

FORTRAN ii



MUSIC CARD FOR THE TI 99/4A

USERS MANUAL

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CHAPTER 1

INTRODUCTION

Welcome to an exciting new world of music on your TI-99/4A computer. The FORTi system is a very capable sound synthesizer and will provide many hours of fun and amazement for you and your friends. This manual is designed to assist you in gaining the maximum performance from your FORTi system in an easy and enjoyable manner.

To use your FORTi system your computer system must have a peripheral expansion system containing a 32K memory expansion card (note that the "side-car" type memory expansion may not work), a disk controller, at least 1 disk drive and an Editor/Assembler command module. You must also have a stereo (or quadrasonic) audio system which can be connected to your FORTi sound card via the AUX or similar input jacks.

Insert the FORTi sound card into your peripheral expansion box. Be-sure to wait two minutes after powering down the expansion box. Now connect the audio output jacks on the rear of the card to the appropriate input jacks on your audio system with the standard RCA type audio cables. For stereo, use the middle two jacks.

Your FORTi software is supplied on a diskette. You are permitted to make as many copies of this diskette as you desire for use on YOUR computer. You should use your Disk Manager or Disk Manager II to make at least 2 copies of this diskette now. You should never use your master copy for anything other than making copies. You should then file it in a safe place (away from temperature extremes and magnetic fields) and continue to make copies from the copies you have made.

The following chapters will introduce you to the various features of the FORTi system and also supply valuable hints to assist you in exploring the various effects and capabilities that they offer. You are probably interested in getting a quick sample of the capabilities of this system before you read this manual, so here's how to get a quick demo.

1. With the Editor/Assembler module in place, place a copy of the FORTi system in DSK1.
2. Select EDITOR/ASSEMBLER.
3. Select LOAD AND RUN.
4. Type DSK1.FORTI.
5. The FORTi system will load and after about 15 seconds, a screen of instructions should appear. You needn't understand the instructions now, just type ALBUM and press ENTER.
6. Sit back and listen. You will soon be able to listen to your favorite tunes performed in a similar way according to your specification.

CHAPTER 2

BASIC CONCEPTS AND USING THE EDITOR

The purpose of this chapter is two-fold. First we will learn some of the basic concepts of the FORTi system. We will then explore the editor which is provided as part of the FORTi system and with which you will be creating your own masterpieces. FORTi is actually a language with which you will program this music system.

Basics

In FORTi any string of characters that does not contain a space is called a Word. This is an important concept and will be both assumed and used continually in the following instructions. The following are all examples of Words:

```
SOPRANO
VOICE:
=REPEAT
(
''
-->
ABCDEFGHIJKLMNOPQRSTUVWXYZ
```

The following phrases are each two Words:

```
SOPRANO PART
A B
'' ''
```

Whenever the word Word is spelled with a capital W in this document it refers to the FORTi concept of Word.

The FORTi system divides a diskette into units of information called Screens. A Screen contains 1024 bytes. Each of these Screens is like a large record in a file. Whenever the word screen is spelled with a capital S, it refers to the FORTi Screen concept; when spelled in lower case, it refers to the viewing area of your computer display. On your FORTi disk, the first 40 Screens contain the FORTi system. The last 50 Screens (numbered 40 through 89) are available for your music. This is where you will do your work. Since the FORTi system must call on various parts of the information on Screens 0 through 39 as you put the system through its paces, a copy of the FORTi disk containing these first 40 Screens intact must always be in DSK1. ALWAYS LEAVE A COPY OF THE FORTi DISK IN DSK1 WHEN USING THE FORTi SYSTEM.

Numbers used in the FORTi system are always integers. They must NOT contain a decimal point.

Some commands (Words) to the FORTi system require numbers for parameters (this is similar to calling a subroutine and passing it

arguments). In FORTi, parameters always come before the Word that references them. As an example you will soon see that the command to edit Screen 50 is:

```
50 EDIT
```

It may seem a little strange now, but it will soon become second nature.

The Editor

The editor that is supplied with the FORTi system is similar to the editor from the Editor/Assembler or the editor in TI-WRITER. In order to make editing FORTi Screens as easy as possible the editor was designed to show an entire FORTi Screen on your monitor without scrolling. In addition, an area giving a very brief description of each of the functions provided in the editor is displayed at the bottom of your screen. The editor is displaying each Screen as 16 rows of 64 characters per line. These characters are quite small and require that your monitor be well adjusted to be read easily. They also use the entire width of the 99/4A screen, so if you have a monitor with a lot of overscan, it may be necessary to leave 1 or more character positions vacant on each side of the screen for readability.

Note that your FORTi disk contains demo music and that you should restrict your practice editing to Screens 49, 50 and 51 until you have received further instruction. To violate this will cause the demo music to be destroyed.

Type 50 EDIT at this time and try out the following editor functions as you read about them. You should see a screen with the top 2/3 black with a flashing underscore cursor in the upper left character position. The functions are listed below the Screen, as is the number of the Screen which you are editing. Note, if all looks normal, but you do not see the cursor, you may have too much overscan. Follow the exercises below and move the cursor onto your visible screen area. Begin editing by typing characters and using the arrow keys to move the cursor about the screen. Notice that when a key is held for about 1 second it will begin to repeat, making moving around the Screen even easier. All keys repeat when held down in the editor.

We will now examine the function keys:

Function 1 is the delete key. Pressing this key causes the character at the cursor position to be deleted and the remainder of the line to be moved to the left to close the resulting space. A space is added to the right end of the line. This key can be held and the repeat action will make deleting several characters very easy.

Function 2 causes a blank to be inserted at the cursor and the remainder of the line moved to the right. Note that characters at the right edge of the Screen will be lost when pushed off the edge. By using the repeat action, a blank space can be created in the middle of the text to support adding words to the middle of a

phrase etc. The cursor does not move.

Control 3 (Control, not Function) is used to delete the entire line on which the cursor is located. The remaining lines on the Screen are moved up and a blank line is added to the bottom of the Screen. The line which is removed is placed in an internal buffer and can be accessed by Function 8 (see below).

Function 4 is used to advance to the next higher Screen number. That is, pressing it while editing Screen 50 will bring Screen 51 to the screen for editing.

Function 5 is the Home key. It is used to place the cursor in the upper left corner.

Function 6 is used to go to the previous Screen number. That is, pressing it while editing Screen 50 will bring Screen 49 to the screen for editing.

Function 7 is used to delete the text from the cursor to the end of the line. The text that is deleted is placed in the same buffer as with Function 3.

Function 8 is used to take the text in the 1 line internal buffer and insert it as a new line above the line on which the cursor is located. This will cause the last line to be pushed off the bottom of the Screen and be lost. Using Function 8 does not alter the contents of the buffer. It is also possible to move a line from one Screen to another by using Control 3 on one Screen and Function 8 on the other. Using Function 7 and Function 8 is an easy way to split an existing long line that you wish to be two lines.

Control 8 is similar to Function 8 but inserts a blank line instead of using the contents of the buffer.

Function 9 is one of two ways to leave the editor. When Function 9 is pressed any information that was modified will be written back to disk.

Function = is the other way to leave the editor. It causes the edit to be aborted and Screens not to be saved back to the disk. It is to be used if you really mess things up and want to get out without destroying the data on the disk. Note, however, that depending on how Function 4 and Function 6 were used, some or all of the previously edited Screens may be saved back to disk before you use Function =.

Function V is a backward Word tab. This will cause text to be skipped in a backward direction and place the cursor on the first character of the preceding Word.

Control V is a forward Word tab. This will cause text to be skipped in a forward direction and place the cursor on the first character of the succeeding Word.

Practice using the editor to create some simple text. You will find that you have a very functional editor for editing the

✓ Screens where you will be creating the text that makes up a piece of music in the FORTi system.

In order to protect against accidentally destroying the information on Screens 0 to 39 the editor will not accept these Screen numbers. Any Screen number lower than 40 will be treated as if it were 40.

Also note that the FORTi system treats the text that you create on a Screen as one very long string of 1024 characters. This means that the last character on the first line is actually adjacent to the first character of the second line and similarly for each of the remaining lines. Because of this, it is a good idea not to use the first (or last) column in order to avoid having FORTi concatenate what appears on the screen to be two separate words.

CHAPTER 3

CREATING VOICELINES

This and the following chapters will explore the various musical capabilities of the FORTi system. You will learn how to create the Screens that describe to the system just what your intentions are. These Screens will contain three types of information:

1) The Voicelines. These describe the musical notes and rests to the system.

2) The Envelopes. This is an optional part because 11 envelopes are built into the system and can be used by you. Envelopes are used in the FORTi system to give different characteristics to the tones that are played. You will be able to specify the amplitude (loudness) of a musical note and have the computer change that amplitude 60 times per second.

3) The Conductor. This is where the real fun lies. When the Voicelines and Envelopes that are needed to play your music have been defined, the conductor allows you to define the tempo, including accelerandos and decelerandos, the loudness with crescendos and decrescendos, to assign voice lines and envelopes to any of the twelve available "musicians" and to even have the current measure number displayed on the screen.

There are several examples of music given in this chapter. We will examine these and learn how to create new music in the FORTi system.

Each piece of music in the FORTi system should begin with the Word START near the top of the first Screen of your music. Individual pieces will be able to span a large number of Screens if the piece is large enough to require this. FORTi also permits the use of comments or remarks in the text. These are skipped over by the system, so they are useful only to you. Get in the habit of using comments liberally. In particular each Screen should contain a comment on the first line identifying what is on the Screen. Comments begin with a "(" followed by at least 1 space because "(" is simply a FORTi Word that means begin a comment. The comment is terminated by a ")" usually on the same line.

A voiceline is a melody or harmony that consists of only one note at a time. If you were programming a quartet you would need to have 4 voicelines. Typically a voiceline corresponds to a score for a musical instrument that is of the one note at a time variety such as a flute, trumpet etc. When music for polyphonic instruments such as a piano, organ etc. is entered, you will need to decide which notes should be part of which voicelines. More on this later.

