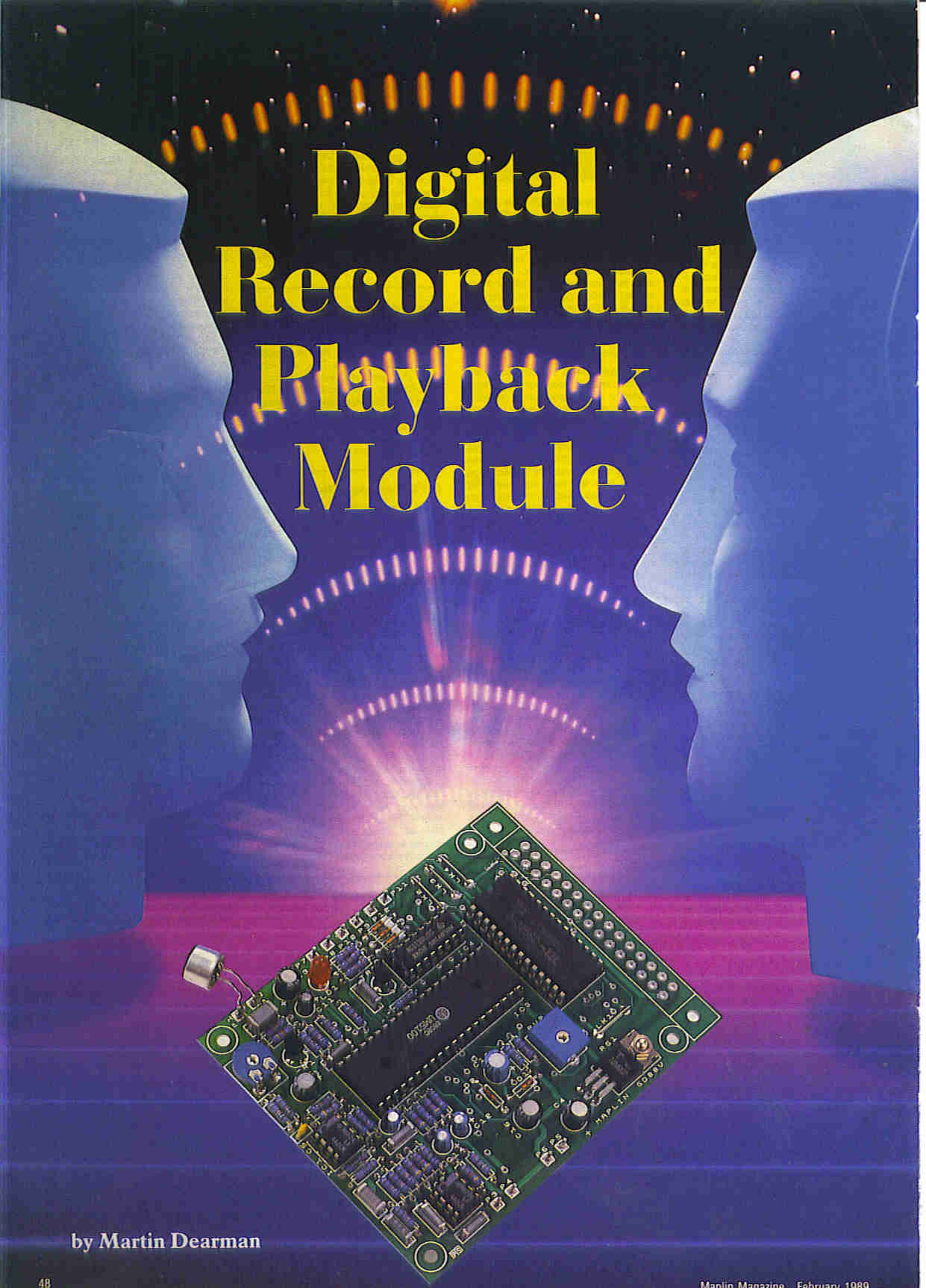
Digital Record and Playback Module



by Martin Dearman

This project is based around the UM5100 digital voice recorder and playback integrated circuit where speech is digitally recorded into memory and then played back. Digital recording has the advantage over tape recording, in that there is no mechanical wear and tear in the tape head or tape. Applications include voice message pads, security systems and telecommunications, and it can also be used in a vehicle, as it will run from a 12V supply. For memory, either an 8k byte CMOS Static RAM (SRAM), type 6264, or