Sampling sounds

SA-01-0988

What is sampling?

Sampling is a process of digitally recording sound waves.

Analog waves and digital waves

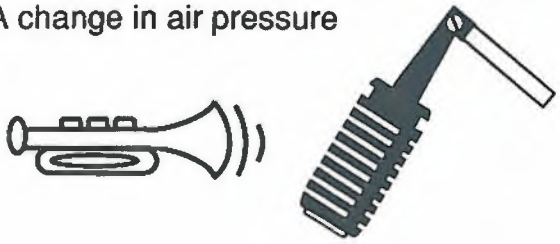
Waveforms are produced by any vibrating source, such as the human vocal cords or an acoustic musical instrument. The vibrations push and pull the air molecules directly adjacent to the source, creating a sound wave that travels through the air. When the sound wave strikes another object, such as the human ear or a microphone, it causes that object to vibrate along with it.

In order for a digital computer to record and manipulate sounds, it must have a way to represent sound data in terms of numbers. The process of converting a waveform into a digital representation of that waveform is called **sampling.**

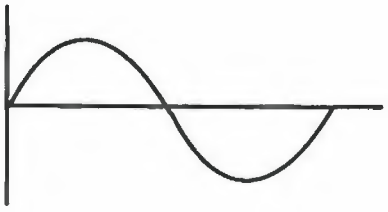
Sampling involves repeatedly measuring the amplitude of a waveform and saving those data points. Each data point is called a **sample.** When the process is complete, the computer has a numeric representation of the original waveform.

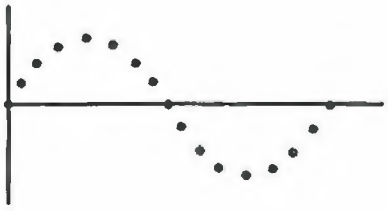
The Synclavier can distinguish 65,536 different levels of amplitude, each expressed as a 16-bit number. These numbers are stored in memory or on disk as a special type of data file, called a **sound file.**

- A change in air pressure

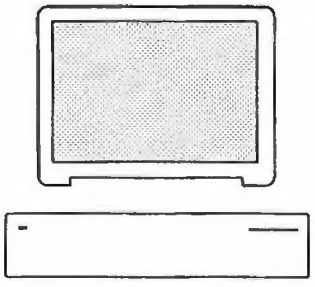


- is converted into an electrical signal or analog waveform





- which is converted into a digital waveform with many points, called samples.



- These samples are converted into a list of numbers, called a sound file, for use by the computer.

What is sampling? (con't)

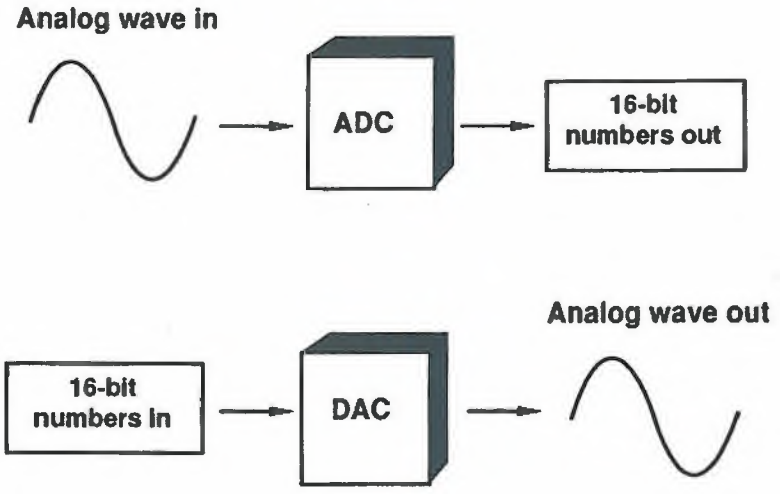
Converting analog to digital and back again

Converting an analog wave into a numeric representation is called **sampling.** During this process, the amplitude of the wave is measured, or sampled, many times each second. The **sampling rate** is the number of times the amplitude of a sound is measured in one second. The Synclavier is capable of sampling at rates between 1000 and 100,000 times per second (from 1 to 100 kHz). This conversion process is accomplished by using an **analog-to-digital converter** (ADC).

