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50p

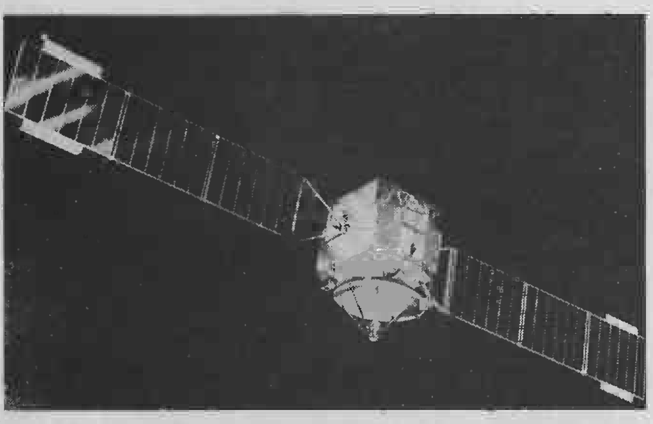
SUPER-FI AMPLIFIER PROJECT

Full details inside

Earth Satellites

Reaction Timer

. . NEWS . . . . PROJECTS . . . . MICROPROCESSORS . . . . AUDIO . . .



MARECS, a marine version of ECS, is intended to provide communications links between ships and shore stations.

Radio 1 and 2 use frequencies in the two and ten metre amateur bands and are intended for use by both American and Soviet radio hams, complementing the service already provided by America's Orbiting Satellite Carrying Amateur Radio (OSCAR) satellites.

Active Limits And Passive Freedom

There are two basic types of navigational system — active and passive. In an active system, the user has to interrogate the satellite(s) to determine his position. That necessarily limits the number of people who can use the system, because each satellite has a finite number of communications channels available at any time.

A passive system, however, relies on ground stations receiving continuously transmitted signals from the satellite(s) and then calculating position from them. It has the advantage that there is no limit to the number of users who can listen in to the satellite transmissions.

The capacity to fix position continuously is not available with the US Navy's Transit system, even with six satellites in operation. Transit is, therefore, not suitable for air traffic control, as an aircraft could travel a considerable distance between fixes. Also, as Transit uses a Doppler technique, the speed of an aircraft affects the measurement of the frequency shift.

Throughout the seventies, the system has been updated and improved. However, expansion of Transit has been dropped in favour of a new system, NavStar, which should be fully operational by about 1985 and will be suitable for use by aircraft.

Home Sweet Home

A major part of Earth satellite applications is concerned with turning the cameras and sensors back towards mother Earth to find out more about this lump of rock that is our home. This field of self-interest can be split into two related and overlapping areas — Earth resources and research satellites.

On the 26th of April 1978, an Applications Explorer Mission satellite (AEM-1) was launched from Vandenberg to measure day and night temperature differences on the Earth's surface. This is the first of NASA's Explorer missions. The second, AEM-2, followed it into orbit on February 18th, 1979. The spacecraft were both of a modular design to keep costs down.

AEM-1, the Heat Capacity Mappint Mission (HCMM), will determine the feasibility of using data from thermal infra-red sensors for:

—discrimination of rock types and possibly location of minerals
—monitoring surface soil moisture changes
—measuring plant canopy temperatures
—measuring urban heat islands
—measuring land and sea surface temperature changes
—predicting water run-off from snow field information

The results will also be correlated with Landsat data and ground observations.

Military Embryo

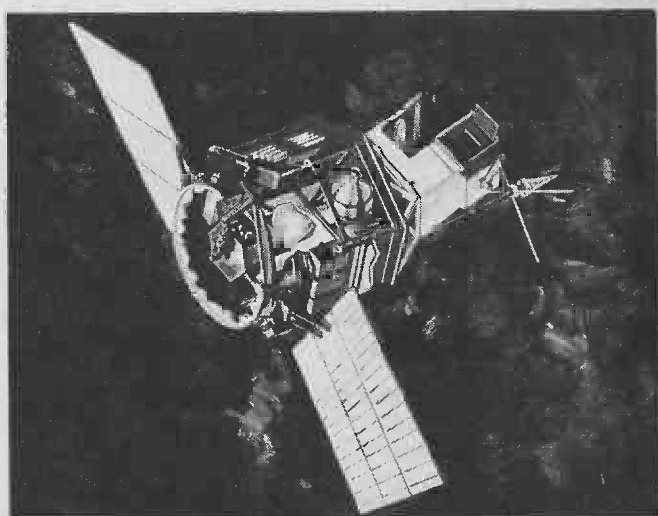
The early development of the American satellite programme was *entirely* in military hands, for obvious reasons. The motivation then was a belief in the axiom of conventional warfare that says, 'he who holds the high ground, controls the battlefield.' The military objective was the high ground — Earth orbit.

The Spy In The Sky

Satellites have been used for military reconnaissance since 1959, with the launch of the first of the Discoverer series, designed by Lockheed. In addition to the use of visible light photography to monitor ground operations, infra-red sensors can be used to detect, for example, heat from aircraft engines or local changes in sea temperature caused by submarines manoeuvring close to the surface or by surface craft manoeuvring at night.

It's difficult to estimate how many Soviet satellites are launched for military reconnaissance purposes, as most go by the 'family' name of Cosmos, whatever their application. However, information about their orbits and duration of flight can be used to deduce their possible applications.

In June 1971 a Titan 3D launch vehicle, capable of putting over 13 tonnes into a polar orbit, lifted a 'Big Bird' low altitude surveillance platform into a Sun-synchronous orbit. The Sun-synchronous orbit ensures that when the spacecraft overflies the target again and again, the Sun angle is always the same. That makes it much easier to compare photos of the same site and detect movements of troops, vehicles, missile launching sites, etc. ▶



An engineer's conception of AEM-1, a heat capacity mapping mission (HCMM) spacecraft and the first of the NASA's Applications Explorer Missions. The hexangular shaped base module for this spacecraft, launched in April 1978, was built for the NASA/Goddard Space Flight Center by the Boeing Aerospace Company of Seattle, Washington.

Soviet satellites are generally recovered intact and the film removed on the ground, but American satellites remain in orbit, while a number of film magazines in protective capsules are ejected. They re-enter the Earth's atmosphere and begin their descent to the surface on parachutes but, long before they get there, they are collected by specially equipped military aircraft.

In the early years of military satellites, once a spacecraft reached its position in Earth orbit, it was relatively safe. However, recent years have seen the development of hunter-killer spacecraft. Search and find craft have been used before to locate targets for photoreconnaissance. More sinister is the hunter-killer craft, which manoeuvres close to a target spacecraft and then explodes. Just how many of these are active and already in Earth orbit is a matter for conjecture. There have also been reports of spy satellite cameras being 'blinded' by intense flashes of laser light. As they say, 'all's fair in love, war and spying.'

Outward To Deep Space

If the sensors can be pointed down towards Earth, they can equally be pointed out into space. The greatest contribution of the satellite to near-Earth research has been the capacity to make on-the-spot measurements of parameters which previously could only be estimated by indirect means.

Britain has been particularly active in this field with the Ariel series. The satellites were called UK 1, 2, etc. until they achieved successful operational orbit, when they were renamed Ariel 1, 2, etc. Ariel 1 and 2, launched in 1962 and 1964 respectively, had substantial American involvement, but Ariel 3, launched in 1967, was the first satellite to be entirely designed and built in Britain. It was a very successful system, which operated for two years — twice its designed lifetime. British Aerospace was the principle contractor.

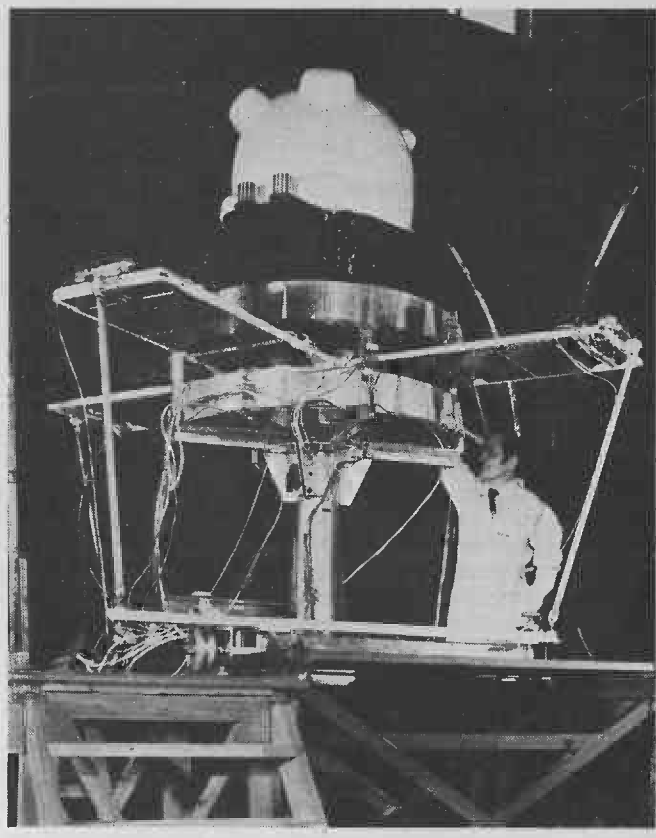
The latest of the series, Ariel 6, was successfully launched in June this year.

The X-Ray Sky

NASA has focused its attention on X-ray sources in the sky with its high energy astronomy programme. The first High Energy Astronomy Observatory (HEAO-1) made a general X-ray sky survey and identified approximately 1500 sources. Precise altitude control is essential for astronomical observations. HEAO-1's mission came to an end, therefore, when its supply of altitude control gas ran out in January this year. HEAO-2, launched in November 1978, can be pointed at selected X-ray sources. A third HEAO is scheduled for launch this year. The satellites are placed in low circular orbits, but their altitude allows them to detect radiation which would not reach the Earth's surface.

The Future

The immediate future should bring improved communications and navigation by satellite as more powerful systems are launched to give global coverage. The, by now familiar, sight of a launch rocket slowly lifting off a pad, carrying its payload towards Earth orbit will inevitably become much rarer. The Space Shuttle will be the first of a generation of reusable spacecraft, which will gradually replace 'one-off' rockets.



Ariel 6 will spend the next two years orbiting the Earth every 96 minutes, studying the ultra-heavy component of cosmic radiation and investigating X-ray sources.

Power From Orbit

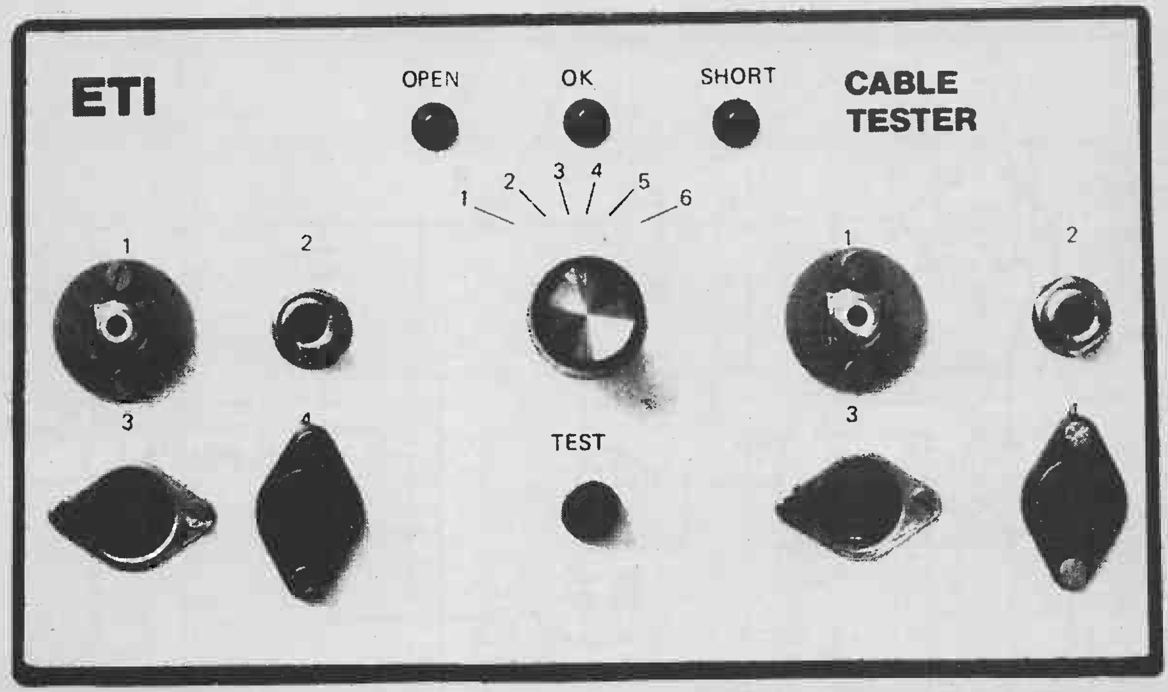
When the oil wells finally dry up, we may supplement our energy requirement by building huge solar arrays in orbit and transmitting the collected power to Earth by microwave. The transmission of power by microwave has already been proven over short distances. You'll find more about power satellites in the August edition of Hobby Electronics.

Whatever the future *does* hold for satellites and their applications, it boils down to how much money governments are prepared to spend on space research. That begs the question — how do you value the returns from space? What price do you put on better weather forecasting, clearer and easier communications, improved air traffic control, etc? As if that wasn't a complex enough question, it doesn't stop there. Whether or not to embark on or continue an existing satellite programme is also inextricably tied up with national prestige, international relations, employment, high technology experience which can be translated to other fields of engineering and electronics . . . . . shall I go on? In the long term, your crystal ball is as good as mine.

I would like to express my thanks to the following for their assistance in preparing this article:
British Aerospace
The Boeing Aerospace Company, Seattle

CABLE TESTER

Quickly test your cables with this invaluable project



ALMOST ALL THE faults in an audio system are caused by cables. Have you ever tried to find which cable is broken among the many connections in a stage audio system, especially with anxious people looking over your shoulder?

The answer is to check each cable before the performance, a rather tedious business.

This Cable Tester checks each wire in turn for both open circuits and short circuits to earth. Each cable can then be thoroughly tested before use and hopefully faults can be found before they cause problems.

The circuit makes cunning use of a 7474 dual D flip flop to light one of three LED's after the test switch is pushed, indicating short, open or OK.

Construction

The unit is mounted on a standard plastic box measuring 196 x 113 x 60 mm. If it is to be used on-stave, then use the strongest box you can find, such as diecast aluminium.

Wiring the switch is the only difficult part of the construction. Note that some of the switch contacts are linked together as shown in Table 1. The transformer we used is a commonly available Ferguson PCB mounting type.

The sockets we have chosen for the prototype are the most common type, however there is no reason why others can't be substituted. The jack plugs, SK7, 8 and the phono sockets SK1, 2 must be insulated from the metal front panel, or the earth connections will be permanently connected together through the panel. Phono sockets are available with insulating mountings, while insulating washers can be made from plastic sheet for mounting the jack sockets. ▶

HOW IT WORKS

IC1 is a 7474 dual D flip-flop with its clock (CLK) and D inputs held at 0V.

First let's assume an open circuit cable. ZD1 conducts, as it has 12 V across it, and turn on Q2, which hold the preset (PR) input on IC1a low. The PR input of IC1b remains high because ZD2 is not biased. When the test switch is pressed, putting a 0 on the CLR input, the outputs of IC1a become: Q, high; Q low. When the test switch is released, leaving both the CLR inputs high, the following outputs are obtained: IC1a-Q, high; Q, low; IC1a/b-Q, low; Q, high.

Since the output of Q, IC1a is low, Q3 is turned off. Therefore LED1 is on, LED2 is off, and LED3 is off.

Now let's look at the 'short to earth' condition. The 12 V rail is shorted to earth through D1 (exit one diode). Q2 is turned off leaving the PR input of IC1a high. The PR input of IC1b is held low. When the test button is pressed the outputs of IC1a go: Q, low; Q, high. When the button is released, placing a high on the CLR inputs, these outputs remain the same. The outputs of IC1b are: Q, high; Q, low. Therefore LED1 is off, LED2 is off because the base of Q3 is held low by IC1b, and LED3 is on, indicating a short.

Finally, if the cable is OK, the voltage across ZD1 is held at 3V3 by ZD2. Q2 is off because ZD1 6V8 is not conducting. The PR input of IC1a is left high and the PR input of IC1b is also high. When the test button is released the outputs of IC1a go: Q, lowl Q, high. The outputs of IC1a go: Q, low Q, high, when the button is pushed and remain the same when it released. Both the Q outputs are low so LEDs 1 and 3 are off and the Q outputs are high so Q3 is conducting and LED2 is on.

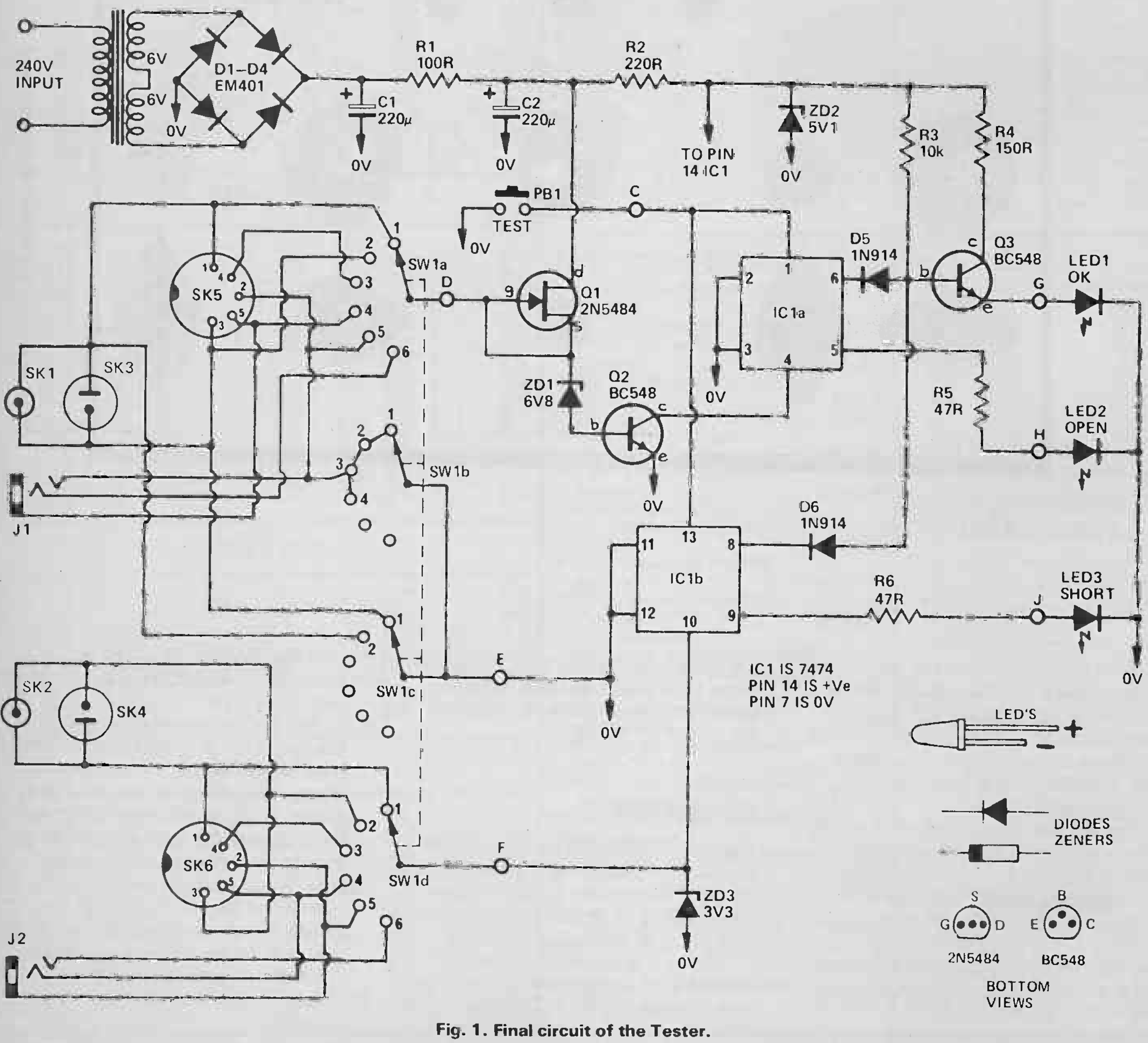
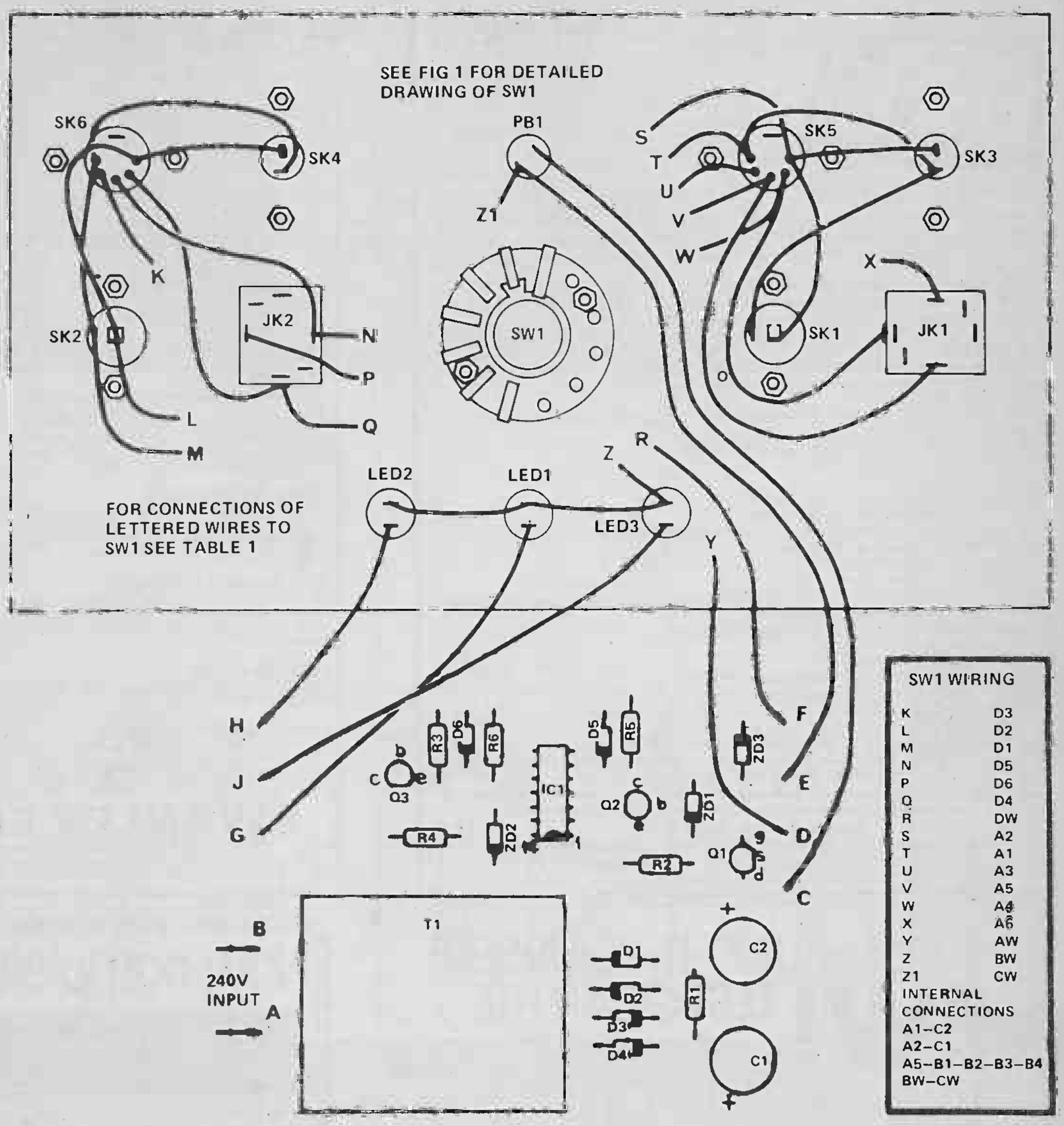


Fig. 1. Final circuit of the Tester.



SW1 WIRING

K	D3
L	D2
M	D1
N	D5
P	D6
Q	D4
R	DW
S	A2
T	A1
U	A3
V	A5
W	A4
X	A6
Y	AW
Z	BW
Z1	CW

INTERNAL CONNECTIONS
A1–C2
A2–C1
A5–B1–B2–B3–B4
BW–CW

Fig. 2. Component overlay and front panel connections.

PARTS LIST

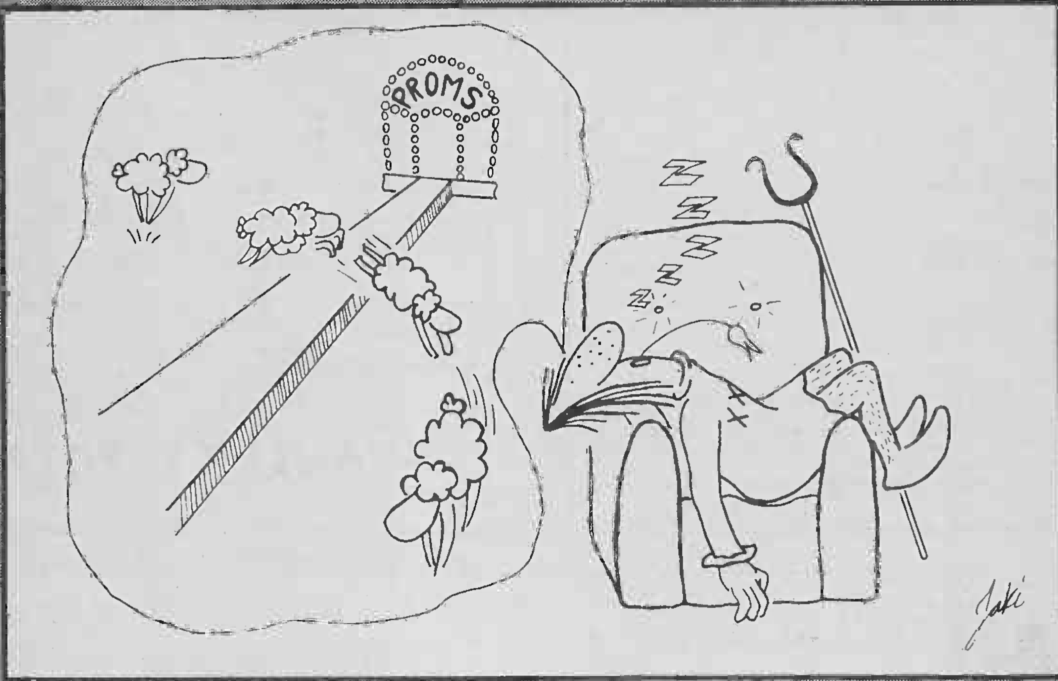
RESISTORS	all ¼W 5%
R1	100R
R2	220R
R3	10k
R4	150R
R5, 6	47R
CAPACITORS	
C1, 2	220 25V electrolytic
SEMICONDUCTORS	
IC1	7474
Q1	2N5484
Q2, 3	BC548
D1-4	1N4001
D5, 6	1N914
ZD1	6V8 400mW
ZD2	5V1 400mW
ZD3	3V3 400mW
LED1-3	TIL 209 or similar
SOCKETS	
SK1, 2	phono skt
SK3, 4	2pin DIN
SK5, 6	5pin DIN
SK7, 8	stereo jack
MISCELLANEOUS	
SW1	4p 6way
T1	6-0-6V 500mA
PB1	push to make

Box to suit, pcb, power lead, etc.

BUYLINES

None of the electronic components in this project will be difficult to get hold of, and the mechanics depend on the application. For stage use a couple of Cannon sockets could be added and wired in accordingly. The switch SW1 should be break before make.

MICROSENSE



RAMS and PROMS are MEMORIES

MICROPROCESSOR systems are made up from two distinct parts called Hardware and Sodtware, the Software is the program which is run on the system, the Hardware is the physical components which go to make up such a system. We will assume that you are able to differentiate between resistors, capacitors and diodes which apart from the crystal and PCB (Printed Circuit Board) leaves only the mysterious ICs and sockets.

An IC looks like a lump of black plastic or similar material with numerous pins sticking out on each side, each IC should have a socket associated with it. For ease of testing and replacement the sockets are soldered into the PCB and the ICs plugged into the sockets. The important things to remember about inserting or removing ICs from the sockets are

1 Make sure that no power is applied to the PCB.
2 Make sure it is the correct IC for that location.
3. Make sure it is the correct way round
4 Ensure that all of the pins are correctly sitting in the socket.

Each IC is identified by a number printed on the top surface of the package, pin 1 of each IC is marked either with a dot, indentation or horseshoe groove near pin 1. If the IC is held with the pins downward and the dot or horseshoe away from you then pin 1 is always the furthest pin on the left

SCRUMPI contains several ICs which may be broken down into the following categories

Main Control Chip. This is the SC/MP microprocessor chip.

Buffers and encoders, etc. These ICs typically have a code such as 74LS xx or 81LS xx and are used to handle control of counting, device address decoding, latching or buffering the address bus and data bus.

RAMS: Random Access Memories. The theory of the insides of these ICs can be likened to a chessboard or a set of 'pigeon holes.' The data in the MM2112 RAM chips is organised as 256 locations each of four bits, if we use two MM2112 chips in parallel it is possible to have an organisation of 256 locations each of 8 bits (or 1 byte). Each of the 256 locations can be accessed directly by the MPU chip and the data at that location copied onto the data bus or the ▶

data on the data bus copied into the selected location. The data in such a memory will remain there until the supply voltage is removed. When first powered-up each time, the contents of a RAM are random and variable.

RAMs can be used for storage of programs or data for the program to be operated upon, under some circumstances even a program can be considered to be data.

PROMs, ROMs, tec. There are a second type of memory device similar in concept to the RAM except that the program or data stored in the device remains even if the power supply is removed. They are thus suitable for holding the fixed programs and data and are a convenient method of shipping such data from one installation to another.

ROM stands for READ ONLY MEMORY and it is usually assumed that the data in a ROM is installed at the time of manufacture of the chip and as such can be referred to as Mask programmed ROMs. PROMs and EPROMs on the other hand are programmed after manufacture and are thus referred to as Programmable Read Only Memories. The E in EPROM shows that the data in the PROM can be erased by exposing the inside of the chip to intense UV radiation, this is usually accomplished through the transparent quartz window let into the top of these devices.

The type of Read Only Memory used in SCRUMPI is the MM5204Q EPROM, this can be replaced with either of the following pin compatible devices —

MM5214 Mask Programmed ROM
Field Programmable ROM

The alternatives offer the advantages of large volume/low cost and/or simplification or power supply to 5V only (no —12V supply is required).

Ports are the method that an MPU uses to communicate to the external world. A port is simply an integrated circuit whose function is to interface the MPU data bus in whole or only in part to devices which cannot interface directly to the MPU system. There are several reasons why external devices cannot be directly coupled to the MPU data bus.

Firstly the devices may not be TRI-STATE output devices which means that they could not be connected to the data bus otherwise their outputs would always be in the logic 1 or logic 0 state and not in the high impedance TRI-STATE mode required. Alternatively the external devices may operate too fast for the MPU, or too slowly, or require buffering so as not to unduly load the drive capabilities of the MPU data bus. The INS8154 is a single chip device containing the logic required to operate 16 of its pins as PORTs, the 16 pins can be operated as two 8 bit ports or as individual Input/Output lines. Each pin can operate in either Input mode or Output mode the choice being made by Software selection, each pin is also capable of latching the data on that pin at either input or output time. In addition to the two 8 bit ports the INS8154 also contains 128 bytes of RAM which is sufficient as a working storage RAM in most applications.

The effects of Scrumpi

If you study the circuit diagram of SCRUMPI you will quickly see that all of the major signals to and from the SC/MP chip are available at one of the two edge connectors so that SCRUMPI is able to communicate with other electronic devices. It can thus be used as the heart of many electronic circuits and can be used in this form to help with the design and debugging of projects by the electronics engineer or by the amateur constructor.

The single-step circuitry shown as IC's 2, 3 and 4 allow the SC/MP to be run at a very slow speed (down to 1 step per hour if necessary), this slow single step speed is useful in checking the effect of each instruction as it is executed. The actuation of the STEP switch causes a single pulse output from IC 4. This pulse sets a Flip-Flop (a simple electronic switch) at IC3 and thus drives the NHOLD line to a positive voltage which instructs the SC/MP to execute an instruction. During this instruction the SC/MP outputs a pulse on the NADS (Address Strobe) output, this pulse

RESETs the Flip-Flop which in turn puts the NHOLD input low and thus stops the SC/MP from executing any further instructions. The next instruction will only be executed after the next actuation of the STEP switch.

A similar situation exists with the single-step switch in the FAST position excepts that here IC 4 will generate a pulse automatically at a rate which is dependent on the value of C1 (usually about 5 pulses per second). This mode can be used to step through a program faster than single-stepping but not at the maximum possible speed.

If CS 4 is put into the RUN position then the SC/MP will execute the program at the maximum speed. Between this mode and the FAST single-step mode is the HALT mode which can be used to stop execution of the program at predetermined points. Here the pulse for the Flip-Flop is generated whenever the SC/MP executes a HALT (X'00') instruction, this pulse RESETs the Flip-Flop and thus terminates execution until the next actuation of the STEP switch. The data bus is connected to a set of switches which can be used either in the DIRECT mode to enter a logic 1 or 0 onto the data bus at any time or in the ADDRESSED mode only when addressed by the SC/MP. This allows the switches to be used to program the memory in the single step mode or to enter data when required by a program.

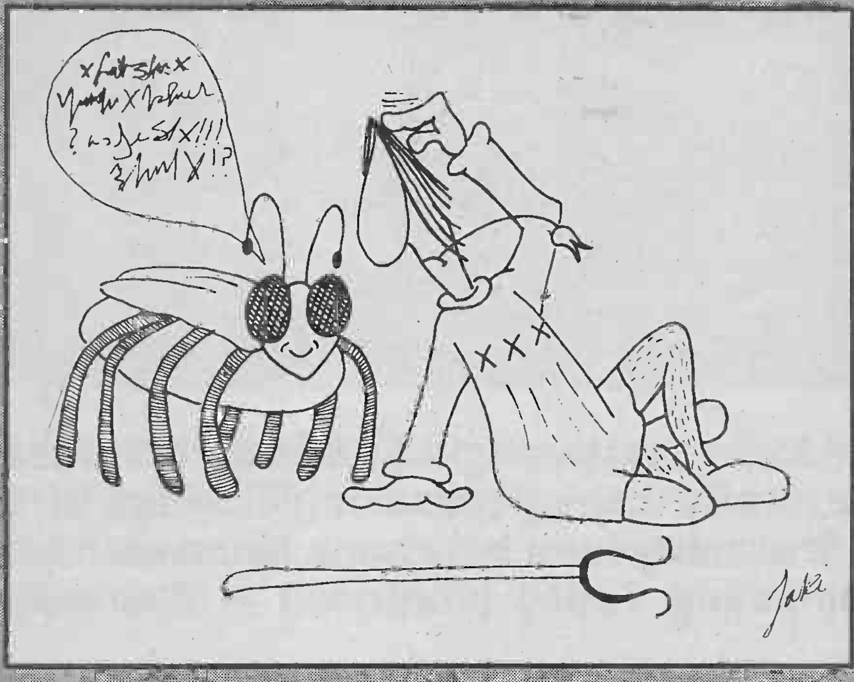
Both the data bus and the address bus are connected via wire links to LED lamps. The LED lamps thus show the status of these buses at any stage of the program, the branching and data addressing of the program can thus be checked easily. Alternatively the LED lamps can be linked to other signal lines by redirecting the wire links, they can then be used to show the status of an output device.

