VIP SUPERSOUND SYSTEM

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INTRODUCTION

You can now convert your COSMAC VIP into a music and sound effects computer. With the VIP Supersound printed circuit card and appropriate software you can make your VIP play any song from "Oh Susannah" to the "Maple Leaf Rag." You can compose or arrange your own music and let your VIP play it for you. If you play an instrument you can program your VIP to back you up.

The VIP Supersound card provides two separate sound channels. This is like a two piece combo that can be programmed to suit your taste. Special provisions have been made to record 3 perfectly synchronized tracks on a four track tape recorder. This lets you program up to 6 individual parts. The same synchronizing system permits multiple VIP's to play in parallel giving you unlimited ability to experiment with real time harmony effects. A third optional drum channel can easily be added and is supported by the Pin-8 (Play It Now) program described here.

The VIP Supersound system does not limit you to one musical scale and each channel has well over a four octave range. No frequency (tuning) adjustments are required. The only adjustment is for tempo.

MUSIC SYNTHESIS

Conventional music is broken up into notes. Each note has a frequency (pitch) and duration. Three basic variables contribute to what a note sounds like:

1. Frequency (pitch) - This variable determines how high or low the note is. A piano keyboard consists of groups of 12 notes. Each group of 12 notes is called an octave. Each 12 notes in the next higher octave is twice the frequency of the equivalent notes in the next lower octave. Octave number 4 begins with middle C on the piano.

2. Frequency Waveshape - This variable determines the quality of the note. Different instruments provide frequencies with varying wave shapes. A square wave has a different sound than a sine wave of the same frequency. The harmonic content of complex wave shapes differ markedly.

3. Volume Envelope - How the frequency varies in volume (amplitude) over the duration of a note makes a large difference in how it sounds. Percussion instruments (piano, bell, etc.) provide maximum volume (amplitude) at the beginning of the note. The volume then decays exponentially during the life of the note.
The VIP Supersound circuits provide programmed control of frequency and volume for two independent channels (A & B). No provision for frequency waveshape control exists. These circuits plug into the VIP 44-pin external interface socket.

The VIP Supersound system is a low cost approach to dual channel digital sound synthesis. It will not produce the same effects as some very expensive analog systems. You will, however, find it much easier to use and be amazed by the range of effects achievable with such a simple system.

CIRCUIT DESCRIPTION

The Supersound circuits are shown in Figs. 1 and 2. When using them with your VIP disconnect the normal VIP sound speaker. Since the Supersound circuits may not always provide keyboard tones with the operating system and CHIP-8 language, you may want to add a switch to your normal VIP speaker. This permits you to switch the normal VIP speaker back in when using the operating system or CHIP-8 language.

IC1 and IC2 are programmable frequency generators. An 8-bit code latched into an internal register determines the division factor for the frequency applied at pin 2. The divided frequency appears as a square wave on pin 14. The hex codes that must be internally latched for various notes are shown in Figure 3. The frequency shown is the desired note frequency. The maximum percentage frequency error is indicated to the right of the hex codes (see CDP1863 data sheet to calculate hex codes for any frequency).

IC4 is a crossbar switch. It can be set to provide any one of 4 frequencies as input to each divider. Each of these frequencies is double the next lower frequency. This permits setting the octave ranges for the notes as shown in Figure 3. Note that each sound channel (A/B) can be independently varied over a 4 octave range.

IC3 and the associated resistor network permit independent, programmed volume (or amplitude control of each frequency (A/B). A 4-bit code set into IC3 determines amplitude of the appropriate A/B frequency. Amplitude is varied from 0 to full in 16 equal steps. Hex 0 = 0 amplitude while hex F = full amplitude.

The two amplitude controlled frequencies are combined and fed to the input of your audio amplifier. The two frequencies could be optionally fed to separate inputs of a stereo amplifier if desired. This would permit specialized stereo effects to be programmed. Because of the wide range of frequencies possible, wide range amplifiers and speakers work best. For this reason we did not bother to provide an unsatisfactory card mounted small speaker.

