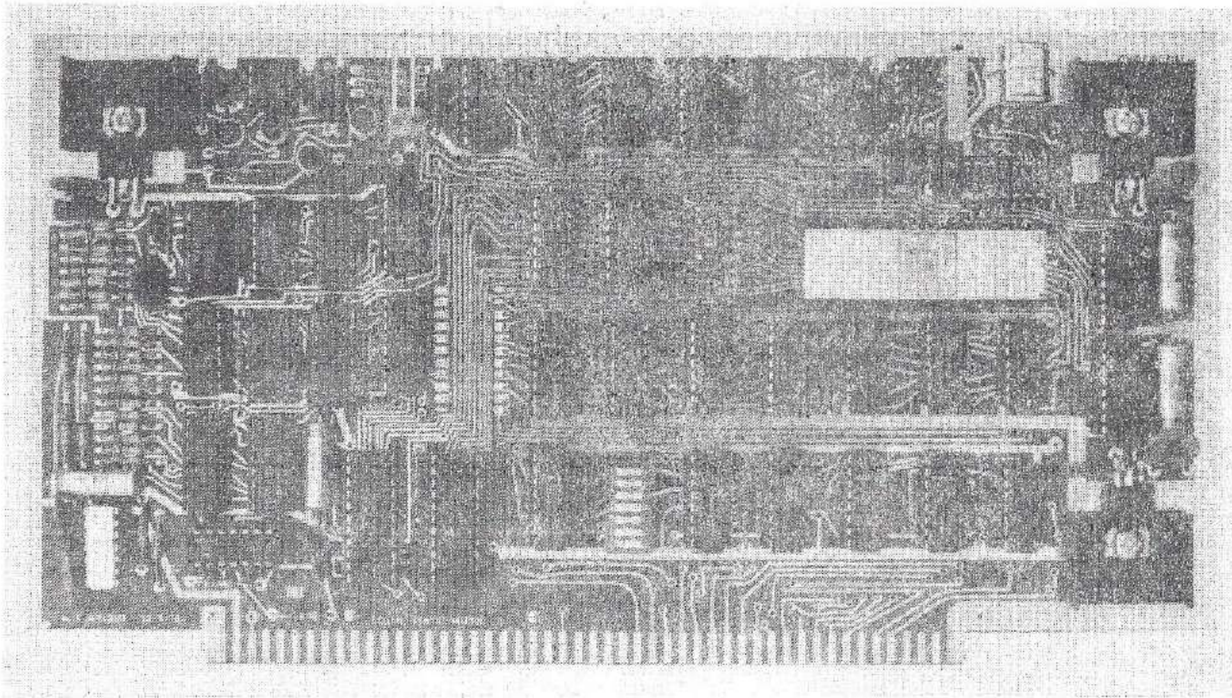
SB1

MUSIC SYNTHESIZER BOARD



FEATURES

Standard

- Plug compatible with the ALTAIR 8800 and IMSAI 8080, or any other system using the "ALTAIR Bus".
- DIP Switch selection of the memory location from 32K and up.
- T.I. low profile sockets provided for all IC's.
- Gold plated edge connector contacts.

Synthesizer

- Frequency range is software controllable from 15HZ to 25KHZ.
- Frequency can be changed by software over a nine octave range.
- Volume of the SB-1 is software controlled over fifteen different levels.
- The waveform from the SB-1 can be defined by the user in 32 bytes of memory.
- The Attack and Sustained levels (Envelope) of a note can be defined by the user.

Software

- "MUS-X1 is a high music interpreter which can drive up to eight SB-1 boards at once.
- Note durations controllable from 1/64 up to a whole note.
- MUS-X1 only occupies 4K of RAM
- MUS-X1 uses standard ANSCII notation for music encoding making it easy for a person to write and correct musical tunes.

2116 Walsh Ave., Santa Clara, CA 95050 (408) 246-2707

C O N T E N T S

1.0 INTRODUCTION

1.1 General Description

The Synthesizer Board (SB1) is a waveform generator card designed to interface with any computer that supports the S-1ØØ Bus and its signals. The SB1 is a memory mapped device of 256 bytes that can be located at any address from 8ØØØH to FFØØH in 256 byte increments. The output from the SB1 is available at a 2-pin connector at about 1 vrms to be fed to auxiliary input of a HiFi amplifier.

The features of the SB1 is that the computer can control the following waveform characteristics:

- Waveform Shape (32 segments in time)
- Envelope Shape (16 segments in time)
- Frequency (15HZ to 25KHZ)
- Octave (nine octaves)
- Volume (16 levels)

The SB1 comes with supporting software called MUS-X1 to run one to eight cards in the playing of music encoded by the user.

1.2 Assembly Instructions (Refer to Assembly Drawing)

- [ ] Check kit contents against parts list.
- [ ] Check PC board for possible warpage and straighten if required.
- [ ] Insert 19 14-pin, 17 16-pin, 2 22-pin, 1 40-pin, and 2 8-pin sockets into the component side of the board with pin one indexed as indicated in the Assembly Drawing. (The component side is labeled Solid State Music.) DON'T SOLDER!
  Note: The Dip Switch doesn't use a socket.
- [ ] Place a flat piece of stiff cardboard of appropriate size on top of the sockets to hold them in place.
- [ ] Holding the cardboard in place against the sockets, turn the board over and lay it on a flat surface. (Be sure that all of the socket's pins are through the holes.)
- [ ] Soldering. Note: Keep soldering iron tip clean to prevent rosin and sludge from being deposited on traces. Wipe tip frequently on a damp cloth or wet sponge.
- [ ] On each socket, solder two of the corner pins, choosing two that are diagonally opposite of each other.
- [ ] Once the sockets are secured, lift the board and check to see if they are flat against the board. If not, seat the sockets by pressing on top while reheating the two pins.

1.2 (continued)

☐ Complete soldering the remaining pins of each socket. Touch pin and pad with iron tip, allowing enough solder to flow to form a filet between the pin and pad. Keep the tip against the pin and pad just long enough to produce the filet. Note: Too much heat can cause separation of the copper pad and trace from the board. A 600 degree iron tip is recommended.

☐ Insert the 4 22.1K ohm 1% and 4 11.0K ohm 1% resistors in the left side of the card per the Assembly Drawing and solder.

☐ Insert the 1 2.2 ohm resistor between U18 and U19. Pads for the resistor are near U18, pin 14 and U31, pin 1. Solder.

☐ Insert and solder 43 ¼w resistors in their respective locations.

☐ Insert and solder 1 sip resistor pack between U34 and the switch with the index pin (pin 1) pointing to the top of the card.

☐ Observing polarity, insert and solder diodes D1 and D2 in their respective location.

