BU9435KV Functional Specifications

Rev. 1.0

ROHM Digital Entertainment LSI Design Div.

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I. Features

◊ BU9435KV is a MP3 decoder IC in which a USB host I/F, SD memory card I/F, audio DAC and system control functions are built. Using a KEY or I2C interface command, the IC reads out a MP3 file written to a memory device having a USB I/F or a SD memory card. All the operations required before the data can be output to audio devices are incorporated into one chip.

◊ BU9435KV supports STAND ALONE MODE which is enabled by commands entered from the keyboard (hereinafter referred to as MODE1), AUTO SLAVE MODE which is enabled by commands entered from the master microcomputer, same as those entered from the keyboard, via the built-in I2C interface (hereinafter referred to as MODE2) and MANUAL SLAVE MODE which can send the memory device information to the master microcomputer via the I2C interface and completely control sequences such as a play sequence by the master microcomputer (hereinafter referred to as MODE3).

◊ BU9435KV outputs folder names, file names and ID3TAG (V1.0, V1.1 V2.2 V2.3 and V2.4) information via the I2C interface. This function is enabled only in MODE 2 and MODE 3.

◊ BU9435KV supports audio line output, audio serial three-line (I2S) output and digital audio interface (SPDIF) output.

I.1 USB host I/F

- Builds in the USB Full speed (12 Mbps) HOST control function.
- Supports the USB mass storage class.
- Does not support externally-added HUBs.

I.2 SD card I/F

- Supports the SPI mode.
- Supports the MMC and mini-SD cards.
- Supports the SDHC cards.
- Supports the SD ver1.01 (file system).
- Does not support CPRM.

I.3 I2C I/F

- Communicates with the master microcomputer using an I2C interface format.
- Supports the standard mode (100 kbps) and fast mode (400 kbps).
- Supports a 7-bit address.
- Can select four types of slave addresses.

I.4 Audio output

- 1bit-DAC output
- Builds in the digital soft mute function.
- Supports the I2C format and digital audio interface (SPDIF) audio output.
- Builds in sound effects of POPS, JAZZ, ROCK, CLASSIC, R&B and BassBoost.*

  * Only audio line output is enabled.

I.5 FAT analysis

- Supports FAT16 and FAT 32.
- Supports VFAT (long file name).
- Supports multi-partition up to 1.
- The maximum number of playable folders within each folder is 65534.
- The maximum number of playable files within each folder is 65534.
- The maximum number of playable folders within each device is 65534.
- The playable folder hierarchy is up to 8 layers containing the root directory.
- The playable file extension supports *.mp3, *.mp2, and *.mp1. For *,mp2 and *.mp1, play enabled/disabled can be selected. Upper case letters and lower case letters are not distinguished in the file extension.
- Sorts and plays up to 100 folders and 100 files in the order of UNICODE.
- Can obtain up to 64 bytes as the folder name or file name.
- Supports 1 sector of 512, 1024 and 2048 bytes.
- Supports up to 2G-1 bytes as the file size.

I.6 MP3 decoder

- Supports MPEG audio 1, 2 and 2.5.
- Supports Layer 1, 2 and 3.

- Supports sample rates 8k, 16k, 32k, 11.025k, 22.05k, 44.1k, 12k, 24k and 48kHz.
- Supports bit rate 8 to 320 kbps and VBR (Variable Bit Rate). *Except free format.
- Supports ID3TAG V1.0, V1.1, V2.2, V2.3 and V2.4.
  (Up to 64 bytes can be obtained for the names of album, artist, and title.)

I.7 Sample rate converter

- Converts all the supported sample rates to 44.1 kHz using a poly-phase operation.

I.8 System controller

- Controls all the system operations including KEY input, LED output, interface control with the master microcomputer, USB device access, SD card access, FAT analysis, sort function, MP3 decode and audio output.

I.9 KEY matrix controller

- Controls 12 types of KEY inputs: play/pause, stop, tune forward, tune backward, folder forward, folder backward, 10-tune forward, volume up, volume down, repeat play, random play and device selection.

I.10 LED controller

- Controls 7 types of LED outputs: play/pause, error, memory accessing, random playing, repeat playing, USB selection and SD selection

I.11 Control from the master microcomputer

- Control from the master microcomputer is enabled using the I2C interface.
- Through the command operations, the following can be controlled: play, pause, stop, tune forward, tune backward, folder forward, folder backward, 10-tune forward, 10-tune backward, volume up, volume down, device selection, volume setting, repeat selection, random play, digital audio output setting, sound effect setting, resume data setting and direct tune selection data setting.
- Controls the following: playing status output, pause, stop, searching, error, folder number, file number within folder, play time information, number of total folders, number of total files, name of folder being played, name of file being played, ID3TAG (title, artist and album), resume data and direct tune selection data (MODE3).

I.12 Function selection

- Selects MODE1 or MODE2/3 (SEL_SLAVE=H: MODE1, L: MODE2/3).
- Selects MPEG Audio Layer (SEL_MP3=H: play MP3 only, L: play MP1/MP2/MP3)
- Digital audio output selection (SEL_DOUT=H: output OFF, L: output ON)
- Sound volume operation selection (SEL_VOL=H: volume adjustable, L: volume not adjustable MAX output)
- Selects operation at power ON to check device (SEL_APLAY=H: stop, L: play). *Enabled in MODE 1 only.
- Selects MODE2 or MODE3 (SEL_SMAN=H: MODE2, L: MODE3). *Enabled in MODE 2/3 only.

II. Overview

II.1 Terminal layout drawing

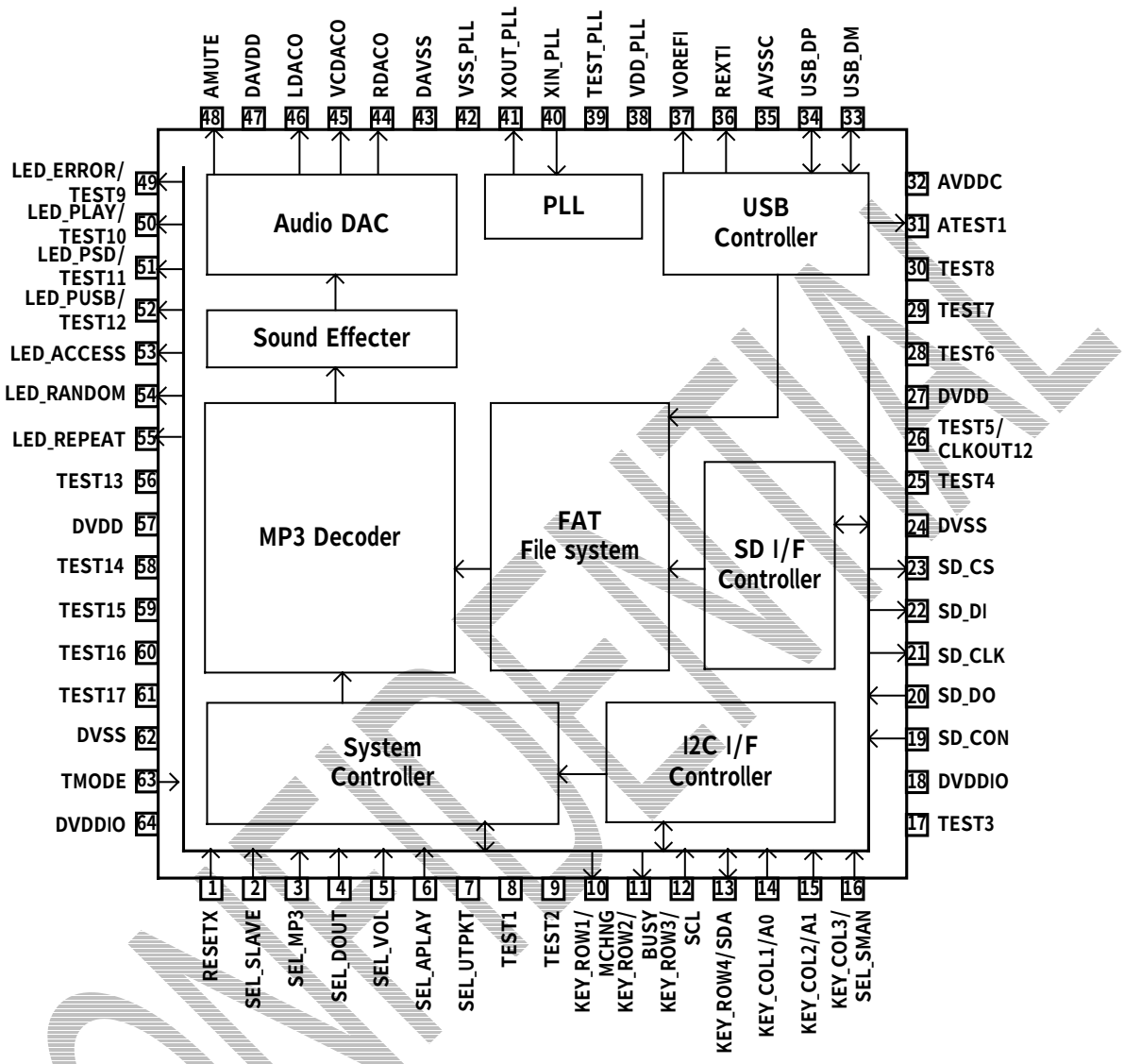


Figure II.1 Terminal layout drawing

II.2 Terminal specifications

Table II.2 Terminal specifications

	STAND ALONE MODE					SLAVE MODE			
Pin No.	Signal Name	I/O Cir	I/O	Pull-Up/ Down	Function	Signal Name	I/O	Pull-Up/ Down	Function
1	RESETX	A	I	-	H: Release RESET, L: RESET	←			
2	SEL_SLAVE	B	I	PU(*1)	H: STAND ALONE, L:SLAVE	←			
3	SEL_MP3	B	I	PU(*1)	H: PLAY MP3 ONLY, L: PLAY MP1,MP2 and MP3	←			
4	SEL_DOUT	B	I	PU(*1)	H: ANALOG DAC Output, L: Digital Output	←			
5	SEL_VOL	B	I	PU(*1)	H: Volume controll valid, L: Volume control invalid	←			
6	SEL_APLAY	B	I	PU(*1)	H: Auto Play OFF , L: Auto Play	←			
7	SEL_UTPKT	B	I	PU(*1)	H: Normal Operation L: USB Test Packet Output	←			
8	TEST1	-	-	-	Pull-up to 3.3V system power supply	←			
9	TEST2	-	-	-	Pull-up to 3.3V system power supply	←			
10	KEY_ROW1	B	I	PU	KEY Input ROW1	MCHNG	O	-	Music change Output
11	KEY_ROW2	B	I	PU	KEY Input ROW2	BUSY	O	-	Command Operation Busy Flag
12	KEY_ROW3	B	I	PU	KEY Input ROW3	SCL	I	-	I2C I/F Clock Input
13	KEY_ROW4	B	I	PU	KEY Input ROW4	SDA	I/O	-	I2C I/F Data Input/Output
14	KEY_COL1	B	O	-	KEY Input COLUMN1	A0	I	PU(*1)	I2C I/F Slave Address Set0
15	KEY_COL2	B	O	-	KEY Input COLUMN2	A1	I	PU(*1)	I2C I/F Slave Address Set1
16	KEY_COL3	B	O	-	KEY Input COLUMN3	SEL_SMAN	I	PU(*1)	H: MODE2, L: MODE3
17	TEST3	B	-	-	Pull-up to 3.3V system power supply	←			
18	DVDDIO	-	-	-	Connect to 3.3V System Power Supply	←			
19	SD_CON	B	I	PU	SD I/F	←			
20	SD_DO	B	I	-	SD I/F	←			
21	SD_CLK	B	O	-	SD I/F	←			
22	SD_DI	B	O	-	SD I/F	←			
23	SD_CS	B	O	-	SD I/F	←			
24	DVSS	-	-	-	Connect to GND	←			
25	TEST4	-	-	PU	Pull-up to 3.3V system power supply	←			
26	TEST5	-	-	PU	Pull-up to 3.3V system power supply	CLKOUT12(*2)	O	PU(*1)	12MHz CLK Output.
27	DVDD	-	-	-	Connect to 1.5V System Power Supply	←			
28	TEST6	-	-	-	Pull-up to 3.3V system power supply	←			
29	TEST7	-	-	-	Pull-up to 3.3V system power supply	←			
30	TEST8	-	-	-	Pull-up to 3.3V system power supply	←			
31	ATEST1	-	-	-	OPEN	←			
32	AVDDC	-	-	-	Connect to 3.3V System Power Supply	←			
33	USB_DM	C	I/O	-	USB DATA-	←			
34	USB_DP	C	I/O	-	USB DATA+	←			
35	AVSSC	-	-	-	Connect to GND	←			
36	REXTI	D	I	-	Connect Bias Resistor to GND	←			
37	VOREFI	-	-	-	OPEN	←			
38	VDD_PLL	-	-	-	Connect to 3.3V System Power Supply	←			

39	TEST_PLL	-	-	-	OPEN	←			
40	XIN_PLL	E	I	-	X'tal Input 16.9344MHz	←			
41	XOUT_PLL	E	O	-	Connect to X'tal 16.9344MHz	←			
42	VSS_PLL	-	-	-	Connect to GND	←			
43	DAVSS	-	-	-	Connect to GND	←			
44	RDACO	F	O	-	Audio DAC Line Output Rch	←			
45	VCDACO	F	O	-	Audio DAC Refference Voltage Output	←			
46	LDACO	F	O	-	Audio DAC Line Output Lch	←			
47	DAVDD	-	-	-	Connect to 3.3V System Power Supply	←			
48	AMUTE	G	O	-	Audio Mute Output (H:Mute Cancel, L:Mute)	←			
49	LED_ERROR	B	O	-	Error LED Output	TEST9	-	-	Pull-up to 3.3V system power supply
50	LED_PLAY	B	O	-	Play LED Output	TEST10	-	-	Pull-up to 3.3V system power supply
51	LED_PSD	B	O	-	Play SD Card LED Output	TEST11	-	-	Pull-up to 3.3V system power supply
52	LED_PUSB	B	O	-	Play USB LED Output	TEST12	-	-	Pull-up to 3.3V system power supply
53(*3)	LED_ACCESS	B	O	-	Memory Access LED Output	LRCK(*4)	O	-	I2S Output LR Clock / SPDIF Output
54(*3)	LED_RANDOM	B	O	-	Random Play LED Output	BCK	O	-	I2S Output Bit Clock
55(*3)	LED_REPEAT	B	O	-	Repeat Play LED Output	DATA	O	-	I2S Output LR DATA
56	TEST13	-	-	-	Pull-up to 3.3V system power supply	←			
57	DVDD	-	-	-	Connect to 1.5V System Power Supply	←			
58	TEST14	-	-	-	Connect to GND	←			
59	TEST15	-	-	-	Pull-up to 3.3V system power supply	←			
60	TEST16	-	-	-	Pull-up to 3.3V system power supply	←			
61	TEST17	-	-	-	Pull-up to 3.3V system power supply	←			
62	DVSS	-	-	-	Connect to GND	←			
63	TMODE	H	I	-	Connect to GND	←			
64	DVDDIO	-	-	-	Connect to 3.3V System Power Supply	←			

*1 When L is input, Pull-UP turns OFF.

