1. General Description

The GM82C650 is a high performance digital sound generator, which is applicable for many musical applications like PC sound card, sound module, karaoke, keyboard,and digital piano etc.

Special features are added for PC application. Those are game port, CD-ROM interface and PC interface.

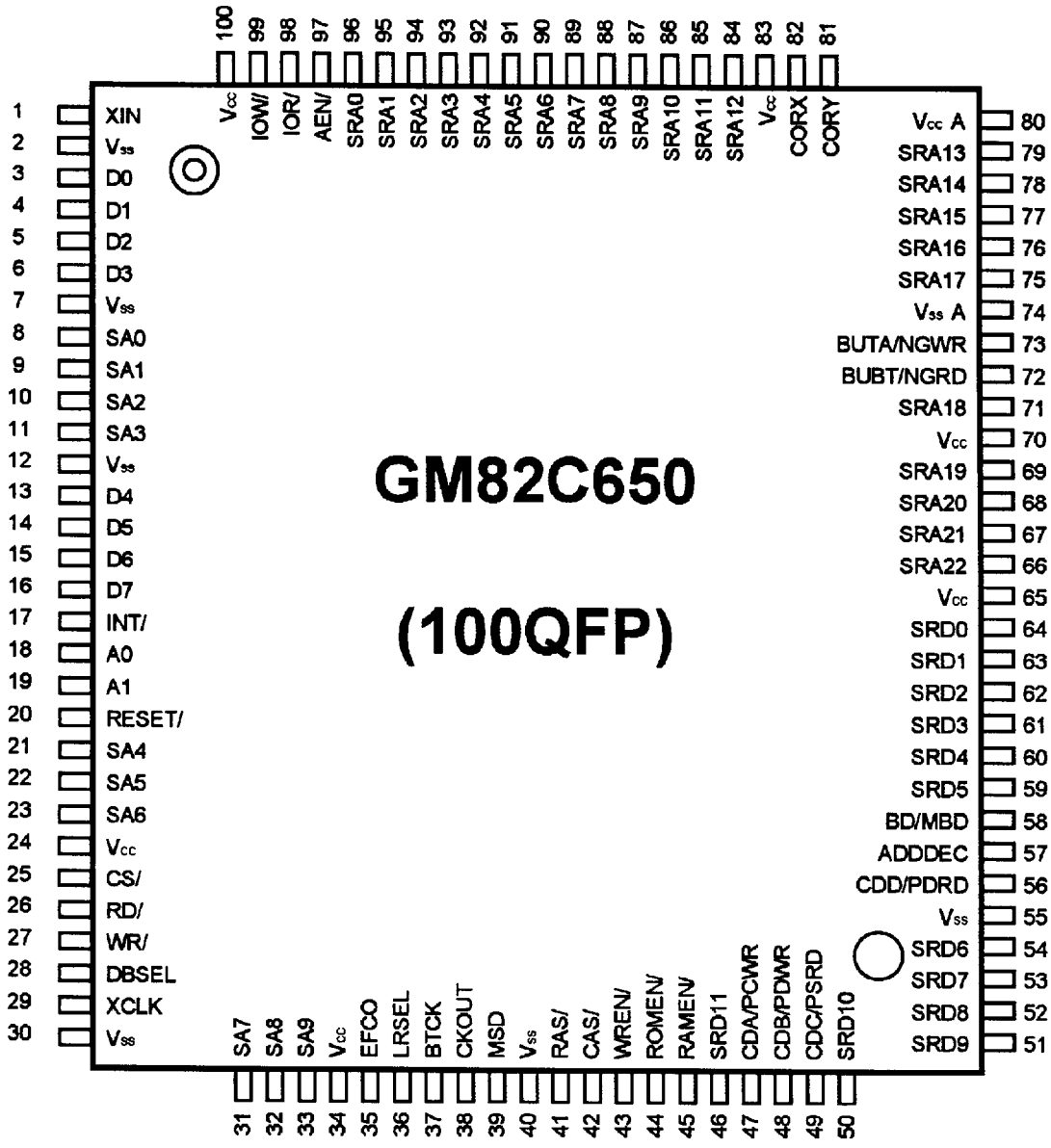
The GM82C650 provides DRAM interface function for user specified sound data, ROM and RAM can be used simultaneously.

The GM82C650 supports various format of DAC up to 20bits to generate the high quality sound data.

2. Feature

- Sound algorithm : PCM / FM (2 operator)
- Polyphony : 16 - 32 voices (up to 32)
- Sound data : Up to 8M x 12 (GM,GS mode support)
  Direct addressing of 8M word address range.
- Sampling rate : Up to 46KHz from 22KHz. Depends on sound quality.
- DAC Interface : Up to 20bits (16, 18, 20bits), Sony or Phillips format supports.
- Maximum envelope level : 8192 steps.
- Auto looping : Up to 128K (256 - 128K)
- Amplitude rate : 256 levels.
- Sound effect channel.
- Two stereo audio output with individual mix at the voice level.
- For multimedia PC application : Built in game port
  : Built in CD-ROM interface (Matsushita,GoldStar)
  : Built in DRAM interface for user sampled data.
- Technology : High performance 0.8 micron CMOS process.
- Package type : 100 QFP

3. Package configuration



4. 82C650 Pin function & Description

Pin No.	Pin Name	I/O	Pin function	Pin No.	Pin name	I/O	Pin function
1	XIN	I	Clock input	26	RD/	I	Read enable
2	Vss			27	WR/	I	Write enable
3	D0	I/O	Data bus 0	28	DBSEL	O	Data bus select
4	D1	I/O	Data bus 1	29	XCLK	O	External clock
5	D2	I/O	Data bus 2	30	Vss		
6	D3	I/O	Data bus 3	31	SA7	I-PU	Slot address 7
7	Vss			32	SA8	I-PU	Slot address 8
8	SA0	I-PU	Slot address 0	33	SA9	I-PU	Slot address 9
9	SA1	I-PU	Slot address 1	34	Vcc		
10	SA2	I-PU	Slot address 2	35	EFCO	O	Effect channel out
11	SA3	I-PU	Slot address 3	36	LRSEL	O	Left,Right select
12	Vss			37	BTCK	O	Bit clock for data
13	D4	I/O	Data bus 4	38	CKOUT	O	Clock out
14	D5	I/O	Data bus 5	39	MSD	O	Main serial data
15	D6	I/O	Data bus 6	40	Vss		
16	D7	I/O	Data bus 7	41	RAS/	O	RAS Enable
17	INT/	O	Interrupt	42	CAS/	O	CAS Enable
18	A0	I	Address 0 from CPU	43	WREN/	O	RAM Write enable
19	A1	I	Address 1 from CPU	44	ROMEN/	O	ROM Out enable
20	RESET/	I	Reset from PC slot	45	RAMEN/	O	RAM Out enable
21	SA4	I-PU	Slot address 4	46	SRD11	I	Sound data 11
22	SA5	I-PU	Slot address 5	47	CDA/PCWR	O	CD control
23	SA6	I-PU	Slot address 6	48	CDB/RDWR	O	CD control
24	Vcc			49	CDC/PRSD	O	CD control
25	CS/	I	Chip select by CPU	50	SRD10	I/O	Sound ROM data 10

* Note : Pin 47,48,49,56 make read a game data when the read signal become enable

Pin No.	Pin name	I/O	Pin function	Pin No.	Pin name	I/O	Pin function
51	SRD9	I/O	Sound ROM data 9	76	SRA16	I/O-U	*NOTE (1)
52	SRD8	I/O	Sound ROM data 8	77	SRA15	I/O-U	
53	SRD7	I/O	Sound ROM data 7	78	SRA14	I/O-D	
54	SRD6	I/O	Sound ROM data 6	79	SRA13	I/O-D	
55	Vcc			80	Vcc A		Analog Vcc
56	CDD/PDRP	O	CD Control	81	CORY	I-U	GAME port X,Y
57	ADDDEC	O	CD Address decoder	82	CORX	I-U	*NOTE (2)
58	BD/MBD	I	*NOTE (0)	83	Vcc		
59	SRD5	I/O	Sound ROM data 5	84	SRA12	I/O-D	*NOTE (1)
60	SRD4	I/O	Sound ROM data 4	85	SRA11	I/O-D	
61	SRD3	I/O	Sound ROM data 3	86	SRA10	I/O-D	
62	SRD2	I/O	Sound ROM data 2	87	SRA9	I/O-D	
63	SRD1	I/O	Sound ROM data 1	88	SRA8	O	Sound ROM address 8
64	SRD0	I/O	Sound ROM data 0	89	SRA7	O	Sound ROM address 7
65	Vcc			90	SRA6	O	Sound ROM address 6
66	SRA22	I/O-U	*When input mode- NOTE (1) *When output mode- It's used sound ROM/RAM address pointer	91	SRA5	O	Sound ROM address 5
67	SRA21	I/O-U		92	SRA4	O	Sound ROM address 4
68	SRA20	I/O-U		93	SRA3	O	Sound ROM address 3
69	SRA19	I/O-U		94	SRA2	O	Sound ROM address 2
70	Vss			95	SRA1	O	Sound ROM address 1
71	SRA18	I/O-U	*NOTE (1)	96	SRA0	O	Sound ROM address 0
72	BUTB/NGRD	I/O-U	*NOTE (2)	97	AEN/	I-U	Address enable
73	BUTA/NGWR	I/O-U		98	IOR/	I-U	I/O Read enable
74	Vss A		Analog Vss	99	IOW/	I-U	I/O Write enable
75	SRA17	I/O-U	*NOTE (1)	100	Vcc		

* Note 0 : Pin 58 (BD/MBD) = Low (External pull down) >> Sound Module application

= High (External pull up) >> PC sound card application

* Note 1 : SAR22 - SAR10 pins are used for setting internal condition when input mode. and it have set up by means of pull up, pull down.

- This setting mode is usable only when pin 58 = high (sound card application)
- Internal configuration registers will be setting by external pull-up, pull down condition during the reset period.

SRA22 - SRA15	For CD ROM Address Decording (Internally Pull Up)
SRA14	High = CD ROM Enable (Internally Pull Down) Low = CD ROM Disable.
SRA13	High = GoldStar CD ROM Enable (Internally Pull Down) Low = MATSUSITA CD ROM Enable.
SRA12	High = Game port Enable (Internally Pull down) Low = Game port Disable (External Game port using)
SRA11	High = Game port Enable (Internally Pull Down) Low = External Game port using.
SRA10	Reserved.
SRA9	High = 12 BIT ROM data (Internally Pull Down) Low = 8 BIT ROM data.