a 32k byte CMOS SRAM, type 62256, can be used and with the 32k byte SRAM supplied, record and playback durations of between 5 and 20 seconds are possible. The module can be further expanded with an EPROM programmer board, and another option will be a replay only board for playing back pre-recorded messages stored on an EPROM (both of these add-ons will be published in a future issue).

Circuit Description

Figure 1 shows a block diagram of the record and playback module, and Figure 2 shows the circuit diagram. Speech is

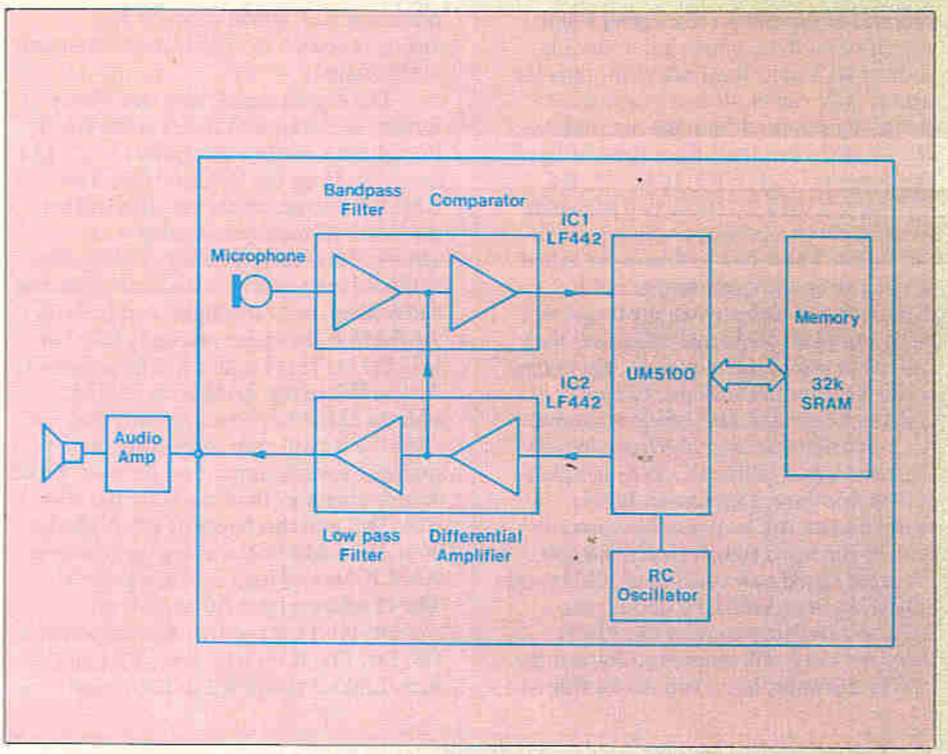


Figure 1. Block schematic of the system.

