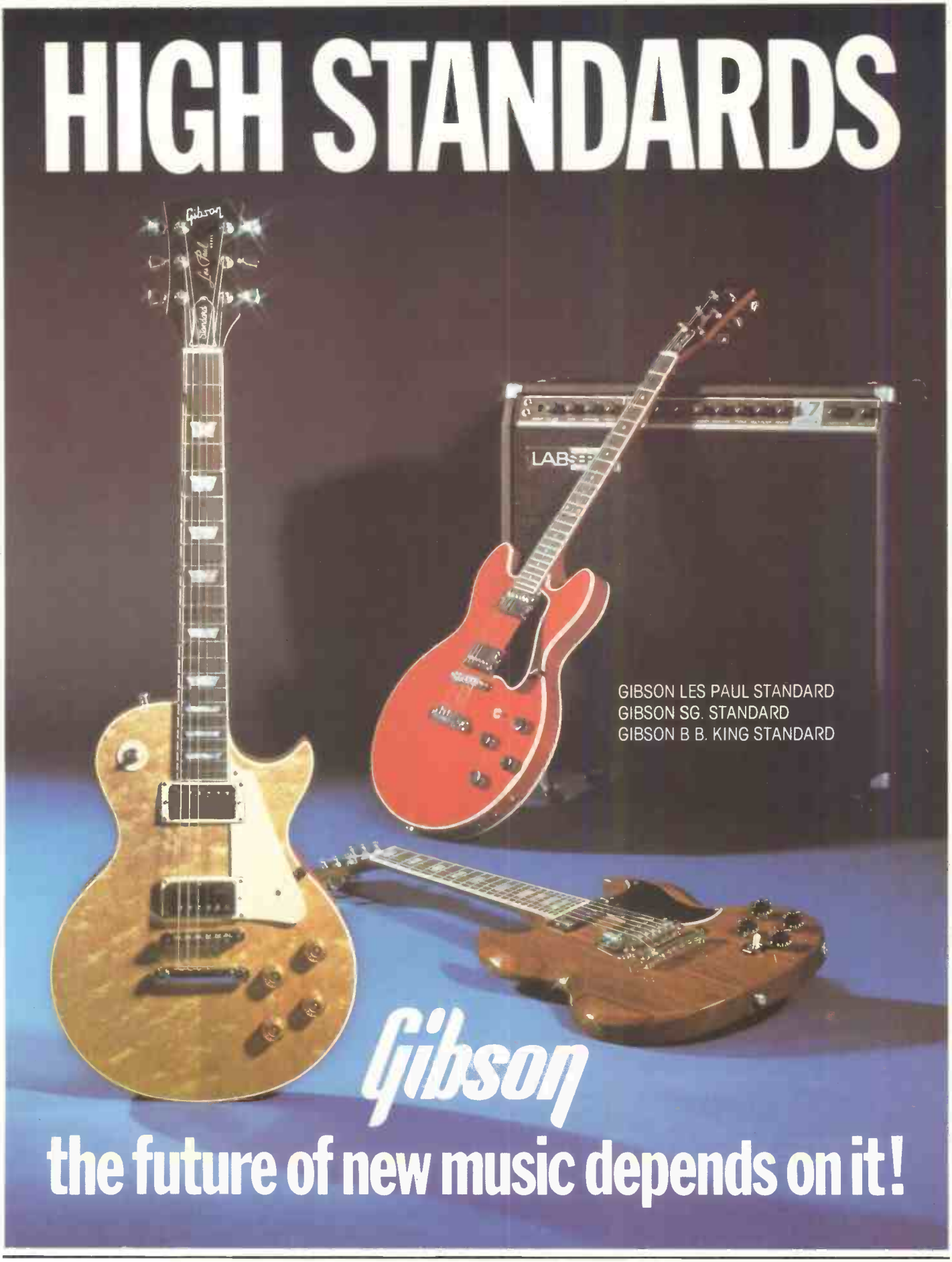

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WOW! — AND THANKS

Before I began preparation on the E&MM questionnaire published last month, I was warned by fellow publishers not to expect a big response from readers. Well, a big thank you has to be in order for all of you who've taken the trouble (it was a long questionnaire!) to fill it in and return it to us. We have been receiving hundreds of replies each day since the March issue came out. If you haven't filled in your questionnaire yet, there's still time to send it to us before the prize draw at the end of March.

One of the first implications apparent from the survey answers is that I was not alone, when I put the concept of E&MM together, in believing that music, computing and electronics would be of vital interest not just for musicians but to the 'hobbyist' as well.

This month we take a different angle on the success of Human League with our 'producer' rather than 'performer' interview. Of course, Human League have not become stars overnight and in many ways Phil Oakey and his group reflect the same determination and enthusiasm to succeed in electronic music as many of our readers.

There's much to learn from our workshops and the special report for guitarists on the latest products at Anaheim.

We always like to publish low cost projects, provided we can maintain a high quality and this month's two main projects certainly meet these requirements and are easy to build.

We'll be looking forward to meeting many of our readers at the International Music Show from March 13-18 at Wembley, London. There'll be opportunity to see and hear many of the musical projects that have appeared in E&MM over the past year, and magazines will be available, as well as E&MM T-Shirts and Demo Cassettes. I'll be on the stand with some of my staff to meet you and no doubt music making will prevail at all times!

We've taken so many pictures of products at Frankfurt, our report is held over until next month's issue, which also features an exclusive interview with Holger Czukay.

Mike Beecher

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Readers Letters

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

E&MM Rules OK

Dear Sirs,
I think your magazine E&MM is quite brilliant and by far the best electronics magazine on the market. This is for several reasons; the reading matter is excellent, there is a lot of it and it is clear cut and easy to read but also quite fascinating — even on subjects I would find uninteresting. The diagrams are also very good and the graphics are well suited to this type of publication.
The magazine manages to cover many subjects without "drifting off the subject", as in many specific electronic magazines.
Thank you for such a great magazine that I enjoy such a lot each month.

Damian Clifton
Maidenhead, Berks

Clap Machine

Dear Sir,
Just before Christmas there was a programme on TV showing an interview with the pop group Police.
During that programme the drummer with the group showed and demonstrated a CLAP machine. This was a noise generator triggered by a sensor on the snare drum which gave the effect of someone clapping their hands.
Can you suggest where I might obtain a circuit diagram to build this machine?

D. Vanderwolf
Torpoint, Cornwall

The Synwave project in the July issue of E&MM can be fixed to a snare drum or triggered independently from a micro, sequencer or synthesiser "trigger out" to give a realistic clap (pulse) sound. Further treatment with short echo delay and reverberation will enhance the effect. Changing the controls manually will vary the clap "cupped hand" pitch.
The result is an effective hand clap for under £15.00!

More Projects!

Dear Sir,
After reading the letter from Mr Smith in the February edition of E&MM, I felt I must write to echo his comments on the lack of projects in the recent issues. When E&MM appeared it provided a real break from the endless search through the magazines on the newsagents' shelf trying to find a good, cheap musical project. As an example I have found the 'Harmony Generator' from the October issue an excellent addition to my effects boxes. I can now obtain some dramatic sounding polyphonic effects from my two single VCO synths (my bank account won't stretch to a Prophet yet).
It is projects like the 'Harmony Generator' and the articles on the ZX81 running a synthesiser, with constructional details, that have established E&MM as the top electro-music magazine, so please keep the projects coming and don't just become a review magazine as this is covered amply by the music press.

John Round
Glasgow

(P.S. Tangerine Dream review was great, especially the 'Choronzon' music.)

Dear Sir,
Please accept my congratulations on a superb magazine. I only came across E&MM in a newsagents recently and I picked it up. WOW! I've been looking for something like this for ages! Perhaps you haven't become quite well known enough yet, for your mag. to be on *all* newsagents stands etc, I don't know but I'm glad I found you. Many thanks again. I would like to order all the back issues, and also ask you if you have done any article(s) explaining to the uninitiated, some or all(!) the terms you use in your reviews e.g., VCO, VCF etc and what they actually do. I realise that your publication may be aimed at people who already know these sort of things, but perhaps you may agree that it may be of benefit to some, if not all your readers. Anyway, just an idea, but no complaints, don't get the wrong idea! Keep up the good work, regards and best wishes for the future.

John Dyson
Sheffield

ZX81 Micromusic

Dear Sir,
Could you please help me with the problem I have! I am about to take my first steps into the world of microcomputers and synthesisers and as such I am a complete and utter novice. Thus I was looking at your magazine in the shops when your article 'Micromusic - Make Polyphonic Music with the ZX81' caught my eye. So I bought the magazine (February, '82) and took it home to read the article, and to be truthful I didn't understand very much of it at all. So I would be most grateful if you could answer a few of my questions and give me some general guidelines.
I am considering buying a Sinclair ZX81 and either a Roland SH09 or a Moog Prodigy. What extra pieces of equipment would I need? i.e. do I need the sinclair 16K Byte RAM or 8 Bit Output Port (January issue) on your Digital to Analogue Converter (February issue). Can your pieces of equipment be bought already made? I haven't a clue about building such things. How much do they cost, can elephants fly? As you can see from the above meandering I just haven't a clue about where to start or what is needed.

John Logan
Strathclyde

The Micromusic ZX81 articles do assume a certain amount of knowledge of computing and electronics. Computing you can hopefully teach yourself once you have a ZX81, and electronics construction is not difficult to master. In both cases, however, the motto is to start at the bottom and work up. If you're impatient to be away, it's a case of finding a knowledgeable friend to help you.
You will need Sinclair's 16K RAM, the input/output port, and also the D to A converter for the synthesisers you mention; you can get away without the RAM to begin with, though. The port should cost roughly £6-£7, and £5-£6 for the converter, but both need to be built up from components, they are not available built up.
Thank you for your interest in the articles; specific queries I can answer, but "where do I start" is a rather broad question!

Peter Maydew

CIRCUIT MAKER

Z80 PIO FOR SHARP MZ80K

Glenn Rogers, Bangor.

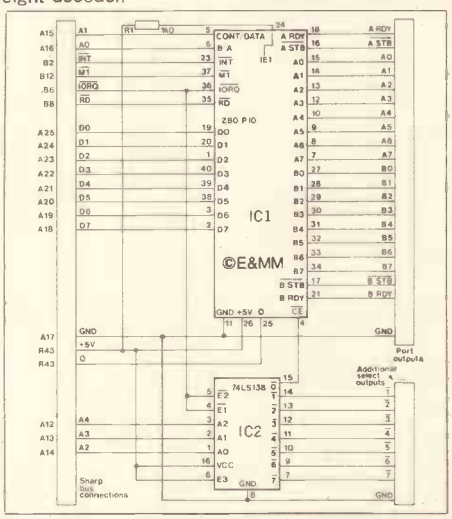
Many of the micro-computers available today do not have any user input/output ports in the basic unit. The input/output facilities are essential for the enterprising home computerist and are generally provided as expansion boards which are usually quite expensive. This circuit shows how to connect a Z80 PIO chip to a Z80 based micro-computer (such as the Sharp MZ80K). The PIO chip can be used on non Z80 machines but it will not be able to operate at its full potential.

There is nothing particularly original about the circuit, it is just a matter of connecting the right pins on the chip to the right bus connections. The selection of the output device (input/output decoding) is carried out by IC2, a one of eight decoder.

The bus connection information given is for the MZ80K and there are a few points to note. The Sharp bus does not carry the clock signal (Ø) or a 5 volt supply. The MZ80K is capable of powering this simple circuit and the two signals mentioned above can be found at either end of R43 on the main PCB. One end of this resistor is at 5 volts and the other end is connected to the microprocessor clock.

The PIO can be configured as 2 input ports with handshaking, 2 output ports with handshaking, 1 input and 1 output port with handshaking, or 1 bidirectional port with handshaking plus a control port and has full interrupt facilities. The programming information for the Z80 PIO chip can be found in many of the books on the Z80 microprocessor system.

Port addresses:
Port A Control: Ø2 Data: ØØ
Port B Control: Ø3 Data: Ø1



ELECTRO RECORD

Exit — Stage Right' by Tangerine Dream has caused a flurry amongst the Tang fans. Beautifully produced LP is in fact a bootleg from a German FM broadcast. It's apparent non distribution might have something to do with the fact that a £25,000 fine plus confiscation is likely to occur!

In the real world of actual releases Pinhas' 'L'Ethique' has proved to be the time-bomb he's threatened us with for years. Pinhas now set to play Venue sometime in April? From the court of Cologne's Can a constant stream of records too good for the popular taste. Holger Czukay's 'Movies' seemingly deleted by EMI to make room for the equally remarkable 'On The Way To The Peak of Normal'. In next two-three weeks the long delayed Spoon releases will hit the shops.

If EMI find Czukay altogether too esoteric and disinterested in fashion to 'succeed', then their confidence in German music must be running high with Kraftwerk. Also it is confirmed that EMI have made the deal with Schulze's I.C. label. Ariola GmbH may release the stuff, but how about EMI (U.K.)? Various mail order companies report continued resistance to anything that isn't German in origin. It's amazing how many electro-music fans are as bigoted as the north stand at West Ham!

According to the U.K. Hi-Fi statistics the American fad of the Walkman type of personal Hi-Fi is definitely taking off here also. Let us hope that the latest American enthusiasm for audiophile pressings and real time cassettes will also be repeated here.

Spain's Neuronium and Michel Huygen are being championed by Andy Garibaldi of Lotus. Although not particularly original their records are beautifully crafted. Apparently the musicians concerned put on excellent live shows and are keen to play in the U.K. Pascal Longuirand from Toronto is also causing interest — even the tip of the iceberg of good electro-musicians emerging from the New World is beginning to look huge.

Disappointing response so far to appeal for details of good shops stocking electro-music. One or two in the West Country ... Drifting in Cheltenham ... Rival in Bath and Bristol and Music Market in Bath.

FOOTNOTE: The massive computer brought into the pressing plant at Teldec (Hamburg) to speed up the organisation did not release any records for eight weeks in January and February. Spoon, Kuckuck, I.C. and numerous other small interesting labels were involved in this disastrous fiasco.

Matthew Gavin

CORRIGENDA

April 81: Power Controller, PCB CSR2 pin references should read from top Mt1, G, Mt2.
June 81: Wordmaker, Figure 10, IC4 transpose pins 1 and 3, 4 and 6.

January 82: We must point out that 'Choronzon' from the Tangerine Dream 'Exit' album was reproduced by kind permission of Virgin Music (Publishers) Ltd.

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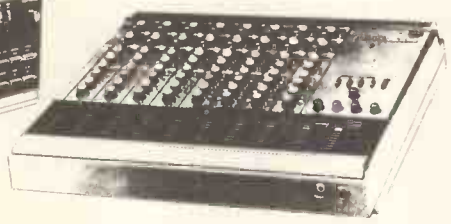

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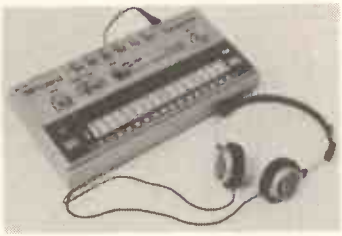

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THE HUMAN LEAGUE IN THE STUDIO

Tony Bacon interviews Human League producer Martin Rushent

ONE DAY IN DECEMBER 1981 I journeyed into deepest Oxfordshire to see Martin Rushent, a producer whose name is on every A & R person's lips since his enormous recent successes with, primarily, the Human League, and with Altered Images. As I travelled on the train to Rushent's Genetic Sound studio, the Human League's *Don't You Want Me* drifted up from my Walkman - Top Of The Pops' number one single for the fifth week running. I got chatting between Walkman sessions to a woman who turned out to be a nurse. She also turned out to be going to the same tiny station as me. "Oh, it's a very pretty place, set in very pretty countryside," she assured me of our mutual destination, "and there's plenty of grand houses. Some very wealthy people live up there."

ONE DAY IN THE LATE 1960s, Martin Rushent joined Advision Studio in London. He'd decided some years earlier that he didn't want to be what his schoolmasters intended, a chemical engineer. He wasn't interested at all. After playing in bands for a while, he went to Advision and developed as an engineer at a time when 4-track was just being phased out, and experienced first-hand the technical traumas of 8-track and the birth pains of 16-track, along with his principal collaborator, Eddie Offord.

Rushent sits now in the study of his house, his secretary Carrie having picked me up from the station and saved me from the clutches of the mutually-destined nurse. The house is a short walk from the Genetic studio, perched in the producer's pleasant rural acreage. Martin picks up the story of the move to 16-track recording from his Advision past. "I think the move from 8 to 16-track was one of the great leaps forward," he explains, "in terms of possibility. Basically though, nobody had a board capable of dealing with a 16-track machine - the machine came before the board! So boards were 8-track boards, and you had to sort of route things through a patchbay and bring things back through echo returns. I suppose that was the best grounding I ever had, back then, now I think about it. Because you had to improvise all the time to make the 16-track system workable, you learnt to use a board in totally unorthodox fashions and that's something that stayed with me ever since. I'm not frightened of using a board in a way that it's not meant to be used, or any other piece of gear. The art of it all is to improvise it, to bend it."

Rushent says he chucked up what was a really good job at Advision in the 1970s, "to go further," as he now puts it. Self-motivation coupled with ambition, among other things, drove him to freelance as an engineer, help build a small 8-track studio which produced a hit or two, and in 1977, during a stint at United Artists' A & R department, to meet up with the Stranglers who, after a few fruitful recording collaborations, provided the basis for Rushent's subsequent success as a producer. Meanwhile in 1977, in a backstreet in Sheffield, the Dead Daughters (one gig, deceased) and The Future had turned into the original Human League, of whom one Philip Oakey soon became helmsman. The League plodded on through such synth-laden work as *The Dignity of Labour Parts 1-4*, all enthusiasm and detuned oscillators, or the jollier *You've Lost That Loving Feeling*, with their own synthetic version of the Wall Of Sound.

Early into the 1980s, the commercially unsuccessful Human League split, revealing two separate and commercially successful off-shoots, Heaven 17 and the (new) Human League, to which Oakey has added two women singers. 1981's impressive *Dare* LP testifies to the band's new-found skills, in tandem with producer Martin Rushent and his gleaming Roland MC8 Microcomposer. The exquisitely crafted and technologically aided slabs of sound, topped off with Oakey's permaflop hairdo, ensured the Sheffield synthesists' success and guided the group to pop stardom.

ONE DAY IN MAY 1981, Martin Rushent sat in Simon Draper's office in West London and played the Virgin boss some tapes Rushent had made at his Genetic studio with Pete Shelley, late of the Buzzcocks and in solo guise the first and then only signing to the Genetic label. Draper was impressed by the all-electronic recordings and Rushent's explanations of the gadgetry employed. The Human League had been signed to Virgin for some time, and when Phil Oakey told Draper of his desire to make his band 'the electronic Abba', the League/Rushent connection occurred. Encouraged, Oakey apparently said that he liked some records by 999 that Rushent had produced.

A meeting took place. Martin remembers that Oakey's initial complaint to him was: "We reckon we're writing hit songs and have been for some time, but we just can't seem to make it work on plastic." Rushent's interest was immediately aroused and the band came down to Genetic for the first session soon after, to record *The Sound Of The Crowd*, the first League/Rushent single. It sold well - 'the highest the League had ever got by light years'. Thus followed another single, *Love Action*, and then the *Dare* LP. Rushent recalls, "We said O.K., we'll go full tilt for it. I said we need an album that's got four, maybe five singles on it, the whole thing." "And," he says, "it *worked*," and laughs out loud, as well he might.

The Dare Sessions

The Martin Rushent précis

"First of all they demo the song up in their little studio in Sheffield. They come down with a demo that's got drum machine on it playing the basic rhythm that they want to use, and the key synthesiser parts: the bass and the main instrumental theme of the song. That's usually about it, so I get given the bare bones. Then we'll sit and talk for maybe an afternoon about the approach that we want to use, honing up the arrangement, deciding how many verses there's going to be before the chorus, solos, and all the rest. Until we've got in mind exactly how this song's going to be structured, we don't go into any detail about other instruments or stuff like that. But we've got a basic plan.

"The whole thing is written out as we go along. Once we've arrived at a basic plan, we write a straightahead bar chart to the song with all the chords on it and stuff like that. The next thing we do is to put a timecode on the multitrack. The timecode's generated by the MC8, the Roland Microcomposer. If the song is 180 bars long, we feed in '180'. If there's any 2/4 or 3/4 bars, they get written in as well. So on the tape we now have the timecode, and from that we can run the Microcomposer which will drive the synthesisers, and we can run the Linn drum machine.

"Having got there, we'll then put down a basic drum track from the Linn with no fills, just hi-hat, bass drum and snare playing the basic rhythm part that we've decided on. Then we'll put the bass on, sometimes manually, sometimes by machine, it really depends on what we want. Also, we get some lovely bass sounds out of an old Korg synth that Phil's got, which is falling apart, we have to bash it to get it working. It's a really early one, only a tiny little job, but we get great bass sounds out of it. It's not programmable because the control voltage and gate inputs aren't wired in or anything. Then we put on the main theme part, often by machine. As we're doing all these things the parts actually get written out on the bar chart, so by the time we've finished the whole record we've got the whole arrangement written out, note for note. Then it's really down to people throwing in ideas: I might think it'd be nice if we had a sort of brass sound coming in here, say.

"The last thing to go on a Human League record is the drums, last of all. And it may mean that we've changed the whole drum pattern that we originally envisaged - we put fills in then, and all the rest of it. That's the

The Human League

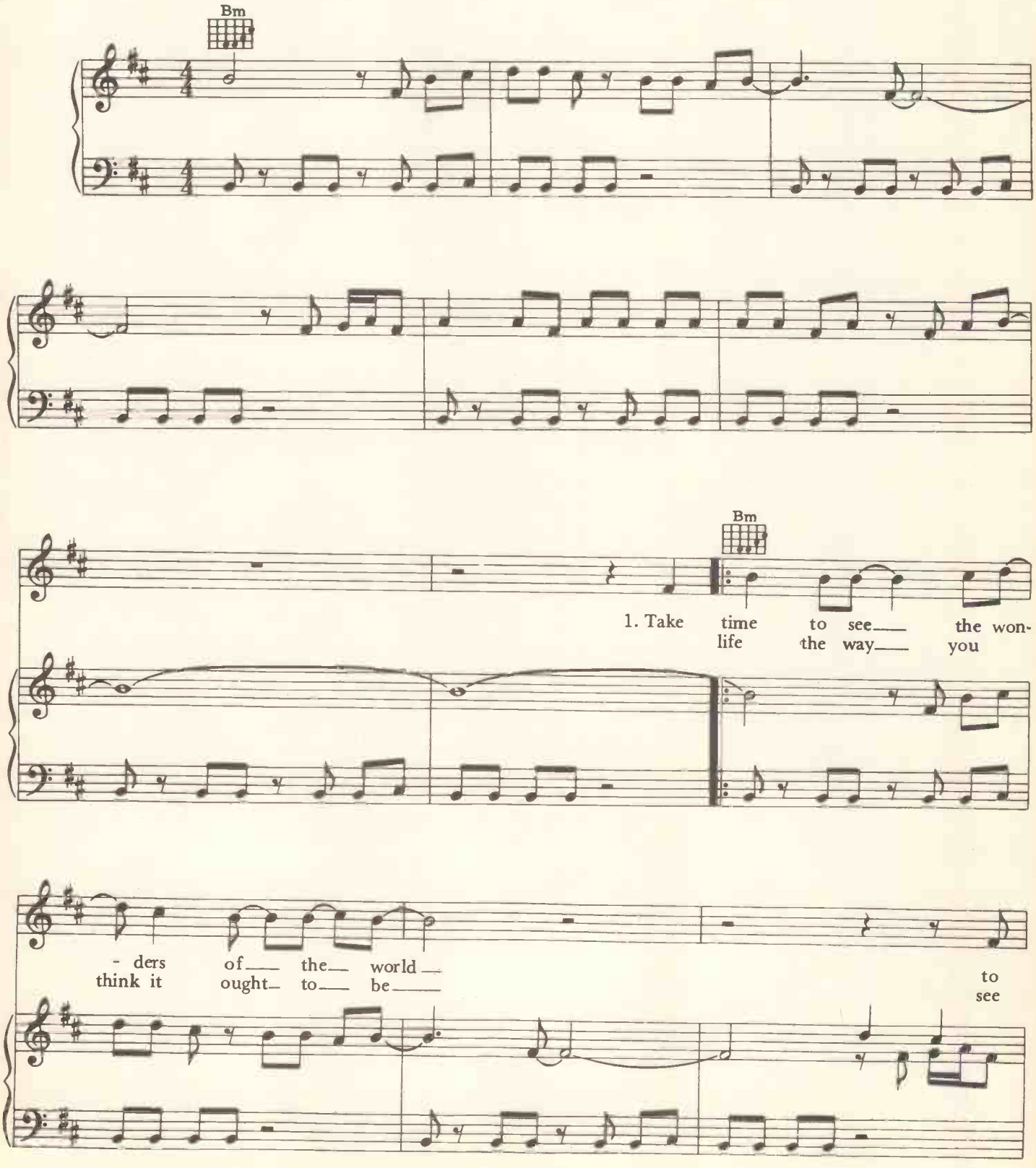
THE THINGS THAT DREAMS ARE MADE OF

PHIL OAKEY/ADRIAN WRIGHT

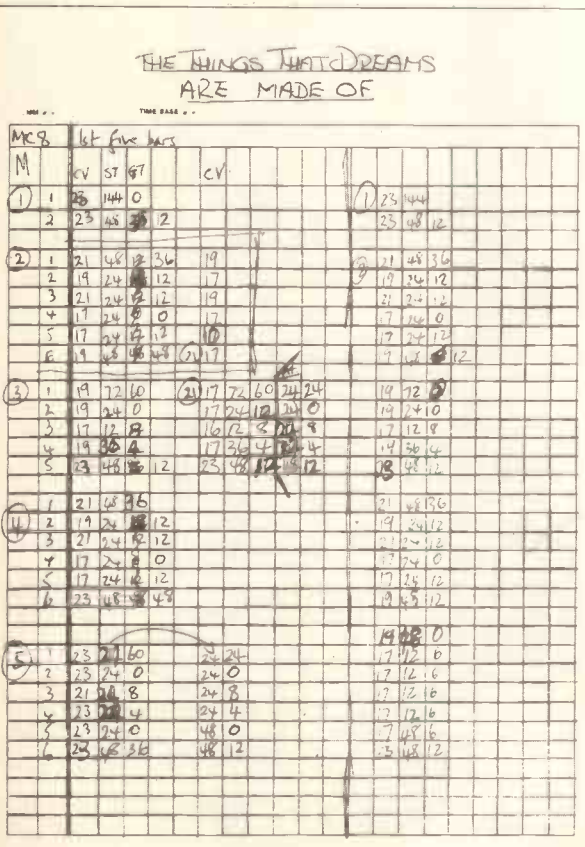
This extract from The Human League's TOTP hit is taken from the music album of 'Dare', available from Music Sales, 78, Newman St., London, W1, @ £2.95, or from all good record stores.

IAN BURDEN	**SYNTHESISER**
JO CALLIS	**SYNTHESISER**
JOANNE CATHERALL	**VOCALS**
PHILIP OAKEY	**VOCALS AND SYNTHESISER**
SUSANNE SULLEY	**VOCALS**
PHILIP ADRIAN WRIGHT	**SLIDES AND OCCASIONAL SYNTHESISER**

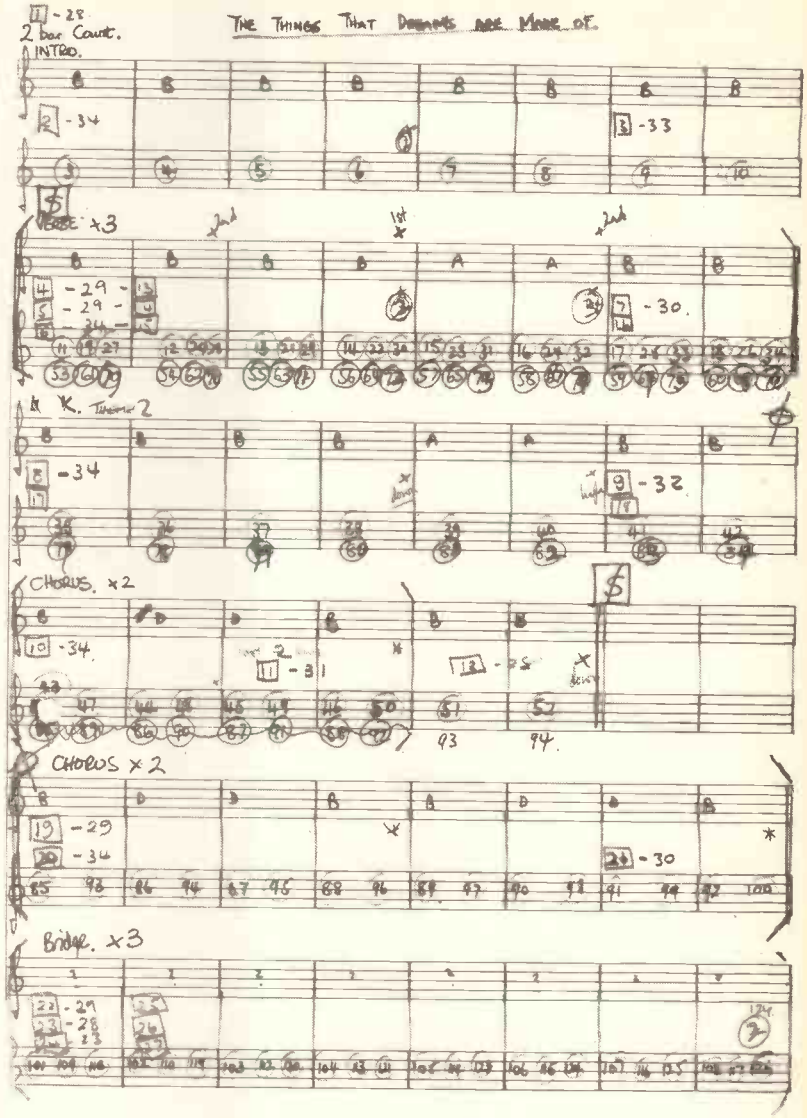
INSTRUMENTS USED: ROLAND MC8, SYSTEM 700, JP4, KORG 770, DELTA, CASIO VLT 1, M10, LINN LM1, YAMAHA CS15

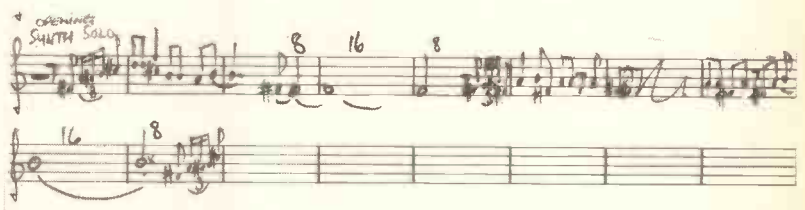


Have you ever wondered how music is actually drafted for the producer's use? It certainly does not appear in a neat edited version as shown on the left hand page! So thanks to Martin Rushent and Carrie at Genetic Operation Ltd for letting us have the arrangement sheets for 'The Things That Dreams Are Made Of' which we've printed here. It'll take a bit of working out, of course, along with the music (from the 'Dare' LP), the staved sheet shows the bar number/repeats for the Roland MC8 (and presumably a guide for the Linn too), and letters indicate bass/chord harmony. See if you can pick out the three themes jotted down, too. We've also shown the MC8 worksheet for the first 5 bars, giving control voltage/step time/ gate time values.

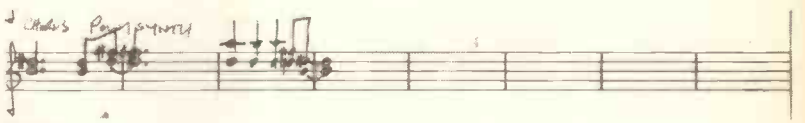


Roland





Opening Synth Solo.



Chorus.

Theme 2.

last thing, which is totally the reverse of how you used to do it. It takes a long time to make a Human League single from start to finish. One track normally takes about a week. Every note that goes into a Human League record is a conscious decision, as opposed to, 'Well, let's take another guitar solo and hope this is a good one,' where you eventually end up getting something which is good but may not be exactly what was required. Here you can decide, well, I think it would be better if that third note was a G rather than an A, and quickly program in a G and listen and say, 'Yeah, that's O.K.'. Every note has been consciously considered at some point, to create the best effect for whatever emotion you're trying to put over.

"*Get Carter* is perhaps an exception to the rest of *Dare*, in that it was done completely manually, there's no computers on that one at all! That's really the only one. It's very simple, almost like a cameo piece rather than a real track. We even used a Casio VL-Tone - it's on *Open Your Heart* playing the main theme. It's on the standard, flute preset. We programmed it into the memory of the VL and just hit the button at the point we wanted it to play, with the tempo synced up. Sort of a lazy man's way of doing it. For £35 or whatever it's an extraordinary thing. They're laying all over the place here, but we have to hide them away because my youngest son absolutely adores them. That tune that the VL has programmed in drives everybody up the wall, you can't get rid of it! I got a Casio watch for Christmas, and it's got eight alarm tunes in it, wakes you up with *Greensleeves* or the National Anthem ... no, no Human League songs yet," Rushent laughs.

The MC8

The Martin Rushent method

"The MC8 really replaces the keyboard, it sends out exactly the signals the keyboard would send out if you were playing it. There are three parameters that are important to a synthesiser in terms of the signal that it gets from the keyboard. In fact on some synths there are more than that, but the basic three are: control voltage, which denotes the pitch of the note; the gate, or trigger pulse, which denotes how long the note's going to sound for, coupled with the ADSR which will give you attack, decay and so on; and step time, which denotes the length of time that the note occupies - it may not *sound* for that long, but it's a crotchet, say, and that's its value. The control voltage is very simple, you just program in all the notes in sequence that you want. Gate time then denotes how long you want each to last.

"All these things are translated into numbers, so your control voltage will go from 0 to 48 which will give every note on the keyboard. With step time, if you value a whole bar at 192, obviously a quarter note's gonna be 48, a quaver's going to be 24, a semi-quaver will be 12, and so on. The gate time, which is the time that you actually want the note to *sound*, or the trigger length to the ADSR - not always the same thing - works on the same basis. So a note that you want to sound for a full bar is entered as 192. If you want it to last for a whole quarter note, it's 48. Or you might have it valued as a quarter note, but you only want it to *sound* the length of a semi-quaver, in which case it would be 12. See, it's really quite simple. Let's say you wanted a half-note rest. O.K., the length of a half-note is 96 so you'd hit in your 96, but you don't want it to sound at all, so you put in a gate time of 0. You end up with a rest of half a bar long. And you can program the most intricate line - if you listen to the more brassy lines on *Dare*, say on *Love Action* or *Don't*

You Want Me, you hear some very flashy playing indeed! You can program in some very sophisticated stuff.