*2 Enabled/Disabled can be selected using commands.

*3 When SEL_DOUT=L, SLAVE MODE setting becomes enabled and STAND ALONE MODE becomes disabled.
In both STAND ALONE MODE and SLAVE MODE, SEL_DOUT=L performs I2S format audio output. See Chapter **V**.4 for further information.

*4 In SLAVE MODE, SEL_DOUT=L allows you to select either I2S format audio output or digital audio interface output (SPDIF). See Chapter **V**.4 for further information.

II.3 Terminal equivalent circuit diagram

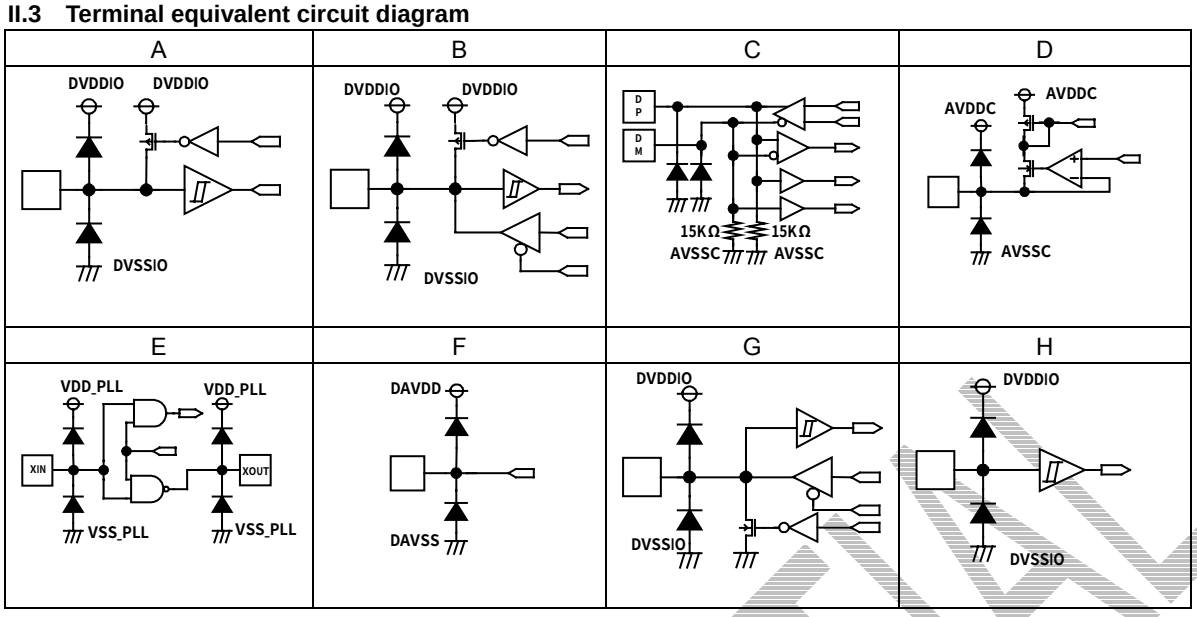


Figure II.3 I/O terminal equivalent circuit diagram

III. Absolute Maximum Rating and Operating Conditions

III.1 Absolute maximum rating

(Ta=25°C)

Item	Symbol	Rating	Unit
Power voltage (analog, IO)	V_{DD1MAX}	4.5	V
Power voltage (CORE)	V_{DD2MAX}	2.1	V
Terminal voltage	$\mathbf{V_{IN}}$	−0.3 ~ V_{DD1}+0.3	V
Storage temperature range	T_{stg}	−55 ~ +125	°C
Operating temperature range	T_{opr}	−40 ~ 85	°C
Power dissipation *1	P_D	750	mW

*1 When using the product at Ta=25°C or higher temperature, 7.5 mW per 1°C should be subtracted.

III.2 Operating Conditions

Item	Symbol	Rating	Unit	Applicable terminal
Power voltage (analog, IO)	V_{DD1}	3.0 ~ 3.6	V	DVDDIO,VDD_PLL DAVDD,AVDDC
Power voltage (CORE)	V_{DD2}	1.4 ~ 1.6	V	DVDD

* Not designed to be radiation-proof.

IV. Electrical Specifications

(Ta=25°C, V_{DD1}=3.3V, V_{DD2}=1.5V, XIN_PLL=16.9344MHz unless otherwise specified.)

Item	Symbol	Speciation			Unit	Condition Applicable terminal
		MIN.	TYP.	MAX.		
General						
Operating power consumption (V_{DD1USB})	I_{DD1USB}	-	22.0	50.0	mA	*1, When playing USB memory
Operating power consumption (V_{DD1SD})	I_{DD1SD}	-	3.2	8.0	mA	*1, When playing SD memory card
Opetrating power consumption (V_{DD2USB})	I_{DD2USB}	-	24.0	40.0	mA	*2, When playing USB memory
Operating power consumption (V_{DD2SD})	I_{DD2SD}	-	15.4	30.0	mA	*2, When playing SD memory card
Logic						
H input voltage	V_{IH}	V_{DD1}*0.7	-	V_{DD1}	V	*3
L input voltage	V_{IL}	DVSS	-	V_{DD1}*0.3	V	*3
H output voltage 1	V_{OH1}	V_{DD1}-0.4	-	V_{DD1}	V	I_{OH}=-1.6mA, *4
L output voltage 1	V_{OL1}	0	-	0.4	V	I_{OL}=1.6mA, *4
H output voltage 2	V_{OH2}	V_{DD1}-0.4	-	V_{DD1}	V	I_{OH}=-3.6mA, *5
L output voltage 2	V_{OL2}	0	-	0.4	V	I_{OL}=3.6mA, *5
H output voltage 3	V_{OH3}	V_{DD1}-0.4	-	V_{DD1}	V	I_{OH}=-0.6mA, *6
L output voltage 3	V_{OL3}	0	-	0.4	V	I_{OL}=0.6mA, *6
H output voltage 4	V_{OH4}	V_{DD1}-1.0	-	V_{DD1}	V	I_{OH}=-0.6mA, *7
L output voltage 4	V_{OL4}	0	-	1.0	V	I_{OL}=0.6mA, *7
USB interface						
H input voltage	V_{IHUSB}	V_{DD1}*0.6	-	V_{DD1}	V	*8
L input voltage	V_{ILUSB}	AVSSC	-	V_{DD1}*0.3	V	*8
Output impedance (H)	Z_{OH}	22.0	45.0	60.0	Ω	*8
Output impedance (L)	Z_{OL}	22.0	45.0	60.0	Ω	*8
H output voltage	V_{OHUSB}	V_{DD1}-0.5	-	V_{DD1}	V	*8
L output voltage	V_{OLUSB}	0	-	0.3	V	*8
Rise/Fall time	T_r/T_f	-	11	-	nS	*8, Output capacity 50pF
Cross point voltage	V_{CRS}	-	V_{DD1}/2	-	V	*8, Output capacity 50pF
Differential input range	V_{diff}	0.8	-	2.5	V	*8
Differential input sensitivity	V_{sens}	0.2	-	-	V	*8
Pull-down resistance	R_{PD}	10.0	15.0	20.0	kΩ	*8
Audio DAC						
Distortion	THD	-	0.03	-	%	1kHz, 0dB, sine, *9
D range	DR	-	88	-	dB	1kHz, -60dB, sine, *9
S/N ratio	S/N	-	93	-	dB	*9
Maximum output level	V_{smax}	-	0.85	-	Vrms	1kHz, 0dB, sine, *9

*1 3.3V system I/O, analog power supply (DVDDIO, VDD_PLL, DAVDD, AVDDC), When playing 1kHz, 0dB, sinewave.
*2 1.5V system CORE power supply (DVDD) , When playing 1kHz, 0dB, sinewave.
*3 1-17, 19-20, 25-26, 40, 49-52, 56,58-61, 63 pin
*4 10-11, 14-16, 48-55 pin
*5 13 pin
*6 21-23, 26 pin
*7 41 pin
*8 33, 34 pin
*9 44, 46 pin

V. I/O Signal Specifications

V.1 Clock and reset

Clock

Signal name	I/O	Function	Remarks
XIN_PLL	I	X'tal (16.9344 MHz) connection input terminal	
XOUT_PLL	O	X'tal (16.9344 MHz) connection terminal	

Reset

Signal name	I/O	Function	Remarks
RESETX	I	System reset input terminal	

To disable a reset signal, continue L input for more than 5 us after clock input from the oscillation I/O terminal becomes stable. (See Figure V.1.)

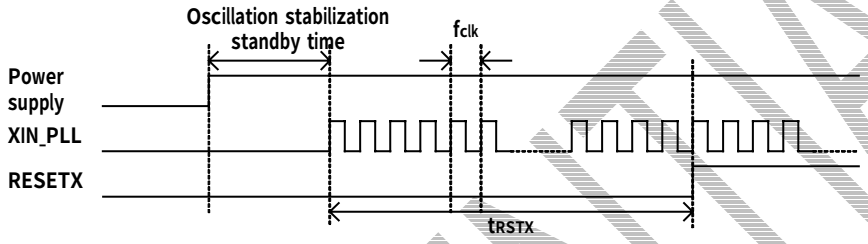


Figure V.1 Reset Timing

Item	Symbol	Specification			Unit	Remarks
		min	typ	max		
Clock frequency	f_{CLK}	16.9344	16.9344	16.9344	MHz	
Reset L interval	t_{RSTX}	5	-	-	us	

V.2 SEL_SLAVE

MODE1/MODE2, 3 selection input signal

Signal name	I/O	Function	Remarks
SEL_SLAVE	I	Selects MODE1 or MODE2, 3.	H: MODE1, L: MODE2, 3

SEL_SLAVE selects MODE1 (STAND ALONE MODE) or MODE 2/3 (SLAVE MODE).
By selecting SEL_SLAVE, SLAVE mode terminal setting shown in Table II.2 is enabled.
SEL_SLAVE is set only at power ON. Note that change of selection after power ON is ignored.

V.3 SEL_MP3

MPEG Audio Layer 1, 2, 3 play selection signal

Signal name	I/O	Function	Remarks
SEL_MP3	I	MPEG Audio Layer selection	H: Can play MP3 only. L: Can play MP1, MP2 and MP3.

SEL_MP3 allows you to select the layer of the MPEG audio to be played. When enabling all the files having mp1, mp2 or mp3 as the file extension to be played, enter L. When enabling mp3 only, enter H.
SEL_MP3 is set only at power ON. Note that change of election after power ON is ignored.

V.4 SEL_DOUT

Audio output selection signal

Signal name	I/O	Function	Remarks
SEL_DOUT	I	Audio output selection	H: Line output, L: I2S 3 lines serial output/SPDIF

This SEL_DOUT selects audio output signal.
Table V4.1 “Audio output” shows the audio outputs for each MODE.
Also table V4.2 ”I2S_fs” shows the I2S output formats for each MODE.
For command, see Chapter VI.
"TEST terminal" describes that this terminal is pulled-up in device.

TableV.4.1 Audio output

Pin No.	MODE1		MODE2,3		
	SEL_DOUT=H	SEL_DOUT=L	SEL_DOUT=H	SEL_DOUT=L	
				SPDIF OFF	SPDIF ON
44	Line Out Rch	HiZ	Line Out Rch	HiZ	HiZ
46	Line Out Lch	HiZ	Line Out Lch	HiZ	HiZ
53	LED_ACCESS	I2S LR CLOCK	TEST terminal	I2S LR CLOCK	SPDIF
54	LED_RANDOM	I2S BIT CLOCK	TEST terminal	I2S BIT CLOCK	TEST terminal
55	LED_REPEAT	I2S LRDATA	TEST terminal	I2S LRDATA	TEST terminal

Table V.4.2 I2S_fs

MODE1	32fs
MODE2/3	Can select 32fs, 48fs, 64fs by command.

SEL_DOUT is set only at power ON. Note that change of selection after power ON is ignored.

V.5 SEL_VOL

Sound volume operation selection signal

Signal name	I/O	Function	Remarks
SEL_VOL	I	Sound volume operation	H: Sound volume operation enabled, L: Sound volume operation disabled

SEL_VOL selects whether sound volume operation is to be enabled or disabled.
Sound volume operation is enabled when SEL_VOL=H.
Initial value of audio output is -24.1dB at power ON.
Sound volume operation is disabled when SEL_VOL=L. Audio output is fixed to 0dB.
Figure V.5 shows the relationship between audio output and sound volume step.
SEL_VOL is set only at power ON. Note that change of selection after power ON is ignored.