A typical input-output device is shown as IC's 15 and 16, two 74C173 latches. These ICs can latch the status of a signal on the inputs so that the outputs carry a copy of that status at a given time even after the original status has disappeared. In the output from SCRUMPI 2 mode the latch can store the data on the data bus at the time that the latch was addressed by the SC/MP. Any data written to the latch will appear on the data bus at the same time as a strobe pulse is output at point 'P' or 'Q'. If the data bus is connected to the inputs of the latch and the pulse used as the clocking strobe to the latch then the data will appear at the outputs of the latch and stay there until the next write to the latch. As an example, some of the LED lamp drivers could be connected to the latch outputs to indicate a particular data output to the operator.

Using the latch for input is a similar operation except that the latch is used the other way round. The outputs are connected to the data bus and the address strobe ('P' or 'Q') is used as the OUTPUT ENABLE control to the latch. Any data in the latch will be read onto the data bus when 'P' or 'Q' is strobed, the data enters the latch via the inputs when the clocking input is pulsed with a logic 0.

The P and Q strobes mentioned above are output from the device decoding circuitry at IC's 17, 18, 19, 20 and 22. This circuitry decodes the addresses specified by the address bus and produces a set of strobes which enable or disable the devices connected to the data bus. Three enable strobes are output to the RAM memories at ICs 5-10 each pair of IC's being enable for Read or Write operation. One enable strobe can be used to enable the outputs from a MM5204 PROM if there is such a PROM at IC21. Output 'P' is enabled if an address in the range X '500' — X '5FF' is addressed, similarly 'Q' is enabled for the X '600' range, either of these strobes can be used to strobe either of the latches for input or output. Strobed output V is normally connected to the ADDRESSED mode of the data switches which means that any data on the switches will be input to the SC/MP when any address in the X '700' range is read.

Examples of microprocessor interfaces to other equipment can be seen in most of the associated hobby magazines and in the 'SC/MP Applications Guide' published by National Semiconductor. ▶



Teaching Your Scrumpi to talk to Outsiders

Some microprocessors are used solely for writing, checking and executing programs, this type is usually to be found in offices handling accounts or stock control. Other microprocessors control equipment and machinery with complex testing and control interface, usually this type of MPU system can be found in vending machines, production lines, complex timing systems, etc. The same microprocessor chip may be found in both types of application but the interfaces to the outside world will be different. In the first type the interfaces will be to printers, keyboard large VDU, floppy disks, etc to handle the collection, sorting and printing of, for example, account details. In the second type the interfaces will be to switches, motors, lamps and buzzers to handle the input of data from various sensors and control machinery accordingly.

Thou Art a You Art

The Universal Asynchronous Receiver/Transmitter is better known as a UART (pronounced You Art) for obvious reasons. Its basic function is to translate the 8 bit data available on the data bus from parallel form to a serial form and vice-versa. The advantage of this idea is that data can thus be transmitted along a single pair of wires rather than the dozen or so wires which would be needed for parallel transmission. Many interfaces to other equipment such as printers, TTYs and telephone use serial transmission to save on wire costs or for convenience if the remote unit is any considerable distance from the MPU.

A transmission starts with the output of the UART at a logic 1 state which is referred to as a MARK condition. Data is written from the data bus into the UART by enabling the Data Strobe input, this immediately signals back to an internal Flip-Flop that the UART transmitter is BUSY and cannot receive any more parallel data at present. In normal practise this Flip-Flop is tested by the MPU software before any attempt to write to the UART, the program loops until the Flip-Flop is reset at the end of the data transmission.

Once the UART has some data to transmit it shifts to the SPACE condition by changing the UART output to a logic 0, this START signal is one bit time long. The time taken to transmit each bit is defined by the rate of the 16x clock input. The frequency input at this pin is divided by 16 to give the bit transmission rate or BAUD RATE.

After sending the START BIT the UART sends each of the data bits in sequence as a MARK or a SPACE condition for 1 bit time each. To ensure that the START BIT of the following byte of data will be recognised by a receiving UART the transmitter now outputs two STOP BITS which are denoted by a MARK condition for two bit times, thus the total number of bits transmitted is not 8 but 11 made up from the 8 bits of data plus a START and two STOP bits.

In the receive mode the UART looks at its input pin continuously and waits for it to go from MARK to SPACE condition to indicate a START bit. After doing various checks to ensure validity the UART will then read in the 8 data bits and verify the presence of at least one STOP bit. On receipt of the first STOP bit the Data Available Flip-Flop is set to indicate to the MPU that parallel data is available, the MPU can now read this data and release the receiver by Resetting the Data Available (RDAV) Flip-Flop.

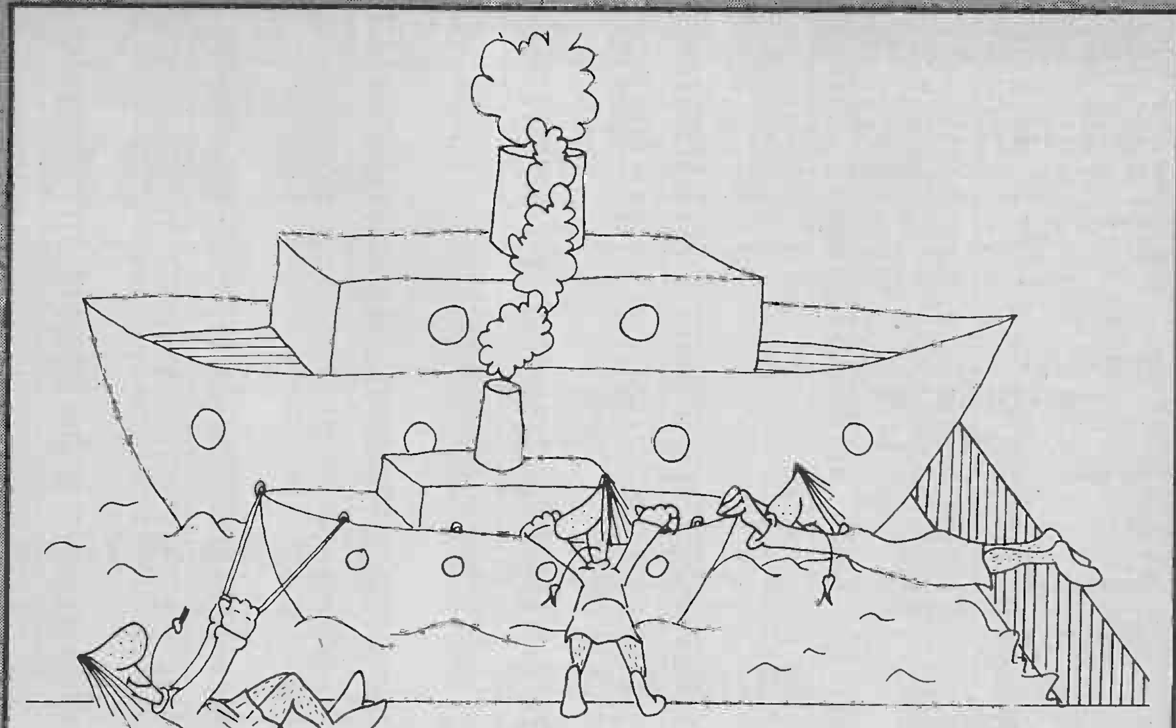
The UART thus handles most of the data shifting, verification transmitting and receiving. The UART is even clever enough to handle both transmitting and receiving at the same time — this is referred to as FULL DUPLEX MODE, using a UART solely for either transmission or reception is known as SIMPLEX MODE.

Serial Standards

There are a set of standards associated with serial data transmission and used by many manufacturers in peripheral equipment. The usual one is the 'Teletype' TTY interface working at 110 Baud over a 20 mA current loop. The 110 baud refers to the bit transmission rate of 110 bits per second; when a UART is used, this rate will transmit 80 data bits or 10 bytes per second. The 20 mA current loop refers to an interface system in which the presence or absence of a current loop defines whether a MARK or SPACE is being transmitted, a lot of TTY equipment still uses relays and switches as an interface where thus the circuit is either open or completed, the current loop is inherited from this type of equipment.

An external printer might require a 1200 Baud RS232 interface, again the 1200 baud refers to the bit transmission rate of approximately 100 bytes per second. The RS232 interface is based on voltage levels and is usually something simple such as MARK = +3v and SPACE = −3v with respect to a common ground wire.

Interested in the mystic might of the microprocessor? Wrapped up in the crafty cabbalistic conjecturings of the software religion? Searching for a holy book to cover these black arts? Try Computing Today (surprise!) — The magazine for all



PORTS

London, Liverpool and TTL

Just as London and Liverpool are ports allowing goods to enter and leave the country so an MPU port allows data to enter and leave the MPU. A port is usually assumed to be 8 bits wide, that is it will carry 8 parallel bits of data into out of the MPU and in the case of the usual 8 bit MPU the port interface directly to the data bus.

To the MPU the port looks like a single address location at which it can read or write data, the MPU addresses the port physically by decoding a unique address strobe from the address bus. Any time that this address is accessed the strobe will become active and thus inform the port that it is being accessed and should thus take appropriate action.

To the engineer and to external equipment the port looks like an 8 bit TTL latch. When used for output the data on the MPU data bus is latched into the port and thus appears latched at the port output pins, from here onwards these outputs can be assumed to have come from any similar TTL type of device. When used for input the port becomes an 8 bit latch presenting its inputs to the external circuitry, usually one of the inputs or an additional control pin acts as the clocking input. Data is presented to the port inputs and latched by strobing the clock input, the data at the inputs can now be released as the data is now held in the port. At ther same time the MPU is informed (or finds out for itself) that there is new data in the port, it can thus 'read' the port address which will enable the port output to deposit their data onto the data bus and thus into the MPU chip. In applications of this type the MPU would then signal to the port that it had read the data and that the port could now input some more, this sequence of "I've got some data for you" "thank you, I've read it" is called 'Handshaking'.

The two theoretical ports described above are assumed to work in only one direction in each circuit. Some of the newer port chips are bi-directional which means that under software control they can either read data from external devices or write to external devices. The latest port chips allow individual bits to be specified as input or output by the software and can thus be changed halfway through a program. ETI

frantic fanatical followers of small system computation, competition and construction. ETIs answer to sliced bread.

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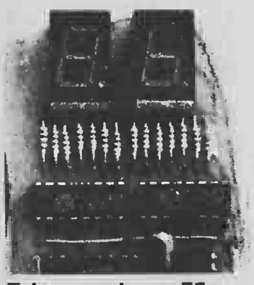
electronics today INTERNATIONAL
OCTOBER 1979 VOL 8 NO 10

Super amp project p.55

FEATURES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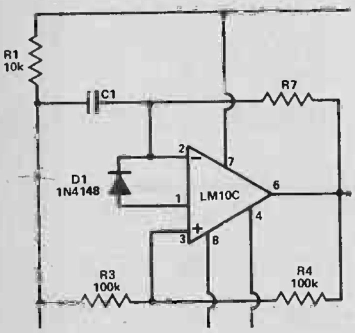
PROJECTS



Well employed p.68

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STRING THING

We continue this month with Part 3 of the String Thing Saga (Son of Part 2 from Tim Orr. For those of you who missed Part 2, String Thing, otherwise known as the Transcendent DPX, is a digital, polyphonic, multi-voice keyboard instrument. (We suspect it probably makes marvellous coffee too.)

Voicing is one of the stronger parameters that goes to characterise generated sound structures. The sounds in the DPX are built out of the same basic components, asymetric squarewaves. The envelope contour is different for each type of instrument and vibrato can be added to emphasise the 'string' sound. However, all the voices, if they were left unfiltered would sound very much the same. But, by filtering the signals, it is possible to add a great deal of information to the sound structure. It must be remembered that natural instruments always sound very different from electronically produced ones, this being due to the incredibly complex structure of most instruments. If you have the opportunity to observe the low notes of a piano on an oscilloscope you will be amazed at the complexity of the signal.

Part 3: This month we bring you details of the String Thing's control circuitry and inter-board wiring.

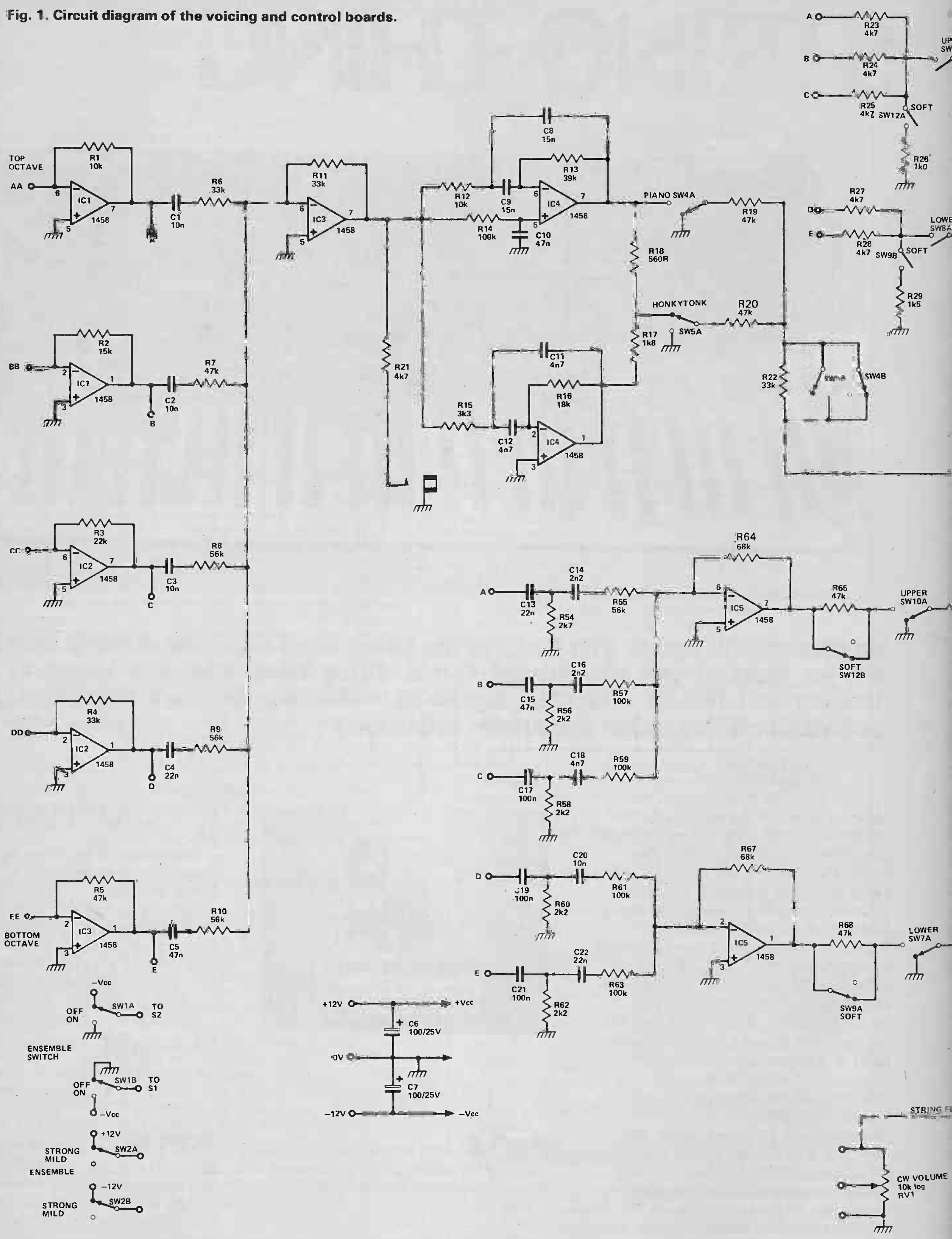
BUYLINES

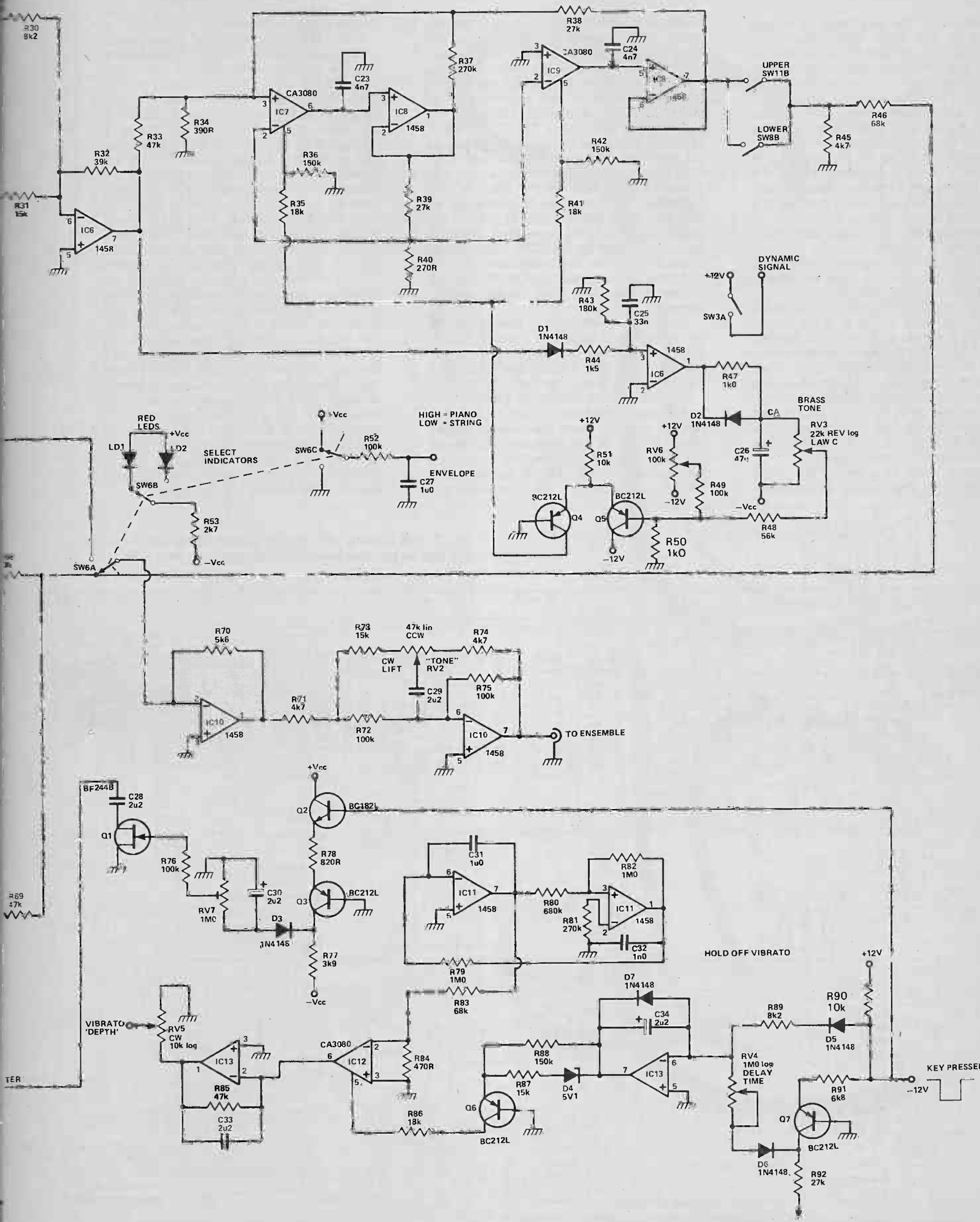
Powertran Electronics are supplying a complete kit of parts for this project at £365+15% VAT. Delivery by Securicor is £2.50 extra. Everything is included in the kit, down to the last nut and bolt. They even give you a plug.

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

Part 4: Next month we conclude String Thing (no, we really mean it this time) with details of the power supply and dynamics boards, and the final constructional details to sort out your nuts and bolts.

Fig. 1. Circuit diagram of the voicing and control boards.




R30
8k2
R31
15k
IC6
1458
R32
39k
R33
47k
R34
390R
CA3080
IC7
R35
18k
R36
150k
C23
4n7
IC8
1458
R37
270k
R38
27k
R39
27k
R40
270R
CA3080
IC9
C24
4n7
IC8
1458
R41
18k
R42
150k
UPPER
SW11B
LOWER
SW8B
R45
4k7
R46
68k
DYNAMIC
SIGNAL
+12V
SW3A
R43
180k
C25
33n
D1
1N4148
R44
1k5
IC6
1458
R47
1k0
BRASS
TONE
D2
1N4148
RV3
22k REV log
LAW C
C26
+12V
RV6
100k
R49
100k
R51
10k
BC212L
Q4
Q5
BC212L
R48
56k
R50
1k0
-12V
-Vcc
RED
LEDS
+Vcc
LD1
LD2
SELECT
INDICATORS
SW6B
SW6C
+Vcc
HIGH = PIANO
LOW = STRING
R52
100k
ENVELOPE
C27
1u0
R53
2k7
-Vcc
SW6A
R70
5k6
IC10
1458
R71
4k7
R73
15k
47k lin
CCW
R74
4k7
CW
LIFT
"TONE"
RV2
C29
2u2
R75
100k
R72
100k
IC10
1458
TO ENSEMBLE
BF244B
C28
2u2
Q1
R76
100k
RV7
1M0
C30
2u2
D3
1N4148
+Vcc
Q2
BC182L
R78
820R
Q3
BC212L
R77
3k9
-Vcc
R69
47k
C31
1u0
IC11
1458
R80
680k
R82
1M0
R81
270k
IC11
1458
C32
1n0
R79
1M0
R83
68k
HOLD OFF VIBRATO
VIBRATO
'DEPTH'
RV5
CW
10k log
IC13
R85
47k
C33
2u2
CA3080
IC12
R84
470R
R86
18k
Q6
BC212L
R88
150k
R87
15k
D4
5V1
D7
1N4148
C34
2u2
IC13
R89
8k2
RV4
1M0 log
DELAY
TIME
D6
1N4148
R90
10k
D5
1N4148
+12V
KEY PRESSED
-12V
R91
6k8
Q7
BC212L
R92
27k

HOW IT WORKS

Each octave of the keyboard is mixed together on the main note generating board. These five octave blocks of signals are fed into virtual earth amplifiers (IC1,2,3) which serve to correct the signal amplitudes. By careful circuit design and layout it is possible to reduce this breakthrough to 70 or 80 dB down on the individual note generating circuits, but the overall effect of 61 circuits, each contributing a slight amount, makes the overall background chorus much worse. Some organs are particularly bad with a performance of about 30 to 40 dB.

The signals from the input amplifiers are then split up and sent to various voicing circuits. The piano/honky-tonk section doesn't have a split keyboard option and so it is driven directly by the sum of all the octave signals. The piano voicing (IC4, pins 5,6,7) is a bandpass filter with a centre frequency of 500 Hz and a Q factor of 1. A slight low frequency lift has been added via R14,C13. This provides moderately pure sinusoids at the top end of the keyboard and much richer sounds at the low end. To obtain the honky-tonk sound, a second resonance is added (IC4, pins 1,2,3) at 5 kHz. This makes the sound much brighter.

The brass voice is a peaky low pass filter (IC6,7,8,9). The filter is swept up in resonant frequency when a note is played, which greatly helps to characterise the brass sound. A tone control (RV3) determines the depth of the sweep. Switches SW11a and SW8a select the upper and lower sections of the keyboard and switches SW12a and SW9b attenuate the signal level when the 'SOFT' mode is selected. The filter is tuned with a pair of CA3080's. As the current into their control input (pin 5) is increased, the resonant frequency of the filter is also increased. This current is generated by IC6, pins 1,2,3. When a note is played, the output of the op amp goes high, which is lowpass filtered by R47,C26. This voltage is used to sweep the brass filter via the common emitter pair Q4,Q5. PR2 is adjusted so that the filter sweep sounds correct.

The string voice (IC5) is composed of a set of high pass filters. The string sounds can be selected on upper and lower manuals (SW10a, SW7a), and there are also soft mode switches (SW12b, SW9a).

To reduce the effects of background and chorus/ensemble noise, a FET switch (Q1) is used to mute the output signal. When a note on the keyboard is pressed, the key-pressed signal goes low. This causes the collector of Q3 to fall to —12 V which turns off Q1. In this state the output signal is not muted.

When the note is released, the collector of Q3 goes high. D3 is then reverse biased and the voltage on the gate of Q1 moves towards 0 V with a time constant of C30. PR1, which is selected to be slightly longer than the longest time constant of any note on the keyboard. As the gate voltage of Q1 approaches 0 V, Q1 turns on and mutes the output signal. RV1 is adjusted so that, with a key pressed, no attentuation is produced by Q1. The key-pressed signal is also used to start the hold-off vibrato circuit. IC11 is a Schmitt trigger/integrator oscillator which produces a low frequency triangle waveform (pin 7). This signal is fed into a CA3080 (IC12) which distorts the triangle by bending it into a sinewave shape. A buffer (IC13) is used to amplify and filter the 'sinewave' which is then used to modulate the master oscillator. The size of the sinewave is controlled by the current flowing into pin 5 of IC12. This current has a delay time constant which is determined by RV5. When a key is pressed, the collector of Q6 goes low and so C34 is charged up via RV5. The voltage on the end of C46 determines the current flowing into pin 5 of IC12. When the key is released, the collector of Q6 goes high and so C34 is discharged via R89,D5.

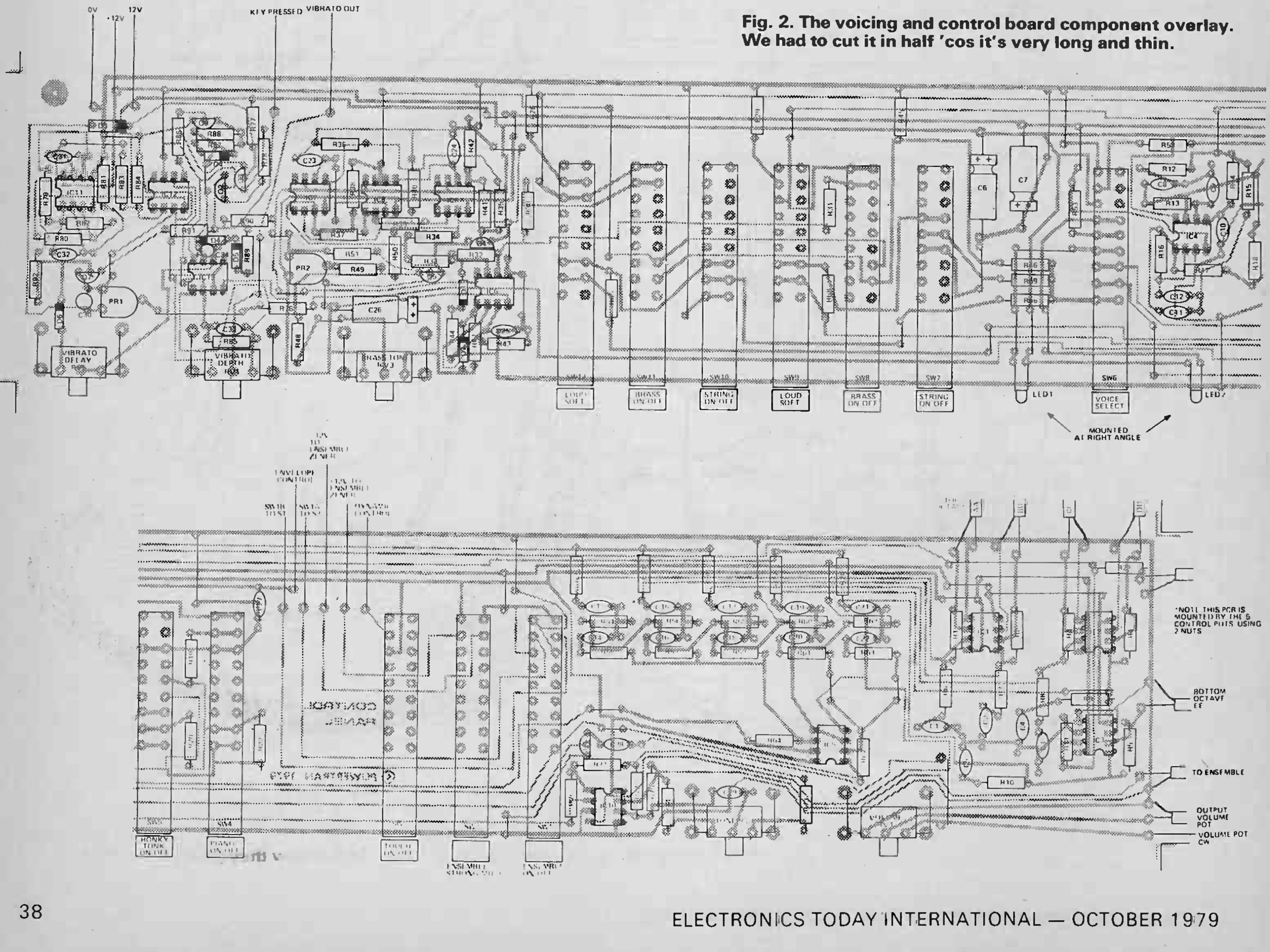


Fig. 2. The voicing and control board component overlay. We had to cut it in half 'cos it's very long and thin.

PARTS LIST

RESISTORS all ¼W 5%

R1, 12, 51, 90	10k
R2, 31, 73, 87	15k
R3	22k
R4, 6, 11, 22	33k
R5, 7, 19, 20, 33, 65, 66, 68, 69, 85	47k
R8, 9, 10, 48, 55	56k
R13, 32	39k
R14, 49, 52, 57, 59, 61, 63, 72, 75, 76	100k
R15	3k3
R16, 35, 41, 86	18k
R17	1k8
R18	560R
R21, 23, 24, 25, 27, 28, 45, 71, 74	4k7
R26, 47, 50	1k0
R29, 44	1k5
R30, 70, 89	8k2
R34	390R
R36, 42, 88	150k
R37, 81	270k
R38, 39, 92	27k
R40	270R
R43	180k
R46, 64, 67, 83	68k
R53, 54	2k7
R56, 58, 60, 62	2k2
R77	3k9
R78	820R
R79, 82	1M0
R80	680k
R84	470R
R91	6k8

POTENTIOMETERS

RV1, 4	10k log
RV2	47k lin
RV3	22k log
RV5	1M0 log
PR1	1M0 preset horiz.
PR2	100k preset horiz.

CAPACITORS

C1, 2, 3, 20	10n polyester
C4, 13, 22	22n polyester
C5, 10, 15	47n polyester
C6, 7	100u 25V electrolytic
C8, 9	15n polyester
C11, 12, 18, 23, 24	4n7 polystyrene
C14, 16, 29	2n2 polystyrene
C17, 19, 21, 27, 31	100n polyester
C25	33n polyester
C26	47u 25V electrolytic
C28, 33	220n polyester
C30	22n 35V tantalum
C32	1n polystyrene
C34	2u 2 35V tantalum

SEMICONDUCTORS

IC1-6, 8, 10, 11, 13	1458
IC7, 9, 12	C43080
Q1	BF244B
Q2	BC182L
Q3-7	BC212L
D1-3, 5, 6, 7	1N4148
D4	5V1 zener
LED1, 2	0.2 inch red

MISCELLANEOUS

PCB, PCB-mounting push-switches (12 off), 8-pin DIL sockets (13 off)

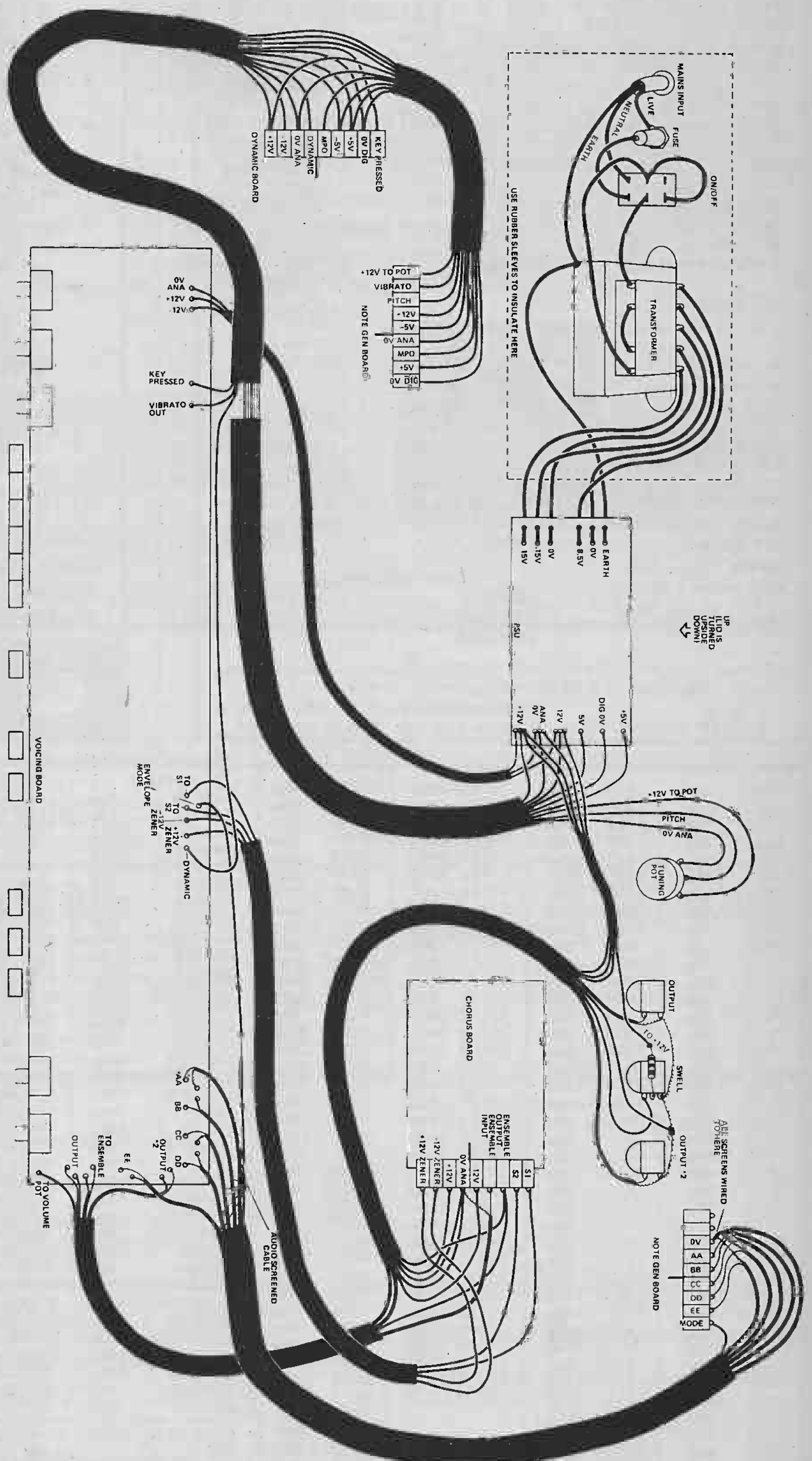


Fig. 3. When you've got your boards finished, this is how they go together.

RAVEN ON...

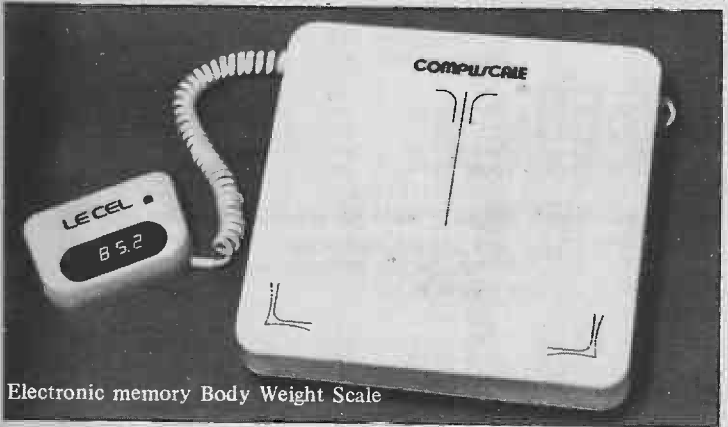
This month's little ramble takes us through foam backed carpets into flat tellys by Sinclair and the best LCD displays in the world — British!

