Orchestra-90

Stereo Music Synthesizer with Percussion for Model III Special Composer's Edition

DISTRIBUTED BY

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TABLE OF CONTENTS

INTRODUCTION

ORCHESTRA-90 is a unique combination of hardware and software that can turn any **16K TRS-80* MODEL III Microcomputer** into a high quality stereo musical instrument.

The hardware is a single printed circuit board that plugs into the I/O expansion connector on the **TRS-80**. The board contains two precision digital-to-analog converters and associated electronics to change the binary computer output into a stereo audio signal. The output of the board is connected to the **AUX/TAPE/TUNER** input of any stereo audio amplifier. (Cables not supplied.)

The software consists of five major components integrated into a single, easy to use, program.

1. Digital Synthesizer

The synthesizer has a six octave range and can produce up to five simultaneous notes or voices in two stereo channels. Each voice can be assigned to any of five user-defined tone color registers. The default tone color registers mimic the sound of a trumpet, oboe, clarinet, violin and pipe organ. The registers are easily altered to imitate other instruments, even percussion, or to make strange new sounds.

2. Music Language Compiler

The music language was designed to allow the direct transcription of virtually any written music to a symbolic form used by the computer. Non-musicians will find the language simple to learn and easy to use since no previous musical training or knowledge is required. Yet, in spite of its simplicity, the language has all the features and capabilities required by the advanced computer musician.

The compiler will accept music written in any key or time signature and any note value within the synthesizer's range from whole notes to sixty-fourth notes. Notes may be single, double or triple dotted and/or played as triplets. All forms of accidentals, single and double, are supported as are staccato, pizzicato and two forms of articulation. There is also the capability of repeats, second ends (with or without retard) and modulation.

3. Editor

A full function, 'full screen' text editor is provided to ease the task of entering and modifing music language programs. A full screen of text is viewable at all times and a blinking cursor can be positioned anywhere within the file. All cursor motion keys automatically repeat when held down. Additional functions include insert/delete character, insert/delete line, and global character string search.

4. File Manager

The file manager provides the orderly storing and retrieval of named program files on tape or disk.

5. Initialization

The initialization routines allow the user to select a three, four or five voice version of the synthesizer and to choose either the standard (2 MHz) or enhanced (4 MHz) CPU clock rate.

Because all of the software components are integrated into a single program, a great deal of inter-module communication is possible. For example, when a syntactical error is encountered during compilation, an error message is displayed and the editor is called to display the file with the cursor positioned exactly where the error was detected. The user simply corrects the error and returns to the compiler. There is also a multi-function command that allows a sequence of music programs to be read into memory, compiled and played, one after another.

ORCHESTRA-90 is available in versions for tape or disk. Each version includes several sample music files and **ORCHUTIL**, a utility program for tape/disk transfer, music file packing, ASCII/Binary conversion and Model I/III tape conversion. The minimum system required to run either version is a 16K Model III Level II or disk system.

*TRS-80 IS A TRADEMARK OF THE TANDY CORPORATION

INSTALLING THE INTERFACE BOARD

This section describes how to connect the interface board to your **TRS-80**.

WARNING The **ORCHESTRA-90** interface board contains static sensitive devices that can be damaged by careless handling. Handle the board as little as possible. Always **TURN OFF** the **TRS-80** before connecting or removing the interface board. Always **TURN OFF** the **audio amplifier** before making or breaking its connection to the interface board.

Observing the warning above, plug the free end of the flat cable into the 50 pin I/O expansion connector located on the bottom and rear of the computer. The flat cable and PC board should extend beyond the back of the computer.

The audio sockets on the board will mate with standard 'RCA type' phono plugs. (Audio cables with this type of plug are readily available at Radio Shack and most Stereo stores.) Connect one end to the phono sockets on the interface board. Connect the other end to the **AUX, TAPE, TUNER** or other high level inputs of a stereo amplifier or receiver. **DO NOT use the PHONO, MIC, or other low level inputs.** After all connections are secure, turn on the computer and the amplifier.

Certain machine instruction combinations, encountered during normal system operation, can trigger the interface board and may result in unexpected pops and clicks. Therefore, always keep the amplifier at minimum volume when not actually playing music.

There are no harmful voltages or currents on any of the exposed parts on the interface board. However, common sense and the warnings above suggest that the board not be touched, particularly with metal objects, when the computer is turned on. Doing so may damage the components on the board and possibly the computer.

When disconnecting the interface board, be sure both the computer and amplifier are turned off.

The small header connector supplied on the flat cable assembly should NOT be unplugged from the **Orchestra-90** PC board. The pins on this header connector are easily damaged. **Orchestra-90** does not interfere with normal computer operations and should be left connected unless the I/O connector is required for another peripheral.

CONFIGURING THE SOFTWARE

This section describes how to configure the software to your specifications.

The **ORCHESTRA-90** program is extremely versatile but very complex. In order to minimize the size of the running program, and thereby maximize the memory available for music, certain functions are performed only once when the program is first executed.

During this configuration phase you choose how many voices the synthesizer will support and if your TRS-80 has been modified for 4 MHz operation, you may instruct the program to take advantage of the faster clock rate. A five voice, 2 MHz synthesizer will have very limited high frequency response and is not recommended.

The generation procedure consists of a programmed sequence of steps. At each step the program will ask a question and wait for your answer. The range of acceptable answers will be displayed with each question. After typing your answer, press the **ENTER** key. If your answer is accepted, the program will proceed to the next step. If not, the question will be repeated until an acceptable answer is obtained. Your answer should not contain any leading or embedded blanks. Pressing the **BREAK** key at any time will clear the input line and allow you to retype your answer.

If you have not already done so, connect the interface board to your computer. If you have a disk system, go to **STEP 2**; **the first steps apply to tape systems only**.

STEP 0: Power up the system. Insert and rewind the cassette containing the programs for the tape version of **ORCHESTRA-90**.

A typical loading sequence follows:

CASS? H [Enter]	(cassette is recorded at 1500 baud)
MEMORY SIZE? [Enter]	(no reserved space needed)
Radio Shack Model III Basic	
READY	
>SYSTEM [Enter]	(the tape is system format)
***? ORC90T [Enter]**	(name of tape version file)
***? / [Enter]**	(begin execution)

When the program starts, the screen will be cleared, a copyright notice will appear on the bottom line and the first question in configuration dialog will appear in the middle of the screen with a blinking cursor on a line below it.

STEP 1
DUPLICATE? <Y/N> At this point you may request the program to make a back-up copy of itself. If you answer **N**, the program will proceed to **STEP 3**.

Before answering **Y** make sure that you have a blank cassette in the cassette deck and are in record mode. The program will begin writing as soon as you press **ENTER**. Once the file is written, the program will return to the **DUPLICATE?** prompt.

STEP 2 **This step applies to disk systems only.**

Power up the system and load the program. A typical loading sequence follows:

DOS READY	
ORCH90 [Enter]	(load and execute the program)

When the program starts, the screen will be cleared, a copyright notice will appear on the bottom line and the first question in configuration dialog will appear in the middle of the screen with a blinking cursor on a line below it.

STEP 3
FAST CLOCK? <Y/N>

If your TRS-80 has been modified for 4 MHz operation answer **Y**. Otherwise, answer **N** and proceed to **STEP 7**.

STEP 4
SOFTWARE CONTROL?<Y/N>

There are two ways to activate the clock speed-up modification; hardware, usually a switch, or software, usually outputting a certain value to a certain port. If your speed-up modification is controlled by software, answer **Y**. Otherwise, answer **N** and proceed to **STEP 7**.

STEP 5
ENABLE CODE?

To make optimum use of a software controlled clock modification the program needs to know the instructions to execute to enable the fast clock. Enter those instructions, up to 8 bytes, in hexadecimal.

One popular mod is enabled from **BASIC** with **OUT 254,1**. In assembly language it is:

```
LD    A,1
OUT   (254),A
```

The hex machine code would be: **3E01D3FE**

STEP 6
DISABLE CODE?

It is usually necessary to disable the fast clock before reading or writing to tape or disk. If you tell it how, the program will switch to the standard clock rate before doing any I/O. Enter those instructions, up to 8 bytes, in hexadecimal.

One popular mod is enabled from **BASIC** with **OUT 254,0**. In assembly language it is:

```
LD    A,0
OUT   (254),A
```

The hex machine code would be: **3E00D3FE**

If you wish to do I/O with a fast clock, enter a **NOP** instruction: **00**.

STEP 7
HOW MANY VOICES? <3/4/5>

Enter the number of voices you want the synthesizer to support. Fewer voices will sound better and use less memory. Music arranged for more voices than the synthesizer supports will not cause any problems, the excess voices are simply ignored. **The five voice option is not recommended unless your TRS-80 has been modified for 4 MHz operation.**

STEP 8
SAVE PROGRAM? <Y/N>

The configured program is now in memory and is ready for use. Answer **Y** if you wish to save this configured program image and avoid the lengthy dialog in the future. Otherwise, answer **N** to begin execution of the program, **STEP 11**.

STEP 9
PROGRAM NAME?

Enter the file name to be used to save the program. A three voice synthesizer based on a fast clock might be named **ORCH3F**.

TAPE version: maximum length is six characters.

DISK version: maximum length is eight characters followed by drive number. The extension **/CMD** will be supplied by the program, i.e. **ORCH3F:0**.

STEP 10

This applies to **TAPE** systems only.

The next file on the cassette is **ORCUTL**, the utility program. Use the **SYSTEM** command to load this program. Then make a duplicate copy as explained in **STEP 1**.

Replace the original cassette before proceeding to the next step. The next four files on the cassette are the sample music files **GYPSY**, **ENTRY**, **CZAR** and **RACES**.

STEP 11

If you have not used the **ORCHESTRA-90** before, you are probably anxious to hear what it can do. Type:

```
GET GYPSY [Enter]
```

to load and play the music called **GYPSY**.

USING THE SYSTEM

This section describes the command structure.
First, some definitions:

Command Line	The first line on the video screen.
Status Line	The second line.

There are two modes of program operation: **Command Mode** and **Edit Mode**.

Command Mode	Distinguished by a blinking line cursor on the top line of the video screen.
Edit Mode	Distinguished by a blinking block cursor in the middle of the screen.

In either **Command** or **Edit Mode** the following control keys are available:

BREAK	Terminates the current process and enters **Command Mode**.
Shift BREAK	Interrupts the current process and enters **EDIT Mode**.
CLEAR	Erases the character at the cursor and everything to the right of it on the line.
Shift CLEAR	Deletes the entire line.
ENTER	Accepts the current line as command or edit input.
Left Arrow	Moves cursor to the left.
Right Arrow	Moves cursor to the right. Note: Left and right cursor movement will wrap around at the logical end of line.
Shift Left Arrow	Deletes the character under the cursor and shifts the remainder of the line to the left. The cursor does not move.
Shift Right Arrow	A space is inserted under the cursor by shifting the character at the cursor and the remainder of the line to the right. The cursor does not move and any character shifted off the end of the line is lost.

In **Edit Mode** these additional control keys are available:

Up Arrow	Moves the cursor to the line above the current line; towards the top or beginning of the file.
Down Arrow	Moves the cursor to the line below the current line; towards the bottom or end of the file.
Shift Up Arrow	Joins the current line to the one above it making one long line. Effective only if the cursor is at the beginning of a line.
Shift Down Arrow	Forms a new line beginning with the character at the cursor.
Question Mark	Makes a copy of the current line and inserts it at the end of the file.
Exclamation Mark	Moves the current line up one position towards the top or beginning of the file.

The latter two control keys are used to rearrange and/or duplicate parts of a file.

All keys will repeat at a rate of about ten per second if held down for more than a half second.

COMMAND MODE

All system commands consist of a keyword optionally followed by one or more operands. Operands are separated from each other and from the keyword by one or more spaces. The keyword may be abbreviated (only the first character is significant) but may not contain any leading or embedded spaces. Unrecognized commands are answered with a ? in the status line.

NEW Delete current file in memory, reset all pointers and begin new file.

TOP Move file pointer to the top or beginning of the current file and display it.

BOTTOM Move file pointer to the bottom or end of the current file and display it.

EDIT Enter **Edit Mode** with current file pointer.

/<string> Where **<string>** is any character string. Search the entire file for a matching character string starting with the character to the right of the file pointer. If a match is found, position the file pointer there. If no match is found, display a **?** in the status line and file pointer does not move.