*Note 2 : When you use the internal Game Port

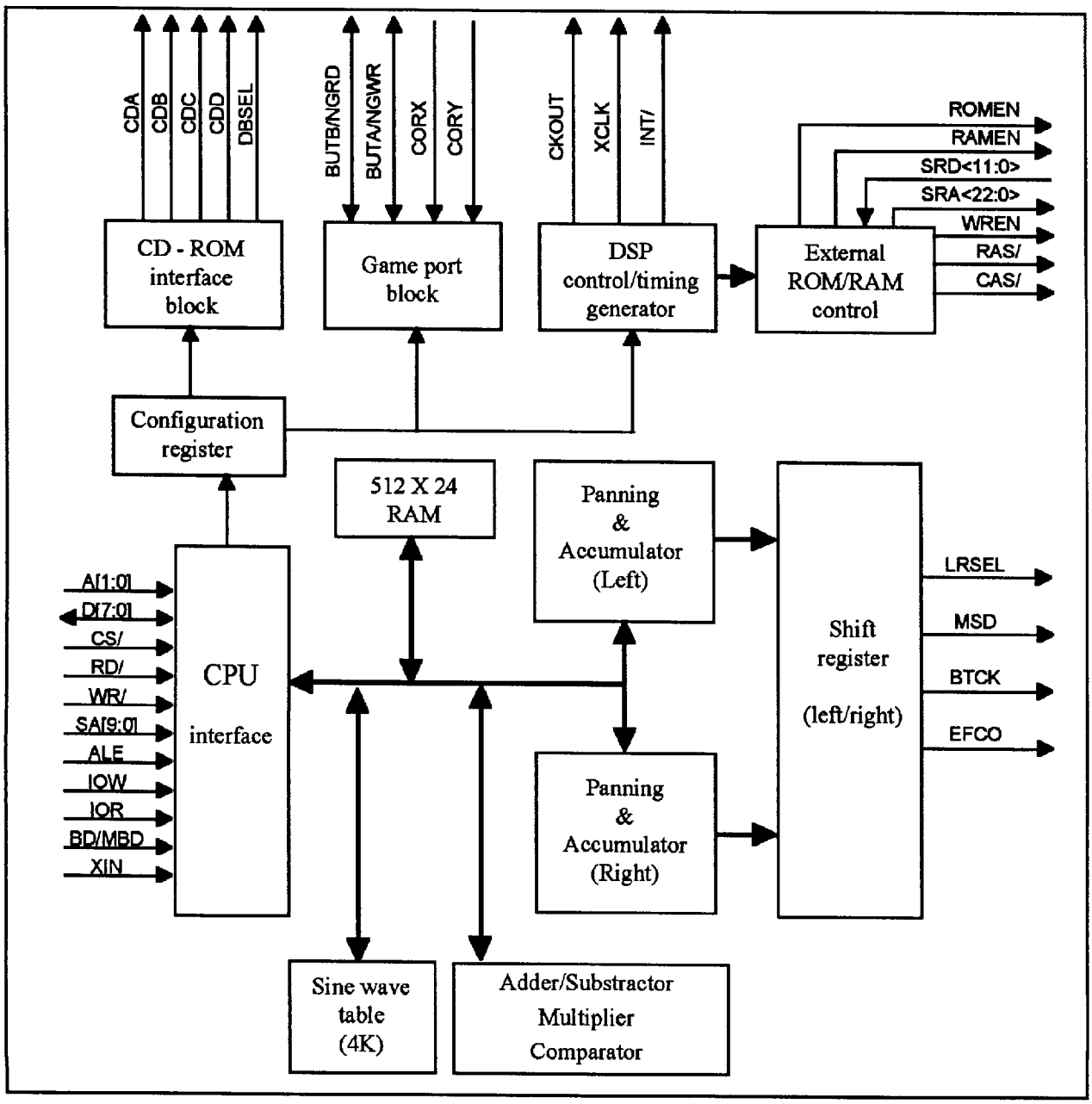
Pin 73 = Button A.
Pin 72 = Button B.
Pin 81 = Y value.
Pin 82 = X value

When you use the external Game Port

pin 72 = Game port read enable output.
Pin 73 = Game port write enable output.
Pin 81 = Not used.
Pin 82 = Not used.

5. GM82C650 Function Block Diagram

The GM82C650 has the DSP based architecture to generate a high quality audio sound. This DSP architecture includes built-in sound algorithm for PCM and FM(2 operator with - - feedback) The built-in algorithm can be controlled by user with variable parameter. The GM82C650 has some additional periphery function to provide a low cost solution for multimedia PC audio function. Those are game port, CD-ROM interface, DRAM interface for user sampled data, sine wave table.



6. Configuration Register Setting

Internal configuration register can be controlled by external pull up or pull down register to set a internal periphery function mode. During power on reset, then GM82C650 reads the external setting condition through SRA9 to SRA22 pins.
These SRA9 - SRA22 pins have pull up or pull down internally already.
If external condition is same as internal. External register setting is not necessary.

• Configuration register 1.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
-	-	CDEN	CDTYPE	GAMEEN	EXGAME	-	ROMTYPE

Bit 0 : The data type of sound ROM

Using SRA9 pin (Internally pull down)
Pull up = 12 bit ROM data size
Pull down = 8 bit ROM data size

Bit 1 : Reversed

Bit 2 : Internal or external game port selection

Using SRA11 pin (Internally pull down)
Pull up = Internal game port select
Pull down = External game port select

Bit 3 : Game port enable

Using SRA12 pin (Internally pull down)
Pull up = game port enable
Pull down = game port disable

Bit 3 : Game port enable

Using SRA12 pin (Internally pull down)
Pull up = game port enable
Pull down = game port disable

Bit 4 : CD type select

Using SRA13 pin (Internally pull down)
Pull up = GoldStar CD ROM enable
Pull down = Matsusita CD ROM enable

Bit 5 : CD ROM enable

Using SRA14 pin (Internally pull down)
Pull up = CD ROM enable
Pull down = CD ROM disable

BIt 6,7 : Reserved

• Configuration register 2.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Add 7	Add 6	Add 5	Add 4	Add 3	Add 2	Add 1	Add 0

Bit 0 - 7 : These bits are used to set the CD address decoding value
Extenal pull up or pull down register should be used.
The 8 bit magnitude comparator (74LS688) function is included in a chip.
The output of this comparator can be used for external CD interface logic.
User dose not need to use 74LS688 externally.

Configuration register 3.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
SR3	SR2	SR1	SR0	DAC	IM	OFFSET	IDLE

Bit 7-4 : Sampling rate control during power on, default value is 40.8497 KHz

SR3	SR2	SR1	SR0	Sampling Rate	Slot Assign
0	0	0	0	40.8497 KHz	18 Slots
0	0	0	1	36.7647 KHz	20 Slots
0	0	1	0	33.4225 KHz	22 Slots
0	0	1	1	30.6373 KHz	24 Slots
0	1	0	0	28.2805 KHz	26 Slots
0	1	0	1	26.2605 KHz	28 Slots
0	1	1	0	24.5098 KHz	30 Slots
0	1	1	1	22.9779 KHz	32 Slots
1	X	X	X	45.9569 KHz	16 Slots

Bit 3 : DAC format select.
GM82C650 can support philips' DAC format and Sony's DAC format both.
During power on, default is philips format.
0 = philips' format, LSB idling.
1 = Sony's format, MSB idling.

Bit 2 : This control bit is used for masking of interrupt signal.
During power on, default state is masking.
0 = masking.
1 = Non- masking.

Bit 1 : GM82C650 can provide a offset value for DAC serial output.
During power on, default state is no offset
0 = No offset.
1 = Offset (5% positive DC offset)

Bit 0 : The processing of all slots are controlled by parameter RAM content.
But all slots are in idle mode by configration register bit 0.
During power on, This is in idle mode.
0 = Idle mode.
1 = Normal processing mode.

7. Electrical Chracteristics.

• Maximum Absolute Ratings.

Ambient Temperature : 0°C to 70°C
Storage Temperature : - 65°C to + 150°C
Voltage1(pin to Vss) : - 0.5V to Vcc + 0.5V
Voltage2(Vcc to Vss) : - 0.5V to 6.5V

• DC Characteristics.

Symbol	Function	Spec.			Unit	Test Condition	
		Min	Typ	Max			
V_{dd}	Operating Voltage	4.5	5	5.5	V		
I_{dd}	Operating Current		60	80	mA	V_{dd} = 5 V, CLK = 50MHz	
I_{st}	Stand by current		15	20	mA	V_{dd} = 5 V, No CLK	
V_{il}	Input Low Voltage			0.8	V		
V_{ih}	Input High Voltage	2.0			V		
V_{ol1}	Output Low Voltage			0.45	V	I_{ol1} = 2mA	Note 1
V_{ol2}	Output Low voltage			0.45	V	I_{ol2} = 4mA	
V_{oh1}	Output High Voltage	2			V	I_{oh} = 800 u A	
V_{oh2}	Output High Voltage	4			V	I_{oh} = 800 u A	
I_{il1}	Input leakage current Without Pull Up/Down			± 10	μA	Note 2 0.45 < V_{in} < V_{dd}	
I_{il2}	Input leakage current Without Pull Up/Down			± 500	μA	Note 2 0.45 < V_{in} < V_{cc}	

Note 1 : 2mA = INT, DBSEL, EFCO, LRSEL, BTCK, MSD, BUTA, BUTB Pins
4mA = Others

Note 2 : Pull up = SA 0 - 9, BUTA, BUTB, CORX, CORY, SRA15 - 22
Pull down = SRA 9 - 14

- **AC Chracteristics & System Timing.**

Symbol	Parameters	Spec.			Unit
		Min	Typ	Max	
1/ T_{CLCL}	Oscillator frequency		50		MHz
T_{CSWR}	CS/ low to WR/ high	10			ns
T_{WRCS}	WR/ high to CS/ high	10			ns
T_{ADWR}	A0,A1,D0-D7 valid before rising WR/	20			ns
T_{WRAD}	A0,A1,D0-D7 valid after rising WR/	10			ns
T_{WW}	WR/ pluse width	40			ns
T_{AS}	Address setup time to CS/ low	10			ns
T_{AH}	Address hold time from CS/ rising	20			ns
T_{RDA}	A0 - A2 hold from RD/ ROM, RAM Access timing	10			ns
T_{SWA}	SRA valid before RAS/ or CAS/ H to L	10 (50MHz)			ns
T_{HWA}	SRA valid after RAS/ or CAS/ H to L AT mode timing	10 (50MHz)			ns
T_{IOADD}	ADDEC inactive from IOR/ inactive	20			ns
T_{IOCD}	CDA, CDB, CDC, CDD data hold from IOR/ DATA, CLOCK output timing	20			ns
$T_{XINBTCK}$	Input clock to BTCK delay			20	ns
T_{XIND}	Input clock to DATA delay			20	ns
$T_{XINXCLK}$	Input clock to XCLK delay			10	ns
T_{RDLD}	RD/ Active to valid data out			20	ns
T_{RDH}	Read data hold time	20			ns
T_{CSW}	CS/ read width	40			ns
T_{RDW}	RD/ width	20			ns