PREDICTIONS OF the effect microprocessors will have in the home are still being made. However, it looks as though 1979 will see the first really domestic products starting to appear. Home Computing is now well established among electronics hobbyists, but the effect of MPU's is not so obvious to people outside the electronics arena. As with the other new technologies the novelty attractions are the first areas to be exploited. Calculators and LED watches were the first to appear using an LSI it has taken a further three to four years of serious product design to incorporate devices into industry.

Open Door

On the market in time for Christmas we shall see a whole new range of products that are only possible because of microprocessors. The now familiar twenty four tune door bells are being manufactured in Hong Kong along with new programmable TV Games that function like flight or vehicle simulators, coming complete with steering wheel. Hand held electronic pocket games, remote control cars and robots also the very sophisticated watches like the Seiko Memory Bank.

One further consumer product now available because of MPU's is the electronic bathroom scale.



Electronic memory Body Weight Scale

This is of particular interest to me since I demonstrated a prototype to my Bank Manager back in 1975, when I had illusions of building a manufacturing complex the size of Plessey. The instrument was an adaption of a small capacitance meter my company was manufacturing and used a novel form of transducer.

It comprises of layers of foam backed carpet separated by layers of tin foil. The capacitance changed quite linearly when the mat was stood upon however I have no doubt that it may not have stood the test of time. The Bank Manager was very impressed but there was a noticeable lack of enthusiasm when it was suggested that he invest the bank's money in the project. With hind-sight he was a very sensible chap since it is unlikely he would have won the support of his own boss in backing the project with the kind of money necessary to launch such an enterprise.

This major difficulty that companies experience in the UK is the main reason that new high volume consumer products are eventually manufactured in the Far East where large sums of development capital exists and also the huge export markets which soak up the bulk volume of these products.

Thousands of words have now appeared in print about minicomputers and the uses of MPU'S.

In fact you could quite easily form the impression that the only new developments taking place in electronics was associated with logic applications. This of course is nonsense and is a misconception that has arisen due to the fashionable use of words in science. One immediate consequence of these trends is that unless a scientist or development engineer can some how design a microprocessor into his proposals then he has less chance of winning the support of financial backers.

Material Gain

Electronics enthusiasts generally know about silicon (or the "silicon chip" as they say on telly) but you never hear Robin Day or Angela Ripoff talk about, Zinc Selenide on Germanium chips, Gallium Arsenide chips or silicon on saphire chips.

Gallium Arsenide is an important semiconductor material. It is not particularly new since its been in use for making devices since the early sixties, Gunn Diodes, Light Emitting Diodes, Varactor Diodes and Field Effect Transistors.

FET's are probably the most exciting development coming from Gallium Arsenide since these transistors can operate at very high frequencies and are increasingly being used in satellite and space communications. Gallium Arsenide FET's (GaAs FET's) have been around for several years the first devices were made by Plessey ten years ago and it has taken all this time to establish the technology to a sufficient level for volume production. Many other companies around the world are also making GaAs fets now and you would currently have to pay in the region of £100 for a FET that will operate at about 18 GHz., (Imagine how it feels to blow one up). The likely effects of GaAs FET's in the next few years are to be seen in the communications field. Computer controlled cars with microwave eyes which can see in all weathers, C.B. Radio using satellites for communications, Digital watches or calculators with CB Radio why not?

Switch Called For?

One area of computerisation I am aprticularly looking forward to is a computer controlled electronic switchboards. Telephone calls to companies out of office hours quite frequently result in the callers being talked to by a phone answering machine. The recording is usually a flat monotone voice which immediately makes the caller feel uncomfortable and results in the phone being hung up. One answering machine story I know was a farmer who because he couldn't get a sensible reply from the recorder shouted a stream of abuse down the telephone and cancelled his contract for fuel oil, with the unsuspecting supplier. To tackle just such problems as abusive farmers there is now a computer controlled switchboard that can answer up to eight telephones lines at once. The computer has a voice recognition system and also a small vocabulary for replies.

A comparison method technique based on statistical analysis of spoken words is used. The machines vocabulary is assembled by taking 500 samples of one word spoken in different dialects from male and female speakers. Each word is sampled 12 times and each sample's overall amplitude is measured and its frequency spectrum plotted at 31 points between 300 and 3k3 hertz. This produces 384 numbers, or elements that describe the word.

The elements resulting from all 500 speakers saying the same word are combined to produce a set of 384 mean values and standard deviations, which are stored in the system as the reference for that word, the incoming unknown word is similarly sampled, analysed and compared element by element with reference words using an algorithm that finds the probability density function for the unknown word. When this probability density is above a certain threshold — which can vary from word to word or system to system — the system declares the word recognised

Sinclar Flat Telly

More information is now available on the flat screened television mentioned in the September edition of ETI. The technology used is that of the conventional CRT and not liquid crystal that the Japanese are going for. The method described is a conventional cathode ray tube which is flat since the beam is projected at right angles to the screen instead of from the back as in a conventional TV.

Glassy Eyed

Two sheets of glass form the front screen and a vacuum formed backing plate. The interior of the backing plate is coated with phosphor and is viewed through the front face from the same side as the electrons strike. The result is that the brightness is more than double that of a conventional CRT. Electrostatic deflection plates in the gun assembly provide horizontal and vertical scanning, and a third set between the phosphor screen and front-face bends the electron beam toward the screen. Without this additional focussing field, the angle of beam incidence would vary across the screen, spreading the beam spot into an ellipse. The focussing electrode is formed on the front face by a transparent tin-oxide coating.

The electron gun is set to one side of the screen with its axis parallel to the screen.

Folding the electron optics would normally distort the raster scan to produce a wedge shape with curved vertical edges, however, by using optical techniques corrections for distortion can be made.

Screen Test

The screen height is reduced by half but the width is kept constant. This narrows the angle subtended by the electron beam onto the screen reducing distortion and deflection power. The picture height is restored by use of a Fresnel lens which is formed in a flat plastic face plate.

The assembly techiques used in producing the new CRT lend themselves to mass production and it is aimed by Sinclair's to set up a new factory for this purpose.

Coincidently, news of a new imaging system with potential for use as a flat screen TV has been patented in Britain.

New Visions

This system uses techniques not unlike those described in this column in September ETI and consists of liquid crystal technology. Two flat screens contain arrays of very thin parallel stripes placed at right angles to each other.

With a electroluminescent or other type of translucent panel behind the liquid crystal screens, light would only be visible at the intersections of the stripes, if these were switched accordingly.

By switching at a very high speed a scanning effect could be achieved as in a conventional TV.

Light could be modulated by altering the intensity of the light panel or by polarising the screens. Filters could also be incorporated for colour operation. ETI

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CD4021	0.90	CD4045	1.26	CD4076	1.17	CD40109	1.03	MC14553	4.43
CD4022	0.82	CD4046	1.20	CD4077	0.39	CD40160	1.19	IM6508	8.05
CD4023	0.18	CD4047	0.89	CD4078	0.20	CD40161	1.19		
CD4024	0.70	CD4048	0.50	CD4081	0.20	CD40162	1.19		
CD4025	0.20	CD4049	0.50	CD4082	0.20	CD40163	1.19		
CD4026	1.55	CD4050	0.43	CD4085	0.64	CD40181	3.40		

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AUDIO COMPRESSOR

Increase your talk power and improve legibility with this ETI Project team design that avoids the complication of RF clipping!

THE HUMAN VOICE varies considerably in level, even when one is speaking in a normal conversational voice. The peaks are considerably higher than the lower levels, which can give rise to problems when the speech waveform is being modulated onto a carrier by a transmitter. For example, if the mic gain control is set so that the peaks are just giving 100% modulation, then soft sounds can barely be heard, whereas if the gain is turned up to give a higher level on vowel sounds, etc., then plosives (p-sounds) will give overmodulation and consequent splattering and poor speech quality.

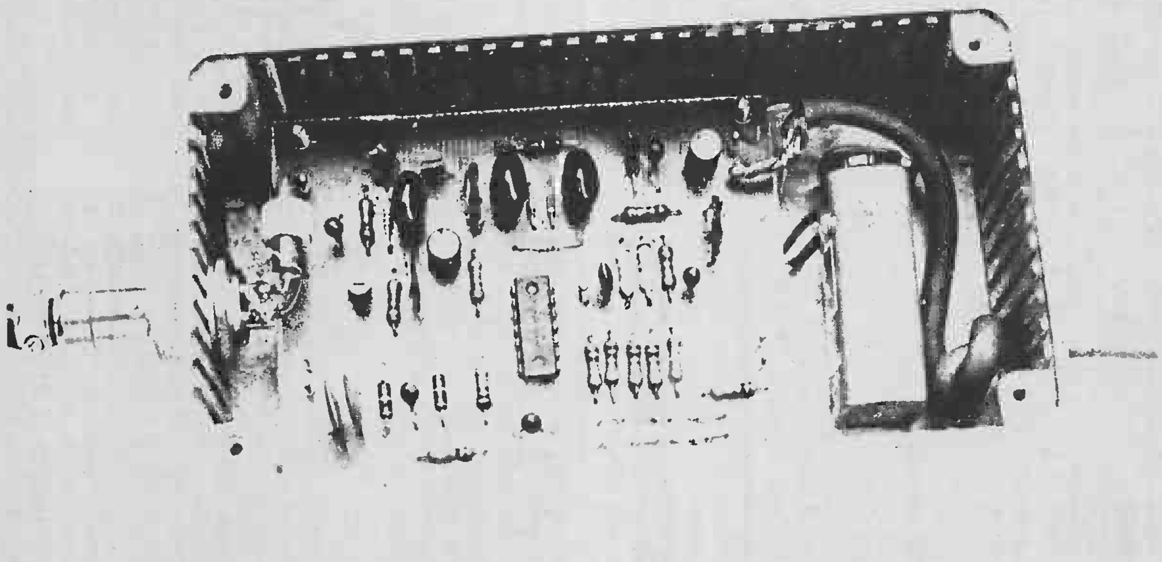
A higher ratio of average power to peak voltage can be achieved by several methods, including compression or clipping of the audio signal and compression or clipping of the radio frequency signal. Radio frequency compression or ALC (automatic level control) is often used in the final states of SSB transmitters.

Radio frequency clipping is the most effective method of increasing the average power; however it requires complex circuitry, since it is necessary to generate an SSB signal, clip, and then insert this signal into the transmitter IF chain.

Almost as effective as RF clipping is a combination of audio compression, clipping and filtering, which is relatively simple and can realise an improvement in signal to noise ratio of up to 5 dB on weak signals.

Compression

When speaking into a microphone it is desirable to keep the voice level as constant as possible. This can be quite difficult as any change in the distance to the microphone will cause a drastic change in its output. To overcome this a variable gain amplifier can be used which senses the average speech level and adjusts its gain accordingly for a constant output voltage. The compressor operates with a fast attack (gain reduction) and a slow decay (gain increase), to quickly respond to the voice while remaining at this level to prevent amplification of background noise during speech pauses. ▸



Inside view of the Processor. The RF choke should be mounted as close as possible to the input socket.

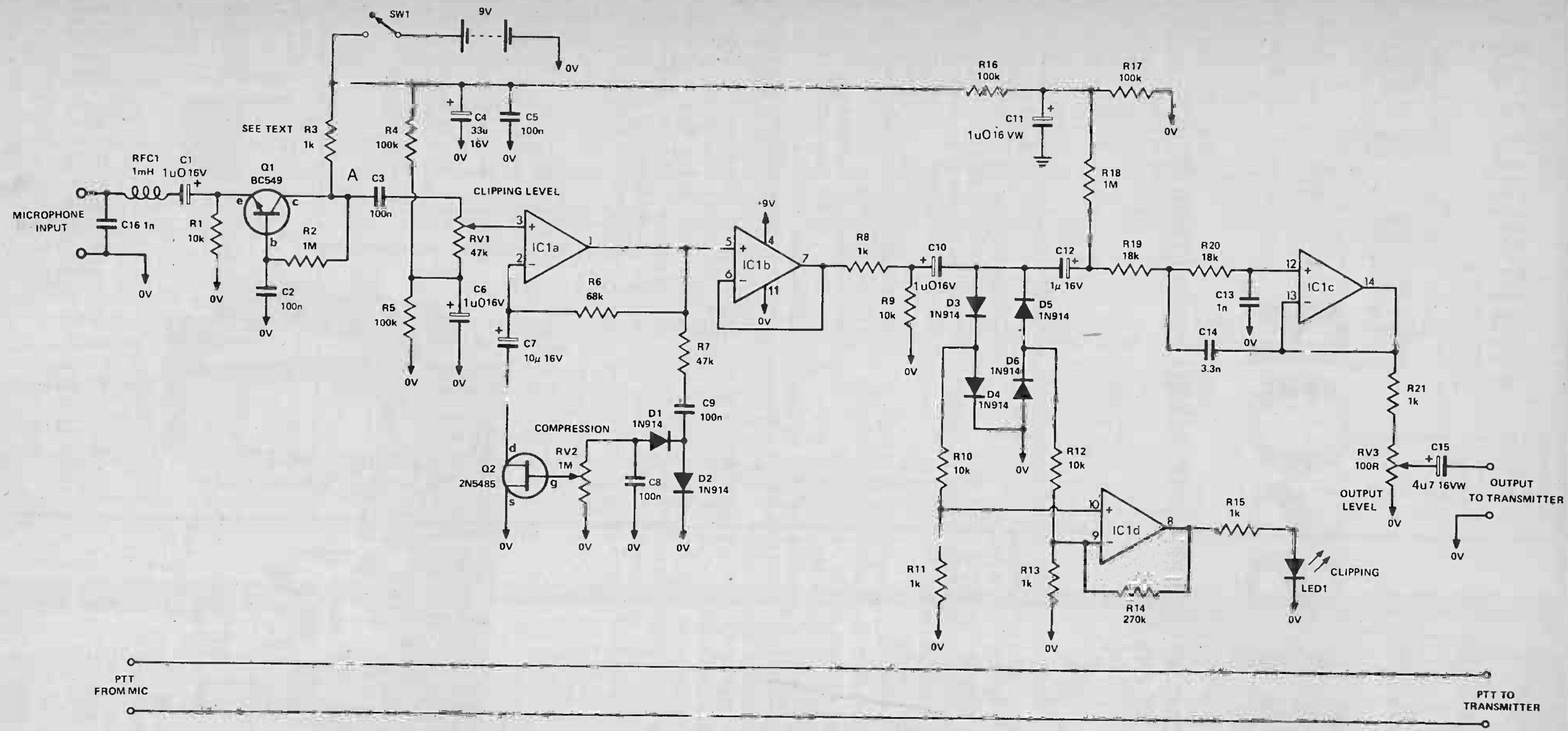


Fig. 1. Circuit of the speech processor.

HOW IT WORKS

The input is fed to a common base amplifier (Q1) and then to the gain control, RV1. The signal is then further amplified by IC1a. Some of the output from IC1a is rectified and negatively charges C8. This voltage is then fed to Q2, a depletion mode N — channel FET. As the output of IC1a increases the voltage on the gate increases negatively and the impedance of Q2 increases. This increases the ratio of the feed back signal applied to the negative input of IC1a and the overall gain is reduced. The attack time is set by the time constant of R7 and C8, while the decay time is set by RV2 and C8.

IC1a is a buffer to isolate the peak limiter from the compressor input. R8 limits the output current of IC1b on peaks while R9 provides output bias current to prevent crossover distortion in the LM324 when driving capacitive loads. The diodes D3-D6 form the peak limiter by shorting any signal over about 1V5. When clipping occurs the voltage across D4 and D6 rises to OV7. This voltage is used to turn on IC1c to give an indication of clipping by lighting LED 1.

The active low pass filter, IC1d, removes the unwanted harmonics produced by clipping. RV3 sets the output level. The low frequency response is limited by the value of the coupling capacitors and C2.

BUYLINES

All the components here are standard items, and even the RF choke will be easily obtained. Keep the box size as close to the PCB size as possible, and the wiring as short as you can. The Norman range of metal boxes is sutiable, or indeed any of the West Hyde cases which will accept the PCB.

Filtering
When a waveform is clipped high order harmonics are produced which, if allowed to reach the transmitter, would cause splatter and interference to neighbouring stations. A filter must be used after the clipper to rapidly attenuate all frequencies above 3kHz, which are unnecessary for intelligibility. This is achieved by using an active filter with 12 dB/octave attenuation above 2k5 Hz.

Clipping
The average power contained in a speech waveform is quite low compared to the peak voltage, and much less than the average power of a sine wave of the same amplitude. If the low energy high voltage peaks are cut off at a preset level the remaining signal can be increased without overdriving the transmitter. The average power is therefore increased. Clipping will slightly change the sound of the voice but will increase the intelligibility of a weak signal, as well as preventing the transmitter form being overdriven by limiting the maximum signal voltage.

Construction
The speech processor is mounted in a diecast aluminium box to guard against feedback which can be caused by strong RF fields. Our box measured 150 mm x 80 mm x 50 mm deep. Either an internal 9V battery or the 12V transceiver supply can be used. The processor is designed to be used in the line from the microphone to the transmitter without any modification to either. A matching socket to the mic plug is used for the input and the output taken via a lead with a matching plug. The connections for the plug and socket vary between makes of transceivers and will have to be taken from the circuit diagram to the transceiver. The clipping indicator (LED 2) and the power switch are mounted on the front panel.

Setting Up
Turn the compressor control to maximum and speak into the microphone at the greatest distance you are likely to use (say 30 cm-. Increase the gain control until the clipping LED flashes. If this point cannot be reached decrease the compression control and try again. The setting of these two controls is best determined by on-air tests. The output level control should be set so the RF indicator on the transmitter reaches the same peak as with only the microphone plugged in.

For high output, high impedance microphones, such as crystal types, Q1 can be omitted, RV1 replaced with a 1M trimpot and the input fed to point A on the circuit.

The gain of Q1 is proportional to the value of R3. Increasing its value increases the gain. To guard against feedback the lowest value possible should be used. ETI

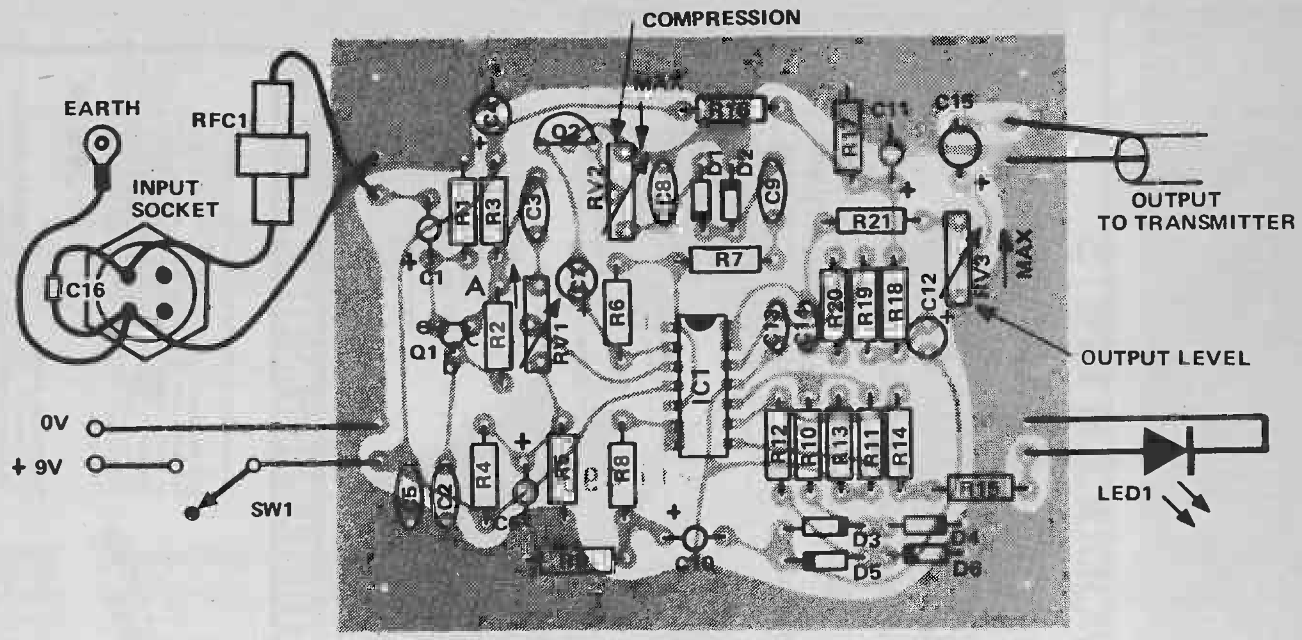


Fig. 2. Component overlay of the speech processor. Note the RF choke and capacitor mounted between the PCB and input socket.

PARTS LIST

RESISTORS	all ¼W 5%	
R1, 9, 10, 12		10k
R2, 18		1M
R3, 8, 11, 13, 15, 21		1k
R4, 5, 16, 17		100k
R6		68k
R7		47k
R14		270k
R19, 20		18k
POTENTIOMETRES		
RV1	47k lin trimmer	
RV2	1M lin trimmer	
RV3	100k lin trimmer	
CAPACITORS		
C1, 6, 10-12	1u 16V electrolytic	

C2, 3, 8, 9	100n Polyester
C4	33u 16V electrolytic
C5	100n ceramic
C7	10u 16V electrolytic
C13	1n polyester
C14	3n3 polyester
C15	4u7 16V electrolytic
C16	1n ceramic
SEMICONDUCTORS	
Q1	BC549
Q2	2N5485
IC1	LM324N
MISCELLANEOUS	
RFC1	1mH or higher
SW1	SPST min toggle
MIC plug & skt, box to suit, battery & holder	

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

MAIDEN STAR CHESS FINALS

Some time ago we received a colourful piece of fluorescent (or is it phosphorescent?) plastic in the post. An eerie green glow pervaded the office as we deciphered the strange hierogrlyphs. They invited us to attend — wait for it — the Galactic, yes Galactic, finals of Star Chess, the TV game guaranteed to give a Grand Master a heart attack in 30 seconds flat.

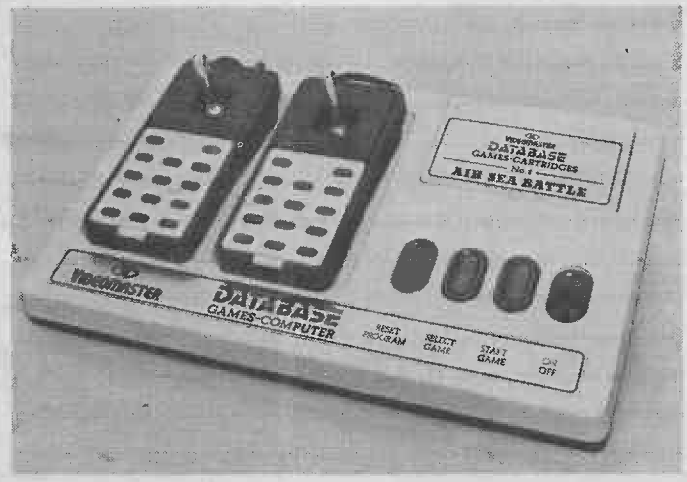
When we arrived at the festival of cathode ray ballistics, we were instantly and eternally grateful to Colin Wild for designing the costumes which coffee and cream Star Maidens, Carolyn and Beverley, were in great danger of nearly wearing. It's truly amazing how a journalist's attention can wander from a six feet square telly screen so quickly.

Dr. Who's K-9 made a manly (dogly?) attempt at commentating on the final game, but I guess he's more familiar with multi-dimensional, hexagonal games with knobs on, because his speech circuits dried up after the first half dozen moves (thank goodness). The final itself was relatively uneventful, neither player risking anything, his sights firmly set on the first prize of a trip to America (and back, of course). It was won by Peter Bond — one of our men at the Inland Revenue, God Bless him.

The fun began when the game finished, as we embarked on a tour of new games from Videomaster. On our way to the screens we noticed a novel chess set — the pieces were glasses of wine (red versus white) engraved with pawn, rook, etc. When you take a piece, you drain the glass. The two ladies who were deeply engrossed in the game seemed to be basing their strategy on how they could exchange the maximum number of pieces in the shortest possible time.

Meanwhile, we hogged the Videomaster Database—a new programmable TV game, including Black Jack, tank, horse racing, circus and boxing. However, we found the air-sea battle the most compelling. Other systems on show included sportsworld (ten games) and Colourscore 2 (six games). We'll tell you more about them just as soon as we can get hold of samples to play with (it keeps us off the streets).

The 1979 Star Chess Galactic Champion, Peter Bond, clutches his trophy, guarded by K-9 and Star Maidens, Carolyn and Beverley. The gent in the kilt is Cameron Macsween, managing director of Videomaster. The proceedings were overseen by Harry Golombeck, the Times chess correspondent.



'CHIPS AND BUGS'

The Economist has taken two tiny technologies with a big future and combined them in the latest of their excellent booklets.

Chips and Bugs, edited by Richard Casement, takes the microprocessor and biotechnology, two apparently unconnected fields, and brings you up to date with the latest developments. In fact they have three things in common. They both rely on studies of microscopic phenomena; they are controversial; and they rely less on building upon past developments than on fundamental discoveries at the frontiers of modern science.

The first half of the twenty page booklet deals with microcomputers — the technology, hardware, software, systems development and the superchips effect on our lives and jobs. The second half takes you from an explanation of the DNA building block to the intricacies of genetic engineering.

'Chips and Bugs' is £2.50 from The Economist Newspaper Ltd, 25 St James's Street, London SW1A 1HG. Hint: If your can get ten or more 'Chips and Bugs' fans together, The Economist will slash the price to £1.50 per copy for bulk orders.

BOSSY LEDS

The BIM 33 and 34 from Boss, who have christened them BIMDICATORS, are front viewing, panel-mounting LED indicators.

Both devices use red, green or amber gallium phosphide LEDs, which have low current, low voltage characteristics, fast switching times and are fully IC compatible.

The BIM 33 has a nickel-plated brass body and is mounted in a 6mm hole, while the BIM 34 has a chromium-placed brass body and is mounted in an 8mm hole.

Further details from Boss Industrial Mouldings Ltd, Higgs Industrial Estate, 2 Herne Hill Road, London SE24 0AU.

BLUE RESEARCH

Your choice of LED colours might include blue in the not so distant future. The new devices, being developed by Siemens, use silicon carbide and are predicted to have a forward voltage drop of 4 V at 50 mA.

microfile

Henry Budgett, our busy micro-man, takes you on a tour of the latest shows and brings you up to date with the latest developments. Need a toolkit for your Pet?

IT'S BEEN one of those months,, if you know what I mean. You don't? Well the summer just seems to explode with things to do and places to go, so some of the items covered in this month's column are gust a little late. Taking things chronologically, it helps. I shall start with the Microcomputer show. One short sentence can describe the overall situation. It was very hot and very busy!

Apparently the air conditioning had broken down on the Thursday but, despite repairs, it was still sweltering hot on the Friday morning. Nothing really spectacular was launched at the show but a large number of old friends were to be found. My first port of call was Technalogics, the Teletext/Prestel/BASIC system people, who were awaiting final PO approval. Well, as I mentioned briefly last month, they now have that approval and will commence delivery in September. They also had one of the rack mounting versions on display, complete with mini floppy. After breakfast at their stand, a quick pint, I moved round the hall to see Julian Allason at Petsoft. Trade there was so brisk that they had to send a truck back up to Brum twice for fresh stocks of software. Also there was Harry Saal, the man who brought you Cluster One, the distributed processing system.

Lunch Break

Very thirsty work these shows, so after yet another pint in the company of a couple of my ex-colleagues who own a Research Machines, I carefully negotiated the rest of the hall. The Nanocomputer was there. A lot of people seemed to be very interested on the educational side. The Nascom stand was overflowing as usual, they even sell T-shirts now. Apparently the '2' has gone into production at last, I wonder when we will see our review machine (gentle hint to Kerr).

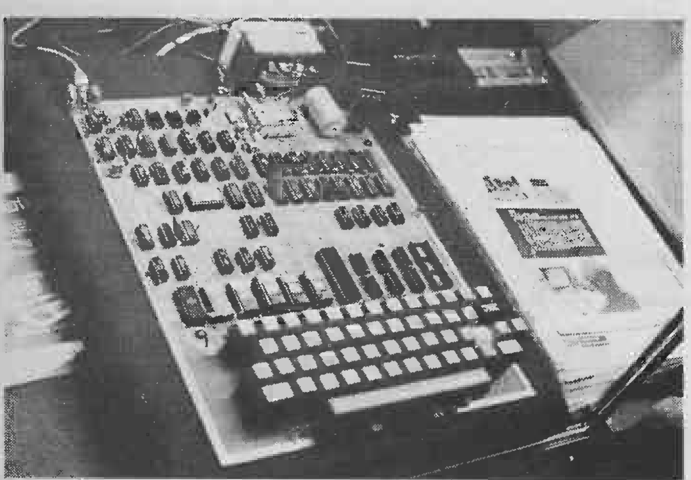
The other main centre of interest was around the UK101. This is the redesigned Superboard II about which much rumour has been flying concerning legal action over software, PCB, etc. Nothing seems to have happend yet and the stand was certainly busy with interested people making up their minds to buy one.

The last laugh at the exhibition went to Online, the organisers. A friend of mine asked one of their staff where the nearest Tube was. ''Thirty feet straight down'' came the reply, nice one.

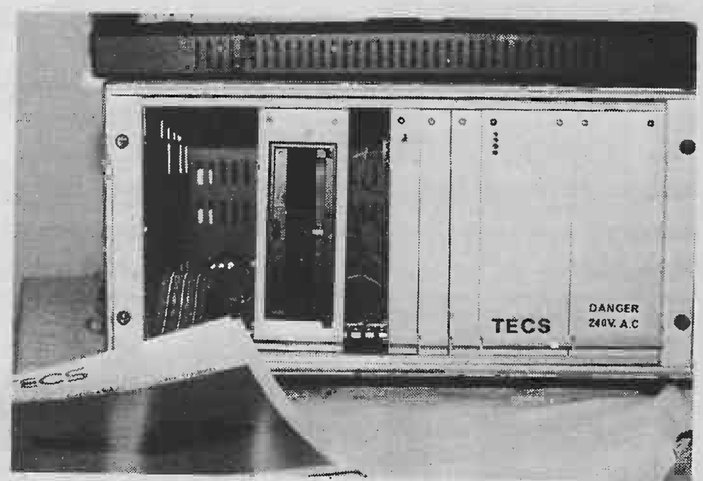
Words On Words

Next in my crowded calendar comes the Word Processing Conference, held at Wembley. The Electronic Office seminar session that I attended was highly amusing. Presentations were given on the how's, why's and wherefore's of office systems by a number of companies, both British and American. However, the prize must go to the gentleman who floored the chair with some embarrassing comments on machine reliability after the Wang audio-visual extravaganza. After several seconds of embarrassed silence they decided to break for lunch. England 1, USA 0.

The companies on show all seemed to be vying for the most far out stand, the prettiest girls, etc. and overall I was left with the feeling that everyone had gone just a little over the top. Among the companies there were such giants as IBM and ICL as well as Wang and Wordplex among many others. It seems to me that the



Is it? No its a UK101. Nearly the same though!



TECS's rack mounted Prestel system, disks coming soon.

WP field is really trying to exploit a market that is just not ready. Even the most sophisticated system will fall foul of a naive user and then the system gets the blame.

Once again thanks are due to Online, especially to the young lady who found me a set of conference notes after much hunting around.

Northward Bound

Stage three of the month's travalogue takes place not a stone's throw from the Mersey. Liverpool, home of the music of the sixties and sit-coms, is also the home of Microdigital, who are not connected with either. They are, however, connected with microcomputers, and very seriously at that. They are one of the few UK computer shops to provide a full backup service in both hardware and software. Bruce Everiss, my host for the day, is justly proud of his achievements over the past year. They have expanded from shop to hire company and along the road have collected a software engineer, two hardware designers and the largest range of computer books in the country.

The software that they produce is mainly for local clients and is business orientated. The sample I tried, albeit only half developed, was very high quality indeed. The hardware team are currently working on a series of boards for the Nascom. The first, a relay board will be ready soon and the next one, an analogue input board is currently under design.

Go West Young Man

Well, West was about the only direction left so I pointed my trusty vehicle in the direction of Newbury and went. The reason? To see the man who has probably done more to make the word software a household name than anyone, Julian Allason.

Despite the fact that Petsoft is now owned by ACT he has stayed on as a director and is actively engaged in finding software from any number of sources. His latest acquisition is the PET Programmers Toolkit, the goodie for PET that I mentioned earlier. Brought over from the States by Harry Saal and shown very briefly at the Microcomputer show it will so impressive that I went to see more.

It is really a piece of firmware, machine code program stored in a 2K PROM that plugs onto the PET expansion port. If you have a new ROM PET you only need the IC as it will plug inside your machine. Apart from plugging it in no modifications are required and you have a vast increase in useability. If you have ever wished for built-in utility programs then this will provide them, it replaces about six cassette programs with single commands. I borrowed one of the only two samples to do a report for CT, but here are the available commands in a brief resumé.

AUTO:	Automatic line numbering, any start, any step.
DELETE:	Bulk line deletion, lines specified only.
RENUMBER:	Any start, any step.
HELP:	Displays just what caused that syntax error.
TRACE:	Displays the last six program steps continuously, can be stopped and started at any time during run.
STEP:	Single step version of TRACE.
APPEND:	Compile programs from subroutine libraries on tape.
DUMP:	Displays all variables and strings used in program.
FIND:	Finds all occurences of specified character string in the program.

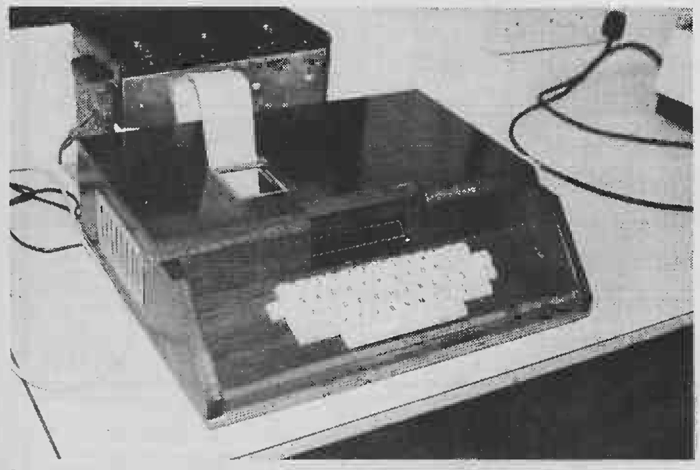
The cost of this little gem is a mere £75 for the plug on version, £55 for the IC.

Micro Coup

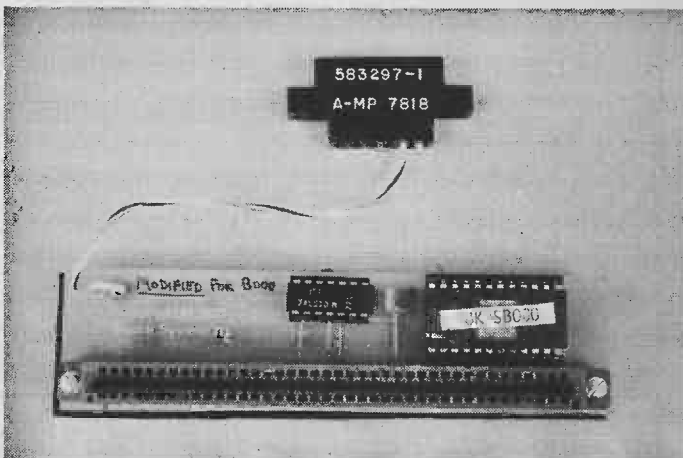
The latest coup for the firm is the acquisition of an American single board computer. Called the ACFA, it is based on the 6808, hopefully the 6809 soon, and has an impressive list of features. Complete with an 8K BASIC on cassette, it has 16K RAM, expandable to 48K RAM on-board, colour graphics using 4K of RAM, ASCII keyboard, Kansas City cassette and an RS232 interface. It will be supplied as a kit complete with PSU and case. The manuals supplied with the system are really a computer course on their own and have been prepared by Dr Veronis, a well-known American author.