In Figure 1 the sound is gated with the COSMAC Q line. Q must always be set to have an audible sound output.
In Figure 2, IC7 decodes various memory addresses to select appropriate sound circuits. All sound circuits are treated as memory locations. Frequency, octave, and volume for each channel are programmed by writing to specific memory locations as follows:

WRITE XX TO M (8001) - SETS A FREQUENCY = XX
WRITE XX TO M (8002) - SETS B FREQUENCY = XX
WRITE 0X TO M (8010) - SETS A AMPLITUDE = X
WRITE 0X TO M (8020) - SETS B AMPLITUDE = X

The octave crossbar switch (IC4) is programmed as follows:

WRITE 00 TO M (8003) - RESET A OCTAVE = 2 SWITCH
" 01 " " 3 "
" 02 " " 4 "
" 03 " " 5 "

WRITE 04 TO M (8003) - RESET B OCTAVE = 2 SWITCH
" 05 " " 3 "
" 06 " " 4 "
" 07 " " 5 "

WRITE 10 TO M (8003) - SET A OCTAVE = 2 SWITCH
" 11 " " 3 "
" 12 " " 4 "
" 13 " " 5 "

WRITE 14 TO M (8003) - SET B OCTAVE = 2 SWITCH
" 15 " " 3 "
" 16 " " 4 "
" 17 " " 5 "

For proper circuit operation the hex sequence 00-01-02-03-04-05-06-07-08-09-0A-0B-0C-0C-0E-0F must be written to M(0003) at the beginning of each program to clear the crossbar switch. Two "A" switches or two "B" switches should never be left set at the same time.

IC9 and IC10 provide a gated variable oscillator that provides COSMAC interrupt signals at a rate determined by the tempo control. This rate should lie in the range of 50 to 250 cycles/second. Rates in excess of 250/second can cause programs to malfunction.

After appropriate COSMAC registers have been set by a program, interrupts are initiated by writing 01 to M(8030). Interrupts are turned off by writing 00 to M(8030). When programs are synchronized to the interrupt routine the manual tempo adjustment can be used.

Note that breaking the X-Y link in Figure 2 permits one VIP to drive other VIP interrupts for synchronous sound generation.
PIN-8 PROGRAM (FOR 2K BYTE RAM SYSTEM)

The pin-8 program listing and flow chart are provided in Appendix I. Pin-8 lets you program music by setting up tables of musical notes in memory (using the VIP operating system). These tables can be saved on cassette tapes for later use. Pin-8 lets you program 3 channels of sound. Separate note tables are provided for A & B sound channels. Tables for the optional drum channel are also provided. See Figure 4 to add this I/O port drum option hardware. Pin-8 is a machine language program designed for high-speed, real time control of the 3 sound channels.

Figure 5 illustrates how the pin-8 tables are constructed to play a tune. A lot of music is available in single line form as shown at A (top left). The circled numbers (C, D7) represent background chords while the notes represent the melody line. The chords can be expanded into runs of individual harmonizing notes as shown at B. Add a rhythm pattern as shown at D for the drum option.

To program channel A, use the note tables shown in Figure 6. Assign the proper 2-hex digit note code to each note as shown. Now construct the A-note table for the two measures shown by listing the note codes within each measure. Label the measure entry points in this table (AM1, etc.). If two measures are identical the measure only has to be entered and labeled once in the note table. (See sample drum table for example of repeated measure.) The A-note table starts at M(0401) and ends at M(04FF). You can program up to 255 notes broken into measures in this table.

Now construct the A-measure table by listing the low order bytes of the addresses of measure starting points from the A-note table. End the A-measure table with a 00 code. When you run the pin-8 program, it will go to the A-measure table to find the sequence of note codes for the first measure of the tune. It will then play this sequence of notes obtained from the A-note table. Upon completion of the last note in the measure, the program will obtain the address of the next note sequence from the measure table. When a 00 code is found in the A-measure table, the program branches to a special subroutine that uses the break table.

The break table consists of groups of 7 control bytes. These control codes set the A & B octave ranges and specify how the notes will sound. See Figure 7 for a description of these codes. The 7th byte in each break table group specifies whether to stop or continue playing the tune.

The break table begins at M(0270) and ends at M(02AE). The first 7 bytes (at 0270-0276) are used prior to beginning to play the tune. In Figure 5, the A channel is set to octave 4 (code 12) and a normal (steady) pitch with an amplitude envelope shown as CF in Fig. 7 is specified for each subsequent A channel note. The B channel is set to octave 2 (14 code) and a normal (steady) pitch with an amplitude envelope shown as BF (chime) in Figure 7 is specified for each subsequent B note. The 00 code in the sample break table causes the two measures of Figure 5 to be repeated indefinitely.
Breaks can be inserted between any two measures of a tune without affecting playing time. This provides you with the ability to change the way the A & B channel notes sound at various points in the tune.

Figure 5 shows how the B channel notes are programmed in a similar manner using the B-note table and B-measure table. Figure 8 summarizes the location of all tables in memory.

The optional drum channel (D) is programmed as shown in Figure 5 using the drum note codes of Figure 9.