Let's take some simple pieces as examples. The example in Figure 1 is the theme of Peter from the work for children "Peter and the Wolf" by Prokofiev. The example in Figure 2 is a fanfare by Wagner. These examples will be used later in this chapter.



Figure 3-1. Peter's Theme

The next musical example has three voicelines.

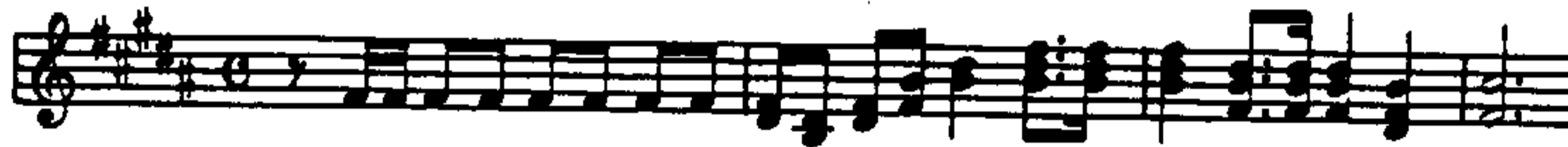


Figure 3-2. Fanfare by Wagner.

Voiceline Words

Each piece of music has a key signature listing the sharps or flats that are expected in the piece. FORTi has the Words FLAT FLATS SHARP and SHARPS to define this for the system. Each of these Words needs to be preceded by a number defining how many there are. You might have entries such as:

3 SHARPS
1 FLAT
0 FLATS or 0 SHARPS
7 FLATS

You can have from 0 to 8 sharps or flats in the FORTi system.

Two octaves of notes are included among the Words of the FORTi system. These are A B C D E F G AA BB CC DD EE FF and GG . These Words "understand" the key signature and adjust the pitches sharp or flat as necessary. The FORTi system can also handle accidentals. The Words for flatted accidentals are A\$ B\$ C\$ D\$ E\$ F\$ G\$ AA\$ BB\$ CC\$ DD\$ EE\$ FF\$ and GG\$. Those for sharped accidentals are A# B# C# D# E# F# G# AA# BB# CC# DD# EE# FF# and GG# . The natural accidentals are A% B% C% D% E% F% G% AA% BB% CC% DD% EE% FF% and GG% .

Since the pitch range of the FORTi system is much greater than this, it is necessary to define for FORTi which octave we mean. The octaves are numbered as follows:

1 OCTAVE starts at the A above middle C (A=440) and goes up through the two octaves of pitches given above.

2 OCTAVE is an octave higher so that A corresponds to (A=880) or the first ledger line above the treble cleff.

0 OCTAVE starts at (A=220) which is the A below middle C.

-1 OCTAVE starts at (A=110) which is the first space of the bass cleff.

OCTAVE can be used with numbers from -3 to 3 to define the musical range most appropriate for the voiceline to be entered. The following table shows the pitch ranges covered by each OCTAVE specification.

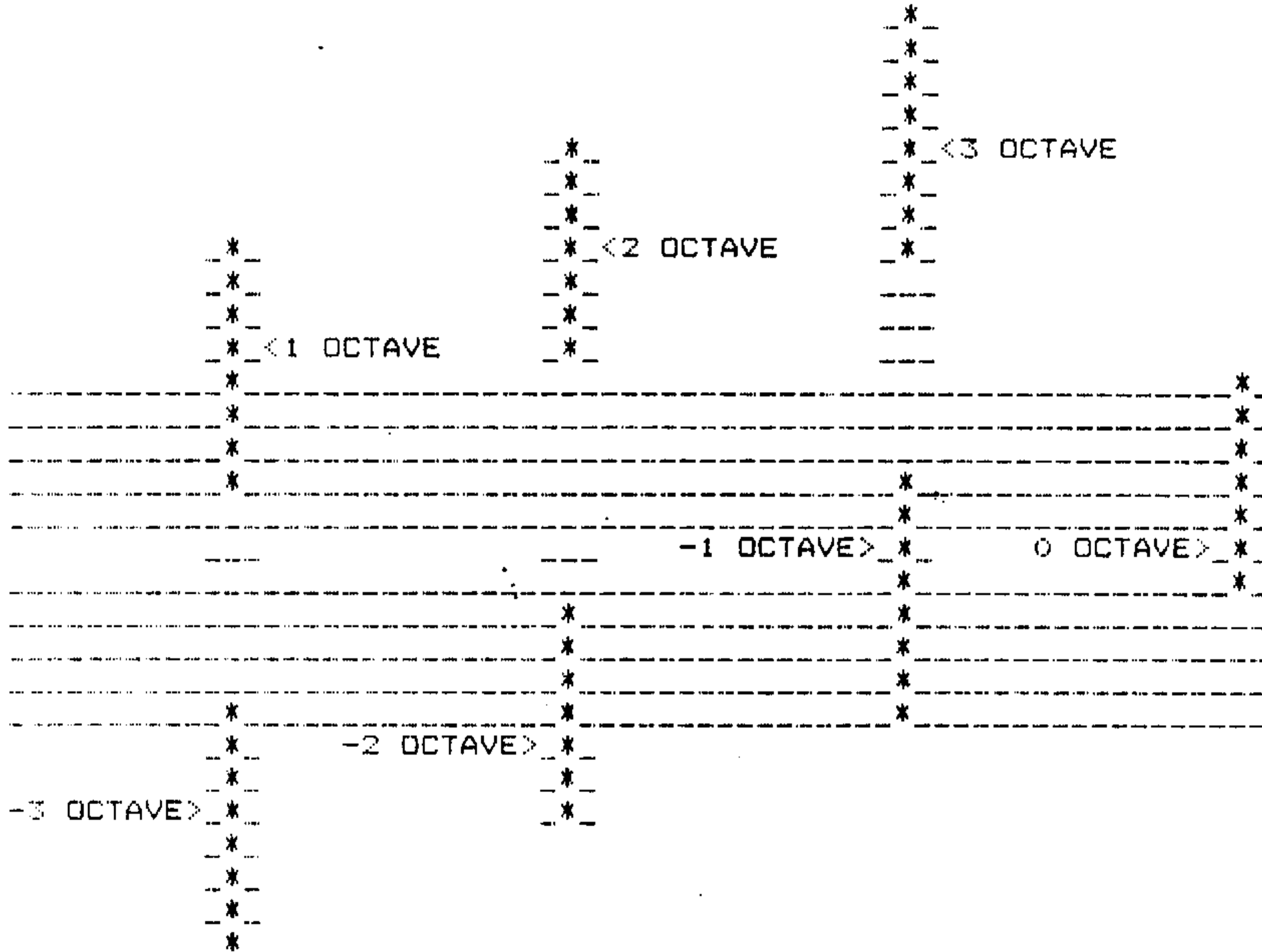


Figure 3-3. Ranges spanned by FORTi OCTAVES.

After an octave has been defined using the Word OCTAVE, the easiest way to go up an octave is with the Word ^ and the easiest way to go down an octave is with V. These Words are designed to look like up and down arrows respectively. So, if you wish to change the octave in a piece (because the given two octave range is not adequate), ^ and V allow changing with a minimum of keystrokes. The new octave remains in effect until another octave changing Word is used.

The next key Word is VOICE: . This Word introduces a new voiceline and is followed by the name (up to 31 characters) you wish to give the voiceline. Some examples are shown below:

VOICE: SOPRANO
 VOICE: PART1
 VOICE: PETER

Notice that there is at least one space between the Word VOICE: and the name assigned (by you) to that voice.

Every voiceline must end with the Word FINIS . As you will see in the examples in the remainder of this chapter, the Words VOICE: and FINIS always bracket a voiceline definition.

Another group of Words needs to be introduced. These are the duration Words. These Words are used to tell the FORTi system the note duration (halfnote, quarter note, dotted-eighth note etc.). Table 3-1 lists the durations that are defined in the FORTi system.

Table 3-1. Note Duration Words

Word	Definition
WH	Whole Note
HA	Half Note
QU	Quarter Note
EI	Eighth Note
SI	Sixteenth Note
TH	Thirty-second Note
S4	Sixty-fourth Note
H.	Dotted Half Note
Q.	Dotted Quarter Note
E.	Dotted Eighth Note
S.	Dotted Sixteenth Note
T.	Dotted Thirty-second Note
3H	Triplet Half Note
3Q	Triplet Quarter Note
3E	Triplet Eighth Note
3S	Triplet Sixteenth Note
3T	Triplet Thirty-second Note

Duration Words, as well as the Words OCTAVE , FLATS , SHARPS etc. remain in effect until superseded by another Word of the same type.

Sometimes one musical note is tied to another note. Other times two or more notes are slurred which means that there is a pitch change, but otherwise the notes are connected. These situations are both called a Tie in FORTi. When two notes are to be tied, the Word T is used between them. Thus, a normal C major scale in quarter notes would look like this:

QU C D E F G A B C

If instead we wanted to tie (slur) the first two notes and the last two notes this would be coded like this:

```
QU C T D E F G A B T C
```

Or if we take advantage of the free format of FORTi and add additional spaces to improve the readability:

```
QU  C T D  E  F  G  A  B T C
```

This type of spacing is recommended as is the addition of an extra space when a duration Word is used so that you can more easily find the duration Words and the musical line will require less study when you come back the next day to find and edit a mistake you may have made.

Putting it Together

We will now show the FORTi encoded version of Peter's theme. Refer to this version in Figure 3-4 for the following discussion.

```
START      ( PETER FROM "PETER AND THE WOLF" BY PROKOFIEV )

VOICE: PETER  0 FLATS  1 OCTAVE
( 1 ) QU  V G ^      ( DOWN THEN UP 1 OCTAVE )
      E. C T SI E  EI G AA  E. G T SI E
( 2 ) EI G T AA  E. BB  SI CC  EI G T E  C T D
( 3 ) QU E$  EI E$ T BB  QU E$  EI E$ T BB
( 4 ) QU E$ T B$  Q. B$

FINIS
```

Figure 3-4. FORTi Encoding for Peter's Theme.