—<string> Similar to '/' above except the search is made toward the beginning of the file. Both '/' and '—' are auto-repeat commands. That is, the command line is not cleared after execution. This allows you to search forwards and/or backwards for each occurrence of a string by holding down the **ENTER** key.

READ filename **TAPE version:** The tape is searched for a matching filename. When found, the file is read into memory replacing any previous file there. An asterisk (*) in the file name will match any character. **READ *** will read the next file on the tape regardless of its name. **READ xx*** will read the next file with a name begining with **xx**. During the search, the name of each file encountered will be displayed in the status line. The operation may be terminated at any time by holding down the **BREAK** key. (The tape must be non-blank and moving.)

DISK version: The disks are searched for a matching filename. When found, the file is read into memory replacing any previous file there. If not found, an error code is displayed in the status line. The filename may be followed by a drive number. The file extension is always **/ORC**.

WRITE filename **TAPE version**: The current file is written with the filename given.

DISK version: The current file is written with the filename given. The filename may be followed by a drive number. The file extension is always **/ORC**.

APPEND filename Similar to '**READ**' above except the new file is **APPENDed** to the **BEGINNING** of the file already in memory.

DIR n **DISK version only:** Displays directory of disk **n (0,1,2,3,)** listing all files with an extension of **/ORC**.

KILL filename **DISK version only:** The named file is deleted from the disk directory. The filename may be followed by a drive number. The file extension is always **/ORC**.

QUIT Returns to **TRSDOS (DISK)** or **LEVEL II BASIC (TAPE)**.

LIST Prints the current file beginning with the current line. Printing may be terminated at any time by holding down the **BREAK** key.

SCORE **Compiles** the current file into the binary form required by the synthesizer. After successful compilation an internal **TOP** function is performed. If an error is encountered, compilation is terminated, an error code is displayed in the status line and the file is positioned with the file pointer at the place where the error was detected.

If there is not enough memory to hold both the source file and the compiled object code at the same time, the program will pause and display the question **OVERLAP?** in the **status line**. If you answer **Y**, compilation will resume and portions of the source file will be **OVERLAPed** by the object code. Answering anything else will cancel the compilation and enter the **command mode**.

This function is useful when compiling large files as the end of the object code can **OVERLAP** the beginning of the source code. **DO NOT OVERLAP** a file that has not been saved on disk or tape since this function implies the probable destruction of the current file. Do not expect to be able to use it in any way once this command is given.

PLAY nn Directs the synthesizer to **PLAY** the most recently **SCORED** object code starting with **PART nn**. If **nn** is omitted, the entire piece is played. An error message will be displayed if the **PART** cannot be found or if the text file was not recently **SCORED**.

The numeric keys on the keyboard can be used to control the operation of the synthesizer while a piece is being **PLAYED**. Keys 1-7 control the **TEMPO**. Holding down any combination of these keys form a binary weighted value which replaces the default tempo programmed in the music. Key 7 is the most significant bit and key 1 is the least. See the section on Tempo Conversion for more details.

The 0 key will stop the synthesizer and enter command mode.

GET file1 file2 file3.... This is a multi-function command. It will perform a **READ**, **SCORE** and **PLAY** for each of the files named. **OVERLAP** will be performed automatically, if necessary.

DISK version: Filenames may be followed by a drive number just as in the **READ** command.

TAPE version: Filenames may contain * as in **READ**. In addition, an at-sign (@) will match any character, repetitively. **GET @** will **READ**, **SCORE** and **PLAY** all files on the tape.

MULTI file1 file2 file3.... **DISK version only:** This command is a perpetual '**GET**'. Useful in background music applications.

EDIT MODE

Perhaps the easiest way to learn how to use the **Text Editor** is to experiment with it. Review operation of the cursor control keys. Since all the keys repeat when held down, try to use a light touch: the keyboard is fully debounced.

Notice that:

1. The cursor always remains on the same screen line and that the file moves up and down around it.
2. The insert character function (**Shift Right Arrow**) adds spaces to the current line and will shift characters off the end of the line.
3. The **Editor** always knows how long each line is and will not go beyond the last character.
4. A **Shift Up Arrow** will un-do only one previous **Shift Down Arrow**.
5. Using the **Shift-BREAK** to enter the **Editor** does not clear the command line. This allows you to search for a character string, enter **Edit Mode** to make changes, exit **Edit Mode** and search for the next occurrence of the same string without retyping the command line.
6. If you make a mistake while editing and have not moved the cursor from the line, **Shift-BREAK** will cancel all changes and return the cursor to the beginning of the line.

COMMAND SUMMARY

CONTROL KEY	FUNCTION
BREAK	Return to **command mode.**
CLEAR	Erase to end of line.
Shift BREAK	Enter **EDIT MODE.**
Shift CLEAR	Delete current line.
ENTER	Accept the current line.
Left Arrow	Move cursor left.
Right Arrow	Move cursor right.
Shift Left Arrow	Delete character.
Shift Right Arrow	Insert space.
Up Arrow	Move cursor up.
Down Arrow	Move cursor down.
Shift Up Arrow	Join line.
Shift Down Arrow	New line.
Question Mark	Duplicate line.
Exclamation Mark	Move line up.

COMMAND	OPERAND	FUNCTION
/	**<any string>**	Search forward for next occurrence of string. (Auto-repeat)
—	**<any string>**	Search backward for next occurrence of string. (Auto-repeat)
APPEND	**filename**	Append the named file into memory at the beginning of the current file.
BOTTOM	(none)	Position file pointer at the end of the file.
DIR	**0**, **1**, **2**, or **3**	List all **/ORC** files on the disk named in the operand. Default = **0**.
EDIT	(none)	Enter **Edit mode.**
GET	**filename ...**	**Read**, **Score** and **Play** each of the files named in the operand.
KILL	**filename**	Delete the named file from the disk.
LIST	(none)	Print the current file on the printer.
MULTI	**filename...**	Perpetual **GET.**
NEW	**(none)**	Erase current file.
PLAY	**Part number** or **blank**	Play the current piece starting with the part number in the operand or at the beginning if no operand.
QUIT	(none)	Return control to **TRSDOS** or **LEVEL II.**
READ	**filename**	Read the named file into memory.
SCORE	(none)	Compile the current file.
TOP	(none)	Position the text pointer at the beginning of the file.
WRITE	**filename**	Write the current file with the name in the operand.

SPECIAL COMPOSER'S COMMANDS

The **Special Composer's Edition** software contains three powerful commands to ease the task of entering and debugging music. All three are entered from the **Command** mode and are variations on the **SCORE** function.

!
Score and Play from Cursor

Scores and plays from the location of the cursor. This command is used to preview the last measure or two of a piece being entered or arranged. Position the cursor to the beginning of any line in the file, then enter the **!** command. The piece will score and play from that point. To replay this section immediately, enter **P**.

This command allows faster entering and testing of music for two reasons. First, the file may be played from any point regardless of whether a **Part Number** exists there or not. Second, the notes preceding the cursor location are ignored during compilation which reduces the compile time considerably, producing an almost immediated play.

@
Where It's At

Advances the cursor to the position in the file at which the last "stop" occurred (using the **0** key). This command is used to locate errors heard during play.

Play the piece and press the **0** key as soon as the wrong note is heard. Then enter the **@** command and the cursor will be positioned at the beginning of the **measure**, **part** or **repeat** following the note actually playing when the synthesizer was stopped.

NOTE: The **@** command will not work following the **!** command; only after a piece has been Scored and Played normally.

?
Register and Voice Status

Displays the variables (register and voice transposition) associated with each voice at the location of the cursor. Position the cursor anywhere in the file, return to the command mode using the **BREAK** key and enter the **?**. The variables will be displayed on the **Status Line** (the second line from the top of the screen).

NOTE: This command, like the **@**, does a partial compilation making it necessary to re-score the piece before it can be played again.

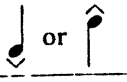
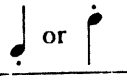
MUSIC LANGUAGE SUMMARY

The Music Language is processed as a single, free format, string of symbol groups. All spaces and line boundaries between symbol groups are ignored. A symbol group consists of a single character symbol and is optionally followed by one or more symbol modifiers.

Unless otherwise specified, all numeric data is hexadecimal.

NOTE SYMBOL	MUSICAL NOTE NAME	STAFF POSITION (see Figure 3)
+G	E	
+F	D	
+E	C	High-C
+D	B	
+C	A	
+B	G	
+A	F	
+9	E	
+8	D	
+7	C	Treble-C
+6	B	
+5	A	
+4	G	
+3	F	
+2	E	
+1	D	
0	C	Middle-C
-1	B	
-2	A	
-3	G	
-4	F	
-5	E	
-6	D	
-7	C	Bass-C
-8	B	
-9	A	
-A	G	
-B	F	
-C	E	
-D	D	
-E	C	Low-C
-F	B	
$	REST	(any)

NOTE MODIFIER	MUSICAL EXAMPLE	NAME
#	♯	ACCIDENTAL SHARP
&	♭	ACCIDENTAL FLAT
%	♮	ACCIDENTAL NATURAL
##	♯♯	DOUBLE SHARP
&&	♭♭	DOUBLE FLAT
%#	♮♯	NATURAL SHARP
%&	♮♭	NATURAL FLAT

EXPRESSION MODIFIER	EXAMPLE	NAME
, **(comma)**		SHORT STACCATO
; **(semicolon)**		LONG STACCATO
' **(apostrophe)**	(none)	SHORT ARTICULATION
" **(quotation mark)**	(none)	LONG ARTICULATION

TIME VALUE SYMBOL	MUSICAL EQUIVALENT	NAME OF NOTE	REST ($)
W		WHOLE note	
H		HALF note	
Q		QUARTER note	
I		EIGHTH note 	
S		SIXTEENTH note 	
T		THIRTY-SECOND note 	
X		SIXTY-FOURTH note 	

TIME VALUE MODIFIER	MUSICAL EQUIVALENT	NAME
. (period)		DOTTED note
: (colon)		TRIPLET

SYMBOL	MODIFIER	DEFINITION
(	(none)	Begin REITERATION.
)	**hex digit**	REITERATE the number of times specified by the modifier.
*	(none)	Unless otherwise indicated, all the NOTES following are assumed to be + or TREBLE clef.
/	(none)	Comments. The remainder of the line is ignored.
<	**hex digit**	All the NOTES in the current and following MEASURES are transposed DOWN the number of semi-tones specified by the modifier.
=	**2-digit hex**	Set TEMPO to value of modifier.
>	**hex digit**	All the NOTES in the current and following MEASURES are transposed UP the number of semi-tones specified by the modifier.
@	(none)	Unless otherwise indicated, all the NOTES following are assumed to be – or BASS clef.
_	(none)	All the unsigned NOTES following are assumed to be PERCUSSION clef. This is the underline character (_).
J	**register name.** R or S, **nine hex digits**	Define the named REGISTER with the named wave-form type, description and volume.
K	**digit 0–7** and # or &.	Define KEY SIGNATURE by number and type specified by the modifier.
M	**any string** and a **space**	Define the beginning of a MEASURE. The current MEASURE is ended. ACCIDENTALS are dropped, the KEY SIGNATURE is restored.
N	H, Q, I, S or T	Define TIME SIGNATURE, set NOTE type in modifier to one BEAT.
O	**hex digit**	Set the OPTIONS to the value of the modifier.
P	**2-digit hex**	Defines the beginning of the PART named by the modifier. The current MEASURE is ended. The current PART is ended.
R	**2-digit hex**	REPEAT the PART named by the modifier. The named PART must be previously defined. This symbol group may be followed by a TEMPO group and/or REGISTER group. A MEASURE following a REPEAT must be defined by a new PART number.
U	**signed hex**	TRANSPOSE all the NOTES following that belong to the current VOICE up or down the number of whole steps indicated by the modifier.
V	1, 2, 3, 4 or 5	All the NOTES following are added to the previous NOTES of this MEASURE belonging to the VOICE named by the modifier.
Y	A, B, C, D or E	Set the current VOICE in the current PART to the REGISTER specified by the modifier.
Z	**hex digit**	Map the stereo channels as specified by the modifier.

INTERPRETING THE MUSIC LANGUAGE

This section will describe in detail the process of transcribing written music to **ORCHESTRA-90** notation. In order to interpret sheet music correctly we must understand musical notation. Included in this section are several extra charts and examples to help explain a few problems encountered during music system entry.