The notes in each measure must always total a whole note (4 quarter notes) for 4/4 time tunes. The notes in each measure must always total a 3/4 note (3 quarter notes) for 3/4 time tunes. This is important for proper note sequencing. You must also set the measure time byte at M(0259) as shown below the note code table (Figure 6) for proper operation.

CONCLUSION

There are many excellent beginner music books. You will find these helpful in understanding musical notation, chord structure, etc. The VIP Supersound system provides unlimited opportunities for experimenting with rhythm patterns, two part harmony, etc. With multiple VIPs or a four channel recorder more complex musical arrangements can be explored.

The note amplitude envelopes can be changed to suit your needs. These envelope tables are located in memory as follows:

<table>
<thead>
<tr>
<th>B0</th>
<th>CO</th>
<th>DO</th>
<th>EO</th>
<th>FO</th>
</tr>
</thead>
<tbody>
<tr>
<td>02BF</td>
<td>02CF</td>
<td>02DF</td>
<td>02EF</td>
<td>02FF</td>
</tr>
</tbody>
</table>

The 16 bytes in the specified table are used to set the channel amplitude (volume) sequentially. The amplitude is changed sixteen times per note. The bytes are sequenced from highest to lowest address. A 00 byte sets amplitude to 0 (inaudible) while an OF byte sets maximum amplitude (loudest).

The note table for the note sequence shown in Figures 3 and 6 is located at M(01E1) to M(01FB). Non-conventional scales can be created by changing this frequency table.

By all means try the sample music programs provided in Appendix II. You'll be amazed at what can be done with the equivalent of two fingers at a keyboard.

For readers who want to try computer music generation, use CHIP-8 to write a program that generates the A & B note and measure tables. Then load the pin-8 program to play your computer composed tune.

If you would like to experiment with weird sounds try the program in Appendix III.
VIP SUPERSONIC CARD (1/2)

Figure 1

JAW 6-78
NOTE 1 - R A & B OUTPUT RESISTORS CAN BE INCREASED/DECREASED TO MATCH AUDIO AMPLIFIER INPUT. SEPARATE 2 CHANNEL OUTPUT IS POSSIBLE.

NOTE 2 - INTERRUPT RATE CAN BE VARIED FROM 50/SEC TO 250/SEC. THIS RATE SETS TEMPO.

NOTE 3 - WHEN USING MULTI-TRACK TAPE RECORDER, X-Y CAN BE BROKEN AND Y DRIVEN FROM PRERECORDED SYNC TRACK INSTEAD OF INTERNAL OSCILLATOR. THIS INSURES PERFECT SYNC BETWEEN TRACKS. A 4 TRACK RECORDER PERMITS 6 CHANNEL SOUND.

NOTE 4 - CIRCLED PIN NUMBERS REFER TO COSMAC VIP 44-PIN EXTERNAL INTERFACE SOCKET.

VIP SUPERSONIC CARD (2/2)

FIGURE 2

JAW 6-78
NOTE: INSTRUCTION G3 = Mx → DRUMS, RX+1
BIT 0 = 0 = CLAVE, BIT1 = 0 = CONGA, BIT 2 = 0 = SNARE, BIT 3 = 0 = BASS
BIT 7 = 1 FOR STRIKE PULSE.

*ADD THIS CAPACITOR TO EK-2 CARD

EK-2 COMPUTER DRUM CARD KIT AVAILABLE FROM PAIA ELECTRONICS, 1020 W. WILSHIRE BLVD., OKLAHOMA CITY, OK 73116... PRICE UNDER $30.

PAIA DRUM OPTION FOR VIP SUPERSOUND SYSTEM

FIGURE 4

JAW 6-78
Figure 3

Table Memory Locations

<table>
<thead>
<tr>
<th>TABLE</th>
<th>MEMORY LOCATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A - NOTE</td>
<td>0401-04FF (255 NOTES)</td>
</tr>
<tr>
<td>A - MEASURE</td>
<td>0300-03FF (128 MEASURES)</td>
</tr>
<tr>
<td>B - NOTE</td>
<td>0501-05FF (255 NOTES)</td>
</tr>
<tr>
<td>B - MEASURE</td>
<td>0380-03FF (128 MEASURES)</td>
</tr>
<tr>
<td>D - NOTE</td>
<td>0681-06FF (127 NOTES)</td>
</tr>
<tr>
<td>D - MEASURE</td>
<td>0600-067F (128 MEASURES)</td>
</tr>
<tr>
<td>BREAK</td>
<td>0270-02AE (9 BREAKS)</td>
</tr>
</tbody>
</table>