☐ Observing polarity, insert and solder 4 20uf capacitors near U41, near U31, near U17, and near U29.

☐ Observing polarity, insert and solder 2 4.7uf drop tantalum capacitors on either side of U1.

☐ Insert and solder 20 0.1uf ceramic capacitors. (Some kits the one 0.01uf capacitor has been changed to 0.1uf).

☐ Insert and solder 2 50pF disc near U10 and U9.

☐ Insert and solder the 20 mhz xtal.

☐ Insert and solder the 100K trim potentiometer.

☐ Insert and solder the 4 transistors near U1.

☐ Insert and solder the Dip Switch with the word "open" on the right side.

☐ Insert and solder the 2-pin molex connector.

☐ Install and solder jumper wires.
- (a) one jumper between U14 and U15
- (b) one jumper between U24 and U25
- (c) one jumper under U5 over to "V" under 2-pin connector
- (d) eleven jumpers between U21 and U22

☐ Place regulators on the board so the mounting hole in the regulator is in line with the hole in the board. Mark leads for the proper bending position to match the board holes (allow for a bend radius).

1.2 (continued)

- [ ] Bend regulator leads to match the holes in the board. (If available, apply thermal compound to the back side of each regulator's metal tab.)

- [ ] Position the 3 heatsinks, drop the 3 regulators in place on the front of the board, insert #6 screws from behind and secure firmly with lock washers and nuts.

- [ ] Solder regulator leads to pads on the back side of the board. Do not use excessive heat.

1.2 (continued)

- [ ] Bend regulator leads to match the holes in the board. (If available, apply thermal compound to the back side of each regulator's metal tab.)

- [ ] Position the 3 heatsinks, drop the 3 regulators in place on the front of the board, insert #6 screws from behind and secure firmly with lock washers and nuts.

- [ ] Solder regulator leads to pads on the back side of the board. Do not use excessive heat.

2.0 FUNCTIONAL CHECK

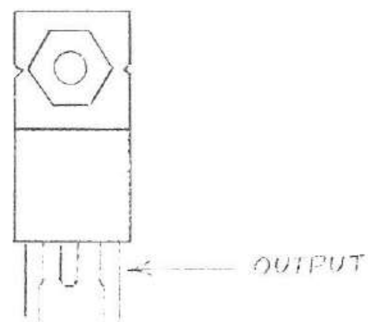
WARNING! DO NOT INSTALL OR REMOVE BOARD WITH POWER ON. DAMAGE TO THIS AND OTHER BOARDS COULD OCCUR.

If an ohmmeter is available, measure the resistance between the following pins:

Negative Probe		Positive Probe	Resistance
Bus pin 50	to	Bus pin 1	greater than 15
Bus pin 50	to	Bus pin 2	greater than 100k
Bus pin 50	to	Bus pin 52	greater than 100k

If your reading is below these values check for electrical shorts on your card.

Apply power (+8v to +10v) to board by plugging into the computer or by connection to a suitable power supply. Measure the outputs of the +5v regulators.



The voltage should be between +4.8v and +5.2v. If the regulator doesn't meet this test, then check the board for shorts or errors.

CAUTION: WHILE IT HAS NEVER HAPPENED TO US, SHORTED REGULATORS HAVE BEEN KNOWN TO EXPLODE WITH POSSIBLE INJURY TO EYES OR HANDS. BETTER SAFE THAN SORRY --- KEEP FACE AND HANDS CLEAR OF THE REGULATOR SIDE OF THE BOARD DURING THIS TEST.

Insert U41. Apply power +14v to +19v to Bus pin 2 and -14v to -19v to Bus pin 52 52 with Bus pin 50 ground. Verify that the outputs U41, pin 1 and U41, pin 8 are about +10 volts and -10 volts respectfully.

Observing polarity, insert the rest of the chips into their sockets per the Assembly Drawing.

Look the board over carefully. Check for bent IC pins, poor solder joints or bridges and touch-up if necessary. Using the Assembly Drawing, recheck part locations and polarity. A few minutes of careful inspection may save a few hours of trouble shooting.

Simple Software Test

This simple test program will load a sawtooth waveform of 32 bytes (x4) and a 16 byte envelope shape into the SB1. The special control byte is set for a repeating envelope shape, and a long duration envelope time. The byte under control by the sense switches, unless changed, is the frequency byte.

Set the Dip switch on the SB1 to all "ON" (closed) for address 8ØØØH. Start program execution at ØØØØ Hex. This program uses one restart instruction for a program called "FILL".

```
                ;SIMPLE TEST OF SB1 CARD #1.
                ;WRITTEN BY MALCOLM WRIGHT,12-26-76 .

0000            LOC     EQU     0       ;START OF PROGRAM.
8000            CARD    EQU     8000H   ;SB1'S ADDRESS

                ;THIS PROGRAM WILL GIVE A REPEATING BELL
                ;LIKE SOUND FROM THE SB1.

0000                    ORG     LOC

0000 313000     BEGIN:  LXI     SP,30H
0003 21F380             LXI     H,CARD+0F3H
0006 3680               MVI     M,80H   ;INITIALIZE SB1
0008 2B                 DCX     H
0009 3680               MVI     M,80H   ;STOP SB1
000B 2B                 DCX     H
000C 36F4               MVI     M,0F4H  ;SET VOLUME & OCTAVE
000E 2B                 DCX     H
000F 366B               MVI     M,6BH   ;SET PITCH TO "C".
                ;LOAD A SAWTOOTH WAVEFORM INTO THE SB1.
0011 2E00               MVI     L,0     ;1ST BYTE OF THE SB1
0013 3E07               MVI     A,7
0015 010880             LXI     B,8008H ;B= # OF BYTES,C= INCREMENT
0018 F7                 RST     6       ;TRANSFER WAVEFORM
                ;LOAD A ENVELOPE INTO THE SB1.
0019 2EE0               MVI     L,0E0H  ;START OF ENVELOPE
001B 3E10               MVI     A,10H
001D 010110             LXI     B,1001H
0020 F7                 RST     6
                ;TURN ON SB1
0021 2EF2               MVI     L,0F2H  ;CTRL BYTE ADDRESS
0023 3600               MVI     M,0     ;TURN-ON
                ;THIS SECTION CAN BE SET TO CONTROL A PARTICULAR
                ;BYTE OF THE THREE USED BY THE SB1 FOR:
                ;       F0 = FREQUENCY CONTROL
                ;       F1 = VOLUME/OCTAVE CONTROL
                ;       F2 = SPECIAL CTRL BYTE

0025 2EF0               MVI     L,0F0H  ;* CAN BE CHANGED BY USER.

                ;THE SENSE SWITCHES ARE USED FOR CONTROL.  IF
                ;YOUR COMPUTER HAS NO FRONT PANEL THEN CHANGE
                ;THE TWO BYTES AT "NEXT:" TO:
                ;       3E,A4   MVI     A,0A4H
```

Simple Software Test (continued)

```
0027 DBFF      NEXT:   IN     0FFH     ;INPUT SENSE SW.
0029 77                MOV    M,A      ;PUT INTO CARD
002A C32700            JMP    NEXT

0030                   ORG    30H      ;START OF RST 6

0030 91        FILL:   SUB    C        ;SUBSTRACT INCREMENT
0031 77                MOV    M,A
0032 23                INX    H
0033 05                DCR    B        ;COUNT BYTES
0034 C23000            JNZ    FILL
0037 C9                RET             ;DONE

0000                   END
```

Adjustment of Trimm Resistor

During the simple test program, the envelope will be repeating at some fixed rate. The envelope duration should be 1.2 seconds, which would equal 50 envelopes per minute. Adjust the trimm resistor at the top edge of the SB1 for 25 envelopes per every half a minute during the simple test.