The ADC generates a list of numbers called a **sound file.** This list is stored in the Synclavier's **polyphonic sampling memory (poly memory).** It can also be stored on a disk.

When you press a key to trigger a sound, the information in the sound file is sent to a **digital-to-analog converter** (DAC) which reconstructs the original analog waveform from the digital samples.

The final output of a sampled sound comes from the POLYPHONIC SAMPLING OUT jacks, which can be connected to your sound system. The left and right outputs are a composite of sounds produced by the keyboard, guitar and Memory Recorder, and are available through both 1/4" phone jacks and XLR jacks.

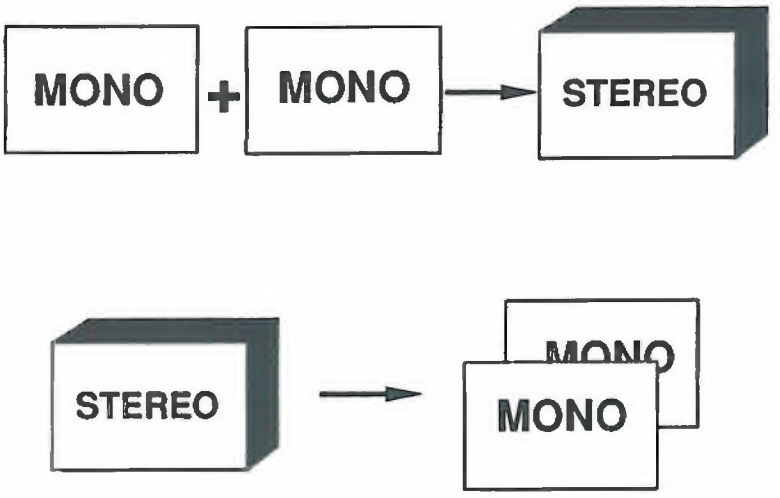

Analog wave in
ADC
16-bit numbers out
Analog wave out
16-bit numbers in
DAC

What is sampling? (con't)

Stereo and mono sound files

Sound files can contain information for one or two channels. When a sound file contains information for only one channel, it is called a **mono,** or monophonic, sound file. When it contains information for both channels, it is called a **stereo,** or stereophonic, sound file. The two channels of a stereo sound file are generally designated as left and right.

You can separate a stereo sound file into two mono files. You can also combine two mono files to make a stereo sound file.



Mono and stereo sound files

The Sound File Editor

By using the Sound File Editor you can record a sound directly into poly memory and then view it graphically, play it, modify it and store it on disk.

The Sound File Editor

The Sound File Editor, activated from the Main Menu, is divided into three sections.

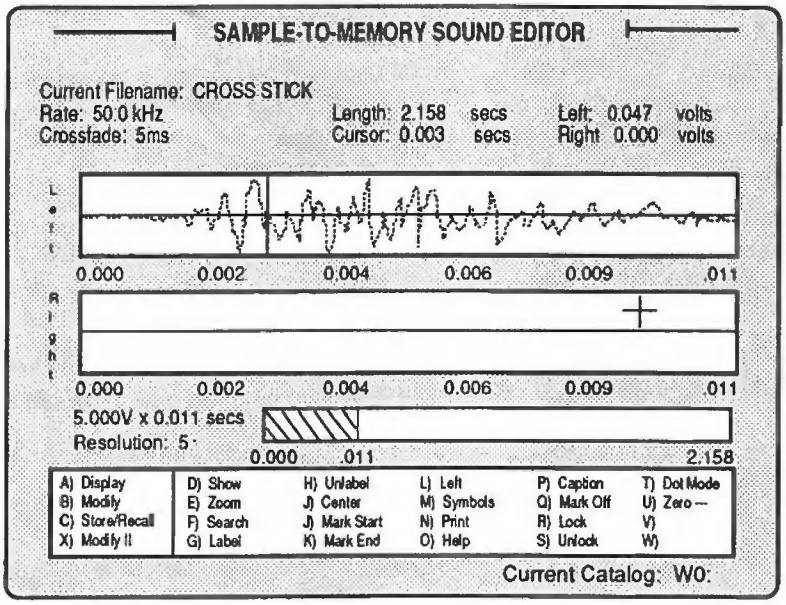
- The top of the screen contains information about the current sound file and Sound File Editor settings.
- The middle of the screen contains the sound file windows for the left and right channels and the zoom window which tells you what portion of the sound file is currently displayed. Each sound file window contains a vertical line called the sound file cursor.
- The first column at the bottom of the screen lists Sound File Editor menus, and the other columns list commands available from the selected menu.

