SYMPHONY

12

Speech Systems
38W255 DEERPATH ROAD
BATAVIA, ILLINOIS 60510
(312) 879-6880

Creating Music for Musica 2 using Symphony 12

If you wish to create music from SYMPHONY 12 for MUSICA 2, it would be helpful to know the duration that MUSICA considers a quarter note. For this reason we have developed a metronome to help you keep time while playing. While you are in the "SYNTHESIZER" mode, hit "3" and make sure the period is about 1500.

New MUSICA 2 Version

Please note the lastest version of MUSICA 2 is version 2.7. See the MUG newsletter for details of the features and the update policy.

Typo Error In Symphony 12 Manual

Two errors exist at the bottom of page 7. In the program

Line 1 should be CLEAR &H200,&H21F0 not CLEAR &H200,&H22F0
Line 3 should be DEFUSR1=&H220E not DEFUSR1=&H230E

SYMPHONY 12

A 12 VOICE HARDWARE MUSIC SYNTHESIZER
FOR THE COLOR COMPUTER

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Speech Systems warrants SYMPHONY 12 againt defects in material and workmanship for a period of Ninety Days from the date of purchase to the original purchaser. The obiligation of Speech Systems is limited to the repair or replacement of the product, free of all charges, which proves defective during this period. This warranty does not cover damage due to accident, negligence, abuse, or tampering.

REPAIRS===

Call the factory for information on the repair charges should the product become defective after the ninety day warranty has expired.

UNPACKING AND INSTALLATION===

Carefully remove SYMPHONY 12 from the box and inspect it for possible damage that may have occured during shipment. If there is any damage, save all packing material and notify the carrier immediately.

Your SYMPHONY 12 uses circuitry which is sensitive to static charges. Do not handle the unit more than necessary. It is imperative that it never be removed or installed while the computer is on.

SYSTEM REQUIREMENTS==

SYMPHONY 12 requires a color computer with a minimum of 32K of memory. SYMPHONY 12 will work in both a disk or tape system.

PROGRAMS INCLUDED WITH SYMPHONY 12=================================

The tape and disk programs provided with SYMPHONY 12 are identical. We supply the software on tape as well as disk at the same price. We do this as a convience for you. The software is not copy protected and we encourage you to make backups. If you wish, we will supply you with the files on disk for $7. The files supplied are:

```
SYMPHONY.BAS     .... Tape version side 1 ....
SYMPHONY.BIN
BANJO.MUS
HILLST.MUS
VIVALDI.MUS
100.MUS                              < These 6 songs are from
200.MUS                              < our music library. Volumes
300.MUS                              < 100, 200, 300, 400, 500 &
400.MUS                              < 600. Enjoy!
500.MUS                              <
600.MUS                              <
SOUNDEMO.BAS     .... Tape version side 2 ....
SOUND.BIN
SPACEY.PIC
```

HELP US==

Speech Systems consists of engineers, programmers and music lovers but no one with PIANO KEYBOARD dexterity. This fact accounts for the reason why all the music files provided are from MUSICA. If you would like to share your 12 voice music with us, we would like to share them with others.

AUDIO OUTPUT CONNECTORS==

You will notice upon exmination of SYMPHONY 12 that there are two connectors. These connectors are the way in which you will connect your music synthesizer to your stereo system. From one conector you will get 6 voices, and 6 additional voices from the other. The output is "line level" and is intended to connect to the "tape" or "AUX" inputs of your stereo. You should not try to connect to speakers directly. You must connect it to some type of amplifier.

Note however, the output is also available to your TV speaker. In other words, if you do not wish to connect to your stereo system, all 12 voices will automatically come from your TV system.

SYMPHONY 12 MEMORY MAP===

SYMPHONY 12 is a hardware device that is memory mapped just like your disk controller and other peripherals such as our VOICE, SUPER VOICE, STEREO PAK, and others. We have designed all our devices so as not to conflict with any of our products or the products of other vendors. SYMPHONY 12 is completely decoded so it requires only 4 bytes of memory starting at $FF60. It is the extra work that we have put into our hardware devices that lets you use them with any expansion chassis such as the MULTI-PAK or a simple Y-CABLE.

MUSICA 2===

As of this writing, the lastest version of MUSICA 2 is 2.7. Several enhancements have been made. For example, this version now incorporates the PIANO KEYBOARD, both the 2 1/2 and 4 octave versions. If you have an earlier version, an update is available for $10 but you must return the original manual and tape/disk. You will be sent a brand new manual.

PIANO KEYBOARD===

SYMPHONY 12 is a hardware music synthesizer that we feel has great potential to the music enthusiast. MUSICA 2 and SYMPHONY 12 make a great match, but with the PIANO KEYBOARD you have just about the ultimate system. Note that should you purchase the PIANO KEYBOARD, you will find that it is not limited to just SYMPHONY 12. At the present time, there are 4 distinct music products that interface to the PIANO KEYBOARD. They are MUSICA 2, SYMPHONY 12, SUPER SYNTHER (for the SUPER VOICE) and SYNTHER 77 PLUS. We sincerely believe that the PIANO KEYBOARD is a powerful peripheral that will give you great enjoyment.

**** SYMPHONY XII ****

INTRODUCTION:

Symphony XII is an easy to use program that will allow you to play and record music with the SYMPHONY 12 cartridge. Symphony XII has many functions that will be described in following sections. A piano keyboard or the MUSICA program are not necessary to use this program, but they will enhance your enjoyment of it. This will become clearer as we continue.

The COCO keyboard will be transformed into a synthesizer keyboard with control over pitch (note and octave), noise parameters, volume and accompaniment.

The most effective way to explain the programs features is to read this manual while running the program. To start the program just type RUN "SYMPHONY" for disk. For tape users you must first CLOAD "SYMPHONY" then type RUN. If you have a disk system you will prompted for DISK or TAPE. If you are using tape make sure that the PLAY button of the recorder is pressed and the SYMPHONY XII tape is in the recorder. After choosing Disk or Tape the program will load the machine language program that is needed (SYMPHONY.BIN). Once the program has loaded you will see a menu on the screen. Press the menu choice 1 to follow along with the rest of the directions.

THE NOTE KEYS ON THE COCO KEYBOARD:

If you do not have the Piano Keyboard from Speech Systems you should press the 'T' key to activate the COCO keyboard. The bottom two rows of the keyboard have been converted to act like the white and black keys of a piano or organ. The bottom row keys Z,X,C,V,B,N,M and the comma, point and slash keys are the white keys and correspond to the notes A,B,C,D,E,F,G,A,B and C. The second row keys S,F,G,J,K and L are the black keys and correspond to B flat (A sharp), D flat (C sharp), E flat (D sharp), G flat (F sharp), A flat (G sharp) and B flat (A sharp). You will notice that the keys allow slightly more than one octave. The white and black keys are displayed on the screen. If a key is being pressed it will show up with the note indicated on the screen. To play the note C, press the C key. To play the note D press the V key etc. After a while you will find the display to be very helpful and you will not need to look at the keyboard.

The note keys modify the pitch values that are contained in the registers 0 through 5 of the sound chips. The last note played is displayed on the screen for your convenience.

The keyboard of the Color Computer is not very well suited for this type of application. In particular, if three keys are pressed it is possible to decode the three keys as a fourth. When you are playing chords and toggling other keys there is a slim chance that the computer will decode your keypress incorrectly. This is unfortunate but cannot be overcome while retaining the COCO keyboard. To observe this phonemenon while in BASIC (cursor flashing), hold down the '.' and ',' keys. Now press the 'T' key a couple of times. Notice that you get 'V' whether you want it or not.

PIANO KEYBOARD:

(Optional from Speech Systems)

There are two versions of the piano keyboard available, 4 and 2 1/2 octaves. The keyboard displayed on the screen is 4 octaves and corresponds exactly with the 4 octave keyboard. The 2 1/2 octave keyboard allows you to play a subset of the 4 octave range and the screen will display only within that range. You can play all of the notes with either keyboard by adjusting the base octave (discussed in next section). The keyboard on the screen will always show the same location independent of which octave is the current base. The display will display any keys that are pressed. If you can press 12 keys at one time it will display them all. Try it! You should also hear them all.

THE OCTAVES:

The note keys set the pitch value relative to the current base octave. The base octave is the octave of the eighth white key from the left of the display. The base octave can range from 1 to 8. When the base octave is three this represents middle C on the piano. If you are using the COCO keyboard the base octave corresponds to the 'C' key. To change the base octave you use the up and down arrows while holding down the <SHIFT> key. The Symphony 12 synthesizer can play notes only up through the eighth octave so that if you are using the 2 1/2 or 4 octave keyboards you can set the octave so that the upper keys (higher notes) are invalid. This cannot happen with the COCO keyboard as it only extends one octave above the base. It is recommended that you do not set the base octave higher than 6 for the 2 1/2 octave keyboard and 5 for the 4 octave keyboard.