"*Hard Times*, which is the B-side of *Love Action*, not on the album, has a brass arrangement which is basically Junior Walker riffs all strung together for the fun of it - all programmed, including the dynamics. You can program tone and dynamics by hitting the VCF and the VCA - obviously, these things are voltage controlled so what you can do is program up another memory on the MC8. You've got eight possible control voltage memories, so you can have up to eight lines playing at once. We only really normally have one line, and then we'll track on harmonies and stuff to that. The other control voltage memories we use to sling out voltages to VCAs and VCFs, to control the tone and the dynamics. There's a lot of that in *Hard Times*. It's very simple and it's very versatile, the MC8 - and things get better all the time, particularly now as manufacturers of synths are starting to think Micro and build a machine that will work with it. Course, it's only a matter of time before the Micro comes down in price, so that ordinary people doing their demos and stuff at home will be able to afford a simplified Micro.

"There are certain things about the newer Roland MC4 which are better than the original MC8, and there are certain things that aren't so good. We're contemplating getting an MC4 soon for specific jobs, because it'll be faster. Its copy functions are much more usable, much faster, and obviously if you've got a song where large chunks of it are identical, you can just say, 'Copy bars 10 through 14, four times.' It's faster doing that, its delete and insert functions are much easier as well. If you want to delete a few bars because you don't want to use them, or you want to insert an extra piece, with the MC8 it's a *fairly* complicated procedure. If you make a mistake you can mess the whole thing up. Whereas with the MC4 it's been much more simple to do that. It's people like us going back to them and saying, 'Look, you know, it's a real drag about this bit here,' and they go, 'Oh really?' And no-one could have forseen those things. You can really only store about 600 bars of something fairly complicated in the MC8. Every note takes three bytes of the memory: your control voltage, step and gate. You're also running tone and dynamics as well, so it's five bytes a note. Say it's got 16 notes to the bar - you soon chew up your memory. We'd like to dump all our data from the MC8 on to Fairlight floppy disks."

ONE DAY IN THE FUTURE, Martin Rushent sees music and technology becoming increasingly united. "Soon, I can see the possibility of something like an MC8 being brought out that's very simple to use and cheap," he says. "I think the Wave from PPG has got tremendous potential. It's not *yet* very reliable in terms of the time code, and whilst it is programmable up to a point they're still solving those problems. But I think that once they've got that out of the way, and the machine runs reliably with an MC8 or an external programming source, then you've got a killer machine. We've got our order in for the moment, they say, 'Here's one you can run with your MC8.' I think we can also look towards a new Linn drum machine in the pro end that will be even more versatile than the current one. I think it will probably have more sounds in it and will be able to do drum rolls. I don't think we're going to get anything totally brand new this year, it'll be developments of what we've already got. They'll be simplified, made cheaper, made more effective. That's probably what we're going to get.

"At Genetic, we want to stay in the forefront of whatever's happening. We act in rather unorthodox ways at times - we enjoy being right on the edge of what's possible," Rushent continues, "and we shall stay up there. It's fun up there, and I think there will be consistent progress in that area. I think we'd like to build a Genetic studio in London - the only thing that is putting us off is the actual cost. The demand is enormous at the moment on the studio here. We're also looking for artists to sign to our own label, Genetic.

"I think video has to be one of the options for us, but we really want to lead the way, or be one of the leaders, in electronic music - I don't think you've seen the end of this by a long way. I think this is really just the beginning. Electronic music can now stand up as a true form, there's no area that it can't get into. Electronic reggae, electronic country music - in a few years time the bulk of film music will be completely electronic, a large amount of it already *is*. I think that TV advertising will have mainly electronic music. I foresee a shrinking of the number of what one would term session musicians in the industry. The influence of it all is really going to change the whole industry, but obviously it won't happen overnight. It will gradually change. It's a fairly slow process - I would think by the end of this decade, Genetic will be a fairly large, respected organisation, very creative. When I say large, I don't mean thousands of people in a head office in London. But certainly involved at every level. It's going to take a decade to do it."

We'll see about that in 1992. Meanwhile, Rushent has been looking around for 'another artist or two' - recent productions include Lene Lovich (on Stiff) and Leisure Process (on Epic), plus David Rhodes for Genetic. Coming up are album projects for Altered Images and Pete Shelley, and the inevitable Human League sessions. The only problem there, Rushent reckons, is finding two months of their very busy 1982 to record in.

ONE DAY IN FEBRUARY 1979, David Bowie watched the fledgling Human League play at a club in West London. They included his (written for Iggy Pop) *Nightclubbing* in the set, and Bowie exchanged phone numbers with the group before he left. He said he'd keep in touch. Now there's a thought...

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Korg Mono/Poly

RECORDED ON CASSETTE NO. 7

Here's an interesting new synth from Korg - the Mono/Poly, and, as you can see, judging from the internal photo of the instrument, we've managed to get hold of one of the very first units to arrive in the country. I say this, with reference to the photo, because you can see that there is a fair bit of loose wiring, and also a piggy-backed board has been fitted - presumably the production models will have dispensed with this board, and incorporated the circuitry onto the main PCBs. Apart from this, I'm assured that the review instrument I was given performs identically to the models that will be in the shops very shortly, and sporting a price tag of £689 (the RRP) or less.

I was told, by a none too reputable source I might hasten to add, that originally Korg wanted to call this synth the 'Monopoly', but their trade mark solicitors warned them that they would be required to go directly to jail without passing GO, and without collecting £200, if they did so. Thus Korg settled on the name of Mono/Poly.

It doesn't take a great deal of intelligence to gather that this synthesiser is going to be able to perform in two modes - monophonic and polyphonic. At £689, you aren't going to expect too much from the polyphonic operation, but you would expect quite a high performance monophonic for such money. This new Korg synth does, in fact, perform well in both modes, and it incorporates some interesting ideas, which make a genuine contribution to the instrument's performance.

You are getting quite a bit of hardware for your money here: a 44 note F to C keyboard, 41 control knobs, 14 slide switches, 6 push button momentaries with LED indicators, 2 performance control wheels, and ten jack sockets, and, of course, a mains ON/OFF rocker switch.

The keyboard isn't bad; the action is good and positive with just the right amount of key dip, but the actual construction does warrant me to use the term 'plasticky'. The casework, however, is very nicely constructed, as most Japanese products are these days. The sides and front are a dark wood veneer, with a plain wooden base board. Into this sits the keyboard, and plastic performance control mountings, and the main control panel (hinged up in the internal shot) is black anodised formed aluminium, with a blue block overlay, for identifying the separate control sections, and white graphics. The control knobs are nothing to write home about, but overall the instrument does have something of an air of quality about it.

There are four voltage controlled oscillators that perform as the main tone generators, and it is the way that the control circuitry assigns these oscillators that dictates whether the machine operates in monophonic or polyphonic mode. The signal from the oscillators, and noise source, is mixed together before proceeding to the voltage controlled filter and voltage controlled amplifier as per usual. So you can immediately see where the polyphonic compromises start, there being just one VCF and one VCA. But let's start by looking at the assignment controls.

Key Assign Modes

These are controlled by the push button momentaries that are conveniently positioned one and a half inches up from the keyboard. Five buttons do all the work here - two polyphonic options marked Poly and Unison/Share; two monophonics - Unison and Chord Memory; and lastly, there's a Hold button. The functioning of Unison and Poly should be obvious - the former assigns the control voltage from the last note played, and routes it to all four oscillators; the latter assigns the first note played to VCO 1, the second note to VCO 2, though if key 1 has been released VCO 1 is used again, and so on. If four notes are played and held, and a fifth note triggered, then VCO 1 is robbed, and gets key 5. Although this is a sensible system to use, it would have been a good idea to have provided a cyclic assignment option, whereby the first note played goes to VCO 1, the second to VCO 2 no matter what VCO 1 is doing, and so on, such that by playing just one note over and over for example, all the VCOs are used in turn. The reasons for wanting this option are rather involved, but with the system provided it is difficult to play and hold a note whilst playing triads on the rest of the keyboard without robbing the sustained note. I won't delve any deeper here, but you may appreciate my suggestion for a cyclic mode better when you've tried the Mono/Poly for yourself.

'Chord/Share' isn't anything breathtakingly new and exciting - Roland had it on their JP-4. Basically, all that happens is that the instrument operates monophonically with all the oscillators in parallel only when the keyboard is being played monophonically; if two notes are played VCOs 1 and 2 are assigned to one note, 3 and 4 to the other; when three notes are played it's a matter of one VCO per note, the fourth just idling.

Finally, we have 'Chord Memory', which again has been seen before, most notably on the Oberheim OB-X, OB-XS, and OB-Xa. Basically, what happens is that a chord is played, say a major seventh, the Chord Memory switch is activated and from then on every note played causes the oscillators to split off into a major seventh, so you now have a monophonic machine but with the oscillators set at predetermined

Mono/Poly opened up.

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intervals apart. Obviously, you can do this without a special button, purely and simply by tuning the oscillators to different pitches and using the synth in mono mode, but this is far faster to use.

So far so good, but with any pseudo-polyphonic synthesiser of this type, sharing all the oscillators with just one VCA and one VCF, there are going to be problems. What happens, for example, when you hold and sustain one note, and play and release another, especially if you want the voicings to sound similar, and they have relatively long release times? The first problem is the filter triggering of the envelope - this is got round by having a single or multiple trigger switch, so that in multiple mode the filter envelope retriggers every time a new note is played, thus affecting not only the new note, but also the one being held; in single mode, however, a new trigger pulse will only be generated after the keyboard has been cleared, thus the new note in our example won't affect the filter. This is a fairly good compromise, with not too drastic limitations - but what happens to the loudness envelope of our second note. In the Mono/Poly the oscillators are gated to the VCF, so when the second key is released, the sound is cut off sharply, leaving just the held note, even if the release time is set for several seconds. This isn't a good state of affairs, so Korg have come up with an 'Auto-Damp' switch, which sustains the release note until the first key is released, both notes fading with the VCA envelope release time. Again, it isn't an ideal situation, but it does come in useful for a lot of playing styles, and with these two facilities, the polyphonic performance of this pseudo-polyphonic machine is greatly enhanced. Before looking at the various voicing elements in more detail, I should point out that the Mono/Poly does offer polyphonic portamento, i.e. there's a slew limiter on the control voltage line to all oscillators.

Each oscillator is affected by the master tune control (± a semitone), and oscillators 2,3 and 4 have separate fine tune controls (also ± a semitone); in addition, a master detune knob can be used to shift the frequencies of VCOs 2 and 4. Otherwise, the oscillators are all the same, offering 16', 8', 4' and 2' pitches with triangle, ramp, pulse (width variable) and pulse width modulated waveforms. As previously mentioned, each oscillator has its own level control and the sound generation network is completed by a noise source.

The voltage controlled filter is a 24dB/octave low pass type, that can be made to self-oscillate, and has keyboard track, positive and negative envelope modulation facilities. The filter has its own ADSR envelope, as does the voltage controlled amplifier.

The Mono/Poly has two low frequency oscillators, or modulation generators as Korg would have them; one providing sawtooth, ramp up, ramp down, and square waves, and being used to modulate, via the performance wheel, the pitch of the oscillators, or the filter, and if required, the pulse width of the oscillators and the second LFO is used again either to control the pulse width, or to act as the clock for the Arpeggiator.

The Mono/Poly is nothing if not comprehensive, and neatly arranged in the centre of the control panel, we have an array of controls that provide different forms of cross modulation and synchronisation effects. These can be preset before hand, and introduced at the touch of a momentary button when required to come into action. I won't delve too deeply here, but I will stress that this is a particularly impressive modulation/effect section.

The Arpeggiator is an increasingly popular feature of today's monophonic and polyphonic synths. Basically, all you need to do is play and hold a chord (you can use the latch feature), and the control circuitry of the synth will play each note in turn at a rate determined by the speed of the second low frequency oscillator. This arpeggio can be further expanded automatically across the width of the entire keyboard, and with the Mono/Poly three patterns are provided: Up, Up/Down and Down.

The final control that we've not yet discussed on the Mono/Poly's fascia is one of the most important yet in the case of this machine, one of the weakest. It's the pitch-bend performance control wheel, which has a centre-dente to ensure that it returns to its initial position. This is important, because if you don't get the instrument back in tune after a 'bend' then all is lost. Here the centre-dente is very weak - I suggest that it should be strengthened considerably (Korg engineers please note).

Finally we come to the rear panel, which offers us: an audio output, headphone output (good and loud), control voltage and gate ins and outs (I'm glad to see that Korg have now gone over to the volts/octave system), VCO FM in, VCF FM in (both for pedals), Portamento (footswitch), and Arpeggio TRIG in (for driving from a drum machine I guess). So a good array of interface sockets here.

Conclusions

Well, I don't think that the Mono/Poly can take much of a knocking - at £689 it is a very nice machine indeed. At first it looks a bit confusing with all the knobs, but it is surprisingly easy to operate. It is well built and has a good overall tone. This synth really is an all-purpose machine - its modulation facilities make it good for home recording, sound effects, imitative synthesis etc., whilst it is suitable for use live, though you'd have to be well experienced on the machine to make quick sound changes. As a polyphonic it performs as well as any other costing under £1,000, and as a monophonic it truly is a versatile beast, especially with the four independent oscillators. So, a good eight out of ten for Korg on this one... no, perhaps even nine.

Dave Crombie **E&MM**

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America

N.A.M.M. Winter Market at Anaheim

The Japanese Di Mini guitar.

The Melobar 'upright' slide guitar.

Is nothing sacred? Even Disneyland had a dark cloud of foreboding hanging overhead. This year's N.A.M.M. winter market at the Anaheim convention centre had more of a sober English feel about it rather than the usual brash and optimistic extravaganza normally associated with Californian affairs.

As in England the battle is on to produce the ultimate oldie replica, particularly those of Fender instruments. Leading the field in this country is Tokai, so it was interesting to see how they fared stateside. By a strange quirk of fate or possibly by intention Tokai were displaying next to the CBS exhibit and only those fleet of foot managed to view the replica vintage Strats and Teles, for a quiet word in the ear from CBS had the Fender lookalikes cleared from the stand within ten minutes.

However, not to be discouraged by copyright infringements, Fernandes guitars placed rather less obtrusively round the corner from the main hall, displayed their claims to fame, which are in fact regarded by our U.S. cousins to be superior to the Tokai anyway. Every effort has been made to duplicate the authentic feel currently being craved, even down to the choice of lacquer, although to my mind the nut and adjacent neck is not completely faithful to its mentor. One feather in their cap is their linkup with Floyd Rose, the originator of the tremolo system bearing his name. This system, which allows the strings to be reduced to nil tension and returned to pitch with negligible tuning deviation, is still available with its 'made in U.S.A.' tag, but now an alternative made in Japan is available at half the price.

At this stage I was wondering how Fernandes thought they could elude the problems encountered by Tokai, so I asked them along with yet another Japanese Fender clone, Riverhead Vintage guitars. Apparently the secret lies in the head decal design, but time will tell for there was a lot of mumbling into the backs of hands on this subject.

Still on the replica theme but in a different league were Phil Kubicki guitars, Phil who worked for Fender for a number of years and was in fact responsible for their much sought after LTD Jazz guitars, has used his experience to produce a reproduction to end all reproductions and for those wishing for a far slinkier feel, Phil also produces 15" radius fingerboards as an option to the usual 10". Seymour Duncan pickups are fitted as standard so of course they sound good. Inspired by requests from players like Jim Messina and John Sebastian for a practical travel guitar, Kubicki guitars also market baby Les Paul and Flying V type 21½" scale guitars featuring 22 frets and specially designed Seymour Duncan ¼lb pickups.

It may have taken a long time to sink in, but CBS have finally seemed to realise that players actually like Fenders the way Leo used to make them, so they've copied their competitors and copied themselves. It is now possible to buy a brand new Fender '52 Telecaster, '57 Strat, '62 Strat, '57 Precision, '62 Precision and a '62 Jazz Bass (dual concentric pots). In addition they have added Super Champ, a 20 watt combo to their amp range.

Latest edition to the Seymour Duncan range is a replacement Firebird pickup in three configurations: vintage, custom and hot. Seymour's stand is fast becoming the Mecca for players at these shows, I actually rubbed shoulders with James Burton, Eddie Van Halen and Albert Lee who had all dropped in at the same time.

G. & L., Leo Fender's new company, have added the G200 guitar to their impressive range and the first production models have the controls mounted on a plate but this will be changed to rear mounted.

After their success at Chicago in launching their cut price wireless guitar system, Samson have now turned their attention to the add-on preamp market and first in no doubt a long line of products is a frequency booster for Rhodes keyboards, which it is promised eliminates the mush in the mid section without the need of an expensive parametric EQ.

Dean Baby.

Although Peavey guitars started out as a bit of a joke to a lot of people there are currently many manufacturers choking on their mirth, for Peavey is not only holding its own in these hard times but actually making ground. The new T-20 bass is, if I'm honest, the first Peavey bass or guitar to actually *demand* my attention and as it will be retailing for under £200 (including case) I should imagine it will claim the attention of many others too. Additional new products from Peavey include flight cased 10" and 12" speaker systems.

New from Yamaha is a portable rehearsal system called the Producer Series. The complete system comprises four units: a headphone amplifier, stereo mixer, stereo headsets and a micro monophonic synth. Literally small and light enough to hang over the shoulder, the amp and mixer allow up to seven musicians to jam together with independent volume and tone controls and the use of headsets mean that a big hall sound can be made without disturbing the neighbours.

Particularly useful for the student or progressive guitarist is a computerised guitar chord method called Chordex. About the size of a large calculator, it has the capacity to display over 1,000 chords on a simulated fretboard.

Having been well established over the last few years as one of the leading add-on active electronics suppliers, Power Pots have now broadened their range with a rack mounted effect, The Redubler, this unit will flange, double and reverb. A multi-tap delay line employing six differently delayed signals is utilised to produce a natural reverb and the effects can be controlled either directly from the front panel or from any guitar volume pedal which can be used to replace the delay time auto control.

One product that hopes to find an expanding market is No. 1 stretch straps. Originally the concept was to distribute the guitar's weight evenly over the shoulder and back, but of course all sorts of fun can be had with them. Peavey were certainly impressed because they snapped up exclusive rights to distribute them in black (so any colour is available as long as it's yellow!).

The ever popular Ovation Roundbacks have taken a logical and what I believe will be a popular move in a new range of cutaway round backs. These guitars have always been highly playable, but with the cutaway giving access to the 18th fret the versatility has been greatly improved. Four models launch the range, the electric Balladeer, electric Legend (deep and shallow bowl types) and electric Custom Legend.

One instrument that I have always felt has tremendous potential but has never been exploited fully due to the technical complications is the violin, so I always keep my eyes open for anything that may inspire the rock musician and this year I came across Alvarez. Although there was nothing revolutionary in the design of these candy apple fiddles, the makers claim that their Hot Bar pickup overcomes the normal achilles heel, feedback.

It is a sad comment on Kramer guitars that they are producing all manner of copies: Fender, Charvel, Steinberger, everything and anything bar a Kramer, when their first models were maybe not the best, but at least they were original.

Fender 62 Precision.

Peavey T-20 Bass.

I was impressed with the Taxi full scale portable guitar at Chicago in June and now the Spitfire has appeared. This 24¾" scale guitar, like its brother, is small and compact enough to carry around in a shoulder bag whilst retaining big guitar feel, in fact baby guitars of one description or another were to be found nearly everywhere.

Dean, whose popular Explorer guitars did much to prompt Gibson to re-issue this model, had his own Baby this year - again full scale instruments based on the V and Explorer. Even the Japanese had got in on the act with Di Mini, tiny Strats, Les Pauls, V's etc., but this time the scale was also reduced, possibly making it more of a toy - but in the hands of the right musician, who knows?

Melobar have been producing slide guitars for many years and presented an updated range with two new stand up slide guitars styled on those two shapes of today,

Cutaway Ovation Roundback.

Music Man Stingray Bass.

Kubicki Strat.

the V and Explorer. For those not familiar with Melobar, these guitars have been designed for playing slide whilst held in the convential upright guitar position by angling the neck, bridge and pickups to face upwards on a triangular elevated centre section.

Probably the most sought after amp sound in the States is Marshall, so it is no surprise that Bartolini have tailored their new Tube-It effect to a Marshall response, although other Tube sounds can be obtained.

A classic English tube sound means Marshall in America and it is on precisely this platform that Legend have based their whole range of amps, although the natural oak cabinets and cane grille give them a more elegant appearance than our own home grown product. New to the range is a 30 watt single channel four band EQ combo. The tube preamp has two gain modes allowing a switchable choice between any two gain settings and both modes are capable of producing distortion or clean gain.

Finally, good news for bass players. Music Man are back in production with the Stingray bass, and as Charvel guitars are now responsible for the woodwork, things should start looking up again for this troubled line.

Peter Cook **E&MM**

Fostex 350 Mixer

The new range of Fostex recording machines, highlighted by the superb and innovative eight track A-8 using ¼" tape, is complimented by a very useful and compact mixer — the Fostex 350.

It is a versatile 8 x 4 x 2 mixer designed for recording, mixdown and PA applications and uses unbalanced input/outputs, as well as a routing system that offers maximum scope from this unit priced at £401.87 ex. VAT. The 350 follows the style and smart grey/orange presentation of the companion tape recorders, measuring only 3¾"(h) x 18½"(w) x 16"(d) and weighing 18 lbs. An optional meter bridge is available (£97.50 ex. VAT) that mounts across the top rear of the mixer, with six VU meters for monitoring the four main output lines (ABCD) and the two auxiliary outputs. The bridge is linked and powered by direct multicable connection to the rear of the mixer and its side screw supports allow angling to suit the user.

Apart from two stereo headphone sockets mounted on the front, all connections are compactly located on the rear panel. The mic/line inputs use standard ¼" jack sockets with all other connections made via RCA phono sockets.

There are eight input channels (impedance 50kΩ) with an adjustable level range for mic/line inputs from 0.5mV to 4V. Each channel has a tape input socket as well as a patching wire link across the signal path at this point that can be removed to 'send' and 'receive' effects and other signal processors.

Thus mixdown is made easy from the eight track by simply flicking the switch for 'mic/line, off, or tape'. There's also a red LED situated above each input fader that flashes warning of likely overload of the input stages.

Whilst the channel fader then feeds an EQ section, the signal is also routed to the auxiliary (L/R) stereo output buss sockets. A switch allows selection of the signal before or after the channel fader, or from the tape input (i.e. pre, post, tape), with gain and pan controls provided for each channel. So the

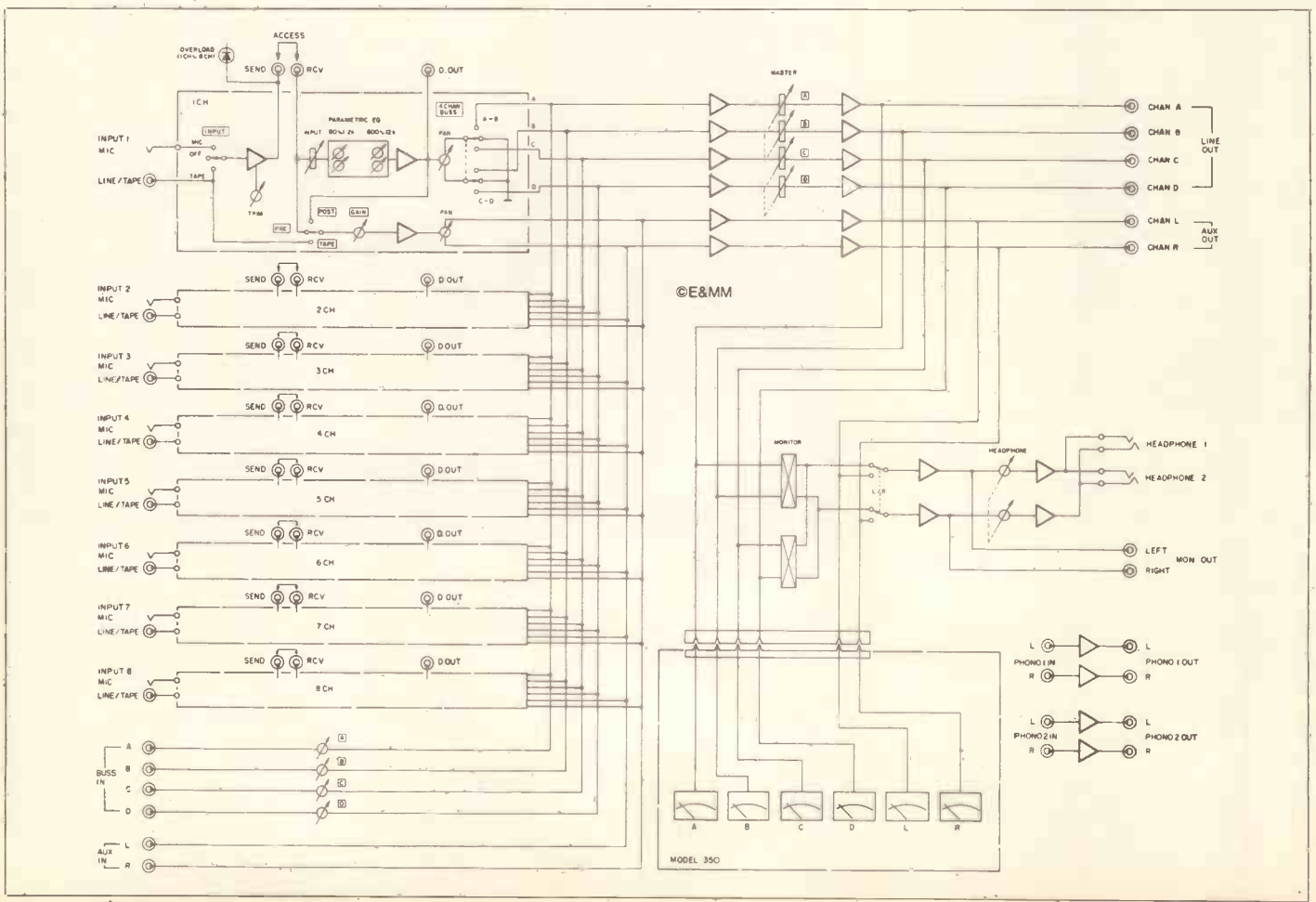

Figure 1. 350 Mixer block diagram.

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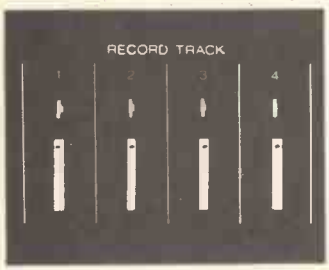

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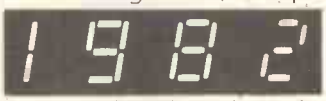

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aux buss is very useful as a stereo foldback (or two mono), as a reverb/echo buss, or as a tape monitor during recording.

The EQ section replaces the normal bass (mid) treble controls and offers lower and upper centre-band frequency control from 80Hz to 1.2kHz, and 800Hz to 12kHz, with boost and cut of 12dB using the gain controls. At first, the section is a little awkward to use, but soon becomes an attractive alternative because of the increased control it allows in tailoring the frequency response. Hums and hisses are easily removed and large tonal changes to the input signal can be made.

The EQ output is split to feed a direct output socket, useful for further sub-routing (to another mixer or recorder), and a pan pot that is routed (via an 'A/B, off, C/D' switch) to either pair of output groups. The A/B, C/D references for the output lines match the A-8 recorder's input routing system and both group outputs are controlled on the mixer by ganged faders, before buffer amps send the signals to 'line out' sockets.

Additional 'Buss In' sockets with gain control are provided on each of the group lines (A, B, C, D) and also on the Aux buss, but with no level controls unfortunately.

The stereo monitoring system is unusual in that it is done through five switches with level controls prior to its L/R output sockets. Nevertheless, it is very easy to use and offers not only A/B and/or C/D monitoring in stereo, but a mono (centred) signal for A or B, and/or C or D — all done by pressing switches A, B, C, D appropriately. If the fifth switch is pressed, the Aux buss (L/R) is heard instead.

Normally, the monitor sockets would go to your amp/speaker system and would require level adjustment from the amp with this mixer. There is also a stereo headphone amp with level controls that allows direct headphone monitoring via two ¼" stereo jack sockets. The quality is exceptionally good, with little background noise and high gain (maximum 100mW to 8Ω).

Finally, two good quality stereo RIAA preamps are built into the 350 mixer and accessed by dual input and output phono sockets on the rear panel. These will appeal not only to disco users, but to electro-musicians who often refer to records during their studio work but don't have room for a separate hi-fi system.

Conclusions

The 350 mixer is very well made and despite its 'plastic' feel, is built to last, on a rigid metal frame internally, with one large PCB holding most of the circuitry. Even input sockets feed directly to this board. Phono preamps and Monitor Select switches each have their own PCBs, and the transformer (not toroidal) is screened, with PSU fuses located next to it. Servicing is quite straightforward as the whole chassis lifts out, once fader knobs and four long screws are removed. Knobs and switches are all well made and the only point was some stiffness at the top of the end of the faders (only apparent on *my* review model, it appears).

The rear connections certainly allow much of the routing you'll require to be prewired, but once the meter bridge is attached to the mixer, there is quite a hassle accessing the jack and phono sockets, especially if you use short connecting leads to your A-8 tape recorder, etc. One answer, of course, is to use a separate junction box linked to the mixer from which access can be made more easily. Incidentally, no leads (except for a fixed mains lead and bridge multi-way lead) are provided; and the medium impedance of the system limits lead length to under 10ft before hum and high frequency losses may occur.

The bridge also has very little angle to manoeuvre once all connections are made. But it's still an advantage to have, particularly for its large illuminated VU meters.

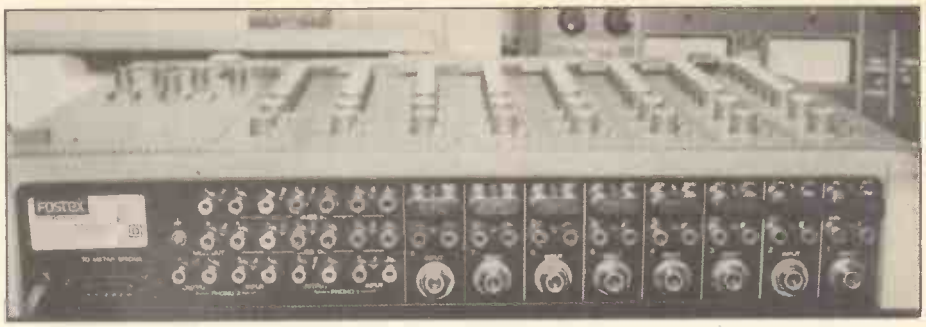
What you have to weight this against is that for a small outlay by today's prices you *can* make this mixer do virtually everything you want in a small 8-track/4-track stereo studio situation and that alone makes the problem of fiddling with connections at the rear worth it. And, of course, it's so small that it fits in any situation. I would have liked a built-in oscillator, although with plenty of synthesisers in my studio, it is easy to line up meters using one of these as an external source. A second foldback and monitor level control would have been useful, but Fostex have obviously kept their design to a sensible minimum.

Operation of the mixer is quite straightforward, with overdubbing, tape mixdown, foldbacks all easily done. A small but comprehensive manual explains the alternative ways of using the 350. Fader attenuation is good with no breakthrough at minimum, and cross talk is claimed to be 65dB at 1kHz.

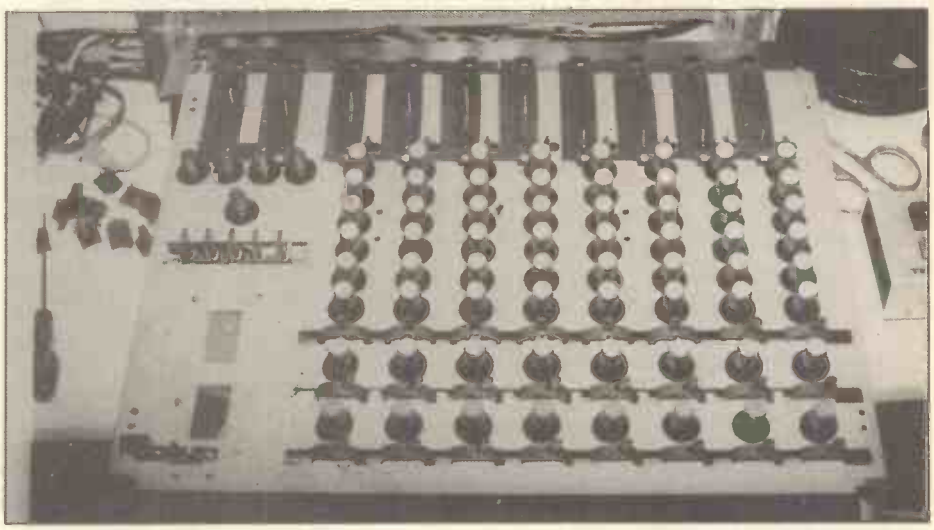
The most important features of this instrument are not only its versatile routing, but its good low noise operation plus — now that CB is here to stay — its minimum RF pickup, yet still giving plenty of gain at the input stages. If you need a small mixer that will maintain your off-tape quality, the 350 is highly recommended.

Mike Beecher **E&MM**

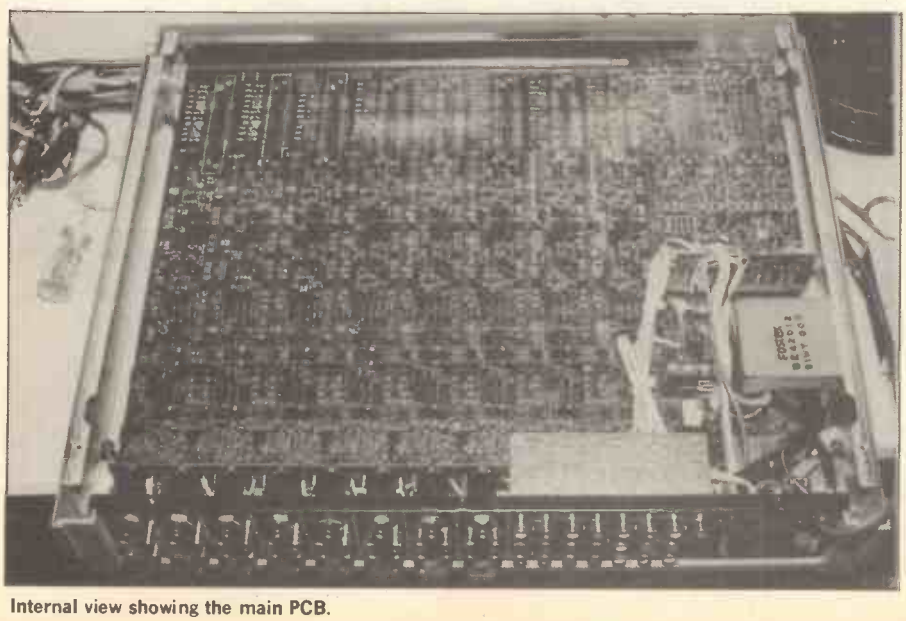
The Fostex 350 Mixer is distributed in the U.K. by Bandive Ltd, 8 East Barnet Road, New Barnet, Herts EN4 8RW. Tel: (01) 440 9304.



Rear connection panel.

