MSX

YAMAHA

FM Voicing Program

YRM-102

OWNER'S MANUAL

NIPPON GAKKI CO., LTD.
PRINTED IN JAPAN

1. INTRODUCTION

We would like to take this opportunity to thank you for purchasing the Yamaha FM Voicing Program (YRM-102). This FM Voicing Program is a ROM cartridge which is used with the Yamaha FM Sound Synthesizer to create voices. This allows a wide variety of original voices to be created by the FM sound generation system. This is of course in addition to the 48 voices already contained in the FM Sound Synthesizer unit.

* This ROM cartridge allows the voices contained in the FM Sound Synthesizer unit to be altered, as well as creating new voices from scratch.

* The data can be displayed on the screen as it is entered from the CX5 keyboard. Naturally, sound can also be output for checking the voice data as it is created.

* The voice data can be saved on cassette tape after it has been created and later utilized with the FM Music Macro and FM Music Composer (sold separately).

* The voice data and the table of voices can both be printed out.

* The music keyboard functions of the FM Music Synthesizer unit can be called up and used for playback when the FM Sound Synthesizer is in use.

CONTENTS

2. OVERVIEW OF THE FM VOICING PROGRAM

There are a number of devices which must be used with the FM Voicing Program to create sounds and there are also some devices available which make this easier. This section gives an overview of the FM Voicing Program and explains its basic operating procedure.

NECESSARY EQUIPMENT

The following devices are essential for use of the FM Voicing Program.

* CX5 Music Computer (or MSX personal computer)

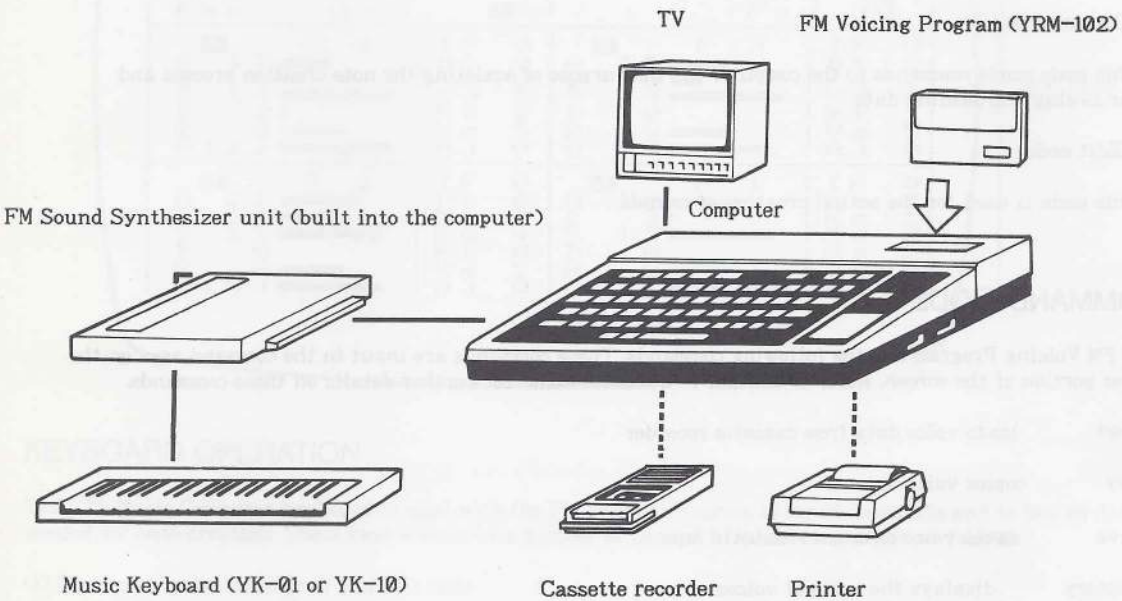
* CRT Display (video monitor or TV set with RF modulator adaptor)

* Yamaha FM Sound Synthesizer unit (SFG-01, built into the computer)

* Yamaha Music Keyboard (YK-01 or YK-10)

* Cassette recorder (used to save voice data)

* Printer (used to print out the voice data and table of voices)



STARTING THE PROGRAM

Check that the devices are correctly connected. Be sure power is off before inserting the ROM cartridge into the cartridge slot.

The FM Voicing Program should automatically start when the power of the computer is turned ON (the command menu will be displayed).

* If the program does not start, turn the computer OFF and confirm that the ROM cartridge is correctly inserted into the slot.

FUNCTIONS OF THE FM VOICING PROGRAM

The FM Voicing Program has the following six basic functions.

* Creation of new voices by altering existing voice data

* Creation of voices from scratch

* Assistance in sound creation

* Saving voice data (requires cassette recorder)

* Prints out voice data (requires printer)

* Calls up Music Keyboard functions for playback

OPERATION MODE

The unit has two operation modes which permit the efficient use of the features contained in the FM Voicing Program.

(1) Command mode

This mode sends commands to the computer for the purpose of assisting the note creation process and for saving and loading data.

(2) Edit mode

This mode is used for the actual creation of sounds.

COMMAND MODE

The FM Voicing Program has the following commands. These commands are input in the command area on the upper portion of the screen. Refer to Section 7 "Command Mode" for further details on these commands.

CLoad	loads voice data from cassette recorder
COpy	copies voice data
CSave	saves voice data onto cassette tape
DIrectory	displays the table of voices
EDit	switches the unit to the edit mode
HElp	displays the table of commands
KIll	initializes voice data (start from scratch)
LOad	sets sound to be played from keyboard
MUsic	calls up Music Keyboard functions
OFf	turns off motor of cassette recorder
ON	turns on motor of cassette recorder
PRint	prints out voice data

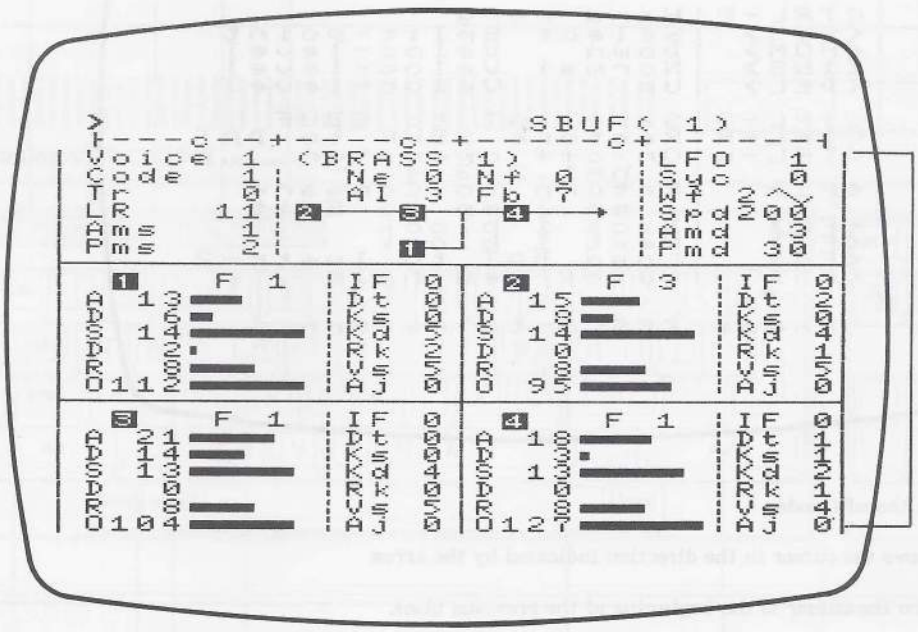
REstore reads data in temporary storage area

SAve stores data in temporary storage area

SWap swaps voice data

EDIT MODE

Created the sound while checking the various parameters on the screen. The cursor (O mark) is moved to the position of data to be changed by pressing the cursor keys. Key in the data at the desired location.



KEYBOARD OPERATION

The CX5 Music Computer keyboard is used with the FM Voicing Program to input commands and to key in data needed for note creation. These keys also have a number of special functions which are as follows.

(1) Keys used in both command and edit mode

BS returns the cursor one position to the left. This key is used to correct input mistakes.

RETURN completes an input operation

SELECT sets the keyboard split position (pg. 32)

HOME decreases the key velocity

DEL increases the key velocity

INS sets the key velocity to the standard value

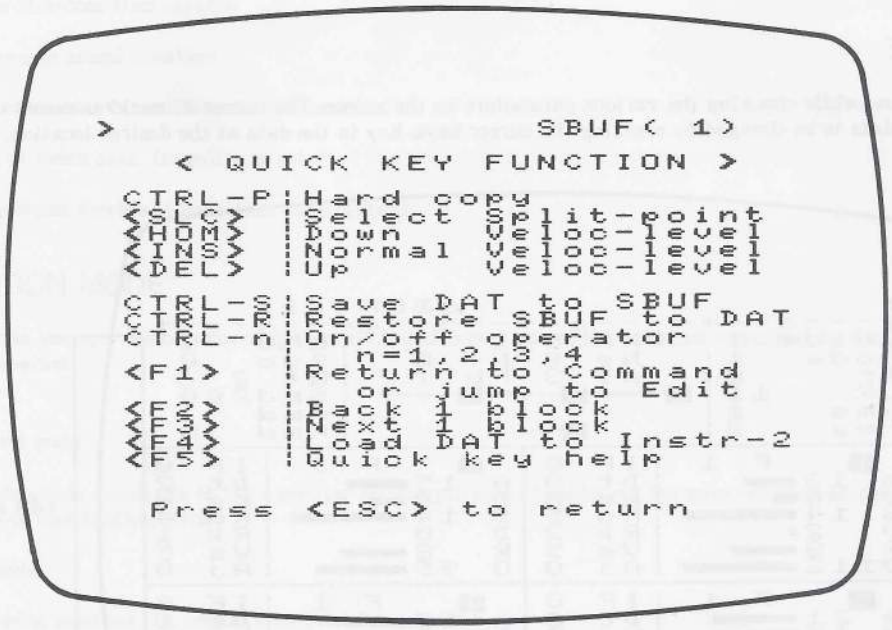
Refer to Pg. 29

CTRL P prints out the display screen as it appears

CTRL Z turns the key click on/off

F1 switches the unit between edit and command modes

F5 displays the main special function keys



(2) Keys used in the edit mode

Cursor keys move the cursor in the direction indicated by the arrow

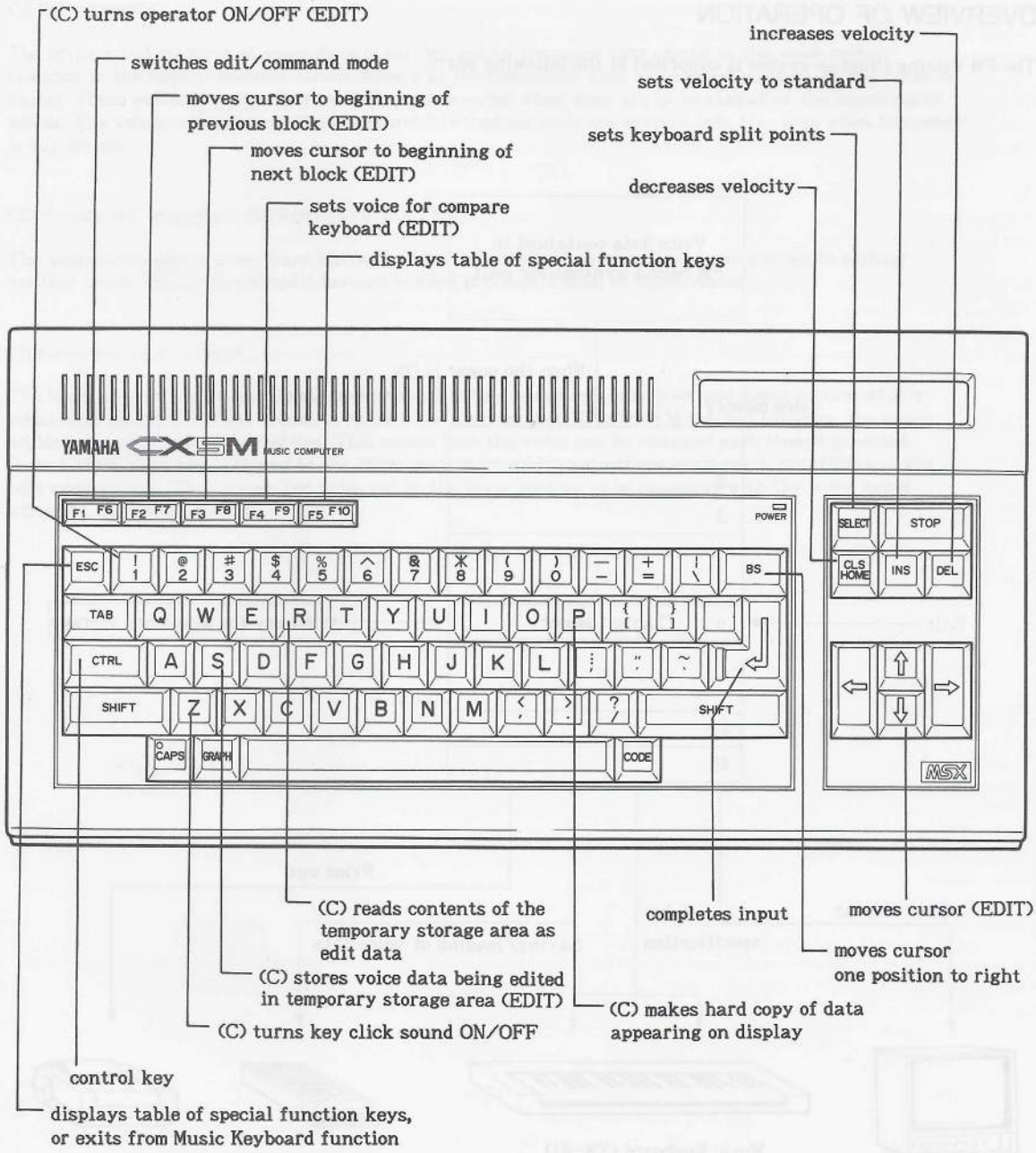
F2 return the cursor to the beginning of the previous block

