The Midas Touch

A User's Guide to the Buchla 400

Version 8/07/82

THE MIDAS TOUCH

A User's Guide to MIDAS and the Buchla 400

Version 8/06/82

CONTENTS

INTRODUCTION

Welcome to MIDAS, (an achronym for Musical Instrument Definition and Scoring), a language designed and implemented for the Buchla 400. MIDAS was written in 1982 by D. N. Lynx Crowe of Buchla Associates and features a graphic facility for defining complex instrumental responses, programmable tuning tables, interactive waveshapeing capabilities, and a comprehensive real-time score editor. In order to use MIDAS you will need the Buchla 400, equipped with a video monitor, a sound system, and either the touch sensitive keyboard or a terminal. This manual assumes the reader has the keyboard configuration, and includes a separate section, (Appendix A), for those users with terminals. A cassette tape of the sample instruments presented in the manual may be obtained from Buchla and Associates. A glossary at the end of the manual gives brief definitions of specialized terms with references to their use in the manual.

SYSTEM DESCRIPTION

THE FRONT PANEL

The panel (see fig. 1), provides the user several means of inputing information to the system and additionally contains the system's outputs. A brief overview of the various knobs and buttons is given here, with more detailed explanations given in the appropriate sections of this manual.

The lower section of the panel contains the all important power and reset switches. The reset switch resets the system to initial values. The edit button switches back and forth between edit and play modes - the LED, (the red "light-emitting diode"), indicating the edit mode. The scroll stick is used to move the score back and forth when editing, the movement of the score corresponding to the movement of the stick. The remote switch enables advancing of the score via external pulses. Activation of the remote switch is also used to stop the progress of the score. The tempo control knob and switches multiply the tempo by the indicated factors. The Voice Selection switches determine which of the six voices are affected by the subsequent 5 parameter articulation controls, the numbers 1 - 6 referring to Voices A-F, respectively. The following 5 knobs affect the indicated parameters, each one provided with an LED to visually alert the user when in a non-zero position. The time scaling knob scales the time-varying functions defined by the user as part of instrument definitions (See INSTRUMENT DEFINITIONS). Note that this knob DOES NOT affect the tempo. The fine tuning knob affects all 6 voices on the instrument, enabling the performer to tune up with other instruments. The gradations indicate the deviation in cents (100ths of a half step) from concert tuning. The analog joystick is destined for use with future languages.

The LEVEL knob serves as a master volume control for the system, affecting the rear panel stereo ouputs, but not the individual front panel outputs.

THE KEYBOARD

Midas was designed to be used with the Buchla 448 keyboard, although provisions were also made for the terminal user (see Appendix A for details). The 448 keyboard consists of two sections: the 98 keys on the left side are primarily for performance, while the keys and cursor controls on the far right (fig. 2) comprise an editing facility. MIDAS uses two cursors, or markers, to show where things are being entered on the screen: the GRAPHICS CURSOR appears as a small bright cross on the video display; the TEXT CURSOR is a blinking underline that generally indicates where data can be entered.

The Performance Section

MIDAS uses only 42 of the 98 performance keys: keys 1 through 25, 52-54, 56-57, 59-61, 63-64, 66-68, 70-71, and 73-74. The willing eye can construe this odd configuration of keys as a 42-note keyboard, similar to the common black and white one, ranging from a low E to an A three and a half octaves higher. This similarity is important to visualize, as it is intrinsically related to the score editor.

The Edit Section

The edit section of the 448 consists of a joystick, two blank round keys, four keys with arrows on them, and a 4 by 5 key array containing a traditional hex pad plus four specialized keys on top. The two blank round keys are destined for use with future software. The joystick is used to move MIDAS's graphic cursor around; the four keys with arrows are used to move MIDAS's text cursor around, as well as jumping the graphics cursor from field to field (see Editing Functions in INSTRUMENT DEFINITIONS). The hex pad is used for menu selection and for hexadecimal and decimal data entry (see the following section for an explanation of hexadecimal notation). The four specialized keys at the top are: a minus sign (referred to as the '-' key in the manual), a plus sign (referred to as the + key), an M (the Menu key), and an X (the Delete key).

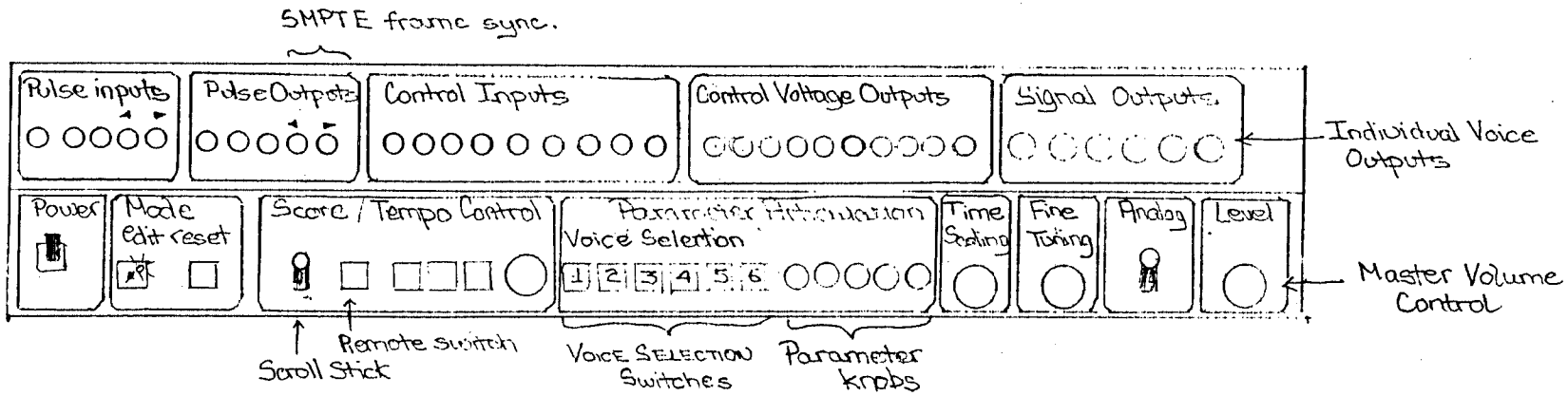


Fig. 1 Front Panel

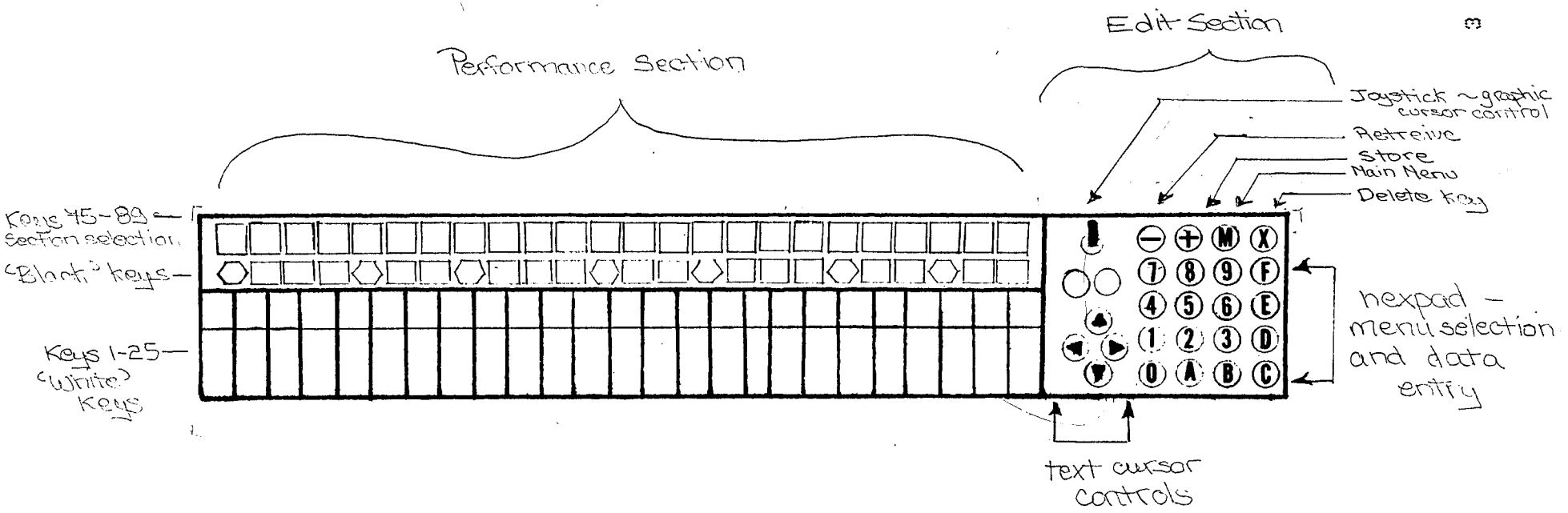


Fig. 2 448 Keyboard

Hexadecimal Notation

Hexadecimal Notation is a base 16 numbering system used often in computer applications as it is a power of 2. It's also a convenient way of fitting 16 numbers into a 1-digit space. If you're unfamiliar with it, here's a reference table:

DECIMAL	HEXADECIMAL
0 through 9	0 through 9
10	A
11	B
12	C
13	D
14	E
15	F

For example, if you wanted to enter the decimal number 13 as a hexadecimal number, you would enter the letter 'D'.

GETTING STARTED

Installation

Video

A standard video monitor is required with the Buchla 400. These are generally available at computer stores in a range of screen sizes and qualities. We recommend a 7 or 9" screen for the musician on the road, a 12" for a typical home or studio based facility (Amdek Video 100 is recommended), or larger monitors for classroom use.

The 400's video output signal is via a BNC connector located on the rear panel. Most monitors require a VHF connector, for which an appropiate cable is provided. Connect this cable from the 400's video output to your monitor's video input.

Sound System

To hear the instrument, you'll need a sound system, minimally consisting of a stereo amplifier and two speakers, preferably of exceptionally high quality. The 400's main output is via two standard phone plugs located on the rear panel. Connect these outputs to the main, aux, or other high level inputs of your amplifier. The separate output is an optional click track, which you can either ignore, feed to a separate amplifier, or mix externally with the main output.

Tape Recorder

A cassette tape recorder is a desirable accessory for storing Orchestras and Scores. Use a high quality deck with line

level inputs and outputs, and preferably an internal monitor speaker. Signal connections are via miniphone connectors Use the left channel of stereo machines to maintain compatability with factory suppplied tapes and for user interchange.

Turning on and Getting Loaded

To turn on the instrument, first turn down the LEVEL knob on the front panel in order to avoid a cacophonous blast of sound, then turn the POWER switch on (the up position). Some little red lights will brighten up, assuring you power is indeed present.

