electronics today INTERNATIONAL

SEPTEMBER 1979

50p

UPDATE YOUR WHEELS!
FOUR Projects For The Old Banger

Sony Pickup On Coils

Dynamic Noise Filter

LM 10 Revealed

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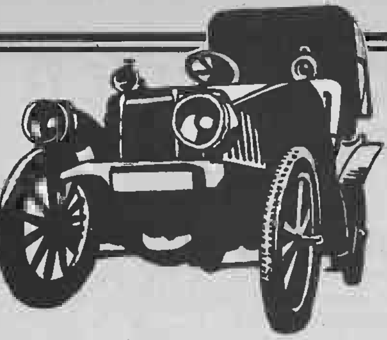


WARNING INDICATOR MONITORING SYSTEM

A unique design that gives a sophisticated audible warning when any of your car 'fault' lights switch on, or when your turn-indicators operate.

VIRTUALLY ALL MODERN CARS are fitted with panel-mounted fault indicator lamps that switch on when the voltage generator circuit packs up or when the engine oil pressure drops below a safe value, etc. Trouble is, most of these lamps are badly sited and in any case are almost impossible to read in bright sunlight. An apparently obvious answer to this problem is to couple up an audible alarm generator or 'repeater' to the warning lamps, so that you get both audible and visual indications of the fault condition. Unfortunately, however, the answer to the problem is not quite that simple: if it were, Ford and BLM would have fitted audible repeaters to all of their cars by now.

The real problem is that the audible repeater is required to draw the driver's attention to the fault, but not distract him from his driving or send him and his passengers mad by sounding continuously if he is unable to correct the fault for a long period of time. The system can not be fitted with a manual 'mute' switch, since that would negate the whole purpose of the repeater, which is to prevent the driver from forgetting about the fault. Also, the repeater must not activate when the ignition is first switched on, because the fault lamps always activate at that time anyway.

Warble Alarm

The ETI design team, being a fair bit smarter than the top brains of the motor moguls (we have an average IQ of nearly thirty-five), have come up with a neat solution to these problems. Our repeater sounds instantly when a fault occurs, generating a 30 second pulsed warble-tone signal that immediately attracts the driver's attention. The unit then generates 4-second 'reminder' tone bursts at intervals that initially occur once every 22 seconds, but which slowly expand to one 4-second burst every 2 minutes by the end of a twenty minutes timing period. After 20 minutes the reminder tones cease completely. The unit resets as soon as the vehicle's ignition is turned off, but is disabled for the first sixteen seconds after ignition switch-on, thus ensuring that the alarm doesn't sound at start-up, but does sound shortly afterwards if the fault-warning lights stay on.

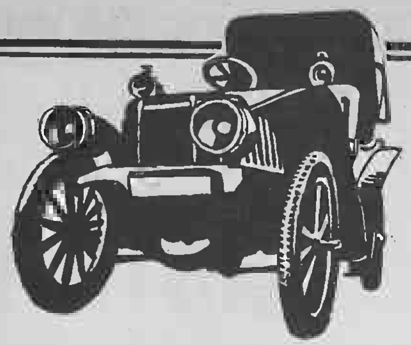
And that's not all that the unit can do. It also acts as an audible repeater for the car's turn-indicators and can accept a wide variety of auxiliary on/off inputs from devices such as low-fuel-level indicators and over-speed detectors, etc.

Cheap and Easy

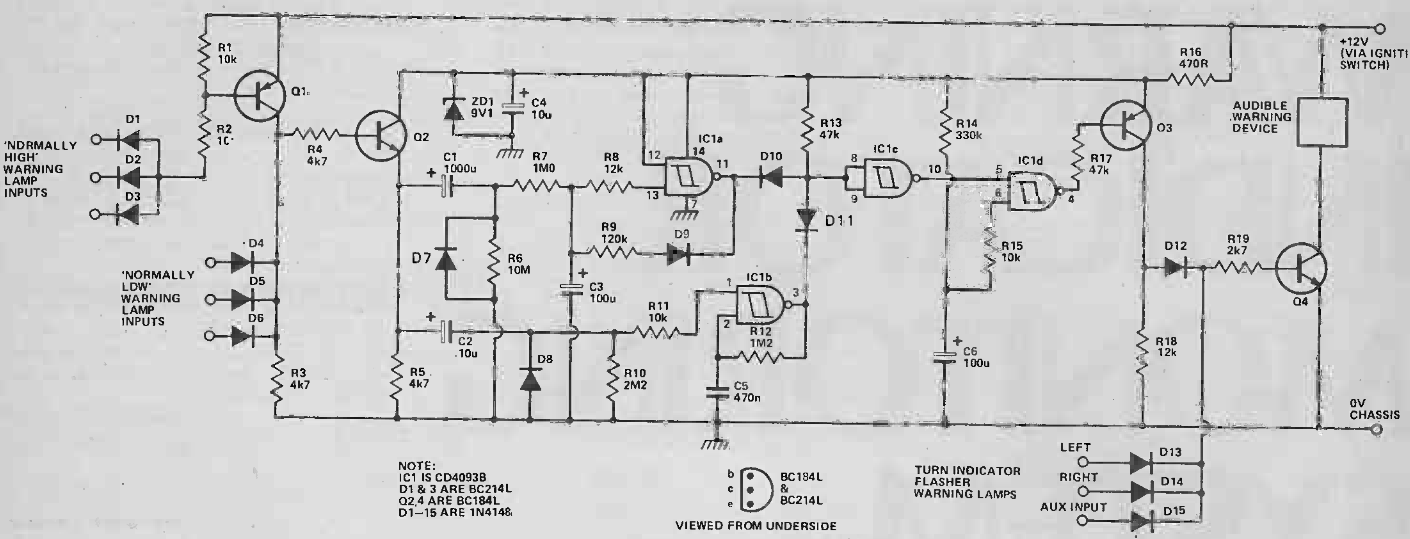
The ETI audible repeater circuit is reasonably inexpensive, and reasonably easy to install in most vehicles. The unit is designed for use in vehicles fitted with 12 volt negative ground electrical systems only.

Construction

All of the circuit (except the audible warning device) is wired up on a single PCB. Note that the PCB holds (amongst other things) fifteen diodes, one zener diode, four transistors and five electrolytic capacitors, so take great care to get the polarities of all these devices correct. When construction is complete, hook the audible warning device into place ▶



Circuit diagram of the Warning Indicator Monitoring System.



and give the unit a full functional check as follows:

(1) Temporarily short the input of D13 to the 12 volt positive supply rail and then connect the unit to the 12 volt supply. The alarm should operate as soon as the supply is connected and cease as soon as the temporary D13-to-supply short is broken. Repeat the test using diodes D14 and D15.

(2) Temporarily short the input of D1 to the zero volts line and connect the unit to the 12 volt supply. The alarm should activate about sixteen seconds after the supply is initially connected, should cease when the D1-to-zero connection is broken and should start again as soon as the D1-to-zero connection is re-made. Repeat the test using diodes D2 and D3.

(3) Temporarily connect the input of D4 to the 12 volt positive line and then connect the unit to the 12 volt supply. The results of the test should be similar to those obtained in test (2) above. Repeat the test using diodes D5 and D6.

(4) Temporarily short the input of D1 to the zero volts line and connect the unit to the 12 volt supply. Check that the alarm activates about 16 seconds after the supply is connected and then gives the full range of operation described earlier in this article, in which the alarm activates intermittently for about 20 minutes and then remains off.

When the above tests are complete, the unit can be installed in the vehicle.

Installation

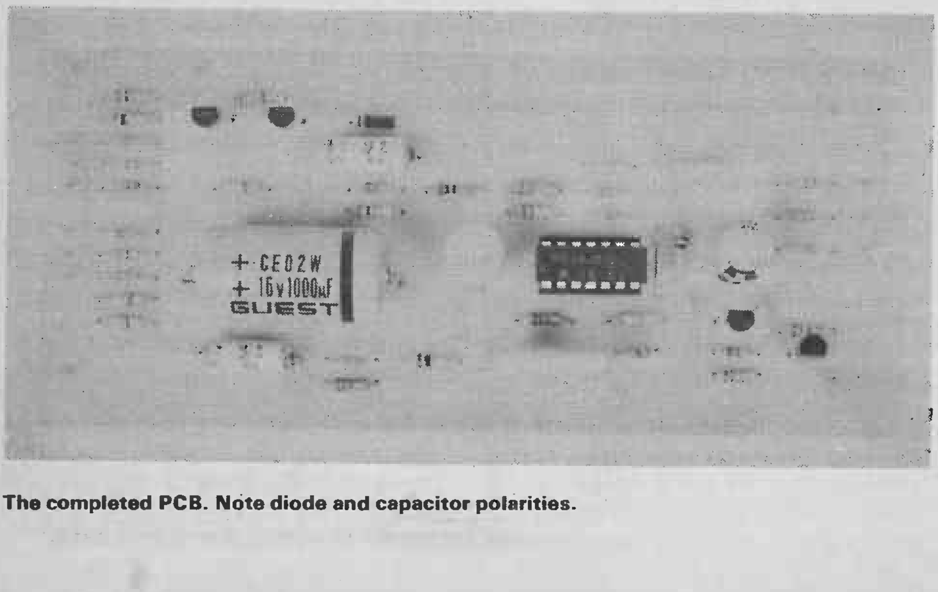
Before you start work on the installation, make up your mind as to exactly which lamps you want to monitor (usually the voltage generator, oil pressure and turn-indicator lamps) and then check the connections for these lamps.

Usually, you'll find that the voltage and oil indicator lamps have 'normally high' connections (they are activated by switches connected between the lamp and chassis) and the turn indicator lamp or lamps have 'normally low' connections (they are activated by switches connected between the lamp and positive supply line).

Once you've checked your diagram, installation is simply a matter of connecting the unit to the vehicle's battery via the chassis and the ignition switch and then making the appropriate connections between the vehicle's indicator lamps and the unit's input diodes.

When you install the unit (presumably under the dash panel), make sure that it is located away from areas of high local temperature (the vehicle's heating system, etc).

ETI



The completed PCB. Note diode and capacitor polarities.

HOW IT WORKS

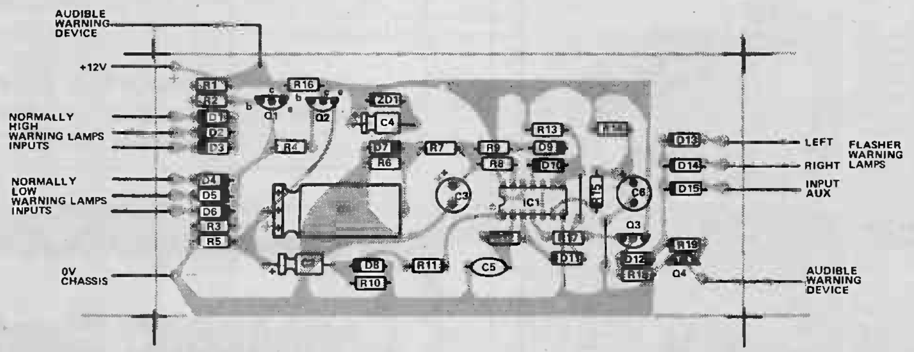
Q1 and Q2 function as a simple input conditioning network which converts OFF and ON lamp inputs to D1-to-D6 into zero and 9-volt levels respectively across R5. When the voltage across R5 switches high, time constant network C2-R10 gates on astable multivibrator IC1b for a maximum period of about 30 seconds (unless R5 switches low in the meantime) and the astable then pulses the unit's audible warning device on and off via D11-IC1c-IC1d-Q3-D12 and Q4 for this period.

Simultaneously, as R5 switches high it activates an asymmetrical voltage-controlled oscillator that is designed around IC1a and which operates as follows. At the moment that R5 switches high C1 is fully discharged (acting like a short circuit), so C3 immediately starts to charge towards the R5 voltage via R7 until, eventually, the R7-C3 junction voltage reaches the upper threshold of the IC1a Schmitt, which then triggers and discharges C3 via R9 and D9 until the R7-C3 junction voltage fails to the lower threshold of the Schmitt, which then reverts to its original condition and allows C3 to start to recharge via R7.

Initially, when the R5 voltage first goes high, IC1a generates a 4-second pulse once every 22 seconds, and this pulse is used to pulse on the unit's audible device via D10-IC1c-IC1d-Q3-D12 and Q4. As time progresses, however, C1 starts to charge up, with the result that C3 charges towards progressively lower and lower aiming voltages via R7 and thus takes progressively longer to charge in each cycle. These charging times finally expand to about 2 minutes after 20 minutes total operating time, after which the C3 voltage is unable to charge to the upper threshold of the Schmitt and the circuit ceases to oscillate.

The outputs of the IC1a and IC1b oscillators are used to activate the audible warning device via, amongst other things, transmission gate IC1d, which is disabled for the first sixteen seconds after initial power-up via C6 and R14, which ensure that the alarm doesn't sound when the vehicle's ignition is first switched on.

Note that the major part of the electronic circuitry is powered from a 9V1 supply via R16-ZD1-C4, which ensure reliable circuit operation under adverse power supply conditions.



Component overlay

PARTS LIST

RESISTORS	
R1, R2, R11, R15	10k
R3, R4, R5	4k7
R6	10M
R7	1M0
R8, R18	12k
R9	120k
R10	2M2
R12	1M2
R13, R17	47k
R16	470R
R19	2k7
CAPACITORS	
C1,	1000u 16V electrolytic
C2, C4	10u 25V electrolytic
C3, C6	100u 16V electrolytic PCB mounting
C5	470n polycarbonate
SEMICONDUCTORS	
IC1	CD4093B
Q1, Q3	BC214L
Q2, Q4	BC184L
D1-D15	1N4148

BUYLINES

The audible warning device used in this project was rated at 12V, 15mA. This can be obtained from major mail order companies that advertise in this magazine, and all the other components are so common even Woolies might sell 'em!

audiophile

How to begin reviewing a pickup and end up living in a Sony showroom. Ron Harris explains an easy way to turn an article into an epic.

A COUPLE OF LITTLE things to begin with. In fact *very* small things. Well actually even smaller than that. Micro in fact.

JVC have ('inevitably' did I hear from that man at the back?) entered the miniature hi-fi market in a big (small?) way. Their T-M1 and A-M1 (tuner and amplifier) measure only $3^{11}/_{16} \times 9^{1}/_{16} \times 10^{7}/^{16}$ — otherwise known as 93 × 230 × 259mm. Which means that stacked together they are smaller than this page.

Mini-Spec.

Their performance (on paper) looks very impressive. Fifty RMS watts for the AM-1 at 0.03% THD across 20-20kHz with excellent S/N ratio and overload figures. The T-M1 too has the zeros in all the right places on the spec. — IF rejection 90dB, separation (1kHz) 50dB, frequency response 30-15kHz (—1.0dB; THD 0.08%, sensitivity 0.9uV etc. It has digital tuning too.

All very impressive. I'm hoping to lay a hand — or more appropriately a finger or two — on these £306 matchboxes soon to see if they *sound* that good.

●

Caption Hold Up

Due to the state the postal services have been in lately, I decided to hold up closing the Audiophile caption competition, and publish the results next month instead. Entries are still coming.

With a bit of luck Felicity Kendal might enter.

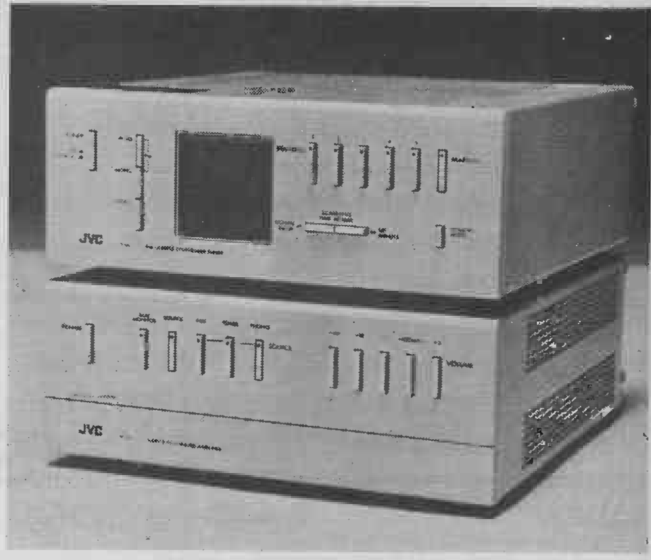
Apparently Marantz *were* at that show, and it was either that they hid when they saw us coming — or much more likely we couldn't see the wood for the trees. Sorry lads. Still, thanks to their press agency and their nice photo we got an amusing competition out of our blindness.

●

Some Sony Day

It all started out as a simple enough review job on the new XL-55 Pro moving coil cartridge. When the dust settled I'd got THREE moving magnet units, a very good turntable and a head amp to deal with — oh yes, and the XL-55 of course.

The more normal cartridges came about simply out of curiosity. Not having lent an ear to Sony pickups before I was interested to see how they'd compare to the more Western approach.



JVCs matchless matchboxes.

The record deck and head amp are utterly and totally the XL-55's fault. Or rather its designer. Anyone who designs a cartridge for this high a fi and then makes sure it won't fit into an SME, Hadock or Grace pickup arm wants his coils seeing to. Of course it fits Sony arms perfectly.

The connector is a standard SME type, but the cartridge DOES NOT come out of the headshell. It is part of it. Lunacy. Absolute Eastern lunacy. Mind you Sony UK were very nice about it:

Sony UK (being helpful): XL55 Pro for review? Certainly. What arm are you gonna use?

Me (confidently): No problems, SME Series III.

Sony UK (tactful and gently): Oh! That one? Only our XL55 doesn't fit that you see . . .

Me (still confident): But EVERYTHING fits an SME . . . doesn't it?

Sony UK (delivering punchline): Not the XL55. You see it's part of its own headshell. . . .

And so it came to pass that there was delivered unto Audiophile a PSX-60 and yet they knew not its virtue! (Never having heard of it before).

Below: the self sufficient PSX-60.

Four little pickups sitting in a row. On the right the massive XL55.

Tables Which Turned

So lets begin there. A paragraph or so on the PSX-60 is undoubtedly in order as it turned out a very satisfying piece of machinery to use. It possesses a deceptively low mass arm with good bearings and nice adjustment for bias and arm height. Both of these parameters simply 'dial on'.

The finish is immaculate (as usual) and the cover beautifully made, with the controls outside once closed. There is a repeat facility included but for the life of me I still can't see anyone ever using it.

My only gripe concerns the turntable itself. It produces a better ring than Bow Bell. The mat provided is very thick and suitably dense, but still contains those curious channels so beloved of manufacturers.

Once the mat is on the platter is reasonably damped — but how much better would it have sounded had it not been so resonant in the first place?

To combat those ribs I used the mat upside down all through, and in this admittedly curious manner the whole system turned in a very creditable subjective performance, managing to preserve detail exceptionally well for its price bracket and with a good solid bass. What a shame about that platter. . . .

The arm is good enough to take some excellent cartridges, but the mass is such that I cannot advise using anything with a compliance higher than 30cu else evil may befall you amid the LF!

This of course means the PSX-60 is ideal for moving-coil cartridges which is undoubtedly why Sony sent it to me! Inscrutable these Orientals.

Recommended then.

Moving Onto Moving Magnets

A quick glance down the specs table gives you a good idea of where these three cartridges lie in the market. All are low-compliance types! to suit the Japanese passion for pickup arms you could dig gardens with no doubt.

In terms of frequency response all three manage 20-20 kHz ± 3dB, with the 45 being the tightest on a straight line. However all three do possess a 'suck-out' in the region from 3 kHz to about 15 kHz. Curious this, almost old fashioned in as much as most manufacturers eliminated this from their designs in the wake of Shure and their V15 III.

Best tracking performance (SME clad) was obtained at 1.3g (XL45), 1.7g (XL35), 1.7g (XL25). Line contact rules OK? Comparisons were made against the Shure V15 IV and Goldring G900SE II — still the best two moving magnet designs in my opinion.

After individual listening tests, all three were used to make up a tape on the EL7 Elcaset of various pieces of music, so that a long program of comparison was possible. Recording tracks, and alternating cartridges gives a much better 'instant answer' to what differences exist between units than laboriously playing the same piece over and over.

Besides which it is a hell of a lot easier and more pleasant — and I'm an *expert* in being lazy!

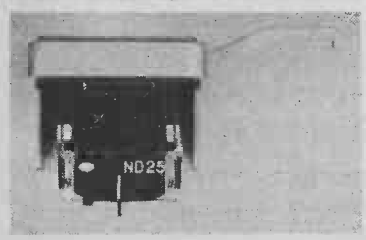
Impressions:—

XL 25

Came out sounding rather lifeless, I tend to think that upper-mid droop is showing a little! It is easy to listen to however, and would suit budget system well, maybe taking some of the 'sting' out of over enthusiastic speakers! Good bass.

XL35

Very nice overall really. Caught out by several 'difficult' tracks, suffering some break-up in the process. Well controlled lower octaves, maybe a bit edgy with high level treble, though only appeared so in direct comparisons. Excellent detail and imaging for its price. ▶



Below: specifications for the whole set of Sony pickups. Manufacturers figure

TABLE ONE

		XL55PRO	XL45	XL35S	XL25
TYPE		Moving Coil	Moving Magnet		
STYLUS		Elliptical	Line Contact	Elliptical	Elliptical
OUTPUT	(1KHz,5cm/sec)	0.2mV	3mV	3mV	4mV
COMPLIANCE	($\times 10^{-6}$ cm/dyne)	15	20	15	15
TRACKING FORCE		2g	1.5g	1.5g	1.5g
CHANNEL BALANCE	(at 1KHz)	<1dB	<1dB	<1dB	<2dB
SEPARATION	(at 1KHz)	>30dB	>30dB	>28dB	>20dB
WEIGHT		22g	5.5g	5.5g	5.2g
APPROX RETAIL PRICE		£90 (inc) (headshell)	£42	£35 (inc) (headshell)	£25

XL45

Good tracker. Very forward presentation appearing very detailed at first. Could be pushed into over-brightness by the recording very easily. Firm bass. Good if care taken regarding balance of supporting system. Too expensive!

All three are very competent designs, and were they priced some £10-£15 lower would get the Audiophile stamp of recommendation! At their present price though, I feel only the XL35s, complete with its headshell, represents good value. Sony have got the balance between price and performance slightly off centre I feel.

My thanks to Paul Edwards for his assistance with this report.

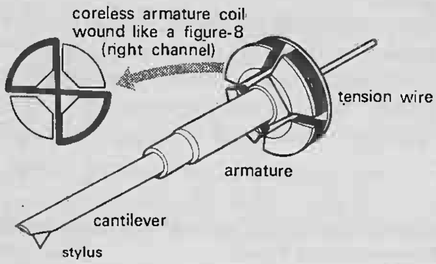
Long And Winding . . .

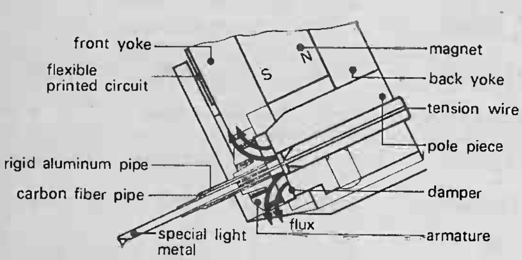
And so to the XL55 Pro itself. Setting this up in the PSX60 couldn't be easier. Literally it just pushes in! Since it weighs an arm-bending 22g including that integral (turtle)shell, Sony provide an extra counterweight to balance out the mass. Skylab had nothing on this. I shudder to think what the *effective* mass of this little lot must be.

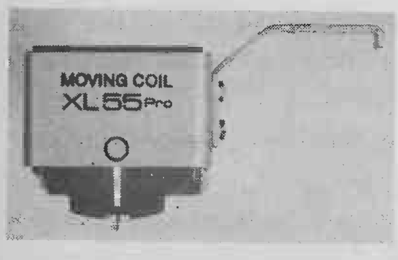
That headshell at least ensures a rigid mounting and hence resonance suppression to some extent, and with the compliance down at 15cu the mass is not a real problem in practice except if your records are warped, dished or otherwise liable to start this mass moving in a direction it shouldn't!

The cantilever itself is composed of beryllium, carbon fibre and aluminium in an attempt to control resonance modes within the structure, and as the drawing shows it is no simple construct.

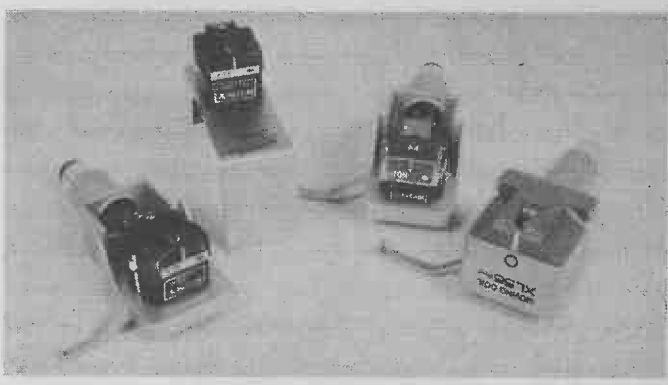
Witness also the novel coil configuration which Sony claim endows their baby with very low distortion. Interesting to see they've used a flexible PCB in there.







Top: coil configuration is a novel figure of eight.
Above: internal details of the cartridge.



Those cartridges again! Note the XL55 is part of its head shell.

Above and right: the excellent HA55. Witness the very high standard of construction.

Up In Arms

Set up in the PSX60 the XL-55 tracked best at 1.9g above which no improvement could be obtained. A fairly high bias setting was required.

None of the moving-coil flock are particularly brilliant trackers anyway, and the XL-55 sets no world records here — albeit a very competent performer which was only caught out once or twice by tortuous modulation levels.

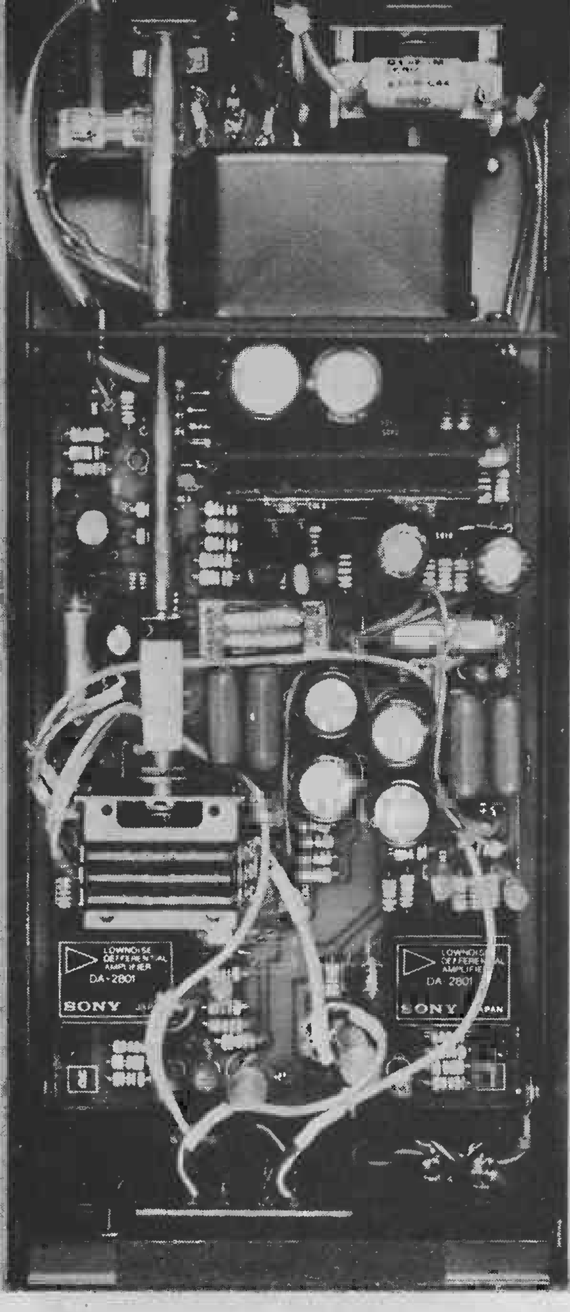
First auditions were carried out with a Lentek head amplifier — and sounded absolutely awful! The image never really existed, bass was loose and ill-defined and there was about as much detail in the sound as there is news in the Sun.