F4 sends the voice data being edited to the keyboard

CTRL S stores the voice data being edited in the temporary storage area

CTRL R reads the voice data in the temporary storage area as edit data

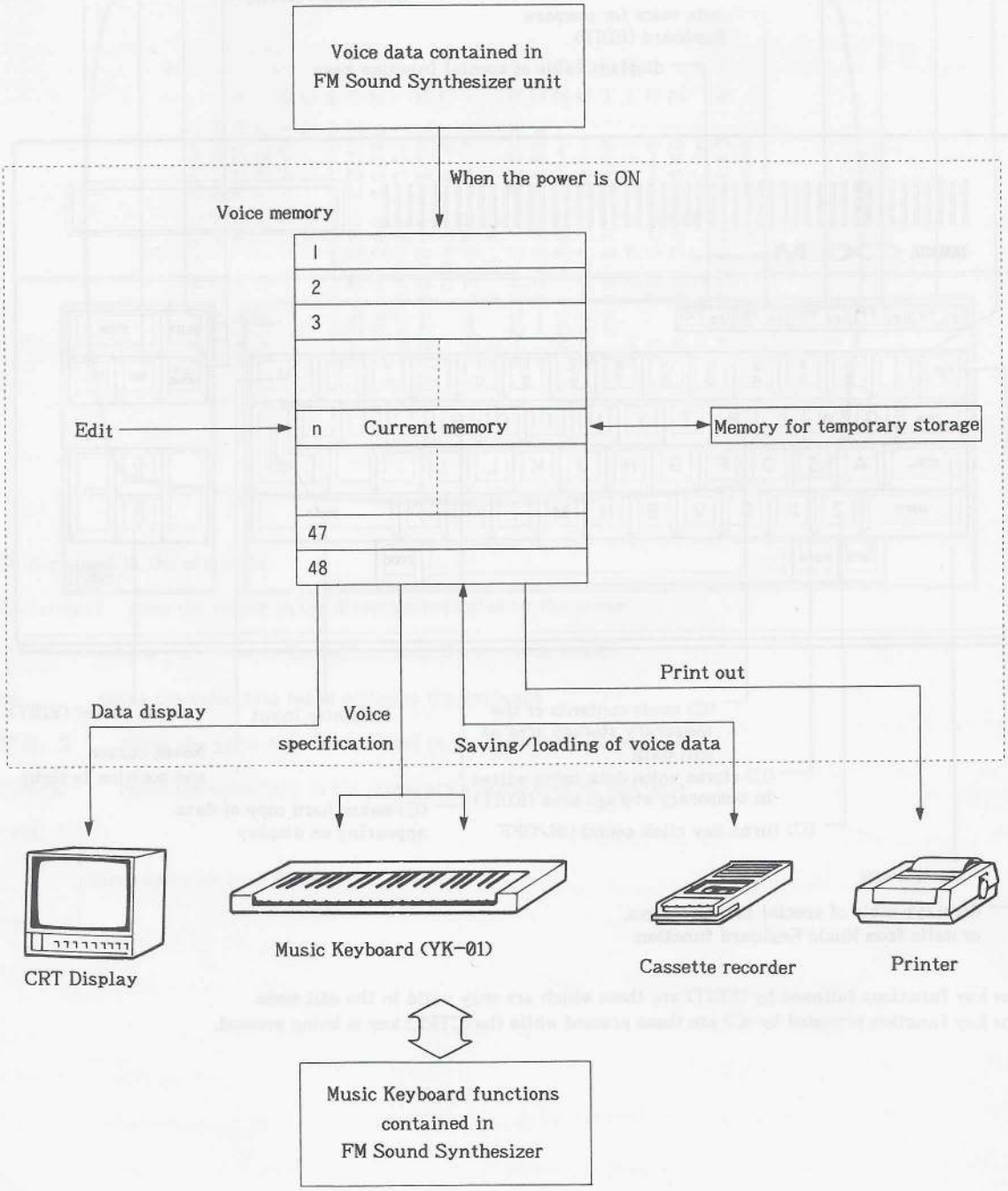
CTRL 1 ~ CTRL 4 turns operator 1 – 4 ON/OFF



The key functions followed by (EDIT) are those which are only valid in the edit mode.
The key function preceded by (C) are those pressed while the (CTRL) key is being pressed.

OVERVIEW OF OPERATION

The FM Voicing Program system is comprised of the following parts.



(1) Voice memory

The editing and creation of voice data is carried out on the voice data stored in the voice memory (located in the RAM or Random Access Memory of the computer). This voice memory allows 48 voices to be stored. These voices are specified by their voice number when they are to be played on the keyboard or edited. The voices contained in the FM Sound Synthesizer unit are written into this area when the power is turned on.

(2) Memory for temporary storage (SAVE BUFFER)

The temporary storage area (save buffer) allows the previous voice to be returned to while editing another voice. The keyboard split feature is used to compare both of these voices.

(3) Keyboard split feature

The keyboard split feature allows the keyboard to be divided into an upper and lower section at any point, and allows different voices to be used for each section. With the FM Voicing Program, the upper section uses the voice being edited. This means that the voice can be changed each time it is edited. Once a voice has been assigned to the lower section, it will remain there until reset, regardless of the edit mode status. This allows the voice set in the lower section to be compared with the voice being edited in the upper section.

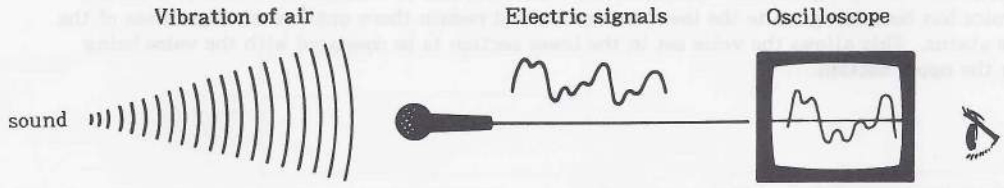
3. BASIC KNOWLEDGE NEEDED TO CREATE SOUND

A piano and a flute have distinctive sounds, both which depend on the individual factors that make up the sound of each instrument. This means that any number of different sounds can be created simply by altering the factors governing the sound, which is precisely what synthesizers do.

The FM Voicing Program allows for various sounds to be created by controlling the factors which comprise that particular sound. Thus, the factors that govern the sound must be understood before the FM Voicing Program can be fully enjoyed.

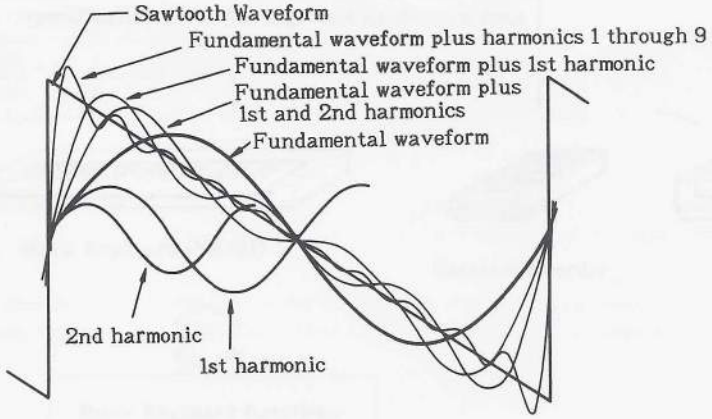
Sound can be considered to originate from the vibration of a object. This vibration passes through the air and reaches our ears as "sound". It is difficult to imagine the components of this sound as it can not be perceived by the eye.

To remedy this difficulty, a microphone can be used to convert the vibration of the air (changes in air pressure) into electric signals. This electric signals can then be converted into visual images by connecting the microphone to a oscilloscope. This visual images which appear on the screen of the oscilloscope are referred to as waveforms. This explanation will frequent refer to the term waveform. It is best to simply consider waveforms to be the same as the visual image of a wave.



THE THREE COMPONENTS OF SOUND

A piano or guitar produces a sound which has an interval or pitch corresponding to the length of the struck or plucked string. The pitch of the sound can be changed by altering the length of the vibrating section of the string. This also alters the number of times that the string will vibrate in a given time period.For example, a low pitch means that the string is vibrating relatively slowly. This principle allows the pitch of the sound to be expressed in terms of the number of vibrations per second (frequency).



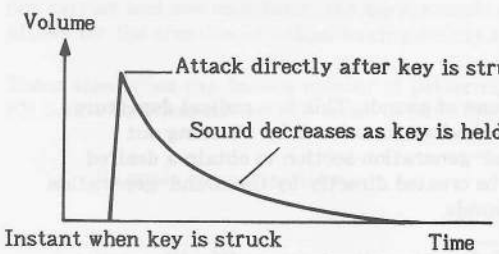
However, while the pitch of a certain note is the same for a piano and guitar, the waveform and tonal character are still quite different. This is determined by the way that the sound is generated. The size and shape of an instrument are going to result in the string of the instrument being vibrated differently. The way the vibration is produced can be expressed by a waveform. The shape of many musical instrument waveforms may appear at first glance to have no rhyme or reason to them, but actually all waveforms are composites of sine waves. If we state this in reverse, a waveform having any shape desired can be created by combining sine waves together. For example, the diagram shows what happens when sine waves which are multiples (double, triple, etc.) of the original sine wave are added to it. The wave begins to resemble a saw tooth wave as higher-multiple sine waves are added to the original sine wave. The original sine wave is called the fundamental and subsequent sine waves are called harmonics. Sounds produced by various instruments will be composed of differing numbers of harmonics. The tone (waveform) of an instrument is determined by the number and relative volume level of harmonics.

The pitch of the sound is determined by the number of times per second (frequency) at which the fundamental vibrates. Strictly speaking, pitch is a subjective value and also depends on absolute volume level. We often use the term pitch when we are really concerned with the fundamental frequency. The amplitude of the vibrations corresponds to the volume of the sound.
Thus, we can say that the subjective differences that we perceive in sounds are a product of the differences in pitch, tone, and volume. The three components of sound that affect these differences are the frequency of the fundamental, the waveform (or harmonic structure) and the amplitude.

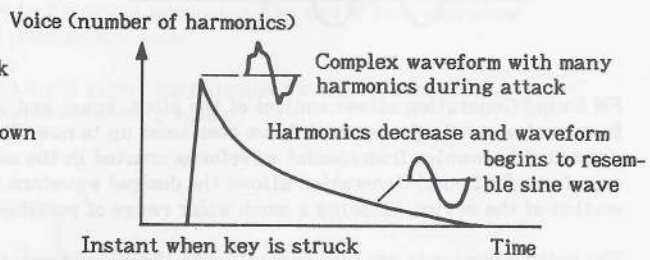
CHANGES IN SOUND OVER A PERIOD OF TIME

There is another principle which must be grasped regarding the differences in sound. When a note is played on, for example, a piano, a initial sound (attack) will be heard when the key is first struck. The sound will gradually diminish in volume as the key is held down. If this is expressed in terms of harmonics, the beginning of the note will contain a large number of harmonics but the number will decrease as the note continues decay. There are a number of changes in the note from the instant it is produced until the point where it decays to inaudibility. We refer to this relationship between time and the change in the sound as the envelope. This point is very important from the viewpoint of sound creation because differences in the envelope will result in a completely different voice.

Volume envelope model for a piano



Voice envelope model for a piano



4. FM SOUND GENERATION

WHAT IS FM?

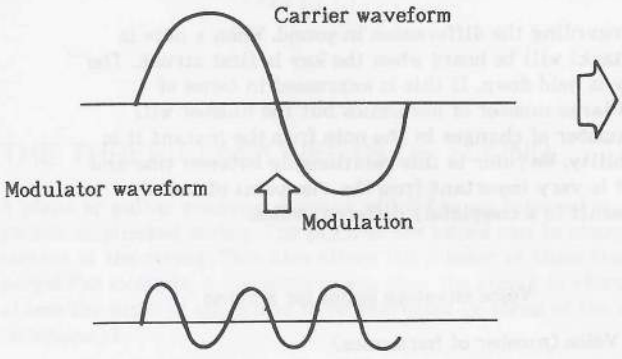
You probably associate the word FM with a type of radio transmission. The FM band on your radio and the FM of FM Sound Generation are one and the same. They both stand for frequency modulation. This is the technique of varying the frequency of a sound by the use of another frequency.

Although both the FM of your radio and the FM of FM Sound Generation have the same meaning, the application is quite different.

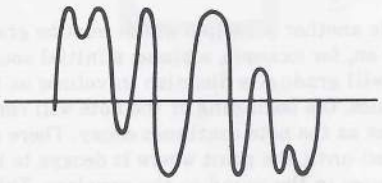
The audio signals (contents of the broadcast) of an FM broadcast ride on a carrier and the frequency of the carrier is changed by the audio signals. The carrier frequency is the frequency allocated to each station, the same as that which appears on your dial. This frequency is extremely high so as to permit the transmission of radio waves through the air. The audio signals are in the range audible to the human ear (approx. 20 to 20KHz). The difference in frequency between the carrier and audio signal (referred to as modulator, since it modulates the frequency of the carrier) is great.

