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TYPE	Silicon Monolithic Integrated Circuit
Product Name	Sound Generator for Cellular Phone
Product No	BU8772KN
Physical Dimensions	Fig. 1 Mechanical dimension
Block Diagram	Fig. 2 Block diagram
Features	<ul style="list-style-type: none"> ○16 harmonies generator available at the same time. 128 sounds + drum set 47 sounds generation. ○FIFO buffer and sequencer reduce the burden of CPU. ○Integrated FIFO buffer for "Down load music data". ○Adjustable parameter for the generation of harmony. ○Selectable parameter of wave form (Square or special rectangle) to sound ○Stereo sound available. ○Integrated stereo sound DAC . ○Integrated 2-dimensional filter (Fc=20Khz) ○Power down mode supported. ○CPU control through integrated serial port. ○QFN28V Package

This chip don't be designed to protect against the radioactivity.

Application example

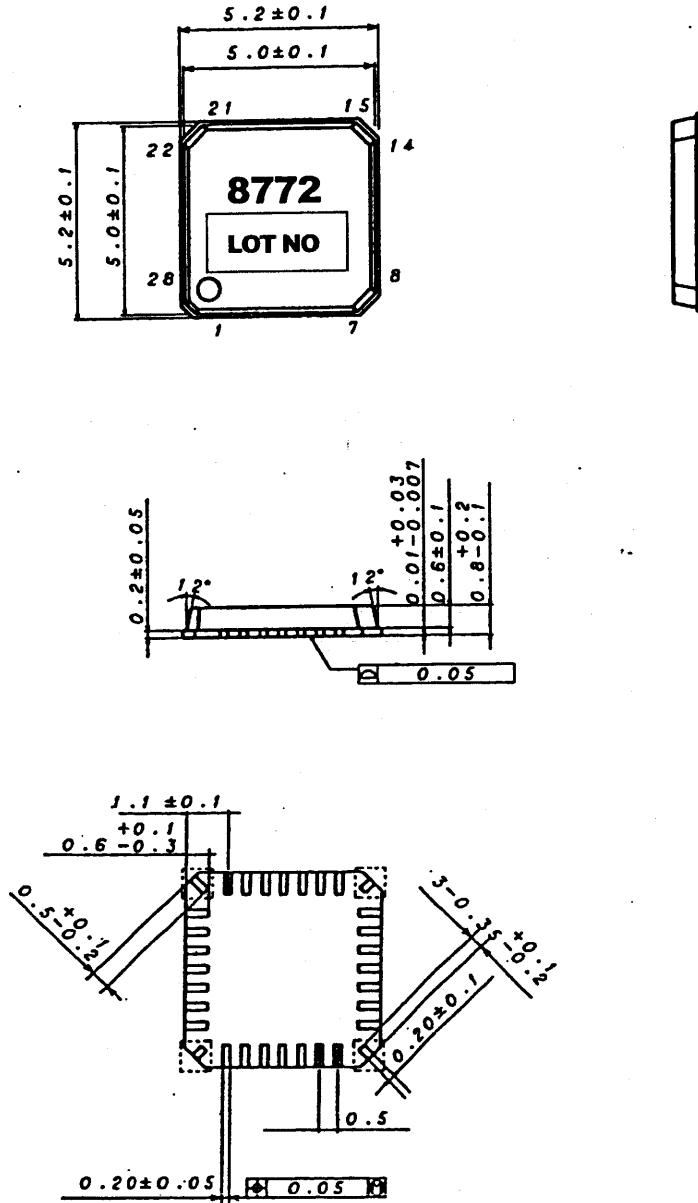
The application circuit is recommended for use. Make sure to confirm the adequacy of the characteristics. When using the circuit with changes to the external circuit constants, make sure to leave an adequate margin for external components including static and transitional characteristics as well as dispersion of the IC. Note that ROHM cannot provide adequate confirmation of patents.

The product described in this specification is designed to be used with ordinary electronic equipment or devices (such as audio-visual equipment office-automation equipment, communications devices, electrical appliances, and electronic toys.) Should you intend to use this product with equipment or devices which require an extremely high level of reliability and the malfunction of which would directly endanger human life (such as medical instruments, transportation equipment , aerospace machinery, nuclear-reactor controllers, fuel controllers and other safety devices), please be sure to consult with our sales representative in advance.

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Design <i>H. Yamada</i>	Check <i>M. Noda</i>	Approval <i>Y. Uchida</i> 18/Jan/02	Date 2002 Jan 15	Specification Rev. E
ROHM CO.,LTD.			Specification No. TSZ02201-BU8772KN-1-2	

● Outline dimensions diagram



Notice) We don't recommend bonding inside dotted line
(Unit: mm)

Figure 1. Outline Dimensions Diagram (plastic mold)