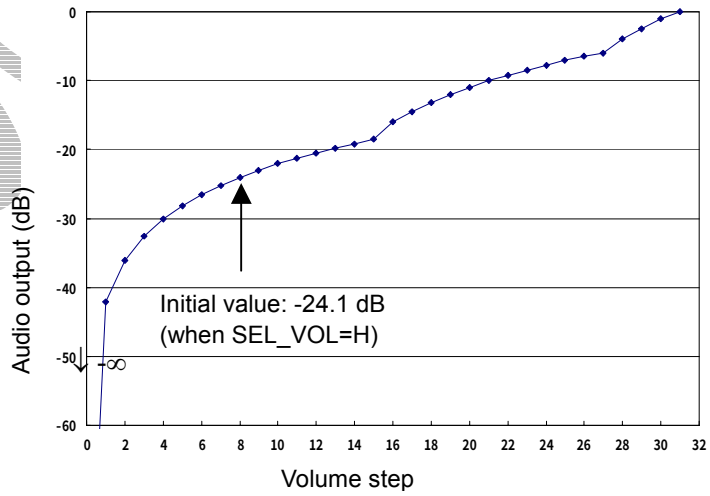


Figure V.5 Volume Step Function

V.6 SEL_APLAY

Auto play selection signal at power ON/device recognition

Signal name	I/O	Function	Remarks
SEL_APLAY	I	Auto play selection signal at device recognition	H: Stop after recognizing device, H: Play after recognizing device

SEL_APLAY selects whether the audio data in the memory is to be automatically played when a memory device (USB memory or SD card) is inserted at power ON or when the system recognizes the memory device inserted.
SEL_APLAY can be selected only in MODE1. Since selection of SEL_APLAY is ignored in MODE2/3, select it from Pull-up. When MODE2/3 is selected, audio data is halted after the system recognizes a device.

V.7 SEL_UTPKT

USB test packet

Signal name	I/O	Function	Remarks
SEL_UTPKT	I	USB test packet send	H: Disabled, L: USB test packet send

A test packet signal is output from USB_DP terminal or USB_DM terminal when L is set to SEL_UTPKT at power ON.
Once enabled, SEL_UTPK keeps that state regardless of operation modes and sends out a test packet.
A test packet signal is continuously output until power turns OFF. Use SEL_UTPKT when evaluating the USB terminal. In other cases, use it from Pull-up.

V.8 Audio output

Audio output

Signal name	I/O	Function	Remarks
LDACO	O	Lch audio line output	-
RDACO	O	Rch audio line output	-

These signals are decoded MP3 music audio data line outputs.
They turn ON when the line output is selected by SEL_DOUT terminal.

V.9 MUTE control output

Audio MUTE

Signal name	I/O	Function	Remarks
AMUTE	O	Audio mute control terminal	H: At audio output, L: At mute

This is a control terminal to mute audio output at power ON or FF/FB (silence).
This terminal outputs H at audio output and L at mute.
Figure **V**.9 shows the operation waveform.

Figure V.9 Waveform at Audio Mute

V.10 KEY input format

3x4 matrix command input

Signal name	I/O	Function	Remarks
KEY_ROW1	I	KEY matrix I/O signal	-
KEY_ROW2	I		-
KEY_ROW3	I		-
KEY_ROW4	I		-
KEY_COL1	O		-
KEY_COL2	O		-
KEY_COL3	O		-

Configure a circuit for the matrix signals terminals for KEY commands as shown in the applied circuit diagram V.10.
The operation corresponding to the key pressed over the circuit is performed.
Details of each operation are explained in Chapter VI.2.

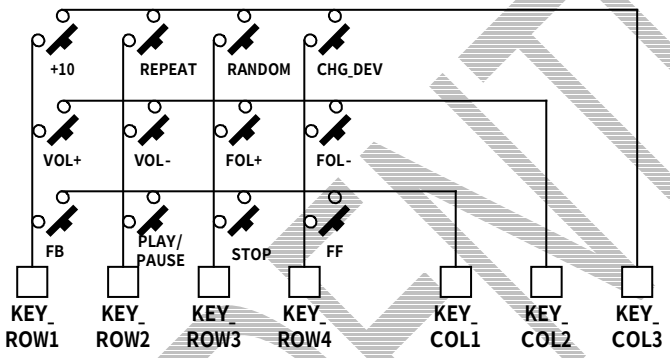


Figure V.10 KEY Matrix Applied Circuit Diagram

V.11 I2C interface format

I2C serial interface

Signal name	I/O	Function	Remarks
SCL	I	I2C interface clock input	-
SDA	I/O	I2C interface data I/O	-
A0	I	Slave address selection terminal	Slave address [0] bit setting terminal
A1	I	Slave address selection terminal	Slave address [1] bit setting terminal

This is an I2C serial interface terminal. By inputting L toSEL_SLAVE terminal, the interface terminal becomes enabled.
The terminal supports slave I2C operation.

V.11.1 I2C protocol

When I2C bus is in IDLE, SDA and SCL are set to H by the external Pull-up resistance. When starting communications, the master sets SDA to L while SCL is set to H (Start condition). When ending communications, the master sets SDA to H while SCL is set to H (Stop condition). Even before sending Stop condition at the end of communications, transfer of Start condition allows restart of communications (Repeated Start Condition). During transfer, SDA is changed only when SCL is set to L. Figure V.11.1 shows Start condition, Stop condition, Repeated Start condition of I2C.

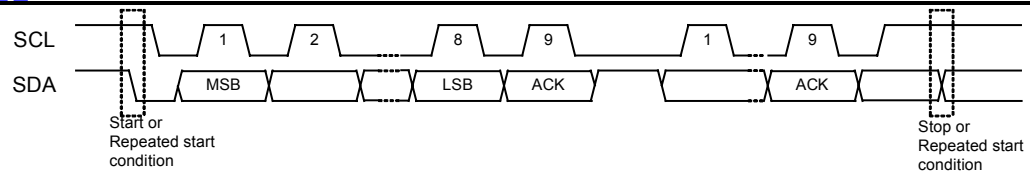


Figure V.11.1 I2C start, stop, repeated start condition

V.11.2 Slave address

An I2C bus slave address corresponds to the 7-bit addressing mode. As shown in Table V.11.2, you can select the slave address using input of A0 terminal and A1 terminal. Figure V.11.2 shows the slave address transfer format.

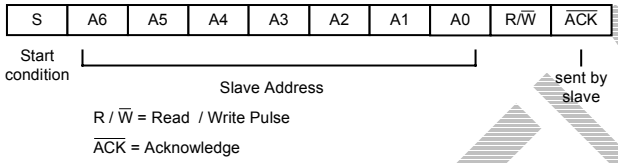


Figure V.11.2 Slave Address Transfer Format

Table V.11.2 Settable Slave Addresses

MSB A6	A5	A4	A3	A2	A1 terminal	LSB A0 terminal
1	0	0	0	0	0	0
1	0	0	0	0	0	1
1	0	0	0	0	1	0
1	0	0	0	0	1	1

V.11.3 Write protocol from master

To send a master command using an I2C bus, follow the transfer protocol shown in Figure V.11.3. For details on each command, see Chapter VI.

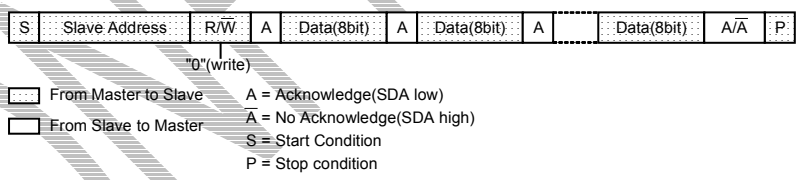


Figure V.11.3 Command send protocol

V.11.4 Read protocol to master

To send reception data using a I2C bus from the slave to the master, follow the transfer protocol shown in Figure V.11.4.1 First, transfer the status read command (step1). Then, input SCL clock of required bytes in step 2 to read the status.

When the device is BUSY at reception of device status or memory data, the I2C bus may possibly be occupied by the device during BUSY. This LSI transfers the bus to the master so as not to generate such bus occupation. However, as a BUSY state still exists inside of the system, appropriate data may not be transferred during BUSY. Therefore, the first byte of transfer data (Step2) is used to judge the transfer data is enabled/disabled. When specifying addresses from the master to the slave and the first byte of the transfer data immediately after data transfer is required is 0x00, transfer data from the slave is enabled. If the first byte is 0xFF, it shows the BUSY state. Therefore, the transfer data should be disabled. If this happens, retry command transfer at Step 1 to read out the status.

Figure V.11.4.2 shows the relationship between the transfer data and BUSY.

* For further information on BUSY, see Chapter V.17.

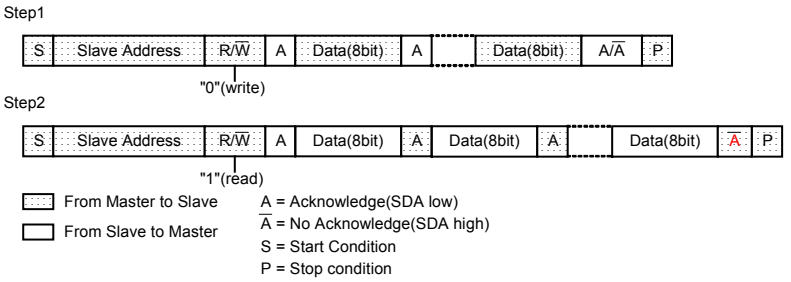


Figure V.11.4.1 Status Reception Protocol

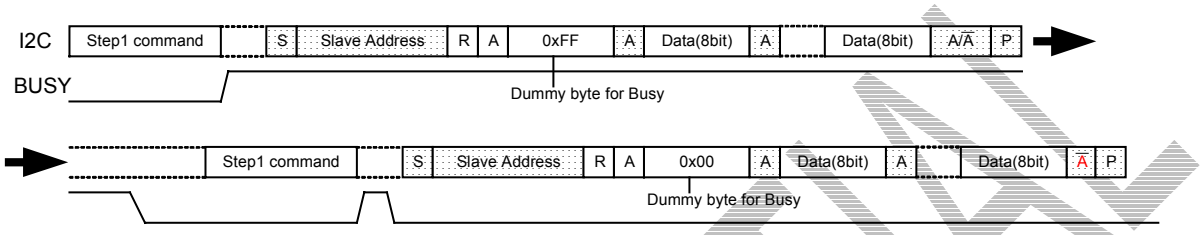


Figure V.11.4.2 Relationship between Transfer Data and BUSY

V.12 I2S format

I2S serial audio interface

Signal name	I/O	Function	Remarks
LRCK	O	I2S Bit clock output (fs=44.1kHz)	-
BCK	O	I2S Bit clock output	-
DATA	O	I2S data output	-

This is a serial audio interface terminal. By inputting L to SEL_DOUT terminal, the interface terminal becomes enabled. When selecting the I2S serial audio output, the output format varies depending on MODE. *See Chapter **V**.4. MODE2 allows you to select 32fs, 48fs or 64fs. *See Chapter V.4. Figures V.12.1. V12.2 and V.12.3 show the I2S format to be output.

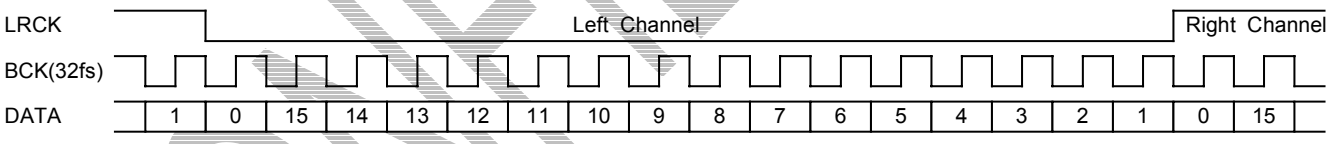


Figure V.12.1 I2S Output Timing (32fs)

Figure V.12.2 I2S Output Timing (48fs)

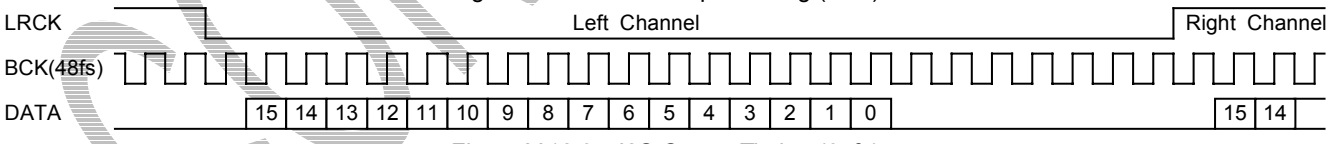
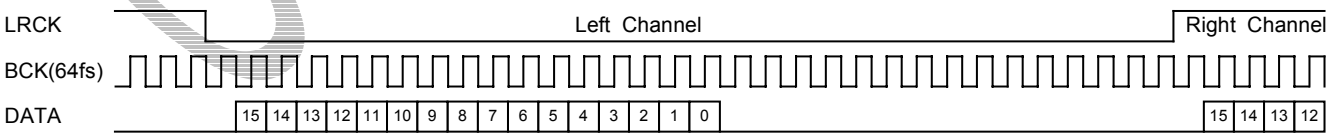


Figure V.12.3 I2S Output Timing (64fs)



V.13 SPDIF format

Digital audio interface

Signal name	I/O	Function	Remarks
SPDIF	O	Digital audio output	-

SPDIF output becomes enabled by setting SEL_DOUT terminal to L and setting this condition using the I2C command. *See Chapter V.4.
Figure V.13 shows the digital audio signal output format.