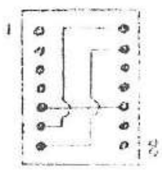
3.0 SET-UP

3.1 Headers

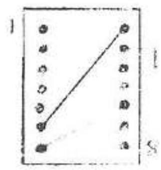
The Header is an interconnection block (U20) used to tie control signals from the Envelope Generation Circuit into the Waveform Generation Circuit. This allows the user to:

(1) Save two waveforms in the SB-1.
(2) Have one to four sequential waveforms per envelope.
(3) Both.

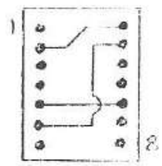
Four general configurations (top view)



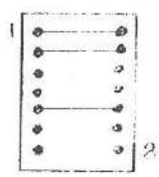
Save two waveforms and only one waveform per envelope. (Used most often with the software, MUS-X1.)



Save one waveform and only one waveform per envelope. (Very basic)



Save two waveforms and output sequentially two waveforms per envelope.



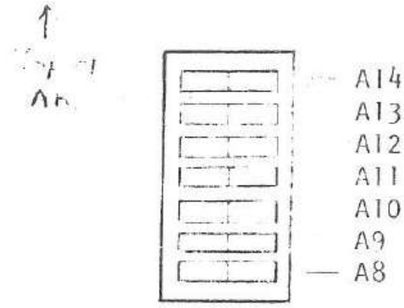
Save two waveforms and output sequentially four waveforms per envelope.

3.2 Addressing

The SB1 can be placed at any page in memory from 32K and up, by setting a dip switch on the board. The MSB of the address (A15) is internally always set at a logic one. A8 end of the switch is near the edge connector. The other end of the switch is A14.

Typical switch settings:
Switch open = 1
Switch closed = Ø

Address	A14	A13	A12	A11	A10	A9	A8
8ØØØ (Hex)	Ø	Ø	Ø	Ø	Ø	Ø	Ø
81ØØ	Ø	Ø	Ø	Ø	Ø	Ø	1
82ØØ	Ø	Ø	Ø	Ø	Ø	1	Ø
83ØØ	Ø	Ø	Ø	Ø	Ø	1	1
84ØØ	Ø	Ø	Ø	Ø	1	Ø	Ø
FFØØ	1	1	1	1	1	1	1



3.3 Control Bytes

The SB-1 thinks it is 256 bytes of memory that can be addressed from 8ØØØH to FFØØH. Within the block 256 bytes there are three control bytes and one initialization byte. The Hex address of these bytes would be:

Address	Comment
*XXFØ	Frequency byte. ØØ = Low freq., FE = high freq.
XXF1	Volume / Octave byte. High 4-bits = Volume level Low 4-bits = Octave range
XXF2	Special Bit Control Bit D7 (MSB) = run/stop run = Ø Bit D6 = Envelope ctrl. One-shot = 1 Repeating = Ø Bit D5 = Spare Bit D4 = Waveform bank select. Bank Ø = Ø Bank 1 = 1 Bit D3 to DØ = Envelope Duration. Ø = longest dura. E = shortest dura.
XXF3	Initialization Byte = 8ØH

* XX = 8Ø Hex to FF Hex depending on card's address.

The initialization byte at XXF3 should be deposited only once to preset the mode of the 8255 IC (U16) on the SB1.

3.4 General Information

3.4.1 Waveform Generation

The SB1 has a 256 byte memory for storing two sets of waveforms. Each waveform set consists of four 32 byte long binary codes of the waveform's amplitude. Selection of waveform set Ø over set 1 is called bank select and is controlled by a bit in the byte at XXF2 (see 3.2).

The selection of how many waveforms will be used sequentially in an envelope is controlled by a jumpered IC header (see 3.1).

The 32 bytes or 128 bytes (a set) of data can only be loaded into the SB1 if it is STOPPED (bit D7 of XXF2, see 3.2). The data is a series of binary codes of the amplitude of the waveform desired. FFH is the highest amplitude and ØØH is the lowest amplitude for each data byte. The Waveform's amplitude can set for every 11.25 degrees (32 bytes). As an example a squarewave would be sixteen FFH bytes followed by sixteen ØØH bytes placed into the SB1's memory. The memory starts at XXØØ and goes to XX7F (first 32 bytes are from XXØØ to XX1F).

A collection of a few waveforms. Squarewave (50% Duty Cycle)

1st Byte	= FF	9th	= FF	17th	= ØØ	25th	= ØØ
2	= FF	10	= FF	18	= ØØ	26	= ØØ
3	= FF	11	= FF	19	= ØØ	27	= ØØ
4	= FF	12	= FF	20	= ØØ	28	= ØØ
5	= FF	13	= FF	21	= ØØ	29	= ØØ
6	= FF	14	= FF	22	= ØØ	30	= ØØ
7	= FF	15	= FF	23	= ØØ	31	= ØØ
8	= FF	16	= FF	24	= ØØ	32	= ØØ

Trianglewave

1st Byte	= 9Ø	9th	= FØ	17th	= 7Ø	25th	= 1Ø
2	= AØ	10	= EØ	18	= 6Ø	26	= 2Ø
3	= BØ	11	= DØ	19	= 5Ø	27	= 3Ø
4	= CØ	12	= CØ	20	= 4Ø	28	= 4Ø
5	= DØ	13	= BØ	21	= 3Ø	29	= 5Ø
6	= EØ	14	= AØ	22	= 2Ø	30	= 6Ø
7	= FØ	15	= 9Ø	23	= 1Ø	31	= 7Ø
8	= FF	16	= 8Ø	24	= ØØ	32	= 8Ø

Sinewave (full amplitude)