8. Timing Diagram.

Fig 1. Processor Write Cycle

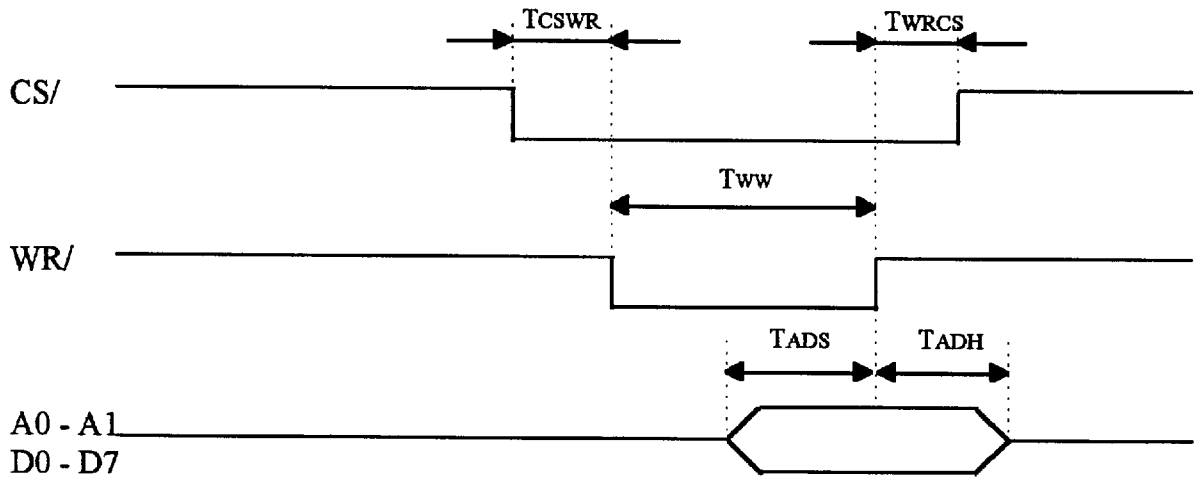


Fig 2. Processor Read cycle

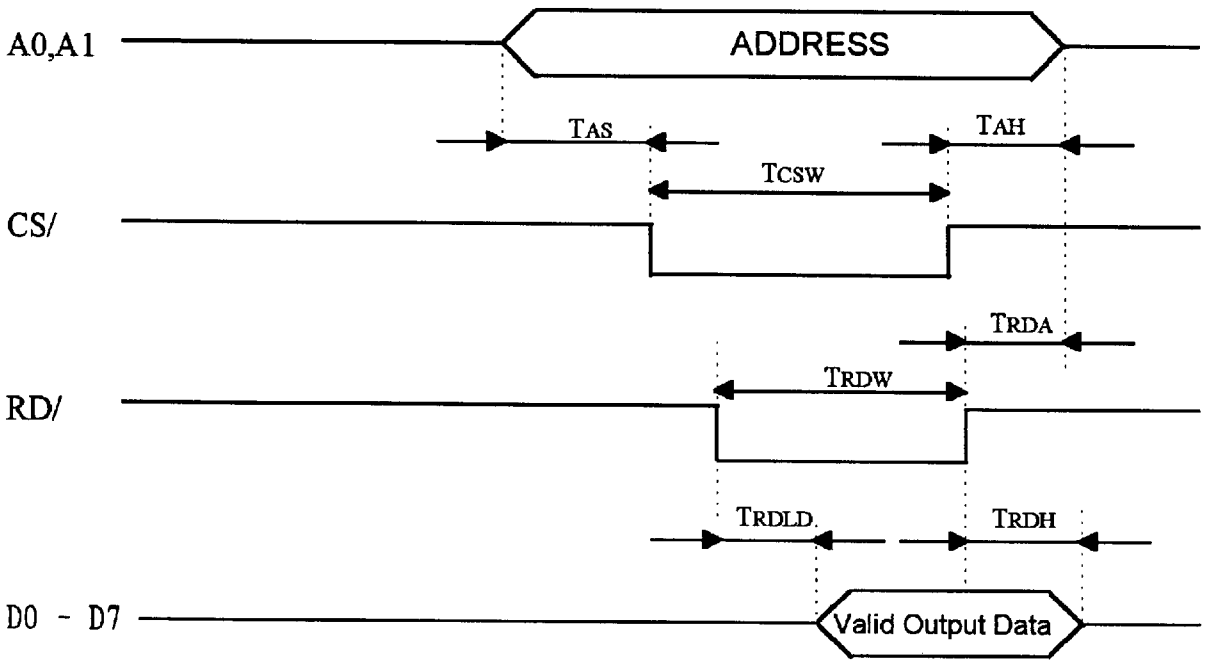


Fig 3. ROM, RAM Access Timing

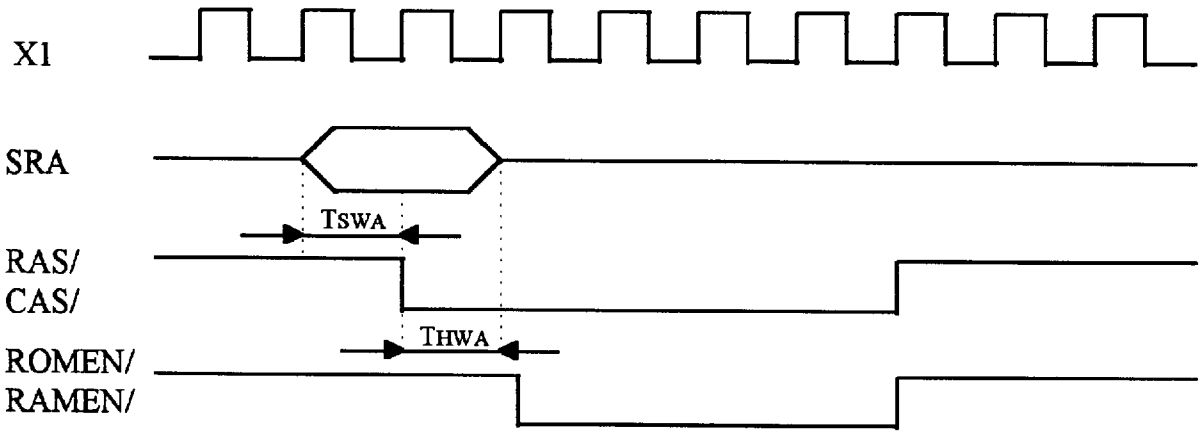


Fig 4. AT mode bus timing

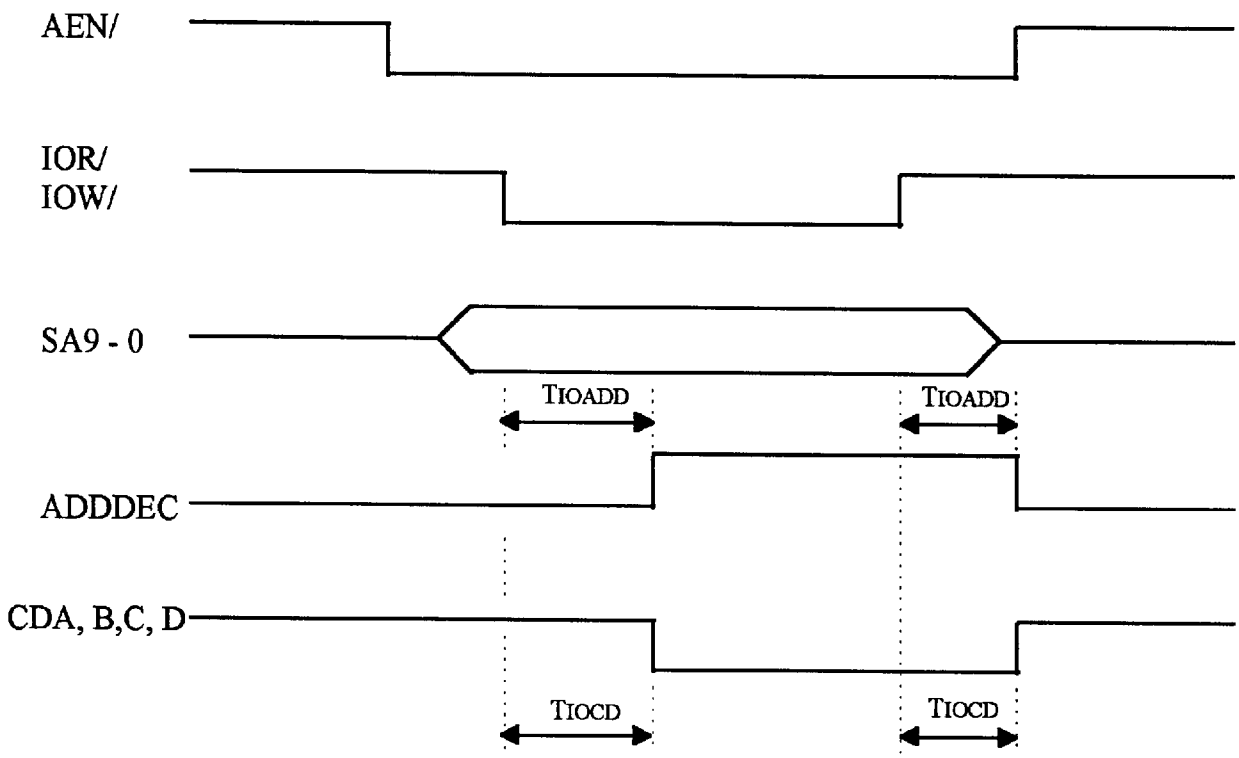
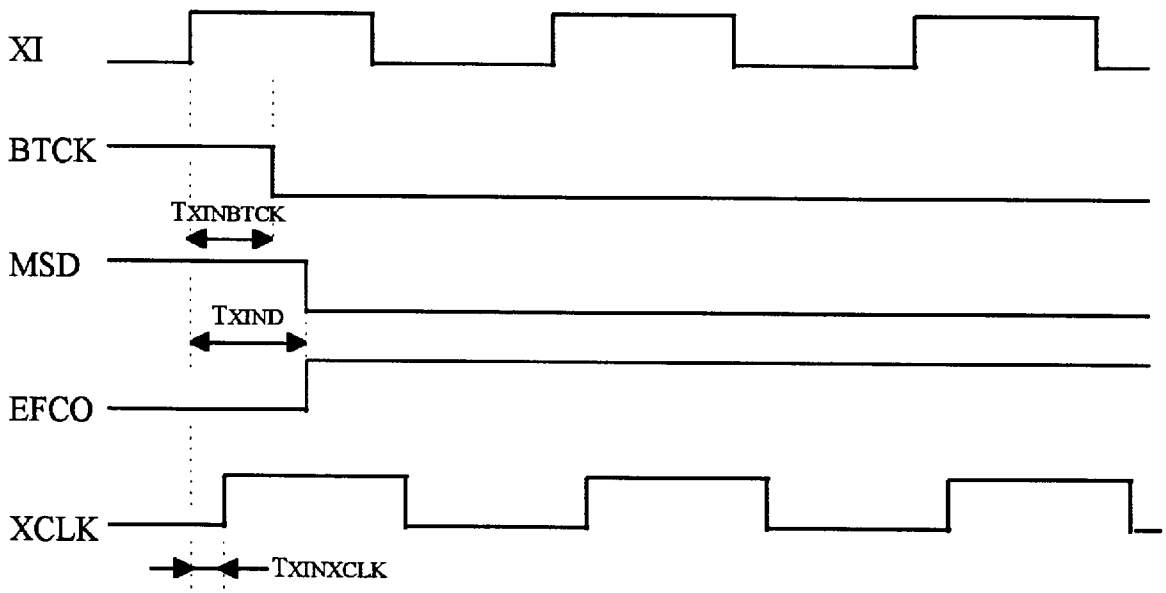
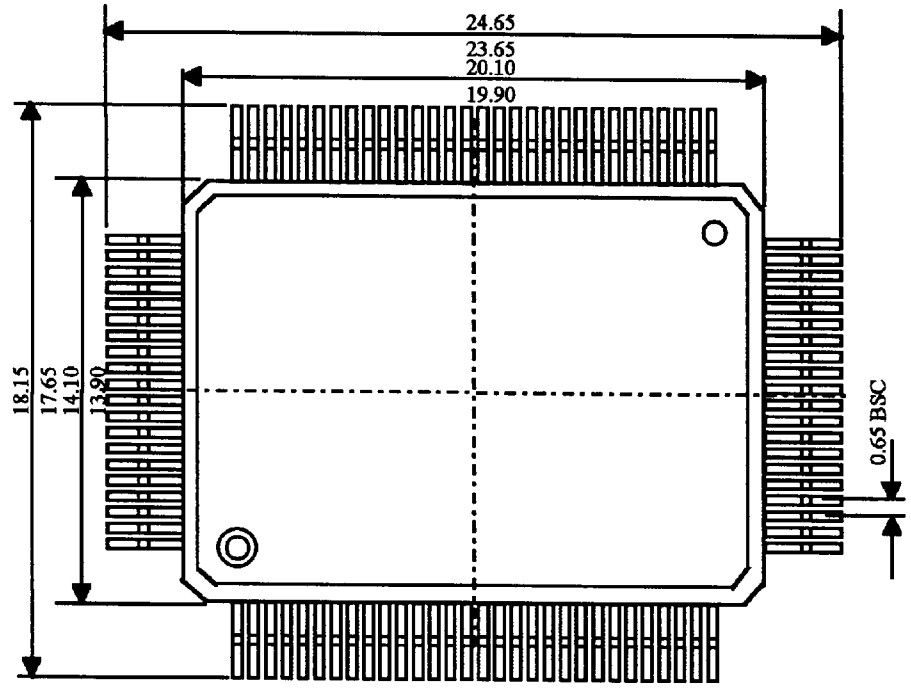
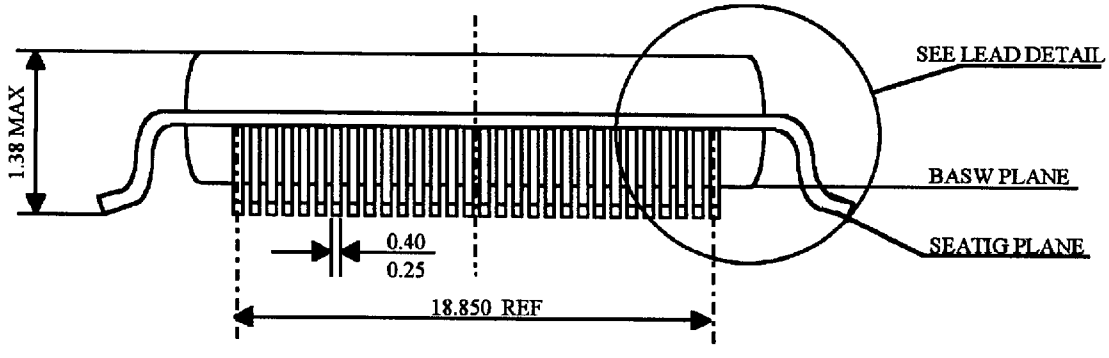


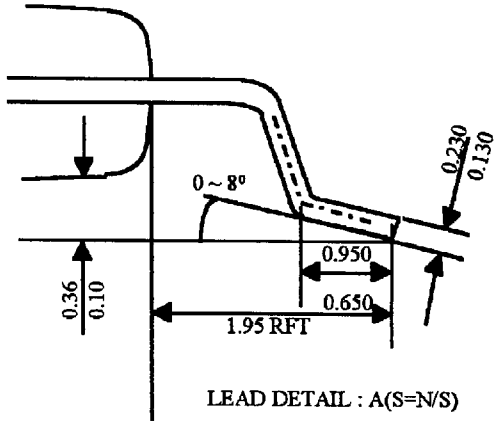
Fig 5. Data, Clock Output Timing



9. Package Dimensions.







The synthesis frame is the time interval between samples sent to a given external DAC channel. So the sampling rate is the inverse of synthesis frame. The number of synthesis slot can be programed from 16 to 32 slots by using the configuration register 3 .

Fig. 1 PCM synthesis frame. (example for 24 slots)

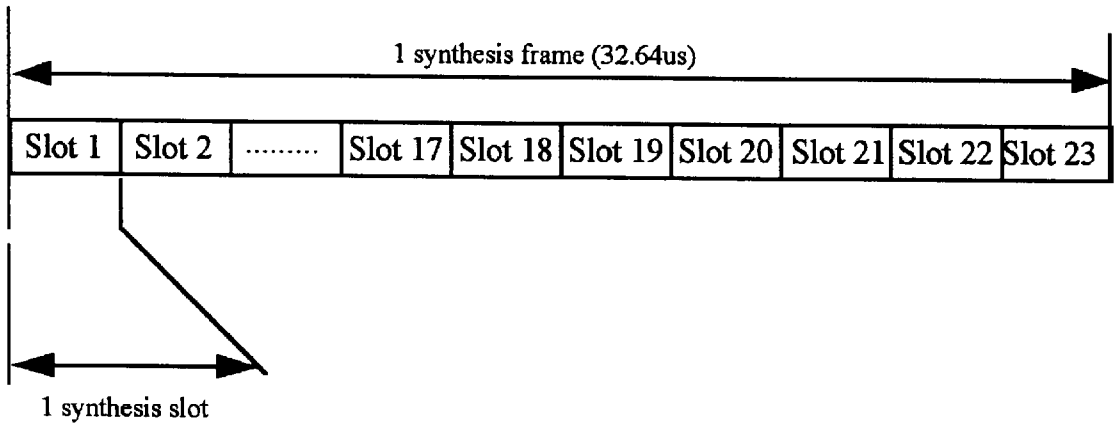


Fig. 2 Configuration register 3. Write Sequence

CS/	WR/	RD/	A1	A0	D7	D6	D5	D4	D3	D2	D0
0	0	1	1	1	1	1	1	1	1	1	1
0	0	1	0	0	Configuration byte						

4 - 6. Active sensing

This message monitor the integrity of MIDI connections. When the MIDI IN connector receives active sensing messages, it will enter the Active sensing message (or other MIDI messages) are not received at 420millisecond intervals, the device will judge that cable is disconnected or there is damages connection. All sounds will be cut off, and a reset all controllers message will be processed. Monitoring for active sensing messages is terminated.

4 - 7. System Exclusive messages

Exclusive messages are used to control a characteristic operation of the device.
Universal system exclusive messages can be used for all devices- regardless of the manufacturer.
General Exclusive message,however cannot convey data between different models.

• GM system on (Universal Non-Real time System Exclusive)

When the GM 'system on' message is received, the General MIDI basic setting will be set, reception of NRPN will not be possible if a GM 'system on' is received.