The above example may look complicated, but don't give up. This example contains nearly everything there is to know about entering voicelines and it will all look obvious shortly.

Since every piece must begin with START this Word is placed right on the first line. The comment that follows is to identify the piece. If you wish to use longer comments, it is a good idea to keep each line as a separate comment, beginning with (and ending with). If you forget to close a comment with) the remainder of your FORTi program may get gobbled up as a comment.*

The Word VOICE: informs the system that we wish to begin the definition of a voiceline. This voiceline is given the name PETER. The phrase 0 FLATS enters the key signature into the system. This phrase could be located before the VOICE: PETER, but in this example we chose to place it inside the definition of the voice. Remember that it will remain in effect throughout this piece unless changed by another FLATS or SHARPS Word. Also note that the key signature could have been entered as 0 SHARPS. The

default key signature is no sharps or flats so we would not have had to specify any key signature at all for this piece.

With the exception of the first note, this entire piece is playable in the range 1 OCTAVE . For this reason the pitch range is given as 1 OCTAVE and as you will see, an exception is made for the first note by using the Words V and ^ . After the V we are really at 0 OCTAVE and then after the ^ we are back to 1 OCTAVE. We could have started with 0 OCTAVE and then used only ^ , but the scheme shown in Figure 3-4 better documents the entire piece as being in the 1 OCTAVE range. Also, the Words V and ^ were not necessary if we had wanted to use the phrase 0 OCTAVE G 1 OCTAVE . Use of V and ^ will be handy for those situations where the octave changes occur frequently.

Notice that the measure numbers are given on the left as comments. On a piece this short, these are probably not necessary. On longer pieces they are extremely helpful when listening to the resulting music while following the sheetmusic score and then attempting to locate typos.

Since the first note of the piece is a quarter note, we start with QU and then the pitch which is (after the octave stuff above) G . The next duration is a dotted eighth note, thus E. is the next Word. Since this and the following note are tied or slurred (see Figure 3-1) we indicate this fact with a T between the two notes. Note that if a T and a duration Word are adjacent, they can be in either order.

So we have a dotted eighth note C tied to a sixteenth note E . Then changing to eighth notes we have a G followed by AA , which is the note immediately above G . At this point you should be able to follow the correspondence between the musical score and the FORTi notation until we get to measure 3. At this point we encounter an accidental, the E flat. Notice that this has been coded as E\$ and that it must be so encoded through out the measure (FORTi does not automatically track accidentals within measures).

When the FORTi system reads the voiceline as you see it in Figure 3-4, it uses the information supplied to build a table whose name is PETER and whose contents are the notes that are listed. Only pitch names actually cause an entry to be placed in the table. All the other Words (OCTAVE FLATS SHARPS QU EI SI T etc.) are used only to determine what goes into the entry. Only the pitch names cause space to be allocated in the table, therefore using memory. A piece that requires changing durations every note (as alternating between E. and SI) does not take any more memory per note than one that is all eighth notes for example. It does, however, take more typing on your part and will probably take more Screens to hold the FORTi source code which you have typed.

Whenever a piece of music does not all fit on one Screen, as is usually the case, the Word --> is used as the last Word on the Screen. This tells the FORTi system to continue scanning your source Screens with the next higher numbered Screen.

Let's look at the next musical example, the fanfare found in Figure 3-2. When coding this type of music, (where the number of

notes to be played simultaneously varies continually) it is usually easiest to include in the first voiceline all those notes that are highest. The second voice line would have rests whenever there was only 1 note and would take the bottom note when there are two or more. The final voiceline takes all the remaining notes and uses rests when there are fewer than three notes. We haven't used rests before, but they are identical to notes in that they must have a duration specified at some prior time. The Word for rests is RE .

The following figure shows the encoded version of the Wagner fanfare:

```

START ( FANFARE FROM TANNHAUSER, BY WAGNER )
5 SHARPS 0 OCTAVE
VOICE: PART1
( 1 ) EI RE SI F F EI F F F F F F
( 2 ) F D F BB QU DD E. FF SI FF
( 3 ) QU FF E. DD SI DD QU DD BB
( 4 ) H. CC FINIS
VOICE: PART2 ( 1 ) WH RE
( 2 ) EI D B D F QU BB E. BB SI BB
( 3 ) QU BB E. F SI F QU F D
( 4 ) H. F FINIS
VOICE: PART3 ( 1 ) WH RE
( 2 ) QU RE RE RE E. DD SI DD
( 3 ) QU DD E. BB SI BB QU BB F
( 4 ) H. RE FINIS
    
```

Figure 3-5. FORTi encoding of Wagner's Fanfare.

One additional feature of voicelines remains. The Words R: and :R can be used to repeat a section of the music. The R: is preceded by a number indicating the number of times to repeat. R: and :R each create table entries, but can result in a great deal of saved typing as well as memory space when used where they are appropriate. These Words are not permitted to be nested; that is if you use an R: , you must use a :R before you can use another R: . The following figure shows one voice of the well known round "Brother John". You will learn how to turn this into the "Brother John Symphony" by examining the music provided on your disk.

```

START ( BROTHER JOHN )
0 OCTAVE 0 SHARPS
VOICE: JOHN
2 R: QU C D E C :R ( ARE YOU SLEEPING? ARE ... )
2 R: E F HA G :R ( BROTHER JOHN, BROTHER JOHN )
2 R: EI G AA G F QU E C :R ( MORNING BELLS ARE RINGING! ... )
2 R: C V G HA C :R ( DING, DONG, DING ... )
FINIS
    
```

Figure 3-6. "Brother John" using repeats on each measure.

CHAPTER 4

ENVELOPES

Envelopes are the principle way in which the tonal character of the sounds produced is specified. There are 11 envelopes predefined in the FORTi system and available for your use. This chapter will describe how to produce new envelopes of your own.

One of the operational principles of the FORTi system is that the sounds of all 12 of the built-in "musicians" are updated sixty times per second. The purpose for the envelope is to describe to FORTi how to modify the loudness (amplitude) of the sound of a single "musician" each of these updates.

Many sounds in nature begin quite loudly and then decay rapidly. This is the characteristic of the sound made by plucking a string for instance. The FORTi system will permit you to generate a variety of this type of sound as well as others that occur on nature and still others that are possible only electronically.

Envelope Basics

Within FORTi the loudness of a sound is described by a number from 0 to 15. 15 is the loudest sound that can be produced, 0 is silence and of course, 1 through 14 are in between.

An envelope is described as a series of numbers between 0 and 15 that describes the sound contour (envelope) that is desired. The envelope is also assigned a name so that you can reference it as needed. A possible envelope is shown below in Figure 4-1. The top part of this figure shows the FORTi notation for the envelope; the bottom part is a graph showing the change in amplitude with time.

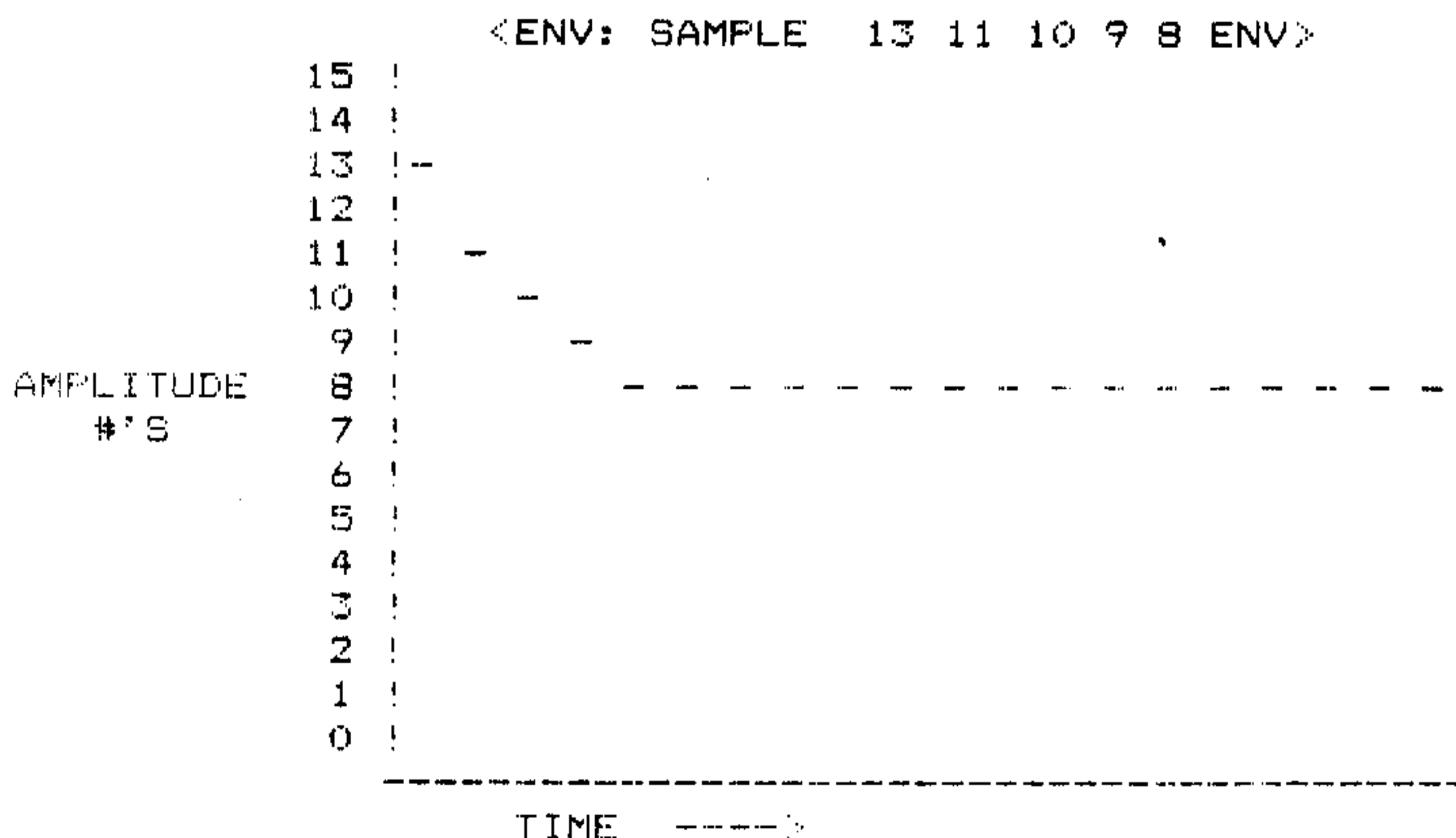


Figure 4-1. A Sample Envelope.