The Final Word

The University of Salford have asked us to let you know about their forthcoming series of microprocessor courses. They are all one day courses and are being held in September. Preparing for the Microprocessors Age (Sept 24 £40), Fundamentals of Microprocessors (Sept 25 £60) and Microprocessor Systems (Sept 26 £60). A 10% discount is being allowed if more than one course is attended. For further details please contact Mrs Sumners, Room 110, University of Salford, Salford M5 4WT or ring 061-736 5842 extn 449. ETI



An open and shut case for the AIM 65. Get yours from Microdigital.



The PET programmer's Toolkit from Petsoft. The best thing to happen to a PET yet!

HIGH QUALITY AUDIO AMPLIFIER

If you're in the market for a true hi-fi amplifier, this is the place to start. A superb design which offers a reproduction quality equal to the very best around today.

IT HAS BEEN some time since we featured a complete stereo amplifier design in ETI — receivers and power amps yes, but not a full hi-fi set-up. When considering putting this right, we wanted to produce a design that could stand with the best commercial units of the day, and yet offer a considerable price saving over such designs in return for the effort of ''doing it yourself.''

We believe our Audiophile 4000 fulfills these aspirations nicely.

Full Of Philosophy

A study of the specification will show that our amp has no need to fear comparison with any other unit. That 60W RMS power rating is deceptive too — built with our PSU the 4000 will outperform most 100W rated commercial designs in terms of transient delivery, bass quality and sheer 'dynamics'.

Listening tests played a large part in determining the final design, and particular stress was placed upon delivery of detail and elimination of TID.

Construction is modular, and we have housed the system in THREE cases. Pre-amp, power amps and pre-amp PSU. You can of course ignore our suggestions and build the whole thing in one box using one PSU for everything. You can *also* expect degraded performance if you do! Separate power supplies for each channel of the power amp should not be considered optional — they are very important to the final specification.

The three case approach has several advantages — not least of which is hum reduction. Casing it ▶

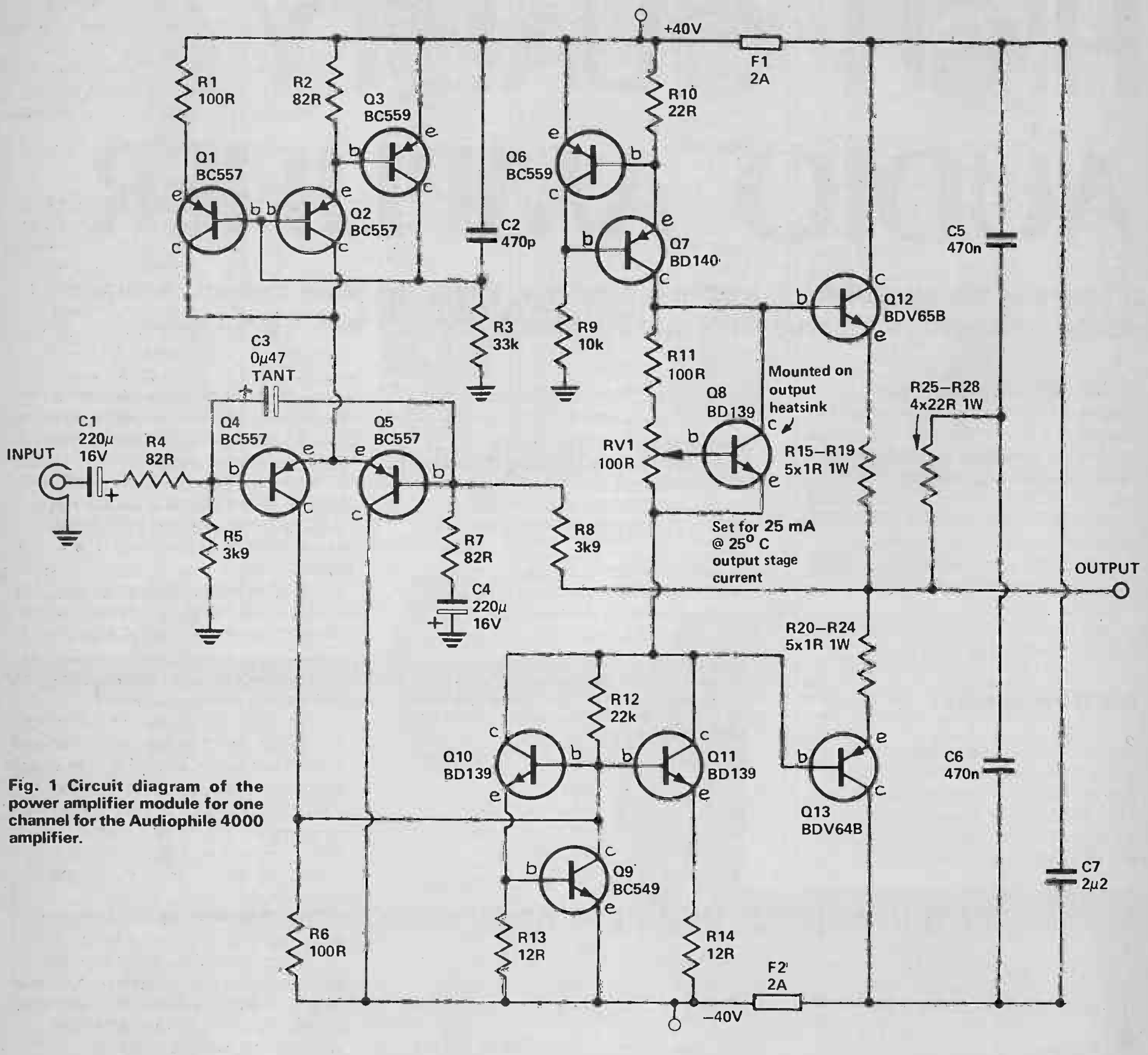


Fig. 1 Circuit diagram of the power amplifier module for one channel for the Audiophile 4000 amplifier.

HOW IT WORKS

The input stage of the amplifier consists of an emitter coupled differential pair (Q4, Q5) with a constant current source (Q1, Q2 and Q3). The use of a constant current source reduces distortion, as well as the possibility of high frequency oscillation and prevents any ripple on the positive supply from unduly affecting the input stage. Unequal emitter resistors (R1, R2) allow the currents in Q4 and Q5 to be optimised. Input lag compensation is provided by C3, limiting the slew rate of the amplifier to reduce high frequency intermodulation. The gain of the differential pair, driving Q10 and Q11, is very low.

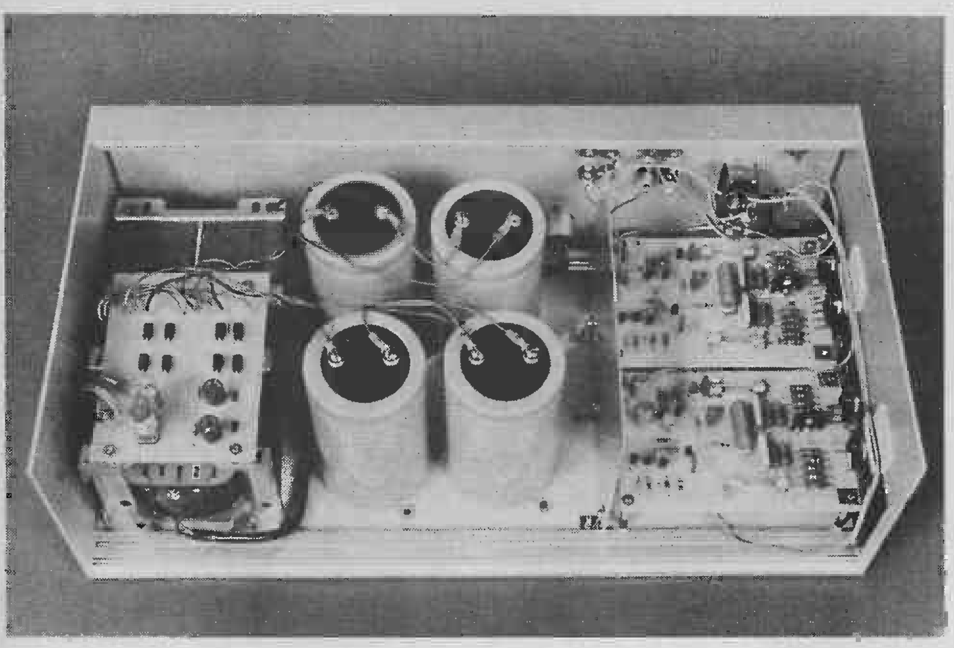
Almost all the gain of the amplifier is obtained from the parallel pair Q10 and Q11. They are operated with series (R13, R14) and shunt (R12) feedback, and a constant current source (Q6, Q7). This results in a highly linear stage.

Q9 protects Q10 and Q11 from high peak currents or damage should a fault occur. When the current through R13 exceeds the safe limit, Q9 conducts and shorts out the drive to Q10 and Q11.

Bias from the output stage is set by RV1 and a shunt regulator (Q8). Q8 is mounted on the same heatsink as the output stages and stabilises the output bias current against heatsink temperature rise. Resistors R15-R24 in the emitters of the output Darlingtons, Q12 and Q13, maintain operation in their safe region as well as reducing the chance of thermal run away.

Protection against ultrasonic oscillation is provided by C7 and the network consisting of R25-R28 and C5, C6.

Both DC and AC feedback is taken from the output, via R8, to the negative input of the differential pair, the amount of feedback being set by the ratio of R8 to R7. C4 increases the feedback, and therefore decreases the overall gain, at very low frequencies. The feedback also automatically holds the DC output voltage at close to zero volts.



Inside the power amplifier case. The power supply for each channel sits on the right of the enclosure, and the rectifier board and de-thump board sits on top of the transformers. Note the screen between channels and the screening between modules and PSUs. Don't be tempted to use a single PSU for both amps — this will degrade transient performance to a considerable degree.

SPECIFICATION ~ POWER AMP

Power Output .... 60 watts into 8 ohms (∓40V supply)

Frequency Response .... 10 Hz to 100 kHz ∓0.5 dB

Input Sensitivity .... 500 mV rms for 60 W output

Hum and Noise .... better than −110 dB on full output (dependent on power supply)

Feedback Ratio .... 35 dB

Distortion .... at 1 kHz, 30 V p-p output into 8 ohms,
Closed Loop .... 0.04 %
(open loop 1 %)

Stability: The amplifier was found to be completely stable when operated into reactive loads consisting of R + C, L + C and pure L

Intermodulation (calculated values) .. at 1kHz, 30 V p-p output into 8 ohms,
3rd order .... less than 0.015 %
5th order .... less than 0.0023 %
(Intermodulation reduces with reduced power)

this way is a good 6dB better than the cheaper alternative is likely to be. Separate PSUs for the power and preamp also avoids LF instability caused by supply line droop when the output pair draw heavy currents.

Preamp Pondered

The requirements for the control section of the system were set down after many hours of office discussion. In fact it would be fair to say that it evolved rather than was conceived.

There is still much discussion around the subject of tone controls and filters in amplifiers. A strong lobby exists to dispose of them completely, indeed in *systems* of the highest quality and in good listening conditions they have little to do with accurate sound replay.

However as most (nearly all) hi-fi falls far short of this level we have included them on our PCB. Also present are loudness, mute, low cut and high cut filters — the latter being of low phase shift variety at sensible turnover frequencies. These can be omitted from the final unit as you will. On our prototype, no loudness or mute facility was included, as you can see from the photos.

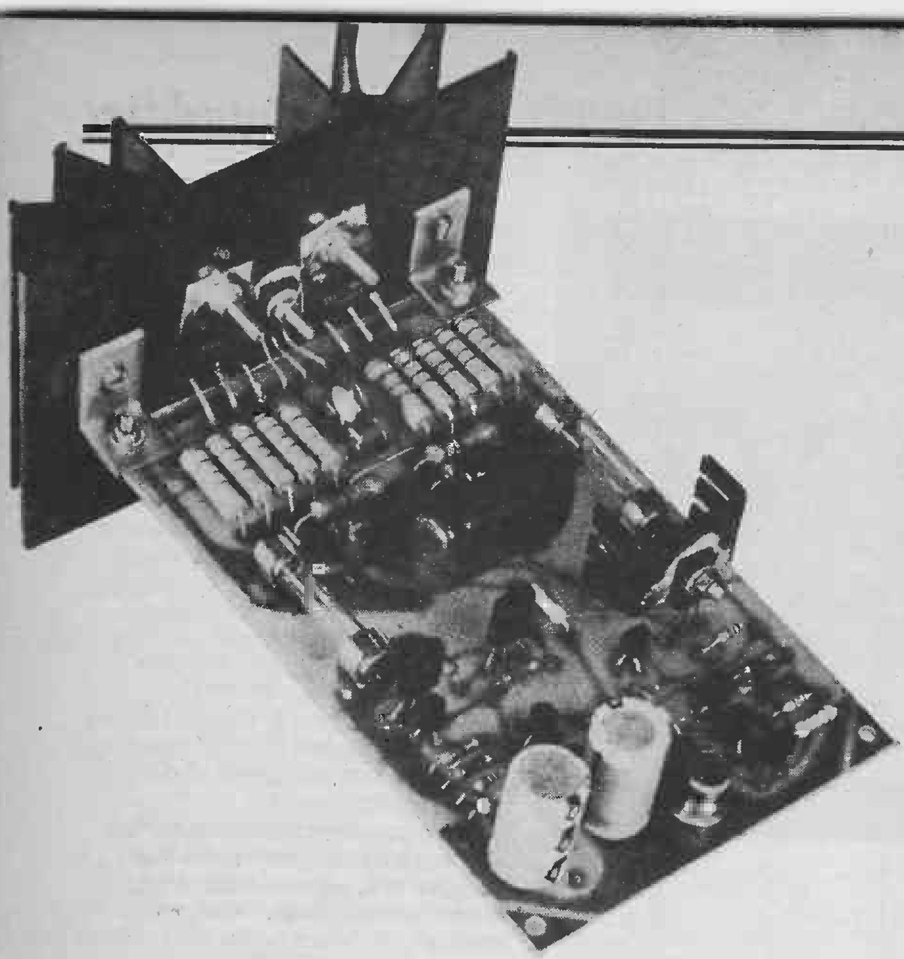
The MC input is in fact not RIAA equalised, to allow for connection of a head amplifier, one of which would almost certainly accompany the cartridge. We are working on a design for a mains powered unit ourselves and will present this at a later date, in a style to match the Audiophile.

The disc pre-amp section of an amplifier must be capable of handling very high input signals before clipping to preserve dynamic range — especially when used with head amps — and ours can take 400mV ptp before clipping. Dynamic range > 100dB).

Powerful Discussion

This power amplifier offers a significant improvement in specifications and ease of construction over most kit amplifiers offered to date. It has been designed particularly with low transient intermodulation distortion in mind.

Although a difficult parameter to measure, transient intermodulation distortion is an inherent characteristic of many amplifier designs — especially those which incorporate large amounts of feedback to even out frequency response and reduce



A completed module — fitted with phono socket input. This is optional, and if omitted wire direct to the foil side of the board. Below: — Fig. 2. Component overlay for the amplifier module.

PARTS LIST

POWER AMPLIFIER (each channel)

RESISTORS all ¼W 5% unless marked

R1, 6, 11	100R
R2, 4, 7	82R
R3	33k
R5, 8	3k9
R9	10k
R10	22R
R12	22k
R13, 14	12R
R15-R24	1R 1W
R25-R28	22R 1W

POTENTIOMETERS

RV1	100R trimmer

CAPACITORS

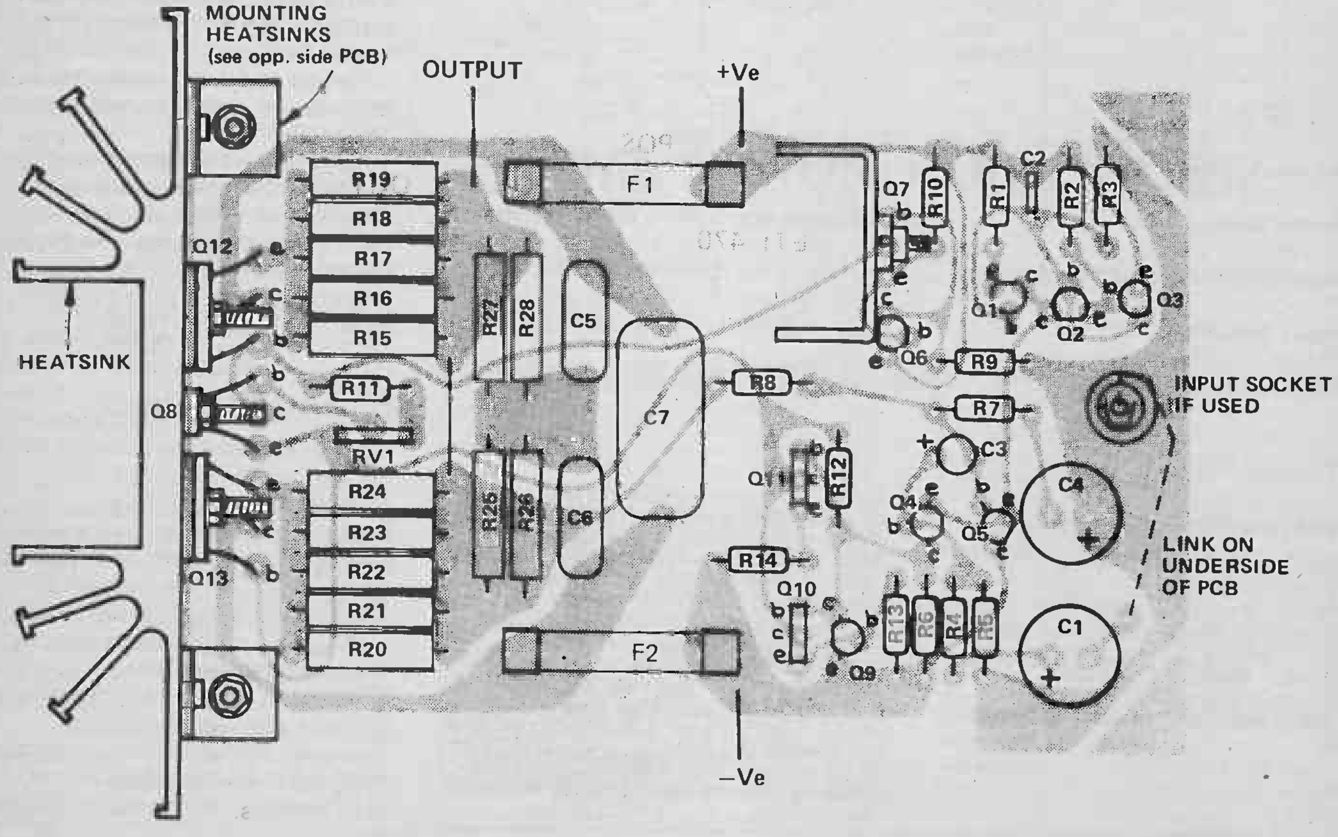
C1, 4	220u 16V
C2	470p ceramic
C3	470n tantalum
C5, 6	470n polyester
C7	2u2 polyester

SEMICONDUCTORS

Q1, 2, 4, 5	BC557
Q3, 6	BC559
Q7	BD140
Q8, 10, 11	BD139
Q9	BC549
Q12	BDV65B or TIP142
Q13	BDV64B or TIP147

MISCELLANEOUS

2A Fuse (2 off) with holders, insulating kits for Q8, 12, 13 heatsinks, brackets, spacers, PCB



harmonic distortion. The heavy feedback 'school' of design produces an impressive list of specifications — but the difference *to the ear* between such an amplifier and one designed for low TID has to be heard to be believed.

The design of the power supply can mean the success or failure of an otherwise well-designed amplifier. The supply voltage should be well-regulated, varying less than 10% from no load to full load, and be able to supply high peak currents.

However, if a voltage regulator is employed it too must be capable of delivering the very high peak currents occasionally demanded. This necessitates an expensive regulator device and large, expensive filter capacitors.

The alternative is to use a fairly large transformer and large value filter capacitors on a capacitor-input bridge rectifier. This is what we chose.

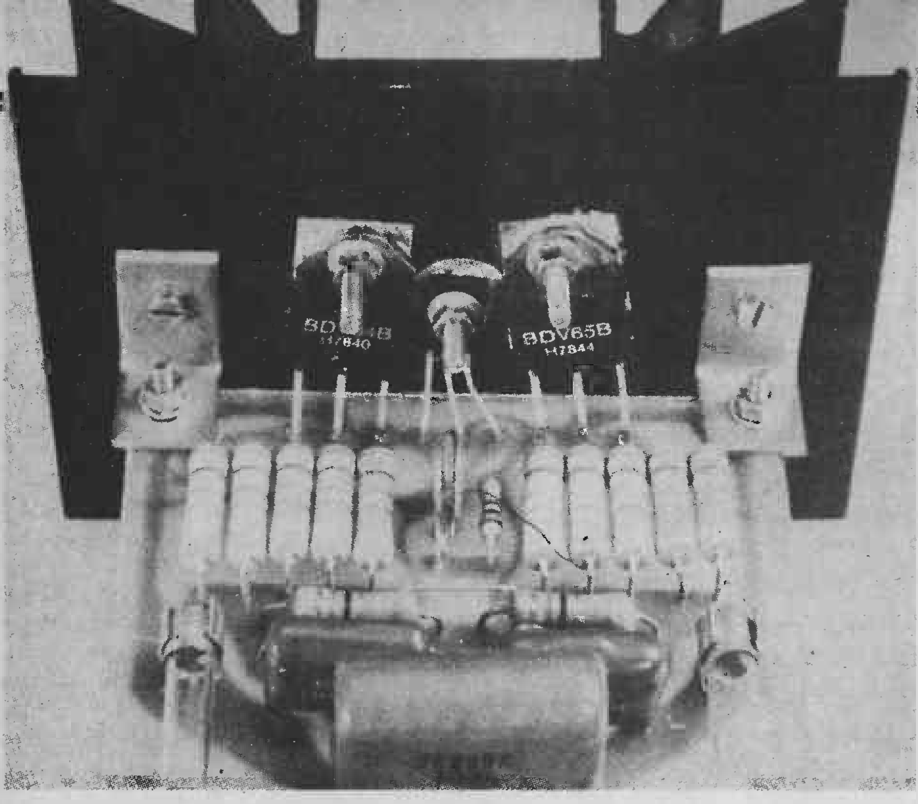
Powering Supplies

The circuit given here shows a power supply suitable for supplying a stereo amplifier using two of these modules. The filter capacitors C8 and C9 consist of two 15000 uF, 60 volt electrolytic capacitors. This is the minimum value we would recommend.

The power supply output should be limited to a peak DC voltage of about 40 volts (for 60 W output). A C-core transformer will generally improve the hum and noise output figures apart from having a reduced field, thereby reducing possible hum pickup problems.

If the amplifier module is to be used with a 4-ohm speaker system the supply voltage must be limited to about 30 volts maximum, otherwise the output devices will attempt to deliver 100 watts followed by rapid self destruction!

Adventurous constructors may wish to try adding a second set of Darlington output devices, with their own emitter resistors as per the circuit, connected in parallel with the original pair. This combination may supply 100 watts or more into a four ohm speaker load. This technique is also recommended if you are contemplating driving highly reactive loads such as electrostatic loudspeakers. ▶



WHY LOW TID?

Looking at the circuit and a quick glance at the specifications, there's little in the circuit that looks outstandingly different from others. So what makes this amplifier special?

The difference in concept that makes this amplifier unique is the use of a very linear, high gain driver stage (Q10, Q11), with a constant current source (Q6, Q7), so that the gain of *this* stage is dependent upon the input impedance of the output transistors. However, *their* input impedance is dependent upon their gain, and therefore *the gain of the amplifier stage is dependent solely upon the characteristics of the output devices.*

Series and shunt feedback is used with Q10 and Q11 which results in a highly linear stage with a very low input impedance (about 28 ohms). The gain of the differential pair when fed into this low impedance is close to unity, so almost all the gain of the amplifier is concentrated in Q10 and Q11.

Provided the phase shifts in the differential pair and the gain stage are negligible the feedback loop is unconditionally stable.

There are two other design features which result in low TID.

The total open loop (feedback disconnected) distortion is only 1% at 30 V p-p output. So, very little feedback is necessary to reduce this to an acceptable level.

Protection of the output transistors is done by fuses, rather than electronically, and very high transient currents can be fed to the speaker without being affected by the (inevitably) non-linear impedance of an electronic protection circuit.

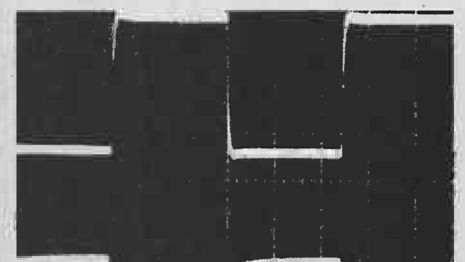
PULSE TESTING

Operation into severely reactive loads was examined by looking at the ac component of the Vbe of Q10 as a measure of the 'overshoot' of the loop and to see if transient overload occured.

f = 1 kHz. CRO is 0.2 mS/div. Output is 30 V into 8 ohms.

Upper trace 10 V/div. Output into 8 ohms.

Lower trace 10 mV/div. Vbe of BD139 gain stage. *No evidence of transient overload was visible.*



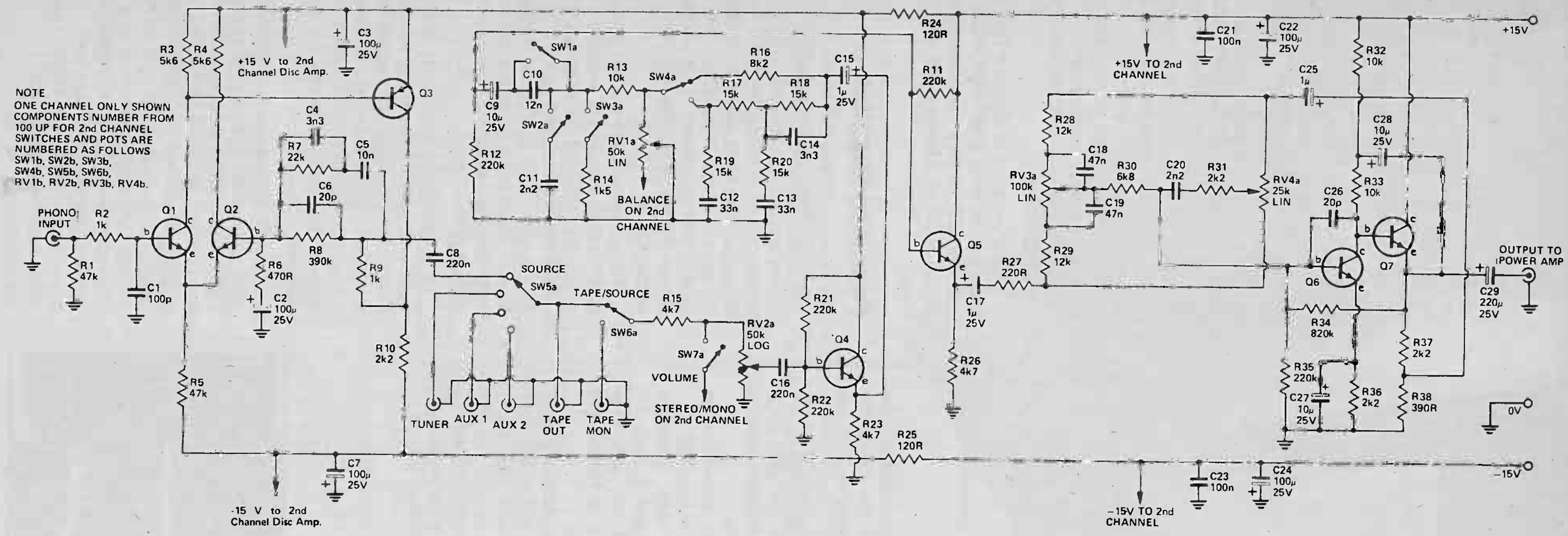


Fig 3. Circuit diagram of one channel of the preamp. Add 100 to all component numbers for second channel.

HOW IT WORKS

The signal from a magnetic cartridge is fed to the base of Q1 via a low pass filter (R2 and C1) for attenuation of radio frequencies. Q1 and Q2 form a differential pair, each half operating at low collector current to minimise noise. The output of the differential pair is taken from the collector of Q1 and further amplified by Q3. Feedback is taken to the base of Q2, the negative input of the differential pair, through the RIAA equalisation network. Overall gain of the phono stage is set by the ratio of the feedback network impedance to the value of R6.

Subsonic bass roll-off of 6 dB/octave, to conform to the new IEC 65 specification, is achieved by a high pass filter consisting of C8 and RV2.

Output from the disc preamplifier is then fed via the Source Switch (SW5), Tape-Source switch (SW6), R15 and the volume control (RV2), to an emitter follower, Q4. This emitter follower presents a high impedance for the aux inputs and a constant impedance for driving the filters.

SPECIFICATION - PREAMP

Distortion	0.015% at 1 kHz 0.015% at 10 kHz (For all inputs, with 500 mV RMS output — distortion is mainly 2nd harmonic).
Hum and Noise	83 dB unweighted (With respect to 10 mV phono input).
Frequency Response	Phono: Within 0.5 dB of RIAA from 20 Hz to 20 kHz (Follows new IEC curve). Other inputs: 20 Hz to 20 kHz ± 0.5 dB Subsonic rolloff: 6 dB/octave below 20 Hz
Output	7 V p-p before clipping
Tape output	150 mV RMS
Sensitivity	For 500 mV RMS output phono: 3 mV RMS other: 150 mV RMS (Phono overload level is 400 mV p-p).
Tone controls	Bass: ± 13 dB at 50 Hz Treble: ± 11 dB at 10 kHz
Filters	High: 6 dB/octave, –3 dB at 5 kHz Low: 6 dB/octave, –3 dB at 100 Hz
Loudness	8 dB boost at 15 kHz and 10 kHz.
Mute switch	20 dB attenuation

When switched in, the loudness network boosts the high and low frequencies with respect to the midrange. In actual fact, all frequencies are attentuated but the midrange is attenuated more. When the loudness is switched out, R16 approximates the impedance of the network.

Muting is achieved by switching R14 to earth. The ratio of R14 to R13 sets the attentuation to 20 dB. C11 shunts high frequencies to earth for high cut, while C10 reduces low frequency content when switched in, providing low cut.

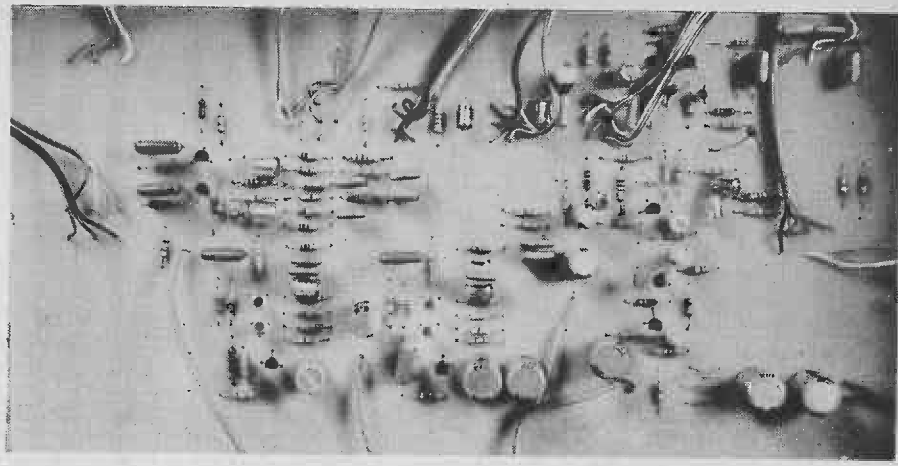
A second emitter follower, Q5, presents a constant impedance source to the tone control stage.

A Baxandall tone stage is used here, a common circuit in many designs. Q6 is a gain stage with a bootstrapped collector load, via C28, to the output. Bootstrapping increases the gain by increasing the effective collection load impedance. Q7 is an emitter follower connected directly to the collector of Q6. This provides a very low output impedance. DC bias for Q6 is taken from the output.

Some of the output signal is fed back to the tone controls and split into high and low frequencies by RV3 and RV4. By adjusting the controls the percentage of the input to the negative feedback signal appearing at the base of Q6 can be varied, thereby varying the overall gain of the amplifier at either high or low frequencies. The gain of the tone stage is set by the ratio of R37 to R38. As R38 is reduced in value the negative feedback is reduced and therefore the overall gain is increased.

To preserve the very low output impedance of the pre-amplifier the balance control is placed ahead of, rather than after, the tone stage.

Power supply filtering and decoupling is provided by 1000u capacitors and resistors in each rail.



Above: the finished preamplifier unit.
Below: the PCB some way into construction.

Construction — Preamplifier

Assemble the PCB as per the overlay, checking carefully the polarity of all semiconductor and polarised components. Only attempt to wire the board to the chosen controls once you are satisfied that all is well. Check VERY thoroughly as mistakes now will cause quite a few headaches.

Use only good quality screened audio cable for wiring between controls and board and keep the runs as short as you can. As there is no mains within the enclosure hum should not be a problem.

The PSU similarly is relatively simple to put together, but watch that mains wiring and make SURE the case is earthed. We used cannon connection for DC output. If you wish to fit mains outlets to power ancillary units, add them to this box, but watch the rating of the switch if it is to control everything.

When switching on don't forget the 'de-thump' circuit which will cause an agonising silence for several seconds after switch on!

Construction — Power Amps

All components are mounted on a PCB — including the output devices. This method of construction is recommended. The module has been designed so that it is mechanically simple to assemble, much simpler than our ETI 480 module.

Firstly, assemble and solder all the components on to the printed circuit board with the exception of Q12, Q13 (the output Darlingtons) and Q8. Carefully observe the polarity of all the electrolytic capacitors and orientation of the transistors.

The board is mounted hard against the heatsink using small right-angle brackets. Be careful to avoid shorting the ends of the one ohm emitter resistors, R15-19 and R20-24, to the brackets.

If the module is to be mounted in a chassis the bottom (copper) side of the board should be 25 mm above the bottom of the heatsink. This will allow the use of 25 mm spacers to support the 'input' end of the board (furthest from the heatsink).

Once the board is attached to the heatsink the output Darlingtons, Q12 and 13, and Q8 may be mounted. Insert them in the board and then press them back against the heatsink to form their leads to the right shape. Do not solder their leads yet.

Smear heat conducting compound on either side of the mica insulators (don't use too much though) and insert these between the devices and the heatsink.

Assemble the washers and mounting bolts for these, finally checking with an ohm-meter that there is not a short circuit between the metal tags (collectors) of the devices and the heatsink.

The input connection to the module is via a length of shielded cable soldered directly between C1 and the board common.