The next step is initializing the program. The VOICE SELECTION switches on the front panel have been assigned particular functions for this purpose. To initialize a PROM-based system (indicated by a label on the rear panel reading: PROM MIDAS version xx/xx/xx) activate VOICE SELECTION switch #1. To load MIDAS from cassette tape, activate switch #2 and turn on the cassette recorder with the MIDAS program tape in it. To load MIDAS from disk, activate switch #3, with the MIDAS program disk in disk drive #1. In all three of these cases, the Main Menu will appear on the video screen once the program is loaded. When this happens rewind, remove and properly stash your tape or disk (if applicable) and proceed to the next section of this manual (THE MENU). After program initialization, the function of these switches changes (see VOICE SELECTION).

There are three resident programs also available to you: activating VOICE SELECTION switch #4 puts you into the Monitor program, (for terminal users), switch #5 starts the RAM memory test; and switch #6 starts the PROM memory test. For details on the memory test programs, see APPENDIX B. The Monitor program is useful only to those users with development systems. For details on its use, refer to the 400 Programmer's Guide.

THE MAIN MENU

MIDAS is essentially a menu-driven language, making it accessible to users with terminals as well as those with the standard keyboard configuration. (For details on editing from a terminal, see Appendix A - Terminal Users.) Shortly after system loading the video will display the main menu, (fig. 3). The digits on the edit section of the keyboard correspond to each of the selections on the menu, according to their position (fig. 4). Therefore, to create an Instrument, touch `Edit Instr', or key 4. Return to the main menu by typing the M from the edit section. Note that the meaning of the edit keys depends on the displayed `menu'. You can always obtain the Main Menu by typing the M from the edit section, and from there you can select a desired display or operation.

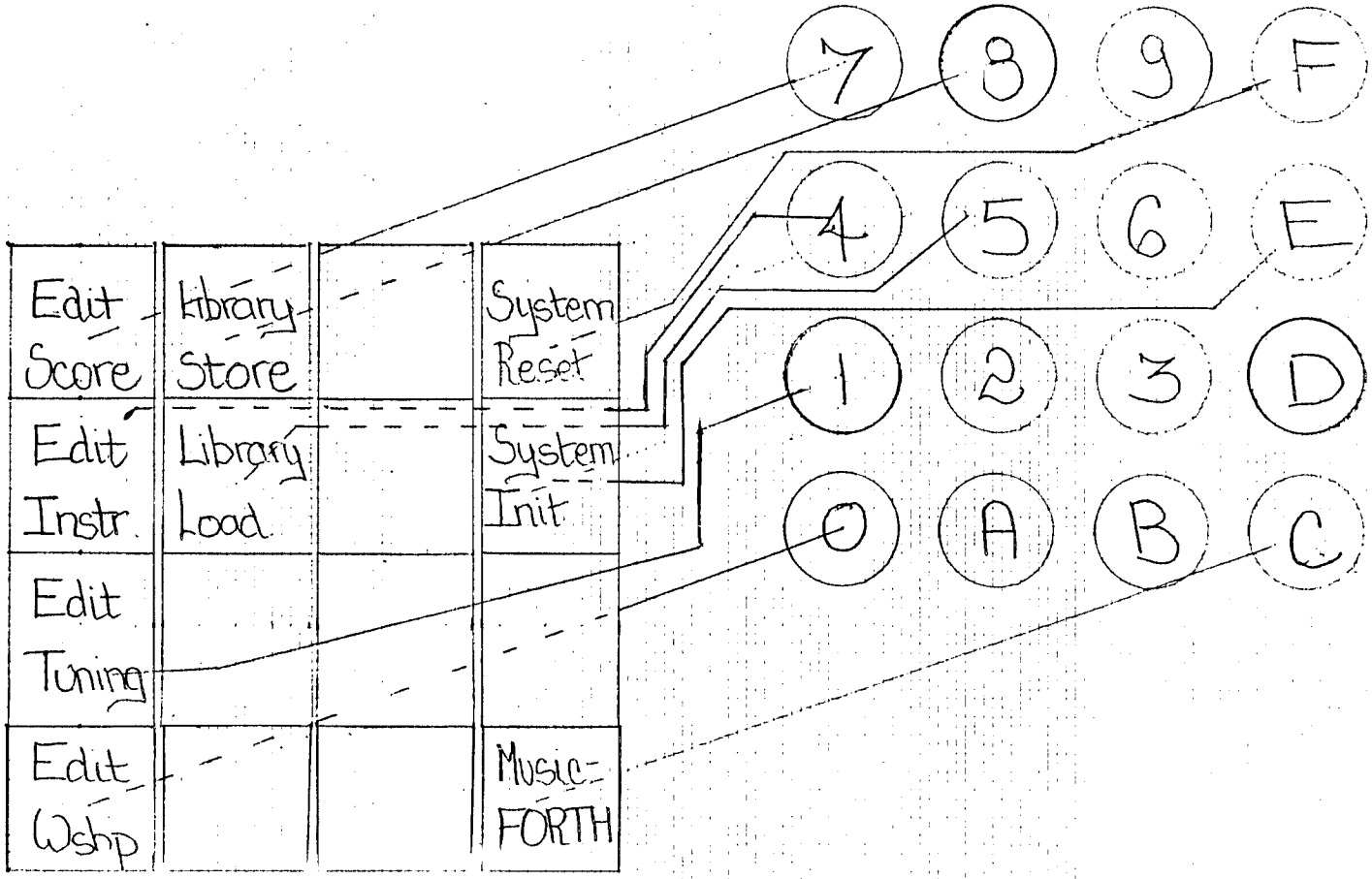


Fig. 4 ~ Hexpad and Main Menu

[Note: if you have the cassette tape of the sample instruments, now is a good time to load them up, following the instructions in the following section.]

LOADING THINGS

To load an Orchestra (a block of 24 instrument definitions, 24 waveshape tables and 4 tuning tables) or a Score into the instrument's internal library, first select Library Load from the Main Menu, (fig. 5) by typing '5'.

The position of the text cursor is shown on the screen by a flashing underline. This cursor is moved around with the four arrows of the edit section of the keyboard. As an excercise, press the down (▽) arrow twice, press the right once, then the left once, then up twice. The cursor should now be back to its original position.

Next, indicate whether the data to be loaded is an Orchestra or a Score (enter an 'A' for a Score, a 'B' for an Orchestra). Then position the cursor in the media field and type a 1, 2, or 3 to indicate whether you are loading from tape, PROM, or disk, and then type +. (The ID number has no significance when loading.) If you are loading from tape, however, wait until the Start Tape instruction appears on the screen before running the tape, as the computer must first clear memory of all resident debris. When the record has been successfully loaded, the display will return to the Main Menu. Be sure that the output level of the cassette recorder is adjusted so that the VU meter is barely in the red zone. If you are loading from PROMs, note that the PROM card should be inserted into the socket on the top of the instrument so that the windows on the integrated circuits arefacing you.

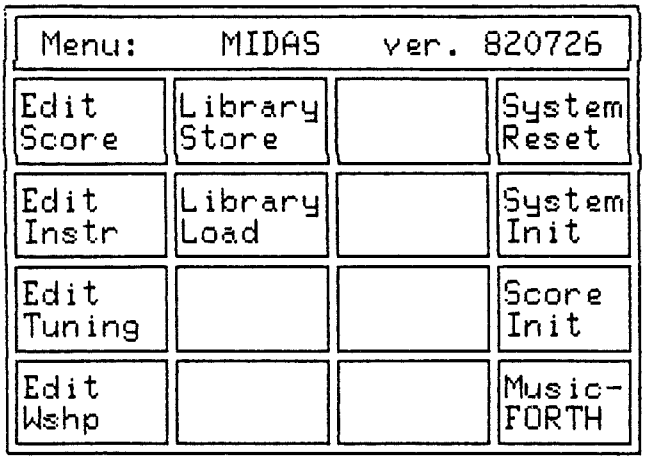


Fig.3

As a practical example, follow this step by step method to

load the sample instrument definitions:

1) If not in the main menu, type 'M'.

2) Select 'Library Load'. Type '5'.

3) Move text cursor (flashing underline) to the DATA field, if it's not already there, with the four arrows. Enter 'B' for Orchestra.

The cursor moves automatically to the Media field.

4) Enter '1' for tape.

5) Put cassette tape of sample instrument definitions into tape recorder, making sure that it is rewound. Type '+' to start the loading process.

6) Wait for the 'Start Tape' instruction to appear on the screen, then start the tape running.

7) When the Main Menu appears on the screen, stop the tape. (This takes a few seonds.) The loading process is completed.

If a Load Error message appears on the screen instead of the Main Menu, repeat the loading procedure using the next record on the tape. The second record starts after the first, following a short silent space.

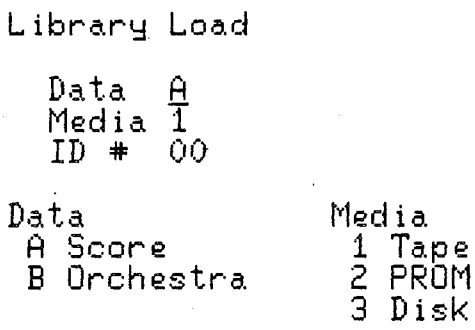
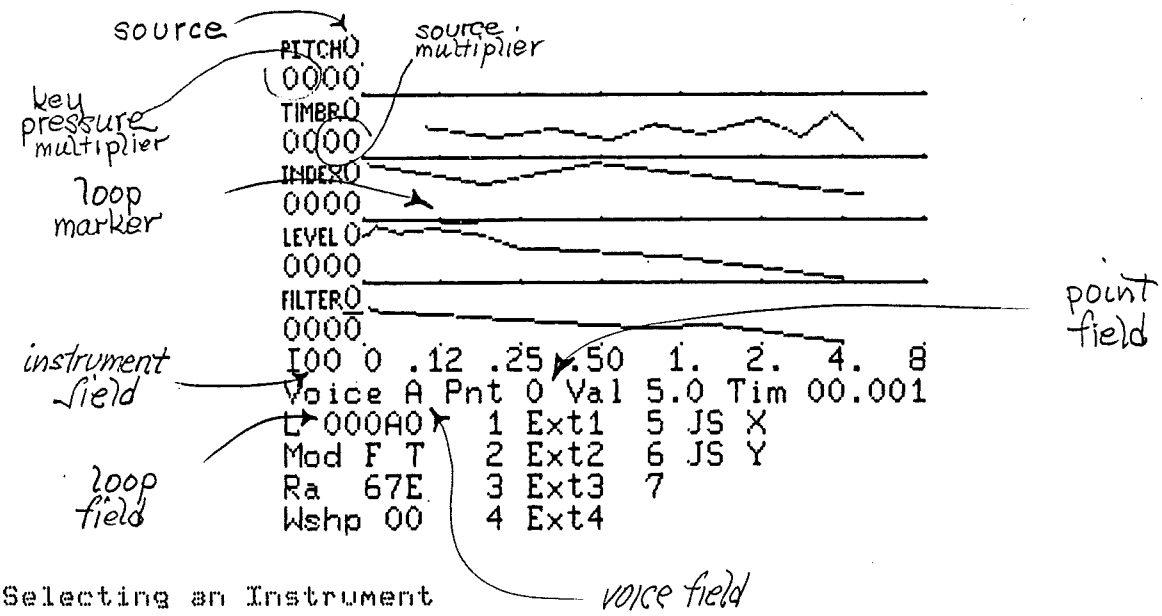


Fig. 5

INSTRUMENT DEFINITIONS

From the Main Menu select the Edit Inst. display by typing '4', (fig. 6). The instrument now 'up' is the system's default instrument, I00. You can alter this instrument and hear the result, but you would not be able to store your new version of it as I00. There are 24 additional instruments available at any one time in the instrument's internal library. These are labeled 1-24, and can be stored on cassette tape for future retrieval. One (C-90) cassette tape can store four thousand instruments to be read back in 24-instrument blocks.