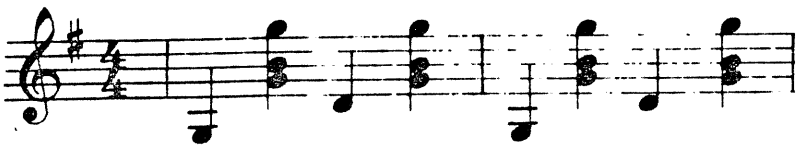
Your **ORCHESTRA-90** program (4-voice) should be loaded and executed according to the instructions previously explained in the manual. You should have a blinking cursor in the upper left corner of the screen and a copyright notice at the bottom.

To enter music we type:

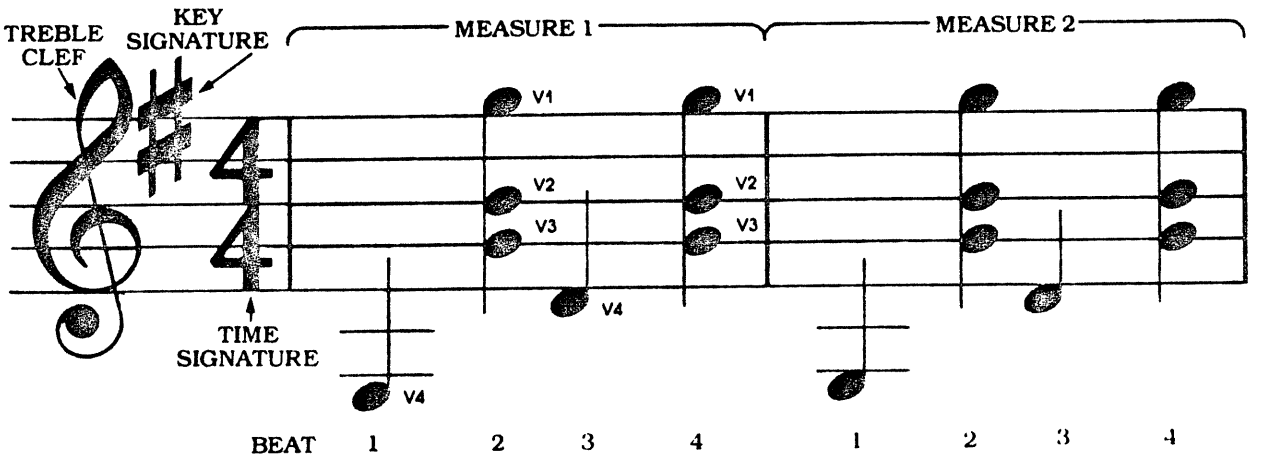
EDIT [Enter]

You now have a blinking white square in the center left section of the screen. The **E** in the upper left corner indicates **EDIT MODE**.

MUSIC SAMPLE 1, ACTUAL SIZE



MUSIC SAMPLE 1, ENLARGED



The long horizontal lines are called **Ledger Lines**. Together they are known as the **Staff**. Most of the information we are looking for may be found on the staff or on additional ledger lines added above or below the staff for extra high or extra low notes.

Reading from the left side of the ledger line we first encounter the **Treble Clef** symbol. All of the music in this example will be in the treble clef. The note symbols for the treble clef are found in **Figure 3**. The upper half of the diagram represents the **Treble Clef**, the bottom half is the **Bass Clef**.

To the immediate right of the treble clef we find a single **#** mark known as a **Sharp**. This one sharp tells us a very important fact about the piece of music, we now know what **Key** it is to be played in. One sharp is the key of G. We tell the system to play in the key of G by simply entering:

K1 # [Enter]

If you are wondering where the line numbers are, don't worry, we never use line numbers in this program. The next piece of information could be placed on the same line as the key signature, but for the sake of clarity we will use separate lines for each new item.

The next piece of information on the staff is the **Time Signature**. This consists of two numbers, one on top of the other, like a fraction.

The top number tells us the number of **Beats** in a **Measure**. A **Measure** is a section of the staff between two vertical lines which extend from the top line of the staff to the bottom line. This example has four beats per measure. 1 - 2 - 3 - 4. It's as simple as that. You will get the feel of the music beat by tapping your foot and counting out loud 1 - 2 - 3 - 4.

Next we examine the bottom number in the time signature which is another **4**. This **4** means that each beat in the music will be equal to a **Quarter-Note**. We have established that we have 4 beats in each measure and each one is equal to a quarter-note. Refer to the chart in the **MUSIC LANGUAGE SUMMARY SECTION** and make sure you know what this note looks like. This example contains all quarter-notes.

Okay, we know that there are four beats to a measure and that each quarter-note receives one beat. This is called **4/4 Time** or **Common Time**. We add a line to describe the **Tempo**, or how fast the music is to be played:

```
NQ=80 [Enter]
```

We just said that a note (quarter-note) will be equal to a time of **80** (hex). If you start out with this tempo value you can always change it later to speed-up or slow-down the piece. The speed can also be determined by holding down the number keys during play as described in the **TEMPO CONVERSION SECTION**.

Well, we explained quite a bit and all you have entered so far is:

```
K1#
NQ=80
```

We can pick up the pace a little now that we've explained music theory.

This piece is ideally suited for four **Voices**. We have added some of our own symbols to help you visualize how we relate notes to voices.

We tell the system what we want each note to sound like. The first time through we will use a different instrument sound for each voice. We have five standard sounds available; **A**, **B**, **C**, **D** and **E**

Try this:

```
V1YA V2YB V3YC V4YD [Enter]
```

We assigned sounds **A**, **B**, **C**, **D** to **Voices** **1**, **2**, **3**, **4** respectively.

Our music will begin with a **Part Number** which will contain one or more measures and can be repeated. Measures can not be repeated directly, only parts containing measures.

```
P01 [Enter]
```

Parts may consist of any two-digit numbers but must be unique.

Type in the first measure symbol but don't hit **ENTER** because we'll be putting the actual notes on the same line.

```
M01
```

All of the notes we are about to enter are in the treble clef. Refer to **Figure 3** for a reference chart of all the notes. The top section of the chart is the treble clef so we will use those numbers. Notice that all of the numbers are positive (**+**). To avoid putting a **+** in front of each number, we use an **Asterisk**, *****, which tells the system that all numbers entered after this symbol will be positive unless specified otherwise. Add a space and this symbol to the first measure line.

```
M01 *
```

We now determine the notes for the first voice. When we tell the system that the notes belong to a specific voice, we start out with a voice number like **V2**. Again, as a convenience, the first line in a measure is implied **V1** and the **V1** is not required.

As you recall, this music has four beats. You must picture each voice as being present throughout the entire measure even when it doesn't appear. During the other two beats the voice is resting. Most music will show an actual symbol to indicate a **Rest**, but occasionally you will find music like this that does not show all the rests. Don't worry, you learned how to count to four a few paragraphs back and we can make use of your new knowledge to solve this problem.

V1 has notes on beats 2 and 4 only, so beats 1 and 3 are silent and must be entered as rests. If we add:

```
Q$
```

We have entered two pieces of information using two new symbols. The **Q** means that all notes or rests which follow have the time of a quarter-note. **Q**=quarter-note. The **$** is the symbol for **Any Rest.** In this case it follows a quarter-note time value symbol, so the first beat becomes a quarter-note rest.

Next in **V1** we find our first note. Checking the scale in **FIGURE 3 we find the symbol for this note to be a B** so we add this to the line:

```
M01 *Q$B
```

After that we find that **V1** does not appear in the third beat of the measure, so we add another rest **$**:

```
M01 *Q$B$
```

And finally, the note on beat four is another **B** which completes the line:

```
M01 *Q$B$B [Enter]
```

Let's define **V2** the same way. The rests occur in the same places, the only difference being that the notes are **6** instead of **B**. **Measure 1** now looks like this:

```
M01 *Q$B$B
    V2Q$6$6
```

We put the voices on separate lines which requires no additional space when the file is saved. You could also enter the measure as follows:

```
M01 *Q$B$B V2Q$6$6
```

The result is the same either way. **Voice Three** has the same timing with the notes being **4** instead of **B** or **6**. Enter **V3**:

```
M01 *Q$B$B
    V2Q$6$6
    V3Q$4$4
```

We have defined 3 voices. On beats 1 and 3 the voices are silent. On beats 2 and 4 the voices will play simultaneously, each playing a different note. The musical term for this is a **Chord**.

Voice 4 has notes on beats 1 and 3. It has rests on beats 2 and 4. The first note is a **-3**. The note on beat 3 is a **1**. It looks like this:

```
M01 *Q$B$B
    V2Q$6$6
    V3Q$4$4
    V4Q-3$1$
```

The measure is finished. At this point we want to listen to the music so we:

[Break] (Press once to leave editor)
SCORE [Enter] (Compile Music)
PLAY [Enter] (You hear the finished music)

Get back into the editor:

```
EDIT [Enter]
```

We are going to enter the second measure. If you take a close look you will see that it is identical to measure 1. Position the cursor to the bottom of measure 1 and type:

```
R01 [Enter]
```

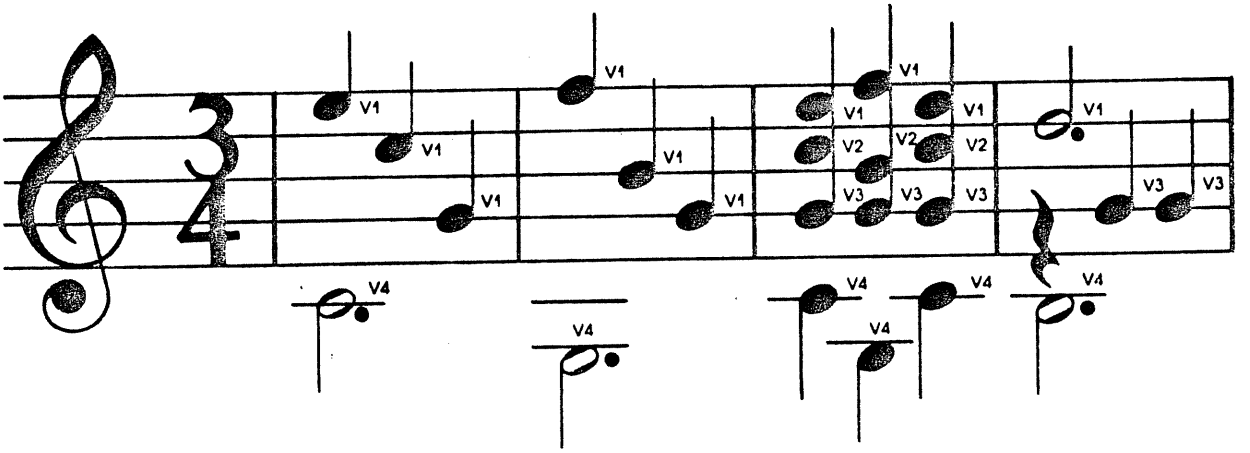
That tells the system to repeat **Part 01** (which contains measure 1), much easier than typing everything over. The example is now completely transcribed:

```
K1#
NQ=80
V1YA V2YB V3YC V4YD
P01
M01 *Q$B$B
    V2Q$6$6
    V3Q$4$4
    V4Q-3$1$
R01
```

Remember, this example was chosen because of the problem with rests. Most music will have the rests written in and will be much easier. Correct transcription will depend on your awareness of timing; the number of beats per measure, the type of note that gets one beat, and the interpretation of rests.

At this point it would be helpful for you to change the tempo, alter the voices, and add repeats. Score and play the music after each change. This will also give you some practice with the editor.

MUSIC SAMPLE 2



Study the sample music and the finished transcription. Remember, this transcription is only one possible interpretation. The final decision should be based on what you feel sounds best.

Enter, **SCORE**, and **PLAY** this piece:

```
K0#
NQ=80
V1YA V2YB V3YC V4YD
P01
M01 *Q974
    V4H.0
M02 *QA64
    V4H.-3
M03 *Q9A9
    V2Q767
    V3Q444
    V4Q0-30
M04 *H.8
    V3Q$44
    V4H.-1
```

Notice that there are no sharps or flats in the key signature. We enter **K0#**.

The time signature tells us that we have three quarter-note beats in each measure.

Measure 1 requires two voices, **V1** for the melody notes and **V4** for the bass notes. The melody notes are usually the highest notes in the measure. The bass notes are the lowest. **V2** and **V3** are not used and therefore not defined in **Measures 1** and **2**.

Measure 1 contains a dotted half-note, **H.**, followed by the note symbol which is **0**. A half-note lasts twice as long as two quarter-notes. A dotted half-note has its value lengthened

by 1/2. The total value of a dotted half-note is equal to three quarter-note beats. In 3/4 time, three beats fill the measure.

In **Measure 2** we find the same timing, but different note symbols.