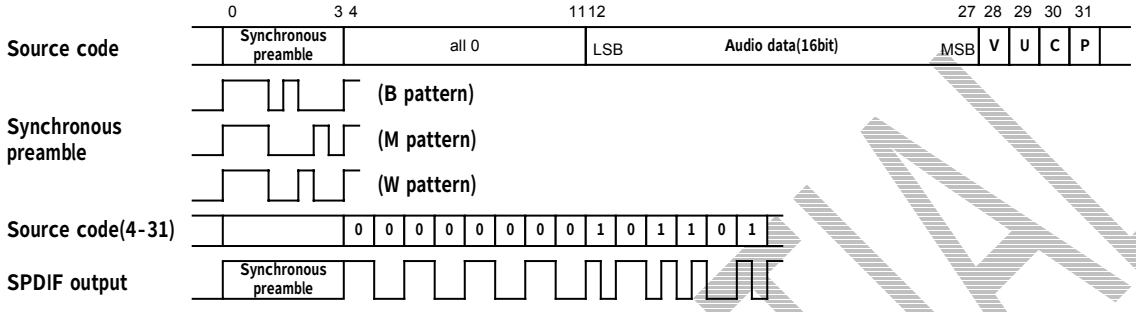


Figure V.13 SPDIF Output Format

A sub-frame of SPDIF is composed of synchronous preamble, 16-bit audio data, V bit (validity flag), U bit (user data), C bit (channel status) and P bit (parity bit).
Output rate is fixed to 1X speed.
SPDIF outputs synchronous preamble (source code 0-3) as it is and others (source code 4-31) as bi-phase output. It outputs L while the operation is stopped.
Synchronous preamble and C bit use 32 frames (≈4.4ms) as one cycle. Table V.13.1 and Table V.13.2 show these formats. V bit is fixed to L. U bit uses 98 frames (≈13.3ms) as one cycle.

Table V.13.1 Synchronous Preamble Pattern

	L0	R0	L1	R1	L2	R2	L3	R3	L4	R4	L5	R5
0	B	W	M	W	M	W	M	W	M	W	M	W
1	M	W	M	W	M	W	M	W	M	W	M	W
:	:	:	:	:	:	:	:	:	:	:	:	:
31	M	W	M	W	M	W	M	W	M	W	M	W

Table V.13.2 C Bit Format

	L0	R0	L1	R1	L2	R2	L3	R3	L4	R4	L5	R5
0	0		0		0		0		0		0	
1	0		0		1		0		0		0	
2	0		0		0		0		0		0	
3	0		0		1	0	0	1	0		0	
4	0		0		0		0		0		0	
5	0		0		0		0		0		0	
:	:		:		:		:		:		:	
31	0		0		0		0		0		0	

Table V.13.3 U Bit Format

	L0	R0	L1	R1	L2	R2	L3	R3	L4	R4	L5	R5
0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0
2	1	0	0	0	0	0	0	0	0	0	0	0
3	1	0	0	0	0	0	0	0	0	0	0	0
:	:	:	:	:	:	:	:	:	:	:	:	:
97	1	0	0	0	0	0	0	0	0	0	0	0

P bit is set to 1 if the number of “1s” of source codes 4-30 is odd, and set to 0 if the number is even. Therefore, the number of source codes which turn to 1 for one data must be an odd value, SPDIF ends with L output and preamble output always starts in the same direction.

V.14 USB I/F

USB I/O I/F

Signal name	I/O	Function	Remarks
USB_DP	I/O	USB D+I/O terminal	-
USB_DM	I/O	USB D-I/O terminal	-
REXTI	O	USB bias resistance connection terminal	Connect resistance of 12kΩ ± 1% to GND.

Differential signals of USB_DP and USB_DM enable communications with USB devices.
REXTI terminals become bias resistance connection terminals of the USB-PHY block.

V.15 SD I/F

SPI interface for SD memory card I/F

Signal name	I/O	Function	Remarks
SD_CS	O	SPI chip select	-
SD_CLK	O	SPI clock	-
SD_DI	O	SPI data input	-
SD_DO	I	SPI data output	-
SD_CON	I	SD card connect detection terminal	H: Not detecting SD card connection. L: Detecting SD card connection.

These I/F enable communication with SD memory cards through SD memory card slots.
Since SD memory card slot requires to detect insertion of SD memory card, use of slot equipped with SD memory card detecting terminal and connection to SD_CON terminal are required.
SD_CON terminal is pulled up within the device and detects SD memory card connection by L input.

V.16 MCHNG

Playing sound tune number detection output

Signal name	I/O	Function	Remarks
MCHNG	O	Music tune number change detection output signal	H: Playing, L: Tune completed/stopped

This signal outputs change of file to be played during playing MP3 file in the memory device.
MCHNG correctly outputs "H" during MP3 decode sequence, outputs "L" during "STOP" status.

V.17 BUSY

BUSY state detection output

Signal name	I/O	Function	Remarks
BUSY	O	BUSY state detection output signal	H: Busy, L: Not Busy

This signal outputs to indicate that this LSI is in BUSY.
BUSY signal analyzes commands from the master and outputs H until the operation is executed.
This LSI ignores command input during BUSY. However, only the ABORT and STOP commands can be accepted even during BUSY, which can be executed. *See Chapter V.11.

VI. Function/Operation Explanation

VI.1 File detection

VI.1.1 Function

- This function supports FAT16 and FAT32 file systems. (It does not support NTFS.)
- The maximum number of playable files per folder

Table VI.1.1 Maximum Number of Playable Files

	Root folder	Sub folder
FAT16	512	65534
FAT32	65536	65534

The number of files described above contains files other than MP3 and folders. If those non- MP3 files and folders exit within the folder and exceed the maximum number, all the MP3 files may not be played.

- Files less than 100 can be sorted by UNICODE in the FAT order within the folder. Files over 100 are sorted in the FAT order. Also, the folders can be sorted in the same manner and those over 100 are sorted in the FAT order.
- The searchable folder hierarchy is of 8 layers containing the root folder. Figure VI.1.1 shows an example of memory layers.

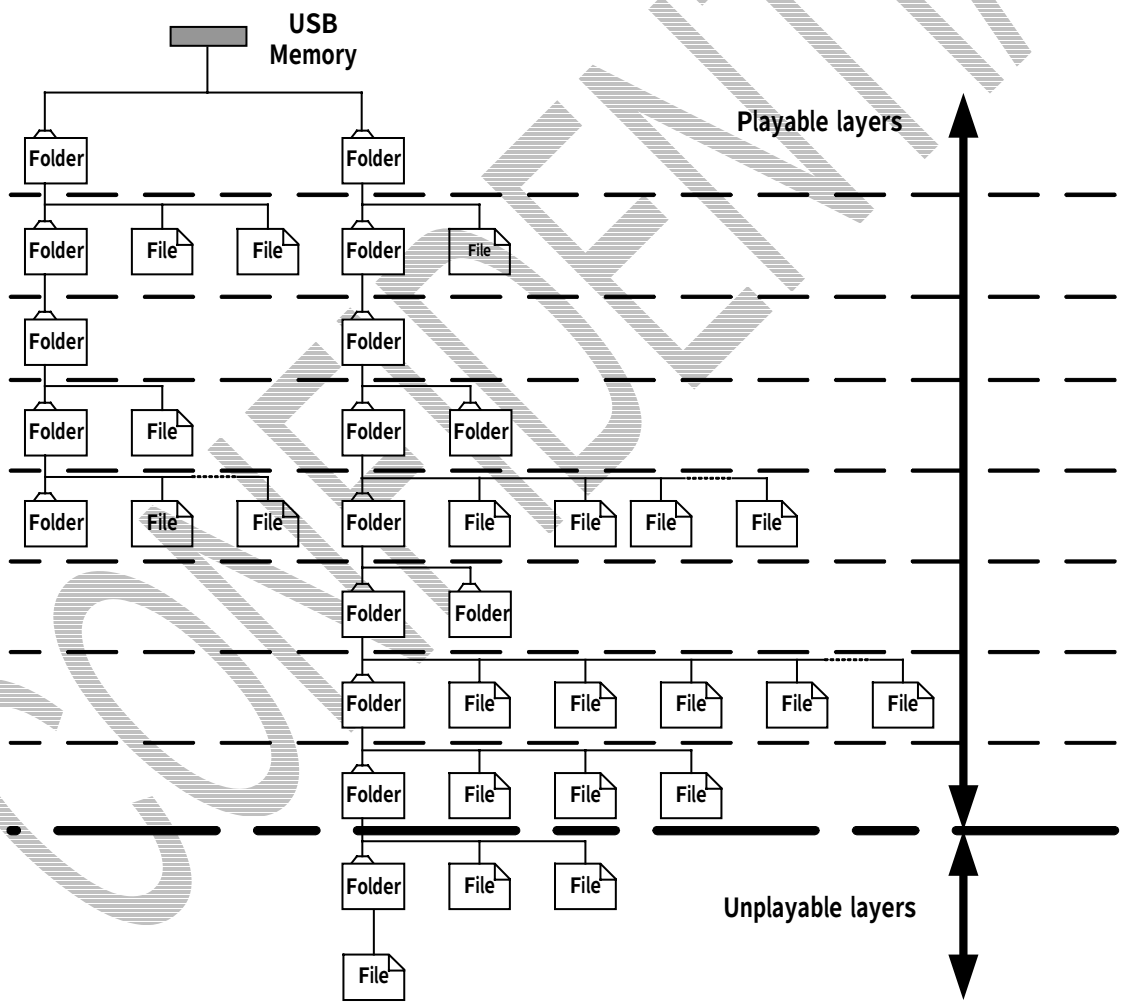


Figure VI.1.1 Example of Memory Layers

VI.1.2 Playable file

The playable file extensions are *.MP3, *.MP2 and *.MP1. (Upper case letters and lower case letters are not distinguished.) Note that the file operation differs in the following cases:

(1) SEL_MP3: See SEL_MP3 for details.
(2) Attribute: A MP3 file whose attribute is masked can be played. A file with system attributes cannot be played.
(3) Data destroyed file: When the data section of MP3 file is destroyed, the music data of the file can be played as much as possible rather than disabling to play the entire file. The section which cannot be played is muted. However, AMUTE terminal remains the H output level.
(4) File name: A file name and its size do not depend on playing.
(5) Extension: When file data is configured in the non-MP3 format and its file extension is *.MP3, *.MP2 or *.MP1, the state is silent playing basically. If playable data can be read, only a part of the file can be played. The information on time required to output serial status also becomes uncertain. Then, partial output is done but the correct time information is not output.

VI.1.3 Playing sequence

The playing sequence of MP3 files is determined based on the following rules. See Figure VI.1.3.

(1) Folders are sorted in the order written in FAT (in the order of FAT), and files 1 to 100 are sorted in the order of UNICODE. (*See Chapter VI. 1.4.) Files over 100 are sorted in the order of FAT. Folders over 100 are sorted in the same manner.
MP3 files are sorted by MP3 following SEL_MP3. Folders are sorted including null folders and those in which MP3 files are not written. Within each folder, MP3 files over 100 and folders over 100 are played in the order written to the FAT directory entry.
Since how to write to the directory entry depends on the OS (Operating System) processing to write to the memory, you cannot understand the file playing sequence.
(2) When a MP3 file exists in the root folder (the highest layer), the MP3 file is played first.
(3) When all the MP3 files in the root folder have been played, those in the folder under the root folder, if any, are played.
(4) When a folder is layered under that, MP3 files in the folder are played. When not, the master searches any other folders at the same layer and plays the one, if any.
(5) After playing all the files, the master returns to the root folder as described in (2) and start playing with the first sorted file.

VI.1.4 Folder/file sort

Folders and files are sorted in the following sequence using this LSI.

(1) Obtain up to 100 files and 100 folders in the order written to FAT.
(2) Compare the obtained folder/file names up to 14 characters (including filename extensions) and sort them in the ascending order.*
(3) When the same strings are generated, follow the order written to FAT.
(4) For 101 or more folders and files, follow the order written to FAT.

* When the folder/file name is within 8 bytes, codes up to ASCII code 0x00-0x7 are extended and sorted as UNICODE. SHIFT-JIS codes are compared as they are as 2-byte codes.

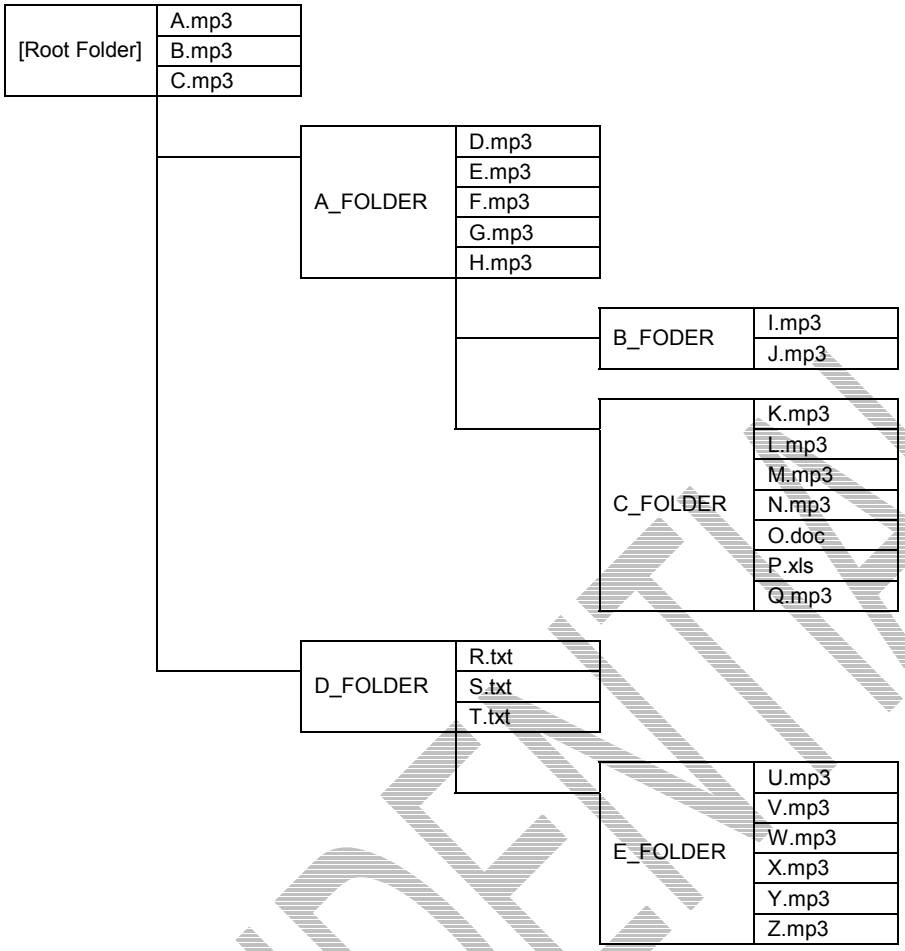


Figure VI.1.3 Configurations of Folders and Files within Memory Device

Table VI.1.3 MP3 File Playing Sequence for Folder/File Configuration as in Figure VI.1.3.