THE VOLUME:

The volume can be controlled while playing by using the 'I' and 'Y' keys. The 'I' key will increase the volume up to a maximum of 30, whereas the 'Y' key will decrease the volume down to a minimum of 0 (no volume). The 'I' and 'Y' keys must be pressed (tapped) for each increase or reduction to take place. When you choose volume level above 30 the volume will be controlled by the envelope registers. The shape and frequency of the envelope are discussed below. When the envelope controlled volume is chosen 'EC' will be displayed as the volume.

THE ENVELOPE:

Figure 7 is a diagram showing the shapes that you can obtain from the envelope register. The volume will follow the graphic representation, getting louder when the line rises and getting softer when when the line goes down. I have made an attempt to remind you what the general shape of the envelope is. On the second line of the information screen (CRT) the envelope parameters are displayed. The number corresponds to the shape that is selected, followed by a rough graphic decription of that shape. You change the envelope shape by using the 'A' and 'Q' keys to go from shape '0' (piano like) to 15. Shapes 1,2, and 3 are all like 0 and are not shown. Likewise, shapes 5,6, and 7 are identical to shape 4. Any sound that is modulated by the envelope will follow this shape. When playing through the keyboard only one value of the envelope register is valid. This shape will be used for all 12 voices and noise registers.
The period of the envelope is controlled by the left and right arrows when the [SHIFT] key is depressed. The period is a 16 bit value and can range from 1 to about 64000. The frequency increases as the period decreases so that a low period (say 200) will give a high frequency of 'beats' (if using a repeat shape). A high period will space the 'beats' out over a longer time. The program is designed so that when making adjustments the period will change faster as the period gets higher.

SPECIAL FUNCTIONS:

One big advantage of using a computer to control the tone generation is that we have a lot of options for varying the information that goes to the sound chips. We can 'bend' the note up or down by using the [CLEAR] key. Press a note and then press the [CLEAR] key. The pitch will go up. If you press the [SHIFT] and [CLEAR] keys together the pitch will go down. The value in the sound period registers will be adjusted accordingly and shown on the screen near the bottom left of the information screen. Three keys are used to toggle the sound, noise and rhythm on and off. The [SHIFT] and the '*' when pressed together will toggle the sound on and off. The [SHIFT] and '-' key will toggle the rhythm on and off. The [SHIFT] and '+' keys will toggle the noise on and off. If the noise is on you cannot turn the rhythm on and vice-versa.

THE NOISE:

Noise can be used to accompany the sound so that it takes on a breathy quality or it can be used for special effects. When the noise is turned on with the [SHIFT] '-' keys the noise will be set to the current volume level of the sound registers. Volume levels from 0 to 32 (EC) (envelope control) are possible. Noise will only be on while a note key is being pressed or if a recurring envelope control pattern is selected. A low volume level for noise will give the best effects if you want to be subtle. The noise period is controlled by the left and right arrows. The range of the noise period is from 1 to 32. Experiment with different settings for the volume and period.

THE RHYTHM:

When rhythm is turned on one noise register is activated with the volume controlled by the envelope register. To set up a metronome you would set the envelope register to a repeating pattern. The 'rhythm' will then follow this pattern. If the sound volume is set at envelope control the rhythm 'beat' may be reset if you play more than 3 notes simultanuously. This is because the same envelope registers are used for the percussion effect of the notes and the rhythm effect. If a volume level of 30 or below is used for the sound, the rhythm should not be affected by note keystrokes. If rhythm is on while a recording is made (discussed below), the timing may be off when played back.

SAVING INSTRUMENT SETTINGS:

After playing around with SYMPHONY XII you will find some particular combinations of the registers that you will find particularly useful. You have the ability to save those settings for immediate recall. When you have found the voice settings that you want to save just press the '@' key. You will be prompted for a number from 1 to 9. The new settings will be saved under this number and can be recalled at any time by pressing this number. The zero (0) key is reserved for the default values. If after pressing '@' you do not wish to save the settings, just hit the <BREAK> key. This technique can be used to quickly jump from instrument to instrument or octave to octave. You will also need to use this method in order to set up individual voices for playing MUSICA files with 4 unique and separate instruments. This will be discussed later.

RECORDING AND PLAYBACK:

You want to make your own recordings! That's easy. When you are ready to start recording just press the 'R' key. You will now be confronted with a decision. There are two ways in which you can make recordings. If you want to record everything that you enter as is, including instrument changes, frequency changes, note bending.. all the doodahs.. then you should record using the Symphony mode. This will record 12 voices and will play back your composition as recorded. Try this method first.

While you are recording the 'RECORDING' message will be on the bottom of the screen. When you want to stop recording press the 'E' key to end. Playback of a SYMPHONY recording is even easier. Just press the 'P' key and sit back and listen. If it wasn't quite what you wanted you can just press the 'O' to stop the playback ('O' is for over). While playback is on the 'PLAYBACK' message will be displayed.

You can record over and over again. Each time you record you wipe out the last recording.

RECORDING/CREATING A MUSICA FILE:

To record a MUSICA file you would press the 'R' then press the 'M' when prompted. You will then be asked to choose between 4 levels of sensitivity. What this means can best be understood by experimenting. A sensitivity of '0' will record EVERY key press. The smallest note that can be in a MUSICA file is a 1/64th note so that any momentary pressing or releasing of a key will result in a new chord being generated. If you are playing more than 1 or 2 notes at a time this could get to be too much and the recording will be bogged down. A sensitivity level of '4' is the other extreme. Quick note changes may not be recorded. The sensitivity to use depends on the type of music being recorded. A sensitivity of '1' is the most generally satisfactory level.

When a MUSICA file is recorded the volumes for each of the voices does not reflect the current level shown on the information screen. A "normal" MUSICA voice will be created. (9:95130010)

If you wish to change the volume & harmonics parameters, you must use the MUSICA program and reset them using the 'G' command. This will be discussed further in the next section.

PLAYING A MUSICA FILE:

To play back a MUSICA recording, whether just recorded or loaded in by file, you press the 'W' key. Being used to questions and choices by now, you will not be surprised to see the prompt.

VOICE - [M]US [S]YM [I]ND

Pressing 'S' will allow you to change the instruments and other parameters while the tune is playing. All four voices will be controlled by the parameters on the display screen, change them and you change the voices.

Pressing 'M' will hand control of the voices to the MUSICA file. The volume of each voice will be obtained from the 'G' command of the MUSICA file. See your MUSICA manual for details on the 'G' command which assigns timbre and volume to each voice. SYMPHONY XII will recognize the first three harmonics of each voice and set the volumes accordingly. The volume of each harmonic is determined by the number before the ':' (master volume) multiplied by the appropriate harmonic level, then scaled to meet the requirements of SYMPHONY XII. If, for instance a voice had a volume & timbre in MUSICA notation of 9:96343521 it would be played with the 1st harmonic at volume 20, second harmonic at volume 12 and the third harmonic at volume level 6.

To get Envelope Controlled volume in a MUSICA file you must have the result of multiplying the master volume and the harmonic contribution greater than or equal to 128. For a master volume of '9' only a harmonic level of 'F' will produce Envelope Controlled volume. Yes you can use hexadecimal in MUSICA. (0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F A=10,B=11,C=12,D=13,E=14,F=15). eg. 9:F0000000 would create a voice with only the first harmonic and at an Envelope Controlled volume. Depending on the Envelope Period it could sound like a piano, harpsichord, chimes or others.

When playing MUSICA files, SYMPHONY XII will recognize repeat bars, tempo changes, voice changes (MUSICA 'C' command) and as mentioned before the 1st, 2nd and 3rd harmonics of each of the four possible voices.

To stop a MUSICA playback before it has ended you must press the [SHIFT] and '0' key at the same time. This is true whether you are in the SYMPHONY XII program or in BASIC. If you leave the program while a MUSICA file is playing it will continue playing in the background and allow you to do other things. You must not load another M/L program and you should not do a CLEAR or PCLEAR command.

You can play a MUSICA file from BASIC by following this procedure.

1. CLEAR &H200,~~&H22F0~~ &H21F0
2. LOAD "SYMPHONY"
3. DEFUSR1~~=&H230E~~ &H220E
4. LOAD in MUSICA file.
5. X$=USR1(A$) to play the MUSICA file.
   (A$ and X$ are not important.)
6. To stop the music you must press the <SHIFT> key and '0' at the same time.

The third method for playing back a MUSICA file is by using individual voices/instruments. [I]ND.

CREATING & USING INDIVIDUAL VOICES:

Sometimes it would be preferable to have the 4 MUSICA voices played as separate instruments. To accomplish this you must first assign the instruments to each voice. The instrument that is assigned to any voice must first exist as a saved instrument. If you want to use an instrument different from the ones already existing you must first create it with the '@' command and assign it to any instrument 1 through 9. After you have created or called the appropriate instrument you proceed by pressing the 'U' key. You will now be asked to which voice you want to assign the intrument. After that you will be prompted for relative volume levels (0-8) of each harmonic. The levels are multiplied by 4 prior to assigning them to volumes, therefore a '0' would be no volume, a '6' would be a volume of 24 (normal) and a '8' would be converted to Envelope Controlled volume (32). You can assign the same instrument to all 4 voices or you can create and assign four unique voices. The only attributes of an instrument that will be assigned to a voice are the noise frequency, envelope shape and period and the volume levels that you assign. Factors like Rhythm and Noise on/off are controlled at play time through the keyboard.