The GS reset MIDI message is included at the beginning of song data that carries the GM mark. When the song data played from the beginning, the device will be automatically initialized to the basic settings.

• GS reset (GS format common Syste m Exclusive)

When the GS reset message is received, the GS basic settings will be set. When GS reset is recevied, the NRPNS specified with the GS format can be received.
The GS reset MIDI message is included at the beginning of song data that carries the GS mark. When the song data is played from the beginning, the device will be automatically initialized to the basic settings.

• Master volume (Universal Real Time System Exclusve)

This is common universal Exclusive message for controlling the mater volume of all parts.

3. VP_RAM Data Description.

3-1. Sample data control parameter (WORD 0, WORD 1)

The whole 8M sample address consists of BANK (6 bits), Table (9bits), sample (8bits). Therefore the PCM memory can be used for 64BANKs of 512 tables of 256 samples. But a single PCM sample cannot cross a BANK boundary.

SRA Pin No.		
22 21 20 19 18 17	16 15 14 13 12 11 10 9 8	7 6 5 4 3 2 1 0
BANK	TABLE	SAMPLE

The GM82C650 sample Control parameter is implemented at the "Table" Level. In another words, The "Table" is a collection of 256 consecutive PCM samples starting at an address multiple of 256. So, the PCM samples stored in memory must be sampled by the multiple of 256.

<WORD 0 >

CS/	WR/	RD/	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0
0	0	1	0	0	Slot Address				0	0	0	0
0	0	1	0	1	LT7	LT6	LT5	LT4	LT3	LT2	LT1	LT0
0	0	1	1	0	0	BK5	BK4	BK3	BK1	BK1	BK0	LT8
0	0	1	1	1	U.S	0	0	0	0	0	0	0

<WORD 1 >

CS/	WR/	RD/	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0
0	0	1	0	0	Slot Address				0	0	0	1
0	0	1	0	1	CT7	CT6	CT5	CT4	CT3	CT2	CT1	CT0
0	0	1	1	0	ET6	ET5	ET4	ET3	ET1	ET1	ET0	CT8
0	0	1	1	1	U.S	0	1	1	1	1	ET8	ET7

* LT [8:0] : Loop table address.
* BK [5:0] : BANK address.
* CT [8:0] : Current table address.
* ET [8:0] : END table address.