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●Block diagram

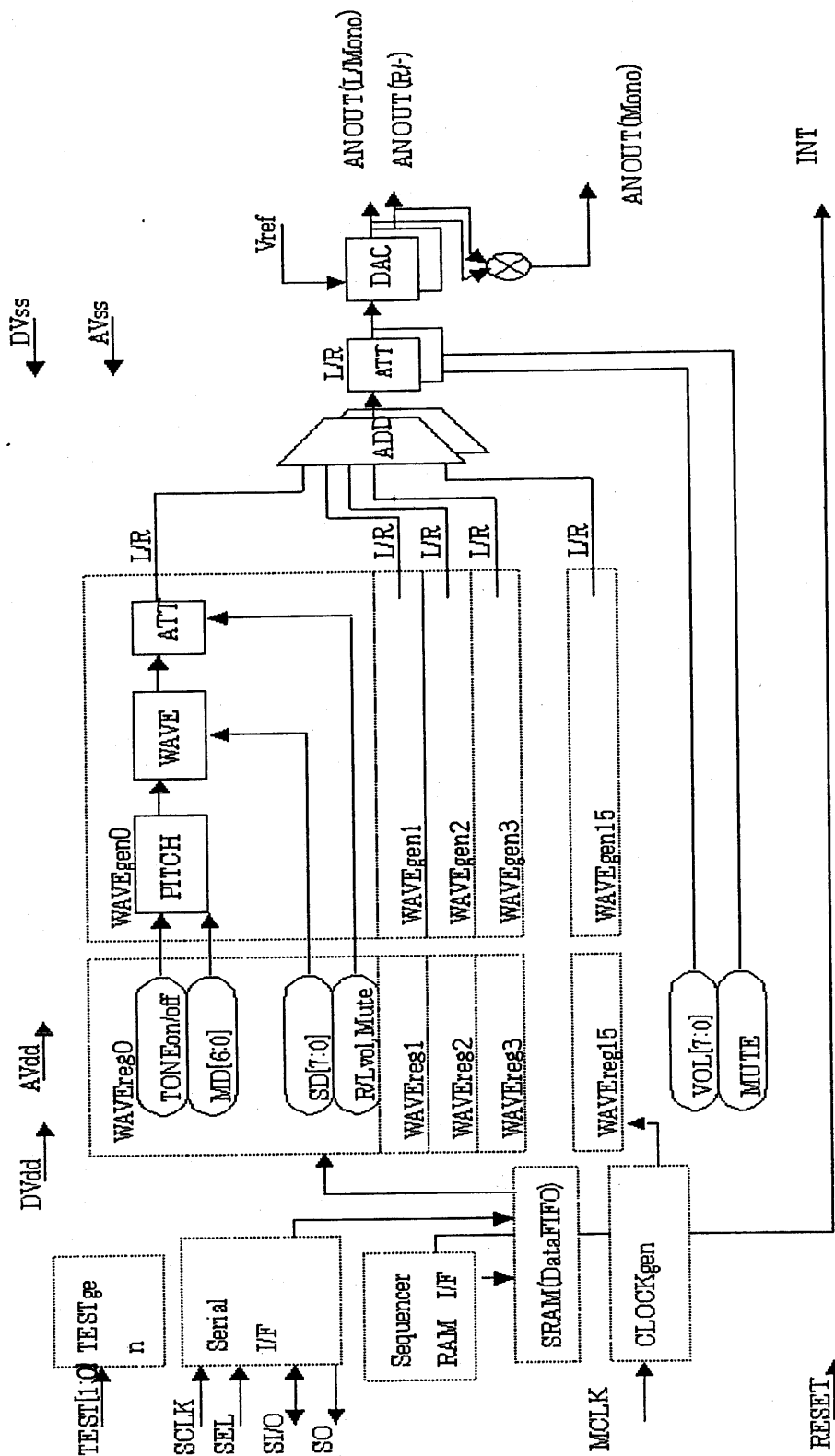


Figure 2. Block Diagram

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Description of circuit blocks

●Test block

This block includes IC testing circuits.

When the TEST [1:0] pin's state is "H, H", this block is in normal mode.

When it is in any another state, this block is in IC test mode.

●Serial interface block

This block includes interface circuits that interface with the system chip.

During a write operation, serial data synchronized with SCLK is received at the S/O pin, then it is converted to parallel data that is expanded in the WAVEreg block or SRAM block.

During a read operation, data from the WAVEreg block is converted to serial data and is output from the S/O pin in sync with SCLK.

●Clock gen block

This is the clock generator that supplies a clock to the sequencer block and WAVEgen block. Division parameters are generated to maintain a constant output frequency from each WAVEgen block's internal divider/counter to enable support for various master clocks (MCLK) as master clock signals supplied via the MCLK pin and divided into system clocks for the sequencer block, WAVEgen block, etc.

●SRAM (FIFO)

This buffer is used for sound source data. It has an FIFO configuration.

The buffer's capacity is 512 byte.

The write point (WP) and read point (RP) are both hardware-controlled.

NearlyEmpty and NearlyFull are included as interrupt sources to prevent overflow and underflow errors.

Both WP and RP can be reset and the FIFO memory devices can be emptied by writing "1" to the SequenceControlReg's Reset bit.

●Sequencer block

This block analyzes and converts message data.

When a melody is played, this block analyzes the RAM read data

and performs the settings required for the melody in the WAVEreg block to set the desired timing.

This block includes an assign function that dynamically assigns to the WAVEgen block.

●RAM interface block

This block controls the SRAM memory.

It generates and controls the write and read pointers that are used to configure the FIFO buffer.

●Timing gen block

This block controls the play timing. It control the timing of access to the WAVEreg block.

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●WAVE registers

These are the control registers for the WAVEgen block.

The sequencer controls the WAVEgen registers.

The control registers for the WAVEgen block cannot be accessed directly by the CPU.

However, common control of sound sources can be controlled directly by the CPU.

●WAVEgen block

This block sets generation of sound (melody) waveforms.

Up to 16 sounds can be generated at the same time.

Waveforms are generated according to the WAVEreg block's register setting data.

The 16 sound sources are generated from a tone palette of 128 voices plus a drum set.

Each sound source is controlled by a sequencer to reduce the CPU's processing load.

Equal temperament is used to produce a scale from A (110.34 Hz) to C8 (4173.983 Hz).

The equal temperament's standard pitch for A is based on a reference clock frequency of 440 Hz.

Pitch is proportionate to the MCLK frequency.

●DAC

This is stereo D/A converter.

The analog output level is increased to support the level generated by up to 16 WAVEgen registers.

The DAC block's dynamic range is $2/3 V_{DD}$ (as a V_{pp} value).

The amplitude required for 16-tone synthesis should be set so as not to exceed this dynamic range.

●LPF

This is a secondary LPF (Low Pass Filter).

It is a smoothing filter that eliminates high-frequency components from analog waveforms generated by the DAC block.

The final analog waveform is output via the ANOUT pin.

The ANOUT pin's minimum load resistance is 100 [K Ω].

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●Description of pin functions

Pin No.	Symbol	Description of function	Attribute	Circuit type	Remarks
24	TEST0	Input pin for IC tests Connect to Vdd	In	A	Used as Connect to Vdd
26	TEST1	Input pin for IC tests Connect to Vdd	In	A	Used as Connect to Vdd
9	SO	Data Out pin for serial interface Hi-Z, when SEL is High	Out	G	
10	SI/O	Data I/O pin for serial interface	In/Out	B	
12	SCLK	Clock input pin for serial interface	In	A	
13	SEL	Select input pin for serial interface (active low)	In	A	
23	MCLK	System clock input pin Can be set within range from 12 MHz to 20 MHz. Scale precision within this range is approximately 0.2%.	In	F	
17	LEDOUT	Out put pin for timing of LED	Out	C	
19	RESET	Reset input pin (active low)	In	A	
20	INT	Interrupt pin for this IC (active low)	Out	B	Used as CMOS (C) output during operation
14	DVDD	Digital power supply pin	-	-	
27	AVDD	Analog power supply pin	-	-	
16	DVSS	Digital ground pin	-	-	
3	AVSS	Analog ground pin	-	-	
1	VREF	AC (signal) ground pin Connect a 1- μ F bypass capacitor between VREF and GND.	Ana	E	
2	ANOUT (L)	Analog output pin. Potential is approximately the same as Avss except during play mode. Becomes Hi-z when reset.	Ana	D	
28	ANOUT (R)	Analog output pin. Potential is approximately the same as Avss except during play mode. Becomes Hi-z when reset.	Ana	D	
5	ANOUT (mono)	Analog output pin. Potential is approximately the same as Avss except during play mode. Becomes Hi-z when reset.	Ana	D	

Continue

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6, 15	For Test	Output for test	-	-	Used as not Connect
7, 8 21, 22	For Test	Input for test	-	-	Used as Connect to Vdd
4, 11 18, 25	NC	-	-	-	