1st Byte	= 9A	9th	= FE	17th	= 67	25th	= Ø2
2	= B1	10	= F5	18	= 4F	26	= ØB
3	= C7	11	= EA	19	= 39	27	= 16
4	= DA	12	= DA	20	= 26	28	= 26
5	= EA	13	= C7	21	= 16	29	= 39
6	= F5	14	= B1	22	= ØB	30	= 4F
7	= FE	15	= 9A	23	= Ø2	31	= 67
8	= FF	16	= 80	24	= Ø1	32	= 8Ø

3.4.1 (continued)

Waveform with only 3rd, 4th, & 5th Harmonics
(Amplitude = 1/3 per Harmonic)

1st Byte	= ED	9th	= 93	17th	= 62	25th	= AC
2	= FF	10	= 8A	18	= 5A	26	= CF
3	= D4	11	= 7C	19	= 6B	27	= C2
4	= 80	12	= 8Ø	20	= 8Ø	28	= 8Ø
5	= 3E	13	= 95	21	= 84	29	= 2C
6	= 31	14	= A6	22	= 76	30	= Ø1
7	= 54	15	= 9E	23	= 6D	31	= 23
8	= 8Ø	16	= 8Ø	24	= 8Ø	32	= 8Ø

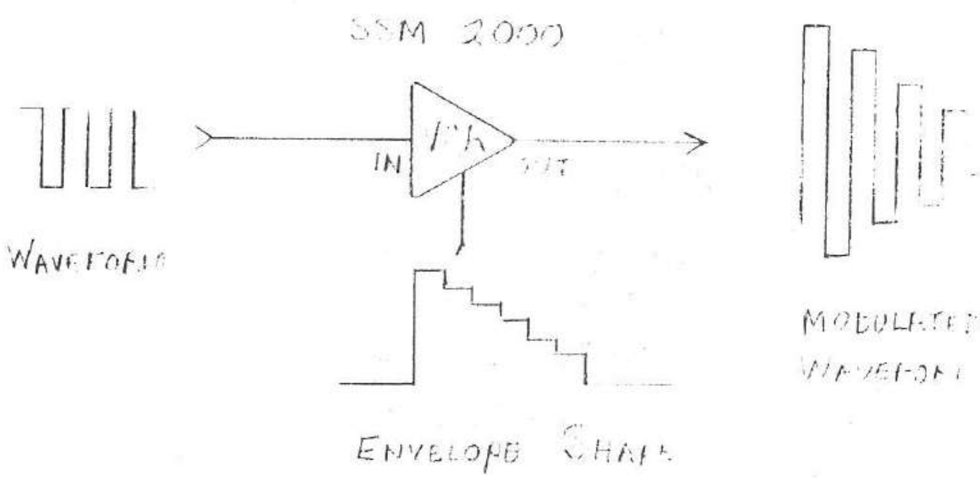
Waveform with only 4th, 5th & 6th Harmonics

1st Byte	= F7	9th	= 9Ø	17th	= A6	25th	= 5B
2	= FF	10	= 7C	18	= A6	26	= AØ
3	= 99	11	= 85	19	= 86	27	= E4
4	= 2D	12	= 8E	20	= 72	28	= D3
5	= 1C	13	= 7A	21	= 7B	29	= 67
6	= 6Ø	14	= 5A	22	= 84	30	= ØØ
7	= A5	15	= 5A	23	= 7Ø	31	= Ø9
8	= BØ	16	= 8Ø	24	= 5Ø	32	= 8Ø

3.4.2 Envelope Generation

The SB1 has a 16X4 bit memory for saving an envelope shape. As a waveform is sent out of the SB1 it can be amplitude modulated to increase or decrease slowly in time by a set envelope shape. The envelope data can vary from ØØ (no output) to ØF (maximum output).

The Envelope memory can only be loaded when the SB1 is STOPPED (see 3.2). The memory address is from XXEØ to XXEF.



Typical Envelopes.
Constant Level

1st Byte = ØF	5th = ØF	9th = ØF	13th = ØF
2 = ØF	6 = ØF	10 = ØF	14 = ØF
3 = ØF	7 = ØF	11 = ØF	15 = ØF
4 = ØF	8 = ØF	12 = ØF	16 = ØF

Decaying Level

1st Byte = ØF	5th = ØB	9th = Ø7	13th = Ø3
2 = ØE	6 = ØA	10 = Ø6	14 = Ø2
3 = ØD	7 = Ø9	11 = Ø5	15 = Ø1
4 = ØC	8 = Ø8	12 = Ø4	16 = ØØ

Slow Attack

1st Byte = ØØ	5th = ØC	9th = ØF	13th = ØF
2 = Ø3	6 = ØF	10 = ØF	14 = ØF
3 = Ø6	7 = ØF	11 = ØF	15 = ØF
4 = Ø9	8 = ØF	12 = ØF	16 = ØF

3.4.3 Pitch

The Pitch (or frequency) of the SBI is determined by dividing down the frequency of a 20 MHZ oscillator by four IC counters. Two counters can be set by the computer to divide by 2 to 256 the incoming 20 MHZ. The other two counters can be selected by a multiplexer to divide by multiples of 2 the first two counters frequency (octave select).

Pitch Equation.

FO = Frequency Out
D = Divisor
N = Octave Number (Decimal)
32 = Number of segments per waveform.

$$FO = \frac{20,000,000}{(D)(32)(2^{(8-N)})}$$

$\overline{D}+1$ = Frequency Byte
256 - D = Frequency Byte

Example: Let's generate middle - C which is 261.63HZ with the octave select at 4.

$$D = \frac{20,000,000}{(32)(261.63)(2^{(8-4)})} = \frac{20(10^6)}{(261.63)(32)(16)}$$

$$D = \frac{20(10^6)}{1.3395456(10^5)} = 149.3$$

The computer can only pass interger numbers, so 149.3 becomes 149.

Frequency byte = 256 - 149 = 107 (decimal)
= 153 (octal)
= 6B (hex)

Frequency Table (Octave 4)

NOTE	NOTE(Hz)	DIVISOR	ERROR(%)	FREQUENCY BYTE (OCTAL)	(HEX)
B	493.88	79	+0.12	261	B1
A#	466.16	84	-0.24	254	AC
A	440.00	89	-0.25	247	A7
G#	415.31	94	+0.06	242	A2
G	392.00	100	-0.35	234	9C
F#	369.99	106	-0.40	226	96
F	349.23	112	-0.13	220	90
E	329.63	119	-0.42	211	89
D#	311.13	126	-0.36	202	82
D	293.67	133	+0.01	173	7B
C#	277.18	141	-0.05	163	73
C	261.63	149	+0.21	153	6B

3.4.4 Octave

The SBI can generate nine octaves of any pitch.set-up by the frequency byte. An octave is the change of pitch by two.

Example: Let XXFØ = A7 Hex.