Playing sequence	File to be played	Remarks
1	A.mp3	· If MP3 files exist in the root folder, those files are played first. · Files are played in the ascending order of UNICODE by file name.
2	B.mp3	
3	C.mp3	
4	D.mp3	· After all MP3 files in the root folder are played, the master searches folders under that layer. · The master searches folders in the ascending order of UNICODE by folder name.
5	E.mp3	
6	F.mp3	
7	G.mp3	
8	H.mp3	
9	I.mp3	
10	J.mp3	
11	K.mp3	
12	L.mp3	
13	M.mp3	
14	N.mp3	
15	Q.mp3	· Non-MP3 files are ignored.
16	U.mp3	· After the master plays all MP3 files including those in the lower layers within A_FOLDER, it moves to a folder in the same layer as A_FOLDER to search MP3 files. · Since there is no MP3 file in D_FOLDER, the layers same as A_FOLDER, the master plays MP3 files in E_FOLDER under that.
17	V.mp3	
18	W.mp3	
19	X.mp3	
20	Y.mp3	
21	Z.mp3	

VI.2 MODE1

VI.2.1 KEY command operation

VI.2.1.1 KEY SCAN

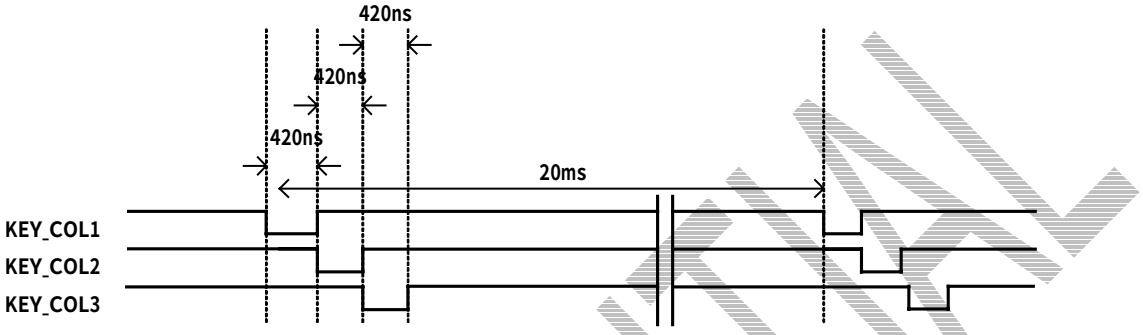
KEY SCAN operates in the following sequence on the circuit configuration as shown in Figure V.10 .

(1) KEY_COL1 to 3 output waveforms at timing as shown in Figure VI.2.1.

(2) By pressing KEY switch, KEY_ROW 1 to 4 are set to L at timing when KEY_COL 1 to 3 are L.

(3) When detecting L input from KEY_ROW 1 to 4 three times, the master judges that KEY has been pressed. Then, after detecting H input three times to release the pressed KEY switch, the master starts the KEY operation.

Figure VI.2.2 shows waveforms when FB KEY is pressed.



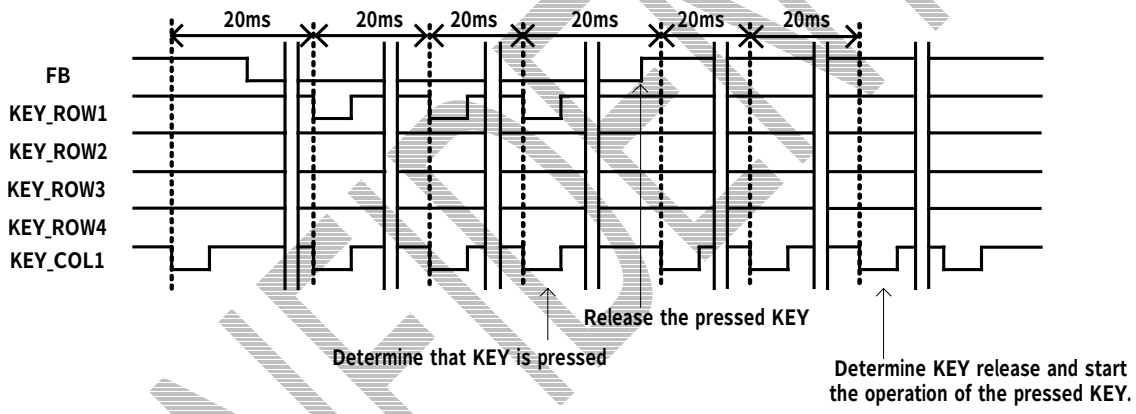


Figure VI.2.1 KEY SCAN Waveform

Figure VI.2.2 Operating Waveforms when KEY is Pressed

Note 1: Based on the above sequence, the master determines that KEY is pressed and starts the operation of the pressed KEY, pressing multiple KEYs at the same time will produce different operations depending on the KEY combinations. Therefore, you cannot regulate the operation sequence correctly even simultaneously pressing multiple KEYs will not cause any problems

Note 2: Because the KEY input does not have a buffering function, KEY inputs other than those described below are ignored.

VI.2.1.2 KEY operation

Table VI.2.1.2.1 shows the types and operations of KEYs.

Table VI.2.1.2.2 shows enabled/disabled states of KEY operations.

Table VI.2.1.2.1 KEY Commands and Operation Description

KEY COMMAND	OPERATION DESCRIPTION
PLAY/PAUSE	· When receiving “PLAY/PAUSE” key during stop, the master starts playing the first MP3 file sorted to the recognized device. · When receiving “PLAY/PAUSE” key during play, the master stops playing the MP3 file temporarily. When receiving PLAY/PAUSE key again, the master restarts playing the file.
STOP	· When receiving “STOP” key during play, pause or file search, the master stops playing, pausing or searching the MP3 file.
FF	· When receiving “FF” KEY during play or pause, the master searches the next MP3 file in the order of sort of files being played or paused. Upon completion of searching, the master starts playing the file. · During play of the last file, the master returns to the first file in the order of sort and plays the file.
FB	· When receiving “FB” KEY during play or pause, the master searches the previous MP3 file in the order of sort of files being played or paused. Upon completion of searching, the master starts playing the file. · During play of the first file, the master plays the last file in the order of sort. · When receiving "FB" KEY within 1sec from top of mp3 file playing, the master searches the previous MP3 file in the order of sort of files being played. Upon completion of searching, the master starts playing the file. When receiving "FB" KEY over 1sec from top of mp3 file playing, the master starts playing from top of this MP3 file.
FOL+	· When receiving “FOL+” KEY during play or pause, the master searches the MP3 files in the next folder in the order of sort of the folder in which the file being played or paused exists. Upon completion of search, the master plays the file. · During play of the file in the last folder in the order of sort, the master plays the first file in the order of sort.
FOL-	· When receiving “FOL-“ KEY during play or pause, the master searches the MP3 files in the next folder in the order of sort of the folder in which the file being played or paused exists. Upon completion of search, the master plays the file. · During play of the file in the first folder in the order of sort, the master plays the first file in the order of sort in the last folder.
+10	· When receiving “+10” KEY during play or pause, the master searches MP3 files 10 files next to the current one in the order of sort of the file being played or paused. Upon completion of search, the master starts playing the file. · When the remaining files are less than 10 during play of the current file, the master plays the first file.
VOL+/VOL-	· When receiving “VOL+/VOL-“ KEY while SEL_VOL terminal is set to H, the master controls sound volume. · Sound volume can be controlled at 32 steps from -∞ (minimum volume) to 0dB (maximum volume). · Since VOL+/VOL- KEY does not judge release of KEY, the master turns up or down volume step by step when detemining press of the KEY. Therefore, VOL KEY can be held down.
CHNG_DEV	· The master selects the device between USB memory and SD memory card. To do this, both devices should be connected or one device should correspond to the other (USB to SD or SD to USB). Otherwise, this key operation is ignored. · Stop after selecting the device at the top tune of the device. · REPEAT and RANDOM settings return to the initial values. · When inserting both USB Memory and SD Memory card, or neither USB Memory and SD Memory card, the master precedes USB Memory.
REPEAT	· This key changes the mode of repeat. · Press of “REPEAT” KEY toggles like: “repeat all tunes in memory” → “repeat one tune” → “repeat within folder”. · When selecting “repeat within folder”, the master repeats MP3 files within the folder being

	played. The initial setting is “repeat all tunes in memory”.
RANDOM	· This key plays the range of ± 8 files from the current one being played in the order of sort at random. · “RANDOM” KEY is enabled to change mode only during play, pause or stop.

Table VI.2.1.2.2 KEY Operation Enabled/Disabled

	After recognizing device (Search or pause)		During play of device		Searching	Error	
	Recognize either USB or SD	Recognize both USB and SD	Recognize either USB or SD	Recognize both USB and SD		Recognize either USB or SD	Recognize both USB and SD
PLAY/ PAUSE	○	○	○	○	×	×	×
STOP	×	×	○	○	○	×	×
FF	×	×	○	○	×	×	×
FB	×	×	○	○	×	×	×
FOLDER+	×	×	○	○	×	×	×
FOLDER-	×	×	○	○	×	×	×
VOL+	○	○	○	○	×	○	○
VOL-	○	○	○	○	×	○	○
+10	×	×	○	○	×	×	×
CHNG_DEV	×	○	×	○	×	×	○
REPEAT	○	○	○	○	×	×	×
RANDOM	○	○	○	○	×	×	×

○ = Enabled × = Disabled

VI.2.2 LED operation

Seven types of LEDs used to display the LSI operation states are controlled. Table VI.2.2 shows the types and states of LEDs.

Table VI.2.2 Types of LEDs and operation description

Types of LEDs	**Operation description**
LED_ERROR	Lights when an error occurs. This happens in the following cases: (1) Neither USB memory or SD memory card is connected. No MP3 file exists even if these devices are connected. (2) Communication error or disconnection occurs in the memory being played.
LED_PLAY	Lights during play. Blinks during pause.
LED_PSD	Lights when SD memory card is connected and played. Blinks when SD memory card is connected but SD memory card is not selected. Goes off when SD memory card is not connected.
LED_PUSB	Lights when USB memory is connected and played. Blinks when USB memory is connected but USB memory card is not selected. Goes off when USB memory is not connected.
LED_ACCESS	Lights during access to USB memory or SD memory card.
LED_RANDOM	Lights during random play.
LED_REPEAT	Lights during folder repeat. Blinks during repeat of one tune. Goes off during repeat all tunes in memory

VI.3 MODE2

VI.3.1 Command operation

You can operate commands via the I2C serial interface. When using the LSI in MODE2, it can be operated by setting SEL_SLAVE to L. The length of command to be sent varies depending on which command is selected.

Table VI.3.1.1 shows the command specifications.

Table VI.3.1.2 shows enabled/disabled state of each command.

Table VI.3.1.1 Command Operation Description

Command name	Command byte length	Command				Operation description
		1st	2nd	3rd	4th	
PLAY	2	0x50	0x01	-	-	· When receiving “PLAY” command during stop, the master starts playing the MP3 file currently selected. The order sorted from the root folder is initially set. · When receiving “PLAY” command during pause, the master restarts playing the file from that point. · When a state which disables MP3 decoding for more than 5 seconds during play, status “DECO_ERR” is set to H. MP3 decoding is continued.
PAUSE			0x02	-	-	· When receiving “PAUSE” command during play, the master stops playing the MP3 files temporarily.
STOP			0x03	-	-	· When receiving “STOP” command during play, pause or file search, the master stops playing the MP3 file. · “STOP” command can be received even during BUSY.
VOL+			0x04	-	-	· When SEL_VOL is set to H, “VOL+” command is enabled. · When receiving “VOL+” command, the master controls sound volume. · Sound volume can be controlled at 32 steps from -∞ (minimum volume) to 0dB (maximum volume).
VOL-			0x05	-	-	· When SEL_VOL is set to H, “VOL-“command is enabled. · When receiving “VOL-“command, the master controls sound volume. · Sound volume can be controlled at 32 steps from -∞ (minimum volume) to 0dB (maximum volume).
REPEAT			0x06	-	-	· This command selects the mode during repeat. · REPEAT command toggles like: “repeat all tunes in memory” → “repeat one tune” → “repeat within folder”. · When selecting “repeat within folder”, the master repeats MP3 files within the folder being played. · The initial setting is “repeat all tunes in memory”. · The last setting to “REPRAND”, “REPEAT” and “RANDOM” commands will be enabled.
RANDOM			0x07	-	-	· This key plays the range of ± 8 files from the current one being played in the order of sort at random. · The last setting to “REPRAND”, “REPEAT” and “RANDOM” commands will be enabled.
CHNG_DEV			0x08	-	-	· The command selects the device between USB memory and SD memory card. To do this, both devices should be connected or one device should correspond to the other (USB to SD or SD to USB). Otherwise, this key operation is ignored. · Stop after selecting the device at the top tune of the device. · REPEAT and RANDOM settings return to the initial values.
ABORT			0x0C	-	-	· This command interrupts ID3Tag analysis. · It interrupts ID3Tag analysis only if MP3 is being played for that ID3Tag.
SET_RESUME_INFO1	8	0x51	0x41	RESUME INFO 1byte-6byte		· This command sets byte 1 to 6 of 42-byte data obtained by “READ_RESUME_INFO”.
SET_RESUME_INFO2			0x42	RESUME INFO 7byte-12byte		· This command sets byte 7 to 12 of 42-byte data obtained by “READ_RESUME_INFO”.
SET_RESUME_INFO3			0x43	RESUME INFO 13byte-18byte		· This command sets byte 13 to 18 of 42-byte data obtained by “READ_RESUME_INFO”.
SET_RESUME_INFO4			0x44	RESUME INFO 19byte-24byte		· This command sets byte 19 to 24 of 42-byte data obtained by “READ_RESUME_INFO”.
SET_RESUME_INFO5			0x45	RESUME INFO 25byte-30byte		· This command sets byte 25 to 30 of 42-byte data obtained by “READ_RESUME_INFO”.