You can return to the Main Menu at any time by pressing the Enter key or by clicking the exit box icon at the upper right corner of the screen.

When you first enter the Sound File Editor, the following message may appear in the upper sound file window.

> Sound file not available.

This means there is no sound file active on the keyboard. In order to use a Sound File Editor function, a sound file must be recorded or recalled to the keyboard.


SAMPLE-TO-MEMORY SOUND EDITOR
Current Filename: CROSS STICK
Rate: 50.0 kHz
Crossfade: 5ms
Length: 2.158 secs
Cursor: 0.003 secs
Left: 0.047 volts
Right 0.000 volts
Left
0.000 0.002 0.004 0.006 0.009 .011
Right
0.000 0.002 0.004 0.006 0.009 .011
5.000V x 0.011 secs
Resolution: 5
0.000 .011 2.158
A) Display
B) Modify
C) Store/Recall
X) Modify II
D) Show
E) Zoom
F) Search
G) Label
H) Unlabel
J) Center
J) Mark Start
K) Mark End
L) Left
M) Symbols
N) Print
O) Help
P) Caption
Q) Mark Off
R) Lock
S) Unlock
T) Dot Mode
U) Zero ---
V)
W)
Current Catalog: W0:

Sound File Editor menus and commands

The Sound File Editor has four menus located in the left column at the bottom of the screen. Each menu has a list of commands which appear on the right when the menu is selected.

Follow these instructions to execute a Sound File Editor command.

1. Select the desired menu by typing the letter next to it or by clicking the menu name.

   The command list changes to show the available commands.

2. Select the desired command by typing the letter next to it or by clicking the command name.

   The command list is replaced by a dialog box for the selected command.

3. Follow the instructions, entering any information requested, and press Return.

   The results of the command can be seen in the sound file display window or heard by playing A3 on the keyboard. You can also drag the sound file cursor across the sound file. The command list reappears on the screen.

You also can abort a command.

- Press Enter or click the exit box icon.

  The dialog box is replaced by the menu from which the command was selected.

Sound File Editor menus and commands

Display menu

A) Display	D) Show	H) Unlabel	L) Left	P) Caption	T) Dot Mode
B) Modify	E) Zoom	I) Center	M) Symbols	Q) Mark Off	U) Zero —
C) Store/Recall	F) Search	J) Mark Start	N) Print	R) Lock	V)
X) Modify II	G) Label	K) Mark End	O) Help	S) Unlock	W)

Modify menu

A) Display	D) Reverse	H) Delete	L) Crossfade	P) Volume	T) Mix
B) Modify	E) Cut	I) Exchange	M) Copy	Q) Normalize	U) Undo
C) Store/Recall	F) Paste	J) Combine	N) Fill	R) Modulate	V) Invert
X) Modify II	G) Extract	K) Ext Mono	O) Loop	S) Rev Loop	W) DC Trim

Store/Recall menu

A) Display	D) Save	H) Collect	L)	P)	T)
B) Modify	E) Unsave	I) Record	M)	Q)	U)
C) Store/Recall	F) Rename	J) Max Time	N)	R)	V)
X) Modify II	G) Recall	K)	O)	S)	W)

The Sound File Editor (con't)

Recalling a sound file

When you recall a sound file to poly memory, it is represented graphically on the Sound File Editor. The section "Recalling sound files" describes how to use the Sound File Directory and the Optical Disk Display to recall a sound file.

Follow these instructions to use the Sound File Editor to recall a sound file.

1. Select RECALL from the Store/Recall menu.

   This message appears on the screen.

   ```
   Enter name of soundfile to recall or CTRL-C for Directory
   =>
   ```

2. Press Ctrl-C.

   The Sound File Directory appears on the screen.

3. Click the name of the desired sound file.

   The sound file is loaded into poly memory, its waveform appears on the Sound File Editor and it is active on the keyboard.