Selecting an Instrument

In order to create or edit an instrument, a voice must first be attached to it. Notice the D in the VOICE field. To change voices, position the text cursor in the VOICE field and type a letter from A to F, selecting one of the six voices. Select VOICE A for the time being. An instrument may be attached to the selected voice by positioning the text cursor in the I (instrument) field and entering a number from 01 to 24 and typing '-'. Now select instrument #01. To blank out the instrument definition display, type the Delete key (X) with the text cursor in the I (instrument) field. This does not delete the instrument definition from the computer's memory. Try it, then reload instrument #01. MIDAS defines its instruments by attaching functions to each of its five parameters. Parameters are the variables, the 5 different aspects of each sound that can be altered. If you'd like to hear the effect of these parameters on the sound, go back to the default instrument (00) - with the text cursor (the flashing underline) in the I (instrument) field, type 00, then '-'. Make sure you are in the PLAY mode - press the edit switch on the front panel until the red light goes off - and activate VOICE SELECTION switches 1, 2, 3 and 4. Now the parameter articulation knobs are attached to the voices played by the keyboard. Experimentation with the effects of these knobs will clarify the meaning of each parameter. Functions are lines

that describe the `shape' of each of these variables. They are described by identifying ten points along a line, which are then connected as in a `connect the dots' puzzle. Select Instrument 01 again. (Be sure to type `-' after entering the instrument number.) Looking at the display, notice how the LEVEL function is determined by 4 points.

Editing Functions

To create or edit parametric functions, the text cursor must first be in the Pnt (point) field. Use the cursor control arrows in the edit section of the keyboard until the text cursor (the flashing underline) is on the number in the Pnt field (it probably is a 0). You now have two choices: you may `draw' the functions by positiong up to 10 points with the graphics cursor, or you may specify the value and time at each point by locating the text cursor and entering numbers from the hex pad. Note that multi-digit fields in MIDAS must be completed by typing the final digit (even if it means typing a zero on top of a zero).

The first example is a simple level function, or envelope. Go to the MAIN MENU (type `M') and then select Edit Score (a `7'). Note the intensified letters A, B, C and D. Move the text cursor to the `B' and type `-'. Repeat for the letters C and D, leaving only the `A' intensified. Now go back to the MAIN MENU again, (type `M'), and select Edit Inst (a `4'). Select Voice A (by entering the letter `A' with the text cursor in the Voice field). Instrument 01 should appear in the I field. (This procedure enables you to play and hear the sample instruments. More detailed explanation is given in the Edit Score section.) You can now play this instrument to see how the level function sounds. For practice, duplicate this level function in the blank PITCH field (the top-most field). With the text cursor in the Pnt field, try moving the graphics cursor down and up the 5 fields. Use the same arrows, pressing the down arrow four times, then the up arrow four times. Notice that the lines connecting the function's points disappear when the graphics cursor is in that field.

For the dot-to-dot method: position the graphics cursor on the desired parameter field in the upper part of the display The joystick on the keyboard moves the graphics cursor up, down and around within a parameter field.

The function starts with a sharp attack, starting from 0 at point 0, so a zero is entered in the Pnt field with the graphics cursor in the lower left corner of the field. That point is now entered. Enter a 1 in the Pnt field and move the graphics cursor to the top of the field and over a bit to the right. The function then sustains that high level for a bit, so enter a 2 in the Pnt field and move the graphics cursor horizontally to .25 seconds. Next the funcion decays gradually to zero. Enter a 3 in the Pnt field and move the graphics cursor horizontally to 1 second, and vertically down to zero. The graphics cursor is moved

to another field, and the completed function appears drawn on the screen. Notice that as points are selected and moved around, their values and times are displayed (the value in 10ths of volts, ranging from 0.0 to 10.0, written A.0 and the elapsed time in 1000ths of a second, ranging from 00.001 to 32.000). The times entered are adjusted to the actual numbers that the computer deals with, so that what is displayed is an accurate representation of what is heard, but may differ slightly from what is entered. It should also be pointed out that the time axis is exponential, as shown by the markings in the grey band underneath the parameter fields. Thus a segment at the beginning of a function represents less time than a segment of equal length at the end of a function.

The same function could easily be specified using the alternative method of data entry. Retrieve I01 from the internal library, and reenter the LEVEL function in the PITCH field using this method. With the text cursor in the Pnt field, type the point number, enter the desired value in the Val field, then the time at which that point will occur in the Tim field. Remember that the entire Tim and Val fields must be typed in order for the entry to be recognized. Back in the Pnt field, type the next point number, then the next value, and the next time. Points can only be entered in sequence, never in reverse order.

Here's a blow by blow description of how to enter the LEVEL function of I01 in the PITCH field:

1) Make sure the text cursor is in the Pnt field and that the graphics cursor is in the PITCH field.

2) Enter a 0 in the Pnt field.

3) Move the text cursor to the Val. field with the right arrow. Enter 0.0. The cursor moves automatically to the Tim field.

4) Enter 00.000 (Notice that 00.001 is displayed). The cursor moves automatically to the Pnt field.

5) Enter 1.

6) Move the text cursor to the Val field. Enter A0. This signifies 10.0 (see the HEXADECIMAL NOTATION table). The cursor moves automatically to the Tim. field.

7) Enter 00.037. The cursor moves automatically to the Pnt field.

8) Enter 2.

9) Move the text cursor to the Val. field. Enter A0. The cursor moves automatically to the Tim field.

10) Enter 00.250. The cursor moves to the Pnt field.

11) Enter 3.

12) Move the text cursor to the Val field. Enter 0.0. The cursor moves to the Tim field.

13) Enter 01.000. The cursor moves to the Pnt field.

14) Move the graphics cursor down one field to see the function displayed.

Changing Functions

To change a function that has already been entered, position the text cursor in the Pnt field, enter the point number to be moved, and adjust its position either by moving the point with the graphics cursor or by entering the new position via the edit keys. To see the changed function, move the graphics cursor to another field. Points cannot be moved past the time of the succeeding point, or before the time of the preceding point. MIDAS replaces illegal entries with the previous values.

Try changing the previously entered PITCH function. With the text cursor in the Pnt field and the graphics cursor in the PITCH field, enter a 3. (You will be changing the last point). To make the function decay nister, move the text cursor to the Tim field, and enter 00.508. Move the graphics cursor down^n one field to see the new function. If you had tried to enter a time less than 00.250 (the time of point 2), the original value would remain displayed.

The Loop Field

The loop field can be used to create more complex functions by inserting loops or jumps into them. It consists of five digits, one for each parameter. The digits, from left to right, correspond to the parameters as displayed on the screen from top to bottom (i.e: pitch, timbre, index, level, filter - in that order). Starting with the level function in I01, we will add a 'bouncing ball' decay on the end using the loop field. First retrieve instrument #01 from the internal library to get rid of the practice PITCH function. (Recall |hat this is accomplished by locating the text curosr in the I field and typing '-'.) Now position the text cursor in the Pnt field, and the graphics cursor in the LEVEL field. Enter a 2, which will be the start of the loop. Type + to indicate the start of the loop. Next the endpoint of the loop, a 3, is entered. Type '-' to indicate the end of the loop. Move the text cursor to the Loop Field and enter a number from 0 to 9 in the fourth digit to indicate the number of times the loop will repeat. In the example there are eight 'bounces', or seven repetitions, so type a 7. The duration of the loop is displayed as a line above the corresponding section of the function. Play the instrument to hear the effect. Select Instrument #02 to see the completed loop function.

The letter A in the loop field works as a sustain: the loop

will occur continuously until the key that initiated the function is released. The letter B in the Loop field serves as an 'enable' which is the opposite of a sustain: the function will go to the end of the loop and will continue to repeat the loop if the key which initiated the function is NOT being pressed. If the key IS being pressed, then the loop does not occur and the function proceeds to its end. The letter C in the loop field means that the loop will be continuous, regardless of the key status. If these explanations are confusing, examine instruments 03, 04, and 05. Try tapping a key, and then try holding it down.

The Loop field also determines when each function is initialized. Notice that in I01, TIMBR, INDEX, LEVEL, and FILTER are intensified. This indicates that these functions will start on key closures (activation on a key by touching it or calling it from the score). Medium (normal) intensity indicates that the function will initialize when that instrument is called, or on reset from the front panel. To brighten or dim a parameter, position the text cursor on the appropriate digit in the loop field and type a + to brighten or '-' to dim.

There can be only one control loop per parameter but each parameter's loop can be of a different sort, with unique starting and ending points.

The Parameters

There are five parameters which describe each instrument according to the functions attached to them. We have already discussed a level function, or envelope. At the top of the screen we have PITCH, a function which will be applied to the pitch of each note. See Instrument 06 for a continuous pitch function. The pitch is normalized at 5.0. Any values below that will lower the pitch, while values above 5.0 will raise the pitch. An increase of .4 in the value will raise the pitch by 100 cents, or one semitone. Therefore, a value of .2 will lower the pitch one octave, and a value of 9.8 will raise the pitch one octave.

The TIMBR function affects the instantaneous harmonic content of that note (see I07 for an example). The effect of varying this parameter is dependent on current waveshape, and experimentation with the timbre knob on the panel in conjunction with various waveshapes is recommended (see Waveshape Tables).

The FILTER is a low-pass filter with a 12db per octave slope and a sharp but unpeaked knee. It is totally closed when the FILTER function has a value of 0.0, and wide open when set to 10.0. The knob on the panel works similarly. (See I08).