Something somewhere does not match something somewhere else. Accusing fingers surround the Lentek which is promptly banished, and enter the HA-55 (Sony). (By now my living-room looks like a Sony showroom gone berserk.)

Set the HA-55 to 40 ohm input, switch on and — at last — smooth detailed sound from the XL-55 Pro! This is definitely more like it. Being of a naturally warped mind though I couldn't leave it there. If the Sony cartridge doesn't match the Lentek amp, will the Entré 1 cartridge behave with Sony amp?

More changing of leads, screws and cusses proved that it does. So does the Coral 777EX. In fact both these units sounded more open through the Sony than they did with their own step-up devices.

Draw your own conclusions.



Gone Home?

By now I wouldn't blame you for having given up all hope of ever finding out anything about the XL-55. For those brave souls still with me (and awake), however, it sounds very good.

Comparing it to both the G900SE II and the Entré shows it to be excellent in the upper-mid range and good at the top, but to lack an extended bass. The bass that is there is well defined, and nicely controlled, but against the others I felt slightly cheated of that gut-moving last octave.

This didn't seem to bother anyone else who heard it, and it certainly did not spoil my enjoyment of the music. Indeed unless you have excellent loudspeakers of room-dominating dimension, you're not gonna miss much.

Overall I rate the XL-55 one of the best moving-coil units I've heard, and certainly well worth its price. I feel it does not outperform say the Entré for example, but it is well worth shortlisting along with the more publicised names, which it *does* better, if you're shopping in this market.

The HA-55 gets five gold stars and an asterisk all to itself, for an absolutely amazing noise performance and a superbly transparent sound. ETI

DYNAMIC NOISE FILTER

Not content with eliminating record clicks as if by magic — the project boys have now found a neat way of reducing tap hiss.

THE HUMAN BRAIN IS a funny thing really! Its connections to the outside world are via the five senses and it relies on these senses to transmit reliable and accurate information about the outside world. However, as you are probably aware, this information can quite often be distorted (think of the countless optical illusions).

Missing Links.

It is not so often that audio illusions are in the news, probably because they are harder to detect, but that doesn't mean they don't exist, eg. The fact that the ear cannot detect small gaps, say 5 mS, in a passage of music allowed us to build the click eliminator. Every time a click (which always have a duration of less than 5 mS) is detected, the sound is automatically cut out for about 5 mS. The final effect being one of apparent continuity of music without the gaps or clicks.

Hissed Up.

Our tape hiss reduction system functions on the principle that on a continuous passage of music the difference between the music and the hiss (signal / noise ratio) is so great that we cannot hear the hiss for the music. All well and good. On a more spasmodic piece of music, where there are gaps of more than say 50 mS between signals, then these gaps have (apparently) a much lower signal / noise ratio, not because the noise level has gone up, but because the signal level has gone down. This means that the hiss is more pronounced.

During these time intervals our device filters out the high frequency tape noise using a current controlled filter (CCF) — immediately allowing high frequency sound through again when a signal comes along. (The illusion of one type of sound covering up another of about the same frequency is called masking.)

Construction

Printed circuit board construction should be relatively straightforward. We suggest a step by step approach be adopted and testing of each stage be undertaken before construction of the following stage. The main reason for this is that the circuit, although having few components, is quite tricky in operation and this makes fault-finding difficult in cases of malfunction.

First, build up the on-board power supply section (D3, D4, C17, C18, IC3, R28 and LED 1). Check with a voltmeter for 12 V DC at its output ie, between the output of IC3 and ground. If the LED lights up it is a good indiciation that the supply is working correctly.

Next the buffer amplifiers and associated components (C1, C2, R1, R2, R3, R4, R20, R21, C11, Q1 and Q2) should be inserted. If a signal source and scope are available put signals at the inputs to the circuit and observe the signals at the emitters of ▶

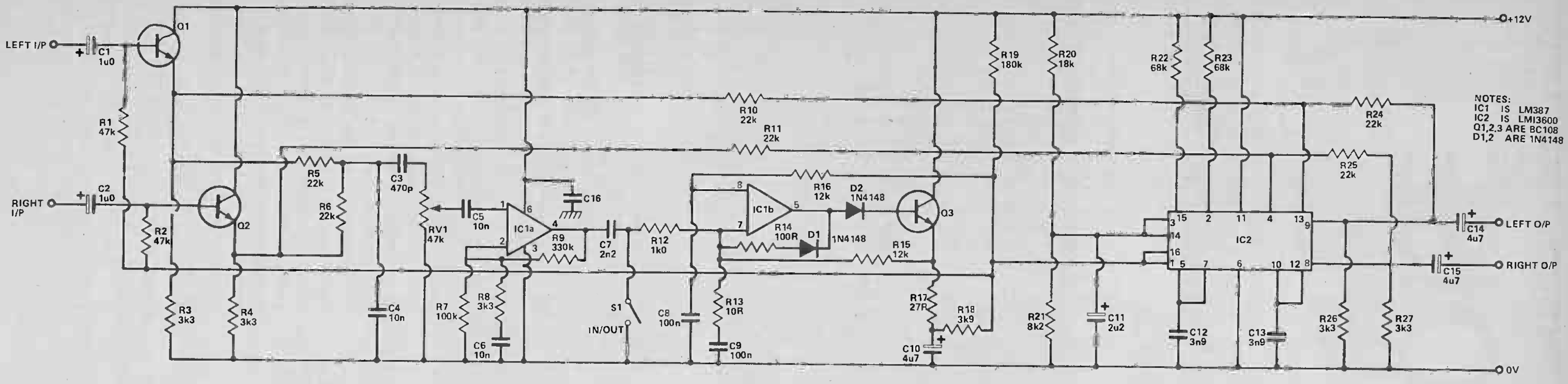
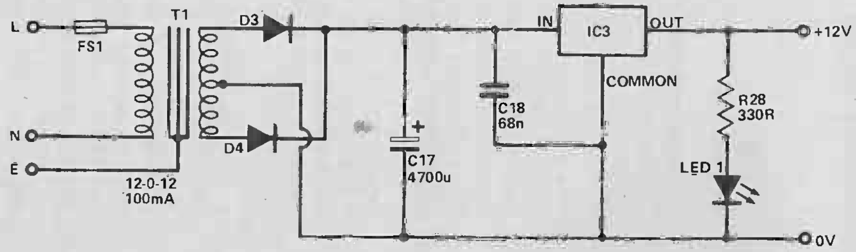


Fig. 1. Circuit diagram of the dynamic tape noise reduction system.

Fig. 2. The power supply.



Q1 and Q2. They should be the same as the transistors are operating as non-inverting buffers.

Following this, the control circuitry (consisting of R5, R6 through to Q3, R17 and C10 on the circuit diagram) should be soldered in place and this tage now tested. With RV1 at mid-position and a high impedance voltmeter or a scope in DC mode connected across C10, it should be seen that the voltage across the capacitor varies with varying signal input. If an audio waveform from, say, a cassette deck is used as a signal, then the voltage should be seen to increase with the higher frequencies (above about 7 kHz) but stay quite low for frequencies below this. Adjusting RV1 should adjust the overall voltage range across the capacitor.

Finally, IC3 and the rest of the components can be inserted and the complete board tested and set up. The signal at the output should be of tghe same amplitude as that at the input. ▶

HOW IT WORKS

The device consists of two buffer amplifiers, two current controlled lowpass filters and control circuitry to detect the presence of a signal. The current produced by the control circuit is used to vary the bandwidth of the CCF to allow the signal through ie when sufficient signal is present to be able to mask the noise, the lowpass filter frequency range covers the whole audio spectrum — however, when there is little or no signal and the noise appears louder then the filter's lowpass range is lowered to a minimum of approximately 1 kHz. The noise is effectively filtered out.

As soon as a signal in the same frequency range as the noise comes along (ie above 7 kHz) the control circuit detects it and applies current to the CCFs thereby increasing the frequency range, allowing the signal through.

The buffer amps are built around the two emitter follower transistors (high I/P impedance — low O/P impedance) and the CCFs around IC2, the LM 13600 which is a new National chip, a dual operational transconductance amplifier. Resistor R19 applies a fixed current to control pins 3 and 14 of the chip, fixing the minimum bandwidth at 1 kHz. The greater the current into these pins the greater the frequency bandwidth.

The control current itself is obtained from the voltage across C10 by connection via R18. As V_{C10} increases then by Ohm's law the current I_{R19} must also increase. The energy stored on C10 is provided from IC1b and Q3, etc. connected as a peak detector. AC into this part of the circuit gives DC out to C10. The values of R17 and C10 are chosen to allow a fast attack time (something under 1 mS) and a comparatively slow decay time (about 40 mS).

IC1a is a mixer, bandpass filter, amplifier. It mixes a sample of signal from both channels via R5 and R6, filtering out frequencies below about 7 kHz, so that only signals with the same general frequencies as that of tape noise will affect the CCFs, and amplifies the signal with a gain of 100.

RV1 adjusts for different noise levels, dependent on a particular tape unit.

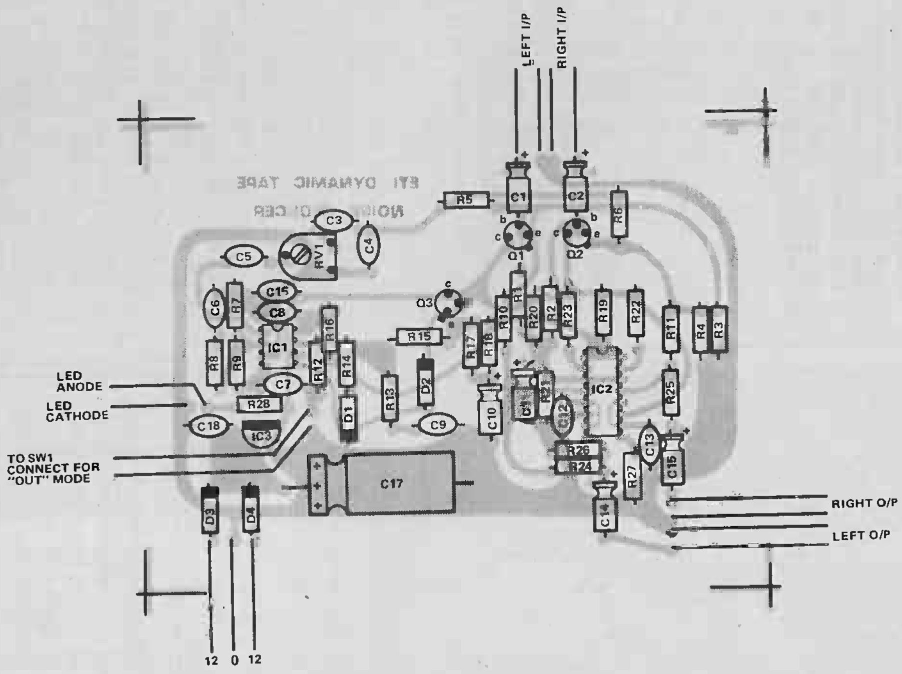


Fig. 3 (left): The component overlay for the Dynamic Noise Filter system.

Note that the power supply circuit as shown in Figure 2 is included on this board, and the input 12-0-12 comes straight from the transformer.

As the system is mainly based on just two IC's sockets are heavily recommended!

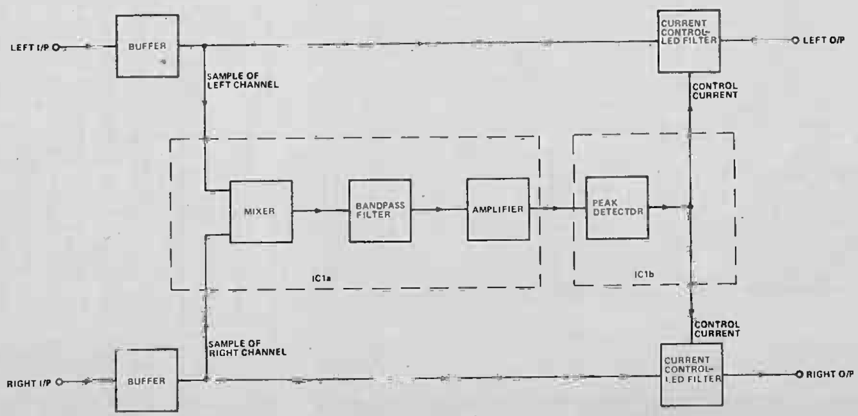


Fig. 4 (left): Block Diagram to the Dynamic Noise Filter project.

Not shown on this simplified diagram is the in/out (bypass) switching. This operates by grounding the output from the first stage.

Such operation will thus prevent the peak detector from operating the filter stage and thus leave a full bandwidth at the output regardless of input level.

PARTS LIST

RESISTORS 'all ¼W 5%'

R1, 2	47k
R3, 4, 8	3k3
R5, 6, 10, 11, 24, 25	22k
R7	100k
R9	330k
R12	1k
R13	10R
R14	100R
R15, 16	12k
R17	27R
R18	3k9
R19	180k
R20	18k
R21	8k2
R22, 23	68k
R26, 27	3k3
R28	330R

POTENTIOMETERS

RV1	47k

CAPACITORS

C1, 2	1u0 electrolytic
C3	470p ceramic
C4, 5, 6	10n polyester
C7	2n2 polyester
C8, 9, 16	100n polyester
C10, 14, 15	4u7 electrolytic
C11	2u2 electrolytic
C12, 13	3n9 polyester
C17	4700u electrolytic
C18	68n polyester

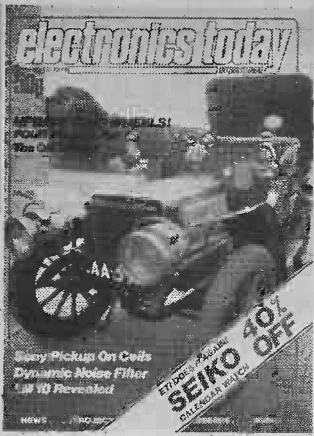
SEMICONDUCTORS

IC1	LM387
IC2	LM13600
IC3	78L12
Q1, 2, 3	BC108
D1, 2	1N4148
D3, 4	1N4001
LED	TIL220

MISCELLANEOUS

T1	12-0-12 c.t. secondary

FS1 + holder, spot toggle switch, case to suit.



Four for cars!

electronics today

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FEATURES


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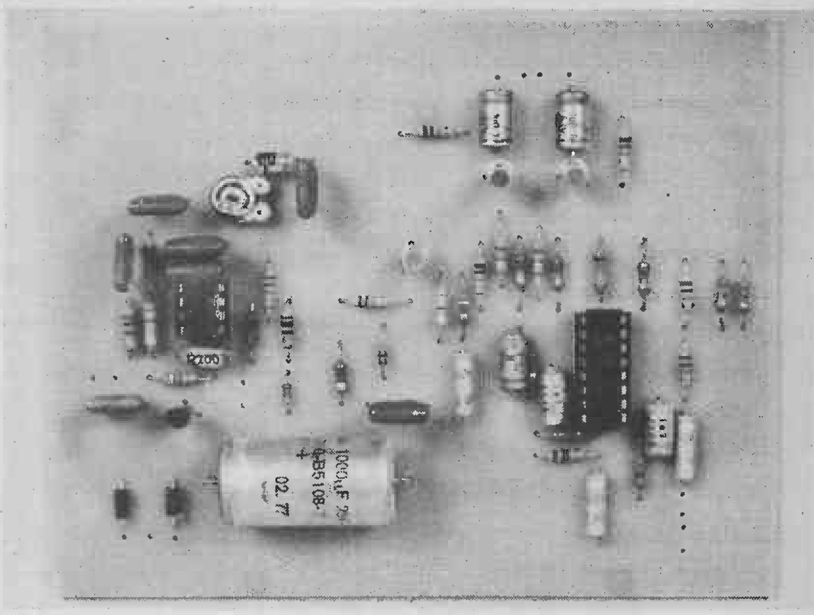
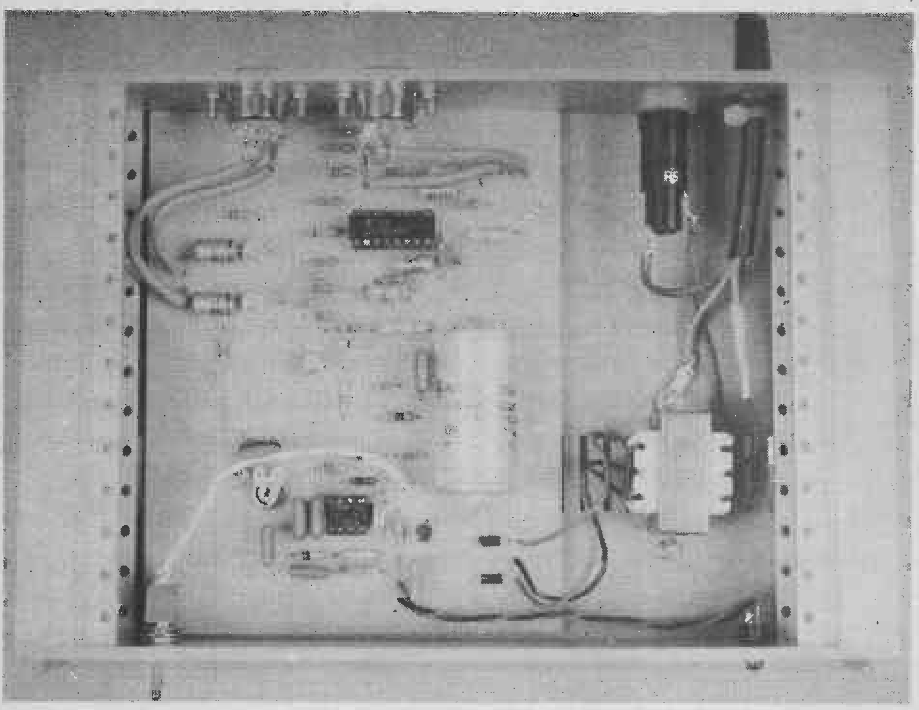
PUBLISHED BY Modmags Ltd., 145 Charing Cross Road
DISTRIBUTED BY Argus Distribution Ltd. (British Isles)
Gordon & Gotch Ltd. (Overseas)
PRINTED BY QB Limited, Colchester

Electronics Today International is normally published on the first Friday of the month prior to the cover date

PROJECT: Dynamic Noise Filter



Right: Close-up on the board — the only board — for the Filter project.
Using this in conjunction with the component overlay shown overleaf should identify all the component positions, and make sure you don't get any polarised components in the wrong way round.
The holes are leadout positions, and if you're left with any over don't call us . . . .



Left: Where to put the board once you've assembled it!
Note that only the transformer is mounted off board. This may need turning from side to side to obtain that elusive minimum hum orientation!
Use screened leads to connect signal sockets to the printed circuit boards.

BUYLINES

Always on the lookout for new housing products we have come up with a really neat case for this project. Introduced by Lektrokit Ltd, Sutton Industrial Park, London Road, Earley, Reading, Berks, RG6 1AZ, and nicely priced at £8.53+20% VAT and P&P, type L20 from the Transistek range, this should house your system in style.

The two integrated circuits in the system should be available from any of the larger mail order firms advertised in ETI.

Setting Up

Once you are sure that everything is working correctly, then setting up is a very simple job. Erase a section of tape and play it back through the unit. Take the output from the unit and amplify it.

Turn RV1 completely anti-clockwise and listen. Slowly turn the preset clockwise until there is a barely perceptible increase in hiss noise. Then, step it back just a fraction, so that the hiss just goes. The device is now set for the tape unit and use with any other tape will require resetting.

A final setup test can be carried out, if necessary, with a signal generator plus an oscilloscope. With an input of about 500 mV, the bandwidth of the device should be up to about 25 or 30 kHz. However, an input of 50 mV should give an output bandwidth of only 6 kHz.

ETI

MICROSENSE

PART TWO: following on from last month's opening episode, John Miller Kirkpatrick's series gets around to programming a cardboard MPU, and begins to take note of the REAL world with a consideration of the SCMP processor. Read on . . .

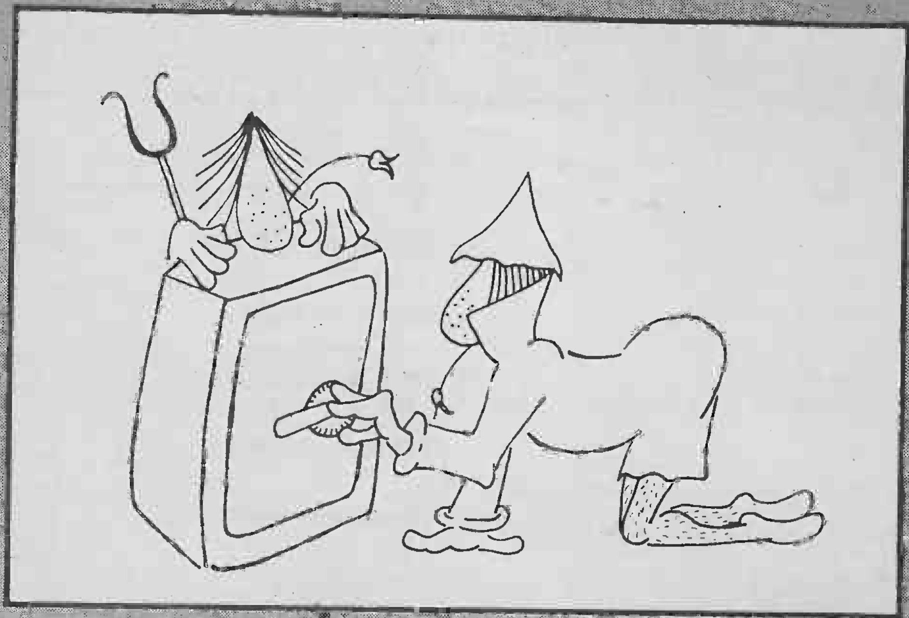
FOLLOWING ON from last month's invention of the PC/MP — which you've made up by now of course — and the definition of the instruction set for our DIY processor, we can now write a program for the unit.

We will use our previous example of stock controlling overalls in a clothing depot. Instruction addresses and instructions are in Hex.

Address	Inst	What It Does
0001	00	Halt processing.
0002	0B	Load the next sequential address data into MAIN LATCH.
0003	01	Bit pattern 0000 0001, data for pevious instruction.
0004	0A	Exchange this value into DUAL LEFT.
0005	0A	DUAL is used as an address for a READ instruction as DUAL has just been loaded so that its upper byte is 0000 0001 the keyboard will be accessed and the data set up there will be copied into MAIN LATCH.
0006	01	Exchange this data into the 2ND LATCH.
0007	0B	Load next to MAIN.
0008	30	Bit pattern 0011 0000.
0009	0C	AND MAIN and 2ND, result to MAIN.
000A	12	IF MAIN is not all zeros jump over the number of instructions at 000B to instruction at 0012. If MAIN is all zeros then go to next instruction at 0000.
000B	06	Number of instructions to ignore.
000C	06	Save old value of MAIN in DUAL RIGHT.
000D	0B	Load next to MAIN.
000E	80	Bit pattern 1000 0000.
000F	0D	OR MAIN and 2ND, result to MAIN.
0010	01	Exchange MAIN and 2ND.
0011	06	Restore old value of MAIN from DUAL RIGHT.
0012	01	Exchange MAIN and 2ND.
0013	03	SHIFT RIGHT MAIN (which now contains old 2ND).
0014	03	Second time.
0015	03	Third.
0016	03	Fourth.
0017	03	Fifth.
0018	03	Sixth.
0019	03	Seventh, the Male/Female bit is now at the right hand end of MAIN, all other bits are 0.
001A	05	ROTATE RIGHT MAIN.
001B	05	Again.
001C	0D	OR MAIN and 2ND, result to MAIN.
001D	03	SHIFT RIGHT MAIN.
001E	03	Second.
001F	03	Third.

▶

0020	03	Fourth.
0021	01	Save MAIN in 2ND.
0022	0B	Load Next to MAIN.
0023	02	Bit value 0000 0010.
0024	07	Exchange this value to DUAL LEFT.
0025	01	Restore MAIN from 2ND.
0026	09	WRITE MAIN to address in DUAL (Display).
0027	0B	Load next to MAIN.
0028	00	Bit pattern 0000 0000.
0029	07	Exchange this value into DUAL LEFT.
002A	0B	Load next to MAIN.
002B	00	Bit pattern 0000 0000.
002C	06	Exchange this into DUAL RIGHT.
002D	08	Exchange DUAL and ADDRESS LATCH. Thus the ADDRESS LATCH will have the value 0000 0000 0000 0000. It will add 1 to this and fetch the next instruction from that address. The instruction at this address (Hex 0001) is the HALT instruction which is the start of this program. NB the value in the ADDRESS latch is automatically incremented by 1 at the end of each instruction.



On The Shelf

If you put this program through the PC/MP you should get a correct result (shelf number) being output to the display. The display is a seven segment digit with a decoder, the decoder and display work as follows:

Data Written to Display	Display shows
0000 0000	Digit zero
0000 0001	Digit one
0000 0010	Digit two
0000 0011	Digit three
0000 0100	Digit four
0000 0101	Digit five
0000 0110	Digit six
0000 0111	Digit seven
0000 1000	Digit eight
0000 1001	Digit nine
0000 1010	Letter A (upper case)
0000 1011	Letter b (lower case)
0000 1100	Letter C (upper case)
0000 1101	Letter d (lower case)
0000 1110	Letter E (upper case)
0000 1111	Letter F (upper case)

The decoder and display are thus able to show the Hex value of the lower half of the data byte written to it. The example of the overalls and shelves is an over simplification of a typical microprocessor application, such a microprocessor would be able to perform the above program about 2000 times each second.