3-2. Phase Control parameter (WORD2, WORD3)

The "Phase Interval" indicates the replay frequency of a PCM samples. The PI value of "00800(hex)" will replay the original sampling frequency. (address increase of 1/frame) For example, if the sample was originally sampled at the frame rate, then amount at trans-position is given by PI/2048.
(A PI value of 00800(hex) will transpose the signal down one octive and a PI value of 01000(hex) will transpose the signal up one octive.)
The offset phase(OP) indicates the offset sample address inside table (256 samples)

<WORD 2 >

CS/	WR/	RD/	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0
0	0	1	0	0	Slot Address				0	0	1	0
0	0	1	0	1	PI7	PI6	PI5	PI4	PI3	PI2	PI1	PI0
0	0	1	1	0	PI15	PI14	PI13	PI12	PI11	PI10	PI9	PI8
0	0	1	1	1	U.S	0	0	0	0	0	PI17	PI16

PI [17:0] ; Phase interval value.

<WORD 3 >

CS/	WR/	RD/	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0
0	0	1	0	0	Slot Address				0	0	1	1
0	0	1	0	1	0	0	0	0	0	0	0	0
0	0	1	1	0	OP4	OP3	OP2	OP1	OP0	0	0	0
0	0	1	1	1	U.S	0	0	0	0	OP7	OP6	OP5

OP [7:0] ; Address of 256 samples.

3-3. Amplitude Control parameter (WORD4)
The Amplitude parameter (AP) is multiplied directly by the External sample.

<WORD 4 >

CS/	WR/	RD/	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0
0	0	1	0	0	Slot Address				0	1	0	0
0	0	1	0	1	AP0	0	0	0	0	0	0	0
0	0	1	1	0	AP8	AP7	AP6	AP5	AP4	AP3	AP2	AP1
0	0	1	1	1	U.S	0	0	0	0	AP11	AP10	AP9

AP [11:0] ; Amplitude Parameter.

3-4. Envelope parameter
The GM82C650 envelope generator is of the linear segment type. The micro-Processor indicates a final level and rate, updated at regular time intervals. (about 10ms)
The Filter is the low-pass resonant filter (12dB).

3-4-1. Filter envelope parameters (WORD5, WORD6)
- Current cut-off frequency level : CCFL<13bit>, 0 to 8191
- Final cut-off frequency level : FCFL<9bit>, step of 16, 0 to 8176
- The value added to <CCFL> at each frame
  until <FCFL> is reached, signed value (from -256 to + 256) : FR <9bit>
- The amount of <CCFL> in dB
  (allows to change the CCFL) : FDL<5bit>

3-4-2. Volume envelope parameters (WORD8, WORD9)
- Current volume envelope level : CVEL<13bit>, 0 to 8191
- Final volume envelope level : FVEL<9bit>, step of 16, 0 to 8176
- The value added to <CVEL> at each frame
  until <FVEL> is reached, signed value (from -256 to +256) : VR<9bit>
- The amount of <CVEL> in dB
  (allows to response to the key velocity, etc) : VDL<5bit>

* FDL (VDL) Table in decibel

FDL (VDL)	CCFL in decible (CVEL)	FDL (VDL)	CCFL in decible (CVEL)
0	- ∞	16	- 22.5
1	- 54	17	- 21
2	- 48	18	- 19.5
3	- 46	19	- 18
4	- 40.5	20	- 16.5
5	- 39	21	- 15
6	- 37.5	22	- 13.5
7	- 36	23	- 12
8	-34.5	24	- 10.5
9	- 33	25	- 9
10	- 31.5	26	- 7.5
11	- 30	27	- 6
12	- 28.5	28	- 4.5
13	- 27	29	- 3
14	- 26.5	30	- 1.5
15	- 24	31	0

<WORD 5 >

CS/	WR/	RD/	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0
0	0	1	0	0	Slot Address				0	1	0	1
0	0	1	0	1	CCFL2	CCFL1	CCFL0	FDL4	FDL3	FDL2	FDL1	FDL0
0	0	1	1	0	CCFL10	CCFL9	CCFL8	CCFL7	CCFL6	CCFL5	CCFL4	CCFL3
0	0	1	1	1	U.S	0	0	0	0	0	CCFL12	CCFL11

<WORD 6 >

CS/	WR/	RD/	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0
0	0	1	0	0	Slot Address				0	1	1	0
0	0	1	0	1	FR7	FR6	FR5	FR4	FR3	FR2	FR1	FR0
0	0	1	1	0	FCFL5	FCFL4	FCFL3	FCFL2	FCFL1	FCFL0	1	FR8
0	0	1	1	1	U.S	0	0	0	0	FCFL8	FCFL7	FCFL6

<WORD8> is the same format as above <WORD5>.
<WORD9> is the same format as above <WORD6>.

3-4-3. Filter resonance (1/Q) <WORD7>

<WORD 7 >

CS/	WR/	RD/	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0
0	0	1	0	0	Slot Address				0	1	1	1
0	0	1	0	1	FIQ0	0	0	0	0	0	0	0
0	0	1	1	0	FIQ8	FIQ7	FIQ6	FIO4	FIQ3	FIQ3	FIQ2	FIQ1
0	0	1	1	1	U.S	0	0	0	FIQ11	FIQ10	FIQ10	FIQ9

FIQ [11:0] : FIQ value is the inverse of the resonance Q.

3-4-4. panning control parameter <WORD15>

<WORD 15 >

CS/	WR/	RD/	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0
0	0	1	0	0	Slot Address				1	1	1	1
0	0	1	0	1	1	1	MXL2	MXL1	MXL0	MXR2	MXR1	MXR0
0	0	1	1	0	0	SI	EMXL2	EMXL1	EMXL0	EMXR2	EMXR1	EMXR0
0	0	1	1	1	U.S	0	0	0	0	0	0	0

* MXL[2:0] : Left panning parameter for MSD pin.
* MXR[2:0] : Right panning parameter for MSD pin.
* EMXL[2:0] : Left effect paning parameter for EFCO pin.
* EMXR[2:0] : Right effect panning parameter for EFCO pin.
* SI : Slot Idle bit
  If SI = 0, this slot operates normally.
  If SI = 1, this slot is in Idle State.

panning value			output attenuation
0	0	0	No output
0	0	1	- 36 dB
0	1	0	- 30 dB
0	1	1	- 24 dB
1	0	0	- 18 dB
1	0	1	- 12 dB
1	1	0	- 6 dB
1	1	1	0 dB

* The VP_RAM WORDS that is not mentioned should be set to "0" before starting the slot.

4. MIDI Implementation Chart.

82C650 Ver 1.00 1994/010/15

Function		Transmitted	Recognized	Remark
Basic channel	Default Changed	1 - 16	1 - 16	
Mode	Default Message Altered	NO NO	3 3 - 4(M=1)	Recognize as m=1 even if m!=1
Note Number	True Voice	NO NO	0 - 127 0 - 127	
Velocity	Note ON Note OFF	NO NO	YES YES	
After touch	Keys Channels	NO NO	YES YES	
Pitch Bender		NO	YES	
Control Change	0, 6	NO	YES	Bank select, Data Entry
	80, 81	NO	YES	Reverb type, Chorus type
	98, 99	NO	YES	NRPN LSB, MSB
	100, 101	NO	YES	RPN LSB, MSB
	64, 66, 67	NO	YES	Hold, sostenuto, soft Pedals
	1	NO	YES	Modulation
	5, 65, 84	NO	YES	Portamento Value, Yes/No, Control
	7, 10, 11	NO	YES	Track Volume, Pan, Experssion
	91, 93	NO	YES	Effect/Reverb, Chrous
	120	NO	YES	All Sound Off
	121	NO	YES	Reset All Controllers
	123	NO	YES	All Note Off
	124	NO	YES	Omni Off
	125	NO	YES	Omni On
	126	NO	YES	Mono On
	127	NO	YES	Poly On
Program change	True Number	NO	YES	1 - 128 Program number
System	Exclusive	NO	YES	Sound transfer/Parameters control
Common	Tune	NO	NO	
System Real time	Clock	NO	NO	
	Commands	NO	NO	
Aux Messages	Local On/Off	NO	NO	
	All note Off	NO	YES(123-125)	
	Active Sense	NO	YES	
	System Reset	NO	YES	

* Notes
Mode 1 : Omni On, Poly
Mode 2 : Omni On, Mono
Mode 3 : OmniOff, Poly
Mode 4 : Omni Off, Mono

4-1. Control Change

These message control the modulation and pan, etc. Each function is classfied with a Control Change number.

• Modulation (control change number 1)

A vibrato effect is applied when this message is received.

• Volume (control change number 7)

This message conveys the volume level of the part.
The part's volume will change when this message is received

• Expression (control change number 11)

This message conveys the change in volume.
This is used to lower or raise the volume during a song.

* The part volume will change with either the volume message (control change 7) or expression message (control change11). Note that if a 0 value is receivedwith either of the message, the part volume will be 0,and the part's volume will not increase even with the other message.

• Pan (control change number 10)

This message conveys the part's pan (effect position during streo output)

• Hold(1) (control change number 64)

This message conveys the prressing and releasing of the damper (sustain) pepal.
Notes will be held when 'hold on' is received.
Sounds which decay naturally (such as pianos) will decay more slowly when a 'hold on' is received. Sustaining sounds (such as organs) will be held until 'hold off' is received.

• Sostenuto (control change number 66)

The pedal that sustains notes only when the pedal is pressed down is called the sostenuto pedal.
This message conveys the action of pressing and releasing this pedal.
When 'sostenuto on' is received, only notes played at the same time will be sustained.
Sounds which decy naturally(such as painos) will decay more slowly when a 'sostenuto on' is received. Sustaining sounds (such as organs) will be held until 'hold off' is recevied.

• Soft (control change number 67)

The pedal that softens the sound of notes played is called the soft pedal. This message conveys the action of pressing and releasing this pedal. When 'soft on' is received, the cut off frequency is lowered, and a soft sound is achieved. When 'soft off' is recevied, the original sound returns.

• **Reverb send level (control change number 91)**
This message applies 'reverb' to a part.

• **Chrous send level (control change number 93)**
This message applies 'chrous' to a part.

• **Portamento (control change number 65)**
• **Portamento time (control change number 5)**
• **Portamento control (control change number 84)**
This portamento function smoothly change the pitch from the last key pressed to the key carrently being pressed. When portamento is received, the portamento effect is turned on or off. The speed of the pitch change is set with the portamento time.
When portamento control is received, the Source Note number (key pressed last) is specified.

• **RPN LSB MSB (control change number 100/101)**
• **Data entry (control change number 6/38)**
RPN (registered parameter numbers) functions are defined with the MIDI standards and can be used with diffrent devices.
The parameter to be changed is specified with RPN MSB and RPN LSB, and the parameter value is set with the following data entry. The pitch bend sensitivity, master coarse turn and master fine turn value can be changed with RPN.

* The values changed with RPN will not be initialized even if the instrument is changed with a program Change, etc.

