

# Solid-State SOUND RECORDER

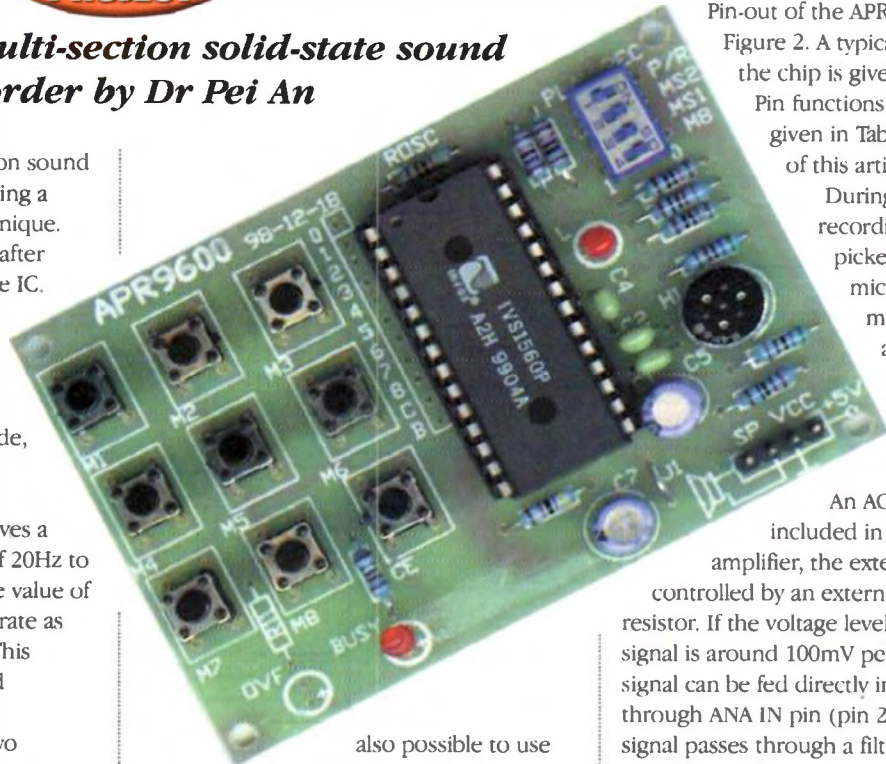
PROJECT

## An APR9600 multi-section solid-state sound recorder by Dr Pei An

The APR9600 is a multi-section sound record/replay IC incorporating a flash analogue storage technique. Recorded sound is retained even after power supply is removed from the IC. The APR9600 has a 28 pin DIP package. Supply voltage is between 4.5V to 6.5V. During recording and replaying, current consumption is 25mA. In idle mode, the current drops to 1mA.

Sampling rate for a 60 second recording period is 4.2kHz that gives a sound record/replay bandwidth of 20Hz to 2.1kHz. However, by changing the value of an oscillation resistor, a sampling rate as high as 8.0kHz can be achieved. This shortens the total length of sound recording to 32 seconds.

The IC can operate in one of two modes: serial mode and parallel mode. In serial access mode, sound can be recorded in 256 sections. In parallel access mode, sound can be recorded in 2, 4 or 8 sections. The operation of the IC can be controlled using push button keys. It is



also possible to use external digital circuitry such as micro-controllers and computers.

The APR9600 experimental board is an assembled PCB board consisting of an APR9600 IC, an electret microphone,

support components and necessary switches to allow users to explore all functions of the APR9600 chip. The oscillation resistor is chosen so that the total recording period is 60 seconds with a sampling rate of 4.2kHz. The board measures 80mm by 55mm. Figure 1 shows the experimental board.

### APR9600 IC

Pin-out of the APR9600 is given in Figure 2. A typical connection of the chip is given in Figure 3.

Pin functions of the IC are given in Table 1 at the end of this article.

During sound recording, sound is picked up by the microphone. A microphone pre-amplifier amplifies the voltage signal from the microphone.

An AGC circuit is included in the pre-amplifier, the extent of which is controlled by an external capacitor and resistor. If the voltage level of a sound signal is around 100mV peak-to-peak, the signal can be fed directly into the IC through ANA IN pin (pin 20). The sound signal passes through a filter and a sampling and hold circuit. The analogue voltage is then written into non-volatile flash analogue RAMs.

During sound replaying, the IC's control circuit reads analogue data from flash RAMs. The signal then passes through a low-pass filter, a power amplifier and output to an 8 to 16 Ohm speaker.

There are different sound recording and replaying modes (see Table 2). These modes are selected using MSEL1 (Pin 24), MSEL2 (Pin 25) and -M8 (Pin 9). -M1 to -M7 keys have different functions in different modes.