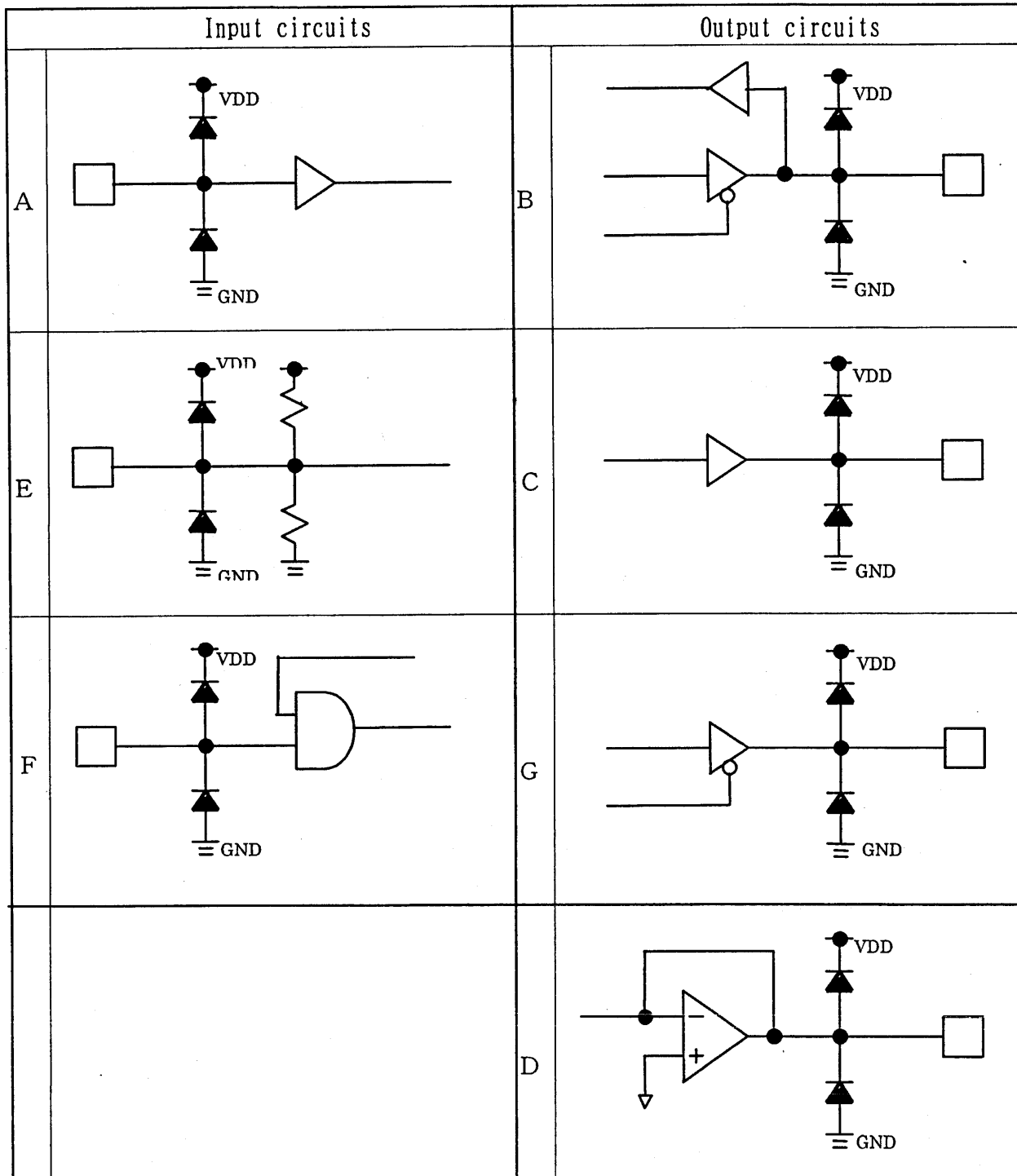
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● I/O circuit diagram



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●ABSOLUTE MAXIMUM RATINGS (unless otherwise noted, Ta = 25°C)

Parameter	Symbol	Rating	Unit	Remarks
Maximum supply voltage	VDD	-0.3 ~ +4.5	V	
Voltage applied to pin	VIN	DVSS-0.3 ~ DVDD+0.3	V	
Input current	IIN	-1 ~ +1	mA	
Allowable dissipation	Pd	370(Note)	mW	
Storage temperature range	Tstg	-50 ~ 125	°C	
Operating temperature range	Topr	-40 ~ 85	°C	

Note: Reduce to 3.7 mW/°C when Ta = 25°C or above.

●RECOMMENDED OPERATING POWER SUPPLY VOLTAGE RANGE

(Unless otherwise noted, Ta = 25°C)

Parameter	Symbol	rating			Unit	Remarks
		Min	Typ	Max		
Power supply voltage	VDD	2.7	3.0	3.6	V	
Ambient temperature	Ta	-40	25	85	°C	
MCLK input frequency	FMCLK	12	—	20	MHz	Scale precision is approximately 0.2%.
SCLK input frequency	FSCLK	500	—	MCLK	KHz	
MCLK duty	DMCLK	40	50	60	%	
SCLK duty	DSCLK	40	50	60	%	
ANOUT pin's load resistance	ZAN	100	—	—	kΩ	

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●ELECTRICAL CHARACTERISTICS (1 of 3)
(Unless otherwise noted, Ta = 25°C)

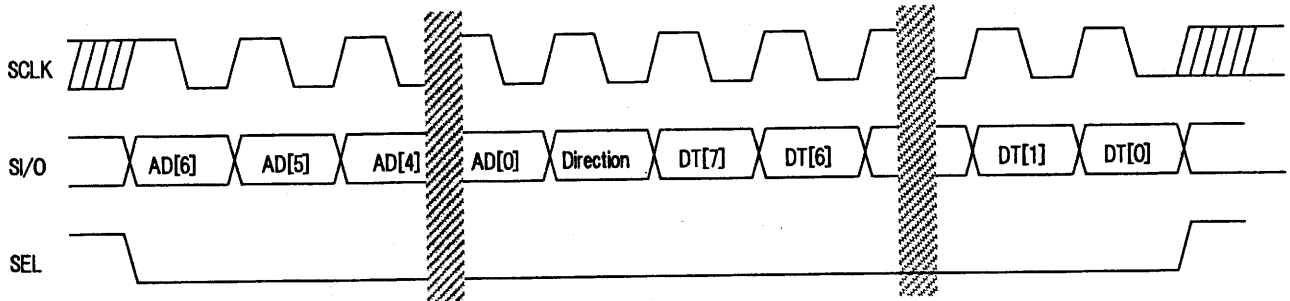
Parameter	Symbol	rating			Unit	Conditions
		Min	Typ	Max		
Digital DC characteristics						
High-level input voltage	V _{IH}	0.7V _{DD}	—	—	V	
Low-level input voltage	V _{IL}	—	—	0.3V _{DD}	V	
High-level input current	I _{IH}			10	μA	V _{IH} =V _{DD}
Low-level input current	I _{IL}	-10	—	—	μA	V _{IH} =GND
High-level output voltage	V _{OH}	V _{DD} -0.3	—	—	V	I _{OH} =-0.8mA
Low-level output voltage	V _{OL}	—	—	GND+0.3	V	I _{OL} =0.8mA
Analog DC characteristics						
VREF pin voltage	V _{AGND}	0.475V _{DD}	0.5V _{DD}	0.525V _{DD}	V	I _{OUT} =0A (no load)
ANOUT pin voltage	V _{OUT}	0.47V _{DD}	0.5V _{DD}	0.53V _{DD}	V	I _{OUT} =0A (no load)
General characteristics						
VREF pin rise time	TR _{VR}	—	25	40	ms	When C _{VREF} = 1μF and RESET = L → H
Analog (ANOUT pin) characteristics						
ANOUT amplitude	V _{MAX}	—	0.667V _{DD}	—	V _{p-p}	Theoretical value for dynamic range
Power consumption V_{DD}=3.0[V], MCLK=12[Mhz]						
Analog I _{DD}	I _{DD1}		0.8	2.2	mA	Playing
Digital I _{DD}	I _{DD2}		17	22	mA	Playing
Analog I _{DD}	I _{DD3}			1	μA	Standby mode
Digital I _{DD}	I _{DD4}			1	μA	Standby mode

●ELECTRICAL CHARACTERISTICS (2 of 3)
(Unless otherwise noted, Ta = 25°C)