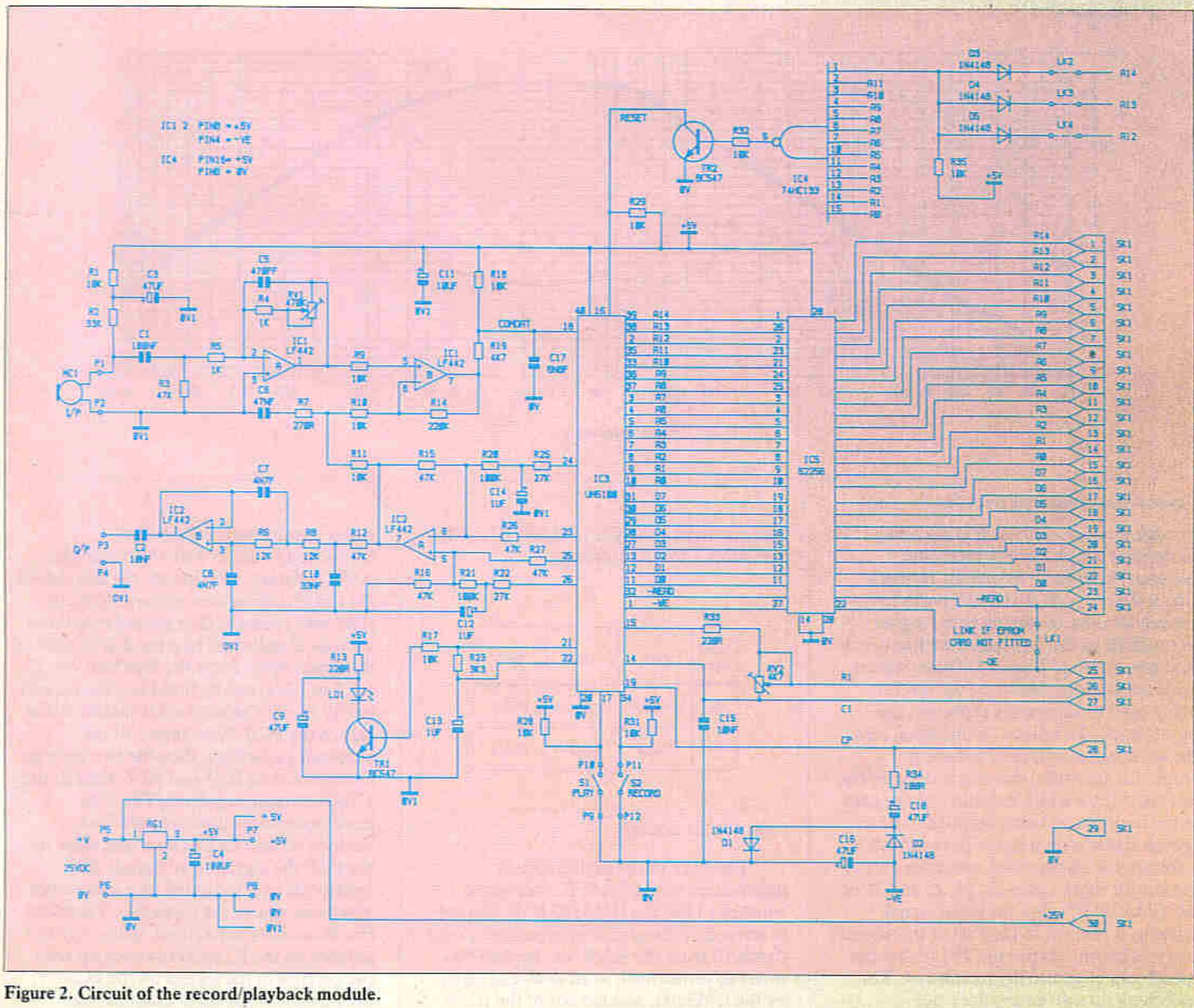


Figure 2. Circuit of the record/playback module.

