Inside Macintosh™
Volumes I, II, and III

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ABOUT THIS CHAPTER

The Sound Driver is a Macintosh device driver for handling sound and music generation in a Macintosh application. This chapter describes the Sound Driver in detail.

You should already be familiar with:

- events, as discussed in chapter 8 of Volume I
- the Memory Manager
- the use of devices and device drivers, as described in chapter 6

ABOUT THE SOUND DRIVER

The Sound Driver is a standard Macintosh device driver in ROM that's used to synthesize sound. You can generate sound characterized by any kind of waveform by using the three different sound synthesizers in the Sound Driver:

- The **four-tone synthesizer** is used to make simple harmonic tones, with up to four "voices" producing sound simultaneously; it requires about 50% of the microprocessor's attention during any given time interval.
- The **square-wave synthesizer** is used to produce less harmonic sounds such as beeps, and requires about 2% of the processor's time.
- The **free-form synthesizer** is used to make complex music and speech; it requires about 20% of the processor's time.

The Macintosh XL is equipped only with a square-wave synthesizer; all information in this chapter about four-tone and free-form sound applies only to the Macintosh 128K and 512K.

Figure 1 depicts the **waveform** of a typical sound wave, and the terms used to describe it. The **magnitude** is the vertical distance between any given point on the wave and the horizontal line about which the wave oscillates; you can think of the magnitude as the volume level. The **amplitude** is the maximum magnitude of a periodic wave. The **wavelength** is the horizontal extent of one complete cycle of the wave. Magnitude and wavelength can be measured in any unit of distance. The **period** is the time elapsed during one complete cycle of a wave. The **frequency** is the reciprocal of the period, or the number of cycles per second—also called hertz (Hz). The **phase** is some fraction of a wave cycle (measured from a fixed point on the wave).

There are many different types of waveforms, three of which are depicted in Figure 2. Sine waves are generated by objects that oscillate periodically at a single frequency (such as a tuning fork). Square waves are generated by objects that toggle instantly between two states at a single frequency (such as an electronic "beep"). Free-form waves are the most common of all, and are generated by objects that vibrate at rapidly changing frequencies with rapidly changing magnitudes (such as your vocal cords).