### Experimental circuit

The circuit diagram of the module is shown in Figure 3. It is built on a single-sided PCB board. Figure 4 and 5 give the PCB artwork and component layout.

The module consists of an APR9600 chip, an electret microphone, support components, a mode selection switch (-RE, MSEL1, MSEL2 and -M8) and 9 keys (-M1 to -M8 and CE). The oscillation resistor is chosen so that the total recording period is 60 seconds with a sampling rate of 4.2kHz. Users can change the value of the ROsc to obtain other sampling frequencies. It should be noted that if the sampling rate is increased, the length of recording time is decreased. Table 3 gives

-M1/MESSAGE	1	28	VCCD
-M2/NEXT	2	27	-RE
-M3	3	26	EXT CLK
-M4	4	25	MSEL2
-M5	5	24	MSEL1
-M6	6	23	CE
OSCR	7	22	-STROBE
-M7/END	8	21	ANA OUT
-M8/OPTION	9	20	ANA IN
-BUSY	10	19	AGC
BE	11	18	MIC REF
VSSD	12	17	MIC IN
VSSA	13	16	VCCA
SP+	14	15	SP-

Figure 1.

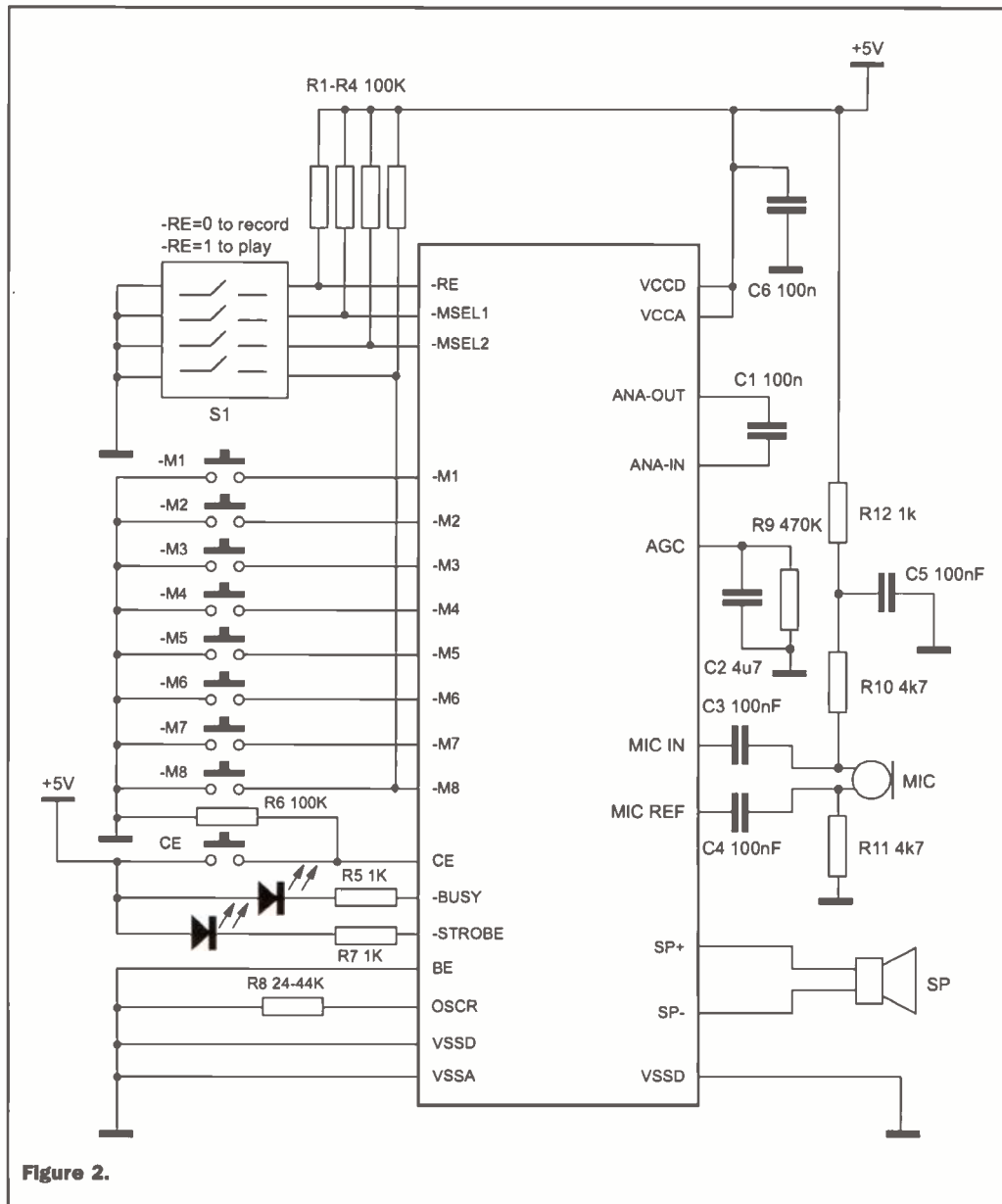


Figure 2.

the details.