received at the electret microphone and amplified by IC1a, which has a variable resistor RV1 in its feedback path, thus the gain of IC1a can be altered to suit the sensitivity required from the microphone. IC1a is also a bandpass filter (consisting of components C1, R3, R5, IC1a, C5, R4, RV1) and is used to reduce two problems from which an analogue to digital circuit can suffer. These two problems are called aliasing error and quantisation noise. Aliasing error occurs when the frequency being sampled (converted) is greater than half of the sampling frequency. The error occurs because the analogue to digital converter circuit (ADC) needs to sample the input signal at twice the frequency of the input signal (at least); i.e. to sample a 10kHz sinewave, a minimum 20kHz sampling rate will be needed to correctly convert the input signal. If, for example, the input signal now consists of 10kHz and 20kHz sinewaves mixed together, the ADC will correctly convert the 10kHz sinewave and it will attempt to convert the 20kHz sinewave, but it will not be able to manage it successfully as it is not being sampled at a high enough rate. The bandpass filter has a frequency response characteristic such that it will reduce or entirely remove these unwanted higher frequencies as can be seen in the frequency response graph of Figure 3. Quantisation error occurs when there are too few bits being used to adequately represent the input signal. To reduce quantisation error, the input signal will need to have its amplitude increased and this is done by the bandpass filter which exhibits voltage gain at the frequencies being sampled. The speech signal is then fed to IC1b, which is a voltage comparator and compares part of the output signal (pins 23, 24, 25 and 26 of the UM5100 IC) with the input signal arriving at pin 5 of IC1b. Part of this signal also reaches the output pin P3, so that the speech can be externally monitored. The speech signal now enters the voice processor IC3, which converts the analogue speech to a digital representation of this signal.

The digital signal, now in a binary format, is placed into IC5, a static RAM IC, via the 8 bit data bus (pins 11, 12, 13 and 27 to 31 on the UM5100 IC). The UM5100 also generates the address that the RAM IC requires, starting with address 0 and incrementing (adding one) to this address every time a conversion has taken place, until the highest address of the RAM IC has been reached, 32767 or 111111111111111 with a 32k byte memory device. When the RAM IC is full, i.e. address 32767 has been reached, the UM5100 IC will stop converting the analogue speech signal, and be reset. Reset occurs when pin 16 of the UM5100 is at +5V DC, and this happens when address lines A0 to A14 (when using the 32k byte RAM IC) are all high, i.e. at a logic '1'. The 15 address lines A0 to A14, are logically ANDed together by components D3, D4, D5, R35, IC4, R32, TR2 and R29. Links 2 to 4 (LK2 to LK4) are inserted to suit the size of RAM IC used, see Table 1 for link settings.

RAM Size	LK2	LK3	LK4
8k	Unmade	Unmade	Made
32k	Made	Made	Made

Table 1. Link settings.

Playback of the digital speech information in the RAM IC will occur when pin 17 of the UM5100 IC is shorted to ground. This speech information is read (fetched) from the RAM via the data bus, then converted back to an analogue signal by the UM5100, and fed out of the IC on pins 23 to 26. The four signals coming out of the UM5100 IC are combined into one signal by differential amplifier IC2a. The signal is then low pass filtered by IC2b, to remove unwanted clock and noise signals, and output to pin P3. This signal will need to be amplified by an external amplifier, as the average level is only 250mV RMS. There is also a LED (LD1) indicator fitted that will light when speech is being received and played back by the UM5100. The record and playback module can be made to replay continuously by keeping pin 17 of the UM5100 shorted to ground.

PCB Assembly

The PCB is a double-sided, plated through hole, fibre glass type. Removal of a misplaced component is therefore quite difficult, so please double-check each component type, value and its polarity where appropriate, before soldering. The PCB has a printed legend to assist you in correctly positioning each item, see Figure 4. The sequence in which the components are fitted is not critical. However, it is easier to start with the smaller components. Begin with the metal film 0.6W resistors, then mount the five diodes D1 to D5, taking care to insert them the right way round as they are polarised; the cathode is indicated by a band at the end of the diode body. Next the four link wires, LK1 to LK4, can be fitted and the pins P1 to P12 have to be inserted from the solder side of the PCB. Next insert all the polyester capacitors, then the two variable preset resistors RV1 and RV2, then fit the 470pF ceramic capacitor. The nine electrolytic capacitors are polarised devices, so take care in inserting them into the PCB the correct way round; the negative lead is indicated by a minus sign down one side of the capacitor. There are five IC sockets to be fitted; make sure the notches on the IC sockets match up with the notches in the legend on the PCB. A little trick to hold the sockets in place