The power supply and speaker connection are soldered directly to ▶

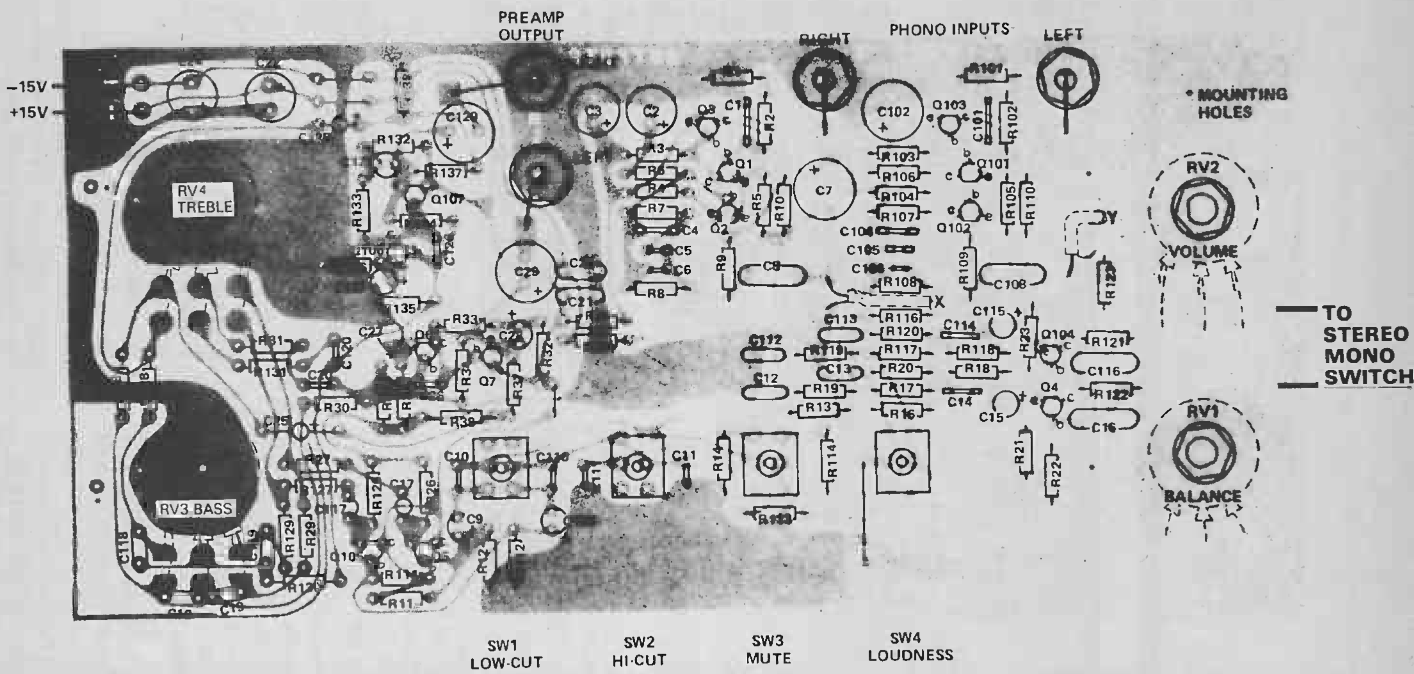


Fig 4. Component overlay for the pre-amp section of the 4000. Links X and Y are screened cable links to the 'phono' input of the selector.

PARTS LIST

Preamplifier

RESISTORS — all ¼W 5%

R 1, 5	47k
R2, 9	1k
R3, 4	5k6
R6	470R
R7	22k
R8	390k
R10, 31, 36, 37	2k2
R11, 12, 21, 22, 35	220k
R13, 32, 33	10k
R14	1k5
R15, 23, 26	4k7
R16	8k2
R17-20	15k
R24, 25	120R
R27	220R
R28, 29	12k
R30	6k8
R34	820k
R38	390R

POTENTIOMETERS

RV1	50k lin
RV2	50k dual log
RV3	100k dual lin
RV4	25k dual lin

CAPACITORS

C1	100p ceramic
C2, 3, 7, 22, 24	100u 25V
C4, 14	3n3 polyester
C5, 10	10n polyester
C6, 26	22p ceramic
C8, 16	220n polyester
C9, 27, 28	10u 25V
C11, 20	2n2 polyester
C12, 13	33n polyester
C15, 17, 25	1u 25V tantalum
C18, 19	47n polyester
C21, 23	100n polyester
C29	220u 25V

SEMICONDUCTORS

Q1, 2, 4-7	BC109, BC549
Q3	BC179, BC559
LED	TIL 220 or similar

SWITCHES (see text)

SW1-4, 6	DPDT toggle
SW5	2 pole 4-way rotary (screened)
SW7	SPDT toggle

MISCELLANEOUS
PCB, case, phono sockets, screened cable, spacers nuts and bolts etc.

Add 100 to component numbers for other channel

Note: the PCB foil patterns for this project can be obtained from ETI offices at 145 Charing Cross Road, London WC2. The pre-amp PCB is far too large to print. The power and module appears with the rest of the foil patterns later in the issue.

the appropriate copper lands on the underside of the board.

The 'earthy' side of the speaker must be returned directly to the zero volt connection of the power supply, as close to the filter capacitors as possible (preferably direct to the negative terminal). Do not connect this side of the speaker to the amplifier board.

Setting Up

Once the amplifier has been assembled and carefully checked, the bias current for the output devices must be set. Remove the fuses, F1 and F2 and connect a 100 ohm resistor across each fuse holder. Remove any input signal. Connect the power supplies and measure the voltage drop across each of these resistors. Adjust the trim pot RV1 for a reading of 2V5 across each resistor. This corresponds to a bias current of 25 mA. The reading should be nearly the same across each resistor. Next check that there is no DC voltage across the output terminals.

If the reading across each of the resistors cannot be adjusted, or if there is a DC voltage across the output greater than one volt then there is a fault and the fuses should not be inserted.

If all is well, remove the two resistors and insert the fuses. Connect the speaker and away you go.

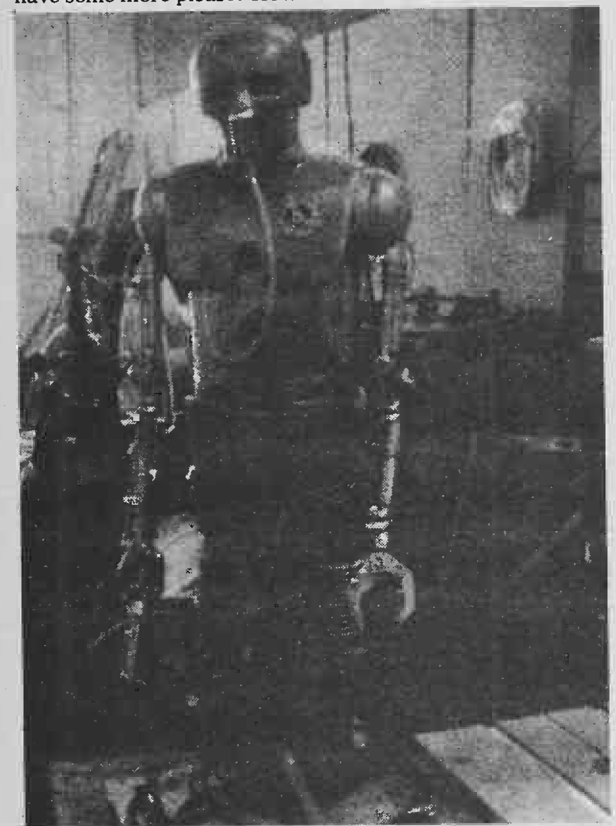
news digest................

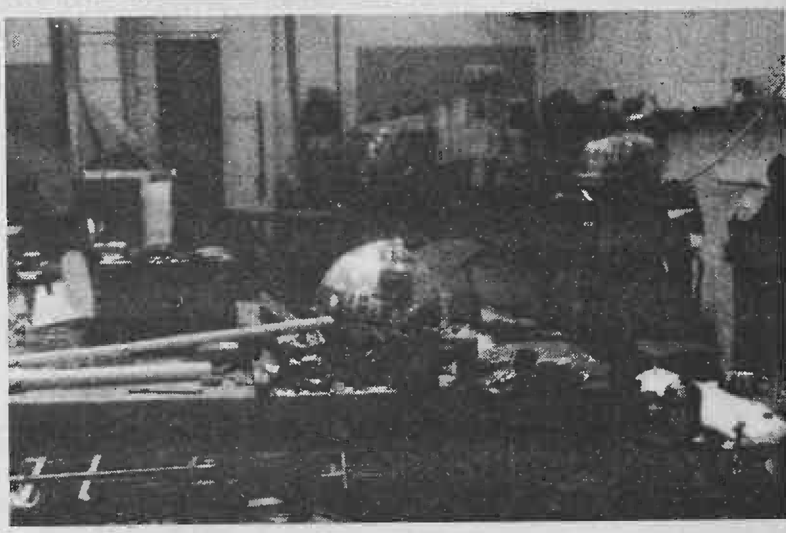
EXCLUSIVE — STAR WARS 2 LEAK

We've just received the first pictures of mechanical men from Star Wars 2, 'The Empire Strikes Back', to escape from their workshop (the pictures, not the mechanical men) somewhere in Hertfordshire. They arrived under plain cover (a brown envelope) by special messenger (GPO) from an, anonymous reader.

R2-D2 peeps over the top of a work bench at the tall, dark handsome medical robot (microphone mouth), while an alien has a snooze in a plastic bag.

Thank you Mr Anonymous, whoever you are. Can we have some more please? How about 'Alien' this time?





ETISKI

As you can imagine we are invited to quite a few Press receptions, lunches, etc. to have a look at new products or meet people in the electronics industry.

This month our invitation-of-the-month award goes without a doubt to Sperry Univac, who are sponsoring the forthcoming first-ever World Water Ski Racing Championships. They decided to see how daft we really are by inviting us to have a bash at walking on water ourselves, while the British team was going through its paces in July. Thankyou Sperry, we would loved to have gone along, if only to see who else was mad enough to turn up and have a go.

The Championships will be held from September 9th to 16th at Whitstable in Kent, Allhallows near the mouth of the Thames and the Welsh Harp Reservoir in London. Sperry Univac will be providing a computerised results service throughout the event.

PROGRAM REACTION

The NRC, the American nuclear watchdog, was happily watching its nuclear dogs when the telephone went.

The caller alleged that some nuclear plants were using a flawed design method, piping in the plants had been designed by invalid computer programs.

In March, the NRC closed five plants because it was unhappy about piping design. It is now studying the likelihood of damage due to earthquakes. If reactors remain closed indefinitely, the lights might start switching off in the areas served.

TOP PROJECTS No 7

Have a look at the CCD Phaser circuit diagram on page 26. R31, 32 fix the voltage on IC5 pin 5 at 10V5. However, as they are labelled, pin 5 sits at a puny 1V5. To make IC5 feel better, make R31 10 k and R32 1k5.

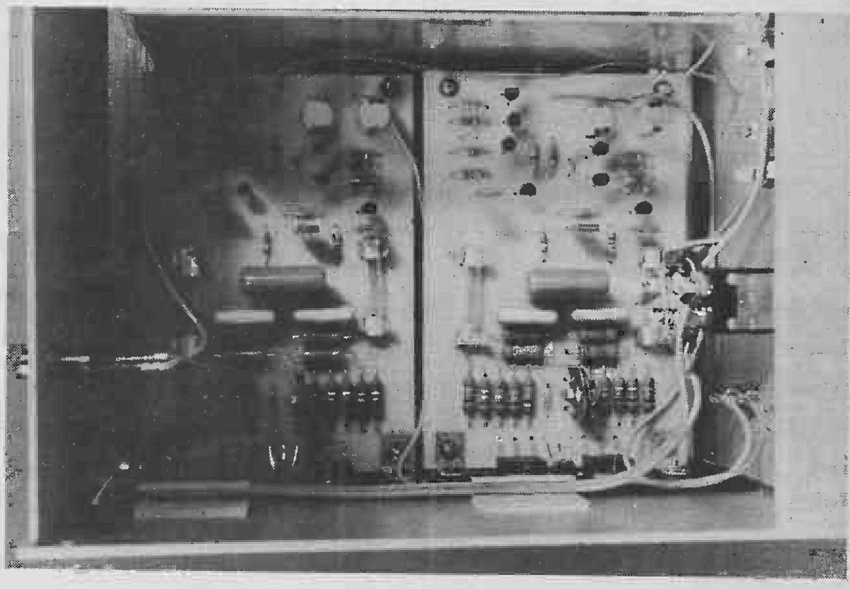
Above: the rear end of the 4000 system. Note the use of Cannon connectors for power.

Power Supply

A completely separate PSU is used for each channel, as the performance is thus greatly improved at what amounts to a small cost increase.

Assemble both the PSUs first and test thoroughly *before* connection to the power amps. Make sure that within the common enclosure the actual amplifiers are well screened from the mains carrying circuits. See photos for guidance.

DO NOT use DIN loudspeaker plugs for the output. Screw down terminals are all we would recommend, fastened as tightly as your fingers will allow! The amplifier itself is stable into any load, and so special cable *CAN* be used, but quite frankly RS 20A is just as good subjectively and neither as expensive nor as awkward to drive. A better deal all around. ▶



Right: fitting the power amps into the case. Here phono sockets have not been used, and stand-off pillars are employed to match up to the heatsinks cut into the side of the case.

BUYLINES

The cases chosen for the Audiophile amplifier was obtained from West Hyde Development (see below for address) from their CLASSIC 2 range, order as CL2 CDL (preamp case), CL2 CGL (amplifier case), CL2 AES (preamp PSU case).

The following items are available from Watford Electronics:–

TIP 142, TIP 147.

Hi-fi type switches, type TS14, TS15.

Preamp transformer 15-0-15 type 749. Amplifier module transformer 30-0-30 at 2A (also available from Electrovalue, type GP602).

All other components used are readily available from major stockists that advertise in this issue.

West Hyde Development, Unit 9, Park St., Industrial Estate, Aylesbury, Bucks. HP20 1ET.

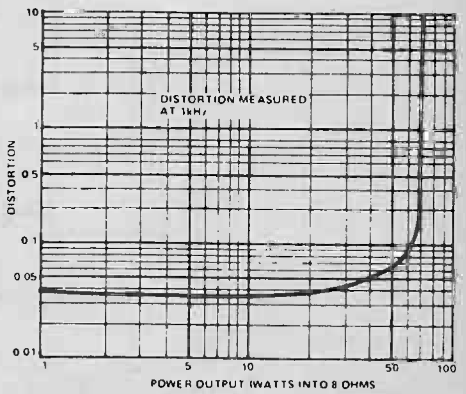
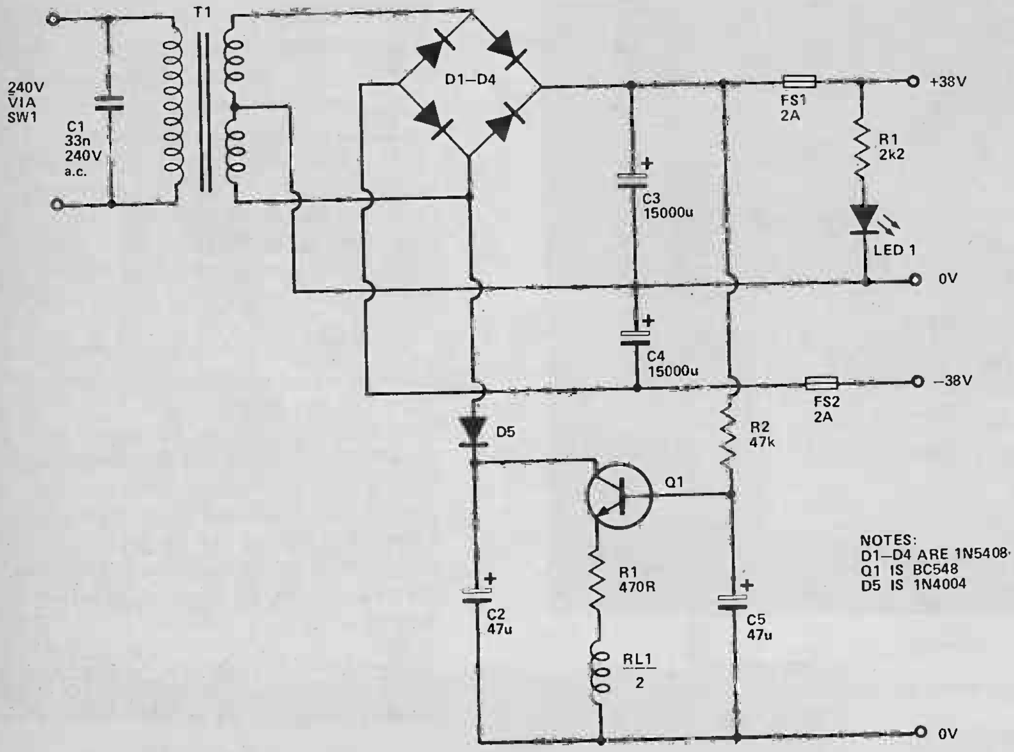


Fig 5. (Above) power output distortion for the Audiophile 4000 power amplifier.

Right: inside story of the pre-amp supply casing



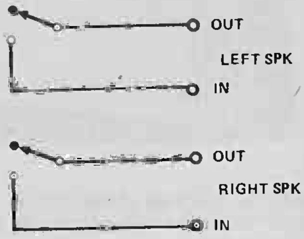


Fig 6 (above) circuit diagram for the power amplifier and de-thump sections of the Audiophile

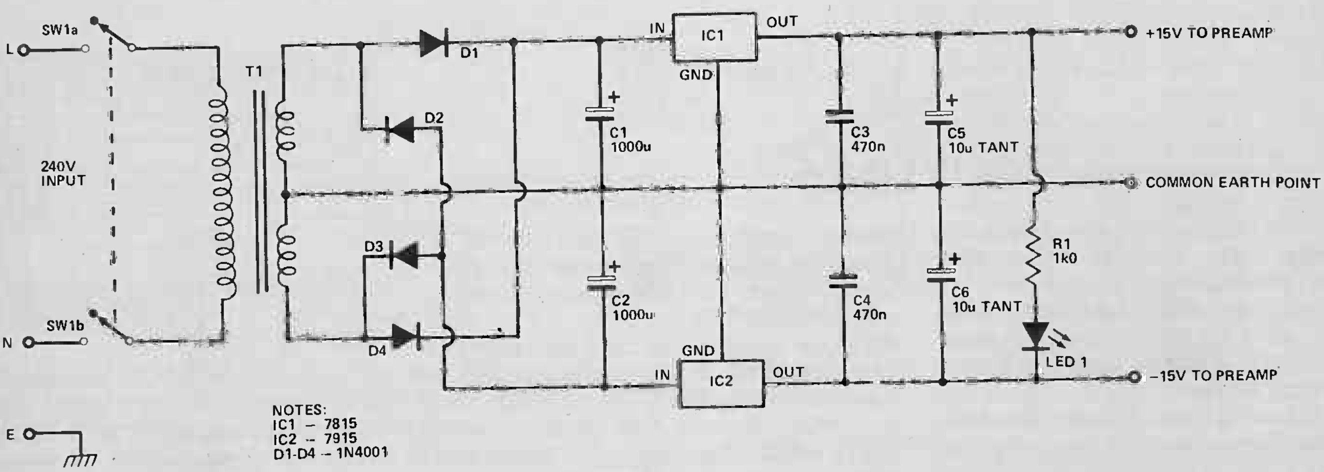
HOW IT WORKS

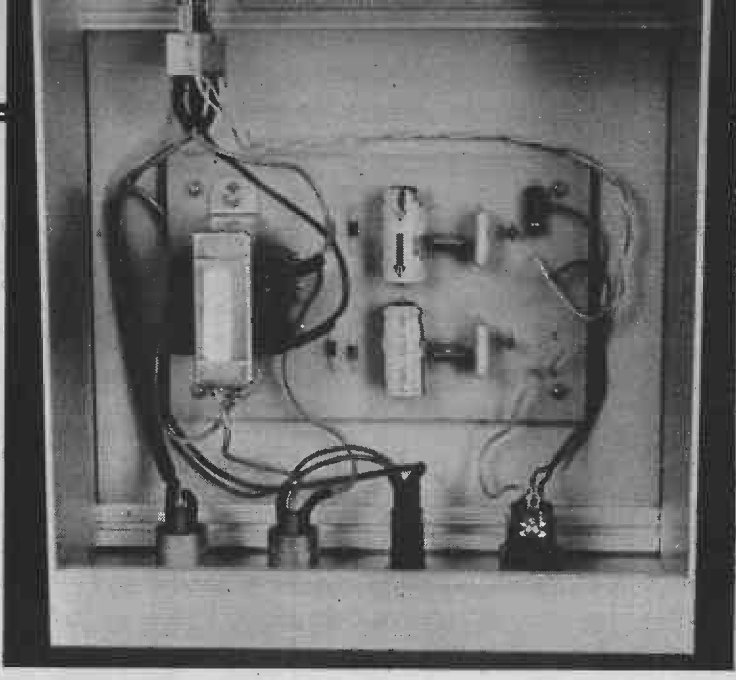
Both supplies are fairly standard circuits. The pre-amp PSU uses IC regulators to achieve good stabilisation. The capacitors C3, C4 on the output arc to prevent interference reaching the pre-amp rails.

The power amp PSU incorporates two massive smoothing capacitors C3, 4. These should *not* be reduced in value. Indeed if the case chosen — and budget — will allow higher values will show advantages in sound output.

The transistor Q1 is part of an 'anti-thump' circuit which functions thus: as the power rails come up toward voltage, capacitor C5 charges via R2. Q1 conducts and pulls in RLA1 thereby connecting the loudspeakers.

Fig 7 (below) pre-amp power supply circuit.





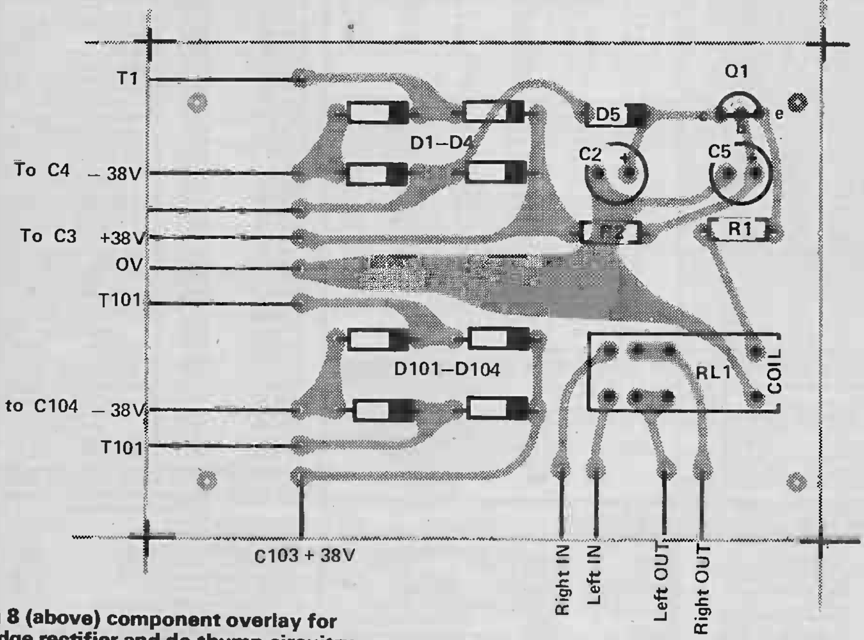
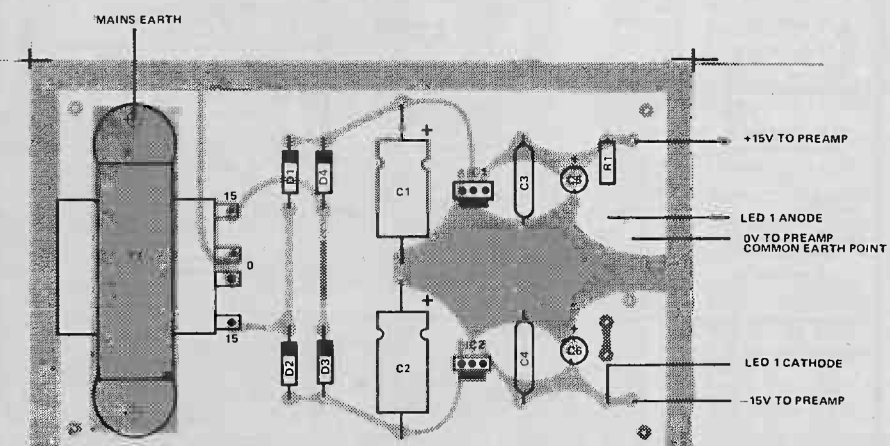
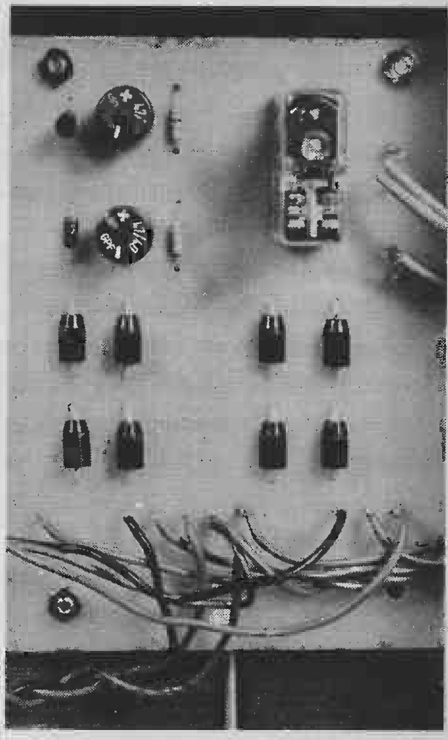


Fig 8 (above) component overlay for bridge rectifier and de-thump circuitry. Above right: the finished article Fig 9 (below) component overlay for the pre-amp supply.





PARTS LIST

PRE-AMP SUPPLY

CAPACITORS

C1, 2	1000u 35V
C3, 4	470n polyester
C5, 6	10u 25V tantalum

SEMICONDUCTORS

D1-4	1N4001
IC1	7815
IC2	7915
LED	TIL220

MISCELLANEOUS

SW1	DPDT mains
FSI	500mA
TRI	20-0-20V secondary
PCB and hardware, case etc	
R1	1k ¼W

POWER AMP SUPPLY

CAPACITORS

C1	33n	240V AC
C2, 5	47u	63V
C3, 4	15000	63V

SEMICONDUCTORS

D1-4	1N5408
D5	1N4004
Q1	BC548
LED	TIL220

MISCELLANEOUS

R1 470R 1W, R2 47k ¼W,, T1 30-0-30 secondary, FS1/2 2A quick blow. RLA1 2 pole changeover 12V coil 2A contacts, R3 2K2 1W.

THE LM10 ~ APPLICATIONS

Following on from last month's introduction, Ray Marston takes a closer look at the revolutionary LM10 amplifier, and comes up with a whole stack of practical applications.

THE LM10 IS A REVOLUTIONARY new type of operational amplifier device that is capable of operating from single ended supplies with voltages as low as 1V1 to as high as 40V. As can be seen from Figure 1, the device contains an op-amp, a precision 200 mV band-gap voltage reference, and a reference amplifier, all housed in an 8-pin package. We introduced basic details of the LM10 in the last edition of ETI.

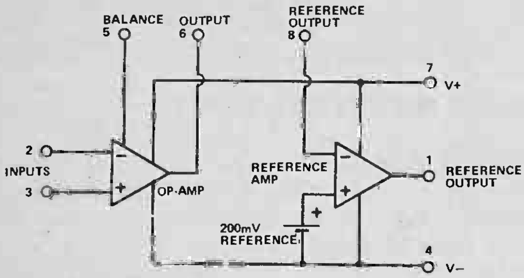


Fig. 1. connections.

In this month's article we take a look at a whole stack of practical application circuits of the LM10.

Voltage Regulator Circuits

The LM10 is, because of it's built-in precision voltage reference and op-amp, ideally suited to use in voltage regulator applications. Figures 2 to 9 show a few practical circuits of this type.

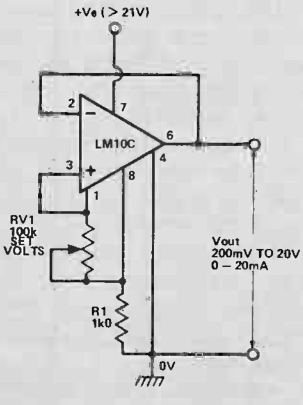


Fig. 2. The built-in reference and amplifier are used to generate a 200 mV to 20 volt potential that is fed to the input of the op-amp, which is configured as a voltage follower and boosts the available output current to about 20 mA.

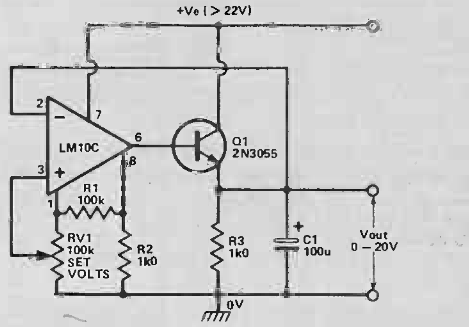


Fig 3: the reference and amplifier produce a fixed 20 volts, which is fed to pot RV1. The op-amp and Q1 are configured as a voltage follower, which boost the 0-20 volts output to current levels up to several hundred milliamps.

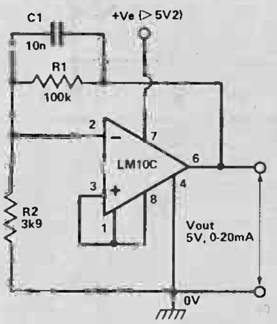
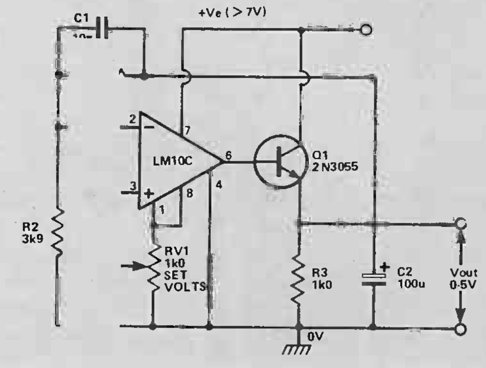
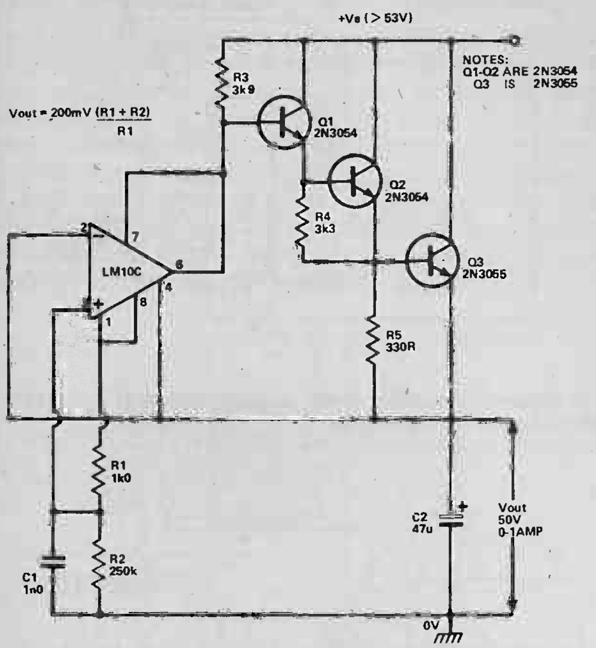


Fig 4: the op-amp input is derived directly from the 200 mV reference, to give a 5 volt output. Fig 5: the op-amp input is derived from a 0-200 mV reference, to give a 0-5 volt output.





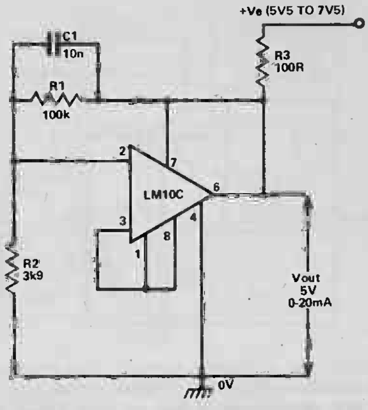
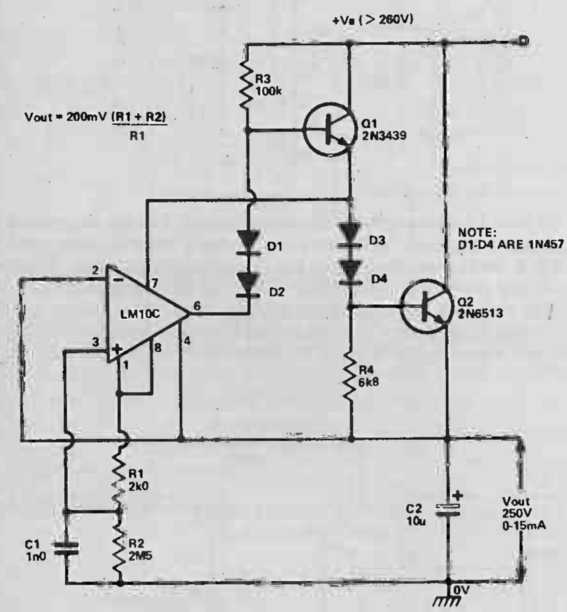
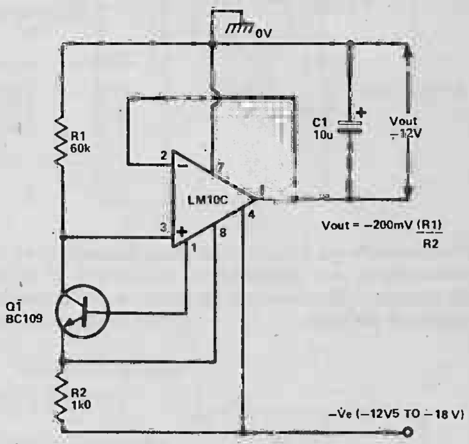
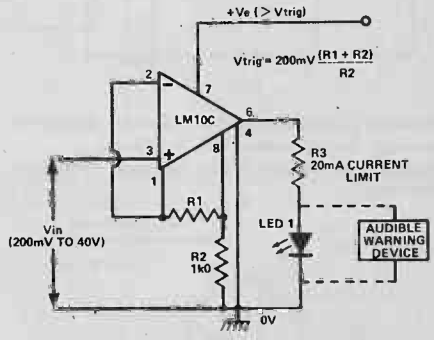


Figure 8: a simple example of the use of the LM10 as a 5 volt shunt regulator. Fig 9: how the IC can be made to act as a negative voltage regulator.

Figures 6 and 7 show how the LM10 can be used in the 'floating' mode, to generate high output voltages. Note in both of these circuits that the IC is used in the 'shunt' mode, with load resistor R3, and that only a few volts are developed across the LM10 itself.







The LM10 can be used in a wide variety of voltage, current, and resistance-sensitive fault-indicator circuits with audible or visual outputs. Figures 10 to 23 show examples of circuits of this type.

In Figures 10 to 17 circuits, the op-amp is used as a simple voltage comparator, with its output feeding to either a LED indicator or an audible warning device via a suitable current-limiting resistor.

Fig 10: over-voltage indicator circuit, the test voltage is fed to the non-inverting terminal of the op-amp, and the trigger reference voltage is produced by the LM10's voltage reference and reference amplifier and is fed to the non-inverting terminal of the op-amp. ▶

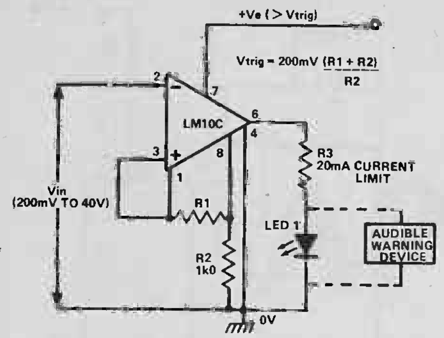


Fig 11: An alternative approach is used in the over-voltage circuit here. A 200 mV reference is fed to one input terminal of the op-amp and a potential-divided version of the test voltage is fed to the other.

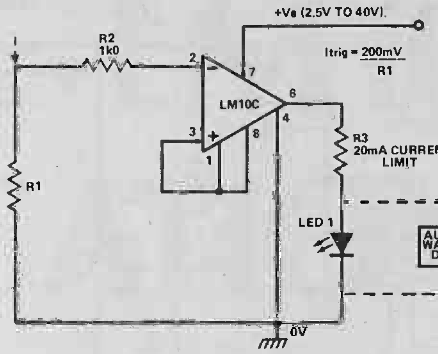


Fig 15 (above): precision under current indicator with LED or audible warning device output.