Moving the sound file cursor

The vertical bar in each sound file window is the **sound file cursor.** It moves when you press one of the arrow keys.

- Press the left or right arrow key.

  The cursor moves slowly.

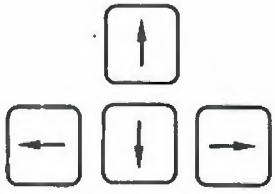
- Press the up or down arrow key.

  The cursor moves 1/4 of the window.

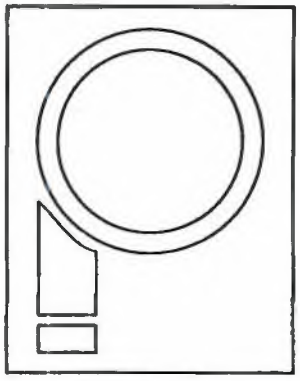
You can use the trackball to move the sound file cursor.

- Roll the trackball until its cursor in one of the sound file windows, and click the large button.

  The sound file cursor moves to the trackball cursor location.



Arrow keys



Trackball

Playing the sound file

You can use the trackball to play the sound file.

- Drag the sound file cursor in the window.

  The sound file plays as the cursor moves.

You also can play notes on the keyboard to hear the sound file.

- Press the A3 key to hear the original pitch of the sound file. Press other keys to hear pitch-shifted versions of the sound file.

Moving around the sound file

Below the two sound file windows is the **zoom window.** The zoom window represents the entire length of the current sound file. The portion of the file currently being displayed in the sound file window is shaded.

You can control the horizontal scale of the display, viewing more or less of the file at a time.

- Drag either end of the shaded portion in the zoom window.

  The displayed portion changes size.

- Drag the entire shaded portion left or right.

  The displayed portion moves as you drag.

You also can use the ZOOM command to change the horizontal scale. You use the up and down arrow keys and the LABEL, SHOW, SEARCH, LEFT, RIGHT, CENTER and SYMBOLS commands to move to any point in a sound file.

All these commands are available from the Display menu. Instructions are in the section "Viewing a sound file."

Recording a sound file

When you sample a sound using the Sound File Editor, you record it directly into a **sound file** in poly memory.

The recorded sound

You can record any signal which is connected to the ADC input(s) in your system. You can record either mono or stereo sound files and at sampling rates up to 100 kHz.

The sound is recorded directly into poly memory where it becomes a sound file ready for editing and/or storing on the Winchester, optical or floppy disk.

If you have a Synclavier keyboard, the sound file becomes the first partial timbre of the keyboard timbre, replacing the previous current timbre. As a partial timbre, the sound file can be modified, assigned to a keyboard patch and/or recorded in a sequence.

The sampling process

You record a sound into poly memory in three stages.

1. Prepare to record.
    - Select the RECORD command from the Store/Recall menu.
    - Select the appropriate hardware and mode.
    - Set a trigger threshold level and sampling rate.
2. Set a record level.
3. Record the sound into memory.

Each step is explained in more detail on the following pages.

Recording a sound file (con't)

Step 1: Preparing to record

1. Select the RECORD command from the Store/Recall menu.

   The command list is replaced by

   ```
   Time available is [number] seconds.
   Mode: STM Mono   Rate: 50.0 kHz      Gain: 0 dB
   Trigger: On      Threshold: 0.015 volts
   ```

2. Make sure you have enough time available in poly memory for the sound(s) you are about to record. If you do not, see the following section, "Memory management."

3. Select a sampling module and mode.

   The "Mode:" item in the dialog box displays the selected ADC. When you enter the Real-Time Performance system, the Sample-to-Memory module is set for mono sampling . If you want to record in stereo, or if you have the Sample-to-Disk (D66) sampling module, press the Spacebar until the appropriate mode selection appears.

(con't next page)

Step 1: Preparing to record (con't)

4. Set the sampling rate.

   The sampling rate is the number of samples taken each second. Sound files with higher sampling rates have increased fidelity, but they use more memory and require additional disk space.

   New England Digital recommends a sampling rate of 50 kHz or higher. The default rate is 50 kHz.

5. Set the trigger status and threshold level.

   Set the trigger status to "Off" if you want to start recording as soon as you press Return. Set the trigger status to "On" if you want to start recording when the level of the incoming signal reaches a specified threshold setting.