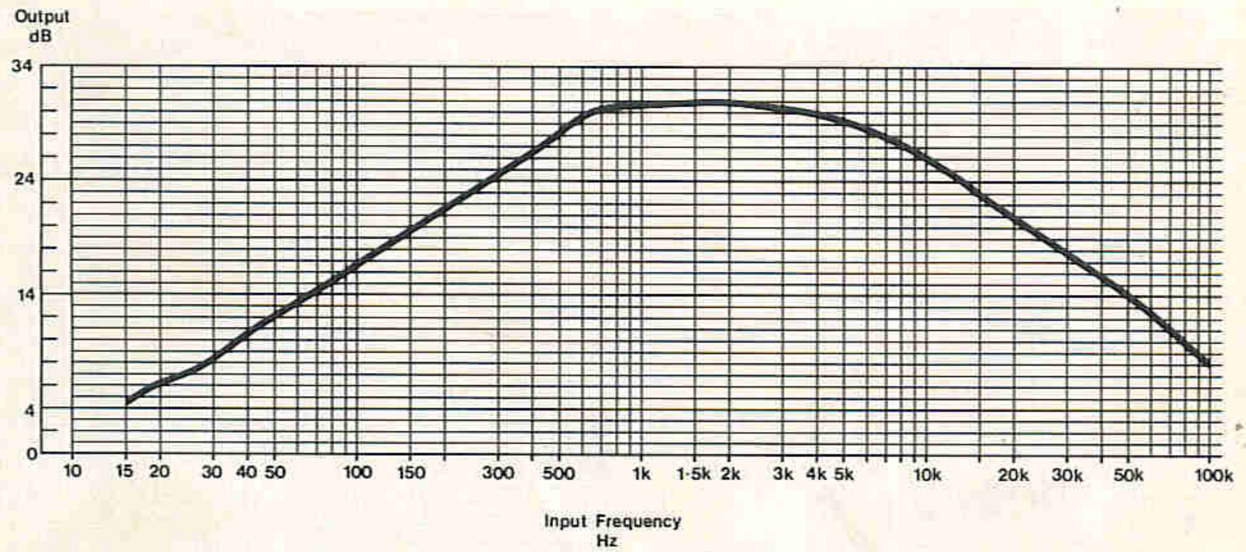


Figure 3. Bandpass filter response.