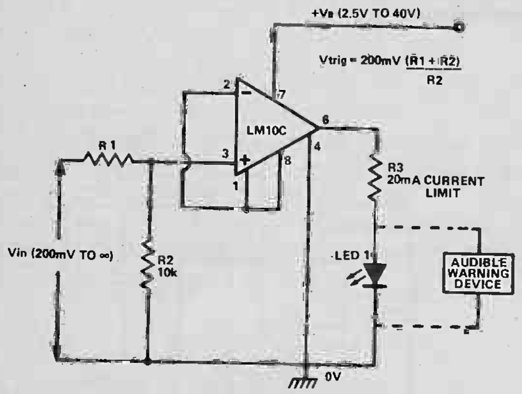
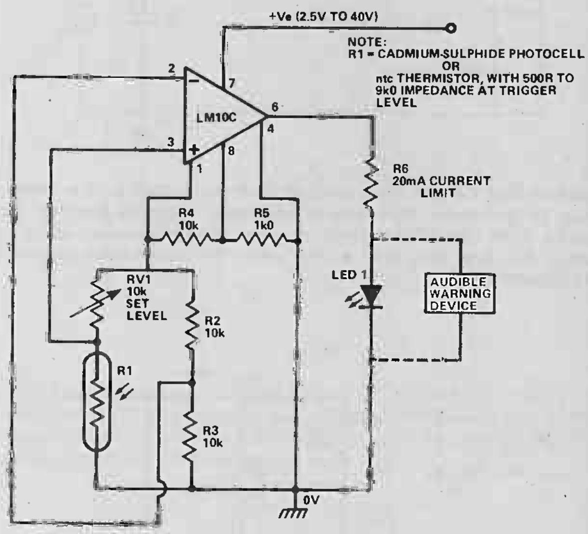


Fig. 12: under-voltage circuit is similar, except that the op-amp input connections are transposed. A feature of both of these circuits is that the LM 10 supply voltage must be greater than the required trigger voltage.



Figures 16 and 17 show precision circuits that can be triggered by any paramters, such as light or temperature levels, that can be sensed by a resistive element. In these circuits, the resistive element forms part of a Wheatstone bridge that is powered from the LM10's voltage reference amplifier, and the output of the bridge is used to activate the comparator-connected op-amp. In the examples shown, the bridge is powered from a 2V2 source.

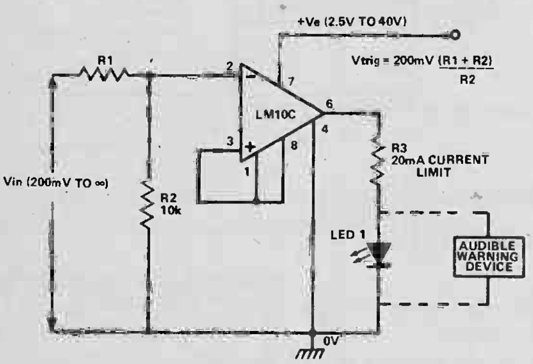
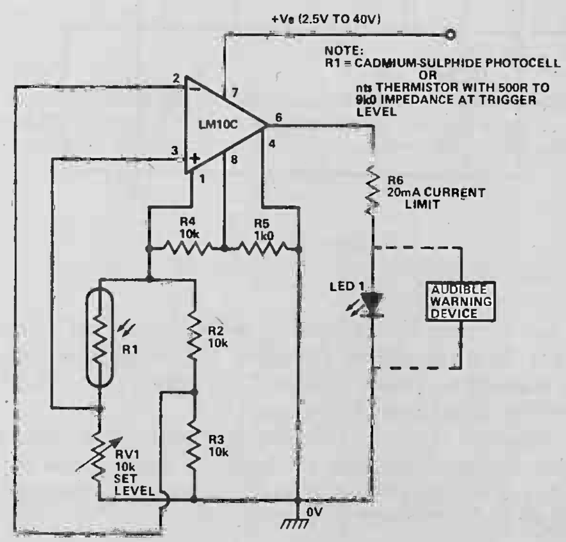
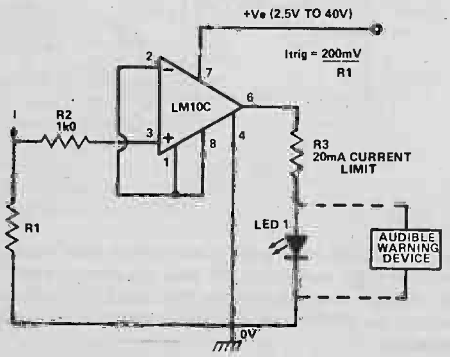


Fig 13 (above): precision under voltage indicator with LED or audible warning. Input sensitivity ≈50k/v.

Fig 14 (below): precision over voltage indicator with LED or audible warning.





Remote Amplifiers And 2-Wire Transmitters

One of the most interesting aspects of the LM10 is its suitability for use in remote-amplifier and 2-wire transmitter applications. The device has an output current drive capacity that is a couple of orders of magnitude greater than the devices quiescent current value, and has excellent supply-rejection characteristics. Consequently, the device can operate quite happily with its output terminal shorted to one or other of it's supply terminals, in which case the supply leads can be used to carry both supply and output signal currents.

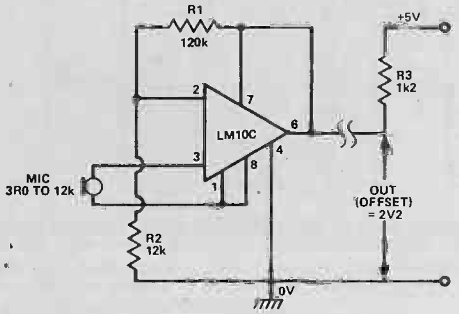


Fig 18 (above): remote 20dB voltage amplifier for use with inductive or magnetic input devices.

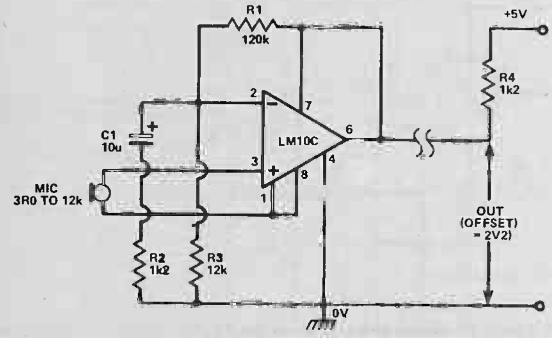


Fig 19(above): remote 40dB voltage amplifier.

Figures 18 to 21 show examples of remote linear amplifiers or 2-wire analogue transmitters. The Fig 18 and 19 circuits are suitable for use with low- to medium impedance input devices, such as moving coil or magnetic microphones, etc., and the Fig 20 circuit is suitable for use with high impedance devices such as crystal microphones or vibration sensors, etc. The Fig 21 circuit is suitable for use with resistive sensors.

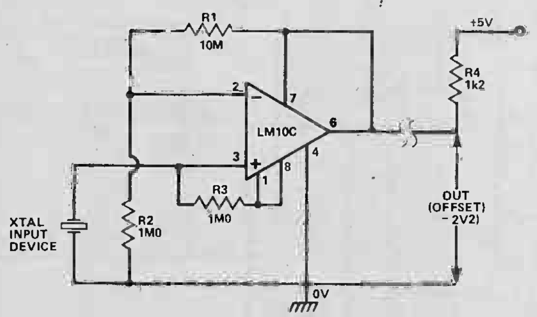


Fig 20 (above): 20dB voltage amp for use with high impedance input device.

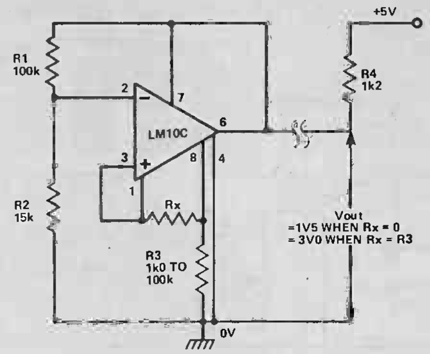


Fig 21 (above): a two-wire transmitter for use with a variable resistance sensor.

Figures 22 to 26 show the circuits of 2-level 2-wire 'fault-indicator' transmitters with either resistor, LED, or transistor outputs at their 'receiver' ends. Figures 25 to 30 show 2-wire 'fault indicator' transmitters with either flashing LED or monotone audio outputs. ▶

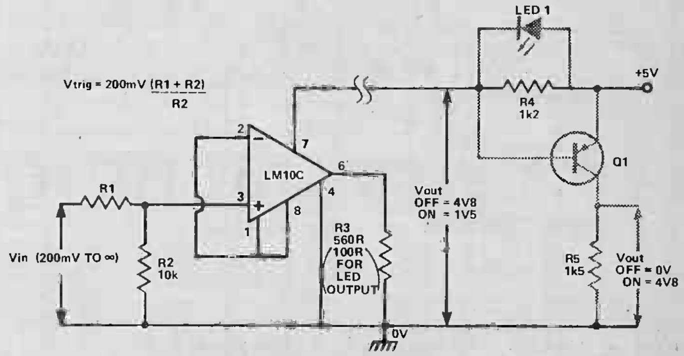


Fig 22 (above): two wire precision over-voltage transmitter with LED or resistor/transistor output.

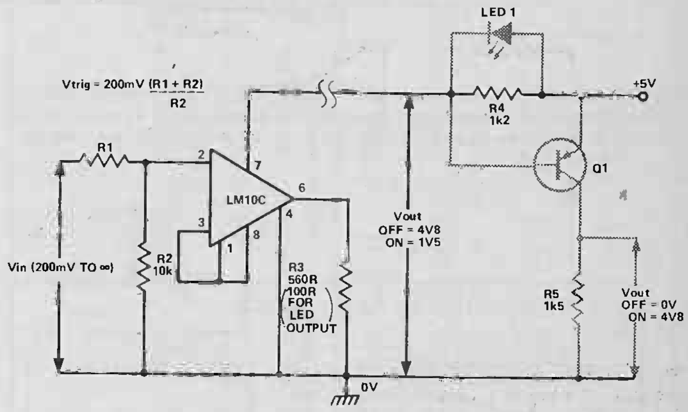
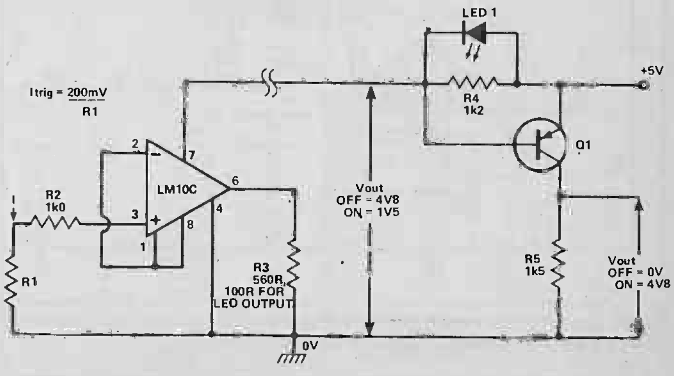


Fig 23 (above): under voltage version of Figure 22 circuit.
Fig 24 (below): over current version of basic circuit.



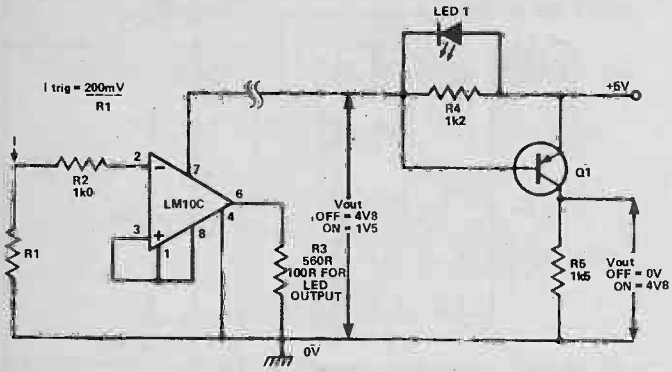


Fig 25 (above): two wire under current transmitter with LED, resistor or transistor output.

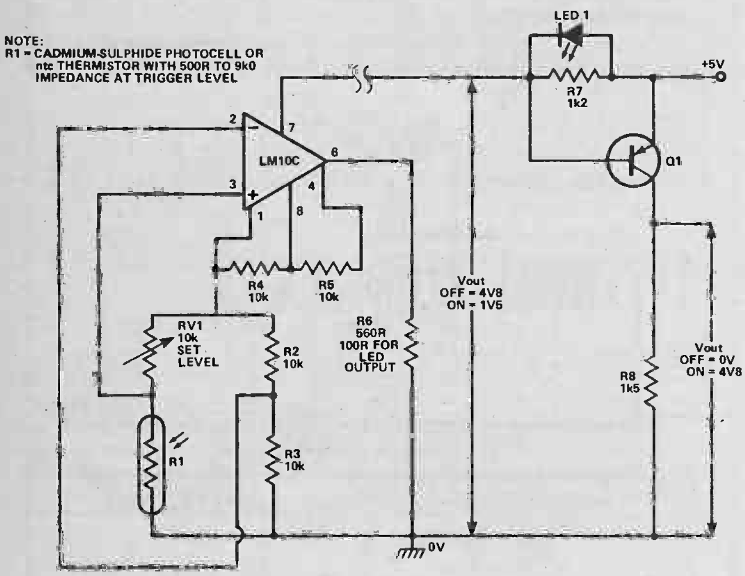


Fig 26 (above): two wire precision 'dark' or 'under-temp' transmitter with same basic outputs as previously. Transposing R1 and RV1 makes the circuit act as a 'light' or 'over-temp' alarm.

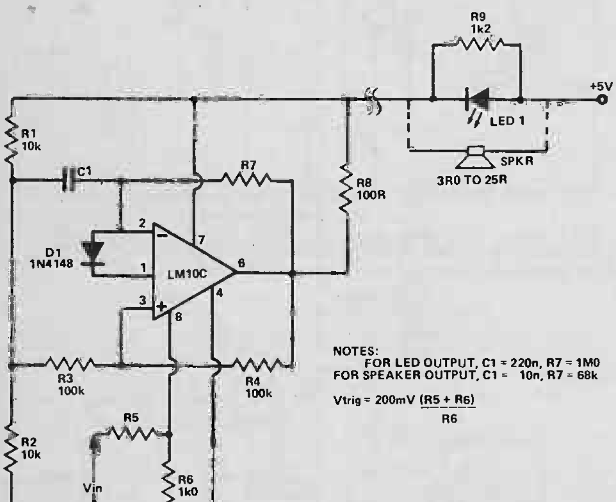


Fig 27 (above): two wire precision under-voltage transmitter with flashing LED or monotone audio output (400 HZ).

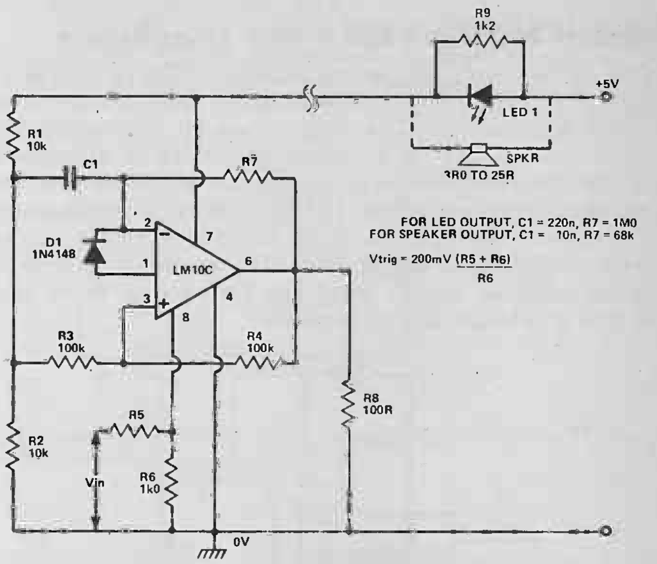


Fig 28 (above): over-voltage transmitter — output options on Fig 27.

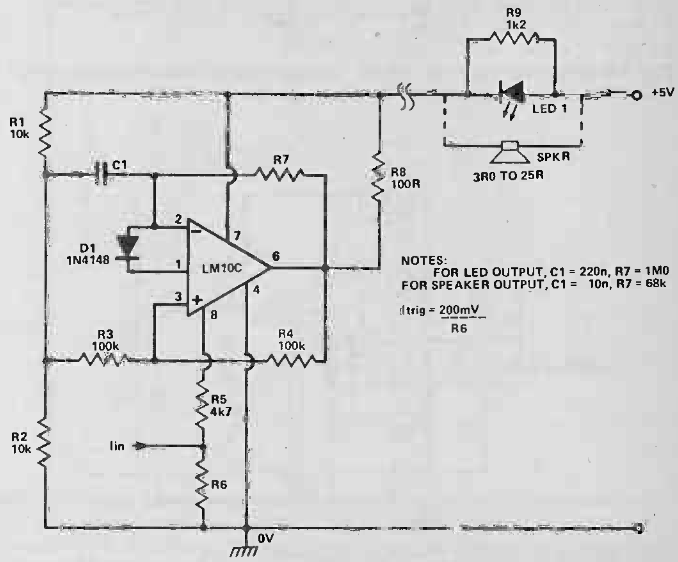
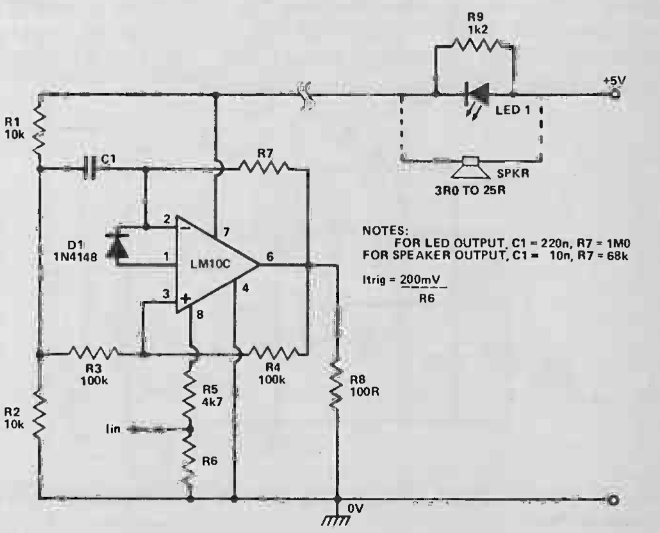


Fig 29 (above): under-current transmitter — output options as Fig 27.

Fig 30 (below): over-current transmitter — output options as Fig 27.



Meter Amplifier Circuits

To conclude this look at applications of the LM10, Figures 31 to 33 show a variety of ways of using the device as a moving-coil meter amplifier.

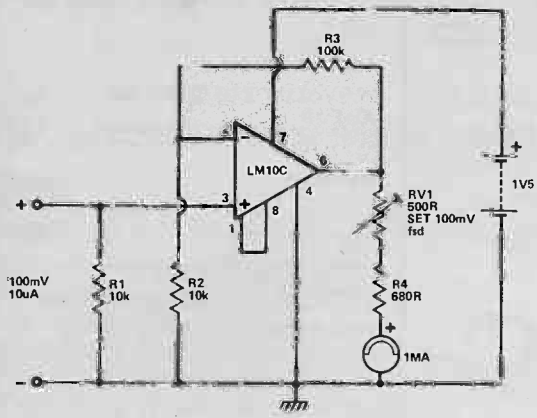


Fig 31: the op-amp is used as a simple non-inverting amplifier, and increases the meter sensitivity by a factor of about 100. This circuit has no 'set null' facility, and can give no indication of reverse-connected signals. The modified circuit of Fig 32 (below) does not suffer from this defect.

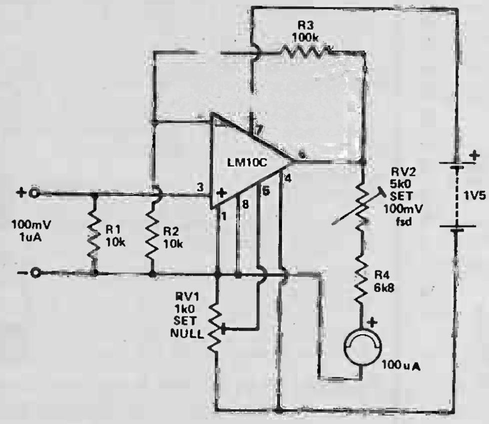
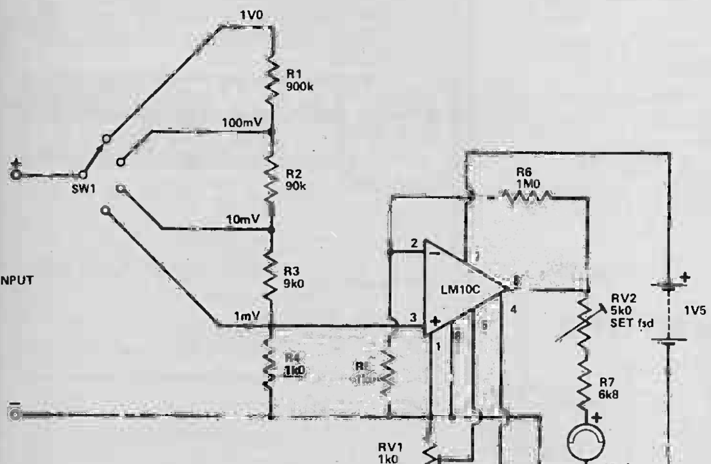


Fig 33 (below) how the basic Fig 32 circuit can be adapted for use as a four-range DC millivoltmeter. Note that these meter circuits are powered from a 1V5 cell! Not bad for an op-amp.



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0.6, 0.6	1A 1A	212	**2.65**	.65
9-0-9	100	13	**1.95**	.60
0.9, 0.9	330 330	235	**1.80**	.60
0-8-9, 0-8-9	500 500	207	**2.40**	.65
0-8-9, 0-8-9	1A 1A	208	**3.50**	.65
0-15, 0-15	200 200	236	**1.80**	.60
0-20, 0-20	300 300	214	**2.40**	.80
20-12-0-12-20	700(DC)	221	**3.15**	.80
0-15-20, 0-15-20	1A 1A	206	**4.25**	.95
0-15-27, 0-15-27	500 500	203	**3.70**	.80
0-15-27, 0-15-27	1A 1A	204	**5.75**	.95

12 AND/OR 24 VOLT
Pri: 220-240 Volts

Amps 12V	Amps 24V	Ref.	Price £	P&P
0.5	0.25	111	**1.95**	.65
1.0	0.5	213	**2.40**	.80
2	1	71	**2.90**	.80
4	2	18	**3.70**	.80
6	3	70	**5.25**	.85
8	4	108	**7.10**	1.10
10	5	72	**7.90**	1.10
12	6	116	**8.50**	1.10
16	8	17	**10.50**	1.20
20	10	115	**13.50**	1.40
30	15	187	**16.50**	1.40
60	30	226	**33.00**	1.70

30 VOLT (Pri: 220-240V)
Sec: 0-12-15-20-24-30V

Amps	Ref. No.	Price £	P&P
0.5	112	**2.50**	.80
1.0	79	**3.25**	.80
2.0	3	**5.25**	.95
3.0	20	**5.95**	1.10
4.0	21	**6.25**	1.10
5.0	51	**9.25**	1.10
6.0	117	**10.75**	1.10
8.0	88	**14.00**	1.40
10.0	89	**16.25**	1.40

50 VOLT (Pri: 220-240V)
Sec: 0-19-25-33-40-50V

Amps	Ref. No.	Price £	P&P
0.5	102	**3.25**	.80
1.0	103	**4.25**	.95
2.0	104	**6.95**	1.10
3.0	105	**8.25**	1.10
4.0	106	**10.50**	1.20
6.0	107	**14.75**	1.40
8.0	118	**19.85**	1.60
10.0	119	**23.75**	2.10

60 VOLT (Pri: 220-240)
Sec: 0-24-30-40-48-60

Amps	Ref. No.	Price £	P&P
0.5	124	**3.50**	.80
1.0	126	**5.25**	95
2.0	127	**7.20**	1.10
3.0	125	**10.75**	1.20
4.0	123	**12.00**	1.40
5.0	40	**13.80**	1.50
6.0	120	**17.25**	1.50

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VA (Watts)	Ref. No.	Price £	P&P
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75	64	**3.75**	80
150	4	**5.25**	95

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500	67	**10.50**	1.40
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200	151	**10.75**	1.20
250	152	**12.95**	1.40
350	153	**15.95**	1.50
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On looking at the logic involved, we saw it could be simplified without any change in operation and with the use of CMOS the power supply is less critical than with TTL.

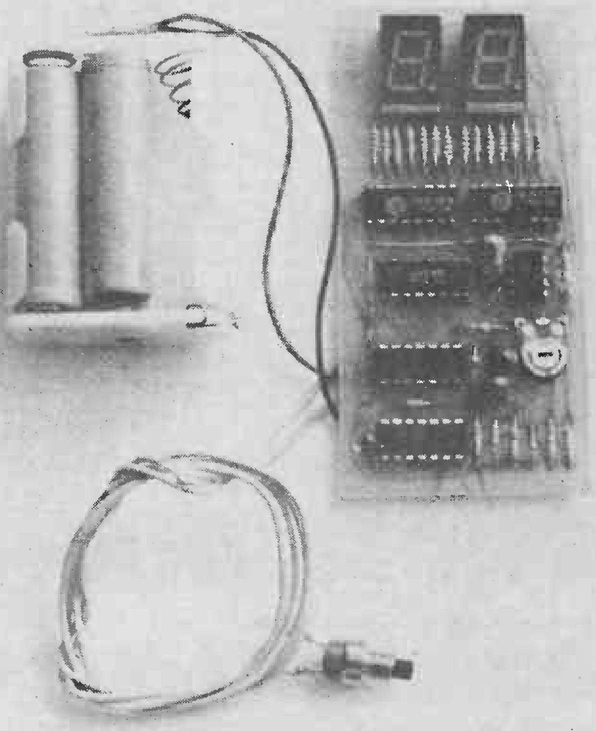
Operation

If the unit has not been used for more than 30 seconds the display will be blank. Pressing the button and releasing it will initiate operation. When the display comes on again it will start counting from zero until the button is pressed. It should be held depressed while the time (in hundredths of seconds) is read. Releasing the button blanks the display for a random time before it comes on again, counting from zero for a second test. If the button is not pressed the display will blank after about 30 seconds to conserve power — no on/off switch is required.

Construction

We will describe only the electrical side of the project, leaving the housing details to individual tastes.

Assemble the PCB with the aid of the overlay in Fig. 1. Start assembly with the resistors, diodes and the four links. The 555 should now be fitted and soldered, followed by the other ICs. These are all CMOS and their pins should not be handled more than is necessary. As an added precaution, solder the power rails first (pins 7 and 14 on ICs 8 and 16) using an earthed soldering iron. The rest of the components can now be assembled. ▶



SPECIFICATION

Reaction time	**0 to 0.99 seconds**
Delay between tests	**½ to 10 seconds (random)**
Power reuiqrements	**4 to 12 volts DC**
	@ 50 mA (display on)
	@ 1.9 mA (display off)

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Suitable displays for this project can be obtained from any of the large semiconductor suppliers advertising in this magazine. People like Technomatic, Marshalls, Maplin, etc. Most will stock all components needed.

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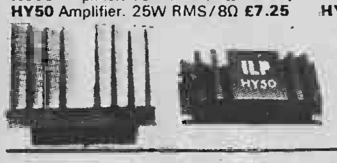

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SWITCHES

TOGGLE: 2A, 250V.

SPST	28p
OPST	34p
DPDT	38p
4 pole on/off	54p

SUB-MIN TOGGLE

SP changeover	59p
SPST on/off	54p
SPST biased	85p
DPDT 6 tags	70p
DPDT centre off	79p
DPDT Biased	115p

SLIDE 250V:

1A DPDT	14p
1A DPDT c/over	15p
½A DPDT	13p
4 pole 2-way	24p

PUSH BUTTON
Spring loaded

SPST on/off	60p
SPDT c/over	65p
DPDT 6 Tag	85p

MINIATURE
Non Locking

Push to Make	15p
Push Break	25p

ROTARY: Make your own multiway Switch. Adjustable Stop Shafting Assembly. Accommodate up to 6 Wafers **75p**
Mains Switch DPST to fit **34p**
Break Before Make Wafers. 1 pole/12 way. 2p/6 way. 3p/4 way. 4p/3 way. 6p/2 way **47p**
Spacer and Screen **5p**
ROTARY: (Adjustable Stop)
1 pole/2 to 12 way. 2p/2 to 6 way. 3 pole/2 to 4 way, 4 pole/2 to 3 way **41p**
ROTARY: Mains 250V AC. 4 Amp **45p**

CRYSTALS

100KHz	385
455KHz	383
1MHz	323
1.6MHz	323
1.8MHz	323
1.0008M	395
1.8432MHz	362
2.4576MHz	362
3.2768M	323
4.032Mhz	323
4.433619M	135
5.0MHz	355
6.5536M	200
7.680M	323
8.08333M	275
9.375M	323
10.0MHz	323
10.7MHz	323
12MHz	392
14.3181MHz	300
18MHz	323
18.432M	323
20.0MHz	323
27.648M	323
48.0MHz	323
100.00MHz	323

TRANSFORMERS (Mains Prim. 220-240V)
6-0-6V; 9-0-9V; 12-0-12V 100mA **95p**
8VA: 6V-.5A 6V-.5A; 9V-.4A 9V-.4A; 12V-.3A 12V-.3A; 15V-.25A 15V-.25A **195p**
12V: 4.5V-1.3A 4.5V-1.3A; 6V-1.2A 6V-1.2A; 12V-.5A 12V-.5A; 15V-.4A 15V-.4A; 20V-.3A 20V-.3A **220p** (20p p&p)
24VA: 6V-1.5A 6V-1.5A; 9V-1.3A 9V-1.3A; 12V-1A 12V-1A; 15V-.8A 15V-.8A; 20V-.6A 20V-.6A **290p** (45p p&p).
50VA: 6V-4A 6V-4A; 9V-2.5A 9V-2.5A; 12V-2A 12V-2A; 15V-1.5A 15V-1.5A; 20V-1.2A 20V-1.2A; 25V-1A 25V-1A; 30V-.8A 30V-.8A **350p** (50p p&p).
100VA: 28V-0-28V-2A **650p** (60p p&p).
100VA: 12V-4A 12V-4A; 15V-3A 15V-3A; 20V-2.5A 20V-2.5A; 30V-1.5A 30V-1.5A; 40V-1.25A 40V-1.25A; 50V-1A 50V-1A **650p** (60p p&p). (N.B. p&p charge to be added above our normal postal charge.)

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4x5[illegible]x1[illegible]"	88
4x2[illegible]x2"	72
5x4x2"	98
6x4x2[illegible]	98
[illegible]x5x2[illegible]"	145
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10x7x3"	210
10x4¼x3"	175
12x5x3"	215
12x8x3"	265

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0-100μA
0-500μA
0-1mA
0-5mA
0-10mA
0-50mA
0-100mA
0-500mA
0-1A
0-2A
0-25V
0-50V AC
0-300V AC
"S"
"VU"
475p each

4¼x3¼x1½"
0-50μA
0-100μA
0-500μA
595p each

VOLTAGE REGULATORS

1A	TO3	+ ve	—ve	
5V	7805	**145p**	7905	**220p**
12V	7812	**145p**	7912	**220p**
15V	7815	**145p**		—
18V	7818	**145p**		—
1A	TO220	Plastic Casing		
5V	7805	**80p**	7905	**90p**
12V	7812	**80p**	7912	**90p**
15V	7815	**80p**	7915	**90p**
18V	7818	**85p**	7918	**90p**
24V	7824	**85p**	7924	**90p**
100mA	TO92 Plastic Casing			
5V	78L05	**30p**	79L05	**65p**
6V	78L62	**30p**		—
8V	78L82	**30p**		—
12V	78L12	**30p**	79L12	**65p**
15V	78L15	**30p**	79L15	**65p**

LM300H	**170p**	LM327	**270p**
LM305H	**140p**	LM723	**38p**
LM309K	**135p**	MVR5	**180p**
LM317K	**350p**	MVR12	**180p**
LM323K	**625p**	TAA550	**50p**
LM325N	**240p**	T8A625B	**95p**
LM326N	**240p**	TDA1412	**150p**

ETI Projects: Parts available for: Click Eliminator Ambush; Guitar Effect Unit; Audio Display; DM900, Audiophile Amp, 60W Amplifier System. Send SAE plus 5p for list.

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TIL211 Grn.	17
TIL212 Yel.	18
TIL220 .2" Red	14
2 Green, Yellow or Amber	18
Square LEDs, Red, Grn., Yel.	48
TIL32 Infra Red	58
LS400	255
OCP71	120
ORP12	63
ORP61	85
2N5777	45

ISOLATORS

IL74	48
TIL111/2	85
TIL114	95
TIL117	110

7 Segment Displays

TIL307	675
TIL312 .3" CA	105
TIL313 .3" CC	105
TIL321 .5" CA	115
TIL322 .5" CC	115
DL704 .3" CC	99
DL707 .3" CA	99
DL747 .6" CA	180
FND357 Red	120
.3" Green CA	180
.6" Green CA	225
LCD 3½ Digit	875
LCD 4 Digit	975

293	128	4006	68	4045	145	4097	372	4515	260	4549	375
295	185	4007	14	4046	66	4098	99	4516	52	4553	398
298	168	4008	55	4047	87	4099	145	4517	382	4554	150
324	240	4009	30	4048	58	4160	78	4518	58	4555	46
325	290	4010	27	4049	25	4161	78	4519	55	4556	44
326	294	4011	18	4050	33	4162	78	4520	55	4557	365
327	286	4012	14	4051	45	4163	78	4521	228	4558	105
347	148	4013	35	4052	45	4174	82	4522	149	4559	375
348	186	4014	55	4053	45	4175	78	4526	65	4560	210
352	228	4015	63	4054	110	4194	90	4527	152	4561	65
353	228	4016	25	4055	99	4408	670	4528	55	4562	375
365	65	4017	60	4056	110	4409	670	4529	145	4566	155
366	65	4018	60	4057	1650	4410	670	4530	85	4569	280
367	65	4019	32	4059	480	4411	795	4531	135	4572	26
368	66	4020	70	4060	90	4412F	1250	4532	67	4580	595
373	180	4021	52	4061	1200	4412V	1050	4534	575	4581	297
374	180	4022	50	4062	995	4415F	520	4536	365	4582	130
375	160	4023	14	4063	110	4415V	390	4538	142	4583	75
377	212	4024	40	4066	30	4419	280	4539	105	4584	63
378	184	4025	14	4067	280	4422	426	4541	135	4585	105
379	215	4026	100	4068	14	4433	780	4543	155		
384	86	4027	35	4069	14	4435	540				
390	230	4028	50	4070	14	4440	1275				
393	230	4029	54	4071	14	4450	260				
395	218	4030	50	4072	14	4451	220				
396	215	4031	150	4073	14	4452					
398	276	4032	80	4075	14	4490F	310				
399	230	4033	95	4076	57	4490	240				
445	150	4034	116	4077	14	4501	16				
447	144	4035	80	4078	14	4502	57				
490	180	4036	80	4081	14	4503	42				
668	182	4037	100	4082	14	4506	46				
669	182	4038	108	4085	52	4507	35				
670	248	4039	320	4086	52	4508	160				
CMOS★		4040	51	4089	110	4510	55				
		4041	60	4093	35	4511	80				
4000	12	4042	50	4094	95	4512	70				
4001	12	4043	46	4095	48	4513	206				
4002	12	4044	46	4096	105	4514	140				

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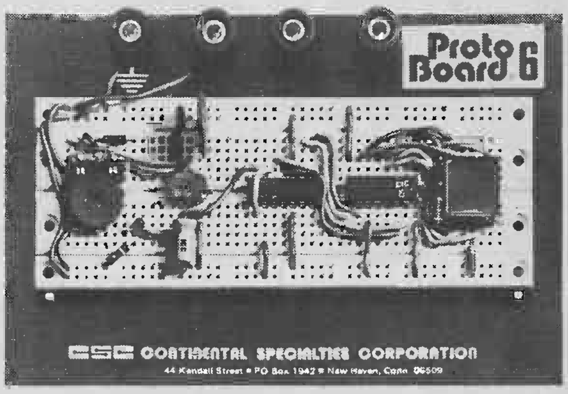
news digest ......