What happens when the frequency of the carrier is lowered, thus making the frequency of the modulator and carrier closer to one another? If this is stated in another way, what happens to the sound of the carrier when the frequency of the carrier is within the audible range, then frequency-modulated? The waveform will be distorted and a wide range of high frequency components will be produced. This is the operating principle used to generate the sound of instruments through FM Sound Generation.

Changes in the waveform caused by FM



When the waveform is frequency modulated



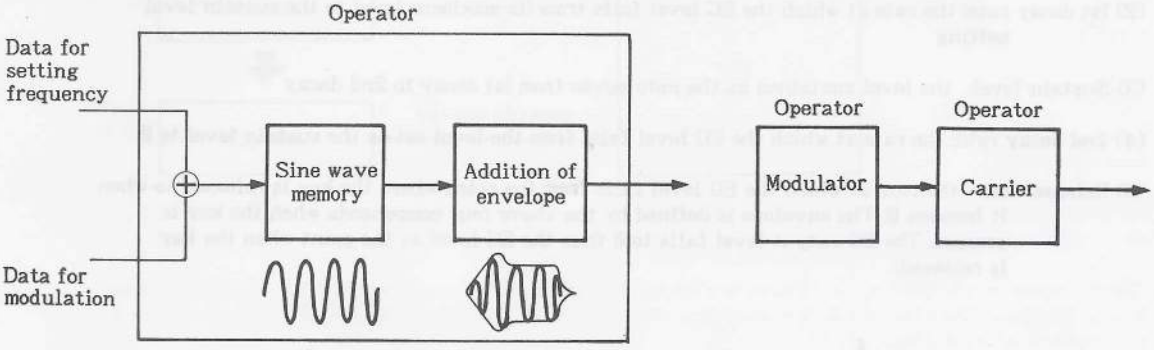
FM Sound Generation allows control of the pitch, voice, and volume of sounds. This is a radical departure from analog synthesizers which have been used up to now. These devices functioned by filtering out unwanted harmonics from special waveforms created in the sound-generation section to obtain a desired waveform. FM Sound Generation allows the desired waveform to be created directly by the sound-generation section of the device, allowing a much wider range of possible sounds.

The noise components are also controlled in the -sound generation section allowing more life-like violin and flute voices, etc. to be produced.

FM SOUND-GENERATION SYSTEM

An oscillator, called an operator, is used in the actual FM Sound-Generation System. This operator is used for the production of both the carrier and modulator, as shown below. Each operator receives the data for determining the frequency and the data for FM, then reads the sine wave from the memory according to the input data. (The wave which is read is a sine wave when there is no FM data). An envelope (refer to pg. 10) is added to the wave which was read from the memory, and the resultant wave is output. If the output is to be used as an audio signal, this operator is the carrier. It is the modulator when its signals are sent to the next operator to control modulation.

Configuration of operators



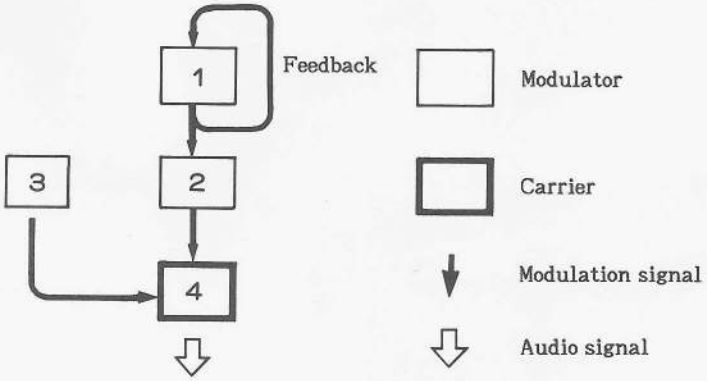
Envelopes are produced by the envelope generator (refer to pg. 13). The envelope controls the change in volume over a period of time for the carrier, and the change in voice for the modulator over a period of time.

The FM Sound Synthesizer unit uses four operators for each sound. Since eight sounds can be generated simultaneously by this unit, there are 32 operators in all.

The ways the four operators are used as carriers or modulators are called algorithms. If there are only one carrier and one modulator, the basic sounds can be FM sound generated. The use of four operators allows for the creation of voices having subtle and complex nuances.

These algorithms can have a number of patterns, but eight algorithm patterns have been selected for the FM Sound Synthesizer unit in order to make the creation of sounds easier.

Example of an algorithm



5. ENVELOPE GENERATOR

ENVELOPE GENERATOR

The concept of envelopes, which was introduced on page 10, plays an important role in the creation of sounds. The FM Sound Synthesizer unit is equipped with an envelope generator for each operator (EG) which allows for the creation of these envelopes. The EG of each operator controls the volume and voice output of their respective operators over a period of time. The way that the sound changes over a period of time can be programmed according to its five components: attack rate, 1st decay rate, sustain rate, 2nd decay rate, and release rate. These five components have the following functions:

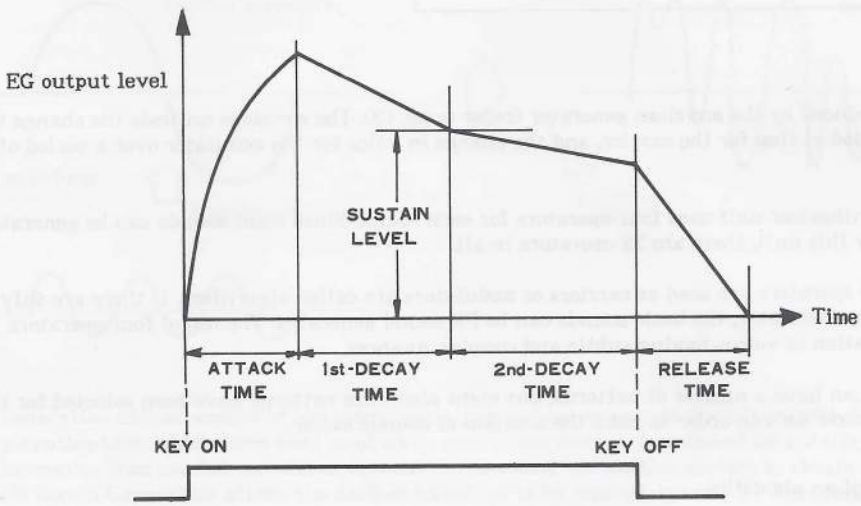
(1) Attack rate: the rate at which the output level of the EG reaches its maximum value when the key is struck.

(2) 1st decay rate: the rate at which the EG level falls from its maximum level to the sustain level setting

(3) Sustain level: the level sustained as the note moves from 1st decay to 2nd decay

(4) 2nd decay rate: the rate at which the EG level falls from the level set as the sustain level to 0

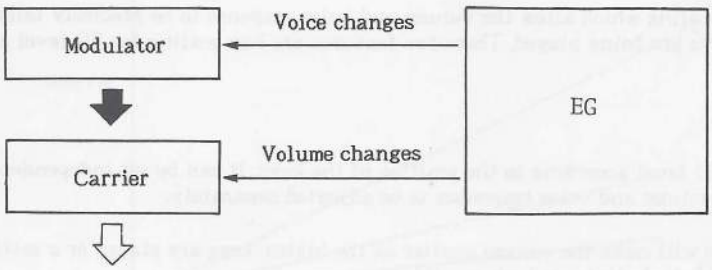
(5) Release time: the rate at which the EG level falls from the point where the key is released to when it becomes 0. The envelope is defined by the above four components when the key is pressed. The EG output level falls to 0 from the EG level at the point when the key is released.



THE RELATIONSHIP BETWEEN FM SOUND GENERATION AND THE EG

The EG of the FM Sound Synthesizer unit controls the operators of the FM Sound Generator and determines the changes in volume and voice over a period of time.

The envelopes for volume and those for voice are created by using the EG of different operators, depending on the function. Changes in volume are performed by the EGs of the operators, which are used as carriers; changes in voice are performed by the EGs of operators, which are used as modulators. Thus, the function of the EG of an operator will change accordingly.



6. KEY SCALING FEATURE

WHAT IS KEY SCALING?

The volume and voice envelopes of the high and low sections of a piano will differ slightly. This is true not only of the piano but of all acoustic instruments. The FM Sound Synthesizer unit has a key scaling feature which allows the degree of envelope generation to be changed according to pitch. The key scaling feature allows subtle nuances of the sound to be programmed according to the position of the keys being played.

TWO TYPES OF KEY SCALING

There are two types of key scaling which allow the volume and voice response to be precisely tailored to the position at which the keys are being played. These two features are key scaling for EG level and key scaling for EG rate.

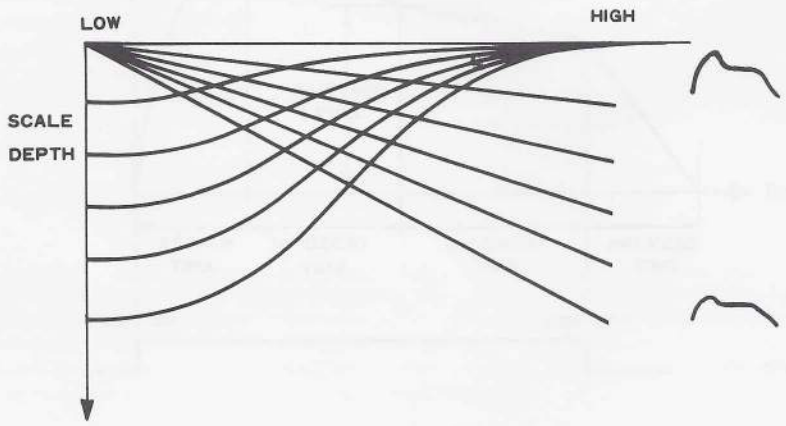
(1) Level scaling

Level scaling changes the EG level according to the position of the keys. It can be set independently for each operator, allowing the volume and voice responses to be adjusted separately.

For example, a setting which will make the volume smaller as the higher keys are played or a setting which makes the sound more full-bodied, are both possible.

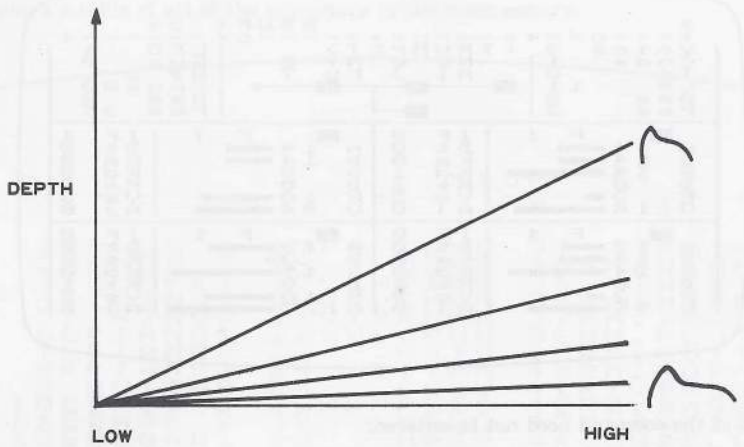
The following level-scaling curve uses two curves. One shows the level decreasing as the keys become higher in pitch. The other shows the level decreasing as the keys become lower in pitch. Both are set by the depth of level scaling.

Level scaling



(2) Rate scaling

Rate scaling changes the length of the envelope according to the position of the keys. This allows a sharp, short envelope to be introduced as the keys become higher. This is also set by the degree of depth for each operator.

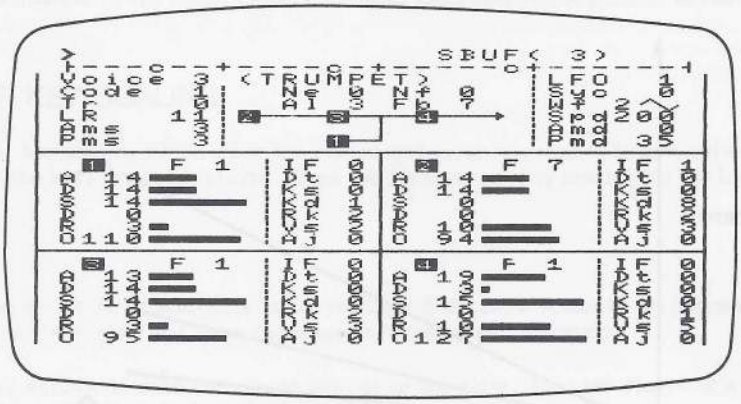


7. COMMAND MODE

The FM Voicing Program uses the command mode as the input command for everything except the editing of voice data.

When the cursor (□mark) is in the command area located in the upper portion of the screen, you are in the command mode.

Command area



All of the characters of the command need not be entered;

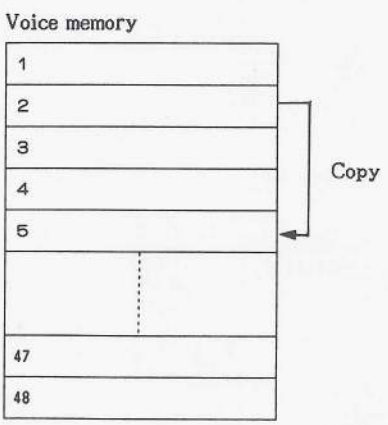
entering only the first two letters is sufficient. Be sure to press the RETURN key after the command has been keyed in. The command is executed when the RETURN key is pressed. For example, the voice list table can be displayed by entering DI, followed by RETURN.

CLOAD (CL) CLoad

This command writes the voice data, stored on cassette tape, into the voice memory. Refer to the section on the loading and saving of data for further details.

COPY (CO) COpy

This command copies the voice data into the voice memory. For example, the voice data of voice number two can be copied onto voice number five by entering CO␣2,5, followed by RETURN. The voice-data table will be displayed simultaneously upon the completion of copying. The voice data of voice number five are automatically saved in the temporary storage area prior to the beginning of copying. This prevents the loss of voice data in the case of a error in copying.

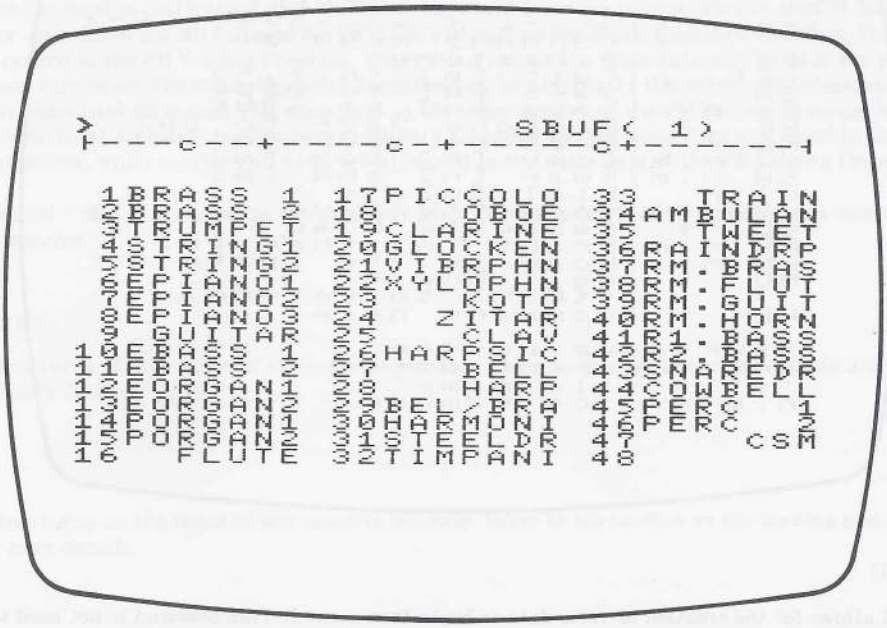


CSAVE (CS) CSave

This command saves all of the voice data in the voice memory on cassette tape. Refer to section 12 (pg. 46) for further details.

DIRECTORY (DD) DIrectory

This command displays a table of all of the voice data in the voice memory.



A screen similar to the one above can be displayed by the input of DI, followed by RETURN.

(EDIT)_n

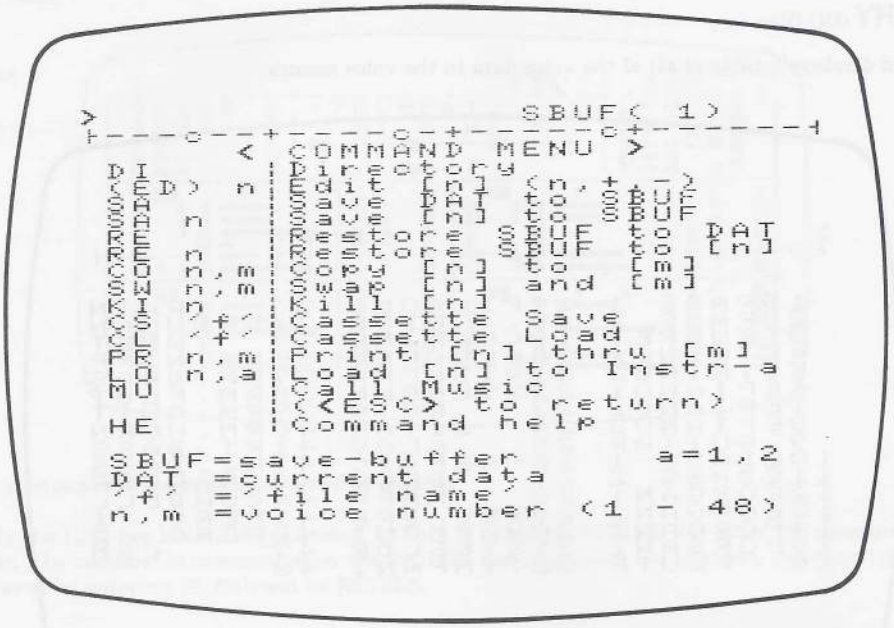
This command switches you to the edit mode and allows the creation of sounds. The FM Voicing Program stores 48 voices in its memory, of which one is chosen for editing. The voice data is specified, by the number appearing to the left of the name of the voice, when the edit mode is selected. For example, when the power is first turned on (and voice data appears as above) editing of EPIANO1 can be specified by entering ED␣6, followed by the RETURN key. Be sure to leave a space between ED and 6.

A plus (+) or minus (−) sign can be used instead of the voice number. This selects the voice following or preceding the voice currently being edited (BRASS 1 when the power is turned on). For example, after editing EPIANO1 in the previous example, entering ED␣+, followed by RETURN will specify EPIANO2 for editing. STRING 2 will be selected if ED␣− is entered, followed by RETURN.

The EDIT command can even be omitted. The input of 6, + and −, followed by RETURN instead of ED␣6, ED␣+ and ED␣−, will perform the same function.

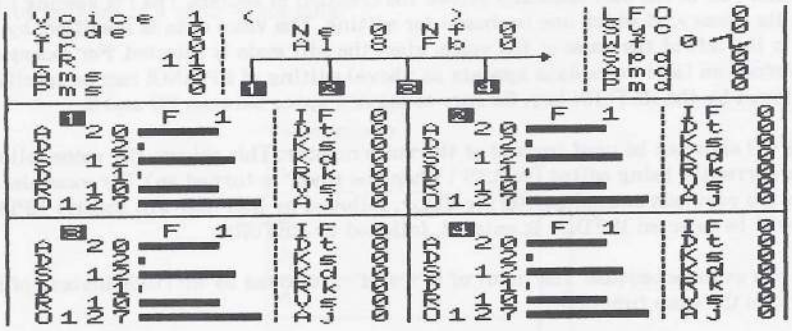
HELP (HE) HElp

This command displays a menu of the main commands. A screen similar to the following can be displayed by the key input of HE followed by RETURN.



KILL (KI) KIll

This command allows for the creation of voice data to begin from scratch. This command is not used to change the contents of voice data already stored but instead is used at the very beginning of voice data creation. For example, input of KI␣1, followed by RETURN will change the voice data of voice number one to the condition shown in the following diagram. In other words, the KILL command is not used when editing data already in the memory, but is used for editing initialized voice data (starting from scratch). Entering the KILL command will initialize the voice data and display the list of voices on the screen.



LOAD (LO) LOad

This command sets the voice to be sounded when the keyboard is played. Refer to the section on the keyboard split function (pg. 32) for further details.

MUSIC (MU) MUsic

This command is used to call up and play the Music Keyboard function incorporated in the FM Sound Synthesizer unit. Entering MU followed by RETURN will call up the Music Keyboard function. The ESC key is pressed to return to the FM Voicing Program. Everything except the voice data will be as if the power has just been turned on. The Music Keyboard function has, in addition to the normal 48 voices, space for entering an additional 48 voices. The voice data in the voice memory of the FM Voicing Program is set into these additional 48 locations. Numbers 1 – 48 are allocated for the voice data contained in the FM Sound Synthesizer, while numbers 49 to 96 are allocated to the voice data of the FM Voicing Program.

The numbers 49 – 96 are allocated in the same way when the Music Keyboard function loads voice data from a cassette recorder.

OFF (OF) OFf

This command turns off the motor of the cassette recorder. Refer to the section on the loading and saving of data for more details.

ON (ON)

This command turns on the motor of the cassette recorder. Refer to the section on the loading and saving of data for more details.

PRINT (PR) PRint

This command is used to print out continuous voice data. The voice data to be printed out are specified by voice number. The voice data are specified from a certain voice number to another voice number. For example, voice numbers six to eight can be printed out by entering PR␣6,8 followed by RETURN. If the start number and end number are the same, only the single voice number will be printed. For example, voice number six can be printed out by entering PR␣6,6, followed by RETURN. The data to be printed out can be displayed on the screen by pressing CTRL P.

Printing can be interrupted by holding down the ESC key and causing the unit to enter the command mode.

RESTORE (RE) REstore

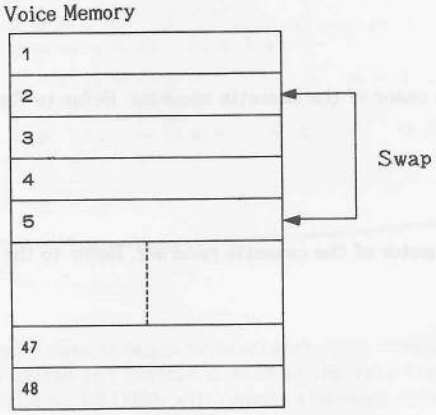
This command writes the voice data held in the temporary storage area into the voice memory. Entering RE followed by RETURN will write that data into the current voice memory location. If the command is entered as RE␣5, for example, followed by RETURN, the voice data in the temporary storage area is not written into the current location but instead is written into the voice memory location specified, in this case, location five. The voice memory location is the same as the voice number.

SAVE (SA) SAve

This command stores voice data in the temporary storage area. Entering SA followed by the RETURN key will store the final data that was edited into the temporary storage area. If the command is entered as SA␣5, for example, the specified voice number, in this case voice number 5, not the current edited data will be stored in the temporary storage area. The specification is the same as the RESTORE command: according to the voice number.

SWAP (SW) SWap

This swaps voice data within the voice memory. For example, enter SW␣2,5 followed by RETURN when the voice data of voice numbers two and five is to be swapped. The tone table will be displayed on the screen upon the conclusion of the swapping operation. The temporary storage area will retain the contents of voice number five as they were previous to swapping.



8. EDIT MODE

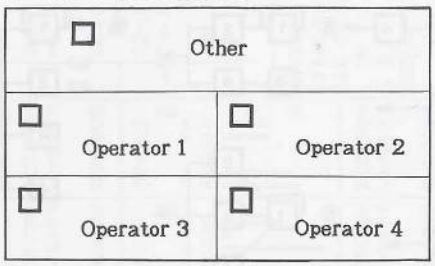
The main feature of the FM Voicing Program is its edit mode, used to create sounds. The various functions of this mode are explained below.

SWITCHING TO THE EDIT MODE

The FM Voicing Program automatically enters the command mode when the power is turned on. Let's assume you are going to edit the BRASS 1 voice in the voice number one location. While still in the command mode, enter ED␣1 (or just 1) and press the RETURN key. The voice data of BRASS 1 will be displayed and the cursor will move to the edit area. This allows editing to begin.

The display of the voice data is divided into five blocks. The lower four blocks correspond to the four operators and display the data (parameters) for setting the operators.

Blocks of the edit area

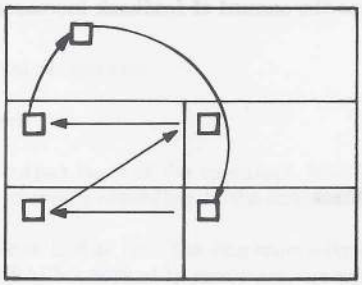


USE OF THE EDITING FEATURE

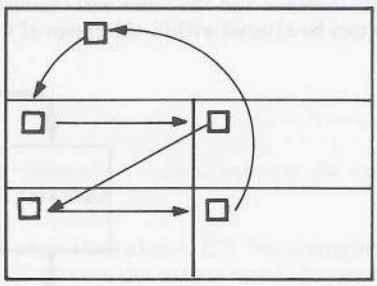
Data is edited by moving the cursor to the position of the data to be edited and then keying in the data. The keyed-in data is entered by pressing the RETURN key, or by moving the cursor.

The cursor can be moved to the beginning of the blocks by using the F2 and F3 keys. The F2 key will move the cursor to the beginning of the previous block, and the F3 key will move it to the beginning of the next block.

F2 key



F3 key



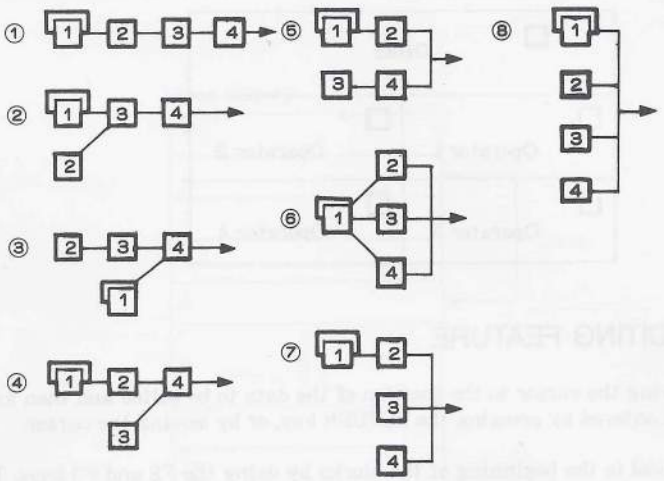
PARAMETERS

(1) Algorithms

Al (Algorithm patterns)

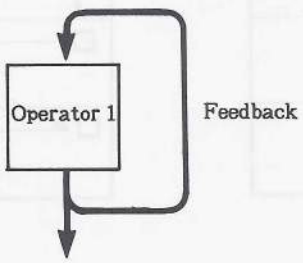
This selects the algorithm from the eight algorithm patterns available. The number of the desired algorithm is keyed in after the cursor has been moved to the Al position. Changing the algorithm can cause a significant change in the voice. The various algorithm patterns have the configurations shown in the following diagram. The operator functions as a modulator when its output goes to another operator, and as a carrier when its signals are output directly. A general rule of algorithms is that the fewer carriers there are (thus the more modulators), the more complex the voice changes will become, and the easier it will be to create noise components.

Algorithm pattern of the FM Sound Synthesizer unit



(2) Feedback

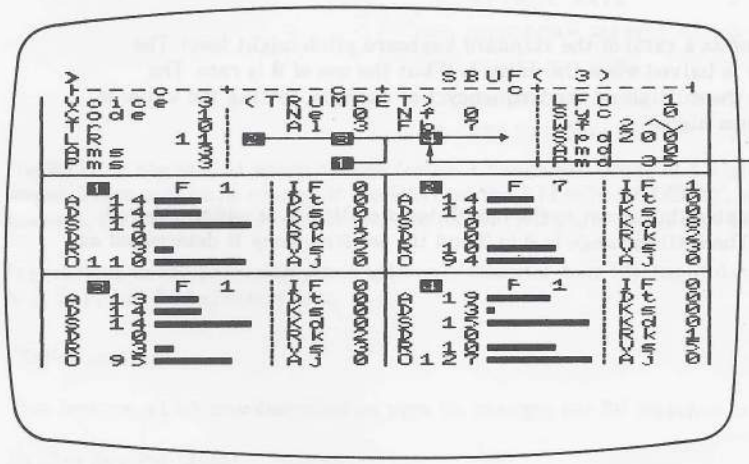
Operator 1 has a feedback feature which allows operator 1 to modulate itself. The high-frequency components will increase and the voice will change drastically as the amount of feedback increases. The feedback data can be altered within the range of 0 to 7.



(3) Operator ON/OFF

Each of the four operators can be switched ON/OFF. Switching is done by pressing the number key corresponding to the desired operator (1 – 4) while holding down the CTRL key. For example, operator one can be turned OFF by pressing the "1" key while the CTRL key is held down. When the "1" key is pressed, the color of the "1" which indicates the algorithm pattern, and that of the operator number will be reversed, and the operator function will be suspended. The operator can be turned back ON by pressing the "1" and CTRL keys again in the prescribed manner.

An operator can also be turned OFF by moving the cursor over the operator number at the beginning of the operator, and then entering any number different from that of the operator. It can be turned ON by entering the same number as the operator number.



An operator is functioning when the background is yellow; it is not functioning when the color of the background is reversed and becomes black.

Let's dissect the voice data of BRASS 1 by the use of this ON/OFF feature. The algorithm pattern is "3" which means that operators one to three are modulators, while operator four is a carrier. Turn OFF operators one to three and listen to only the carrier (operator four). The round sound that you hear is the sound of an unmodulated sine wave. Turn ON operators one to three in order and listen to how the sound changes.

(4) Output level of operator

O (Output level)

This sets the output level of the operators. With the FM Sound-Generation system, not only the volume but the voice also changes according to the output level.

The setting range is 0 to 127. The maximum output is specified when the value is 127. Try changing the output level BRASS 1 with only operators one and four ON. First change the output level of operator one. This will change the volume because operator four is the carrier. Next, change the output level of operator one.

Operator one is the modulator, thus the output level is equivalent to the degree of modulation. As the level is raised, the amount of modulation will increase and the sound will become more brilliant. Increasing the level still further will cause the sound to become simply noise. Lowering the output level will cause the sound to become rounder as the degree of modulation decreases. There will be no frequency modulation, and the output will become a sine wave when the level drops to 0.

Aj (Adjust)

Altering the algorithm pattern allows the number of carriers to be varied. The final output level will also depend upon the number of carriers. This adjustment feature is used when the need exists to match the output level of the created sound with that of another sound. The setting range is Ø to 15. The total output level of the operator will be decreased as the numeric value is increased. When there is a large number of carriers, the output level of each operator can be adjusted to lower the final output level.

(5) Frequency of operator

F (Frequency)

This sets the frequency of each operator as a ratio of the standard keyboard pitch (eight feet). The setting range is Ø to 15. The frequency is halved when the value is Ø but the use of Ø is rare. The frequency set by the value is equal to the multiple of the frequency. For example, setting the value to eight will result in frequency eight times higher.

IF (Inharmonic Frequency)

This also sets the frequency of the operators but is set to the non-integer multiples or odd-numbered harmonics of the reference frequency. The setting range is Ø to 3 and the set frequency is determined as follows:

Set value	Frequency ratio
Ø	1 time
1	1.41 times
2	1.57 times
3	1.73 times

Thus, for example, if F=2 and IF=3, the frequency will be 2 X 1.73 or 3.46 times

Frequency ratio determined by F and IF settings

IF \ F	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	0.50	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00
1	0.71	1.41	2.82	4.23	5.64	7.05	8.46	9.87	11.28	12.69	14.10	15.51	16.92	18.33	19.74	21.15
2	0.79	1.57	3.14	4.71	6.28	7.85	9.42	10.99	12.56	14.13	15.70	17.27	18.84	20.41	21.98	23.55
3	0.87	1.73	3.46	5.19	6.92	8.65	10.38	12.11	13.84	15.57	17.30	19.03	20.76	22.49	24.22	25.95

Turn ON operators one and four only for BRASS 1 and listen to the changes in sound as the frequency ratio changes. The pitch will increase as the frequency of the carrier (operator four) increases. High-frequency components increase as the frequency of the modulator (operator one) increases, resulting in a more brilliant sound.

Dt (Detune)

This feature allows the sound to be expanded by slightly shifting the pitch of the operators. The setting range of the operators is −3 to 3. A sound effect similar to a phaser can be created by slightly shifting the pitches of the carrier and modulator. Shifting the pitch of the carriers of algorithm patterns, such as 5 to 8, which have more than one carrier, will allow the creation of a chorus−like effect.

(6) Envelope generator

The envelope of each operator is set in the order A,D,S,D,R. The setting range of these components, which were described on page 14, are as follows:

Screen display	Function	Setting range
A	ATTACK RATE	0 ~ 31
D	1st-DECAY RATE	0 ~ 31
S	SUSTAIN LEVEL	0 ~ 15
D	2nd-DECAY RATE	0 ~ 31
R	RELEASE RATE	0 ~ 15

The RATE is the rate at which change occurs. Change will occur at a higher rate as the value becomes larger. There will be no change if the RATE of the ATTACK, 1st DECAY, or 2nd DECAY IS set at 0. For example, the EG output level will not rise for ATTACK, and the output level will not fall for DECAY.

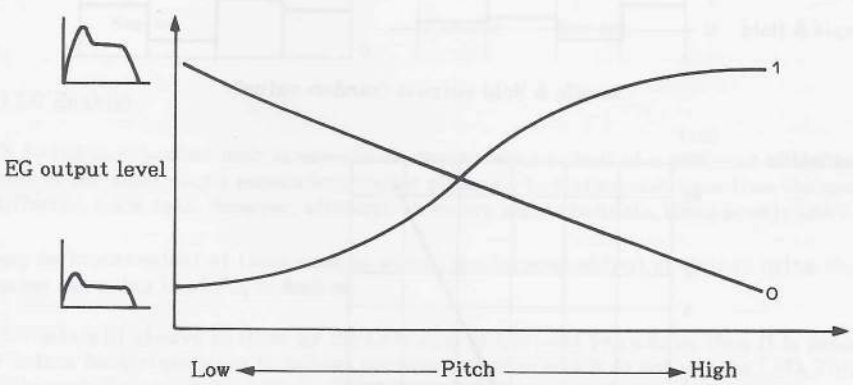
Try various envelope combinations with only operator four ON. Input data after moving the cursor to the A, D, S, D, and R of operator four.

(7) Key scaling

This feature, which was described on page 15, changes the EG response in relation to the pitch.

Ks (Key Scaling table)

Choose either 0 or 1 as the level scaling curve (scaling in relation to EG output level). The value 0 decreases the output level as the pitch becomes higher; the value 1 decreases the output level as the pitch becomes lower.

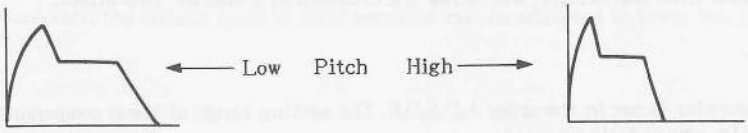


Kd (Key Scaling down)

This sets the degree of level scaling. The setting range is 0 to 15. The degree of level scaling will increase as the value increases.

Rk (Rate Key Scaling Depth)

This sets the degree of rate scaling (rate of EG change becomes greater as the pitch becomes higher). The setting range is 0 to 3. The highest degree of rate scaling occurs when the value is 3.

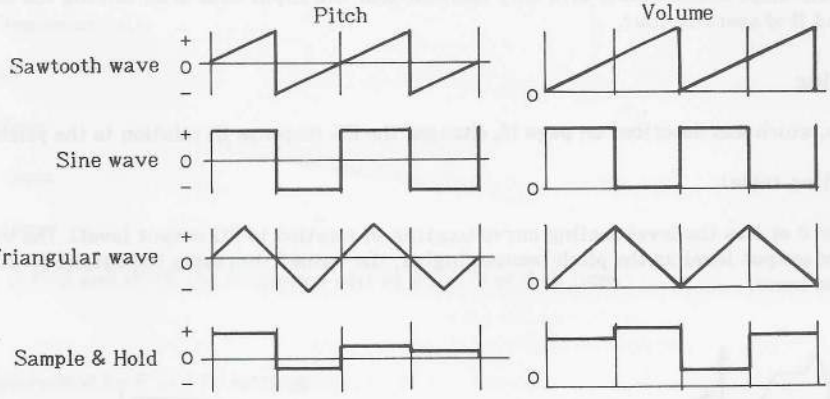


(8) LFO

The LFO (Low-Frequency Oscillator)is an oscillator used for the production of signal of extremely low frequency. It allows the creation of vibrato and tremolo effects by changing the pitch and volume.

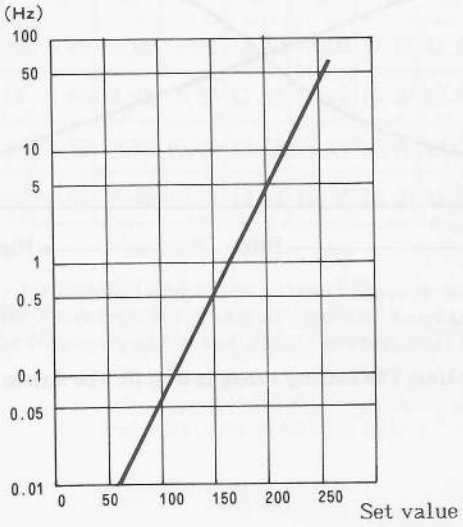
Wf (Waveform)

This selects the waveform of the LFO. The changes in pitch and volume will depend upon these waveforms. The setting range is 0 to 3. The various waveforms are as follows:



Sample & Hold outputs (random value)

Relationship between set value and LFO speed



Spd (Speed)

This sets the speed (frequency) of the LFO. The frequency can be set between approximately 0.008Hz and 53Hz. The frequency becomes higher as the value becomes larger and the rate of change becomes faster. The setting range is 0 to 255.

Amd (Amplitude Modulation Depth)

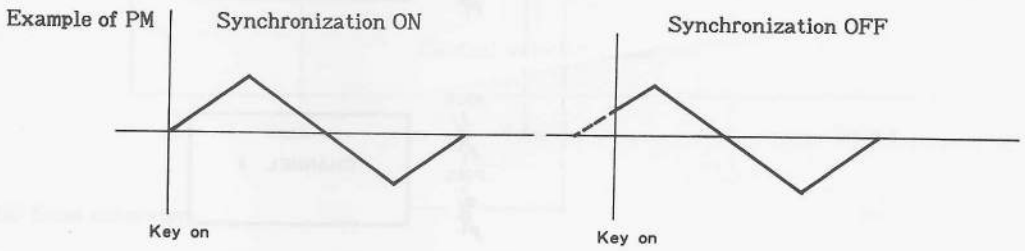
This sets the output level of the LFO in relation to the volume (output level of the carrier). The setting range is 0 to 127. The depth increases as the value becomes larger.

Pmd (Pitch Modulation Depth)

This sets the output level of the LFO in relation to the pitch. The setting range is 0 to 127. The depth increases as the value becomes larger.

Syc (Synchro)

This sets whether or not Key On (the instant when the key is pressed) is synchronized to the LFO. Pressing "1" activates synchronization, pressing "0" releases it. The Synchronization On mode means that the waveform of the LFO will start each time the key is played. This is shown in the following diagram:



LFO (LFO Enable)

The FM Sound Synthesizer unit is capable of simultaneous output of a maximum of eight voices. This means that each of the eight sound generators (called channels to distinguish them from the operators) is set with different voice data. However, although there are eight channels, there is only one LFO.

This may be inconvenient at times such as when simultaneous output of strings using the LFO and percussion not using the LFO, is desired.

The LFO data will always be reset by the LFO data of the next voice data, thus it is impossible to define the LFO data for strings when it follows percussion voices which do not use the LFO. This problem is solved through the use of the LFO Enable feature, which is usually set to "1"(ON). Setting it to "0"(OFF) will prevent LFO data, set in the voice data, from being reset by new voice data.

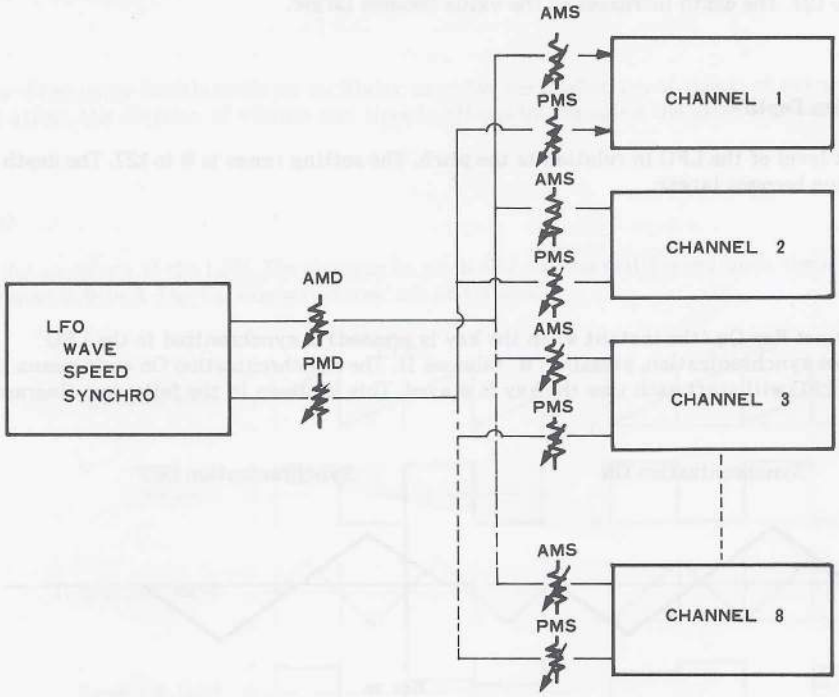
* Software such as the Yamaha FM Music Composer is needed for the simultaneous output of eight voices.

Ams (Amplitude Modulation Sensitivity)

The amount of LFO modulation can be set separately for each voice when a number of voices are simultaneously output. The Ams sets the LFO sensitivity in relation to the volume. The setting range is 0 to 3. Maximum sensitivity is when the value is 3.

Pms (Pitch Modulation Sensitivity)

This sets the LFO sensitivity in relation to the volume for each channel in the same way as the Ams. The setting range is 0 to 7. Maximum sensitivity is when the value is 7.



There will be no LFO signals in relation to pitch when either Pmd or Pms is 0. This also applies to Amd and Ams.

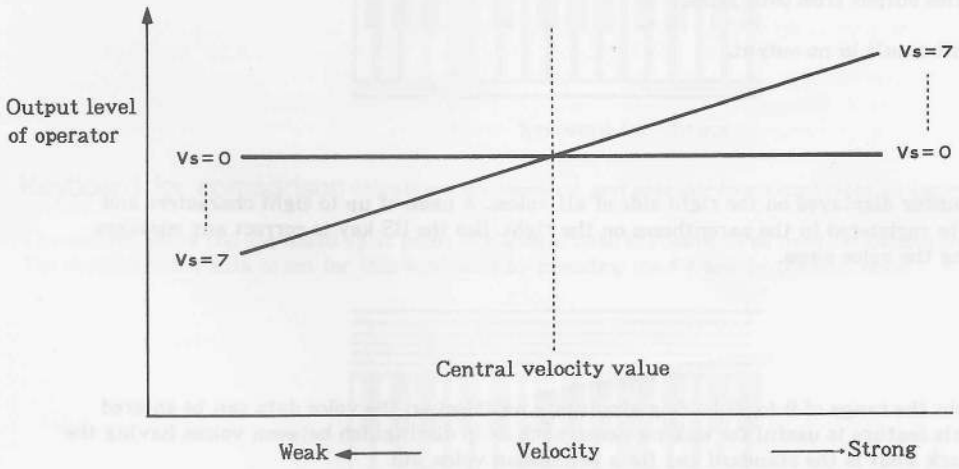
(9) Velocity

The volume and voice of the notes played on a piano will change when the keys are played harder. Some synthesizers have an initial touch-and-response feature to simulate these sound characteristics. These features normally monitor the speed at which the keys are played (velocity) and adjust volume and other factors accordingly. The FM Sound Synthesizer unit also has a feature which controls the volume and voice in accordance with velocity data. The Music Keyboard (YK-01) has no feature for monitoring velocity data. Adjustment is possible during automatic program playback, or when MIDI is used to allow sound to be output over the FM Sound Synthesizer unit.

Vs (Velocity Sensitivity)

This sets the sensitivity to velocity data. In other words, it sets the degree to which the velocity data causes changes in the output level of the operators. Each operator can be set separately. This means that increasing the sensitivity of the carriers will cause changes in volume, and that increasing the sensitivity of the modulators will cause changes in voice. The setting range is 0 to 7. Maximum sensitivity is when the setting is 7. Pressing the HOME, INS, and DEL keys start sound output, allowing determination of the degree to which the sound is changed by velocity. The velocity data when the keyboard is played can thus be altered.

The current strength of the velocity is indicated on the keyboard split line by a yellow mark ●. The ● mark will move when the velocity is changed. The velocity will become stronger as the mark moves to the right. The velocity data of the YK-01 is normally set to the central value. The strength increases when the DEL key is pressed and decreases when the HOME key is pressed. The velocity immediately returns to the central value when the INS key is pressed.



(10) Noise generator

The FM Sound Synthesizer unit has 32 operators of which one can be used as a noise generator or as an operator. The use of this noise generator is somewhat limited and and can only be used for sound output of the comparison keyboard. The F4 key must be pressed during editing to allow the editing results to be checked.

Ne (Noise Enable)

This switches between the operator function and the noise generator function. The noise generator is selected when the value is 1.

Nf (Noise Frequency)

This selects the type of noise. The setting range is 0 to 31. The frequency of the noise will increase as the value increases.

(11) Additional parameters

Tr (Transpose)

This allows tranposing in half steps over a maximum of two octaves up or down. Setting is made with a negative or positive numeric value. For example, if the desired transposition is one octave (12 half steps) up, 12 is keyed in. If it is 1 octave down, −12 is keyed in. The setting range is −128 to 127. If the final pitch of the note exceeds the range of the sound generator, the FM Sound Synthesizer will raise or lower it in one octave units.

LR (Left Right Switch)

The FM Sound Synthesizer unit has stereo audio output jacks. The output jacks can be selected for each voice. 10 is input when output from only the left side is desired and 01 is input for only output from the right. 11 specifies output from both jacks.

The input of 00 will result in no output.

Voice

There is a noise number displayed on the right side of all voices. A name of up to eight characters and numbers can also be registered in the parentheses on the right. Use the BS key to correct any mistakes made when entering the voice name.

Code

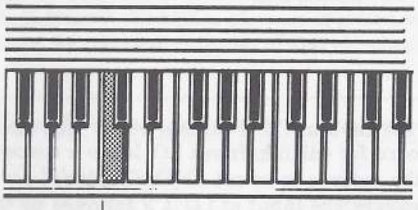
Numeric data within the range of 0 to 99 having absolutely no affect on the voice data can be entered into the voices. This feature is useful for making memos such as to distinguish between voices having the same name or to mark what is the standard key for a percussion voice, etc.

9. KEYBOARD SPLIT FEATURE

The keyboard can be split at a specific key into two sections: one for editing and the other for comparison. The section of the keyboard for editing can be used when editing voice data and for sound output of the data as it is entered for the purpose of checking. The voice data for the comparison section of the keyboard will remain set until it is reset. This allows sound creation to be carried out in the edit mode while comparing the previous voice on the comparison section to the new voice on the editing section.

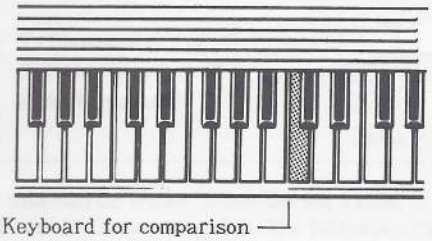
Keyboard for editing (displayed on command and special-function tables as Inst-1)

The section above the keyboard split point is the keyboard for editing; it can output a maximum of seven voices simultaneously. The voice data specified when the edit mode is switched in, is automatically set for this keyboard and editing of this voice can begin.



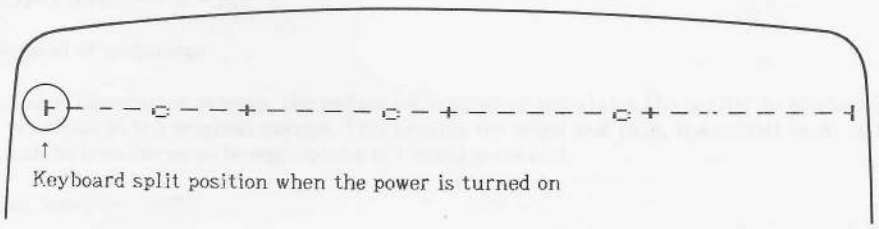
Keyboard for comparison (displayed on command and special-function tables as Inst-2)

The section below the keyboard split point is a simple note keyboard to be used for comparison purposes. The current voice data is set for this keyboard by pressing the F4 key in the edit mode.

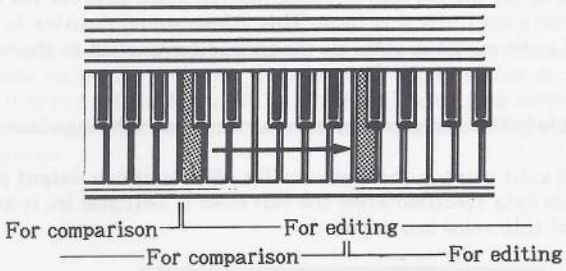


SETTING THE KEYBOARD SPLIT POINT

The keyboard split point is automatically set as the lowest sound on the keyboard when the power is turned on. In other words, the keyboard for editing uses all the keys on the keyboard. To change the split point, first press the SELECT key. The color of the ● mark on the line directly below the command area will change from green to red. Next, press the key on the keyboard corresponding to the desired split point. The red ● mark will return to its original green color and move to the selected position.



The green mark indicates the current position of the keyboard split point. The C on the line shows the position of C notes on the keyboard to provide you with a relative index of the key position.



LOAD command

The LOAD command can be used to set the keyboard to a certain voice. This can be used for both the keyboard for comparison and the keyboard for editing. Input LO, leave a space and then enter the voice number of the voice and the key that the voice is to be set to. The keyboard for editing is specified by 1 and that for comparison by 2. For example, the input of LO 3, 2 followed by the RETURN key will set voice number 2 in the keyboard being used for comparison.

10. THE BASICS OF VOICE CREATION

This section deals with the actual voice creation process.

Clear the data of voice number one using the KILL command, then switch the unit to the EDIT mode. Enter the following data:

Algorithm→ 5
OP 1, 2→ON OP 3, 4→OFF

(OP is the abbreviation for operator)

BASICS OF VOICE CREATION USING FM SOUND GENERATION

The smallest algorithm possible for use with FM Sound Generation is one having a single carrier and a single modulator. The first step is to master the basics of voice creation using only this algorithm. The waveform of the sound can be altered by the manipulation of the parameters of the algorithm. These items are as follows:

Item	Item of FM Voicing Program	min ← Sound change → max
Output level of carrier	O (Output level) of each operator	0← →127 Minimum level Maximum level
Output level of modulator		0← →127 Rounded tone Bright tone
Feedback level of modulator	Fb (Feedback Level)	0← →7 Normal tone Sharp tone Noise
Carrier frequency	F (Frequency) and IF (Odd-Harmonic Frequency) of each operator	0.50← →25.95 Low pitch High pitch
Modulator frequency		0.50← →25.95 Close harmonics Separated harmonics

The frequency of the modulator and carrier shown is not the set value. It is, instead, the final frequency ratio determined by F and IF (refer to pg. 25). The following items are the same.

Skillful manipulation of the following parameters allows the the use of the FM Sound Generation section for determining pitch, voice and volume.

(1) Output level of carrier

This can be considered to be the audio signal volume control the carrier is an audio signal.

OP 2 Output level --> 0 - 127

(2) Output level of modulator

In the FM Sound Generation process, the modulator frequency modulates the carrier to produce harmonics which did not exist in the original carrier. This creates the voice and thus, the output level of the modulator can be considered to be equivalent to the voice control.

OP 2 Output level --> 127

OP1 Output level --> 0 - 127

Raising the output level of OP 1 (modulator) will cause the generation of brighter voices.

(3) Feedback level of modulator

Feedback means that the modulator is frequency modulating itself. Applying feedback to the carrier, as with OP 1 of algorithm 8, will act as a tone control in the same way as adjusting the output level of the modulator. However the modulator has this function in most algorithms. In this case, further modulation will further strengthen the tone control function of the output level of the modulator.

OP 1 Output --> 127

Feedback level --> 0 - 7

Setting the output of the modulator to a high level (more then 115) and then increasing the feedback level will allow for the creation of noise. The noise components will vary according to the modulator frequency. The same effect can be obtained by employing three or more modulators, increasing the output level of each to a high level.

(4) Carrier frequency

The carrier is equivalent to the actual audible audio signals. When there is one carrier, the pitch is determined by its frequency. What happens when there are two carriers? The following example uses OP4 as well to answer that question.

OP4 --> ON

OP1 --> ON

The following three effects can be created by altering the ratio between the pitch of the two carriers.

* When the pitch ratio is set to low integers (1 : 1 - 6)

  OP 2 Frequency --> 0 - 6

  The pitch of the two carriers will harmonize to create a new voice (as does the coupler effect of an organ). In this case, the carrier having the lower frequency controls the pitch effect.