Recording a sound file (con't)

Step 2: Setting the record level

The upper sound file window shows a short horizontal bar and the following message.

> Performing level check . . .

The horizontal bars are a real-time peak level meter. A record level meter is also active in the keyboard display window. The last segment of the meter indicates clipping.

If you are recording a stereo sound file, a separate meter is active in each sound file window of the Sound File Editor. The meter in the keyboard display window indicates the level of the higher of the two input signals.

You set the record level in one of two ways.

- Adjust your console or preamp levels for optimum performance to eliminate any possible causes of distortion.
- Set the input gain (in the RECORD dialog box) for optimum level by entering an integer value between -3 and +28 dB. Negative gain settings provide attenuation.

Step 3: Recording the sound

1. Press Return to start recording.

   If the trigger status is set to "Off," recording begins immediately. If the trigger status is set to "On," a message appears in the sound file window.

   Waiting for trigger . . .

   Recording begins when the level of the incoming signal reaches the specified threshold setting.

   The sound is recorded directly into poly memory. If you have the 64-voice poly system, you record into Poly Bin 1. You cannot record into Poly Bin 2.

2. Press Return to stop recording.

   If the trigger status is set to "On," any recorded signal at the end of the sound file which is below the trigger threshold level is trimmed from the file.

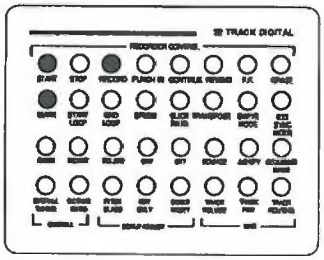
   The recorded sound is stored in poly memory as a sound file named

   NEWF[number]

   The display is redrawn to show the entire sound file. The word "ORIGIN" marks the start of the sound file, and the word "END" marks the end of the sound file.

The sound file is active on the keyboard and sounds at its original pitch when you press A3. The sound becomes distorted as you play notes farther away from A3.

Recording a sound file (con't)



START, MARK, RECORD panel 2

Synchronized sampling

You can record a sound synchronized to the current sequence in the Memory Recorder, which in turn can be synchronized to video, film or tape. This feature is used for recording vocals, Foley effects or dialog replacement while listening to or watching a playback.

Before you attempt synchronized sampling, you should understand how to record a sequence. (See the *Sequence editing* manual.)

1. Make sure you have completed the instructions in "Preparing to record" and "Setting the record level." Set the trigger status to "On."

2. Use the START or MARK button to locate a cue point in the sequence.

3. Press the RECORD button on the keyboard control panel.

   The sequence begins to play from the mark point or current location.

   The sound is recorded onto the first available track in the Memory Recorder and into poly memory.

(con't next page)

Synchronized sampling (con't)

4. At the point in the sequence when synchronization is desired, make sure the incoming signal is at the specified threshhold.

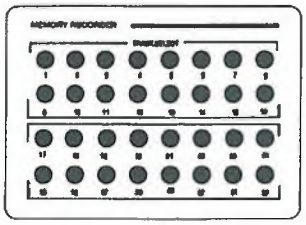
5. Press the STOP or RECORD button.

   If you press the STOP button, the sequence stops playing. If you press the RECORD button, the sequence continues to play, but sampling stops. The sound is synchronized to the sequence.

When recording of the first sound is finished, the system is ready to record another sound. If you press the RECORD button again, another sound is recorded and another note is placed on the next available track.

To preserve the synchronization, both the sound file and the sequence containing the note which plays the sound file must be saved to disk.

Recording a sound file (con't)



TRACK SELECT buttons panel 3

Selective track monitoring

The synchronized sampling feature allows you to record many "takes" in a short time. You can set up the system so that you do not hear previous takes while recording new ones.

1. Solo any tracks which need to be heard while recording.

   The TRACK SELECT buttons light, and the last button pressed blinks.

2. Select the track on which the recorded sound will be placed.

   The button begins blinking. The other TRACK SELECT buttons remain lit.