INDEX refers to modulation index and represents a scaling factor applied to the modulating oscillator's signal (see Mod Field, below). By way of illustration, if a 'vibrato' effect were created using frequency modulation, the index would control the width of the vibrato. Select instrument #09 and notice the

effect of the INDEX knob on the front panel. (Be sure voice selection switch #1 is activated, since you are listening to voice A.)

The Mod Field

The Mod field determines whether the 400 will perform frequency and/or timbre modulation of the oscillator attached to that instrument. Position the text cursor in the Mod field, and type a + on the F for Frequency modulation, or on the T for timbre modulation. The appropriate letter will be intensified to indicate the type of modulations selected. These are toggled functions; to defeat modulition, retype a + in the desired field. Below the Mod field is the Frequency/Ratio field. Values entered in this field represent the frequency of modulation expressed as either an absolute value (Fr) or as a ratio (Ra) between the frequencies of the modulating signal and the primary signal. Typing the + key while the text cursor is in the Fr field will switch the modulation and the display back and forth between the frequency and the ratio mode. The subsequent three digits must then be entered - tables 1 and 2 provide a reference guide to the significance of these values. There is one modulation oscillator for each main oscillator, and the same modulation frequency and modulation index will be applied to both frequency and timbre if both are selected.

TABLE 1

PITCH	FREQ	HEX DATA	PITCH	FREQ	HEX DATA	PITCH	FREQ	HEX DATA
	00	000	D2	73.5	540	G#5	830.9	A80
	01	020	D#	77.8	540	A 6	880.5	AC0
	02	040	E	82.4	580	A#	933.0	AC0
	03	060	F	87.3	5A0	B	987.9	AE0
	04	080	F#	92.5	5C0	C6	1047	B00
	05	0A0	G	98.0	5E0	C#	1109	B20
	06	0C0	G#	103.9	600	D	1176	B40
	07	0E0	A 3	110.0	620	D#	1244	B60
	08	100	A#	116.6	640	E	1319	B80
	09	120	B	123.5	660	F	1398	BA0
	10	140	C	130.9	680	F#	1481	BC0
	11	160	C#	138.7	6A0	G	1568	BE0
	12	180	D	146.8	6C0	G#	1661	C00
	13	1A0	D#	155.6	6E0	A 7	1760	C20
	14	1C0	E	164.9	700	A#	1865	C40
	15	1E0	F	174.8	720	B	1976	C60
C0	16.3	200	F#	185.0	740	C	2094	C80
C#	17.3	220	G	196.0	760	C#	2218	CA0
D	18.3	240	G#	207.6	780	D	2350	CC0
D#	19.4	260	A 4	220.0	7A0	D#	2490	CE0
E	20.6	280	A#	233.1	7C0	E	2639	D00
F	21.8	2A0	B	246.9	7E0	F	2794	D20
F#	23.1	2C0	C	261.6	800	F#	2960	D40
G	24.5	2E0	C#	277.2	820	G	3137	D60
G#	26.0	300	D	293.8	840	G#	3325	D80
A 1	27.5	320	D#	311.3	860	A 8	3524	DA0
A#	29.1	340	E	329.6	880	A#	3729	DC0
B	30.9	360	F	349.3	8A0	B	3952	DE0
C	32.8	380	F#	370.2	8C0	C	4186	E00
C#	34.7	3A0	G	392.3	8E0	C#	4435	E20
D	36.7	3C0	G#	415.3	900	D	4700	E40
D#	38.9	3E0	A 5	440.1	920	D#	4978	E60
E	41.2	400	A#	466.4	940	E	5275	E80
F	43.7	420	B	494.2	960	F	5589	EA0
F#	46.3	440	C	523.8	980	F#	5923	EC0
G	49.0	460	C#	554.4	9A0	G	6272	EE0
G#	51.9	480	D	587.3	9C0	G#	6646	F00
A 2	55.0	4A0	D#	622.3	9E0	A 9	7042	F20
A#	58.3	4C0	E	659.4	A00	A#	7463	F40
B	61.8	4E0	F	698.7	A20	B	7909	F60
C	65.4	500	F#	740.0	A40	C	8372	F80
C#	69.3	520	G	784.1	A60			

Some useful harmonic ratios and their corresponding hexadecimal data are listed in table 2. These values produce stable tones often with strong subharmonics that shift the fundamental (a ratio of 1/4 will frequently shift the perceived fundamental down 2 octaves). Values close to those shown will result in audible beat frequencies, and non-harmonic ratios will generally poduce more complex, often clangorous or dissonant tones. Experimentation is the recommended route to familiarization with the effects of modulation ratios.

TABLE 2

RATIO	HEX DATA
1/4	500
1/3	5A0
1/2	680
3/5	6D6
2/3	720
3/4	760
4/5	784
1	800
5/4	87C
4/3	8A0
3/2	8E0
5/3	91A
2/1	980
3/1	A60
4/1	B00

Note that in this field (the Fr. or Ra. field), only even numbers are accepted as data. Note also that when the frequency of modulation is expressed as a ratio, an increase of one in the second digit represents an increase of a quarter tone in the modulation frequency relative to the frequency of the Voice, while an increase of 2 in the third digit represents an increase of a 16th of a tone in the modulation frequency.

Waveshape Selection

There are 24 waveshapes available (at one time. These waveshapes can be defined and stored by the user.(See Waveshape Editing.) To attach one of these waveshapes to an instrument definition, position the text cursor in the Wshp field, and enter a number from 01 to 24.

Source Multipliers

The digits to the right and below each of the parameter names in the upper part of the instrument display signify sources and their multipliers which can be added to those functions. Position the text cursor in one of these source fields and the source menu will appear at the bottom of the screen (fig. 5). The digit to the right of the parameter name indicates the currently selected source as defined by this menu. Ext. 1, 2, 3, and 4 refer to the control voltage inputs on the panel. JS X and JS Y refer to the horizontal and vertical movements of the joystick on the keyboard. The four digits below the parameter name are actually two separate numbers, each with two digits. The two right-most digits scale the sources selected from the source menu as described above. Numbers from 00 to A0 are accepted, corresponding to a range from .00 to 1.00. A `-' typed in this field will cause these digits to be interpreted as negative multipliers, indicated by an underline, while a + will reinstate a positive interpretation. The two left-most digits comprise a multiplier that scales the key pressure voltage which will be applied to the indicated parameter (Insts. 10 and 11.) Note that the Parameter name must be intensified (even though there may be no function in its field) for the key pressure to work as a source. The key pressure is dealt with polyphonically: a note's parameters are affected only by the pressure applied to the key that initiated that particular note.

Instrument Storage

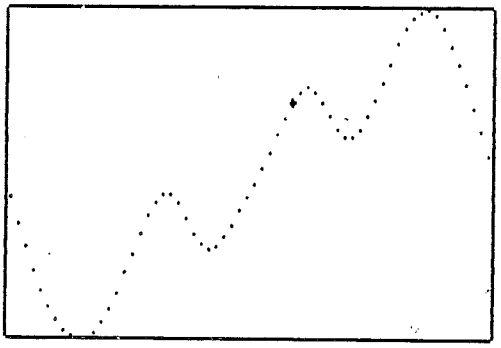
Instrument definitions may be stored temporarily in the computer's internal library, as well as permanently in blocks of 24 on cassette tape or PROM, ("offline storage"). (See Library Storage and Library Loading for details.) Although the six instrument definitions currently attached to the six voices are(always in the computer's c>rrent editing area, it is necessary to store the definitions in the computer's general memory, and it's wise to(do this before selecting a new voice or another display. To store an instrument definition, position the text cursor in the I field and type a +. To copy an instrument definition, or renumber one, first retrieve the instrument to be copied by typing its number in the I field and typing a `-'. Then type the new instrument number and type a +. To clear the editing area, position the text cursor in the I field and hit the delete key (X on the hex pad). All the functions will disappear and you are ready to start over again.

Voice Selection

To select a new voice, position the text cursor in the VOICE field, and enter a letter from A to F. A voice selection refreshes the screen, and displays the instrument currently attached to that voice. Therefore, if you want to save an instrument definition, you should do it before selecting a new voice.

WAVESHAPE TABLES

To get to the waveshape display, first get back to the Main Menu by typing an M from the hexpad, then select Edit Wshp by typing a 0. The Waveshape Display will appear on the screen (fig. 7). The waveshape initially displayed is Wshp 00, a default waveshape that, like Instrument 00, cannot be stored by the user. There are 24 waveshapes available to the user at one time. To select one for editing, position the text cursor in the Wshp field, enter a number from 01 to 24, and type a '='. To listen to the 24 sample wavehapes provided with the sample instruments, position the text cursor in the VOICE field, select Voice A, ind then select any of the 24 waveshapes. Activate the VOICE selection switch #1 on the front panel, and experiment with the timbre and index knobs to hear the full effect of each waveshape.



Voice A Wshp 00 X= 37 Y= 180

Fig. 7

Editing Waveshape Tables

Editing waveshapes tables is similar to editing time-varying functions in instrument definitions. A waveshape table is defined by 64 points, and determines the harmonic structure of a sound. For more information on waveshapes and techniques of creating interesting sounds, refer to Appendix C for a reference bibliography. At system turn-on, the same default waveshape will exist in each of the 24 waveshape tables. These tables may be altered or created through use of the graphics cursor or via

entry of the desired numerical values for each point. (If you've loaded the sample instrument tape you've also loaded 24 sample waveshapes.) After locating the graphics cursor on the desired point, move the point vertically to alter its value. By the alternate method, position the text cursor in the X field, type in the number of the point you wish to alter (00 to 63) and then type the vertical position of that point in the Y field (000 to 255). In order to hear the effect of changing waveshapes, explore different settings of the timbre knob on the front panel while selecting various waveshapes or editing. To warn you that an edited waveshape has not yet been stored, the waveshape number remains intensified until storage is complete.

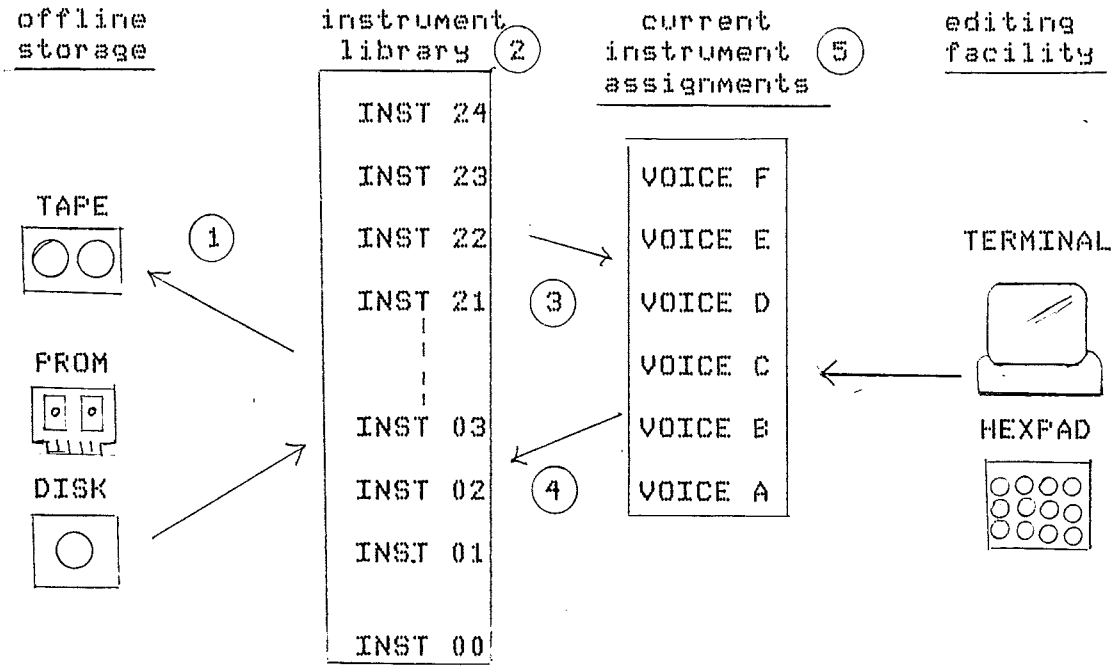
Storing Waveshapes

In order to store a waveshape you must first have a voice attached to it. Select a voice by positioning the text cursor in the VOICE fiell and typing a letter from A to F. To store the waveshape in the computer's internal library, position the text cursor in the Wshp field, and type a +. The intensity of the field will go down when the waveshape is stored. As a protective measure, a waveshape that is not yet stored but is used in an instrument definition will appear intensified in the instrument definition display. To copy a waveshape or change its number, first retrieve it by positioning the text cursor in the Wshp field, entering the number of the waveshape to be copied, and typing a `-'. Then enter the new number, and type a +. For more information on storing waveshapes permanently on cassette, PROM or disk see STORING THINGS.

MORE ABOUT MEMORY

MIDAS deals with three types of memory: offline storage, consisting of cassette tape, PROM, or disk; an internal library; and the current editing area. The internal library consists of 24 instrument definitions, 24 waveshape tables, and four tuning tables. The current editing area contains 6 instrument definitions, 6 waveshape tables, and one tuning table. These are the definitions, waveshapes and tuning table(currently attached to each of the 6 voices. Everything in the internal library is stashed each time something is stored offline (on tape, PROM, or disk). See LIBRARY STORAGE for details. However, nothing in the current editing area is stored offline, which is why these 6 instrument definitions, 6 waveshapes and one tuning table must first be stored in the internal library, or they will be lost when a LIBRARY STORE happens.

The following diagram illustrates the multilevel relationships between mass storage of instruments, the instrument library, and the voice assignment editing facility of MIDAS and the Buchla 400.



(1) Instruments are stored and retrieved from tape, PROM, or disk through use of main menu keys 5 and 8.

(2) The instrument library is a section of memory reserved for 25 instruments that are instantly accessible for assignment to voices. Instrument 00 is a default, non-modifiable instrument that appears at system turn-on; instruments 1-24 can be shuffled and edited individually, or stored and retrieved in blocks of 24.

(3) Instruments are attached to voices from the instrument display (through use of the '-' key in the I field) or from the score.

(4) Instruments are stored in memory by typing a '+' from the I field of the instrument display.

(5) Another section of memory, this one dedicated to currently assigned instruments. An instrument must be assigned to a voice before it can be viewed and edited.

THE SCORE EDITOR

MIDAS is equipped with a real time score editor that allows the musician to create scores directly from the keyboard and to subsequently edit them interactively. From the main menu select Edit Score by typing a 7 to get to the score display (fig. 8). Key activity is displayed on the upper part of the screen as notes on the traditional treble and bass clef staves. The duration of each note is represented by its actual length, a characteristic in common with a piano roll. Sharped and flatted notes are depicted as in fig. 8. The vertical line down the center of the staves indicates the instant in the score currently being edited or played. The scroll stick on the front panel moves the score backwards or forwards, as long as the instrument is in the edit mode and 'Run' is intensified. (Type E to turn Run on and off.) In the play mode, the score will only scroll forwards. Note that while scrolling, the values in the Time field increase and decrease accordingly. A menu at the bottom of the screen allows the user to select various play or edit possibilities, (The EDIT menu). To enter a score, select the Edit Mode by activating the front panel EDIT key. The Play mode is reentered by reactivating the EDIT switch. The system is in the EDIT mode when the red light on the EDIT switch is on. To position the score at an exact location, press the REMOTE switch on the front panel to stop the score (RUN must still be active), then scroll to the desired position (remember that you must be in the EDIT mode to scroll backwards).

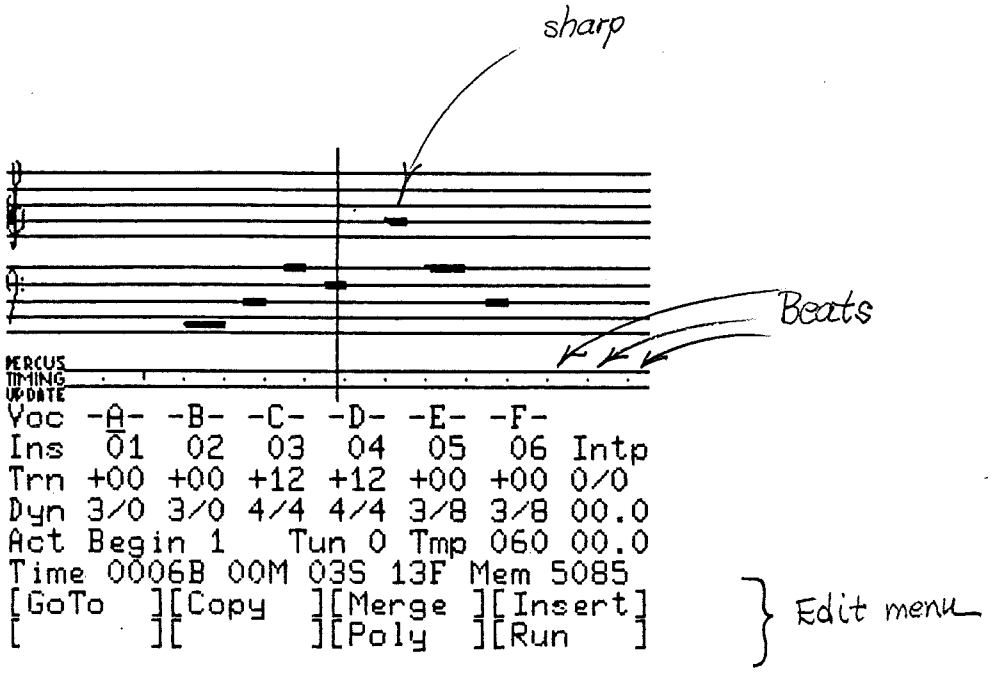


Fig. 8

The note cursor (consisting of two opposing arrows) is controlled by vertical movement of the scroll stick and should be at its lowest point (invisible) to display the edit menu. Practice moving the cursor up and down. Use a gentle touch to move it slowly. Now practice scrolling the score: the note cursor must be at its lowest point. Enter the EDIT mode (with the EDIT switch). Activate RUN (type 'E'). To scroll slowly, activate the remote switch from the front panel. You should now be able to position the score to single frame accuracy. The remote switch is used whenever the score is to be positioned precisely, as in deletion of notes or when entering notes one by one. It is also used to advance the score via the external pulse inputs, providing synchronization with other media.

THE EDIT MODE

Selecting a Voice and an Instrument

Voices are edited 'polyphonically' using a rotational voice assignment algorithm. To take advantage of the polyphonic voice assignment routine, select Poly from the lower menu (type a '6'). The Poly will brighten up when active. When in the polyphonic mode, each key activation results in one sounded note, whereas in the Chorus mode (non-Poly), all activated voices will be sounded with each key closure. The Polyphonic mode is automatically engaged when the Edit mode is selected. If not in the EDIT mode, you may exit the Polyphonic mode by typing another '6'. Voices to be entered or edited are intensified by positioning the text cursor in the desired Voc field and typing +'s on the voices to be edited. The medium intensity of a voice letter indicates that it will be heard when the score is scrolled, but it cannot be edited. The reduced intensity indicates that the voice will be silent and invisible on the score, but whatever it has been programmed to do will still be in the computer's memory. This allows the user to see only those voices currently important while editing, thereby uncluttering the score. Type +'s to increase the intensity, -'s to reduce the intensity of a designated voice. If the instrument is in the Poly mode, then each of the selected voices will be assigned a different note, enabling the user to enter chords of up to six notes. To select an instrument definition, position the text cursor in the Ins field under the voice in question, and enter the number of the desired instrument definition. Each voice may have a different instrument attached to it, or several voices may share one instrument definition. Now intensify VOICE A only, attach instrument 00 to it, and create a score.

Entering a Score

Once a voice and an instrument have been selected, you may enter a score. Remember that you must be in the EDIT mode. To position the score, you must activate RUN (type 'E'), and then activate the remote switch to have the maximum scrolling control. Scroll the score (with the scroll stick) until the vertical line is positioned where the first note will start. Move the note cursor up to the desired pitch (also with the scroll stick). A new menu will appear on the bottom of the screen (fig. 10). Select 'Begin' (type a '7') from this menu to indicate the beginning of a natural (non-sharped) note. Position the score at the end of the note and type 'end' (an '8'), being careful to maintain the same position of the note cursor. Since we are entering only Voice A, you should not enter overlapping notes. The note is now entered and appears on the score as a horizontal bar.