If you are interested in printing sheet music of your creations ,editing the recording or enhancing the voices you should use the Musica recording method. In the Musica mode you will be limited to recording a maximum of 4 voices with no record of octave changes, note bending etc. Only note changes will be recorded. The MUSICA recording mode is the recommended mode for music development.

SAVING INSTRUMENT SETTINGS AND RECORDINGS TO DISK OR TAPE :

To save your tunes along with the instrument settings you return to the main menu by pressing the <BREAK> key. Once at the main menu you will see the options available.

1. SYNTHESIZER
2. LOAD RECORDING
3. SAVE RECORDING
4. BACK TO BASIC
5. DISK DIRECTORY (DISK ONLY)

Menu choice 1 gets you into the main program.

Menu choice 2 allows you to load in previously recorded work from disk or tape. If you choose a SYMPHONY file the instrument settings will be loaded in at the same time.
If you are using disk, be sure that the file is on the disk. If you are using tape, be sure that the file is on the tape and that you are positioned before the file. You will be prompted for the file type. Choose 'S' for SYMPHONY files or "M" for MUSICA files.

If you have created a new set of instruments and wish to keep them, you should save them before loading in a new SYM file. To insure that you are saving only the instruments, you should record a null SYMPHONY file. That is, in the Synthesizer mode, press the 'R' key, then the 'S' key. Then immmediately press the 'E' key. You have now recorded a SYN file with only the instruments saved.

Menu choice 3 allows you to save the current recording and the instrument settings. If there is no recording present and you have chosen SYMPHONY files then it will save only the instrument settings. When saving a file you must save the correct format. If you have just recorded in MUSICA format then you must save a MUS file. SYN files and MUS files cannot be stored in memory at the same time as they use the same space. You must therefore save in the format that you just recorded.

For the same reason you should not load a file in if you want to save a current recording that has not been saved. Always save recordings before loading in any other files. The only exception to this would be the loading of a .SYM file that contained only instrument information. If using disk be careful not to name the file the same as an existing .SYM or .MUS file as it will replace the old file. For tape users, be sure that the RECORD and PLAY button are depressed before saving the file.

For choices 2 and 3 you will be prompted for a file name. The name must be no more than eight characters with no spaces, slashes, commas, quotes or periods. You can precede the file name with the drive number for loading and saving from multiple drives. (eg 1:VIVALDI)

Menu choice 4 will take you back to BASIC.

For disk users menu choice 5 will show all SYMPHONY XII and MUSICA recordings on the drive specified. SYMPHONY XII recordings will have the extension SYM. MUSICA files will have the extention .MUS. Do not use the extension when asked for a filename, SYMPHONY XII will provide it automatically based on your reply to the earlier prompts.

Press the SHIFT and @ key to stop the directory as in BASIC. After the directory is shown the default drive is set to the drive chosen. Files from this drive can now be accessed without a leading drive number. For example, if you asked for a directory of drive 2, you could now load in .SYM and .MUS files from drive 2 by giving only the file name. Files from drive '0' must now be preceded by 0:. eg 0:VIVALDI.

GENERAL COMMENTS :

Have fun with the program and don't be afraid to try any combinations. If you get the opportunity, play the music through a good speaker or component stereo. The real lows and highs that characterize synthesizer music will have a chance to be heard. If you did not purchase the piano keyboard and the MUSICA program, we highly recommend that you do. It is with these additional tools that you can fully explore the potential of computerized music.

If you do not have MUSICA and would like to hear a variety of compositions, you can get a selection of MUSICA LIBRARY from SPEECH SYSTEMS. Over 500 songs are available on disk for your entertainment and experimentation.

KEYBOARD SUMMARY:

KEYS	FUNCTION
[SHIFT] plus Up and Down Arrows :	Change Base Octave.
Left and Right Arrows :	Change Noise Period.
[SHIFTED]	Change Envelope Period.
'Q' and 'A' :	Change Envelope Shape.
'R' and 'E' :	Start and end Recording.
'P' and 'O' :	Start and end Playback. (Symphony Files)
'W' and [SHIFT] 'O':	Start and End Playback. (MUSICA Files)
'I' and 'Y' :	Increase and decrease Volume. Level 32 (EC) is Envelope controlled.
'1' through '9' :	Recall Instrument settings.
'@' then '1' through '9':	Save Instrument settings.
'U' :	Assign Individual Voices.
'T' :	Toggle between COCO & Piano Keyboards.
[SHIFT] plus '*' :	Toggle Sound On/Off.
[SHIFT] plus '-' :	Toggle Rhythm On/Off. **
[SHIFT] plus '+' :	Toggle Noise On/Off. **
[CLEAR]:	Decrease note period (higher note).
[SHIFT] plus [CLEAR] :	Increase note period (lower note).
<BREAK> :	Return to Menu.
'ZSXCFVGBNJMK,L./'	The Notes. (COCO keyboard)

** Note that Noise and Rhythm cannot both be on at the same time.

Enjoy

Frank Delargy

Frank Delargy

SOUND PROCESSOR

SYMPHONY 12 was intended for music, however, it is a powerful device to inable you to create sound effects. The following section describes SOUND, a program that is limited mostly by your imagination. Should you develop some sound effects and would like to share them, send them and we will distribute them.

***** SOUND XII *****
* sound processor for SYMPHONY 12 *

OVERVIEW:

The SOUND XII program is a sound command processor which will allow you to directly control all facets of each of the 12 voices of SYMPHONY 12. You will be able to control factors such as pitch, note length, noise frequncy, envelope period and envelope shape as well as other features of the 4 AY8912 chips in the SYMPHONY 12 unit. To accomplish all this you need only create strings of commands that yo pass to the command processor through easy to use USR calls.

To get a feel for how some of the more simple sound and music effects possible RUN the DEMO program. For disk you merely type : RUN "DEMO"

After the program has started it will display a menu. Hit one of the keys from 1 to 9 to hear a variety of special effects.

THE COMMANDS:

The first letter of all commands define the action to be taken.

Examples of commands are:

LETTER	ACTION
R	Stop all sounds (RESET)
I	Interrupt any previous command string and do this one immediately.
X	End of command line.
P	Pause for specified duration.
W	Wait for specified duration.
O	Set Octave.
T	Set Tempo.
A,B,C,D,E,F,G	Notes
V	Set Volume
N	Set Noise Period.
S	Set Envelope Period.
L	Load Sound Register Directly.
Z	Turn Noise On or Off.

Most of the commands need qualifiers.
(ie. what voice and what value.)

A more detailed explanation of the commands follows.

R - Stop all sounds.
Resets volumes to zero and turns off all voices.
[A$="R": X$=USRO(A$)]

I - Interrupt any onging commands and process this line.
This must be the first command in a command string.
Use this command to insure that sounds are synchronized with other events.
[A$="I,..other commands ..":X$=USRO(A$)]

X - Signals end of command string.
Nothing beyond this on same line will be processed.
Optional but recommended at end of each command string.
[A$="..commands,..,X":X$=USRO(A$)]

P,n - Pause for duration specified by n.
Turns off volume for specified time before going on to next command.
n is, in musical terms, the length of a note.
Useful values of n are 1,2,4,8,16 & 64.
Values correspond to whole note, half note ... to 1/64 note.
[A$="...,P8,...,P2,.."]

W,n - Wait for duration similar to Pause command.
As with Pause the actual time depends on the current value of Tempo.
Hold all volumes etc. at current level and then continue.
[A$="....,W4,...,W16,.."]

O,n - Set Octave at value n.
Valid values of n are 1 to 7.
All notes are played in current Octave.
To play note in other octave you must first change the octave.
[A$="...,O,3,..."]

T,n - Change tempo to value of n.
This is similar to tempo command in the PLAY statement of extended BASIC.
Valid values are 1 to 255.
1 is very slow and 255 is very fast.
8 is default value.
[A$="...,T,16,..."]

Note,v - Play note in voice v.
Valid values for voice are 1 to 12.
Valid notes are A,B,C,D,E,F & G.
To play a sharp you follow the note with '#' or '+'.
To play a flat you follow the note with '-'.
If the voice is not supplied it is assumed to be VOICE 1.
examples C#,2 D-,11 G A- E,1

V,v,n - Set volume of voice v at value n.
Valid values of v are as before 1 to 12.
Valid values for volume (n) are 0 to 31.
See separate discussion on volume levels.
[V,10,0 V,1,31 V,9,15]

N,v,n - Set Noise period of voice v to value n.
Valid values of n are 1 to 31.
Since there is only one Noise register for each chip compared to 3 Sound (Voice) registers, changing the period of any voice in a chip will change the other two as well.
ie. If you change voice 1 you also affect voices 2 and 3.