(con't next page)

Selective track monitoring (con't)

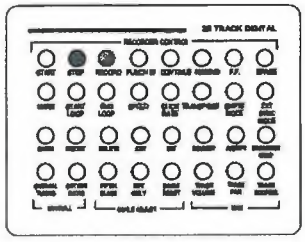
3. Press RECORD when the sequence reaches the desired location.

4. Press STOP or RECORD when finished.

5. Unselect the track which was previously blinking, and select the track on which the next sound is to be recorded.

   You can do this by pressing both buttons simultaneously.

Note: The sequence can be playing while you are recording and selecting or unselecting tracks. For multiple takes, you can place an overall loop on the sequence.



STOP, RECORD panel 2

Recording a sound file (con't)

Sampling into memory from the Direct-to-Disk system

If you have a Direct-to-Disk system, you can use its ADC for polyphonic sampling.

When a Direct-to-Disk system is installed, the memory expansion panel on the Synclavier control unit is replaced by a new panel which includes a connector labeled SAMPLE-TO-MEMORY IN. On the Direct-to-Disk control unit, a short ribbon cable connects the ADC to the Direct-to-Disk system.

Follow these instructions to connect the Direct-to-Disk ADC for polyphonic sampling.

1. Remove the short ribbon cable from the Direct-to-Disk system.

   While the ribbon cable is disconnected, you cannot record on Direct-to-Disk tracks.

2. Connect the black ribbon cable, supplied with your Direct-to-Disk unit, from the connector labeled SAMPLE-TO-MEMORY OUT on the Direct-to-Disk unit to the connector labeled SAMPLE-TO-MEMORY IN on the Synclavier control unit.

You are now ready to record directly into poly memory using as your source any signal plugged into the Direct-to-Disk inputs.

1. Select the RECORD command from the Store/Recall menu of the Sound File Editor.
2. Select the appropriate module and mode.
3. Set the trigger mode.
4. If the trigger is "On," set a trigger threshold level.
5. Select the sampling rate.
6. Set the record level.
7. Start recording by pressing Return. For synchronized recording, press the RECORD button on the keyboard control panel.
8. Stop the recording by pressing Return. For synchronized recording, press STOP or RECORD on the keyboard control panel.

   The sound file is stored in poly memory and is ready to edit or save to disk.

Memory management

Since all sampled sounds are recorded directly into poly memory, management of memory is an important part of the sampling process.

The sound file in polyphonic sampling memory

All sampled sounds are recorded directly into poly memory. If you have the 64-voice poly system, the sounds are recorded into Poly Bin 1 only. You cannot record into Poly Bin 2.

Each sound file loaded into poly memory remains there as long as there is room for it. Sound files that are not part of the current timbre or used in the current sequence may be deleted automatically when another sound file is recalled. These currently unnecessary sound files can also be deleted using the COLLECT command under the Store/Recall menu.

When you leave the Real-Time Performance system to move to any of the other software modules (Monitor, Screen Editor, Music Printing), the sound files remain in poly memory.

All sound files in poly memory are erased whenever the system is turned off.

Available recording time

You can find out the amount of recording time available by selecting the RECORD command from the Store/Recall menu. This message appears at the top of the dialog box.

> Time available is [number] seconds.

This number represents the largest contiguous space available for recording at the currently selected sampling rate. You can increase the amount of memory available for recording by reducing the sampling rate or in one of the two ways explained on the following pages.

- Collect available memory by erasing all sound files not used in the current sequence or current timbre.
- Clear all sound files from poly memory.

If you have the 64-voice poly system, you also can increase the amount of available sampling memory by moving sound files from Poly Bin 1 to Poly Bin 2.

1. Select the Max Time command from the Store/Recall menu.

   A message prompts you to confirm the command.

   > Shuffle poly memory for maximum recording time
   > [OK confirms] =>

2. Type **ok**.

   Both bins are shuffled and as many sound files as will fit into Poly Bin 2 are moved from Poly Bin 1. No sound files are erased.

Memory management (con't)

COLLECT—Collecting poly memory

The COLLECT command from the Store/Recall menu recovers all available poly memory by erasing any sound files not associated with the current sequence and current timbre. The current sound file remains as part of the keyboard timbre. The COLLECT command has no effect on sound files stored on disk.

Before using the COLLECT command, be sure that any sound files you wish to keep have been stored to disk using the SAVE command. You also can prevent the loss of a sound file in poly memory by placing it in the current sequence, as explained on the following page.