To finish your education using PC/MP the more usual names for the 'pigeon holes' are REGISTERS, those in PC/MP should be renamed

MAIN LATCH	Accumulator Register	AC	D
2ND LATCH	Extension Register	EX	A
STATUS LATCH	Status Register	ST	T
DUAL LATCH	Pointer Register number 1	P1	A
ADDRESS LATCH	Pointer Register number 0	P0	B
	or U	PC Program Counter Register	U S

The SC/MP Microprocessor

By now you should be used to mnemonics to understand that they can be used as a short form of identification for long words or complex descriptions. For instance from here onwards the word microprocessor may be replaced with the mnemonic MPU for MicroProcessor Unit. Other mnemonics will creep into the text initially with their meaning in

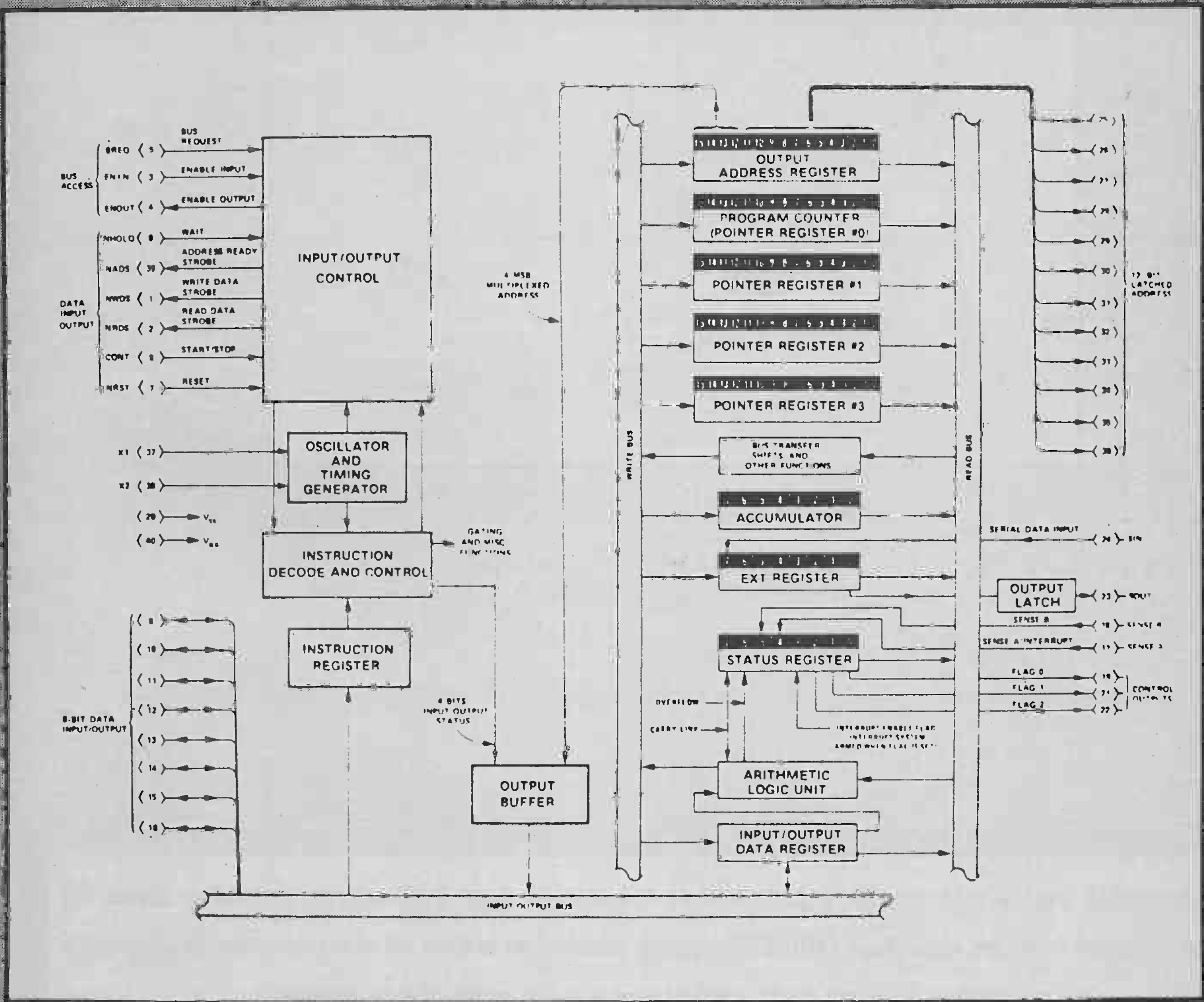


Fig. 1. The CPU architecture and pin-outs for the SC/MP chip.

brackets, or vice-versa. Now that you have grasped the basics of MPUs here is a real one to get to grips with. The SC/MP (Simple Cost effective MicroProcessor) is one of the simplest of all of the MPUs to understand. consider the SC/MP Functional Block Diagram and compare it to that of the PC/MP. You should be able to identify the OUTPUT ADDRESS Register and a separate PROGRAM COUNTER (PC) register and three other DUAL Registers called P1, P2 and P3. Also you should be able to see the INPUT/OUTPUT Register connected to the DATA BUS and the ACCUMULATOR, EXTENSION AND STATUS Registers. The SC/MP has internal units to handle Arithmetic and Logical operations, SHIFT operations, instruction recognition and control. On the left of the SC/MP block diagram you will find the SC/MP Input/Output (I/O) controller. This has NHOLD and CONT for the HOLD and CONTINUE options, RESET, READ line (NRDS), WRITE line (NWDS) and an output to indicate a valid external address (NADS). NADS is required because the SC/MP DATA BUS has a dual function, when NADS is at five volts (logic 1) the DATA BUS carries data, when NADS is at logic 0 the DATA BUS carries the upper four address bits plus some more indicator flags. The data on the DATA BUS at this time can be latched externally to increase the features of the basic SC/MP if required, in most applications they are not required.

The BUS REQUEST (BREQ), ENABLE INPUT (ENIN) and ENABLE OUTPUT (ENOUT) control lines are used in multiprocessor applications and in most basic applications can be ignored. For details of the operation of these signal lines refer to the SC/MP data sheet.

SC/MP also has the facility to SHIFT RIGHT the EXTENSION Register so that the value of the bit at the right hand end will appear at an output pin labelled SOUT (Serial OUT). At the same time the value at the SIN (Serial IN) pin will be loaded into the leftmost bit of the EXTENSION Register, this facility allows the SC/MP to handle high speed serial data rather than parallel data bits on the DATA BUS.

SC/MP Instruction Set

The SC/MP can handle something like 122 differant instructions most of which are variations of the PC/MP instruction set. They can be broken down into groups of instructions.

EXTENSION REGISTER a set of eight instructions handling various operations concerning the EXTENSION Register and the ACCUMULATOR. Such operations being COPY, Exchange, Arithmetic and Logical.

SHIFT, ROTATE, SERIAL I/O. A set of five instructions that allow various forms of movement of bits RIGHT in the ACCUMULATOR or EXTENSION registers.

MISCELLANEOUS. A set of nine instructions including HALT, copy STATUS to or from ACCUMULATOR, DELAY, Enable and disable the automatic INTERRUPT function.

POINTER REGISTER. A set of instructions which allow the exchange of 16 bit pointer registers P1, P2 and P3 with the Program Counter (PC). The upper and lower bytes of the Pointer registers can also be exchanged with the ACCUMULATOR.

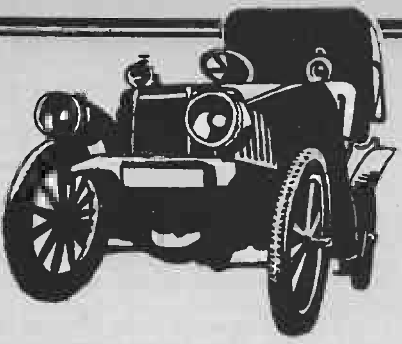
TRANSFER. A set of instructions which allow program logic transfer to an address specified as a number of bytes offset from one of PC, P1, P2 or P3. The Jump may be conditional on the value in ACCUMULATOR or unconditional (Jump Always).

MEMORY REFERENCE. A set of instructions which act on the ACCUMULATOR and the data at a memory location offset from one of the pointer registers or from the program counter. A subset is similar to the 'Load next to MAIN' instruction on the PC/MP. The subset is the IMMEDIATE instruction subset. The set of memory reference instructions include READ, WRITE AND, OR, XOR, and arithmetic operations.

MEMORY INCREMENT. This is really another subset of the above set. The data at the address being accessed is loaded into the ACCUMULATOR and then has the value 1 either added or subtracted and the new value is then stored back at the original address.

Further details on SC/MP II are available in the manufacturers data sheet.

Next Month: RAM, ROM and the escaped vicar. In other words the stuff that memories are made of!



FUEL LEVEL MONITOR

ETI's medically approved ulcer generator. It's designed to make you WORRY for half an hour before you finally get stranded through lack of fuel!

THE ETI LOW-FUEL-LEVEL ALARM is designed for use in modern vehicles fitted with 12 V electrical systems only. It is driven from the vehicle's existing fuel gauge system, and activates when the fuel level falls below a pre-set value.

When the alarm activates, a LED and a low-frequency oscillator switch on. The output of the oscillator can be used to activate the unit's own audible warning device, or to activate the alarm generator of the 'audible repeater' project described elsewhere in this issue.

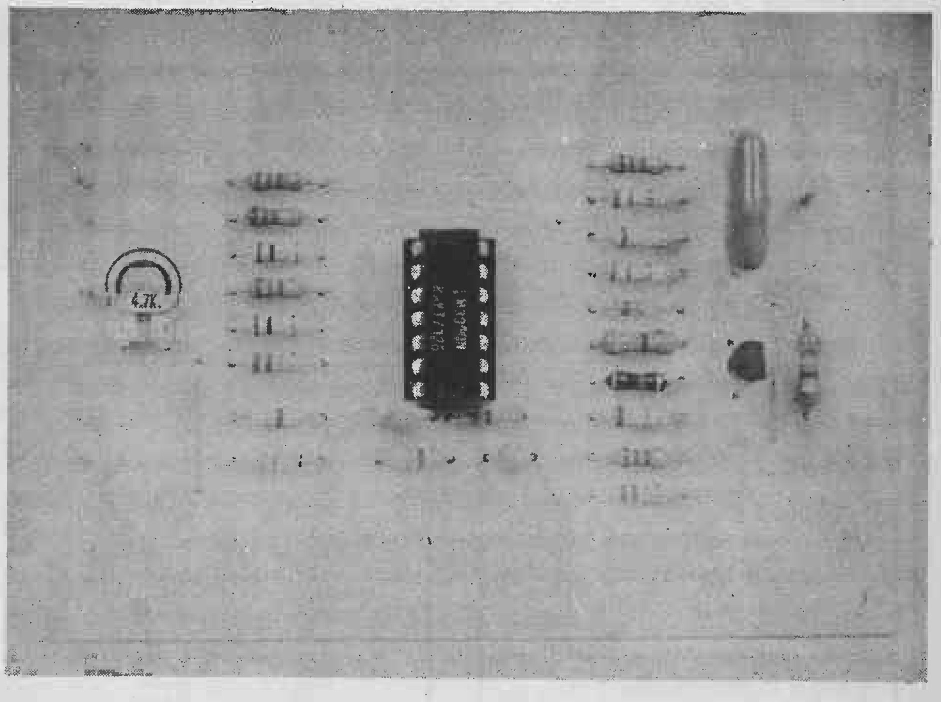
The alarm system is provided with a mute switch, which lets you disable the low-frequency oscillator 'warning' circuit, but not the LED circuit, once the alarm has been activated. The mute switch automatically turns off when the vehicle's ignition is first switched on.

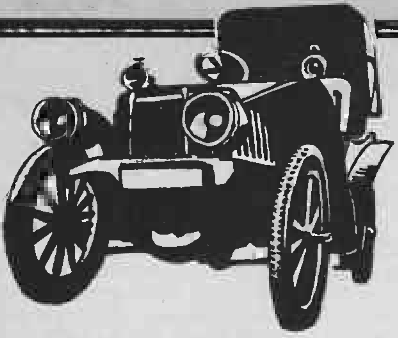
The Low-Fuel-Level Alarm is a genuinely useful unit to have in any vehicle and is inexpensive and easy to construct. The unit is, however, fairly difficult to fit into most modern cars, typically taking 2-3 hours to install. Installation usually involves the partial dismantling of the vehicle's instrument panel. (You have been warned!).

Construction

Construction of the unit is perfectly straightforward and should present no problems. Note that the PCB is provided with Veropin terminals for making external connections, including those to the off-board mute switch and the LED.

The load that is fitted in series with Q1 emitter can take a variety of forms, but must have an impedance greater than 100R. It can, for example, be a relay or a self-contained audible warning device. Alternatively, if the unit is to be used in conjunction with the 'audible repeater' project described elsewhere in this issue, the load can simply be a 4k7 resistor, and Q1 emitter can be connected to the auxiliary input (D15) of the repeater. ▶





HOW IT WORKS

The fuel-level indicating system of a modern car consists of a float-driven rheostat 'transmitter' in the fuel tank, which governs the magnitude of current flow through a hot-wire type of meter that is used as the fuel gauge: to ensure calibration reliability, the voltage supply to the system is controlled by a simple regulator (see main circuit diagram). A characteristic of this system is that the voltage across the transmitter rheostat increases as the fuel level falls, typically reaching 3 to 4 volts when the tank is emply.

The ETI Low-Fuel-Level Alarm works by monitoring the voltage across the transmitter rheostat (at one side of the fuel gauge), and activating an LED and a low-frequency oscillator when this voltage rises above a pre-set value (when the fuel level falls below a pre-set value). The oscillator can be used to drive a variety of types of load, including an audible warning device. The circuit is provided with a 'mute' facility which can be used to disable the oscillator but not the LED circuit. The 'mute' system turns off automatically when the vehicle ignition is first switched on. A brief resume of the circuit's elements is as follows.

IC1a is wired as a voltage comparator, with a small degree of regenerative hysteresis applied via R7 and R3. The trigger level of the circuit can be pre-set via RV1, which is driven from the same 'regulated' supply as the fuel gauge. The output of IC1a is normally high, but goes low when the input voltage rises above the pre-set trigger level. Under this condition LED 1 is driven on via IC1c and astable multivibrator IC1d is enabled via D2-R15. The output of the astable is fed to an external load via emitter follower Q1.

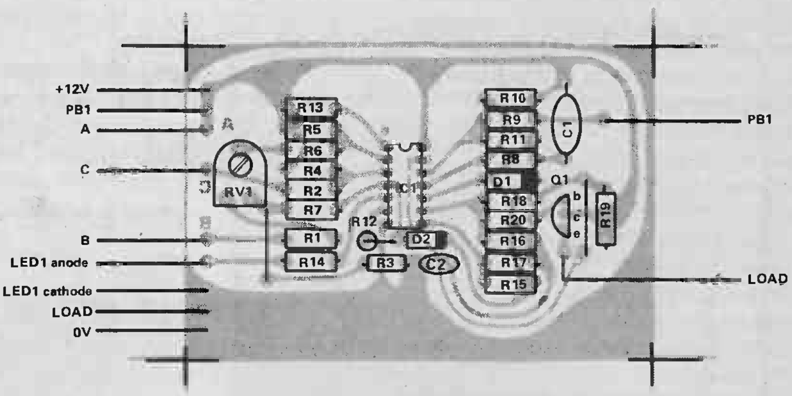
IC1b is wired as a simple bistable, which is automatically set to the output-low state at ignition turn-on via C1-R8. The output can be latched high, thus disabling the astable multivibrator (and hence the external load) via D1-R15 by momentarily closing MUTE switch PB1.

Installation

Installation is, in theory, simply a matter of connecting the unit's zero volt line to chassis, point 'A' to the +12V side of the vehicle's instrument regulator, point 'B' to the output of the instrument regulator and point 'C' to the junction of the vehicles fuel gauge and transmitter unit, as shown in the main circuit diagram.

In practice, the implementation of these connections will probably involve the removal of the vehicle's instrument panel, and perhaps the PCB that is attached to the back of that panel. Make sure you disconnect the vehicle's battery before starting the installation work.

When using the alarm unit, note that, because the fuel in the tank tends to slop around a fair bit under actual driving conditions, and thus generate a fluctuating voltage across the tank's transmitter, the alarm system will operate intermittently as the fuel level approaches the pre-set 'mean' warning level, thus giving the driver an advance warning of the danger condition.



The component overlay

BUYLINES

There should be no problems for components for this project. The optional load uses the same rated audible warning device as used elsewhere in this months ETI !

PARTS LIST

RESISTORS

R1	4k7
R2, 6	100k
R3, 14	470R
R 4, 5	1M5
R7, 15	22k
R8, 9	820k
R10, 13, 17	1M2
R11	560k
R12	680k
R16	56k
R 18, 19	3M3
R20	1k0

POTENTIOMETERS

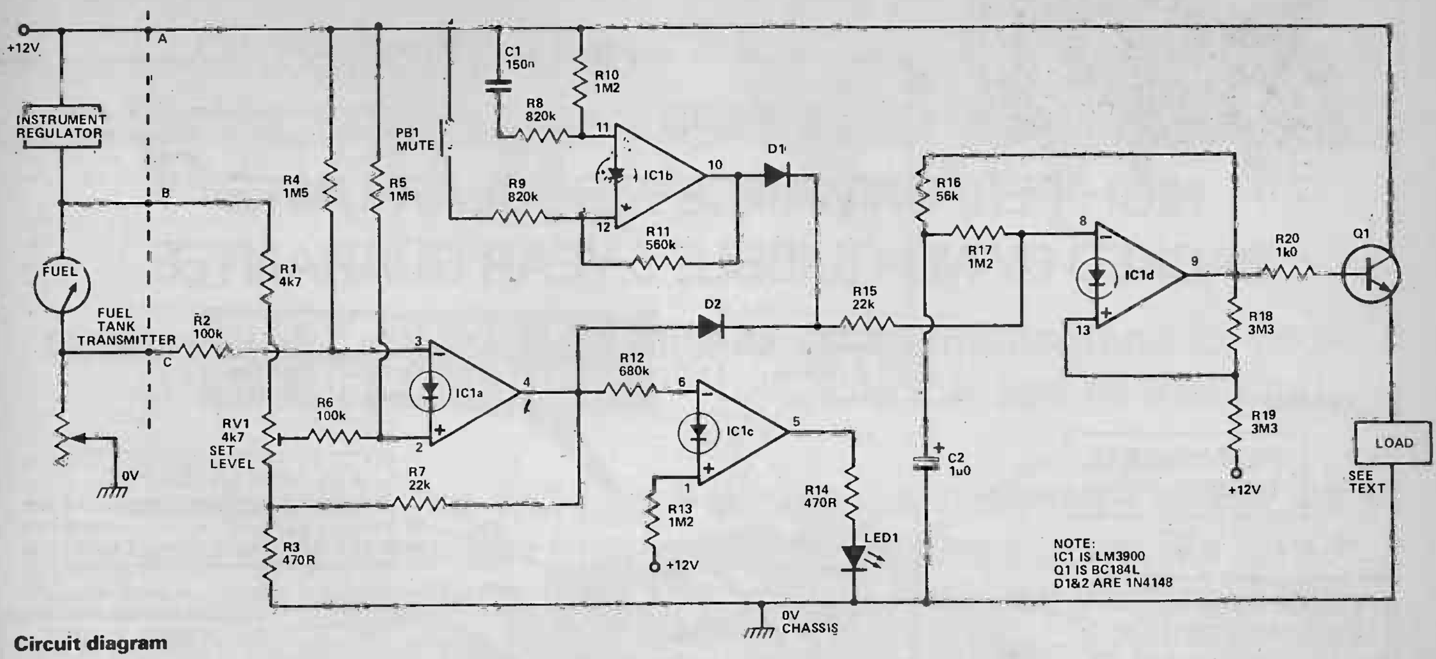
RV1	4k7 Preset

CAPACITORS

C1	150n polyester
C2	1u0 tantalum

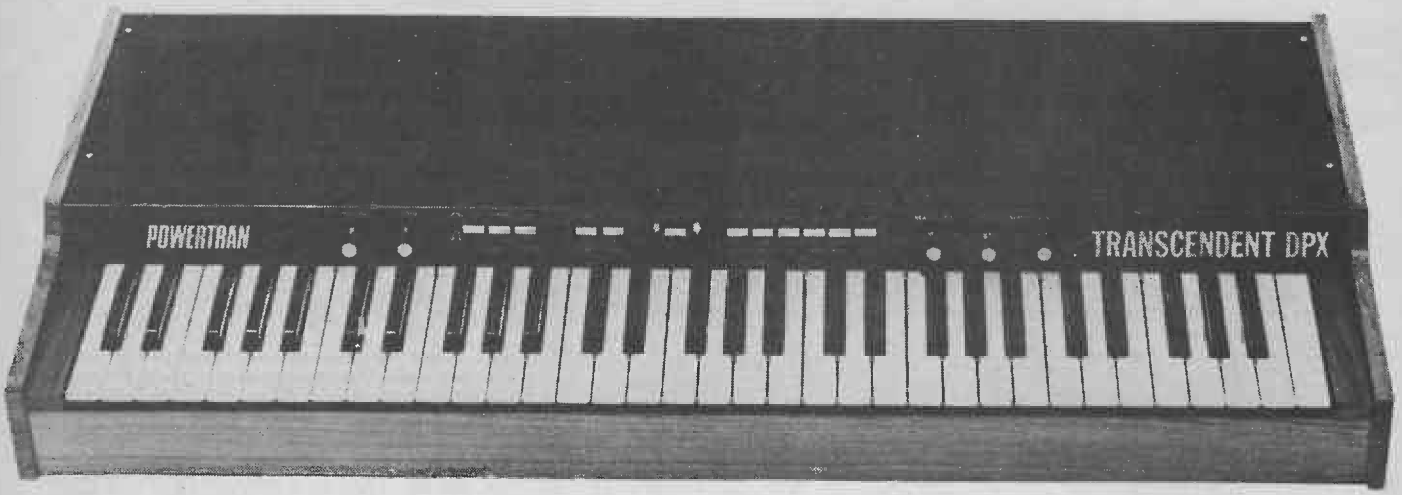
SEMICONDUCTORS

IC1	LM3900
Q1	BC184L
D1, 2	1N4148



Circuit diagram

STRING THING



We continue this month with Part 2 of the String Thing Saga (Son of Part 1) from Tim Orr. For those of you who missed Part 1, String Thing, otherwise known as the Transcendent DPX, is a digital, polyphonic, multi-voice keyboard instrument. (We suspect it probably makes marvellous coffee too.)

LAST MONTH WE began Tim Orr's String Thing project with a general view of the whole system and circuit details of the keyboard multiplexer and chorus/ensemble board. Constructional details of the keyboard PCB were also included.

This month we look at the note generator and demultiplexer circuits, thus proving the well-known phrase or saying 'What goes multiplex must be demultiplexed' (ETI apologise for the quality of humour in this article).

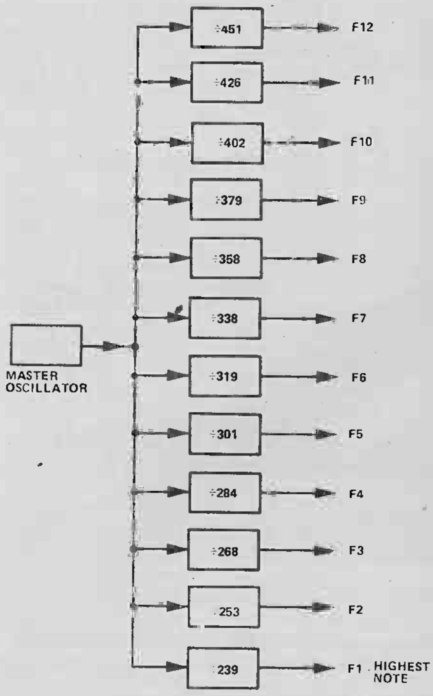
It is our normal practice to print PCB foil patterns for projects. However, in this case, all PCB foil patterns are copyright of Powertran Electronics, from whom you can buy a complete kit of parts for String Thing (see Buylines).

Part 3: We conclude String Thing next month with a description of the dynamics and voicing circuits. Also included are details of the power supply. Assembly and testing procedures round off the whole package.

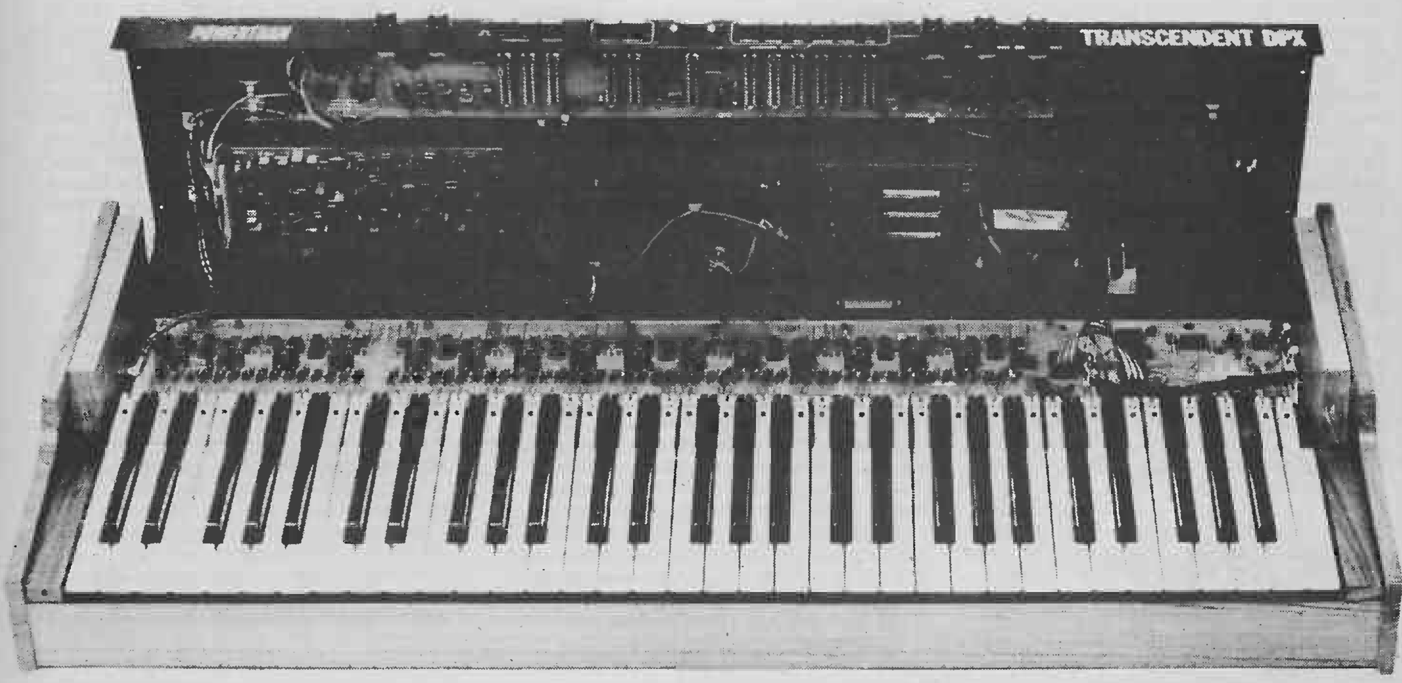
BUYLINES

Powertran Electronics are supplying a complete kit of parts for this project at £365+15% VAT. Delivery by Securicor is £2.50 extra. Everything is included in the kit, down to the last nut and bolt. They even give you a plug.

Powertran will also supply components, boards, etc separately. Please send an sae for details.



Below: String Thing with its top panel lifted up, revealing the control circuitry.



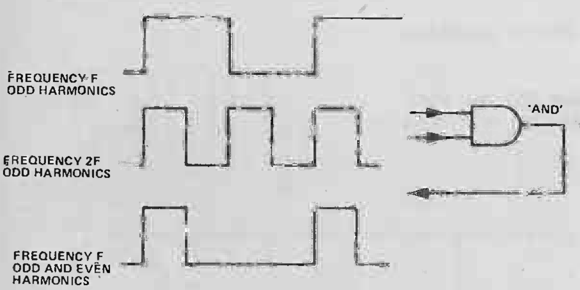


Fig. 2. (above) Waveshape Production. By ANDing frequency F (odd harmonics) with frequency 2F (odd harmonics), frequency F (odd and even harmonics) can be obtained.

Fig. 1. (left) Bock diagrams of the top octave generator, which derives different frequencies from one master oscillator.