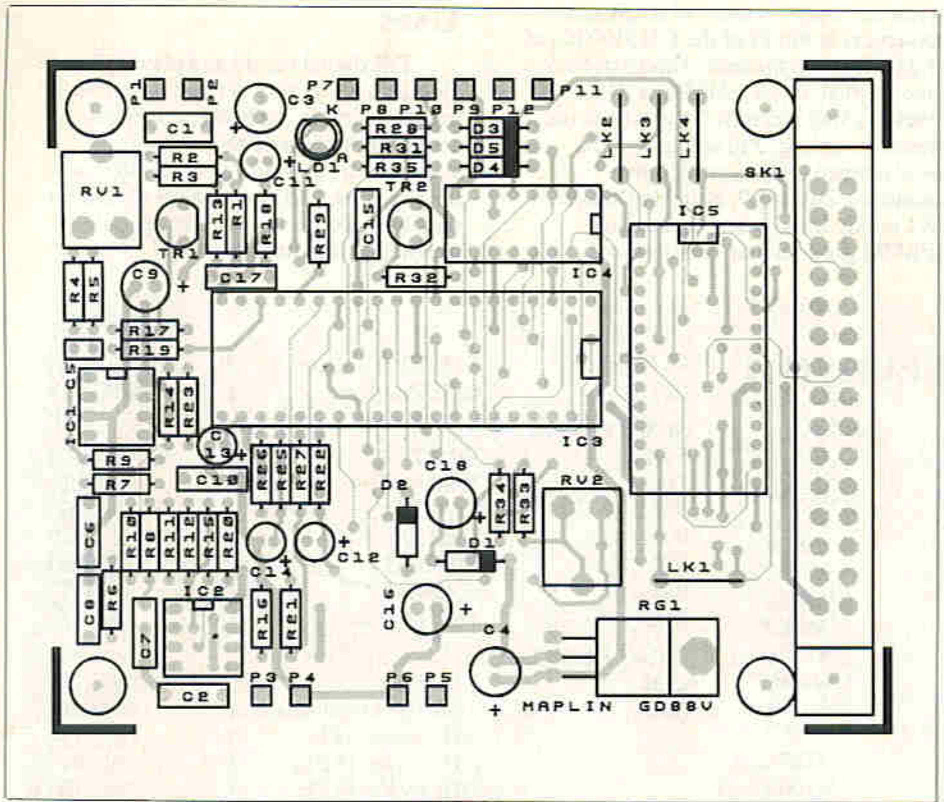


Figure 4. Layout of the PCB.

during soldering, is to bend two of the sockets legs over once it has been inserted into the PCB. This will hold the socket in place until all the other leads have been soldered, then straighten out the two previously bent legs and solder them. The ideal pair of legs to bend are the two at each end of the socket and diagonally opposite each other. Next fit the two transistors TR1 and TR2, taking care to match the body shape of the transistor with the outline on the PCB, then the LED is inserted into the PCB; the cathode is indicated by a flat side on the body and by the shorter of the two leads. The regulator IC is fitted next and is bolted to the PCB using an M3 nut and bolt (see Figure 5). The leads of the regulator have to be bent at an angle to get them into the PCB with the M3 nut and bolt as shown. Mount the electret microphone as shown in Figure 6, taking great care to wire it the correct way as it is a polarised device; the 0V (ground) pin is connected to the microphone case.

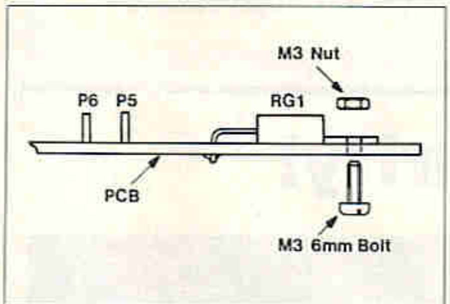


Figure 5. Mounting the regulator.

Testing

All of the tests necessary can be made with the minimum of equipment. You will need an electronic digital (or analogue moving coil) multimeter and a stabilised DC power source, that can supply up to 50mA at 7.5 to 25V DC. The lower voltage would be preferable at this stage, due to the power dissipation in the 78M05 +5V voltage regulator being less at 7.5V DC, the higher voltage of 25V DC will be required when the plug-in EPROM programmer PCB is used (this will appear in a later issue). Connect the power source to P6 and P5, with 0V to P6 and the positive to P5, and note the average current drain is about 10mA. Also an amplifier will be needed, the LM386 amplifier module (kit number LM76H) being ideal for this task (see 'Data File' in issue 29). Connect the amplifier to P3 and P4, with 0V to P4 (see Figure 7). Now you are ready to record a voice. To activate recording mode, P11 will have to be momentarily shorted to ground by connecting P11 to P12, if P11 is left connected to P12 then recording will be continuous, the UM5100 will notice that P11 is shorted to ground when it is reset, which occurs when the RAM IC is full, then the UM5100 will put its converted speech signal into the lowest memory location of the RAM IC, and of course the data previously in the memory device will be overwritten. Please note that the optimum speaking distance from the electret microphone is 100mm. The recording level sensitivity can be adjusted by rotating variable preset resistor RV1; the direction of rotation for minimum and maximum sensitivity is also shown in Figure 7. The recording and playback duration can be adjusted by variable preset resistor RV2 and the recording and playback duration has a range of 5 to 20 seconds. There is a trade off of course, for the longer duration times the quality of the speech deteriorates. The highest quality