• **NRPN LSB MSB (control change number 100/101)**
• **Data entry (control change number 6/38)**
The device's characteristics variation parameter can be changed with the NRPN (non - registered parameter numbers).
The parameter to be changed is specified in NRPN MSB and NRPN LSB, and the parameter value is set with the following data entry.
Common NRPN are set in the GS format, and the variation parameter can be changed using application software, etc.,
That is GS format compatible. The vibrato, cut off frequency, resonance, and envelope can be changed with NRPN.

* The values change with NRPN will not be initialized even if the instrument is changed with a Program Change, etc.

4 - 2. Aftertouch (Channel pressure)

Aftertouch refers to pressing down on a key after playing a note. The variation in aftertouch pressure can create changes in the sound produced. There pressure affects all note numbers in the same MIDI channel. Polyphonic key pressure affects only the key (note number) that is pressed with the greatest force.

4 - 3. All sounds off

This messgae turns off all sounds which are currently playing. The sounds in the corresponding channel will be turned off.

4 - 4. All notes off

This message turns all 'note on' message to 'note off' messages. However, if hold 1 or sostenuto is turned on, the sound will not stop until these turn off.

4 - 5. Reset all controllers

This messages reset all controller values to their defaults.

Controller	Default value
Pitch bend change	0 (Center point)
Polyphonic key Pressure	0 (Min.)
Channel key Pressure	0 (Min.)
Modulation	0 (Min.)
Expression	0 (Max.)
Hold	0 (Off)
Portamento	0 (Off)
Soft	0 (Off)
Sostenuto	0 (Off)
RPN	state with no number set
NRPN	state with no number set

* Parameter values set with RPN and NRPN will not change even if reset all controllers is received.

4 - 6. Active sensing

This message monitor the integrity of MIDI connections. When the MIDI IN connector receives active sensing messages, it will enter the Active sensing message (or other MIDI messages) are not received at 420millisecond intervals, the device will judge that cable is disconnected or there is damages connection. All sounds will be cut off, and a reset all controllers message will be processed. Monitoring for active sensing messages is terminated.

4 - 7. System Exclusive messages

Exclusive messages are used to control a characteristic operation of the device.
Universal system exclusive messages can be used for all devices- regardless of the manufacturer.
General Exclusive message,however cannot convey data between different models.

• GM system on (Universal Non-Real time System Exclusive)

When the GM 'system on' message is received, the General MIDI basic setting will be set, reception of NRPN will not be possible if a GM 'system on' is received.
The GS reset MIDI message is included at the beginning of song data that carries the GM mark. When the song data played from the beginning, the device will be automatically initialized to the basic settings.

• GS reset (GS format common Syste m Exclusive)

When the GS reset message is received, the GS basic settings will be set. When GS reset is recevied, the NRPNS specified with the GS format can be received.
The GS reset MIDI message is included at the beginning of song data that carries the GS mark. When the song data is played from the beginning, the device will be automatically initialized to the basic settings.

• Master volume (Universal Real Time System Exclusve)

This is common universal Exclusive message for controlling the mater volume of all parts.

5. MIDI Implementation

5 - 1. Channel voice Message

	status	second	Third	
•Note off	8nH 9nH	kkH kkH	vvH 00H	vv = velocity : 00H - 7FH (0 - 127) velocity is ignored
•Note on	9nH	kkH	vvH	vv = Velocity : 01H - 7FH (1 - 127)
•Polyphonic key Pressure	AnH	kkH		vv = Value : 00H - 7FH (1 - 127)

5 - 2. Control change

The value set by control change message won't be receiving new program change message.

Bank select	BnH BnH	00H 20H	mmH llH	* the LSB 7 - bits are ignored (always regards as llH = 00H) in this Model. * "Bank select" is suspended until receiving "Program change". To select a timbre of another bank, you have to send a Bank select (mm,ll) before sending the Program change. * The "Variation number" of GS Format is defined as the decimal expression of the MSB value (control change number 00H) of the Bank select. * In Drum Parts select message will be ignored.
Modulation	BnH	01H	vvH	vv = Modulation depth : 00H - 7FH (0 - 127)
Portmento time	BnH	05H	vvH	vv = Portamento time : 00H - 7FH (0 - 127) default Value = 00H (0) * The Portamento time value changes the rate of pitch change when Portamento is ON or when using portamen to control message. Value 0 is the fastest
Data entry	BnH BnH	06H 26H	mmH llH	mm,ll = Value of of the parameter specified with RPN and/or NRPN
Volume	BnH	07H	vvH	vv = Volume : 00H - 7FH (0 -127) * volume message control the volume level of the specified channel (part) Use volume message to control volume balance
Panpot	BnH	0AH	vvH	vv = Panpot : 00H -04H-7FH (left-center-right)
Expression	BnH	0BH	vvH	vv = Expression : 00H -7FH (0 - 127) * Expression and volume message are cumulative, and result will control the overall volume. Use Expression message for expression pedal, or creating expressive effects, such as crescendo, decrescendo, while playing

	Status	Second	Third	
Hold1	BnH	40H	vvH	vv = Control Value : 00H - 7FH (1 -127) 0 - 63 = OFF, 64 - 127 = ON
Portamento	41H	41H	vvH	
Sostento	42H	42H	vvH	
Soft	43H	43H	vvH	vv = Control Value : 00H - 7FH (1 -127)
Effect1 depth (Reverb send level)	BnH	5BH	vvH	vv = Control Value : 00H - 7FH (1 -127) * Effect depth message control the send level of the specified channel (part) to the internal reverb unit.
Effect3 depth (Chorus send level)	BnH	5DH	vvH	vv = Control Value : 00H - 7FH (1 -127) * Effect3 depth message control the send level of the specified channel (part) to the internal chorus unit.
Portamento control	BnH	54H	vvH	kk = source note number for pitch reference. 00H - 7FH (0 - 127)

* When a note on message is received after a portamento control message. The voice's pitch will glide from the pitch specified by the source note number of the portamento control message at the rate set by the portamento time controller .(regardless portamento on/off)
If there is a currently sounding voice whose note number is coincident with the source note number, the voice's pitch will glide to the new note on's pitch according to the portamento time without re-triggering (played legato).
Then no new voice should be assigned.

Example 1.

On	MIDI		Description	Result
90	3C	40	Note on C4	C4 on
B0	54	3C	Portamento control from C4	no change
90	40	40	Note on E4	Re-turning (glide) from C4 to E4
80	3C	40	Note off C4	no change
80	40	40	Note off E4	E4 off

Example 2.

On	MIDI		Description	Result
B0	54	3C	Portamento Control from C4	No change
90	40	40	Note on E4	E4 on with glide from C4
80	40	40	Note off E4	E4 off

NRPN MSB/LSB

Status	Second	Third	
BnH	63H	mmH	
BnH	62H	llH	mm = MSB of the NRPN ll = LSB of the NRPN

* The values set by NRPN won't reset by receiving new program change message or reset all controllers.

** NRPN

An NRPN (Non Registered Parameter Number) is an expanded control change message.Each function of an NRPN is described by the individual manufacturer. To use NRPN, set NRPN number (MSB/LSB) before sending data. Then send data by data entry message (control change #6/38).
And then. it is recommended to send RPN null (RPN number = 7FH/7FH)
to prevent the data from being unexpectedly change.

You can change the following parameters using an NRPN.

NRPN MSB	NRPN LSB	Data entry MSB	Description
01H	08H	mmH	Vibrato rate relative change on specified channel. mm : 0EH - 40H - 72H (-50 - 0 - +50)
01H	09H	mmH	Vibrato depth relative change on specified channel. mm : 0EH - 40H - 72H (-50 - 0 - +50)
01H	0AH	mmH	Vibrato delay relative change on specified channel. mm : 0EH - 40H - 72H (-50 - 0 - +50)
01H	20H	mmH	Filter cutoff frequency relative change on specified channl. mm : 0EH - 40H - 72H (-50 - 0 - +50)
01H	21H	mmH	Filter resonance relative change on specified channl. mm : 0EH - 40H - 72H (-50 - 0 - +50)
01H	63H	mmH	Volume Env. Attack time relative change on specified channl. mm : 0EH - 40H - 72H (-50 - 0 - +50)
01H	64H	mmH	Volume Env. Decay time relative change on specified channl. mm : 0EH - 40H - 72H (-50 - 0 - +50)
01H	66H	mmH	Volume Env. Release time relative change on specified channl. mm : 0EH - 40H - 72H (-50 - 0 - +50)
18H	rrH	mmH	Pitch cosarse of drum instrument releative change on specified drum instrument rr : key number of drum instrument mm : 00H - 40H - 7FH (-64 - 0 - +63 semitone)
1AH	rrH	mmH	Volume level of drum instrument absolute change on specified drum instrument rr : key number of drum instrument / mm: 00H - 7FH (Zero - maximum)
1CH	rrH	mmH	Panpot of drum instrument absolute change on specified drum instrument. rr : Key number of drum instrument. mm : 00H - 40H - 7FH (Left - Center - Right)
1DH	rrH	mmH	Reverb send level of drum instrument absolute change on specified drum instrument rr : key number of drum instrument / mm : 00H - 7FH (zero - maximum)
1EH	rrH	mmH	Chrous send level of drum instrument absolute change on specified drum instrument. rr : key number of drum instrument / mm : 00H - 7FH (zero - maximum)

* Dataentry LSB is ignored.
* The relative change means that the parameter value (e.g. - 50 - 0 - + 50) will be added to the preset value.
* The absolute change means that the parameter value will be replaced by the received value.

RPN MSB/LSB

Status	Second	Third	
BnH	65H	mmH	
BnH	64H	llH	mm = MSB of the RPN ll = MSB of the NRPN

* The values set by an RPN won't be reset by receiving new program change message or reset all controllers.

** RPN

An RPN (Registered Parameter Number) is an expanded control change message.
Each function of an RPN is described by the MIDI standard. To use an RPN, set the RPN number (MSB/LSB) before sending data. Then send data by Data entry message (Control change #6/38).
It is then recommended to send RPN null (RPN number = 7FH/7FH) to prevent the data from being unexpectedly change. For more explanation

You can change the following parameter using an RPN.