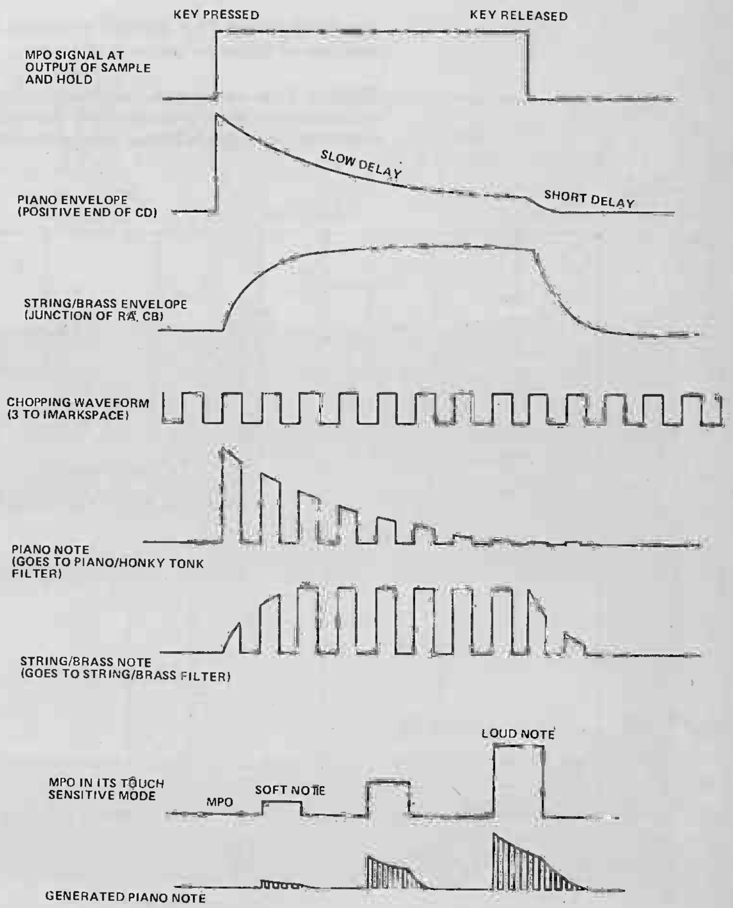
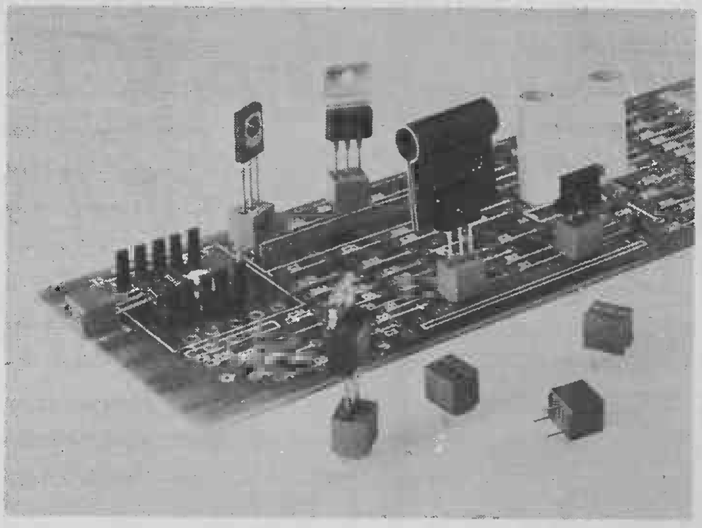


Fig. 3. (right) Note production, compare the piano waveform with the string/brass waveform.

news digest................

SOCKET TO ME



To simplify fault finding and component replacement for the commercial market, Winslow Component Systems have designed a transistor socket for TO220 and TO 202 power transistors.

Available in two versions, the W3416 has staggered contacts to stop it falling over during flow soldering, and the W3416S has in-line contacts.

The body of the socket is moulded in glass-reinforced polyester and the phosphor bronze contacts are available in both gold plated and bright acid tinned finishes.

For further information contact Winslow Component Systems Ltd, Southern House, Edenbridge, Kent.

CB SPECIAL

Price change — CB Special, from the publishers of Hobby Electronics, will cost 75 pence plus 25 pence postage. Just send a PO/ cheque for £1.00 to CB Special, 145 Charing Cross Road, London WC2H 0EE.

CASE STUDY

Having problems boxing your goodies? You might find what you want in the new releases from Vero and West Hyde Developments.

Vero's G-Series is a range of small metal instrument cases, which come in three standard sizes with satin anodized aluminium top cover, and front and rear panels and base in matt black PVC-clad steel.

When the case is assembled, there are no visible fixings. The cover can be removed by unscrewing the feet. The cases have a sloping vizor to protect light displays against glare.

The latest additions to the BOCON range from West Hyde are ten, two part cases with loose front and rear panels.

PCBs can be mounted on the bosses, the three middle sizes taking one and the three largest sizes taking two standard Eurocards on both top and base. Further pillars are also provided as intermediate mounts as are extra chassis supports.

A useful feature of this range is that the four smallest sizes are available with battery compartments at one end to take 1V5 pencells or flat 9V types. The smallest case is intended for use with hand-held, battery instruments.

Further details of Vero's G-Series from Vero Electronics Ltd, Industrial Estate, Chandler's Ford, Eastleigh, Hampshire SO5 3ZR.

For information on the BOCON range, contact West Hyde Developments Ltd, Unit 9, Park Street Industrial Estate, Aylesbury, Bucks HP20 1ET.

Happy Boxing Day!

SERVO AMP

New from Ferranti, the ZN419CE is a precision IC servo amplifier for use in pulse width position servo mechanisms and motor speed control applications.

It features low quiescent current, high output drive capability, low external component count and can operate over a wide range of repetition rates and pulse widths.

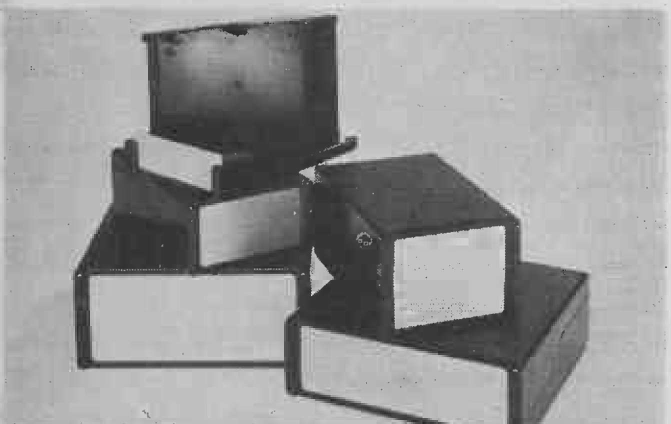
The device operates from a standard 1.5 mS pulse width with Schmitt trigger input shaping. The supply can be anything from 3.5 to 6.5V as the ZN419CE incorporates precision internal voltage stabilisation.

More information can be obtained from Ferranti Electronics Ltd, Fields New Road, Chadderton, Oldham OL9 8NP.

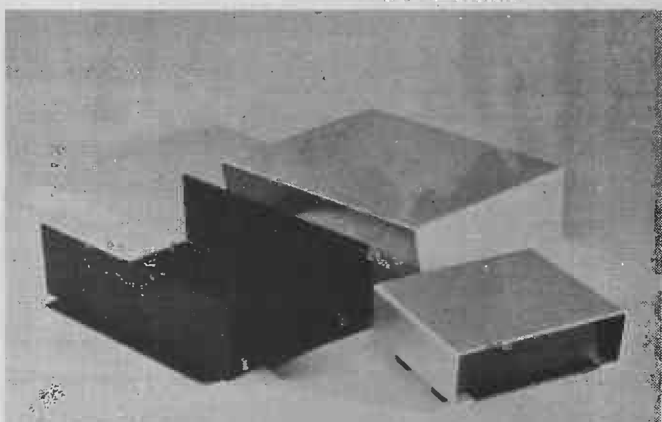
We've had several inquiries about errors in the System 8000 Tuner-amplifier project, which appeared in the June and July editions of ETI.

Unfortunately, we are unable to answer any technical queries on this project as the design from which Uni-Electric are producing their kit has been changed since we published the project.

In view of this, all inquiries on the System 8000 should be addressed to Uni-Electric Ltd, 182-184 Addington Road, South Croydon, Surrey. Tel. 01-657 4136.



New additions to West Hydes BOCON range.



Vero's G-Series

HOW IT WORKS

Keyboard Demultiplexer

The MPO signal that the dynamics board generates is used to turn off and on the notes selected by the keyboard. However, the MPO signal is multiplexed and so a demultiplexing system must be used to route the MPO signal to the correct note generator. The demultiplexer is virtually the same as the circuit used for the keyboard multiplexer except that the signal can be considered as travelling in the other direction. When an MPO signal is generated it is routed through a switch selected by the current address count to the correct output. Here it is used to charge up a capacitor which forms part of a simple sample and hold circuit. The voltage on this capacitor is used to generate a note and so this voltage determines the amplitude of the note. So, when middle C is played on the keyboard, it is detected by the keyboard multiplexer which generates a signal (MPI) which it sends to the dynamics board.

The key velocity is computed and an MPO signal is generated, whose amplitude determines the volume of the note. The MPO signal is demultiplexed and the sample and hold circuit for middle C rises to the amplitude of MPO. The voltage from this sample and hold is then chopped with a squarewave at a frequency of middle C and hence the note is generated. The problem in using 4051's as demultiplexers is that the switches inside the device are 'make before break' in operation. This causes many of the switches to be connected together for a few hundred nanoseconds when the address changes. As a result of this, when middle C is played a few other notes turn on slightly. This problem is overcome by inhibiting the 4051 (with the OEN signal) for a short period when the address changes.

Note Generator

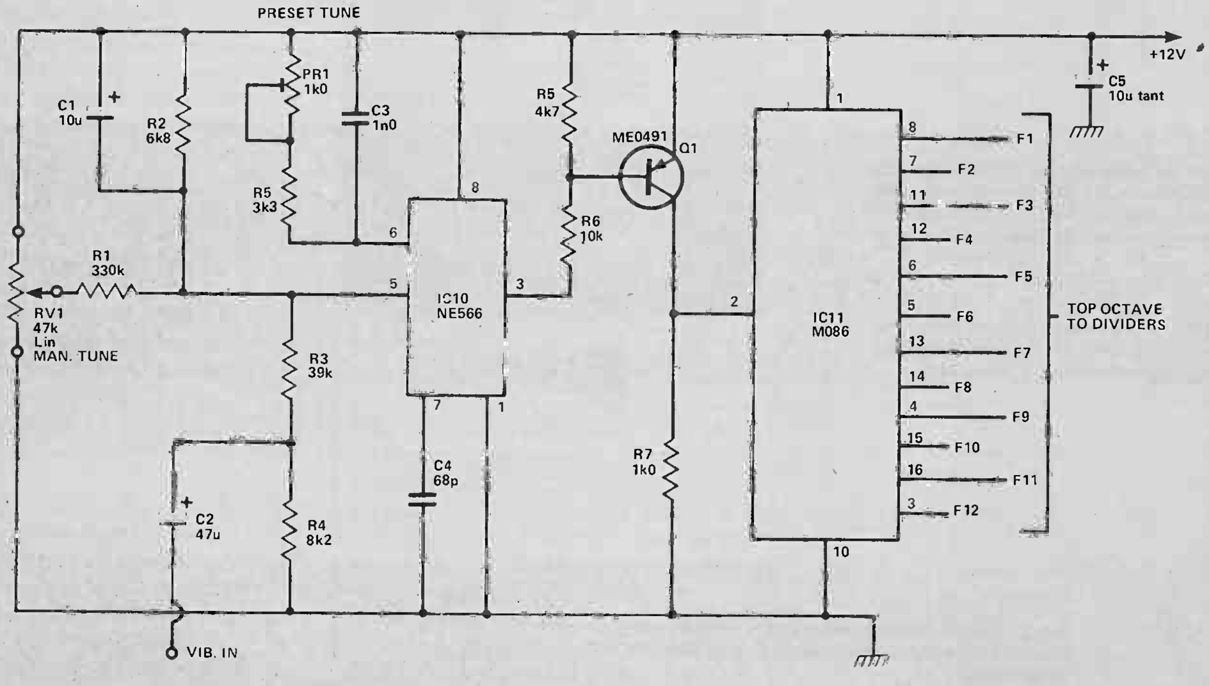
The waveform that appears at the output of the sample and hold when a note has been pressed is a squarewave, the amplitude of which is controlled by the velocity of the key depression. This squarewave is modified by two networks which produce two envelope contours that characterise the piano or the string/brass sounds. The string brass network is a simple RC, ie R_A, C_B, lowpass filter which gives the envelope a slow attack and decay contour. C_A is clamped to the clamp generator for this contour. The piano network is a slightly more complicated RC highpass filter. When the output of the sample and hold goes high, the negative end of C_A also goes high. This pulls C_B high (via D_B). The positive end of C_B is discharged to ground by the R_A resistors. Note that whilst the key is pressed both C_A plus C_B are discharged by the R_A resistors. When the key is released, the output of the sample and hold returns to OV and the negative end of C_A goes negative. Now D_B is reverse biased and so the envelope decay rate is more rapid because there is now only C_B to be discharged by the R_B resistors. D_A discharges C_A upon release of the key.

Chopping Volts

The selection of waveforms is performed with an electronic single pole switch. A mode control signal selects the envelope on all 61 generators. The notes are produced by chopping the envelope voltage with a single transistor chopper. Two square waves from the divider chain, an octave apart, are mixed and used to turn the transistor on and off. The mixture of these two waveforms turns the transistor on for 75% of the time and off for 25%. The resulting waveform is a series of pulses with an envelope contour of either the piano or string/brass shape. Diode D_C is

Fig 4 (Below) The circuit diagram for the master oscillator section of the note generator board.

(Right) The keyboard numbering system used for the note generators, and decoupling components circuit which is repeated for each IC from ten to twenty.



used to reduce background signal breakthrough and the notes are mixed together in octave blocks and sent to the voicing board for filtering.

Master Oscillator Top Octave Generator Divider Network

The top octave of the keyboard is produced by a tone generator IC, the MO86. This is a preprogrammed digital divider that divides a master high frequency oscillator by twelve integers ranging from 239 to 451. These twelve divisions produce squarewaves which are spaced at semitone intervals. Conventional keyboard tuning has twelve notes per octave, the interval between each note being a semitone, which is separated by the twelfth root of two from its neighbour. So the tone generator IC can produce the top twelve notes for the keyboard.

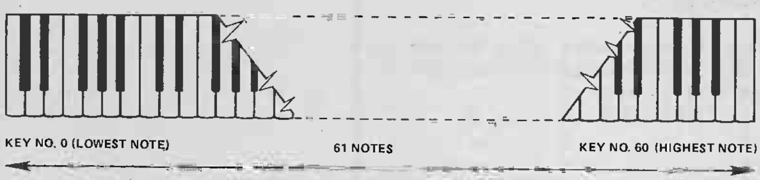
The lower octaves are produced by dividing down the top octave with divide by two flip flops. This would produce a separate squarewave for each note of the keyboard. However, squarewaves don't have a suitable harmonic structure for they contain only odd harmonics. The problem is overcome by 'ANDing' together two octave related notes to produce a pulse waveform with a one to three mark space ratio, which contains both odd and even harmonics. The resulting pulse has the frequency of the lower octave note, which means that for every note, a square wave one octave higher in pitch is needed to generate it. This is no problem for lower octave notes because the higher octave notes already exist. However, the top octave of the keyboard needs an extra stage of dividers, which means that the master oscillator must run an octave faster. If the highest note on the keyboard is 2.093 kHz then the master oscillator frequency is $239 \times 2 \times 2.093$ kHz = 1000.45 kHz.

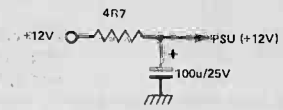
Master IC

The master oscillator has to produce a 12V squarewave at 1000.45 kHz, which doesn't drift with temperature and which can be voltage controlled. This is realised using a function generator IC, the NE566, which is capable of 1 MHz operation and has a relatively low temperature coefficient. Voltages from this IC can be used to control the oscillation frequency so that manual tuning and vibrato effects are easily obtained. A transistor (Q1) is used to level convert the output squarewave from the NE566. This transistor is a fast switching PNP device. Ordinary transistors tend to saturate for about a microsecond, which is much too long a time for an oscillator running at this frequency.

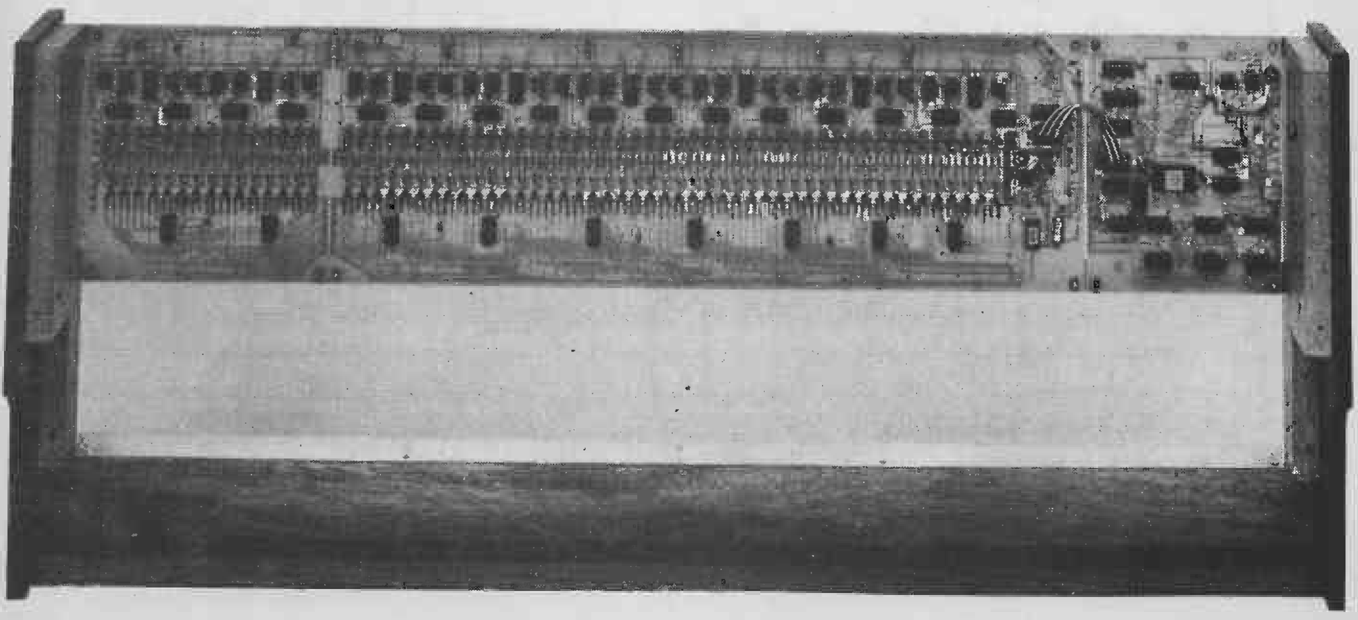
Stage Division

The dividers used are HBF 4727A which have been specifically designed for organ type divider systems. The IC contains seven divider sections which have been split up into two two-stage sections and three one-stage sections. The advantage of this is that you can put the dividers near to where you want them, that is, next to the notes that they drive. Some other designs have used a CMOS divider, the 4024. This will produce all the required six octaves of division but localised around the IC. Therefore, a five octave keyboard would need 72 wires or PCB tracks eminating from the divider section. However, by using the HBF 4727A it is possible to spread the dividers out along the length of the note generating board. This greatly reduces the wiring because all of it is done on the PCB with about 14 tracks. There are, of course, PCB wire links but these are very much easier to handle than a large wiring bundle.

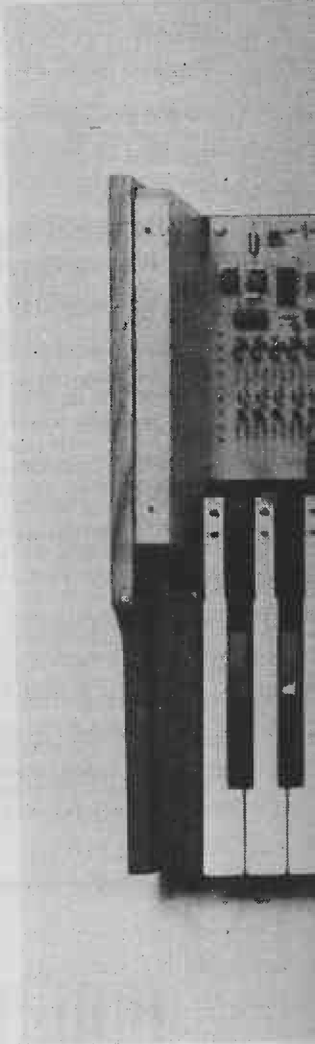




FOR IC10-20



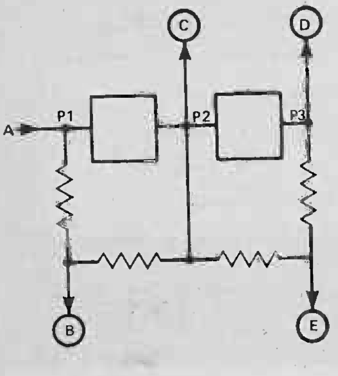
NOTE A	NOTE C	NOTE D		PIN NOS P1	P2	P3	KEYBOARD KEY B	E
F1	1B	1C	IC12	3	12	11	60	48
F2	2B	2C		2	14	13	59	47
F3	3B	—		4	10	—	58	—
F4	4B	—		5	9	—	57	—
F5	5B	—		6	8	—	56	—
F6	6B	6C	IC13	3	12	11	55	43
F7	7B	7C		2	14	13	54	42
F8	8B	—		4	10	—	53	—
F9	9B	—		5	9	—	52	—
F10	10B	—		6	8	—	51	—
F11	11B	11C	IC14	3	12	11	50	38
F12	12B	12C		2	14	13	49	37
3B	3C	—		4	10	—	46	—
4B	4C	—		5	9	—	45	—
5B	5C	—		6	8	—	44	—
8B	8C	8D	IC15	3	12	11	41	29
9B	9C	9D		2	14	13	40	28
10B	10C	—		4	10	—	39	—
1C	1D	—		5	9	—	36	—
2C	2D	—		6	8	—	35	—
3C	3D	3E	IC16	3	12	11	34	22
4C	4D	4E		2	14	13	33	21
5C	5D	—		4	10	—	32	—
6C	6D	—		5	9	—	31	—
7C	7D	—		6	8	—	30	—
10C	10D	10E	IC17	3	12	11	27	15
11C	11D	—		2	14	—	26	—
12C	12D	—		4	10	—	25	—
1D	1E	—		5	9	—	24	—
2D	2E	—		6	8	—	23	—
5D	5E	5F	IC18	3	12	11	20	8
6D	6E	6F		2	14	13	19	7
7D	7E	—		4	10	—	18	—
8D	8E	—		5	9	—	17	—
9D	9E	—		6	8	—	16	—
12D	12E	12F	IC19	3	12	11	13	1
1E	1F	1G		2	14	13	12	0
2E	2F	—		4	10	—	11	—
3E	3F	—		5	9	—	10	—
4E	4F	—		6	8	—	9	—
11D	11E	11F	IC20	3	12	11	14	2
8E	8F	—		2	14	—	5	—
9E	9F	—		4	10	—	4	—
10E	10F	—		5	9	—	3	—
7E	7F	—		6	8	—	6	—

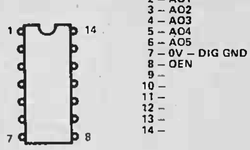


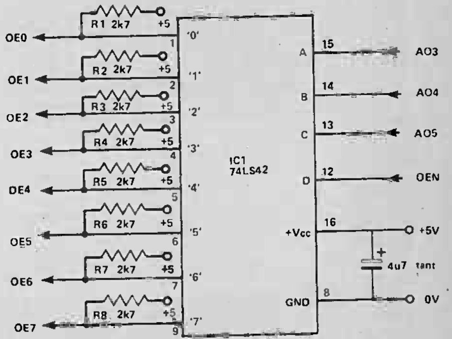
POWER FOR 4051B

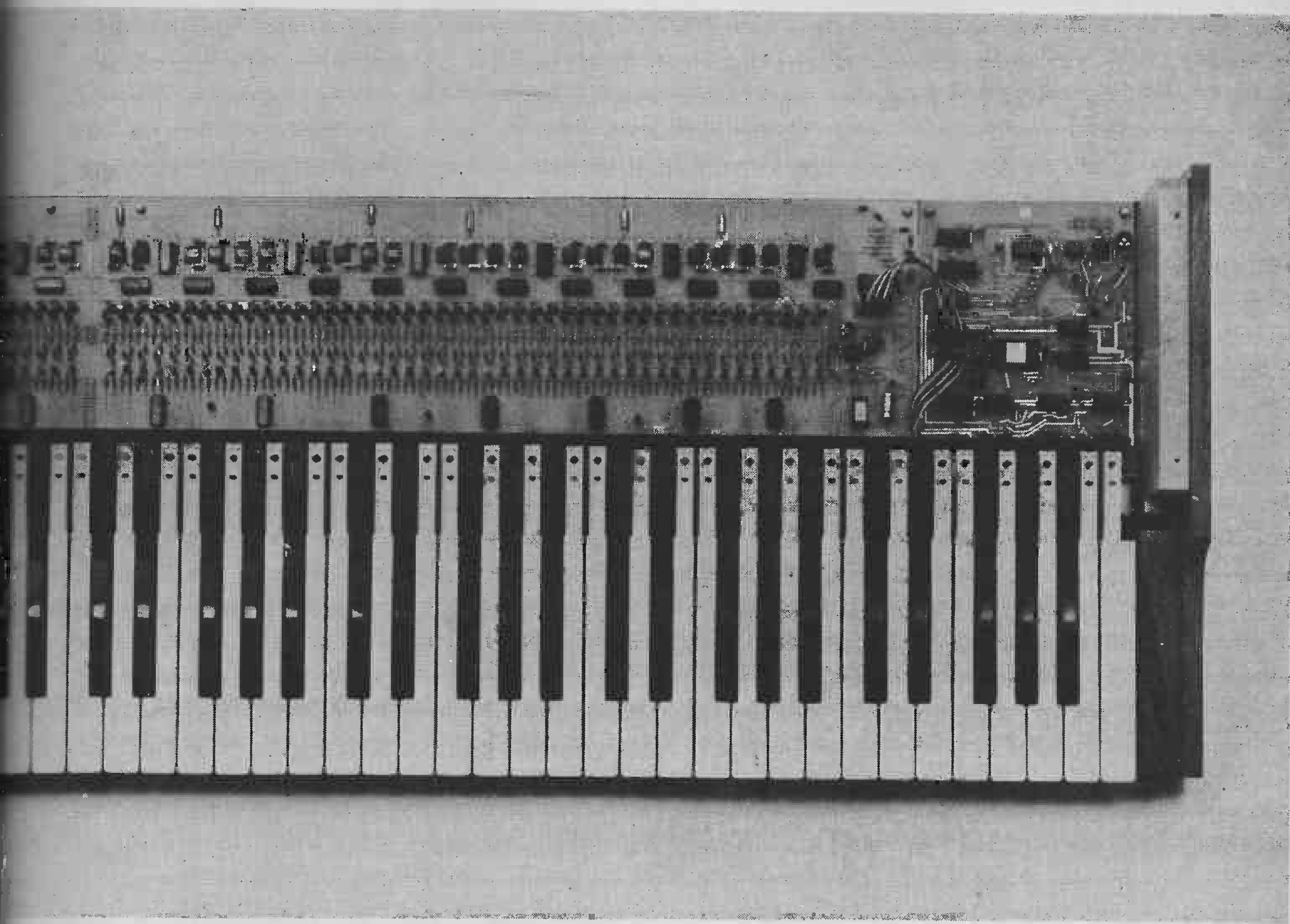
PIN 16 Vdd	PIN 8 Vcc	PIN 7 Vee
+Vcc	0V	0V

Above and below: connection details for IC12-20. The diagram below shows the annotations for the dividers, and the table gives the note, pin nos and connection points.









With the top panel removed, the two note generator boards can be seen.

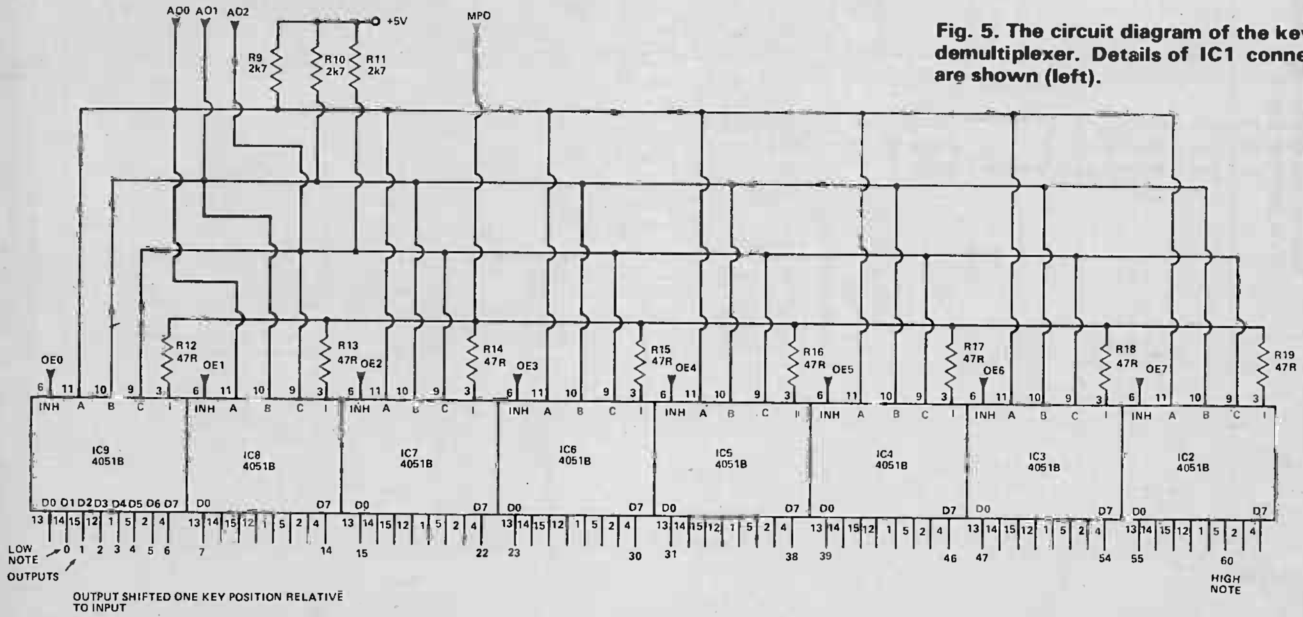


Fig. 5. The circuit diagram of the keyboard demultiplexer. Details of IC1 connections are shown (left).