Figure 8
MUSIC CODING EXAMPLE

A-NOTE TABLE

A1 → 0401 = 2B
0402 = 2B
0403 = 44
0404 = 06
A2 → 0405 = 2B
0406 = 2B
0407 = 26
0408 = 24

B-NOTE TABLE

B1 → 0501 = 24
0502 = 2B
0503 = 24
0504 = 2B
B2 → 0505 = 26
0506 = 2A
0507 = 2D
0508 = 30

D-NOTE TABLE

D1 → 0681 = 17
0682 = 1A
0683 = 17
0684 = 1A

BREAK TABLE

0270 = 12
0271 = 01
0275 = 8F30
0276 = 00

A-MEASURE TABLE

0300 = 01 (A1)
0301 = 04 (A2)
0302 = 00 (BREAK)

B-MEASURE TABLE

0380 = 01 (B1)
0381 = 05 (B2)
0382 = 00 (BREAK)

D-MEASURE TABLE

0600 = 81 (D1)
0601 = 81 (D2)
0602 = 00 (BREAK)

FAST 4/4 TIME : SET M(0259) = 7F

FIGURE 5
**Note Code Table**

* Fast 4/4 Time: Set M(0259) = 7F
** Slow 4/4 Time: Set M(0259) = FF
** Slow 3/4 Time: Set M(0259) = BF

**Figure G**

_jaw 7-78_
### Break Table Codes

**Break Table (entered by 00 in a measure table)**

<table>
<thead>
<tr>
<th>Break</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Break</td>
<td>0270</td>
<td>A Octave</td>
</tr>
<tr>
<td></td>
<td>0271</td>
<td>A Mode</td>
</tr>
<tr>
<td></td>
<td>0272</td>
<td>A Envelope</td>
</tr>
<tr>
<td></td>
<td>0273</td>
<td>B Octave</td>
</tr>
<tr>
<td></td>
<td>0274</td>
<td>B Mode</td>
</tr>
<tr>
<td></td>
<td>0275</td>
<td>B Envelope</td>
</tr>
<tr>
<td></td>
<td>0276</td>
<td>Break Control</td>
</tr>
<tr>
<td>Break</td>
<td>0277</td>
<td>A Octave</td>
</tr>
<tr>
<td></td>
<td>0278</td>
<td>A Mode</td>
</tr>
<tr>
<td>Break</td>
<td>02AB</td>
<td>A Octave</td>
</tr>
<tr>
<td></td>
<td>02A9</td>
<td>A Mode</td>
</tr>
<tr>
<td></td>
<td>02AA</td>
<td>A Envelope</td>
</tr>
<tr>
<td></td>
<td>02AB</td>
<td>B Octave</td>
</tr>
<tr>
<td></td>
<td>02AC</td>
<td>B Mode</td>
</tr>
<tr>
<td></td>
<td>02AD</td>
<td>B Envelope</td>
</tr>
<tr>
<td></td>
<td>02AE</td>
<td>Break Control</td>
</tr>
</tbody>
</table>

**A/B Mode Code**

- 0X: Normal Pitch (no variation)
- 1X: Slide down to pitch
- 2X: Slide up to pitch
- 4X: Slow Pitch Variation
- 8X: Fast Pitch Variation

**A/B Envelope Code (Mode Code: X1)**

- 80: Max Vol
- 81: Min Vol
- CO: Flute
- DO: ?
- EO: Soft Chime
- FO: ?

**Break Control Codes**

- 00: Repeat entire song from beginning
- 0E: Repeat song but use next set of break codes
- 0D: Continue with next set of break codes
- 0F: Stop

