

VOICE RECORDING AND PLAYBACK USING APR9600 CHIP



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Digital voice processing chips with different features and coding techniques for speech compression and processing are available on the market from a number of semiconductor manufacturers. Advanced chips such as Texas instruments' TMS320C31 can implement various voice-processing algorithms including code-excited linear prediction, adaptive differential pulse-code modulation, A law (specified by California Council for International Trade), μ law (specified by Bell Telephone) and vector sum-excited linear prediction.

On the other hand, APR9600 single-chip voice recorder and playback device from Aplus Integrated Circuits makes

use of a proprietary analogue storage technique implemented using flash non-volatile memory process in which each cell is capable of storing up to 256 voltage levels. This technology enables the APR9600 to reproduce voice signals in their natural form.

The APR9600 is a good standalone voice recorder or playback IC with non-volatile storage and playback capability for 32 to 60 seconds. It can record and play multiple messages at random or in sequential mode. The user can select sample rates with consequent quality and recording time trade-off. Microphone amplifier, automatic gain control (AGC) circuits, internal anti-aliasing filter, integrated output amplifier and messages management are some of the features of the APR9600 chip.

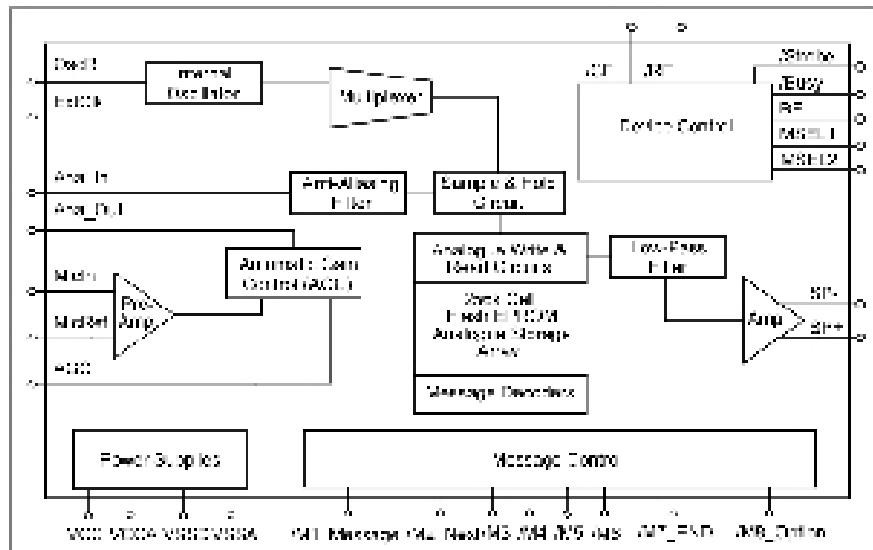


Fig. 1: Functional block diagram of IC APR9600

PARTS LIST

- Semiconductors:**
- IC1 - APR9600 voice processor
 - IC2 - LM386 low-power audio amplifier
 - T1-T3 - BC557 pnp transistor
 - D1 - 1N4001 rectifier diode
 - LED1-LED3 - Red LED
- Resistors (all 1/4-watt, $\pm 5\%$ carbon, unless stated otherwise):**
- R1, R2, R4-R8, R16, R17 - 100 kilo-ohm
 - R3, R10 - 390-ohm
 - R9 - 220-kilo-ohm
 - R11 - 1-ohm
 - R12(A) - 33-kilo-ohm
 - R12(B) - 5-kilo-ohm
 - R13, R14 - 4.7-kilo-ohm
 - R15 - 1-kilo-ohm
- Capacitors:**
- C1, C3, C4, C6, C8, C9, C11 - 0.1 μ F ceramic disk
 - C2 - 4.7 μ F, 16V electrolytic
 - C5 - 22 μ F, 16V electrolytic
 - C7 - 100 μ F, 16V electrolytic
 - C10 - 0.47 μ F, 63V electrolytic
 - C12 - 100 μ F, 25V electrolytic
 - C13 - 100 μ F, 10V electrolytic
- Miscellaneous:**
- S1-S9 - Push-to-on switch
 - S10-S12 - On/off switch
 - LS1 - 8-ohm, 0.5W speaker
 - Condenser microphone

Fig. 1 shows the functional block diagram of IC APR9600. Complete chip management is accomplished through the device control and message control blocks.

