The Syndrom

Part 1 How it Works

Sampled drums have become so much the norm these days – a syndrom (e) of modern music, you might say – we felt it was about time we devoted an E&MM project to this area of musical technology. Because this technology is relatively new, a lot of it is priced well beyond the reach of the average modern musician, yet the Syndrom can be built for only the fraction of the cost of ready-built units. Design and presentation by Ken Pykett, Clive Buxton, **and** David Ellis.

Rather than presenting an entire digital drum machine project, where a dedicated processor is used to goad digitised sounds into action, we've elected to go for a more modular approach consisting of individual drum boards with pre-programmed sound EPROMs. And since each board will cost just £10 to put together, plus £5 or £6 for a pre-programmed 2716 or 2732 sound EPROM, there's very little financial outlay involved in starting the project.

In fact, the board is just about as basic as you can get, including as it does a clock, a set of counters, some triggering circuitry, the all-important EPROM, and a DAC and buffer to turn all the theory into acoustic reality. Definitely a no-frills or fancies approach!

We did think about adding a further counter to increase the address range to cover the use of a 2764 (8K) EPROM, but decided against this because of pin connection differences between this and 2716/32 EPROMs, and the fact that cymbal-type sounds really need considerably more than 8K to do them justice. We may well produce a further design specifically for longer sounds, however, in the not-too-distant future.

The point to bear in mind about the Syndrom is that it can be used in a host of different ways, and over the next few months we'll be looking at some of the following possibilities:

1 A means of adding on new percussion sounds to any drum machine.
2 A micro-interfaceable drum module.
3 A monophonic sampled voice for keyboard control.
4 A sound-effect foot pedal.
5 A dynamic live drum sound played from pads.
6 A means of finding out what your monitor ROM actually sounds like(!)

Some of these applications will require modifications (for CV control, for instance) and retro-fits (to enable dynamic pad playing) to the basic unit, and we'll be following these up as and when necessary.

A	B	C
0	0	1
1	0	1
0	1	1
1	1	0

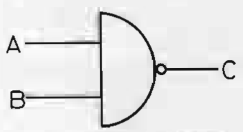


Figure 1. NAND-gate truth table.

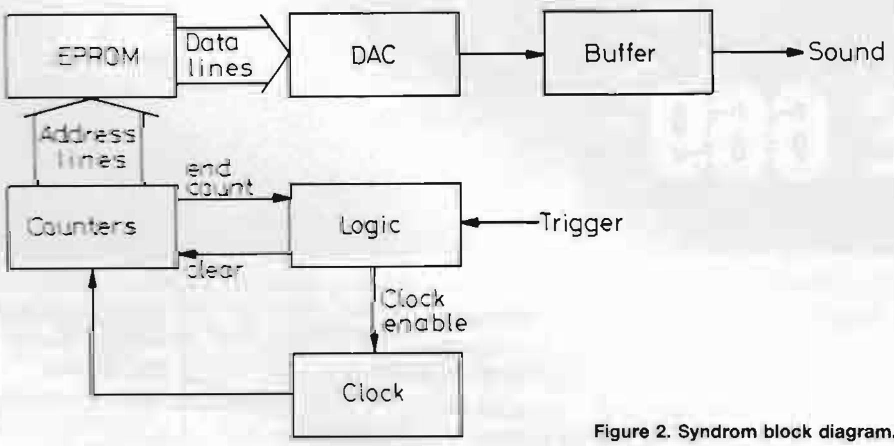


Figure 2. Syndrom block diagram.

Circuit Description

The first stage of the regurgitation process (block diagram shown in Figure 1) to consider is what happens when a trigger pulse is received by the board. At this point of the game, everything centres around the logic – four NAND gates, in fact – encapsulated in IC2. To understand what's going on, logic-wise, have a look at Figure 1. This 'truth table' lays out what happens to the output when certain things are going on input-wise.

To start the proceedings, the trigger pulse passes through the first NAND gate (IC2c), actually used like a Schmitt trigger inverter, and is then presented to the 'clear' inputs on the three 74LS163 4-bit counters (IC3,4,5) in order to clear the board as far as counting is concerned. At the same time, the output from IC2c causes the 555 clock (IC1) to charge its timing capacitor (C1).

Then, providing the trigger pulse is greater than the charge period (approximately 150us), the clear condition will be implemented by the rising clock pulse. If it isn't long enough, the pulse will be regarded as noise and won't start the count. Once the counters are cleared, the appropriate Q output or terminal count (depending on which type of EPROM is being used) from the last counter will fall, and the clock enable input on the 555 will be held whilst the clock is putting the counters through their cycling routine. If the trigger input remains high, the counters will cycle continuously, thereby giving a roll effect to the sampled sound.

Alternatively, the method of triggering can be altered so that the count is initiated on the falling edge of a square wave by short-circuiting C2. The basic circuit therefore allows triggering from both positive- and negative-going trigger sources, and is also suitable for direct TTL-triggering from a micro. At the same time, if the trigger pulse is repeated before the entire sample has been used, the trigger signal is differentiated by C2, R5, and D1, with the result that the counters are cleared and the sampling output re-started, which is necessary if you're after the effect of a drum undergoing rapid paradiddles.

Sounds are supplied pre-digitised in 2716 (2K) or 2732 (4K) EPROMs. In the case of the former, only 11 address lines (A0-A10) are involved and Q3 of the third counter (IC5) goes to reset the triggering circuitry. If a 2732 EPROM is used, the Q3 line of IC5 goes to A11 (pin 21), and the terminal count output of IC5 goes to IC2a. To simplify these alternative matters, it's easiest if you add a switch (SW1) as shown in the circuit diagram, but, if only one sort of EPROM is likely to be used, the switch can be replaced with links. Note, however, that using a switch also allows the contents of a 2732 to be played only as far as the first 4K, ie. halving the sample duration, a facility that may be useful in certain situations – especially when playing samples at a lower than normal pitch.