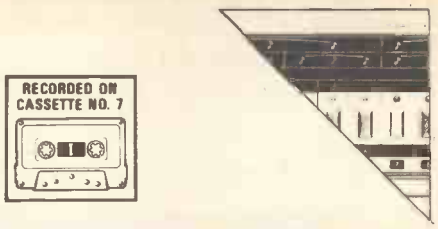


The metal chassis supporting controls.



Internal view showing the main PCB.

Roland TB-303 Bass Line



RECORDED ON CASSETTE NO. 7

One of the most interesting little boxes to be seen and heard at the recent Frankfurt musical instruments fair was Roland's new TB303 Bass Line machine, designed to some extent as a partner-in-rhythm for the not-quite-so-new TR606 Drumatix drum machine (see review in E&MM February 1982), although more than useful on its own. In fact, on first glance the 303 does look rather similar to the 606 — the same slim, silver box measuring about 12in by 6in by 2in contains the works, but there the similarity ends. We have had a brief preview of what, at the time of writing, was the only 303 in the U.K.; by the time you read this, supplies should be reaching Roland dealers at an attractive retail price of £215. This page is therefore intended as an introduction to the machine's main capabilities.

So what is the Roland TB303 Bass Line? It's a machine which enables the operator to devise, write, and recall from memory 64 melodic patterns, or measures, of up to 16 steps each, and then to link these patterns either by 'chaining' or by inserting them in selectable order into one of the unit's seven track memories. The aim is to provide programmed bass guitar-like or bass synth-like lines for recording and (more adventurously) live use. In addition to the expected outs for headphones and mixer or amp, other interface sockets give sync facilities so that the 303 can be linked with, say, a 606 to give a rather wonderful electronic rhythm section in two small, portable, good-value units. And, of course, all manner of other interconnection and control is possible.

Writing patterns into the 303 centres on the machine's 13-note C-to-C keyboard which takes up most of the bottom left and centre of the fascia. 'Keyboard' is perhaps a slight exaggeration, but readers familiar with the Casiotone VL-1 will not be disappointed by the description. As with the 606 drum machine, the 303's controls are nearly all multi-purpose — Roland have once again crammed an awful lot into a small space so this initial confusion is really to be expected, and doesn't last too long. Thus the keyboard's 'keys' double as pattern memory location switches — after turning the large Mode knob (third from the left over the keyboard) to Pattern Write, you select a pattern memory position by pressing one of the eight 'white-note' keys. These eight memory positions each have a choice of four pattern groups (selected on the knob next to Mode), and a further choice of 'A' or 'B' pattern section (on a switch to the right of the keyboard). This, then, gives us 8 x (4 x 2) = 64 pattern memory locations.

Having cleared your selected memory position with the Clear/Reset button, you can write a pattern, or measure, of up to 16 steps into each location, activating the keyboard with the Pitch Mode button. At this stage you're not concerned with the timing of notes — you're just putting the pitch of the notes in the required order into one or more of the pattern memory positions. Once this pitch information is correctly written in, you then press the Time Mode button, whereupon you can go through the already memorised measure step by step, giving each note its value by using three switches which correspond either to 'start sound', 'continue sound', or 'no sound' for each step. You can choose between two step modes to give virtually any time signature you care to play with.

And so, with your overall composition in mind, you continue to write measures into the relevant number of memory positions. You can add accents to particular steps and slides between certain notes to give a better overall feel, and have the choice of five 'tone controls' along the top of the machine with which to alter the eventual playback sound. They are: Cut-off frequency, for overall tonal quality; Resonance, to bring out certain frequencies; Envelope Modulation, which controls the tone 'movement'; Decay, giving the fading-away characteristic; and Accent, giving intensity of accented notes. These combine to give most sounds that you'll need, from a reasonably accurate and wooden string bass to much synthier bass runs. There's also a selector switch for either sawtooth or squarewave, plus a tuning rotary and a tempo control. Patterns can be written into one of the seven track memories, each of which can accommodate up to 64 patterns — you can write in more by using two or three consecutive tracks if necessary. With a little diligence, results can be as complex as you need them to be.

As with the 606 drum machine, you really have to write things down at an early stage to get the best from the 303 — you can if you like use it for off-the-cuff bass lines in a sequencer-like fashion, but for anything beyond very basic use you have to plan out what you're going to do before even switching the machine on. Playing with the 303 for a few seemingly wasteful hours — making a few mistakes, losing a few programs, swearing once or twice, etc — helps you understand that things which seemed like stupid idiosyncracies at first are merely the machine's inherent insistence on mathematical order. Once you grasp this basic notion, the 303's potential can be more fully realised.

The Roland TB303 Bass Line has plenty more handy tricks tucked away inside, all accessible to the practised button-pusher. They include: checking written pitches and note-lengths; transposing written patterns; writing by the alternative of hitting a Tap button; correcting tracks by deletion and insertion; return and repeat functions; chaining patterns for measures greater than 16 steps in length; using two different step modes within a measure; and recalling particular bars within a track by number. We've only scratched the surface here (not literally, Mr Kakehashi!): the detailed 90-page owner's manual is a long and pellucid read. We await the next Roland innovation with interest!

Tony Bacon **E&MM**

The TB303 Bass Line is distributed by Roland (U.K.) Ltd, Great West Trading Estate, 983, Great West Road, Brentford, Middlesex. Tel: 01-568 4578.

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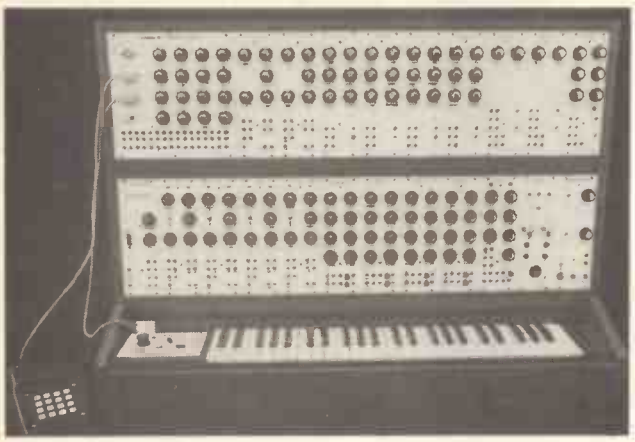

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CASSETTE REVIEW

Electronics & Music Maker's CASSETTE REVIEWS aim to give an indication of what readers are up to musically, and also include a short appraisal of their work.
To this end we invite home electro-musicians to send in a cassette of their work for possible inclusion in future issues.
The recording method used is, of course, entirely up to you.
The range we seem to get is from sound-on-sound on a stereo tape machine, through bouncing in stereo between two machines, up to small 4-track multitrack recordings. But if your method comes 'above' or 'below' these in technique or application, don't hesitate to send your cassette in as well. It can be a one-off demo-type tape, an independent cassette-only release or anything in between.

You should send one cassette, mono or stereo, clearly marked with your name and address on the cassette itself, information on instruments used and recording method adopted, and a relevant black-and-white photograph. Send to: E&MM Review, 282 London Road, Westcliff-on-Sea, Essex SS0 7JG.
Subjective 'scores' given at the end of each listing below are out of a maximum 10 for each category; tapes are generally given 4 for basic ferric types (e.g. TDK D, AD, etc), 5 for chrome types (e.g. TDK SA etc), and 6 for metal (e.g. TDK MA etc), with sometimes a point either way for variations.
If you'd like further information on any of the cassettes mentioned, such as contact addresses, please write to 'E&MM Review' at the above address.

Tony Bacon

Tape of the Month

THE HEADS OF STATE Six tracks. Peter Cook: vocals, guitars, synthesisers, bass, percussion, rhythm machine. Steve Driver: Synthesisers, bass, guitar, recorder, percussion. Transcendent 2000 synth, E-Bow device, Carlsbro Stingray Pro combo, Roland Cube 60 bass amp, E-H DRM16 rhythm machine. Recorded between Akai 4000DS and Sony TC377 reel-to-reels. Scotch Chrome.
A pleasingly different tape, made after Cook and Driver left a local Medway rock group. The recording method is haphazard to say the least, and the tape submitted is recorded at very low level, barely reaching -5dB on PPMs even on loud passages. Balance, one suspects, is largely down to chance. THOS say their work falls into two categories, loosely described as 'ethnic' or 'pop', and it's on their ideas that the group get the Tape of the Month tag, as with last month's choice, Martin Lloyd. Perhaps the best combination of their two stated categories is found on 'New Impressions Of Africa', a bass theme almost lost in the mix, but a compelling atmospheric whole. Other 'ethnic' selections are very short - 'The Great Wall' with its whirling pipe-like melodies, or 'The Mind Within The Body' featuring distorted single-line guitar and the odd percussive jangle. The 'pop' stuff doesn't work quite so well - 'Silence Kills' is clumsy and jagged, although 'Heads of State' itself fares better. With a little more attention to recording and a more homogeneous musical approach, THOS could do very well.
Music: 7 Production: 4 Presentation: 2 Tape: 5

HEAT LOSS 'A Thief In The Night' Trux cassette, from Gincarlo Martina, Codroipo, Italy. Percussion, sax, guitar, piano. Recorded with Superscope CD330 and C205, Technics 610, and Sony tape recorders, via Superscope mics and JVC equaliser. Recorded in 1978, mixed August 1981.
An odd package from Italy - the music is what we would tenuously describe as avant-garde. Sound is of the essence, and Heat Loss (whoever they may be - no personal credits identifiable on the attractive sleeve) go about their sonic business with serious intent. Strange...
Music: 5 Production: 6 Presentation: 6 Tape: 4

STEPHEN FROST 'Home Produced Music' excerpts from 'Soundscapes' (distributed by Mirage) cassette-only release, plus recent work. Korg MS10 synth, Korg SQ10 sequencer, ARP Quartet, Soundmaster SR88 drum machine, various FX. Recorded on Teac A108 cassette deck, or track-bounced on Philips N7150 reel-to-reel. TDK D, Dolby.
Side one of Stephen's tape features music from his 'Soundscapes', recorded April 1980 - August 1981, while two is of work from the September-December 1981 period. Two is a little denser and more fully arranged, although there is little to choose between the two recording methods as heard, both of which Frost has handled well. Despite our cassette being marked Dolby 'In', it sounded much happier without Dolby on playback, pointing to misalignment somewhere along the line. The 'Soundscapes' material is instrumental, largely sequencer-based music, as in 'What Climate', although tempo livens up for 'Motorway Madness', reverting to a more reflective style on 'Solitude' and 'Guess I'm Only Dreaming'. Best of side two is 'Magical Isle', a pleasing concoction of synths with plenty of ARP strings.
Music: 6 Production: 6 Presentation: 4 Tape: 4

Best of the Rest

BILLY GREEN 'Mini Album' Track 4 Tapes cassette-only release. Guitar, bass, percussion, drums, vocals, all by Billy Green. Recorded on Teac A3440 4-track reel-to-reel.
This is Green's first cassette release, on which he plays everything. Fairly basic songs and limited arrangements ensue, with a rather constricted sound and quite reasonable balance, although clumsy in places. Green reports that he is currently at work on another release with the aid of a new Casio MT30, which he describes as 'a fantastic little keyboard'.
Music: 4 Production: 4 Presentation: 4 Tape: 4

EXPANDIS 'I'm Not Waving... I'm Drowning' Philip Thornton: synth, keyboards, guitar; Dave Miller: guitar, keyboards, vocals; John Wilde: vocals. Korg MS20 synth, Korg SQ10 sequencer, Simmons SDS-IV drum synth, Moog Source synth, various other instruments and FX. Recorded between Akai cassette deck and Sony TC377 reel-to-reel via H/H 5-channel PA amp, mixed in mono (except 'Movieola', live piano direct to Sony in stereo).
Recorded 'at home with care' in 1981, this cassette-only release is sold at the group's gigs and in local (Bexhill) record shops - so, as you might expect, there is a relatively professional air about the tape: a good sleeve designed by vocalist John Wilde, xeroxed in black and white, informs on all the combinations used for the 19 tracks. The music is extremely varied and the group use their relatively limited instrumentation to excellent effect throughout, with an affection for places and dates: 'Dancing In Vienna 1957', 'Holland 1973', 'Potters Bar 1977', 'St. Leonards Jan 1977', or 'Caledonia Sept. 1243'. Aural postcards? Anyway, Thornton's production is also commendable considering his tools - a recommended tape, on which the music is never allowed to stray too far from the overall scheme. This month's E&MM Gold Star for Effort.
Music: 6 Production: 6 Presentation: 6 Tape: 4

Billy Green.

Expandis.

Paul Nagle.

PAUL NAGLE 'Alcove' (ART007) and 'Modulus' (ART008) Soft Room, distributed by Flowmotion. Korg MS20 synth, Korg MS50 synth, Korg Delta synth, Kitten synth, Korg SQ10 sequencer, Boss DR55 drum machine. Recorded on Akai reel-to-reel, using Boss 6/2 mixer.
These two cassettes, recorded between April and June 1981, are made by 19-year-old Nagle at home in Preston. There are some moments of interest on both tapes - they exhibit a rather dense sound - and we preferred the lengthier pieces, like 'Na' Apet' on 'Modulus', although the more concise pieces, like 'Field Of Cormallen' on 'Alcove', have their charm.
Music: 5 Production: 4 Presentation: 5 Tape: 4

CYBERNETICS 'Your Next Visitor' Sorcerer Sound Productions. EMS VCS3 synth, mics/tape time delays. Recorded with two Revoxes.
A short tape with a track on each side - 'Mirror Image' and 'Urban Desolation (Control Test)'. Odd delayed and treated sounds abound - virtually an exercise in sound creation. At times intriguing, at others simply annoying. We are informed that the work is produced by 'the Sorcerer'. Hi, Martin.
Music: 4 Production: 5 Presentation: 3 Tape: 4

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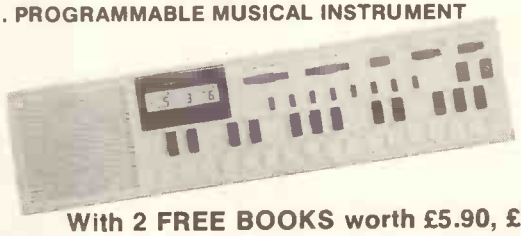

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Cardiff University Electronic music studio

RECORDED ON CASSETTE NO. 7

If you take a walk through Cardiff's very attractive civic centre, past the City Hall and the Museum with cascading fountains and neolithic standing stones to your right, you will shortly come across a rather impressive building. It is within the scholarly corridors of this building that the electronic music studio of Cardiff University is situated. Whilst the premises were built in 1897, the studio has been in existence a more modest twelve years but during that time a lot of highly innovative work has taken place.

The studio is actually part of the physics department and forms part of an acoustics research complex where work on psychological acoustics, musical instrument acoustics and electronic sound is done. The studio, therefore, forms part of a research triangle in which there is a constant interchange of ideas, equipment and personnel. Most of the hours spent in the studio are taken up with teaching and the course run there is in two parts. The biggest is the Diploma in Electronic Sound which is for the science or arts non-music graduate and is run in parallel with an M.A. in Contemporary and Electronic Music which is run jointly with the studio and the music department. This latter course is for the music graduate specifically but basically anyone with a degree and an inclination towards electronic sound is eligible to apply for the Diploma course. The courses are both one year full-time but the Diploma can be done part-time over two years. They can take six to eight students, the reason for this relatively small number being that many hours are needed for practical work so unfortunately a 'bottleneck' appears when it comes to the students using the studio for their projects. Because the studio is in the physics department the work is more technical than musical and all the staff are scientifically trained but it is recognised that most students are studying the technical side for artistic or musical reasons and musical guidance is available.

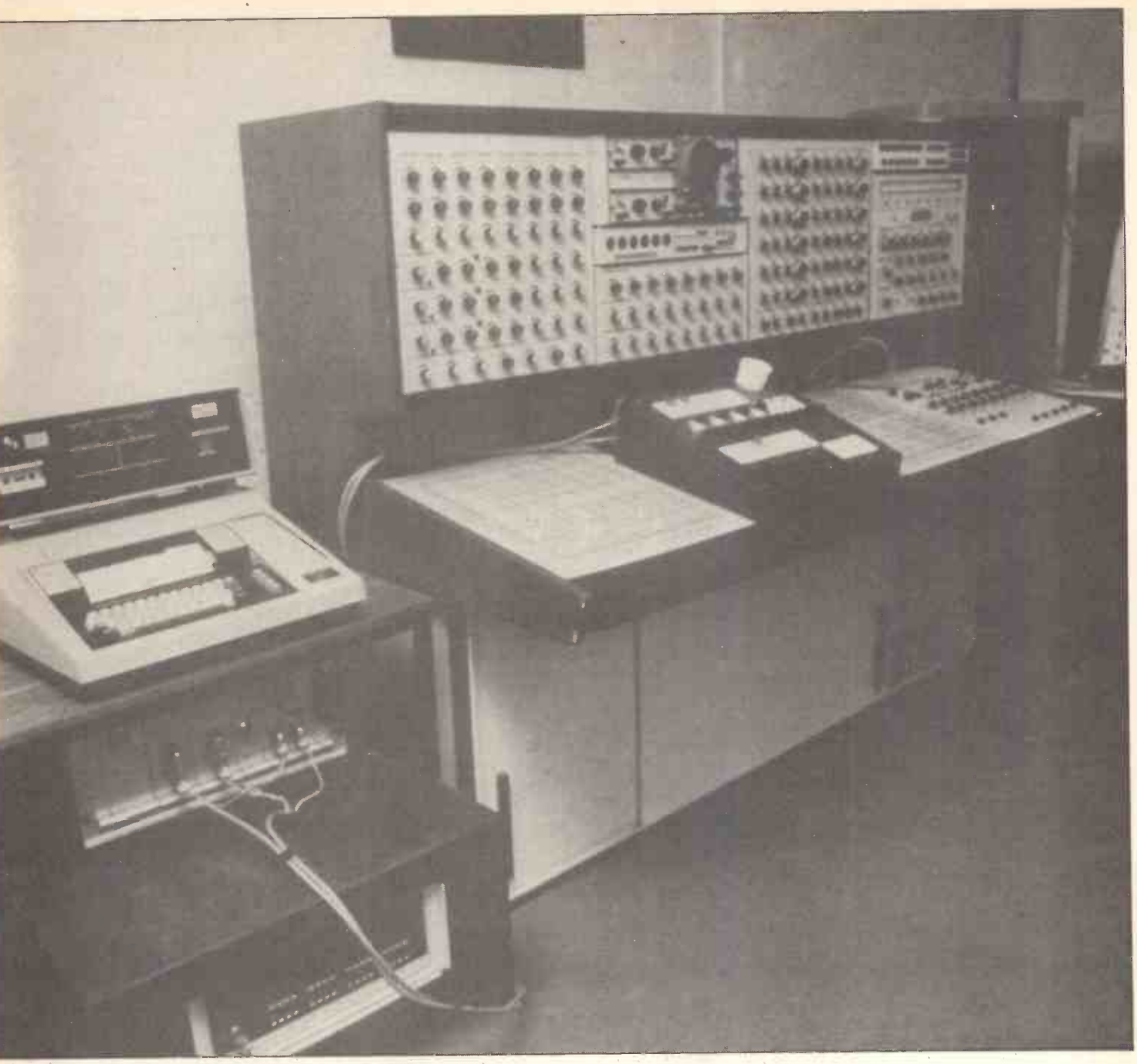
The course starts with the students being set fairly well defined projects of a very basic nature which become more difficult as the course progresses. The first thing a student will learn is basic studio techniques like tape manipulation and use of the studio equipment so one of the first exercises will involve using only tape reversal, tape echo and loops, etc. Once these techniques have been mastered the students will then start to use the synthesisers. They will be given exercises which initially utilise the oscillators, gradually moving on to using the filters, etc., as the course progresses. This way, by the end of the year, the students will have a thorough knowledge of every item in the studio, from the splicing block to the computer, both singly and in combination with each other and so realise the full potential of each device. The assessment is made mainly on the technical aspects of the studio, i.e. whether or not the student is seen to be using the equipment properly; if the end result is artistically pleasing then all well and good but it is the technical side which is the most important.

The main studio.

The studio is in fact divided into two parts and both are generously equipped with various multitrack tape recorders which include, in the main studio, a Scully 1" 8-track (which, incidentally, they are not too happy with owing to its tendency to discard knobs and switches quite frequently!). Studio 1 also has a 12-4 mixer that was built at the university which has an ingenious patching system allowing access to any point in the signal chain for processing or monitoring or whatever. Studio 2, the smaller of the two studios, has ¼" Teac and 1" Studer 4-track machines and an Alice 8-2 mixer. Needless to say, there is a goodly supply of trusty Revoxes in both studios. On the synth side they have, in the main studio, the enormous EMS SYNTHI 100. This is the second one ever to have been built and rumour has it that the window had to be completely removed in order to get it into the studio. For those of you not familiar with this instrument it comprises 12 VCOs, 8 VCFs (4 hi-pass, 4 lo-pass), 8 VCAs, 3 VC envelope shapers, 3 Ring modulators, 2 noise generators, 2 VC random voltage generators, 2 VC reverbs, an eight octave filter bank, a pitch to voltage converter, VC slew limiters, 2 five octave dynamic keyboards as well as a polyphonic sequencer, oscilloscope and frequency meter. Access to every parameter (as you can see, everything is voltage controllable) is via two 60 x 60 patch panels, one for control voltages, the other for signal routing, where every module can be connected by the insertion of one or more mini-jack type pins. Whilst I feel it is fair to say that the SYNTHI 100 has seen better days and maybe doesn't compare so favourably with more recent modular type synths, it is the ideal tool for teaching because of its undoubted patching versatility - all aspects of additive and subtractive synthesis can be demonstrated as well as sophisticated control functions.

The studio is also equipped with a rather amazing polyphonic computer controller. It is a Texas Instruments 990 (based on a TMS 9900 microprocessor chip) which can control up to four voices on the SYNTHI via digital-to-analogue and analogue-to-digital conversion peripherals. The system was developed by Marcus West while he was a research student at the university. He wrote the software program and what it has to offer is truly remarkable. The software, called SEQUEMUSE, occupies about 4.5K words of core and is written in assembler language. Besides sequencing music, it has the ability to compensate for the shortcomings of analogue synthesisers (i.e. drift and non-linearity) by going through a tuning up routine. This is a routine in which the computer monitors the frequency of the VCO being tuned, compares it with the note it has been programmed to play and if there is any deviation in pitch it increases or decreases the control voltage accordingly so that it is in perfect tune. It does this through the audio range, semitone by semitone, and then stores the relevant control voltages in its memory so that it is able to provide exactly the right voltage when programmed to play a particular note. You can use this procedure to programme micro- and macrotonal scales as well as totally bizarre scales and modes (i.e. Dorian, Phyrygian, etc.).

To programme the computer, one uses a QWERTY typewriter keyboard terminal - this takes a bit of getting used to but with practice is easy enough even for those people unfamiliar with computer programming. The user enters bar data as a number of bars, each with a specified number of notes (up to 31 per bar) each with its own pitch, duration and envelope characteristic (timbre and dynamic changes can also be programmed but require other control voltage outputs to control filter cut-off frequency and VCA gain, etc.). Up to 200 bars may be



EMS Synthi 100 (centre) with computer controller (left).

defined which might not seem very much but one of the controllers most powerful features is the ability to repeat bars a specified number of times; these bars can also be transposed up or down both tonally and chromatically and changes made at any point in the sequence. For instance, if I were to programme the following into the computer (after I had defined what notes, etc. exist within the bars, of course): '4(1 3 5)2-6.' bars 1, 3 and 5 would be played four times (as indicated by the number before the bracket) which would be followed immediately by bars 2 to 6. A complete piece of music could therefore be entered into the computer using, let us say, only eight bars of four notes each. These could be transposed up or down, repeated in any configuration or harmonically and rhythmically transformed in any number of sophisticated ways. This is in sharp contrast to other computer controllers which require that you programme in every single note - a tedious task, especially if you have a lengthy piece of music. Speed of the piece is totally variable with SEQUEMUSE without, of course, any change in pitch and pieces can be 'dumped' onto cassette for storage of programs. The 4 voice polyphonic system can be extended by synchronisation with a multitrack tape recorder.

I have had the pleasure of working with Marcus on this system and it really is very powerful indeed. Examples of music performed on the computer can be heard on E&MM Demonstration Cassette No. 7.

Another development is a self-improvisational computer system which is being built by Mike Greenhough, the director of the studio. This system generates sequences of pitches in real time according to statistical rules. It can also be controlled in real time by a voice input, following the voice's pitch in perfect tune. It quantises the voice digitally and compensates for human pitch error. The 'improvisations' can be stored in computer memory where they can be edited into a more structured piece. It is basically intended as an aid to composition and as such is proving to be very interesting. Other projects include an 8-voice polyphonic, digital synth with a unique infra-red scanning dynamic keyboard which was being developed by Steve Parkes whilst he was a research student. Another interesting development is a Walsh function generator. This is a system which, instead of using sinewaves for waveform generation (i.e. using sinewaves as multiples of a fundamental frequency at relative levels to create harmonics and hence different waveforms), uses squarewaves for the same purpose, these being easier to produce digitally than sines.

So, as you can see, there is a lot of highly innovative work going on at Cardiff University. Plans for the future include exploiting a new link between the computers and a mainframe computer (which is situated elsewhere in Cardiff) for even greater control. Tight financial limitations have limited the purchasing of new equipment but this has not prevented them from being extremely innovative in their approach to electronic sound. Any of you who may be interested in the courses or any of the developments can obtain further details from Mike Greenhough, Dept. of Physics, University College, Cardiff. I'm sure it has a great deal to offer anyone interested in this field; it will certainly give one a good grounding in both the basic and more advanced techniques of electro-music - techniques which can be put to good use whatever aspect of synthesiser music one may be involved in.

Steve Howell **E&MM**

RECORD REVIEWS

Cured
by Steve Hackett
Charisma CDS4021

This is Hackett's fifth solo album — this time, 'solo' means only one additional musician, Nick Magnus, as opposed to the previous bands (although there are very brief appearances from Bimbo Acock's sax and John Hackett's flute and bass pedals). Hackett's decision to operate in this way for 'Cured' stems partly from musical and, inevitably, partly from financial considerations: running a full-time band is an expensive pastime, while a small working unit enables the musician to concentrate on music, rather than personality problems and wage packets. So Hackett and Magnus worked in the time-honoured popular music framework of a partnership: two musicians attuned to, and complementing, each other.

Hackett spent three months out of the U.K. writing the material, the two players eventually getting together at Redan studio, a 24-track in Queensway, West London, with the ever-faithful John Acock at the controls. The instrumental split means that Hackett plays all the acoustic and electric guitars (including an Ovation UKII electric, which features an aluminium frame supporting a light urethane body, described by Ovation as a 'high-density foam material'), while Magnus plays all the synthesised drums and keyboards: the record is almost an aural catalogue of modern keyboard sounds, with Korg CX3 organ bristling on 'Hope I Don't Wake', Roland vocoder on 'Picture Postcard' and 'Funny Feeling', Novatron on the intro to 'Can't Let Go', massed Prophets on 'Air-Conditioned Nightmare', stereo Rhodes on 'Turn Back Time', and so on.

Of particular interest is the fluent use by Magnus of the Linn LM1 drum computer (see Warren Cann's review in E&MM September 1981). Magnus has programmed some very accurate tracks and breaks, and achieves an impressive overall drum feel, aided here and there by Simmons electronic drums. Some of the synth bass makes for rather bottom-heavy mixes, but Hackett's bass guitar, where apparent, is welcome — a notable bass sound is evident on 'Can't Let Go', for example. The instrumental track, 'Air-Conditioned Nightmare' becomes a little too dense in places, although it has one of the LP's best drum sounds, achieved by putting the Linn through a Yamaha bin perched on the very live back staircase at Redan!

Recording order tended to be drums down first, then keyboards to define the size and space of the track, leaving bass till later for EQ 'cutting-through' considerations, and guitars and vocals generally going on last. The album makes good listening, and there's enough variety to sustain interest — Hackett puts his usual nylon acoustic solo spot in, 'A Cradle Of Swans' — and there's even a touch of 'Holland' — period Beach Boys on 'Turn Back Time'. 'Cured' proves that technology can be used to substitute for a conventional rock band — but isn't a replacement.

Tony Bacon

Dare
Human League
Virgin VR 80388

One of the most popular electro/dance bands in this country today have got to be The Human League. With the strength in depth of this album its easy to see why this is so. Their lack of pretention together with a desire to produce good 'pop' music has resulted in a very successful year for them. The singles are probably familiar to most of you and are included on this their third album.

Earlier last year The Human League divided in two, thus spawning Heaven 17/B.E.F. The present line up of Adrian Wright, Philip Oakey, Jo Callis and Ian Burden are now joined by singers Joanne and Susanne. From the cover to the music this album has style. The equipment used to full effect here includes the ubiquitous Linn drum computer as well as Roland's fine MC8 sequencer/micro composer.

Programming and production are by Martin Rushent who once again has done a first class job, ably assisted by one Dave Allen, and recorded at Genetic Sound studios in Oxfordshire. Genetic Sound appears to be THE place to record at. They put out the very first Visage single and were talking to both Spandau Ballet and Ultravox when no one else wanted to know. Martin Rushent's experience in the business, having produced 'Rattus Novegicus' for the Stranglers, the first Madness LP and various other extremely successful records shows, although he is quoted as saying "I don't believe you should be able to hear the producer in there at all. It should just sound great". It does!

Anyway, enough of the production, etc. Let's get down to the music. Opening Side One with 'The Things That Dreams Are Made Of', shows us that Human League can come up with potential singles "just like that"! A great song which one finds oneself singing, having heard it only a couple of times. Hits are made of songs like this! And indeed what have we next but the hit single 'Open Your Heart'. You've probably heard this one at your local disco, although in my opinion its not as strong as 'The Sound of the Crowd' which follows. Their dance potential is obvious with plenty of electronic percussion, memorable lyrics and strong simple melodies. Interesting lyrics are the strongest feature of 'Darkness'.

Back to dance music with 'Do or Die', featured on the Virgin sampler 'Methods of Dance'. Presented in a different form on this album, this more complex musical arrangement is less interesting than the previous tracks. It sounds the sort of single that those other 'popsters' Abba might put out! I believe, in fact, the Messrs Oakey and Wright are quite keen to emulate Abba's quality 'pop' music. On this showing they are quite likely to! At least they are honest enough to admit it and do not wish to be taken too seriously.

The short instrumental track which opens Side Two is played on a Casio VLT 1 and leads us straight into one of the more interesting tracks 'I Am The Law', a sombre lecture into the reason for laws. "You know I am no stranger, I know rules are a bore, but just to keep you from danger, I am the law". Very philosophical Philip! 'Seconds' continues their social comment with a poignant lyric aimed at various assassins — in particular those of J. F. Kennedy and possibly J. Lennon. One of my favourite tracks and a previous hit single 'Love action' follows.

The album is brought to a conclusion with the current single 'Don't You Want Me'. I would not have been taking much of a risk to suggest that this would undoubtedly be a chart success. However, I would have thought that the first track would have made a better single. All in all then a very worthwhile album - plenty of good danceable pop songs.

Derek Pierce

Thoughts of War
by Mark Shreeve
Uniton 001
Distributed by Making Waves and Lotus Records

This is a debut album for both Mark Shreeve and Uniton (a Norwegian-based record company) although Mark has released and circulated privately four cassettes.

Several things are remarkable about this album. Firstly, for a debut album it is extremely well thought-out, composed and produced.

Secondly, the equipment used is minimal. To quote from the sleeve: Yamaha CS30 synthesiser, Hohner K4 String Machine, Eko 12-String Guitar, Coat Hanger, Phaser, Flange, Tape-looped Voices and Revox A77 Tape-echo. That is all! The range of sounds and effects produced is comparable to that achieved by artists using banks of equipment. (A reflection, I feel, on the limited use many synthesists make of their mountains of equipment).

Thirdly, the whole album was recorded originally on a Revox A7 and mastered (in terms of balance and EQ adjustment) at Trent Park Studios. The quality and apparent number of sound layers for such an operation is exceptional. There are, in fact, only 3 layers of sound present at any one time and the A77 was used to add echo during the recording process. The lone electro-musician working with one synth and a few ancilliary pieces of equipment should not feel a professional piece of work is beyond him.

Fourthly, the album lasts almost an hour which must surely be value for money - more sounds for your pound. Perhaps other record companies will take note.

Fifthly (and I cannot let this pass), the back sleeve of the album shows an amiable, bearded young man (rather like a young Michael Moorcock) who is actually *smiling*. How many album sleeves show photos of *happy* synthesists? Is music such a serious business? Anyway, back to the record.

The album is a tone-poem expressing various 'Thoughts of War'. The opening track, 'Escalation', begins with a high-register riff with echos bouncing over the speakers. Bass notes swell in and out and a lead line comes in over the top. Tones change and a bass riff and improvised lead line *à la* TD complete this section which slides into 'Cold Emotion' with more tone changes and high, tumbling notes. The pace slows and an ad-lib combination of sounds takes this section out.

The second track, 'Nightmare of Reality', I shall describe in a little detail. It begins with a bass drone under 'tweetering' sounds with combinations of metallic and harsh tones fading in and out. The drone becomes a slow E/G\F#\F# riff with wailing, phased/flanged synth tones on top which gives way to dark ad-lib string

lines with heavy LFO modulated synth tones sweeping down onto it. Then comes a still-slow section, mid-range, with a pulsing bass which is followed by more electronic sounds which fade into noise effects with spurts of electronics. A plaintive melody on a low voice under swimming high-register tumblings finishes the piece. This is an indication of the amount of change and variation evident in the album. New tones and sounds are continually forming.

Side two is in a similar vein and rather than attempt a similar dissection (which can do little more than whet your appetite) I will only add that the opening riff: E/G\F#\B repeated, sounded familiar and I realised it is a half-tempo version of the riff used by TD in 'Search' from their Sorcerer LP. The treatment of the layers over the riff is quite different, however.

The promotion sheet heralds Mark as the first Englishman to develop an individual style which can be called English. His inspirational sources are listed as Schulze, Jarre and Tangerine Dream and hints of these are apparent but style is difficult to define and even harder to cultivate. Mark Shreeve has produced an extremely interesting first album, comparable to that of a seasoned synthesist. I look forward to future works with great hope and anticipation.

Ian Waugh

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BASIC Strings

A BASIC string is a sequence of one or more letters or symbols in any combination, enclosed within quotation marks. It is treated as a single collection of alphanumeric data which can be manipulated by means of string functions and assigned to string variables. The use of string variables, string assignment and string arrays has been described in previous parts of 'BASICALLY BASIC'. To understand how the computer represents alphanumeric data and can perform operations with strings, we need to look at the ASCII code (American Standard Code for Information Interchange).

ASCII Code

The ASCII code is a standard developed by the computer industry in which each symbol used in BASIC is assigned a unique binary digit pattern (bit pattern). When a symbol is typed on the keyboard, the terminal converts it to its binary code. For example, if you type the letter A on the keyboard, the terminal converts it to 01000001, which the computer recognises as A. Table 1 lists the set of ASCII character codes. The binary numbers have been converted to decimal numbers to make the assignments easier to understand.

The ASCII code is used to determine alphabetic precedence when alphanumeric data is compared with relational operators. This is described in the next section.

String Operators

A relational operator is a symbol used to compare the value of one variable or expression to another variable or expression within a BASIC program. The use of relational operators to determine numeric relationships has been described previously. Relational operators can also be used to compare alphanumeric data. The comparison is made in terms of the ASCII value of characters to establish alphabetical sequence. Consider the following program:

```
10 LET A$ = "BAS"
20 LET B$ = "SIC"
30 IF A$ < B$ THEN PRINT A$:GOTO 50
40 PRINT B$
50 END
```

Line 10 assigns the string BAS to the string variable called A$.
Line 20 assigns the string SIC to the string variable called B$.
Line 30 is a relational string expression. It compares string A$ with B$ to determine if A$ occurs first in alphabetic sequence. The comparison is made character by character using the ASCII character code. In this case the first letter of the string A$ is 'B' which precedes 'S', the first letter of the string B$, in the ASCII table. Therefore string A$ precedes B$ in alphabetic sequence so the condition is true and the string A$ is printed on the terminal. If the first two characters are the same the comparison proceeds to the second two characters, until a difference is found. For example, if A$ was assigned to the string BAY and B$ was assigned to the string BAT, the first character in each string match. The next two characters also match. Finally the last character of the string A$ is compared with the last character of the string B$. The ASCII code of Y (89) is greater than the ASCII code of T (84), hence the result of the comparison is false and line 40 prints the string B$ on the terminal.

Table 2 lists the string relational operators available in BASIC and their meaning.

Note: it is not permissible to compare a numeric or integer expression to a string expression using a relational operator. If this is attempted an error message will be output by the computer.

String Functions

BASIC provides a set of string functions (similar to the math and print functions described last month) to enable certain operations to be performed on strings. The following descriptions are intended to be general since the functions may perform differently for different computer systems. You should refer to your systems Language Reference Manual for a complete list of functions available in your version of BASIC. The string function names ending with a dollar sign ($) return a string value whereas function names not ending with a dollar sign return a numeric value.

ASCII Function

The ASCII function returns a numeric value that is the equivalent ASCII code for the first character in the string given as the argument to the function. The general format of the ASCII function is: ASC (string), where string is either a string constant or a string variable. For example, the command PRINT ASC ("P") will output 80, the decimal ASCII value of the character P, on the terminal. The following program uses the ASC function with a string variable as an argument:

```
10 A$ = "BASICALLY"
20 PRINT ASC (A$)
30 END
```

When the program is run the ASCII function returns the decimal ASCII value of the first character in the string assigned to the string variable A$, hence the decimal 66 will be output to the terminal.

CHR$ Function

The CHR$ (Character) function is the inverse of the ASCII function. It returns a single character string having an ASCII value of the numeric value specified as the argument to the function. The range of the ASCII codes is Ø to 127. If the value specified to the CHR$ function is outside this range it is treated as modulo 127. This means that 128 is treated as Ø, 129 as 1 and so on. A non-integer argument to the CHR$ function will be truncated and the character returned will be that represented by the truncated number.

The following program demonstrates the use of the CHR$ function with different arguments.

```
1Ø PRINT CHR$ (7Ø)
2Ø PRINT CHR$ (198)
3Ø PRINT CHR$ (1Ø)
4Ø PRINT CHR$ (6Ø.1)
5Ø END
RUN
F
F
<
```

The output from the program is as shown.

Line 1Ø prints the character represented by the ASCII code 7Ø (an upper-case F).

Line 2Ø specifies an argument of 198. This is treated as modulo 127 (198 - 128 = 7Ø) which is the ASCII code for an upper-case F.

Line 3Ø outputs a line feed character on the terminal causing a blank line of output. The decimal number specified as an argument to the CHR$ function on line 4Ø is truncated to an integer. The truncated number (6Ø) represents the character<. (Characters may be different with your micro.)

The remaining BASIC string functions will be described in the next 'BASICALLY BASIC'. **E&MM**

Operator	Example	Meaning
=	X$=Y$	Strings X$ and Y$ are equivalent in characters after removing trailing blanks and nulls.
<	X$<Y$	String X$ occurs before string Y$ in alphabetical sequence.
<=or=<	X$<=Y$	String X$ is equivalent to or occurs before Y$ in alphabetical sequence.
>	X$>Y$	String X$ occurs after string Y$ in alphabetical sequence.
>=or=>	X$>=Y$	String X$ is equivalent to or occurs after Y$ in alphabetical sequence.
<>	X$<>Y$	String X$ is not equal to string Y$
==	X$==Y$	Strings X$ and Y$ are identical in characters and length.

Table 2. String relational operators.

Table 1. ASCII character code.

Decimal	Character	Meaning	Decimal	Character	Decimal	Character
000	NUL	Null	043	+	086	V
001	SO11	Start of heading	044	'	087	W
002	STX	Start of text	045	—	088	X
003	ETX	End of text	046	.	089	Y
004	EOT	End of transmission	047	/	090	Z
005	ENQ	Enquiry	048	0	091	[
006	ACK	Acknowledge	049	1	092	\
007	BEL	Bell	050	2	093	]
008	BS	Backspace	051	3	094	↑
009	HT	Horizontal tab	052	4	095	←
010	LF	Line feed	053	5	096	`
011	VT	Vertical tab	054	6	097	a
012	FF	Form feed	055	7	098	b
013	CR	Carriage return	056	8	099	c
014	SO	Shift out	057	9	100	d
015	SI	Shift in	058	:	101	e
016	DLE	Data link escape	059	;	102	f
017	DC1	Device control 1	060	<	103	g
018	DC2	Device control 2	061	=	104	h
019	DC3	Device control 3	062	>	105	i
020	DC4	Device control 4	063	?	106	j
021	NAK	Negative acknowledge	064	@	107	k
022	SYN	Synchronous idle	065	A	108	l
023	ETB	End of transmission block	066	B	109	m
024	CAN	Cancel	067	C	110	n
025	EM	End of medium	068	D	111	o
026	SUB	Substitute	069	E	112	p
027	ESC	Escape	070	F	113	q
028	FS	File separator	071	G	114	r
029	GS	Group separator	072	H	115	s
030	RS	Record separator	073	I	116	t
031	US	Unit separator	074	J	117	u
032	SP	Space or blank	075	K	118	v
033	!	Exclamation mark	076	L	119	w
034	"		077	M	120	x
035	#	Number, sign	078	N	121	y
036	$		079	O	122	z
037	%		080	P	123	{
038	&		081	Q	124	|
039	'		082	R	125	}
040	(		083	S	126	~
041	)		084	T	127	DEL
042	*		085	U		

BOOK REVIEWS

Customising Your Electric Guitar
by Adrian Legg
Published by Kaye & Ward
Price £3.95

Adrian Legg's book is a welcome home-grown addition to my largely American guitar-book collection, and lives up pretty accurately, to its title. If you'd like to overcome, as Adrian puts it, the British tradition of "ignoring instructions until something goes wrong", then this book is for you. It is also thankfully written by a human being - some of those American guitar books I mentioned just now seem to originate from either crazy collectors who have never played a guitar in their lives, or from writers keen on bombarding the reader with measurements, serial numbers, response graphs, construction plans - anything but direct, sensible advice based on experience. Mr. Legg seems largely to reverse that trend, and sums up his task in the very first sentence of the book: "The idea of this book is to pass on things I've found out or experimented with on a 'try it and see basis', partly in search for a better sound for myself, and partly merely out of curiosity."

The bulk of the book deals with Legg's obsession with wiring configurations - readers may remember his contributions to E&MM on this subject. There are in the Wiring section of his book around 70 spidery drawings, all insisting that wires are wavy lines and not the usual straight lines of traditional wiring diagrams. Other sections of the book deal with setting up your guitar - seven thoughtful pages taking in action, frets, the nut, and the setting of the intonation. Glues and Finishes get a brief few pages each, but enough to explain basic types and techniques, and then we're into the big Wiring section.

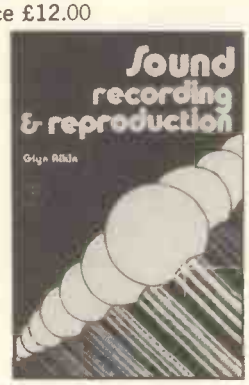
A simple explanation of the workings of basic pickups gets us underway, and the author takes the commendable course of declining to suggest suitable brands, leaving this decision where it belongs, with the reader. Adrian discusses the actual workings rather than the name on the box, which is fine. The fact that DiMarzio pops up a lot in pictures and captions can be put down either to the fact that Legg is Guitar Technician for Rose-Morris, who import DiMarzio pickups, or to the sheer popularity of this particular American replacement pickup. To be fair, names like Lawrence and Schecter turn up here and there too.

And so we're guided through coil taps, phase reversal, series/parallel wiring, Strat and Tele wirings, push-pull pots, powered effects units on boards, status LEDs, on-site battery recharging (the price of batteries these days... etc.), stereo wiring, and Precision wiring, all with necessary brevity but helpful clarity. Along the way, we see the Legg Special go through all kinds of internal and external upheaval with the aid of photos taken at various stages in its rather eventful life. There are also plenty of pix of all manner of other guitars undergoing or having undergone major surgery - not for the squeamish. To close, a smaller section deals with building a guitar from spare parts, where Legg once again opines that the most necessary commodity required by the budding do-it-yourselfer is common sense. A short glossary tells you things like the fact that 'pot' is incorrect slang for variable resistor, or that SPDT stands for Single Pole Double Throw switch, and there are also a couple of useful photos within the glossary showing you the sort of tools you might need in your axe-smashing escapades.

The 64-page book is a softback with a pleasant page size just a little smaller than E&MM's, and comes to you for £3.95 which, I suppose, isn't too bad (the price of books these days... etc.). Derek Baxter's photos are O.K. and reproduced reasonably well. A small criticism of design - the photo captions are a bit too close in size to the body text, which can lead to momentary confusion. But not to worry - to the guitarist who fancies some screwing and soldering, Customising Your Electric Guitar, while obviously a very personal view into the guitar's innards, could make things easier and more fun. Have a look for yourself.

Tony Bacon

Sound Recording & Reproduction
by Glyn Alkin
Focal Press
Price £12.00



Glyn Alkin has more than thirty years of experience in Radio and TV sound engineering at the BBC, and, armed with such impressive dedication to Auntie's cause, he has produced a book which is "designed to bridge the gap between the professional recording engineer and the enthusiastic amateur who wishes to improve his techniques and gain a better understanding of the recording medium". I think it does this admirably, taking the reader from production techniques in different recording (analogue and digital) and acoustic environments through to the variety of reproduction techniques (audio, that is) around today.

The format is somewhat unusual, in that each topic or subsection is covered in two pages - the left with headings and info, the right with diagrams, drawings and data - but this makes it an easy book to browse through and still gain some sense of direction along the tortuous pathway of the recording chain.

My only real grips is with the price of the book, which seems very expensive for just 224 smallish, large-print pages - and without a single glossy photo for light relief. A paperback version would certainly make greater sense to the 'amateur' readership that it's aimed at.

David Ellis

Beginner's Guide to Electronics
by Owen Bishop
Published by Newnes Technical Books
Price £3.60

In producing a guide to any subject an author is faced with a number of problems. Where to begin, how much depth should be included, how far to go and so on. He strives to achieve a balance between information for the novice, sufficient depth for the more enlightened — without frightening of the novice — and sufficient breadth for the more adventurous. In this book the author has achieved the correct balance with commendable success and must be congratulated.

Taking the reader gently by the hand, the opening chapter presents the intricacies of electric current in a simple, yet precise manner. With growing confidence and understanding one proceeds smoothly through direct and alternating current at the end of which a thirst for further knowledge has grown. Are semiconductors and optoelectronics a mystery to you? Don't worry; chapters 3 and 4 will bring an element of clarity. What about integrated circuits? One cannot turn round these days without stumbling over them and to these ends chapter 5 provides enlightment.

Having introduced the building blocks of electronics, the second half of the book proceeds to put them to good use. Basic switching circuits and amplifiers are amply covered. Test instruments, so essential to the constructor, are described.

With computers forming such an important part of our everyday lives, a large chapter is devoted to Computer Electronics. The mysteries of binary logic are unravelled, and simple gating is explained together with computing systems. Various types of storage are introduced with the chapter concluded by a brief survey of various computer languages.

Brief coverage is given to the essentials of microwaves and medical electronics and the book is completed with chapters on radio and TV, recording and industrial electronics.

In general an extremely well presented publication full of interesting and informative data, written in a manner that is acceptable to both the novice and the more established amateur. It is amply illustrated with the mathematical content kept to an absolute minimum. A book I unreservedly recommend and one that already occupies my bookshelf.

Anthony M. Ball

VIDEO REVIEW

Paul McCartney and Wings Rockshow
Running time 102 minutes
TVB 90 0334 2

Quite why MPL Communications waited six years to produce this tribute to the now defunct Wings escapes me, but this sample from their famous 1976 World Tour is a memorable concert from the King Dome in Seattle Washington. 67,000 fans witnessed 15,000 watts of pleasure heightened by spectacular and innovative use of holograms.

The 'Wings Over America' triple album contains all of the set which is slick and varied. 'Jet', 'Live and Let Die' and 'Silly Love Songs' poured out, mixed with 'Venus and Mars' tracks such as 'Medicine Jar'. All ably supported by a powerful, five strong, horn section built around the tenor playing of session man Howiy Casey. Denny Laine (who has since formed his own band) powers through 'Go Now' and the visual appeal provided by an acoustic guitar interlude with Mr and Mrs McCartney would take a lot of beating.

Joe English's drums drive along the band and the frequent instrumental breaks by the late Jimmy McCulloch's screaming guitar are certainly progressive, even for the middle seventies.

The sound quality is surprisingly good considering the size of the stadium and the difficulty in getting an acceptable balance. In fact, a few numbers benefit from the visual and aural combination that video offers — notably 'Live and Let Die'.

Visually, Wings were a most appealing band and when Paul sang the ex-Beatles song 'Yesterday', 67,001 people (the extra being me) smiled with pleasure. Lighting was very effective and it seems that ELO were not the first to experiment with lasers.

My personal interest in the music of Wings meant that I knew all the songs and was prepared to sit through an hour and forty-two minutes of constant music without any interviews, back-room shots or light-hearted comments from Mr McCartney. The whole thing was therefore rather impersonal and it is debatable whether anyone should buy the video in preference to the albums, because of the mono reproduction.

I also remember seeing quite a few clips on the television in a 'Wings Over America' compilation some years ago.

Hence the video is a late and rather fleeting look at a band who now only exist on record. It is worthwhile for the genuine fan, but anyone with little knowledge of the band's repertoire should seriously consider becoming acquainted with all the material available on record.

Neil Johnson

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MAKING NOTES

This new workshop series goes right back to the basics of reading music. Its direct approach is aimed at all our readers who have not had the chance to get to grips with music notation.

If you follow my articles in their logical sequence of musical stepping stones, they should help to clear many of the misunderstandings you may have had regarding 'Music Theory'. The difficulties that many have with this subject should be slowly disappearing if you can understand my simple interpretation of the established rules of music.

The Major Scale formation in last month's article formed the basis for understanding "Key Signatures". This is not their sole purpose as I will be using the Major Scales again this month for forming left hand chords.

The melody notes on the treble stave have to appear on the manuscript but musicians have a choice for reading the accompanying left hand chords, which can be shown as notes written upon the bass stave or as "Chord Symbols" normally written above the treble stave.

To read the traditional bass stave notation, the names of the lines and spaces must be identified (which can initially be confusing as they occur in a different position from the treble stave), but this has to be achieved to reproduce the musical arrangement exactly as it is written.

A left hand chord is written as a group of notes on the bass stave (see Figure 1). The individual note represents a pedal note when playing an electronic organ or similar instrument such as a synthesiser with a bass pedalboard.

One problem arising here can be that the *name* of the chord is seldom known and the manuscript is followed "to the dot" is an almost mechanical fashion, which does not stimulate musicians into learning how to develop their own musical interpretation, and they will rely upon being shown the accompaniment as notes on the bass stave.

Being a music teacher for a number of years, I have tried to analyse how a player reads and interprets the bass stave on to the keyboard. There seems to be no hard and fast rules, but here are some of the replies I have had when asking this question.

A left hand chord on the bass stave can be identified by:
1) *Naming* each individual note and mentally grouping them together into the chord. 2) Taking each group of notes as a whole and recognising the *pattern on the bass stave*, without giving each note a name. 3) By forming and recognising a *hand and finger shape* on the keyboard. No prizes awarded for instantly replying, "We are not supposed to be looking at the keyboard as we play". Can I suggest a self-analysis exercise for my readers? I would be pleased to receive your views on this subject.

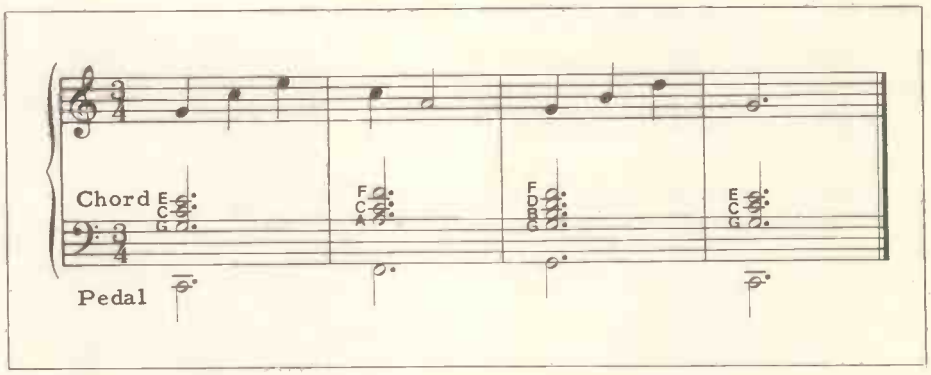


Figure 1.

Most music teachers use the traditional two or three stave method for pupils taking exams in grades of music, but have also extended this form of teaching to include the home musician playing for pleasure.

The chord symbol, written above a single treble stave, is shorthand for writing the *name* of a left hand chord and requires the player to identify the group of notes which make up the chord. The single stave method is used by many keyboard players for instant sight reading, as the eyes do not have to accommodate so much information at one time. The chord symbols, when used to their fullest extent, convey to the player not only a left hand chord and bass pedal note but also chord progressions, counter melody and harmony without having to continuously read a bass stave.

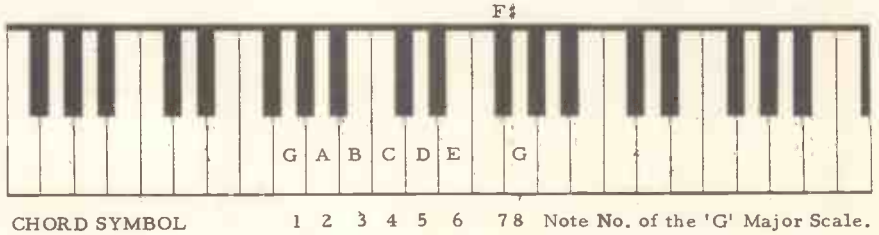
Another point in favour of an arranger using chord symbols and a single treble stave is that the manuscript can be condensed to avoid unnecessary turning over of the pages.

In the past there has been unnecessary controversy about using chord symbols instead of the traditional bass stave, perhaps their full worth was not appreciated, or was not recognised in the world of music.

The origination of left hand chords is seldom explained; in other words, where do the chords come from in the first place? Chords are formed upon

MAJOR	1 - 3 - 5	Notes of the major scale
SIXTH	1 - 3 - 5 6	Added 6th note of the major scale
SEVENTH	1 - 3 - 5 - 7♭	Added 7♭ note — tone below the 8th note
MINOR	1 - 3♭ - 5	Flattened 3rd note of the major chord
MINOR SIXTH	1 - 3♭ - 5 6	Flattened 3rd note of the sixth chord
MINOR SEVENTH	1 - 3♭ - 5 - 7♭	Flattened 3rd note of the seventh chord

Figure 2.



CHORD SYMBOL	1	2	3	4	5	6	7	8	Note No. of the 'G' Major Scale.
'G' (Major)	G		B		D				1 - 3 - 5
'G6' (Sixth)	G		B		D	E			1 - 3 - 5 6
'G7' (Seventh)	G		B		D		F		1 - 3 - 5 - 7♭
'Gm' (Minor)	G		B♭		D				1 - 3♭ - 5
'Gm6'(Minor Sixth)	G		B♭		D	E			1 - 3♭ - 5 6
'Gm7'(Minor Seventh)	G		B♭		D		F		1 - 3♭ - 5 - 7♭

Figure 3.

PART 4 Forming Left Hand Chords.

Brenda Hayward

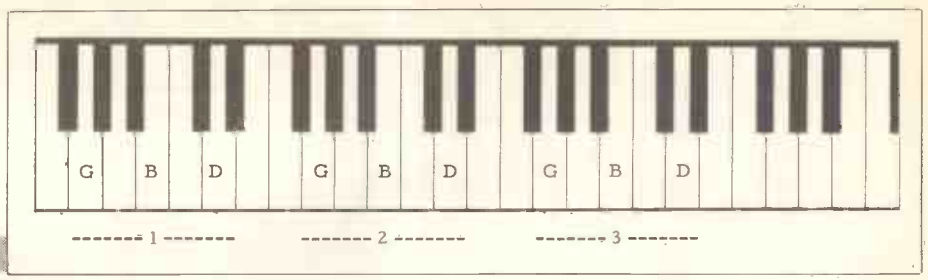


Figure 4.

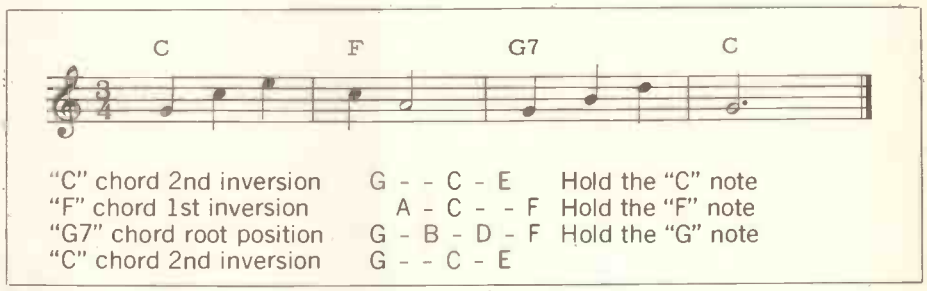


Figure 5.

specific notes of the major scales, and once the major chord, or triad, is formed upon the ROOT NOTE (1st note) — 3rd note — 5th note of a major scale, any type of chord can be built upon it using a very simple method of chord structure based upon note numbers of the major scales (see Figure 2).

Find the chord of "G" major (G - B - D) and add the 6th note of "E" (G - B - D E) to play the "G" sixth chord "G6". Substitute the 7♭ note of "F" for the note of "E" to play the "G" seventh chord "G7" (G - B - D - F). The "G" minor, "G" minor sixth and "G" minor seventh chords are created by "flattening" the 3rd note of "B" to "Bb" in each chord (see Figure 3).

Any left hand chord formed upon the 1st note, or root note of a major scale, is said to be in its "root position". The "7b" note in the seventh and minor seventh chords is the *normal* seventh note of the major scale, *flattened by a semitone*.

To read the chord symbols, its "Letter Name" will indicate a major chord, i.e. "C" for "C" major. Instructions to adapt the major chord appear *after* the letter name, i.e. "Cm", the small letter "m" means "minor", turn the major chord into a minor chord. Numbers following the letter name are simply note numbers of the major scale added to the major chord. Figure 3 shows how to interpret the chord symbols correctly.

The chord structure can now be used for left hand chord formation from every major scale. Experiment by writing the note names of the "E♭" major scale; E♭ F G A♭ B♭ C D E♭, illustrated in February's article, and using exactly the same note numbers as in the above chord structure from the major chord upon the ROOT NOTE (1st note) — 3rd note — 5th note of the "E♭" major scale (E♭ - G - B♭). Now continue to form all the other chords upon it.

When a group of notes which make up a chord are moved to a different position on the manual, it is said to be an "Octave" movement. For example, the "G" major chord, G - B - D, can be played in three different positions on the keyboard (see Figure 4). When illustrating the left hand chord positions in my teaching books they are always shown on a *full manual* for correct playing position. When a chord is shown on only a small part of the keyboard, confusion can arise because most chords can be played in any of three positions, as illustrated in Figure 4.

A CHORD INVERSION is created when *one note* in the chord moves its position at a time, as against the whole chord octave movement. While one note moves its position, the other notes of the chord remain unchanged.

A three note chord such as "G" major can be played in two *inversions*.

"G" major	G - B - D
1st inversion	B - D - - G
2nd inversion	D - - G - B

The root note of "G" will move its position from the extreme left of the major chord to the extreme right of the 1st inversion, while the notes of "B" and "D" remain unmoved. The note of "B" on the extreme left of the 1st inversion will move to the extreme right of the 2nd inversion while the notes of "D" and "G" remain unmoved.

The "C" major chord of C - E - G (root position) becomes E - G - - C in its 1st inversion and G - - C - E in its 2nd inversion.

The "F" major chord of F - A - C (root position) becomes A - C - - F in its 1st inversion and C - - F - A in its 2nd inversion.

A seventh chord such as "G7", being a four note chord can have three inversions. Root position, formed upon the root note, G - B - D - F; 1st inversion B - D - F G; 2nd inversion D - F G - B; 3rd inversion F G - B - D. The extreme left hand note in each ascending inversion moved its position to become the extreme right hand note of the next inversion. In descending chord inversions, the extreme right hand note moves its position to become the extreme left hand note of the next inversion.

Chord inversions will enable chords to be moved into the correct playing position on the keyboard to create smooth left hand chord changing. It may then be possible to hold on to and pivot on one note if it is common to two chords in a sequence. On the electronic organ it is possible to play all the left hand chords with the exception of thirteenths, between the octave "F" to "F" either side of middle "C" on the lower manual.

For smooth chord changing in a four bar sequence, as in Figure 5, the "C" major chord is played in its 2nd inversion, to be positioned near to the chord of "F" major in its 1st inversion and the chord of "G7" in its root position. The following five steps will achieve this:

1) Play the 2nd inversion of the "C" major chord and hold the "C" note.
2) Move the "G" note to the "A" note with the little finger.
3) Move the "E" note to the "F" note to play the "F" chord: A - C - - F.
4) Hold the upper "F" note, move the notes of "C" to "B" and "A" to "G". Add the note of "D" and you should be playing the "G7" chord.
5) Hold the note of "G", release the "B" note. Move the "D" note to "C" and the "F" note to "E" to play the "C" major chord again.

To play a single stave arrangement with chord symbols, each chord is held until a chord change is indicated by a new chord symbol. In Figure 5, each chord is held (sustained) for the time value of one bar.

When playing an instrument with a bass pedalboard, the chord symbol represents the name of the pedal note to play with each chord: "C" chord — "C" pedal, "F" chord — "F" pedal, "G7" chord — "G" pedal, etc.

The letters "N.C." are an abbreviation for "NO CHORD" and are written in place of the chord symbol when you should not play a chord or a bass pedal note, even though you may be playing a melody.

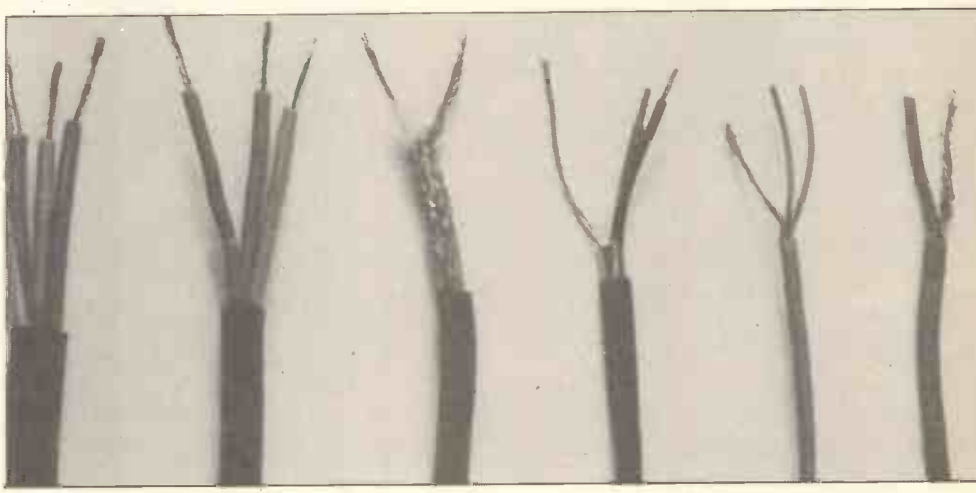
Next month I will be continuing with the formation of advanced left hand chords: ninths, major ninths, eleventh and thirteenths, and illustrating simple transposition from one major key to another.

MEMO — Try to avoid looking down at the keyboard as you play. Find the notes by feeling for their position instead of looking for them, as you cannot read the music and look at the keyboard at the same time without losing your place on the manuscript. **E&MM**

ELECTRO-MUSIC ENGINEER

Here's a comprehensive guide to mains, audio and speaker cables prepared by Ben Duncan

A well practised rigger tidying up after a major concert appears to take cables for granted when he neatly coils half a dozen leads with nothing more than a little wriggle in the wrist. Apart from such an apparent surface manifestation of attunement to cables, a good rigger also develops an instinctive awareness of cables which are damaged or suspect; an intuitive sense arising from prolonged - and often painful - practical experience. And for many musicians, 'painful practical experience' most aptly sums up the boringly iterative misbehaviour of leads and cables. Of course, badly wired, sub-standard connectors are frequently legitimate scapegoats in these circumstances. Nevertheless, the hassle-free application of cables in a live performance environment has its share of pitfalls too.



Covering materials

The cheapest and commonest mains cables make use of PVC or similar thermoplastic sheaths. Their prime shortcoming is a tendency to succumb to abrasion, deformation and outright damage from a host of live performance perils, including badly aimed soldering irons, well-aimed glass fragments, stampedes of steel-cloven footwear, antisocial door hinges, flightcases being dragged across the stage (*sans* wheels), and even the generous weight of an artic's rear axle!

Humour aside, it's sobering to recall that the casually abused PVC is often the sole material keeping sweaty palms away from Britain's uniquely lethal 240 volt juice. To recognise PVC's susceptibility to damage, and accordingly, to check PVC mains cables regularly is a sensible way to avoid abrupt power failures and fires, quite apart from electrocution. The potentially onerous task of inspection can conveniently become a part of the cable coiling routine, particularly if you run your fingers along the cable as you coil it up, feeling for serious lesions.

PVC's other antisocial habit is its misbehaviour in the face of temperature extremes. Below 0°C, it hardens and can become surprisingly brittle. Of course, audiences aren't renowned for attending gigs played in the arctic wastes of North Yorkshire, but apart from Icelandic concept albums, whenever cables are transported in freezing trucks, whether A1 northbound or on other cryogenic superslabs across the European and North American continents, frozen PVC is a distinct possibility.

In such extreme circumstances, allow warm air to restitute your leads before trying to unravel them.

At the opposite extreme, PVC becomes 'soggy' and easily melts outright when cables are thoughtlessly strung in front of heaters and stage lights. So for live performance rigging, it's wise to regard all vents, louvres and lamps as potential sources of surreptitious incineration, and steer cables well clear of them!

From a less spectacular viewpoint, PVC's predisposition to soften at high temperatures is a great aid to tidy and predictable coiling: by holding a PVC lead in front of a heater, or dunking it in hot water, it can be readily softened, coiled neatly into a convenient radius and then left to cool off, cold water being used to speed the process. The result is a 'trained' cable which will fall naturally into a coil without the need for bulky, expensive and impractical restraining devices such as drums.

Rubber is the principal up-market alternative sheathing material. It's relatively immune to temperature extremes and physical damage, so even if the expense of rubber forbids universal application, it's recommended for key mains extension leads. In comparison to PVC, rubber cables aren't so easily trained, the cable's natural radius being inherently determined by the length of time it's spent in a particular configuration. For new cables, this radius is frequently that of the manufacturer's drum, and the only foolproof means of training such a lead into a conveniently sized radius is to coil it into the desired form with brute force, using hefty tiewraps for restraint! The corsetted cable should then be left in a warm atmosphere for as long as possible. Of course, this situation is one of swings and roundabouts, and whilst initially stroppy, rubber cables rarely 'forget' once trained, unlike PVC, which requires frequent retraining.

Safety

As regards safety, cables complying with BS6500 meet the U.K.'s extremely rigorous electrical safety standards, and in practice, the vast majority of cables available from reputable suppliers in the U.K. are BS6500 approved. West European mains cables are mercifully standardised (or harmonised, in the unwitting advertising jargon of the very un-musical standards authorities!), thus nominal equivalents are intrinsically safe. However, USA mains practice is definitely not practicable in Britain, and American mains leads are best regarded as being potentially lethal. The same attitude should prevail in connection with oriental equipment, although to be fair, Japanese (Cf. Taiwan, etc) standards can be very good. Even if American or Oriental equipment is powered from an isolated 110 volt supply, a significant fire hazard can still exist. Replacing unsheathed skimpy 2 core leads with decently sheathed 3 core cables, together with competent line fusing and earthing of the equipment chassis is recommended in no uncertain terms.

Aside from leads falling out of shoddily wired mains connectors, experience suggests that the most common and certainly the most obnoxious olfactory *faux pas* of DIY stage power distribution is the aroma of the 'ignited drum'. This dramatic event arises from a misapprehension of cable current ratings. All cables exhibit resistance, and albeit small, it's sufficient to cause a slight temperature rise at the rated current. Indeed, we can regard any mains cable as a flexible electric element, with a tendency to dissipate between 1 and 50 watts. Generally, cables are rated for operation in 'free air', which implies an ability to dissipate this heat freely. But the danger of a catastrophic increase in temperature comes not so much by merely restricting air circulation (e.g., by taping cables onto a stage), but rather by bunching a number of cables - or lengths of cable - each radiating a small amount of heat, into a confined space. In this case, the rated current (viz: the amount of current a cable can handle before the insulation or conductors become hot enough to cause mutual damage or give rise to a fire hazard) falls dramatically, typically by an order of magnitude or more. Thus attempting to pass 13 amps - or even 5 amps - through the tightly coiled 13 amp cable on a drum can all too easily lead to unscheduled visits by fire appliances! The golden rule, then, is to unravel every inch of mains extension cable, regardless of the length you require or the degree to which the cable's current capacity

exceeds the power consumption of your gear. Then spread out the surplus length; to leave it in a tightly packed coil is only marginally less dangerous than leaving it on the drum.

Although the discussion above isn't encouraging, the wealth of 'not quite long enough' mains leads suggests a somewhat contradictory rule, at least as regards equipment cables. All mains leads should be made 50% longer than you think they need to be. Certainly, the 1½ metre cables supplied as standard on many items of equipment are frustratingly short in real life (though they do save the manufacturer 30p), and a much more practical standard length is 3 metres. Of course, the frustrations of improper length can be largely avoided if you make extensive use of pluggable mains leads (e.g., with Euroconnectors) and maintain a stock of varying lengths.

Audio Cables

As with mains cables, the basic choice of sheathing is between PVC and rubber, the latter being much the best choice for the rigours of microphone and stage connections, whilst PVC is fine for more sedentary occupations behind speaker stacks, between PA amplifiers and in 'outboard' equipment looms. However, whilst the ruggedness of mains leads in terms of the basic 'meatiness' of the cable cross-section is governed primarily by the current rating (i.e., a 20 amp cable is tougher than one rated at 2 amps, PVC or rubber sheath regardless) for audio cables, 'meatiness' and the integrity of the screening obviously have no such governing factor. Instead, these cables can be loosely classified as 'external' and 'equipment' types. External cables can be identified by their thick sheathing, often with supporting cords, numerous conductor strands and braided (i.e., woven) or foil screening, (see Table 1). Needless to say, construction of this calibre is the *sine qua non* for all external connections in sound equipment. Lamentably, run-of-the-mill music shops frequently offer only dainty equipment style cable, which whilst okay in its own right, is intended solely to lead an abuse-free life inside an equipment enclosure. Small wonder so many DIY microphone extensions and patch leads come to grief!

Audio cables broadly feature 3 styles of screening. Lapped screens (i.e., parallel wires wrapped around the central conductor(s) in a spiral) are prone to physical damage and degradation of their shielding abilities through flexing, hence they are usually restricted to equipment cables. The poor shielding properties of the lap screen is readily demonstrated by laying a lap screened guitar lead close to a mains cable. Hum! The braided screen is altogether a virtuous beast, being better suited to the perils of severe flexing and crushing, whilst its excellent shielding properties are reflected by the universal application of braided screens in radio equipment.

At the same time, the inherent efficiency of braiding has led less than scrupulous manufacturers to skimp the density of braiding hoping that nobody notices the difference in performance! The moral here is to resolutely inspect braiding prior to purchase and to demand cables with thickly woven screens whenever efficient shielding and physical strength are called for: a satisfactory braid will completely obscure the inner conductors.

An altogether different animal is the foil-screened cable, epitomised by the name 'Belden'. Here, the centre conductors are wrapped in an all-embracing shield of aluminium foil, an idea which makes other methods of screening look rather silly; that is, until we laconically consider the difficulties of reliably terminating the laughably delicate and hard-to-solder foil. This minor shortcoming of the foil concept is circumvented by sandwiching a bare wire, known in American terminology as the 'drain', between the foil and the insulation of the inner cores. Although it's not soldered to the foil, the drain wire makes a good connection by virtue of being pressed against it throughout the length of the cable. And at each end, the drain wire provides a means of termination that's not only workable, but indeed, easier than the task of combing and twisting a braid screen.

Although it's not as hardy as braided cable, particularly under sufferance of severe kinking, the superlative shielding of the foil screen renders it the ideal choice for long cables carrying low level signals, where the potential for severe RFI (Radio Frequency Interference) is especially great. In a word, multicores! Foil screened cables of the equipment variety are also widely used *en masse* in racks for patching purposes, essentially because they're quick and and easy to wire up and they exhibit a natural springiness which can give rise to well behaved looms. They are also a natural choice in studios where the avoidance of spurious interference from Radio Moscow or Kid Jensen is rather more important than ultimate durability!

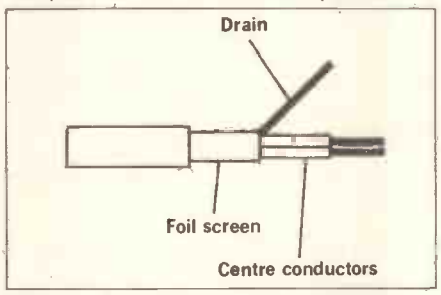


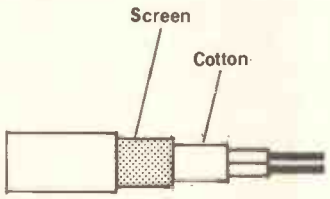
Figure 1. Sample of Belden equipment cable with foil screen.

Similar in concept are cables with conductive plastic screens, e.g., Filotex or Turnkey's 6527. These are considerably more rugged in terms of damage through flexure, but they are still essentially for equipment rather than external cables, so for stage use, they're best reserved for situations where their excellent screening properties will be most appreciated, microphone cables being a good candidate.

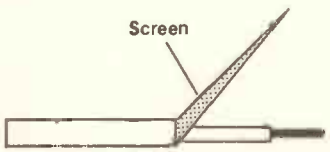
Whether braided or foil screened, sloppily terminated screens frequently become self-defeating by enthusiastically shorting out live conductors. Serving or booting the exposed shielding with an expandable rubber sleeve (or binding sleeve) is thus a great aid to reliable termination, and the special sleeve expansion tool, colloquially known as 'honeymoon pliers' is an invaluable aid to craftsmanship when making up leads.

Being available in a variety of exotic colours, binding sleeves placed just above the connector are also an excellent aid to

Specification	External Cable	Equipment Cable
Overall Diameter	6.5mm	3.1mm
Screen Construction	70 x 0.1mm Braided wires	28 x 0.1mm lapped wires
Sheath Thickness	1.2mm	0.5mm
Centre conductors	Each 16 x 0.2mm strands	7 x 0.2mm strands



Typical external cable



Typical equipment cable

Table 1. Typical external and equipment cable specifications.

Order Code or Reference	Notes (All cables PVC unless otherwise specified)
Maplin XR01B/2C	Light duty mains for equipment and instrument connection, not rugged enough for stage use.
Maplin XR03D/4E/5F	General purpose mains cable for equipment or instrument connection, also suitable for speaker connections.
Maplin XR09K/10L/11M	Medium duty cable for mains power distribution, also as a speaker cable.
RS Components 377-906	Medium duty *rubber* cable for mains distribution.
RS Components 378-101	Two core 0.75mm² PVC cable for general purpose speaker connections.
Maplin XR60Q	High current speaker cable, sheath not rugged enough for stage use.
Maplin XR16S/18U/08J	General purpose braid-screened cable for external leads.
Maplin XR15R/20W	Light duty lap-screened cable for internal (equipment) wiring looms.
*(Various) RG 58/CU	Military spec. RF coaxial braid-screened cable having low capacitance and being rugged - makes good guitar leads, where curly leads are disliked.
Future Film Developments/Belden/ West Penn: "M01"	2 core foil screened cable for equipment racks and internal looms.
Future Film Developments "HDX"	2 core heavy-duty *rubber-sheathed* braid-screened cable for stage use.
Turnkey "6527"	2 core conductive-plastic screened cable for equipment racks and internal looms.

*This cable is universally available under this US MIL-SPEC reference, but beware of low grade copies arising from the CB Market.

Table 2. Cables for stage use.

lead identification, being much more durable than taped mnemonics. Another garnishing which aids discrimination is to use a variety of sheathing colours (although this scheme is obviously less applicable if rubber cables are in use), typically black for mains, grey for mic. and line level leads, and orange for speaker connections. Going to even more zealous lengths, screened cables are available in a gamut of colours, and clearly this can make complex multimic or patching setups much easier to trace and check. As a means of cable identification, it's prone to errors arising from colour blindness, however. Thus it's inadvisable to adopt such a scheme where mistaken colours might have serious consequences.

Speaker leads

The general rule here is 'stout and short', and if you use male and female XLR plugs at each end of your leads, then it's easy to lengthen one that's too short. Thus generous lengths serve no purpose. Placing an amplifier rack equidistant from the speakers of a large stack implies cable lengths of 6 to 15 feet, and in this case, conductor cross-sections in the range of 1.25mm² to 2.5mm² (13 to 20 amps) are suitable per driver. Two core sheathed cables of these dimensions aren't readily available, but of course, 3 core mains cables can be used, the earth conductor being either chopped off or wired in parallel with one of the other cores. Alternatively, where Power Bridged and single ended (conventional) amplifiers are in simultaneous use, the third core can serve as a foolproof connection for the bridged outputs only, in conjunction with 3 pin XLR's, whilst maintaining speaker leads which are universally applicable.

For treble drivers, the concept of electrical damping has little significance and cables with 0.75mm² (6 amp) conductors are ideal for lone units. However, treble horns are frequently mounted in arrays, up to 500 watts, their total impedance being circa 2 to 4 ohms, and in this case, peak currents of around 20 amps will be attained, calling for 2.5mm² cable. In the bass and midrange, peak currents in kilowatt arrays quickly become astronomic (e.g., 112 amps for 5kW driving 4 ohm units), and without exception, drivers should be wired to amplifiers individually, or at worst, in pairs.

In small sound systems, boasting one lonely amplifier, running a long lead across the stage is naturally unavoidable, but it is possible to improve upon the habitual and stingy bell wire! If there's a lack of cash, the essential requirement here is something tough, with a rugged sheath, rather than to concentrate on thick and expensive copper, which governs power loss and definition in the bass. It's easy to show by calculation that X metres of nasty cable reduces the power available at the speaker by 30%, for instance, but in terms of perceived loudness, the loss in long cables is often insignificant, and it's arguably more important to seek a heavily sheathed cable, even if it has relatively thin conductors, rather than succumb to a sudden absence of music from one speaker.

Ominous Facets of the System

In broad terms, rock music and the reliable creation and transmission of that music are basic incompatibles, because musical creativity and the corresponding physical requirement - equipment versatility - imply diversifying tendencies and a corresponding lack of reliability. The ultimate sense of this paradigm is for connectors and cables to be either reliable, and useless, because they are inflexible, or versatile and flexible, yet unreliable, though in practice, the options are less clear cut. For instance, we can use a multipin connector to reduce the time taken to plug in dozens of leads, but flexibility vanishes and the reliability of all the connections is gambled on one expensive multipin connector, wherein any single failure may spell total failure. The alternative is to accept lots of leads which continually fall apart, but at least the arrangement is flexible and a spare lead can usually be found to take the place of a bad one. In comparison, with the multipin approach, total failure here is improbable, because it calls for multiple failures in temporal synchronisation; but partial failure is endemic. Discrete cables are also a less reliable means of connection purely in respect of confusing channels 6 with 9, *ad nauseam*... In other words, flexible, creative systems are particularly open to human error.

Clearly, neither approach is wholly satisfactory, though each has benefits, and wherever the cost can be justified, the dilemma can be waylaid by using multiple XLRs in parallel with a multipin connector, an approach exemplified on the rear panels of the best mixing desks. Such a system is also a workable way to frustrate the ubiquitous law of Murphy, unless you forget to bring your XLR patching leads, whereupon you can be sure the multicore connector will promptly disintegrate! From another viewpoint, providing it doesn't compromise flexibility or performance, reliability is enhanced by arranging your sound equipment to use the bare minimum of leads and connectors. **E&MM**

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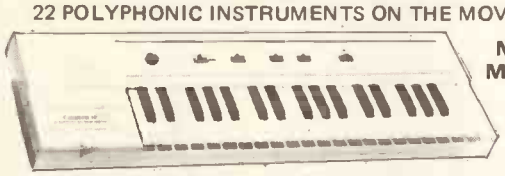

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E&MM/4/82

ELECTRIC DRUMMER Part 4

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Peter Kershaw B.Sc

Percussion Generator Update

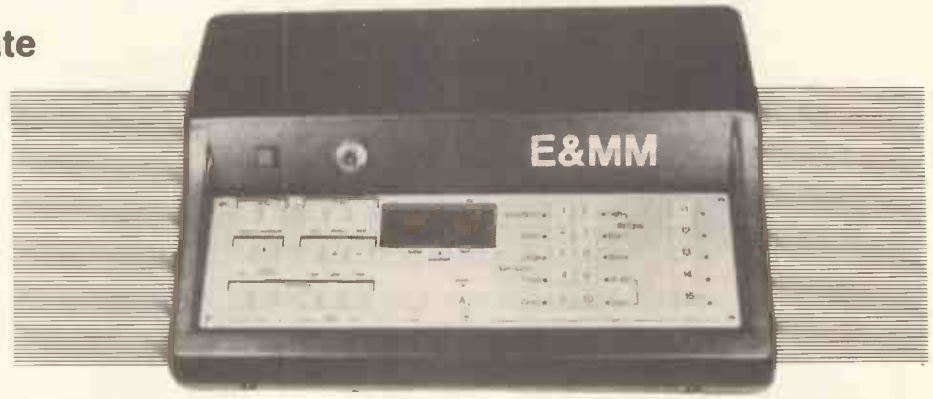
The percussion sound generator board described last month was designed specifically to work with negative-going 15V trigger pulses from the Electric Drummer. Extensive trials with microcomputer ports and other equipment have shown that it would be more convenient in these cases to trigger from positive going signals. Accordingly, we have redesigned the board to include an input stage on each trigger and the accent, so that positive going inputs from 1 volt upwards may be used in addition to the negative 15 volts. We have also taken the opportunity to improve some of the sounds, and the new board is single sided to make for easier construction.

The revised circuits are shown in Figure 1. The resonant sounds remain unchanged, with the exception of a couple of component changes. In the case of the wood block sound, this has alleviated the noise problem so that a special IC is no longer required.

The noise sounds now use a VCA IC — the MC3340 — which allows more positive accenting, and also boosts the level of these instruments to be a closer match to the resonant generators.

To obtain a more convincing snare drum sound, the snare trigger now does two things. Firstly, it triggers the "high bongo" generator which simulates the skin and drum resonating; secondly, a noise section imitates the snare wires rattling. The level of snare noise is independently adjustable by means of its own preset.

The board should now be operated from + and - 15 volt supplies irrespective of what triggers are used; this should make it much easier to swap between different driving sources. If the Electric Drummer, or another source of negative going 15 volt pulses is going to be the sole triggering method, the input transistors and their associated resistors may be omitted. The hi-hat open/closed input is unchanged, i.e. +5V=closed, 0V=open. **E&MM**



PARTS LIST CHANGES

Delete:
R7-10, 17-20, 27-30
C3,7,11
TR2,4,6
D2,4,6

Add:

			Maplin Code
R80,85,90,95,97, 99,101,103, 105,107	33k	10 off	(M33K)
R81,86,91,96,98, 100,102,104, 106,108	15k	10 off	(M15K)
R82,87,92	330k	3 off	(M330K)
R83,88,93	4k7	3 off	(M4K7)
R84,89,94	180R	3 off	(M180R)
R109	470k		(M470K)
C34,37,40	470nF polycarbonate	3 off	(WW49D)
C35,38,41	680pF ceramic	3 off	(WX66W)
C36,39,42	10uF 35V electrolytic	3 off	(FF04E)
TR8,10,11,13, 14,16-23	BC184L	13 off	(QB57M)
TR9,12,15	BC179	3 off	(QB54J)
IC13-15	MC3340	3 off	(QH49D)
D14,15	1N4148	2 off	(QL80B)

Change:
R1 (2k7) to 120k
R2 (2k7) to 39k
R6(2M2) to 1M0
R11 (39k) to 100k
R16 (4k3) to 470k
R21 (47k) to 68k
R45,50 (1M0) to 10M
R59 (27R) to 100R
R61-63 (100k) to 47k
C1 (3n3) to 68n
IC10 (LH0042C) to 741C

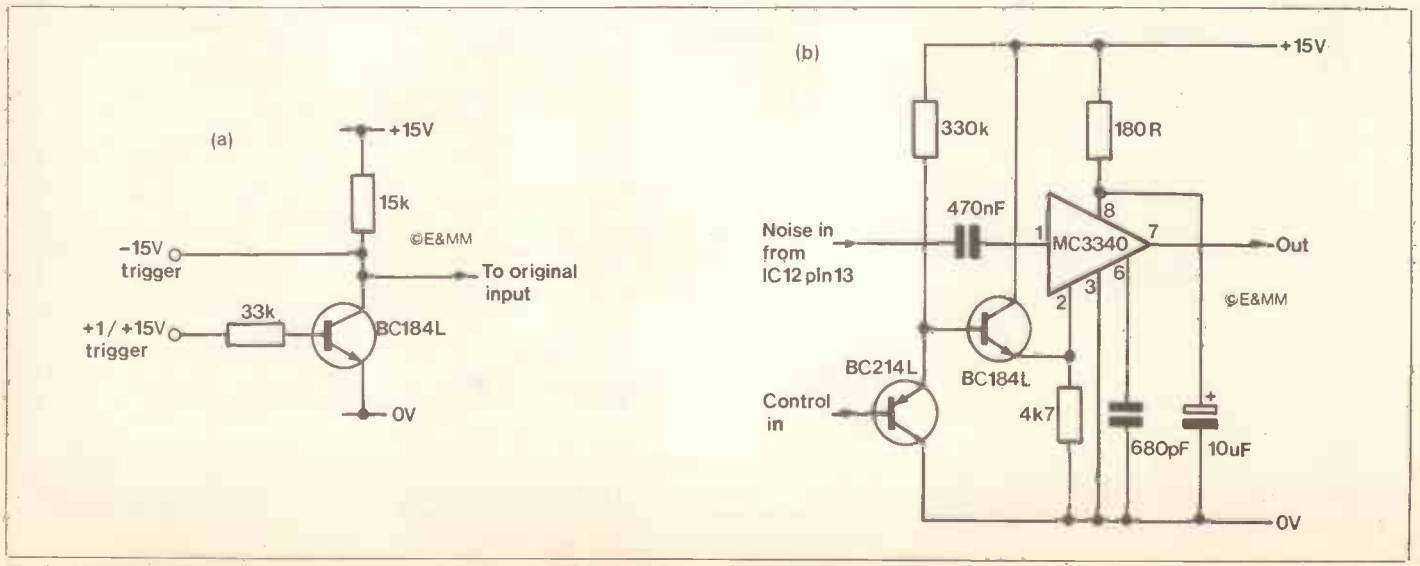


Figure 1. Additional circuits on the Percussion Sound Board. a) Trigger inverter/amplifier. b) Noise VCA.

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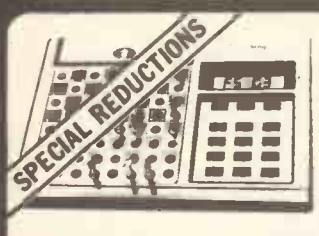

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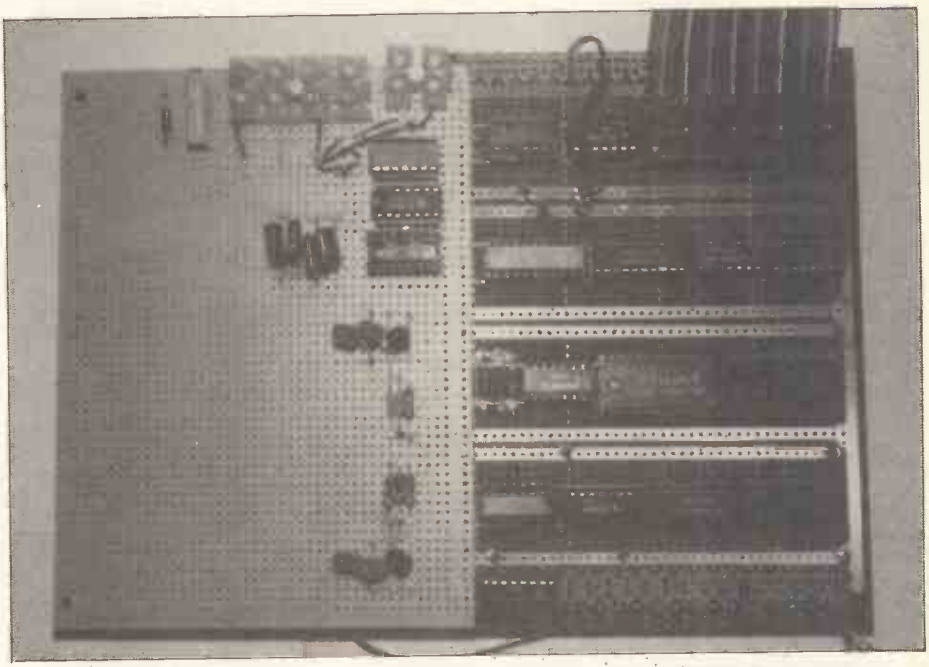
Micromusic

TRS80 Analogue/Digital Interface

Lyndsay Robinson

This month we leave the ZX81 and move on to Tandy's well established TRS80 microcomputer. As usual, we start with an interface system, which is essential for serious music making control. Certainly, it's *the* most comprehensive that we've seen published for the TRS80 and includes address decoding for 24 input and 24 output channels, 8 channel multiplexed analogue input, analogue output, and digital inputs and outputs, e.g., LEDs and switches. The total cost is approximately £30 including the TRS80 interface cable.

The prototype circuit was wire-wrapped on a Vero DIP board and connected to the TRS80 via a 40 way ribbon cable terminated in an insulation displacement type edge connector (see parts list).



Address Decoding

Channels 0 to 15 are decoded from the computer's IN and OUT signals with the required port address, 0 to 255. This is simpler than using memory mapped addressing with a Z80 based computer as less decoding hardware is required. A 74154 TTL 4 to 16 line decoder is used to select one out of 16

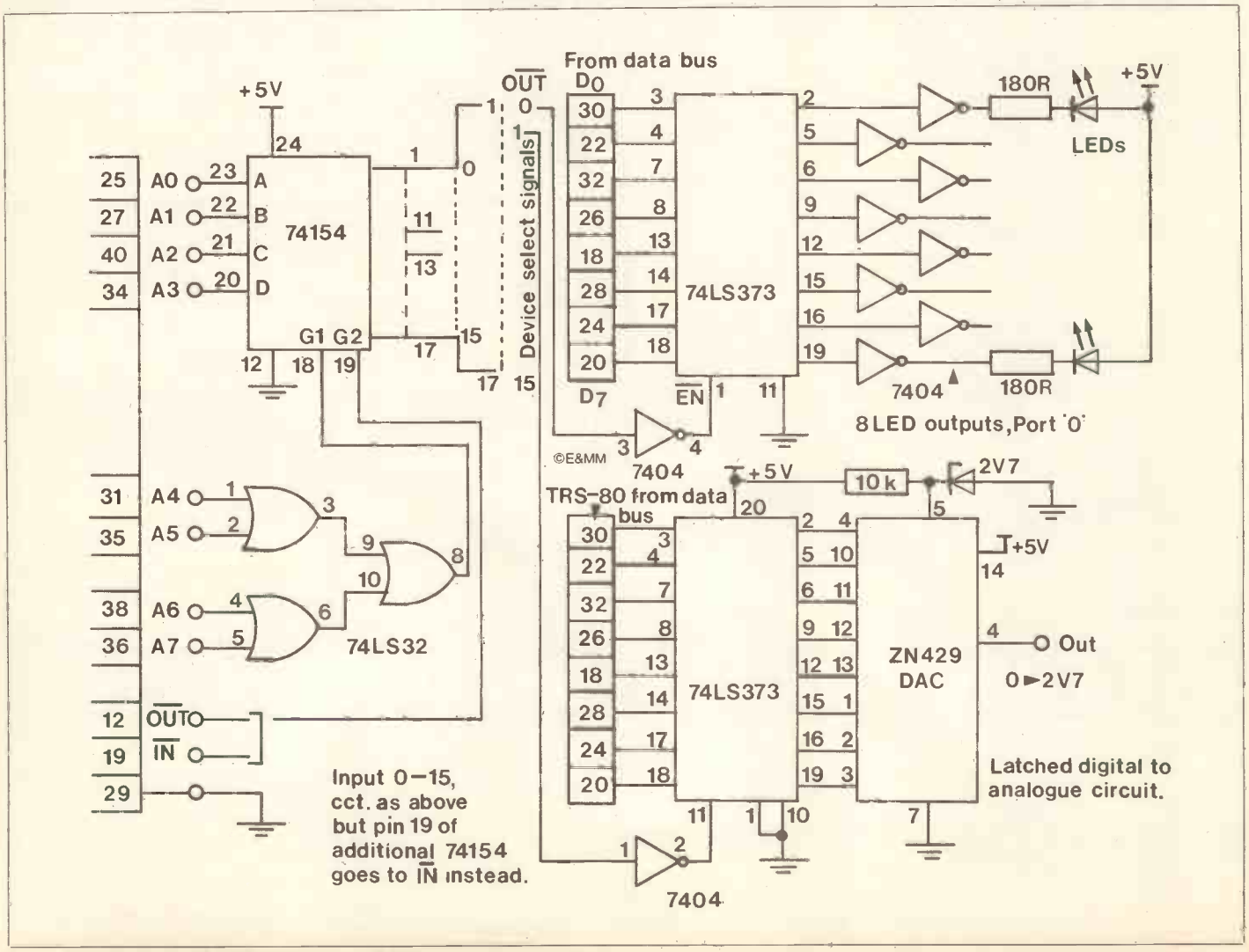


Figure 1. Address decoder with ports for one digital and one analogue output.

external devices. Channels 16 to 23 are decoded as shown in the circuit and are used for the analogue inputs, leaving channels 0 to 15 spare to use as required.

Digital Inputs

A TTL 74LS244 octal buffer, tri-state is used to interface TTL compatible signals to the input of the TRS80. For example, a SPST switch can be connected as shown, to set the bit to 1 or 0. One of the most simple and obvious applications is to use an external clock oscillator or controller (such as the Synclock or MF1) at one input port bit for setting the tempo of music and rhythms generated by the microcomputer.

Digital Outputs

A 74LS373, octal tri-state latch is used to interface devices to the output of the data bus. Two 7404 hex inverters can also be used to drive LEDs as shown - useful for confirming coding of output port lines to, for example, a drum generator board (such as in the E&MM Electric Drummer).

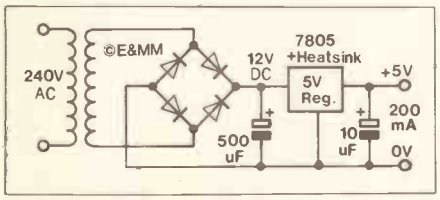


Figure 3. Power supply, + 5V.

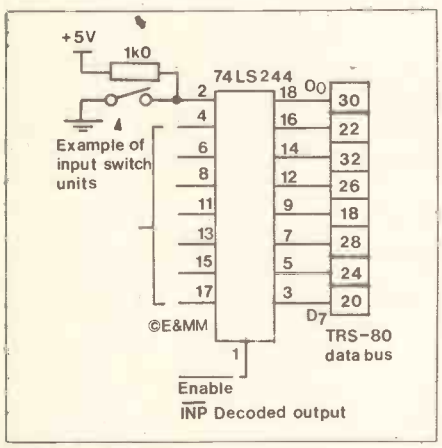


Figure 4. Input port.

Analogue Output

A ZN429 Digital to Analogue converter is wired as shown in Figure 1, to the interface. This device has an 8 bit input, 1us settling time and typically 2.5V output which can be increased by use of an op-amp. For each additional analogue output a separate 74LS373 and ZN429 is used.

Several analogue outputs could be used for external synthesiser control of such sections as VCO, VCF, VCA etc. on a modular system. Alternatively, provided output voltages are programmed carefully, to match

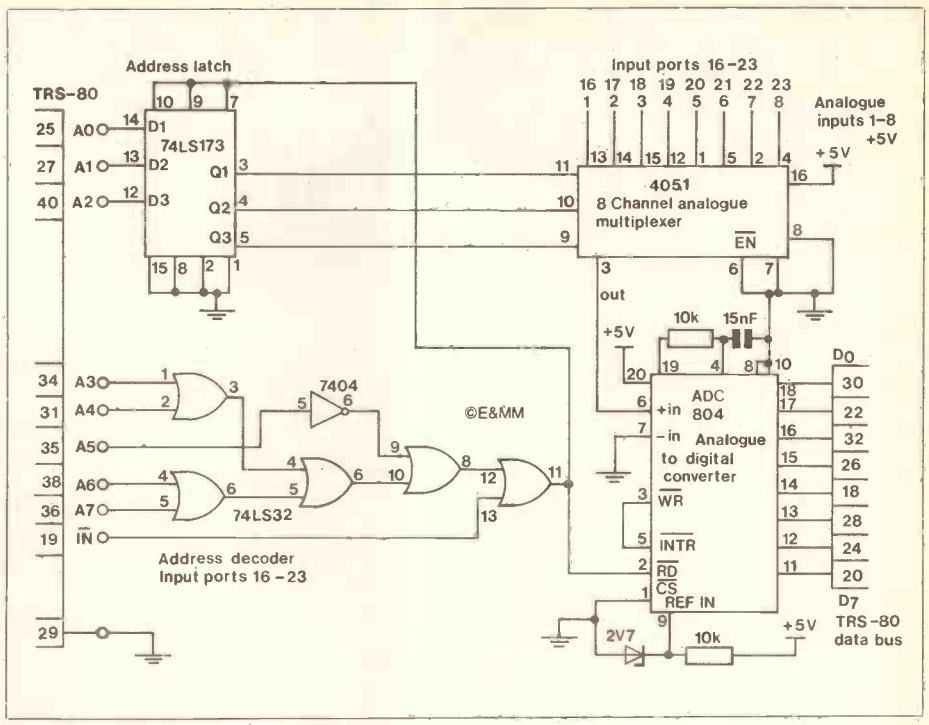


Figure 2. Eight channel analogue input.

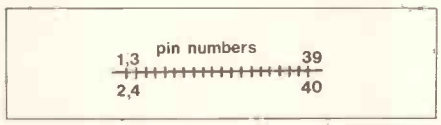


Figure 5. Rear view of computer edge card.

semitones, it's quite straight forward to match most synths CV in and TRIG in for computer control of your instruments (usually up to 5V output is required).

Eight Channel Analogue Input

The circuit shown is a simple but effective multiplexing circuit connected to an 8 bit Analogue to Digital Converter. The ADC804 is a successive approximation ADC with 100us conversion time. The simple circuit is achieved by running the converter in the self clocking continuous converter mode. One out of eight output channels is selected from input ports 16 to 23 by software control, and the appropriate address is latched by the 74LS173D type register and the analogue multiplexer input is connected to the ADC.

There are obviously a multitude of possible applications in two main groups: the computer could be an intermediary between the musician and the control parameters of the synthesiser, in which case it can take over all the 'donkey work' such as remembering different settings, initiating sequences or controlling a number of events, at the touch of a button.

Alternatively, everything could be controlled by the software, the computer becoming its own composer or the musician only controlling the general characteristics of the piece in progress.

Lastly, a completely new and very exciting field is open by connecting transducers of our bodily parameters like muscle activity, skin temperature, etc. There is already a large choice of 'biofeedback' sensors commercially available, which after processing could be used to control the synthesiser. Who knows? Maybe thought control isn't unreachable after all...

It should be pointed out that although this is necessarily limited in complexity, a first improvement could be to use one of the digital outputs to initiate the A to D conversion, thus eliminating possible erroneous readings that can arise if the computer reads data at an instant of transition.

Programs for the Interface

Analogue input

```
10 CLS
20 A=INP(B)
30 PRINT A
40 FOR Q=1 TO 500:NEXT
50 GOTO 10
```

where B is input port; use ports 16 to 23 for analogue channels

Analogue output

```
10 OUT B,D
```

where B=port number: D=Data, D=0, all bits are 0, D=255, all bits are 1 **E&MM**

PARTS FOR TRS80 INPUT AND OUTPUT PORTS

Resistors - all ⅓W 5% unless specified		Maplin Code
180R	8 off	(M180R)
1k0	1 off	(M1k0)
10k	3 off	(M10K)
Capacitors		
15nF polyester	1 off	(BX71N)
10uF 35V	1 off	(FF04E)
470uf 25V	1 off	(FF16S)
Semiconductors		
W005 Bridge rectifier	1 off	(QL37S)
BZY88C2V7 zener diode	2 off	(QH00A)
LED	8 off	(WL27E)
uA78L05AWC regulator	1 off	(QL26D)
4051BE	1 off	(QW34M)
7404	2 off	(QX40T)
74LS32	2 off	(YF21X)
74154	2 off	(WH08J)
74LS173	1 off	(YF73Q)
74LS244	1 off	(QQ56L)
74LS373	2 off	(YH15R)
ADC0804 LCN A/D converter	1 off	(QQ00A)
ZN429 D/A converter	1 off	(Ferranti)
Miscellaneous		
40 pin IC socket	1 off	(HQ38R)
40 way ribbon cable	24"	(Watford Electronics or 2 sections of XR07H)
40 position card edge connector		(Tandy 276-1558)

The above parts list is for the following port connections: 8 bit digital output, one analogue output, an 8-bit digital input and an 8-channel analogue input.

UNDERSTANDING ELECTRONICS

A regular column that explains the electronics of music

Robert Penfold

Reading Circuit Diagrams

The ability to look at a circuit diagram and fully understand each part of the circuit, plus the overall working of the unit, is something that can only be achieved after a great deal of experience and knowledge have been attained. Even then there are so many areas of specialist interest that it is unlikely that anyone can comprehend every circuit. However, translating a circuit diagram just in terms of how the various components are interconnected is a much more simple process, but is nevertheless a very useful asset for the musician using electronic equipment. Furthermore, many of the articles in E&MM have circuit diagrams which can give you a practical insight into the workings of instruments and projects.

In essence, circuit diagrams are very straightforward and simple to understand with lines being used to represent wires that connect the various components together, and the components being represented by symbols. The main difficulty in translating the diagram into actual wires and components is that there is no real standardisation of the symbols used, although if a little common sense is employed this should not be a great problem in practice. Another problem is merely that two components that are physically quite different can have the same circuit symbol.

Where two lines on a circuit diagram meet and there is a dot at the junction of the two, as shown in Figure 1(a), this means that the two wires connect together. If the two lines cross over and there is no dot, or one line is looped over the other, as shown in Figure 1(b), the two wires do not connect to one another. Note that dots are only used to show connections at "T" junctions on the diagram, and in Figure 1(c) for example, where no dots are used, the capacitor is in fact connected across the resistor.

Some of the more common circuit symbols appear in Figure 2. Here symbols (a) to (e) are all capacitors of various types and are respectively an ordinary capacitor, an electrolytic capacitor, a polarised non-electrolytic capacitor (such as a tantalum type), a trimmer capacitor, and a variable capacitor. Electrolytic and other polarised capacitors normally have a "+" sign marked on the body of the component to show which lead is which, and electrolytic capacitors sometimes have an indentation around one end of the component's body to indicate that the positive leadout emanates from this end of the component.

The symbols shown in (f) to (h) are for various types of resistor, and respectively represent an ordinary (fixed value) resistor, a preset resistor, and a variable resistor or potentiometer. The alternative symbols shown in (i) to (k) are often used instead of those shown in (f) to (h).

Some circuit diagrams use a rectangle in the capacitor symbol instead of the two parallel lines, and also use the resistor symbols of (f) to (h). Such diagrams are usually rather slow and difficult to follow since the resistor and capacitor symbols are similar, and in the case of a fixed resistor and a fixed non-polarised capacitor they are identical! In order to distinguish between the two, it is necessary to look at the identification legend for the component in question: it will start with a "C" in the case of a capacitor, or an "R" if the component is a resistor. Also, the value will be shown in *farads* for capacitors and *ohms* for resistors. Fortunately most circuit diagrams do not use this system, and it is usually only found in manufacturers handbooks, service manuals, and similar publications.

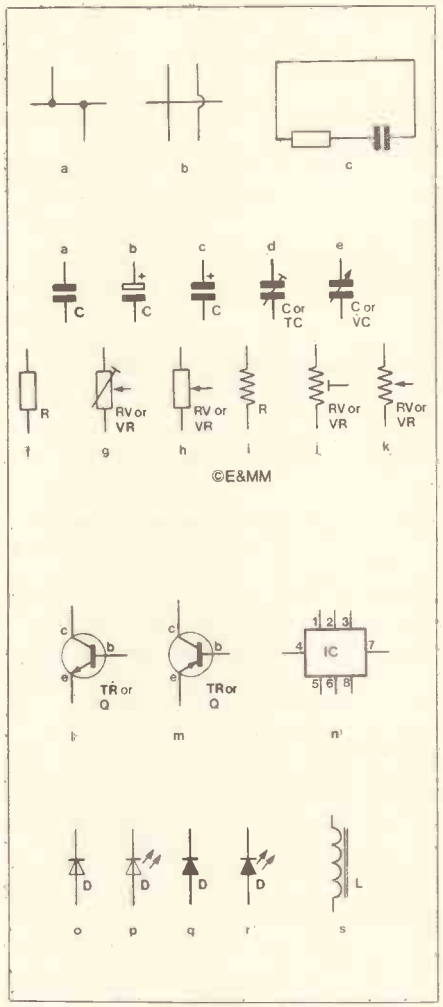


Figure 1.

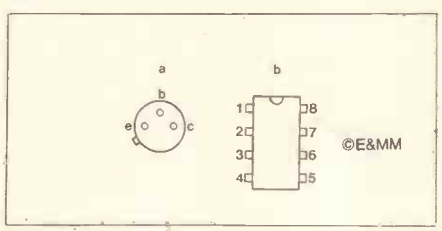


Figure 2.

Most resistors and some capacitors have their value marked using a colour code, and this was covered in detail in last month's "Understanding Electronics".

Bipolar transistors use the circuit symbols of (l) and (m); these being n.p.n. and p.n.p. types respectively. Transistors can be a bit awkward when it comes to dealing with the actual components since there are a large number of different case styles in use, although there are relatively few that are in common use. Another area of confusion is that of identifying the leadout wires, and the difficulty arises due to some case styles (such as the popular TO-92 plastic encapsulation) having more than one leadout configuration. Thus, although the 2N3702, 2N3904, and BC650 all have the same basic encapsulation, the leadout configuration is different in each case! It is a good idea to equip yourself with a transistor data book or one of the large mail order component catalogues that give transistor case and leadout information, and to always check the leadout details of unfamiliar devices.

Integrated circuits are normally represented by a large rectangle or triangle from which wires emanate, with the pin numbers being marked around the circuit symbol as shown in (n). There are only a few integrated circuit case styles in common use these days, but one point to bear in mind is that whereas a transistor leadout diagram such as that given in Figure 2(a) is a base view, an integrated circuit pinout diagram such as the one shown in Figure 2(b) is a top view. In other words the transistor is as it would be seen with the leadouts pointing towards the viewer whereas the integrated circuit is as it would be seen if viewed looking at the side having the type number, and with the pins pointing away from the viewer.

The circuit symbol for a diode or rectifier is shown in (o), and (p) is the symbol for a light emitting diode (LED). The alternative symbols of (q) and (r) are often used. The cathode leadout of a diode is normally indicated by a band marked around the appropriate end of the component's body. This is by no means always the case though, and many diodes have a number of bands. In such cases the bands are normally offset slightly towards one end of the component, and are offset towards cathode leadout wire. Some diodes, for no apparent reason, have the band marked around the wrong end of the component! It is a good idea to check which leadout is which using a test meter, continuity tester, or semiconductor tester, when dealing with unfamiliar diodes. LEDs often have the leadouts identified by having one slightly shorter than the other, but unfortunately there is no standardisation as to which is the shorter, and other systems are sometimes used. It is therefore necessary to either refer to the manufacturers (or retailers) data, or to check using a suitable piece of test equipment.

The circuit symbol of (s) is the one used for a ferrite cored inductor (R.F. choke). This is another component which in some circuit diagrams is represented by a rectangle, together with resistors and capacitors.

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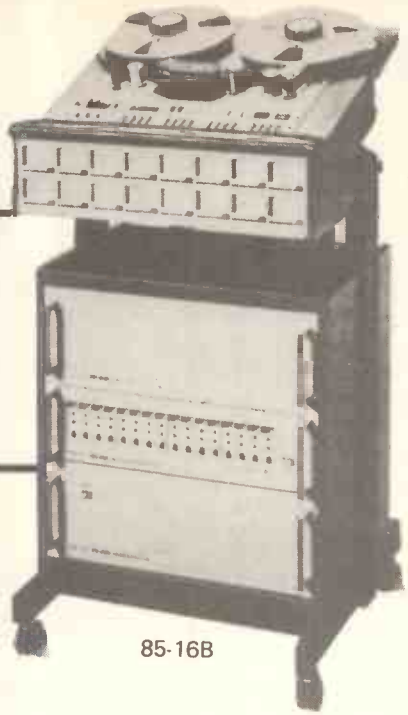

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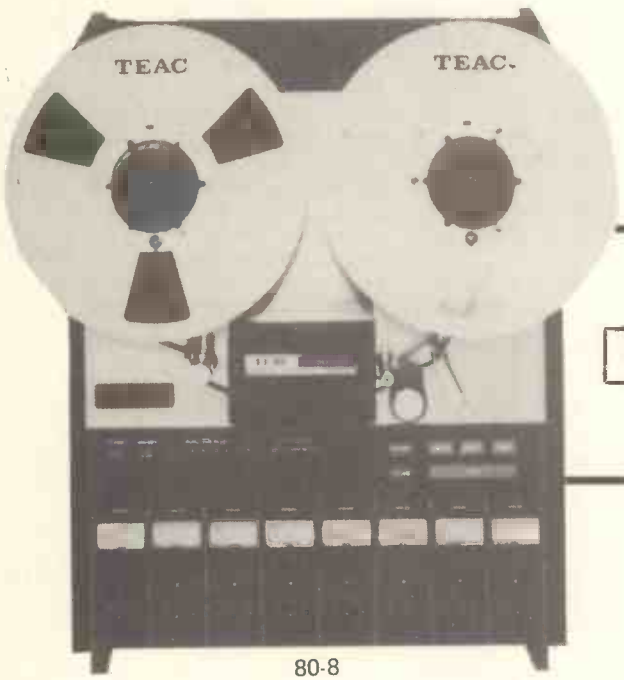

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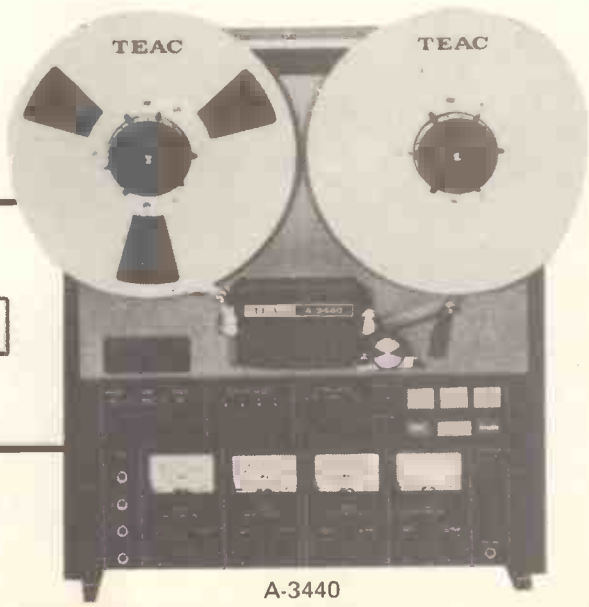

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PARTS COST GUIDE £20 including case

How many times have you dreamt that you could control your sequencer or drum machine from a pre-recorded tape? Well, if you've got a sync input, here is something to plug into it!

There are three basic situations in which the MF1 Sync Unit can help:

* *As an independent clock generator.*

When a number of effects have to run in synchronisation, one is far too often faced with the fact that although many effects have a sync input, very few have an internal clock input. The only way out is to use an external clock generator and this can be our sync unit. Its normal and inverted outputs (active high and active low respectively) will happily control a large number of sync inputs of both standards, provided their 'master clock' rates are compatible.

* *Another direct application of the unit is for the pre-programming of a sequence of tempos for a live performance.*

In this case, an ordinary cassette recorder can be used to 'memorise' the sync pulses (available at the 'record' output) whose rate can be changed at any time. When we replay the recorded sequence into the 'play' input of the MFI, it will again generate a clean set of pulses.

* *The most important application of the unit is in multitracking situations.*

The problem arises from the fact that often different instruments like drum machines, sequencers, etc., have to be recorded at different times, yet with perfect synchronisation, with respect to each other. The only solution is to use a multi-track recorder, reserving one of the tracks for synchronisation purposes (as a 'click track'). We can then use exactly the same technique as in the previous example, controlling a different instrument at every replay and recording the output of that instrument onto another track. The net result is that every time, the new instrument will play exactly in synchronisation with the previous ones.

* *As a sound trigger.*

Here's an incidental use of the unit with the high sensitivity of the 'play' input and the internal wave shaper being used to shape the outputs of a transducer, e.g. microphone, in order to use it as a synchronisation or pulse trigger source.

The unit has been used with various Roland sequencers and drum machines and has proved totally reliable in operation. In fact, to avoid any spurious breakthrough of the control pulse recorded on a tape track to other adjacent channels (important with the new Fostex A8 and Teac A3340S), a very low level signal only is required. The new Roland series (TR808, CSQ600 etc.) all need the value of C1 to be 10nF.

Whether you have a 4 or 8 track, this unit gives you the opportunity to put down e.g., a standard 4 in a bar rhythm throughout a piece from which you can synchronise your other tracks, and then later modify the drum or sequence tracks as you wish - a great advantage.

General Description

The block diagram of Figure 1 shows the arrangement of the various stages of which the unit is comprised. A variable frequency astable multivibrator generates the clock signal which is fed via an attenuator to a buffer amplifier. Some of the output from the buffer stage is fed to an output level control and then to the output socket by way of an amplifier. When switched to the 'record' mode, some of the output from the buffer stage is fed into the circuitry used to interface the recorder to the controlled instrument. This gives a monitor signal at the antiphase clock outputs.

In the 'playback' mode the clock oscillator is disconnected from the pulse shaping circuits, and these are instead fed with the input signal from the cassette tape recorder. The input signal is fed to the pulse shaping and processing circuits by way of a variable gain amplifier which ensures these circuits receive a suitable signal level. Although the output from the tape recorder may well have serious waveform distortion due to the limited frequency response of an inexpensive cassette recorder, the processing circuits ensure that the output from the clock output sockets will always be good quality squarewaves of opposite phase.

Circuit Description

Figure 2 shows the complete circuit diagram of the MF1 Sync. Unit. IC1a and IC1b are used in a conventional CMOS astable multivibrator circuit which has a stable operating frequency that is not significantly affected by variations in the supply voltage. RV2 enables the operating frequency to be varied from just a few Hertz to several kiloHertz, and this is the 'tempo' control. RV1 is a preset control which sets the upper frequency limit of the clock oscillator.

R2 and R3 attenuate the output of the clock oscillator by a little over 20dB before it is applied to a simple buffer stage based on operational amplifier IC2a. The signal is then applied to output level control RV4, and then to the 'record' output socket via another buffer stage. The output is sufficiently strong to drive the 'aux' input of a tape recorder or some other high level input.

With S1 in the 'record' position, some of

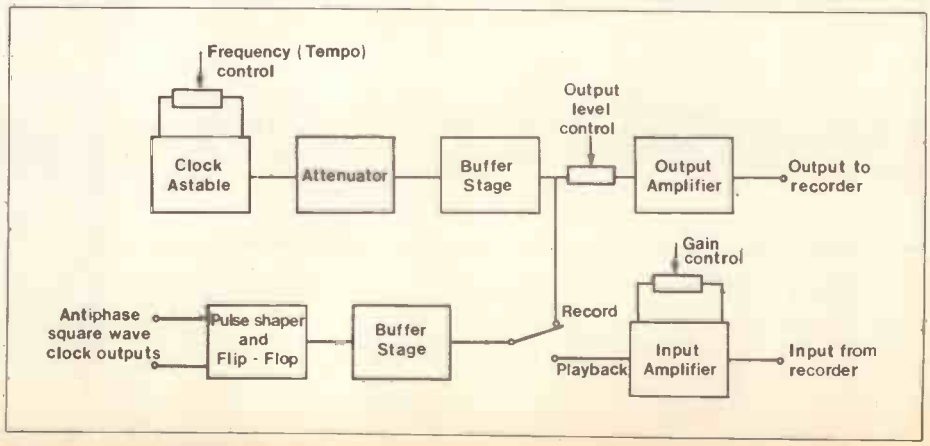


Figure 1. Block diagram of the MF1.

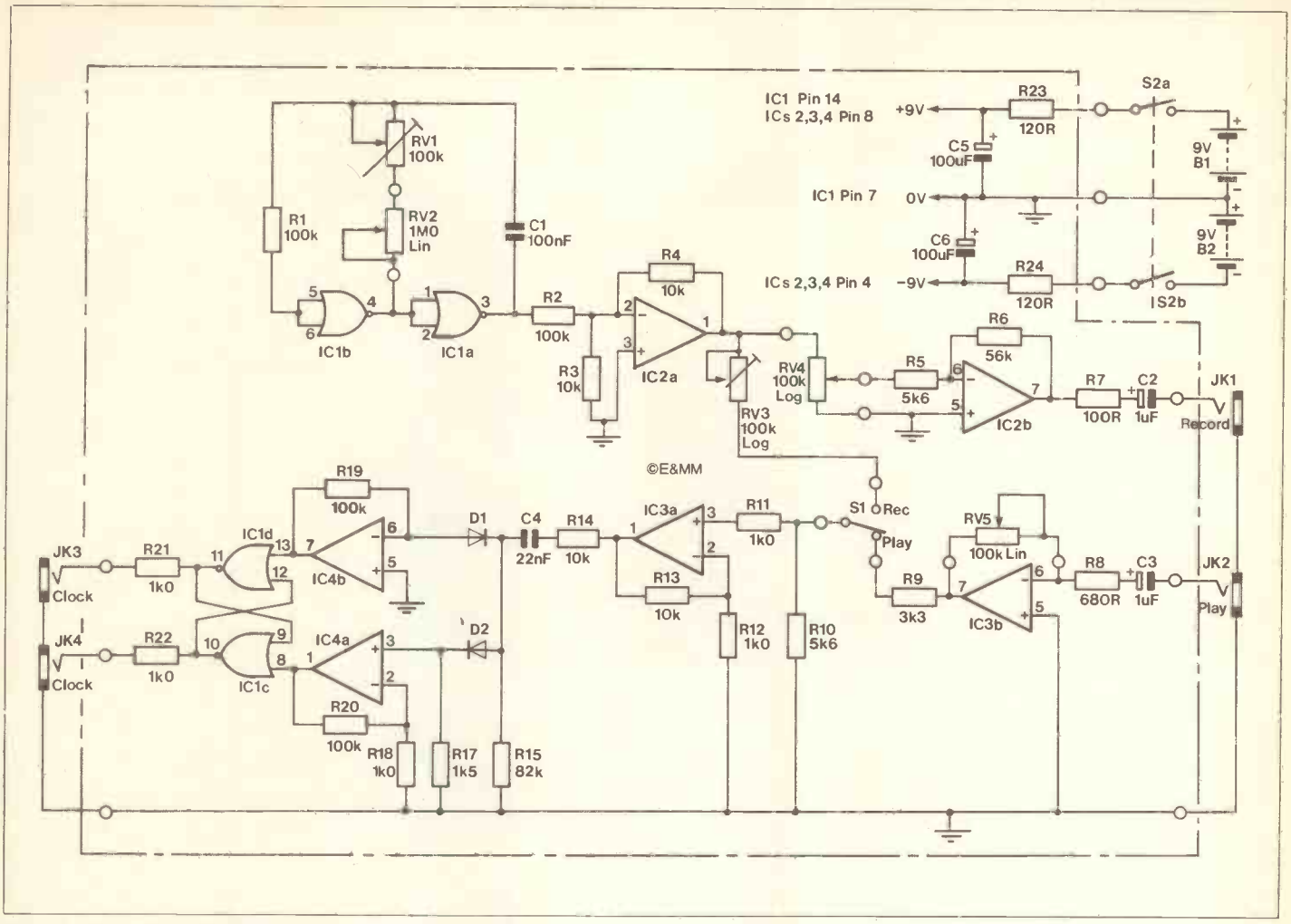


Figure 2. The MF1 circuit diagram.

the output of IC2a is fed through RV3 to the signal shaping and processing circuits. With S1 in the 'playback' position these circuits derive their input signal from the output of the tape recorder and a variable gain amplifier using IC3b enables a suitable signal level to be obtained. RV5 is the gain control and gives less than unity gain when at near minimum resistance, and over 40dB of gain at maximum resistance. This enables the unit to function properly with a very wide range of input levels. The first stage of the signal processing circuitry is a simple buffer amplifier employing IC3a.

The signal at the output of IC3a may be a squarewave of reasonable quality, but it is likely that the rise time will be rather low due to limited high frequency response of a cassette recorder (or virtually any other type of recorder for audio frequency use). If the clock frequency is very low, say in the region of 20 Hertz or less, the low frequency response of a cassette recorder, or any normal audio frequency recorder, will produce severe waveform distortion. In a severe case alternate positive and negative pulses will be obtained at the output instead of each squarewave cycle. The positive pulses are produced by the rising edges of the input signal, and the negative pulses are produced by the trailing edges.

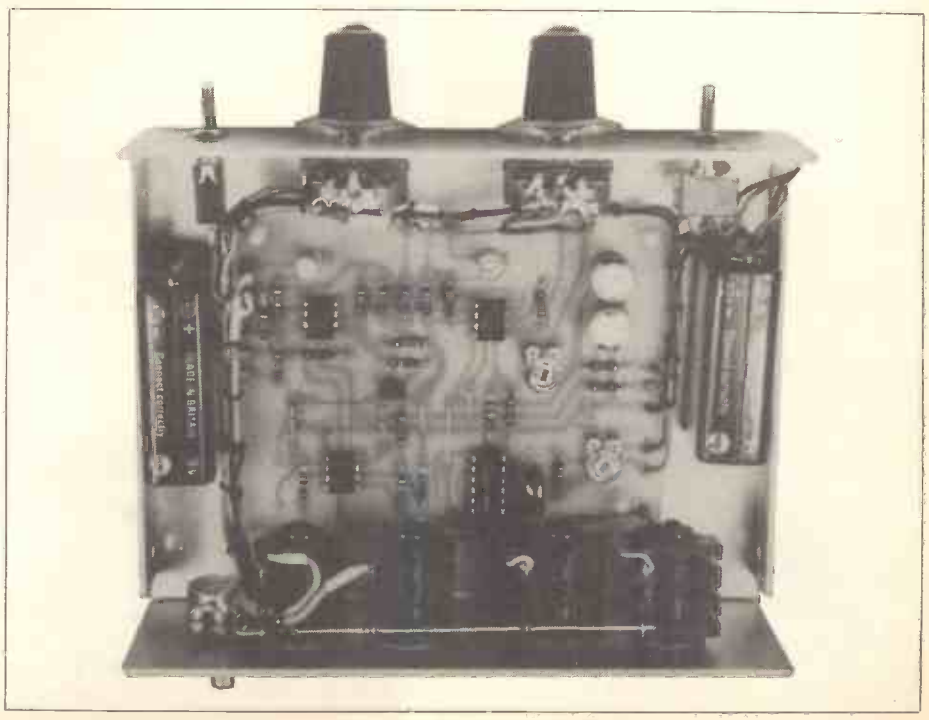
C4, D1, D2, and the surrounding components are used to process the input signal so that brief antiphase pulses are produced regardless of whether the input is a reasonable squarewave or has undergone serious waveform distortion. These pulses are amplified separately by IC4a and IC4b and used to set and reset an RS flip-flop formed by IC1c and IC1d. This gives a good quality squarewave output from each of the antiphase outputs of the flip-flop, and any deficiencies on the input signal are not present on the output signals.

Power is obtained from two PP3 batteries and the current consumption is only about 6 to 7mA from each of these.

Construction

An instrument case measuring about 150mm by 120mm by 50mm makes a good housing for the unit, but note that this is about the minimum size that will accommodate all the components comfortably. As can be seen from reference to the photographs, RV4 and the four sockets are mounted on the rear panel, and the four main controls are fitted on the front panel.

The two batteries fit on opposite sides of



Internal view of MF1.

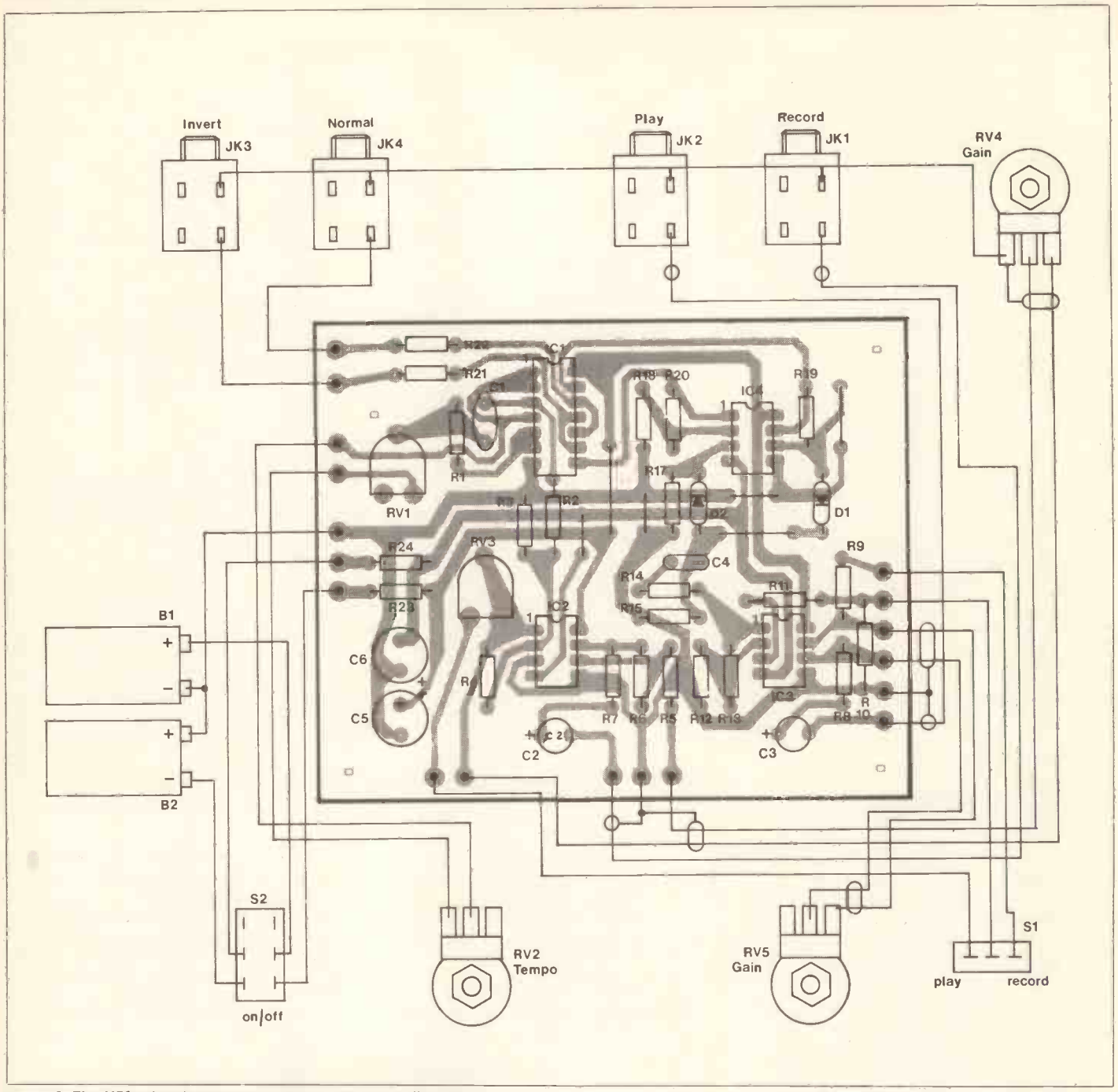


Figure 3. The MF1 printed circuit board layout and wiring diagram.

the case, and all the other components are mounted on the printed circuit board. Details of the printed circuit board are shown in Figure 3, and there should be no difficulties when fitting the components into place provided the specified printed circuit mounting capacitors are employed. In addition to the components there are five short wire links to be soldered in place. IC1 is a CMOS device and in order to minimise the risk of damage by static charges it should be the last component to be soldered into place. As the 4001 is a very inexpensive device it is probably not worthwhile using a socket for this device, but use a soldering iron having an earthed bit when connecting it, and handle this component as little as possible once it has been removed from its protective packaging.

The printed circuit board is mounted centrally on the base panel of the case using four 6mm stand-offs, or four 6BA bolts and 6mm spacers. As there is not much excess space inside the case it is probably best to fit

Rear panel of MF1.

the board into a suitable position on the base panel and then use it as a template when marking the positions of the four mounting holes. After temporarily removing the controls and sockets from the case the mounting holes are then drilled. This method ensures that the controls, batteries, or sockets do not obstruct the printed circuit board and prevent it from being fitted into place.

Either the component panel must be wired to the other components before it is finally installed in the case, or pins must be fitted at the points where connections to off-board components will be made, so that this wiring can be completed with the board mounted in the case. Figure 4 illustrates the point-to-point style wiring of the unit. Be sure to use screened leads where indicated in the wiring diagram.

Setting Up

There are only two preset controls to set up, and it is not necessary to have any test equipment in order to give these the correct settings. Initially, RV1 should be set at midway, and RV3 should be adjusted fully clockwise. Set the tempo control (RV2) to maximum, S1 to 'record', and connect the clock input of the unit which is to be controlled by the MF1 to one of the clock output sockets (JK3 or JK4). Set the controlled equipment for use with an external clock signal and then switch on both units. Nothing should happen at this stage, but if RV3 is slowly adjusted in an anticlockwise direction at some point the controlled equipment should start operating. This is the

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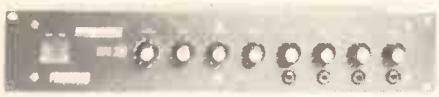

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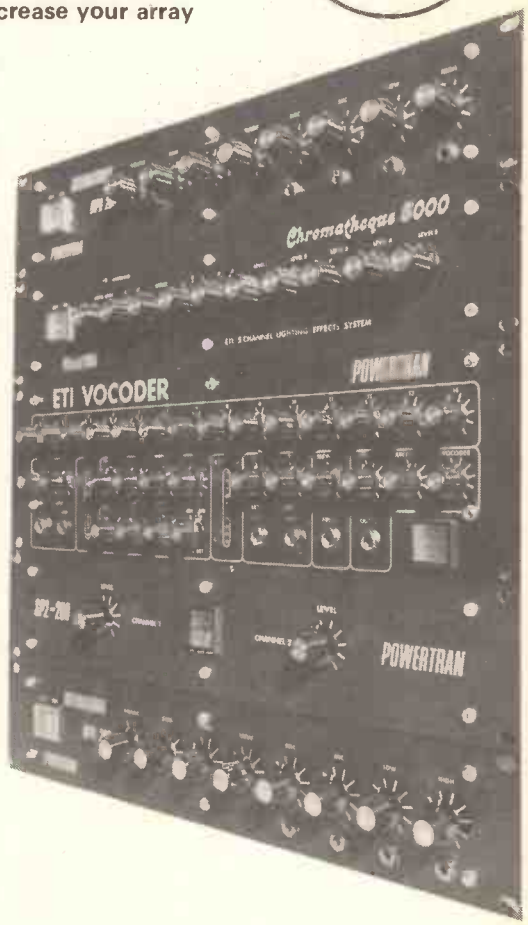

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PARTS LIST FOR THE MF1 SYNC UNIT

Resistors — 5% ½W carbon unless specified			Maplin Code
R1,2,19,20	100k	4 off	(M100K)
R3,4,13,14	10k	4 off	(M10K)
R5,10	5k6	2 off	(M5K6)
R6	56k		(M56K)
R7	100R		(M100R)
R8	680R		(M680R)
R9	3k3		(M3K3)
R11,12,18, 21,22	1k0	5 off	(M1K0)
R15	82k		(M82K)
R17	1k5		(M1K5)
R23,24	120R	2 off	(M120R)
RV1,3	100k min horiz preset		(WR61R)
RV2	1M lin pot		(FW08J)
RV4	100k log pot		(FW25C)
Capacitors			
C1	0.1uF mylar		(WW21X)
C2,3	1uF 16V electrolytic (vertical)	2 off	(FF01B)
C4	22nF mylar		(WW19V)
C5,6	100uF 16V electrolytic (vertical)	2 off	(FF11M)

Semiconductors			Maplin Code
D1,2	1N4001	2 off	(QL73Q)
IC1	4001BE		(QX01B)
IC2 to 4	1458C	3 off	(QH46A)
Miscellaneous			
JK1 to 4	¼" mono socket	4 off	(HF90X)
S1	SPDT sub min switch		(FH00A)
S2	DPDT sub min switch		(FH04E)
	Calibrated knobs	3 off	(RX11M)
	PCB standoffs (medium)	4 off	(FW17T)
	*PCB		
	**Case		
	PP3 batteries	2 off	
	PP3 clips	2 off	(HF28F)
	Wire		

***The PCB is available price £4.50, inc. U.K. p&p, from MacFison Electronic Engineers, 13 Northfalls Road, Canvey Island, Essex.**
****The case used for the prototype was the No-Vise box 7310 NA supplied by Zaerix Electronics Ltd. If, however, you wish to obtain all the parts from Maplin Electronics Supplies Ltd then Verobox type 214, order code LQ07H, or the aluminium instrument case model 231, order code XY44X, will suffice.**

correct setting for RV3.

Next RV1 is adjusted to give the fastest tempo that will be required, and it should be borne in mind that setting RV1 for a higher tempo than this will make RV2 cover a wider frequency range and thus make it more difficult to adjust to precisely the required tempo. It may be found that the range of clock frequencies available is too low for satisfactory results with some items of equipment, and this can be corrected by reducing the value of C1 to 0.01uF (10nF). This boosts output frequencies by a factor of ten.

The output signal from JK1 should drive the 'aux.' input or other high level input of a tape recorder without any problems. It should also be possible to use the microphone input of a recorder if a high level input is not provided, but output level control RV4 would need to be adjusted almost fully anticlockwise to prevent the recorder from being overloaded. If the unit is used into a microphone input it would be advisable to reduce the maximum output level by reducing R6 from 56k to 5k6.

As the MF1 will operate with an input level of anything from a few millivolts RMS to several volts RMS it will operate properly with any normal cassette recorder or deck, and the position of the recorders volume control or output level control will not be critical. Gain control RV5 is adjusted just beyond the point at which the unit has sufficient gain to produce a clock output signal.

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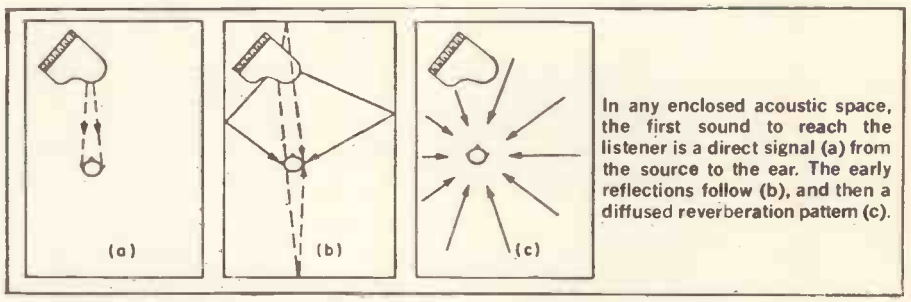
REVERBERATION REVERBERATION REVERBERATION

Dr David Ellis

It's probably true that the quality of ambience heard is a fairly important factor in determining whether or not a sound is liked or disliked, and it certainly adds depth, dimension, and some 'live' perspective to the potential artificiality of many a multitracked piece of music. One of the many trials and tribulations of modern recording techniques is the small problem of meeting the rather exacting demands of the human ear for the right amount of ambience in the right place at the right time. As a result, a good deal of time and effort is taken up ensuring that recorded signals are 'dry', so that when ambience is added it's of a uniform variety and not likely to give rise to the sort of mushy, acoustically-anarchic mess that would result from recording and mixing together a load of signals each with their own idea of what ambience is all about.

Au Naturel

When a sound is made inside a room, the listener initially hears the sound as it comes directly from the source (Figure 1a). A short time later, after a delay of somewhere between 5 and 50 milliseconds, the first echo reaches the listener, followed by several more individual echoes (Figure 1b). Many more echoes follow on the body of the first group (Figure 1c), and, as the quantity increases, so the brief time span between them becomes shorter and shorter until they join together in a healthy reverberant melée as a seemingly continuous sound. The original sound is now diffused throughout the room due to the multiple echoes and random paths taken by the original sound waves. As the degree of diffusion increases, the amplitude decreases, and it's this fading of the reverberant sound that constitutes the reverb decay.



In any enclosed acoustic space, the first sound to reach the listener is a direct signal (a) from the source to the ear. The early reflections follow (b), and then a diffused reverberation pattern (c).

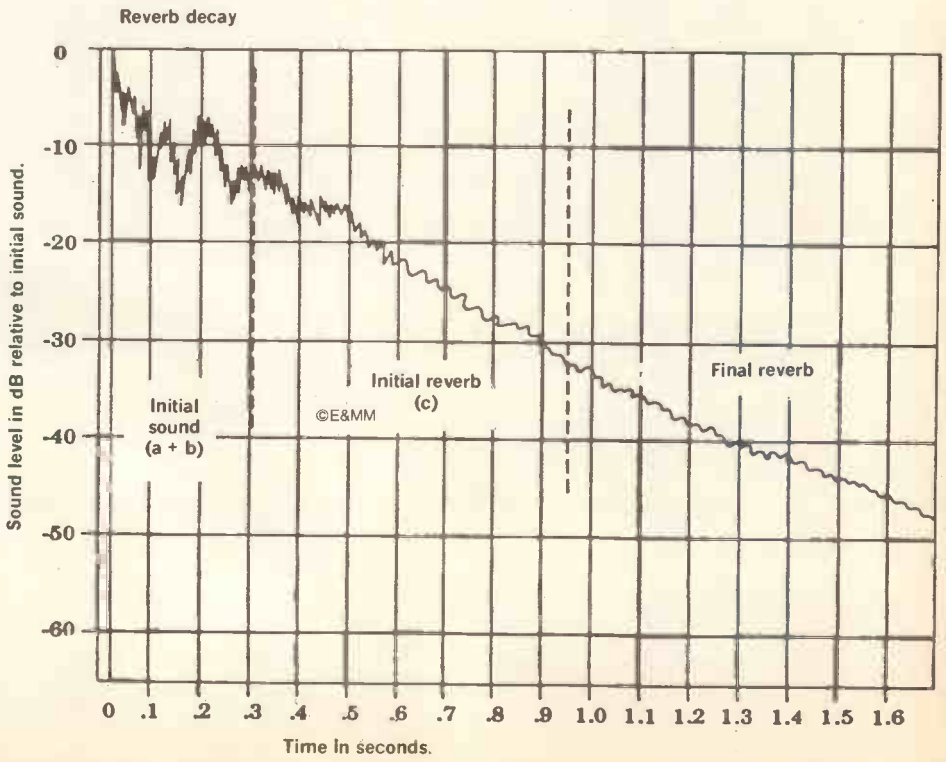
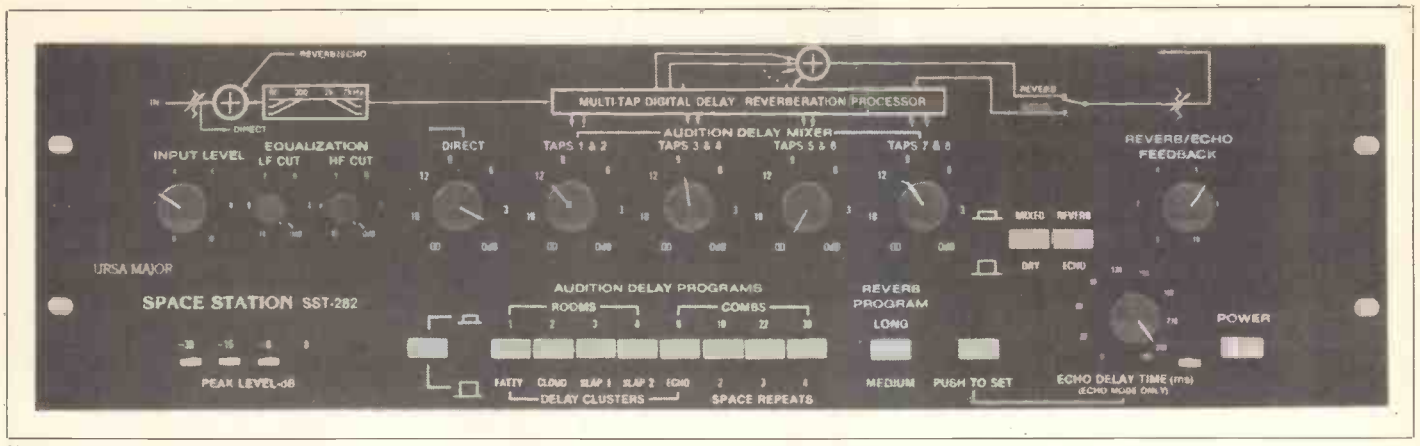


Figure 1. Phases of ambience.



Ursa Major Space Station SST-282.

The apparent rate of reverb decay during this initial period depends both on the size and shape of the hall or room and on the position of the listener, and, according to those that study the complexities of auditory perception, the ear uses the first 200 milliseconds or so of reverb to perceive the size and shape of the ongoing ambient situation. The overall reverb time is usually measured by making a loud noise and measuring the time the sound takes to decay through 60 dB. The value measured will obviously be dependent on the factors that we've already mentioned, but, at later stages of the reverb decay, the absorption coefficient of materials used in the room's construction is an important consideration.

Thus, values for α, the absorption coefficient, range from 0.03 for plastered wall (i.e., it's relatively reflective) to 0.6 for curtains hung in folds (i.e., they're like acoustic golden syrup). Ploughing these figures into Sabine's formula, namely, $T_r = \frac{0.164V}{S\alpha}$

where V is room volume (m^3) and S is room surface area (m^2), gives the value for T_r, the reverberation time, in seconds.

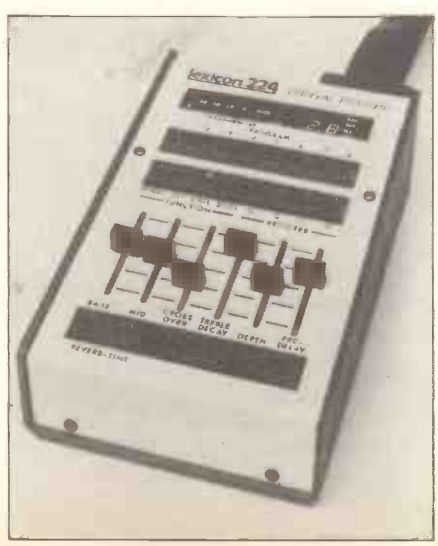
The difficulties of designing either an acoustically 'dead' recording studio or an ideally reverberant concert hall shouldn't be underestimated, and two of London's finest concert halls only achieved their current acoustic status after a lot of nail-biting to iron out various glaring design problems that manifested themselves after the edifices had been erected. The Royal Festival Hall may have been remarkably innovatory in design for a post-War building, but, for various reasons stemming mainly from the enthusiasm of the architects, the hall also functioned as a curious sort of comb filter as soon as an audience was in position. Peaks and troughs may be fine for flanging and the like but they aren't everyone's idea of the best treatment for Beethoven or the other Top Ten composers on London's South Bank, and the non-linear reverb characteristics were rapidly remedied by means of judicious reinforcement of certain critical frequencies at key spots in the hall. And, whilst Queen Victoria might not be that amused by the sudden intrusion of UFOs into the upper reaches of her beloved Albert's very royal hall, the addition of the infamous 'flying dishes' certainly rescued the RAH from a fate worse than death.

Mechanical Aids

In the sort of recording situation facing the average electro-musician, ambience only comes about as a result of the injection of some delaying tactics into the process of mixdown. Mechanical reverb devices are certainly the most cost-effective way of inducing some semblance of natural ambience into the otherwise clinical clarity of synthesiser tracks. However, the range of *modae operandum* and variation in cost of units, for such an apparently straightforward procedure, can make choosing the right sort of reverb device a rather painful business. Four methods prevail:

1. Live Acoustic Chamber

Generally, high quality live acoustic chambers are constructed with non-parallel and hard, sound reflective surfaces so that the sounds will echo (or, more correctly, reverberate) within the chamber. Though live chambers are difficult to design and correspondingly difficult to build, some smaller studios have successfully found suitable 'lively' environments close to hand — bathrooms and toilets, for example. In operation, a loudspeaker is placed at one end of the room and a microphone at the other, with baffles added in between to maximise the pathlength across the room. Sounds to be treated can then be replayed through the speaker, and the resultant direct plus reverberant soundfield picked up by the microphone.



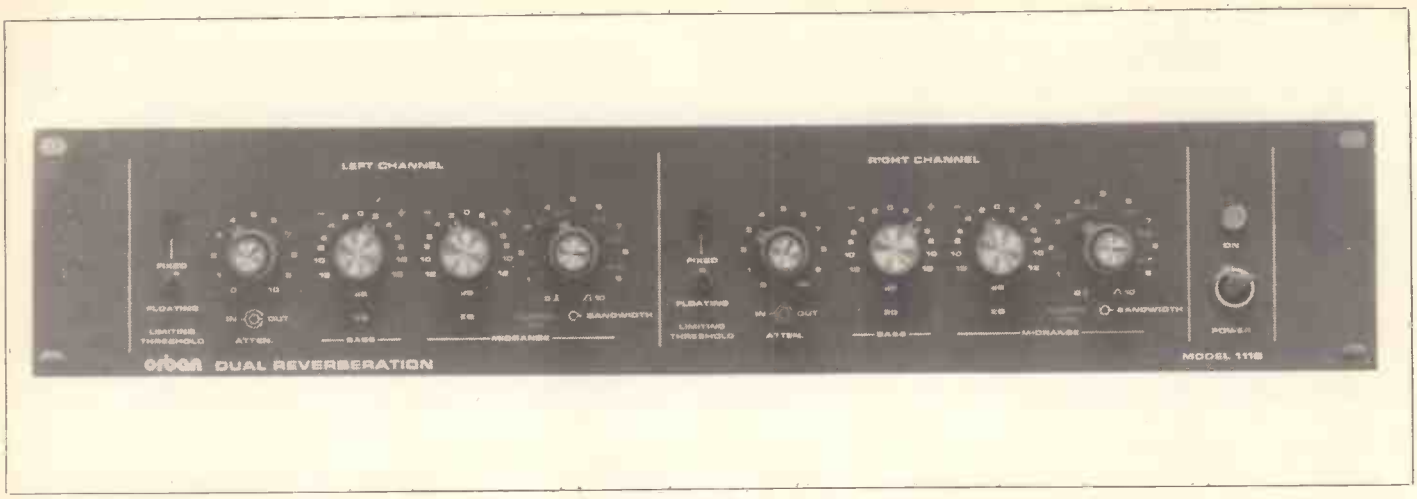
Lexicon 224 Digital Reverb controller.

2. Reverb plate

One of the prized possessions of most large recording studios is the omnipresent EMT reverb plate (also erroneously called an 'echo' plate). This consists of a steel sheet approximately 2·5m x 1.5m, sometimes plated with gold or silver, and suspended vertically on springs. A moving coil transducer is mounted at a critical position to 'energize' the plate, and two or more piezo-ceramic contact microphones mounted at strategic points around the plate pick up the reverberant vibrations as they radiate to and from the edges of the plate. Plates tend to give a rapid response to transients and good high frequency resolution, two factors which account for their popularity in recording rock music — particularly for simulating a live 'cage' of ambience around a drum kit.

3. Reverb springs

The simplest and cheapest reverb device consists of two or more sets of springs, often of different lengths, joined together at the ends. Sound waves are induced into one end of the springs in a torsional manner and recovered at the other end. The energy reflects back and forward between the two ends of the spring until it dies away giving a more or less reverberant effect. The length of springs used in reverb units varies enormously from a 2" twin unit in the very cheap Accessit reverb unit to a 16" triple unit in the Furman Sound RV-1. It's difficult to know what type and arrangement of springs makes for a good sound — doubtless spring tension and diameter play as important a part as anything else. 'Floppy' springs often account for nasty jangles as the spring decides it can't cope with a loud transient — hence the logic of limiters, pre-spring EQ, and LED overload indication. In theory, by using various amounts of bass or treble boost, different types of 'rooms' (or reverb patterns) can be synthesised, ranging from one containing a lot of absorbent material (an auditorium with well-padded walls, for example) in which the bass frequencies are more prominent,



Orban Dual Reverberation Model 115.

to very 'bright' or unabsorbent environments where the high frequencies contribute more to the reverberation effect. Most spring-line reverb units have a decay time that is characteristic of a particular spring set up. The AKG units, on the other hand, make use of what they term their 'torsional transmission line principle', whereby frequency-dependent decay time variation is effected via motional feedback. Damping elements are placed along the spring-line so that feedback can effectively shorten the spring length and vary the overall decay time from 2 to 4.5 seconds.

The most frequent descriptions applied to spring-line reverb are 'boing', 'twang', and 'flutter', and there's no doubt that the best evaluation technique for reverb units is the use of a drum track or any other sharp, percussive signal which will show up the presence of these less than desirable fellows. Signal processing tricks can be employed to overcome or conceal reverb deficiencies, but the usual result is a loss of the natural reverb qualities possible with a good spring unit. The four reverb units compared in Figure 2 all produce high quality reverberation, but with more or less subtly different characteristics. As modern mixing desks enable both the 'echo send' and 'echo return' to be separately equalised, pre-spring and post-spring EQ in the reverb unit itself is hardly an essential feature, and 'no frills' designs like the Bandive Great British Spring make a lot of sense.

4. Tape echo

Tape recorders can be used to create a 'flutter' echo effect; by feeding back the delayed, off-tape signal to the input, sounds will be subjected to multiple repeats before dying away. However, such an effect is only like prolonging the initial echo phase of a sound, and, because of its repetitive and unrandom nature, becomes somewhat tedious. Where flutter echo is useful, though, is in conjunction with a spring or plate reverb, the straight tape delay enhancing the reverb, and a signal that has been delayed by a short interval before being connected to a reverb device often sounds more realistic when added to the final stereo mix.

Digital Doobries

As we've seen, true reverb is a rich, random pattern of sound reflections whose echo density increases as the sound decays. The strength of each reflection, its time delay, and its frequency response determine the sound of the reverberation. Simulating realistic reverb effects electronically is a challenging problem and can't be done easily by tapping off increments of delay along a delay line and then summing the outputs together (these tend to create flutter echo with a low density of reflections). In theory, a digital delay line with a very large number of taps (something of the order of 5,000 per second of delay) could be constructed and used to duplicate natural reverb exactly. A high-speed processor could then be used to access numbers from the memory, multiply them by constants representing the required amplitude for that portion of the decay curve, add them together, and send the sum to the output. This operation needs to be controlled by a program that precisely describes the time delay and amplitude for each reflection — the reverberation algorithm. However, if the sampling rate is 20kHz (giving a bandwidth of something less than 10kHz), then the processor has only about 50 us in which to perform about 5,000 multiplications and additions — some 1,000 times faster than available 8-bit technology is capable of at present!

Digital reverberation systems solve this problem of inadequate processing time by using many short delays, with each tap being fed back into memory, and the magical ingredient of the reverberation algorithm randomizing the tapping to a greater or lesser extent. This combination of a smaller number of taps and feedback is the principle of all current digital reverb units. The principal factors to be considered in designing a digital reverberator are the time delay of each segment, the amount of feedback, the digital filtering applied to the feedback around each loop, and how all the taps are summed to make the final reverberant stew.

This reverberation algorithm may go a long way to providing a usable type of reverb, but, as compromises have to be made, it isn't possible to exactly duplicate the natural reverberation of a typical concert hall, or whatever. Even with the best of intentions, such algorithms can often produce very metallic-sounding, fluttery reverb, and it's only after some very ingenious program-writing that Schroeder came up with the all-pass reverberation algorithms commonly used by units such as the Lexicon 224 and Ursa Major Space Station. Schroeder's work enabled these manufacturers to produce units that are capable of a quality of reverb sound that approaches the 'naturalness' of top-flight plate reverberation units. Just as small rooms and echo chambers produce high initial diffusion, the reverberation tending to spread and colour the sound it is added to (e.g. the bathroom 'solo'), modern algorithms tend to prescribe high diffusion after the reverberation has built up, but with different degrees of initial diffusion.

The real beauty of digital reverb is the adaptability of the system to all

	Master Room XL-121	Furman Sound RV-1	Bandive Great British Spring	AKG BX5	Orban 111B
post-spring EQ	Yes	Yes	No	Yes	Yes
pre-spring EQ	No	Yes	No	No	Yes
limiting	No	Yes	No	Yes	Yes
overload indication	Yes	Yes	No	Yes	Yes
rack-mounting	Yes	Yes	No	Yes	Yes
twin-channel (stereo)	Yes	No	Yes	Yes	Yes
variable decay time	No	No	No	Yes	No
price (£s/VAT exclusive)	302	257	174	375	631
springs/channel	3	3	3	?	6

Figure 2. Comparison of spring-line reverb units.

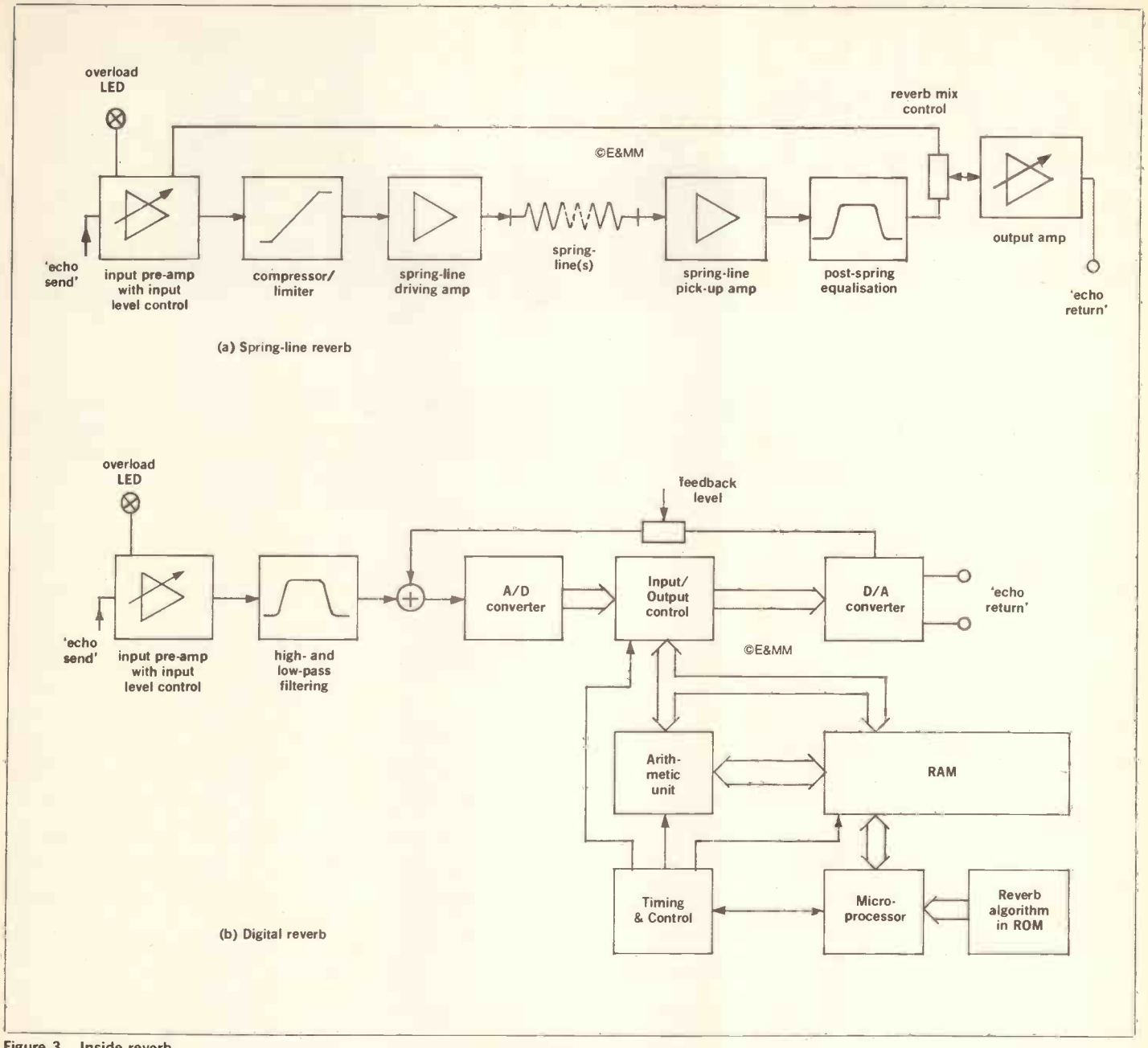


Figure 3. Inside reverb.

manner of reverb types, both natural-sounding and outrageous, as well as the production of special effects via notch-filtering and so on. A short, rapid diffusion reverb, such as that from a fully damped plate, may be used on drum tracks, a live chamber type on vocals, and a medium-damped plate with some initial delay on brass.

The Lexicon 224 is probably the most sophisticated digital reverb system available at present, and current software enables six reverb types to be punched up at will: small concert hall, vocal plate, large concert hall, acoustic chamber, percussive plate, and alternative small concert hall.

Conclusions

Digital reverberation is so utterly open-ended in terms of the variety of ambient environments that can be synthesised that its relevance to the limitless sound-world of electronic music is crystal clear. However, the technology is very expensive (Ursa Major Space Station — £1,475; Lexicon — £4,800) and likely to stay that way until large capacity RAM drops significantly in price.

Bandhive Great British Spring.

Whilst it is true that spring-line reverb units have a habit of jangling to their hearts' content, and to the musician's discontent, if used carelessly, the various signal-processing features included in some units can reduce colouration, jangle tendency and so on, but the user would be well advised to make sure that this isn't because the manufacturer is trying to make a silk purse out of a sow's ear. Spring-line reverb certainly offers the most cost-effective solution to quality reverb for the less well-off studio (unless, of course, you happen to have a convenient bathroom to hand — and one that's not being used for the usual purposes!). A number of spring-line units selling for around £200 are perfectly capable of deceiving the brain into thinking it's perceiving real ambience, and the addition of some pre-reverb tape delay adds the finishing touch to the story. **E&MM**

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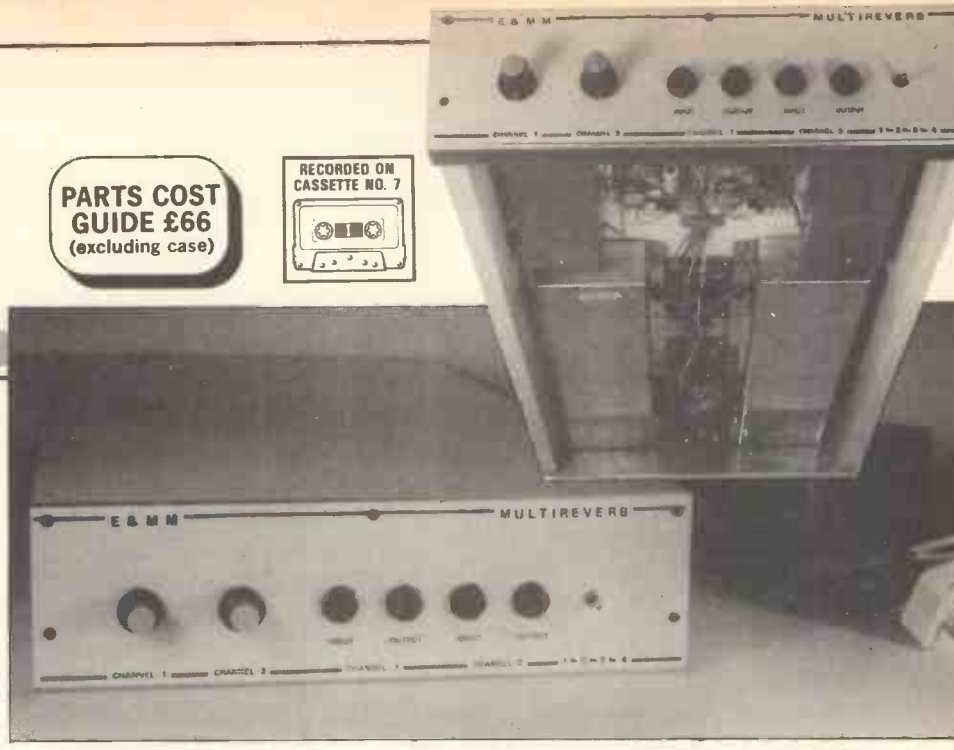

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- ★ **Versatile EQ options for many different reverberant sounds**
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Natural reverberation is caused by reflected sounds, and in a normal room most of these reflections come from the walls and ceilings. It is important to differentiate between reverberation and echo; an echo is heard as a clear repetition of the original sound, whereas reverberation consists of numerous reflected sounds which normally come only marginally behind the original sound. Reverberation can nevertheless last several seconds due to sounds being reflected from a number of surfaces and therefore travelling a considerable distance before they reach the listener. The decay time of reverberation in a small room with carpets and normal furnishings (which tend to be good sound absorbers) is usually only in the region of a few hundred milliseconds or less, but in a large hall a decay time of a few seconds is quite common. The decay time, incidentally, is generally accepted as the time taken for the sound to decrease by 60dB. This should not be confused with the delay time, which is the time delay between the direct sound and the first reflection being received, and is naturally much shorter than the decay time in most cases.

Reverberation tends to enhance sounds by giving depth and colour, and artificial reverberation is understandably a very popular effect. There are several ways of obtaining artificial reverberation, but the most popular method, and one which provides excellent results at low cost, is the use of a springline based system.

A springline normally consists of two long springs mounted side-by-side, and having an input transducer at one end and an output transducer at the opposite end. A signal applied to the input transducer results in sound waves being transmitted down the springs, and these are designed so that there is a significant delay time. Also, in order to produce a more realistic effect it is normal for the springs to give different delay times. The sound waves produce an output signal when they reach the output transducer, but some of the energy is reflected back to the input transducer, and then back to the output transducer where a further output signal is produced. In fact, the energy will be reflected up and down the springs numerous times, gradually diminishing until no significant output is produced from the output transducer.

This is obviously analogous to sounds being reflected around a room, and for such a simple system can give a very realistic effect.

Driver Circuits in General

Only a limited amount of circuitry is necessary in addition to the springline, and basically all that is required is an amplifier at the input to match the signal source to the low impedance of the input transducer, and a high gain amplifier at the output. The latter is needed because of the large losses through the springline. Some designs have a built-in mixer so that the reverberation signal can be mixed with the unprocessed input signal in the desired proportions. However, this is not an essential feature, and for studio use it is usually more convenient to use a separate mixer. This design does not therefore have a built-in mixer.

A slight complication arises due to the inductance of the electro-magnetic transducer used at the input of a springline. The inductance results in a given input signal voltage producing a greater current flow at low frequencies than at high audio frequencies, and this effectively boosts bass frequencies and cuts treble frequencies. Some designs do not include any form of equalisation to give an improved frequency response, and this gives reasonable results but there is an undesirable 'boominess' due to the excessive bass and a noticeable lack of treble output.

The design incorporates equalisation to give a reduction in bass response and treble boost so that an improved frequency response is obtained. It must be emphasised that the frequency response is far from flat over the audio frequency range, and it would not be desirable to have a flat response anyway. Natural reverberation tends to have relatively little bass and treble content, and artificial reverberation must emulate this in order to give realistic results. The frequency tailoring of this design can easily be modified to suit individual tastes and requirements, as will be fully explained later on.

In fact, this design can easily be adapted to suit individual requirements in other ways. The basic circuit is designed for use with a Maplin short springline unit, but it can easily be modified to suit the Maplin long springline unit, and all this requires is a change in the value of one resistor. The prototype is actually a versatile stereo unit which has four springlines (each having its own driver/equalisation/output amplifier module) and a built-in mains power supply. Each channel can be separately switched to use a long springline, a short springline, or both connected in series. When switched to

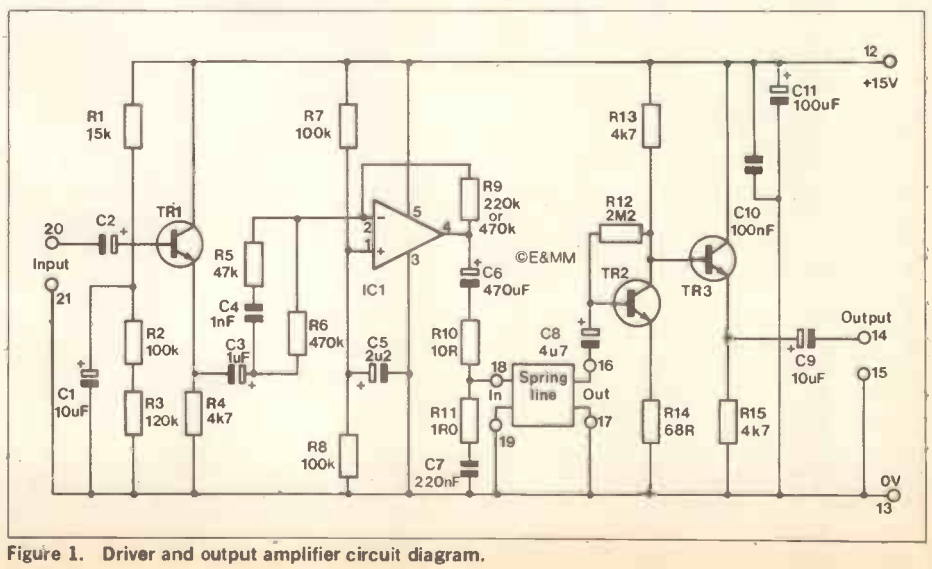


Figure 1. Driver and output amplifier circuit diagram.

the mono mode it is possible to have two short springlines in series or two long springlines in series. It is even possible to have all four springlines connected in series in order to give a very long decay time.

However, if you require a mono springline having a fairly short decay time, all that is required is a short springline plus a driver/output amplifier module and a mains power supply module. It is just a matter of selecting the springline or springlines that suit your requirements, and then a driver/output amplifier module for each springline must be constructed, together with a power supply module (which will power up to four driver/output amplifier modules).

The Maplin short springline unit has a decay time of 2.5 to 3 seconds and a delay time of 25 to 35 milliseconds. The corresponding figures for the Maplin long springline unit are 7 seconds and 35 to 45 milliseconds respectively.

Driver Circuit Description

The circuit diagram of the driver and output amplifiers is shown in Figure 1. TR1 is employed as an emitter follower buffer stage which gives an input impedance of about 50k and a low output impedance to drive the subsequent stage. C1 and R1 decouple the supply to the bias components for TR1 so that these do not couple noise from the supply lines to the input of the circuit.

Springlines are normally driven with a fairly strong input signal so that as little gain as possible needs to be used at the output of the unit. This minimises problems with microphony. In this circuit the springline is driven using a TDA2006 integrated circuit power amplifier, and this device is rather like an operational amplifier having a high power Class B output stage. Pin 1 is the non-inverting input and it is biased to half the supply voltage by R7 and R8. C5 decouples any noise which might otherwise be fed to the non-inverting input of IC1.

R9 and R6 are a negative feedback network which sets the closed loop voltage gain of IC1 equal to the value of R9 divided by the value of R6. This gives a voltage gain of unity, or about -6dB, depending on the value used for R9. A 220k is used if the circuit is to be used with a short springline, and a 470k component is employed if the circuit is to be used in conjunction with a long springline. Greater gain is needed with a long springline simply because it has slightly greater losses.

At low frequencies C4 has a very high impedance, and C4 and R5 therefore have no significant affect on the circuit. At higher frequencies the impedance of C4 decreases, and the shunting effect C4 and R5 have on R6 produces treble boost. R5 limits the maximum boost to about 20dB, but the value of this component can be increased if less boost is required, or decreased if greater treble boost is desired. It could be replaced by a potentiometer or a series of switched resistances if variable boost is required, and there is plenty of room for experimentation here.

IC1 provides little or no voltage gain, but it is mainly needed to provide equalisation and to give a low output impedance to drive the input transducer of the springline. The input impedance of a short springline is nominally 16 ohms, and that of a long springline is 8 ohms. However, as explained earlier the inductance of the input transducer produces a very low input impedance at bass frequencies with a consequent boost in the bass response of the circuit.

This is counteracted in this circuit simply by using R10 in series with the springlines input transducer. At low frequencies where the input transducer has a low input impedance R10 introduces large losses, but at higher frequencies where the input impedance is substantially higher the losses through R10 become comparatively small.

Once again this resistor can be changed in value to tailor the frequency response to suit individual tastes. A lower value gives increased bass response, a higher value gives increased bass attenuation. Variable equalisation can be obtained by using a low value (20 or 25 ohm) wirewound potentiometer or a series of switched resistances in place of R10.

R11 and C7 are needed to aid the stability of the circuit, and these do not have any significant affect on the response of the circuit over the audio frequency range.

The output amplifier uses TR2 as a high gain low noise common emitter amplifier, and TR3 as an emitter follower buffer stage which gives the unit a low output impedance. The full voltage gain available from TR2 is not needed in order to give the circuit an overall voltage gain of about unity, and R14 is therefore used to introduce negative feedback which slightly reduces the voltage gain of TR2.

Power Supply Circuit

Figure 2 shows the circuit diagram of the power supply, and this is a straightforward circuit having full wave rectification and the output stabilised at a nominal potential of 15 volts by monolithic voltage regulator IC2. The maximum output current is 1 amp and this is sufficient to supply four springline circuits.

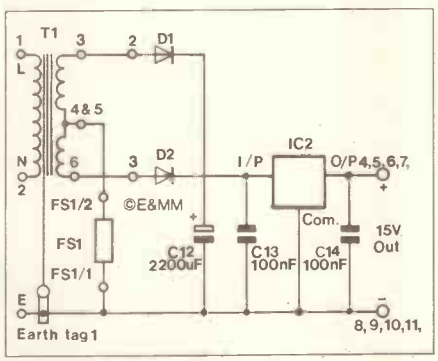


Figure 2. PSU circuit diagram.

Switching

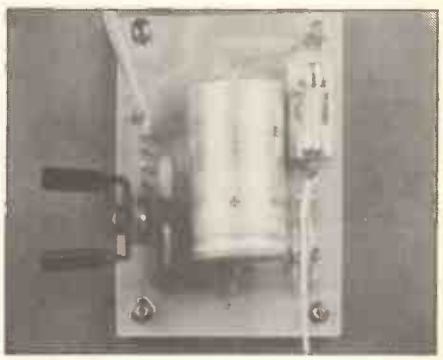
The switching of the Multireverb Unit is shown in Figure 3. S1 is the mode switch for the right hand channel and it enables the signal to be routed through the short springline only, the long springline only, or through both springlines. S2 provides identical switching for the left hand channel.

S3 is the mono/stereo switch, and in the stereo mode it merely connects the two stereo channels through their own separate paths. In the mono mode the output of the left hand channel is isolated from the left hand output socket and is instead routed to the right hand input (which is isolated from the right hand input socket). The two input sockets are connected in parallel, as are the two output sockets.

Thus, in the mono mode S1 and S2 provide the same options as in the stereo mode, but as the two channels are connected in series it is possible to obtain two short springlines in series, two long springlines in series, or two long and two short springlines in series. It is also possible to obtain a short springline plus a long springline in series, which is also available in the stereo mode. However, just a short springline or a long springline cannot be obtained in the mono mode, although this can obviously be achieved by switching to stereo and ignoring one channel of the unit.

Construction

The springline driver and output amplifier circuits are assembled on one printed



PSU board.