Parameter	Symbol	rating			Unit	Conditions
		Min	Typ	Max		
Serial interface format						
Character bit length	N _{cha}	16	—	—	bit	MSB first
Serial interface timing characteristics						
SCLK input frequency	F _{SCLK}	500	—	MCLK	KHz	
SCLK duty	D _{SCLK}	40	50	60	%	
Data setup time	T _{sc}	25	—	—	ns	To FallingEdge of SCLK
Data hold time	T _{hc}	25	—	—	ns	To FallingEdge of SCLK

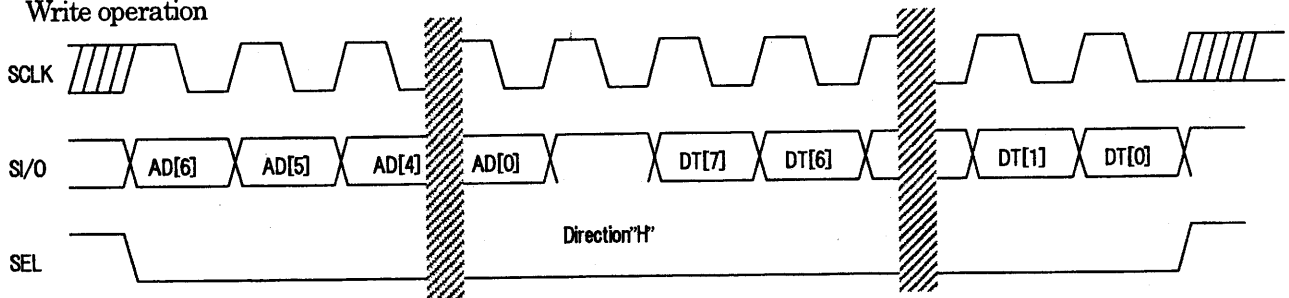
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1. Serial interface timing chart

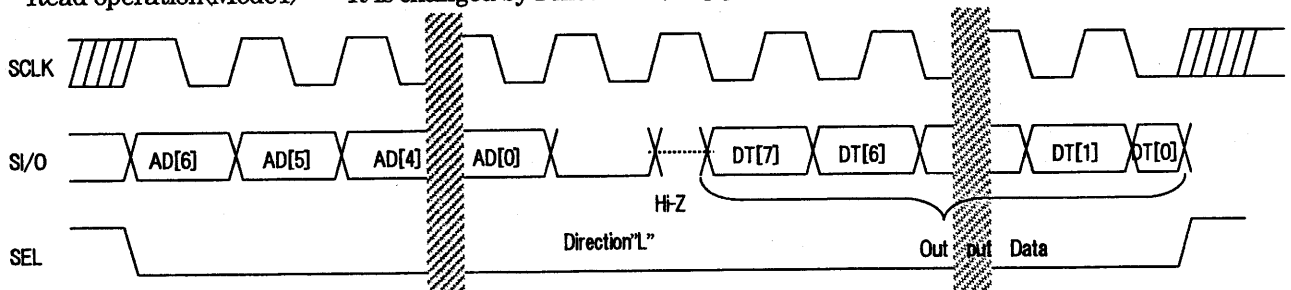


When direction is "1": Write operation
When direction is "0": Read operation

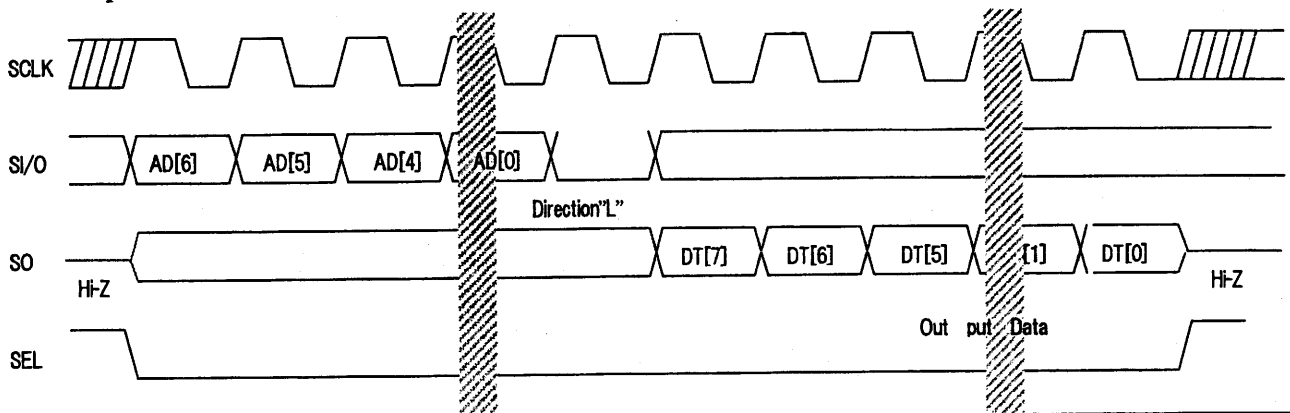
Write operation



Read operation (Mode1) It is changed by Pmode bit (bit[3] of Address0x0)



Read operation (Mode2) It is changed by Pmode bit (bit[3] of Address0x0)



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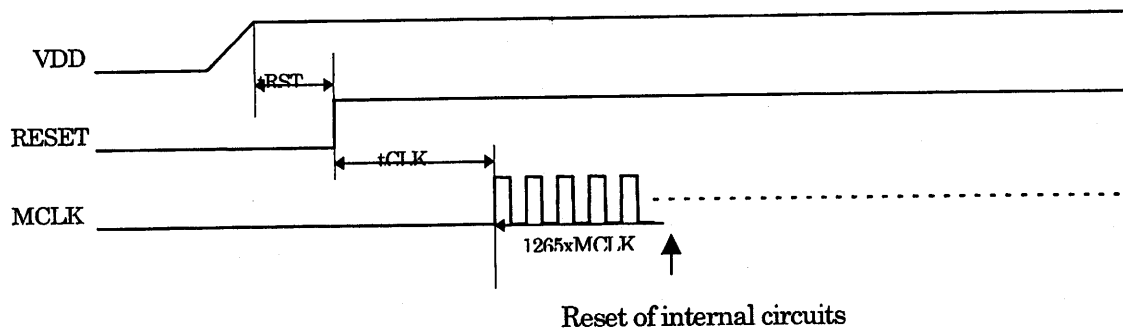
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● ELECTRICAL CHARACTERISTICS (3 of 3)
(Unless otherwise noted, Ta = 25°C)

Parameter	Symbol	rating			Unit	Conditions
		Min	Typ	Max		
Reset sequence						
VDD=>RESET time	TRST	10	—	—	ms	
RESET=>MCLK time	TCLK	0	—	—	ms	MCLK waveform must be normal

<Pin reset sequence>



* RESET, supply low-level voltage, when POWER ON.

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●Description of sequencer

This sequencer uses the timing information in the melody data to control the timing of sound sources.

To take full advantage of the sound sources, this sequence also has an assign function which dynamically assigns data to sound sources.

This function enables high-quality musical expressions.

[General operation]

- 1) Fetches melody data stored in FIFO directives and assigns them to empty sound sources.
- 2) Tones are generated when information from melody data is set to any WAVEgen setup register.
- 3) Controls tone generation, turns tone OFF at tone end timing, and releases the sound source.
- 4) Decide the order of priority that registers to Wave.gen in consideration of Track No, Voice No.

The following table shows a map of control registers in the WAVEgen block.

WAVEgen block control registers

Number	Reg Name	D 7	D 6	D 5	D 4	D 3	D 2	D 1	D 0
0	WAVE0gen Setup	SD7	SD6	SD5	SD4	SD3	SD2	SD1	SD0
1			MD6	MD5	MD4	MD3	MD2	MD1	MD0
2		TONEon	ENVtrg	LV5	LV4	LV3	LV2	LV1	LV0
3		MUTE	x	RV5	RV4	RV3	RV2	RV1	RV0
4	WAVE1gen Setup	SD7	SD6	SD5	SD4	SD3	SD2	SD1	SD0
5			MD6	MD5	MD4	MD3	MD2	MD1	MD0
6		TONEon	ENVtrg	LV5	LV4	LV3	LV2	LV1	LV0
7		MUTE	x	RV5	RV4	RV3	RV2	RV1	RV0
..	...								
6 0	WAVE15gen Setup	SD7	SD6	SD5	SD4	SD3	SD2	SD1	SD0
6 1			MD6	MD5	MD4	MD3	MD2	MD1	MD0
6 2		TONEon	ENVtrg	LV5	LV4	LV3	LV2	LV1	LV0
6 3		MUTE	x	RV5	RV4	RV3	RV2	RV1	RV0

SD [7:0]	Tone data
MD [6:0]:	Scale data
LV [5:0]:	Left-channel volume data
RV [5:0]:	Right-channel volume data
TONEon	Tone ON/OFF control
ENVtrg	Envelope start trigger
MUTE	Mute sound sources

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● Sound source control

Overall control of sound sources is performed directly by the CPU.

1. Description of registers

The common control register is controlled directly by the CPU.

A map of its registers is shown below.

Map of Common Control Register for Sound sources

Address	Reg Name	R/W	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
0x00	Common setup	W	x	SE	Ring		Pmode	AN1/2	Mono	TMute
0x01	WAVE VOL	W	VOL7	VOL6	VOL5	VOL4	VOL3	VOL2	VOL1	VOL0
0x02	INT Mask	W	INTPol			LEDenb				
0x03	Status	R	Empty	NearEP	NearFL	LED	III Format	Empty Area	Full Area	BUSY
		W	Clear	Clear	Clear	Clear	Clear			
0x04	Sequ Control	W	Reset	Stnby	Anout Disable	Anout Mono Disable				Start
0x05	FIFO Control	W	Nearly Full setup				Nearly Empty setup			
0x06	FIFOwindow	W	Data [7:0]							
0x07	Time reg (1)	W	Time Setup data (1)							
0x08	Time reg (2)	W	Time setup data (2)							
0x09	WaveSel	W					Wave Select [3:0]			
0x0A	Wave Window	W	SD [7:0] Tone							
0x0B		W	MD [6:0] Key							
0x0C		W	Lvol [5:0]							
0x0D		W	Rvol [5:0]							
0x0E		W	Tone on/off	Mute						
0x0F	Test	W	For Test							
0x10-0x7F	Reserved		Reserved							

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Address 0x00 Common setup register

(Write)

- Bit6: SE SE Mode 'H' write operation.
The sequencer can use Wave.gen[8:15] only.
The other can be control from CPU directly.
'L' write operation
The sequencer can use Wave.gen[0:15]. (Default setting)
- Bit5: Ring Ringer Mode 'H' write operation.
Increase of output.
'L' write operation
Normally (Default setting)
- Bit4: Don't write 'H'.
- Bit3: Pmode Select Port Mode "H" write operation sets serial port as "Mode2".
"L" write operation sets serial port as "Mode1".
(Default setting)
- Bit2: AN1/2 Select data format "H" write operation sets input data format as "B".
"H" write operation sets ,when all Wave.gen are control from
CPU directly.
"L" write operation sets input data format as "A".
(Default setting)
- [For further description of formats, see the next section.]
- Bit1: Mono Monaural setting bit "H" write operation sets output as monaural.
"L" write operation sets output as stereo.
(Default setting)
- #When monaural mode, Monaural output is ANOUT(L).ANOUT(R) is mute.
- Bit0: Tmute Mute sound sources "H" write operation sets mute for melody.
"L" write operation clears mute for melody.
(Default setting)

Address 0x01 Wave Vol register

(Write)

Bit[7:0]:VOL[7:0] Total volume

Address 0x02 INT Mask register

(Write)

Bit7: INT Polarity Interrupt output polarity
"H" write operation sets interrupt output signal enable "H".
"L" write operation sets interrupt output signal enable "L".
(Default setting)

Reset from only an input pin it assumed to be effective.

An influence is not received from address 0x04 bit[7] firm ware reset.

Bit4: LED Int enb LED interrupt enable "H" write operation sets LED interrupts as valid.
"L" write operation masks LED interrupts. (Default setting)

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Address 0x03 Status register

(Read)

- Bit7: Empty FIFO Empty bit (interrupt source)
"H" indicates that melody data FIFO is empty.
- Bit6: Nearly Empty FIFO Nearly Empty bit (interrupt source)
"H" indicates that remaining data in melody data FIFO has reached to the level set in the FIFO control register.
- Bit5: Nearly Full FIFO Nearly Full bit (interrupt source)
"H" indicates that remaining data in melody data FIFO has reached the level set in the FIFO control register.
- Bit4: LED LED bit (interrupt source)
"H" indicates that Voice0 sounds are generated in melody data.
- Bit3: Ill Format Illegal format bit (interrupt source)
"H" indicates that performance data format of halfway "Empty" it detects.
"H" indicates that abnormal completion of a sequencer and the action from a transmission sequence is necessary.
- Bit2: Empty Area
"H" indicates that a remainder melody data pointer exists in the area of Empty.
- Bit1: Full Area
"H" indicates that a remainder melody data pointer exists in the area of Full.
- Bit0: BUSY Busy bit
"H" indicates that melody data output or sequencer operation is in progress.

(Write)

- Bit7: Empty Clear FIFO Empty Clear bit
Writing "1" clears the Empty bit.
- Bit6: Nearly Empty Clear FIFO Nearly Empty Clear bit
Writing "1" clears the Nearly Empty bit.
Any interrupt signal is negated.
- Bit5: Nearly Full Clear FIFO Nearly Full Clear bit
Writing "1" clears the Nearly Full bit.
Any interrupt signal is negated.
- Bit4: LED Clear LED Clear bit
Writing "1" clears the LED bit.
Any interrupt signal is negated.
- Bit3: Ill Format Clear Illegal format Clear bit
Writing "1" clears the Illegal format bit.

Address 0x04 Sequence Control register

(Write)

- Bit7: Reset Firmware reset "H" write operation resets this sequencer.
When end of performance, this bit sets.
- Bit6: Standby Standby mode "H" write operation sets this IC to standby mode.
"L" write operation releases standby mode.
If this bit operation is executed during play mode, correct playback of the current song is not guaranteed.

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- Bit5:** Anout Dis Anout Disable bit "H" write operation sets Hi-z at Anout(L/R/Mono).
"L" write operation become to output at Anout(L/R/Mono).
(Default setting)
If this bit operation is executed during play mode, correct playback of the current song is not guaranteed.
- Bit4:** Anout Mono Dis Anout Mono Disable bit "H" write operation sets Hi-z at Anout(Mono).
"L" write operation become to output at Anout(Mono).
(Default setting)
If this bit operation is executed during play mode, correct playback of the current song is not guaranteed.
- Bit0:** Start Sequencer start bit. "H" write operation starts the sequencer.
"L" write operation stops the sequencer.
If this bit operation is executed during play mode, correct playback of the current song is not guaranteed.

Address 0x05 FIFO Control register
(Write)

- Bit[7:4]** NearlyFullSetup
"1000" sets remaining space at 1/16 of FIFO capacity
"0100" sets remaining space at 1/8 of FIFO capacity (default setting).
"0010" sets remaining space at 1/4 of FIFO capacity.
"0001" sets remaining space at 1/2 of FIFO capacity.
Others- Don't Use !!
- Bit[3:0]** NearlyEmptySetup
"1000" sets remaining data at 1/16 of FIFO capacity
"0100" sets remaining data at 1/8 of FIFO capacity (default setting).
"0010" sets remaining data at 1/4 of FIFO capacity.
"0001" sets remaining data at 1/2 of FIFO capacity.
Others- Don't Use !!

Address 0x06 FIFO Window register
(Write)

- Bit[7:0]** FIFO Window Melody data FIFO window
Writing to this register fills the FIFO.
The write pointer is incremented after each write operation

Address 0x07 time setup register (1)
(Write)

- Bit[7:0]** time setup Minute circumference ratio is set up to make 128KHz needed for a sound resource from MCLK.
- | | |
|-----------------|--|
| When MCLK=12Mhz | Setting value = 0x5E (default setting) |
| MCLK=14Mhz | Setting value = 0x6D |
| MCLK=16Mhz | Setting value = 0x7D |
| MCLK=18Mhz | Setting value = 0x8D |
| MCLK=20Mhz | Setting value = 0x9C |

Calculation style) $MCLK/128Khz = \text{Setting value}$

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Address 0x08 time setup register (2)
(Write)

Bit[7:0] time setup Minute circumference ratio is set up to make 22.05KHz needed for a sound resource from MCLK.

When MCLK=12Mhz	Setting value = 0x10 (default setting)
MCLK=14Mhz	Setting value = 0x3D
MCLK=16Mhz	Setting value = 0x6B
MCLK=18Mhz	Setting value = 0x98
MCLK=20Mhz	Setting value = 0xC6

Calculation style) $MCLK/(22.05Khz*2) = \text{Setting value}$

In MCLK is 12Mhz~20Mhz.Bit[9] become fixation "1".

Accordingly setting unnecessary.

Setting only bit[7:0].

Address 0x09 Wave Select register
(Write)

Bit[3:0] Wave Select

"0000"- Selects a Wave.gen0 (default setting)

"0001"- Selects a Wave.gen1

"0010"- Selects a Wave.gen2

"0011"- Selects a Wave.gen3

"0100"- Selects a Wave.gen4

"0101"- Selects a Wave.gen5

"0110"- Selects a Wave.gen6

"0111"- Selects a Wave.gen7

"1000"- Selects a Wave.gen8

"1001"- Selects a Wave.gen9

"1010"- Selects a Wave.gen10

"1011"- Selects a Wave.gen11

"1100"- Selects a Wave.gen12

"1101"- Selects a Wave.gen13

"1110"- Selects a Wave.gen14

"1111"- Selects a Wave.gen15

Address 0x0A~0x0E Wave.gen register
(Write)

Inside Wave reg can be gained access directly.

Address 0x0F TEST register
(Write)

Address 0x10~0x7F Reserved
Don't Touch !!

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2. Melody data format

The CPU indicates the format of the data stored in RAM (FIFO).
Select from either of two data formats.
Select whether to use AN1 or AN2 bit.

[Format A]

Note message format (7 bytes)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Delta Time							
Track Number 0~255							
Voice Number				Key[5:0]			
Tone (Expansion code *Length of 6 Byte)							
Key[6]				L-Volume			
Mute	Extension			R-Volume			
Length of sound [Delta Time]							

[Format B]

Note on message format (6 bytes)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Delta Time							
Track Number						Voice Number	
ToneON/Off	Key[6:0]						
Tone (Expansion code)							
				L-Volume			
Mute				R-Volume			

Note off message format (3 bytes)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Delta Time							
Track Number						Voice Number	
ToneON/Off	Key[6:0]						

Description of format

- Delta Time : Each setting in the Δ time register is called 1 Δ time, which indicates the amount of time that has elapsed since the previous event.
- Track Number : Indicates the sequence in which tracks are played (0, 1, 2, etc.)
- Voice Number : Indicates voice number in current track
- Key[6:0] : Indicates the key (scale) of sounds being generated
- Sound length : Indicates the length of a generated sound. This is expressed as the Δ time. When sound length is 0xFF, it is based on the extension of the sound length being done in the rest, and pronunciation at this time is protected 【 any case 】 , too.
- Tone (Expansion code) : 0x00~0xFC make to indicate the tone of the sound source
: 0xFD~0xFF make an expansion code.
Expansion code is length of 6 byte.

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[NOP Message]

	0xFD
+1Byte	0x00
+1Byte	0x00

[Δtime Message]

	0xFE
+1Byte	Δtime (U)
+1Byte	Δtime (L)

Setting in Δtime that was turned into be common in performance data.
Accordingly, Track number and voice number disregarded.
The information of a performance data overall is made.
Integer9bit+decimal7bit, Total 16bit with unit [ms].
Range is 0.125 to 511[ms].

[TimeBase Message]

	0xFF
+1Byte	0x00
+1Byte	TimeBase

Whether each track is what times were shown with "Δtime message" is set up.
Accordingly, Track number disregarded and the information of each track number is made.

Sound length of Format A is controlled by this message.

Yet, only track0 to 15, "Time base" is handled as 110b in the track15 of after.

Appropriate sound length setting requires.

TimeBase[2:0]	000b = x64
	001b = x32
	010b = x16
	011b = x8
	100b = x4
	101b = x2
	110b = x1
	other = Don't use !!

L-Volume : Volume of left channel
R-Volume : Volume of right channel
Mute : Mute setting
Tone On/Off : Tone ON/OFF control 1: Tone on
0: Tone off
Extension : 0: NOP

1: It is shown that the extension of the sound length is done in the rest.

The control which is equal to the time when sound head is 0xFF is done.

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[Notes]

(1) Format A is the format in which the tone OFF status is calculated based on the sound length and control is performed in the sequencer.

Format B is the format in which the tone OFF status is calculated on the data generation side and control is performed using messages.

2. Standby general operation

Address 0x4, Sequence control register bit[6];

"H" write operation sets this IC to standby mode.

When standby mode:

MCLK(input) is gated .

Analog block sleep .

All control register not move (without Sequence control register bit[6]).

Normal from standby mode:

Address 0x4, Sequence control register bit[6];

"L" write operation sets this IC to normal mode from standby mode.

[Transition from the performance state to the suspension state]

step1 Address 0x4 write operation data 0x00 (Sequencer stop)

step2 Address 0x4 write operation data 0x40 (Standby mode set)

Forego procedure is necessary.

[Notice for using "formatB"]

At "formatB" unable to change volume during NOTEON.

When NOTEON message inputs for changing volume, BU8772KN assign onother wave generator.

Therefore several sounds are generated at same TrackNo and Key. So, without NOTEOFF message for them,

The wave generator ever NOTEON.

When translates to "formatB", don't input to BU8772KN data for changing volume, or input them as NOP Message.

[Notice for using "formatA"]

When same TrackNo, VoiceNo and Key data is already NOTEON, BU8772KN treat next data as extention for length of sound.

When translates to "formatA", set other TrackNo(VoiceNo) for each tone data, or set other Key for each tone data of same TrackNo, VoiceNo. Especially, notice for specific effect sounds.

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4. Tone data table

The tone data table is shown below.

These correspond to the tones in the melody data format.

SD[7:0]	Instrument	SD[7:0]	Instrument	SD[7:0]	Instrument
0x00	Acoustic Grand Piano	0x30	String Ensembles 1	0x60	FX1(rain)
0x01	Bright Acoustic Piano	0x31	String Ensembles 2	0x61	FX2(soundtrack)
0x02	Electric Grand Piano	0x32	Synth Strings 1	0x62	FX3(crystal)
0x03	Honky-tonk Piano	0x33	Synth Strings 2	0x63	FX4(atmosphere)
0x04	Electric Piano 1	0x34	Choir Aahs	0x64	FX5(brightness)
0x05	Electric Piano 2	0x35	Voice Oohs	0x65	FX6(goblins)
0x06	Harpichord	0x36	Synth Voice	0x66	FX7(echoes)
0x07	Clavi	0x37	Orchestra Hit	0x67	FX8(sci-fi)
0x08	Celesta	0x38	Trumpet	0x68	Sitar
0x09	Glockenspiel	0x39	Trombone	0x69	Barjo
0x0A	Music Box	0x3A	Tuba	0x6A	Shamisen
0x0B	Vibraphone	0x3B	Muted Trumpet	0x6B	Koto
0x0C	Marimba	0x3C	French Horn	0x6C	Kalimba
0x0D	Xylophone	0x3D	Brass Section	0x6D	Bagpipe
0x0E	Tubular Bells	0x3E	Synth Brass 1	0x6E	Fiddle
0x0F	Dulcimer	0x3F	Synth Brass 2	0x6F	Shanai
0x10	Drawbar Organ	0x40	Soprano Sax	0x70	Tinkle Bell
0x11	Percussive Organ	0x41	Alto Sax	0x71	Agogo
0x12	Rock Organ	0x42	Tenor Sax	0x72	Steel Drum
0x13	Church Organ	0x43	Baritone Sax	0x73	Woodblock
0x14	Reed Organ	0x44	Oboe	0x74	Talko Drum
0x15	Accordion	0x45	English Horn	0x75	Melodic Tom
0x16	Harmonica	0x46	Bassoon	0x76	Synth Drum
0x17	Tango Accordion	0x47	Clarinet	0x77	Reverse Cymbal
0x18	Acoustic Guitar (nylon)	0x48	Piccolo	0x78	Guitar Fret Noise
0x19	Acoustic Guitar (steel)	0x49	Flute	0x79	Breath Noise
0x1A	Electric Guitar (jazz)	0x4A	Recorder	0x7A	Seashore
0x1B	Electric Guitar (jazz)	0x4B	Pan Flute	0x7B	Bird Tweet
0x1C	Electric Guitar (jazz)	0x4C	Blow Bottle	0x7C	Telephone Ring
0x1D	Overdrive Guitar	0x4D	Shakuhachi	0x7D	Helicopter
0x1E	Distortion Guitar	0x4E	Whistle	0x7E	Applause
0x1F	Guitar Harmonics	0x4F	Ocarina	0x7F	Gun Shot
0x20	Acoustic Bass	0x50	Lead1(square)		
0x21	Electric Bass (finger)	0x51	Lead2(sawtooth)		
0x22	Electric Bass (pick)	0x52	Lead3(callicope)		
0x23	Fretless Bass	0x53	Lead4(driff)		
0x24	Slap Bass 1	0x54	Lead5(charang)		
0x25	Slap Bass 2	0x55	Lead6(voice)		
0x26	Synth Bass 1	0x56	Lead7(frths)		
0x27	Synth Bass 2	0x57	Lead8(bass+lead)		
0x28	Violin	0x58	Pad1(new age)		
0x29	Viola	0x59	Pad2(warm)		
0x2A	Cello	0x5A	Pad3(polyynth)		
0x2B	Contrabass	0x5B	Pad4(choir)		
0x2C	Tremolo Strings	0x5C	Pad5(powrd)		
0x2D	Pizzicato Strings	0x5D	Pad6(metalic)		
0x2E	Orchestral Harp	0x5E	Pad7(halo)		
0x2F	Timpani	0x5F	Pad8(sweep)		

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SD[7:0]	Instrument	SD[7:0]	Instrument	SD[7:0]	Instrument
0x80	Acoustic Bass Drum	0xB0	Cursor move sound (Long)	0xE0	Special rectangle(no ENV)
0x81	Bass Drum	0xB1	Beep(Normal)	0xE1	Sin(1.6s)
0x82	Side Stick	0xB2	Beep(Outer space)	0xE2	Sin(0.8s)
0x83	Acoustic Snare	0xB3	Siren1	0xE3	Sin(no ENV)
0x84	Hand Clap	0xB4	Character power up	0xE4	Reserved
0x85	Electric Snare	0xB5	Character get	0xE5	Reserved
0x86	Low Floor Tom	0xB6	Up	0xE6	Reserved
0x87	Closed H-hat	0xB7	Down	0xE7	Reserved
0x88	High Floor Tom	0xB8	Luffin'	0xE8	Reserved
0x89	Pedal H-hat	0xB9	Scream	0xE9	Reserved
0x8A	Low Tom	0xBA	Pretty	0xEA	Reserved
0x8B	Open H-hat	0xBB	Mystery	0xEB	Reserved
0x8C	Low Mid Tom	0xBC	Robot	0xEC	Reserved
0x8D	High Mid Tom	0xBD	Foot step	0xED	Reserved
0x8E	Crash Cymbal1	0xBE	Character rotation	0xEE	Reserved
0x8F	High Tom	0xBF	Character jump	0xEF	Reserved
0x90	Ride Cymbal 1	0xC0	Laser gun(Short)	0xF0	Reserved
0x91	Chinese Cymbal	0xC1	Hit1(hard)	0xF1	Reserved
0x92	Ride Bell	0xC2	Hit2(noise)	0xF2	Reserved
0x93	Tambourine	0xC3	Bomb(Short)	0xF3	Reserved
0x94	Splash Cymbal	0xC4	Bomb(Long)	0xF4	Reserved
0x95	Cowbell	0xC5	Monster damage	0xF5	Reserved
0x96	Crash Cymbal2	0xC6	Robot damage	0xF6	Reserved
0x97	Vibra-slap	0xC7	Character fade out	0xF7	Reserved
0x98	Ride Cymbal2	0xC8	Engine	0xF8	Reserved
0x99	High Bongo	0xC9	Approach (fade in)	0xF9	Reserved
0x9A	Low Bongo	0xCA	Take off(fade out)	0xFA	Reserved
0x9B	Mute H Conga	0xCB	Space(fier down)	0xFB	Reserved
0x9C	Open H Conga	0xCC	Science(H down)	0xFC	Reserved
0x9D	Low Conga	0xCD	Bubble	0xFD	Reserved
0x9E	High Timbale	0xCE	Drop	0xFE	Reserved
0x9F	Low Timbale	0xCF	Reserved	0xFF	Reserved
0xA0	High Agogo	0xD0	Reserved		
0xA1	Low Agogo	0xD1	Reserved		
0xA2	Cabasa	0xD2	Reserved		
0xA3	Maracas	0xD3	Reserved		
0xA4	Short Whistle	0xD4	Reserved		
0xA5	Long Whistle	0xD5	Reserved		
0xA6	Short Guiro	0xD6	Reserved		
0xA7	Long Guiro	0xD7	Reserved		
0xA8	Claves	0xD8	Reserved		
0xA9	Hi Wood Block	0xD9	Reserved		
0xAA	Low Wood Block	0xDA	Reserved		
0xAB	Mute Cuica	0xDB	Reserved		
0xAC	Open Cuica	0xDC	Reserved		
0xAD	Mute Triangle	0xDD	Reserved		
0xAE	Open Triangle	0xDE	Special rectangle (1.6s)		
0xAF	Cursor move sound(Short)	0xDF	Special rectangle (0.8s)		

Note: The following assignments set Compact MIDI format compatibility for the above tones.