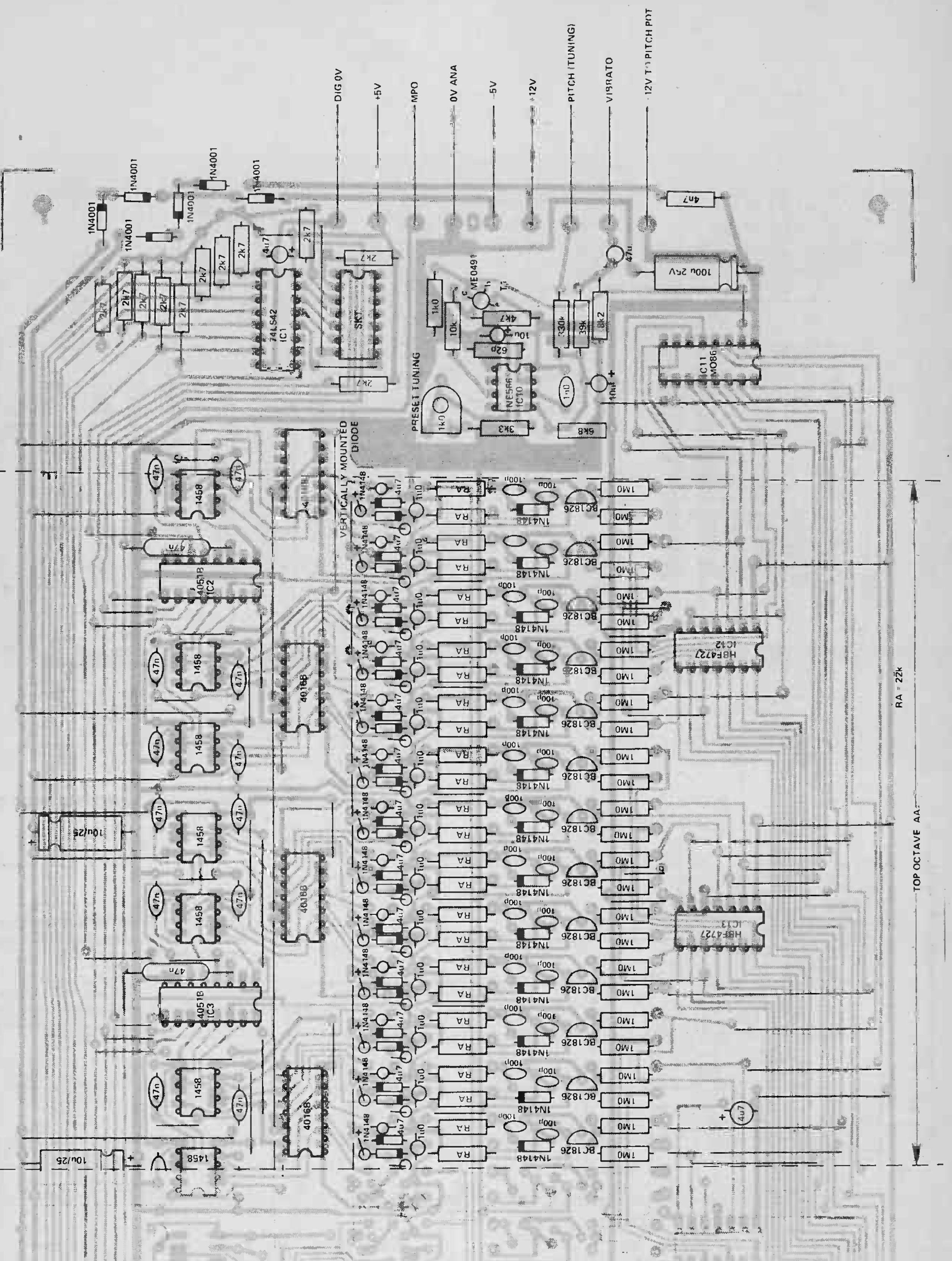


Fig. 6. The component overlay of the top note generator. These components are repeated down the length of the Board for each octave, except for RA. A table of values for RA is given in Fig. 8.

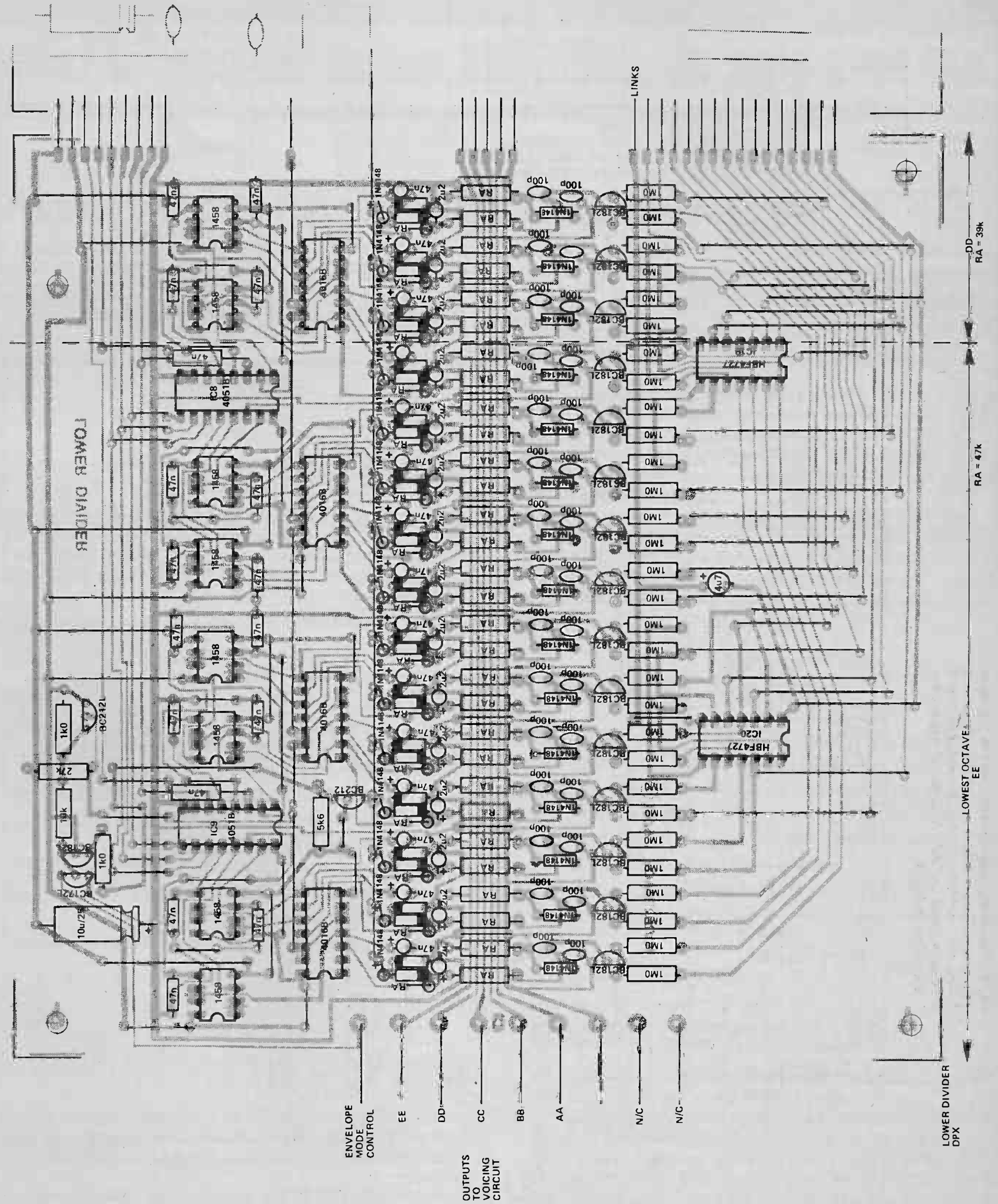


Fig. 7. Component overlay of the lower note generator.

PARTS LIST

KEYBOARD DEMULTIPLEXER

RESISTORS all 1/5th Watt 5%

R1-11	2k7
R12-19	47R

CAPACITOR

C1	4u7 tantalum

SEMICONDUCTORS

IC1	74LS42
IC2-9	4051B

NOTE GENERATOR BOARDS

Master Oscillator and Top Octave Generator

Component	Qty
RESISTORS (all 1/5W 5%)	
4R7	1
1k0	1
3k3	1
4k7	1
8k2	1
10k	1
39k	1
330k	1

Component	Qty
POTENTIOMETER	
1k0 preset	1
CAPACITOR	
1n0	1
68p polystyrene	1
0u47 tantalum	1
100u 25 V electrolytic	1
SEMICONDUCTORS	
M086	1
NE566	1
ME0491	1
MISCELLANEOUS	
Top Note PCB	1
Lower Note PCB	1

Divider Section

Component	Qty
1M0 1/5 W 5%	122
4u7 16 V tantalum	4
HBF4727	9
14 pin DIL sockets	9

Envelope Section

RESISTORS (all 1/5 W 5%)	
1k0	2
5k6	1
10k	1
22k	39
27k	37
33k	36
39k	36
47k	36
CAPACITORS	
100p ceramic	122
47n (7.5mm pitch)	61
1u0 electrolytic	8
2u2 16 V tantalum	61
4u7 16 V tantalum	61
SEMICONDUCTORS	
TLMC1458C	31
4016B	16
BC182LA	61
BC182L	2
BC212	2
1N4001	6
1N4148	244
MISCELLANEOUS	
8 pin DIL socket	31
14 pin DIL socket	16

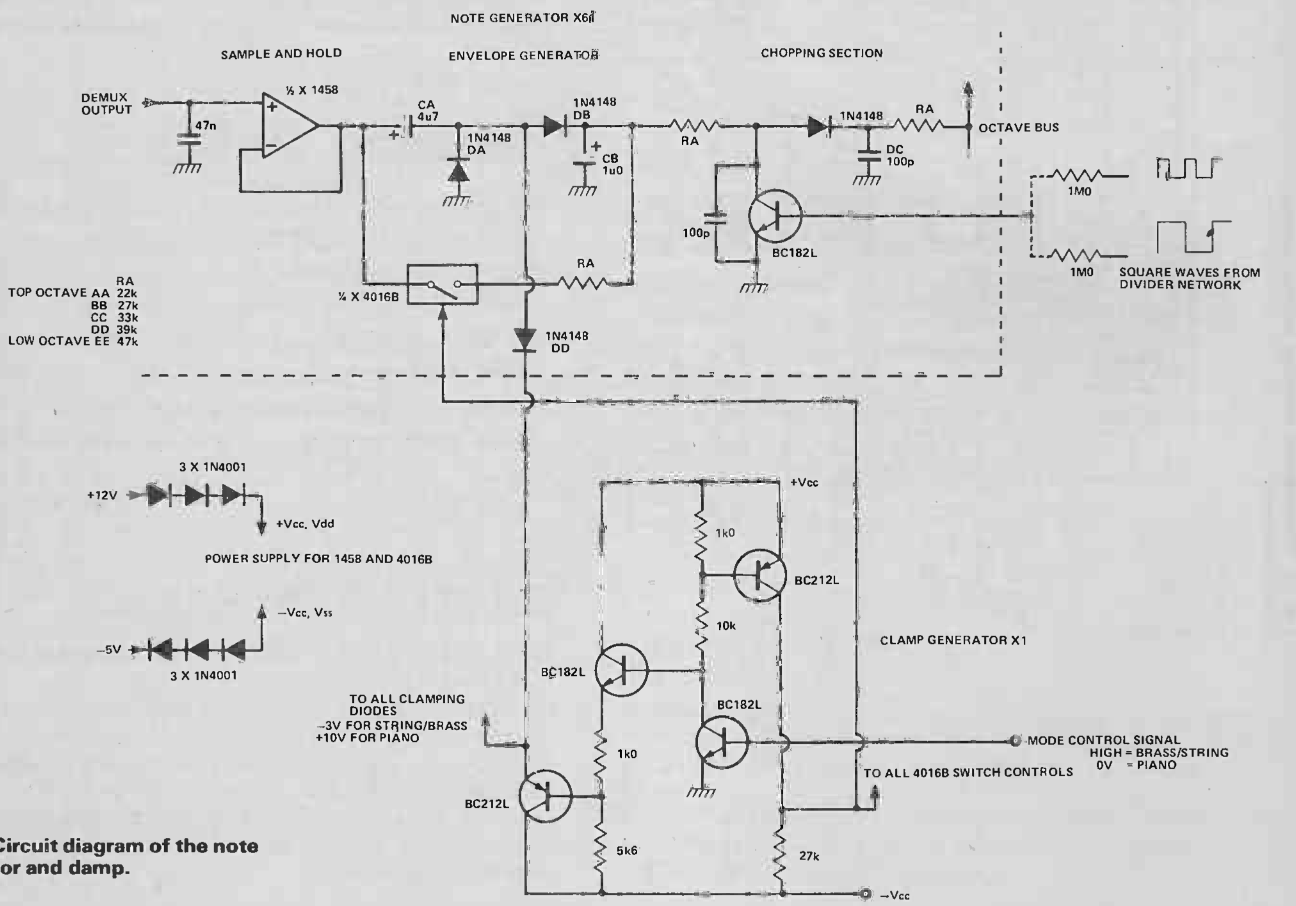


Fig. 8. Circuit diagram of the note generator and damp.

DESIGNER'S NOTEBOOK

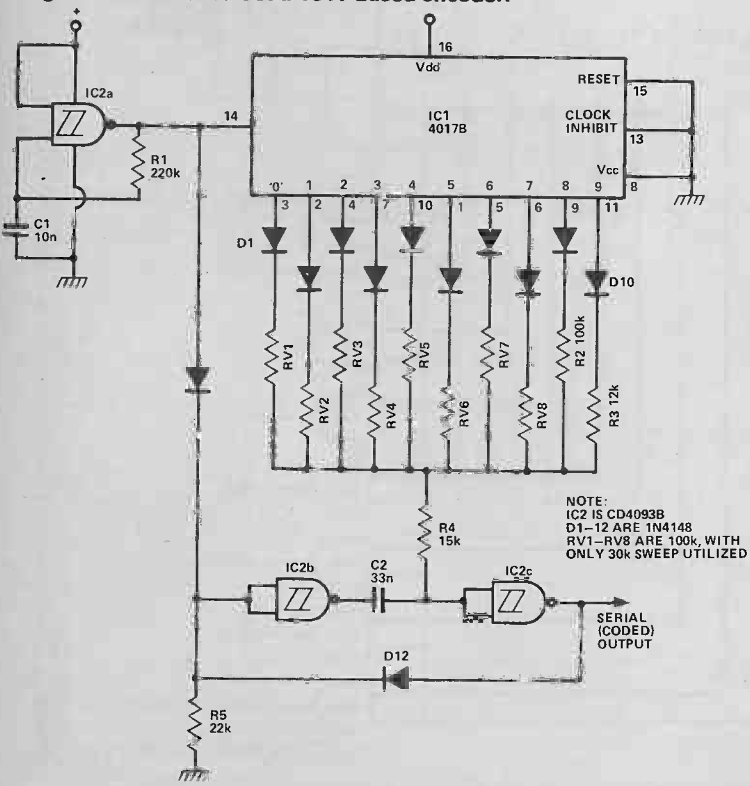
A monthly look at the notebook of ETI's chief design engineer, project editor Ray Marston.

SIMULTANEOUS multi-channel remote control systems, giving either fully proportional or simple on/off action (or a combination of the two) are widely used by the model 'plane, boat and car fraternities. Figure 1 shows the basic block diagram of an 8-channel version of the type of system in use.

In the transmitter, eight manually-actuated pots (in a proportional system) or switches (in an on/off system) are sequentially sampled at a fixed rate by an ENCODER circuit, which at each sample point generates a pulse with a width proportional to the state of the device being tested. The output of the encoder consists of a repeating series of 'frames' of eight width-controlled pulses followed by a synchronisation pulse, all presented in serial form.

Typically, in an 8-channel proportional system, the width of the controlled pulses may be variable from 0.5 mS to 1.5 mS (depending on the settings of individual control pots), the sync. pulse width may be 3 mS, the sample period 2 mS and the frame width 20 mS.

Fig. 1. Practical circuit of a 4017 based encoder.



Servo code

The serial output of the encoder is coupled via a suitable 'link' to the input of a decoder circuit that is located in the remote receiver. The link may take the simple form of two wires (or only one if a ground return is used), or the more complex form of a modulated radio, ultrasonic, infra-red, or magnetic signal, etc. The decoder circuit detects the sync. pulse in each frame, and then counts the individual controlled pulses in the frame and routes each one to its own output terminal. There it may be fed to an electronic switch or a servo-mechanism which will reconstruct the original mechanical control movement that took place at the transmitter.

The 'heart' of the remote control system described above is the encoder and decoder. As already mentioned, the actual 'link' can take any one of a variety of forms. The basic control system is highly versatile and has a vast number of untapped potential applications. The number of channels that can be simultaneously controlled can range from two to dozens (or even hundreds). In on/off applications, the outputs can easily be binary decoded to give non-simultaneous on/off control of a vast number of remote devices: an 8-channel system can, for example, control 256 devices, or a 12-channel system can control 4096.

The system can readily be adapted to give remote operation of lamp dimmers, volume controls, 'combination' locks and garage doors, or independent on/off control of hundreds of household fittings via signals pumped down the mains wiring. You can even, if it takes your fancy, use the system to remote control a full sized piano from the comfort of an armchair via a hand-held keyboard and an infra-red link!

An 8-Channel Proportional Control Encoder

Figure 1 shows the practical circuit of a 4017-based 8-channel encoder for use in simultaneous control systems. IC2a is a 500 Hz (2 mS) astable multivibrator that simultaneously feeds clock signals to the input of the 4017 and trigger signals to the input of the IC2b-IC2c monostable multivibrator. In any given clock cycle, the period of the monostable is determined by C2-R4 and by the resistance value in series with the relevant 'high' output of the 4017. In clock cycles '0' to '7' the pulse widths are determined by the settings of RV1 to RV8 respectively. In the '8' clock cycle the pulse has a width equal to the clock cycle period (2 mS), and in the '9' clock cycle the pulse is fixed at about 1 mS, thus ▶

giving a composite 3 mS sync pulse from the 8th and 9th cycles. The system is designed to give a fixed 20 mS frame width.

Note that, in conformance with normal practice, only one third (or less) of the sweep ranges of RV1 to RV8 are utilized. In practice, component values may have to be altered slightly to give precise ranges of coded output pulse widths.

An 8-Channel Proportional Control Decoder

Figure 2 shows the circuit of a decoder for use with the above system. The incoming 'coded' waveform is fed simultaneously to the clock terminal of the 4017 and to the trigger terminal (via C1-R1-D1) of the IC2c-IC2d monostable. IC2c of this monostable produces a negative-going pulse with a period slightly less than the 2 mS clock period (about 1.8 mS), and this negative pulse is ANDed with the positive clock signal by IC2a and IC2b to produce a reset output signal from the 3 mS input sync pulse, but not from the 'control' pulses, which all have periods significantly less than the 1.8 mS reference value.

Note that the value of R3 may have to be adjusted on test to set the correct reference period.

Outputs 1 to 8 of the 4017 are sequentially ANDed with the coded clock input signal once the counter has been reset by the sync pulse, so that each individual code pulse is routed to its own designated output terminal or channel. The individual outputs, which take the form of 0.5 mS to 1.5 mS pulses with repetition periods of 20 mS, can then be fed to suitable servos, etc, to convert the pulses into proportional mechanical movements.

An 8-Channel Simultaneous On/Off Encoder

Multi-channel simultaneous on/off coder/decoder systems are technically no easier to implement than full proportional systems. In fact they are often more difficult. Figure 3 shows a practical example of a simultaneous 8-channel on/off control encoder.

Here, astable multivibrator IC2a simultaneously feeds 500 Hz clock signals to the 4017, to the IC3a-IC3b 200 uS monostable multi, and to one input terminal of the IC2b-IC2c AND gate. The other input of the AND gate is sequentially taken from the '0' to '7' outputs of the 4017 via any of the PB0 to PB7 switches that are closed, and directly from the '9' output. The outputs of the AND gate and the 200 uS monostable, plus the direct '8' output of the 4017, are all ORed to produce the final serial coded output across R4.

The final output waveform comprises 200 uS pulses and 1 mS pulses to represent off and on switch states respectively, plus a 3 mS sync pulse spanning the 8th and 9th clock cycles.

An 8-Channel Simultaneous On/Off Decoder

Figure 5 shows a decoder circuit that is suitable for use with the above encoder. Here, the IC3a-IC3b-IC2a-IC2b network detects the input sync pulse and then resets the counter, and the IC3c-IC3d-IC2c-IC2d network detects 'wide' (1 mS) or 'on' code pulses and then ANDs the selected output of the 4017 via the IC4-IC7 array to produce a high potential on the appropriate output channel. Note that the purpose of the D-R-C network in each output channel is to convert a detected 'wide' pulse into a steady DC voltage that will remain high (or low) for greater than one frame period.

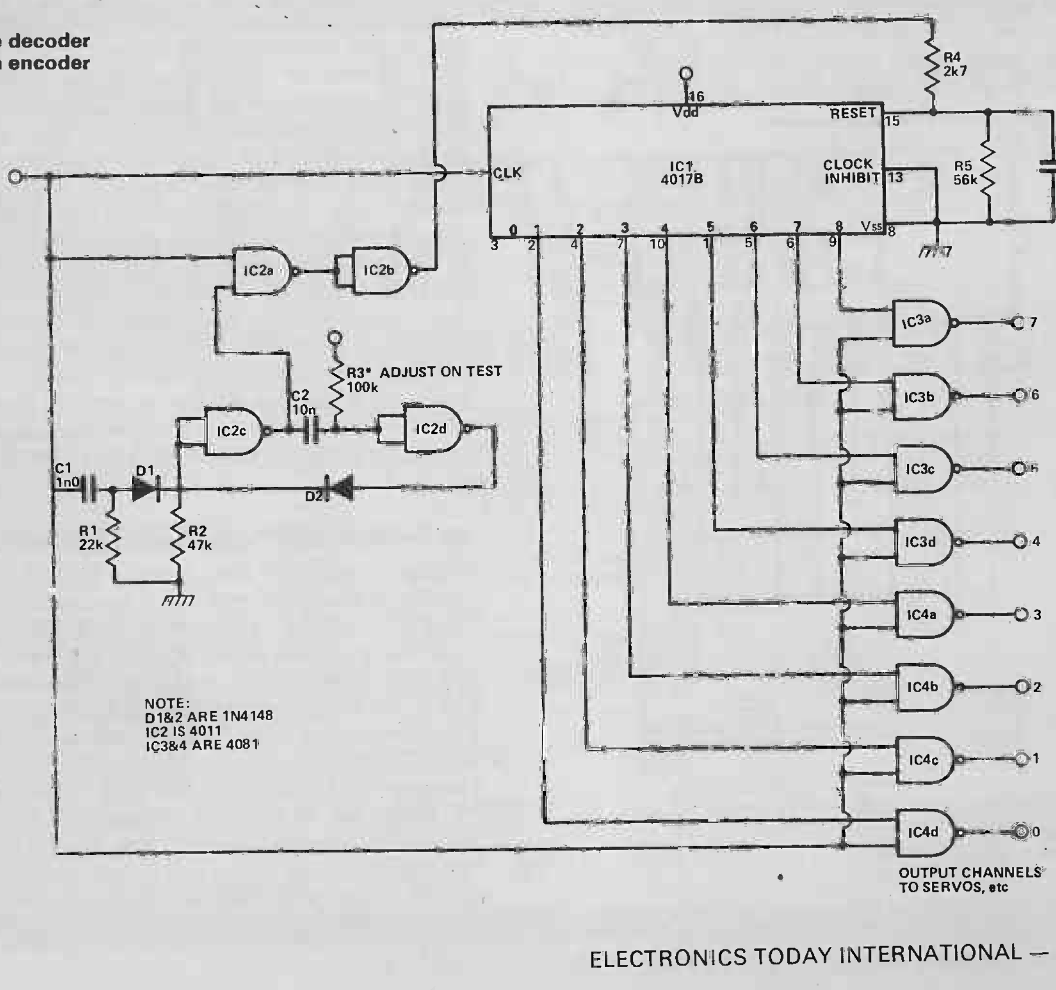


Fig. 2. Suitable decoder circuit to match encoder (Fig. 1).

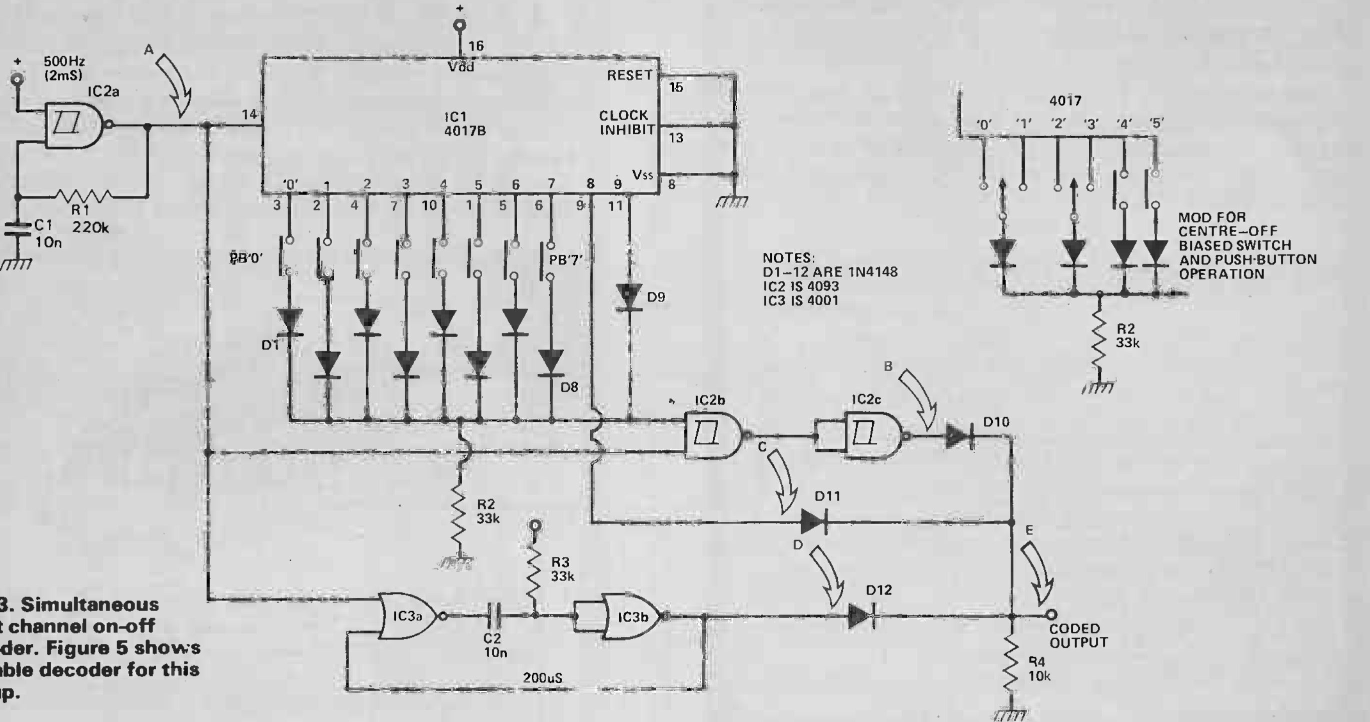


Fig. 3. Simultaneous eight channel on-off encoder. Figure 5 shows a usable decoder for this set-up.