In **Measure 3** we are back to four-part harmony using all four voices. All the notes are quarter-notes.

In **Measure 4** we use three voices. **V2** is not used. **V1** consists of a single dotted half-note. **V3** has two quarter-notes played after a quarter-note rest ($):

```
V3Q$44
```

That's a quarter-note rest followed by two symbol **4** quarter-notes.

V4 is a dotted half-note, symbol **-1**.

This example was correct notation-wise in that it was not necessary to calculate any missing rests.

Listen again to this piece, especially **Measure 4**.

The two notes in **V3** have no **Articulation**, making them sound like one continuous note. Change **V3** in **Measure 4** to:

```
V3Q$4'4
```

We've created a small space between the two notes to make them more distinct.

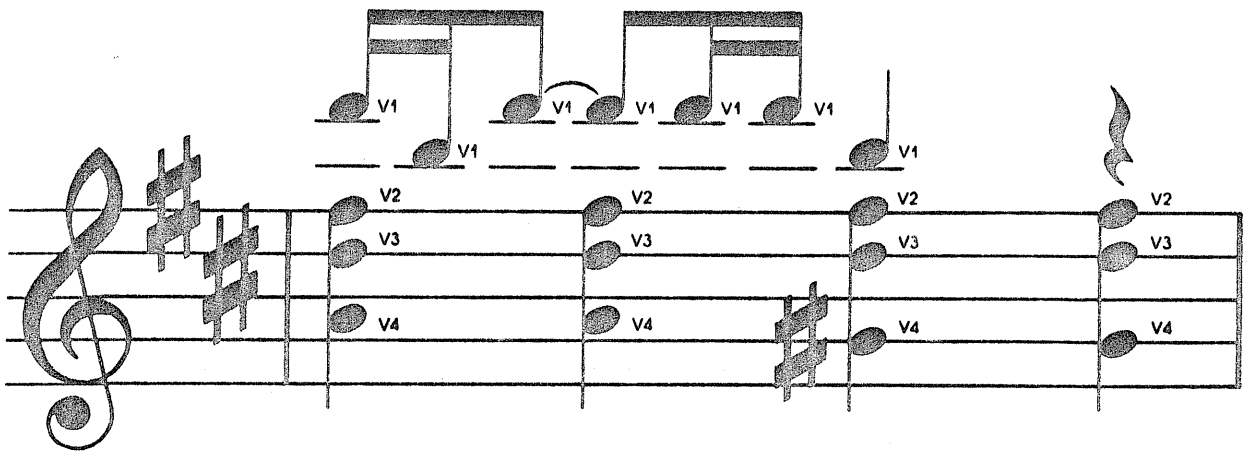
We can also produce an effect called **Staccato** by adding a semi-colon, **;**, behind each note in **V1, Measures 1** and **2**:

```
M01 *Q9;7;4;
M02 *QA;6;4;
```

SCORE and **PLAY** this new version. The musical notation for staccato is a dot directly above or below the note

Experiment with articulation and staccato to produce different effects in your music.

MUSIC SAMPLE 3



This measure, in 4/4 time, looks difficult at first, but is actually very simple. The example is extremely important, however. Enter the file exactly as shown:

```
K2#
NQ=80
V1YA V2YB V3YC V4YD
P01
M01 *SF'D'IFF'SF'F'QD$
    V2QAAAA
    V3Q8888
    V4Q554#4
```

SCORE and **PLAY** the piece. It may not be apparent to you at first, but the melody notes (**V1**) are so high that they are barely audible. Let's make a change that will bring the melody down to a comfortable frequency.

We can do this in two ways. If we want to lower only **V1**, we can add a voice modifier after the part number:

```
P01 V1U-7
```

V1U-7 instructs the system to play the notes in **V1** one octave lower than written. Make this change, **SCORE**, and **PLAY**. The melody is more audible, however, the other voices are still too high. The solution is to lower all the voices.

Remove **V1U-7** from the line and replace with **<9**:

```
K2#
NQ=80
V1YA V2YB V3YC V4YD
P01<9
M01 *SF'D'IFF'SF'F'QD$
    V2QAAAA
    V3Q8888
    V4Q554#4
```

SCORE and **PLAY**, the entire piece has been lowered over an octave. Try replacing the **9** with an **A**, **C**, or any hex digit up to **F**. The tone quality of the voices improves and distortion of the high notes is reduced.

V1 starts out with two sixteenth-notes, **F** and **D**, each followed by a **'**, (articulation to make these notes more distinct).

The third and fourth notes are eighth-note **F**. The curved line between the two notes indicates that the notes are **Tied**, meaning no articulation on the first **F**. The two notes must sound without interuption. The second **F** has articulation to separate it from the two sixteenth-notes that follow.

The two sixteenth-notes are **F** and have articulation because they are not tied.

A quarter-note **D** follows without articulation.

The last beat in **V1** is a rest (**$**).

V2 and **V3** consist of four quarter-notes each. **V2** has 4 **A** notes. **V3** has 4 **8** notes.

V4 also has four quarter-notes. The first two notes are **5**, the third note has an accidental applied to it. In musical terms, the **#**, a **sharp**, preceding the note means that the note and all following notes of the same symbol are to be played 1/2 step higher than normal. Our system carries the accidental automatically so the first note is entered as **4#** and the following note is entered just like it is written, **4**. The second **4** will be played as a **4#** no matter which voice plays it.

After playing the original transcription, change **V2**, **V3**, and **V4**:

```
V2QA;A;A;A;
V3Q8;8;8;8;
V4Q5;5;4#;4;
```

A ; has been added to every note. **SCORE** and **PLAY** this new version and you will hear a completely different musical effect. The chords have a shorter duration which tends to accent the four beats in the measure.

Articulation, used in this piece and the following samples, is included to demonstrate a special musical effect. Articulation is optional. In fact, most notes don't need articulation unless they are followed by a note of the same symbol.

TRANSCRIBING MUSIC

This section introduces the notation of the music language and compares it with standard musical notation.

The music language provides the means by which standard musical notation is transcribed into a symbolic form usable by the computer.

The use of the language can be shown best by example. **Figure 1** is an excerpt from **J. S. Bach's Capriccio**. **Figure 2** is the same music transcribed for a three-voice synthesizer. While the two figures may appear to have little in common, they both contain essentially the same information.

In **Figure 2** each line begins with a three digit number followed by a space. These line numbers are added for the purpose of this discussion only and have no bearing on the music. Remember, the contents of each line effectively begin after the first space.

Lines 10, 20 and 30 are informational only. A slash (**/**) appearing anywhere in a line causes the remainder of that line to be ignored.

For the purposes of transcription, a piece of music is considered to be subdivided into **parts**, **measures** and **voices**. A **part** defines one or more **measures** that are played in the same key, tempo and with the same registration and usually correspond to a portion of the piece that may be repeated, i.e. a phrase, stanza, chorus etc. **Parts** are defined by the letter **P** followed by either a two digit number or a space. Numbered **Parts** can be repeated; un-numbered **Parts** cannot.

Measures are indicated by a character string beginning with the letter **M** and ending with a space. The characters following the **M**, usually a **measure number**, are ignored by the compiler and only serve as a reference between the printed musical score and the transcribed music language text.

A **voice** is a separate strand of music, in harmony or counterpoint. A trio has three voices and a quartet four. Up to five voices may be defined and they are identified by **V1**, **V2**, **V3**, **V4** and **V5**. As a convenience, each measure begins with an implied **V1**.

In the example, the Aria consists of two repeated sections, one 5 measures long and the other 7 measures long. The first section is defined in line 40 as **P50**. The choice of the two-digit number is arbitrary and serves only to identify the part. However, each **part** defined must have a **unique number**. Line 200 defines a **Repeat** of **Part 50**. Likewise, line 390 is a **Repeat** of **Part 52** (line 210).

Line 50 defines the **key signature**. You need only specify the number of **sharps** (**#**) or **flats** (**&**); the compiler will know which notes are affected. If the key signature is not specified, C-major (no sharps or flats) is assumed.

Line 60 defines the **time signature** and **tempo**. **NQ** indicates that each **quarter note** gets a **beat** (**H=half, Q=quarter, I=eighth, S=sixteenth**). **=CØ** indicates the relative length of a beat. Normally, the tempo parameter is determined experimentally by holding various combinations of 1-7 keys while the piece is playing. The key pattern is then translated, using the **Tempo Conversion Tables**, to a two digit number which is entered into the source file. It may also be necessary to alter the time signature parameter to achieve the desired tempo.

Line 62 defines **transposition**. The character < or > followed by a number defines the direction and number of **semi-tones** the piece is to be transposed (**<= down, >= up**). It is common practice to transpose a piece of music as it is transcribed to accommodate the range and fingering of the new instrument. While **ORCHESTRA-90** should not pose any 'fingering' problems, it is often desirable to transpose a piece down a few semi-tones to avoid the distortion and aliasing present in the higher notes. This is especially true with 2 MHz, 4-voice synthesizers.

Line 64 defines the **tone color registers** to be used by the different **voices**. **Voice 1** uses register **C** (clarinet), **voice 2** and **3** use register **B** (oboe). The default register is **D** (organ).

The music proper begins in line 70 with the definition of **measure 1**.

Each of the symbols representing a note in standard musical notation imply two pieces of information:

1. **Its shape, along with the time signature, defines how long, relative to a beat, the note is to be held.**
2. **Its position on the staff, along with the key signature and clef define the note to be played.**

Transcribing this two-dimensional form into a single line requires two characters to represent each note. The **time value**, or **shape**, is defined by a single letter: **W=whole, H=half, Q=quarter, I=eighth, S=sixteenth, T=thirty-second, X=sixty-fourth**. The **time value** may be modified by additional symbols. **Dotted notes** are indicated by a **period** (.) following the letter. **Triplet** time values are indicated by a **colon** (:) following the letter, e.g. **Q** means all the notes following are **quarter notes**, **I.** means all the notes following are **dotted eighth notes**, **S:** means all the notes following are **sixteenth note triplets**. Note length modifiers may be combined: **H:..** means all the notes following are **double dotted half note triplets**. (Dot modifiers cannot precede a triplet modifer, i.e. **Q.:** is not valid.)

The **staff position** of a note is defined by its relationship to a fixed point on the staff, **Middle-C**. Middle-C is always location **0** and notes above it are defined by a positive (+) displacement while notes below it are defined by a negative (–) displacement. See **Figure 3**. The displacement uses a hexadecimal-like number scale with the letters **A** to **G** representing the numbers **10** to **16**. The maximum positive displacement is **+G**, the maximum negative displacement is **–F**. A **dollar sign** ($) defines a **rest**.

Coding note displacements can be simplified by specifing a default displacement sign or clef. An **asterisk** (*) sets the default to **+** or **treble clef**, and all unsigned notes following are assumed to be **+**. An **at-sign** (@) sets the default to **–** or **bass clef**, and all unsigned notes following are assumed to be **–**.

Accidentals are indicated with a **sharp** (#), **flat** (&) or **natural** (%) sign immediately following the note affected. Accidentals stay in effect until the end of the measure or are modified by another accidental. **Double sharps** (##) and **flats** (&&) and **natural sharps** (#% or %#) and **flats** (&% or %&) are allowed. **Double naturals** (%%) and **flatted sharps** (&#) or **sharp flats** (#&) will give unpredictable results and should be avoided.

You should now be able to decipher all the symbols in lines 70, 80 and 90 and relate them to the first measure in **Figure 1**.

Line 100 introduces several new symbols. The **parenthesis** indicate **reiterative compilation**. The number following the right parenthesis is the reiteration **count** which tells the compiler how many more times to compile the bounded sequence. Line 100 will be compiled as if it were written:

```
M2 *I6;SD6"I6;SD6"I6;SD6"I6;SD6"
```

Reiteration should not be confused with Part **repetition**. Reiteration occurs at compile time; Part repetition directs the synthesizer to re-play a particular Part. Reiteration blocks may not be nested.

Notes may be further modified by '**expression**' modifiers which alter the way a note is played, but not its pitch or overall duration, by **replacing a portion of the note with a rest**. There are two major types of expression, **staccato** and **articulation**, and each type has two forms, **long** and **short**.

Short staccato, indicated by a **comma** (,), shortens the note by 1/2 and **adds a rest equal to 1/2 the note's duration. Long staccato**, indicated by a **semi-colon** (;), is similar except the note is **shortened by 1/4 of its value and adds a 1/4 rest. Articulation** is used to introduce a **small rest** after a note to **separate** it from the note following. **Short articulation**, indicated by an **apostophe** ('), **shortens the note by an amount equal to 1/3 of a 1/128 note and adds a rest of that value. Long articulation**, indicated by a **quote** ("), is similar except **the amount shortened is double, 2/3 of a 1/128 note**. In all cases, expression modifiers effect only the note they follow. Accidentals must precede expression modifiers.