As you can see the definition of an envelope begins with the FORTi Word <ENV: and ends with the Word ENV> . Note that the < > and : symbols are part of the words and that they are required. The name given to this envelope is SAMPLE , but any name of up to 31 character would be ok. This envelope would cause a note to be sounded with a very fast attack (the note begins quite loudly and reaches this loudness instantaneously). It decays rather rapidly (begins to get softer) and remains fixed at volume 8. That is, the sound does not just quit when the end of the envelop is reached, but rather continues at the last volume level specified. Volume level 7 or 8 is considered the standard level, as it falls in the middle of the range and when musical dynamics markings are encountered in the chapter on the conductor, it will be possible to both raise or lower the loudness of an envelope significantly when 7 or a number near 7 is used as the sustaining level.

More Features

It is sometimes desirable to have envelopes that have properties that are not possible with the simple mechanism described above. There are two additional envelope features that are comprehended by the use of one additional FORTi Word: =REPEAT . The use of this Word permits the repetition of a section of the envelope for such effects as tremelo as well as defining what the end of the envelope should be regardless of the duration of the note that the envelope is describing. Take for example the sound of a piano. It begins very loudly, sustains at a slowly decaying rate and then, when the key is lifted, decays very quickly.

The Word =REPEAT must be preceded by a number which is not used as an amplitude, but rather is the position within the envelope number series to which FORTi should jump, thus repeating a section of the envelope. This type of envelope could be created as shown is Figure 4-2. In this example the repeated section is just a single level, as the repeated section is only one entry long. The twelfth entry is repeated until it is time for the tail to begin. The tail (the final part of the note as with the piano when the key is released) is defined between the Words =REPEAT and ENV> . The length of the tail is determined by the number of values included there and thus determines how much of the note's duration is considered the tail. Of course, you can even ask the tail volume to increase at the end of the note for a strange effect similar to playing a phonograph record backward.

```
(ENV: SAMPLE2 14 13 12 11 11 10 10 10 9 9 9 8
12 =REPEAT
7 5 3 1 0 ENV)
```

Figure 4-2. An Envelope somewhat imitating a piano.

The SAMPLE2 envelope will sustain at the level 8 until near the end of the note at which time it will proceed to get softer and fade away. Note that the 12 =REPEAT refers to the twelfth value (the 8) and will cause it to be repeated. Never refer to a position that has not been defined or the FORTi system may hang

and need to be powered off to regain control.

An example of an envelope that includes a tremolo effect is shown in Figure 4-3. This shows an example of a tremolo with no tail (nothing between =REPEAT and ENV>), however a tail could be included.

```
<ENV: SAMPLES 13 12 11 10 9 8 7 6 7 8 9      4 =REPEAT ENV>
              ^                                   v
              ^<<<<<<<<<<<<<<<<<<<<<<<<<<v
```

Figure 4-3. A Tremolo envelope.

In the above example, the fourth entry (the 10) is the repeat target so the envelope will after the initial 13 12 11 begin repeating the series 10 9 8 7 6 7 8 9 10 9 8 7 6 etc.

You will enjoy experimenting with envelopes to see how they sound both individually and when used together especially with overtones. This subject will be expanded in the following chapters.

If you find the subject of envelopes to be confusing, the following listing of the built-in envelopes may help. Use these descriptions while listening to the built-in envelopes on a simple tune, first individually, then in simple combinations. You can also see from the following figure that the built-in envelope names are ENV0 , ENV1 ...; ENV10 .

```
<ENV: ENV0  7 ENV>
<ENV: ENV1 11 14 12 11 10 9 8 8 7 7 7 6 6 6 6 5 ENV>
<ENV: ENV2 11 13 14 12 10 8 6 5 4 4 3 ENV>
<ENV: ENV3 11 12 13 14 11 8 5 3 ENV>
<ENV: ENV4 13 11 9 8  4 =REPEAT  6 4 2 ENV>
<ENV: ENV5 14 13 12 11 10 9 8  7 =REPEAT  7 4 1 ENV>
<ENV: ENV6  6 7 8 9 9 8 7 6  1 =REPEAT  6 5 4 3 2 1 ENV>
<ENV: ENV7 14 12 10 8 6 4 4 5 7 9 11 13  1 =REPEAT  6 3 1 ENV>
<ENV: ENV8 13 12 11 11 12 13  1 =REPEAT 12 10 7 3 1 ENV>
<ENV: ENV9 12 11 9 7  1 =REPEAT  3 1 ENV>
<ENV: ENV10 0 0 0 13 11 9 7 5 3  4 =REPEAT  3 1 ENV>
```

Figure 4-4. The Built-in Envelopes.

Because of the way that envelopes are represented internally, no envelope can contain more than 125 values between <ENV: and ENV> . Also note that the levels 15 and 1 are special in that when these values, very loud and very soft respectively, are NOT changed by dynamics markings as described in the following chapter, these levels are fixed. This can be helpful if you wish to have a note with a very loud attack even when the dynamic level is very soft. The level 15 will do this whereas the level 14 would be softened by the dynamic level marking.

CHAPTER 5

THE CONDUCTOR

The conductor is that portion of the FORTi system which is used to define what to do with the voicelines and envelopes that you learned about in the previous chapters.

The conductor always begins with the Word CONDUCTOR . The conductor is not given a name as are the voicelines and envelopes as there should always be only one conductor for a piece of music.

The Basics

The conductor can do many of its things automatically for you if you are willing to use the built-in default values. In the simplest case where you have entered a voiceline and wish to hear it, the conductor can be as simple as:

```
CONDUCTOR 1 PETER FINIS
```

This would cause the voiceline PETER , which we defined previously, to be played. The Words CONDUCTOR and FINIS are used to indicate to FORTi the beginning and end of the conductor respectively. The above conductor would cause the voiceline PETER to be played on the first (hence the 1) "musician". The FORTi system contains 12 "musicians", which are depicted graphically as 12 rectangles on the screen while the music is playing. Only those musicians playing notes are visible, those with rests are not seen. The "musicians" are numbered from 1 to 12 so if we wish to play PETER with "musicians" 1, 6 and 10 we could write:

```
CONDUCTOR 1 PETER 6 PETER 10 PETER FINIS
```

Or we could use write a conductor to play the three parts of the Wagner fanfare like this:

```
CONDUCTOR 1 PART1 2 PART2 3 PART3 FINIS
```

where PART1 , PART2 and PART3 are the names of the three voicelines.

One of the things you can do with the conductor is to set or change the tempo of the music. The tempo is expressed in notes per minute using the Word =TEMPO as shown in the following examples:

```
QU 120 =TEMPO
EI 216 =TEMPO
H. 42 =TEMPO
```

Where the first of these describes the tempo of 120 quarter notes per minute; the second 216 eighth notes per minute and the last 42 dotted half notes per minute. Use the note duration that is most appropriate for expressing the tempo. If you don't enter a tempo, FORTi will play 100 quarter notes per minute.

Creating Your Arrangement

The tempo can be changed either by using =TEMPO or by using +TEMPO. +TEMPO is also preceded by a number, but in this case the number is in terms of the smallest tempo change that FORTi recognizes (about 2.3 quarter notes per minute). This is a very useful Word when used inside an R: :R pair in the conductor to create ritards or accelerandos. You must never allow the tempo to be zero because all forward progress of the music stops at that point and you will need to use Function 4 to stop the sound.

The following examples show a ritard and an accelerando respectively.

```
QU 4 R: -5 +TEMPO RE :R ( RIT QUICKLY )
```

```
QU 4 R: 1 +TEMPO RE :R ( ACC SLOWLY )
```

Another Word pair in the conductor, =MEAS and +MEAS, are used to assign and to increment the measure number that appears on the screen while the music is playing. =MEAS is used to assign this number (either initially, or anywhere else you like) as in

```
0 =MEAS or  
1 =MEAS
```

+MEAS does NOT take a leading argument, but rather assumes that you want to increment by one. One further note: when the value in the measure counter is 0, then nothing is displayed on the screen. 255 is the largest number that can be assigned, but, you can increment to larger numbers.

The various activities of the conductor must take place at the proper times. To do this the conductor keeps track of time by "playing" rests. A simple example of a conductor is given below to show how this is done:

```
CONDUCTOR 1 PETER QU 120 =TEMPO  
0 =MEAS WH 4 R: +MEAS RE :R FINIS
```

This example shows PETER being assigned to "musician" 1 and a tempo of 120 quarter notes per minute being set. Then the measure number is initialized to 0. The duration word is WH so that we can use whole rests. The song is 4 measures long, so we repeat the contents of the R: :R construct 4 times. Inside, the measure number is incremented, and then the conductor waits for the duration of a whole rest. The process repeats for each of the 4 measures. Finally the word FINIS is used to end the conductor. You can consider all FORTi Words except rests to occupy no time in the conductor, that is, they are instantaneous. Only rests require time. Note that although rests and durations are used, notes are NOT to be used in the conductor.