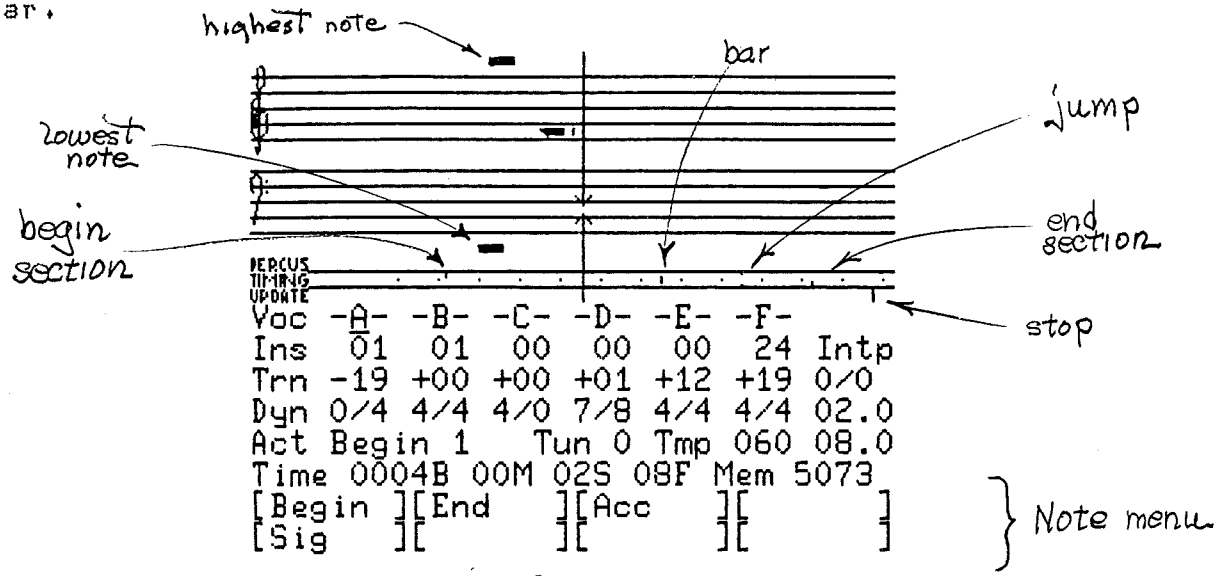


fig 10

To enter sharped notes, type 'Acc' (a '9') instead of 'Begin'; to enter flatted notes, first type 'Sig' (a '4'), then '-' (minus) and then 'Acc' to begin the note. Typing '+' and '-' switches the effect of 'Acc' back and forth between sharping and flatting. (Fig. 11 illustrates the differences between the MIDAS score and standard notation.)

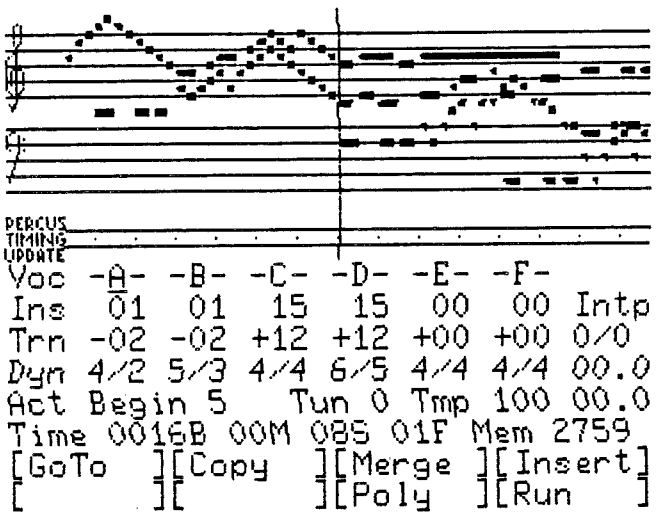

PERCUS
TIMING
UPDATE
Voc -A- -B- -C- -D- -E- -F-
Ins 01 01 15 15 00 00 Intp
Trn -02 -02 +12 +12 +00 +00 0/0
Dyn 4/2 5/3 4/4 6/5 4/4 4/4 00.0
Act Begin 5 Tun 0 Tmp 100 00.0
Time 0016B 00M 08S 01F Mem 2759
[GoTo][Copy][Merge][Insert]
[ ][ ][Poly][Run]

Fig. 11

To delete a note, position the score at the exact beginning of the the note and type the Delete key (X on the hex pad). To display the corrected score after deletion, activate the EDIT switch twice. Note that deletion of a note adds 2 to the available memory. This lets you know immediately, without refreshing the score, if your deletion attempt has been successful. All notes that start at the same time will be deleted, as long as their voice is selected for editing (Voice letters displayed at the highest intensity). Note also that the note cursor must be in the note field (above the timing line) for notes to be deleted. (The note menu will be displayed if the cursor is in the proper position.)

Notes can also be entered by playing them on the keyboard. Be sure you're in the edit mode, and the note cursor is NOT in the upper field (the music staves). Type Run from the menu, and play away. The notes can be entered at half speed by first activating the .5 tempo switch on the front panel. Or the score can be alvanced manually while |he remote switch is activated through manipulation of the scroll stick after each note is entered. To stop the scrolling of the score when you're finished playing into it, type Run again from the menu.

The Transposition Field

The transpositon field allows any voice to be transposed from 1 to 19 semitones either up or down. Position the text cursor under the appropriate voice in the Trn field, type either a `+' or a `-' and the desired number of semitones. The other voices will not be affected.

Dynamics and Location

The Dyn field deals with the overall dynamics of each voice and its location in space. The data consists of two digits: the left digit represents the dynamic level, from ppp to fff, with 0 representing the softest level, and 7 the loudest, (see table 3); the right digit represents the location of the voice, with 0 signifying the extreme left, 4 in the middle, and 8 extreme right. Again, the data in this field applies only to the voice directly above it.

TABLE 3

Number in Dyn Field	Conventional Notation	db level*
0	ppp	-12
1	pp	-9
2	p	-6
3	mp	-3
4	mf	0 (default)
5	f	+2
6	ff	+4
7	fff	+6

* db's are relative units of volume, in this case measured from the mf, or 4, setting.

Tuning

The Tun field assigns a tuning table to all 6 Voices. (See Tuning Tables). Position the text cursor in the Tun field, and select a tuning table from 0 to 4. The default table, Tuning 0, assigns the traditional chromatic, tempered scale to each of the keyboard's keys.

Tempo

The Tmp field represents the current tempo in standard MM (beats per minute). The Tempo Control knob and the multiplier switches on the panel affect this tempo, so this metronome setting will only be accurate if these controls are set to 1.

The Time Field

The Time Field includes five related data fields: beats (B), minutes (M), seconds (S), frames (F), and memory remaining (Mem) (see fig. 8). The beats are defined by the tempo (Tmp) field, and are indicated as dots in the center of the Timing Track, below the staves. A frame is always one 16th of a beat, regardless of tempo; a second is always 30 frames, and a minute is always 60 seconds, or 1800 frames. These three fields, (minutes, seconds, and frames) were designed to be used in composition for media (film or video) and will only represent real times when the tempo is set to 112 MM. For composition with

video, the instrument is provided with decoded SMPTE (Society for Motion Picture and Television Engineers) coded pulse outputs and remote sync pulse inputs on the front panel.

The Mem field

The Mem field indicates the number of score events remaining in the computer's memory. A note consumes two events, one key closure and one release, jumps consume two events, all others are one event.

The Interpolate Fields

Under the 'Intp' displayed on the right side of the screen are 3 fields, indicating the transition time to new values in their respective lines. In the Trn line, the Intp field represents in two hexadecimal digits the speed of the 'glissando' to the new, transposed pitch. The first digit indicates the number of semitones per beat, and the second digit represents the number of 32nd-tones per beat. If no glissando at all is desired, enter 0's in these two fields and the pitches will be immediately transposed upwards or downwards. Note that if an interpolation is entered, the glissando will occur on EACH note played by that voice. The Dyn and Tmp Interpolate fields each consist of two digits indicating the number of seconds that will elapse before a new value is reached.

The Timing Track

The timing track displays various score division and manipulation possibilities. Position the graphics cursor on the Timing Track and a new menu will appear on the bottom of the screen (fig. 12). From this menu we can label sections, indicate jumps to different sections, add bar lines, add a 'click' track, or unconditionally stop the score.

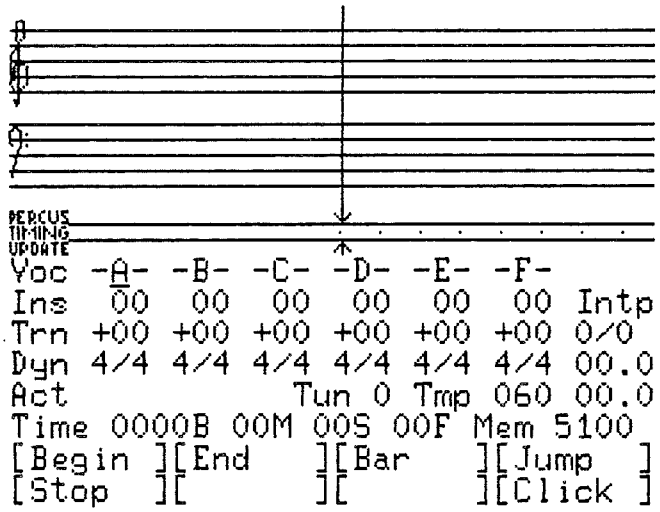


Fig. 12

Labelling Sections

The user may label up to 16 sections, enabling him to manipulate large portions on the score in the Play Mode, pr copy sections from one part of the score to another for speedier writing. To designate a section, scroll the score so that the vertical line is on the beginning of the section. With the text cursor on the Timing Track, type 'Begin' (a '7'), followed by the desired section number in hexadecimal (numbers 1-F). Sections cannot begin or end in the middle of notes, or exactly on a note beginning, as this will result in unending or unsounded notes. Next scroll the score to the end of the section, and type 'End' (an '8'), followed by the number of the section. The Timing track shows the beginning and ends of sections by little bars (fig. 12) and the Action (Act) field displays the name of each section as it is playing, brightening up on beginnings and endings.

Jump

The Jump instruction asks the score to go to the beginning of an indicated section a specified number of times. To initiate a jump, scroll to the spot where the jump will occur. Type 'Jump' (an 'F') followed by two digits. The first digit is the number of the section to which the score will jump. Jumps can only be

made to the beginnings of sections. The second digit is the number of times the jump will be made, up to 16 times (1-F, hexadecimal). When the instrument is in the Edit Mode, the jumps are indicated by little bars on the bottom of the timing track (fig. 1Ø), but when the instrument is in the Play Mode all the jumps will be written out as they are heard, and they will be displayed in the Action Field.

Bar

The Bar instruction (type a '9') adds bar lines on the Timing Track whenever it is activited (fig. 1Ø). These bar lines are for visual reference only. They do not affect the performance of the music, nor do they necessarily have to be regularly spaced.

Stop

The Stop instruction causes the score to stop when that point is reached if the instrument is in the Play Mode. This might be used to synchronize different activities during the course of a piece, or to line up the beginnings of different sections, etc. Scroll the score to the stopping place and activate the 'Stop' key (a '7'). A 'hanging' bar appears in the Update Field where the stop will occur (fig. 1Ø). When encountered in the score, the Stop instruction must be followed by a Run command for the score to continue (see the Editing Menu). To delete a Stop, the vertical cursor must be on the Update line, and the score must be positioned exactly on the frame in which the Stop occurs. The word 'Stop' will appear intensified in the Act field, but the timing track menu will not be displayed when the cursor and score are in the proper positions. Press the Delete key (X), and the Stop is deleted.

The Click Track

When the Click Track is activited by typing 'E', a signal consisting of a click on each beat will be produced at the CLICK OUTPUT on the rear panel.