Note that the steady (non-pulsed) outputs of the eight channels of this system can readily be binary decoded to make a total of 256 non-simultaneous channels available.

Expanded Multi-Channel Control Systems

All of the coder/decoder circuits presented in this month's "Notebook" can be expanded to incorporate any number of channels (with appropriate increases in frame periods and miscellaneous timing component values) by using multi-stage 4017 counter networks (see the last Notebook) in place of the single counters shown here. If you want more information on this circuit and its brother decoder, you'll have to wait until the circuit reappears in an ETI project some-time later!

▶

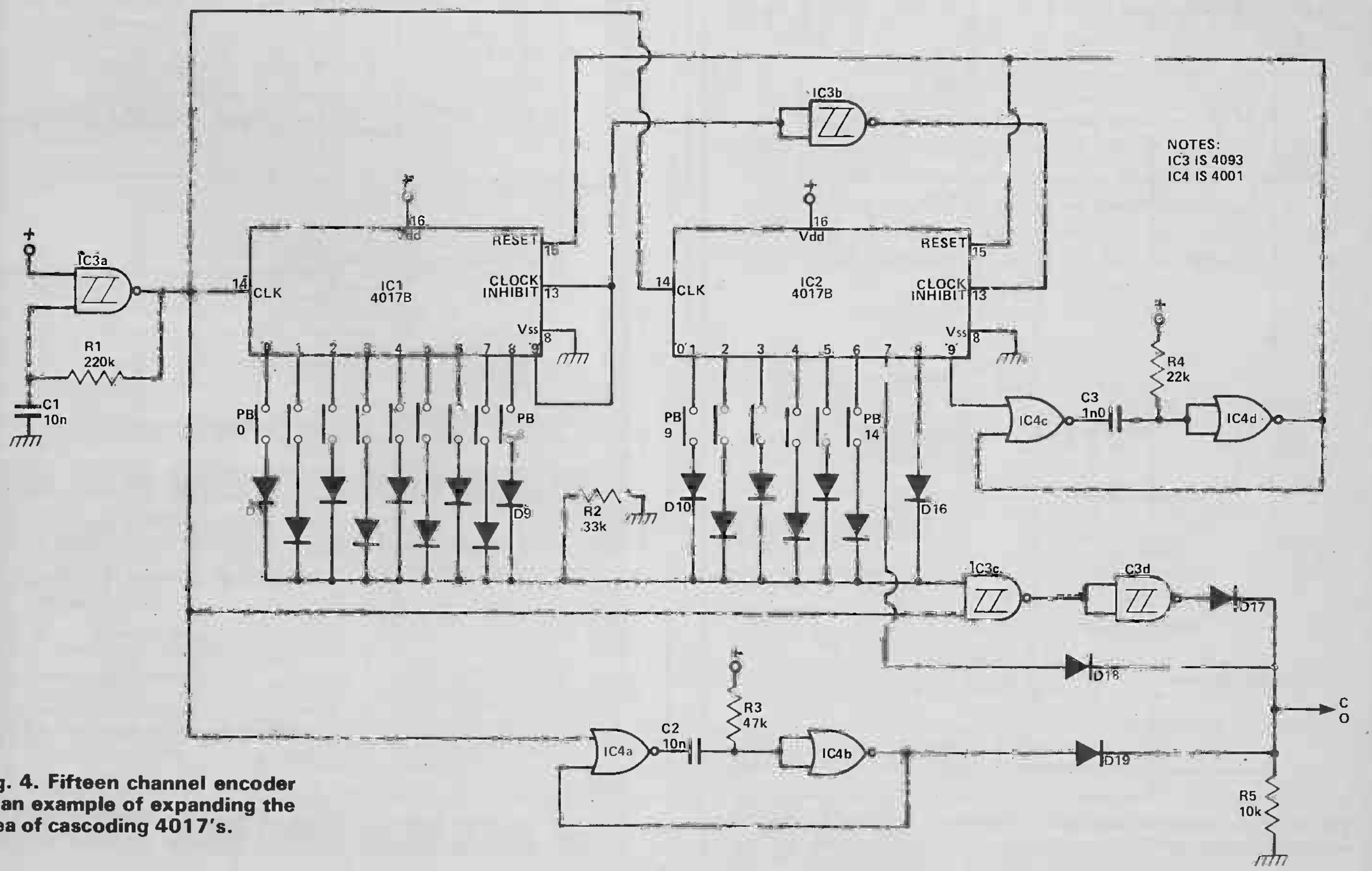


Fig. 4. Fifteen channel encoder — an example of expanding the idea of cascoding 4017's.

news digest

SCOPE FOR IMPROVEMENT

Philips have announced two new 35 MHz oscilloscopes to extend the facilities already found in the well-proven 25 MHz range.

In appearance, the new scopes, designated the PM3216 and PM3218, are very similar to their predecessors. Spot the new scopes in our photos. (The new models are below).

The main difference between the two new instruments is that the PM3216 is dual-trace, single timebase and the PM3218 is the dual-trace, dual timebase model. The PM3218 also features an alternate timebase so that both main and delayed timebase signals can be displayed for easy reference.

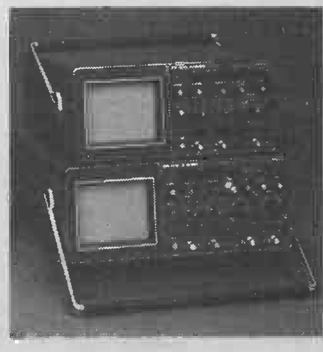
Sensitivity for both of the new models is 2mV over the full 35 MHz bandwidth, coupled with a trigger sensitivity of 1 div and an external trigger sensitivity of 200 mV. In addition a 10:1 attenuator on the external trigger provides a very wide dynamic range.

Z-input modulation makes the scopes ideal for logic analyzer applications.

Both accuracy and ease of use are enhanced by means of double insulators which allows the instruments to be operated safely without an earth connection, thereby eliminating earth loop and hum problems.

The new models can be operated almost anywhere, with possible mains supplies of 110, 127, 220 and 240V AC (±10%) in the frequency range 46 to 440 Hz, and also 21 to 27V DC. An optional internal 24V battery supply makes the unit truly portable. Power consumption is 30 W.

Further information from Pye Unicam Ltd, York Street, Cambridge CB1 2PX.



The Commercial Radio Control Scene

The commercial radio control scene is going through a world-wide boom at the present time. A big craze for radio controlled model or 'toy' cars is currently sweeping Japan, where manufacturers are planning to step up production from last year's 700,000 units to 2 million units in 1979.

At the back of this craze are some interesting new R/C ICs. Single IC 6-channel transmitters (coder plus RF stages) and 4-channel receivers (RF stages plus decoder) will soon be available in the UK. The ETI design team expects to get samples of these chips within the next few months, and may describe them in a future feature article. ETI

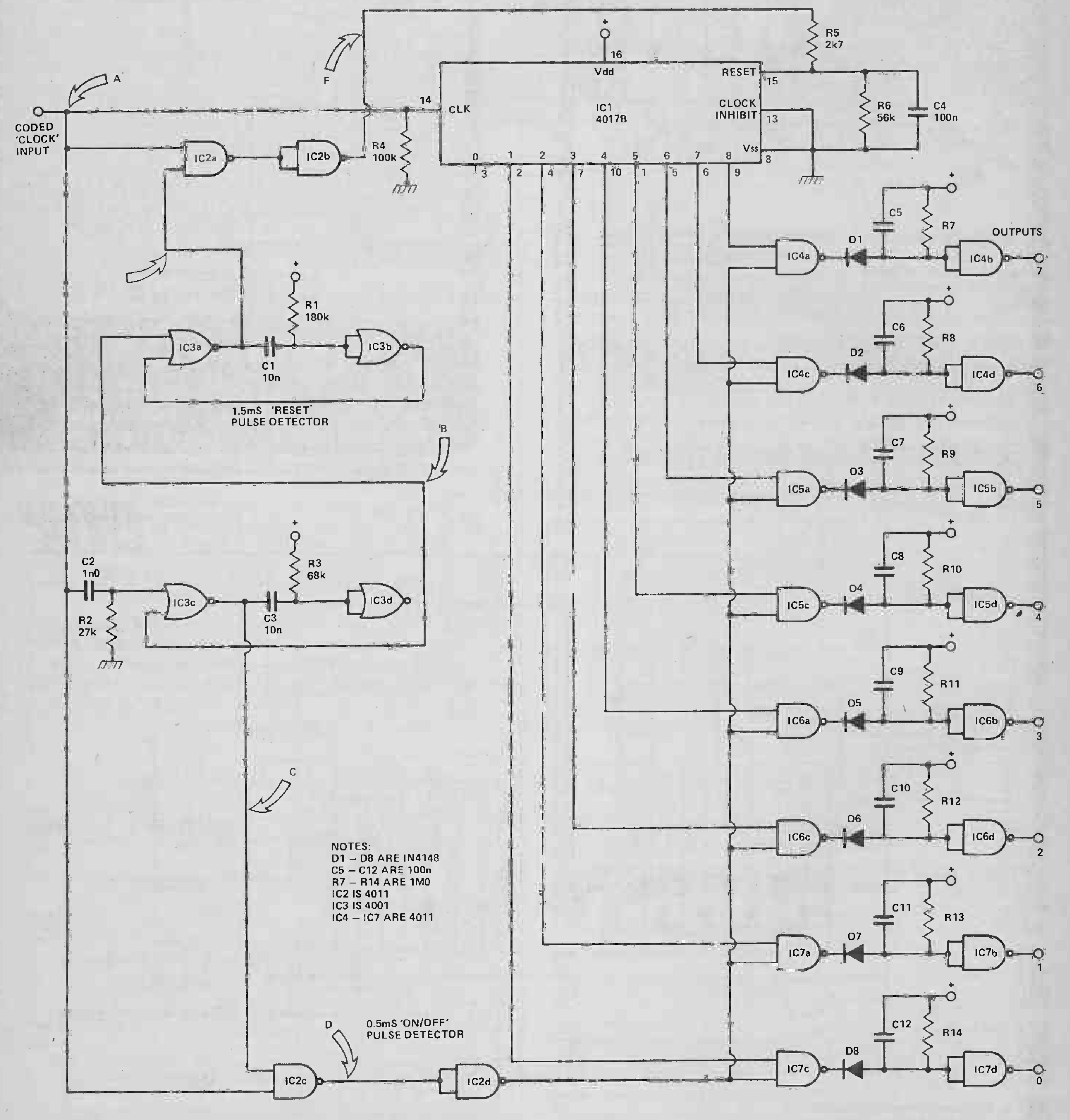
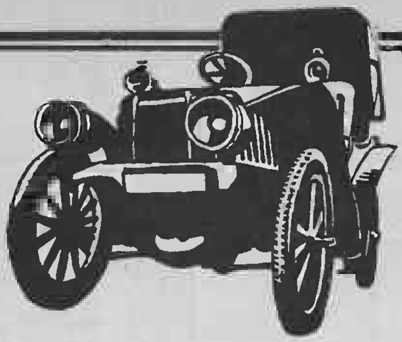


Fig. 5. Eight channel decoder which will operate as a system with either encoder (Figures 3 or 4).



OVERSPEED ALARM

This unit activates when your vehicles engine or road speed exceeds pre-set limits. It can be used as a stand-alone project, or can be used in conjunction with the fault monitor described elsewhere in this issue.

THE ETI OVER-SPEED ALARM is designed for use in petrol-engined vehicles fitted with 12 volt negative-ground electrical systems only. It is driven from the engine's contact-breaker points, and can be used to activate when the engine RPM exceeds a pre-set limit, or when the vehicle's top-gear road speed exceeds one of four pre-set values.

The unit switches on a LED and energises an optional load, such as a relay or an audible warning device, when it is activated. If the unit is used in conjunction with the 'Fault-Light and Turn-Indicator Audible Repeater' project described elsewhere in this issue, the optional load of the Over-Speed Alarm can be omitted and the unit's auxiliary output can be used to activate the audible warning device that is built into the 'Repeater' unit.

The over-speed alarm is inexpensive, is easy to build and is quite easy to install in the vehicle.

Construction, Installation And Use

Before starting construction, note the following points and add or delete components to or from the design as appropriate.

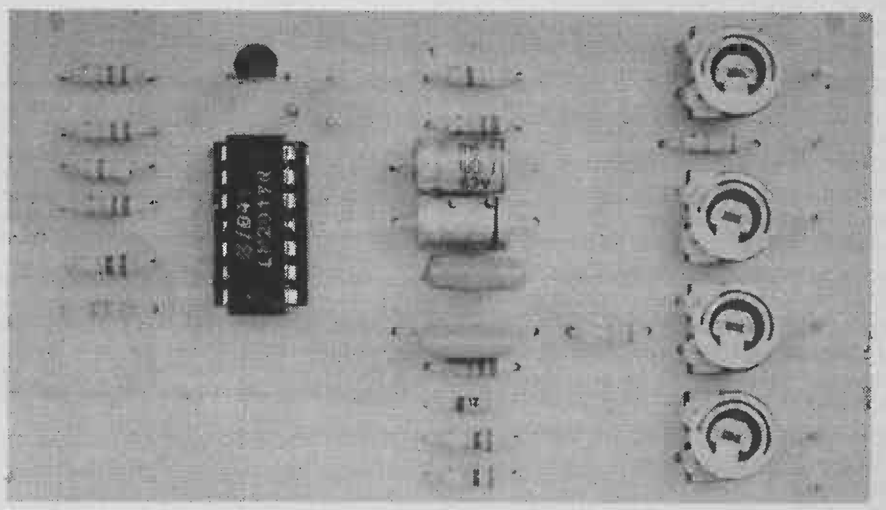
(1). If you intend to use the unit purely as a single-range excess-RPM alarm, delete SW1 and RV2 to RV4 from the circuit, and connect pin 3 of the IC to ground via RV1 and R6. In this case the circuit's positive supply rail can be taken to the vehicle's battery via the ignition switch, so that the system is permanently enabled when the vehicle is in use.

(2). If you are going to use the unit as a 4-range excess road-speed alarm, note that the system works on the assumption that you will always be in top gear when you exceed a speed limit and is thus designed to be effective only when the vehicle is in top gear. In this case, therefore, the unit's positive supply rail should be taken to the vehicle's battery via the ignition switch and an on/off switch. The on/off switch can either be a manually-operated type, or can be a microswitch that is activated by the vehicle's gear lever.

(3). If you decide to fit the unit with an optional load, such as a relay or an audible warning device, the load must have an impedance greater than 100R.

(4). If you decide to use the unit in conjunction with the 'Audible Repeater' unit described elsewhere in this issue, you can eliminate R7 and Q1 from the design and connect the auxiliary output terminal of the over-speed alarm to the auxiliary input terminal of the 'Repeater' unit.

(5). The C2 value of the circuit must be chosen to suit the required RPM trigger range of your vehicle. A value of 100n enables an RPM span of 1500 to 6000 to be covered on a 4-cylindered 4-stroke engine. If your vehicle is an 8-cylinder 4-stroke, or a 4-cylinder 2-stroke, halve the value of C2 to get the same RPM span. ▶



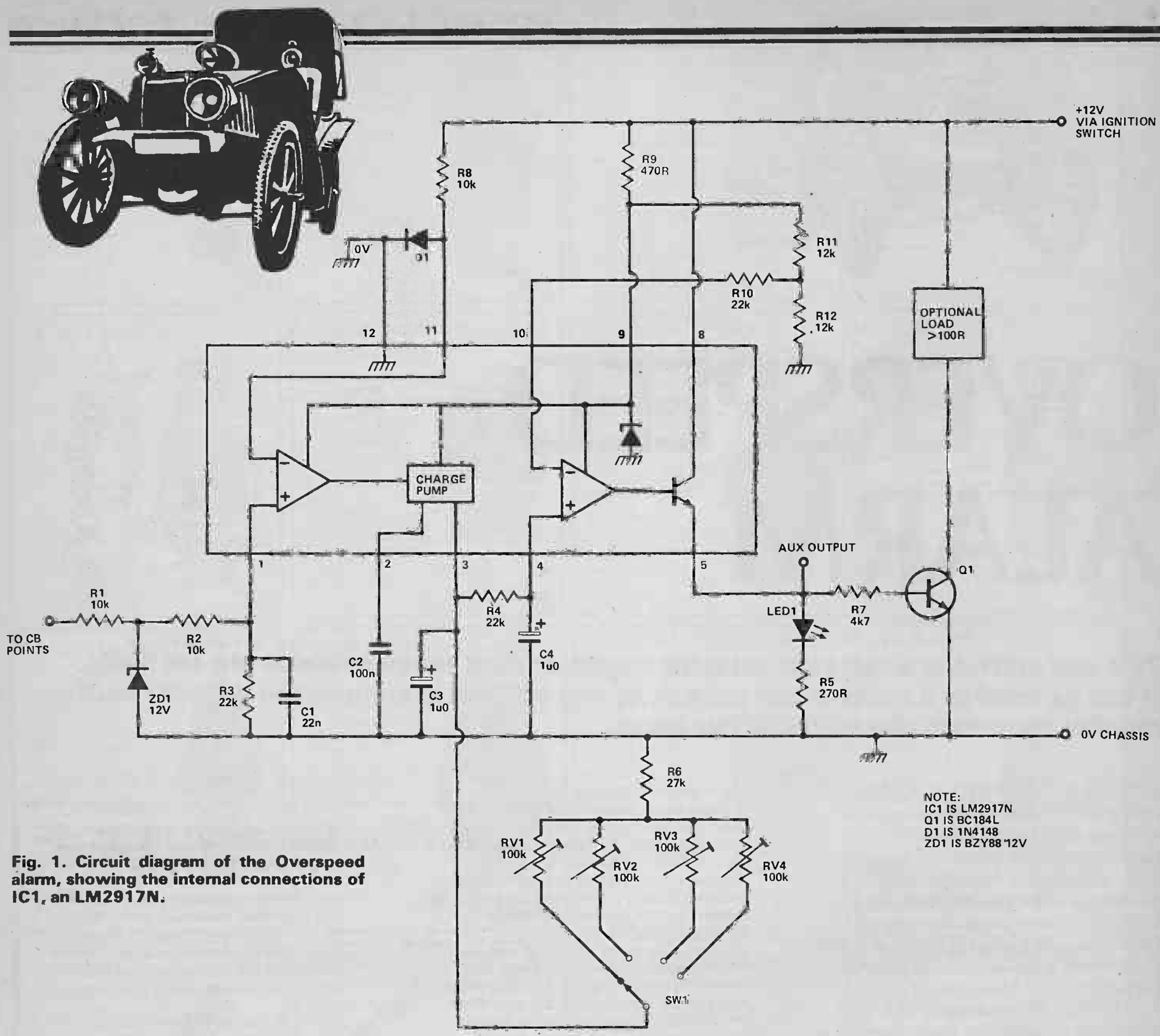


Fig. 1. Circuit diagram of the Overspeed alarm, showing the internal connections of IC1, an LM2917N.

One you've sorted out these five points, you can go ahead with the construction and installation of the unit. Construction is simplicity itself, and should present no problems.

Installation is simply a matter of connecting the unit's 0-volt line to chassis, the positive rail to the vehicle's battery via the ignition switch (and possibly an on/off switch), the input to the vehicle's contact-breaker points and the output to a suitable audible warning unit as already described.

Calibration of the unit is a two-man operation, with one driving the vehicle to the required trip speeds and the other adjusting the unit's pre-set pots to give the required trigger action!

HOW IT WORKS

The over-speed alarm works by detecting the engine RPM rate via the vehicle's contact breaker points, converting the resulting C-B frequency into a linearly proportional voltage and feeding this voltage to a comparator that trips and activates a LED and an audible warning device when the voltage (and thus the RPM) exceeds a pre-set value.

The assumption is made that the unit will only be used as an excess road-speed alarm when the vehicle is being driven in top gear (the engine RPM is directly proportional to road speed). In this case the unit's positive supply rail connection should be broken when the vehicle is not in top gear.

Most of the work of the unit is done by IC1, a frequency-to-voltage converter chip. Components R1-ZD1-R2-R3 and C1 'condition' the contact-breaker signal and make it suitable for driving the chip. C2 and RV1-RV4 and R6 determine the frequency-to-voltage conversion rate of the IC. and C3-R4-C4 remove ripple from the resulting DC signal that is fed to one side of the IC's voltage comparator stage. The output of the IC is used to drive LED 1 and to switch on Q1, which is capable of providing a 120 mA load current.

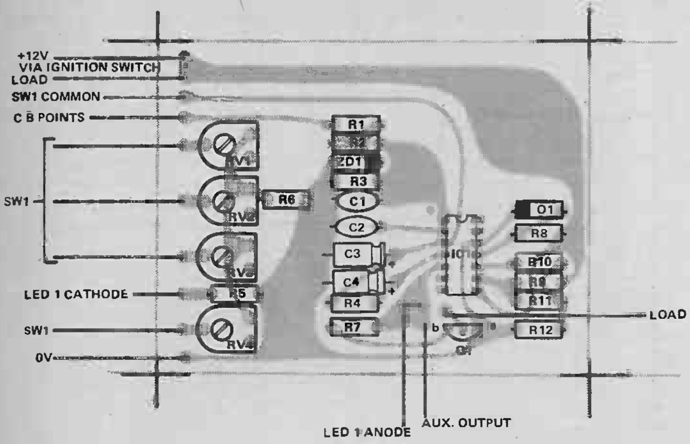


Fig. 2. Component overlay.

"At last! My energy saving car! All I need now is fifty-five miles of mains cable"

PARTS LIST

RESISTORS	
R1, R2, R8	10k
R3, R4, R10	22k
R5	270R
R6	27k
R7	4k7
R9	470R
R11, R12	12k
POTENTIOMETERS	
RV1-4	100k sub min presets
CAPACITORS	
C1	22n polyester
C2	100n polyester (see text)
C3, C4	1u0 63V electrolytic
SEMICONDUCTORS	
IC1	LM2917N
Q1	BC184L
ZD1	BZY88 12V
D1	1N4148
LED1	0.2" standard red LED
MISCELLANEOUS	
SW1, single pole 4-way rotary switch.	

BUYLINES

The LM2917N can be obtained from Maplin Electronics. The optional load uses the same rated audible warning device as this month's other car projects and the rest of the bits are available anywhere.

microfile

This month Henry Budgett treats us to the first lesson in the new science of Comparative Micrology. He prises the silver lining out of the micro supply cloud and even manages to squeeze in a club note.

Eight Versus Sixteen

AUDIOPHILE LONG SEEMS to have had a monopoly on comparitive equipment tests, whereas in the micro world it is not easy to compare machines of varying types down to the CPU level. Well, to change all that a new board has been announced by a firm called BL Microelectronics. Engineered on a double, double Eurocard, that can be split in two, with an attendant full ASCII keyboard it will allow direct comparison of the Z80 and TMS 9980 microprocessors. The unit is supplied as a kit with either or both of the CPU's and their monitors and has a number of interesting features.

Buffered Buses

The TV interface section, the right hand Eurocard section, provides a memory mapped display of 16 lines, 64 characters long using an 8 by 5 matrix. The character generator is a 2708 allowing the user to supply his own character sets if required. A cassette interface is also available on-board with a 300 Baud rate. The standard is modified Kansas City and a choice of output levels are available. Also supplied as standard on the board is an RS232 interface with programmable Baud rates. All the bus lines are fully buffered and are available for user expansion, there are memory mapped I/O lines provided as well.

The BIPROC 8/16 microcomputer board with no CPU and monitor installed. The board can be cut in two for rack mounting.

The system monitor is supplied separately for each CPU in a 2K EPROM and has six available commands allowing memory modification, inspection, dump and load, breakpoint insertion and program execution. However, the monitor also includes a microassembler so your programs may be loaded in mnemonic form as well as machine code, a very useful facility indeed.

By using the same monitor for each CPU in turn, the two may not be used at the same time for fairly obvious reasons, a direct comparison of the performance may be obtained. The price of the kit varies from £194 for the Z80 to £225 for both and further information can be obtained from BL Microelectronics at 1 Willow Way, Loudwater, Bucks.

Club Roundup

I have received a few replies from our Club Survey in CT last month. It seems things have changed a bit since I compiled the information!

The Thames Valley Amateur Computer Club is now run by Brian Quarm (Hon Sec) who may be contacted on Camberley 22186 and the Meetings Organiser is Brian Steer. Membership fees have not yet been decided and the club is open to anyone with an interest in computers. They meet on the first Thursday of each month and you may obtain more details from the Publicity Secretary, Chris Wallwork at Oak Cottage, Ecchinswell, Nr Newbury, Berkshire. The second and rather more embarrassing slip up was the South Yorkshire Amateur Computer Club. Mr Beard has written to tell me that he never has run an ACC, because he's a newsagent! So if you have his name on a list of clubs, please cross it off.

Mailbag

Two club newsletters arrived during the month, both Nascom orientated. The INUC have produced a newsletter, although not as well produced as some I have seen. It does make interesting and informative reading. The cartoons are quite amusing as well. The other one is from INMC, the official one, and is their second. Well I never got to see the first, but it's also well produced with excellent software listings which I shall be trying out when our "2" arrives. Keep up the good work and let's hear from some other clubs as well. ▶

NEWS Microfile

Supply And Demand

Many criticisms have been levelled at several firms in the micro business about the availability of product, both recently and over the past year. The earlier problem of Superboard II supplies has now been cleared and stock quantities are available from at least three suppliers, namely Lotus Sound, Watford Electronics and Videotime. The price is currently £229 + VAT.

The more current mysteries surrounding the supplies of the Apple II into the country are also clearing up. From conversations with several suppliers it now appears that Microsense are to be appointed UK master distributors by Eurapple and Keen Computers will be acting as distributors. Personal Computers, who previously held the distributorship are currently in the States clarifying their situation but stated that they are supplying to their dealerships. The new PAL card for the machine will shortly be available, after a long wait. The Apple is currently Black and White and selling at £830, the PAL card will be aevial input, cost in the range of £90. I hope this clears up any queries on the matter.

Chuckles

A couple of amusing tales have reached me concerning salesmen and systems. In one of London's computer shops, situated in the Hi-Fi jungle, a customer was heard to ask if he could implement COBOL on an ITT 2020. The reply? "No problem Sir. COBOL is just a better version of BASIC . . . Oh, you get machine code as well!" Uhh!

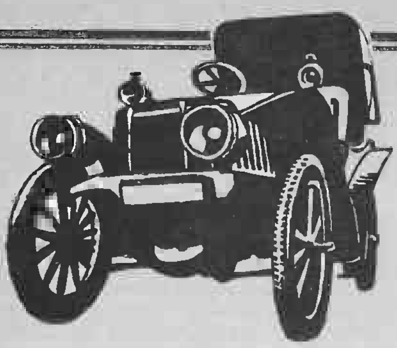
The second incident was related to us by a gentleman who had contacted an International Mainframe Business. He was offered a system with 8" VDU, ½ megabyte of disk store and a printer. The machine had 16K of RAM and a 4K BASIC. The BASIC, said the salesman, would handle numbers up to 40 decimal places and any number of strings. As if that isn't odd enough he then quoted a price, £11000! Well, it's a hard world these days.