SET_RESUME_INFO6			0x46	RESUME INFO 31byte-36byte		· This command sets byte 31 to 36 of 42-byte data obtained by “READ_RESUME_INFO”.
SET_RESUME_INFO7			0x47	RESUME INFO 37byte-42byte		· This command sets byte 37 to 42 of 42-byte data obtained by “READ_RESUME_INFO”.
FF	4	0x55	0x01	0x00	0x00	· When receiving FF command during play, pause or stop, the master searches the next MP3 file in the order of sort of the file being played or paused. · During play of the last file, the master returns to the first file in the order of sort. · Operation stops upon completion of search. · When ID3 analysis is set by SEL_ID3 command, operation stops upon completion of ID3 analysis.
FF&PLAY				0x01	0x00	· When receiving”FF&PLAY” command during play, pause or stop, the master searches the next MP3 file in the order of sort of the file being played or paused. · During play of the last file, the master returns to the first file in the order of sort. · Operation starts playing, after completion of search. · When ID3 analysis is set by SEL_ID3 command, the file is played upon completion of ID3 analysis.
FB			0x02	0x00		· When receiving “FB” command during play, pause or stop, the master searches the previous MP3 file in the order of sort of files being played or paused. · The master returns to the last file in the order of sort during play of the first file. · Upon completion of search, the operation stops. · When ID3 analysis is set by SEL_ID3 command, the operation stops upon completion of ID3 analysis.
FB&PLAY				0x01		· When receiving “FB&PLAY” command during play, pause or stop, the master searches the previous MP3 file in the order of sort of files being played or paused. · The master returns to the last file in the order of sort during play of the first file. · Operation starts playing, after completion of search. · When ID3 analysis is set by SEL_ID3 command, the master plays the file upon completion of ID3 analysis.
FOL+			0x03	0x00		· When receiving “FOL+” command during play, pause or stop, the master searches the next folder in the order of sort of the folder in which the file being played or paused exists. · The master returns to the first folder in the order of sort during play of the last folder. · The operation stops upon completion of search. · When ID3 analysis is set by SEL_ID3 command, the operation stops upon completion of ID3 analysis.
FOL+&PLAY				0x01		· When receiving “FOL+” command during play, pause or stop, the master searches the next folder in the order of sort of the folder in which the file being played or paused exists. · The master returns to the first folder in the order of sort during play of the last folder. · The operation stops upon completion of search. · When ID3 analysis is set by SEL_ID3 command, the master plays the file upon completion of ID3 analysis.
FOL-			0x04	0x00		· When receiving “FOL-“ command during play, pause or stop, the master search the next folder in the sort of the folder in which the file being played or paused exists. · During play of the first folder, the master returns to the last folder in the order of sort. · The operation stops upon completion of search. · When ID3 analysis is set by SEL_ID3 command, the operation stops upon completion of ID3 analysis.

FOL-&PLAY				0x01		· When receiving “FOL-“ command during play, pause or stop, the master searches the next folder in the order of sort of the folder in which the file being played or paused exists. · During play of the top folder, the master returns to the first folder in the order of sort. Upon completion of search, the master plays the folder. · When ID3 analysis is set by SEL_ID3 command, the master plays the folder upon completion of ID3 analysis.
+10			0x05	0x00		· When receiving “+10” command during play, pause or stop, the master searches the MP3 file of the 10th tune in the order of sort of the file being played or paused. · When the remaining files to be played are less than 10 in the order of sort, the master returns to the first file. · The operation stops upon completion of search. · When ID3 analysis is set by SEL_ID3 command, the operation stops upon completion of ID3 analysis.
+10&PLAY				0x01		· When receiving “+10” command during play, pause or stop, the master searches the MP3 file of the 10th tune in the order of sort of the file being played or paused. · When the remaining files to be played are less than 10 in the order of sort, the master returns to the first file. · The operation stops upon completion of search. · When ID3 analysis is set by SEL_ID3 command, the master plays the file upon completion of ID3 analysis.
-10			0x06	0x00	0x00	· When receiving “-10” command during play, pause or stop, the master searches the MP3 file of the previous 10th tune in the order of sort of the file being played or paused. · When playing the top 10 or less files in the order of sort, the master returns to the first file. · The operation stops upon completion of search. · When ID3 analysis is set by SEL_ID3 command, the operation stops upon completion of ID3 analysis.
-10&PLAY				0x01		· When receiving “-10” command during play, pause or stop, the master searches the MP3 file of the previous 10th tune in the order of sort of the file being played, paused or stopped. · When playing the top 10 or less files in the order of sort, the master returns to the first file. · The operation stops upon completion of search. · When ID3 analysis is set by SEL_ID3 command, the master plays the file upon completion of ID3 analysis.
SET_DOUT	4	0x51	0x20	0x00	0x58	· This command outputs the audio data in the I2S (32fs) format. · When the line output is selected by SEL_DOUT terminal, the command is ignored.
					0x59	· This command outputs the audio data in the I2S (48fs) format. · When the line output is selected by SEL_DOUT terminal, the command is ignored.
					0x5B	· This command outputs the audio data in the I2S (64fs) format. · When the line output is selected by SEL_DOUT terminal, the command is ignored.
				0x01	0x01	· This command performs serial audio interface (SPDIF) output. · When the line output is selected by SEL_DOUT terminal, the command is ignored.
				0xFF	0x00	· This command stops serial audio interface (I2S, SPDIF) output. · When the line output is selected by SEL_DOUT terminal, the command is ignored.
SET_EQ * See Chapter VI.3.3.	2	0x52	0x00	-	-	This command turns OFF the EQ setting.
			0x01	-	-	POPS
			0x02	-	-	JAZZ
			0x03	-	-	ROCK
			0x04	-	-	CLASSIC
			0x05	-	-	R&B
			0x07	-	-	This command turns OFF the EQ setting.
			0x08	-	-	BASS BOOST1
			0x09	-	-	POPS+BASS BOOST1
			0x0A	-	-	JAZZ+BASS BOOST1

			0x0B	-	-	ROCK+BASS BOOST1
			0x0C	-	-	CLASSIC+BASS BOOST1
			0x0D	-	-	R&B+BASS BOOST1
			0x0F	-	-	BASS BOOST2
SET_VOL	2	0x53	Setting value	-	-	· This command sets the sound volume to the 2nd byte value of the command. The setting value ranges 32 steps from 0x00 to 0x1F. Any value outside of the above range is ignored.
REPRAND	2	0x54	0x00	-	-	· This command repeats all the tunes within the memory. This is initially set. · The last setting to “REPRAND”, “REPEAT” and “RANDOM” commands will be enabled.
			0x01	-	-	· The command repeats playing the MP3 file within the folder being played. · The last setting to “REPRAND”, “REPEAT” and “RANDOM” commands will be enabled.
			0x02	-	-	· This command repeats playing the MP3 file being played. · The last setting to “REPRAND”, “REPEAT” and “RANDOM” commands will be enabled.
			0x03	-	-	· This command plays through the range of ±8 files in the order of the sort from the current one being played at random. · The last setting to“REPRAND”, “REPEAT” and “RANDOM” commands will be enabled.
SEL_ID3	2	0x56	0x00	-	-	· This command does not perform ID3Tag analysis written to the MP3 file. · The MP3 file played immediately after set will be enabled first.
			0x01	-	-	· This command analysis ID3Tag written to the MP3 file. · The MP3 file played immediately after set will be enabled first. · Upon completion of ID3Tag analysis, the data is written to the status register.
SEL_TOC	2	0x57	0x00	-	-	· This command does not perform TOC analysis. · TOC analysis is not performed at initial setting.
			0x01	-	-	· When receiving the command, inserting into the device or changing the device, the master analyzes the total folders (including root directory) and total MP3 files within the device. · The number of total MP3 files conforms to SEL_MP3 terminal. · When receiving the command, only change from OFF to ON is executed. · Upon completion of TOC analysis, the master returns to the top tune of the device and stops. · After TOC analysis, the data is written to the status register.
SEL_12MOUT	2	0x58	0x00	-	-	This command stops 12MHz clock output from CLKOUT12 terminal.
			0x01	-	-	This command enables 12 MHz clock output from CLKOUT12 terminal.

Table VI.3.1.2 Command Enabled/Disabled in Various States

	After recognizing device, search or pause		During play of device		Searching	Error	
	Recognize either USB or SD	Recognize both USB and SD	Recognize either USB or SD	Recognize both USB and SD		Recognize either USB or SD	Recognize both USB and SD
PLAY	○	○	○	○	×	×	×
PAUSE	×	×	○	○	×	×	×
STOP	×	×	○	○	○	×	×
VOL+	○	○	○	○	×	○	○
VOL-	○	○	○	○	×	○	○
REPEAT	○	○	○	○	×	×	×
RANDOM	○	○	○	○	×	×	×
CHNG_DEV	×	○	×	○	×	×	○
ABORT	×	×	×	×	○	×	×
SET_RESUME_INFO1-7	○	○	○	○	×	×	×
FF	○	○	○	○	×	×	×
FF&PLAY	○	○	○	○	×	×	×
FB	○	○	○	○	×	×	×
FB&PLAY	○	○	○	○	×	×	×
FOL+	○	○	○	○	×	×	×
FOL+&PLAY	○	○	○	○	×	×	×
FOL-	○	○	○	○	×	×	×
FOL-&PLAY	○	○	○	○	×	×	×
+10	○	○	○	○	×	×	×
+10&PLAY	○	○	○	○	×	×	×
-10	○	○	○	○	×	×	×
-10&PLAY	○	○	○	○	×	×	×
SET_DOUT	○	○	○	○	×	○	○
SET_EQ	○	○	○	○	×	○	○
SET_VOL	○	○	○	○	×	○	○
REPRAND	○	○	○	○	×	×	×
SEL ID3	○	○	○	○	×	×	×
SEL_TOC	○	○	○	○	×	×	×
SEL 12MOUT	○	○	○	○	×	○	○

○ = Enabled × = Disabled

VI. 3.2 Status output

The operation information, such as internal status, play time information, folder information, file information and ID3Tag information, is output using a I2C interface.

Statuses as shown in Table VI. 3.2.1 MODE 2 Status Register Map are output.

The status register has a ring buffer structure of OFFSET 0x00-0x7F. The OFFSET position is automatically incremented after reading byte data.

Status read specifies OFFSET of the status register map. There are two methods available: to read a desired number of bytes continuously from the OFFSET position and to read the data by one command without specifying the OFFSET position. Figure VI.3.2.2 shows the status output commands. Table VI.3.2.3 shows the enabled/disabled state of the status output commands.

Status register outputs a byte data of OFFSET 0x00-0x7F by "Little Endian" format

Table VI. 3.2.1 MODE2 Status Register Map

OFFSET	Status	bit7 (MSB)	bit6	bit5	bit4	bit3	bit2	bit1	bit0 (LSB)
0x00	STATUS1	ERROR 0: No error 1: Error occurs	SEARCH 0: Search stop 1: Searching	SEL_ID3 0: ID3Tag OFF 1: ID3Tag ON	SEL_TOC 0: TOC display OFF 1: TOC display ON	DEC_ERR 0: No error 1: Error occurs	STOP 0: Not stopped 1. Stopping	PAUSE 0: Not paused 1: Pausing	Play 0: Not played 1: Playing
0x01	STATUS2	USBINS 0: USB not connected 1: USB connection detected	SDINS 0: SD not connected 1: SD connection detected	USBFILE Playable file within USB memory 0: Absent 1: Present	SDFILE Playable file within SD memory 0: Absent 1: Present	MDEVUSB USB memory 0: Not recognized 1: Recognized	MDEVSD SD memory 0: Not recognized 1: Recognized	PDEVUSB PDEVUSB USB memory 0: Stopping 1: Playing/ID3Tag analyzing	PDEVSD PDEVUSB SD memory 0: Stopping 1: Playing/ID3Tag analyzing
0x02	STATUS3	BUSY 0: Not BUSY 1: BUSY	MCHNG Tune number change detection 0: Tune ended/stopped 1: Playing/ stop before playing	0	ID3READY ID3 information 0: Preparation not completed 1. Preparation completed	ID3RSID1 ID3Tag Version1 0: Present 1: Absent	ID3RSID2 ID3Tag Version2 0: Present 1: Absent	TINFUSB Total number of folders/files within USB memory 0: Not obtained 1: Obtained	TINFSD Total number of folders/files within SD memory 0: Not obtained 1: Obtained
0x03	STATUS4	0	0	0	0	0	RANDOM Random play setting 0: OFF 1: ON	REP1 One-tune repeat setting 0: OFF 1: ON	REPFOL Folder repeat setting 0: OFF 1: ON
0x04	STATUS5	12MOUT 12 MHz clock output 0: OFF 1: ON	0	0	0	0	0	0	RES_ERR Resume error 0: No error 1: Error occurs
0x05	VOLINF	0	0	0	VOLINF Sound volume information [4: 0]				
0x06	EQINF	EQINF Equalizer setting information 0000: OFF 0001: POPS 0010: JAZZ 0011: ROCK 0100: CLASSIC 0101: R&B 1000: BASS BOOST 1001: POPS+BASS 1010: JAZZ+BASS 1011: ROCK+BASS 1100: CLASSIC+BASS 1101: R&B+BASS 1111 BASS BOOST2				0	0	0	0
0x08	DOUT	0	0	0	0	0	0	0	DOUT Audio output 0: LINE output 1: I2S / SPDIF
0x09	DOUTINF	DOUTINF I2S format status 0x58: 32fs(Initial value) 0x59: 48fs 0x5B: 64fs 0x00: OFF 0x01: SPDIF output							

0x0A	PFOLNL	PFOLNL Playing folder number lower-order byte [7:0]	
0x0B	PFOLNH	PFOLNH Playing folder number upper-order byte [15:8]	
0x0C	PFILENL	PFILENL Playing file number lower-order byte [7:0]	
0x0D	PFILENH	PFILENH Playing file number upper-order byte [15:8]	
0x0E	PSEC	Playing time second information [7:4]x10 sec.	Playing time second information [3:0]x1 sec.
0x0F	PMIN	Playing time minute information [7:4]x10 min.	Playing time minute information [3:0]x1 min.
0x10	TFOLUSBL	TFOLUSBL USB memory total folder number lower -order byte [7:0]	
0x11	TFOLUSBH	TFOLUSBH USB memory total folder number upper-order byte [15:8]	
0x12	TFILEUSBLL	TFILEUSBLL USB memory total folder number lower -order byte [15:0] [7:0]	
0x13	TFILEUSBLH	TFILEUSBLH USB memory total folder number upper-order byte [15:0] [15:8]	
0x14	TFILEUSBHL	TFILEUSBHL USB memory total folder number lower -order byte [31:16] [23:16]	
0x15	TFILEUSBHH	TFILEUSBHH USB memory total folder number upper-order byte [[31:16] [31:24]	
0x16	TFOLSDL	TFOLSDL SD memory total folder number lower -order byte [7:0]	
0x17	TFOLSDH	TFOLSDH SD memory total folder number upper-order byte [15:8]	
0x18	TFILESDL	TFILESDLL SD memory total folder number lower -order byte [15:0] [7:0]	
0x19	TFILESDLH	TFILESDLH SD memory total folder number upper-order byte [15:0] [15:8]	
0x1A	TFILESDHL	TFILESDHL SD memory total folder number lower -order byte [31:16] [23:16]	
0x1B	TFILESDHH	TFILESDHH SD memory total folder number upper-order byte [31:16] [31:24]	
0x20 | 0x7F	COMAREA	COMAREA Data common area The content varies depending on the status read command.	