An 8-16 Ohm speaker is used with the module. Users can select different modes using the mode selection switch.

### Parallel mode recording and replaying: Record sound tracks

The mode switch should have the following pattern: MSEL1=1 (switched to left-hand side of the mode selection switch), MSEL2=1 (left-hand side). -M8=1 (left-hand side). RE=0 (right-hand side). The maximum length of the 8 tracks is 7.5 seconds. Press -M1 continuously and you will see BUZY LED illuminates. You can now speak to the microphone. Recording will terminate if -M1 is released or if the recording time exceeds 7.5 seconds. Similarly, press -M2 to -M8 to record other sound tracks.

### Replay sound tracks

Now make RE=1 (switched to Left-hand side of the mode selection switch) while keep other switches at the same location.

Toggle -M1 to -M8 (press key and release) causes a particular sound track to replay once. While the sound is playing, press the same key again or pressing the CE key will terminate the current sound track. Press the

other key while a sound is being played causes a new sound track to be played.

If a key from -M1 to -M8 is pressed continuously, the particular sound track will be played continuously. Press CE to stop playing the sound track.

### Serial mode recording and replaying: Record sound tracks sequentially

The mode switch should have the following pattern:

MSEL1=0 (switched to right-hand side of the mode selection switch), MSEL2=0 (right-hand side). -M8=1 (left-hand side). RE=0 (right-hand side). Press CE first to reset the sound track counter to zero. Press and hold -M1 down and you will see BUZY LED illuminates. You can now speak to the microphone. Recording will terminate if -M1 is released or if the recording time exceeds 60 seconds (in this case you will run out the memory for your next sound track). Press -M1 again and again to record 2nd, 3rd, 4th and other consecutive sound tracks. Each sound track may have different lengths, but the accumulated length of all sound tracks will not exceed 60 seconds.

### Replay sound tracks sequentially

Now make RE=1 (switched to Left-hand side of the mode selection switch) while keep other switches at the same location. Toggle -M1 (press key and release) causes the 1st sound track to be played once. Toggle -M1 again and again

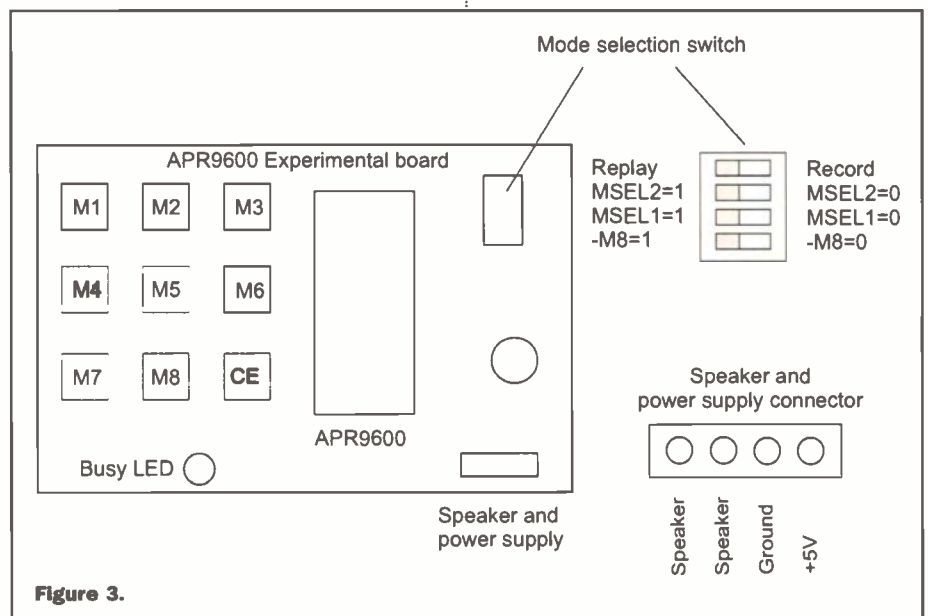


Figure 3.