Post Haste

News has just come in that Technalogics have received Post Office approval for their TECs computer system. This means that you can have a Teletext/Prestel/Basic system for around £2500 in its most complete form, the range starts at about £360. Sales will start in September, owing to PO restrictions, and Technalogics will convert any previously sold machine subject to test. For more information on the system see the review in CT May or contact Technalogics at 8 Egerton Street, Liverpool L87LY. Telephone 051-724 2695.

Foot Note

The Thames Valley ACC have just contacted me to say that they are having a "Junk" sale with bring-and-buy stalls at their meeting on the first Thursday in September. Phone Brian Quarm for venue details.



REAR SCREEN HEATER CONTROLLER

An inexpensive unit that gives push-button turn-on and time-controlled (3-30 minutes) auto-turn-off of your rear-screen heater.

ONE OF THE MOST useful fitments in a modern car is the rear-screen heater. It can clear an iced or misted-up rear window in a matter of minutes. The only problem is, of course, that you are supposed to remember to turn the switch off again once the window has cleared. The ETI rear-screen heater controller is designed to overcome this little problem, by turning the heater off automatically at the end of a period that is pre-settable from 3 to 30 minutes, (and by letting you turn the heater on in the first place via a pretty little push-button, rather than via a dirty great 15 amp rocker switch!)

The unit is easy to wire into the vehicle, using just two connections for it's power supply and two connections for the screen heater control. The timing periods of the unit can either be pre-set on the PCB, or can be made fully variable via a panel-mounted pot, which can be placed adjacent to the start push-button and an indicating LED.

Construction

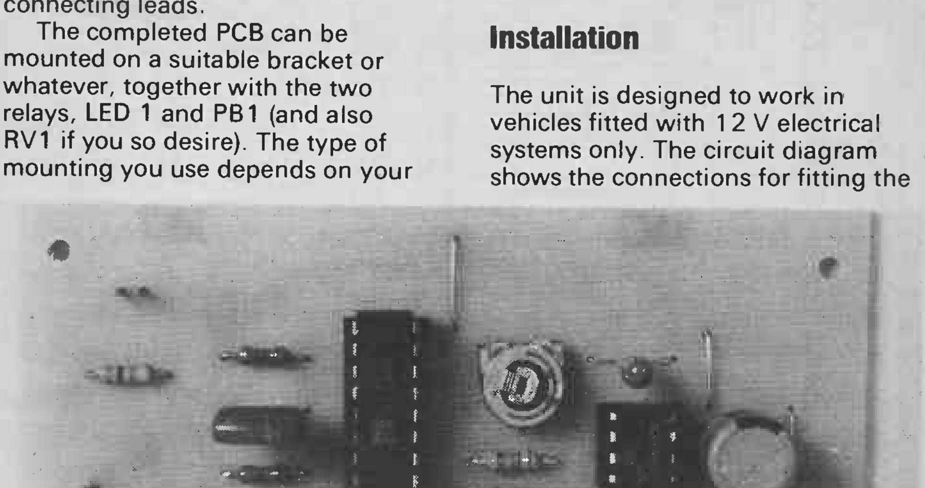
All of the electronics except the two relays, the push-button switch and the LED 'ON' indicator, are mounted on a single PCB. Construction should present no problems, so long as care is taken to observe the polarities of all semiconductor devices and electrolytic capacitors. If you decide to make the timing periods variable via a panel-mounted pot, omit RV1 from the PCB and wire the external pot in it's place via suitable connecting leads.

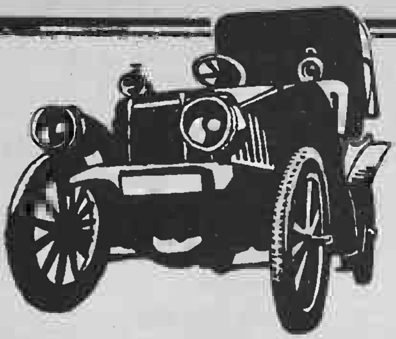
The completed PCB can be mounted on a suitable bracket or whatever, together with the two relays, LED 1 and PB1 (and also RV1 if you so desire). The type of mounting you use depends on your own tastes, and on the available space that you have in your particular vehicle. Note that RLA is a light-duty two-pole relay, and is used to 'slave' heavy-duty relay RLB, which must have contact ratings of at least 10 A.

Complete the interwiring of the PCB and relays, etc. and then give the circuit a functional check to see that everything is working OK.

Installation

The unit is designed to work in vehicles fitted with 12 V electrical systems only. The circuit diagram shows the connections for fitting the ▶





unit to vehicles with negative ground systems, in which the positive supply is fed to the unit via the ignition switch and the 'O V' line goes to the chassis: reverse these notations for positive ground vehicles.

The two output leads from contacts RLB/1 can be taken directly to the existing heater switch connections. The existing heater switch should be disabled or removed.

BUYLINES

The heavy duty relay is obtainable from Maplin Electronics, order no YB89W. The rating is for 12V coil, at 15A contact rating and coil resistance around 45R.

Nothing else here should prove difficult.

PARTS LIST

RESISTORS

R1	2k2
R2	10k
R3	1M0
R4	12k
R5	2k7
R6	270R
R7	470R

POTENTIOMETER

RV1	100k submin. Preset

CAPACITORS

C1	100u electrolytic
C2	1u5 electrolytic
C3	100n polyester

SEMICONDUCTORS

IC1	NE555
IC2	CD4020B
Q1	BC214L
D1	IN4001
ZD1	12V @400mW (BZY88)
LED1	0.2in. dia.

MISCELLANEOUS
RLA 12V 120R DPCO
RLB 12V 45R SPCO (10 A contact rating)
PCB, fixing mounts etc.

HOW IT WORKS

The basic action of the circuit is such that relay **RLA** turns on and energises heavy-duty relay **RLB**, which in turn completes the rear-screen heater connections, as soon as power is applied to the unit via start switch PB1. As RLA turns on, contacts RLA/1 close and thus maintain the power connections to the unit once PB1 is released. The unit enters a timing cycle as soon as power is applied and at the end of this cycle (3 to 30 minutes) both relays automatically turn off and disconnect the unit's power feed and break the connections to the rear-screen heater, thus completing the operating sequence.

The heart of the unit is IC2, a CD4020B 14-stage ripple carry binary counter. This IC is clocked by the IC1 type-555 astable multivibrator circuit and the output of IC2 is taken from its 14th binary divider stage. At the moment of switch-on a positive pulse is fed to the pin-11 RESET terminal of IC2, thus emptying the counter and driving output pin-3 low, thereby causing RLA to turn on via Q2 and Q1, and activating RLB via contacts RLA/2.

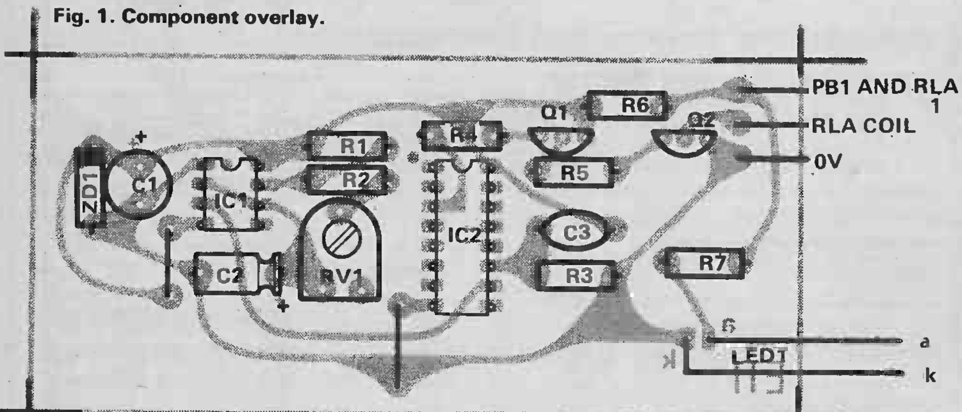
The 555 astable starts operating as soon as power is applied and feeds clock pulses to IC2. The output of IC2 switches high on the arrival of the 8192nd clock pulse, thus turning RLA (and hence RLB) off via Q2 and Q1 and completing the sequence of operations.

The operating period of the 555 clock generator is variable over the approximate range 22 mS to 220 mS via RV1, thus making output timing periods of 3 minutes to 30 minutes available from the circuit.

The voltage supply to the main part of the electronic circuitry is smoothed via C1 and is limited to 12 volts peak via ZD1 and R6, thus ensuring reliable operation even under adverse power supply conditions.

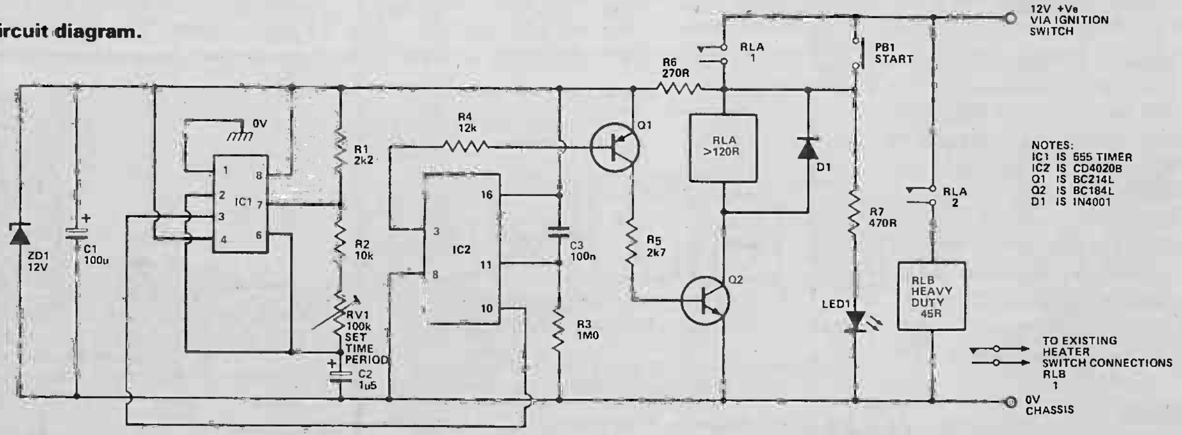
Note that two relays are used in this circuit. A two-pole relay is needed to give the desired auto-turn-off action, but the relay that is supplying the rear-screen heater needs a contact current rating of at least 10 amps. Since 10 amp two-pole relays are not readily available, it has been necessary to resort to the use of two relays to obtain the required circuit action when using a low-current switch in the PB1 position.

Fig. 1. Component overlay.



NOTE:-
D1 IS MOUNTED ACROSS RLA

Fig. 2. Circuit diagram.



RAVEN ON...

A new regular spot for David Raven of Metac Electronics. From his lofty perch above the commercial world of electronics he can see a lot happening that we can't. A monthly report from the lookout post!

CHANGES AT SINCLAIR Radionics indicate a new direction for a company that grew famous in the dawn of consumer electronic products. Equity totalling 73% of the shares were sold to the National Enterprise Board after heavy losses were incurred during the earlier attempts to manufacture Digital Watches. The company required investment capital to help develop and manufacture the world's smallest television set and to date the NEB have invested £4.45 million. The company's operations are now divided into three groups comprising Industrial Instruments, Consumer Products and Research & Development. Each division will operate under independent management with Clive Sinclair heading the R & D section.

The NEB is apparently not planning further investment in the company and they are also trying to find a new investor to take over production of the Microvision. Calculator production is also threatened as the company takes a hard look at its full range of products.

They will, however, continue to produce the programmable calculators for at least a further 6 to 12 months.

The future for British made calculators cannot be seen as rosy in the light of the new government's attitude to the NEB and loss making companies. There is always a ray of sunshine just around the corner (so the story books tell us) and what better way to view it than through a "Flat TV screen".

At first inkling Sinclair's latest venture could be *the* winner after the previous modest successes achieved with calculators, watches and TV's.

Plans are afoot to manufacture a 3 inch screen model slightly smaller than a paperback book, using a new patented technology. It is claimed that the definition is better than a comparable cathode ray tube four times the size. An automated factory is to be set up employing about 150 people to manufacture this new product, code named TV2, and it is envisaged that a partner will be introduced to help finance the operation. (Sinclair has received £750,000 from the National Research and Development Corporation to carry out development work into television technology). This joint venture project provided NRDC with a share in any future profits.

Deja Vu

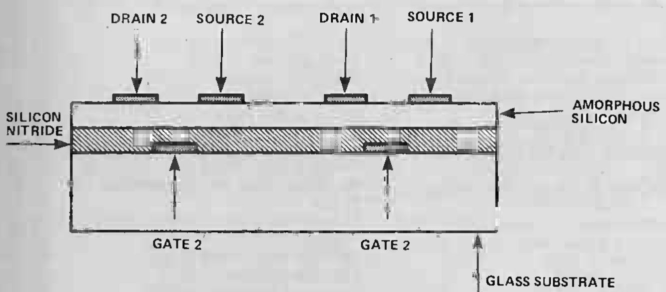
Work on flat screen TV's is not however new since reports were published in 1973 by Westinghouse Research Laboratory. The original aim was to produce a screen using liquid crystal (which is not the technique used by Sinclair). Attempts were made to produce a flat screen display using FET's and neumatic crystals, a screen size of 6 inches by 6 inches, 20 lines per inch and 14000 picture elements, each driven by a cadmium Selenide FET.

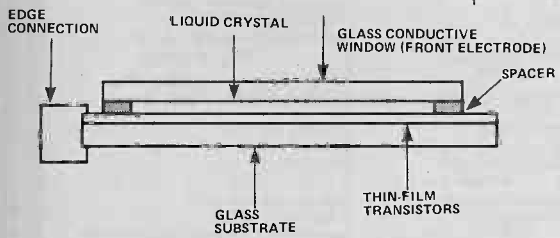
The main difficulties were, however, in controlling the two-component materials, Cadmium-Selenide used to produce the FET's. Research work at Dundee University has contionued in this field headed by Professor Walter E. Spear.

Amorphous-silicon insulated-gate field effect transistors (IGFET's) are being produced at Dundee that have encouraging electrical characteristics. To drive the liquid crystal elements the amorphous silicon IGFETs require an on-to-off-current ratio of 300, and an on-resistance of less than 9 M to allow sufficient rapid charging of the elements, also an off resistance greater than 3000 M to prevent escessive charge decay between scans. When assembled, the liquid crystal would be sandwiched between a glass substrate which contains the IGFETs fabricated on the surface in a matrix pattern and a conducting glass window. In an integrated display the IGFET is connected at each junction of the X-Y matrix and stored information is discharged onto each column in turn. Meanwhile a scanner turns on all transistors in an addressed row. As a result, voltage proportional to brightness would be applied to each liquid crystal element in that row. The applied voltage rotates the plane of polarization of the element, altering the light transmitted through it. Moves to scale the process up have gone well and long term device stability may be better than the group compounds used previously. Specimens stored at room temperature for several years have shown little change and reproducibility looks good.

Electronic Fuel Savers

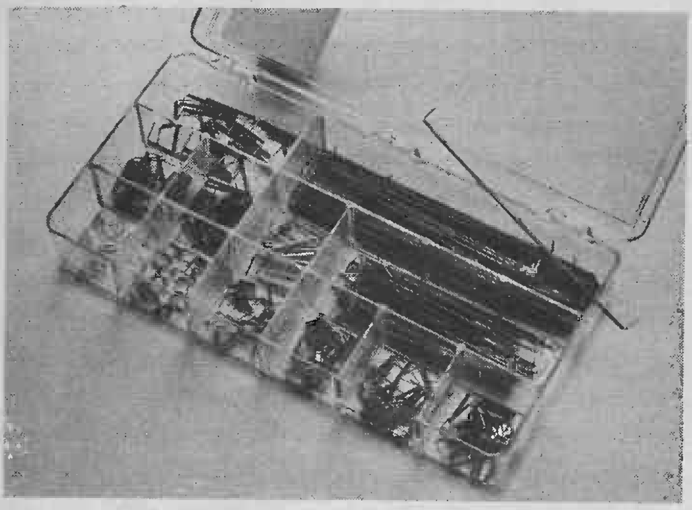
With petrol shortages destined to be the order of the day it is some comfort to know that a contribution to saving fuel can be made using micro-electronics. Lucas Industries are producing a chip which will continuously check fuel consumption and vary supply according to second by second changes in speed. It is expected that microchip monitors will be standard in every car during the next decade, controlling, in particular, fuelling, ignition, combustion and analysis of exhaust fumes. Future electric cars are predicted to take on a hybrid form running on batteries for short trips and coupling on a trailer with petrol, diesel or methane gas to charge up on a long distance drive. There are no miracle batteries on the way. Problems with one recent innovation using sodium sulphur were caused by the battery heating up to 500°C and having a tendency to set fire to the car. If you reside in the country and have access to unused corn then it may be worthwhile fermenting this into alcohol which can then be used as an additive. They also say that old chicken dung can be quite good for producing methane gas.

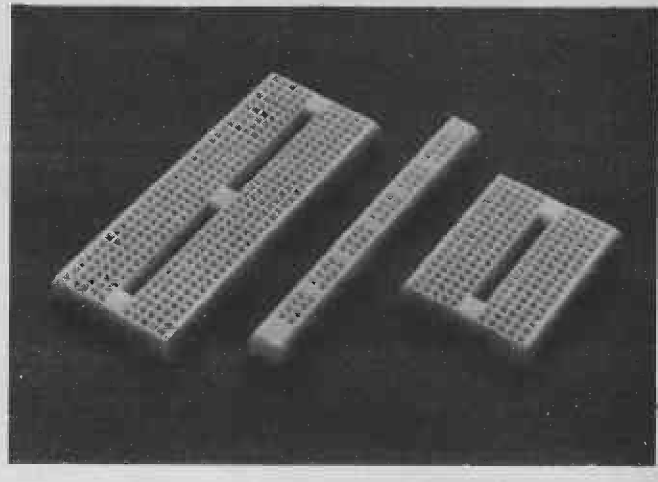




The shape of things to come? Some day your telly screen could be made up from a relative of this device. It's an amorphous-silicon insulated-gate field effect transistor, known within the confines of Dundee University as an IGFET. Its encouraging electrical characteristics hold the promise of flat telly screens.

news digest..................

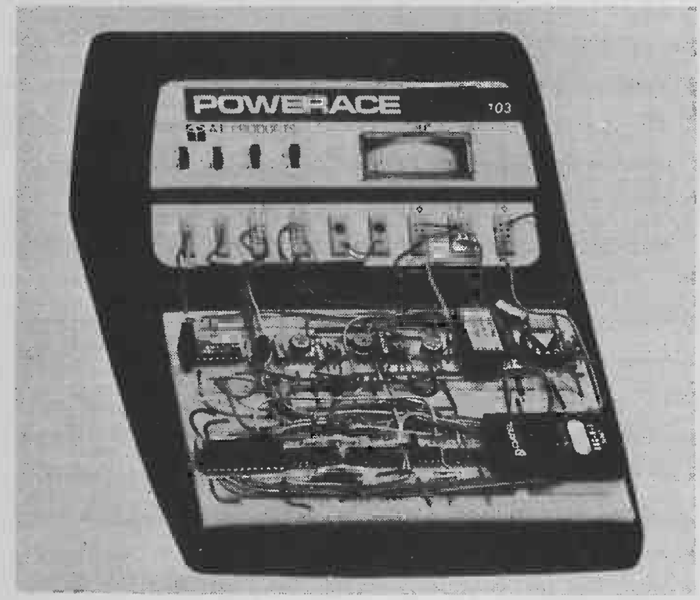




BUMPER BUNDLE FROM LEKTROKIT

We suspect that everyone at Lektrokit must be working 26 hours a day, 8 days a week. Every post seems to bring news of more goodies from them.

Let's start with the Powerace 103. No, it's not an electronic poker game. Lektrokit describe it as a circuit prototype construction aid. It's a complete, self-contained unit, enabling analogue and/or digital circuitry to be built without using one of those nasty, hot soldering irons.



The unit has its own internal power supplies to provide all necessary power rails for the circuitry under construction. DC voltage outputs of +5V (750mA), +15V (250 mA) and —15V (250 mA) are available. All DC supplies are regulated with ripple and noise of less than 10 mV and line and load regulation of less than 1%.

The matrix of 1680 solderless, plug-in tie points will accept all ICs and has the capacity to hold up to 18, 14 pin, DIL packages. A 15-0-15V meter on the front panel has accessible inputs, enabling supplies or circuitry to be monitored.

The front panel also carries two logic switches, two data switches and two buffered LED logic indicators.

Powerace is only 7.5×11.5×4 in, weighs in at 2.5 lbs and is mains powered.

Lektrokit is also to market three new units that together form a solderless breadboard system.

The 217L and 234L terminal strips and the 206R distribution strip offer 170, 340 and 48 preconnected sockets respectively on a standard 0.1 in matrix. The three units can be fixed together in any configuration. Each has a self-adhesive backing for fixing to any flat surface and screw holes permit more secure fixing (they even give you free screws!).

When you have your breadboard, try to persuade granny to buy you a Lekrokit breadboard jumper wire kit. Each kit contains 350 wires with their ends already stripped and bent at right angles for instant use.

Fourteen different lengths are included, from the smallest pieces with a 0.1 in span, for linking adjacent holes on the 0.1 in matrix, to others with a span of five inches. Each length has its own distinct colour sleeving for easy identification. All the wires are solid, tinned 22 awg with PVC sleeving. The kit is presented in a smart, compartmentalised case.

That little lot should solve some of your Christmas stocking problems. If you want to know more about these Lektrokit products, contact Lektrokit Ltd, Sutton Industrial Park, London Road, Earley, Reading, Berkshire RG6 1AZ.

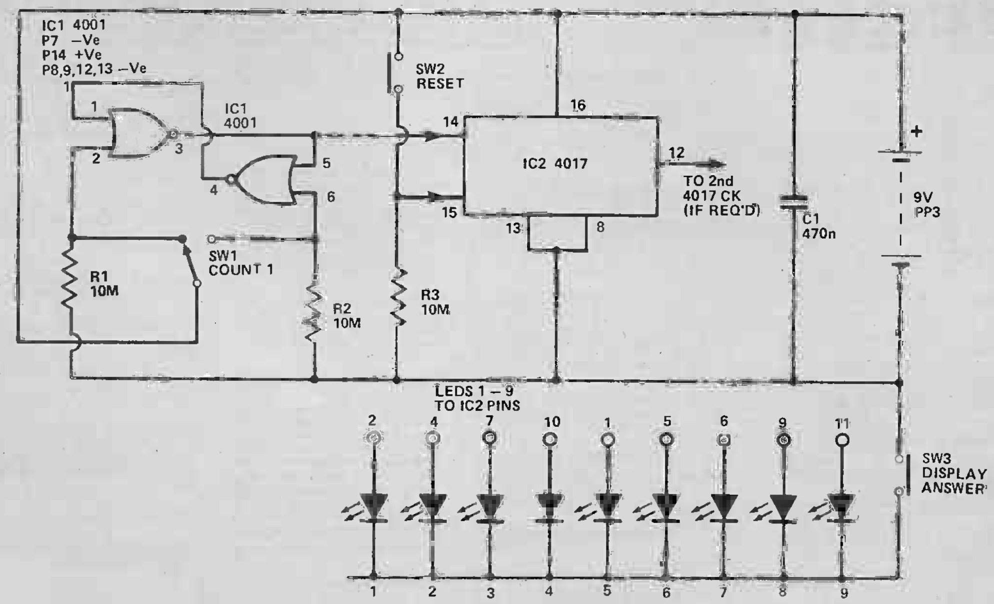
GIGAMPU COUNTER?

No, it doesn't count Gigampu's. It's an MPU-based frequency counter from Racal with a frequency coverage of 10 Hz to 26.5 Gigahertz.

The model 548 extends the standard range of the 54 series to 40 GHz with a resolution of 1Hz. Further options, to extend the range even further, are in the pipeline.

Standard features are high sensitivity to —30 dBm, input protection, easy to operate keyboard control and keyboard selected test and diagnostic functions. Options include power measurement, GPIB connection, remote programming/BCD output and digital to analogue converter output.

For further details contact Racal-Dana Instruments Ltd, Duke Street, Windsor, Berkshire SL4 1SB.



Pocket Calculator

S. Lamb

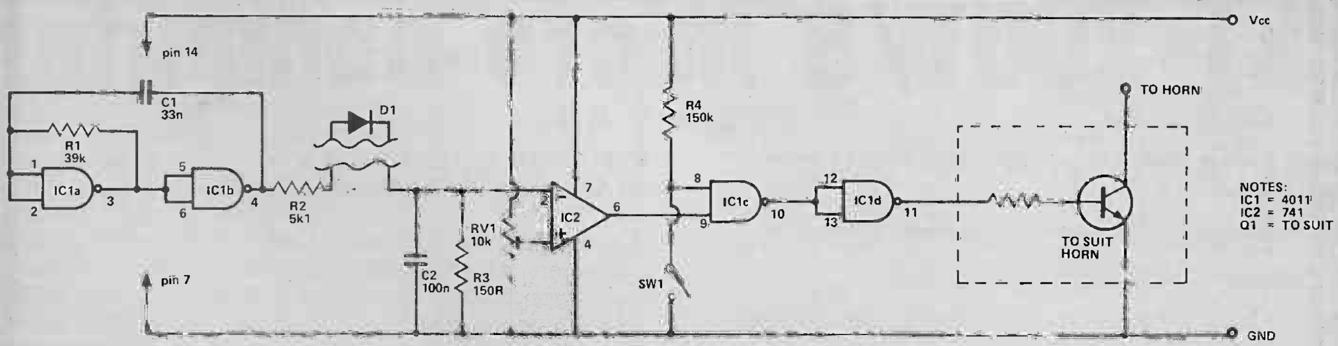
The diagram shows an inexpensive pocket calculator which will count up to nine pockets which can, by adding another IC count up to 99 pockets. Although it can be extended indefinitely I feel it is ludicrous to have more than 99 pockets.

To use press SW2 to reset IC2, place unit in each pocket in turn and press SN1 (use microswitch with definite click action to avoid miscounting). Two NOR gates eliminate switch bounce effects and IC2 is incremented once per operation of SW1. When all pockets have been accounted for press SW3 to display answer. The nine LEDs are labelled 1 to 9.

If the switches are suitably recessed the answer can be retained indefinitely because of the low current requirement of CMOS and SW3 can be pressed for an instant answer.

The prototype was built in a polythene soap dish (Boots). It should be realised that if the counter is not in the "reset" position and SW3 is open-circuit that one of the LED anodes will be at about +9V and will reverse bias the other eight and may well exceed the typical maximum PIV of 3V. For extreme reliability put a silicon diode in series with each LED and a 100 k resistor in parallel with each LED (in case of leaky diodes).

The two unused gates of IC1 could be used to flash one LED as an 'overflow' indicator if required, or to construct a second counter perhaps for coat pockets.



