PATCH-VI User's Guide

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Revision 2

Page 20 from this manual is missing. It looks like it was a misfeed in the copier when it was originally made. If anyone can locate a copy of this page, please let me know at: rkfaulhaber@gmail.com .... Thanks!

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INTRODUCTION

PATCH-VI is one of many possible control languages for the Buchla 400-series computer-aided electronic musical instruments. The language is written in assembly language for a Z80-based microprocesser, and provides real-time control facilities for performance and compositional use. PATCH-VI was designed by Donald Buchla and programmmed by D.N. Lynx Crowe in 1983.

This high-level control language allows the user to:

* specify complex relationships between applied stimuli and instrument responses (Edit PATCHES).

* specify arbitrary time-varying functions for control of various acoustic parameters (Edit FUNCTIONS).

* specify multiple sequences of actions to be taken, using register manipulations and conditional branching to realize complex musical processes (Edit SEQUENCE).

* specify waveshapes for timbre generation (Edit WAVESHAPES).

It also provides for the storage of these instrument definitions on a variety of media, and provides a print facility for documenting instrument data in "hard copy" form.

Extensive use of labels and sub-menus makes PATCH-VI an easy language to learn and apply. Real-time displays of sequencer, register and trigger status facilitate performance and program analysis.

GETTING LOADED

The MEMORY STATUS switches on the rear panel should be in the following positions before loading the program (0 = down, 1 = up; in early systems, 0 = right, 1 = left):

C	B	A	PROTECT
0	1	1	0

After the program is loaded, switch PROTECT to 1. You are now ready to use PATCH-VI.

After PATCH-VI has been loaded it will automatically run a checksum test. This test verifies the integrity of the program. If a checskum error occurs it will be indicated by a message on the display. In this case you should reload the program.

If you encounter any loading problems, refer to GETTING LOADED in the Buchla 400 User's Hardware Guide.

USING PATCH-VI

Start the program by pressing "A" of PARAMETER ARTICULATION on the front panel. (Some vintage 400's PARAMETER ARTICULATION switches are marked 1-6 instead of A-F.) A menu is displayed showing the assignment of the keys on the hexpad in the editing area of the keyboard to each of the different displays and program operations. Selection is accomplished by pressing the hexpad key that corresponds to the menu. The menu display may be selected from any other display by touching the "M" key.

The arrows that appear in the upper right hand corner of the main menu display indicate the correct settings for the rear panel memory protect switches (as viewed from the rear).

The front panel EDIT switch must be activated to enable the edit keys. This is to protect the user's data from being inadvertantly changed.

Default initialization settings in PATCH-VI are listed in APPENDIX A: System Initialization.

There are tne displays and operations currently defined by the menu in PATCH-VI:

* Edit patch table
* Edit function table
* Edit waveshape
* Edit sequence table
* Load & Store
* CRT Align
* Print
* System reset
* System initialization
* Store system

EDITING FEATURES

Text Cursor

Once a program function has been selected from the menu, a text cursor appears in the display as a blinking underline beneath the character position where data entry will occur. It can be manipulated by the four arrows in the editing area of the keyboard.

Example:

1. Start by pressing the EDIT switch on the front panel to enable the edit mode.

2. Press the hexpad key corresponding to EDIT FUNCTION TABLE (an "8" on the 448 keyboard, a "9" on the 461) to display the function table.

3. Move the blinking cursor around using the 4 arrows.

Graphic Cursor

In graphic displays, the cursor appears as a blinking cross which can be controlled by entering data from the hexpad or by moving the point directly with the keyboard joystick.

Example:

1. Press the hexpad key that corresponds to EDIT WAVESHAPE TABLE.

2. Move the graphics cursor around in the display using the keyboard joystick.

Plus (+), Minus (-)

In PATCH-VI, the plus and minus keys have many uses. They may be at various times used to:

1. Enter a sign for a value.

2. Select from a sequence of possible entries. Plus moves through the sequence in one direction and minus in the opposite direction.

3. Obtain a blank edit line in the patch table (plus only).

4. Initiate loading and storage of instrument definitions (minus only).

5. Select certain library load or store menu options.

6. Copy parts of patch table lines to facilitate entering repetitive patches.

The Delete Key (X)

This key will delete an entry or a portion of an entry in most displays. Details of its use may be found in the individual discriptions of the editing areas where it is functional.

CONTROL VOLTAGES

Control Voltage Sources

PATCH-VI provides access to the following sources of control voltages for use in Function Processing Unit (FPU) operations:

Port	Source
0	Foot pedal CV input
1	Front panel CV input 1
2	Front panel CV input 2
3	Front panel CV input 3
4	Front panel CV input 4
5	Joystick x voltage
6	Joystick y voltage
7	Envelope detector voltage
8	Velocity voltage (461 keyboard only)
9	Pressure voltage
A	Velocity and Pressure voltages (461 only)

These control voltages are enabled by appropriate entries in the Source Multiplier (S/M) field of the patch table.

Control Voltage Output Ports

PATCH-VI provides the following output port assignments:

Port	Assignment
0	Tempo control voltage (beats/minute)
1	Front panel CV output 1
2	Front panel CV output 2
3	Front panel CV output 3
4	Front panel CV output 4
5	Front panel CV output 5
6	Front panel CV output 6
7	Front panel CV output 7
8	Front panel CV output 8
9	Front panel CV output 9
A	Front panel CV output 10 and frequency of Phase Oscillator
B	Modulation index of Phase Oscillator

These control voltages are accessed with appropriate Voltage (VLT) entries in the Address (Addrs) field of the patch table.

THE PATCH TABLE

With the system menu displayed, activate the key that corresponds to EDIT PATCH TABLE (a "1" on the 448 keyboard or an "C" on the 461 keyboard). An initialized patch table will be displayed.

EDITING FEATURES IN THE PATCH TABLE

Menu

Field entries in the patch table are menu-driven according to the lower portion of the patch table display. This menu corresponds to the keys of the hexpad in the editing area of the keyboard. The possible entries that may be made for a given field are highlighted when the text cursor is placed at the beginning of that field. For example, only stimulus entries KEY, REL, TRG and PLS are acceptable in the Def and Stm fields; only these entries are highlighted in the menu when the cursor is placed at the beginning of one of these fields.

When the text cursor is placed at the beginning of the Addrs field, two menus are available. The first is a menu of field entries that do not apply to a specific voice. These are:

VOC (Voice)	VLT (Control Voltage Input Port)
SEQ (Sequence)	REG (Register Control)
SUB (Subroutine Call)	
LED (LED Control)	

Entering "VOC" (Voice) by pressing the corresponding key on the hexpad changes the menu display to show entries that require assignment to a particular voice. These are:

-*-	LVL (Level)	FLT (Filter)
PCH (Pitch)	DYN (Dynamics)	FLQ (Filter Q)
TMB (Timbre)	LOC (Location)	TRN (Transposition)
MOD (Modulation)	CTL (Control)	

Note that stimulus entries such as KEY, TRG and PLS are possible entries from either menu display.

Entering "-*-" will recall the first menu.

In most cases, additional data must be specified with the Addrs field entry. Once the field entry has been selected from the menu, the highlights in the menu will darken and the cursor will position itself where the additional data is expected.This data is entered from the editing hexpad in a variety of codes that are explained in the individual descriptions of the field entry types.

Only some of the Op-Code fields are acceptable for a given patch. When the cursor is placed at the beginning of the Op-Code field, the acceptable types of entries will be highlighted in the menu. These variations are listed in the descriptions for each type of patch address. Op-Code field entries may include:

DA - data
VL - value
FN - function line number
SM - source multiplier

Specify the desired type of data by activating the corresponding key; then enter the data. In most cases, a blank data field will disable any previously assigned Op-Code data for that patch address. This is also known as a "no-op" or no-operation entry.

Example:

Def	Stm	Addrs	Op-Code	
	K64	LVL A	FN 01	(Closing Key 64 assigns a function beginning on line 01 in the Function Table to the level of Voice A.)
	K65	LVL A	FN	(Closing Key 65 disables any function activated by a previous patch from the Level of Voice A.)

Delete (X)

The delete key (X) when used in the Def field will erase the contents of the Def field and will not modify the remainder of the patch.

Use of the delete key in the Stm field will delete the entire patch as the Stm field is required for a valid patch.

Use of the delete key in either the Addrs or Op-Code field will delete the contents of that field without disturbing the remainder of the patch.

Plus (+)

Pressing the plus key when the text cursor is in the definition field will blank out the entire edit line so that a new patch may be entered.

The plus key, when in the Addrs or Stm field, will enter the patch currently appearing on the edit line when time it is pressed. This is useful to create a series of patches where the definition and/or stimulus fields change but the address and operations stay the same. This is done by changing only the DEF or STM entries and then typing "+".

Incomplete patch entries are not executable. If a patch is being modified it will become unexecutable when the information it contains is incomplete, and if left incomplete, will be deleted as the result of a scrolling operation.

ENTERING PATCHES

500 patch table lines may be entered.

The data entry fields for each patch are labeled at the top of the display, and are described below:

DEFINITION (Def) and STIMULUS (Stm)

The definition field (Def) determines when PATCH-VI will act on the remaining 3 fields. It contains either a blank field or a stimulus value. If the definition field is blank, the patch can be used immediatly by PATCH-VI. If a stimulus such as a key closure or pulse, appears in the definition field, that stimulus must be received by PATCH-VI before the remainder of the patch can be activated. Once a patch becomes active, it remains so until deactivated, either by replacement from another definition stimulus or by deletion.

The stimulus field (Stm), along with the address (Addrs) and operation (Op-Code) fields constitute the body of the patch. When the stimulus associated with an active patch is received, the data specified by the operation field will be sent to the indicated address. All patches are uniquely specified by their stimulus and address fields. This means that there will be only one active patch sending data to a given address as a result of a given stimulus. When a patch having the same stimulus/address pair as another patch is entered, it will replace the one already in the table. This same action occurs when a patch is newly activated as a result of its definition field stimulus being received.

There are four types of stimulus entries available in PATCH-VI:

1. Key closure	K00...KA0	(101 entries)
2. Key release	R00...RA0	(101 entries)
3. Trigger	T 1...T F	(15 entries)
4. Pulse	P 1...P 3	(3 entries)

Keys

In PATCH-VI, Key 00 corresponds to the front panel RESET switch. This key is automatically released each time a new patch table is loaded into the memory; thus it is useful as an initialization device since it can be used to enable a "default" set of patches created by the user. To do this, enter R00's in the definition fields of those patches that are to be enabled automatically after the patch table is loaded. Note that load generates a release for key 00, but not a closure. This can be used to distinguish between activations of key 00 by the load procress and actual activations of the reset key by using K00 as the stimulus for things which should happen any time the system is reset, and R00 for those things that need happen only once, when the program is loaded.

All keys carry sustain information. Sustain status is set when any key closure is received for a key and reset when any release for that key is received.

Triggers

Internal triggers (T1-TF) may be used to initiate any patch, sequence or function, and will appear to be permanently closed as long as the trigger is called. Therefore, be cautious when triggers are used to call functions, since if the function has a sustain, it will hang up there until the trigger is disabled. A trigger may be used to call such a function by attaching it to a key, as in the following example:

Stm	Addr	Op-Code
K01	Trg 1	R1 = 0
R01	Trg 1	R1 < 0

This patch will activate the trigger upon closure of K01 as long as Register 1 contains a 0, and will release it when K01 is released since Register 1 can never be less than 0.

Trigger status is shown in the column at the far right of the display, under the heading "T". 1 indicates closure, 0 a release.

For additional information, see "TRG -- Conditional Trigger".

Pulses

External pulses from the front panel PULSE INPUT ports (P1-P3) may be specified as stimuli for any patch, however, only P1 conveys sustain information. All pulses initiate events on their rising edge; the falling edge of P1 is seen as a change in trigger status for functions or sequences, but will not initiate any new patch execution.

ADDRESS (Addrs) and OPERATION (Op-Code)

The address field (Addrs) tells PATCH-VI the object to be affected by the patch, and the operation field (Op-Code) specifies what is to be done with that object when the specified stimulus is received.

Each of the possible Addrs field entries are summarized below, followed by a detailed description of each of their functions and their applicable Op-Code field entries.

Addrs (Address)	Dta (Data)	Val (Value)	Fnc (Function)	S/M (Source Mult.)
PCH n	G931	C7 +	FF +	F+C7
TMB n	F	C7 +	FF +	F+C7
MOD n	FFF	C7 +	FF +	F+C7
CTL n	RTFAa			
FLT n		C7 +	FF +	F+C7
FLQ n		C7 +	FF +	F+C7
DYN n		C7 +	FF +	F+C7
LOC n		C7 +	FF +	F+C7
LVL n		C7 +	FF +	F+C7
TRN n	FFF			
VLT n		C7 +	FF +	F+C7
SEQ n	FF			
LED n	FFFF			
TRG n	RF=C7			
SUB n	FFFF			
KEYnn	T			
PLS n	T			
REG n	!R9			

PCH -- Pitch

This patch controls the pitches of the voices.

Address format: PCH n

n is the voice affected by the patch, A...F.

Op-Code choices: DA VL FN SM

Data (DA) format: xyzz

Pitch (x) is specified by pitch class, letters A...G. "G" is entered by typing "9" on the editing hexpad.

Octave register (y) is specified by numbers 0...9 where 0 is the lowest register and 9 the highest. It is important to note that these registers are based on an A-G scale rather than the traditional C-B scale.

Range: C000 (16.3 cps) to C900 (8372 cps).

Pitch offset from a tempered major scale tuning (zz) may be specified in 32nds of a whole-tone by entering 00...31. Thus B-flat in the third octave would be A316.

Value (VL) format: vv +

The VL Op-Code specifies a voltage value that is sent as the analog pitch control value for the indicated voice. This voltage will only be acted upon if the analog enable bit for this voice has been set (initialization value).

Note that this voltage is initialized to 5.0; thus 5.0 results in zero pitch deviation. Larger or smaller values cause positive or negative pitch deviations. The scale factor for this voltage is approximately .4 per semitone, or 4.8 volts/octave.

vv is the value 00...C7 (mixed base).

+ if present causes the value to be added as an offset to the current function value when the next function segment is sent to the Function Processing Unit (FPU). If the + is omitted, a current function will be terminated and replaced by the specified function.

Function (FN) format: ll +

The FN Op-Code specifies a function to be operational on the pitch of a given voice.

ll is the line number of the function table where the desired function begins, 00...FF, hexadecimal.

+ if present causes the value of the function to be added to the last value sent by VL as an offset. Omitting the + sign will cause any offset to be set to zero.

For other details, see EDITING FUNCTIONS.

Source Multiplier (SM) format: psmm

Entries in this field direct control voltage sources from the front panel and the joystick in the editing area of the keyboard, as well as other optional locations. (See CONTROL VOLTAGES.)

p is the source port number 0...7.

s is the sign, + or -.

mm is the multiplier value 00...C7 (mixed base) with an implied 2 digits after the decimal point. (See APPENDIX C: Mixed Base Representation of Numbers.)

Example: 62 is read 0.62
B3 is read 1.13

TMB -- Timbre

This patch determines waveshape table selection and how the timbre of a voice is affected by the selected table. The default waveshape table produces a sine wave for each voice slot.

It may be useful to read "EDITING WAVESHAPES" at this time.

Address format: TMB n

n is the voice affected by the patch, A...F.

Op-Code choices: DA VL FN SM

Data (DA) format: n

n is the waveshape table number 0...F.

The selected waveshape table will be active only in the slot assigned to the given voice. The default assignments are:

Voice	A	B	C	D	E	F
Slot	0	1	2	3	4	5

These assignments may be changed with a CTL (Control) patch. (See CTL -- Control in this section.)

Data entered in VL, FN and SM fields determine how the selected waveshape table affects the timbre of the voice. Increasing TMB results in more harmonic intensity. The fundamental and low-ordered harmonics are affected in ways that depend on the waveshape tables assigned to the voice.

Value (VL) format : vv +

See "PCH -- Pitch : Value (VL)" in this section.

Function (FN) format: ll +

See "PCH -- Pitch : Function" in this section.

Source Multiplier (SM) format : psmm

See "PCH -- Pitch : Source Multiplier" in this section.

MOD -- Modulation

This patch controls the modulation frequency or ratio, and the modulation index of a selected voice. This patch, in conjunction with a Control (CTL) patch, determines how the 400 will perform frequency and/or timbre modulation of the selected oscillator. There is one modulation oscillator for each primary oscillator; thus the same modulation frequency and modulation index will be applied to both frequency and timbre if both are selected in the Control (CTL) patch.

A patch specifying data (DA) determines the frequency or ratio of modulation according to the associated control patch. (Ratio is enabled by default.)

A patch specifying a value (VL), function (FN) or source multiplier (SM) determines the modulation index.

Address format: MOD n

n is the voice affected by the patch, A...F.

Op-Code choices: DA VL FN SM

Data (DA) format: nnn

nnn is the modulation value 000...FFF.

The interpretation of this value is dependant on the selection of Ratio or Frequency in the Control (CTL) patch (see CTL -- Control in this section). Values entered in this field represent the frequency of modulation expressed as either a ratio between the frequency of modulation and the primary signal or an absolute value.

Only even numbers, expressed in hexadecimal notation, are accepted as data. For the relationship between the hex data and frequency of modulation, see APPENDIX E: Pitch - Frequency - Hex Data - Transposition.

Function (FN) format: ll + .

See "PCH -- Pitch : Function" in this section.

Source Multiplier (SM) format: psmm

See "PCH -- Pitch : Source Multiplier" in this section.

Modulation Ratios

The hex data representing ratios of modulation are determined by the following equation:

$$n_h = 180 \log_2 r + 800_h$$

where h indicates hexadecimal notation
r = ratio desired
n = data entry

Thus, if the ratio is 1:1, the corresponding hexadecimal data would be 800.

Note that when the frequency of modulation is expressed as a ratio, an increase of 1 in the second digit represents an increase of a quarter tone in the modulation frequency relative to the carrier frequency, while an increase of 2 in the third digit represents an increase of a 16th of a tone in the modulation frequency.

Useful Modulation Ratios

Some useful harmonic ratios and their corresponding hexadecimal equivalents are listed in the table below. These values often produce stable tones with strong subharmonics that shift the fundamental. (A ratio of 1:4 will frequently shift the perceived fundamental down two octaves.) Values close to those shown will generally produce more complex, often clangorous or dissonant tones. Experimentation is the recommended route to familiarization with the effects of modulation ratios.

Ratio	Hex Equivalent
1:4	500
1:3	5A0
1:2	680
3:5	6D6
2:3	720
3:4	760
4:5	784
1:1	800
5:4	87C
4:3	8A0
3:2	8E0
5:3	91A
2:1	980
3:1	A60
4:1	B00

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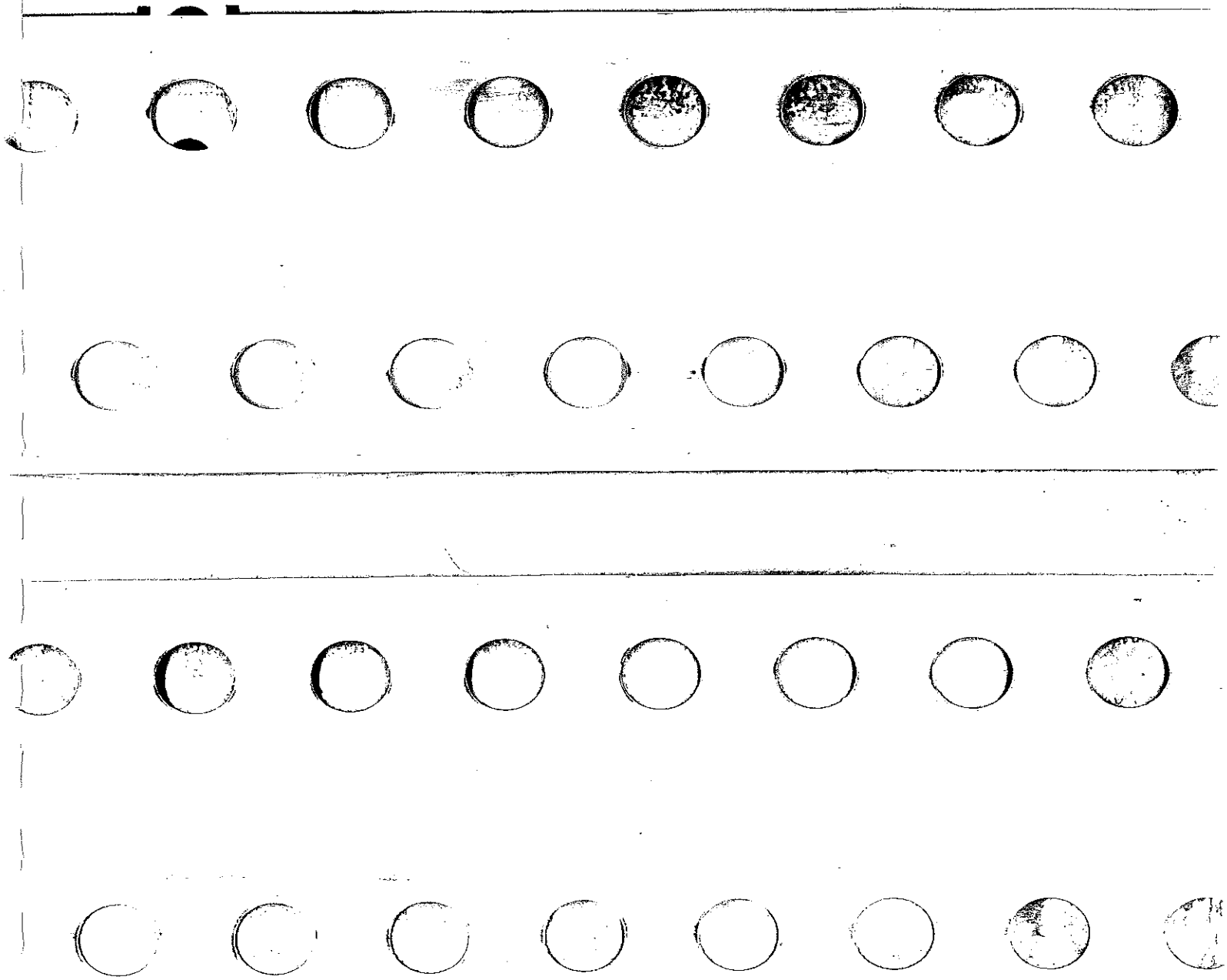


The above subfields are selected using the plus and minus keys in a rotational selection sequence.

FLT -- Filter

This patch selects the cutoff frequency of the voltage controlled low-pass filter associated with each voice. The filter has a 12-db per octave slope and a sharp but unpeaked knee. The filter closes completely with a voltage value of 0.0 and is wide open with a value of 10.0.

Address format: FLT n

n is the voice affected by the patch.

Op-Code choices: VL FN SM

Value (VL) format: vv + (See PCH -- Pitch : Value format)

Function (FN) format: ll + (See PCH -- Pitch : Function format)

Source Multiplier format: psmm (See PCH -- Pitch: Source Multiplier format

FLQ -- Filter Q

This patch selects the Q, or resonance frequency, of the voltage controlled low-pass filter associated with each voice.

Address format: FLQ n

n is the voice affected by the patch, A...F.

Op-Code choices: VL FN SM

Value (VL) format: vv + (see PCH -- Pitch)

Function (FN) format: ll + (see PCH -- Pitch)

Source Multiplier (SM) format: psmm (see PCH -- Pitch)

DYN -- Dynamics

This patch specifies the dynamic (loudness) control voltage for a given voice. The default value is 5.0 volts, approximating the equivalent of mezzo-forte in the dynamic range. The dynamic range is nominally 0.0 to 10.0 volts.

Address format: DYN n

n is the voice affected by the patch, A...F.

Op-Code choices: VL FN SM

Value (VL) format: vv + (See PCH -- Pitch)

Function (FN) format: ll + (See PCH -- Pitch)

Source Multiplier (SM) format: psmm (See PCH -- Pitch)

LOC -- Stereo Location

This patch specifies the stereo location of a voice in the stereo output mix. Zero volts corresponds to the left channel, ten volts to the right channel, with five volts, the default value, placing the voice in the center of the mix.

Address format: LOC n

n is the voice affected by the patch, A...F.

Op-Code choices: VL FN SM

Value (VL) format: vv + (See PCH -- Pitch)

Function (FN) format: ll + (See PCH -- Pitch)

Source Multiplier (SM) format: psmm (See PCH -- Pitch)

LVL -- Level

This patch specifies the level control voltages for the voltage controlled amplifier associated with each voice. This specifies the envelope of the generated sound.

Address format: LVL n

n is the voice affected by the patch, A...F.

Op-Code choices: VL FN SM

Value (VL) format: vv + (See PCH -- Pitch)

Function (FN) format: ll + (See PCH -- Pitch)

Source Multiplier (SM) format: psmm (See PCH -- Pitch)

TRN -- Transposition

This patch transposes the pitch reference for a specified voice by the amount specified by the hexadecimal number entered in the data field. The data must be an even number. An 800 represents no transposition; changing the third digit by 2 transposes the voice by a sixteenth of a tone; changing the second digit by 1 represents a change of a quartertone. Adding or subtracting 1 from the first digit transposes the voice up or down a minor sixth. For reference, see APPENDIX E: Pitch - Frequency - Hex Data - Transposition.

Address format: TRN n

n is the voice affected by the patch.

Op-Code choice: DA

Data (DA) format: FFFF

VLT -- Control Voltage Outputs

This patch specifies the value of one of the 11 auxiliary control voltages outputs available. The address assignments of these control voltages are listed in the section entitled CONTROL VOLTAGES.

A description of the optional Phase Oscillator and its use is found in APPENDIX F: Phase Shift Oscillator.

Address format: VLT n

n is the control voltage port number 0...F.

1...A Front panel CV outputs 1-10
B Phase oscillator index

A also controls the frequency of the Phase Oscillator.

Op-Code choices: VL FN SM

Value (VL) format: vv + (See PCH -- Pitch)

Function (FN) format: 11 + (See PCH -- Pitch)

Source Multiplier (SM) format: psmm (See PCH -- Pitch)

SEQ -- Sequence Control

This patch initiates action on one of the 15 sequence channels. The state of each sequence is shown in the right-hand portion of the Patch Table display under the heading "S". The current line number of each sequence is shown under "LN".For more information, see EDITING SEQUENCES.

Address format: SEQ n

n is the sequence number 1...F.

Op-Code choice: DA

Data (DA) format:

nn is the line number in the sequence table where the sequence is to begin.

01...FF starting line number of sequence

Five line number entries have special meanings:

blank	no operation
FD	decrement 1 and run (backwards)
FE	decrement 1 and stop
FF	increment 1 and stop
00	increment 1 and run (forwards)

LED -- LED control

LED's on the performance keyboard may be turned on and/or off in any order and grouping according to the code specified in the address field. The LED's are divided into groups of 8. Each patch can only control one such group at a time.

Address format: LED n

n is the LED group.

On the 448 keyboard, the LED groups are:

A : Keys 75-82
B : Keys 83-90
C : Keys 91-99

On the 461, the LED groups are:

A : Keys 64-71
B : Keys 72-79
C : Keys 80-87
D : Keys 88-95

Op-Code choice: DA

Data (DA) format: rrss

The data field will specify which LED's in the group will light and which will extinguish. This is done with 4 hexadecimal numbers 0...F. The first of the four entries determines which of the 4 LED's furthest to the LEFT of the group will be turned OFF. The second entry determines which of the 4 RIGHT LED's will be turned OFF. The third entry determines which of the 4 LEFT LED'S will be turned ON. The last entry specifies which of the 4 RIGHT LED's will be turned ON. The controlling number, when converted to binary code (base-2) will reflect the LED's to be activated (1) and those not affected (2) by the patch.

Example: 1 - 0001 (4th (rightmost) LED only)
5 - 0101 (2nd and 4th LED's)
F - 1111 (All 4 LED's)

7080 - Turns first of 4 left LED's on, the other three off, and doesn't affect the 4 right LED's.

A LED may be set to toggle on and off with consecutive actions of the associated key. This is accomplished by setting both the on bit and the off bit for the LED to 1's. By way of example, a data field of 8080 causes the leftmost LED of a group to be toggled by successive key actions. LED/Key combinations in the toggle mode act as alternate action switches, with key status indicated by the LED. Turning on the LED causes a key closure stimulus to be issued and turning off the LED causes a key release status to be issued for the associated key.

TRG -- Conditional Trigger

This patch specifies the condition which controls the status of a software internal trigger. Each trigger condition is examined on each pass through the main scan loop. If the condition if found to change from false to true a stimulus will be issued for the trigger and the status of the trigger will be set to active. The status of the trigger will remain active as long as th condition holds true. When the trigger condition no longer is true, the status of the trigger will be set to inactive. The status of each trigger is shown in the far right of the Patch Table display under the heading "T". An active trigger is indicated by a 1, an unactive trigger by a 0. See "DEFINITION (Def) and STIMULUS (Stm) : Trigger" for more information.

Address format: TRG n

n is the trigger number 1...F.

Op-Code choice: DA

Data (DA) format: iicvv

ii is the item to be compared.

R1...RF	Register contents (See REG -- Registers)
V1...V7	Input CV value (See CONTROL VOLTAGES)

c is the condition code.

<	less than
=	equal to
>	greater than

The entries in the above subfields are selected via the plus and minus keys in a rotational selection sequence.

vv is the comparison value.

00...C7	Constant value
R1...RF	Register contents
V1...V7	Input CV value

REG -- Register Manipulation

This patch performs register manipulations. Fifteen registers are available for calculations and for passing parameters to functions and sequences.

Registers 1 through 9 limit at values of 0 and 127 (C7) on arithmetic underflow and overflow, respectively. Registers A through F wrap around through 0 to 127 (C7), or 127 (C7) to 0 on underflow or overflow, respectively.

The status of each register is shown in the right hand of the Patch Table display under the heading "R".

Address format: REG n

n is the register number 1...F.

Op-Code choice: DA

Data (DA) format: xvv

x is the operation to be performed on the register.

blank	no operation
!	set the register
+	add to the register
-	subtract from the register
?	random add or subtract (See APPENDIX D: Random Numbers)

The above operations are selected via the plus and minus keys using a rotational selection sequence.

vv is the value specifier for the operation.

00...C7	Constant
R1...RF	Register contents
V1...V7	Input CV value
?0...?F	Random number scaled by 0...F (See APPENDIX D: Random Numbers.)

SUB -- Subroutine Call

This patch calls a user-supplied subroutine programmed in assembly language with a specified value. See the Programmer's Guide for details.

KEY -- Key Action

This patch causes a simulated key action to be generated. Simulation of the hardware reset key, K00 or R00 does NOT cause a hardware reset to occur. See "DEFINITION (Def) and STIMULUS (Stm) : Keys" for more information.

Address format: KEYnn

nn is the key number 00...A0.

Op-Code choice: DA

Data (DA) format: x

x is the action.

C	Closure
R	Release
T	Transient (closure, then release)
blank	no operation

The above entries are selected using the plus and minus keys in a rotational selection sequence.

PLS -- Pulse Output

This patch causes a pulse output to occur. All output pulses carry sustain information..

Address format: PLS n

n is the front panel Pulse Output port number 1...3.

Op-Code choice: DA

Data (DA) format: x

x is the action.

blank	no operation
C	Closure (1)
R	Release (0)
T	Transient (closure, then release)

The above entries are selected using the plus and minus keys in a rotational selection sequence.

EDITING FUNCTIONS

The function table contains entries describing the voltage function segments used to construct arbitrary complex control voltage functions. Enter "EDIT FUNCTIONS" from the editing hexpad. Functions are displayed in tabular form.

A function segment entry is described by five fields:

- Line number LN
- Time -TIME-
- Interpolate flag I
- Value VL
- Action code ACT

Line Number

There are 256 lines in the function table. The lines are numbered 00 to FF in hexadecimal.

Entering a line number will cause the display to be scrolled to show the entry at that line and the five lines preceding and following it.

Time Field

The time field specifies the time the FPU will take before reaching the specified voltage value. Times are specified in seconds with a 1 millisecond displayed resolution and a 2 millisecond actual resolution.

Times may be specified as a constant from 00.001 to 65.535 seconds, or as an exponent and a mantissa source. The exponent may range from 0 to F (hexadecimal), and the mantissa source may be either a register or a control voltage input port.

Before time data may be entered, the type of data must be selected from the menu by entering the corresponding key on the hexpad.

Time Format

Constant (CON): dd.ddd

dd.ddd is the time in decimal seconds, with a range of 00.001 through 65.535.

Register (REG): En Rx

n is the exponent.
x is the register, 1...F.

Control Voltage (VLT): En Vx

n is the exponent.
x is the control voltage port number, 1...7.

When either a register or control voltage is used to control time, the actual time sent to the FPU will be determined by the addition of the high-order bit from the mantissa source to the value given as the exponent to determine the exponent sent to the FPU, and the use of the low-order 6 bits of the mantissa source as the high-order 6 bits of the mantissa, with the least significant bit set to zero.

Interpolate Flag

The interpolate flag, entered by pressing "+" in the I field, specifies that the FPU should interpolate from the previous value sent to the one currently being specified. If the interpolate flag is not set, the FPU will wait the specified time interval and then set the voltage output to the given value.

Value Field

The value field specifies the value to which the control voltage will be set. It may be a constant from 00 to C7 (mixed-base), or a register R1-RF, the contents of which will be used to specify the output voltage.

Action Code Field

The action code field specifies optional actions which may be taken during a function. They include:

.ENBL	Continue if stimulus active.
.SUST	Pause if stimulus active.
.STOP	Stop function.
.K nn	Trigger Key nn (transient mode).
.P n	Output a pulse to pulse port n (1...3).
.J nn	Jump to line nn of the function table.

Function Execution

Function execution is initiated by a patch table entry with a function line number (FN) Op-Code field. The function will begin execution at the line number specified when the assigned stimulus is received.

The Jump, Enable and Sustain actions allow arbitrarily complex types of attack-sustain-decay functions to be implemented by conditionally selecting which segments are sent to the FPU and the order in which they are sent.

Functions may be interrupted and restarted by patch table entries, and may also be offset by a fixed value.

Use of a pulse to trigger a function will not pass sustain information to the function. Functions containing sustain or enable operations will act as though the pulse has already gone inactive when the operation is reached, and cause these operations to hang up.

EDITING SEQUENCES

Sequences are lists of actions to be performed and are specified as entries in a 256 line sequence table.

The sequence table is displayed in tabular format.

Each entry consists of five fields:

- Line number LN
- Time TIME
- Action code 1 ACT1
- Action code 2 ACT2
- Action code 3 ACT3

Each line of a sequence will be executed after the time specified has elapsed since the execution of the previous line or since the occurence of the stimulus that began the sequence. Jump and skip operations are provided to allow conditional execution of actions in the sequence.

Line Number

The line number is a two-digit hexadecimal field with range of 00 through FF. Only lines 01 through FF are used for starting sequences.

Specifying the following line numbers will result in specialized operations:

blank	no operation
FD	decrement 1 and run (backwards)
FE	decrement 1 and stop
FF	increment 1 and stop
00	increment 1 and run (forwards)

Time Field

Times in sequences are specified in seconds as a four digit decimal field.

Time format: dd.dd (00.00 to 99.99 seconds)

The display of the decimal point is combined with the digit appearing as the second digit of the field. When the time field is printed the decimal point will not appear.

Action Code Field

The action codes specify the types of actions to be taken at each step in the sequence.

The possible entries in the action code fields are:

- K nn — transient trigger of key nn
- P n — transient pulse output to pulse port n
- J nn — jump to sequence line nn
- SKnn — skip the next action if key nn is inactive
- SP n — skip the next action if pulse n is inactive
- ST n — skip the next action if trigger n is inactive
- r<nn — skip the next action if register r contains < nn
- r=nn — skip the next action if register r contains nn
- r>nn — skip the next action if register r contains > nn
- SSTM — skip the next action if the initiating stimulus is inactive
- STOP — stop the sequence
- r!Rn — set register r to the contents of register n
- r+Rn — set register r to the sum of the contents of register r and register n
- r-Rn — set register r to the difference of the contents of register r minus register n
- r?Rn — set register r to the contents of register r plus or minus (randomly selected) the contents of register n
- r!Vn — set register r to the value of c.v. input n
- r+Vn — set register r to the sum of the contents of register r and the value of c.v. input n
- r-Vn — set register r to the difference of the contents of register r minus the value of c.v. input n
- r?Vn — set register r to the contents of register r plus or minus (randomly selected) the value of c.v. input n
- r!nn — set register r to the value nn

- r+nn set register r to the sum of the contents of register r and nn
- r-nn set register r to the difference of the contents of register r minus nn
- r?nn set register r to the contents of register r plus or minus (randomly selected) the value nn
- r!?n set register r to a random number scaled by n
- r+?n set register r to the sum of the contents of register r and a random number scaled by n
- r-?n set register r to the difference of the contents of register r minus a random number scaled by n
- r??n set register r to the contents of register r plus or minus (randomly selected) a random number scaled by n

Skip operations may only appear as entries in action fields one or two.

Sequence Execution

Sequence execution is initiated by the execution of a patch entry with a **SEQ** address field. The line number at which the sequence is to begin is specified in the **DA** field of the patch.

Specifying line 00 as the starting line of a sequence will cause the sequence to execute the next line it is pointing at and then stop. Subsequent references to line 00 will execute successive sequence table entries.

Arithmetic operations on registers 1 through 9 will be limited on underflow to a value of 0, or on overflow to a value of 127. Registers A through F wrap around through 0 to 127 on underflow, and from 127 to zero on overflow.

STATUS DISPLAY

Whenever the patch, sequence, or function table displays are active a display is also made of the status of the sequences and the conditional triggers. This status display appears in the rightmost nine columns of the video display screen.

The status display consists of 4 fields:

- Label / sequence status **S**
- Sequence line number **LN**
- Register contents **RG**
- Trigger status **T**

The label indicates both the labeling for each line of the status display and the status of the associated sequence. When a sequence is active the associated label will be intensified. The label will appear in normal intensity when the sequence is inactive.

The line number shown is the number of the last line executed in the associated sequence.

The contents of each of the fifteen registers is displayed in the register contents field.

The status of each of the conditional triggers is shown in the rightmost column of the display. This field will contain a 1 if the trigger is active, and a 0 if the trigger is inactive.

The updating of the status display is the lowest priority real-time task in PATCH-VI, and is interruptable.The status display will be seen to disappear and reappear as the result of scrolling operations in any of the patch, sequence or function table displays.

Sequence Status

The status of each sequence is shown in the right-hand area of the Patch Table display under the heading "S". Each sequencer number is highlighted when the clock for that sequencer is operating, and the line numbers are shown in the column labeled "Ln".

EDITING WAVESHAPES

Waveshape Display

The waveshape display is a graphic representation of the oscillator transfer function used to create the timbral character of a voice.

Each waveshape table is a 64 entry table containing values ranging from 0 to 255. A sinusoidal scanning function is used to access entries in this table which are then used to determine the oscillator output value at that point in the scan.

Entries in the waveshape table are sent to the oscillator in real-time and their effect may be immediately heard. Entries may be produced or modified by positioning the graphics cursor in the X direction to the column of the table to be modified, and then positioning the cursor in the Y direction to the desired value. This may be done with the graphic cursor control (keyboard joystick) or by positioning the text cursor in the X or Y value field and entering the desired value.

Each voice may be assigned to use one of six active waveshape slots. Each slot may be loaded with one of the 16 waveshape tables in the current instrument definition.

Assignment of a waveshape table to a slot is handled by the use of the timbre patch table entry (**TMB DA**).

Assignment of a voice to a waveshape slot is handled by the use of the control patch table entry (**CTL DA**).

Storing Waveshapes

Waveshapes are stored in the waveshape library by positioning the cursor in the waveshape number field and entering a "+" with the desired number and waveshape displayed. Waveshape number "0" is a default table and cannot be stored. To retrieve a desired waveshape table, enter its number in the waveshape number field and press "-".-

PRINT OPERATION

Printouts may be made of the following:

- Patch table
- Function table
- Sequence table
- Waveshape tables

Printouts are selected by positioning the cursor next to the type of printout desired and touching the plus key. This will cause the printout type to be intensified, indicating its selection status. Alternate uses of the plus key will select and de-select a printout type.

When the printouts desired have been selected the minus key is touched to begin printing.

Printing may be interrupted by touching the delete key, and then either:

- re-started from the beginning by touching the minus key,
- re-started from where it was terminated by touching the delete key again,
- or, aborted completely by touching the menu key.

A printing status display will appear at the bottom of the screen indicating printout status as running or waiting once printing has been started.

LIBRARY LOAD AND STORE OPERATIONS

PATCH-VI provides for the storage of user-generated data on either tape or disk. The patch, function, sequence and waveshape tables may be stored, and later, selectively retrieved.

A highlighted entry indicates that the menu selection is activated. Touching the corresponding key selects the entry.

The "-" key initiates the load process, while the "+" key intiates the store process. Load is a doulbe action key. Note that load or store may only be initiated when the cursor is in the file (leftmost) field.

On retrieval, patches may be either added or replaced in the patch table. Touching the Append/Replace key toggles its status. Functions, sequences and waveshapes always replace previous ones if they are selected for loading in the menu display.

MAKING BACKUPS

Make Tape

A duplicate cassette tape of PATCH-VI can be made by entering "Make Tape" in the main Menu from the hexpad. This is a double entry key. The program data is sent to the "To Cassette" socket on the rear panel and takes about 3.5 minutes.

While system storage is in progress a message will appear at the bottom of the menu indicating that PATCH-VI is being stored. This message will disappear when storage is complete.

Make Tape

A duplicate 3.5" microdisk copy of PATCH-VI can be made by entering "Make Disk" in the main Menu from the hexpad. This is a double entry key. A microdisk must be present in the drive for this command to execute properly.

While system storage is in progress a message will appear at the bottom of the menu indicating that PATCH-VI is being stored. This message will disappear when storage is complete.

Both of the above keys are double entry, that is, they require two activations to be effective. The first activation will cause the label in the menu to be highlighted, and the second will cause the desired action to occur. Should you accidentally activate one of these keys you can clear it without having it occur by simply activating the menu key. This will cause the label to return to its normal state and will cancel selection of that function without having it executed.

CRT ALIGN

The "CRT Align" function allows you to check to convergence of your color monitor. Touching the key will put a grid test pattern on the display. Touching any key will return to the main menu. Misconvergence of the CRT will show up as colr fringing of he grid lines, or misalignment of segments of the pattern.

If the test pattern shows any color misconvergence you should take appropriate steps to correct it. CRT alignment should be done by properly trained service personnel as it involves high voltage circuitry. Refer to your color monitor manual for service information.

APPENDIX A: System Initialization

Init System

When the system initialization operation is selected, either as a result of initial program loading, or selection from the main menu, all of the operating tables of PATCH-VI will be cleared and the hardware will be reset to the default state as described under system reset.

Reset System

When the system reset operation is selected the 400 series hardware will be reset to a default state, as folows:

- Control voltage values 0 through F will be set to 0 volts
- Control voltage sources will all be set to 0
- Control voltage multiplier values will all be set to 0
- Pitch control voltages will be set to 5.0 volts and a digital pitch of 0 Hertz will be sent
- Timbre voltages will be reset to 0 volts
- Modulation control voltages and digital values will be set to 0
- Control bits for the oscillators will be set to select timbre modulation, deselect frequency modulation, select ratio mode, and enable analog inputs.
- Level control voltages will be set to 0 volts
- Filter control voltages will be set to 0 volts
- Stereo location control voltages will be set to 5.0 volts (center positioning)
- Dynamics control voltages will be set to 5.0 volts (approximating mezzo forte dynamics, or a 0db level)
- Voice to waveshape slot assignments will be set to their default values: A = 0, B = 1, C = 2, D = 3, E = 4, F = 5
- Ratio enabled
- Timbre Modulation enabled
- Frequency Modulation disabled
- Analog controls (front panel) enabled

After hardware reset to the above values occurs stimuli for the closure and release of key 0 will be issued. This allows the user to program different initial conditions than those above.

APPENDIX B: Ranges of Values

The following list summarizes the ranges of values found in PATCH-VI fields:

Control voltages:	0.0 to 12.7 volts (00 to C7) nominal range: 0.0 to 10.0 volts
Multipliers:	-1.27 to +1.27 (-C7 to +C7)
Sources:	0 to A (see table)
Voices:	A through F
Pitches:	C000 to C900 (16.3 to 8372 Hertz)
Register numbers:	R1 to RF (registers 1 to 15)
Register values:	00 to C7 (0 to 127)
Random specs:	?0 to ?F (see table)
Sequence numbers:	1 to F (1 to 15)
Sequence lines:	00 to FF (0 to 255)
Function lines:	00 to FF (0 to 255)
CV output numbers:	1 to B (1 to 11)
CV input numbers:	V1 to V7
Waveshape numbers:	0 to F (0 to 15)
Subroutine numbers:	0 to F (0 to 15)
Pulses:	P 1 to P 3
Keys:	K00 to KA0 (0 to 100)
Triggers:	T 1 to T F (0 to 15)

APPENDIX C: Representation of Numbers

Hexadecimal Notation

Hexadecimal Notation is a base-16 numbering system used in computer applications because it is a power of 2. It is also a convenient way of fitting 16 numbers into a 1-digit space. When more than one digit is used, the last digit represents decimal units of 1, the second digit units of 16, the third digit units of 256, etc. Here is a reference table to help those unfamiliar with this system:

DECIMAL	HEXADECIMAL
0...9	0...9
10	A
11	B
12	C
13	D
14	E
15	F
16	10
17	11
18	12
19	13
20	14
25	19
30	1E
50	32
100	64
500	1F4
1000	3E4

Mixed base representation of numbers

PATCH-VI uses a mixed base representation in some display fields in order to obtain a range of 0 to 12.7, or 0 to 1.27 in a 2 digit field. The following table shows the correspondence between mixed base representations and decimal representations used for value and multiplier fields:

	CV values 0.0 to 12.7	multipliers .00 to 1.27	
Mixed	Decimal	Decimal	
00	0.0	.00	
05	0.5	.05	
10	1.0	.10	
15	1.5	.15	
20	2.0	.20	
25	2.5	.25	
30	3.0	.30	
35	3.5	.35	
40	4.0	.40	
45	4.5	.45	
50	5.0	.50	
55	5.5	.55	
60	6.0	.60	
65	6.5	.65	
70	7.0	.70	
75	7.5	.75	
80	8.0	.80	
85	8.5	.85	
90	9.0	.90	
95	9.5	.95	
A0	10.0	1.00	
A5	10.5	1.05	
B0	11.0	1.10	
B5	11.5	1.15	
C0	12.0	1.20	
C5	12.5	1.25	
C7	12.7	1.27	(Maximum value)

Note that the above table only shows values at .5 and .05 intervals, and that any value from 0.0 to 12.7 or 0.0 to 1.27 may be represented in this system.

APPENDIX D: Random Numbers

Random values may be obtained from a software random number source which generates a pseudorandom series of numbers by adding a prime number to a counter on each pass through the real-time clock routine and on each use of a random number. This range of this value may be selected as shown in the table below:

Random Spec.	Range of values	Scale range
?0	0 .. 127	full scale
?1	0 .. 127	full scale
?2	0 .. 63	1st half scale
?3	64 .. 127	2nd half scale
?4	0 .. 31	1st quarter scale
?5	32 .. 63	2nd quarter scale
?6	64 .. 95	3rd quarter scale
?7	96 .. 127	4th quarter scale
?8	0 .. 15	1st eighth scale
?9	16 .. 31	2nd eighth scale
?A	32 .. 47	3rd eighth scale
?B	48 .. 63	4th eighth scale
?C	64 .. 79	5th eighth scale
?D	80 .. 95	6th eighth scale
?E	96 .. 111	7th eiththh scale
?F	112 .. 127	8th eighth scale

	PITCH	FREQ	HEX DATA	TRANSP.
		00	000	-64
		01	020	-63
		02	040	-62
		03	060	-61
		04	080	-60
		05	0A0	-59
		06	0C0	-58
		07	0E0	-57
		08	100	-56
		09	120	-55
		10	140	-54
		11	160	-53
		12	180	-52
		13	1A0	-51
		14	1C0	-50
		15	1E0	-49
	C_0	16.3	200	-48
	C#	17.3	220	-47
	D	18.3	240	-46
	D#	19.4	260	-45
	E	20.6	280	-44
	F	21.8	2A0	-43
	F#	23.1	2C0	-42
	G	24.5	2E0	-41
	G#	26.0	300	-40
1	A_1	27.5	320	-39
2	A#	29.1	340	-38
3	B	30.9	360	-37
4	C_1	32.8	380	-36
5	C#	34.7	3A0	-35
6	D	36.7	3C0	-34
7	D#	38.9	3E0	-33
8	E	41.2	400	-32
9	F	43.7	420	-31
10	F#	46.3	440	-30
11	G	49.0	460	-29
12	G#	51.9	480	-28
13	A_2	55.0	4A0	-27
14	A#	58.3	4C0	-26
15	B	61.8	4E0	-25
16	C_2	65.4	500	-24
17	C#	69.3	520	-23

↑ TUNING TABLE ENTRY NUMBER

	PITCH	FREQ	HEX DATA	TRANSP.
18	D_2	73.5	540	-22
19	D#	77.8	560	-21
20	E	82.4	580	-20
21	F	87.3	5A0	-19
22	F#	92.5	5C0	-18
23	G	98.0	5E0	-17
24	G#	103.9	600	-16
25	A_3	110.0	620	-15
26	A#	116.6	640	-14
27	B	123.5	660	-13
28	C_3	130.9	680	-12
29	C#	138.7	6A0	-11
30	D	146.8	6C0	-10
31	D#	155.6	6E0	-9
32	E	164.9	700	-8
33	F	174.8	720	-7
34	F#	185.0	740	-6
35	G	196.0	760	-5
36	G#	207.6	780	-4
37	A_4	220.0	7A0	-3
38	A#	233.1	7C0	-2
39	B	246.9	7E0	-1
40	C_4	261.6	800	0
41	C#	277.2	820	1
42	D	293.8	840	2
43	D#	311.3	860	3
44	E	329.6	880	4
45	F	349.3	8A0	5
46	F#	370.2	8C0	6
47	G	392.3	8E0	7
48	G#	415.3	900	8
49	A_5	440.1	920	9
50	A#	466.4	940	10
51	B	494.2	960	11
52	C_5	523.8	980	12
53	C#	554.4	9A0	13
54	D	587.3	9C0	14
55	D#	622.3	9E0	15
56	E	659.4	A00	16
57	F	698.7	A20	17
58	F#	740.0	A40	18
59	G	784.1	A60	19

↑ TUNING TABLE ENTRY NUMBER

	PITCH	FREQ	HEX DATA	TRANSP.
60	G#5	830.9	A80	20
61	A_6	880.5	AA0	21
62	A#	933.0	AC0	22
63	B	987.9	AE0	23
64	C_6	1047	B00	24
65	C#	1109	B20	25
66	D	1176	B40	26
67	D#	1244	B60	27
68	E	1319	B80	28
69	F	1398	BA0	29
70	F#	1481	BC0	30
71	G	1568	BE0	31
72	G#	1661	C00	32
73	A_7	1760	C20	33
74	A#	1865	C40	34
75	B	1976	C60	35
76	C_7	2094	C80	36
77	C#	2218	CA0	37
78	D	2350	CC0	38
79	D#	2490	CE0	39
80	E	2639	D00	40
81	F	2794	D20	41
82	F#	2960	D40	42
83	G	3137	D60	43
84	G#	3325	D80	44
	A_8	3524	DA0	45
	A#	3729	DC0	46
	B	3952	DE0	47
	C_8	4186	E00	48
	C#	4435	E20	49
	D	4700	E40	50
	D#	4978	E60	51
	E	5275	E80	52
	F	5589	EA0	53
	F#	5923	EC0	54
	G	6272	EE0	55
	G#	6646	F00	56
	A_9	7042	F20	57
	A#	7463	F40	58
	B	7909	F60	59
	C_9	8372	F80	60

↑ TUNING TABLE ENTRY NUMBER

Transposition numbers show the degree of transposition from center (800) in semitones.

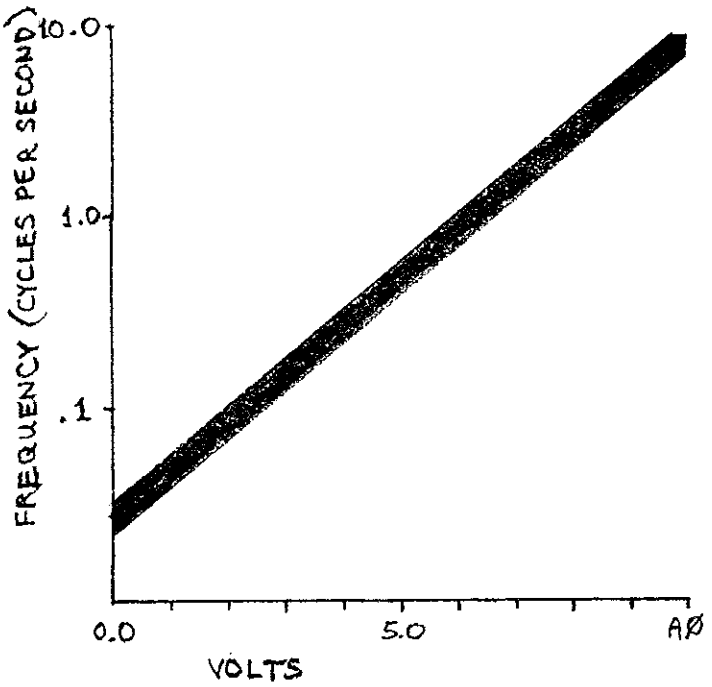
A231
- 00-31, 1/32's offset
- 0-9, OCTAVE
- A-G, NOTE

APPENDIX F: Optional Features

Phase Oscillator

Voices between the left and right outputs are routed through specialized phase shifting circuitry to produce a pseudo-stereo output. Control voltages A and B may be used to modulate the phase shift to enhance the effect; CV output A determines the modulation frequency, and CV output B determines the intensity of modulation.

The correspondence between specified voltage data and the resulting frequency of phase shift is shown in the graph below:



PHASE SHIFT OSCILLATOR

Foot Pedal Inputs

Provisions are made on the Model 452 Revision Level 1 for a foot pedal control voltage input accessed from the rear panel FOOT PEDAL INPUT C. This socket provides 0 volts at the base, +15 volts on the ring, and takes the signal input from the tip. The voltage is attached using Control Voltage Input 0.

Signal Input

The Model 455 Revision Level 1 provides for a auxilliary signal input from the rear panel (SIGNAL INPUT). Control of the level of this signal is possible through Control Voltage Output 12 (C), and the location of the signal is controllable via Control Voltage Output 13 (D).

An envelope detector for the auxilliary signal input is available at Control Voltage Source 7.