CHIP #1 Voices 1, 2 & 3
CHIP #2 Voices 4, 5 & 6
CHIP #3 Voices 7, 8 & 9
CHIP #4 Voices 10, 11 & 12

[A$="...,N,3,15,..."]

S,v,n - Set Volume Envelope register of voice v to value n.
Valid values of n are 1 to 65536.
This changes the value in the single envelope register in each chip.
Use the preceeding list to see which voices are affected by setting adjacent voices.
The Envelope register, when activated attenuates the volume according to a specified pattern.
The envelope register is in control of the volume for volume levels above 15.
See section 3.5 of appendix A for details on the Envelope Register.
[S,3,42000 S,11,200]

L,v,n - Load value n directly into sound register of voice v.
Valid values of n are 1 to 4096.
Each voice can be controlled seperately.
Values are loaded into registers 0 to 5 of each chip.
See section 3.1 in Appendix A. (Tone Generators Control)
[L,1,300 L,12,3895 L,12,2]

Z,v,Y - Turn Noise on for voice v.
Z,v,N - Turn Noise off for voice v.
Y = Yes N = No

STRINGING COMMANDS TOGETHER:

Commands can be put together to form a string.
For example: A$="V,1,9 C,1 W,8 R X "

When sent to the string processor this string will set the volume of voice 1 to 9, play the note C (in octave previously set), wait for 1/8 note then stop all sounds.

A$="V,1,9 C W8 P8 C W8 S X"
will play the note 'C' twice with a pause in between. Notes and pause are 1/8 note length. Notice that no voice was stated with the 'C' note. It therefore defaults to voice 1. This provides a degree of compatability with EXTENDED BASIC's PLAY command. Since there is more than one voice, unlike BASIC, we must wait until a WAIT (W) is in the command string to hold the note. Otherwise, only one note at at time could be played.

Commands and command parts are generally seperated with a comma, semicolen or a space. If there is no ambiguity in the string, the comma, semicolen and space are not needed. When the command processor expects the command to be over it will accept a new command immediatelly.
For example A$="V1,9CW8PCW8SX" is equivelent to the previous command string.

Notice that a comma WAS needed between the voice and the volume level in the 'V' command. This is because the command processor would get confused if it got 19 as a voice and C as a volume level. This abbreviated method can reduce the amount of typing and also reduce the amount of string memory used by any program using the sound effects.

ABOUT VOLUME:

The volume of each voice can be controlled seperately. The The tone (sound) and the noise for each voice use the same volume. There are 16 levels of fixed (steady) volume, 0 through 15. Zero volume is no volume and a volume of 15 is maximum. Volume levels above 15 are not constant. They are controlled by the Envelope period and have different shapes. Figure 7 in appendix A shows the different shapes that can be controlled by the envelope registers. The volumes in the left column are the values of n in the V,v,n command that correspond to the appropriate envelope shape.
The period of the cycle is determined by the contents of the Envelope Period register for each chip. This is set by the S,v,n command. The larger the Envelope period value, the longer it takes to repeat the cycle or to decay, etc. To get a better

understanding of the registers of the AY8912 we recommend that you read through the material in appendix A.

The program DEMO supplied on the disk shows several examples of how easy it is to create sound effects using the sound processor. Use the DEMO program as a guide in developing your own BASIC programs with sound effects and music.

To use the SOUND program, use the following procedure:

```
CLEAR 200,&H75FF :'reserve &H7600 to &h7ZFFF for M/L program.
LOADM "SOUND" : 'Load in M/L program
DEFUSR0=&H7600 : 'Set the USR0 value to &H7600
'Now construct a command string.
A$="V1,9 C W4 D W4 E W4 F5 W4 P2 X"

'Then call USR0 with A$
X$=USR0(A$)
```

The sound will be generated in the background while your program continues. It does this by using interrupts. When the command string has been coimpleted the sound processor is ready for another string. If you send another string right before the last one has finished, the program will wait until it can complete the USR call. To insure immediate response to sound commands, start the command string with an 'I'.

An example of its use might be :

```
A$="I D W2 A W2 P2 X"
```

This will interrupt any current string that is being played and immediately begin this one.

The DEMO program listing is provided so that you can see the effects of using many different types of command strings. Feel free to use change it , but be sure to make backup copies of all of the programs on the disk.

I hope that you enjoy using the SYMPHONY 12 SYNTHESIZER and we look forward to your comments for further applications.

symphony 12 (speech systems)

```
10 'demonstration program for
20 'sound cartridge version 1.0
30 'copyright DEL software 1985
40 'written by frank delargy
50 'last update aug 27th, 1985
60 PCLEAR4:CLEAR400,&H75F0:CLS
70 IF PEEK(&H7E00)=&H55 THEN 90
80 LOADM"SOUND":LOADM"SPACEY.PIC":DEFUSR0=&H7600
90 GOSUB 190:'  menu sub
100 SCREEN 0,1:'pink screen
110 NU$=INKEY$:IF NU$="" THEN 110 ELSE NU=VAL(NU$)
120 IF NU$="0" THEN 170
130 IF NU>9 THEN 110
140 PRINT@491,"   WAIT   ";
150 ON NU GOSUB 370,520,650,730,800,850,1340,950,1120
160 NU=0:GOTO90
170 CLS:END
180 '
190 'menu display
200 A$="R":X$=USR0(A$):CLS0
210 PRINT@132,"<1> WOLF WHISTLE          ";
220 PRINT@164,"<2> RACECAR               ";
230 PRINT@196,"<3> LASER (PACMAN)        ";
240 PRINT@228,"<4> WHISTLING BOMB        ";
250 PRINT@260,"<5> BOMB WITH EXPLOSION ";
260 PRINT@292,"<6> EXPLOSION             ";
270 PRINT@324,"<7> BACH ONE LINER        ";
280 PRINT@356,"<8> STEAM TRAIN           ";
290 PRINT@388,"<9> SPACEY SOUNDS         ";
300 PRINT@420,"<0> BACK TO BASIC         ";
310 PRINT@491,"CHOOSE ONE";
320 PRINT @10,"SOUND DEMO";
330 PRINT @69,"(C) DEL SOFTWARE, 1985";
340 RETURN
350 '
360 'whistle sound effect
370 A$="N2,122YV1,15V2,9X":X$=USR0(A$)
380 FOR X=64 TO 32 STEP -2
390 A$="L1"+STR$(X)
400 X$=USR0(A$):NEXT X
410 FOR X=1 TO 150:NEXT
420 FOR X=64 TO 48 STEP -2
430 A$="L1"+STR$(X)
440 X$=USR0(A$):NEXT X
450 FOR N=1 TO 100:NEXT
460 FOR X=48 TO 96 STEP 2
470 A$="L1"+STR$(X)
480 X$=USR0(A$):NEXTX
490 RETURN
```