Voice signal from the microphone (see Fig. 2) is fed into the chip through a differential amplifier. It is further amplified by connecting Ana_Out (pin 21) to Ana_In (pin 20) via an external DC blocking capacitor C1. A bias signal is applied to the microphone and to save power during playback, the ground return of this bias network can be connected to the normally open side of the record switch. Both Mic.in and Mic.Ref (pins 18 and 19) must be coupled to

TABLE I
Modes Selection

Mode	MSEL1	MSEL2	/M8_Option
Random-access, 2 fixed-duration messages	0	1	Pull this pin to Vcc through 100k resistor
Random-access, 4 fixed-duration messages	1	0	Pull this pin to Vcc through 100k resistor
Random-access, 8 fixed-duration messages	1	1	Becomes the /M8 message trigger input pin
Tape-mode, normal operation	0	0	0
Tape-mode, auto-rewind operation	0	0	1

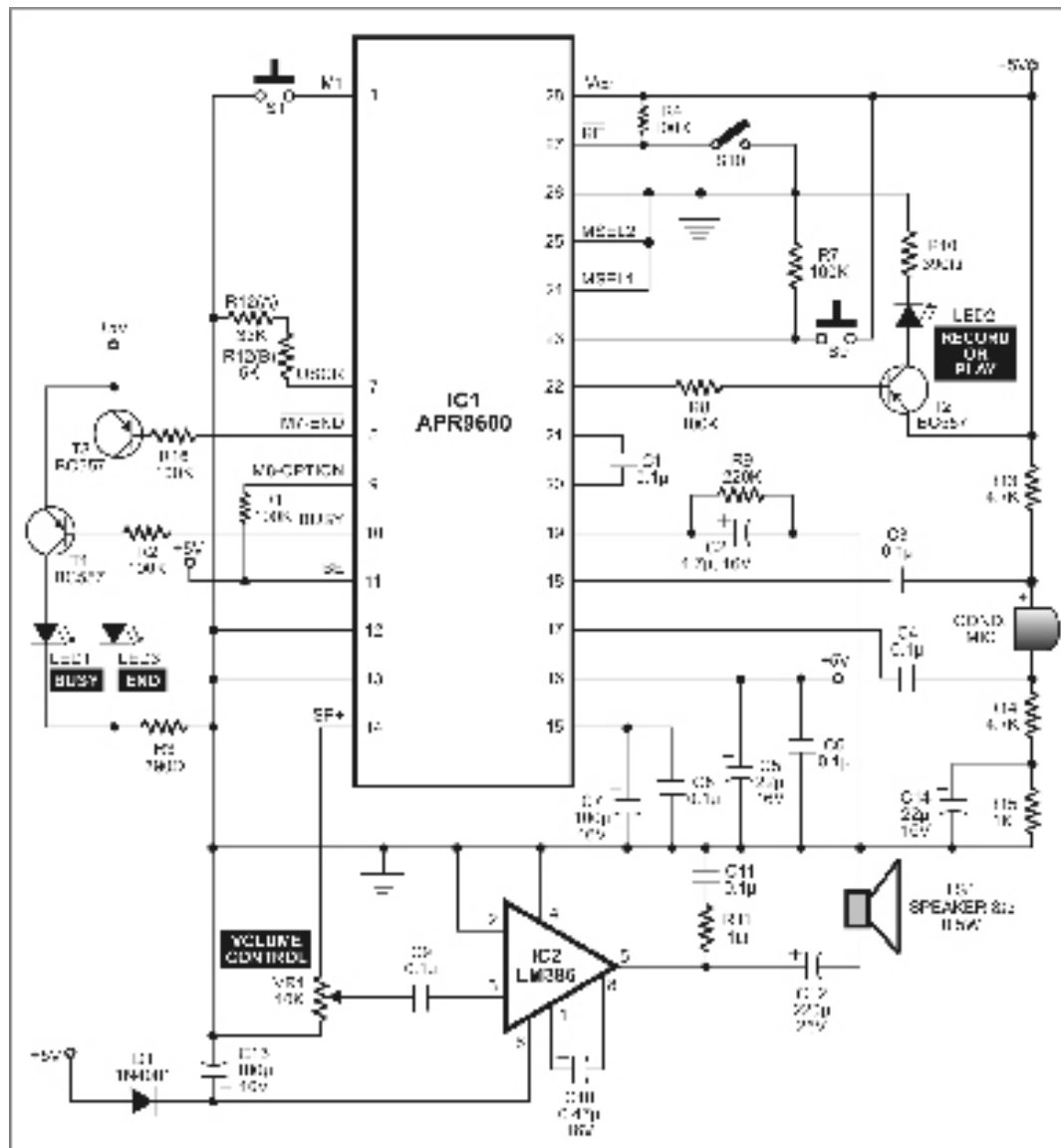


Fig. 3: Circuit for recording/playback in tape mode with auto-rewind option

output; for example, the start of recording is indicated by a beep, so the person can now start speaking into the microphone. This feature is enabled by making pin 11 (BE) high.