XXF1 =	XØ	X1	X2	X3	X4	X5	X6	X7	X8
Frequency =	27.5	55	110	220	440	880	1760	3520	7040

3.4.5 Envelope Duration

The SBI can computer control the duration of its envelope over an eight to one range. The longest duration is set by the adjustable resistor at the top of the SBI card. The frequency range of oscillator (U8, pin 3) is about 60 to 600HZ, and should normally be set to about 200HZ.

Duration Equation.

TO = Envelope length in seconds.
FI = Frequency In from U8, pin 3.
16 = Number of envelope segments.
N = Duration Number to XXF2.

$$TO = \frac{(16-N)(16)}{FI}$$

3.4.6 Volume

The computer can change the volume of the SB1 over sixteen discrete levels. The control byte at XXF1 uses the upper 4-bits for setting the volume level.

Address	Byte	Comment
XXF1	0X	very quiet
XXF1	1X	very soft
XXF1	2X	soft sound
XXF1	3X	medium soft
-	-	- -
XXF1	EX	loud
XXF1	FX	very loud

4.0 Trouble Shooting Hints

a. Check for proper settings of Dip switches.
b. Verify that all ICs are in the correct sockets.
c. Visually inspect all ICs to be sure that leads are in the sockets and not bent under.
d. Verify that the output voltage of each regulator is correct.
e. Inspect back side of board for solder bridges, running a small sharp knife blade between traces that appear suspicious. A magnifying glass is a must for this.
f. If you have a addressing problem:
   1) Check U40 (74LSØ4), U28 (74ØØ), U36 & U37 (74L85) for addresses A15 thru A8.
g. If no 20MHz oscillation:
   Check U9 (74SØØ) circuit and IC.
h. If SBI's pitch is inconsistent or way off:
   Check U17 & U29 (74163) ICs. Clock to Carry output propagation delay is too long.
i. Card can not be initialized at XXF3:
   1) Check function select circuit. U25 (74LS42),U23 (74LSØØ), U26 (74LSØ4), U28 (74LSØØ) and U27 (7410) for a select circuit.
   2) Check U38 & U39 (8216) IC. Does your computer's CPU generate SWO?
   3) Check U40 (74LSØ4) IC.
j. Waveform present at U10, pin 2 but No output from card:
   1) Check U1 (MC1458) opamp. U1, pin 1 should be only +0.6v higher than pin 3. U1, pin 7 should be only +0.6v higher than pin 5.
   2) Check Q1 & Q2 transistors. Collectors should be at about +6 to +7 volts. Emitters should be at a potential greater than zero volts.
   3) Check Q4. Emitter should be at about -0.8 volts.

5.0 THEORY OF OPERATION

5.1 Useage

1) U1 (MC1458) is an operational amplifier used to current control, by the use of Q_1 & Q_2, the gain of U1Ø.
2) U2, U6, U26 & U28 are general logic functions.
3) U3 (74151) is used to select the octave range.
4) U4 (7493) & U5 (74197/8291) used to divide down the frequency by two's for use by the octave select U3.
5) U9 (74SØØ). Half of this IC is used as a 20mhz oscillator.
6) U7 (74163) is used to control the time of the envelope's duration.
7) U8 (555) is a low frequency oscillator used to drive U7 for envelope duration timing.
8) U10 (SSM 2000), a dual voltage controlled amplifier used to combine waveform & envelope together for a composite waveform and control the amplitude of this signal.
9) U11 (7430) is an end-of-envelope time detector.
10) U12 & U13 form a memory address sequencer used to control the envelope-ram (U19).
11) U14 & U15 form a memory address sequencer used to control the waveform-rams (U32 & U33).
12) U16 (8255) is used as three memory locations to control the frequency, octave, volume and on/off functions of the SB-1 card.
13) U17 & U29 (74163) are used as a programmable frequency divider to reduce 20mhz to some lower frequency.
14) U18 (7404) is used with some resistors to form a 4-bit DAC for generating the Envelope shape.
15) U19 (7489) is the Envelope data memory that drives U18.
16) U20 & U21 form a special function circuit for connecting envelope timing into the Waveform memory.
17) U22 & U34 (8216) are used to buffer address lines AØ thru A7 onto the SB1.
18) U23, U25 (7442) and U24 (7420) are used as address decoders for controlling internal logic.
19) U27 (7410) is used to control chip select of U38 & U39 and control the parallel loading/counting of U14 & U15.
20) U30 (8097) is used to generate wait-states in conjunction with U42 and generate the lower 2-bits of a 8-bit DAC.
21) U31 (8097) is used to generate the upper 6-bits of a 8-bit Waveform DAC.
22) U32 & U33 (2101) are 256X4 memory for saving user defined waveforms.
23) U36 & U37 (74L85) are 4-bit magnitude comparators used to set the address of the SB1 at some specific 256 boundary.
24) U38 & U39 (8216) are used as a bidirectional data buffer for receiving data from the computer.
25) U40 (74L04) is used to buffer read, write and power-on-clear signals into U16.
26) U41 (4194) is used as a ± 10 volt regulator.
27) U43, U44 & U45 are five volt regulators.

5.2 Operation

5.2.1 Board Addressing

The two magnitude comparator U36 & U37 are cascaded to decode one boundary of 256 by comparing the switch S1 (U35) with addresses A8 thru A14. A15 is used to enable U36 & U37 only if it is a logic one, which is from 8ØØØ to FFØØ Hex.

U37, pin 3 is sent through an inverter (U26, pin 9 & 8) to control U25. When the upper address bits are valid, then U26, pin 8 goes low and enables U25. U25 is used to decode boundaries of 32 bytes within the 256 possible. On the first four 32 byte boundaries a gate U24 is driven, so U24, pin 8 is a 128 byte decoder. U24, pin 8 goes high, if the bus address signals are within the first 128 bytes (waveform data) of 256. U25, pin 9 goes low, if the bus address signals are within the last 32 bytes (envelope & control data) of 256.

The last 32 bytes is divided into 4 byte boundaries by U23. The first 16 bytes is decoded by U24, pin 1, 2, 4 & 5 to give a high on pin 6 if the state is true. This is the envelope's ram address. The next 4 bytes are addressed to control U16 (8255) as if it was four bytes of memory.

5.2.2 Control Circuit

The Main control IC on the SB1 is U16 (8255). U16 is used as three output ports on the SB1 that are memory mapped. U16 must receive a mode control byte code after the SB1 is powered up to set its function (80 Hex).

Data is passed back and forth to the SB1's bidirectional bus by the use of U38 & U39. U38 & U39 (8216) are bidirectional tri-state drivers controlled by the addressing circuit (chip select) and $\overline{SWO}$ (direction ctrl).

U16 uses additional signals like DBIN, $\overline{WR}$, AØ and A1, and all these signals are buffered by U40 & U34.

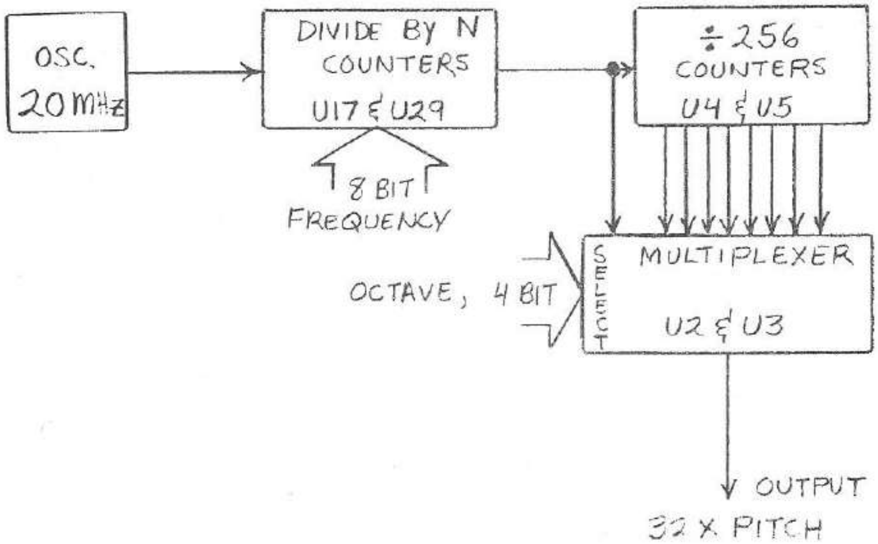
The three ports of U16 are used as follows:

Port A (pins 1 thru 4, 37 thru 40)--- Frequency Control
Port B (pins 18 thru 25)--- Volume/Octave Control
Port C (pins 10 thru 17)--- Special CTRL byte

Port A drives the parallel input lines of the frequency counters U17 & U29 to control pitch. Pins 22 thru 25 of Port B drives a resistor network to form a 4-bit DAC for volume control. Pins 18 thru 21 of Port B drives the select lines of a multiplexer (U3) to select the octave range of the SB1. Pins 14 thru 17 of Port C are used to drive the parallel input lines of U7 to control the Envelope's duration.

5.2.3 Main Pitch Generator

The main pitch of the SB1 is set by dividing down the frequency of a 20mhz oscillator through four counters (U4, U5, U17, U29) and selecting the desired octave by a multiplexer (U2, U3).

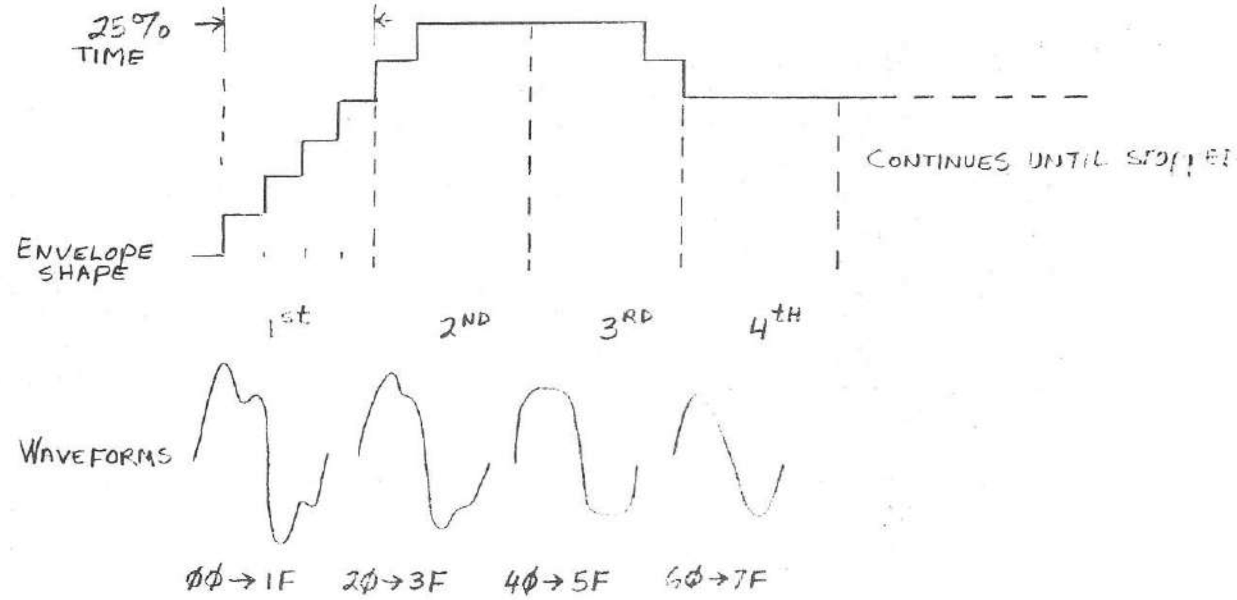


The frequency at the output of the multiplexer is 32 times the pitch you will hear, because the SB1 constructs its waveforms out of 32 data bytes (sample technique) from U32 & U33.

5.2.4 Waveform Addressing Circuit

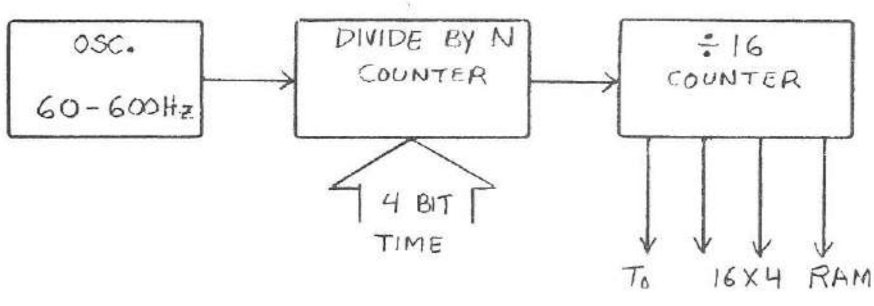
The waveform addressing circuit consist of two counters (U14 & U15), a couple of nand gates (U27 & U28) and a Quad two-input multiplexer (U21). The two counters drive five of the addressing lines of the 256X4 memories U32 & U33, which will give 2^5 or 32 possible segments to the generated waveform. The counters are driven by a clock frequency from the main pitch generation circuit. The computer is given access to U32 & U33 by placing a load signal on U14 & U15 by changing the logic signal at U27, pin 12 to a low-state. Loading of U32 & U33 with waveform data is inhibited when the SB1 is running (U9, pin 8 = 1).