Sign Here

8 Sound Driver

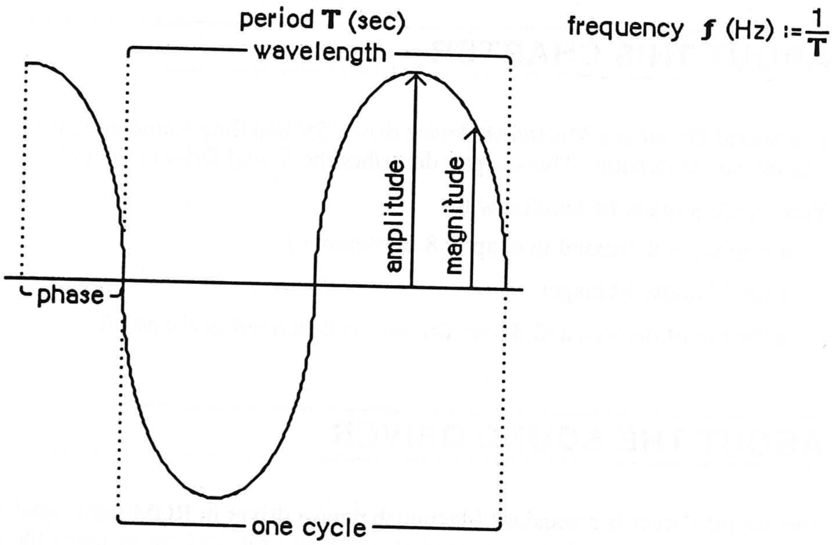

Figure 1. Waveform

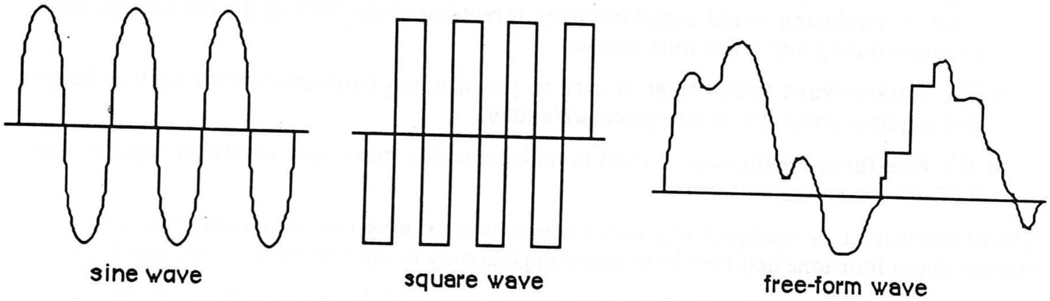

Figure 2. Types of Waveforms

Figure 3 shows analog and digital representations of a waveform. The Sound Driver represents waveforms digitally, so all waveforms must be converted from their analog representation to a digital representation. The rows of numbers at the bottom of the figure are digital representations of the waveform. The numbers in the upper row are the magnitudes relative to the horizontal zero-magnitude line. The numbers in the lower row all represent the same relative magnitudes, but have been normalized to positive numbers; you'll use numbers like these when calling the Sound Driver.

A digital representation of a waveform is simply a sequence of wave magnitudes measured at fixed intervals. This sequence of magnitudes is stored in the Sound Driver as a sequence of bytes, each one of which specifies an instantaneous voltage to be sent to the speaker. The bytes are stored in a data structure called a **waveform description**. Since a sequence of bytes can only represent a group of numbers whose maximum and minimum values differ by less than 256, the magnitudes of your waveforms must be constrained to these same limits.

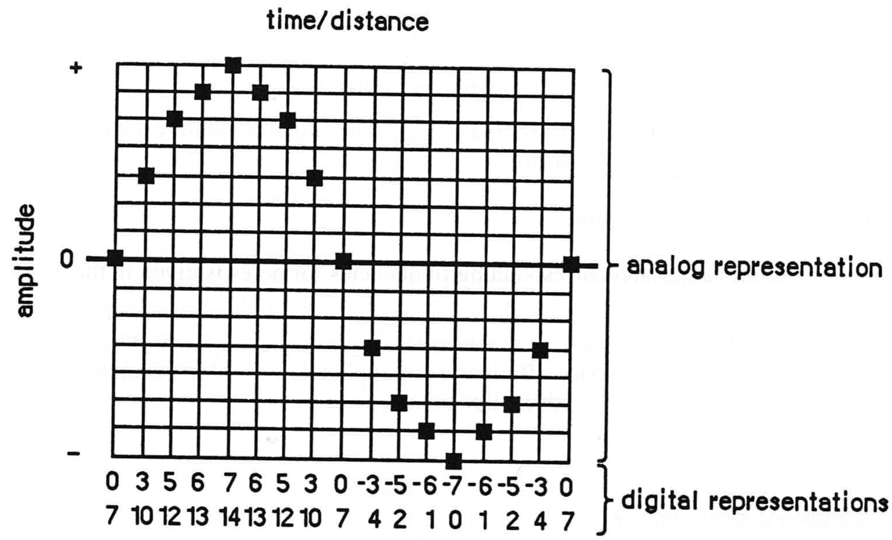

Figure 3. Analog and Digital Representations of a Waveform

SOUND DRIVER SYNTHESIZERS

A description of the sound to be generated by a synthesizer is contained in a data structure called a **synthesizer buffer**. A synthesizer buffer contains the duration, pitch, phase, and waveform of the sound the synthesizer will generate. The exact structure of a synthesizer buffer differs for each type of synthesizer being used. The first word in every synthesizer buffer is an integer that identifies the synthesizer, and must be one of the following predefined constants:

```
CONST swMode = -1;  {square-wave synthesizer}
      ftMode =  1;  {four-tone synthesizer}
      ffMode =  0;  {free-form synthesizer}
```

Square-Wave Synthesizer

The square-wave synthesizer is used to make sounds such as beeps. A square-wave synthesizer buffer has the following structure:

```
TYPE  SWSynthRec = RECORD
                     mode:      INTEGER;  {always swMode}
                     triplets:  Tones     {sounds}
                   END;

      SWSynthPtr = ^SWSynthRec;

      Tones = ARRAY[0..5000] OF Tone;
      Tone  = RECORD
                count:      INTEGER;   {frequency}
                amplitude:  INTEGER;   {amplitude, 0-255}
                duration:   INTEGER    {duration in ticks}
              END;
```

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