The Percussion Track is reserved for use with future software.

Score Manipulations

Back in the Edit Menu, (move the note cursor down to one of the note fields), there are several instructions useful for editing or manipulating sections of the score. These are Copy, Merge, and Insert.

Copy

'Copy' is used when a section of the score is to be inserted into another part of the score, or added on to the end of the existing score. Scroll to the point in the score where the addition will be made. Type 'Copy' (an '8') followed by the number of the section (1-F) to be copied. The score is 'opened up' to insert the section, the remainder of the score being moved over to the right.

Merge

'Merge' works similarly to 'Copy', except that the score is not opened up, but the section is superimposed on the existing music. (Position the score, type 'Merge' (a '9'), followed by the number of the section to be merged. The designated section is now layed on top of the score. This has no effect on the timing of the piece. Two sections using the same voice at the same time cannot logically be merged together. This instruction is useful when one voice's activities are repeated several times on top of other things, as in a repetitive rhythm track.

Insert

'Insert' is to notes what 'Copy' is to sections. It is used to insert notes into the score, moving everything over that follows the insertion. Position the score, type 'Insert' (an 'F'), enter the note or notes, then type 'Insert' again.

THE PLAY MODE

The Play Mode is activated from the front panel by pressing the edit switch (the light should go off). In this mode the score will be heard and displayed with all the indicated jumps. To begin playing, type 'Go To' (a '7'), followed by the number of the section with which you would like to start the piece. To begin at the beginning, type a 'Go To' then a 0. Next, type 'Run' ('E') to start the score rolling. To Fast Forward the score, use the scroll stick on the front panel. If the Score encounters a Stop, it will stop and you have to type Run ('E') again to get it going.

You can play the keyboard at the same time as a score is playing. Only the voices shown at the highest intensity in the score display can be played. If the Poly mode is off, then all enabled voices (those at high intensity) will be played simultaneously with each key touched. Otherwise, they will be assigned rotationally, one per key touched.

Keys 75-89 on the performance section of the keyboard have been assigned a special function. While in the Play mode and in the Edit Score display, they will perform a 'Go To', then a specific section number, then a 'Run'. Thus, key 75 will start the score playing at section 1, key 76 will start the score

playing at section 2, key 77 at section 3, etc. up to key 89 starting the score at section 15. The score will then run on until it ends or encounters a Stop instruction. Remember that you heve to be in the score disply for these keys to work. Key 90 tacets all voices and serves no knon musical purpose. We'd suggest avoiding its use.

While the score is playing, there are numerous possiblities for performer interaction. Instrument definitions can be changed or reassigned at any time. Parameter articulation from the front panel can be used to alter sounds, or the tempo can be tampered with. Instrument definitions can be set up to use the control voltage inputs or the keyboard pressure.

TUNING TABLES

MIDAS is provided with 5 tuning tables, any one of which can be active at one time. Table 0 is the default tuning system, consisting of the traditional chromatic, tempered scale. Like Instrument 00 or Waveshape 00 it can be altered temporarily but not stored. From the main menu type 'Edit Tuning' (a '1') for the display (fig. 13).

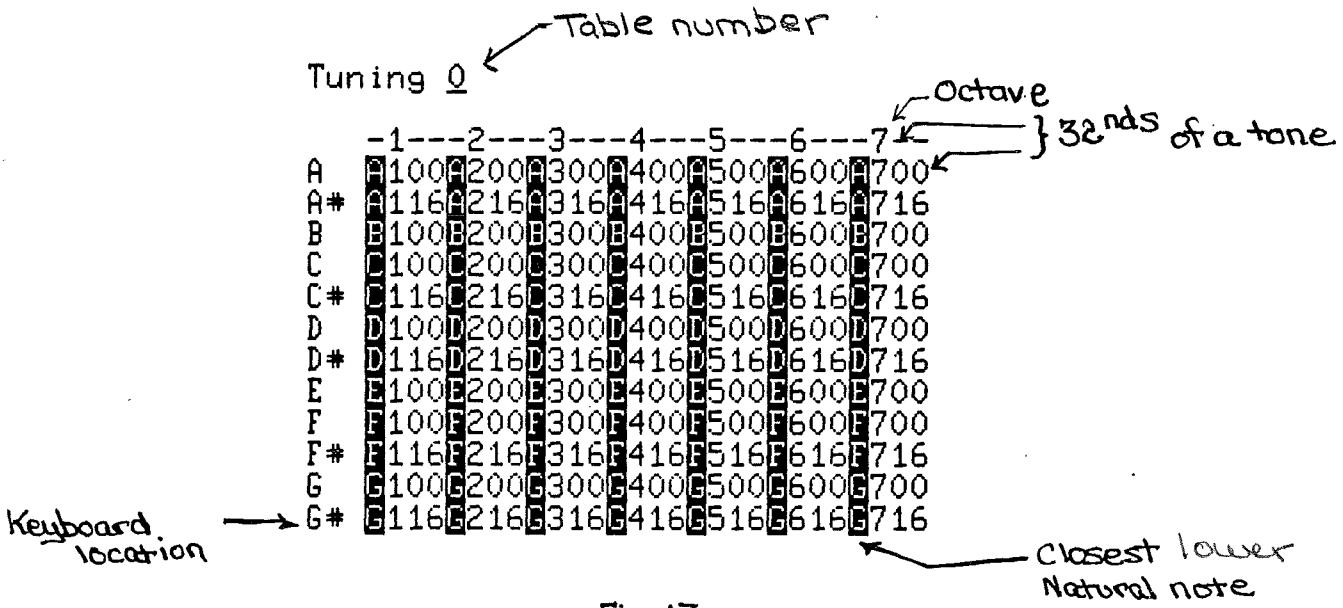


Fig. 13

The column at the left edge of the display corresponds to the letter names of the keys on the keyboard. Each of the following seven main columns correspond to an octave on the keyboard, with 1 being the lowest, and 7 the highest. Each of the seven main columns has two parts: a letter name (in the grey column), and a three digit number. The letter refers to the name of the closest natural note below or equal to the desired pitch. The first digit of the number indicates the octave registration, ranging from 1 to 7, of the note; while the remaining two digits indicate the number of 32nds of a tone to be added to the natural note. Thus, in Table 0, the 'white' keys of the keyboard all end

in 00's; the octaves all agree with the column number; the letter names all agree with those in the left column; and the 'black' keys are all raised by 16/32'nds from the naturals. The tuning tables, however, can be used to adjust the temperament of intervals or to more drastically reconfigure the keyboard (sample tuning table 1 tunes the keyboard in quartertones, tuning 2 consists of just intonation pentatonic scales on the 'white' keys and 'black' keys). Note that the 448 keyboard, when no transposition is called for by the score, ranges from E2 to A6. Score transpositions are literal semitones only for standard tuning. They actually represent key displacements in the tuning table, and may thus range from A1 to E7.

Editing Tuning Tables

To edit a tuning table, first select the number of the table (1-4), then position the text cursor on the note to be altered. For an entry to be recognized, the last digit must be entered, then the computer will reduce the figures to their closest 'white' key. Thus, 3/4's of a tone above B in the lowest octave, entered as B, then 124; would be reduced to C plus 08 32nds, or C108.

Storing Tuning Tables

To store a tuning table in the internal library, position the text cursor under the table number and type a +. Remember that table 0 cannot be stored in an altered state.

STORING THINGS

To preserve your instruments and scores offline on cassette or prom, go back to the Main Menu and select Library Store (type an '8'). The Store display will appear on the screen. Indicate whether you are storing a Score or an Orchestra, by entering an 'A' or a 'B'. An Orchestra consists of the 24 Waveshapes, the 24 Instrument Definitions and the 4 Tuning Tables currently in the computer's memory. Select the storage medium by typing a 1, 2 or 3 (tape, PROM, or disk) assign an ID # from 00 to FF, insert a blank PROM card, a disk or start the tape recorder (on record), and type a +.

The record level on the tape recorder should be adjusted so that the VU meters remain in the red zone. When storing on PROMs, the PROM card should be inserted into the socket on top of the instrument so that the windows on the integrated circuits are facing the user.

Music Forth - See the Buchla 400 Programmer's Guide

APPENDIX A - For Terminal Users

Cursor control can be accomplished from a terminal without

the benefit of the Buchla 448 keyboard. The text cursor is moved forward with the Space Bar, backwards with the backspace key, (^H on some terminals) up with the Line Feed key, and down with the Return key. The graphics cursor is moved to the right with the 'greater than' sign (>), to the left with the 'less than' sign (<), up with the K key, and down with the L key. In the special case of moving the graphics cursor from one parameter field to another (see INSTRUMENT DEFINITIONS), the vertical text cursor controls are used.

The M key (to select the Main Menu display) from the 448's hex pad is replaced by the Escape key on a terminal, and the X key (the Delete key) is replaced by the Rubout key or Delete key on a terminal. (Rubout and Delete are shifted on many terminals.) The other numbers and letters, as well as the plus and minus signs can be typed directly from the terminal.

To simulate a key closure from the terminal, use the X key. To simulate a key release, use the Z key. A pitch of A220 will be assigned when the X key is activated

Appendix B --- The Memory Tests

The front panel PROM contains two memory tests. The diagnostic aspects of the tests may be performed by the user; servicing information is povided for the convenience of authorized service personnel only.

- RAM test - this tests system RAM memory for errors, using a memory test pattern written into each location and then verified. Both main memory and window memory are checked.

- PROM test - this is a visual indication of the checksums of PROM memory. The checksums are displayed for each of the PROMs, and a master checksum for the entire set is calculated and displyed. By looking at the master checksum you can quickly tell if something is wrong with any of the PROMs. The individual checksums can then be checked if an error in the master checksum is noted.

RAM test

The RAM test is initiated from the Parameter Articulation switches by pressing switch "5" just after power has been turned on. This will cause the video display to be cleared and then the message:

RAM TEST

will be displayed. The program will then run a "walking bit" RAM test on each of the RAM locations. This testing takes a while, so be patient. If all goes well, and no errors are found, your patience will be rewarded with the message:

RAM TEST SUCCESSFUL

indicating that the system is functional and ready for use. At this point the LED for Parameter Articulation switch "5" will also be extinguished and you can make another selection as though power had just been turned on.