Table VI. 3.2.2 MODE2 Status Output Commands

Command name	Command		Status output bytes	Status
	1st byte	2nd byte		
READ_BUFF	0x5E	OFFSET	Optional	· The command outputs the desired bytes of data from the OFFSET position specified in the status register map. · Since the status register functions as a ring buffer of 0x00-0x7F, the master returns to 0x00 after OFFSET position 0x7F during data read.
READ_STATUS	0x5F	0x00	5	· This command outputs the data of OFFSET 0x00-0x04 in the status buffer.
READ_PLAY_INFO		0x01	6	· This command outputs the data of OFFSET 0x0A-0x0F in the status buffer.
READ_VOL		0x02	1	· This command outputs the data of OFFSET 0x05 in the status buffer.
READ_EQ		0x03	1	· This command outputs the data of OFFSET 0x06 in the status buffer.
READ_ID3_TITLE		0x04	64	· This command outputs the data of ID3Tag Title.
READ_ID3_ARTIST		0x05	64	· This command outputs the data of ID3Tag Artist.
READ_ID3_ALBUM		0x06	64	· This command outputs the data of ID3Tag Album.
READ_FILE_NAME		0x07	64	· This command outputs the data of playing MP3 file name. see VI.1.4
READ_FOLDER_NAME		0x08	64	· This command outputs the data of folder name includes playing MP3 file. see VI.1.4
READ_RESUME_INFO * See Chapter VI.3.3.		0x09	42	· This command outputs the data to resume. see VI.3.4

Table VI.3.2.3 Command Enabled/Disabled in Various States

	After recognizing device (stopping after searching)	During play of device	Searching	Error
READ_BUFF	○	○	○	○
READ_STATUS	○	○	○	○
READ_PLAY_INFO	○	○	×	×
READ_VOL	○	○	×	○
READ_EQ	○	○	×	○
READ_ID3_TITLE	○	○	×	×
READ_ID3_ALBUM	○	○	×	×
READ_ID3_ARTIST	○	○	×	×
READ_FILE_NAME	○	○	×	×
READ_FOLDER_NAME	○	○	×	×
READ_RESUME_INFO	○	○	×	×

○ = Enabled, × = Disabled

VI.3.3 Equalizer

You can select 5 types of equalizer and 2 types of BassBoost for the audio line output using a command (see Table VI. 3.3.1). Combination of equalizer and BassBoost1 is available.

Equalizer setting is enabled even when line output is not selected. No change of sound quality by the equalizer is found in digital outputs.

Figures VI.3.3.1 to VI. 3.3.6 show the frequency characteristics of each filter.