Follow these instructions to use the COLLECT command.

1. Select the Store/Recall menu.
2. Select the COLLECT command.

   A message prompts you to verify the command.

   ```
   Delete all unused sound files in poly memory [OK confirms]
   =>
   ```

3. Type **ok.**

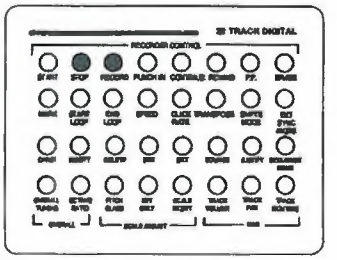
   All sound files not associated with the current sequence or the current timbre are erased. The remaining sound files are collected into a contiguous area of poly memory.

Preventing the loss of a sound file

When using the COLLECT command, you can prevent the loss of any sound file in poly memory by placing it in the current sequence.

1. Recall the sound file you want to preserve in poly memory as the current sound file.
2. Press RECORD.
3. Press a key on the keyboard.
4. Press STOP.

   A note containing the keyboard timbre with the current sound file is placed in the current sequence.



RECORD, STOP
panel 2

Memory management (con't)

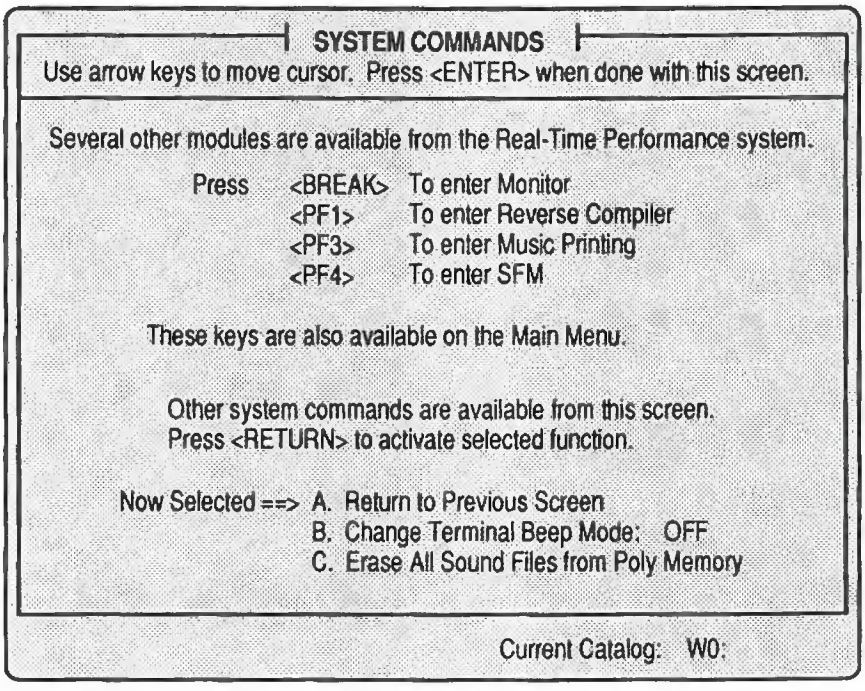
Clearing poly memory

You can erase all sound files from poly memory to make room for sampling. This has no effect on any sound files stored on disk.

1. Select the System Commands menu from the Main Menu.
2. Select "Erase all sound files from poly memory."
3. Type **ok** and press Return.

   A message appears telling you that all sound files have been erased from poly memory.

Note: It is a good idea to erase the current sequence before clearing poly memory. Certain functions, such as SKT, cause the sound files associated with the timbre to be reloaded from disk.


SYSTEM COMMANDS
Use arrow keys to move cursor. Press <ENTER> when done with this screen.
Several other modules are available from the Real-Time Performance system.
Press <BREAK> To enter Monitor
<PF1> To enter Reverse Compiler
<PF3> To enter Music Printing
<PF4> To enter SFM
These keys are also available on the Main Menu.
Other system commands are available from this screen.
Press <RETURN> to activate selected function.
Now Selected ==> A. Return to Previous Screen
B. Change Terminal Beep Mode: OFF
C. Erase All Sound Files from Poly Memory
Current Catalog: W0: