– APPENDIX I –

THE PROGRAMMABLE SOUND GENERATOR

Controlling the PSG

Creating sound effects and music is possible with either of two system calls. **Dosound()** processes commands in a supplied buffer during interrupt processing (50 times per second). It is best suited, therefore, at playing musical passages while program flow continues. **Giaccess()** provides register-level control over the PSG resulting in a higher level of flexibility and constant updating by the application. This makes **Giaccess()** more suited for short sound effects.

The function definitions of **Dosound()** and **Giaccess()** both reference the register numbers of the PSG. It should be noted that registers 14 and 15 actually control periperals connected to Port A and Port B of the PSG. The PSG's registers are assigned as follows:

Name	*register*	Meaning
PSG_APITCHLOW **PSG_BPITCHHIGH**	0 1	Set the pitch of the PSG's channel A to the value in registers 0 and 1. Register 0 contains the lower 8 bits of the frequency and the lower 4 bits of register 1 contain the upper 4 bits of the frequency's 12-bit value.
PSG_BPITCHLOW **PSG_BPITCHHIGH**	2 3	Set the pitch of the PSG's channel B to the value in registers 0 and 1. Register 0 contains the lower 8 bits of the frequency and the lower 4 bits of register 1 contain the upper 4 bits of the frequency's 12-bit value.
PSG_CPITCHLOW **PSG_CPITCHHIGH**	2 3	Set the pitch of the PSG's channel C to the value in registers 0 and 1. Register 0 contains the lower 8 bits of the frequency and the lower 4 bits of register 1 contain the upper 4 bits of the frequency's 12-bit value.
PSG_NOISEPITCH	6	The lower five bits of this register set the pitch of white noise. The lower the value, the higher the pitch.
PSG_MODE	7	This register contains an eight bit map which determines various aspects of sound generation. Setting each bit on causes the following actions: **Name** — **Bit Mask** — **Meaning** **PSG_ENABLEA** 0x01 Chnl A tone enable **PSG_ENABLEB** 0x02 Chnl B tone enable **PSG_ENABLEC** 0x04 Chnl C tone enable **PSG_NOISEA** 0x08 Chnl A white noise on **PSG_NOISEB** 0x10 Chnl B white noise on **PSG_NOISEC** 0x20 Chnl C white noise on **PSG_PRTAOUT** 0x40 Port A: 0 = input, 1 = output **PSG_PRTBOUT** 0x80 Port B: 0 - input, 1 = output
PSG_AVOLUME	8	This register controls the volume of channel A. Values from 0-15 are absolute volumes with 0 being the softest and 15 being the loudest. Setting bit 4 causes the PSG to ignore the volume setting and to use the envelope setting in register 13.
PSG_BVOLUME	9	This register controls the volume of channel B. Values from 0-15 are absolute volumes with 0 being the softest and 15 being the loudest. Setting bit 4 causes the PSG to ignore the volume setting and to use the envelope setting in register 13.

PSG_CVOLUME	10	This register controls the volume of channel C. Values from 0-15 are absolute volumes with 0 being the softest and 15 being the loudest. Setting bit 4 causes the PSG to ignore the volume setting and to use the envelope setting in register 13.
PSG_FREQLOW **PSG_FREQHIGH**	11 12	Register 11 contains the low byte and register 12 contains the high byte of the frequency of the waveform specified in register 13. This value may range from 0 to 65535.
PSG_ENVELOPE	13	The lower four bits of the register contain a value which defines the envelope wavefrom of the PSG. The best definition of values is obtained through experimentation.
PSG_PORTA	14	This register accesses Port A of the Yamaha PSG. It is recommended that the functions **Ongibit()** and **Offgibit()** be used to access this register.
PSG_PORTB	15	This register accesses Port B of the Yamaha PSG. This register is currently assigned to the data in/out line of the Centronics Parallel port.

The following table lists the twelve-bit value required to produce the desired musical tones with the PSG's tone generators A, B, and C. The upper nibble of the value is placed into the 'coarse-tuning' register and the lower **BYTE** is placed into the 'fine-tuning' register. In addition, because the PSG must approximate musical frequencies according to an equal-tempered scale, the ideal and actual frequencies are also listed.

Note	Ideal Frequency	Actual Frequency	Value
C1	32.703	32.698	0xD5D
C#1	34.648	34.653	0xC9C
D1	36.708	36.712	0xBE7
D#1	38.891	38.895	0xB3C
E1	41.203	41.201	0xA9B
F1	43.654	43.662	0xA02
F#1	46.249	46.243	0x973
G1	48.999	48.997	0x8EB
G#1	51.913	51.908	0x86B
A1	55.000	54.995	0x7F2
A#1	58.270	58.261	0x780
B1	61.735	61.733	0x714
C2	65.406	65.416	0x6AE
C#2	69.296	69.307	0x64E
D2	73.416	73.399	0x5F4
D#2	77.782	77.789	0x59E
E2	82.406	82.432	0x54D
F2	87.308	87.323	0x501
F#2	92.498	92.523	0x4B9
G2	97.998	98.037	0x475
G#2	103.826	103.863	0x435
A2	110.000	109.991	0x3F9
A#2	116.540	116.522	0x3C0
B2	123.470	123.467	0x38A
C3	130.812	130.831	0x357

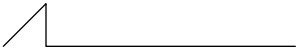
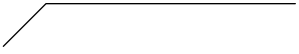
Note	Ideal Frequency	Actual Frequency	Value
C#3	138.592	138.613	0x327
D3	146.832	146.799	0x2FA
D#3	155.564	155.578	0x2CF
E3	164.812	164.743	0x2A7
F3	174.616	174.510	0x281
F#3	184.996	184.894	0x25D
G3	195.996	195.903	0x23B
G#3	207.652	207.534	0x21B
A3	220.000	220.198	0x1FC
A#3	233.080	233.043	0x1E0
B3	246.940	246.933	0x1C5
C4	261.624	261.357	0x1AC
C#4	277.184	276.883	0x194
D4	293.664	293.598	0x17D
D#4	311.128	310.724	0x168
E4	329.624	329.973	0x153
F4	349.232	349.565	0x140
F#4	369.992	370.400	0x12E
G4	391.992	392.494	0x11D
G#4	415.304	415.839	0x10D
A4	440.000	440.397	0xFE
A#4	466.160	466.087	0xF0
B4	493.880	494.959	0xE2
C5	523.248	522.714	0xD6
C#5	554.368	553.766	0xCA

Note	Ideal Frequency	Actual Frequency	Value
D5	587.328	588.741	0xBE
D#5	622.256	621.449	0xB4
E5	659.248	658.005	0xAA
F5	698.464	699.130	0xA0
F#5	739.984	740.800	0x97
G5	783.984	782.243	0x8F
G#5	830.608	828.598	0x87
A5	880.000	880.794	0x7F
A#5	932.320	932.173	0x78
B5	987.760	989.918	0x71
C6	1046.496	1045.428	0x6B
C#6	1108.736	1107.532	0x65
D6	1174.656	1177.482	0x5F
D#6	1244.512	1242.898	0x5A
E6	1318.496	1316.009	0x55
F6	1396.928	1398.260	0x50
F#6	1479.968	1471.852	0x4C
G6	1567.968	1575.504	0x47
G#6	1661.216	1669.564	0x43
A6	1760.000	1747.825	0x40
A#6	1864.640	1864.346	0x3C
B6	1975.520	1962.470	0x39
C7	2092.992	2110.581	0x35
C#7	2217.472	2237.216	0x32

Note	Ideal Frequency	Actual Frequency	Value
D7	2349.312	2330.433	0x30
D#7	2489.024	2485.795	0x2D
E7	2636.992	2663.352	0x2A
F7	2793.856	2796.520	0x28
F#7	2959.936	2943.705	0x26
G7	3135.936	3107.244	0x24
G#7	3322.432	3290.023	0x22
A7	3520.000	3495.649	0x20
A#7	3729.280	3728.693	0x1E
B7	3951.040	3995.028	0x1C
C8	4185.984	4142.992	0x1B
C#8	4434.944	4474.431	0x19
D8	4698.624	4660.866	0x18
D#8	4978.048	5084.581	0x16
E8	5273.984	5326.704	0x15
F8	5587.712	5593.039	0x14
F#8	5919.872	5887.410	0x13
G8	6271.872	6214.488	0x12
G#8	6644.864	6580.046	0x11
A8	7040.000	6991.299	0x10
A#8	7458.560	7457.560	0xF
B8	7902.080	7990.056	0xE

Sound Envelopes

An envelope may be applied to sounds generated by the PSG. Registers 11 and 12 specifiy the frequency of this envelope and the low four bits of register 13 specifies the envelope shape as follows (an ‘x’ digit means either 0 or 1):

Value	Waveform Shape
%00xx	
%01xx	
%1000	
%1001	
%1010	
%1011	
%1100	
%1101	
%1110	
%1111