* When the pitch ratio is set to high integers (1 : 7 - 15)

  OP 2 Frequency --> 7 - 15

  The pitch of the two carriers is far apart and two seperate sounds can be heard: a high one and a low one. If the pitch ratio does not have harmonics of 2, 3 or 5 (for example 1 : 7), the pitch of the two carriers will not harmonize and a dissonant sound will be heard.

* When the ratio is a non-integer

OP 2 Frequency --> 1

OP 2 1F setting --> 1 - 3

The pitch ratio can be made to be a non-integer through the use of the Odd-Harmonic Frequency feature. There will be absolutely no harmonization and the sound will seem to come from two separate sources.

Voice effects which can be created by altering the pitch ratio of the carriers

Pitch ratio	Effect
Low integer 1 : 1 ~ 1 : 6	Perfect harmonization of the two carriers A new voice is created Coupler effect
High integer 1 : 7 ~ 1 : 30 (=0.5 : 15)	The two sounds seem separated
Non-integer 1 : 1.41 ~ 1 : 51.9 (=0.5 : 25.95)	The two sounds are totally separated

(5) Modulator frequency (ratio of carrier and modulator)

The modulator is the signal that modulates the carrier by FM. FM allows the creation of harmonics which were not in the original carrier and thus allows for the creation of various voices. The modulator frequency (the frequency ratio in relation to the carrier) determines the frequency of the harmonics to be produced, and the parameters function as a way of setting the voice of the sound. A feel for the use of this function is very important when creating original voices.

OP 1 --> ON

OP 4 --> OFF

OP 1 Output level --> 115

Feedback level --> 0

* When the pitch of the modulator is higher than that of he carrier

Leave the pitch of the carrier (OP 2) at 1.00 and raise the pitch of the modulator (OP 1).

OP 1 Frequency --> 0 - 15

1 Frequency --> 0 - 3

Raising the frequency of the modulator (raising the pitch ratio with the carrier) will cause the generation of higher-frequency harmonics and a brighter tone. Creating higher harmonics while simultaneously creating harmonics lower than the current pitch level will, as the pitch ratio with the carrier approaches the maximum, cause the normal pitch relationship to be destroyed and the voice will suddenly change to a new one in the high range. This effect is created because the higher harmonics extend beyond the audible range and the lower pitch takes over the control of the pitch effects.

* When the pitch of the modulator is lower than that of the carrier

This permits the creation of various effects through the manipulation of OP 2.

OP 1 Frequency --> 0

1 Frequency --> 0

OP 2 Frequency --> 0 - 15

1 Frequency --> 0 - 3

THE CONCEPT OF ALGORITHMS

Algorithms comprise a great number of attributes. The algorithm currently being used can create a large number of voices, but even more can be created if the concept of algorithms is mastered. For the sake of clarity, the following description divides algorithms into the number of carriers they comprise.

(1) Algorithms having one carrier (1 - 5)

When one of the operators is being used as a carrier, the rest must function as modulators. This means, that bright tones will probably be produced. Switching between the algorithms and comparing the generated voices will show that algorithm patterns having one carrier are used for the brightest tones.

OP 1 - 4 Output level --> 110

Feedback level --> 0

Algorithm --> 1 - 8

With the algorithm one selected, set the feedback and output levels of all the operators at their the maximum, producing a voice containing extensive noise components.

Algorithm --> 1

OP 1 - 4 Output level --> 127

Feedback level --> 7

OP 4 Frequency --> 15

OP 4 1 Frequency --> 3

This sound is called white noise. There is absolutely no pitch effect from the carrier. White noise means that noise components are randomly generated across the entire range. This is the same as the sound of your breath and of the wind. (Analog synthesizers use a special sound generator to create this sound.)

Algorithm patterns using one carrier

allow not only the creation of tones having extreme changes, but subtle tones having complex waveforms can also be generated through moderate changes in the output level of the modulator. This kind of algorithm is most appropriate for the creation of single instrument sounds.

(2) Algorithms having two carriers (5)

This type of algorithm is an all-purpose pattern which allows the results of sound creation to be easily predicted and a wide variety of voices to be created. Elaborate voices can be produced because there are two modulators in addition to the two carriers. Shifting the pitch of the two carriers will create a chorus effect. The note to be created can be divided into two components to aid in the creation of elaborate voices. For example, algorithm pattern five can be used to create a flute voice. Operators three and four can be used to create the basic flute voice while operators one and two add a breathy character.

(3) Algorithms having three or four carriers (6 - 8)

This type of algorithm pattern is used for the creation of rich and textured voices. For example, shifting the pitch of each carrier slightly will result in a chorus effect similar to the sound of a number of instruments being played simultaneously. Select algorithm eight and use the DETUNE feature to slightly shift the pitch of the four carriers. This allows the creation of a ensemble (string, vocal, etc.). Algorithms, such as eight which has four carriers, are perfect for the creation of organ-like voices through the coupler effect.

THE CONCEPT OF VOICE CREATION

The following is an actual example how to create a voice from scratch. The example used is the creation of the voice of an electronic piano.

(1) Voice creation flow chart

There are a number of different procedures for the creation of voices, but the one outlined below is the most common.

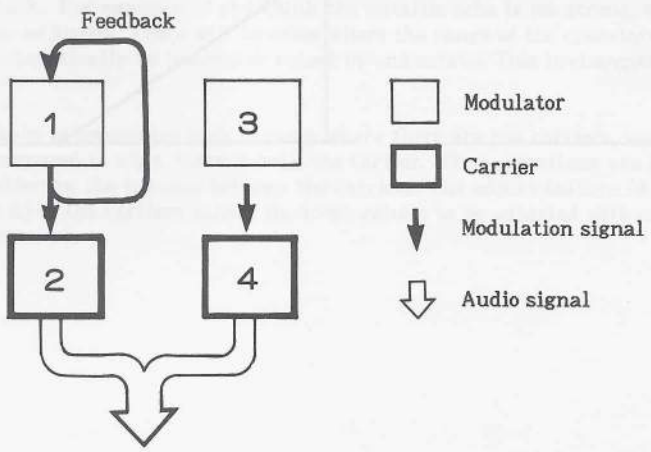
Operation	Parameter of FM Voicing Program
1 Initialization of voice data	KILL command
↓	
2 Selection of algorithm	Al
↓	
3 Setting of operator frequency	F and IF
↓	
4 Setting output level of operators	O
↓	
5 Setting EG	A, D, S, D and R
↓	
6 Setting of key scaling	Ks, Kd and Rk
↓	
7 Re-adjustment of voice data	
↓	
8 Adding effects	LFO, Dt and Vs

(2) Initialization of voice data

Initialize voice number one by using the KILL command. This is done by entering KI_1 followed by RETURN. Initialization of voice data means that the voice data is set to a state which can be likened to that of a blank sheet of paper. This does not mean there is no data but, instead, it means that there are certain parameters which are then edited to obtain the desired voice.

(3) Selection of algorithm

After the voice data has been initialized, switch the operation mode from the command mode to the edit mode. Voice number 1 was initialized so 1 is entered and the RETURN key pressed. This switches the



operation mode from command to edit. The initial voice data will be displayed on the screen. Algorithm 8 is selected for the initial voice. A different algorithm which is more suitable for the sound of an electronic piano is selected. Set A 1 to 5 for the selection of algorithm 5. This algorithm pattern has two carriers, is easy to use, and allows the creation of a relatively wide variety of sounds. In this example, OP 1 and 2 are used for the main tone while OP 3 and 4 are used to create a metallic echo-like sound.

(4) Setting of operator frequency

The next step is to set the frequency of each of the operators. The frequency is set by F and IF, but in this example only F is set. The frequency of OP3, which is the modulator of OP4, is set to 10 in order to create a metallic echo. The other operators are all left at 1.

(5) Setting output level of operators

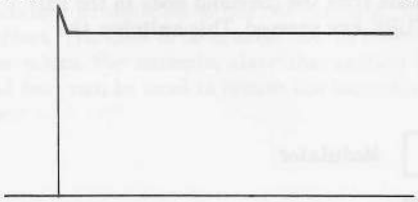
This step alters the output level of the modulator to adjust the voice. When adjusting the level of OP 1, set OP 3 and 4 to OFF so that sound is output only from OP 1 and 2. Set OP 1 to about 115 for a fairly bright sound, and set OP 3 to 80 so the pitch sensitivity is not decreased and a metallic echo-like sound is produced. There is only feedback for OP 1, and it is set to 2 in order to increase the brightness of the voice.

(6) Setting EG

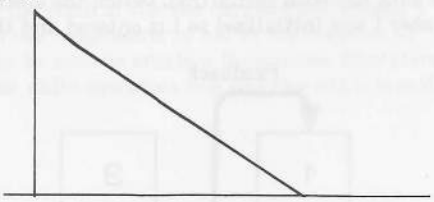
It is now time to set the volume and pitch envelopes. This will transform the voice, which now sounds like an organ, into that of an electronic piano. OP 1 – 2 and OP 3 – 4 should be adjusted separately, then put together in the final stage to let you hear the total sound. OP 1 – 2 are adjusted first. The attack of this main voice is to be made sharper and a little longer through the use of the proper envelope. OP 1 is the modulator. There will be a greater number of harmonics, but only on the attack, after which the character of the voice changes very little.

	ATTACK	1st-DECAY	SUSTAIN	2nd-DECAY	RELEASE
OP 1	31	15	13	0	6
OP 2	31	12	13	5	8

EG of OP 1



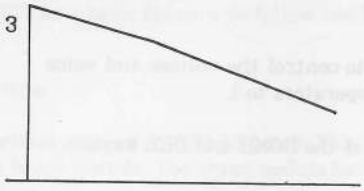
EG of OP 2



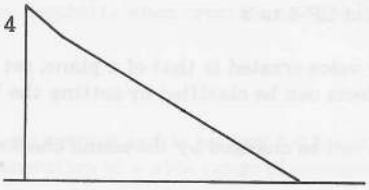
The setting of OP 3 – 4 is adjusted next. This is the metallic echo effect, so an envelope sharper than that of OP 1 and 2 is desired. The setting of the carrier OP 4 is the same as that for OP 2, and is adjusted later by key scaling. Set the envelope of the modulator OP3 so that there is relatively little change in the character of the voice.

	ATTACK	1st-DECAY	SUSTAIN	2nd-DECAY	RELEASE
OP 3	31	7	11	3	6
OP 4	31	12	13	5	8

EG of OP 3



EG of OP 4



The above setting will create a voice very similar to that of an electronic piano. Next, use key scaling to sharpen the high notes and compensate for the high notes which are too bright. Rate scaling adjusts the sharpness of the notes, while level scaling is used for voice character and volume. The level scaling curve is Ø in order to limit the higher pitched sounds.

	Ks	Kd	Rk
OP 1	0	6	2
OP 2	0	3	2
OP 3	0	6	3
OP 4	0	4	3

The use of this key scaling procedure to edit the envelope shortens the overall length of the envelope. The settings were made with this in mind. The length of the envelope can be adjusted by the EG settings.

(7) Re-adjustment of voice data

The setting of the voice components is now complete. However changing a setting such as the EG will change the voice. The final voice can be re-adjusted by the adjusting the output level of the operators and the level of feedback. For example, if you think the metallic echo is too strong, the output level of operator four can be adjusted. There will be cases where the range of the operators is exceeded and the sound will thus automatically be lowered or raised by one octave. This is changed by the transposing (Tr) feature.

The volume is more likely to become too high in cases where there are two carriers, such as in the example given here, compared to when there is only one carrier. Thus, sometimes you will want to lower the volume while considering the balance between the carriers. The adjust feature (Aj) is useful for this. Setting only the Aj of the carriers allows the total volume to be adjusted without changing the balance between the carriers.

(8) Adding of effects

Effects are added in this final step to make the created voice resemble that of an electronic piano even more. Tremolo and chorus effects are added for this purpose.

The tremolo effect is added by the use of the LFO. Set the the LFO to 1, then select waveform two (triangular wave) for a moderate tremolo effect. The speed is then set to an appropriate setting of approximately 190 – 195. Use the Amd feature for setting the depth of the tremolo. There is a close relationship between the Ams and Amd features. Set Amd at 10 for the shallowest Ams effect. Change Amd to 10 for a very slight tremolo effect. Pmd and Pms are not set, as this voice does not use a vibrato effect. The chorus effect is created by shifting one of the carriers slightly, and a phase effect is created by shifting one of the modulators slightly. This richer sound is obtained by setting the Dt of OP 1 to −3 and the Dt of OP 4 to 3.

Finally, since the voice created is that of a piano, set the velocity to control the volume and voice character. The effects can be clarified by setting the Vs of all the operators to 1.

The velocity data can be changed by the sound checked by the use of the HOME and DEL keys.

11. SOME EXAMPLES OF SOUNDS CREATION

There is a shortcut which can be used to create sounds much more easily. This is through the copying of existing notes. This is not simply wholesale imitation but is the process instead of creating new voice while checking the meaning of the existing data. It is much easier to modify an existing voice to fit your image of what original sound you wish to create. This section chooses an number of voices from those stored in the FM Sound Synthesizer unit and explains the process of sound creation after the voice has been initialized.

THE CREATION OF BRASS VOICES

Let's create a voice in the FM Sound Synthesizer unit from scratch. This example uses voice three (TRUMPET) as a base. Be sure to follow the following steps carefully when creating a voice from scratch.

(1) Algorithm

The algorithm pattern of BRASS 1 is 3. This pattern uses one carrier, and is perfect for the creation of brilliant brass sounds. The three modulators permit the generation of a wide range of changes for bright brass voices.