---

*Figure 7*
<table>
<thead>
<tr>
<th><strong>SNARE</strong></th>
<th><strong>CONGA</strong></th>
<th><strong>CLAVE</strong></th>
<th><strong>FAST TIME</strong></th>
<th><strong>SLOW TIME</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>XX X X X</td>
<td>0 0</td>
<td>10 20</td>
<td>30 40</td>
<td>50 60 70</td>
</tr>
<tr>
<td>XX X X</td>
<td>0 1</td>
<td>11 21</td>
<td>31 41</td>
<td>51 61 71</td>
</tr>
<tr>
<td>XX X</td>
<td>0 2</td>
<td>12 22</td>
<td>32 42</td>
<td>52 62 72</td>
</tr>
<tr>
<td>X X X X</td>
<td>0 3</td>
<td>13 23</td>
<td>33 43</td>
<td>53 63 73</td>
</tr>
<tr>
<td>X X X X</td>
<td>0 4</td>
<td>14 24</td>
<td>34 44</td>
<td>54 64 74</td>
</tr>
<tr>
<td>X X X X</td>
<td>0 5</td>
<td>15 25</td>
<td>35 45</td>
<td>55 65 75</td>
</tr>
<tr>
<td>X X X X</td>
<td>0 6</td>
<td>16 26</td>
<td>36 46</td>
<td>56 66 76</td>
</tr>
<tr>
<td>X X X X</td>
<td>0 7</td>
<td>17 27</td>
<td>37 47</td>
<td>57 67 77</td>
</tr>
<tr>
<td>X X X X</td>
<td>0 8</td>
<td>18 28</td>
<td>38 48</td>
<td>58 68 78</td>
</tr>
<tr>
<td>X X X X</td>
<td>0 9</td>
<td>19 29</td>
<td>39 49</td>
<td>59 69 79</td>
</tr>
<tr>
<td>X X X X</td>
<td>0 A</td>
<td>1A 2A</td>
<td>3A 4A</td>
<td>5A 6A 7A</td>
</tr>
<tr>
<td>X X X X</td>
<td>0 B</td>
<td>1B 2B</td>
<td>3B 4B</td>
<td>5B 6B 7B</td>
</tr>
<tr>
<td>X X X X</td>
<td>0 C</td>
<td>1C 2C</td>
<td>3C 4C</td>
<td>5C 6C 7C</td>
</tr>
<tr>
<td>X X X X</td>
<td>0 D</td>
<td>1D 2D</td>
<td>3D 4D</td>
<td>5D 6D 7D</td>
</tr>
<tr>
<td>X X X X</td>
<td>0 E</td>
<td>1E 2E</td>
<td>3E 4E</td>
<td>5E 6E 7E</td>
</tr>
<tr>
<td>X X X X</td>
<td>0 F</td>
<td>1F 2F</td>
<td>3F 4F</td>
<td>5F 6F 7F</td>
</tr>
</tbody>
</table>

**DRUM CODE TABLE**

**FIGURE 9**
APPENDIX I

PIN-8 PROGRAM LISTING
&
FLOWCHART
* INTERRUPT ROUTINE

1. SET RAM POINTER TO A-CHANNEL PARAMETER LIST

2. DO A/B NOTE SUBROUTINE (FREQ -> F, VOLUME -> V)

3. BREAK FLAG = 00?

   - YES
     4. LET A FREQUENCY = F
        5. LET A VOLUME = V
        6. DRUM NOTE TIMER = 00?
           7. MEASURE TIMER = 00?
              8. GET NEW MEASURE ADDRESS FROM D-MEASURE TABLE ...
                 9. MEASURE TABLE POINTER + 1
                 10. GET NOTE CODE FROM D-NOTE TABLE, PLAY NOTE ...
                    11. SET DRUM NOTE TIMER ...
                        12. D-NOTE TABLE POINTER + 1
                        13. SET RAM POINTER TO B-CHANNEL PARAMETER LIST
                           14. DO A/B NOTE SUBROUTINE (FREQ -> F, VOLUME -> V)
                           15. LET B FREQUENCY = F
                               16. LET B VOLUME = V
                               17. FF -> BREAK FLAG
                                   18. MEASURE TIMER - 1 IF ≠ 00
                                       19. SET MEASURE TIMER IF = 00
                                           20. TERMINATE DRUM STRIKE PULSE
                                           21. RETURN FROM INTERRUPT

   - NO
     22. NO DRUM NOTE TIMER - 1

* INTERRUPT ROUTINE FLOWCHART

* Interrupts occur 50-250 times/sec. depending on tempo control setting.
A/B NOTE SUBROUTINE

1. Get A/B channel parameters stored in RAM
   - 0101 - 0112

2. Note timer = 00?
   - 0113 - 0115

3. Measure timer = 00?
   - 0116 - 0118

4. Get new measure address from measure table...
   - Let break flag = this address
   - Measure table pointer + 1
   - 0119 - 011B

5. Break flag = 00?
   - Yes
   - 011C - 011D
   - Get next note code from note table...
   - Decode note
   - Note table pointer + 1
   - 011E - 013A

6. Note timer = 1
   - 013B

7. Set option variables
   - 013C - 014C

8. Note = rest?
   - No
   - 0140 - 014E

9. Let V = 0
   - 014F - 0151

10. Let F = frequency as a function of previous break list mode code, current frequency, & note timer.
    - 0152 - 0172

11. Let V = volume as a function of previous break list mode code, envelope control register, & note timer.
    - 0173 - 019A

12. Put updated A/B parameters back into RAM locations.
    - 019B - 01AF

13. Return to interrupt routine
    - 0100

PIN-8 A/B NOTE SUBROUTINE