The use of a multiplexer (U21) in the addressing circuit is to allow four waveforms to be generated during a envelope period for special voicing (sound effects). U20, a header, ties some of the envelope timing signals to U21 which in turn controls two address lines of U32 & U33. For every four segments (25%) of the envelope shape a new waveform shape can be selected.



5.2.5 Envelope Addressing Circuit

The envelope addressing circuit consist of one low frequency oscillator (U8), a couple of gates (U6, U13 & U26) and two counters (U7 & U12). U8 is a 555 timer IC that runs at a frequency from 60 to 600hz depending on the setting of a 100K potentiometer on the SB1. The frequency from U8 is sent to U7 so the computer has some limited control over envelope duration by preseting the starting count in U7. Four bits from U16 control the starting count of U7 to give an 8 to 1 frequency control range.



The counter U12 receives its basic clock frequency from U7 and divides it down by 16. The outputs (4-bits) of U12 directly drives the addressing lines of U19 (16X4 ram) which contains envelope shape data. To load U19 the counter, U12 is put in a parallel load mode to pass the computer's address signals directly through to U19.

5.2.6 Digital-to-Analog Converters (DAC)

The DAC's used on the SB1 are called resistor-ladders and are composed of 11K and 22K ohm resistors. The Volume is set by 4-bit DAC off of U16, envelope shape is set by a 4-bit DAC off U18 and the waveform shape is a 8-bit off of U30 & U31. The 8-bit DAC needs more accurate resistors than 5%, so 8 resistors are 1%.

5.2.7 Analog Output Circuit

The output circuit consist of a dual opamp (U1), a few transistors (Q1 to Q4) and a dual voltage control amplifier (U10). The transistor (Q1) and U1A form a voltage controlled current source to control U10A. The transistor (Q2) and U1B form a voltage controlled current source to control U10B. The 8-bit waveform DAC is fed to U10, pin 2 and the 4-bit envelope DAC controls the amplitude waveform by driving U1, pin 3. The composite waveform is sent to the next stage of U10, pin 8 for volume control by a 4-bit DAC driving U1, pin 5. Q3 is used to turn down the volume of the SB1 (when it is stopped) by grounding the volume control signal.

The final composite waveform is buffered by an emitter follower (Q4) to give a low impedance output for driving an Auxiliary Amplifier. The 330 ohm resistor is series with the output is used to short proof the output circuit.

6.0 Warranty

Solid State Music warrants its products to be free from defects in materials and/or workmanship for a period of 90 days for kits and bare boards, and one (1) year for factory assembled boards. In the event of malfunction or other indication of failure attributable directly to faulty workmanship and/or material, then, upon return of the product (postage paid) to Solid State Music at 2116A Walsh Ave., Santa Clara, California, 95050 "Attention Warranty Claims Department", Solid State Music will, at its option, repair or replace the defective part or parts to restore said product to proper operating condition. All such repairs and/or replacements shall be rendered by Solid State Music without charge for parts or labor when the product is returned within the specified period of the date of purchase. This warranty applies only to the original purchaser.

This warranty will not cover the failure of Solid State Music products which, at the discretion of Solid State Music, shall have resulted from accident, abuse, negligence, alteration, or misapplication of the product. While every effort has been made to provide clear and accurate technical information on the application of Solid State Music products, Solid State Music assumes no liability in any events which may arise from the use of said technical information.

This warranty is in lieu of all other warranties, expressed or implied, including warranties of mercantability and fitness for use. In no event will Solid State Music be liable for incidental and consequential damages arrising from or in any way connected with the use of its products.

9-7-1977
M.T.W

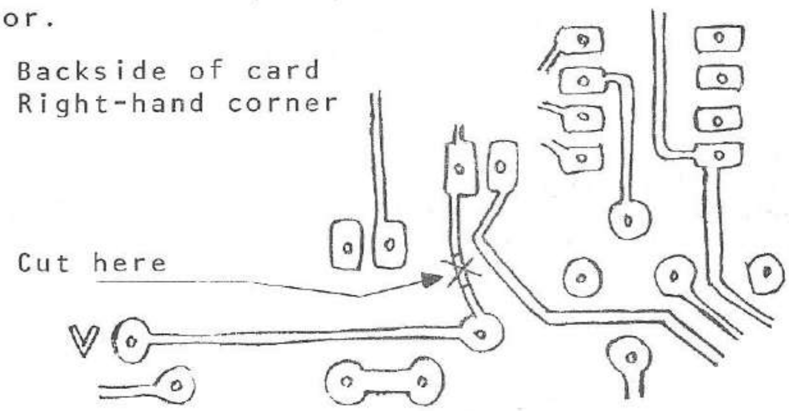
SB-1 MOD-KIT

It has been found that the turn-off characteristics of the SB-1 card can be improved by changing the interconnections to Q3. The Q3 transistor is used to decrease the card's volume when it was not producing sound. The present interconnection of Q3 causes an unwanted DC level shift in the output signal when the card is turned off.

Please make the following card changes:

1. Remove the jumper that went from a pad "V"(label on backside of the card) to a small pad to the left of a 22K ohm resistor and U16(8255 chip).
   Note: By the way, label the small pad near the 22K resistor as pad "OV"(output volume control).

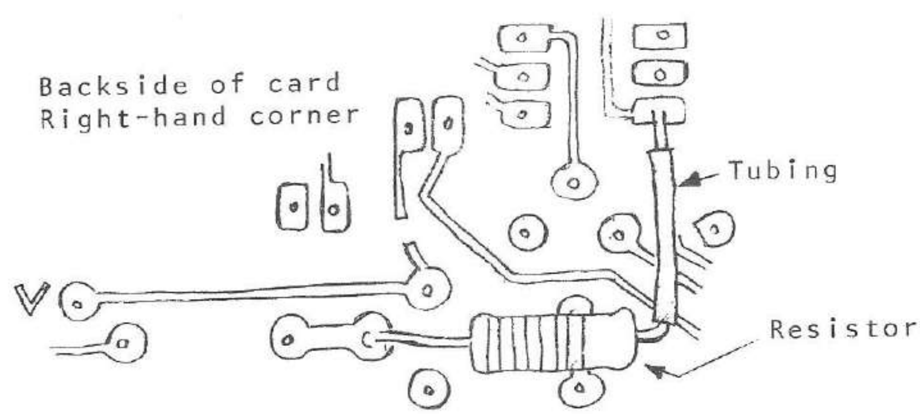
2. Cut the printed circuit trace with a razor blade on the backside of the SB-1 that runs from Q3-collector(lead of Q3 closest to the top edge of the card) to the 0.1 mfd capacitor.