Tone bank 2 & tone data 0 to 63 are assigned to 0x00 to 0x3F in SD [7:0].

Tone bank 3 & tone data 0 to 63 are assigned to 0x40 to 0x7F in SD [7:0].

Tone bank 52 & tone data 0 to 31 are assigned to 0xAF to 0xCE in SD [7:0].

Tone bank 62 & tone data 0 & Key date 0 to 46 are assigned to 0x80 to 0xAE in SD [7:0].

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5. KEY date (KEY)

The KEY data table is shown below.

These correspond to the KEY in the melody data format.

Key[6:0]	Real KEY	Remarks*MIDI	Remark*Compact MIDI	
			OCTSFT	KEY
0	A[27.5Hz]	21	-2	0
1	A#	22		1
~	~	~		~
61		82		61
62		83		62
12	A[55Hz]	33	-1	0
13	A#	34		1
~	~	~		~
73		94		61
74		95		62
24	A[110Hz]	45	0	0
25	A#	46		1
~	~	~		~
85		106		61
86		107		62
36	A[220Hz]	57	1	0
37	A#	58		1
~	~	~		~
97		118		61
98		119		62

[The pronunciation area of the endorse toward each timbre]

NO	Instrument	The pronunciation area of the endorse									
		MIDI Key		BU8772 Key		CompactMIDI Key					
		KEY Lower limit	KEY Upper limit	KEY Lower limit	KEY Upper limit	KEY Lower limit			KEY Upper limit		
						OCTSFT	KEY	Hex	OCTSFT	KEY	Hex
0	Acoustic Grand Piano	21	95	0	74	-2	0	80	0	50	32
1	Bright Acoustic Piano	21	95	0	74	-2	0	80	0	50	32
2	Electric Grand Piano	21	95	0	74	-2	0	80	0	50	32
3	Honkey-tonk Piano	21	95	0	74	-2	0	80	0	50	32
4	Electric Piano1	28	95	7	74	-2	7	87	0	50	32
5	Electric Piano2	28	95	7	74	-2	7	87	0	50	32
6	Harpsichord	41	89	20	68	-1	8	C8	0	44	2C
7	Clavi	36	95	15	74	-1	3	C3	0	50	32
8	Celesta	60	95	39	74	0	15	F	0	50	32
9	Glockenspiel	72	83	51	62	0	27	1B	0	38	26

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10	Music Box	60	84	39	63	0	15	F	0	39	27
11	Vibraphone	53	89	32	68	0	8	8	0	44	2C
12	Marimba	48	84	27	63	0	3	3	0	39	27
13	Xylophone	65	95	44	74	0	20	14	0	50	32
14	Tubular Bells	60	77	39	56	0	15	F	0	32	20
15	Dulcimer	60	84	39	63	0	15	F	0	39	27
16	Drawbar Organ	36	95	15	74	-1	3	C3	0	50	32
17	Percussive Organ	36	95	15	74	-1	3	C3	0	50	32
18	Rock Organ	36	95	15	74	-1	3	C3	0	50	32
19	Church Organ	21	95	0	74	-2	0	80	0	50	32
20	Reed Organ	36	83	15	62	-1	3	C3	0	38	26
21	Accordion	53	83	32	62	0	8	8	0	38	26
22	Harmonica	60	83	39	62	0	15	F	0	38	26
23	Tango Accordion	53	89	32	68	0	8	8	0	44	-2C
24	Acoustic Guitar (nylon)	40	84	19	63	-1	7	C7	0	39	27
25	Acoustic Guitar (steel)	40	84	19	63	-1	7	C7	0	39	27
26	Electric Guitar (jazz)	40	86	19	65	-1	7	C7	0	41	29
27	Electric Guitar (clean)	40	86	19	65	-1	7	C7	0	41	29
28	Electric Guitar (muted)	40	86	19	65	-1	7	C7	0	41	29
29	Overdriven Guitar	40	83	19	62	-1	7	C7	0	38	26
30	Distortion Guitar	40	86	19	65	-1	7	C7	0	41	29
31	Guitar harmonics	40	86	19	65	-1	7	C7	0	41	29
32	Acoustic Bass	28	55	7	34	-2	7	87	0	10	A
33	Electric Bass (finger)	28	55	7	34	-2	7	87	0	10	A
34	Electric Bass (pick)	28	55	7	34	-2	7	87	0	10	A
35	Fretless Bass	28	55	7	34	-2	7	87	0	10	A
36	Slap Bass1	28	55	7	34	-2	7	87	0	10	A
37	Slap Bass2	28	55	7	34	-2	7	87	0	10	A
38	Synth Bass1	28	55	7	34	-2	7	87	0	10	A
39	Synth Bass2	28	55	7	34	-2	7	87	0	10	A
40	Violin	55	95	34	74	0	10	A	0	50	32
41	Viola	48	84	27	63	0	3	3	0	39	27
42	Cello	36	72	15	51	-1	3	C3	0	27	1B
43	Contrabass	28	55	7	34	-2	7	87	0	10	A
44	Tremolo Strings	28	96	7	75	-2	7	87	0	51	33
45	Pizzicato Strings	28	96	7	75	-2	7	87	0	51	33
46	Orchestral Harp	23	103	2	82	-2	2	82	0	58	3A
47	Timpani	36	57	15	36	-1	3	C3	0	12	C
48	String Ensemble1	28	96	7	75	-2	7	87	0	51	33
49	String Ensemble2	28	96	7	75	-2	7	87	0	51	33
50	Synth String1	36	96	15	75	-1	3	C3	0	51	33
51	Synth String2	36	83	15	62	-1	3	C3	0	38	26
52	Choir Aahs	48	83	27	62	0	3	3	0	38	26
53	Voice Oohs	48	79	27	58	0	3	3	0	34	22
54	Synth Vox	48	84	27	63	0	3	3	0	39	27
55	Orchestra Hit	48	72	27	51	0	3	3	0	27	1B
56	Trumpet	58	94	37	73	0	13	D	0	49	31
57	Trombone	34	75	13	54	-1	1	C1	0	30	1E
58	Tuba	29	55	8	34	-2	8	88	0	10	A
59	Muted Trumpet	58	82	37	61	0	13	D	0	37	25
60	French Horn	41	77	20	56	-1	8	C8	0	32	20
61	Brass Section	36	77	15	56	-1	3	C3	0	32	20
62	Synth Brass1	36	83	15	62	-1	3	C3	0	38	26

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