Motorbike Protector

P. M. Jessop

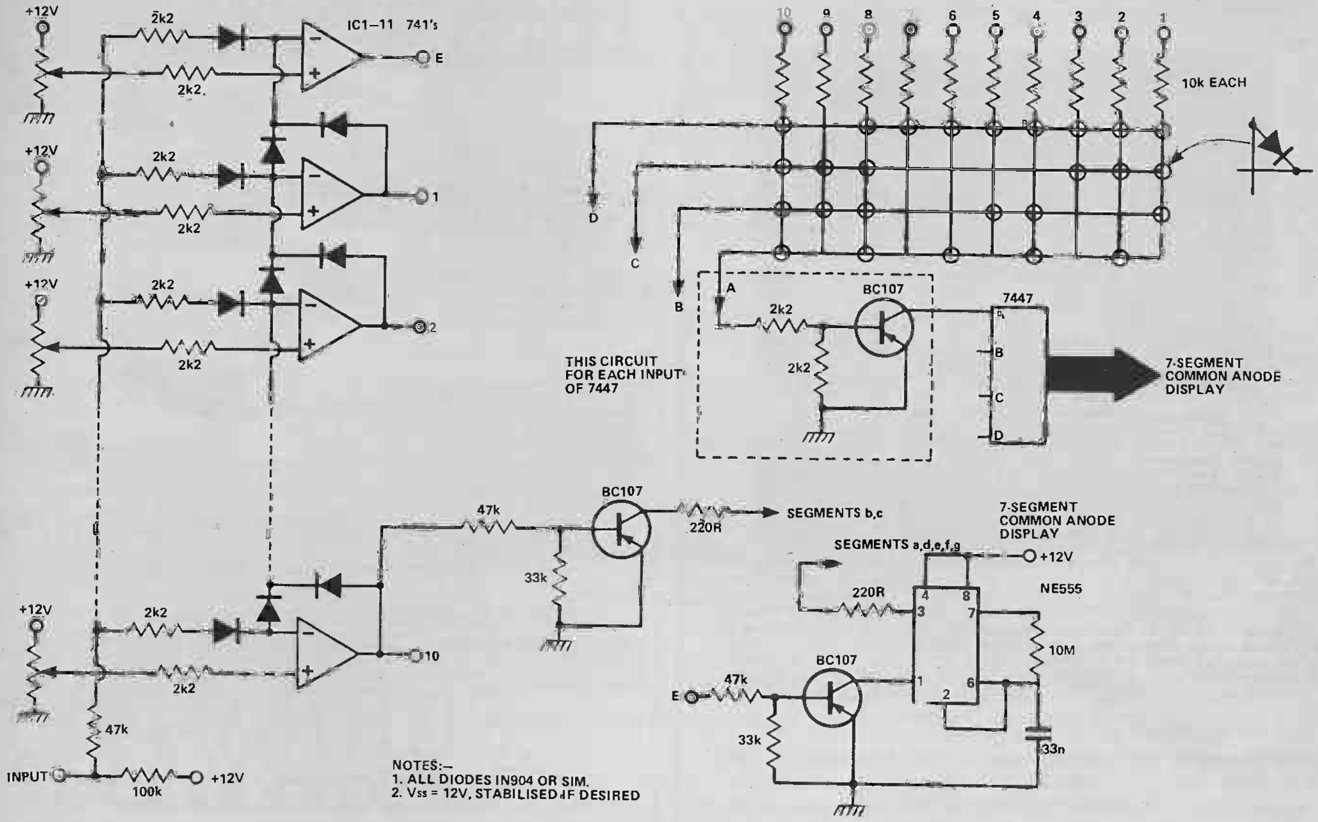
Many of the accessories fitted to a motorbike can be quite valuable and easily removed by a thief. On a motorbike, a top-box may be lockable but can easily be removed complete.

This circuit will protect such accessories. Diode D1 is mounted *inside* the box or other accessory and two leads are run to the rest of the circuit which should be mounted near to the horn. Gates IC1a and IC1b form an oscillator which charges C2 through D1 and R2. The voltage on C2 (normally nearly V_{cc}; is fed to comparator IC2. If D1 is removed from circuit by cutting the leads, C2 discharges through R3 and the comparator is triggered. However, if an enterprising thief tries to bypass the alarm by shorting the leads, the voltage on C2 falls to about ½V_{cc} and again the comparator is triggered.

SW1 which should be well concealed, disables the alarm which will otherwise sound the horn if triggered.

Tech-Tips is an ideas forum and is not aimed at the beginner. We regret we cannot answer queries on these items.

ETI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for. Drawings should be as clear as possible and the text should preferably be typed. Circuits must not be subject to copyright. Items for consideration should be sent to ETI TECH-TIPS, Electronics Today International, 145 Charing Cross Road, London WC2H 0EE.

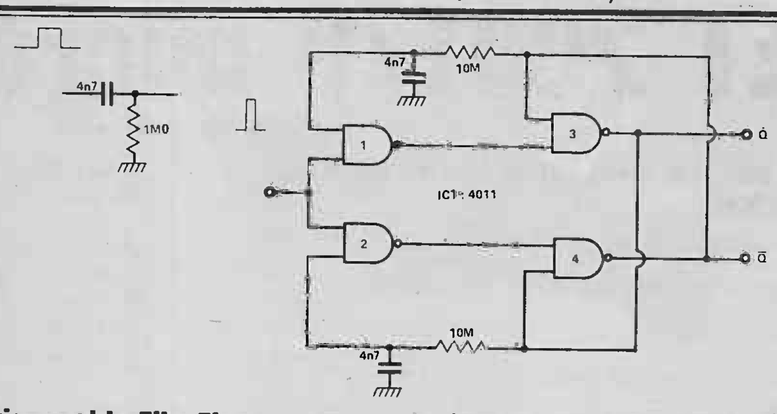


10 Gallon Digital Fuel Gauge

B. R. H. King

This circuit is based on the design published in ETI Circuits No 2, but has been extended to ten gallons without the need for the large number of diodes which would be required if the original circuit were used. Also incorporated is a flashing E when the tank is nearly empty.

The input is the voltage across the fuel-tank 'sender' which typically rises from zero at full tank, to about 5V when empty. As the voltage falls, the higher-numbered 741 comes on, extinguishing all the lower-numbered ones via the diode network. The outputs are fed to a decimal-to-BCD encoder (two pieces of veroboard with tracks at right-angles, with diodes sandwiched between). Each of the four outputs drives a BC107 to sink the inputs of a 7447 BCD-to-7 segment converter. This system is more economical in space and components than a discrete diode, decimal, 7 segment matrix. Output ten also provides drive to segments b and c of another display to give the figure one. This display is also used to show an E which is flashed by a 555 turned on by output from the E 741. A certain amount of trial-and-error is required to get values to suit individual cars, display types etc and the voltage divider at the input provides bias to compensate for the non-zero output of the 741's in their off-state. The circuit needs to be calibrated by filling the tank gallon by gallon and adjusting the 10 k presets. The prototype works very satisfactorily.



Retriggerable Flip-Flop

G. S. Wills

The following circuit was devised as a cheap retriggerable flip-flop using a single Quad-NAND chip (4011).

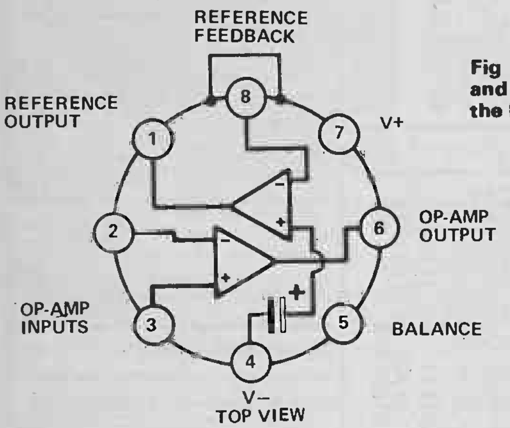
It is sometimes useful to have a single input flip-flop instead of the usual SET & RESET, this one being used on the end of an ultrasonic remote pause for a cassette recorder and switching to its opposite state for each received pulse.

Gates 3 and 4 are wired as a standard flip-flop configuration, their inputs going to gates 1 and 2 which steer the input pulse alternately.

The only requirement to remember is that the input pulse must be shorter than the CR constant of the circuit, but this is easily arranged by including a differentiator network (at the input) with a lower time constant.

LM 10—THE BASICS

The LM10 is a startling and exciting new type of op-amp. Ray Marston describes the new device in this first part of a 2-part feature.



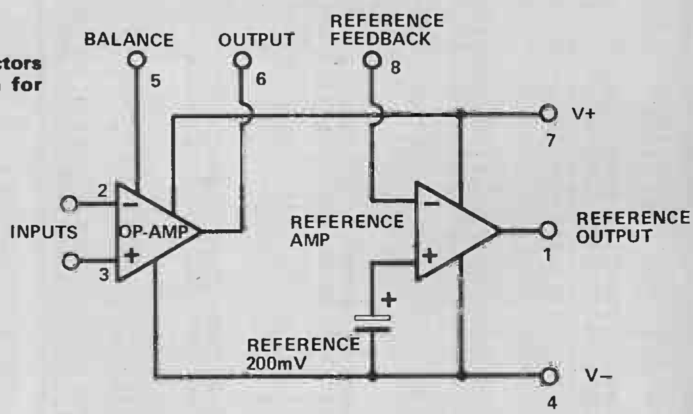


Fig 1. TO-5 can connectors and schematic diagram for the LM 10.

THE LM10 IS THE FIRST of a brand new and very exciting generation of highly versatile op-amp devices. It has been specifically designed to have a capability of working from single-ended supplies with voltages as low as 1V1 to as high as 40 V while giving a performance that is vastly superior to that of most of today's 'conventional' dual-supply op-amps.

The LM10 has been designed by Robert J. Widlar, the acknowledged 'Father of the op-amp' (he also designed the uA709, 710, 711, LM101, LM108, etc), and incorporates some brilliant design innovations. The device is being manufactured by National Semiconductors.

Parting With It

When we at ETI first heard about the device we reckoned it sounded pretty good, so we decided to run a one-part feature on the LM10. Since then, however, we've received actual samples of the IC!

In this month's part of the series we tell you what the device is, and describe some basic ways of using it. In next month's concluding part we'll show you a whole stack of practical applications.

The LM10: An Introduction

THE LM10 is a brand new and revolutionary type of monolithic op-amp. It draws a total quiescent current of only 270 uA over the entire voltage range, is capable of delivering tens of milliamps output current, and can operate from either fixed or fully-floating power supplies.

The op-amp has a PNP differential input stage that can accept input signals down to zero volts, and has a complementary class-B output stage that can swing within 50 mV of the supplies at 50 uA load current, or within 400 mV at 20 mA load current. The input is well protected via integrated current-limiting resistors against damage from excessive voltages and the output is protected by thermal overload and short-circuit detection circuitry.

The LM10 actually comprises three circuits, all housed in a single TO-5 8-pin package (see Fig. 1). The circuits comprise the op-amp, a 200 mV band-gap voltage reference and a reference amplifier. The reference is an ultra-precision device, with a temperature coefficient better than 0.002%/°C, and is externally available at the amplifier output. The reference output value can be adjusted over a wide range (200 mV to 39 volts) by trimming the amplifier feedback.

The LM10 Family

There are five members of the LM10 family. All the characteristics except the unity gain bandwidth (0.3 MHz) and the slew rate (0.15 V/uS) are exceptionally good (the device is clearly not designed for high frequency operation). The five devices in the range are categorised by their operating temperature ranges (LM10, LM10B, or LM10C) and also by their maximum supply voltage ranges of either 7 volts ('L' suffix) or 40 volts. The LM10C is a relaxed-specification 'commercial' version of the 40 volt unit and presently retails at over £6 in one off quantities.

The device is moderately complex (it incorporates 88 transistors, 81 resistors, and 16 capacitors), is fairly pricey, and is initially likely to be used only in unique (and until now 'impossible') applications for which no alternative solution is possible.

Several manufacturers are considering second-sourcing the LM10, however, and when they do the price of the device can be expected to drop significantly. This factor, combined with the certainty of spin-off devices based on the new circuit design techniques of the brilliant Bob Widlar, must mean that the LM10 and its derivatives will become classic IC devices, just like the 741 op-amp and the 555 timer, in the next couple of years. We at ETI vote the LM10 as IC of the year and Robert J. Widlar as design Superman of the decade.

Using The LM10: Power Supplies

The LM10 is a remarkably easy device to use. It can be powered from either fixed or floating single ended or dual supplies, and can use total voltages anywhere in the range 1V1 to 40 V. Figures 2 to 6 show a few ways of powering the device.

Figs. 2 and 3 show methods of powering the unit from dual supplies, for 'conventional' applications in which the inputs are referenced to the zero volts rail and the outputs can swing between the positive and negative supply line voltages. The Fig. 2 circuit uses two independent supply rails and the Fig. 3 circuit uses two rails derived from a single source.

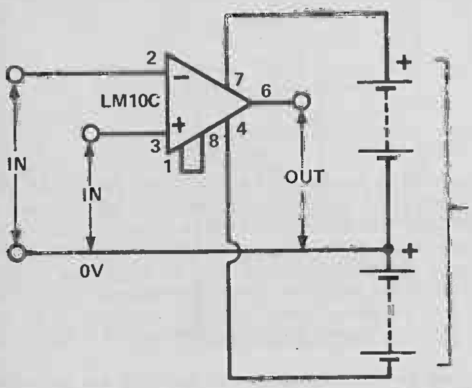


Fig 2 (above). Method of powering the LM 10 for conventional split-supply operation.

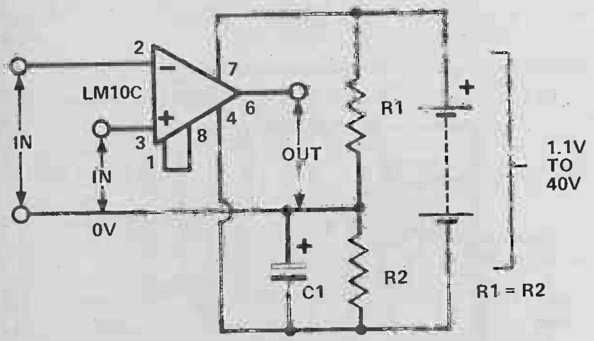


Fig 3. Method of powering the LM 10 for split-supply operation using a single supply source.

The Fig. 2 and 3 supply connections enable the LM10 to be used in all of the standard op-amp configurations, but with the quite remarkable advantages of using total supply voltages down to a mere 1V1 at total quiescent currents of only 270 uA and of having outputs that can swing within a few tens of millivolts of the supply rail voltages.

Fig. 4 shows the standard and self-evident method of powering the LM10 from a single pair of supply rails. The supply can again have any value in the range 1V1 to 40 V, and the op-amp output can again swing within a few millivolts of the zero and positive supply rails. An additional and rather pleasant surprise is that the op-amp can handle input signals right down to zero volts when used with a single power supply.

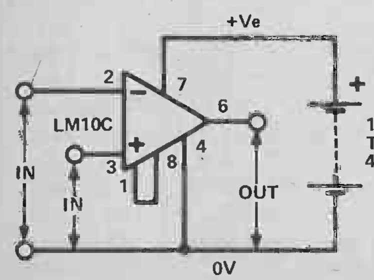


Fig 4. Standard method of powering the LM 10 from a single pair of supply rails.

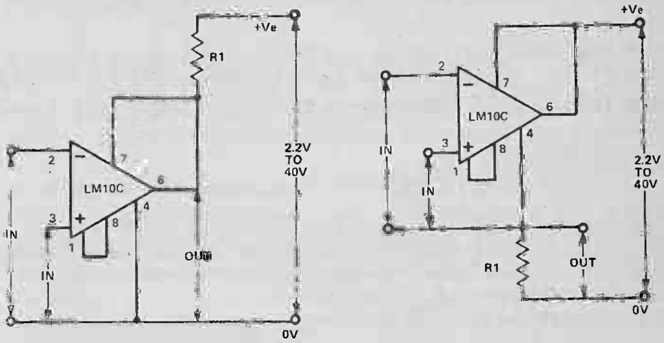


Fig 5 and Fig 6 (above). Two alternative methods of 'shunt' supplying the LM 10.

Finally, Figs. 5 and 6 show two quite unique and mind blowing ways of powering the LM10 from a single pair of supply rails. In these configurations the op-amp output terminals are shorted directly to the positive supply terminal of the LM10, so that the output 'shunts' the devices supply and a limiting resistor is wired in series with one of the supply leads.

The LM10 op-amp has an output drive current capability that is a couple of orders of magnitude greater than the device's normal quiescent current. This factor, combined with the device's excellent supply-voltage rejection figure of 96 dB and wide operating voltage range, enables it to operate quite happily in either the linear or the switching mode while at the same time using its own output to modulate its own supply voltage and current!

Thus, this 'shunt' method of operation can be used in two-wire remote-sensor applications, in which the two wires carry both the supply current and the resulting signal information. Note that the minimum supply voltage used in this application must be significantly greater than the normal 1V1 figure, to enable reasonable data amplitudes to be developed across R1 without reducing the LM10 voltage below its minimum working value.

Using The LM10: The Reference Amplifier

If you don't want to use the reference facility in a particular application, or wish to use it simply as a 200 mV reference, strap pins 1 and 8 of the IC together as shown in Fig. 7. That gives the reference amplifier

▶

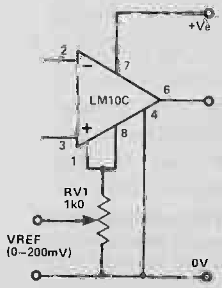
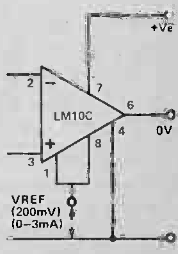


Fig 7 (right) and Fig 8 (left). Putting the LM 10 reference to work for its 200mV. Fig 7 makes it a straight 200mV, and Fig 8 makes it variable from 0-200mV.



something useful to do and makes a 200 mV 0-to-3 mA reference available between pins 1 and 4.

If you want a precision reference in the range 0 to 200 mV, wire a fixed or variable potential divider between pins 1 and 4, strap pins 1 and 8 together and take the output from the potential divider junction or slider, as shown in Fig. 8.

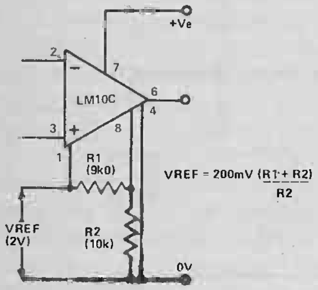
If you want a precision reference in the range 200 mV to 39 volts, use the connections shown in Fig. 9. In this configuration the reference amplifier is used as a non-inverting amplifier with an input of 200 mV and a voltage gain of (R1+R2)/R2.

A useful point to note about the reference amplifier is that it has a typical unity gain bandwidth of about 500 kHz and can be gainfully employed in some special applications as an AC amplifier, if you use a little ingenuity in your circuit design.

A final point to note is that the reference amplifier can also be used as a simple voltage comparator that can be quite useful in some special applications (an ETI discovery). Fig. 10 shows the basic connections.

Using The LM10: The Op-Amp

The op-amp section can be used in a wide variety of basic configurations in the single-supply mode. Some of these configurations are shown in Figs. 11 to 24.



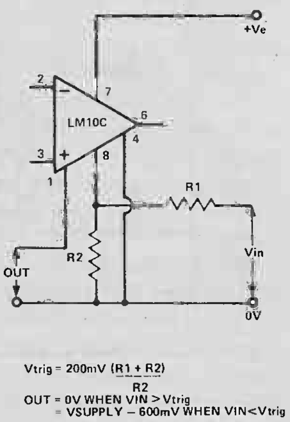


Fig 9 (left) and Fig 10 (right) give a circuit for getting the reference to behave as a 200mV-39V precision output and using the reference as a simple voltage comparator respectively.

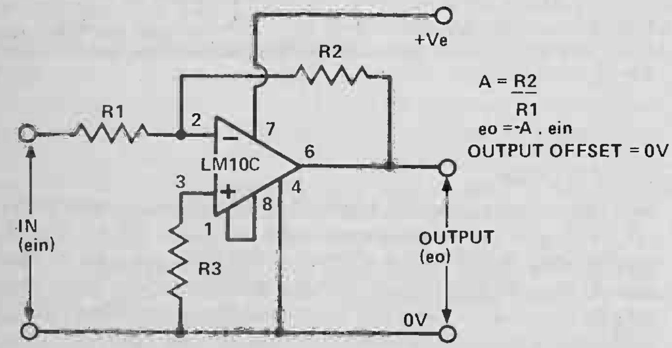


Fig. 11 shows the basic connections for using the op-amp as an inverting DC amplifier. Note here that the circuit can usefully accept input signals that are negative with respect to the 'zero' volts rail only.

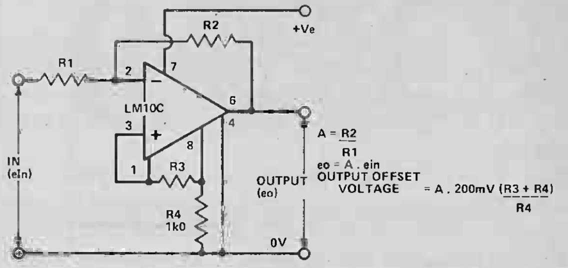


Fig. 12. If you want the circuit to accept positive DC input signals, you can do so by feeding an offset biasing voltage to the non-inverting terminal of the op-amp from the built-in reference amplifier.

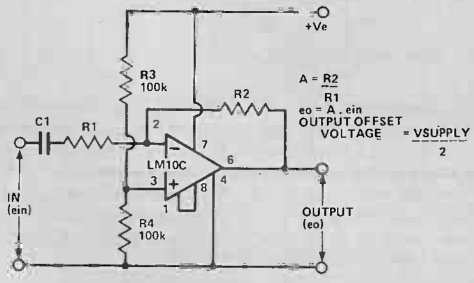


Fig. 13 shows the connections for making an inverting AC amplifier. The output is biased at half-supply volts, for maximum signal swing, by the R3-R4 potential divider.

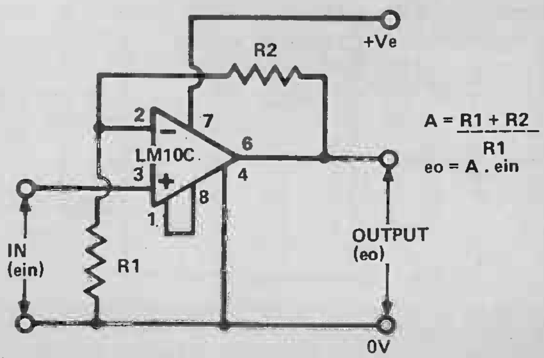
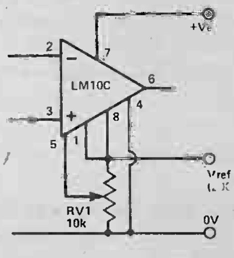
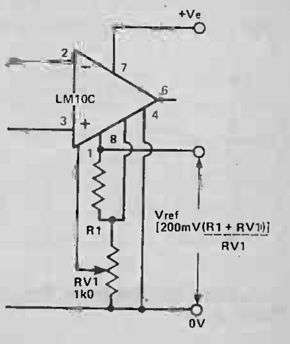


Fig. 14 shows how to use the LM10 as a non-inverting DC amplifier that will accept input signals down to zero volts. The circuit can be used as a unity-gain voltage follower by removing R1 and replacing R2 with a short circuit. The circuit can be used, in conjunction with the built-in voltage reference and amplifier, as a precision voltage regulator in this mode.

Figs. 15 and 16 show standard methods of applying offset adjustment or compensation to the op-amp, using the IC's built-in reference amplifier.





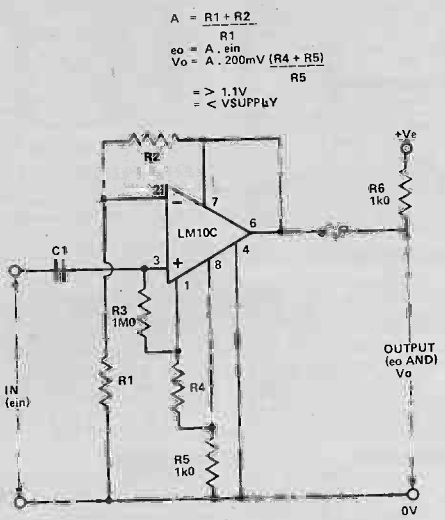


Fig. 17 shows how the LM10 can be used in a 'shunt' mode when connected as a non-inverting AC amplifier. Note that the output must be biased so that the quiescent output voltage (V_o) is part way between the positive supply value and the 1V1 minimum operating potential of the IC. Both the IC supply and signal currents flow through R6 in this mode of operation, thus enabling the IC to be used as a 2-wire (or single-wire if a common earth return is used) sensor or data transmitter.

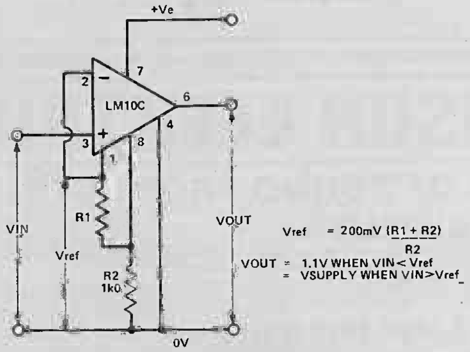


Fig. 18 shows how to use the LM10 as a precision voltage comparator, using the IC's built-in voltage reference and amplifier. The action of the circuit can be reversed, so that the output goes high when V_{in} falls below V_{ref}, by transposing the op-amp pin 2 and pin 3 connections.

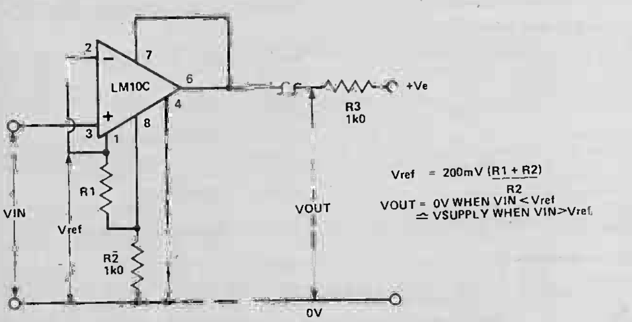
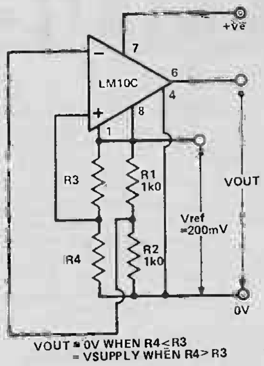


Fig. 19 shows how the voltage comparator can be used in the shunt mode.



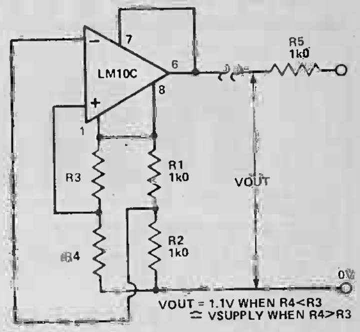


Fig. 20 (left) shows how the LM10 can be used as a resistance comparator, using the IC's built-in reference to power the test and reference resistors. The sensitivity of the circuit can be improved by raising the reference voltage above the basic 200 mV value. Note that the total output current of the reference must not be allowed to exceed 3 mA.

Fig. 21 (right) shows how the resistance comparator can be connected in the shunt mode. Note in this case that the reference voltage value should not exceed 1 V.

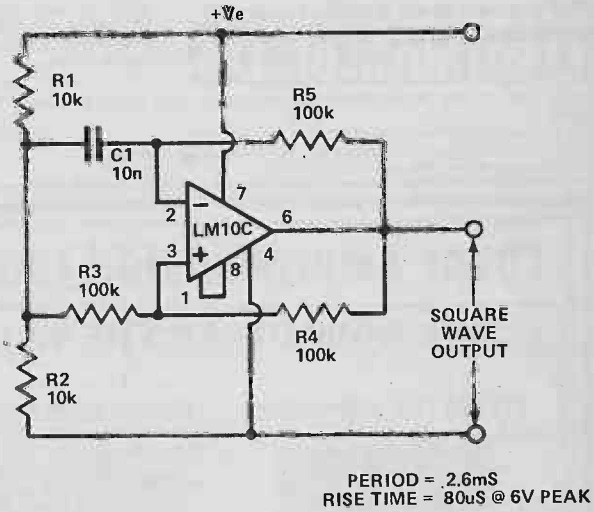


Fig. 22 is the basic astable circuit and is a fairly simple development of the standard 'dual supply' op-amp astable, with R1 and R2 acting as a potential divider that sets the 'common' point of the R3-R4 and C1-R5 networks at half-supply volts. Because of the poor slew-rate characteristics of the LM10, the circuit gives a pretty lousy square wave output, with typical rise and fall times of about 80 uS when used with a 6 V supply. The circuit is, nevertheless, very useful in low frequency applications (up to a couple of kHz) as a simple alarm-tone generator or LED flasher, etc.

Coming Soon

We'll show you a whole stack of practical applications in the final part of this series next month. All of these applications will be based on the LM10C version of the device. In the meantime, if you want to play with the LM10C yourself, it should be available from Marshall's, or Watford within a week or so of the publication this issue. **ETI**

TO BE CONCLUDED