When referring to "musicians", there is frequently a need to have all or most of the "musicians" do something. The special Word ALL can be used to refer to all the musicians at the same time. If you want most of the "musicians" to play something, simply use ALL to set all of them and then use individual musician numbers to set

those that are different. An example (not really a good one) might be if you wished to play the Fanfare with "musician" 4 playing PART2 and "musician" 11 playing PART3 with all the others playing PART1 then you could use:

```
ALL PART1 4 PART2 11 PART3
```

There is a built-in voiceline called SILENT . It is customary to use this as ALL SILENT when you want to start a new section of a piece and many reassignments of parts are happening. The voiceline SILENT consists of a single very short rest.

In a similar fashion, we can assign an envelope to a musician by naming the musician and then naming the envelope. To have our "musician" 3 play using built-in ENV5 we would say 3 ENV5 .

The conductor is also responsible for determining how loud each of the "musicians" is to play. The following list of dynamic defining Words can be used with a "musician" number or ALL to indicate how loudly the envelope is to be played. This list is in order of increasing loudness and as you can see some naming license was used to derive the values between the common musical symbols for these levels: PFF MPPF PF MPP P MP M MF F MFF FF MFFF FFF . To have all musicians play moderately loud would require

```
ALL MF
```

The FORTi Words +VOLUME and -VOLUME are used to increase and decrease the volume respectively and can be used to easily do crescendos and decresandos inside an R: :R loop. Don't over do it though. FORTi does not check what the cumulative effect of a series of these volumes changes is and anything below PFF or above FFF may cause strange errors while playing. A slow crescendo from P to FF could look like this:

```
ALL P HA 6 R: RE ALL +VOLUME :R
```

where the volume change takes place over a period of 6 half notes (rests). If there are 2 half notes per measure and you wish to display the measure count this would probably be coded as:

```
ALL P HA 3 R: +MEAS RE ALL +VOLUME RE ALL +VOLUME :R
```

More Capabilities

Not all musicians have equal talent. This is also true in the FORTi system. "Musicians" 3, 6, 9 and 12 are special. They can play the same parts as the other musicians if you wish. They are capable, however, of playing very low bass parts as well as percussive type sounds. To switch these musicians among their various talents, the Words =BASS and =DRUM are used for bass and percussion respectively. To switch back to normal use =TREBLE . Each of these words is designed to be preceded by the "musician" number of one of these special "musicians". Don't use other numbers or the Word ALL with these Words; it doesn't make sense and will probably not do what you want. Now that we have introduced =BASS , the fact that we mentioned -3 OCTAVE in chapter

3 makes sense because FORTH really can play music that low (if you have speakers that can go below 30Hz). The default setting in the conductor is for these "musicians" to play in their =BASS mode.

The conductor can also request the musicians to transpose. The words +OCTAVE , -OCTAVE , +FIFTH , -FIFTH , +HALF and -HALF are each preceded by a "musician" or ALL and will cause the selected "musician(s)" to play at the new pitch. This makes it very easy to have a single voiceline played in more than one octave or with parallel fifths or whatever!

Frequently you will not have 12 musical lines to spread across the 12 "musicians". You can then use the remaining musicians to add harmonic color to some of the lines. Let's assume that "musician" 1 is playing a voiceline with ENV5 and you wish to add character to this voice. Of the many possibilities you could play the same part an octave and a fifth higher (the third harmonic of the notes played by "musician" 1) using a different envelope. To do this would require the following (again using PETER):

```
1 PETER 1 ENV5
2 PETER 2 ENV2 2 +OCTAVE 2 +FIFTH
WH 4 R: RE :R
```

If you are not familiar with the musical notation of a fifth, +FIFTH would cause a C to be played as the G above it. -FIFTH would cause a C to play the F below it. Also the words +HALF and -HALF refer to semitones. That is, again starting with C, +HALF would cause C# to be played and -HALF would cause B to be played. If you are confused, you might wish to show this to a musician friend and ask for a short lesson.

If you understand the above paragraph then it should be obvious that 1 +HALF 1 +HALF would raise "musician" 1 a whole tone etc. When using this type construct, don't forget to name the "musician" before each transpose word.

CHAPTER 6

FORTi COMMANDS

FORTi expects a FORTi Command whenever the system has a flashing rectangular cursor on the screen. The commands are summarized on the initial screen when the FORTi system is loaded. This screen can be displayed by typing HELP whenever FORTi is waiting for a command. In this chapter we will cover each of the commands listed on the Help screen as well as several that are less commonly used.

When you type in a FORTi command, about the only mistakes that you can make are forgetting to include a parameter for the command or misspelling the command name. Both of these errors should result in the name of the command which could not be executed being echoed back to you with a ? appended to it. If this happens, simply retype the command (correctly), including any parameters, and all should proceed as normal. CAUTION: In case your misspelling corresponds to some other FORTi internal command (of which there are many) in the system, it WILL be executed. For this reason, DO NOT attempt to create errors; they may hang your system or in other ways pollute it.

EDIT-LOAD-PLAY

You have already been exposed to the EDIT command. As you learned in chapter 2, this command must be preceded by the number of the Screen that you wish to edit. All music in the FORTi system begins as FORTi source code by entering it with the editor.

After you have entered a piece of music with the editor, (or at least one voiceline and a conductor that calls it) you must have FORTi translate the source into its internal table format before you can listen to it. This is done via the LOAD command. The LOAD command must be preceded by the Screen number of where to start LOADING your piece. If more than one Screen is involved, they should be connected by the --> Word. Optionally, the Word LOAD can be used on the Screens created by the editor to cause LOADING of portions of a piece that are not stored sequentially on the disk. This may be especially helpful if you have a set of envelopes that you have defined and wish to use for several pieces. If these envelopes were on Screen 88, then you might include

```
88 LOAD
```

in your source screens before you define the conductor that uses the envelopes.

While the LOAD command is processing, FORTi will be placing messages on the screen so that you can observe how the LOAD is progressing. These one-line messages have several fields which are defined as follows: 1) The first field is three characters wide and is used to inform you what type of word FORTi is processing. Comments will show a (, voicelines show voi ,

envelopes show env etc. 2) The next two columns show the Screen number and the row number on that screen where the word type in 1 above is located. 3) The final field shows the name of the voice or envelope, the word conductor or the comment (truncated if necessary).

Also while LOADING, you may receive the message: _____ HAS BEEN PREVIOUSLY DEFINED. This means that you have chosen to name something in your FORTi source the same as some other word already recognized by FORTi (possibly one of its internal words). This usually won't matter, however, it will cause problems if the name happens to be one of the FORTi command names. To correct the problem, use the editor and change the name as well as every reference to it in the conductor.

Once your music is LOADED, FORTi will come back with the message: ok. The music is now ready to play. Simply enter the command PLAY and listen (don't forget to have your audio equipment on and ready). If what you heard is not what you expected, you can either wait until the music stops or you can press Function 4 to stop it. When FORTi is ready for a command you can then use the editor to change your work or use any other command. Once the music has been LOADED, it need not be loaded again to replay it, so, to replay the piece, type PLAY again. Should you ever happen to type PLAY when no music is LOADED (and you will), FORTi will inform you that it is unable to find the conductor. To save time you can also cascade the PLAY command on the LOAD (or OLD) commands. So, to do a LOAD and PLAY of music at Screen 60:

```
60 LOAD PLAY
```

can be typed on one line.

Sometimes while you are loading, FORTi will discover an error in your FORTi source code. When this happens, the Word which FORTi believes to be the offender is echoed to the screen with a ? and the LOAD stops without giving the ok. The error must be corrected before the music can be completely LOADED. The FORTi Word WHERE is very useful in these situations. WHERE will call up the editor and place the cursor at the location where FORTi found the error. To use this feature, WHERE must be typed before anything else is done or the error location information will be lost. Note: misspelling WHERE will cause this loss. If this happens, the best approach is to use EDIT using the screen number from the last informational message that was sent to the screen.

Using Internal Table Format

When a piece of music is finished and you wish to simply listen to it, it is annoying to have to wait for the LOAD process. The following words are used to store the music tables in their internal format to disk for rapid retrieval of the music. You will be saving these tables to disk on Screens. Therefore, it will be necessary to determine how much space (how many Screens) is required to hold the tables. The word SIZE is designed to do this for you. With the information that is returned, you will be able to determine the most appropriate place on disk to place the

- ✓ This command should be used for gaining disk space when the disk was not filled sequentially.

The final command in this chapter is CLEAR . This command is preceded by two parameters and is used to quickly and easily blank a block of Screens. To blank the Screens from Screen 60 to Screen 75 (inclusive) the command is:

```
60 75 CLEAR
```

Your FORTi disk arrived with several music examples on it. When you make copies of this disk, the example music is on the copies as well. When you wish to strike out on your own, it will be necessary to have a disk with all the user accessible areas clear and ready for your EDITing. You can clear this area by typing:

```
40 89 CLEAR
```

You should only do this to one of your copies because you may wish to refer to the FORTi music examples until you are proficient in using the system.

In case the use of these commands creates an error condition other than those mentioned in this chapter, Appendix A contains a list of error messages and their possible causes.

CHAPTER 7

BUILDING AN ALBUM

The purpose of this chapter is actually twofold. Besides learning how to build an Album, that is, permitting FORTi to play all the music on a disk with no user intervention, you will also learn how to quickly and easily maintain a record of what you have placed where on the disk. YOU are the file manager in FORTi.

Only two new FORTi Words are used in creating an Album: <ALBUM and ALBUM>. These are used as brackets around a list of Screen numbers. The Screen numbers correspond to the Screens to which each piece of the Album was SAVED. As an example, if you have pieces SAVED to Screens 49, 56, 60 and 72 then these pieces could be fashioned into an Album by using:

```
<ALBUM 49 56 60 72 ALBUM>
```

Remember not to use commas between the numbers. The numbers can appear in any order and in fact, not all the pieces on a disk must appear in the album and if you want, a piece could appear more than once. These last possibilities are, however, in violation of the disk indexing scheme described next.