NRPN MSB	NRPN LSB	Data entry MSB	Data entry LSB	Description
00H	00H	mmH		Pitch bend sensitivity. mm : 00H - 18H (0 - 24 semitones) Default value = 02H (two semitones) ll : Ignored (value = 00H) (Up to 2 octaves)
00H	01H	mmH	llH	Master fine turnig mm,ll : 00 00H - 40 00H - 7F 7FH (-8192 x 100/8192 - 0 - + 8191 x 100/8192 cents)
00H	02H	mmH	--	Master coarse turning. mm : 28H - 40H - 58H (-24 - 0 - + 24 semitones) ll : Ignored (value = 00H)
7FH	7Fh	--	--	RPN null Return to disable condition. The parameter already set retains is value. mm,ll : ignored

	Status	Second	Third	
• **Program change**	CnH	ppH	ppH	pp = Program number (prog.1 - prog.128) * The voices already ON before receiving a program message aren't affected.The Tone will be changed by a new Note - on message after the program change is received. * In the drum part, Program change message are ignored when the Bank is set at 129 - 16384 (ie. the value of the control change number 0 is not 00H).
• **Channel pressure**	DnH	vvH	vvH	vv = value : 00H - 7FH (0 -127)
• **Pitch band change**	EnH	llH	mmH	mm,ll = value : 00 00H - 40 00H - 7F 7FH (-8192 - 0 - +8191)

5 - 3.Channel Mode messages

	Status	Second	Third	
• **All sounds off**	BnH	78H	00H	* When "All sounds off" is received, all sounds on a specified channel turn off immediately. However, the state of channel messages does not change. You must not use "All sound off" message for "Note off"
• **All notes off**	BnH	7BH	00H	* When "All notes off" is received, all notes are turned off in the specified channel. However, sound continues while hold 1 and / or sostenuto is on.
• **OMNI OFF**	BnH	7CH	00H	* OMNI OFF is only recognized as "all notes off" the mode doesn't change.
• **OMNI ON**	BnH	7DH	00H	* OMNI ON is only recognized as "all notes off". Mode doesn't change (OMNI off remains)
• **MONO**	BnH	7EH	mmH	* MONO is recognized as "all sounds off", The specified channel turns to Mode4 (m=1), even if mm is not equal 1. (min is ignored)
• **POLY**	BnH	7FH	00H	* POLY is recognized as "all sounds off". The specified channel turns to Mode3.

• **Reset all controllers**

Status	Second	Third
BnH	54H	vvH

* When "reset all controllers" is received, the controller value of a specified channel returns to the default values as follows.

Controllers	Default Value
Pitch bend change	0 (center)
Polyphonic key pressure	0 (off)
Chennel pressure	0 (off)
Modulation	0 (off)
Expression	127 (maximum)
Hold1	0 (off)
Portamento	0 (off)
Soft	0 (off)
RPN	disabled. The parameter already set retains its old value.
NRPN	disabled. The parameter already set retains its old value.

5 - 4. System realtimes Message

• **Activing sensing**

Status
FEH

* Having received an "active sensing" message, GS expects to receive additional active sensing messages at 300ms intervals. If the interval is greater than 420ms, GS executes "All sounds off", "All notes off" and "Reset all controllers" and returns to normal opration.
(monitoring of active sensing message will terminate.)

5 - 5. System Exclusive Message

Status	Data	Status
F0H	iiH,ddH,.....eeH	F7H

F0H : System Exclusive
ii = ID number : The ID number identifies the manufacturer of a MIDI device that triggers an Exclusive message. Value 7EH and 7FH are reserved to use as universal message which are used for extension of the MIDI standard.
7EH : Universal Non - Realtime Message
7FH : Universal Realtime Message
dd,...,ee = data : 00H - 7FH (0 - 127)
F7H : EOX (End of Exclusive / System common)

• System Exclusive Message of Mode Change

System Exclusive message of Mode Change are the message used to initialize the internal parameters of the device to General MIDI mode or GS default mode.

GS Reset

Status	Data	Status
F0H	41H, 10H, 42H, 12H, 40H, 00H, 7FH, 00H, 41H	F7H

Byte	Description
F0H	Exclusive ststus
41H	ID Number
10H	Device ID
42H	Model ID (GS)
12H	Command ID (DT1)
40H	Address MSB
00H	:
7FH	Address LSB
00H	Data (GS Reset)
41H	Checksum
F7H	EOX (End of exclusive)

* Upon received this message, all the internal parameters are set to the default settings of the GS Format. (Rx.NRPN SW and Rx. Bank sel SW will be turned ON by this message.)

• **Turn General MIDI System On**

Status	Data Byte	Status
F0H	7EH, 7FH, 09H, 01H	F7H

Byte	Description	
F0H	Exclusive status	
7EH	ID number	(Universal realtime message)
7FH	ID of target device	(Boardcast)
09H	sub - ID #1	(General MIDI message)
01H	sub - ID #2	(General MIDI On)

• **Universal Realtime System Exclusive Message**

• Master volume

Status	Data Byte	Status
F0H	7FH, 7FH, 04H, 01H, llH, mmH	F7H

Byte	Description	
F0H	Exclusive status	
7EH	ID number	(Universal realtime message)
7FH	ID of target device	(Boardcast)
04H	sub - ID #1	(Master control Message)
02H	sub - ID #2	(Master volume)
mm,ll	Master volume	00 00H - 7F 7FH (0 - 16383)
F7H	EOX	(End of exclusive)

* The LSB (llH) is ignored (value = 0)

6. INSTRUMENT TABLE

	PC	CCO	Instrumental name	V
Piano	1	0	Piano 1	1
	2	0	Piano 2	1
	3	0	Piano 3	1
	4	0	Honky-tonk	2
	5	0	E. Piano 1	1
		8	Detuned EP 1	2
	6	0	E. Piano 2	2
		8	Detuned EP 2	2
	7	0	Harpsichord	1
		8	Coupled Hps.	2
	8	0	Clav.	1
Chromatic Percussion	9	0	Celesta	1
	10	0	Glockenspiel	2
	11	0	Music Box	2
	12	0	Vibraphone	1
	13	0	Marimba	1
	14	0	Xylophone	1
	15	0	Tubular - bell	2
		8	Church Bell	1
	16	0	Santur	1
Organ	17	0	Organ 1	1
		0	Detuned Organ 1	2
	18	0	Organ 2	1
		8	Detuned Organ 2	2
	19	0	Organ 3	2

PC : Program change number (Instrument number)
CCO : Value of control number 0 (Variation number)
V : Number of voices

	PC	CCO	Instrumental name	V
Organ	20	0	Chruch Organ 1	1
		8	Chruch Organ 2	2
	21	0	Reed Organ	1
	22	0	Accordion Fr	2
	23	0	Harmonica	1
	24	0	Bandoneon	2
Guiter	25	0	Nylon-str. Gt.	1
		8	Ukulele	1
	26	0	Streel-str Gt.	1
		8	12-str. Gt.	2
		16	Mandolin	1
	27	0	Jazz Gt.	1
		8	Hawaiian Gt.	1
	28	0	Clean Gt.	1
		8	Chrous Gt.	2
	29	0	Muted Gt.	1
	30	0	Overdrive Gt.	1
	31	0	Distortion Gt.	1
		8	Feedback Gt.	2
	32	0	Gt. harmonics	1
		8	Gt. Feedback	1
Brass	33	0	Acoustic Bs.	1
	34	0	Fingered Bs.	1
	35	0	Picked Bs.	1
	36	0	Fretless Bs.	1
	37	0	Slap Bass 1	1
	38	0	Slap Bass 2	1
	39	0	Synth Bass 1	1
		8	Synth Bass 3	2
	40	0	synth Bass 2	2
		8	synth Bass 4	2

	PC	CCO	Instrumental name	V
Strings / orchestra	41	0	Violin	1
	42	0	Viola	1
	43	0	Cello	1
	44	0	Contrabass	1
	45	0	Tremolo Str	1
	46	0	Pizzicato Str	1
	47	0	Harp	1
	48	0	Timpani	1
Ensemble	49	0	Strings	1
		8	Orchestra	2
	50	0	Slow Strings	1
	51	0	Syn. Strings 1	1
		8	Syn. Strings 3	2
	52	0	Syn. Strings 2	2
	53	0	Choir Aahs	1
	54	0	Voice Oohs	1
	55	0	SynVox	1
	56	0	Orchestra Hit	2
Brass	57	0	Trumpet	1
	58	0	Trombone	1
	59	0	Tuba	1
	60	0	MutedTrumpet	1
	61	0	French Horn	2
	62	0	Brass 1	1
		8	Brass 2	2
	63	0	Synth Brass 1	2
		8	Synth Brass 3	2
	64	0	Synth Brass 2	2
		8	Synth Brass 4	1

PC : Program change number (Instrument number)
CCO : value of control number 0 (Variation number)
V : Number of Voices

	PC	CCO	Instrumental name	V
Reed	65	0	Soprano Sax	1
	66	0	Alto Sax	1
	67	0	Tenor Sax	1
	68	0	Baritone Sax	1
	69	0	Oboe	1
	70	0	English Horn	1
	71	0	Bassoon	1
	72	0	Clarinet	1
Pipe	73	0	Piccolo	1
	74	0	Flute	1
	75	0	Recorder	1
	76	0	Pan Flute	2
	77	0	Bottle Blow	2
	78	0	Shakuhachi	1
	79	0	Whistle	1
	80	0	Ocarina	2
Brass	81	0	Square Wave	1
		1	Square	1
		8	Sine Wave	2
	82	0	Saw Wave	1
		1	Saw	1
	83	0	Syn. Calliope	2
	84	0	Chiffer Lead	2
	85	0	Charang	2
	86	0	Solo Vox	2
	87	0	5th Saw Wave	2
	88	0	Bass & Lead	2
Synth pad etc.	89	0	Fantasia	2
	90	0	Warm Pad	1
	91	0	Polysynth	2
	92	0	Space Voice	1
	93	0	Bowed Glass	2
	94	0	Metal Pad	2
	95	0	Halo Pad	2
	96	0	Sweep Pad	1

	PC	CCO	Instrumental name	V
Synth SFX	97	0	Ice Rain	2
	98	0	Soundtrack	2
	99	0	Crystal	2
	100	0	Atmosphere	2
	101	0	Brightness	2
	102	0	Goblin	2
	103	0	Echo Drops	1
	104	0	Star Theme	2
Ethnic	105	0	Sitar	1
	106	0	Banjo	1
	107	0	Shamisen	1
	108	0	Koto	1
		8	Taisho Koto	2
	109	0	Kalimba	1
	110	0	Bag Pipe	1
	111	0	Fiddle	1
	112	0	Shanai	1
Precussive	113	0	Tinkle Bell	1
	114	0	Agogo	1
	115	0	Steel Drums	1
	116	0	Woodblock *	1
		8	Castanets *	1
	117	0	Taiko *	1
		8	Concert BD *	1
	118	0	Melo Tom 1 *	1
		8	Melo Tom 2 *	1
	119	0	Synth Drum *	1
		8	808 Tom *	1
	120	0	Reverse Cym. *	2

PC : Program change number (Insrument number)
CCO : Value of control number 0 (variation number)
V : Number of voices