If, on the other hand, you get a message like:

RAM ERROR xxxx yy zz ww

your system has a failing memory which will need to be corrected before it can be used. The information in the message identifies the failure mode and the failed chip.

xxxx is the RAM address at which the failure was noted
yy is the data that was read from the bad location
zz is what the data should have been
ww is what the window control register had in it

The RAM address is the first thing to look at. If it lies within the range C800 through CFFF there was an error in the window memory, and the window control register contents will give the first two hexadecimal digits of the address of the bad chip. The window memory (#313), is identified by the existence of 2 DIP switches among its edge. These two digits, and the map below, give the location of the failing chip. The following map represents the component side of the window memory board. Only the RAM chips are shown as having hexadecimal addresses. The other chips on the board are PROM chips and have window numbers W0 through W7. Access to these may be needed in case of a checksum error.

```
------------ top of board ------------
00 18 30 48 60 70 80 90 A0 B0 W7 W5 W2
08 20 38 50 68 78 88 98 A8 B8 W6 W4 W1
10 28 40 58                    W3 W0
----- connector edge of board --------
```

Map of window memory chips

If the RAM address lies within the range B800 through C7FF or within the range D000 through EFFF you've had a RAM failure on the main memory board. This board (#312) has 4 .DIP switches along its edge. The first two digits of the address given should be used to locate the failing chip on the map shown below:

```
------------ top of board ------------
00 18 30 48 60 70 80 90 A0 B0 C0 D0 E8
08 20 38 50 68 78 88 98 A8 B8 C8 D8 F0
10 28 40 58                    E0 E8
----- connector edge of board --------
```

Map of main memory chips

Once the failing RAM chip has been identified, it should be replaced by one of the same type and the test should be repeated.

It is conceivable that a support chip could fail, in which case a large number of failing chips will be indicated, usually starting with the first chip on the board. If this occurs requiring more extensive tests than can be described here.

PROM test

The PROM test calculates and displays the checksum for each of the PROM chips in the system, as well as a master checksum for the entire set. By comparing the master checksum displayed with the one provided in the documentation for your particular system you can determine whether or not a PROM failure has occurred.

The PROM test is initiated by pressing Parameter Articulation switch "6" just after power has been turned on. The video display will be cleared and then the checksums will be dislayed. The map below will tell you which position on the display corresponds to which PROM chip. Note that chips labelled with W0 through W7 on the map below are on the window board, and that not all of them may be present. Checksums will only be shown on the display for PROMs that are present in your system.

CHECKSUMS mm

00 08 10 18 20 28 30 38

40 48 50 58 60 68 70 78

80 88 90 98 A0 A8 B0

F0

W0 W1 W2 W3

W4 W5 W6 W7

Checksum display format

After you have displayed the checksums you should verify that the master checksum, shown as mm above, matches the one given in the documentation you received with your system. If it does, all is well and your system should be ready to operate.

If the master checksum is incorrect, check each of the individual checksums to determine which of them is in error, and then replace the appropriate chip(s). Remember that W0 through W7 are located on the window board (#313). All others are on the main memory board (#312).

APPENDIX C - Waveshape Reference Bibliography

GLOSSARY

CENTS - units of pitch, 100 cents equal one semitone

CURSOR - a marker on the video display, generally indicating the location where data can be entered. See TEXT CURSOR, GRAPHICS CURSOR and NOTE CURSOR

DB - abbreviation for decibel, relative units of volume

DEFAULT VALUE - initial value or setting. Defualt values are assigned to everything at system turn-on and to appropriate locations after score initialization of instument deletion.

DISK - a medium used for digital data storage, an alternative to cassette or PROM storage.

FIELD - location on the screen where data may be entered

FREQUENCY MODE - in this mode, the modulation frequency is interpreted as a constant and therefore will not change as the pitches of the voice being modulated change (see ratio mode)

FREQUENCY MODULATION - a cyclic changing of the frequency of one oscillator by another. The process is described by two variables, the FREQUENCY of the modulating oscillator and the INDEX, or amount of modulation applied. FREQUENCY MODULATION results in vibrato for low modulation frequencies and indices, and potentially complex timbral changes for higher modulation frequencies.

FUNCTION - a description of the 'shape' of the five parameters, or variables, applied to each sound. The description consists of a line made up of segments described by a series of interconnected points

GRAPHICS CURSOR - a bright star displayed in the parameter fields of the instrument definitions. Used to draw in the parametric functions. Controlled from the edit (right-hand) section of the keyboard by the joystick. The graphics cursor is moved from one parameter field to another by the four arrows in the edit section of the keyboard, but only when the text cursor is in the Prt field. Terminal users see Appendix A for details on cursor control.

HARDWARE - the real, physical portion of th4e system. Some of the 400's characterisitics (input structure and basic vocabulary, for example) are established by hardware.

HEXADECIMAL - a numbering system based on the number 16, rather than the more conventional 10, used often in computer applications as it is a product of 2, the building block of computer languages. Particularly efficient since one digit can express numbers from 0 to 15 instead of just those from 0 through 9. The letters A through F are used to express the numbers 10 through 15. See table 1 on page 4.

INDEX - the amount of modulation, or change, applied to a modulated voice. The larger the index, the more the sound will be affected. With an Index of zero, the sound will not be affected at all.

INSTRUMENT DEFINITIONS - a term used in MIDAS that refers to the total description of the response of a voice on activation of a key. An instrument definition display includes the number of the instrument, graphs of the five time-varying parameters, the voice to which it is currently attached, a waveshape number, and various modulation characteristics. These definitions can be selected from the score, and can also be stored for future retrieval on cassette tape, disk, or PROM. Instrument definitions in this context have no analogies in the world of acoustic instruments. The ability to immediately and significantly reconfigure the stimulus/response map of a musical instrument is unique to computer-aided instruments, and will undoubtedly provide the basis for new compositional strategies and performance techniques.

JOYSTICK - a device which moves in two dimensions, and transmits its position as two numbers: one describing its horizontal position (the 'x' coordinate) and one describing its vertical position (the 'y' coordinate). The 400 has 3 joysticks: the scroll stick on the front panel used to move the score horizontally and the note cursor vertically; the analog joystick also on the front panel which is destined for use with future software; and the joystick on the editing section of the keyboard which is used to move the graphics cursor up, down, and around.

LED - an abbreviation for light-emitting diode, an electronic device that emits a light. On the 400, all the LED's are red, and they are used on the front panel and the keyboard to indicate to the user the status of various switches, knobs and keys.

LIBRARY - the space in memory used by MIDAS to store scores and orchestras. The library contains room for 24 instrument definitions, 24 waveshape tables, 4 tuning tables, and one extended score. Things must first be put into the library before they can be stored 'offline' on tape, PROM, or disk. (See Instrument Storage, pg. 15 ; and Storing Scores, pg. 27). Instrument definitions, tuning tables, and waveshape tables can be taken from the library and put into the editing space to be modified, (accomplished by typing a '-' in the appropriate field). Instruments and tunings selected by the score must be resident in the library.

MENU - an array of options that appears on the video display. The user selects an instruction by pointing to its location on the screen. In MIDAS, this is done by touching the key whose location on the edit section of the keyboard corresponds to the location of the instruction in the display (see fig. 4). MIDAS has one MAIN MENU (fig. 3) containing the instructions for branching to other displays. The INSTRUMENT DEFINITION display has a source menu (fig. 6), while the SCORE display uses three menus: an edit menu (fig. 8), the timing track menu (fig. 12) and a note menu (fig. 10). The incorporation of menus in MIDAS makes it accessible to users without a specialized keyboard, and allows easy addition of features to the language. (See Appendix A - for Terminal Users).

MODULATION - the modification of one signal with another signal. In the 400, each voice has a modulation oscillator associated with it. This modulation oscillator can be used to modify the frequency of the voice, its timbre, or both.

MONITOR - a collection of utility programs accessed by selecting VOICE 4 at instrument turn-on. Of use to those with development systems, a compete description of the 400's monitor may be found in the 400 Programmer's Guide.

NOTE CURSOR - the opposing arrows in the upper part of the SCORE display which indicate the position of the note to be entered.

ORCHESTRA - a term used in MIDAS to describe a collection of 24 INSTRUMENT DEFINITIONS, 24 WAVESHAPE TABLES, and 4 TUNING TABLES.

PARAMETER - an aspect of the sound which can be described by the user, either in the INSTRUMENT DEFINITIONS, with the knobs on the front panel marked PARAMETER ARTICULATION, or via externally applied control voltages. In the INSTRUMENT DEFINITIONS, the parameters are described by drawing the shapes of their evolution through time.

PERFORMANCE SECTION - the left-hand section of the keyboard consisting of an array of 98 touch-sensitive keys. MIDAS uses only keys 1-25, 52-54, 56-57, 59-61, 63-64, 66-68, 70-71, and 73-74. Keys 75-89 have been assigned a specific function (see THE PLAY MODE).

PROM (or EPROM) - an abbreviation for (Erasable) Programmable Read Only Memory. These are IC's (Integrated Circuits) used to store data. They are an alternative to cassette or disk storage and have the advantages of been small, fast to read, and immune to accidental modification. They also have the disadvantages, however, of being more expensive, slow to erase, and relatively long to store into. Once data has been stored on a PROM (it's been 'blown'), it can only be erased by putting it under ultra-violet light for several hours.

SCORE - a term in MIDAS meaning the sequence of key closures, instrument definitions, transpositions, dynamic changes, and other data entered and stored by the user. The SCORE is displayed as scrolling biss and treble staves with the key closures displayed as horizontal bar 'notes'.

SMPTE - an abbreviation for Society of Motion Picture and Television Engineers. The SMPTE time code is a standardised electronic signal the identifies each frame of a film or video tape with elapsed time expressed in hours, minutes, seconds and frame numbers. The code is used to precisely synchronize film, video recorders, and/or multitrack audio tape recorders. The 400's score editor can be synchronized by inputting frame pulses to the labelled panel inputs.

SOFTWARE - that portion of a system that consists of information in the form of computer programs and data. Most operational characteristics of the 400 are determined by SOFTWARE, providing a high level of lexibility and totential for future refinement.

TEXT CURSOR - the flashing underline in the video display that indicates where data may be currently entered. The TEXT CURSRO is moved by the four arrows in the

edit section of the keyboard.

TIMBRE - the steady-state harmonic structure of a sound. In the 400, TIMBRE is one of the five parameters modifiable by the user in the INSTRUMENT DEFINITIONS or via the knobs on the front panel. Increasing TIMBRE will usually increase a sound's energy in the high-ordered harmonics and will affect the fundamental and low-ordered haqrmonics in ways that depend on the current waveshape table.

TUNING TABLES - a list of pitches assigned to each of the keys used in MIDAS. The pitches are described in units of 32nds of a tone. There can be 4 user-defined TUNING TABLES in the computer's internal LIBRARY at one time.

WAVESHAPE TABLE - a list of numbers that determines the basic timbral, harmonic characteristics of a sound. Waveshape tables are displayed as 64 points which are then connected to form a continuous line. A waveshape table containing a straight line will produce a sine wave as the final waveform, while more complex shapes will result in harmonically richer sounds. There are 24 WAVESHAPE TABLES in the computer's internal LIBRARY at one time. They are assigned to voices through instrument definitions.