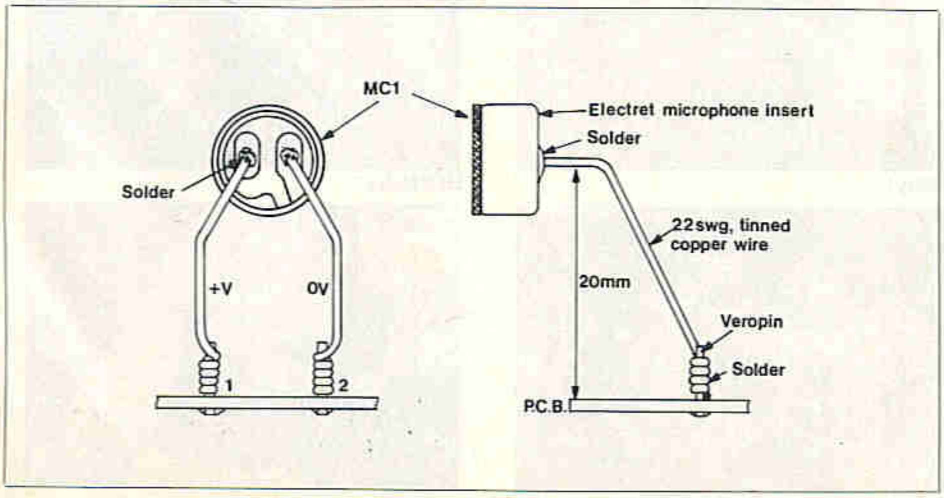


Figure 6. Mounting the electret microphone.

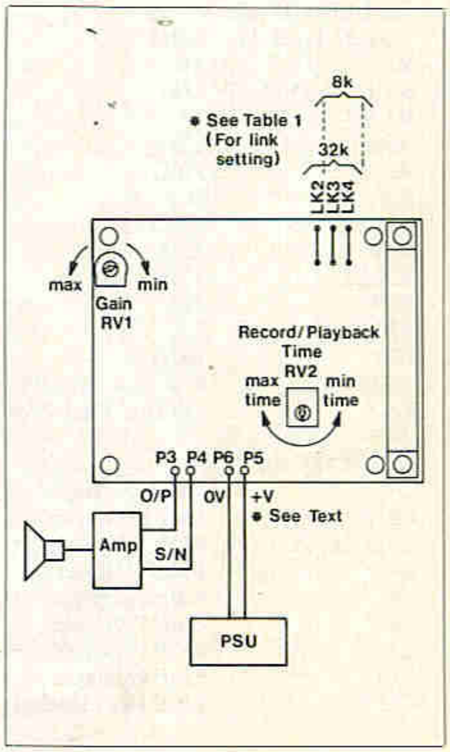


Figure 7. Controls and power connections.

 DIGITAL RECORD AND PLAYBACK MODULE

speech occurs at the shortest duration of recording and playback time, i.e. 5 seconds. If you have an oscilloscope or better still a frequency counter, this record and playback time can be determined by measuring the frequency of the signal at pin 19 of the UM5100 voice processor IC. The formula for working out the time is 8 divided by the frequency at pin 19, multiplied by the memory capacity in bytes, i.e. with 32k bytes of RAM and a frequency, at pin 19 of the UM5100 IC, of 19.21kHz, then the record and playback time is equal to (8/19.21kHz) x 32 x 1024 bytes = 13.65 seconds. To playback the speech recording, P10 will have to be taken momentarily to ground by connecting P10 to P9. Note that socket SK1 is only fitted when the optional EPROM programmer board is used.

Uses

The digital record and playback module has a variety of uses, including a burgler alarm in the home, a telephone answering system, in the car as an annunciator, in the office as an electronic message pad, and as a message system for the blind. Comments on other possible uses are invited from readers.