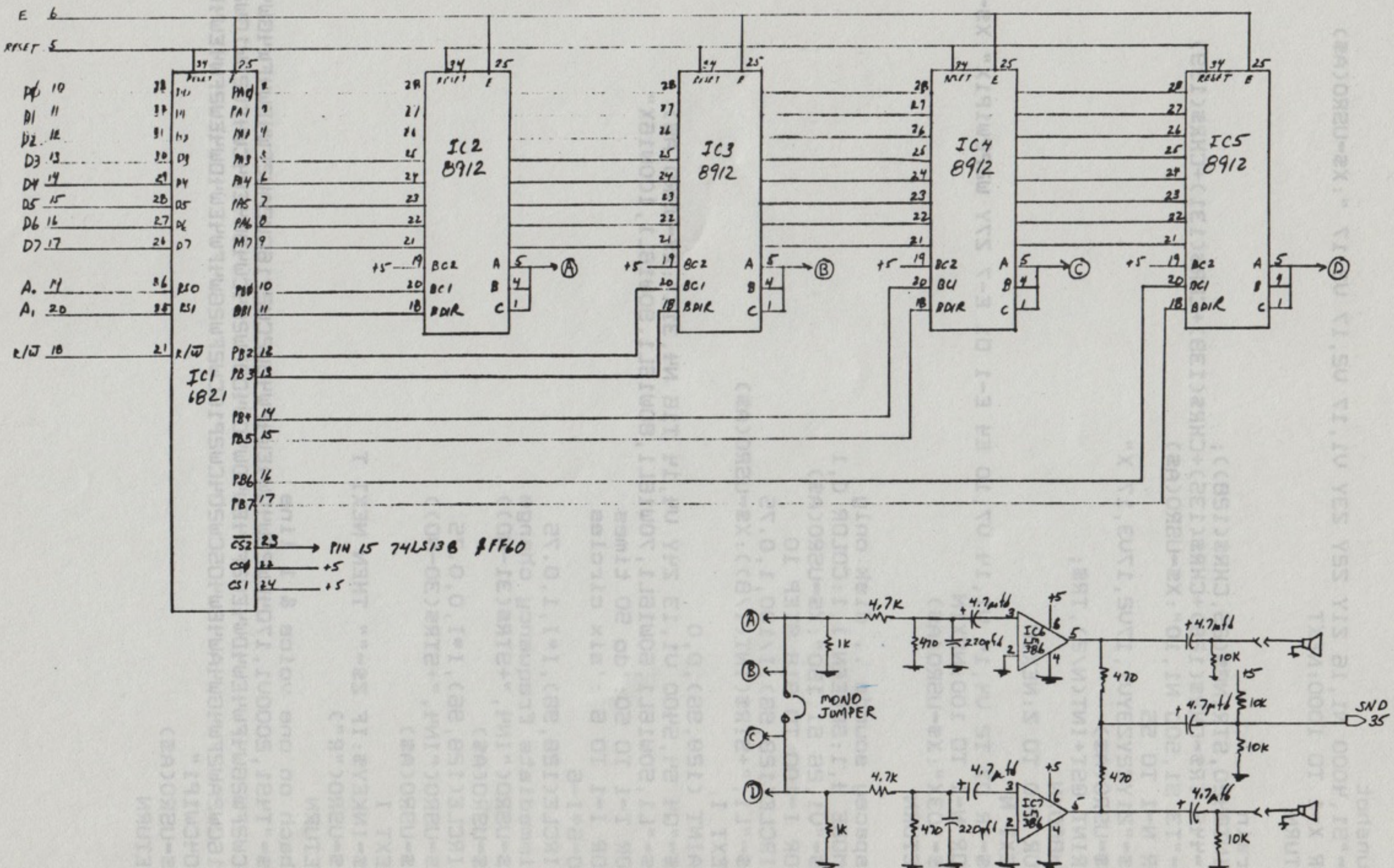
```
500 '
510 'Race car sound effect
520 A$="L2,3835 V1,15 V2,10":X$=USRO(A$)
530 FOR X=11*256 TO 4*256 STEP -8
540 A$="L1"+STR$(X):X$=USRO(A$)
550 NEXT X
560 FOR X=9*256 TO 3*256 STEP -8
570 A$="L1"+STR$(X):X$=USRO(A$)
580 NEXT X
590 FOR X=6*256 TO 2*256 STEP -8
600 A$="L1"+STR$(X):X$=USRO(A$)
610 NEXT X
615 FOR N=1 TO 2000:NEXT
620 RETURN
630 '
640 'pacman or laser sound
650 A$="V1,14":X$=USRO(A$):'set up voice 1 volume
660 FOR A=0 TO 25
670 FOR B=50 TO 100 STEP 10
680 A$="L1"+STR$(B)
690 X$=USRO(A$)
700 NEXT B,A
710 RETURN
720 '
730 'whistling bomb sound effect
740 A$="V1,15":X$=USRO(A$)
750 FOR X=30 TO 200
760 A$="L1"+STR$(X):X$=USRO(A$)
770 NEXT
780 RETURN
790 '
800 'bomb with explosions"
810 GOSUB 730
820 GOSUB 850
830 RETURN
840 '
850 'explosion
860 A$="S1,14300 N1,31 V1,17 Z1Y V2,17 Z2Y V3,17 Z3Y":X$=USRO(A$)
870 FOR X=1 TO 250:CLS RND(8):NEXT
880 RETURN
890 '
```

```
900 'gunshot
910 A$="S1,4000 N1,16 Z1Y Z2Y Z3Y V1,17 V2,17 V3,17 ":X$=USR0(A$)
920 FOR X=1 TO 1000:NEXT
930 RETURN
940 '
950 'train
960 PRINT@420,STRING$(25,CHR$(128));
970 ST=448:TR$=CHR$(128)+CHR$(135)+CHR$(139)+CHR$(131)+CHR$(139)
980 A$="T3 S1,500 N1,10":X$=USR0(A$)
990 FOR N=1 TO 55
1000 A$="Z1YZ2YZ3YV1,17V2,17V3,17 X"
1010 X$=USR0(A$)
1020 PRINT @ST+INT(N/2),TR$;
1030 Z=800/N
1040 FOR M=0 TO Z:NEXTM
1050 NEXT N
1060 A$="R O7 T2 V4,14 V1,14 V7,10 E4 E-1 O1 E-7 Z7Y W2P2W1P1X":X$=USR0(A$)
1080 FOR N=1 TO 100:NEXTN
1085 A$="O3X":X$=USR0(A$)
1090 RETURN
1100 '
1110 'spacey sounds .. disk only
1120 PMODE 4,1:SCREEN 1,1:COLOR 0,1
1130 A$="V1,26 S1,150":X$=USR0(A$)
1140 FOR I=100 TO 518 STEP 10
1150 CIRCLE(128,96),I/100,1,0.75
1160 A$="L1,"+STR$(INT(I/8)):X$=USR0(A$)
1170 NEXT I
1180 PAINT (128,96),0,0
1190 A$="Q4 S4,5400 V1,13 Z4Y V4,14 T16 N4,31X":X$=USR0(A$)
1200 A$="L1,50W16L1,60W16L1,70W16L1,80W16L1,90W16L1,100W16X"
1210 FOR T=1 TO 50:'do 50 times
1220 FOR I=1 TO 6 :'six circles
1230 NO=6*I-6
1240 CIRCLE(128,96),I*I,1,0.75
1250 'immediate frequency change
1260 X$=USR0("IN4,"+STR$(31-NO))
1270 X$=USR0(A$)
1280 CIRCLE(128,96),I*I,0,0.75
1290 X$=USR0("IN4,"+STR$(30-NO))
1300 X$=USR0(A$)
1310 NEXT I
1320 Z$=INKEY$:IF Z$="" THEN NEXT T
1325 X$=USR0("R")
1330 RETURN
1340 'bach on one voice & 1 line
1350 A$="T4S1,2000V1,17O4GW2CW4DW4EW4FW4GW2CW2P16CW2AW2FW4EW4FW4GW4AW4BW4O5CW2O4
CW2P16CW2FW2GW4FW4EW4DW4EW2FW4EW4DW4CW4O3BW2O4CW4DW4EW4CW4EW2DW1GW2CW4DW4EW4FW4G
W2CW2P16CW2AW2FW4GW4AW4BW4O5CW2O4CW2P16CW2FW2GW4FW4EW4DW4EW2FW4EW4DW4CW4DW4EW4FW
2O3BW2O4CW1P1"
1360 X$=USR0(A$)
1370 RETURN
```

ENGINEERING NOTE

SUBJECT	SECTION	PROJECT	SERIAL-CATEGORY	PAGE
SYMPHONY 12				

NAME: R. R. PARRY
DATE: 8/1/85
REVISION DATE:



APPENDIX

ADVANCED PROGRAMMING DATA

The following section is a reprint from the General Instrument technical specifications for the AY-3-8912, the chip that represents the heart of SYMPHONY 12. We included it without any notes of explanations. We trust the reader of this information need no additional help.

3 OPERATION

Since all functions of the PSG are controlled by the host processor via a series of register loads, a detailed description of the PSG operation can best be accomplished by relating each PSG function to the control of its corresponding register. The function of creating or programming a specific sound or sound effect logically follows the control sequence listed:

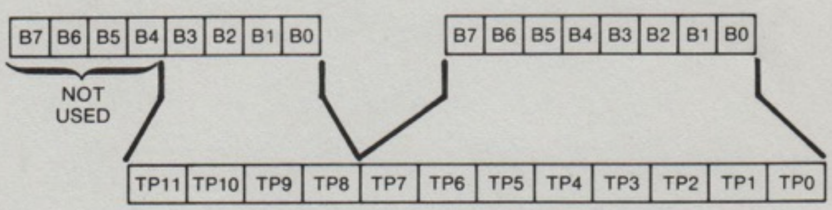
Section	Operation	Registers	Function
3.1	Tone Generator Control	R0--R5	Program tone periods.
3.2	Noise Generator Control	R6	Program noise period.
3.3	Mixer Control	R7	Enable tone and/or noise on selected channels.
3.4	Amplitude Control	R10--R12	Select "fixed" or "envelope-variable" amplitudes.
3.5	Envelope Generator Control	R13--R15	Program envelope period and select envelope pattern.

3.1 Tone Generator Control

(Registers R0, R1, R2, R3, R4, R5)

The frequency of each square wave generated by the three Tone Generators (one each for Channels A, B, and C) is obtained in the PSG by first counting down the input clock by 16, then by further counting down the result by the programmed 12-bit Tone Period value. Each 12-bit value is obtained in the PSG by combining the contents of the relative Coarse and Fine Tune registers, as illustrated in the following:

Coarse Tune Register	Channel	Fine Tune Register
R1	A	R0
R3	B	R2
R5	C	R4



12-bit Tone Period (TP) to Tone Generator

Note that the 12-bit value programmed in the combined Coarse and Fine Tune registers is a period value—the higher the value in the registers, the lower the resultant tone frequency.

Note also that due to the design technique used in the Tone Period count-down, the lowest period value is 000000000001 (divide by 1) and the highest period value is 111111111111 (divide by $4{,}095_{10}$).