	PC	CCO	Instrumental name	V
SFX	121	0	Gt. FretNoise *	1
		1	Gt. Cut Noise *	1
		2	String Slap *	1
	122	0	Breath Noise	2
		1	Fl. Key Click *	1
	123	0	Seashore *	1
		1	Rain *	2
		2	Thunder *	1
		3	Wind *	1
		4	Stream *	2
		5	Bubble *	2
	124	0	Bird *	2
		1	Dog *	1
		2	Horse - Gallop *	1
	125	0	Telephone 1 *	1
		1	Telephone 2 *	1
		2	Door Creaking *	1
		3	Door *	1
		4	Scratch *	1
		5	Windchime *	2
	126	0	Helicopter *	1
		1	Car - Engine *	1
		2	Car - Stop *	1
		3	Car - Pass *	1
		4	Car - Crash *	2
		5	Siren *	1
		6	Train *	1
		7	Brust Noise *	2
	127	0	Applause *	1
		1	Laughing *	1
		2	Screaming *	1
		3	Punch *	1
		4	Heart Beat *	1
		5	Footsteps *	1
	128	0	Gun Shot *	1
		1	Machine Gun *	1
		2	Lasergun *	1
		3	Explosion *	2

6.1. MT - 32 Set (Variation : 127)

PC	Instrument name	V
1	Acou Piano 1	1
2	Acou Piano 2	1
3	Acou Piano 3	1
4	Elec Piano 1	1
5	Elec Piano 2	1
6	Elec Piano 3	1
7	Elec Piano 4	1
8	Honktonk	2
9	Elec Org 1	1
10	Elec Org 2	2
11	Elec Org 3	1
12	Elec Org 4	1
13	Pipe Org 1	2
14	Pipe Org 2	2
15	Pipe Org 3	2
16	Accordion	2
17	Harpsi 1	1
18	Harpsi 2	2
19	Harpsi 3	1
20	Clavi 1	1
21	Clavi 2	1
22	Clavi 3	1
23	Celesta 1	1
24	Clestaa 2	1
25	Syn Brass 1	2
26	Syn Brass 2	2
27	Syn Brass 3	2
28	Syn Brass 4	2
29	Syn Bass 1	1
30	Syn Bass 2	2
31	Syn Bass 3	2
32	Syn Bass 4	1

PC	Instrument name	V
33	Fantasy	2
34	Harmo Pan	2
35	Chorale	1
36	Glasses	2
37	Soundtrack	2
38	Atmosphere	2
39	Warm Bell	2
40	Funny Vox	1
41	Echo Bell	2
42	Ice Rain	2
43	Oboe 2001	2
44	Echo Pan	2
45	Doctor Solo	2
46	School Daze	1
47	Bellsinger	1
48	Square Wave	2
49	Str Sect 1	1
50	Str Sect 2	1
51	Str Sect 3	1
52	Pizzicato	1
53	Violin 1	1
54	Violin 2	1
55	Cello 1	1
56	Cello 2	1
57	Contrabass	1
58	Harp 1	1
59	Harp 2	1
60	Guitar 1	1
61	Guitar 2	1
62	Elec Gtr 1	1
63	Elec Grt 2	1
64	sitar	2

PC	Instrument name	V
65	Acou Bass 1	1
66	Acou Bass 2	1
67	Elec Bass 1	1
68	Elec Bass 2	1
69	Slap Bass 1	1
70	Slap Bass 2	1
71	Fretless 1	1
72	Fretless 2	1
73	Flute 1	1
74	Frute 2	1
75	Piccolo 1	1
76	Piccolo 2	2
77	Recorder	1
78	Pan Pipes	1
79	Sax 1	1
80	Sax 2	1
81	Sax 3	1
82	Sax 4	1
83	Clarinet 1	1
84	Clarinet 2	1
85	Oboe	1
86	Engl Horn	1
87	Bassoon	1
88	Harmonica	1
89	Trumpet 1	1
90	Trumpet 2	1
91	Trombone 1	2
92	Trombone 2	2
93	Fr Horn 1	2
94	Fr Horn 2	2
95	Tuba	1
96	Brs Sect 1	1

PC	Instrument name	V
97	Brs Sect 2	2
98	Vibe 1	1
99	Vibe 2	1
100	Syn Mallet	1
101	Windbell	2
102	Glock	1
103	Tube Bell	1
104	Xylophone	1
105	Marimba	1
106	Koto	1
107	Sho	2
108	Shakuhachi	2
109	Whistle 1	2
110	Whistle 2	1
111	Bottleblow	2
112	Breathpipe	1
113	Timpani	1
114	Melodic Tom	1
115	Deep Snare	1
116	Elec perc 1	1
117	Elec Perc 2	1
118	Taiko	1
119	Taiko Rim	1
120	Cymbal	1
121	Castanets	1
121	Triangle	1
123	Orche Hit	1
124	Telephone	1
125	Bird Tweet	1
126	One Note Jam	1
127	Water Bell	2
128	Jungle Tune	2

PC : Program change number (Instrument number)
V : Number of voices

7.DRUM SET TABLE

Note number	PC 1 : STANDAD	PC 9 : ROOM set	PC 17 : POWER set	PC26 : 808 Set	PC 41 BRUSH Set	PC 49 ORCHESTRA Set
27	High Q					Closed Hi-hat
28	Slap					Pedal Hi-hat
	Scartch Push					Open Hi-hat
29	Scratch Pull					Ride Cymbal
30	Sticks					
31	Square Click					
32	Metronome Click					
33	Metronome Bell					
34	Kick Drum2/Jazz BD2				Jazz BD2	Concert BD 2
35	Kick Drum1/Jazz BD1		MONDO Kick	808 Bass Drum	Jazz BD1	Concert BD 1
36	Side Stick			808 Rim shot		
37	Snare Drum 1		Gated SD	808 Snare Drum	Brush Tap	Concert SD
38	Hand Clap				Bruch Stap	Castanets
39	Snare Drum 2				Bruth Swiri	Concert SD
40	Low Tom 2	Room Low Tom 2	Room Low Tom 2	808 Low tom 2		Timpani F
41	Closed Hi - hat			808 CHH		Timpani F#
42	Low Tom 1	Room Low Tom 1	Room Low Tom 1	808 Low Tom 1		Timpani G
43	Pedal Hi - hat			808 CHH		Timpani G#
44	Mid Tom 2	Room Mid Tom 2	Room Low Tom 2	808 Mid tom 2		Timpani A
45	Open Hi - hat			808 OHH		Timpani A#
46	Mid Tom 1	Room Mid Tom 1	Room Mid tom 1	808 Mid Tom 1		Timpani B
47	High Tom 2	Room Hi Tom 2	Room Hi Tom 2	808 Hi Tom 2		Timpani C
48	Crash Cymbal 1			808 Cymbal		Timpani C#
49	High Tom 1	Room Hi Tom 1	Room Hi tom 1	808 Hi Tom 1		Timpani D
50	Ride Cybal 1					Timpani D#
51	Chinese Cymbal					Timpani E
52	Ride Bell					Timpani F
53	Tamborine					
54	Splash Cymbal					
55	Cowbell			808 Cowbell		
56	Crash Cymbel 2					
57	Vibra - slap					
58	Ride Cymbel 2					
59	High Bongo					
60	Low Bongo					
61	Mute High Conga			808 High Conga		
62	Open High Conga			808 Mid Conga		
63	Low Conga			808 Low conga		
64	High Timbale					
65	Low Timbale					
66	High Agogo					
67	Low Agogo					
68	Cabasa					
69	Maracas			808 Marcs		
70	Short Hi whistle					
71	Long Low Whitle					
72	Short Guiro					
73	Long Guiro			808 Claves		
74	Claves					
75	High Wood Block					
76	Low Wood Block					
77	Mute Cuica					
78	Open Cuica					
79	Mute Triangle					
80	Open Triangle					
81	Shaker					
82	Jingle Bell					
83	Bell Tree					
84	Castanets					
85	Mute Surdo					
86	Open Surdo					
87	———					Applause *
88						

PC : Program change number (drum set number)

* : Tones which are created using two voices. (All other are created by one voice)

Blank : Same as the precussion sound of "STANDARD"
------- : No sound

7 - 1 SFX set

Note number	PC 57 : SFX set
40	High Q
39	Slap
41	Scartch Push
42	Scratch Pull
43	Sticks
44	Square Click
45	Metronome Click
46	Metronome Bell
47	Guiter sliding finger
48	Guiter cutting noise (down)
49	Guiter cutting noise (up)
50	String slap of double bass
51	Fl. Key Click
52	Laughing
53	Screaming
54	Punch
55	Heart Beat
56	Footsteps 1
57	Footsteps 2
59	Applause *
58	Door Creaking
60	Door
61	Scratch
62	Windchime *
63	Car - Engine
64	Car - Stop
65	Car - Pass
66	Car - Crash *
67	Siren
68	Train
69	Jetplane *
71	Helicopter
70	Starship *
72	GunShot
73	Machine Gun
74	Lasergun
76	Explosion *
75	Dog
77	Horse - Gallop
78	Birds *
79	Rain *
81	Thunder
80	Wind
83	Seashore
82	Stream *
84	Bubble *

* : Tones which are created using Two voices.
(All other tones are created by one voice.)

7 - 2 CM - 64/32L set

Note number	PC 128 : CM -64/32L set
34	----------
35	Acoustic Bass Drum
36	Acoustic Bass Drum
37	Rim Shot
38	Acoustic Snare Drum
39	Hand Clap
40	Electonic Snare Drum
41	Acoustic Low Tom
42	Closed High Hat 2]
43	Acoustic Low Tom
44	Open High Hat 2
45	Acoustic Middle Tom
46	Open High Hat 1
47	Acoustic Middle Tom
48	Acoustic High Tom
49	Crash Cymbal
50	Acoustic High Tom
51	Ride cymbal
52	----------
53	----------
54	Tambourine
55	----------
56	Cowbell
57	----------
58	----------
59	----------
60	High Bongo
61	Low Bongo
62	Mute High conga
63	High conga
64	Low conga
65	High Timbale
66	Low Timbale
67	High Agogo
68	Low Agogo
69	Cabasa
70	Maracas
71	Short Whistle
72	LOng Whistle
73	Quijada
74	----------
75	Claves
76	Laughig
77	Screaming
78	punch
79	Heartbeat
80	Footsteps 1
81	Footsteps 2
82	Applause
83	Creaking

Note number	PC 128 : CM -64/32L set
84	Door
85	Scratch
86	Windchime
87	Engine
88	Car - Stop
89	Car - Pass
90	Crash
91	Siren
92	Train
93	Jet
94	Helicopter
95	Starship
96	Pistol
97	Mashine Gun
98	Lasergun
99	Explosion
100	dog
101	Horse - Gallop
102	Birds
103	Rain
104	Thunder
105	Wind
107	Waves
108	Stream
	Bubble