RECORD/PLAYBACK MODULE PARTS LIST

RESISTORS: All 0.6W 1% Metal Film			
R1,9,10,11,17,18, 28,29,31,32,35	10k	11	(M10K)
R2	33k	1	(M33K)
R3,12,15,16,26,27	47k	6	(M47K)
R4,5	1k	2	(M1K)
R6,8	12k	2	(M12K)
R7	270Ω	1	(M270R)
R23	3k3	1	(M3K3)
R13,33	220Ω	2	(M220R)
R14	220k	1	(M220K)
R20,21	100k	2	(M100K)
R19	4k7	1	(M4K7)
R22,25	27k	2	(M27K)
R34	100Ω	1	(M100R)
RV1	470k Hor. Encl. Preset	1	(UH08J)
RV2	4k7 Hor. Encl. Preset	1	(UH02C)
CAPACITORS			
C1	100nF Polylayer	1	(WW41U)
C2, 15	10nF Polylayer	2	(WW29G)
C3, 9, 16, 18	47µF 16V Minelect	4	(YY37S)
C4	100µF Minelect	1	(RA55K)
C5	470pF Ceramic	1	(WX64U)
C6	47nF Polylayer	1	(WW37S)
C7,8	4n7F Polylayer	2	(WW26D)
C10	33nF Polylayer	1	(WW35Q)
C11	10µF 16V Minelect	1	(YY34M)
C12,13,14	1µF 63V Minelect	3	(YY31J)
C17	6n8F Polylayer	1	(WW27E)
SEMICONDUCTORS			
TR1,2	BC547	2	(QQ14Q)
D1-5	1N4148	5	(QL80B)
IC1,2	LF442	2	(QY30H)
IC3	UM5100	1	(UJ48C)
IC4	74HC133	1	(UB30H)
IC5	62256	1	(UH40T)
RG1	µA78M05UC	1	(QL28F)
MISCELLANEOUS			
LD1	LED Red	1	(WL27E)
MC1	SUB Min Omni Insert	1	(FS43W)
	DIL Socket 8 Pin	2	(BL17T)
	DIL Socket 16 Pin	1	(BL19V)
	DIL Socket 28 Pin	1	(BL21X)
	DIL Socket 40 Pin	1	(HQ38R)
	Pin 2145	1 Pkt	(FL24B)
	Isobolt M3 × 6mm	1 Pkt	(BF51F)
	Isonut M3	1 Pkt	(BF58N)
	22 swg TC Wire	1 Reel	(BL14Q)
	PC Board	1	(GD88V)
	Constructors Guide	1	(XH79L)

A kit for the above project is available:
Order As LM80B (Rec/playbk Kit) Price £34.95
The following item is available separately:
Record/Playback PCB **Order As GD88V Price £6.95**

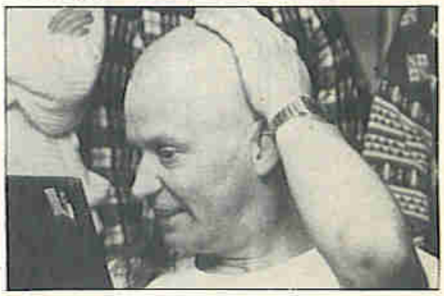
Phil cools it for charity!

Great Ormond Street Hospital Wishing Well appeal benefitted to the tune of £300 recently, when service department engineer Phil Cannadine came up with the 'Samson-like' idea of cutting off all of his hair for charity. Quite a hair-erasing notion considering winter winds are whistling round the corner! Local hair-dresser Alan Duke gave his services free of charge (and even donated £5 to the collection) and workmates looked on and cheered as Phil's locks fell away. The collection from friends and Maplin employees raised £215 which was boosted to £300 by the generosity of Maplin managing director Roger Allan. Well done Phil! When asked what his next fund-raising stunt would be, he said that he'd thought of having his legs shaved but he was worried about it going too far!!

Hairy!

Half Hairy!

Helping Hands!



Hairless!