The equations describing the relationship between the desired output tone frequency and the input clock frequency and Tone Period value are:

$$\text{(a)}\quad f_T = \frac{f_{CLOCK}}{16TP_{10}} \qquad \text{(b)}\quad TP_{10} = 256CT_{10} + FT_{10}$$

Where: f_T = desired tone frequency
f_{CLOCK} = input clock frequency
TP_{10} = decimal equivalent of the Tone Period bits TP11--TP0.
CT_{10} = decimal equivalent of the Coarse Tune register bits B3--B0 (TP11--TP8)
FT_{10} = decimal equivalent of the Fine Tune register bits B7--B0 (TP7--TP0)

From the above equations it can be seen that the tone frequency can range from a low of $\frac{f_{CLOCK}}{65{,}520}$ (wherein: $TP_{10}=4{,}095_{10}$) to a high of $\frac{f_{CLOCK}}{16}$ (wherein: $TP_{10}=1$). Using a 2 MHz input clock, for example, would produce a range of tone frequencies from 30.5 Hz to 125 kHz.

To calculate the values for the contents of the Tone Period Coarse and Fine Tune registers, given the input clock and the desired output tone frequencies, we simply rearrange the above equations, yielding:

$$\text{(a)}\quad TP_{10} = \frac{f_{CLOCK}}{16f_T} \qquad \text{(b)}\quad CT_{10} + \frac{FT_{10}}{256} = \frac{TP_{10}}{256}$$

Example 1: $f_T = 1\text{kHz}$
$f_{CLOCK} = 2\text{MHz}$

$$TP_{10} = \frac{2\text{x}10^6}{16(1\text{x}10^3)} = 125$$

Substituting this result into equation (b):

$$CT_{10} + \frac{FT_{10}}{256} = \frac{125}{256}$$

$$\therefore CT_{10} = 0 \qquad = 0000 \text{ (B3--B0)}$$
$$FT_{10} = 125_{10} = 01111101 \text{ (B7--B0)}$$

Example 2: $f_T = 100\text{Hz}$
$f_{CLOCK} = 2\text{MHz}$

$$TP_{10} = \frac{2\text{x}10^6}{16(1\text{x}10^2)} = 1250$$

Substituting this result into equation (b):

$$CT_{10} + \frac{FT_{10}}{256} = \frac{1250}{256} = 4 + \frac{226}{256}$$

$$\therefore CT_{10} = 4_{10} = 0100 \text{ (B3--B0)}$$
$$FT_{10} = 226_{10} = 11100010 \text{ (B7--B0)}$$

3.2 Noise Generator Control

(Register R6)

The frequency of the noise source is obtained in the PSG by first counting down the input clock by 16, then by further counting down the result by the programmed 5-bit Noise Period value. This 5-bit value consists of the lower 5 bits (B4--B0) of register R6, as illustrated in the following:

Noise Period
Register R6

B7	B6	B5	B4	B3	B2	B1	B0
NOT USED			5-bit Noise Period (NP) to Noise Generator				

Note that the 5-bit value in R11 is a <u>period</u> value—the higher the value in the register, the lower the resultant noise frequency. Note also that, as with the Tone Period, the <u>lowest</u> period value is 00001 (divide by 1); the <u>highest</u> period value is 11111 (divide by 31_{10}).

The noise frequency equation is:

$$f_N = \frac{f_{CLOCK}}{16\ NP_{10}}$$

Where: f_N = desired noise frequency
f_{CLOCK} = input clock frequency
NP_{10} = decimal equivalent of the Noise Period register bits B4--B0.

From the above equation it can be seen that the noise frequency can range from a low of $\frac{f_{CLOCK}}{496}$ (wherein: $NP_{10} = 31_{10}$) to a high of $\frac{f_{CLOCK}}{16}$ (wherein: $NP_{10} = 1$). Using a 2 MHz input clock, for example, would produce a range of noise frequencies from 4 kHz to 125 kHz.

To calculate the value for the contents of the Noise Period register, given the input clock and the desired output noise frequencies, we simply rearrange the above equation, yielding:

$$NP_{10} = \frac{f_{CLOCK}}{16\ f_N}$$

3.3 Mixer Control-I/O Enable

(Register R7)

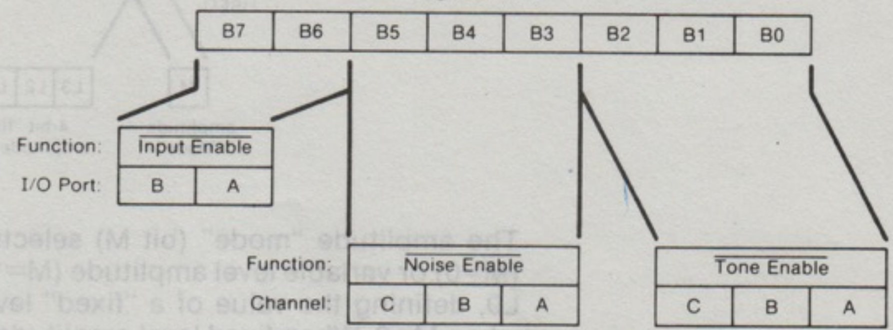
Register 7 is a multi-function $\overline{\text{Enable}}$ register which controls the three Noise/Tone Mixers and the two general purpose I/O Ports.

The Mixers, as previously described, combine the noise and tone frequencies for each of the three channels. The determination of combining neither/either/both noise and tone frequencies on each channel is made by the state of bits B5--B0 of R7.

The direction (input or output) of the two general purpose I/O Ports (IOA and IOB) is determined by the state of bits B7 and B6 of R7.

These functions are illustrated in the following:

Mixer Control-I/O Enable
Register R7



Noise Enable Truth Table:

R7 Bits B5	B4	B3	Noise Enabled on Channel		
0	0	0	C	B	A
0	0	1	C	B	—
0	1	0	C	—	A
0	1	1	C	—	—
1	0	0	—	B	A
1	0	1	—	B	—
1	1	0	—	—	A
1	1	1	—	—	—

Tone Enable Truth Table:

R7 Bits B2	B1	B0	Tone Enabled on Channel		
0	0	0	C	B	A
0	0	1	C	B	—
0	1	0	C	—	A
0	1	1	C	—	—
1	0	0	—	B	A
1	0	1	—	B	—
1	1	0	—	—	A
1	1	1	—	—	—

I/O Port Truth Table:

R7 Bits B7	B6	I/O Port Status IOB	IOA
0	0	Input	Input
0	1	Input	Output
1	0	Output	Input
1	1	Output	Output

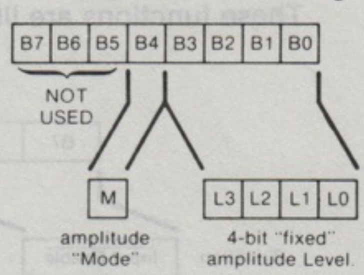
NOTE: Disabling noise and tone does not turn off a channel. Turning a channel off can only be accomplished by writing all zeroes into the corresponding Amplitude Control register, R10, R11, or R12 (see Section 3.4).

3.4 Amplitude Control

(Registers R10, R11, R12)

The amplitudes of the signals generated by each of the three D/A Converters (one each for Channels A, B, and C) is determined by the contents of the lower 5 bits (B4--B0) of registers R10, R11, and R12 as illustrated in the following:

Amplitude Control Register #	Channel
R10	A
R11	B
R12	C



The amplitude "mode" (bit M) selects either fixed level amplitude (M=0) or variable level amplitude (M=1). It follows then that bits L3--L0, defining the value of a "fixed" level amplitude, are only active when M=0. When fixed level amplitude is selected, it is "fixed" only in the sense that the amplitude level is under the direct control of the system processor (via bits D3--D0). Varying the amplitude when in this "fixed" amplitude mode requires in each instance the direct intervention of the system processor via an address latch/write data sequence to modify the D3--D0 data.

When M=1 (select "variable" level amplitudes), the amplitude of each channel is determined by the envelope pattern as defined by the Envelope Generator's 4-bit output E3 E2 E1 E0.

The amplitude "mode" (bit M) can also be thought of as an "envelope enable" bit; i.e., when M=0 the envelope is not used, and when M=1 the envelope is enabled. (A full description of the Envelope Generator function follows in Section 3.5).