Measure 5 (lines 170-190) presents a very common problem; **too many voices**. An experienced musician will probably have no trouble; for the rest of us, it will be a matter of blind luck or painstaking trial and error deciding which notes to use and which to ignore. Ultimately, the 'right' solution is the one that sounds best.

Thus far, the assumption has been that the music being transcribed is in bass/treble clef notation. To take advantage of music arranged for different instruments in different clefs (soprano, alto, tenor, etc.), each voice can be defined as belonging to a different clef. Voice/clef definition is indicated by a **U** followed by a number that is the displacement from Middle-C in the clef being defined to Middle-C in the treble clef. For example.

```
V1 U-2 V2 U-6 V3 U-8 V4 U-C
```

defines **Voices 1-4** as **soprano, alto, tenor** and **bass**, respectively. Because all clefs are defined relative to the treble clef, each voice is transcribed exactly as if it were the treble clef, and no clef symbols (* or @) need be used.

Another useful transposition would be **V4U-7** to **lower Voice 4 one octave** to get a low bass sound. Since the most common clef transposition is negative, the default sign is '—'; e.g., **U7** is the same as **U-7**.

Often, when transcribing part-music, the accidentals in one voice interfere with the accidentals in another voice. This is because the compiler applies every accidental to all voices. **OPTION 1**, specified **01**, will limit the application of accidentals to the voice in which they appear.

OPTION 2, specified **02**, will carry any accidentals forward into the next measure. This is necessary when a particularly long measure must be split into two or more measures to meet the 32 note per voice per measure limit of the compiler. **02** must be set in each and every measure in which accidentals are to be carried forward.

OPTION 0, specified **00**, nullifies both **01** and **02**.

INSTRUMENT DEFINITION

This section describes how to alter the **tone color registers**, use of the **percussion clef** and **stereo mapping**.

The **default tone color registers** were based on the spectral analysis of orchestral instruments and were chosen to provide a wide range of musical sounds. The registers are easily altered to imitate other standard instruments or to create strange new sounds, harmonic or percussive.

A **register definition** consists of the letter **J** followed by the **register name** (**A**, **B**, **C**, **D**, or **E**), the **wave form type** (**R** or **S**), the **parameter list** consisting of **eight hex digits** representing the **weight** of **partials** #1 through #8, and a **single hex digit** representing **volume**. The standard registers are all **harmonic** or **wave form type S** (Sinesoidal). **Percussive sounds** may be obtained from **wave form type R** (Random) as well as type **S**.

The **harmonic registers** are defined by the sum of eight sine waves or **partials**. Each partial is an integer multiple of the fundamental frequency. The first partial is the fundamental, the second is two times the fundamental, the third is three times, etc. The eight digits in the parameter list define the relative strength or weight of each partial in the register.

A trumpet-like sound is defined as follows:

JASEFA50000E / Standard (default) Register A

SYMBOL	MEANING
J	begin register definition
A	define register A
S	Sinesoidal (harmonic) wave
E	partial #1, fundamental, weight E (nearly maximum)
F	partial #2, first harmonic, weight F (maximum)
A	partial #3, second harmonic, weight A
5	partial #4, third harmonic, weight 5
0	partial #5, fourth harmonic, weight 0
0	partial #6, fifth harmonic, weight 0
0	partial #7, sixth harmonic, weight 0
0	partial #8, seventh harmonic, weight 0
E	volume E (nearly maximum)

Each register definition must contain weights for all eight partials. Partials with a weight of **0** make no contribution to the final wave form.

Because it takes a considerable amount of time to generate a harmonic wave, the compiler will do so only when the register definition changes. You will notice that the first piece compiled takes an unusually long time. This is because all five default registers are being generated. **All registers are fully defined to default values unless redefined in the music file.**

To redefine one of the default registers simply enter a complete register definition at the beginning of the music file:

```
JASEFA50000F
```

The only difference between this register and the standard default register is that the volume has been increased to **F**, slightly louder than the default volume of **E**. You could also change the weighting of the partials. You can make a voice silent by changing all the partials to **0**. Partials 5-8 should be weight **0** if you are using the standard clock rate unless you are after special ef-

fects. Your special register definitions will be saved along with the rest of the music file.

The standard default registers are:

```
JASEFA50000E   / define register A, trumpet
JBS48F80000F   / define register B, oboe
JCSE0500000A   / define register C, clarinet
JDSF4080000B   / define register D, organ
JES4F280000D   / define register E, violin
```

The default registers at 4 Mhz clock rate are:

```
JASEFA54E00E   / define register A, trumpet
JBS48F8F200F   / define register B, oboe
JCSE050F000A   / define register C, clarinet
JDSF4080000B   / define register D, organ
JES4F281400D   / define register E, violin
```

Answering "**Y**" to the **FAST CLOCK** question will automatically define two additional partials. **Never answer "Y" unless you have the 4 Mhz hardware modification.**

PERCUSSION and other special effects may be obtained by defining a register as **R** which indicates that a pseudo-random number generator is to be used. The eight hex digits in the parameter list define a **four digit random seed** and the **four digit "randomizing" function**, respectively. You can experiment by changing these eight digits to create your own unique effects. Because there are billions of combinations of seeds and functions, few generalizations can be made about the kinds of percussive effects available. Here are two samples:

```
JBR000300058   / register B, scratchy sounds
JCR101000018   / register C, squeaky sounds
```

In both cases the volume is **8**.

The **Sinesoidal wave form** can also be used for percussion:

```
JES80011001E   / register E, wooden blocks
```

This register definition will be used for percussion examples later. Just as you would not attempt to play a melody on a drum, you should not try to play music on a percussion register.

Regardless of which wave form you use, there is a special way to play percussion which requires a unique clef.

The **PERCUSSION CLEF**, defined by an underline (**_**), has 16 notes, defined by the unsigned hex digits **0-9** and **A-F**. **The underline character is produced with a Shift--**. This clef also inverts the function of the **articulation**. The usual operation of articulation is to shorten a note by a very small amount and insert a small rest at the end. In the **Percussion Clef** the note is made very short and a large rest is inserted at the end. This **REVERSE ARTICULATION** creates the short percussive sound of a drum and allows the entry of drum rhythms using the same note values found in drum tablature. The ' and " are the best expression modifiers to use for **reverse articulation** in the **Percussion Clef**. The following score will demonstrate the features of the **Percussion Clef**:

```
                    /PERCUSSION DEMO
JER8001100 1A       /define register E, random wave form, volume A
JCS8001100 1F       /define register C, sine wave form, volume F
                    /other registers default
                    /articulation on all notes
P00 <7              /unnumbered Part, piece played one octave down
                    / play standard scale using default register D
M01 V1YD *I0'1'2'3'4'5'6'7'8'9'A'B'C'D'E'F'Q$
                    / same scale using random wave form without Percussion Clef
M02 V2YE *I0'1'2'3'4'5'6'7'8'9'A'B'C'D'E'F'Q$
                    / same scale using random wave form with Percussion Clef
M03 V2YE _I0'1'2'3'4'5'6'7'8'9'A'B'C'D'E'F'Q$
                    / same scale using sinesoidal wave form and Percussion Clef
M04 V3YC _I0'1'2'3'4'5'6'7'8'9'A'B'C'D'E'F'Q$
```

Measure 1 (M01) sounds normal, **M02** sounds very unusual because the notes are not shortened by **reverse articulation**. **M03** and **M04** are examples of proper use of **register definition**, **reverse articulation** and **Percussion Clef**. Once you have defined a percussion register you may wish to play the entire scale using the **Percussion Clef** and select notes which sound best. Some notes in any percussion register may have no sound at all or may not be suited for a particular piece.

Remember that the underline character (_) defines default Percussion Clef with Reverse Articulation and all notes following will be percussion notes until the (*) or (@) sign is encountered.

A music Voice following a percussion Voice must be defined by (*) (Treble Clef) or (@) (Bass Clef). Typically, the last Voice in any measure is used for percussion with the first Voice in the following measure being defined as either (*) or (@).

MAPPING allows you to balance or position voices in each stereo channel or to "ping-pong" voices between channels. The mapping symbol is **Z** followed by a number between **0** and **n**; where **n** depends on the number of voices supported by the synthesizer. The default is **Z0**.

symbol	channel A	channel B	synthesizer
Z0	V1 V2	V3 V4 V5	3, 4, or 5
Z1	V1 V3	V2 V4 V5	3, 4 or 5
Z2	V2 V3	V1 V4 V5	3, 4 or 5
Z3	V1 V4	V2 V3 V5	4 or 5
Z4	V2 V4	V1 V3 V5	4 or 5
Z5	V3 V4	V1 V2 V5	4 or 5
Z6	V1 V5	V2 V3 V4	5
Z7	V2 V5	V1 V3 V4	5
Z8	V3 V5	V1 V2 V4	5
Z9	V4 V5	V1 V2 V3	5

The simplicity of the table masks the complexity of the implementation. The compiler actually performs the mapping in two parts. **Voice mapping takes place at Measure boundaries, while instrument registers are mapped at Part boundaries.** This means that if the mapping symbol appears somewhere other than the beginning of a Part, a voice may become disconnected from its register. To put it another way, if all voices are playing the same register, mapping may be specified at measure boundaries, otherwise the results are unpredictable.

COMPILER ORGANIZATION

This section describes certain features of the Compiler in more detail. A little bit of technical information will help in understanding how the compiler works and how certain parameters are interpreted.

The output of the Compiler consists of two lists; a Part List and a Note List. Each element in the Part List contains a pointer to a Note List element and parameters, such as tempo and registration, that describe how the Note List is to be played. Each element in the Note List contains note frequencies and durations for each of three, four, or five voices.

During compilation, the source file is processed and the data collected is placed into either a Part Buffer or a Note Buffer. At the appropriate time, the contents of the Buffers are processed into the corresponding List.

When compilation begins all Buffers are cleared and the default values are entered. If written out, the default values would look like this:

```
P00          /un-numbered part
K0#          /key of C-major, no sharps or flats
<0           /no transposition, up or down
NQ           /time signature based on a quarter note
=C0          /each beat has a value of 60
V1 YD U0     /voice 1 uses register D, no clef transposition
V2 YD U0     /voice 2 uses register D, no clef transposition
V3 YD U0     /voice 3 uses register D, no clef transposition
V4 YD U0     /voice 4 uses register D, no clef transposition
V5 YD U0     /voice 5 uses register D, no clef transposition
JASEFA50000E /define register A, trumpet
JBS48F80000F /define register B, oboe
JCSE0500006A /define register C, clarinet
JDSF4080000B /define register D, organ
JES4F280000D /define register E, violin
M V1 *       /begin a measure with voice 1 in treble clef
```

The contents of the Part Buffer are added to the Part List whenever a PART or REPEAT symbol is processed or the end of the file is reached. The contents of the Note Buffer are added to the Note List whenever a MEASURE, PART or REPEAT symbol is processed or the end of the file is reached.

Referring to Figure #2, the PART symbol in line 40 will cause the contents of the Part Buffer to be added to the initially empty Part list and the Note Buffer to be added to the initially empty Note List. A new Note List element is started and the Note list pointer in the Part Buffer is changed to point to it.

Lines 50 to 64 modify most of the default values in the Part Buffer. In line 70, the MEASURE symbol will cause the Note Buffer to be processed and the Note frequencies to be transferred to the Note List. The Note Buffer is cleared and any accidentals are reset. (Since the Note Buffer is empty nothing of interest has happened yet.) The notes defined in lines 70, 80 and 90 are then placed in the Note Buffer.

The MEASURE symbol in line 100 causes the Note Buffer to be processed using the key signature and transposition parameters in the Part Buffer, and the calculated note frequencies of Measure 1 are transferred to the Note List. The Note Buffer is cleared, accidentals reset and the rest of the line is transferred to the Note Buffer.

This process of accumulating notes in the Note Buffer and processing them only when a new measure is defined continues until line 200. The REPEAT symbol causes the Note Buffer to be processed and Measure 5 is added to the Note List. It also causes the Part Buffer to be added to the Part List and a new Note List element to be started. The Note List pointer in the Part Buffer is changed to point to the same Note List element that PART 50 pointed to.