By dedicating a Screen (we will always use your first screen, Screen 40, in our examples) as an index to the disk and by using the <ALBUM and ALBUM> Words along with comments, a very useful screen can be generated. Figure 7-1 is an example of what such a screen would look like.

```
<ALBUM      ( ALBUM OF CHRISTMAS CAROLS )

( JOY TO THE WORLD      41 - 45 ) 46
( UNUSED                47      )
( JINGLE BELLS          48 - 51 ) 52
( UNUSED                53 - 54 )
( O HOLY NIGHT         55 - 64 ) 65 ( -66 )
( UNUSED                67 - 68 )
( WHITE CHRISTMAS      69 - 72 ) 73
( UNUSED                74 - 89 )
```

```
ALBUM>
```

Figure 7-1. An Example Album/Index Screen

Notice first of all that nearly everything on the screen is contained in one of the many comments. The only items which are not within comments are the words <ALBUM and ALBUM> and the numbers of the Screens to which the pieces were SAVED (46 52 65 and 73). The comments document the Screen range where each of

the pieces is located. In addition, only one of the pieces required more than one Screen to SAVE the piece. This is noted by the comment following the SAVE location.

Performing a LOAD on this Album Screen (40 LOAD) will result in the Album being "installed" on the disk. The Words ALBUM and MIX can now be used any time that this disk is in the system. Remember to update this screen regularly.

CAUTION: if you create an Album on a disk and later destroy the integrity of one or more of the SAVED images, ALBUM or MIX will probably crash attempting to play the bad image.

You can "unmake" an Album by making another one. This includes the possibility of the null Album:

<ALBUM ALBUM>

~~The~~ The above suggested method of using Album as an indexing mechanism is a suggestion only and in no way does the functioning of the FORTi system depend on it.

CHAPTER 8

TIPS AND TECHNIQUES

How to Code Second Endings etc.

Many musical pieces have first and second endings, codas or other musical notations that cause a piece of music not to be played straight through that are not handled by the R: :R construct of FORTi. The easiest way to handle these is to use several voicelines to handle a single musical line. If you use a new voiceline starting at each place in the music that is jumped to, the conductor will be able to easily create the necessary weaving of the partial voicelines into the entire piece.

The simplest example is a piece with a first and second ending that causes a repeat to the beginning of the piece. In this case, code the piece from the beginning through the first ending as the first voiceline and the second ending and any music that follows it as the second voiceline. In the conductor you would start the first voiceline playing. Upon reaching the end of the first ending, the conductor (or an R: :R pair) would cause the first voiceline to again be repeated. This time, however, the conductor will be responsible for assigning the second voiceline at the time that the first ending part of the first voiceline is encountered. The piece can then play to its conclusion.

When determining how to break up a piece, always remember that the conductor can only request a voiceline to be played from the beginning. You must then ensure that the partitioning of the music permits the conductor access to each section of the voiceline. If in doubt, you can always code some sections in more than one voiceline, but, at the expense of some memory space.

Reverberation

By playing the same voiceline in more than one "musician", and by offsetting slightly the time at which the two "musicians" start, it is possible to create reverberation or echo effects. The conductor is responsible for starting the voices with this offset. In order to permit very accurate adjustment of this timing a very short duration is available in the conductor. This duration, RF (for Real Fast), is only a third as long as a sixty-fourth note. If you use RF RE RE between the assignment of voicelines to "musicians", there will be a delay of less than a sixty-fourth note between the voices. As an example, study the following conductor and experiment with this technique on your own. You can of course use longer durations if you wish, RF has been introduced to permit you to "fine tune" these delays.

```
CONDUCTOR 1 MELODY RF RE RE 2 MELODY
          RE RE 3 MELODY FINIS
```

Here the voiceline MELODY is played by three "musicians" with "musician" 2 slightly delayed from "musician" 1 and "musician" 3 delayed still more.

Shortening LOAD Time

After the voicelines are entered, there is frequently much work remaining until you get the conductor "just right". The load time for the voicelines when you are doing frequent LOADs to tweek the conductor may be shortened. By saving just the voicelines with the SAVE command and then starting the conductor screen with an OLD START you can cause the saved table images to be restored from disk. nn is the screen number from which the OLD is to take place. This is much shorter than a LOAD for a lengthy piece of music. When doing this, remember to use the Word START on the beginning of the conductor screen.

Multiple Conductors for One Piece

The technique shown above is also useful if you want to play the same piece with several different interpretations. Simply create a different conductor for each interpretation. If some of the voicelines differ, you can add additional voicelines as well after the OLD. Basically, OLD will restore to the tables exactly what they contained when you SAVED them. If you prefer, the Word LOAD can also be used to perform some of this flexibility. If different mixtures of voicelines are needed for different interpretations, you may want to use the LOAD command at the beginning of the conductor screen to cause each of the desired voiceline screens to be LOADED.

How to Effectively Use Overtones

If you are familiar with or play the organ, you know that a single key on the keyboard can cause notes at several pitches to be generated simultaneously and automatically. The pitches that are commonly added are an octave lower than the played note, an octave higher than the played note as well as an octave and a fifth higher, two octaves higher etc.

With the FORTi system, you have similar capabilities. You simply add additional "musicians" playing the same voiceline, but at different pitches and frequently with different envelopes and dynamic (loudness) levels. The following table shows the FORTi words used to create each of the required pitches for a large number of overtone pitches.

TABLE 8-1

Word Sequences For Overtones

Words	Organ Designation
-OCTAVE	16'
+OCTAVE	4'
+OCTAVE +FIFTH	2-2/3'
+OCTAVE +OCTAVE	2'
+OCTAVE +OCTAVE +FIFTH	1-3/5'
+OCTAVE +OCTAVE +OCTAVE	1'

Note that if you ask the FORTi system to go too high, it will break back an octave (play an octave lower than you requested). A similar thing happens if you attempt to play too low. This is especially noticeable if you play very deep bass on an =TREBLE voice as A110 is the lowest pitch that can be generated this way.

Single Stepping

You may have already discovered that FORTi holds at what ever it is doing if you hold the space bar while the music is playing. This is intentional and can sometimes be valuable when debugging voicelines. This capability along with the ability to play very slowly with the conductor is a great asset when attempting to find that one last wrong note.

Using FORTi With Two or Three Disks

The FORTi system can be used with more than one disk drive. Always remember that a FORTi disk with Screens 0 to 39 must be in DSK1 regardless of what is in DSK2. Because of the way in which the disk system operates, the catalog for the FORTi disk is actually located on the first Screens of the disk. If you place a FORTi disk in DSK2, you can examine the entire contents as Screens 100 through 189 (and DSK3 as Screens 200 through 289). If you wish, you can use all these screens. It is recommended, however, that you not use the first two screens on either DSK2 or DSK3. By leaving these in tact, the disks will remain copiable with the Disk Manager. Also note that the system portion of the FORTi disk may be over-written when it is used in one of the higher numbered drives.

It is recommended that if you use multiple disks, that you keep them in sets and treat the set as one large disk. In this way the ALBUM and indexing scheme described in the previous chapter will still work well. A reasonable approach is to keep the source Screens on the higher drives and the SAVED tables on DSK1. In this way you can use only a single diskette to play an album. Because of the internal buffering of diskette data that takes place in FORTi, you should never change diskettes in any of the

drives without typing FLUSH before changing diskettes. This will cause the FORTi system to remove any data stored in its internal buffers.

CHAPTER 9

FOR THE VIRTUOSO PROGRAMMER

This chapter touches on a number of topics. The subject matter presented here was not introduced in earlier chapters because to do so would have made the presentation of the basics of FORTi more complicated. It is thus expected that you are now a FORTi programmer in that you have created at least 2 small FORTi works.

Grace Notes

A grace note is a very short decorative note that "steals" time from the preceeding note. If the duration of a grace note was to be as a thirty-second note for example, and this note was to follow a quarter note, the following rather cumbersome notation could be used:

E. A T TH A B ...

Where the dotted eighth tied to the thirty-second note is the shorted quarter note and the B is then the desired grace note. The above representation is "ugly" in that it is cumbersome if it must be used frequently and it is not an accurate representation of the musical score. In addition, things get more complicated if at a later time you decide that the grace note's duration really should be longer or shorter than a thirty-second note.

Two special words are supplied to solve these problems: =GR and GR . =GR should be preceeded by a duration and is typically used only at the beginning of a piece. It sets the duration that grace notes will receive. If we have used TH =GR to set the grace note duration to a thirty-second note, the above music becomes:

QU A GR B

The table building actions involved are that the word GR has subtracted the duration of a grace note (as previously defined by =GR) and has changed the duration to GR (here a TH). Because GR performs a subtraction from the previous note duration, figures like mordents can be created by using several GR's. Such a figure could be coded:

S4 =GR QU B GR GR GR GR C D C B QU C

Where C D C and B are all decorative notes of a sixty-fourth note duration. The time to play them was stolen from the quarter-note B. The quarter-note C is played on the beat just as if the decorative notes were not present.

In the case where a voiceline begins with a grace note, DO NOT encode it this way. There is no note from which to subtract the necessary duration and a malformed table will result. In such a case the voiceline should either have the grace note coded as any other note or begin the piece with a rest and have the grace note steal time from the rest.

Fermatas

A fermata is when a note is held and the forward progress of the music stops for some period of time. The Words FERMATA and =FERMATA are used in FORTi to implement this. The implementation in FORTi is for time to be made to stand still for all the "musicians" and for the conductor to continue to beat time (in order to determine how long the fermata is to be held). =FERMATA is used to define how much additional duration is to be added to the note or rest being held. The Word FERMATA invokes the action in the conductor. An example is given below.

HA =FERMATA WH RE RE QU RE RE RE FERMATA RE

In this example the held note is the last quarter note of the third measure shown. Each of the musicians will be holding the note that they have at the beginning of that fourth beat. After a period of time equal to a halfnote, they will finish that note. That is if the "musician" had a quarter note as the last note of that measure, it would receive the equivalent of 3 beats. Also note that envelope processing takes place during the fermata, so tremolos and other envelope characteristics will be heard.