(2) Operator output level and Feedback

The output level of the carrier OP4 can be left at 127. The output level of OP 1 – 3 can be moderately adjusted within the range of 90 – 110. Feedback is very important for this voice and is set to its highest value (7).

(3) Frequency of operators

The basic setting of all the operators can be 1.00. OP2 can be set to "2" for a slight metallic echo, further improving the sound of the brass instrument. The output level of OP2 is set at 94 for a very subtle sound.

(4) EG

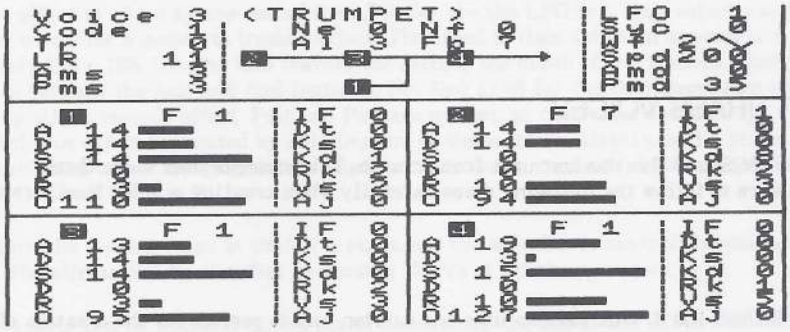
The EG is also very important for creating a brass voice. All of the operators have a slow attack. Set modulator A so that it is slightly slower than any of the carriers. This creates the special attack characteristic that brass instruments have. If carrier A is slower than the modulator A, there will be no character change detectable in the attack section and the sound will resemble that of an organ. The A data of the three modulators should all differ slightly to create even more realistic character changes.

(5) Key scaling

The sharpness of the higher keys will be lost when a slow attack envelope is set. The rate scaling feature corrects this so that the voice sounds natural when fast passages are played. Rate scaling is set at 1 – 2 for all operators to preserve the sharpness of the higher keys.

(6) LFO

With brass instruments, the pitch of the long tones is going to waver no matter how good the musician is. This effect is produced by the LFO. Set the vibrato effect to a barely detectable level.



THE CREATION OF STRING VOICES

The next example uses as its base STRING 1, which is voice number 4.

(1) Algorithm

Algorithm pattern 3 is also used for STRING 1. This has one carrier and three modulators, an algorithm used for voices having a high degree of character change. It is used in this example to reproduce the complex sounds of string instruments.

(2) Frequency of operators

OP1, 3 and 4 remain at 1.00. The pitch of OP2 is set to 5.00 for creating the delicate gossamer texture associated with string instruments.

(3) Output level of operators and Feedback

The output level of the modulator must not be too high. The appropriate setting is about 80 to 120. If the output level of the modulators is raised above this, the voice will begin to resemble that of a horn instrument, with some additional noise components. The feedback is used to reproduce the feeling of the vibrating string, and is thus set to 7.

(4) EG

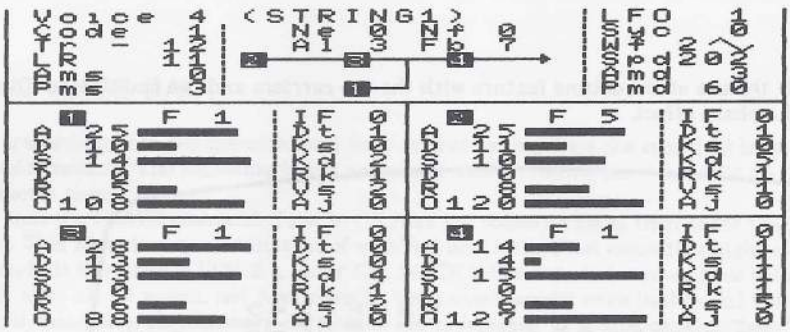
String instruments also have a slow attack, so the A of the carrier is slowed down slightly by setting it between 13 and 15. Thus the modulators are set faster then the carrier. The R of the carrier is also slowed down slightly (5–6) to simulate the sound of an ensemble. This causes the sound to linger after the key has been released.

(5) LFO

Vibrato is one the most important characteristics of string instruments. However, since this is an orchestral sound, there is no need for the deep vibrato heard with solo string instruments.

(6) Transposing

Transposing lowers the high range by one octave to obtain a richer middle and lower range sound.



THE CREATION OF PIPE-ORGAN VOICES

The final example uses PORGAN 1 which is voice number 14. This voice uses two carriers.

(1) Algorithm

PORGAN 1 uses algorithm pattern 5, having two carriers and two modulators. This "all-mighty" program allows close control over the voice creation process because the voice components can be divided into two parts. In this example, the voice is divided into the set of OP3 and 4, used for the deep reverberations of the pipe organ, and the set of OP1 and 2 for the high-frequency reverberations. Both of these can be programmed independently.

(2) Frequency of operators

OP3 and 4 are set at 0.50 for the deep, low reverberations of the pipe organ. OP1 and 2 for the high-frequency reverberations of the organ are set to 8.00 and 4.00 respectively. The harmonic ratios are thus 1:2 and 4:8. This produces the coupler effect of the organ (two pitches harmonizing to create a new sound).

(3) Output level of the operators and Feedback

The output level of the modulators must be prevented from becoming too high. There is no need for feedback.

(4) EG

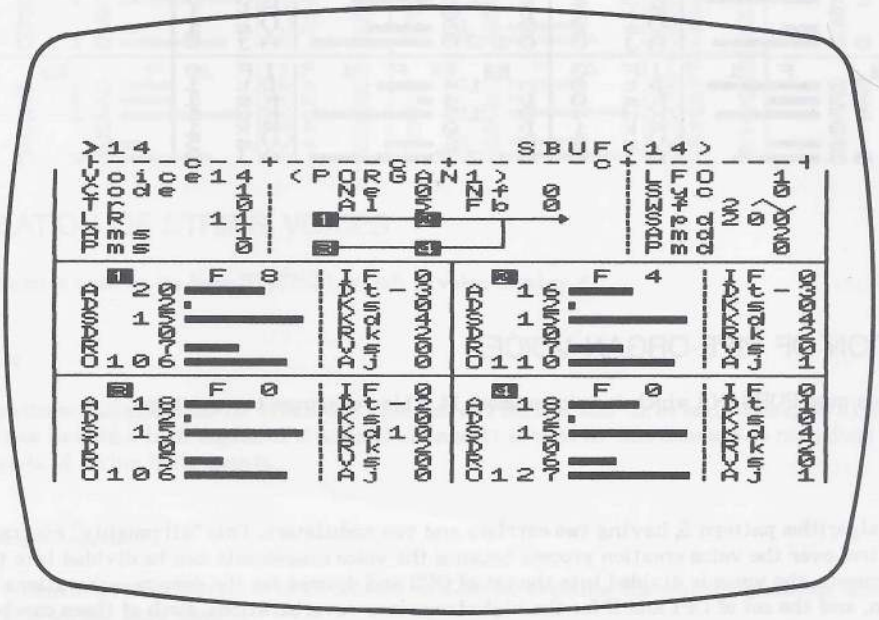
The attack of the pipe organ is probably not as slow as you think. If it is too slow, the sound will begin to resemble the old foot pedal-driven organs. The appropriate level of the A of the carrier is 16 to 18. Taking the construction of a pipe organ and the conditions of the hall where it played into account, together with the intention of causing some reverberation to remain after the keys are released, the R setting of both the carrier and modulator is between 5 and 7.

(5) Key scaling

Rate scaling corrects the overly long reverberation that tends to occur after the higher keys are released. Level scaling is applied to the modulators and limits the frequency modulation on the higher keys for a clearer voice.

(6) Detune

The sound is made richer by the use of the detune feature with the two carriers and two modulators. This provides both a chorus and a phase effect.



12. SAVING AND LOADING VOICE DATA

The data for voices created or edited with the FM Voicing Program can be saved with a cassette recorder. This section explains saving (i.e., recording) and loading (i.e., retrieving) in detail.

Be sure that the computer and the data recorder are connected together in accordance with the instruction manual of the CX5 Music Computer.

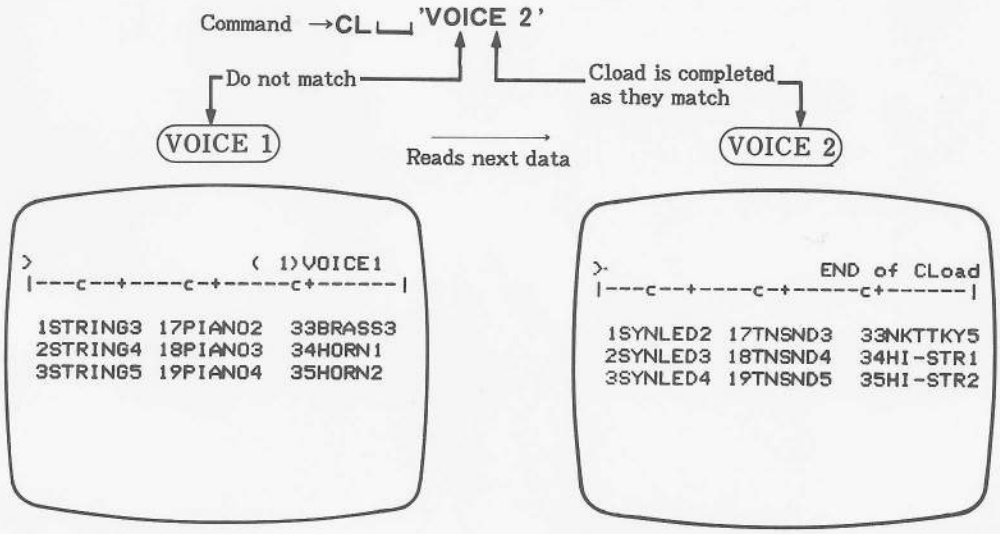
SAVING VOICE DATA

Saving (recording onto the cassette) and loading (retrieving from the cassette) is carried out on the entire voice memory. The following is the procedure used to record the voice data in the voice memory onto cassette tape.
Saving uses the CSAVE command. Type in CS from the command mode, then enter the file name for the data to be saved. This name is any combination of numbers and letters not exceeding eight characters in length. For example if the name is VOICE 1, enter CS␣VOICE 1. (Be sure to leave a space between CS and the name.) This will save all 48 voices, not just voice 1. You cannot accept save individual voices. The computer will ask if cassette or data memory cartridges are to be used. If a tape cassette tape is used, enter "Y" in response to the prompt. If "N" is entered, the computer will prompt for confirmation of data memory cartridge save. Enter "Y" to select this option. Now press the playback and record buttons of the cassette recorder. Saving begins as soon as the RETURN key of the computer is pressed. The cassette recorder will automatically stop when recording is complete and "End of Csave" will be displayed on the right side of the command area. The unit will return to the mode where commands can be entered. Return the cassette recorder to stop by pressing its stop button to release the playback and record buttons. Be sure to note the location of the saved data, using the counter of the recorder. This is useful for later retrieval (loading) of the data.

LOADING VOICE DATA

Try loading the voice data you just saved on cassette into the voice memory of the computer.

Loading uses the CLOAD command. Key in CL, leave a space and then enter the file name. The group of voices labels "VOICE 1" is loaded by entering CL␣VOICE 1. Now press the playback button of the cassette recorder. Loading begins as soon as the RETURN key of the computer is pressed. The cassette recorder will automatically stop when loading is complete and "End of Cload" will be displayed on the right side of the command area. The unit will return to the mode where commands can be entered. Return the cassette recorder to stop by releasing the playback and record buttons. If the file name specified at loading was not the same as the file name on the tape, the name of the file recorded on the cassette tape will be displayed on the right of the command area and that voice will be displayed in the table of voices and the next recorded voice will be loaded.

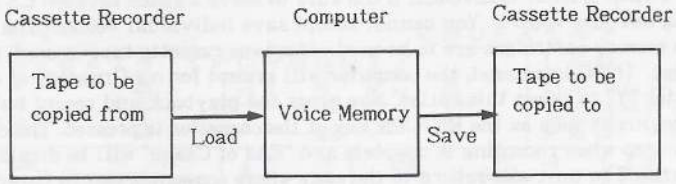


PRECAUTIONS REGARDING LOADING AND SAVING

(1) The fast forward and reverse functions of the cassette recorder cannot be commanded from the cassette recorder when the recorder is connected to the computer for remote control. The remote-control mode can be released with the ON command, and the reverse/fast-forward functions can be used. Return the unit to the remote control mode afterwards through the use of the OFF command.

(2) Saving or loading can be interrupted by pressing the STOP and CTRL keys of the computer simultaneously. Pressing the stop button of the cassette recorder will also interrupt saving/loading.

(3) It is highly recommended that you make a copy of any cassette tape on which you have recorded voice data. This is called making a backup. Do not use recorder-recorder dubbing to copy the data. Instead, load the data to be saved into the computer and then save it on a different tape. This procedure prevents the data from being altered or deteriorating.



13. MESSAGES

The voice number of the voice data stored in the temporary storage area (Save Buffer) is usually displayed on the right side of the command area. However, other message also are displayed in this area when the necessity arises. The meanings of these messages are as follows:

Bad argument the data following the command is incorrect (for example, the voice number used with the PRINT command)

Bad Command the command was not correctly entered

Cload error an error occured during the loading of voice data from a cassette tape (displayed when loading is interrupted by user)

End of Cload loading from the cassette tape has been completed

Csave error an error occured during the saving of voice data on cassette tape (displayed when saving is interrupted by user)

End of Csave saving on cassette tape has been completed

Print error printout is not possible (faulty connection, no paper, etc.)

End of Print printout has been completed

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