The EPROM is clocked by using binary synchronous counters configured to count up to a desired maximum according to whatever EPROMs are currently in vogue. The original circuit used a ZN425E DAC as the digital-to-analogue converter because of its blissfully untroublesome power requirements (single-rail, 4.5 to 5.5volts). However, even though the final choice of the DAC0800 makes life complicated by requiring bi-polar supplies (though this is easily achieved for a single board with a couple of PP3s), the output swing is rated at up to 20volts peak-to-peak, which makes for an extremely dynamic sound, and, what's more, the chip is less than half the price of the ZN425. R2 is provided to allow the user to vary the clock rate (and therefore the sample length/pitch of the digitised sound) over a range of widely variable usefulness.

One circuit fact that needs a word of explanation is the present lack of any low-pass output filter. To be honest, trial and error has given us the impression that with short, sharp sounds like those from the percussive stable, the ear's so stunned by their dynamism that it couldn't give a hoot about what else is going on around the D/A converted signal in the way of clocks, grunge, and the like! On second thoughts, that sounds terribly unscientific, so we'd better say that filters will be added on later (together with dynamic control circuitry) as a retro-fit. . . .

Next month, we'll have the details of the EPROMs available for the Syndrom and how you can go about getting them. Also, a PCB should be available by then to make constructional life a little easier.

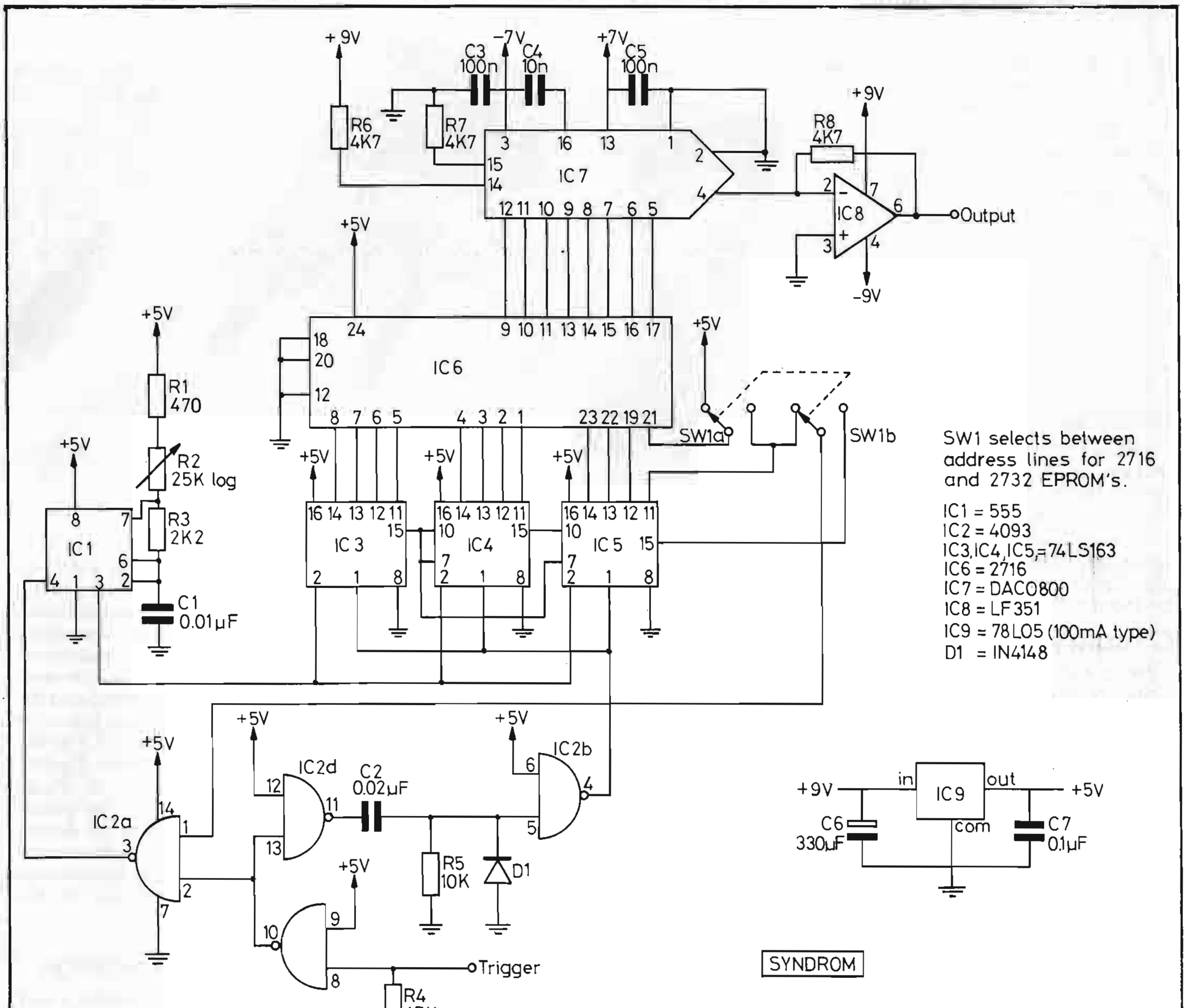


Figure 3. Syndrom circuit diagram.

THE SYNDROM

David Ellis **continues our percussion-sampling project. This month, full constructional details, pricing and availability, and details of a cassette that demonstrates the Syndrom's sonic capabilities.**

Part 2

Getting it together

The first thing to do this month is to correct a few errors that crept into Part 1. First, in the paragraph at the bottom of page 91 that relates to using the switch to play just half of the contents of a 2732, the line should go: 'only as far as the first 2K. . . .' Silly us. Next, on the circuit diagram front, the only real blunder is the value of the +/− supply going to IC7, but this is probably self-evident, ie. for '−7V' and '+7V', it should read '−9V' and '+9V'. Not our fault, m'lord. Honest.