When coding chorale type music where the music has a slight break between musical phrases, try adding a short rest between then phrases in each of the voicelines. You can then use a FERMATA in the conductor when the "musicians" are playing the rest and easily adjust the length of the pause between phrases. Remember that =FERMATA can be used between uses of FERMATA to change the length of the hold.

Creating New Durations

Each note in the FORTi system has a duration that is measured in units such that the note values provided in the system have the following number of these units.

rhythm that is desired. The pitch that is used will affect the sound that is produced as will the envelope that is assigned to the drum "musicians". High pitched notes with a short envelope can be used to imitate a snare drum. Experimentation is the only real way to find out how to effectively use this ability.

Note that it is possible to use different pitches in the voiceline for the drum and that this causes the percussion sound to change from note to note. When experimenting with the effect of pitch on the percussive sound, try using the Words +OCTAVE etc in the conductor to make the pitch changes.

Expression Using Envelopes

Musical expression frequently involves getting louder when holding a long note. Musicians frequently do this automatically to add interest and vitality to the music they are performing. A method of performing this in FORTi that is easier than using the dynamic level Words of FORTi is to use an envelope that has this characteristic built in. The effect desired is a very gradual crescendo or a very gradual increase in the amount of tremelo added to a note. An envelope demonstrating this technique for the case of increasing tremelo is shown below:

```
<ENV: SWELL/TREM 14 12 11 10 9 8 8 8 8 8 8 8 8 8 8 8 8 9 9 9 8 8 8
8 9 9 9 8 8 8 8 9 10 9 9 8 7 8 9 10 9 9 8 7 8 9 10 11 10 9 8 7 8 9
10 11 10 9 8 7 53 =REPEAT.6 4 3 2 1 1 ENV>
```

The 53 =REPEAT causes the repetition of the last 8 loudnesses preceeding the repeat. Remember that the envelope list must have fewer than 125 entries. The above envelope is about half the permitted length.

Major/Minor Changes

Changes from major to minor are easy to test by changing the key signiture so that three flats are added, three sharps subtracted or a combination of sharps subtracted and flats added. You may also have to use some naturals in your voiceline to gain a pleasant minor effect.

Staccatos and Accents

Stacatto notes are most easily accomodated by selecting envelopes that have a long tail that has the sound turned all the way off (level 0).

Accented notes can be done by changing to an envelope with a louder attack or by changing the dynamic level to something louder for the notes with the attacks.

Phrases

Frequently a musical phrase is used repeatedly in a piece, but not

Table 9-1

Duration Word	Value
WH	192
H.	144
HA	96
Q.	72
3H	64
QU	48
E.	36
3Q	32
EI	24
S.	18
3E	16
SI	12
T.	9
3S	8
TH	6
3T	4
S4	3
RF	1

An examination of the above table will show that the durations are all the proper mathematical relationships for their musical representations. Occasionally, it is necessary to have still other durations. One such case may be the need to play 5 notes (of equal duration) in the time period where 4 eighth notes would normally be played. According to the above table, 4 eighth notes would require 4 times 24 or 96 units of time. To play 5 notes during the same time would require each note to have 19.2 units of time. We can invent a name for this duration and assign the value 19 to it (only integers are permitted) as follows:

```
19 DEFDUR SE
```

where the name assigned to this duration is SE. This assignment CANNOT be made inside any other definition. It is best if this type definition is done immediately after the START. The Word DEFDUR can be used in this manner to define other durations. A duration cannot exceed 255. You noticed that the value of 19 units of time was slightly short (5 times 19 is 95 not 96). When using such non-standard time increments, you must make up the difference, or the "musician" playing the defined durations will get very slightly ahead of the other musicians (by exactly 1 unit of time). It is easiest to tie either the first or last note of the 5 note series to a note of duration RF to again line-up all the "musicians" timewise.

Use of =DRUM for Noise

Percussive, effects can be added to FORTi music by using the =DRUM directive in the conductor with any of the special "musicians" (3, 6, 9 or 12). These "musicians" must have a voiceline to play, but it is usually a series of notes, each at the same pitch and of the

> so regularly that much is gained by using R: :R . It may also be difficult to use the large number of voicelines and the complex conductor necessary to avoid retyping the repeated phrase whenever it occurs.

FORTi provides a mechanism whereby a musical phrase can be named and reused as necessary in the voicelines. The actions taken are similar to the expansion of a macro in a macroassembler, that is, after the phrase has been defined, each time the phrase name is encountered, FORTi will substitute the definition of the phrase (character by character) at the location of the phrase name. The FORTi words used are <PHRASE: and PHRASE> .

The phrase must be named by providing a FORTi style name after the <PHRASE: . This is followed by the definition of the phrase and then the PHRASE> . Phrase definitions must NOT be embedded in any other definition, voiceline etc.

The following is an example of how this might be used:

```
<PHRASE: BOOGIE-C EI C E G AA BB$ AA G E PHRASE>
```

```
.  
. .  
. .
```

```
0 OCTAVE BOOGIE-C -1 OCTAVE BOOGIE-C ...
```

Remember that the use of the phrase name (BOOGIE-C) results in a character by character substitution. For example if the EI duration had not been included in the phrase definition, then the notes would have been played with whatever the duration was when the phrase name was encountered. This type of coding will work well for many bass guitar parts.

Printing FORTi Screens

FORTi screens can be printed on your printer with the FORTi Word PRINT . PRINT expects to be preceded by two parameters which are the first and last screen numbers of a sequence of screens to be printed. When PRINT executes it will prompt for your printer device name. You must respond with something like RS232.BA=4800 . You can request that FORTi PRINT an entire disk by giving the first and last screen numbers. This will work even when FORTi table images are on the disk because FORTi will skip any screen containing any non printable characters. All the table images contain nonprinting characters. You will not be able to print multiple disks with a single command as the screen numbers between disks will cause the PRINT to stop when it encounters the disk error caused by this access.

Command Line Conductors

Anything that can be entered into FORTi with the editor can also be done from the command line. Most things are too cumbersome to do this way and the user must also ensure that the proper overlays are in place. One situation where it is easy to apply this

technique, however, is to create simple conductors for the purpose of checking out voicelines. Even if a conductor is already present, it is possible to add additional conductors. Only the last one created will be functional.

Cancellation

It is not recommended that two or more identical music lines be played through a single audio channel. The mixing that is performed is very exact and sometimes the two "musicians" will be exactly out of phase with one another and will cancel each other out. This tends not to be a problem when complex musical passages happen to have several "musicians" playing the same note only occasionally.

APPENDIX 1

ERROR MESSAGES

Missing Parameter(s)

A word or command has been given with too few parameters.

Too Much Music - Memory Full - type NEW

Either the current piece is too large for memory or more than one piece has been LOADED and the sum of the pieces is more than memory can hold. Type NEW and reLOAD. Attempt to shorten piece.

Has Been Previously Defined

The Word echoed back before this message has already been found in the FORTi vocabulary of Words and commands. No action is usually necessary.

Disk error - Bad disk surface or bad screen number

Illegal copy operation has been attempted.

FORTi Internal Word Usage Violation

Most likely cause is misspelled Word or command.

Wrong # Parameters in <PHRASE:

This should result only from use of undocumented internal words.

File I/O error - possible bad print device name

Check the print device name and correct it.

Attempting to write to protected disk region

Attempting to save data to a screen not allocated for user screens.

Must LOAD from a source screen

Self-explanatory.

Wrong parameter usage in <PHRASE ... PHRASE>

Too few or too many parameters used between <PHRASE: and PHRASE>.

<ALBUM...ALBUM> Error

Malformed Album definition. Check syntax.