General functional description.

On power up, pin 23 (CE) is pulled low through resistor R7 to enable the device for operation. Toggling this pin by switch S9 also resets several message management features. Pin 27 (RE) is pulled low to enable recording and it is pulled high for playback. To start recording/playback, switch the appropriate trigger pin as described later. Glowing of LED1 indicates that the device is busy and no commands can be currently accepted. The LED is driven by pnp transistor T1, which is connected to pin 10

(Busy) of the chip. LED2 indicates recording in each individual memory segment. It is driven by pin 22 (strobe) through transistor T2.

Random-access mode

As mentioned earlier, the random-access mode supports 2, 4 or 8 messages of fixed durations. It allows easy indexing of messages as they can be recorded or played randomly. The length of each message is the total recording length available (as defined by the selected sampling rate) divided by the total number of memory segments/tracks enabled (as per Table I).

Recording of sound. The circuit for recording/playback of eight fixed-duration messages in random-access mode is shown

in Fig. 2. Pins 9 (M8_Option), 24 (MSEL1) and 25 (MSEL2) are pulled high through resistors R1, R6 and R5, respectively. When switch S10 is closed, record pin 27 (RE) goes low to enable recording of the message from the microphone. The maximum length of the eight sound tracks is 7.5 seconds each.

Now to start recording the first message, press switch S1 and hold it in this position. A beep sound is heard and LED2 blinks. You can now speak into the condenser mic. The recording will terminate if switch S1 is released or if the recording time exceeds 7.5 seconds. Similarly, press switches S2 through S8 to record other sound tracks. For recording of two or four sound tracks of fixed duration, the status of pins 9, 24 and 25 is as per Table I.

Playback of sound tracks.

Open switch S10 to make pin 27 high while keeping other switches in the same positions as in recording. Toggling switches S1 through S8 causes playback of particular sound tracks. Pressing

the same switch again or switch S9 terminates playback of the sound track. Pressing any other switch (S1 through S8) while a sound track is being played causes a new sound track to be played. If the switch is held pressed, the particular sound track will play continuously.

Tape mode

The tape mode operation is much like the conventional cassette tape recorder, but with auto-rewind and normal operation options. In auto-rewind mode, the device automatically rewinds to the beginning of the message immediately after recording or playing the message. In normal mode, it must be switched for rewind.