The other point of errata is that a couple of blobs got lost in the circuit diagram wash, and these should be at the junction of C3, C4, −9V, and pin 3 of IC7, at the junction of C5, +7V, and pin 13, and at the junction of the common connection of IC9 with ground. Obvious, but worth pointing out all the same. On the subject of components, life is easier pitching-wise if a linear rather than log 25K pot (R2) is used. The ideal is the anti-log variety, but that's about as common as life on Mars. The same's almost as true for the 330uF (C6) electrolytic capacitor used for smoothing the 5V output from C9, but a 470uF (either tantalum or normal type) won't mind being substituted instead. Lastly, we've replaced the original 100m 78L05 regulator (IC9) with a 1A 7805, for the simple reason that it's better to be safe than sorry.

Construction

The PCB is quite straightforward to put together, but it helps to have a narrow-tipped soldering iron wherever closely-packed tracks are concerned. The best plan of action is to start by inserting the resistors, then the capacitors, and next, D1 (the positive end is indicated by the black circle at the end of the body), the sockets for IC1-8, and IC9. SW1 can be fitted quite happily on the board, as shown in the photo, ready to do the master of ceremonies bit and switch between the acts of the two sorts of EPROMs. If you've plans to use Syndroms *en masse* in something like a rack-mount unit, then both the trigger and output jack sockets should be mounted on the baord together with R2, so that all three can merrily poke out of a front panel and secure the PCB at the same time.

Having connected up a couple of 9V batteries *via* some appropriate connectors, and made sure that the 'out' side of IC9 is indeed delivering +5V, it's now time to disconnect the batteries and insert the ICs. Because the TTL and ROM are fairly profligate consumers of electrons, the battery on the positive side of the business has a habit of doing a disappearing trick that'd put Mr Marvel to shame. For the record, the +9V rail takes about 125ma, and the −9V around 15ma. So, for starters, see how you get on with a big butch PP9 on the positive side and a PP3 on the negative. And remember to disconnect them when not using the thing! However, if you're going to use the Syndrom seriously and/or intensively, a power supply is an absolute must, and we'll be putting forward some sensible recommendations (including a design of our own, the RackPack) in next month's E&MM.

To actually make the Syndrom speak to you, you'll need some sort of trigger to set the sound regurgitation into motion. We'll be covering the possibility of making drum pad transducers next month, but for initial experiments, there are two ways of going about making Herr Schmitt do his thing.

(1) Using the +5V trigger from any pre-existing drum machine or sequencer – the simple option.

(2) Wiring in any push-to-make switch between the trigger input and the +5V power rail – the more complicated option.

In the latter case, don't be surprised if anything other than a quick jab at the button produces a sound more reminiscent of a roll than a single sound. Remember that as long as the trigger input remains high (the situation when your finger's on the button), the counters will cycle till kingdom come, and you're therefore repeatedly yanking the sound out of the EPROM – hence the roll effect.

The Sounds

Now, sampling a sound is easier said than done. To be perfectly frank, there's a pretty complex equation at work that's doing its best to make a pig's ear of a mess if you don't use the right sound source with the right sampling rate. The thing you have to keep utmost in mind is that there's no earthly point in sampling a sound with masses of high harmonics into just 2 or 4K of sample space. The technique we developed in putting together the initial set of samples was to perform a constant juggling act between sampling rate, input level, and input low-pass filtering until we felt that the situation had been optimised. The 21 sounds break down into 2716 (2K) and 2732 (4K) types as follows:

2716: Kick drum, Snare, Hi-hat (closed), High tom, Low tom, High Bongo, Low bongo, Cabasa, Guiro, Handclap (multiple), Explosive finger click, Dog bark, David's aaah, Door slam, David's burp.

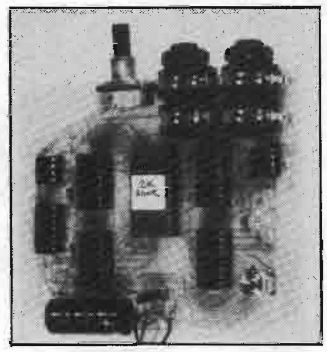
2732: Hi-hat (open), Crash cymbal, Orchestral thump, Brassy, Squawk 1, Squawk 2.

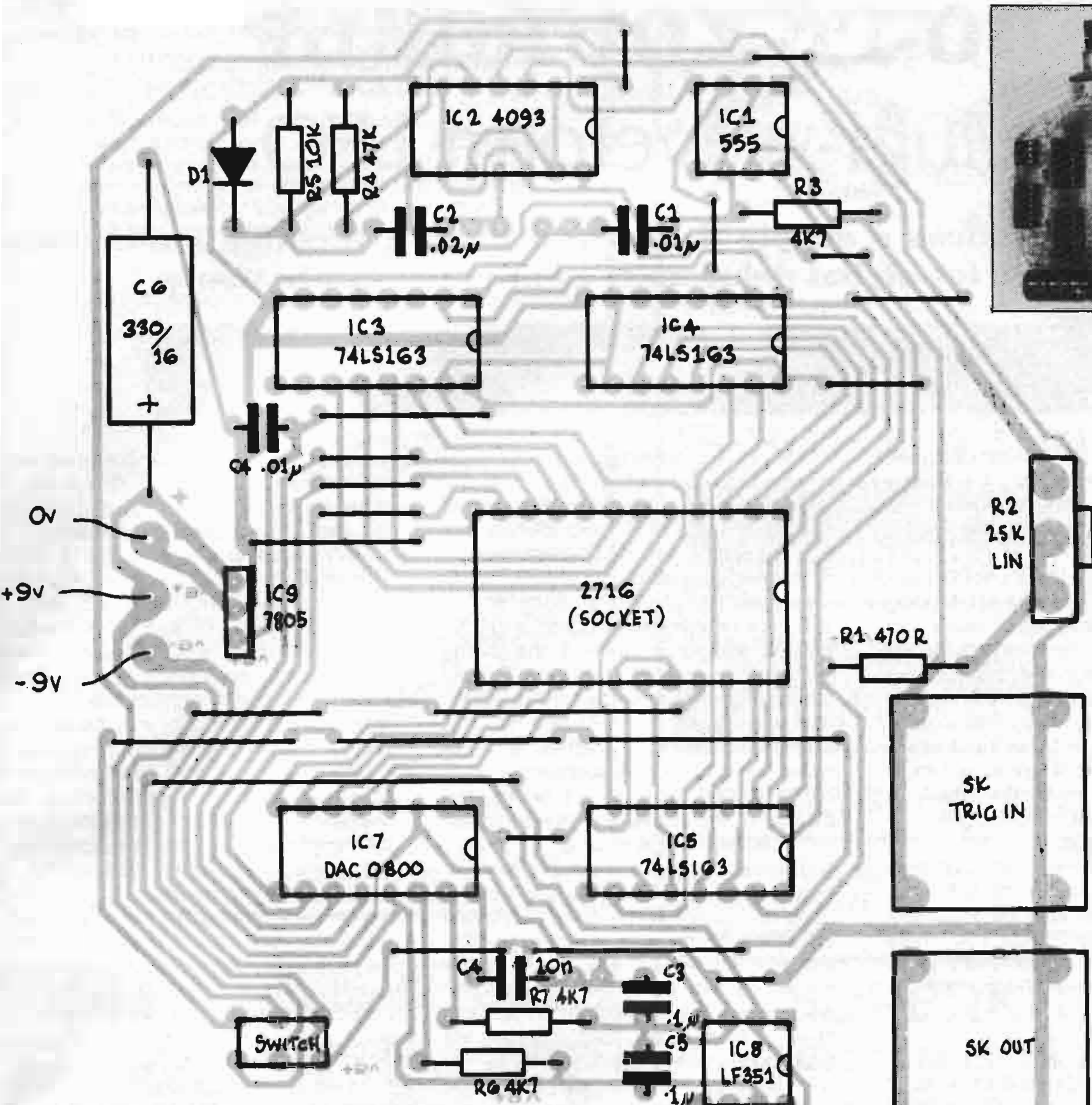
Now, a few of these sounds proved problematic because of the difficulty in obtaining a really clean sound source. We considered C-ducing the dog, but thought better of that in view of the RSPCA's stance on the abuse of animals. That left boring old microphone techniques, but old Fido proved implacable when it came to performing on cue: so what we're left with is a rather noisy bark taken from one of Auntie's sound effects discs. It's hardly like howling at the moon, but we're getting there, and it'll be updated as and when we get our hands on a Great Dane that doesn't suffer from stage-fright. In the meantime, take a listen to the 'Explosive finger click' and 'David's burp' for a more objective view of what a sample of life and the Syndrom can do together.

The Demo Cassette

Of course, the inevitable problem with buying a sound EPROM is that until you try them out you've no idea of what they sound like. You might hit lucky and get a sampled bass drum that has a kick like a mule, but, on the other hand, you might get something that's more reminiscent of a thwack around the ear with Lady Bracknell's handbag. So, to add a bit of sonic assistance we've produced a 15-minute demo cassette that includes examples of all 21 sound EPROMs, played both individually over a four-octave range and together in rhythmic patterns. Note however that the latter effect was achieved by simply switching a solitary DAC input from one sound to another in quick succession. In reality, you'd use multiple Syndrom boards to get overlaid percussion tracks, but that's a story for the future. . . By the way, there's a free EPROM of your choice for anyone who can guess the source of 'Orchestral thump'!

The sounds on the cassette are arranged in three groups, with sounds appearing in the order shown, and these





Syndrom PCB component overlay.

are followed by rhythmic patterns using combinations of the sounds in those groups.

Group 1: Kick drum, Door slam, Explosive finger click, David's burp, Handclap, Dog bark.

Group 2: High tom, Low tom, High Bongo, Low bongo, David's aaah, Snare, Hi-hat (closed), Cabasa, Guiro.

Group 3: Hi-hat (open), Crash cymbal, Orchestral thump, Brassy, Squawk 1, Squawk 2.

The Syndrom demo cassette is available for £1.00 (inclusive of VAT and postage) from E&MM's editorial address, payable to Glidecastle Publishing Ltd. Once you've decided on the sound that you'd like to try out on your Syndrom board, the appropriate EPROM can be ordered (£6.75 for a 3K 2716 or £7.75 for a 4K 2732) from Silicon Sound, 20 Bolton Street, Swanwick, Derbyshire, DE55 1BU, and cheques should be made payable to the same. If at any time you want to change the sound in an EPROM, we're also offering a 'burn it again, Sam' option, whereby an EPROM returned with £2.50 will be burned in with a new sound of your choice.

E&MM

Syndrom Parts List

Resistors (all ¼W, 5%)

R1	470R
R2	25K linear pot (or anti-log)
R3	2K2
R4	47K
R5	10K
R6, 7, 8	4K7

Capacitors (all disk ceramic except for C6)

C1, 4	0.01uF (10n)
C2	0.02uF (20n)
C3, 5, 7	0.1uF (100n)
C6	330uF (or 470uF) 25V

Semiconductors

D1	IN4148
IC1	555
IC2	4093
IC3, 4, 5	74LS163
IC6	2716 or 2732 (supplied separately)
IC7	DAC0800 (or DAC0801)
IC8	LF351 (or TL071)
IC9	7805

Miscellaneous

PCB
IC sockets: 2×8-pin, 1×14-pin, 4×16-pin, and 1×24-pin
2-pole, 2-way sub-miniature toggle switch
2 PCB mounting jack sockets
PP3 and PP9 battery connectors

All parts are available from Maplin or Technomatics, except for the sound EPROM (IC6), which is burned to order and available from the address given in the text.

PCBs are available from E&MM at the editorial address, price £4.95, payable to Glidecastle Publishing Ltd. A kit of parts is also available from E&MM for £24.95, exclusive of the sound EPROM, but inclusive of the PCB, all electronic components, and the miscellaneous items. Alternatively, you can buy your Syndrom ready-built for £29.95.

The Syndrom

Part 3 Fun and Frolics

With over 100 PCBs already sold, the Syndrom is proving to be one of our most popular constructional projects ever. This month, David Ellis **introduces some brief design modifications and a double triggering circuit.**

This month, we kick off with a few (very minor) component changes to improve a) the triggerability of the Syndrom at slower than usual clock rates, and b) the range of the clock rate pot. These modifications go as follows:
C1 – change from .01μF to .0047μF.
C2 – change from .02μF to .033μF.
R3 – change from 2K2 to 1K.

Note also that a couple of the components shown in the PCB overlay in Part 2 weren't quite where nature (ie. the author) intended them. C4 managed to be in two places at once, pushing C7 out of the picture. In fact, what's shown as C4 next to pin 9 of IC3 should actually be C7, and its value should be 0.1μF rather than 0.01μF. Next, there's R3 (next to IC1) under the mistaken impression that it's resistive value is 4K7. This gets changed as per the above.

On the triggering side, we've discovered that the Syndrom triggers very happily direct from a piezo transducer. These *objets de ceramique* normally get made to beep for the purpose of gratifying Spectrum owners, but used the other way, ie. striking them as if you were hitting a micro running a seemingly undebuggable program, they generate a voltage that can be used for a variety of (perhaps somewhat dubious) pleasures. Maplin Electronics are a convenient source for the piezo transducer (cat. no. QY13P, price 30p), and they also sell a rubber disc which sticks onto the transducer (cat. no. QY16S, 5p), which helps when it comes to attaching the transducer to something that's going to be hit.

You'll need to use a bit of care when soldering a screened lead to the transducer – screen to the brass edge, live to the centre – but you'll find that plugging the other end into the Syndrom *via* a jack plug gives you an effective physical means of triggering the board. After you've bashed around with it for a bit and driven cat and wife out of house and home, it's time to experiment with attaching it to the underside of a practice pad. Remember that you can also use it to augment the sound of a normal drum kit by means of some Gaffa tape and judicious positioning – we found the combination of a bass drum and David's burp to be particularly effective. (What's all this 'we' nonsense? – **Music Ed.**)

One further point on the triggering side: re-triggering whilst the trigger pulse stays high can occur if your particular drum machine or sequencer is too generous with its pulse lengths. Fiddling around with the values of C1 and C2 will help, but an alternative is simply to disable the re-triggering feature of the Syndrom by short-circuiting C2.

Pitch Variations

One good thing about the Syndrom is that it gives you a very wide range of pitches. Admittedly, as you turn the pot way down low, you'll hear the inevitable aliasings creeping into the background, but provided you use a bit of imagination and commonsense, a single sound can be used in all manner of worthy ways.

The trouble, of course, is that triggering only yanks out the sound at the current setting of R2. So if you were after high, medium, and low toms (say), you'd be obliged to use three boards with individual sound EPROMs on each. That's a bit on the tough side, money-wise, though you should remember that having the three boards in parallel does mean that all three toms can be played together. The alternative to multiplying the hardware bill is to pursue the time-sharing principle by adding some circuitry that permits multiple pitch triggering from a single EPROM. In fact, this is the solidly economic basis behind most of the digital drum machines on the market.

The circuit in Figure 1 provides the means of adding a double trigger to the basic board. Again, it's all down to using gates to let the right pulses through into the digital farmyard. The gating may look on the complicated side, but in fact there are just two flip-flops (IC10a/b and IC10c/d), a couple of NOR gates (IC11b/c) to lock out the opposite flip-flop, and a further gate (IC11d) to deliver the necessary 'clear' state to the three counters on the Syndrom board. Finally, the clock pulses are combined at IC11a, and the appropriate Q output of the counters is differentiated to reset the flip-flops. This time, the trigger inputs are differentiated before being applied to their respective sections of IC11, so that repeated cycling of the sound is avoided.

The only major hassle in implementing this circuit is that there's no PCB available, which means that it's very much a question of getting out the old veroboard. The new circuit then has to be latched into that of the Syndrom.

First, the original 555 (IC1) should be removed and the clock output (from IC11a) from the double trigger circuit taken to pin 3 of the empty IC1 socket. Next, the 'clear' output of the double trigger goes to the original trigger input of the Syndrom, and a connection should then be made between pin 1 of IC2a and the 'reset' input of the new circuit. Finally, don't forget that the double trigger will also need its share of the Syndrom's +5V supply and ground.

New Sounds for Old

Various sounds have been added to the Syndrom library, and the new goodies to delight (or assault, depending on your percussive tendencies) your lugholes include:

Snare (4K) – lots of snare, plenty of bounce.
Bass Guitar (4K) – the slapped bass to end all thumb twangers.
Hi-hat (open) (4K) – a good metallic sound.
Hi-hat (closed) (4K) – good in conjunction with its open counterpart.
Low tom (4K) – nothing wimpy about this.
Rimshot (4K) – for those after a slice of military action.
Tambourine (2K) – eat your heart out, Sally Army.
Cowbell (2K) – snow-capped mountains, Gruyere cheese. . .

So, adding these to the original 21 gives the following list:

2716: Kick drum, Snare, Hi-hat (closed), High tom, Low tom, High bongo, Low bongo, Cabasa, Guiro, Tambourine, Cowbell, Handclap, Explosive finger click, Dog bark, David's aaah, Door slam, David's burp.

2732: Hi-hat (closed), Hi-hat (open), Crash cymbal, Snare, Rimshot, Low tom, Bass guitar, Orchestral thump, Brassy, Squawk 1, Squawk 2.

As before, these sound EPROMs are available from Silicon Sound, 20 Bolton Street, Swanwick, Derbyshire DE55 1BU, and the prices remain at £6.75 for a 2K 2716 and £7.75 for a 4K 2732. Because of reader demand, Silicon Sound are now also offering a custom programming service, whereby EPROMs can be programmed with Syndrom users' own sounds. This costs an extra £5 on top of the price of the 2716 or 2732 EPROM. If you're interested in pursuing this, here are a few guidelines:

1 Record the sounds on a high quality cassette so that the tape is well-saturated. A modicum of compression may not come amiss.

2 Record the sounds several times in succession and make sure the sounds are really clean.

3 Keep the sounds as short as possible. We can sample longer sounds at a slower sampling rate, but do remember that there'll be a fairly drastic trade-off in quality in this instance. For the record, we usually sample at around 20kHz, which gives a fairly good compromise between quality and sample length.

Help!

Getting hold of four of the components used by the Syndrom is proving a major headache for some readers. The objects of this frustration are the 74LS163s and the DAC0800. Like most TTL chips, the 74LS163 has zoomed up in price over the past few months, and most places are quoting £1.20 or more. So, if you read in the Maplin catalogue that they're just 49p, take that with a pinch of salt! In fact, Maplin's current prices for the 74LS163 and DAC0801 are £1.22 and £4.45 respectively.

However, E&MM is now able to offer – for a limited period, we suspect – a package of the four chips (three 74LS163s and one 0800) at a special price of £5.50 including VAT and p&p. Send your orders in to the editorial address (cheques/POs payable to Music Maker Publications Ltd) and allow the usual 28 days for delivery. But be quick!

One extra component that's worth investing in if you've plans to change EPROMs regularly is a Zero Insertion Force socket for IC6. The problem (as you'll soon discover) is that 24-pin ICs don't take kindly to being levered out of tight sockets with a great deal of monotonous regularity, and the easiest way around bent and broken legs (the IC's, not yours) is to invest £4.42 in something like Maplin's 24-pin ZIF socket (order no. YX50E). The best way of using this is just to plug it into the 24-pin DIL socket that's already on the board. That way, the ZIF socket will be raised above the various jumpers and so on that wend their way across the PCB. On the other hand, if you're contemplating turning the Syndrom into a rack-mounted unit with multiple boards and a decent power supply, it's worth thinking about mounting the ZIF socket on the front panel, taking a ribbon cable from this to a 24-pin DIL header that plugs into the EPROM socket. The beauty of this approach is that changing a sound on a particular channel becomes a one-second operation.

A considerable number of readers have contacted us about using the Syndrom EPROMs in other digital drum machines. And since the Linn and MXR replacement drum chips cost in excess of £30 each, that's hardly surprising. The problem is that their manufacturers code the sounds into the ROMs in some wonderfully devious way, which means that they're both mutually incompatible and Syndrom-incompatible. Shame. Still, we're looking into this, and we may have an answer for Linn and MXR users in the near future.

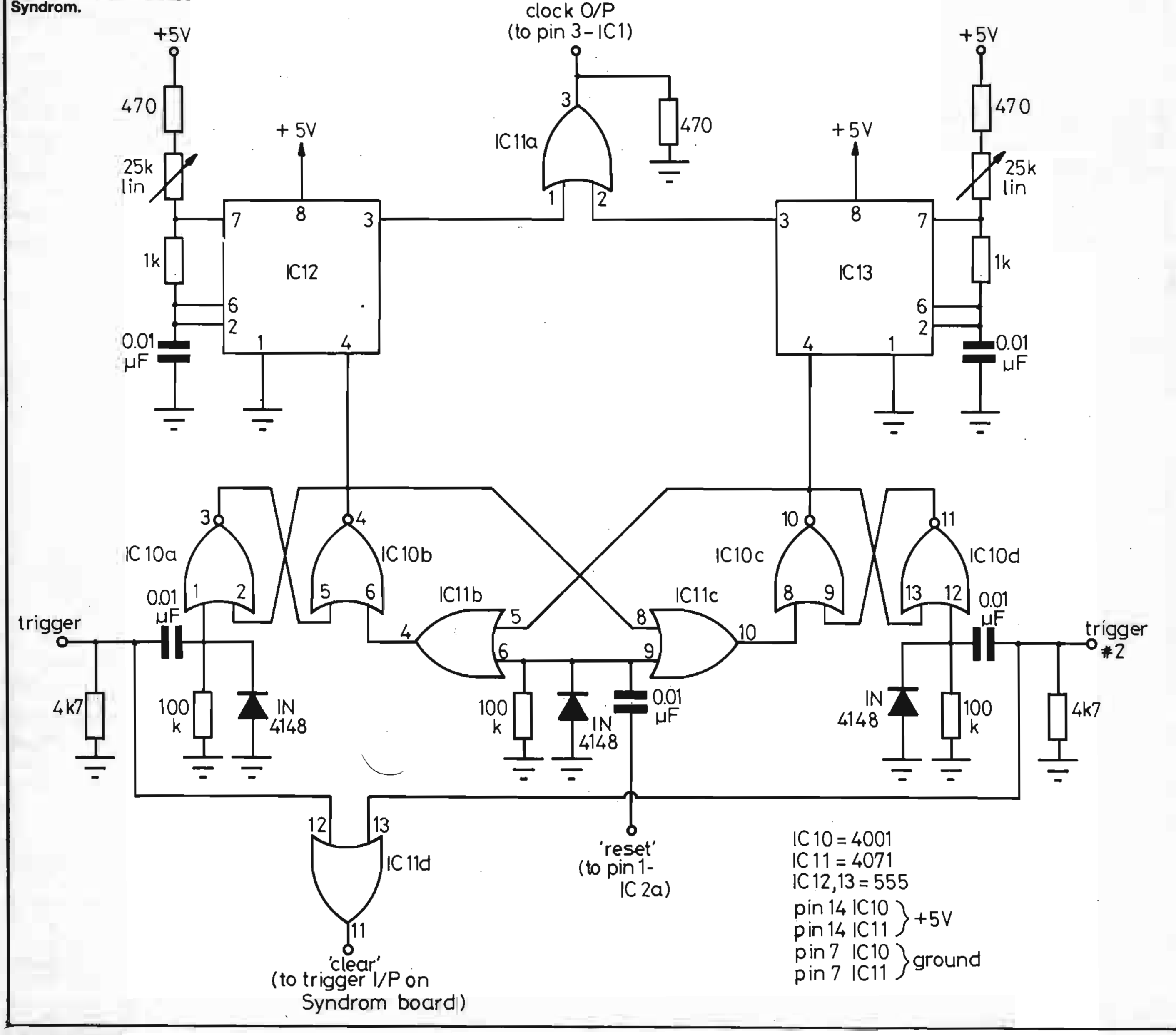
David Ellis **E&MM**

Syndrom Demo Cassette

A demo cassette containing examples of sounds being generated by the Syndrom is still available from E&MM at the new price of £1.50 including VAT and p&p. Orders should be sent to the editorial address (cheques/POs payable to Music Maker Publications Ltd) and you should allow 28 days for delivery.

The Syndrom itself is, of course, still available in kit form or as a ready-built item, prices being £24.95 and £29.95 respectively. PCBs are also available from E&MM, price £4.95.

Figure 1. Double-trigger circuit add-on for Syndrom.



The Syndrom

Part 4: Walking the Dog. . .

Circuits that enable E&MM's digital percussion unit to be triggered from any audio source and pitch-controlled from a synthesiser keyboard.

David Ellis, Clive Buxton, and Ken Pykett

Technical Editor Paul White has put together the above unit using six Syndrom modules, powered by the E&MM RackPack (July 84).

So, Part 4 of the Syndrom saga . . . isn't it amazing how time flies when you're having fun? No? Oh well, we promise that this will be the *last* instalment of the present incarnation of Syndrom.

In fact, this month sees the most important additions to the basic Syndrom circuit:

1 Audio triggering, including Simmons drum pads or microphones.
2 CV/trigger control from any one volt-per-octave synth.

Trigger Interface

As you'll no doubt be aware, the basic Syndrom will trigger from only a limited range of sources, ie. a +5V pulse or a piezo transducer. This trigger interface circuit, on the other hand, allows the Syndrom to be triggered from any audio source, including Simmons and other drum pads, microphones, or what have you. In fact, the dynamic range over which it'll trigger is 30dB or greater, and the sound can be of any length without re-triggering occurring.

The trigger interface circuit is shown in Figure 1. The input signal is DC-blocked by C1 and the level adjusted by VR1, before it's fed to the non-inverting input of the 1458 dual op-amp (IC1a). The gain setting switch enables gains of 50 or 500 to be selected. The output from IC1a is rectified by D1 and D2 and the peak amplitude is followed by C2, the time constant being set by the 470K resistor.

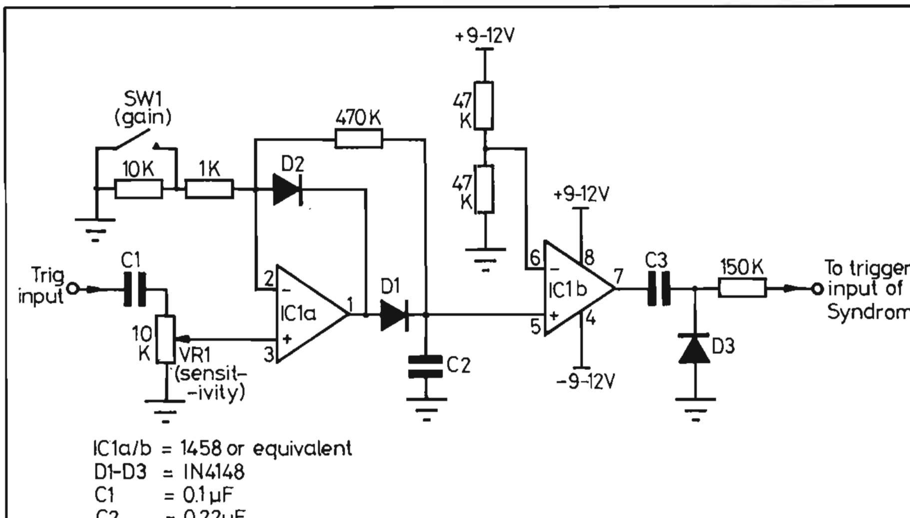


Figure 1. Audio Trigger interface.

The level on C2 is compared at IC1b with the voltage on the inverting input, which is set at a half the value of the positive rail (9 or 12V, depending on whether you're using batteries or a PSU like E&MM's RackPack). If the value exceeds this voltage, the output of IC1b will jump from the negative rail to the positive limit of the chip: this is then differentiated by C3/D3 to produce a positive spike, which is divided by the subsequent 150K resistor and the input resistor of the Syndrom to an amplitude of +5V if the rails are +/−12V, or slightly less in the case of +/−9V. This is where the Syndrom takes over, and the first gate, a Schmitt NAND, turns the spike into a TTL pulse to operate the Syndrom.

Using the circuit is straightforward. First, the gain should be set by SW1. Drum pads, microphones, and so on will

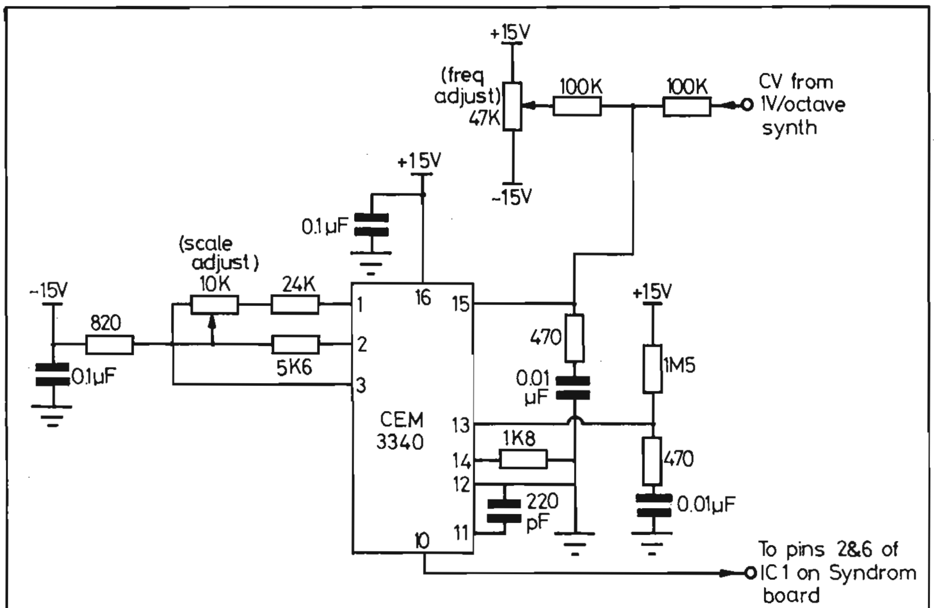


Figure 2. CV/trigger interface.

require the high gain setting (SW1 closed), while high level inputs such as line levels or another Syndrom will require SW1 to be open. Then, connect the sound source to the input and operate it repeatedly, adjusting VR1 until the Syndrom attached to the output triggers. When the circuit was first tested, a second Syndrom was used for the sound source, and this was triggered from a pulse generator. We found that the trigger interface was capable of distinguishing between sound envelopes even when they were repeated at a rate of about 10 times a second, so it should cope pretty well with just about anything you care to chuck into its input.

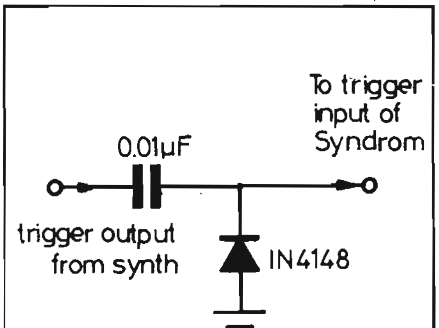


Figure 4. Inverter.

CV/trigger Interface

As anyone who's familiar with the Sequential Circuits Drumtraks will attest, a lot of mileage can be had out of a single drum sample if its pitch can be varied. But more than that, certain samples – slapped basses and orchestral thumps, for instance – are crying out to be used with a more rigorous control of pitching than can be achieved by just twiddling a pot in a more or less random fashion. This, then, is the rationale for the CV/trigger interface – a means of enabling the Syndrom to be controlled by any one volt-per-octave synth.

Although the 555 timer chip used in the basic Syndrom circuit functions as a voltage-controlled oscillator – twiddling the pot varies the controlling voltage, which alters the output clock frequency and therefore the rate at which samples are yanked out of the EPROM – these chips don't belong to any particular school of linearity, so attempts to make them function in a musically-meaningful fashion are doomed to failure. The way around this impasse is to bypass the onboard clock and substitute an external VCO that will work as nature really intended.

The circuit (Figure 2) is based around the CEM3340 VCO, a chip well suited for controlling the rate of sampling from an EPROM because of its superb specification and upper frequency limit of greater than 100kHz. Generally speaking, the

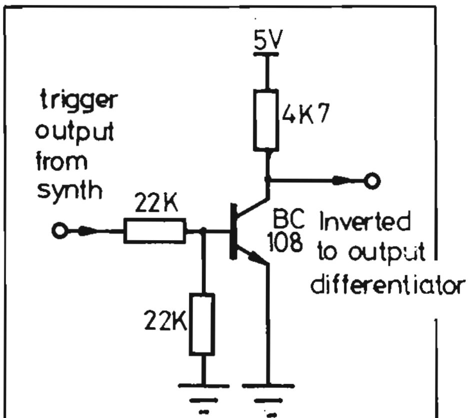


Figure 3. Differentiator.

circuit uses values recommended by the manufacturer, but the timing capacitor (between pins 11 and 12) has been reduced to 220pF to provide a higher frequency range. A full explanation of the IC's innards can be found in the data sheets supplied with the device. All components should be of 1 or 2% high-stability type, though it would take a mighty discerning ear to spot pitching discrepancies.

In order to get the VCO ticking to the Syndrom, the output of the VCO (pin 10) should be connected to pins 2 and 6 of the 555 (IC1 on the Syndrom board), ie. the trigger and threshold inputs. As pin 10 of the VCO is a triangular output, the 555 will regard this as if it were the rising and falling voltage on its own timing capacitor, and will therefore convert this to a TTL-compatible waveform to drive the counters. The existing timing components on the Syndrom board – R3, R2, and C1 – must, of course, be removed for this to work.

Triggering of the Syndrom in this situation will largely depend on what the synthesiser cares to pass on to the outside world. For instance, if the trigger rises to about 5V when a key is depressed, the combination of the 0.01uF capacitor and an IN4148 diode – a simple differentiator – will suffice as the conditioning circuit needed to be inserted prior to the normal Syndrom trigger input (Figure 3). On the other hand, if this voltage is exceeded, it's good policy to insert a zener diode (a 4.7V BZY88 type) in place of the IN4148, though with the same orientation. Finally, if the trigger is negative- rather than the more usual positive-going, a simple one-transistor inverter (Figure 4) should precede the differentiator.

Aside from the complication of the CEM3340 requiring +/−15V supplies, the operation of this add-on is again pretty straightforward. Once the VC and trigger from the synth have been connected to the relevant parts of the circuit, the only critical step is the adjustment of the two presets that determine the scale (RV1) and adjust the frequency (RV2). First, set RV1 to midway in its travel, and then adjust RV2 whilst playing the bottom key of the attached synth until the Syndrom falls in line with the pitch. Next, play octaves up and down the keyboard adjusting RV1 as you go, until you're satisfied that the Syndrom is falling in line with the one volt-per-octave standard.

Conclusions

Well, four instalments on, the Syndrom has expanded considerably from its humble beginnings. Lots of expandability, lots of circuits, and lots of headaches for anyone trying to cobble the whole lot together. Frankly, it's all very well adding on just a single circuit to the basic unit, but once you start talking about adding on multiple and audio triggering and CV control, life's getting a bit too complicated for comfort. We sympathise. Which begs the question of 'where do we go from here?' Well, we're seriously thinking about a 'Syndrom II', a PCB-based design that'll incorporate all that's been added to the first Syndrom so far plus a lot more. But because of chip prices and so on, this needs careful thought before we jump in at the deep end. So, as they say, watch this space for further developments. . . ■

Part 1 of the Syndrom featured in E&MM April 84, the PCB overlay and parts list followed in E&MM June, while additons to the original design appeared in E&MM August. The Syndrom is still available in kit form or as a ready-built unit, prices being £24.95 and £29.95 respectively. PCBs are also available from the E&MM Mail Order Department at £4.95. All prices include VAT and postage and packing.