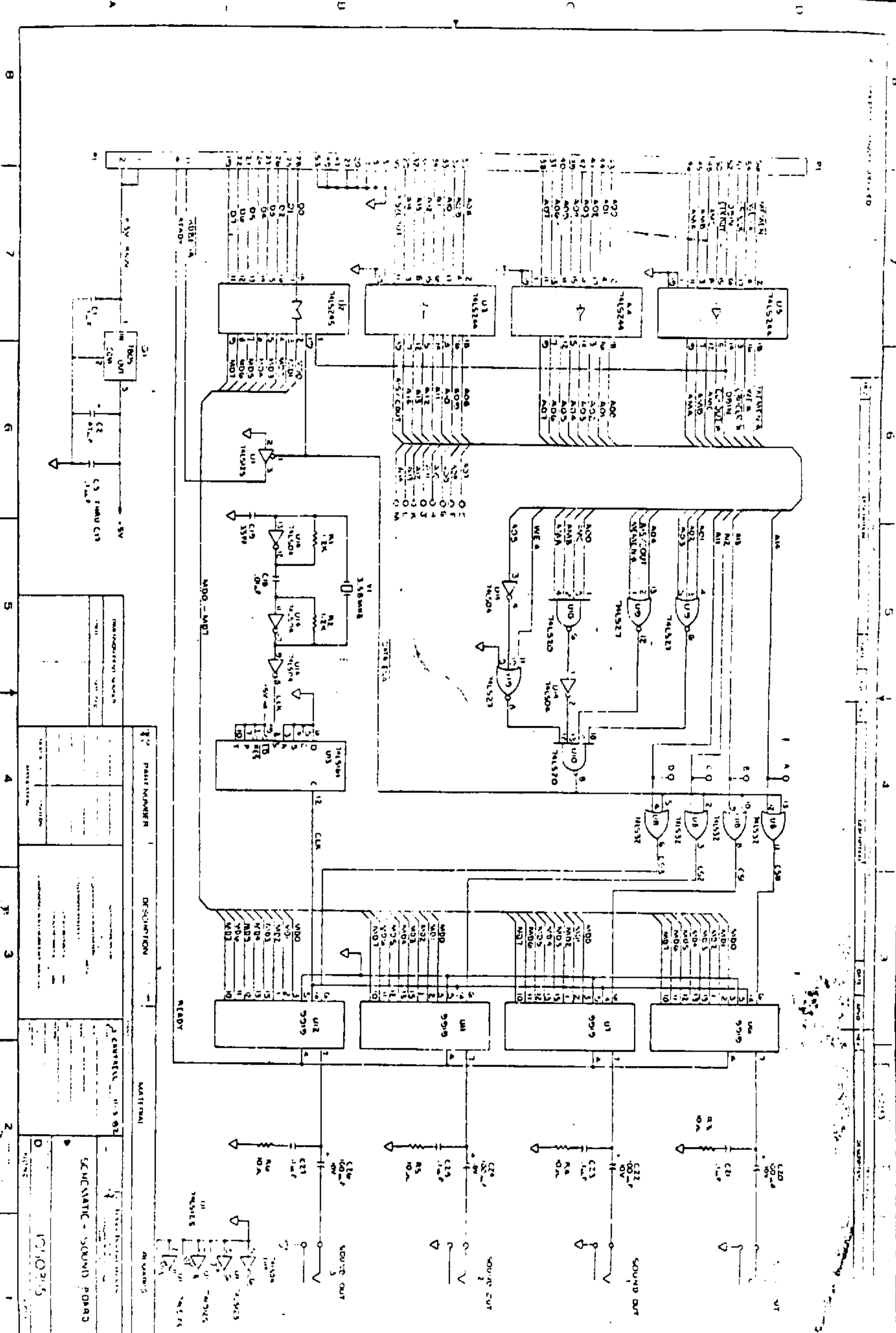
FOPT: Parts List

U1	74LS125
U2	74LS245N
U3, U4, U5	74LS244N
U6, U7, U11, U12	SN76494N (TMS9919)
U8	74LS32N
U9	74LS27N
U10	74LS20N
U13	74LS161A
U14	74LS04N/BCB
Q1	7805
C1, C3-C17, C21, C23, C25, C27	.1 mfd @35v
C2, C20, C22, C24, C26	47 mfd @35v
C18	.01 mfd @35v
C19	33 pf @35v
R1, R2	1.2 K ohms
R3-R6	10 ohms
R Mixer * 6	390 ohms
1-PCB	1050354-1 (TI)
CLAM SHELL SET	(TI)
J1-J4	RCA PC/JACKS
EDGE CARD CONNECTOR	TI #L2111121-30

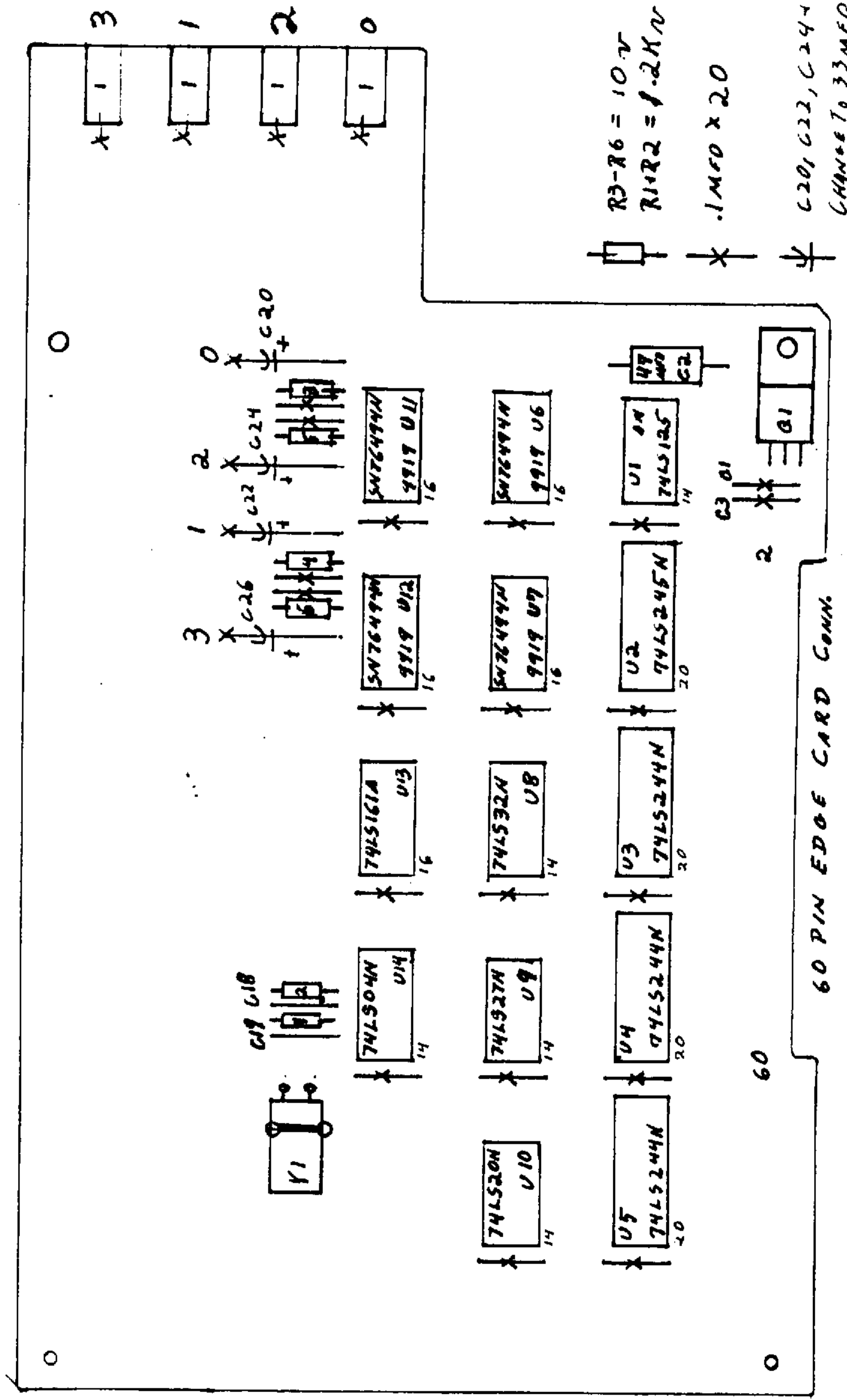
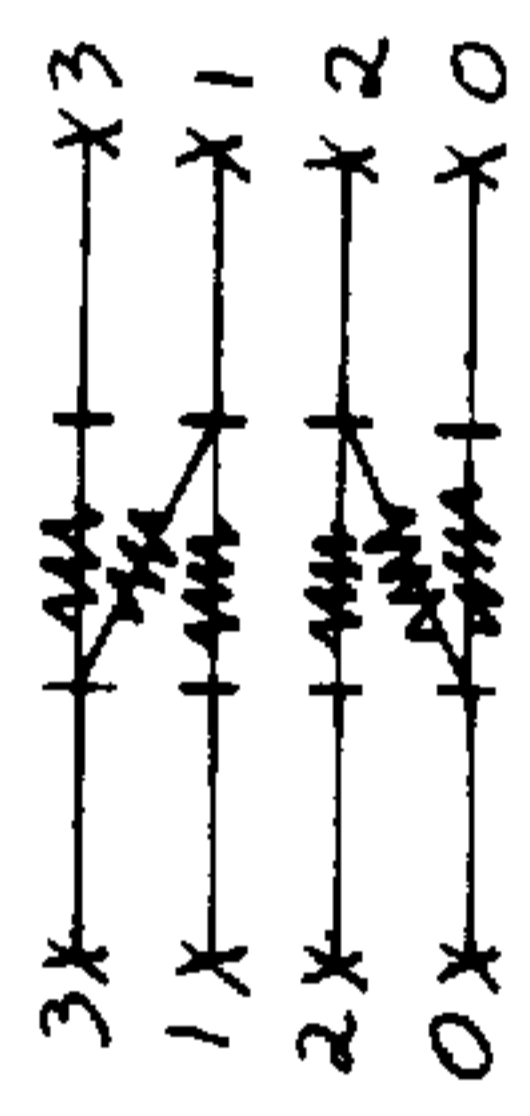
OPTIONAL:

IC SOCKETS:

4ea	20-PIN
5ea	16-PIN
5ea	14-PIN
3ea	NUT & BOLT



STEREO MIXER
6-390NF
VSE OUTPUT
#1+2



C18 - .01 MFD
C19 - 33 PF

**ForTI Card on a 9640?
From Delphi's Message Base**

BCS TI-99/4A Newsletter

The following information is taken from the message base on Delphi. It contains information about how the ForTI twelve voice music card's hardware appears on the 9640. I do not know of anyone who is successfully using a ForTI on the 9640. Can anyone out there help?

Like the speech synthesizer, the ForTI card is located at page >BC. It is not fully decoded, and therefore could respond at pages >3C, >7C, and >FC as well. Here is the ForTI address bus mapping:

Address bit	Source	Selects	Address	Sound Chips Selected
AME.A	NC	X	>8400	ALL
AMD.A	NC	X	>8402	2-4
AMC.A	Mapper	1	>8404	1, 3, 4
AMB.A	"	1	>8406	3, 4
AMA.A	"	1	>8408	1, 2, 4
A0	"	1	>840A	2, 4
A1	"	0	>840C	1, 4
A2	"	0	>840E	4
A3	9995	0	>8410	1-3
A4	"	0	>8412	2, 3
A5	"	1	>8414	1, 3
A6	"	X	>8416	3
A7	"	X	>8418	1, 2
A8	"	X	>841A	2
A9	"	X	>841C	1
A10	"	X	>841E	None
A11	"	CE4	active LOW	sound chip 4 enable
A12	"	CE3	"	" 3 "
A13	"	CE2	"	" 2 "
A14	"	CE1	"	" 1 "
A15	"	0		

On the 99/4A, writing to >8400 will load data into all ForTI sound chips as well as the console sound chip. Writing to any ForTI sound chip will also write to the console sound chip, I think. The only way to write to the console sound chip without writing to the ForTI sound chips is by using address >841E. Note that the states of A6-A10 do not matter, such that >8400, >8420, >8440, >8460, etc., are all equivalent ways of accessing ALL sound chips, and so forth.

Jeff White

P.S.: When I put >BC at >8004 in the GPL mapper, the system stops.