CONTINENTAL BREAD

Continental Specialities Corporation aim to get you from circuit diagrams to final designs in the cheapest and easiest way possible with their range of solderless breadboarding systems.

You can take your first plunge into breadboarding without wringing out your wallet, with the CSC Protoboard PB-6. For £9.20, you get a pre-assembled breadboard socket, two solderless bus strips, four 5-way binding posts all on a metal baseplate. Up to six 14-pin ICs can be accommodated on its 630 tie points.

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The Experimentor series of breadboards will snap together horizontally or vertically, if your circuit layouts are driving you up the wall. The range starts at £3.15 for Experimentor 350, offering 270 contacts. The Experimentor 650, at £3.60, and the 600 are the only breadboards on the market with full 4-terminal fan-out for microprocessors, clock chips, RAMs, ROMs and other large DIL packages. Also in the range, and particularly useful, is the Experimentor scratchboard — a pad of paper with a full-size layout of the hole and connection pattern of the breadboard. Your finished design can then be transferred to the Experimentor Matchboard, already drilled and etched to match the breadboard contact layout.

CSC's new catalogue features their full range of breadboarding equipment and test instruments. Catalogues and further details of products are available from Continental Specialities Corporation, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ.

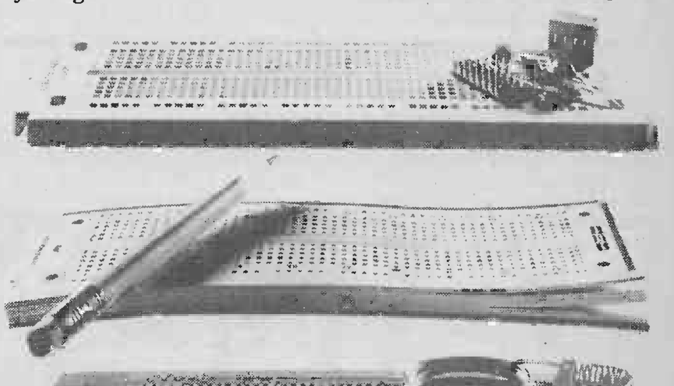
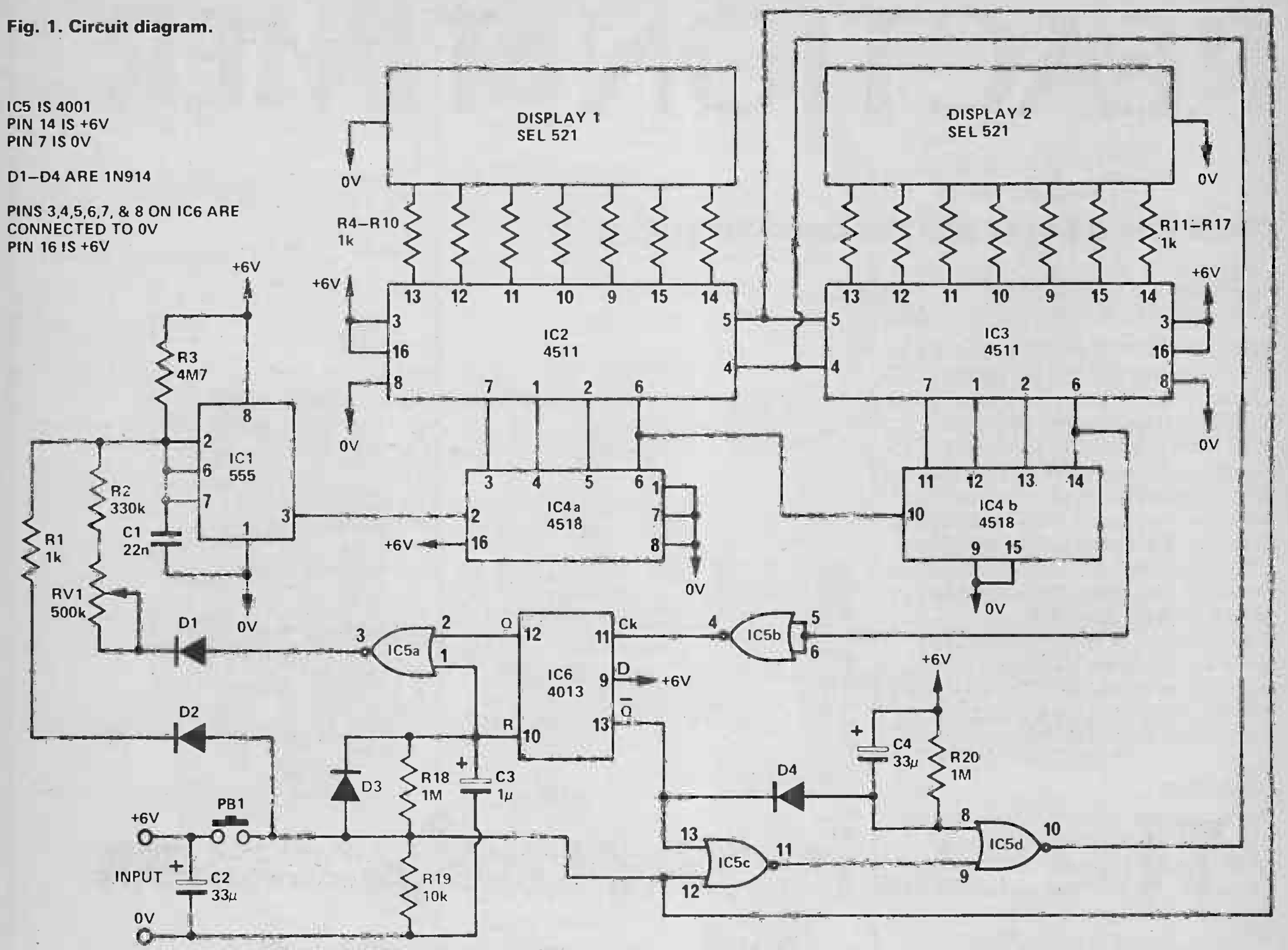


Fig. 1. Circuit diagram.



HOW IT WORKS

The unit is basically an oscillator, IC1, clocking two decade counters (i.e. ÷ 100), with their outputs being decoded by IC2 and IC3 and displayed on the LED displays. Control of the oscillator and displays is done by IC5 and IC6.

When the push-button is activated, IC6 is reset so that pin 13 is "0" and pin 12 is "1". Also, a "1" is applied to the latches in the decoders (IC2, 3) so that the number presented to the decoders at that instant is stored. It also applies a "1" to pin 12 of IC5c, forcing its output low. As there is a "0" on pin 13 of IC6, the diode D3 brings the voltage on pin 8 of IC5d low. Two "lows" on these gates (NOR) make the output go high. As the output of this gate controls blanking ("0" = dark), the display will be on.

The push-button also (yes, it does a lot) causes the 555 oscillator to run at about 50 kHz. The oscillator clocks the counter ICs — they are completely cycled 500 times per second.

When the button is released, the oscillator frequency drops to about 10 Hz. The display blanks as IC5c now has both zeros on its input, a "1" on its output and hence a "0" in the output of IC5d. The latches in the decoder ICs also open, although counting cannot be seen as the display is blanked.

After about ½ sec the voltage on the reset input of IC13 (pin 10) falls below the threshold level, allowing it to be toggled by the clock input (pin 11). As when the push-button was released, the counters (IC4) could have started at any count, the time until the voltage on pin 14 of IC4 goes low is random. The delay on the reset line going low is to prevent IC6 from being toggled too soon.

When IC6 is toggled (after ½ sec to 10 sec), pin 13 goes high and pin 12 low. IC5a now has two lows on its input, giving a "1" on its output. This raises the oscillator frequency to 100 Hz. The "1" now on pin 13 of IC5c gives a "0" on pin 9 of IC5d and a "1" on pin 10. This brings the display back on. As IC6 can only be toggled on the overflow of IC4, the display comes on at the zero count.

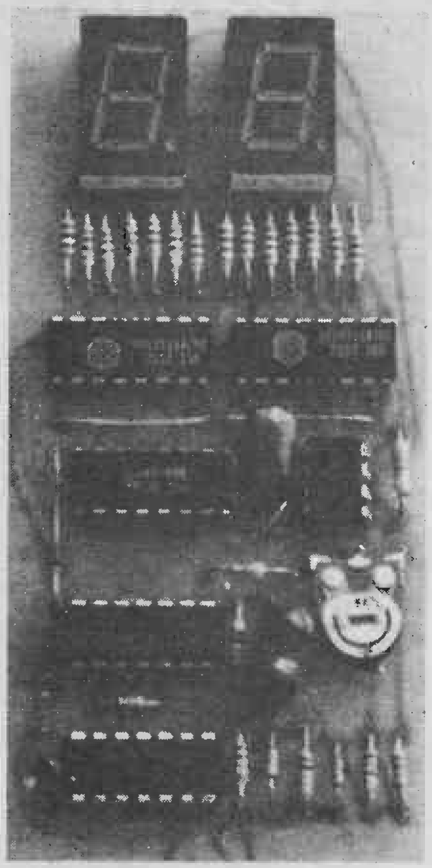
The display continues counting up at 100 Hz until the button is pressed, freezing the display to indicate reaction time. The whole thing is then repeated.

If the button is not pressed for more than 30 sec the voltage on pin 8 of IC5d will go above the high threshold, forcing the output low and thus blanking the display.

PARTS LIST

RESISTORS	all ¼W 5%
R1, 4-17	1k
R2	330k
R3	4M7
R18, 20	1M
R19	10k
POTENTIOMETERS	
RV1	500k trimmer
CAPACITORS	
C1	22n polyester
C2, 4	33u 16V tantalum
C3	1u 16V tantalum
SEMICONDUCTORS	
IC1	555
IC2, 3	4511
IC4	4513
IC5	4001
IC6	4013
D1-3	1N914
DISP1, 2	SEL 521 or similar "jumbo" LED

MISCELLANEOUS
PCB, box to suit, push to make pushbutton
6V battery and holder



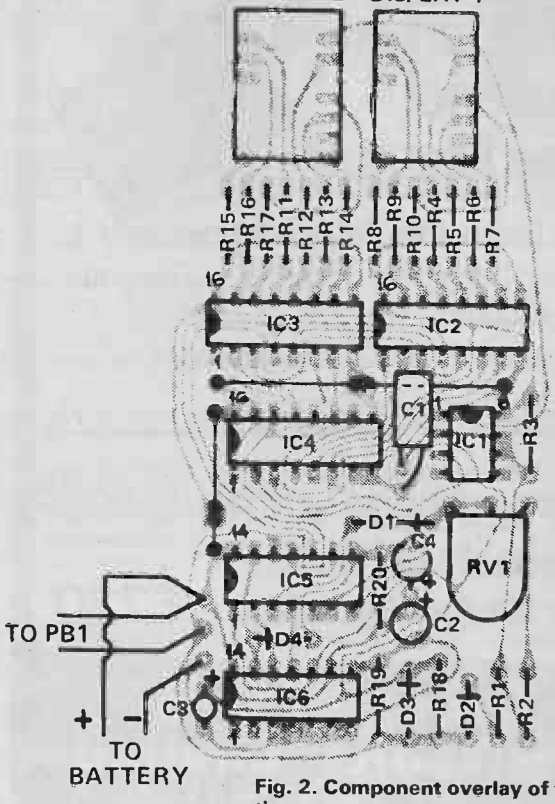


Fig. 2. Component overlay of the reaction timer.

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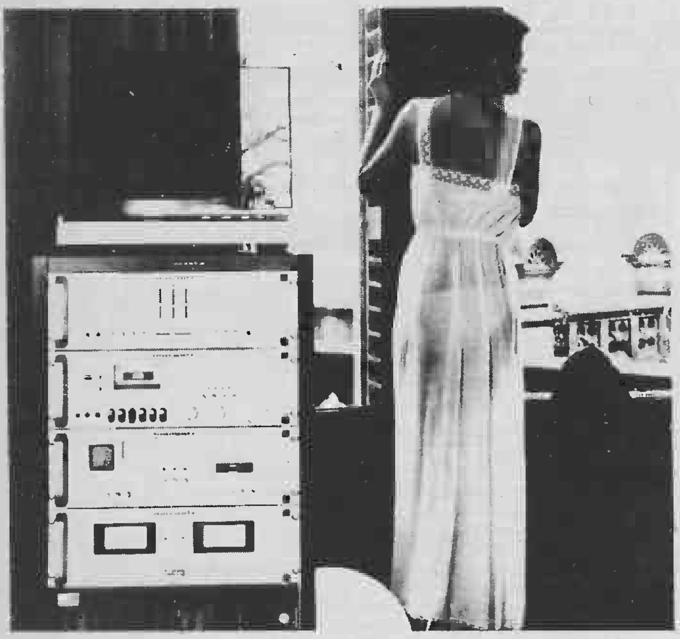
audiophile...................

Competition results, a new amplifier manufacturer and a totally new concept in loudspeaker design. Ron Harris considers . . .

MANY THANKS to all the readers who entered the Audiophile competition a while back.

Entries ranged from outright unprintable (but mostly hilaraious) to outright obscure. All but displayed a wit of which Oscar Wilde would have been proud. In consequence I chose four runners-up all of whom will be receiving copies of Top Projects No 7 as some consolation.

The winning entries are given below, Mr Percival's triumphant ditty first:—



"Oh maid so beautious and so fair,
What vanity makes you look out there?
The whistle was not from a handsome blade,
But from your hi-fi, wrongly played!"
F. PERCIVAL
SALE
CHESHIRE

"I know it's wrong to doubt, but does my husband's fidelity match up to Marantz?"
S. IBBS
WOLVERHAMPTON
W. MIDLANDS

"It's transparently obvious that this unit has class — you don't need statistics to see there's no distortion."
P. HORSFALL
SALE
CHESHIRE

"Now, if I can just find a SPEAKER salesman . . ."
P. PARSONS
BATH
AVON

"Complete home entertainment for the discerning amateur."
S. GILLBARD
DYLOE
CORNWALL

Well done one and all

Now all I want is someone to offer ME a chance to enter a competition, with dinner at San Martinos with Felicity Kendal as the prize.

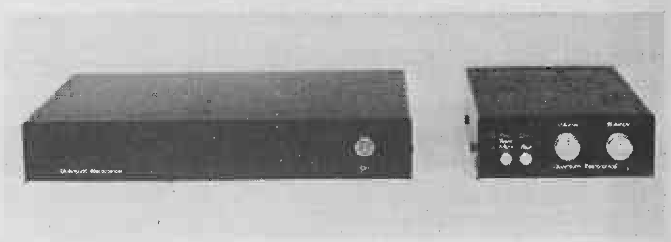
●

Quantum Jump

Formation of new audio companies is always good to see. Quantum Electronics is a new name in the DIY amplifier market, being an off-shoot in both personnel and (developed) product from another VERY well known module manufacturer.

Quantum sell kits in the main, but will supply ready built units upon request. In kit form the amps arrive as tested PCBs metwork and output transistors. Couldn't be easier really. The pre-amp is of the 'Naim' species lacking tone controls and other frills.

Assembly of any of the range seems to consist of bolting in all the bits and wiring up inputs and outputs to the PCBs.



There are four amplifier variations and two pre-amps (moving coil and 'normal'). Prices range from £67.81 for the (mono) 45W P1 up to a mere £99 for the stereo 110W P4. RMS of course.

Tests will be under way soon, and Audiophile readers will hear the results very shortly I hope. Meanwhile if you're interested Quantum are existing at Stamford House, 1A Stamford Street, Leicester — from which the eagle-eyed will be able to infer which module company Quantum is sired by!

●

Speaker Speaker

The following is from a letter I received from a reader named Mr H. Lipschutz. It outlines a brand new form of loudspeaker design he has pioneered (no pun — honest) and makes very interesting reading indeed.

Anyone — manufacturers for example — wishing to contact Mr Lipschutz can do so c/o Audiophile.

Description

The low frequency output of a speaker does not depend on size of box but on size of cone area. This can be quadrupled for a given size of box by mounting drivers in the four usually unused side walls. The combined increase in efficiency due to this, and the direct coupling of low-cost power-ICs to each driver from a common electronic cross-over/12db per octave attenuator (to attenuate excess output at higher frequency), is traded off against loss due to operating woofer below resonance frequency, while medium/high frequency driver(s) are operated above resonance frequency. Thus neither is influenced by resonance effects. Cost of multiple drivers and ICs is saved on box and usual cross-over.

Result is: Small box, but output equal to unit several times its size.

There is no getting away from the fact that loudspeaker development, in terms of distortion, efficiency, and size, is well behind the rest of the hi-fi chain, even if the better speakers sound quite 'nice.' It is debatable which of the parameters needs improving most, but I decided that to reduce size without impairment of the other parameters would be a good start, especially as most buyers of hi-fi speakers would prefer the convenience of small size when given the choice, provided everything else was equal or even better than other speakers.

I therefore decided to develop such a speaker. As the problem of size is normally associated with the woofer and its box, my approach was concentrated upon that area.

To avoid cancellation of the pressure waves front and rear, bass drivers have to be enclosed in a box, the size of which is normally governed by

a) the requirements of resonance of the system as a whole, and

b) the cone area, which ideally should increase in line with the increase in wavelength towards the lower bass.

As below 125 Hz sound directivity is minimal, it did not matter which way the driver(s) faced; it was therefore possible to increase cone area at least fourfold without increase of box size merely by utilizing four sides of the box. The result — a considerable improvement in efficiency. The enclosure comes into its own mainly when used as a resonator, when it is intended to use resonance in order to boost output at a particular frequency, usually the lowest for which the system was designed.

This, however, required large size, which was therefore decided by the laws of physics. While it is convenient to use resonance of the systems for this particular purpose, it is not necessarily the only, or best way.

It has been stated in a number of textbooks and magazines that it is for all practical purposes impossible to force a great deal of electrical power into a speaker from an amplifier at frequencies below their main resonance, and that vastly greater distortion is produced below this resonant frequency, as well as speakers becoming very inefficient at generating sound output, so that normal designs suffer a great drop in output just where a peak is required, and distort badly as well.

This, however, is not the result of physical laws per se, but due to the limitations of the particular design. Clearly the normal bookshelf air suspension design with its 'enormous' 8-inch driver, and design resonance at approx. 75 Hz would attain maximum cone excursion at this very same frequency, caused and helped by resonance of the system. In order to move correspondingly further in and out, which it cannot do without hitting its end-stops, quite apart from the fact that in its work to compress and rarefy the enclosed air it now does not get any help from the effects of resonance.

If, however, it is designed to attain its maximum excursion at 32 Hz, regardless of whether it is helped to do so by resonance effects or not, then this is a different matter, although its movement at resonance, now being far too much, would have to be controlled. This can be done most conveniently by making the box so small that system resonance falls *above* the cross-over point, i.e. above, say, 125 Hz.

Accordingly a speaker with these features was built, with quadrupled cone area, utilizing four sides of the box, active cross-over before the amplifier, in order to avoid power loss in the usual passive cross-over; and the gain in acoustical efficiency traded off against the absence of the usual gain from resonance, with the cross-over frequency at 125 Hz, and a roll-off of 12 dB per octave towards the high end in order to compensate for the increase in output due to the large cone area compared to the smaller wavelength towards 125 Hz.

The result was a speaker of similar efficiency to a transmission line speaker of 10 times its volume with the additional advantage of quadrupled voice-coils (connected in series/parallel) affording four times the heat dissipation capabilities of comparable normal designs, and therefore increased output reserve.

Furthermore, since the 'box' only consisted of not much more than a frame for the four drivers, it was extremely cheap and simple, and quite stiff as well.

Ideally each driver should be driven by its own amplifier.

In listening tests, compared to highly recommended professional monitor speakers, every listener so far has preferred the sound of the prototype, thus proving that the size reduction did not result in loss in any other parameter.

This principle has meanwhile been further developed, and patents are pending for new types of drivers, which permit an increased efficiency estimated to be more than tenfold over conventional systems, thus making possible the design of a speaker which combines small size, extended bass and very high efficiency — design parameters which until now have been considered to be mutually contradictory.

It is intended to follow this development with the construction of an advanced speaker, in which distortion and linearity is improved likewise by a factor of ten at least, thus bringing it more in line with the quality of the other links of the audio chain.

Provis. Patent applied. H. Lipschutz

ETI

DESIGNER'S NOTEBOOK

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

THERE ARE MANY occasions when the electronics design engineer needs one or two basic gates in a circuit and is faced with the possibility of having to wastefully commit an entire IC to this simple function. Alternatively, it may be the case that the inputs to a gate come from such widely separated points of a circuit that the use of an IC in a particular application will result in an excessively complicted PCB layout. In both of these instances, a simple diode gate may offer an ideal solution to the problem.

Figure 1 shows the practical circuit of a 3-input diode OR gate. The circuit is simple, reasonably fast, very cost-effective, and can readily be expanded to accept any number of inputs by merely adding one more diode to the circuit for each new input.

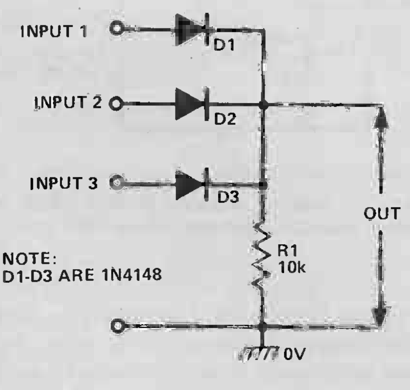


Fig. 1. The diode OR gate is simple but efficient. It can be expanded to accept any number of inputs by adding extra diodes.

The diode OR gate can be converted to a NOR type by either feeding its output through an NPN transistor inverting stage, as shown in Fig 2a, or by feeding it's output through any type of IC inverting stage that happens to be 'spare' in the circuit that you are playing with, as shown in Fig 2b.

Figure 3 shows the connections for making a 3-input diode AND gate. The circuit can again be expanded to accept virtually any number of inputs by simply adding an appropriate number of diodes. ▶

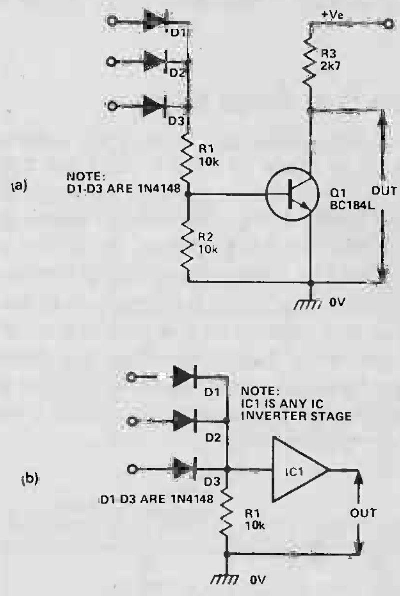


Fig. 2. The diode OR gate can be converted to a NOR type by feeding its output through a transistor (a) or IC (b) inverting stage.

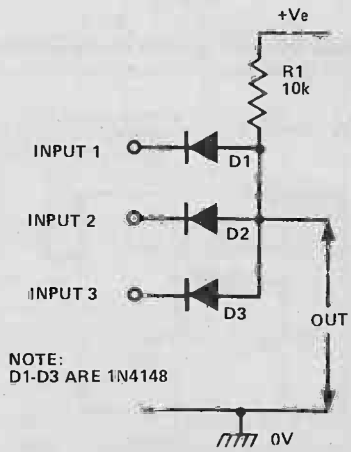


Fig. 3. The circuit of a 3-input AND gate. The number of inputs can be increased by adding extra diodes.

The AND gate can be converted to a NAND type by feeding it's output through a PNP transistor or an IC inverting stage, as shown in Figures 4a and 4b respectively.

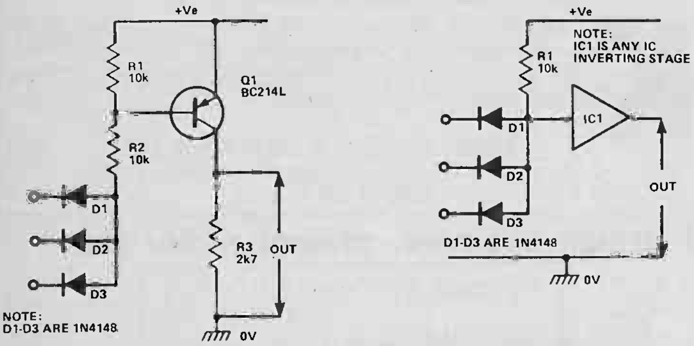


Fig. 4. The diode AND gate can be converted to a NAND type by feeding its output through a transistor (a) or IC (b) inverting stage.

Linear Operation Of Diode Gates

Diode AND and OR gates can give very useful performances when one or more of their inputs are operated in the linear mode. Figures 5 and 6 show two useful ways of using the 2-input diode OR gate in linear applications.

In the case of the Figure 5 circuit, in which analogue voltages are applied to both of the input terminals, the output of the circuit is (ignoring a diode volt drop of about 600 mV) equal to the greater of the two input voltages.

Figure 6 shows what happens when a pulse signal is fed to one input of the OR gate and an analogue voltage is fed to the other. The output signal comprises a pulse with a peak amplitude equal to that of the input pulse, and with a 'zero' value equal to the analogue input voltage.

Figures 7 and 8 show similar circuits based on the 2-input diode AND gate. In the Fig 7 circuit, where analogue voltages are fed to both inputs, the output is (ignoring a diode volt drop 'gain' of about 600 mV) equal to the lesser of the two inputs.

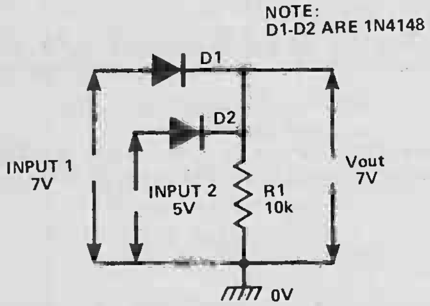


Fig. 5. When a diode OR gate is used in the linear mode, Vout equals the greater of the inputs.

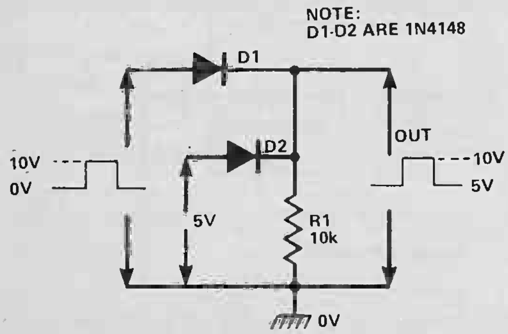


Fig. 6. The effect of feeding a pulse to one input and a DC voltage to the other input of a 2-input diode OR gate.

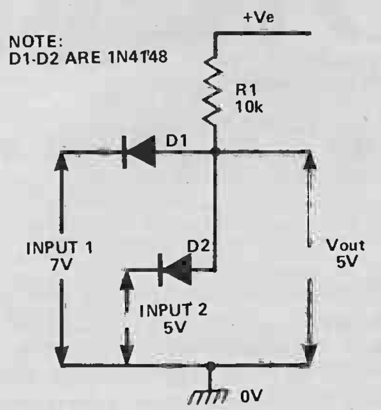


Fig. 7. When a diode AND gate is used in the linear mode, Vout equals the lesser of the inputs.

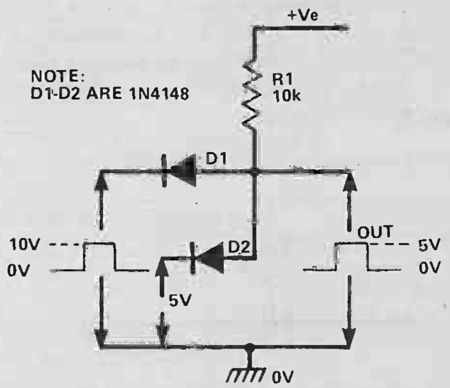


Fig. 8. The effect of feeding a pulse to one input and a DC voltage to the other input of a 2-input diode AND gate.

In the case of the Fig 8 circuit, where a pulse is fed to one input and an analogue voltage to the other, the output pulse has a peak amplitude equal to that of the analogue input voltage.

Diode Volt Drops

We've mentioned above that the output of the 'analogue' diode gate may be 'within a diode volt drop' of the input signal. The magnitude of this 'volt drop' depends on the type of diode that is in use, on the magnitude of the diode forward current, and on the temperature of the diode junction. All silicon diodes have a negative temperature coefficient of about —2mV/°C.

Figures 9 and 10 show typical volt-drop curves for the popular 1N4148 and 1N4001 silicon diodes at 25°C. The graph of Fig. 9 spans the current range 0.1 to 1 mA, and the graph of Fig. 10 spans the range 1 mA to 50 mA.

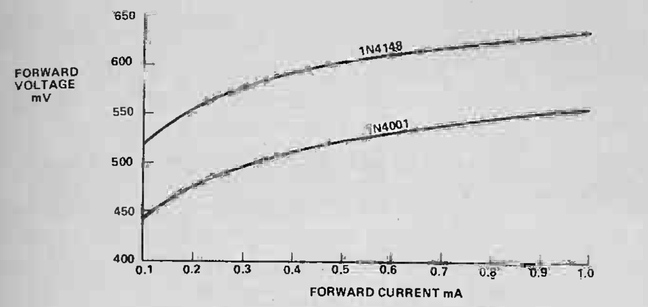


Fig. 9. Volt-drop curves for 1N4001 and 1N4148 diodes over the 0.1mA to 1mA current range.

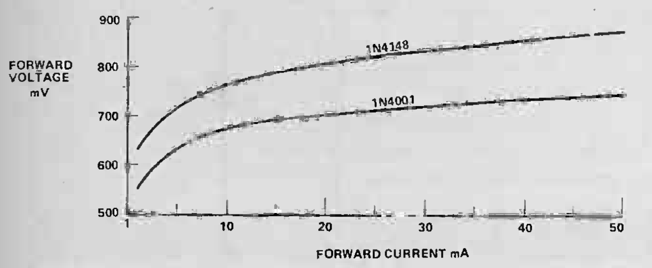


Fig. 10. Volt-drop curves for 1N4001 and 1N4148 diodes over the 1mA to 50mA current range.

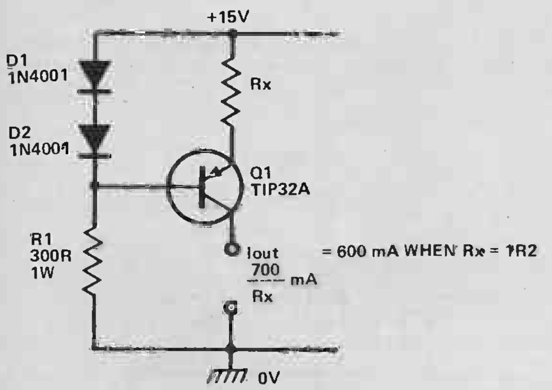


Fig. 11. A simple but useful constant-current generator.

Note that the 1N4148 volt drop typically ranges from 519 mV at 0.1 mA to 874 mV at 50 mA, compared to the 1N4001's range of 441 mV at 0.1 mA to 744 mV at 50 mA.

A point of particular note about the 1N4001 curve is that it's volt drop of 714 mV at 25 mA increases by only a fraction over 4% (to 744 mV) when the current is doubled, to 50 mA. In other words, the diode has a voltage-to-current coefficient of about .04%/% in this current range. The diode can thus be used as a reasonably stable voltage reference at these current levels, but has a negative temperature coefficient of about —0.3%/°C.

A Constant Current Generator

Figure 11 shows how the above mentioned 'voltage reference' characteristics of the 1N4001 can be put to good use in a simple constant-current generator circuit that can be used for re-charging Ni-Cad cells or for linearly charging large capacitors, etc. Here, two 1N4001's are wired in series and operated at a current level of roughly 50 mA. Consequently, the voltage across R_x is equal to the volt drop of the two diodes minus the base-emitter volt of Q1 (about 700 mV), which gives an R_x voltage of about 700 mV. The emitter (and hence collector) current of Q1 is thus approximately $700/R_x$ mA.

To give an idea of the magnitudes of things, an Rx value of 1R2 gives an output current of about 600 mA, 3R9 gives about 200 mA, and 6R8 gives about 100 mA. All in all, a simple but very useful circuit.

Diode Protection Circuits

To wrap up this edition of 'Notebook', let's take a quick look at some diode 'protection' circuits. By 'protection' we mean circuits that are designed to insure devices against irreversible damage, and also circuits that are designed to prevent simple malfunctioning. Figures 12 to 15 show four circuits in this latter category.

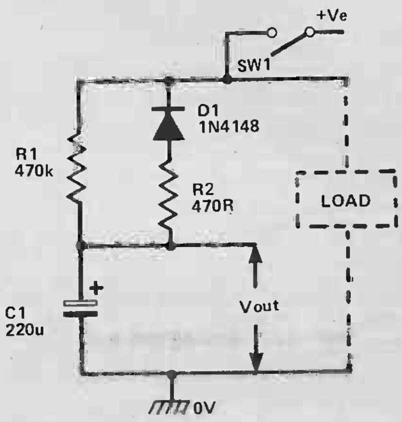


Fig. 12. An example of the use of a diode to rapidly discharge a timing capacitor when the power supply connection is broken.

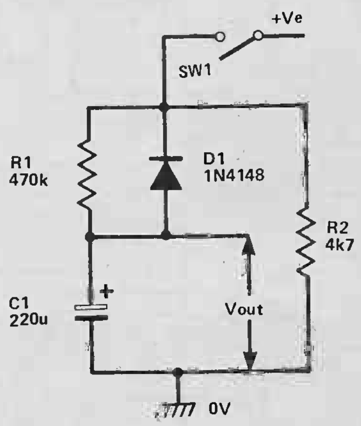


Fig. 13. A modification in the use of a capacitor discharge diode.

In the case of Fig 12, we have a basic time constant circuit in which a rising voltage with a time constant of about 100 seconds is developed across C1 each time ▶

SW1 is closed. This voltage may be used to activate some additional circuitry. The problem is that once C1 has charged up, it has no means of rapidly discharging again (resetting) once SW1 is opened. If there is a load in parallel with the C-R network, as shown dotted in the diagram, C1 will of course discharge via R1 and the load, but then has a very long (greater than 100 seconds) time constant.

An easy way round this problem is to connect a discharge diode in parallel with R1, as shown in Figs 12 and 13. If there is a low-impedance load in parallel with the C-R betwork, a current-limiting resistor must be wired in series with the discharge diode, as shown in Fig 12. If there is no load in parallel with the C-R network, then an artifical load must be provided to complete the discharge path, as shown in Fig 13.

Figures 14 and 15 show two basic variations of the above circuits, in which the C and R networks are configured to give a falling output voltage across R1. Circuit operation should be self-evident.

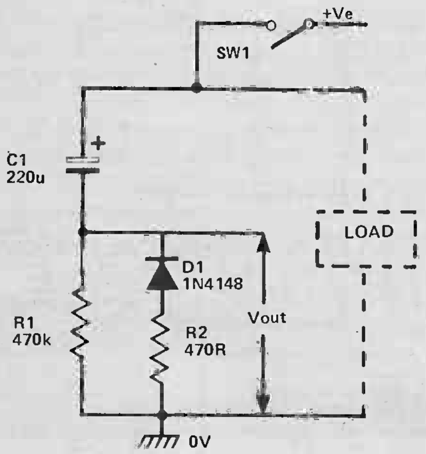


Fig. 14. A basic variant of the Fig. 12 circuit.

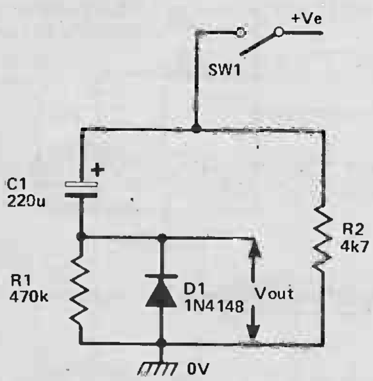


Fig. 15. A basic variant of the Fig. 13 circuit.