Sound recording in tape mode with

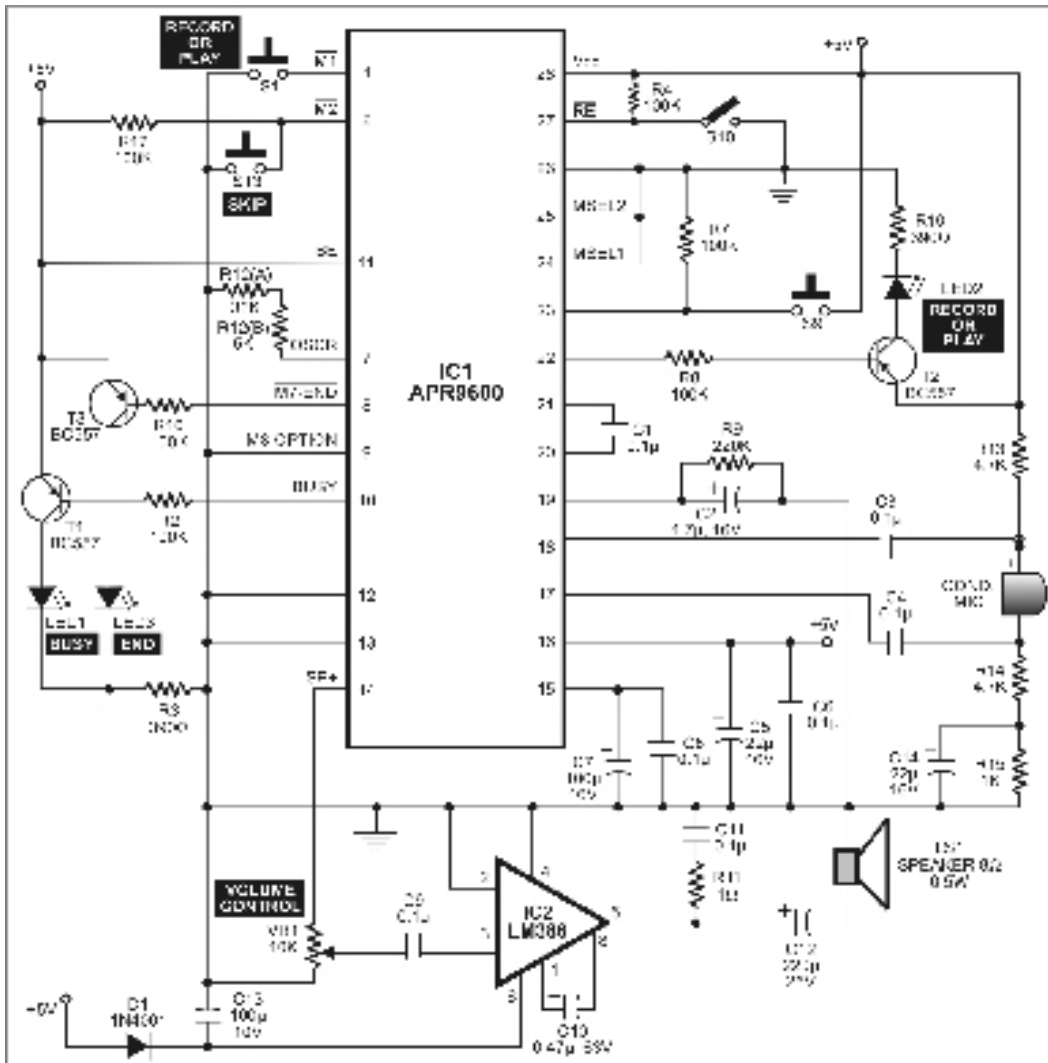


Fig. 4: Circuit for recording/playback in tape mode with normal option

pin 27 high while keeping other switches in the same positions as applicable during recording. Toggle switch S1 repeatedly to play consecutive sound tracks. Press switch S9 to reset the sound track counter to zero. During playback, LED3 indicates that all recorded messages have been played.

Recording in tape mode with normal option. Fig. 4 shows the circuit for recording/playback in tape mode with normal option. Connect pins 24 (MSEL1), 25 (MSEL2) and 9 (M8_option) to ground. Close switch S10 to enable the recording of message. Press switch S9 to reset the sound track counter to zero. The normal-mode recording is similar to the rewind-mode recording, except that after switch S1 is released, the sound counter doesn't increment itself to the next sound track location. To record the first sound track, press switch S1 and hold it in this position. A beep sounds and LED2 blinks. Now you can speak into

auto-rewind option. Fig. 3 shows the circuit for recording/playback in tape mode with auto-rewind option. In this configuration, pins 24 (MSEL1) and 25 (MSEL2) are connected to ground, whereas pin 9 is pulled high through resistor R1. Close switch S10 to enable the recording of message. Press switch S9 to reset the sound track counter to zero. Now press switch S1 and hold it in this position. A beep sound is heard and LED2 starts blinking. This means you can speak into the mic. Recording will terminate when switch S1 is released or if the recording time exceeds 60 seconds. Press switch S1 again and again to record second, third, fourth and other consecutive sound tracks. Each sound track may have a different length but the total length of all sound tracks cannot exceed 60 seconds. When LED3 lights up during recording, it indicates the end of memory array.