The PART symbol in line 210 acts much the same as that in line 50. Similarly, line 390 is like line 210 and the end of the file forces out the remaining buffer contents.

The result of the compilation is a Note List with the following elements:

<1> (empty)
<2> measures 1, 2, 3, 4, 5
<3> (empty)
<4> measures 6, 7, 8, 9, 10, 11, 12
<5> (empty)

and a Part List with elements and Note List pointers as follows:

<Ø0> points to <1>
<50> points to <2>
<Ø0> points to <2>
<52> points to <4>
<Ø0> points to <4>

Notice that Note List elements 3 and 5 are not pointed to. These are the elements created when the REPEAT symbol is processed. Any notes defined between a REPEAT and a PART symbol are processed into one of these 'un-claimed' elements and are never played. In all other respects, REPEATs are like un-numbered PARTs.

REPEATs can alter any of the parameters in the Part Buffer and thereby repeat sections of music with a different tempo and/or registration. For example, the following will play a sample scale using each of the different tone color registers.

```
PØ1 YA SØ12343210$    /register A
RØ1 YB                /register B
RØ1 YC                /register C
RØ1 YD                /register D
RØ1 YE                /register E
```

The default values **NQ=CØ** and **V1** * are assumed.

SUMMARY

Parameters take effect when data is processed from the buffer to the list. All parameters remain in effect until changed, explicitly or by default.

Parameters affecting the Key Signature (**K** and **01**) or Transposition (**<**, **>** and **U**) take effect at the beginning of the current Measure and stay in effect until changed.

Accidentals take effect immediately and stay in effect until changed or the end of the current Measure unless **Option 2 (02)** appeared within the measure. (Accidentals are also reset by **K**).

Parameters affecting the tempo (**N** and **=**) or Registration (**Y**) take effect at the beginning of the current Part and remain in effect until changed.

Parameters affecting the Clef (*****, **@** and **_**) or Note duration (**W**, **H**, **Q**, **I**, **S**, **T**, or **X**, with or without modifiers, **.** or **:**) take effect immediately and remain in effect until changed.

Parameters selecting the current Voice (**V**) take effect immediately and remain in effect until changed or the beginning of the next Measure. Measures always begin with a default **V1**.

Register definition (**J**) takes effect at the beginning of the piece.

The stereo mapping parameter (**Z**) has two different actions that take effect at different times. Voice mapping takes effect at the beginning of the current measure and remains in effect until changed. Register mapping takes effect at the beginning of the current part and remains in effect until changed.

The synthesizer uses a sampling technique commonly used in professional digital synthesizers.

The Sampling Theorem tells us that any wave form, no matter how complex, can be reconstructed from a rapid succession of discrete voltages. The reconstructed wave form will actually be a stepped approximation of the original but if the steps are small enough they will not be noticed. The size of the steps is determined by the sample rate and the frequency of the wave being reproduced.

Consider one cycle of a simple sine wave. If we were to measure its amplitude at 100 equally spaced intervals and record the values in a table we could reproduce it by serially setting a voltage equal to each entry in the table. Since the table represents exactly one cycle, the frequency of the synthesized wave will be equal to the sample rate divided by 100 (the number of entries in the table). At 1000 samples per second the entire table will be accessed 10 times per second, producing a 10 Hertz sine wave. Doubling the sample rate will double the frequency of the synthesized sine wave.

Using the same table and sample rate we could effectively double the frequency of the synthesized wave by accessing every other table entry. This gets us through the entire table twice as fast. Similarly, taking every third or forth table entry will triple or quadruple the frequency. This is the basis of the synthesizer, except to get musically accurate frequencies, it is necessary to skip a fractional number of table entries.

Theoretically, the highest frequency that can be synthesized is equal to half the sample frequency. This is called the Nyquist frequency. As this limit is approached, the synthesized wave form becomes more and more distorted since there are fewer samples in each cycle. As the distortion increases, a secondary tone, or alias, is produced. If the Nyquist frequency is exceeded, the synthesized frequency is replaced by its alias. This phenomenon is not limited to the fundamental frequency. It affects each component of the synthesized wave form.

Aliasing cannot be filtered out, it can only be avoided. If aliasing is a problem, redefine the registers with fewer partials or transpose the entire piece down a few semi-tones. An alternative solution would be to speed up your CPU.

ORCHUTIL UTILITY PROGRAM

This section describes the music file utility program. **ORCHUTIL**, or **ORCUTL** as it is called on tape, is used to transfer music files between different media, perform format conversion and a limited amount of global modifications. The program is self-prompting and will run on **any TRS-80 Model I or III, tape or disk.**

When loaded from tape, **ORCUTL** will precede the standard menu with the prompt: **DUPLICATE? (Y/N) ->**. If you wish to make a backup of the program, make sure you have a blank cassette in the recorder before typing **Y**. Type **N** or any other character to proceed to the main menu.

There are ten items on the main menu.

I
Select Input
O
Select Output

These two items allow you to select the desired **Input** or **Output** mode to be used for all subsequent file transfers. The mode in effect is displayed in the second and third status lines. The selection is made from the following secondary menu:

L: Low Speed Tape (500 Baud)

This mode is for reading and writing Model I compatible tapes and is valid for all machines.

H: High Speed Tape (1500 Baud)

This mode is for reading and writing Model III compatible tapes and is valid only on a Model III with high speed support enabled.

B: Binary Format Disk (/ORC)

This mode is for reading and writing standard **Orchestra** disk files and is valid only on Model I or Model III disk systems. The file extension is always **/ORC.**

A: ASCII Format Disk (/HEX)

This mode is for reading and writing **Orchestra** disk files in an **ASCII** format suitable for transfer via modem and is valid only on Model I or Model III disk systems. The file extension is always **/HEX.**

ORCHUTIL performs all the necessary format conversion as the file is read or written. You may read in one mode and write in another in any combination supported by the hardware.

R
Read File
W
Write File

Selecting either item will provide a prompt for the name of the file to be **read** or **written.** If the current file mode is **tape**, the file name should be 6 characters or less and there should be no leading or embedded blanks. A file name longer than 6 characters will be truncated. An asterisk (*) in the filename will match any character(s). Therefore, reading a file named * will read the next file on the tape.

If the current file mode is **disk**, the file name should be 8 characters or less, optionally followed by colon (:) and a **drive number**. In either case there should be no leading or embedded blanks. A file name greater than 8 characters will produce uncertain results, depending on the DOS in use.

After a file is read, its name will appear in the first status line as the **current memory file**. The **Write** command will not be accepted unless there is a valid file in memory.

M
Modify X to Y
C
Change XX to YY

These items allow you to globally change any one or two character sequence in the file. Selecting either will result in the prompts **XY** and **XXYY**, respectively. In either case, **x** represents the character(s) to match and **Y** is the replacement character(s). The replacement operation considers the file as one character string; line boundaries are ignored. When a match is found, the character(s) is replaced and the scan continues with the next character in the file. These commands will not be accepted unless there is a valid file in memory and the **XY** or **XXYY** strings are entered with precisely **2** and **4** characters respectively.

P
Pack File

The **Pack** command is used to reduce the size of an **Orchestra** file by removing all unnecessary measure numbers and spaces. It will be rejected if there is no valid file in memory.

K
Kill File

Selecting **Kill** will provide a prompt for the **filespec** of the file to be deleted. This command is valid only on disk systems and is comparable to the DOS command **KILL**. You must enter the **complete filespec** (including /ORC or /HEX extension) which will be passed on unaltered to the DOS.

D
Directory

The **Directory** command is valid only on disk systems and will provide a prompt for a drive number. When the drive number is supplied, **ORCHUTIL** will list all the files on that drive with an extension of **/ORC** or **/HEX**. If the screen fills up or the directory is exhausted, you will be prompted to hit **ENTER** to continue.

Q
Quit

The **Quit** command terminates the program and returns control to the DOS (disk system) or ROM (tape system).

BREAK

Hitting the **BREAK** key at any time will terminate the operation in progress and return to the main menu.

ERRORS

Errors will be indicated in the right half of the first status line.

???

The command is recognized but cannot be executed at this time. Either the mode or operation selected cannot be performed or there is no valid file in memory.

I/O Error

The previous operation terminated in error. For **disk I/O**, all errors are those reported by the DOS and include the conditions: file not found, disk or directory full, read errors and improper filespecs.

For **tape I/O**, the error conditions are: read errors and high speed not supported.

NO ROOM

The file read exceeds the memory capacity.

ERROR MESSAGES

When an error is detected an error number will be displayed and, whenever possible, the file positioned with the file pointer at, or near, the place where the error was encountered.

ERR 1: MEMORY OVERFLOW

There is not enough memory to **SCORE** the current file, even after **OVERLAP**ing.

There is not enough memory to **EDIT** the current file. Consider expanding your system or splitting the file into two or more smaller sections.

There is not enough memory to **READ** or **GET** the requested file. Expand the memory in your system.

ERR 2: SYMBOL OUT OF CONTEXT

The command operand contains an invalid hexadecimal digit.

The **TEMPO** symbol = is not followed by two hexadecimal digits.

The compiler was expecting a hexadecimal digit or a note symbol (**0-9** or **A-G**) but none was found.

ERR 3: PARAMETER ERROR

The number of sharps or flats in the **KEY signature** is too large or is not followed by **SHARP** (**#**) or **FLAT** (**&**) symbol.

The note value in the **TIME** signature is not **H**, **Q**, **I**, **S** or **T**.

The **VOICE** specified is not **1**, **2**, **3**, **4** or **5**.

The **REGISTER** specified is not **A**, **B**, **C**, **D** or **E**.

ERR 4: INVALID PART NUMBER

The **PART** or **REPEAT** specified is not a two digit hexadecimal number or the **PART** is not blank. **P00** is considered an **un-numbered part**.

The **PART** is already defined.

The **REPEAT** is not previously defined.

The piece cannot be **PLAYED** because the **PART** cannot be found or because the piece needs to be **SCORED**.

ERR 5: MEASURE OVERFLOW

The measure being compiled contains more than 32 notes per voice. Split the measure in half and carry forward any accidentals.

Note: Staccato, pizzicato and articulation generate a note and a rest so count them as two notes.

ERR 6: NOTE OVERFLOW

Dotted whole notes, 7-dotted triplets and other unusual combinations cannot be compiled.

ERR 7: FILE I/O ERROR

The host operating system reported an I/O or other error during the last file operation.

READ or **GET**: File not found.

WRITE: Disk or directory full.

READ, WRITE, GET or **DIR**: Unrecoverable I/O error.

DIR: Invalid device number.

OVERLAP?

If there is not enough memory to hold both the source file and the compiled object code at the same time, the program will pause and display the question **OVERLAP?** in the **status line**. If you answer **Y**, compilation will resume and portions of the source file will be **OVERLAPed** by the object code. Answering anything else will cancel the compilation and enter the **command mode**.

This function is useful when compiling large files as the end of the object code can **OVERLAP** the beginning of the source code. **DO NOT OVERLAP** a file that has not been saved on disk or tape since this function implies the probable destruction of the current file. Do not expect to be able to use it in any way once this command is given.

Nº 3. Capriccio

sopra la lontananza del suo fratello dilettissimo.

Ist eine Schmeichelung der Freunde, um denselben von seiner Reise abzuhalten.

Aria di Postiglione.