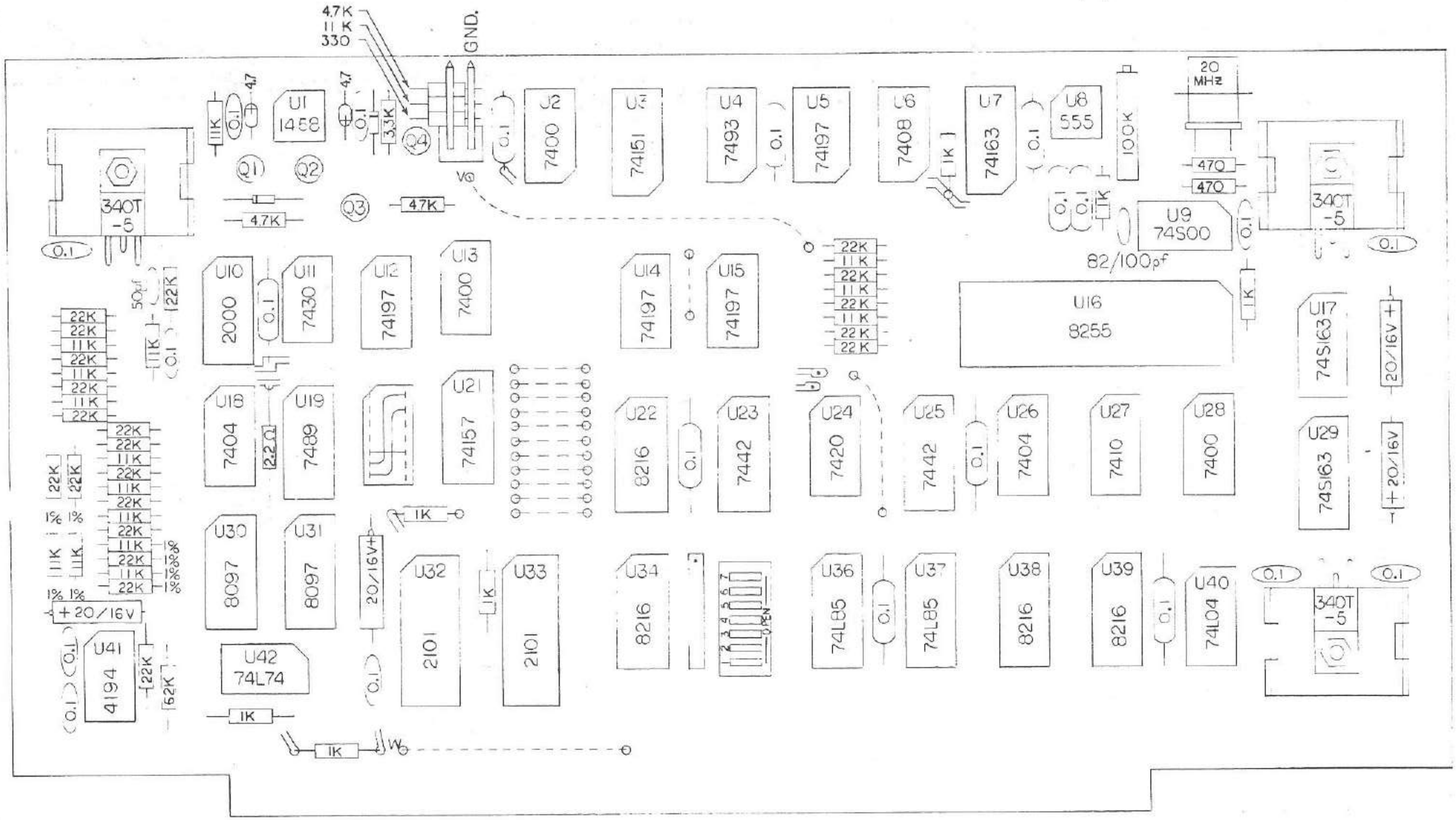
3. Connect a jumper wire from "OV"(see note for step1) to to pin 5 of U1(1458 chip).

4. Connect a jumper wire from "V"(just below the two pin output connector,on backside) to pin 1 of U10(SSM 2000 IC).

5. Add a 33K ohm,5%,1/4 W resistor to the card. Slip 3/8 inch of insulating tubing over one lead of the 33K resistor. Solder the insulated lead to pin 4 of U1(1458 chip) and the other lead to the base of Q3. See diagram below.



REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED



- - - - - JUMPERS
○ SOLDER PAD
—▷|— DIODE

TOLERANCES UNLESS OTHERWISE SPECIFIED FRACTIONS DEC ANGLES	COPYRIGHT 1977 SOLID STATE MUSIC		
APPROVALS / DATE — DRAWN DBM. CHECKED	SB:1 SOLID STATE MUSIC		
	SCALE 2:1	SIZE C	DRAWING NO
	DO NOT SCALE DRAWING		SHEET

SB1 PARTS LIST

IC Pack

1 - U1	MC1458/1458/AM1458
3 - U2,13,28	7400
1 - U3	74151/ 74LS151
1 - U4	7493/74LS93
4 - U5,12,14,15	8291/74197
1 - U6	7408/74LS08
1 - U7	74163
2 - U17,29	74S163
1 - U8	LM555
1 - U9	74S00
1 - U10	SSM2000
1 - U11	7430/74LS30
2 - U18,26	7404/74LS04
1 - U19	7489
1 - U21	74157
2 - U23,25	7442/74LS42
1 - U24	7420
1 - U27	7410/74LS10
2 - U30,31	74367/8097
4 - U22,34,38,39	8216
2 - U36,37	74L85
1 - U40	74L04/74LS04
1 - U41	RC4194
1 - U42	74L74

Memory Pack

1 - U16	8255
2 - U32,33	2101

Resistor pack #1

12	11K 1/4w 5%
17	22K 1/4w 5%
1	2.2 ohm 1/4w 5%
1	330 ohm 1/4w 5%
2	470 ohm 1/4w 5%
7	1K 1/4w 5%
1	3.3K 1/4w 5%
3	4.7K 1/4w 5%
1	62K 1/4w 5%

Resistor Pack #2

1	100K potentiometer
1	SIP 7 x 4.7K
4	11.0K 1%
4	22.1K 1%

Capacitor Pack

2	82/100pf disc
10	0.1uf disc
4	20uf 16v dc
2	4.7uf drop tantalum
10	0.1uf ceramic

Transistor Pack

3	7805/340T-5
4	2N3693
2	1N914/1N914A
1	20Mhz xtal

Socket Pack

1	7 position DIP switch
1	14 pin header
2	16 pin sockets
1	40 pin socket
2	8 pin sockets
2	22 pin sockets

Hardware Pack

3	sets #6 hardware
3	heatsinks
1	set molex connector

Misc.

PC board
Music program tape

15	16 pin sockets
19	14 pin sockets
1	Mod kit