Playback in tape mode with auto-rewind option. Open switch S10 to pull

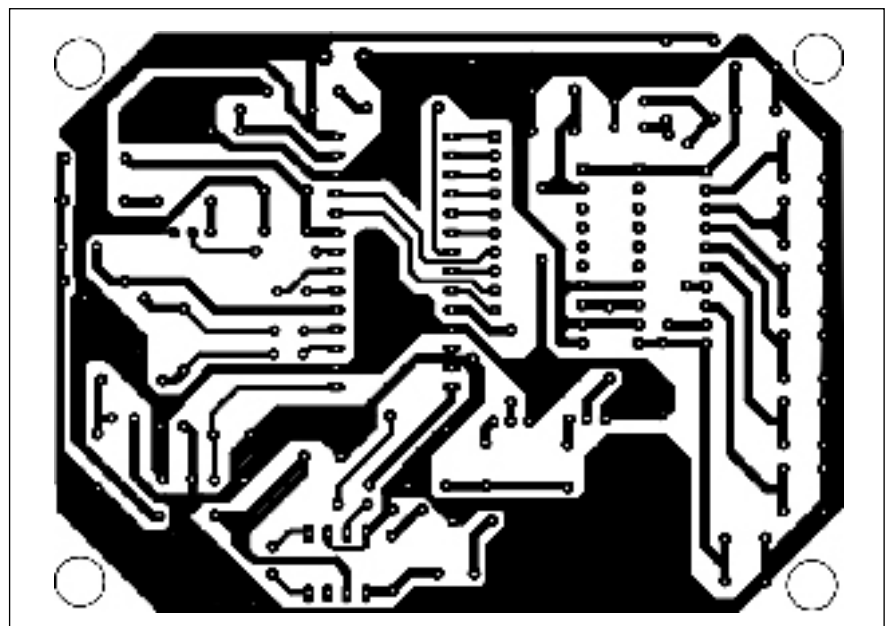


Fig. 5: Combined actual-size, single-side PCB for circuits of Figs 2, 3 and 4

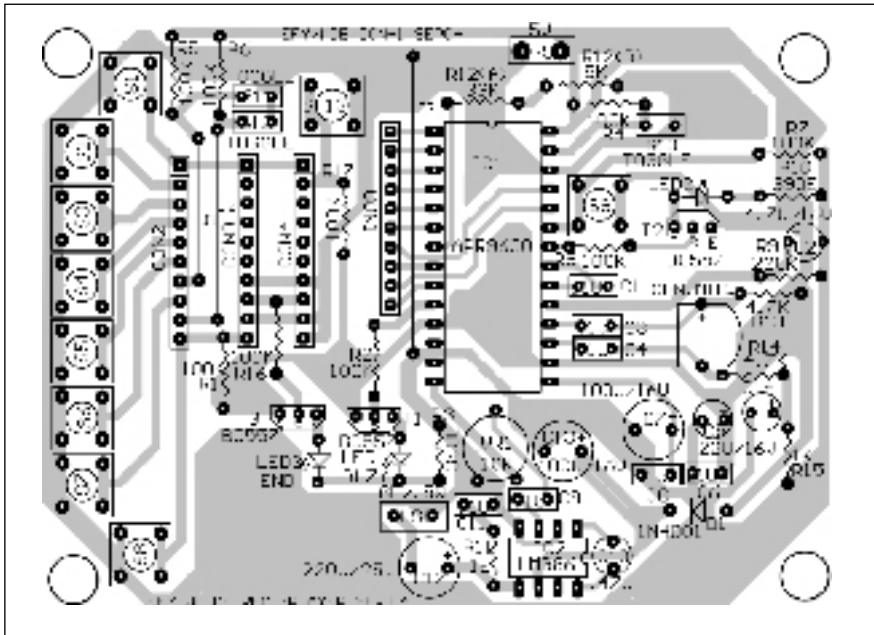


Fig. 6: Component layout for the PCB

the microphone. To record the next message, release switch S1 and toggle switch S13. Now press switch S1 again and hold in this position. A beep sounds and LED2

blinks. This means you can speak into the microphone to record the message. In case you press switch S1 without toggling switch S13 to record the message, the mes-

sage will be recorded at the location of the first message.

Playback in tape mode with normal option. Open switch S10 to pull pin 27 high while keeping other switches in the same positions as during recording operation. First, press switch S9 to reset the sound track counter to zero. Now momentarily press switch S1 to play the first sound track. Momentarily pressing of switch S1 again and again will still play the first sound track. The sound track counter can be incremented to play the next sound track by momentarily pressing switch S13.

The combined actual-size, single-side PCB for the circuits of Figs 2, 3 and 4 is shown in Fig. 5 and its component layout in Fig. 6.

To obtain the configuration of Fig. 2, connect connector Con1 to Con2 using burgstick connectors with ribbon cable or simply using jumper wires. Similarly, configuration of Fig. 3 or Fig. 4 can be realised by connecting Con1 to Con3 or Con4. Note that switch S1 is common for all configurations. □