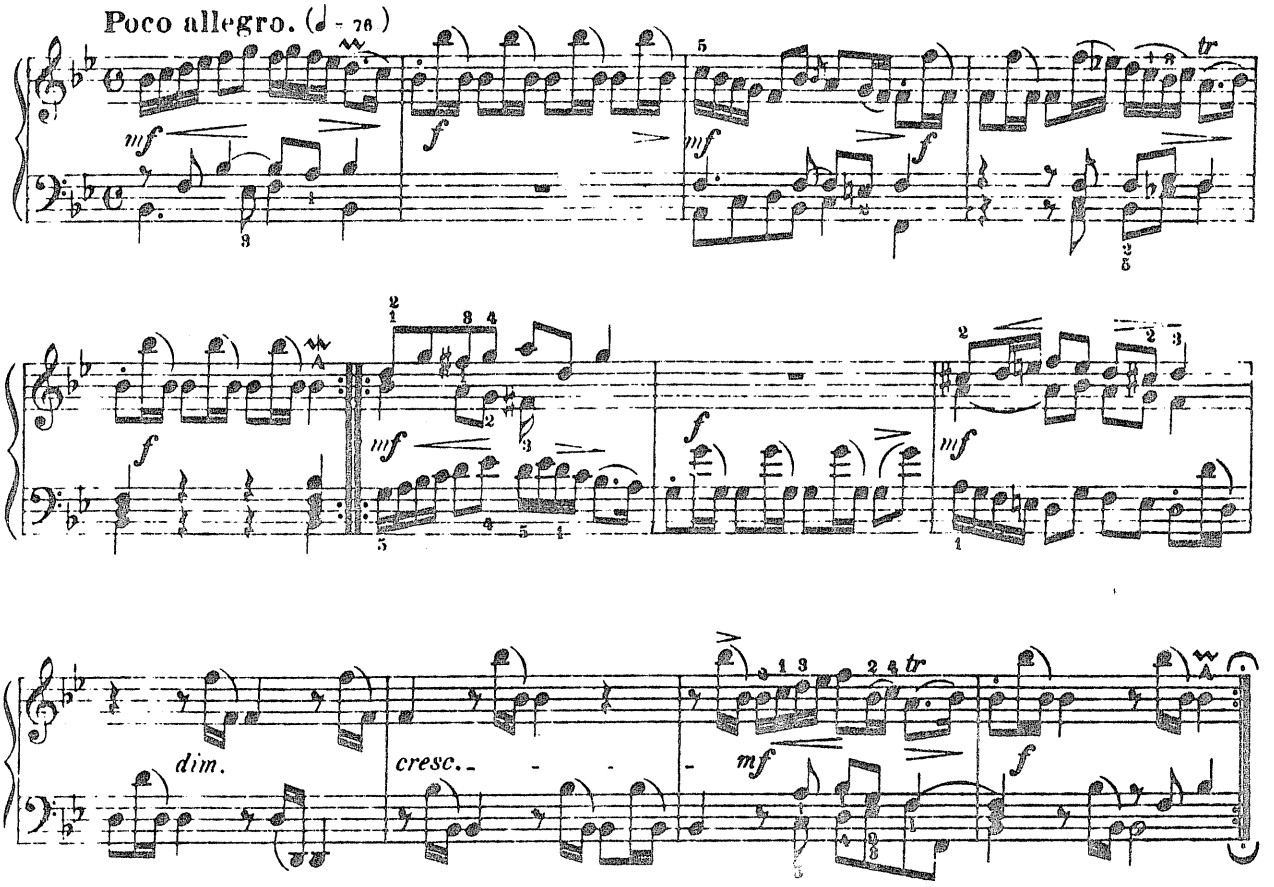


FIGURE 1.

The numeric keys 1-7 are used to set or alter the tempo of a piece while it is playing. When none of the keys are depressed the piece will play at the tempo defined when it was compiled. Otherwise, the binary weighted value of the keys held down is used to set the tempo. The following table shows the hexadecimal and decimal value for each key combination.

Once the correct tempo has been established by experimentation, the corresponding hexadecimal value should be transferred to the source file. Tempo settings below **80** (hex) may cause an undesirable shift in frequency and should be avoided. It may be necessary to adjust the time signature parameter to get the tempo between **80** and **FE**. Increasing the note value of the time signature will allow you to double the value of the tempo, e.g., **NQ=C0** is preferable to **NI=60.**

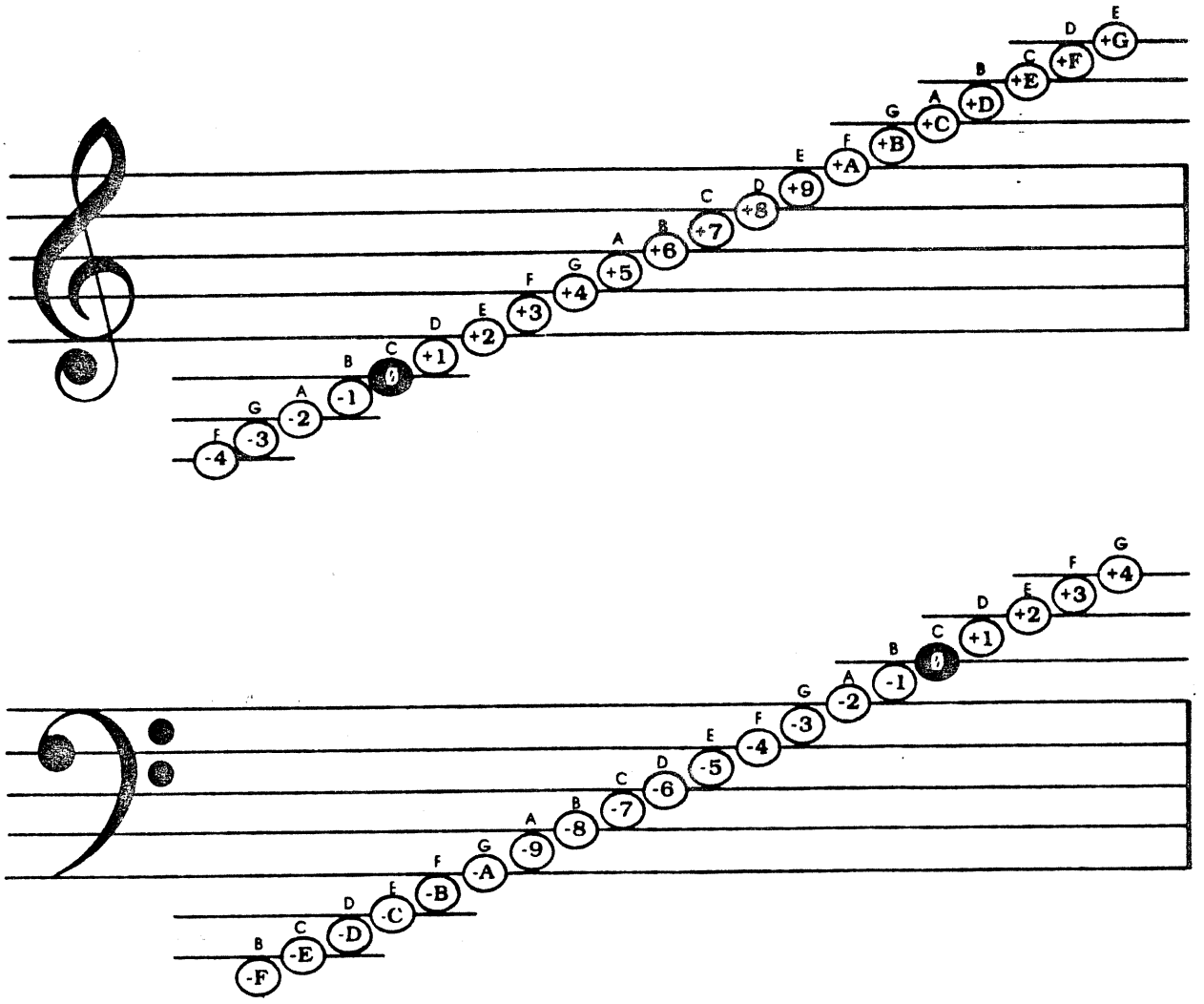
The **0** key is used as a stop switch. When that key is depressed, the synthesizer will stop and the program will enter the command mode.

DIGITS	HEX	DEC	DIGITS	HEX	DEC	DIGITS	HEX	DEC
1234567	**FE**	254	12345-7	**BE**	190	123456-	**7E**	126
-234567	**FC**	252	-2345-7	**BC**	188	-23456-	**7C**	124
1-34567	**FA**	250	1-345-7	**BA**	186	1-3456-	**7A**	122
--34567	**F8**	248	--345-7	**B8**	184	--3456-	**78**	120
12-4567	**F6**	246	12-45-7	**B6**	182	12-456-	**76**	118
-2-4567	**F4**	244	-2-45-7	**B4**	180	-2-456-	**74**	116
1--4567	**F2**	242	1--45-7	**B2**	178	1--456-	**72**	114
---4567	**F0**	240	---45-7	**B0**	176	---456-	**70**	112
123-567	**EE**	238	123-5-7	**AE**	174	123-56-	**6E**	110
-23-567	**EC**	236	-23-5-7	**AC**	172	-23-56-	**6C**	108
1-3-567	**EA**	234	1-3-5-7	**AA**	170	1-3-56-	**6A**	106
--3-567	**E8**	232	--3-5-7	**A8**	168	--3-56-	**68**	104
12--567	**E6**	230	12--5-7	**A6**	166	12--56-	**66**	102
-2--567	**E4**	228	-2--5-7	**A4**	164	-2--56-	**64**	100
1---567	**E2**	226	1---5-7	**A2**	162	1---56-	**62**	98
----567	**E0**	224	----5-7	**A0**	160	----56-	**60**	96
1234-67	**DE**	222	1234--7	**9E**	158	1234-6-	**5E**	94
-234-67	**DC**	220	-234--7	**9C**	156	-234-6-	**5C**	92
1-34-67	**DA**	218	1-34--7	**9A**	154	1-34-6-	**5A**	90
- 34-67	**D8**	216	--34--7	**98**	152	--34-6-	**58**	88
12-4-67	**D6**	214	12-4--7	**96**	150	12-4-6-	**56**	86
-2-4-67	**D4**	212	-2-4--7	**94**	148	-2-4-6-	**54**	84
1--4-67	**D2**	210	1--4--7	**92**	146	1--4-6-	**52**	82
---4-67	**D0**	208	---4--7	**90**	144	---4-6-	**50**	80
123--67	**CE**	206	123---7	**8E**	142	123--6-	**4E**	78
-23--67	**CC**	204	-23---7	**8C**	140	-23--6-	**4C**	76
1-3--67	**CA**	202	1-3---7	**8A**	138	1-3--6-	**4A**	74
--3--67	**C8**	200	--3---7	**88**	136	--3--6-	**48**	72
12---67	**C6**	198	12----7	**86**	134	12---6-	**46**	70
-2---67	**C4**	196	-2----7	**84**	132	-2---6-	**44**	68
1----67	**C2**	194	1-----7	**82**	130	1----6-	**42**	66
-----67	**C0**	192	------7	**80**	128	-----6-	**40**	64

FIGURE 2.

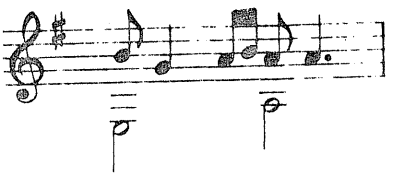
```
010    / CAPRICCIO
020    / SOPRA LA LONTANANZA DEL SUO FRATELLO DILETTISSIMO
030    / J.S. BACH
040    P50 / ARIA DI POSTIGLIONE
050    K2&
060    NQ=E0 / POCO ALLEGRO
062    >2
064    V1YC V2YB V3YB
070    M1 *S6789IABSABA9I.8S7
080       V2@I$4Q1I12Q1
090       V3@Q.8I5Q48
100    M2 *(I6;SD6")3
110    M3 *S7654I365S43"I3;SA3"
120       V2@Q.4"I445%Q4
130       V3@I9768Q7B
140    M4 *I3;SA3"I3;SA9&8767I.5S6"
150       V2@Q$I$4"43Q4"
160       V3@Q$I$785&Q4
170    M5 *(I6;SD6'')2Q6;
180       V2@Q4$$4
190       V3@Q6$$6
200       R50
210       P52
220    M6 *I8BA#BC8QB
230       V2*Q6I54S3#
240       V3@S3210*I12S1210@I.1S2
250    M7 V3@(I3;S+43")2I3;+4
260    M8 *I7#S89%IA987#Q8
270       V2*Q5I5654Q3
280       V3@S2345%I63456;S+16"
290    M9 *Q$I$SA3"Q3I$SA3"
300       V2@I6;S+16"Q6I$S6D"QD
310    M10 *Q3I$SD6"Q6
320       V2@I$S18"Q8I$S18"I8;S18"
330    M11 *I$SD6"6789IAS67I.5S6"
340       V2@Q8I$213Q4
350       V3@Q$I$7654B
360    M12 *I6;SD6"Q6I$SD6"Q6"
370       V2@Q4I$S18"H8
380       V3@Q6$I$4Q1
390    R52
```

FIGURE 3.

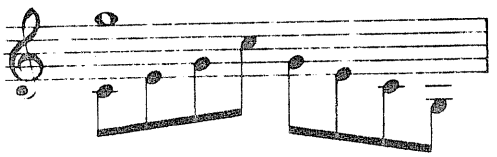


Note: The symbols inside the notes represent the **Orchestra-90** scale. The small letters above the notes represent the musical scale and are for reference only.