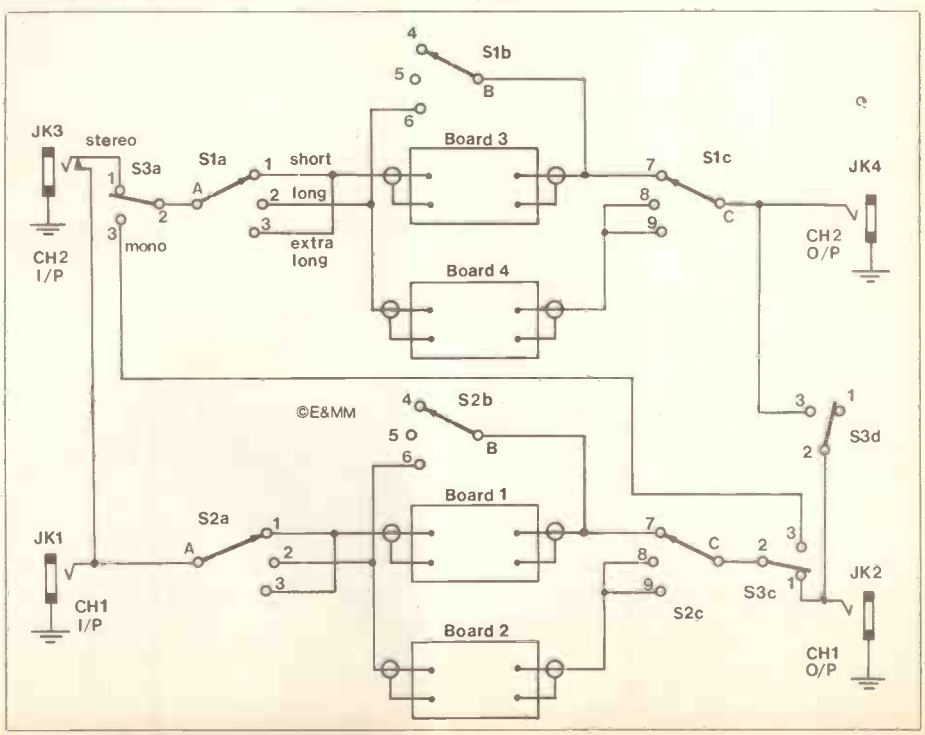
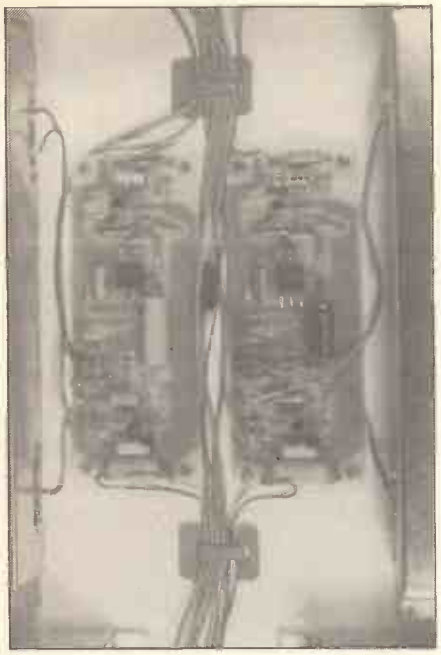


Figure 3. Switching in the Multireverb unit.



Two Reverberation Modules and associated wiring.

circuit board (one board being required for each springline used) and the power supply is assembled on a separate board. Ready-made printed circuit boards are supplied with a driver/output amplifier board and a power supply board as a single panel which must be cut along the broken line in order to separate the two boards or can be left attached as in Figure 4. Of course, if you are using more than one springline there will be spare power supply boards which can be saved for future use.

Details of the driver/output amplifier circuit board are provided in Figures 4 and 5. Note that IC1 is bolted to the printed circuit board using a 6mm M3 bolt and fixing nut. The leadouts of IC1 are preformed and need to be slightly reformed before IC1 can be fitted on to the board properly.

Figures 4 and 5 give details of the power supply printed circuit board and the other power supply wiring. The fuseholder is bolted to the board using a 6mm M3 bolt. IC2 does not have to dissipate a great deal of power, and a ready-made finned heatsink is adequate even if four springline circuits are powered from the supply unit.

Mechanical construction of the unit can obviously be varied to suit individual circumstances and requirements, but the basic arrangement used for the prototype should serve to give some good guidelines. The case has chipboard sides and a chipboard rear panel on which the springlines and printed circuit boards are mounted. The top and base panels are made from 18 swg aluminium, and the three controls and four sockets are mounted on the top panel. The base panel is drilled to take the power supply cable which connects the output from the power supply to the reverberation unit. In our prototype the power supply board and mains transformer were fitted in a separate case which stands on the floor beneath the reverberation unit (which is designed for wall mounting). This keeps the mains transformer well separated from the springlines so that there is no possibility of inductive coupling between the transformer and the springlines. However, if required the PSU board can be left connected to the driver board and mounted in the case as in Figure 4.

Finally, the wiring required to complete the unit is detailed in the wiring table and Figure 4. **E&MM**

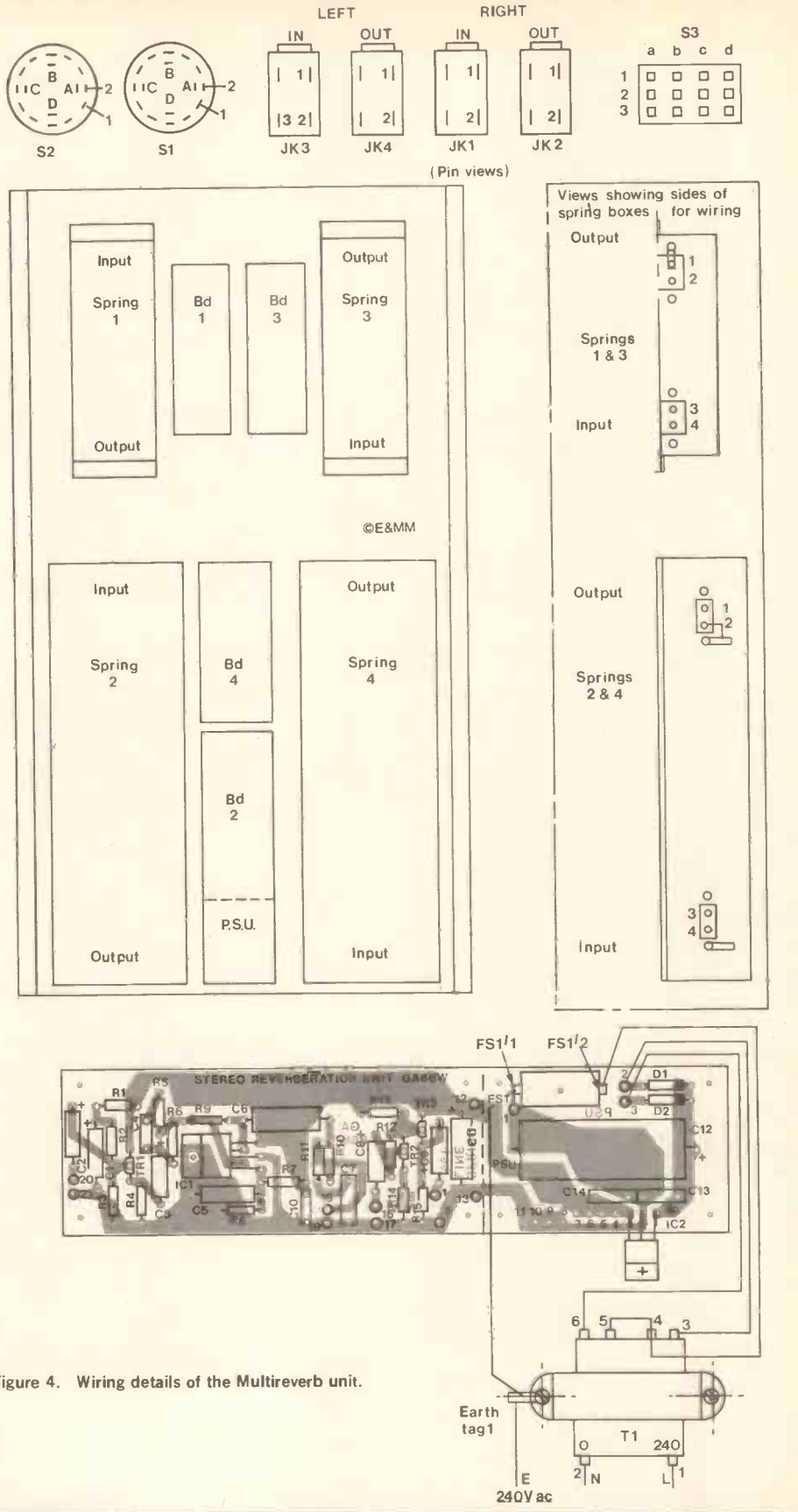
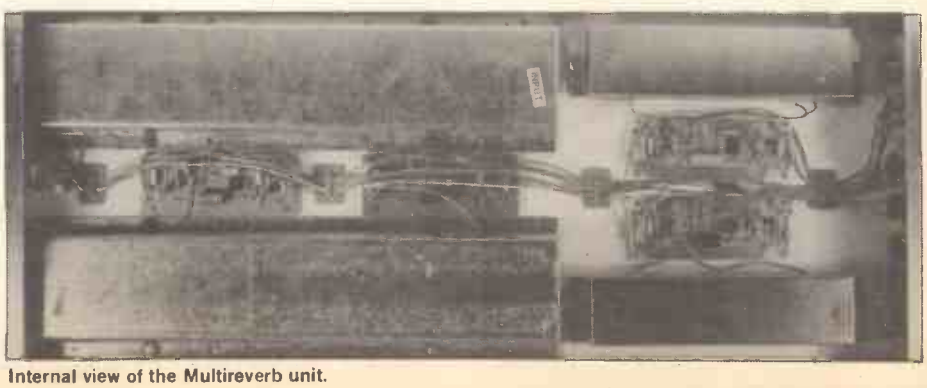


Figure 4. Wiring details of the Multireverb unit.



Internal view of the Multireverb unit.

From	To	Remarks
T1/1	L input	240V AC
T1/2	N input	240V AC
Earth tag 1	E input	
T1/3	Bd 4/2	
T1/4	FS1/2	Link T1/4 to T1/5
T1/6	Bd 4/3	
Earth tag 1	FS1/1	Link to Bd 4/1
Bd1/12	Bd4/4	
Bd1/13	Bd4/8	
Bd1/14	S2c/7	(conductor) link to S2b/B
Bd1/15	not used	(screen)
Bd1/16	Spring 1/2	(conductor)
Bd1/17	Spring 1/1	(screen)
Bd1/18	Spring 1/4	(conductor)
Bd1/19	Spring 1/3	(screen)
Bd1/20	S2a/1	(conductor) link to S2a/3
Bd1/21	not used	(screen)
Bd2/12	Bd4/5	
Bd2/13	Bd4/9	
Bd2/14	S2c/8	(conductor) link to S2c/9
Bd2/15	not used	(screen)
Bd2/16	Spring 2/1	(conductor)
Bd2/17	Spring 2/2	(screen)
Bd2/18	Spring 2/3	(conductor)
Bd2/19	Spring 2/4	(screen)
Bd2/20	S2a/2	(conductor) link to S2b/6
Bd2/21		(screen)
Bd3/12	Bd4/6	
Bd3/13	Bd4/10	
Bd3/14	S1c/7	(conductor) link to S1b/B
Bd3/15	not used	(screen)
Bd3/16	Spring 3/2	(conductor)
Bd3/17	Spring 3/1	(screen)
Bd3/18	Spring 3/4	(conductor)
Bd3/19	Spring 3/3	(screen)
Bd3/20	S1a/1	(conductor) link to S1a/3
Bd3/21	not used	(screen)
Bd4/14	S1c/8	(conductor) link to S1c/9
Bd4/15	not used	(screen)
Bd4/16	Spring 4/1	(conductor)
Bd4/17	Spring 4/2	(screen)
Bd4/18	Spring 4/3	(conductor)
Bd4/19	Spring 4/4	(screen)
Bd4/20	S1a/2	(conductor) link to S1b/6
Bd4/21		(screen)
S3a/1	JK1/2	
S3a/2	S1a/A	
S3a/3	S3d/3	
S3c/1	S3d/2	link to JK 4/2
S3c/2	S2c/C	
S3d/1		no connection
S3d/3	JK 2/2	link to S1c/C
JK 1/1	Bd4/11	link, JK1/1, JK2/1, JK3/1, JK4/1
JK1/2	S2a/A	link to JK3/3

Wire connection details for complete Multireverb.

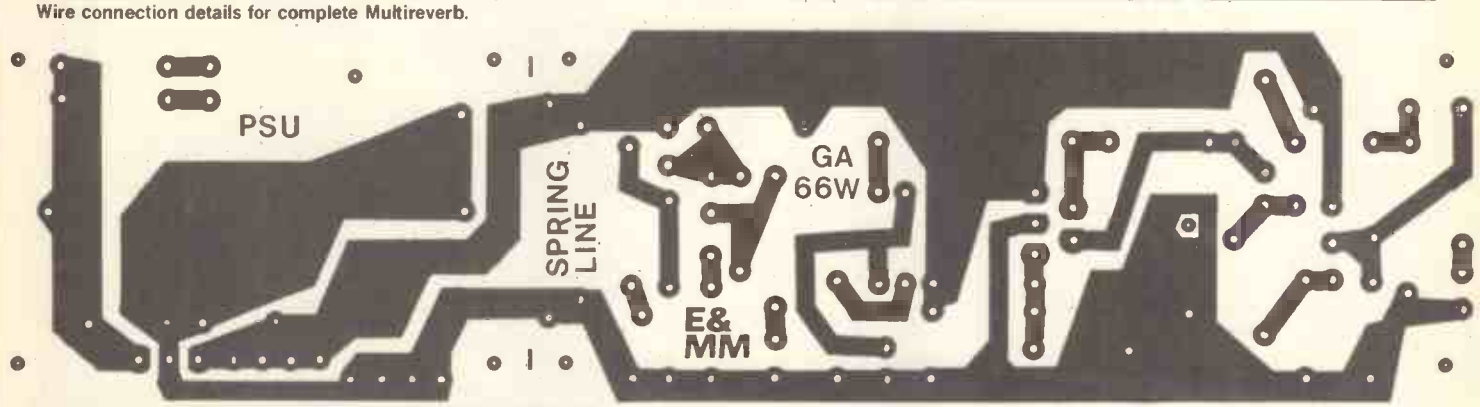


Figure 5. Single Multireverb module plus PSU PCB track layout.

PARTS LIST FOR ONE REVERBERATION MODULE

	Resistors — all ⅓W 5% unless specified		Maplin Code
R1	15k		(M15K)
R2,7,8	100k	3 off	(M100K)
R3	120k		(M120K)
R4,13,15	4k7	3 off	(M4K7)
R5	47k		(M47K)
R6	470k		(M470K)
R9	220k or 470k (see text)		(M220K) or (M470K)
R10	10R		(M10R)
R11	1R		(M1R0)
R12	2M2 (10%)		(M2M2)
R14	68R		(M68R)
	Capacitors		
C1,9	10uF 10V electrolytic	2 off	(FB22Y)
C2,5	2u2 63V electrolytic	2 off	(FB15R)
C3	1u0 63V electrolytic		(FB12N)
C4	1n0 carbonate		(WW22Y)
C6	470u 16V electrolytic		(FB72P)
C7	220n polyester		(BX78K)
C8	4u7 63V electrolytic		(FB18U)
C10	100n polyester		(BX76H)
C11	100u 25V electrolytic		(FB49D)
	Semiconductors		
IC1	TDA2006		(WQ66W)
TR1,2,3	BC650	3 off	(QB74R)
	Miscellaneous		
	Printed circuit board		(GA66W)
	Short or long springline		(XL08J) or (XB44F)

PSU PARTS LIST

D1,2	1N4002	2 off	(QL74R)
IC2	uA7815UC		(QL33L)
C12	2200uF 40V electrolytic		(FB91Y)
C13,14	100nF polyester	2 off	(BX76H)
T1	Mains transformer having twin 17V 1A secondaries		(WB07H)
FS1	1A 20mm antisurge fuse		(WR19V)
	20mm chassis fuseholder		(RX49D)
	Printed circuit board		(see text)
	Vaned heatsink		(FL58N)

The power supply is capable of supplying four springline modules, and so only one supply is needed for the Multireverb unit.

MISCELLANEOUS PARTS FOR MULTIREVERB UNIT

S1,2	3-way 4-pole rotary switch		(FF76H)
S3	4-pole changeover toggle		(FH08J)
SK1,2,3,4	Standard Jack Socket	4 off	(HF90X)
	Control knobs	2 off	(YX02C)
	Screened lead		(XR15R)
	Materials for case		
	Grommet		(FW59P)
	Twin power cable		(XR39N)
	Mains Lead		(XR02C)
	Mains Plug		(RW67X)
	6mm M3 bolt		(BF51F)
	M3 nut		(BF58N)
	Screened cable		(XR15R)
	Connecting Wire		(BL00A)
	Veropins		(FL23A)

Note that four springline modules (two short springline modules and two long springline modules) are required for the Multireverb Unit, and we are able to offer these at a special reduced price:
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2 short springlines
2 long springlines

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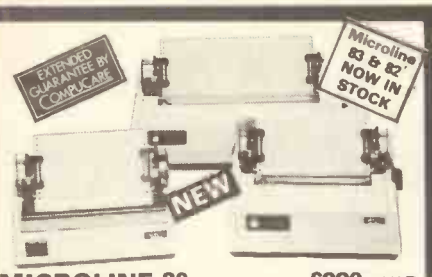

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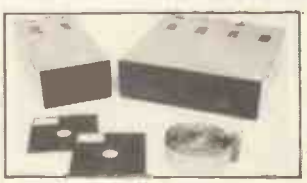

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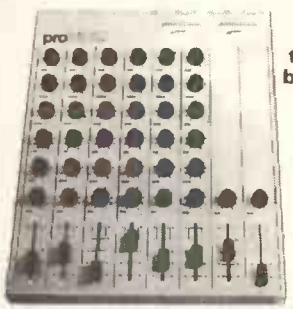

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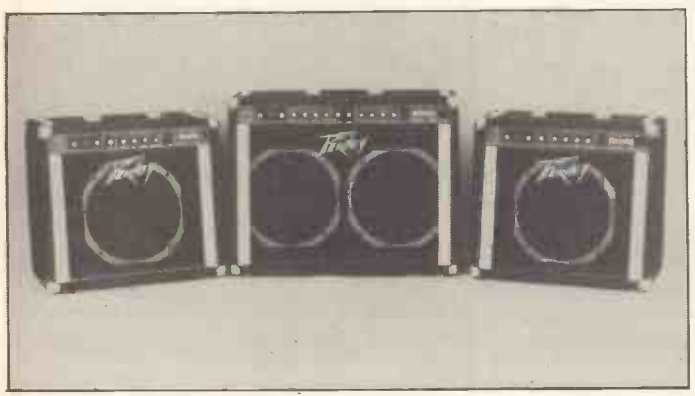
MUSIC MAKER EQUIPMENT SCENE

From MXR to AKG

It seems likely that AKG microphones will be easier to find in your local music shop, following Atlantex Music's announcement that they are to distribute these items to retailers in the U.K. Atlantex are probably best known for their distribution of MXR units and Whirlwind accessories. Prices of the AKG mics involved range from £10.35 for a dynamic moving coil type, to over £1,000 for a condenser. Well worth checking out is the new AKG D80, which sells at £29.33. If you want to know your nearest shop, or need more information, contact Atlantex Music, 1 Wallace Way, Hitchin, Herts. Tel: 0462 31511.



Renowned Peavey

A 160 watt 2 x 12 combo is the latest addition to Peavey's Solo Series — it's the Renown, and it should sell for around £325 (plus VAT). The Renown's two channels can be used separately, or they can be combined using the Automix footswitch, which comes with the combo. The Normal channel features pre- and post-gain plus active three-band EQ (incorporating a middle parametric shift), while the lead channel has traditional three-band EQ plus presence, and includes Peavey's 'Saturation' overload facility. Both channels have push-pull treble and mid-range boosts. The combo's reverb effect also has a footswitch, and you'll also find FX patching jacks, an impedance-matching output transformer, and an external speaker jack. The Renown joins the 120 watt Special and the 50 watt Bandit in the Solo Series. Peavey Electronics (UK) Ltd, Unit 8, New Road, Ridgewood, Uckfield, Sussex TN22 5SX. Tel: 0825 5566.

Phil's golden face

The tape manufacturer Ampex recently gave Phil Collins one of its 'Golden Reel' Awards for the album 'Face Value', which was recorded at London's Town House studio using Ampex 256 tape. Awards also went to Linda Gamble for the Town House, and to the engineers of the record, Hugh Padgham and Nick Launay. To mark the award, Ampex donated $1000 to UNICEF, the charity nominated by Collins. Ampex International, Acre Road, Reading, Berks.

Jazz this Easter

The Jazz Centre Society's ever-popular Easter Jazz Course will be held at Morley College in London this year, on the 13-16 April, from 10 a.m. to 5 p.m. daily. The four-day course covers all instruments, and the tutors are all well-known jazz players and excellent teachers — this factor has done much to ensure the success of previous courses, which have often been over-subscribed. 1982's tutors are: Geoff Castle (keyboards); John Etheridge (guitar); Peter Ind (bass); Bryan Spring (drums); Ian Carr (trumpet); Claf Vas (alto sax); Bobby Wellins (tenor sax); Eddie Harvey (trombone). The curriculum includes time for individual and group tuition, practical playing and technique, and there are classes in harmony, arranging and composition. The fee is £30 if you're under 21, otherwise it's £35. Contact the JCS immediately if you're interested — places go very quickly.

Easter Course, Jazz Centre Society, 35 Great Russell Street, London WC1. Tel: 01 580 8532.

PRS: Computers and campaigns

The chief of the Performing Right Society, Michael Freegard, recently outlined the society's aims for 1982. High on the list of priorities is the desire to obtain increased payments from broadcasting companies who use members' music — particularly Independent TV and Independent Local Radio. Freegard said that the PRS also want to persuade the British government to revise current U.K. copyright legislation, and to this end was seeking to create a greater public awareness of the society's role. Internally, a five-year plan was underway to transfer the huge filing systems of the PRS to one centralised computer.

Freegard placed the problems of PRS members in the context of world markets, saying, "We must invest resources in educating government and public opinion. We must urge the governments of the developing countries to enact copyright legislation to protect their own creators. And we must campaign to see that in such areas as Latin America, where there are good laws, a great deal more is done to enforce them".

The Performing Right Society Ltd, 29-33 Berners Street, London W1P 4AA. Tel: 01 580 5544.

Pink Sox and the TSB

The Regional Finals of the Trustee Savings Bank's Rock School Competition take place between 25th February and 17th March, for which 63 groups have been selected from over 250 original entries. The winning group at each Regional Final will be presented with a framed silver disc and will go on to the National Final, which will probably be held in early April. Winners of the National Final will receive a gold disc and a prize to the value of £2,000, with awards totalling a further £2,000 for the runner-up. Yamaha will be donating £1,000 of musical equipment to the winning school, while the Premier Drum Co will provide a drum kit for use at the various finals. The drums will be amplified thanks to C-Tape, who have provided C-Ducer tapemics for the finals. Here at E&MM, our favourite group names from the 63 Regional Finalists are Pink Sox (from the Ballymena Academy in Co Antrim), Ltd Pryde (from Bannerman High School, Beillieston in Glasgow), and Olly The Squid (from the Duke of York's Royal Military School in Dover). On the day, the entrants will be needing more than a good name, of course. Which should prepare the participants for life in the real world. . .

Paradise in Poland

It's just possible you could spout a long list of problems associated with being a musician in the U.K. in 1982. Well, spare a thought for your fellow music makers in Poland who, one can only assume, have seen an increase in their immediate problems just lately. The Rotosound string company in Bexleyheath were sent this photo that might show that all is not glum in Poland — but then again, it might not. It was sent to Rotosound by Zbigniew Zabowski, and shows his Paradise Band. Zbigniew is the one with the Rotosound T-shirt on. But they're all . . . OK, Zbigniew is the one playing the Flying V, a tasteless badge of capitalist oppression if ever we saw one.

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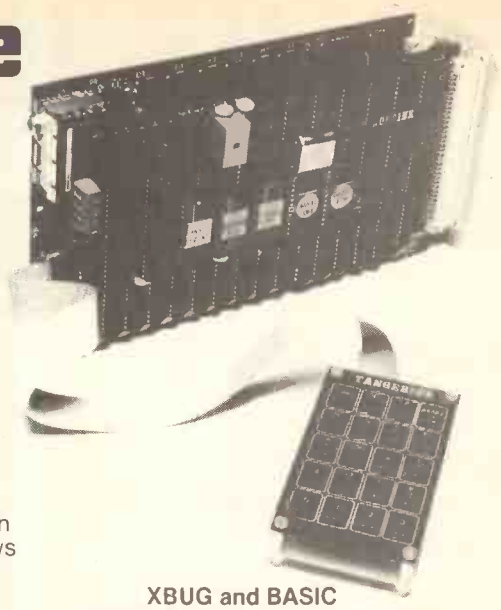

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For the first time buyer or experienced user, Microtan 65 is a superb route into personal computing. If you are looking for a sophisticated machine with the capability of expansion into a professional system, then this is the computer for you. Step by step with the computer system designed for tomorrow. . . .

6502 Microprocessor

Probably the most popular CPU (central processing unit) for personal computers, having a powerful instruction set and architecture.

2K Monitor TANBUG

The built-in 'mind' of the machine, TANBUG controls all system functions and gives comprehensive machine-code facilities. Functions include:- set and clear breakpoints, single step through program, execute program, copy block of memory, modify memory locations and much more.

Intelligent keyboard socket

For absolute beginners we can supply an easy to use 20-way Hex keypad; for the more experienced user there is a full typewriter style ASCII keyboard. Either way, Microtan will work out exactly which type you are using and act appropriately.

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For drawing simple lines and graphs,, or for animated games, Chunky Graphics is a low cost answer. This set of chips plug into the Microtan board and allow graphics to be built up on the screen at a resolution of 64 rows by 64 columns.

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Microtan is available ready-built or as a kit. We recommend that you should have some soldering experience before attempting the Microtan Kit, although if you do run into problems you can make use of our "Get you Going" service (telephone for details).

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XBUG and BASIC

XBUG is a 2K extension to TANBUG that contains a mnemonic assembler and disassembler and cassette firmware running at 300 Baud CUTS, standard or high speed. 2400 Baud Tangerine standard with 6 character filenames. Tangerine have taken out a full O.E.M. licence for Microsoft BASIC, the microcomputer industry standard, this is a full feature implementation with interrupt and machine code handling, and a superb program editor.

Both XBUG and BASIC plug directly into Tanex and are supplied with comprehensive user manuals.

Parallel I/O

When fully expanded Tanex includes two V.I.A.s (Versatile Interface Adaptors) which implement the cassette interface and the parallel I/O ports. Software in TANBUG V2.3 enables you to plug in and use a Centronics type printer.

Serial I/O

Also on the expanded board is a serial I/O port that can be used to interface RS232 or 20Ma loop terminals or VDU's, again all controlled by TANBUG V2.3.

To complete Tanex, a comprehensive user guide is supplied which contains full constructional details. This manual is also available separately.

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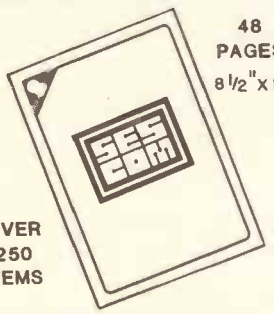

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Paul Williams, Stevenage, Herts, 0438 50471, K, B, E, -.

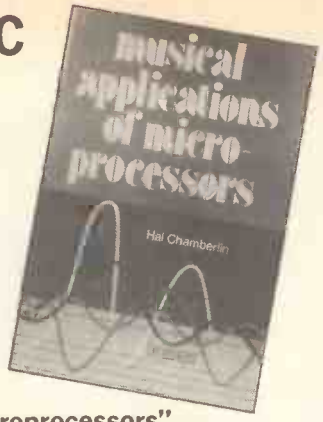
NAME
TOWN
COUNTY
TELEPHONE
INSTRUMENT
K=KEYBOARDS
O=ORGAN
G=GUITAR
E=ELECTRIC BASS
M=SOUND ENGINEER
D=DRUMS
V=VOCALS
S=STRINGS
W=WOOD
B=BRASS
C=COMPOSER
LEVEL
B=BEGINNER
M=AVERAGE
A=ADVANCED
TYPE OF MUSIC
C=CLASSICAL
J=JAZZ
P=PROGRESSIVE
R=ROCK
E=EXPERIMENTAL
B=BEAT
G=REGGAE
V=VARIOUS
ELECTRONICS
D=DESIGNER
C=CONSTRUCTOR
N=NEITHER

(Fictitious example) ▶

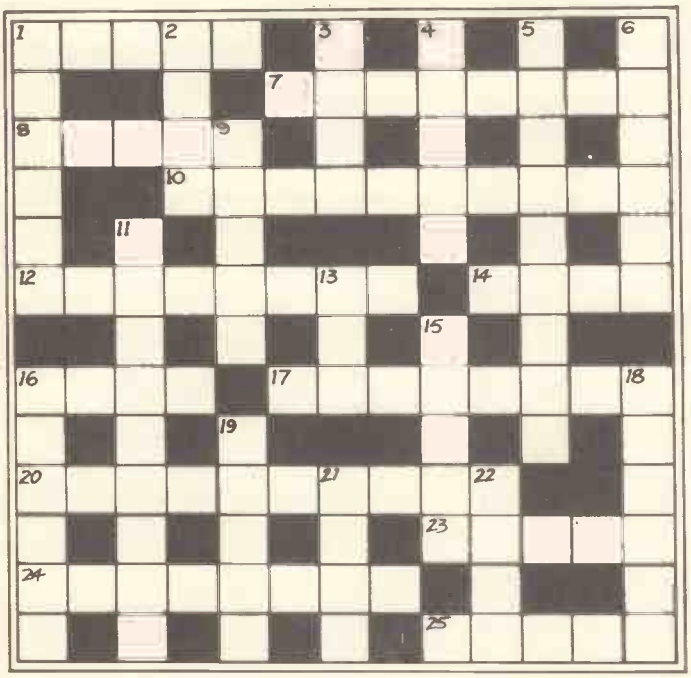
NAME	TOWN
BILL JONES	SOUTHEND
COUNTY	TELEPHONE
ESSEX	0524 61232 STD Code + no
INSTRUMENT	LEVEL
K	M
MUSIC	ELECTRONICS
E	C

Send your information in this format for your directory ad next month (closing date 20th February).
Cheques made payable to Maplin Publications. £1.00 for 3 insertions.

ELECTRO-MUSIC CROSSWORD COMPETITION No. 1



Here's a chance to win a copy of one of the most important books for the electro-musician — "Musical Applications of Microprocessors" by Hal Chamberlin. This valuable prize, worth £20, will be awarded for the first correct crossword drawn out of the hat at the end of March. Send your completed crossword, including your name and address to: E&MM CROSSWORD, 282 London Road, Westcliff-on-Sea, Essex SS0 7JG.



Across

1. Shafts of light or electrons (5)
7. A transient letter carrier? (8)
8. To increase, particularly in tone circuits (5)
10. On the level - the x-axis (10)
12. Basic constituents of all matter (8)
14. An illuminating gas (4)
16. Small pierced cylinder, often of ferrite (4)
17. The current method of measurement? (8)
20. A type of loudspeaker (6,4)
23. Doyle turns around for an Alpine song (5)
24. Let's talk to computers; but with what? (8)
25. A scaled indicator, found in analogue and digital forms (5)

Down

1. ..... memories, currently under development for high density on-chip (6)
2. A network (4)
3. Against (4)
4. One of the many sub-atomic particles (5)
5. A measurer of your potential (9)
6. No left turn - non stick (6)
9. Red Indian Pole's TTL output (5)
11. Active device found in echo units, phasers, flangers, etc. (9)
13. A young man who always has the time (3)
15. Surname of popular male vocalist who has worked for many years with Roxy Music (5)
16. Confound and bemuse with loudspeaker terminology (6)
18. A device which produces an output pulse, whenever a set number of input pulses have been received (6)
19. Eliminate insects and eliminate mistakes (5)
21. The logic state above the rest (4)
22. Musical memo? (4)

Compiled by J. Hoggarth. Answers will be published next month.

We acknowledge with thanks the cooperation of John Wiley & Sons Ltd, who distribute "Musical Applications of Microprocessors" in the U.K.

This book, reviewed in E&MM July 1981 issue, is available from: Maplin Electronic Supplies Ltd order ref. WG40T price £22.65 inc. p&p.

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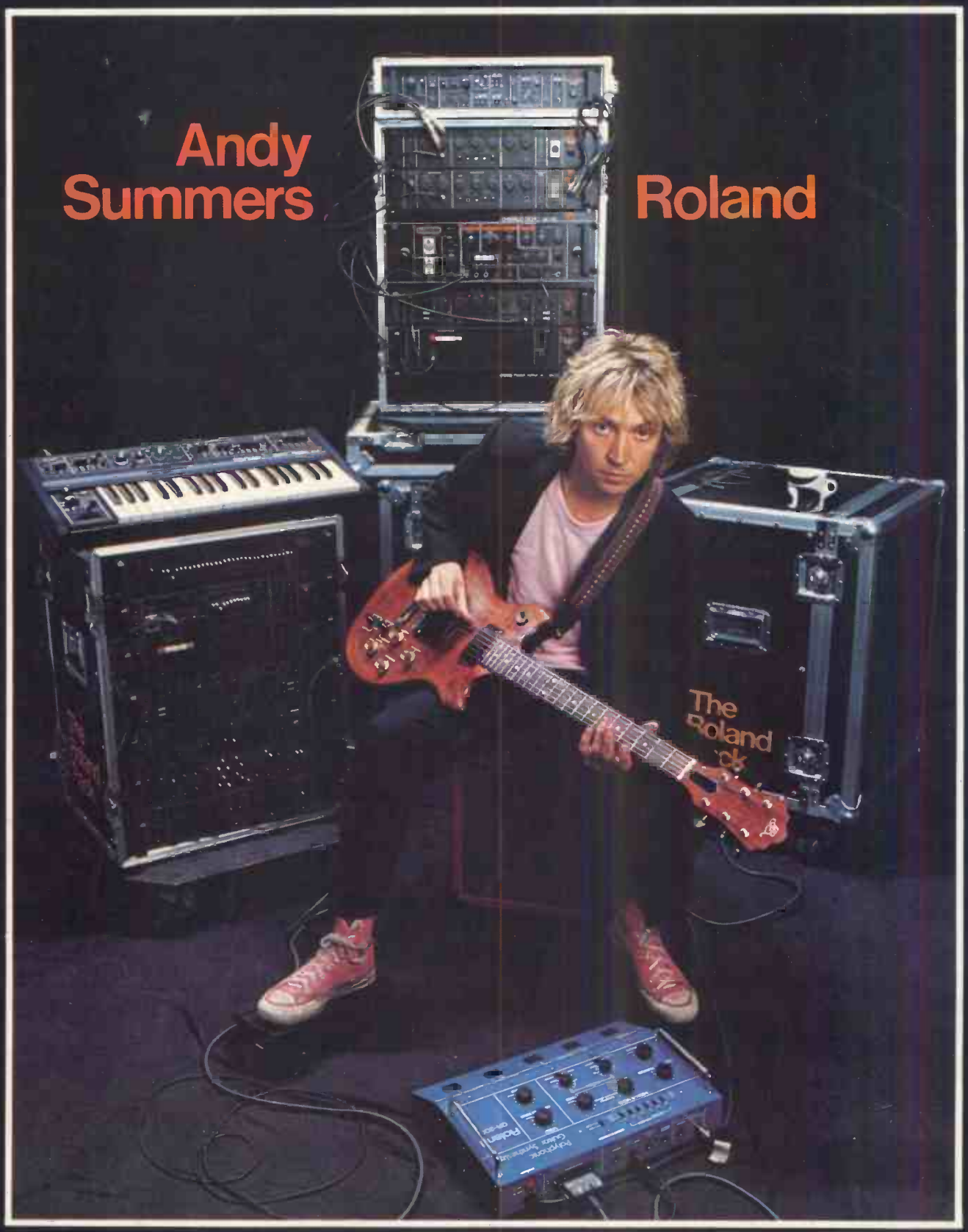

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