The full chart describing all combinations of the 5-bit Amplitude Control is as follows:

Amplitude Control Register #	Channel
R10	A
R11	B
R12	C

B7	B6	B5	B4	B3	B2	B1	B0
NOT USED			M	L3	L2	L1	L0

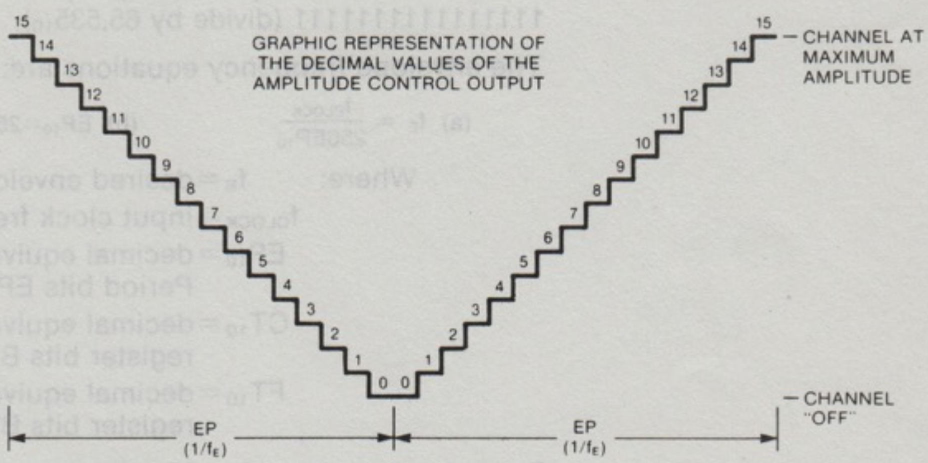
M	L3	L2	L1	L0	Amplitude Control Output				
0	0	0	0	0	*0	0	0	0	The amplitude is fixed at 1 of 16 levels as determined by L3 L2 L1 L0.
.	.	.	.	.	.	.	.	.	
0	1	1	1	1	1	1	1	1	
1	X	X	X	X	E3	E2	E1	E0	The amplitude is variable at 16 levels as determined by the output of the Envelope Generator.

(X=Don't Care)

*The all zeroes code is used to turn a channel "off".

Fig. 6 graphically illustrates a selection of variable level (envelope-controlled) amplitude where the 16 levels directly reflect the output of the Envelope Generator. A fixed level amplitude would correspond to only one of the levels shown, with the level directly determined by the decimal equivalent of bits L3 L2 L1 L0.

Fig. 6 VARIABLE AMPLITUDE CONTROL (M=1)



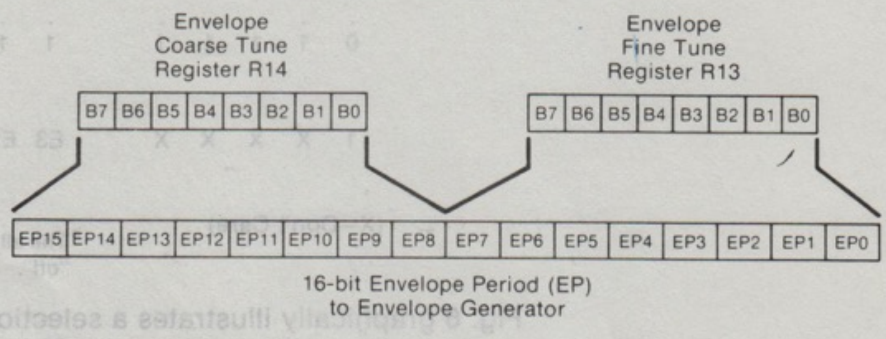
3.5 Envelope Generator Control

(Registers R13, R14, R15)

To accomplish the generation of fairly complex envelope patterns, two independent methods of control are provided in the PSG: first, it is possible to vary the frequency of the envelope using registers R13 and R14; and second, the relative shape and cycle pattern of the envelope can be varied using register R15. The following paragraphs explain the details of the envelope control functions, describing first the envelope period control and then the envelope shape/cycle control.

3.5.1 ENVELOPE PERIOD CONTROL (Registers R13, R14)

The frequency of the envelope is obtained in the PSG by first counting down the input clock by 256, then by further counting down the result by the programmed 16-bit Envelope Period value. This 16-bit value is obtained in the PSG by combining the contents of the Envelope Coarse and Fine Tune registers, as illustrated in the following:



Note that the 16-bit value programmed in the combined Coarse and Fine Tune registers is a period value—the higher the value in the registers, the lower the resultant envelope frequency.

Note also, that as with the Tone Period, the lowest period value is 0000000000000001 (divide by 1); the highest period value is 1111111111111111 (divide by $65{,}535_{10}$).

The envelope frequency equations are:

(a) $f_E = \frac{f_{CLOCK}}{256EP_{10}}$ (b) $EP_{10}=256CT_{10}+FT_{10}$

Where: f_E = desired envelope frequency

f_{CLOCK} = input clock frequency

EP_{10} = decimal equivalent of the Envelope Period bits EP15--EP0

CT_{10} = decimal equivalent of the Coarse Tune register bits B7--B0 (EP15--EP8)

FT_{10} = decimal equivalent of the Fine Tune register bits B7--B0 (EP7--EP0)

From the above equation it can bee seen that the envelope frequency can range from a low of $\frac{f_{CLOCK}}{16{,}776{,}960_{10}}$ (wherein: $EP_{10}=65{,}535_{10}$) to a high of $\frac{f_{CLOCK}}{256}$ (wherein: $EP_{10}=1$). Using a 2 MHz clock, for example, would produce a range of envelope frequencies from 0.12 Hz to 7812.5 Hz.

To calculate the values for the contents of the Envelope Period Coarse and Fine Tune registers, given the input clock and the desired envelope frequencies, we rearrange the above equations, yielding:

(a) $EP_{10} = \dfrac{f_{CLOCK}}{256 f_E}$ (b) $CT_{10} + \dfrac{FT_{10}}{256} = \dfrac{EP_{10}}{256}$

Example: $f_E = 0.5$ Hz

$f_{CLOCK} = 2$ MHz

$$EP_{10} = \frac{2\times10^6}{256(0.5)} = 15{,}625$$

Substituting this result into equation (b):

$$CT_{10} + \frac{FT_{10}}{256} = \frac{15{,}625}{256} = 61 + \frac{9}{256}$$

$CT_{10} = 61_{10} = 00111101$ (B7--B0)

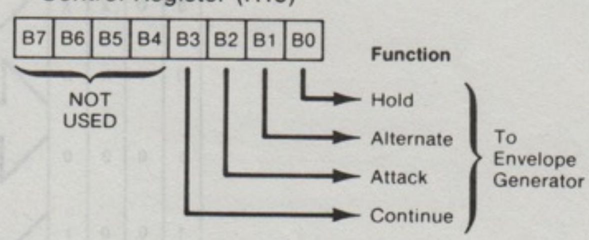
$FT_{10} = 9_{10} = 00001001$ (B7--B0)

3.5.2 ENVELOPE SHAPE/CYCLE CONTROL (Register R15)

The Envelope Generator further counts down the envelope frequency by 16, producing a 16-state per cycle envelope pattern as defined by its 4-bit counter output, E3 E2 E1 E0. The particular shape and cycle pattern of any desired envelope is accomplished by controlling the count pattern (count up/count down) of the 4-bit counter and by defining a single-cycle or repeat-cycle pattern.

This envelope shape/cycle control is contained in the lower 4 bits (B3--B0) of register R15. Each of these 4 bits controls a function in the envelope generator, as illustrated in the following:

Envelope Shape/Cycle
Control Register (R15)



The definition of each function is as follows:

Hold — when set to logic "1", limits the envelope to one cycle, holding the last count of the envelope counter (E3--E0=0000 or 1111, depending on whether the envelope counter was in a count-down or count-up mode, respectively).

Alternate — when set to logic "1", the envelope counter reverses count direction (up-down) after each cycle.

NOTE: When both the Hold bit and the Alternate bit are ones, the envelope counter is reset to its initial count before holding.

3.5 Envelope Generator Control (cont.)

Attack — when set to logic "1", the envelope counter will count up (attack) from E3 E2 E1 E0=0000 to E3 E2 E1 E0=1111; when set to logic "0", the envelope counter will count down (decay) from 1111 to 0000.

Continue — when set to logic "1", the cycle pattern will be as defined by the Hold bit; when set to logic "0", the envelope generator will reset to 0000 after one cycle and hold at that count.

To further describe the above functions could be accomplished by numerous charts of the binary count sequence of E3 E2 E1 E0 for each combination of Hold, Alternate, Attack and Continue. However, since these outputs are used (when selected by the Amplitude Control registers) to amplitude modulate the output of the Mixers, a better understanding of their effect can be accomplished via a graphic representation of their value for each condition selected, as illustrated in Figs. 7 and 8.

Fig. 7 ENVELOPE SHAPE/CYCLE CONTROL

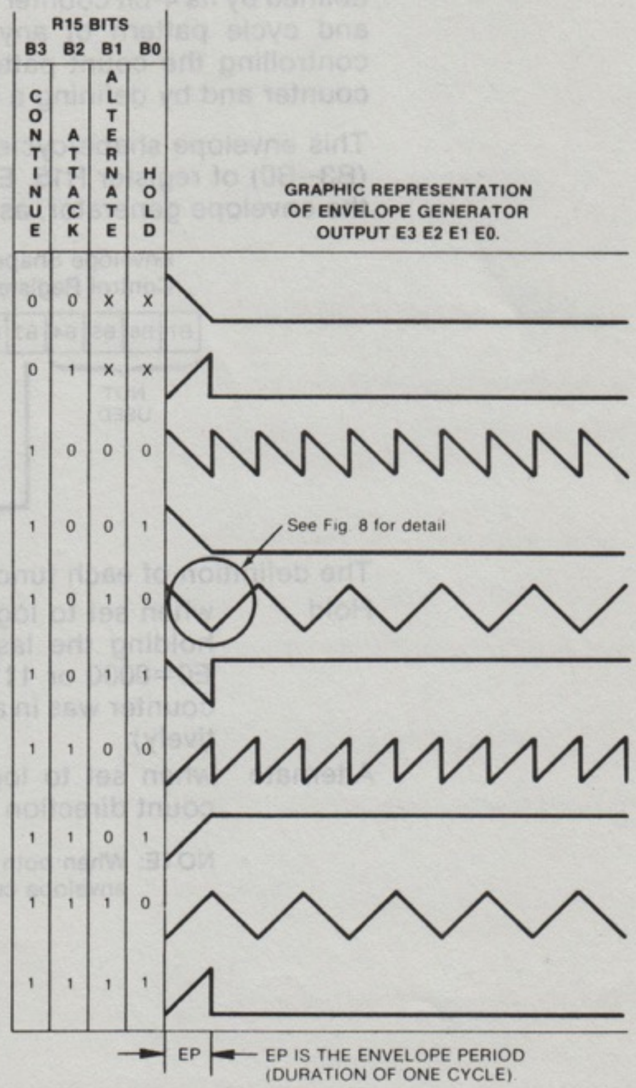
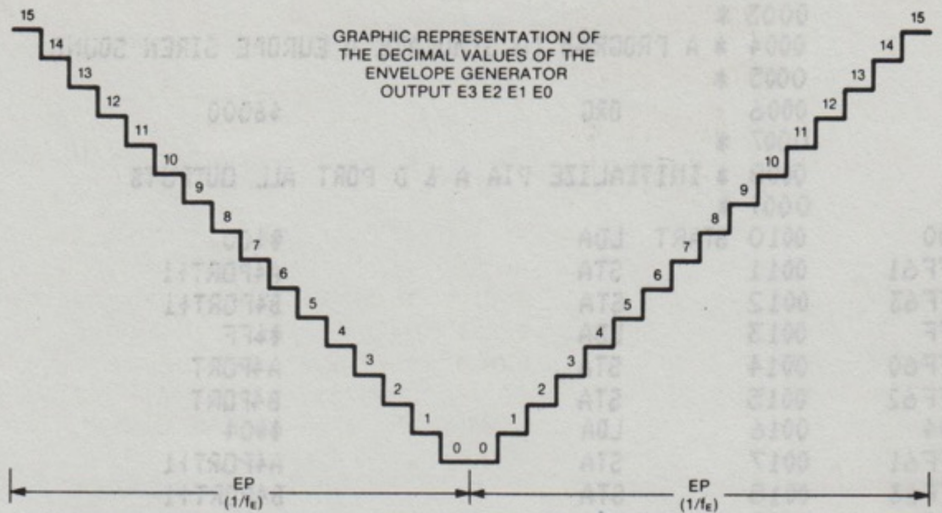


Fig. 8 DETAIL OF TWO CYCLES OF Fig. 7
(ref. waveform "1010" in Fig. 7)



```
FF60              0001 A4PORT EQU           $FF60        SYMPHONY 12 BASE
FF62              0002 B4PORT EQU           A4PORT+2
                  0003 *
                  0004 * A PROGRAM TO SIMULATE A EUROPE SIREN SOUND
                  0005 *
6000              0006        ORG           $6000
                  0007 *
                  0008 * INITIALIZE PIA A & B PORT ALL OUTPUTS
                  0009 *
6000 8600         0010 START  LDA           #$00
6002 B7FF61       0011        STA           A4PORT+1
6005 B7FF63       0012        STA           B4PORT+1
6008 86FF         0013        LDA           #$FF
600A B7FF60       0014        STA           A4PORT
600D B7FF62       0015        STA           B4PORT
6010 8604         0016        LDA           #$04
6012 B7FF61       0017        STA           A4PORT+1
6015 B7FF63       0018        STA           B4PORT+1
6018 8600         0019        LDA           #$00
601A B7FF60       0020        STA           A4PORT
601D B7FF62       0021        STA           B4PORT
6020 7F6089       0022        CLR           COUNT
                  0023 *
                  0024 * COCO INITIALIZATION
                  0025 *
6023 863D         0026        LDA           #$3D
6025 B7FF03       0027        STA           $FF03
6028 863F         0028        LDA           #$3F
602A B7FF23       0029        STA           $FF23
                  0030 *
                  0031 * GLOBAL INITIALIZATION
                  0032 *
602D 8607         0033        LDA           #7
602F C6FE         0034        LDB           #$FE         IO/NOISE OFF CHAN "A" ON
6031 8D33         0035        BSR           STORIT
6033 8608         0036        LDA           #8
6035 C60F         0037        LDB           #$0F         FIXED AT MAX AMP.
6037 8D2D         0038        BSR           STORIT
                  0039 *
                  0040 * FIRST TONE 440 HZ
                  0041 *
6039 8600         0042 EUROPE LDA           #0           REG. ADDRESS
603B C67F         0043        LDB           #127         CHAN. A FINE
603D 8D27         0044        BSR           STORIT       GO STORE REG&DAT
603F 8601         0045        LDA           #1
6041 C600         0046        LDB           #$00         CHAN. A COURSE
6043 8D21         0047        BSR           STORIT
                  0048 *
                  0049 * WAIT 350 MS
                  0050 *
6045 8D3A         0051        BSR           WAIT
                  0052 *
                  0053 * SECOND TONE 187 HZ
                  0054 *
6047 8600         0055        LDA           #0
6049 C62B         0056        LDB           #43
604B 8D19         0057        BSR           STORIT
604D 8601         0058        LDA           #1
```

```
604F C601       0059        LDB                 #$01
6051 8D13       0060        BSR                 STORIT
                0061 *
                0062 * WAIT 350 MS
                0063 *
6053 8D2C       0064        BSR                 WAIT
                0065 *
                0066 * REPEAT
                0067 *
6055 7C6089     0068        INC                 COUNT
6058 B66089     0069        LDA                 COUNT
605B 8103       0070        CMPA               #3
605D 26DA       0071        BNE                 EUROPE    REPEAT IT
605F 8608       0072        LDA                 #$08
6061 C600       0073        LDB                 #$00      SILENCE
6063 8D01       0074        BSR                 STORIT
6065 39         0075        RTS                            RETURN
                0076 *
                0077 * THIS ROUTINE ASSUMES THE REGISTER ADDRESS
                0078 * OF THE AY-89XX IS IN ACCUMLATOR "A" AND THE
                0079 * DATA TO BE STORED IS IN ACCUMULATOR "B".
                0080 *
                0081 *        *** PSG 4 ***
                0082 *
6066 3402       0083 STORIT PSHS               A
6068 86C0       0084        LDA                 #$C0
606A B7FF62     0085        STA                 B4PORT    STROBE REG. LATCH
606D 3502       0086        PULS               A
606F B7FF60     0087        STA                 A4PORT    STORE REG. ADDR.
6072 7FFF62     0088        CLR                 B4PORT    STROBE INACTIVE
6075 F7FF60     0089        STB                 A4PORT    STORE DATA
6078 8680       0090        LDA                 #$80      STROBE DATA
607A B7FF62     0091        STA                 B4PORT
607D 7FFF62     0092        CLR                 B4PORT    STROBE INACTIVE
6080 39         0093        RTS
                0094 *
                0095 * THIS ROUTINE WILL WASTE 350 MS
                0096 *
6081 8EA000     0097 WAIT   LDX                 #$A000
6084 301F       0098 MORE   LEAX               -1,X
6086 26FC       0099        BNE                 MORE
6088 39         0100        RTS
                0101 *
                0102 * DATA AREA
                0103 *
6089            0104 COUNT  RMB                 1
                0105 *
6000            0106        END                 START
       NO ERROR(S) DETECTED


   SYMBOL TABLE:

A4PORT FF60     B4PORT FF62     COUNT  6089     EUROPE 6039
MORE   6084     NARG   0000     START  6000     STORIT 6066
WAIT   6081

CMD=EUROPE /P
```

================= SYMPHONY 12 FEATURES ====================

+ 12 Simultaneous voices.

+ 4 Noise channels for sound effects.

+ Stereo Output, 6 voices through each channel.

+ All 12 voices are available to the computer directly.

+ May be connected to Speech Systems 2 1/2 (32 note) or 4 octave (49 note) PIANO KEYBOARD.

+ Plays MUSICA 2 music files.

+ Plays MUSIC LIBRARY 100, 200, 300, 400, 500, and 600 music files.

+ Music developed using SYMPHONY 12 may be saved in MUSICA 2 format to allow editing and/or printing.

+ Music may be recorded in real time and played, or saved to disk/tape for future playback.

+ Many music files included so you need not create your own immediately.

+ Many sound effects examples included.

+ Completely decoded in memory to assure no contention with other devices such as Speech Systems Super Voice, Stereo Pak, EARS etc.

+ Easily interfaced to users home stereo system.

+ Phono cables included for interfacing with home stereo system.

+ Sound Processor included to allow easy development of sound effects.

+ Works with ALL versions of the Color Computer.