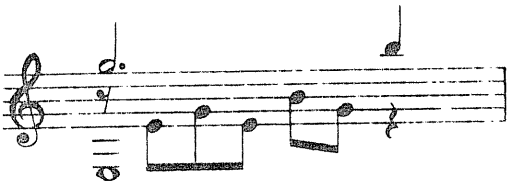
Note: Remember to check the Key signatures, all samples are in 4/4 time.



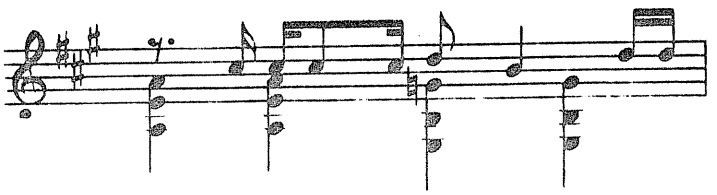
```
*I6Q4S5'6'I5'Q.5
@V2H52
```



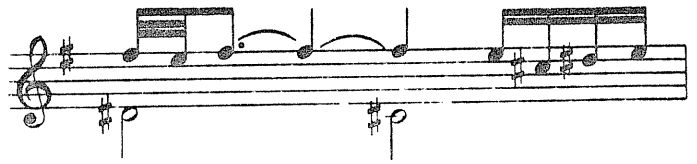
```
*WB
V2I0247420-3
```



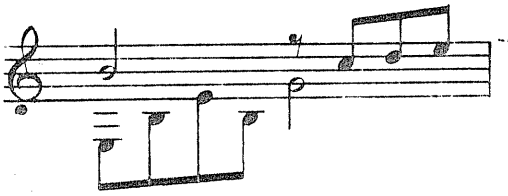
```
*H.BQD
V2I$24264Q$
V3W-5
```



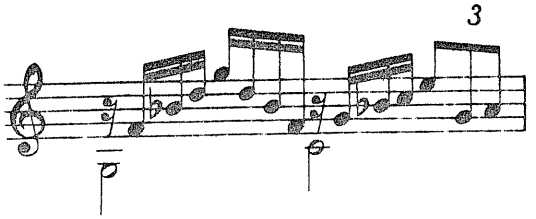
```
*I.$S7'7'I7'S7'I8Q6S8'8'
V2Q5'54%4
V3Q2'2-1'-1
@V4Q2'25'5
```



```
*TA'9'I.AQAQAS9'7#'8#'9'
V2H1#0#
```

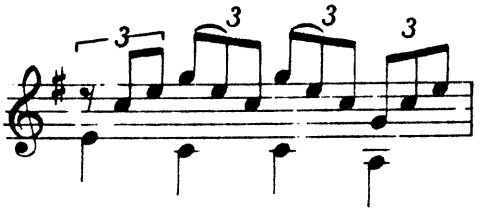


```
*H6I$789
V2I-5-12-1H4
```

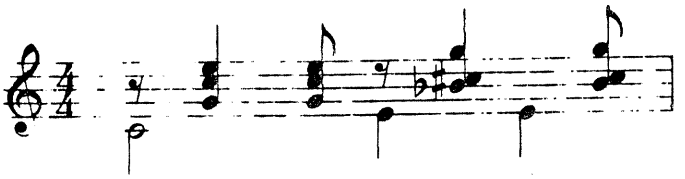



```
*S$3'6&'8'B'8'6'3'$4'6&'7'I:945
V2H-30
```

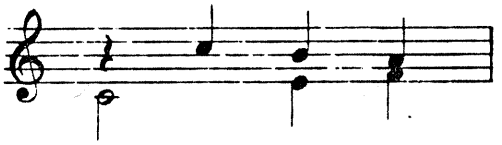
```
*I97'Q7I9753
V2Q5'5'5'8
V3Q3'3'30
```



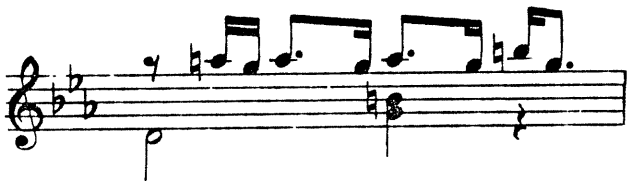

```
*I:$7'9'B9'7'B9'7'4'7'9'
V2Q20'0-2
```



```
*I$Q9'I9$QB'IB
V2I$Q7'I7$Q7#'I7
V3I$Q4'I4$Q6&'I6
V4H0Q2'2
```



```
*Q$765
V2H0Q23
```



```
*I$SC%'B'I.CSB'I.CSB'D%'I.B
V2H$Q6%$
V3H1$
```

NOTE SIGNS

DOTTED NOTES A dot after a note adds one-half the value of the preceding note.

Examples in 4/4 time:

Dotted Quarter Note  = 1-1/2 beats

Dotted Half Note  = 3 beats

TRIPLET NOTES Three notes of equal time value played in the time of two of the same kinds of notes.

HOLD Notes sound longer than their actual values.

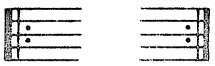
TIED NOTES The first of two tied notes must have no articulation. The two notes sound as one continuous note.

An accidental on the first note is passed to the note in the next measure.

STACCATO Expression modifier used to make a note sound separate or detached from the other notes. Use a comma or a semicolon after the note symbol to produce this effect.

ARTICULATION Expression modifier used to make a note sound clear and distinct, especially within a series of similiar notes. Use an apostrophe or quotation mark after the note symbol.

PERFORMANCE SIGNS



Repeat Sign

First and second endings

Repeat preceding measure

Common time 

Cut time

rit. Gradually slower

Fine Finish

D.C. al Fine Repeat from the beginning to the end of the measure marked *Fine*

D.S. al Fine Repeat from the sign 𝄋 to the end of the measure marked *Fine*

D.C. al ⊕Coda Repeat from the beginning to the *Coda* sign ⊕ and then skip to the *Coda*

D.S. al ⊕Coda Repeat from the sign 𝄋 to the *Coda* sign ⊕ and then skip to the *Coda*

𝄋 Repeat from this sign

⊕ *Coda* mark when playing second time after *D.C.* skip from this sign to the *Coda*

PERCUSSION SAMPLES

These samples demonstrate some of the percussion effects possible with **ORCHESTRA-90**. You can use these samples in your own music or create your own percussion. To play these samples correctly, edit the following information into the beginning of your music file:

```
JES8$011$01E      /define Register E, Sine wave, volume E
V4YE              /assign Register E to Voice 4
NQ=60             /play the samples at this tempo
```

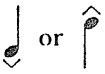
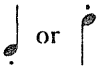
4/4 TIME

```
_V4QSA''B''C''D''ID''8''QD''IB''A''
_V4QD''E''8''IE''E''
_V4QC''9''IF''D''E''9''
_V4IE''8F''C''ID''E''8F''C''IF''D''8F''C''
_V4QC''F''I8''D''8''E''
_V4QC''I8''9''F''8''E''
_V4QC''9''D''IA''E''
_V4QE''I9''F''Q7''I8''9''
_V4QB''IA''8''E''8''6''C''
_V4Q8''I8''8''9''9''9''
_V4QB''I9''D''8''D''A''
_V4I8''SA''A''I9''F''SF''8''I8''E''SA''C''
```

3/4 TIME

```
_V4I8''8''QC''ID''E''
_V4IE''SE''B''I8''B''QD''
_V4(ID''SE''E''ID'')1
_V4IS6''7''8''9''IE''8''E''8''
_V4S:(E''F''F'')3IF''F''
_V4I8''8''B''8:C''D''E''ID''E''
```

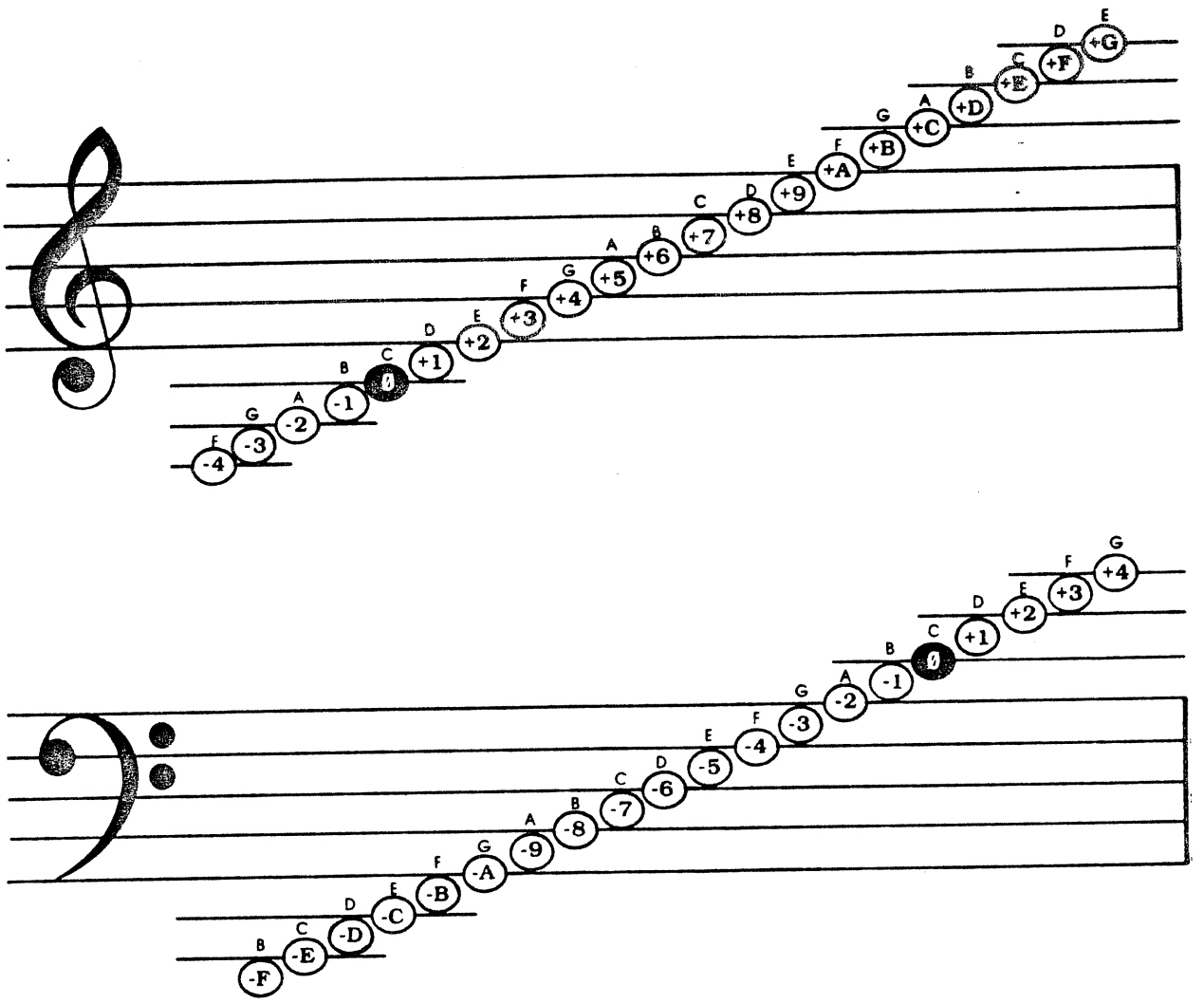
NOTE MODIFIER	MUSICAL EXAMPLE	NAME
#	♯	ACCIDENTAL SHARP
&	♭	ACCIDENTAL FLAT
%	♮	ACCIDENTAL NATURAL
##	𝄪	DOUBLE SHARP
&&	𝄫	DOUBLE FLAT
%#	♮♯	NATURAL SHARP
%&	♮♭	NATURAL FLAT

EXPRESSION MODIFIER	EXAMPLE	NAME
, (comma)		SHORT STACCATO
; (semicolon)		LONG STACCATO
' (apostrophe)	(none)	SHORT ARTICULATION
" (quotation mark)	(none)	LONG ARTICULATION

TIME VALUE SYMBOL	MUSICAL EQUIVALENT	NAME OF NOTE		REST ($)
W		WHOLE note		
H		HALF note		
Q		QUARTER note		
I		EIGHTH note		
S		SIXTEENTH note		
T		THIRTY-SECOND note		
X		SIXTY-FOURTH note		

TIME VALUE MODIFIER	MUSICAL EQUIVALENT	NAME
. (period)		DOTTED note
: (colon)		TRIPLET

FIGURE 3., NOTE POSITION REFERENCE CHART



Note: The symbols inside the notes represent the **Orchestra-90** scale. The small letters above the notes represent the musical scale and are for reference only.

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