Pin	Name	Functions	Pin	Name	Functions
1	-M1	Select 1st section of sound or serial mode recording and replaying control (low active)	15	SP-	Speaker, negative end
2	-M2	Select 2nd section or fast forward control in serial mode (low active)	16	VCCA	Analogue circuit power supply
3	-M3	Select 3rd section (electret type microphone)	17	MICIN	Microphone input of sound
4	-M4	Select 4th section of sound	18	MICREF	Microphone reference input
5	-M5	Select 5th section of sound	19	AGC	AGC control
6	-M6	Select 6th section sound	20	ANA-IN	Audio input (accept a of signal of 100mV p-to-p)
7	OSCR	Resistor to set clock frequency. See Table 3 for details	21	ANA-OUT	Audio output from the microphone amplifier
8	-M7	Select 7th section of sound or IC overflow indication	22	STROBE	During recording and replaying, it produces a strobe signal
9	-M8	Select 8th section of sound or select mode (see Table 2)	23	CE	Reset sound track counter to zero/ Stop or Start / Stop
10	-BUSY	Busy (low active)	24	MSEL1	Mode selection 1 (see Table 2)
11	BE	=1, beep when a key is pressed =0, do not beep	25	MSEL2	Mode selection 2 (see Table 2)
12	VSSD	Digital circuit ground	26	EXTCLK	External clock input
13	VSSA	Analogue circuit ground	27	-RE	=0 to record, =1 to replay
14	SP+	Speaker, positive end	28	VCCD	Digital circuit power supply

**Table 1. Pin-functions of the APR9600**

will play the 2nd, 3rd, 4th and other consecutive sound tracks. Press CE to reset the sound track counter to zero.

### Record sound tracks with forward control

The mode switch should have the following pattern: MSEL1=0 (switched to right-hand side of the mode selection switch), MSEL2=0 (right-hand side). -M8=0 (right-hand side). RE=0 (right-hand side). Press CE first to reset the sound track counter to zero. This mode is rather similar to the above sequential sound recording. The only difference is that after -M1 is pressed and released, the sound track counter does not increment itself to the next sound track location. To move to the next sound track, -M2 should be toggled. So if -M1 is not toggled again and again without toggling -M2, sound will be recorded at the same sound track location.

### Replay sound tracks with forward control

Now make RE=1 (switched to Left-hand side of the mode selection switch) while keep other switches at the same location. Toggle -M1 (press key and release) causes

the 1st sound track to be played once. Toggle -M1 again and again will still play the 1st sound track. Once -M2 is toggled, the sound track counter is incremented and the next sound can be played. Press CE to reset the sound track counter to zero.

### Sampling rates

The sampling rate is determined by the value of the OSC resistor (R8 in the circuit diagram). It can be adjusted by users to suit their specific requirements. The relationships amongst the resistance, sampling rate, bandwidth and recording period are shown in Table 3.

### Technical support

The APR9600 IC and its experimental board are available from the author. Please forward your enquires to Pei An at:

<pan@intec-group.co.uk>

Telephone/fax/answer:

44(0)1614779583.

OSCR resistance [kOhm]	Sampling rate [kHz]	Bandwidth [kHz]	Recording time [Second]
44	4.2	2.1	60
38	6.4	3.2	40
24	8.0	4.0	32

**Table 3. OSC resistor selection guide**

MSEL1	MSEL2	-M8	Function Keys	Functions
0	1	0 or 1	-M1, -M2 to select 1st and 2nd sound tracks. CE to stop	Parallel mode, 2 sections, 30 seconds for each
1	0	0 or 1	-M1 to -M4 to select a sound track, CE to stop	Parallel mode, 4 sections, 15 seconds for each
1	1	1	-M1 to -M8 to select sound track, CE to stop	Parallel mode, 8 sections, 7.5 a seconds for each Pressing and hold down a key from -M1 to M8 to play the selected sound track repeatedly
0	0	1	-M1 and CE	Serial mode, allow up to 256 sound tracks to be recorded and played. Sound tracks are played from 1st to N in order after -M1 is toggled. Press CE to play from the 1st sound track.
0	0	0	-M1,-M2 and CE	Serial mode, Press -M1 to replay one sound track. Toggle -M2 once to move to the next sound track. Press CE to play sound from the 1st sound track

#### Notes:

RE=0 to record sound. RE=1 to replay sound

Press -M1 to -M8 once to replay a sound track. Press the key again to stop replaying the track

Press and hold -M1 to -M8 continuously, the corresponding track will be replayed repeatedly

During recording, -M1 to M8 should be pressed while the sound is being recorded.

Releasing the key terminates recording.

**Table 2. Operation modes**