Finally, Figures 16 and 17 show ways of using diodes to protect two types of transistor circuit from destructive damage. Figure 16 shows how to protect a pulse-driven common-emitter amplifier that has a highly inductive collector load, such as a transformer or a relay coil. Very high back EMF's can be generated by inductive loads, and can easily be sufficient to destroy transistor junctions. In the diagram, D1 prevents the collector of Q1 from being driven above the positive supply rail value by these back EMF's and D2 prevents it from being driven below the zero-volts value.

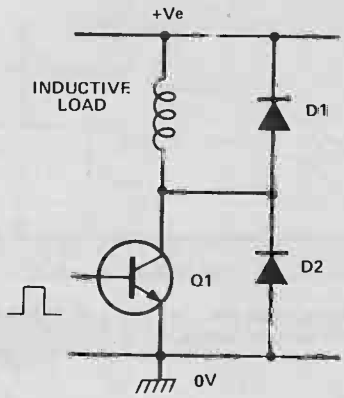


Fig. 16. An example of the use of diodes to protect a pulse-driven common emitter amplifier with an inductive collector load.

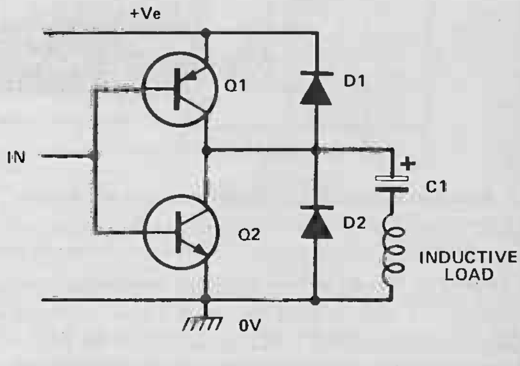


Fig. 17. An example of the use of diodes to protect the complementary emitter follower output stage of a power amplifier that is used to drive an inducting load.

Figure 17 shows how a similar type of protection can be given to the complementary emitter follower output stages of a power amplifier that is used to drive highly inductive loads. This circuit can give good protection to Hi-Fi amplifiers in which the speakers may be inadvertently plugged in at a moment when the amplifier is being hard driven. The protection diodes must have a current rating that is compatible with the inductive (speaker) load.

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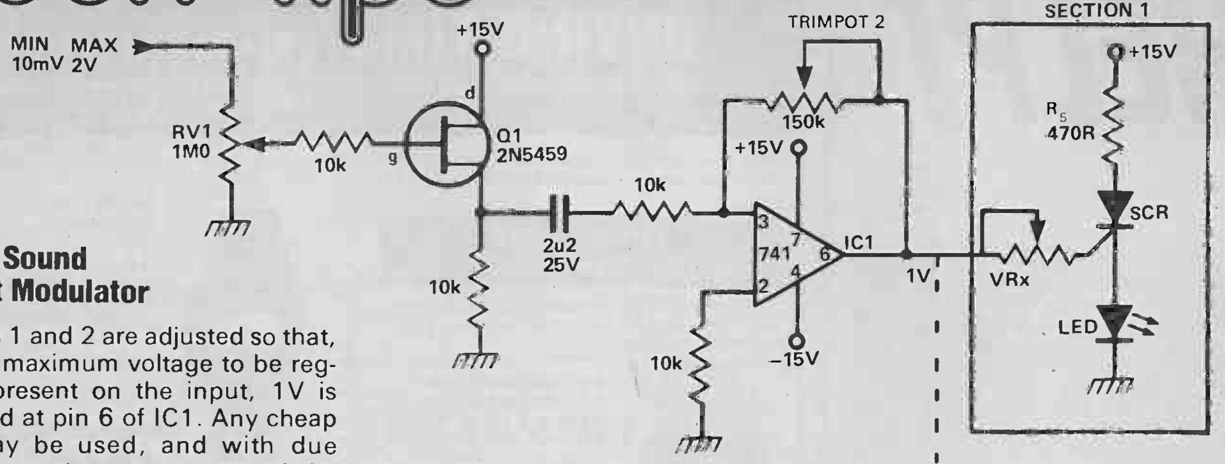
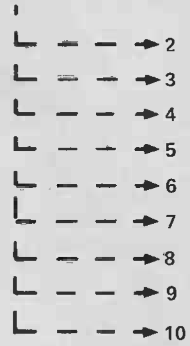




Simple Sound to Light Modulator

Trimpots 1 and 2 are adjusted so that, with the maximum voltage to be registered present on the input, 1V is registered at pin 6 of IC1. Any cheap SCR may be used, and with due reference to the gate current of the SCR, VRx can be calculated: R(ohms) = V/I, where V = 1V and I = gate current. In setting up, VRx is adjusted in section 1 so that the LED lights up when 1V is present at pin 6 of IC1. This is repeated in sections 2-10 with VRx being adjusted with 0.9:0.8 . . . −0.1V at pin 6. Any number of sections can be added/subtracted with due adjustment to VRx. If the supply voltage is changed (from 5-0-5 to 15-0-15) Rs must be changed to give approx 30 mA through the LED. The main advantage of this circuit is the very high input impedance given by the FET input and thus the original audio signal is hardly affected and has negligible current drawn from it (as is not the case with other VU circuits).

CMOS Mixer

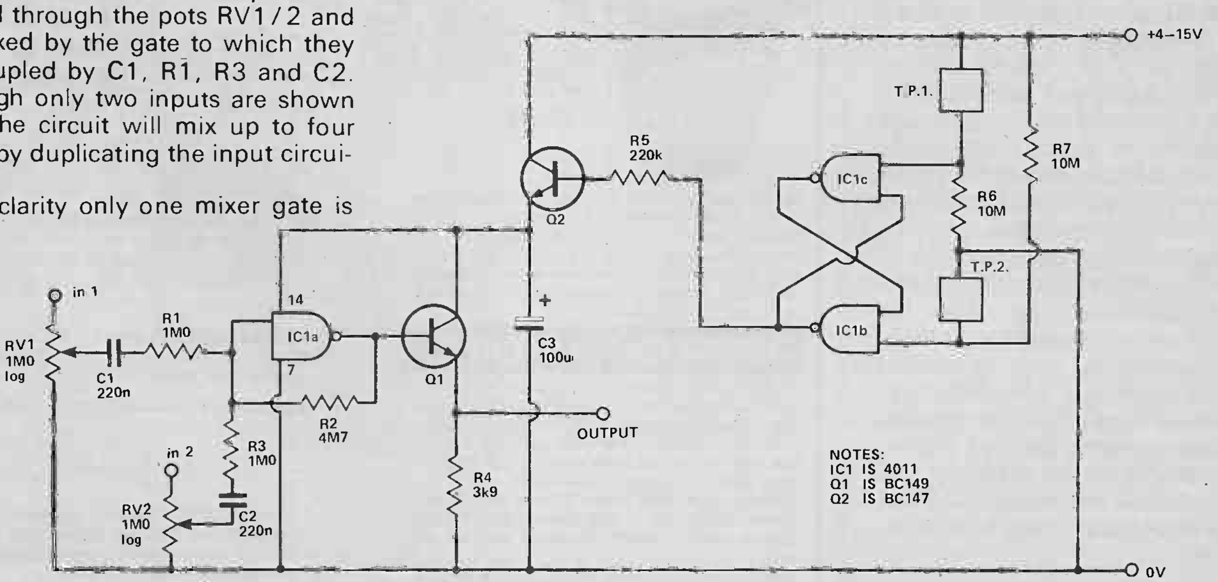
J. P. Macaulay

Although this circuit employs only one cheap CMOS IC and two transistors it is capable of high quality results. The IC, a 4011, contains four dual input NAND gates. Two of these are used with their inputs connected together to form inverters and biased into the linear mode by means of the feedback resistors, R2. Inputs are applied through the pots RV1/2 and are mixed by the gate to which they are coupled by C1, R1, R3 and C2. Although only two inputs are shown here, the circuit will mix up to four inputs by duplicating the input circuitry.

For clarity only one mixer gate is shown in the schematic. The other gate, along with all the components to the left of C3 are duplicated on the other channel. The other two gates are used in a touch operated on-off switch.

The plates, which may consist of a small piece of Veroboard with alternate strips linked together and connected to the input of the gate and line respectively, control the output polarity of the gates.

When the circuit is turned on, by placing a finger on the touch plate, the output of this gate goes high switching Q2 hard on and supplying the circuit with current. To switch off the other touch plate is touched with the finger. The output then goes low removing the operating current from the circuit. The transistor Q2 gives the circuit a low output impedance and the gain with the input pot at maximum is four.



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.

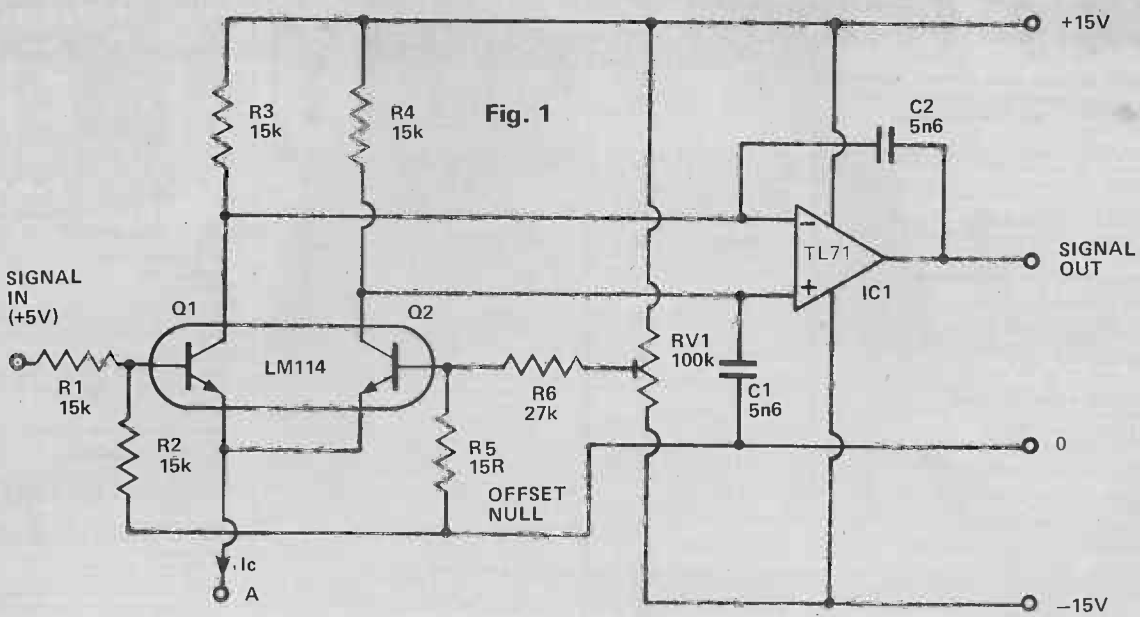


Fig. 1

Voltage Controlled Filter

T. W. Stride

The voltage controlled state variable filter has become almost standard in sound synthesizers, especially since the advent of the CA3080 transconductance amplifier. However, the CA3080 is a reasonably noisy device and this can be annoying when large passbands and/or high Q values are being used in the filter. This circuit is for a low noise, high performance transconductance multiplier, which though not cheap, will offer a truly Hi-Fi performance.

R1 and R2 attenuate the input signal to keep distortion low, and Q1, Q2 with R3, R4 form the transconductance multiplier. The differential output current is integrated by means of IC1, C1 and C2, a differential integrator. RV1 is provided to cancel out the offset of Q1, Q2; it is best adjusted by sweeping the filter and adjusting for minimum DC output shift.

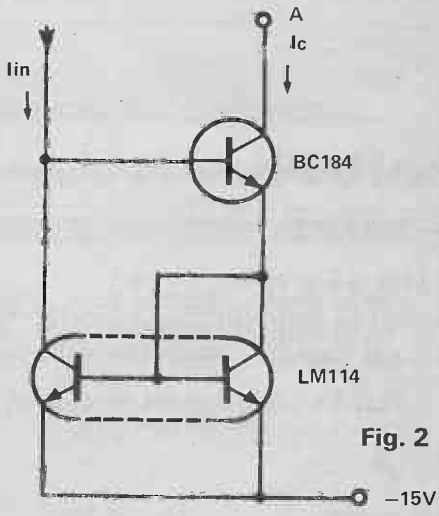


Fig. 2

As can be seen from Fig. 1, the gain of the integrator is controlled by a constant current IC. This current can be provided in two ways, either from a current mirror (Fig. 2) which then makes the circuit an almost exact replacement for the CA3080, or for original equipment designs, from a current source. If it is desired to use this circuit as a replacement for a CA3080 in, for example, the Transcendent 2000 synthesizer, the following modifications are necessary. The integrating capacitor on the output of the 3080 must be replaced with a 10 k resistor and the input attenuator on the above circuit is discarded. The control current that would flow into pin 5 of the 3080 is input to the current mirror and the output current is drawn from the transconductance multiplier (point A).

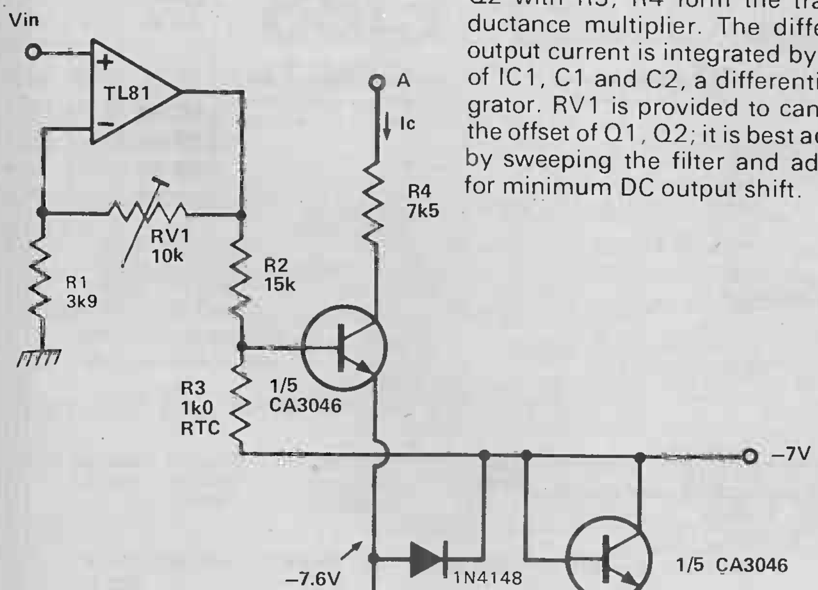


Fig. 3

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At a Price that has no resistance at all

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*FULLY GUARANTEED FOR 2 YEARS
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- 3½ digits 0.56" high LED for easy reading
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- High accuracy achieved with precision resistors, not unstable trimpots
- Input overload protected to 1000V (except 200mV scale to 600V)
- Auto zeroing, autopolarity
- Mains (with adaptors not supplied) or battery operation-built-in charging circuitry for NiCads
- Overrange indication
- Hi Low power ohms, Lo for resistors in circuit, Hi for diodes

SPECIFICATIONS:

DC Volts	Range 200mV, 2V, 20V, 200V, 1000V Accuracy 1% ± 1 digit, Resolution .1mV Overload protection 1,000 volts max
AC Volts	Range 200mV, 2V, 20V, 200V, 1000V Accuracy 1.5% ± 2 digits, Resolution .1mV Overload protection 1000V max, 200mV scale 600V
DC Current	Range 2mA, 20mA, 200mA, 2amp. Accuracy 1% ± 1 digit, Resolution 1 Microamp Overload protection – 2 amp fuse and diodes
AC Current	Range 2mA, 20mA, 200mA, 2 amp Accuracy 1.5% ± 2 digits, Resolution 1 Microamp Overload protection – 2 amp fuse and diodes
Resistance	Range 20, 200, 2K, 200K, 2 Meg. 20 Meg. Accuracy 1% ± 1 digit, Resolution .01 ohms
Environmental	Temp coefficient 0°to 30°C ± .025%°C Operating Temp 0° to 50° C Storage – 20° to 60° C
General	Mains adaptor: 6 - 9 Volts @ 200mA (not supplied) 4C size batteries (not supplied) Size 8¼ x 5¾ x 2¼ Weight 2½ lbs.

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1st Floor, Unit 10, East Block
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news digest......

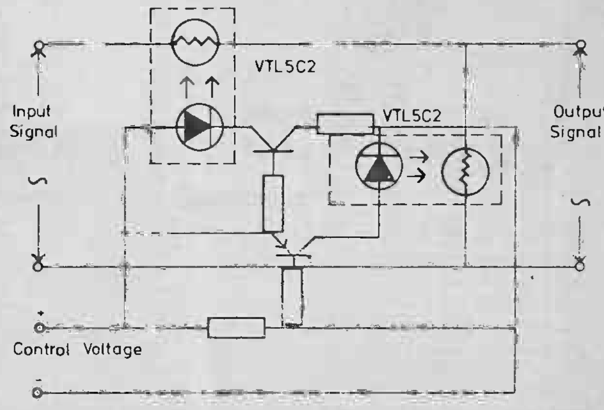
IN-CAR COMPUTING

There's a lot of it about. It's even happening in cars now — microprocessor control, I mean.

General Instrument Microelectronics have developed a clever little car brain based on its PIC 1655 single chip microcomputer. It's designed to replace speedometer, odometer and tripmeter (how far you've travelled since reset) functions. If you want to go mad and computerise everything in sight, there is sufficient on-chip memory to be allocated to other functions, such as water temperature, oil pressure, fuel, tachometer, etc.

Considering the wide variations in current car systems requirements, it's not surprising that GI's system has been designed with a great deal of in-built flexibility. It can drive fluorescent discharge tubes, LED or LCD devices. Distances can be shown in kilometres or miles and pressure, temperature, fluid measures, etc can be displayed in metric or in good, old-fashioned pounds, bushels and inches.

GI claim that the system will save space and weight, and increase reliability and performance. Further details, specification, etc are available from General Instrument Microelectronics Ltd, Regency House, 1-4 Warwick Street, London W1R 5WB.



NEVER SAY DIE

Norbain claim that if you use their Vactrols properly (within their ratings) they have virtually unlimited life expectancy — the Vactrols, not Norbain.

Sounding like the baddie in a Sci-Fi saga, a Vactrol consists of an LED and a photoresistor in a common package. It provides high input-output isolation and low coupling capacitance (about 0.5 p).

One of the several types of audio attenuators possible is shown. The degree of attenuation is varied by adjustment of the control voltage.

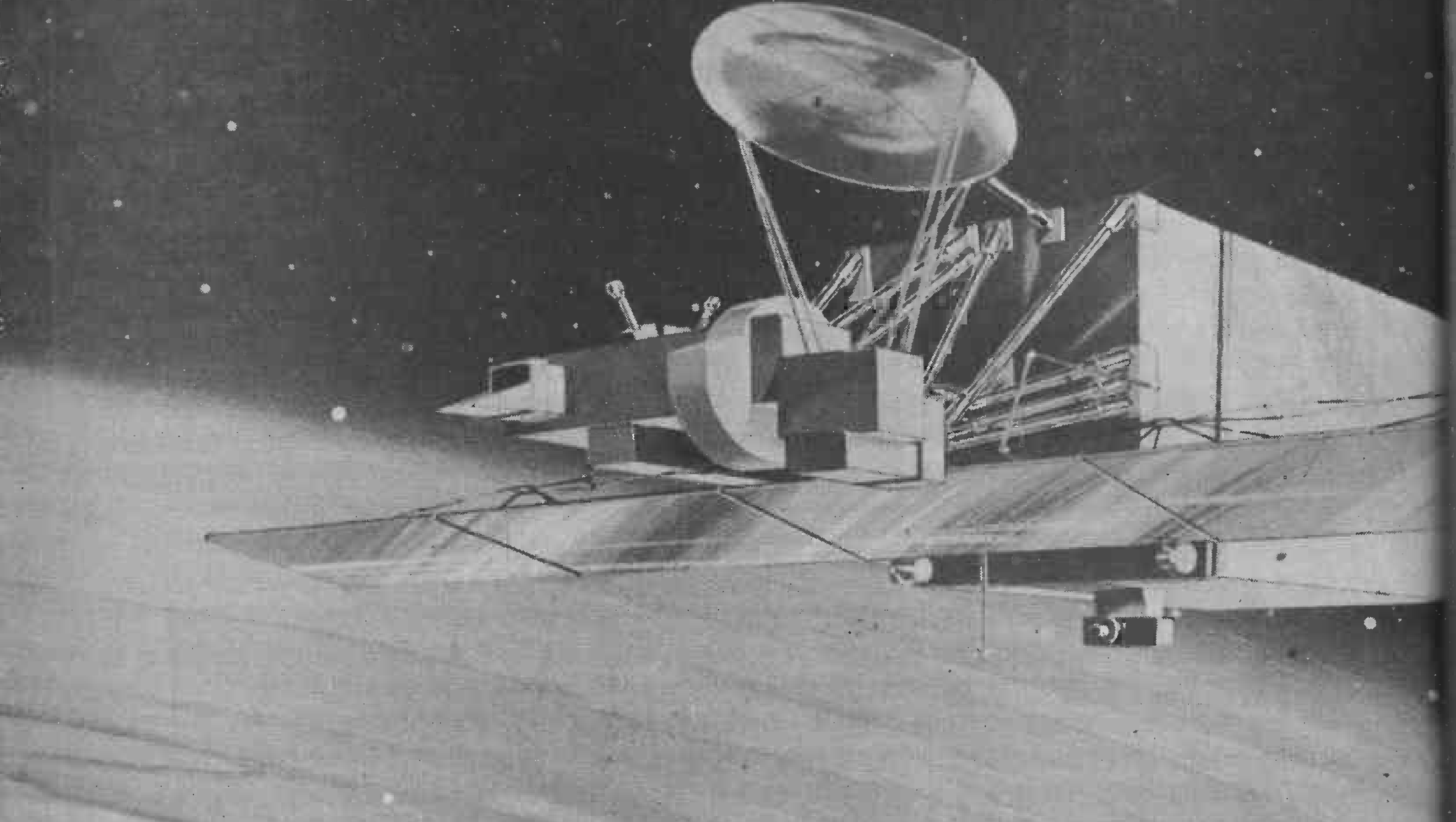
The distortion level for Norbain's VTL5 Vactrols is about 0.5% at IV rms, for a cell resistance of 3k, when using VTL5C4 or 7 types. It is reduced to less than 0.1% with a VTL5C2 and can be further reduced when using the VTL5C3 and 6 types under the same conditions.

Maximum attenuation with a single cell is 40 to 60 dB. Higher values can be achieved by cascading several stages.

For more information contact Norbain Electro-Optics Division, Norbain House, Arkwright Road, Reading, Berkshire RG20LT.

EARTH SATELLITES

Sputnik 1 started the ball rolling in 1957. Since then, thousands of tons of hardware have been lifted into Earth orbit. Ian Graham looks at the different types of Earth satellites and their applications.



IT IS TEMPTING to look upon current satellite systems as highly sophisticated miracles of the space age, but the reality is that the technology is, indeed, in its infancy. Even so, Earth satellites already affect our everyday lives. As we watch live television from America, make international telephone calls and see how the next anticyclone is winding its way towards us, all by courtesy of satellites, it is easy to forget that the satellite age has been with us for little more than 20 years. The first weather satellite was not launched until the dawn of the sixties. The first telecommunications satellite, Telstar, was launched in 1962. Earth satellites fall into six categories — communication, navigational, meteoroligical, Earth resources, research and military.

Before The Dawn

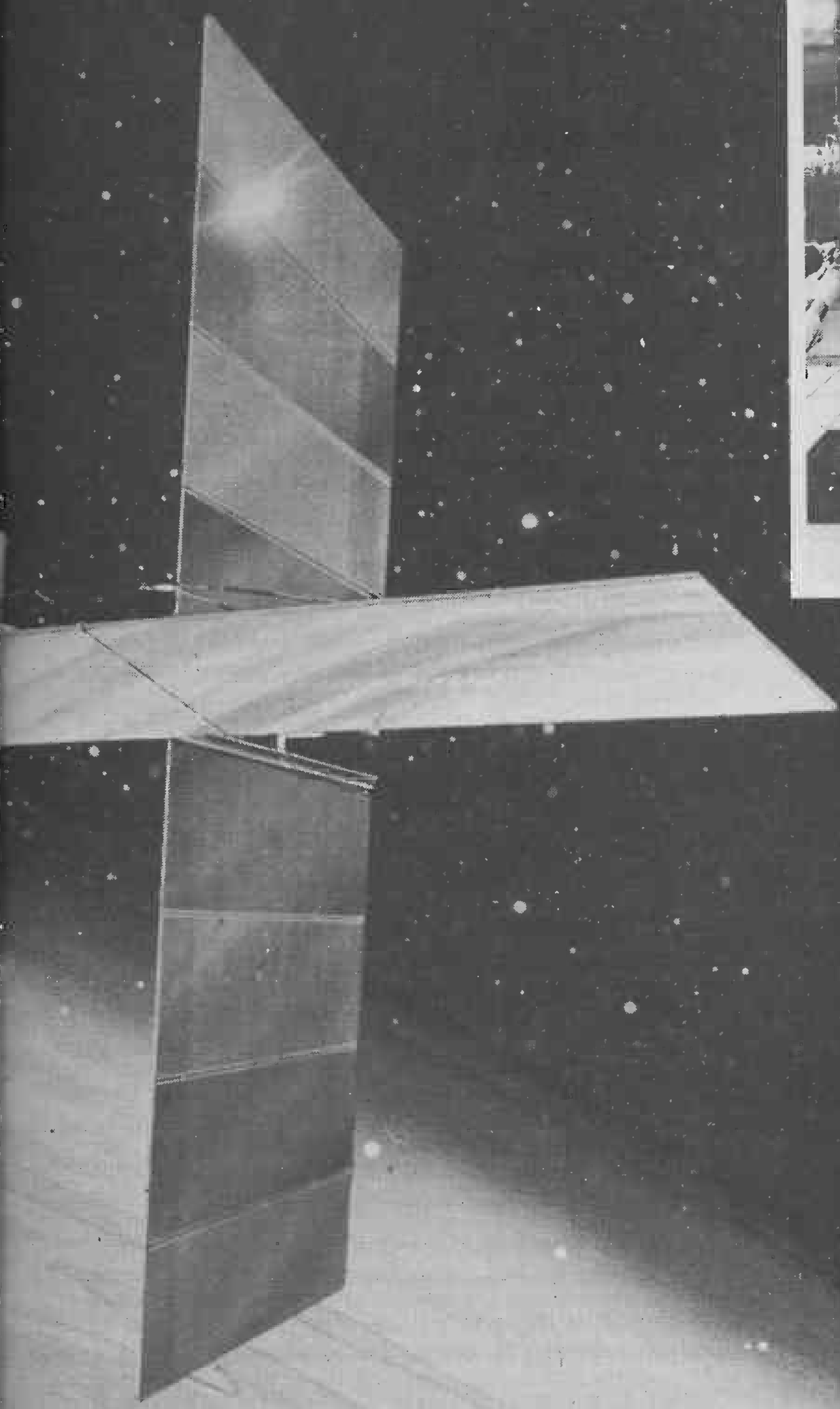
Before the age of the weather satellite, meteorologists had to rely on data from surface observatories and balloon-borne instruments. The system provided good coverage of land masses, particularly over areas of high population density, but left the oceans largely uncovered.

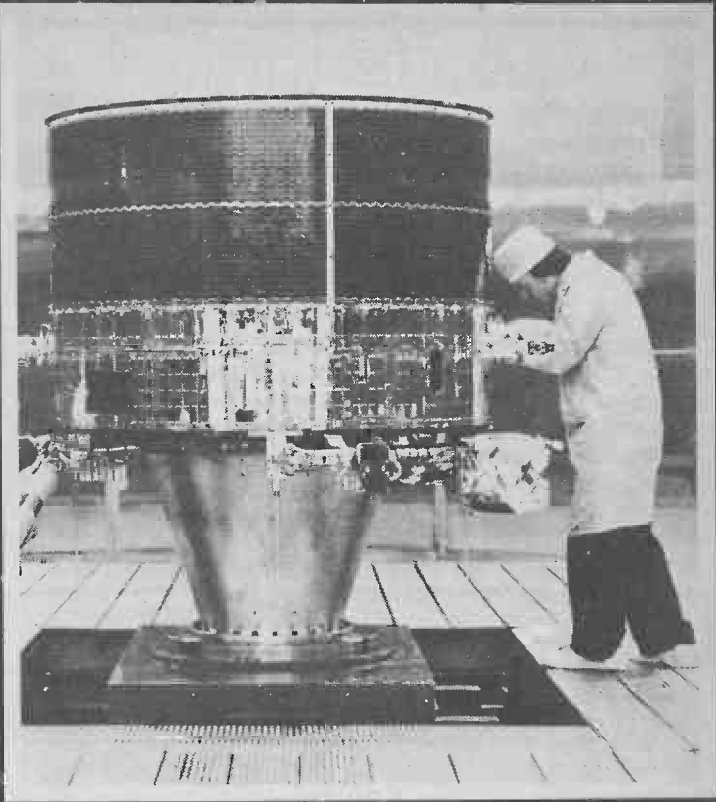
This made accurate, long-range weather forecasting and fundamental studies of global weather patterns virtually impossible. The met men were then in an unenviable position for any scientist — trying to predict the progress of an ever-changing system, basing their predictions on information which was itself imprecise.

The outstanding feature of the weather satellite is its ability to transmit a picture of, for example, a large depression perhaps several hundred miles across, in its entirety. The forecaster no longer has to build up his own weather picture from scattered individual observations. However, surface observations have not been dispensed with. They are of great value when assessing the local components of a much larger weather system.

Space Age Forecasting

Regular satellite monitoring of atmospheric phenomena began in April 1960 with the launch of the first of ten Television Infra-Red Observational Satellites (TIROS-1). The forecaster still has to use his skill to interpret the pictures, but satellites offer the possibility of watching recognisable features develop over several hours or





GEOS-2, Europe's latest scientific satellite, will study the magnetosphere — the region of near-Earth space under the influence of the Earth's magnetic field.

days, an obvious aid to the timing of expected weather events.

So far satellites have been launched into two different types of orbit to achieve global coverage. Three satellites in geostationary (geosynchronous) orbits can just cover the lower latitude regions of the Earth. Although they can see most of the polar regions, the extreme angle of view distorts pictures to such an extent that warrants launching further satellites into polar orbits. ▶

Arresting Motion

As the name suggests, a satellite in a geostationary orbit appears to hold its position in the sky over the same spot on the Earth's surface. It is, of course, orbiting the Earth as any other satellite does, but at an altitude of nearly 36000 km, in a circular orbit, it keeps pace with the Earth's rotation and so appears to be stationary.

Around The World In 90 Minutes

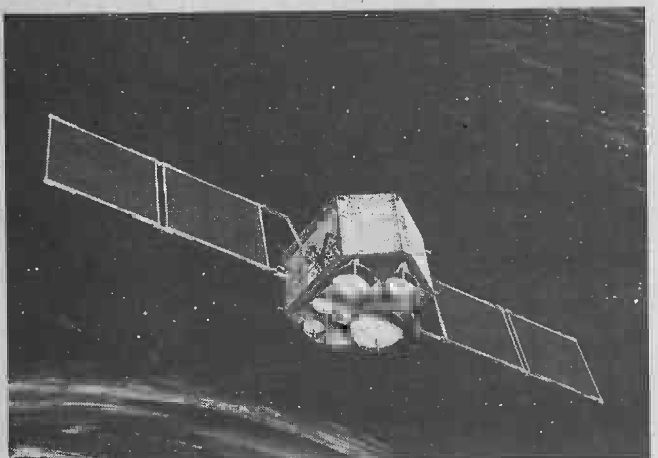
From TIROS-9 onwards satellites have also been launched into polar orbits, with a period of 1½ to 2 hours. The satellite orbits in the same plane, with the Earth rotating beneath it. The ground track of each orbit is some 28 degrees to the west of the previous one. Each spot on the Earth's surface is overflown twice a day, once at night and once during daylight hours. Two imaging systems are used. Visible light pictures are taken during daylight and infra-red at night.

Clearly IR

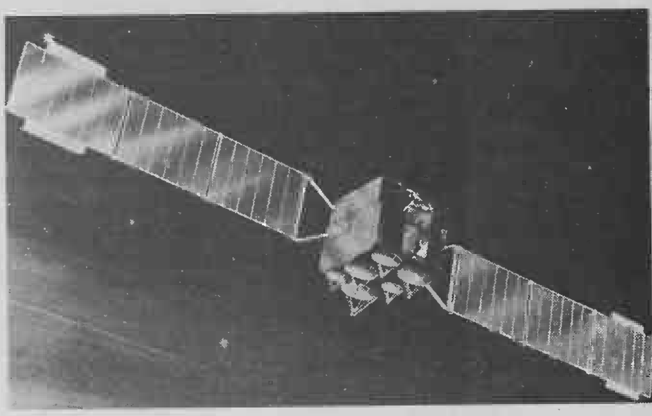
Infra-red sensors on the spacecraft can monitor temperatures from sea level up to the highest cloud. High cloud is the coldest and tropical sea the warmest. Light grey or white patches on the familiar black and white weather pictures of the UK, now a regular feature of television weather forecasts, are the colder cloud areas. Darker areas are the warmer land and sea masses. Coastlines will show clearly if there is sufficient difference in temperature between land and sea. In general, infra-red pictures show more detail than those taken by visible light, as they successfully avoid the problems of reflected glare from cloud tops and ground shadows from thick cloud.

Communications — The Early Days

It all started with Telstar in 1962. During each orbit of about five hours, Telstar and the succeeding Relay could only provide simultaneous visibility from both sides of the Atlantic for about 45 minutes. The Syncom series of satellites in 1963 explored the possibility of building a system from a small number of satellites in geostationary orbits. Syncom also showed that minor perturbations in a satellite's orbit, due to the non-uniformity of the gravitational sea in which it floats, could be rectified by the use of small correcting gas jets.



OTS-2, the forerunner of the European Communications Satellite, is intended to provide pre-operational capacity until ECS begins operations in 1981/2.



The European Communications Satellite (ECS) will carry a large proportion of European telephone, telex and television traffic.

Delay Fears

One fear, which never materialised, was that the increase in transmission time when bouncing telephone conversations off high altitude satellites would be unacceptable. The one way delay is a little over a quarter of a second. In 1964, Early Bird (later to become known as Intelsat 1) showed that the delay, inherent in the system, was not a serious problem.

Intelsat is an important name in the short history of communication satellites. In 1969, three Intelsat-3 satellites established the first global communications network. Even before the launch of Telstar, the Earth to satellite (uplink) and satellite to Earth (you guessed it — downlink) frequencies had been carefully selected. Below about 1 GHz (10^{12}Hz) galactic background noise is a significant factor. Below about 0.5 GHz it exceeds atmospheric noise. Above 10 GHz atmospheric noise rises steeply, moreso in heavy rain. The frequencies chosen then and adopted for the Intelsat programme were, therefore, between 1 and 10 GHz — 6 GHz for the uplink, 4 GHz for the downlink.

Britain is playing a particularly active role in satellite communications. British contractors contributed to the Intelsat 3, 4 and 4A programmes and British Aerospace is currently involved in the Intelsat 5 system, due to become operational in 1980.

European Communications

In May 1978, the European Space Agency's Orbital Test Satellite (OTS) was launched. It will test transmission techniques and prove the performance and reliability of on-board equipment in space. This is the forerunner of its operational successor, the European Communications Satellite (ECS) — a regional satellite communications system. It will be capable of carrying a significant proportion of future European telephone, telex and television traffic. OTS-2 will also provide adequate pre-operational traffic capacity. Two ECS spacecraft should become operational in 1981/82. Two maritime versions of ECS, to be known, not surprisingly, as MARECS, are also scheduled for launching in 1981/82. MARECS is planned to provide direct telephone and telex links between ships and shore stations in the UK and elsewhere.

Radio Piggy Back

In October 1978, the 1045th Cosmos satellite was placed in Earth orbit. It carried two smaller satellites called Radio 1 and 2, designed and built by radio hams.