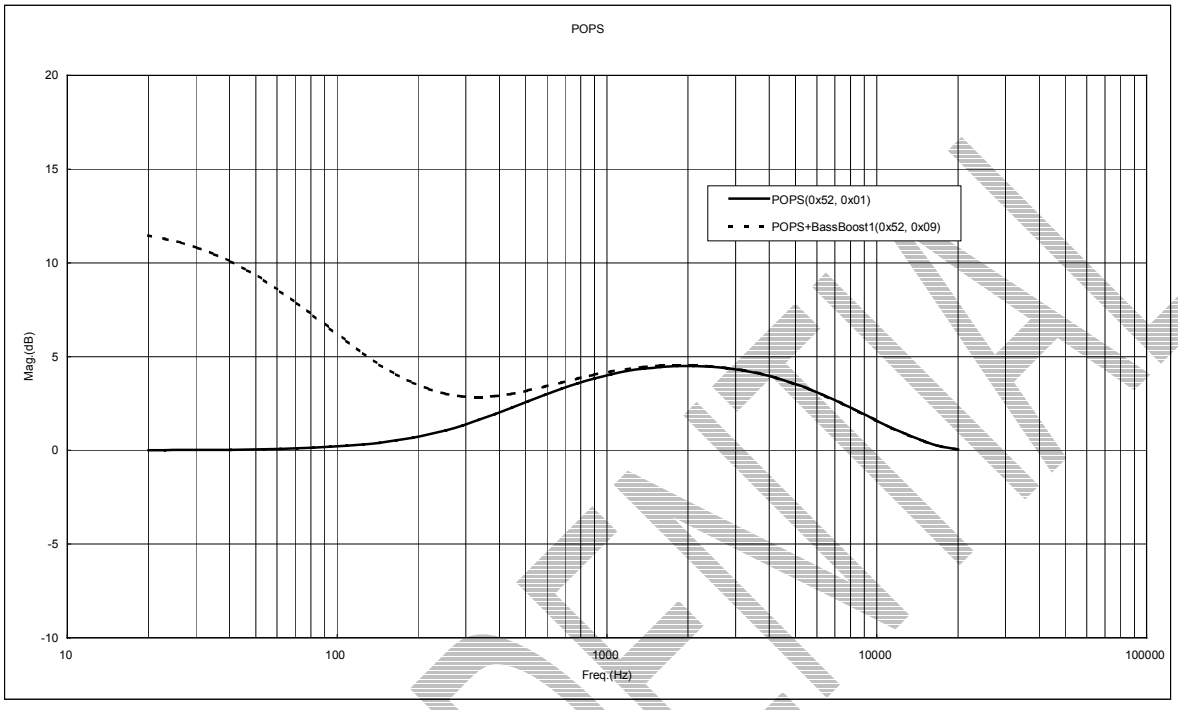


Figure IV.3.3.1 POPS Frequency Characteristics

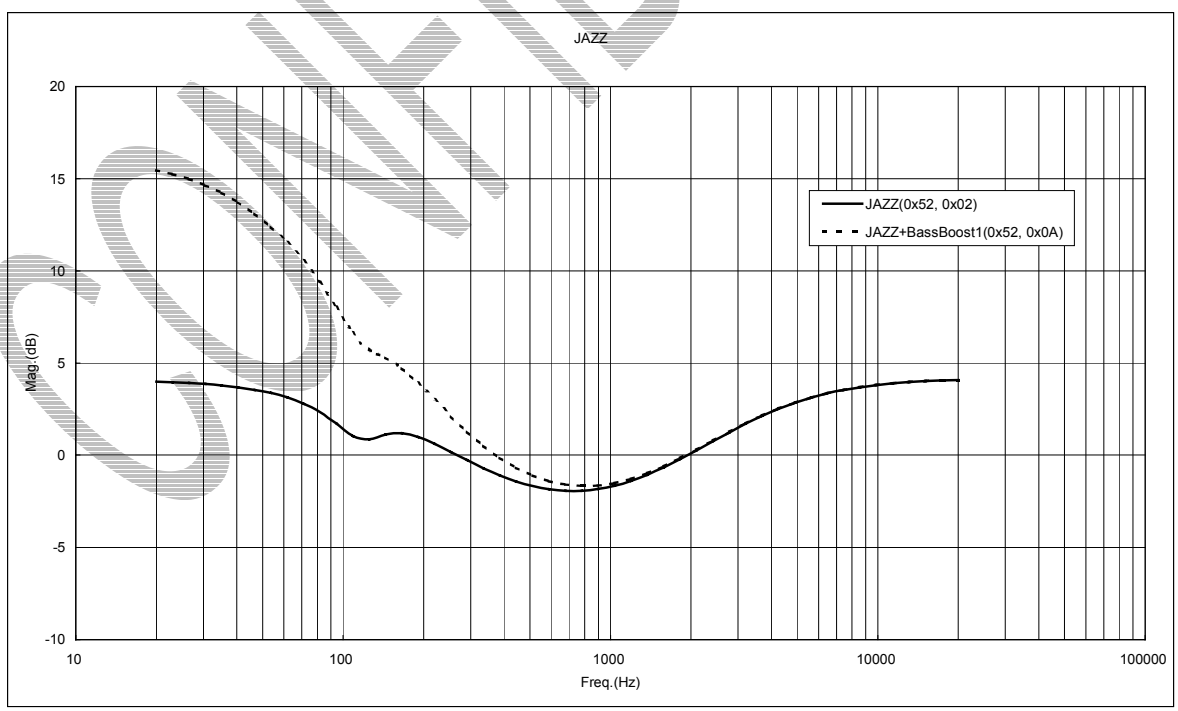


Figure VI. 3.3.2 JAZZ Frequency Characteristics

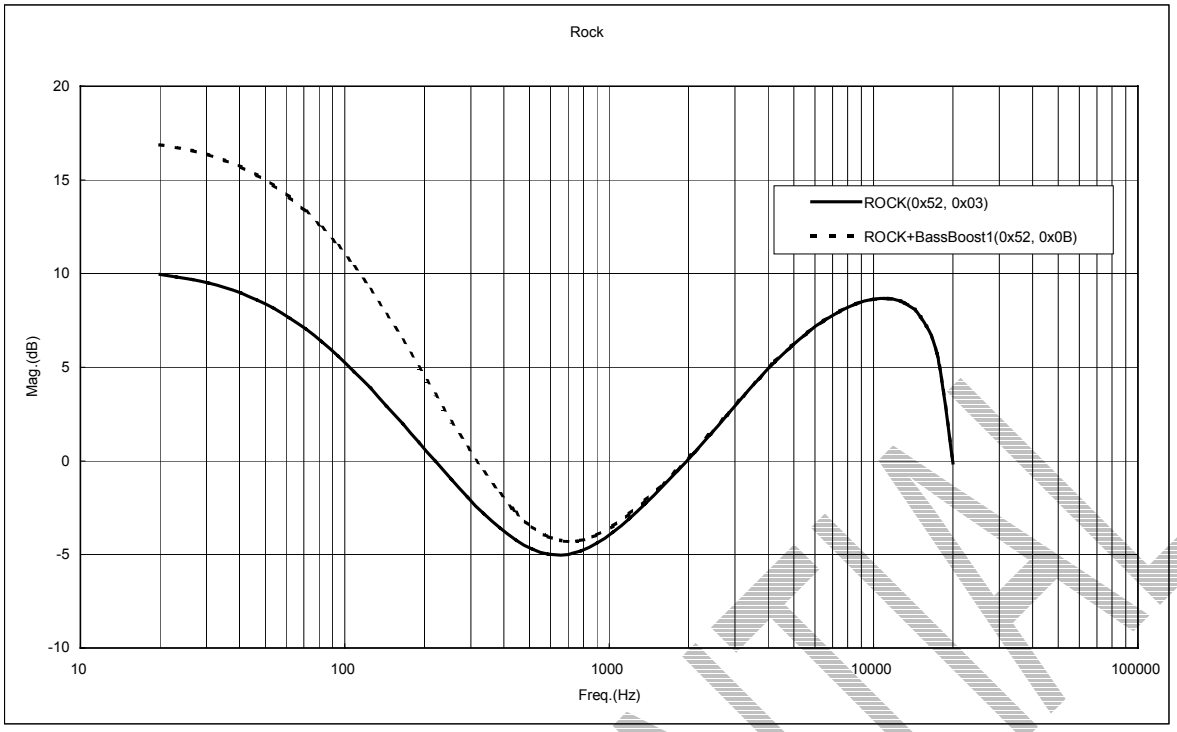


Figure VI. 3.3.3 ROCK Frequency Characteristics

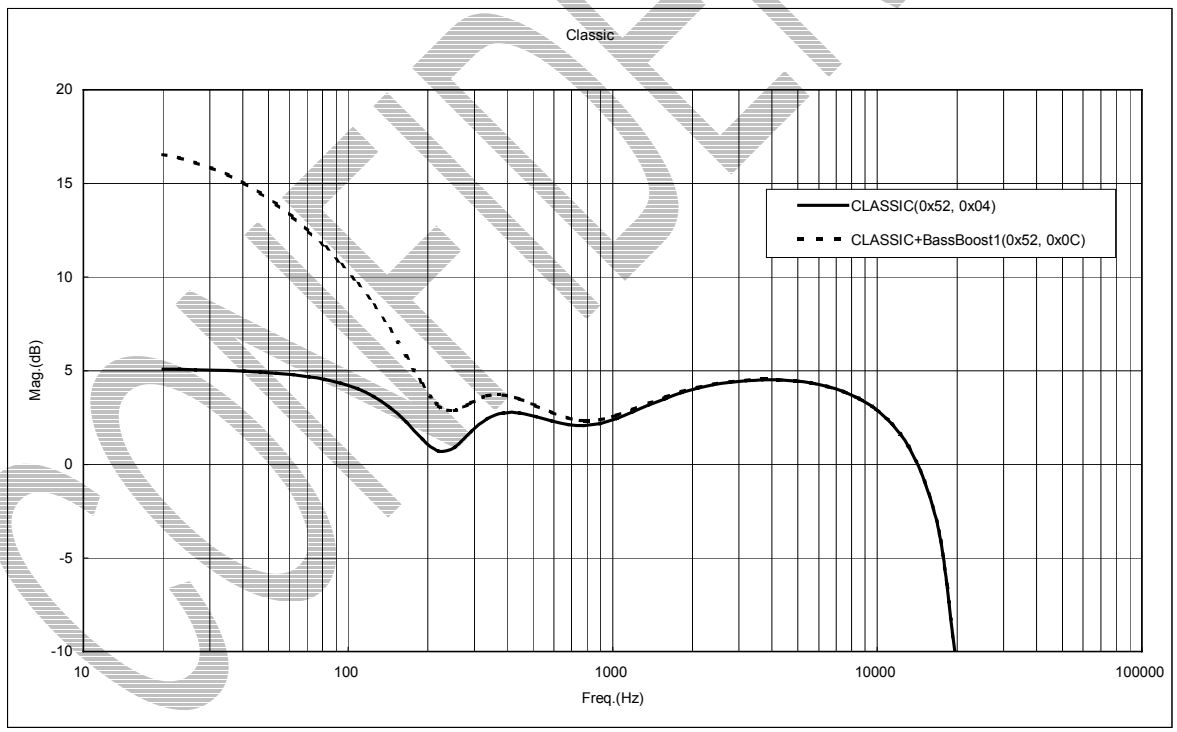


Figure VI. 3.3.4 CLASSIC Frequency Characteristics

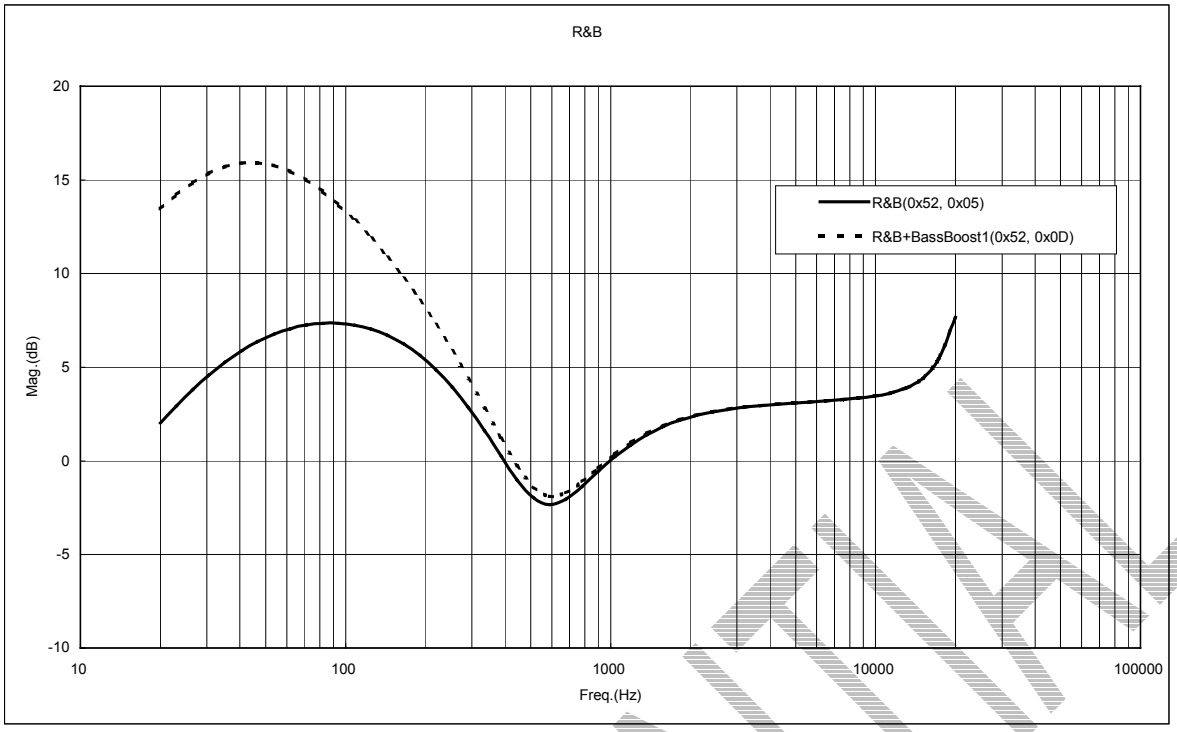


Figure VI. 3.3.5 R&B

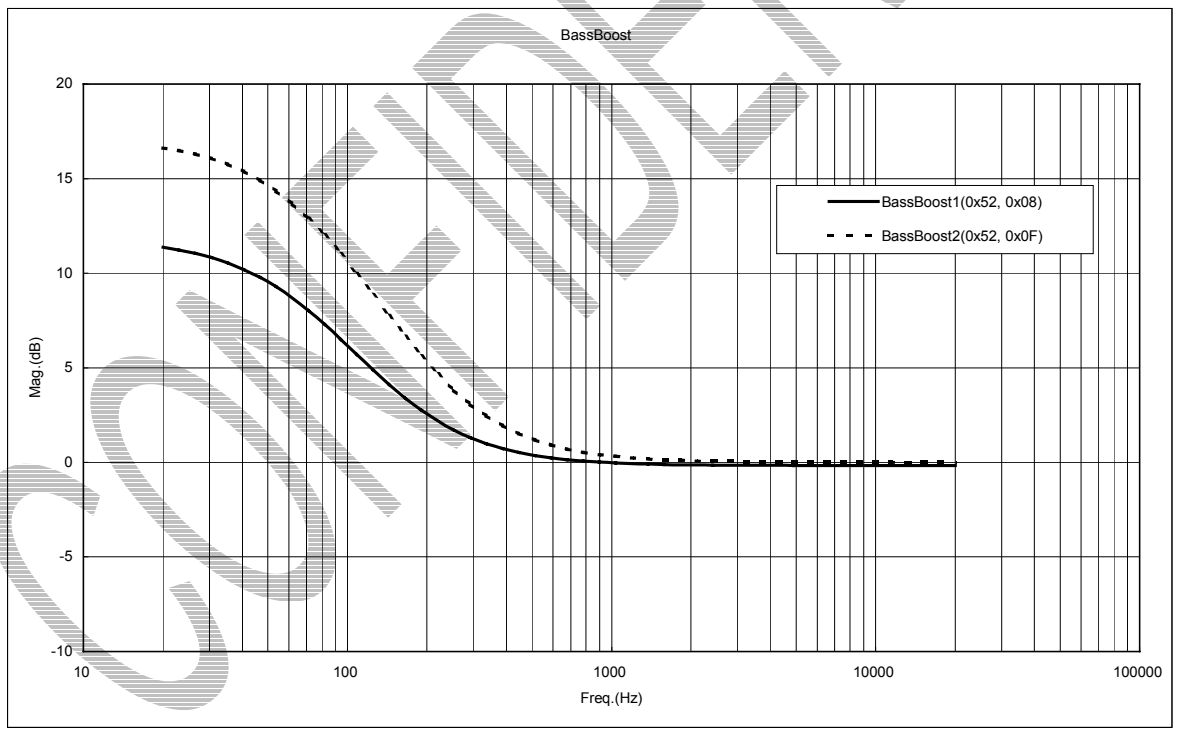


Figure VI. 3.3.6 BassBoost

VI. 3.4 Resume information

This LSI outputs the information required to implement the resume function using the “READ_RESUME_INFO” command.

Table VI.3.4 shows the resume information status register structure.

Table VI. 3.4 Resume Information Register Structure

Status OFFSET	Resume information
0x20-0x24	Access data [5 bytes]
0x25-0x26	Folder number [2 bytes]
0x27-0x28	File number [2 bytes]
0x29-0x48	File information [32 bytes]
0x49	Reserve [1 byte]

i. Access data : Shows the position where the folder information is written within the memory.
ii. File number : Shows the number of the file pointed now. This is a number uniquely set to the LSI.
iii. Folder number : Shows the number of the folder pointed now. This is a number uniquely set to the LSI.
iv. File information : Outputs the information on the file pointed now.
v. Reserve : Outputs all “0s”.

Since the above 42-byte resume information is used to execute resume play, do not change the contents before use.

You can implement the resume function by reading the resume information read using the “READ_RESUME_INFO” command and then writing the information using the “SET_RESUME_INFO1-7” command. After “SET_RESUME_INFO1-7” is all written, the LSI automatically searches and plays a resume file upon completion of writing of “SET_RESUME_INFO7”.

VI.4 MODE3

MODE3 specifies and plays the MP3 file to be played by the master microcomputer by outputting the MP3file/folder status information, written to USB memory or SD memory card, to the master microcomputer.

VI.4.1 Command operation

The LSI sends commands to obtain the file/folder information in USB memory or SD memory card, to analyze ID3Tag, and to set a file to be played and start playing it.

Table VI.4.1 shows the commands available in MODE3. When sending a command other than listed below in MODE3, it is ignored.

Table VI.4.1 MODE3 Command

Command name	Command byte length	Command			Operation description
		1st	2nd	3rd - 6th	
CHNG_DEV	2	0x50	0x08	-	· The command selects the device between USB memory and SD memory card. To do this, both devices should be connected or one device should correspond to the other (USB to SD or SD to USB). Otherwise, this command is ignored. · After selecting the device, the LSI waits for a command.
GET_DIRECT			0x09	-	· This command obtains the folder information (*see VI.4.3) and file information (*see VI.4.3) for the folder/file set by SET_DIRECT. · Read the information using the status commands “READ_FOLDER_INFO” and “READ_FILE_INFO”. · The status of “ANA_END”, “FOLINF”, “FILINF”, “FOLFULL” and “FILFULL” are reset.
GET_NUMBER			0x0A	-	· This command obtains the number of files and folders for the folder set by SET_DIRECT. · Read the information using status command “READ_NUMBER”. · The number of non-MP3 files is ignored. · The statuses of “ANA_END” is reset.
GET_ID3			0x0B	-	· This command performs ID3Tag analysis for the MP3 file set by SET_DIRECT. · The command also analyzes even if the folder is not specified. However, at the end of analysis, a status in which ID3Tag information is not contained will be output. - The statuses of “ID3READY”, “ID3RSID1” and “ID3RSID2” are reset.
PAUSE			0x02	-	· When receiving “PAUSE” command during play, the master stops playing the MP3 files temporarily.
STOP			0x03	-	· This command stops the operations of ID3Tag analysis. · This command stops playing the MP3 file and stop at top of this MP3 file.
ABORT			0x0C	-	· This command stops the operations of ID3Tag analysis, folder analysis and file analysis. · The statuses of “ANA_END”, “FOLINF”, “FILINF”, “FOLFULL”, “FILFULL”, "ID3READY", "ID3RSID1" and "ID3RSID2" are reset.
PLAY_DIRECT			0x0D	-	· This command starts playing the MP3 file set by SET_DIRECT. · The command plays the file even when the preset file is not a MP3 file or when the folder is specified, the command plays the specified one. If MP3 decode disabled is detected for 5 seconds or longer, the command outputs status "DECO_ERR"=H.
VOL+			0x04	-	· When SEL_VOL is set to H, “VOL+” command is enabled. · When receiving “VOL+” command, the master controls sound volume. · Sound volume can be controlled at 32 steps from -∞ (minimum volume) to 0dB (maximum volume).

VOL-			0x05	-		· When SEL_VOL is set to H, “VOL-“command is enabled. · When receiving “VOL-“command, the master controls sound volume. · Sound volume can be controlled at 32 steps from -∞ (minimum volume) to 0dB (maximum volume).
SET_DOUT	4	0x51	0x20	0x00	0x58	· This command outputs audio data in the I2S (32fs) format. · When line output is selected by SEL_DOUT terminal, the command is ignored.
					0x59	· This command outputs audio data in the I2S (48fs) format. · When line output is selected by SEL_DOUT terminal, the command is ignored.
					0x5B	· This command outputs audio data in the I2S (64fs) format. · When line output is selected by SEL_DOUT terminal, the command is ignored.
				0x01	0x01	· This command performs serial audio interface (SPDIF)output. · When line output is selected by SEL_DOUT terminal, the command is ignored.
				0xFF	0x00	· This command performs serial audio interface (I2S, SPDIF) output. · When line output is selected by SEL_DOUT terminal, the command is ignored.
SET_NUMBER	6		0x21	0xXX		· This command sets the number of obtained folders for those set by SET_DIRECT. · Parameter: “Number of obtained folders: 2 bytes” + “Number of obtained MP3 files: 2 bytes”. By specifying “0”, all the folders and files are obtained.
SET_EQ *See Chapter VI.3.3.	2	0x52	0x00	-		· This command turns OFF EQ setting.
			0x01	-		· POPS
			0x02	-		· JAZZ
			0x03	-		· ROCK
			0x04	-		· CLASSIC
			0x05	-		· R&B
			0x07	-		· This command turns OFF EQ setting.
			0x08	-		· BASS BOOST
			0x09	-		· POPS+BASS
			0x0A	-		· JAZZ+BASS
			0x0B	-		· ROCK+BASS
			0x0C	-		· CLASSIC+BASS
			0x0D	-		· R&B+BASS
			0x0F	-		· BASS BOOST2
SET_VOL		0x53	Setting value	-		· Set sound volume the second byte value of the command. The setting values are 32 steps ranging from 0x00 to 0x1F. · A value specified outside the above range will be ignored.
SEL_12MOUT		0x58	0x00	-		· This command stops 12 MHz clock output from CLKOUT12 terminal.
			0x01	-		· This command enables 12 MHz clock output from CLKOUT12 terminal.
SET_DIRECT	8	0x59	0x00	0xXX		· This command specifies the current position of the folder/file by specifying the folder/file information access data (6 bytes). · Specify access data (6 bytes) at 0xXX. · By specifying “0”, the position is set to the root folder.

Table VI. 4.2 Command Enabled/Disabled in Various Status

	After recognizing device		Analyzing	During play of device		Searching	Error	
	Recognize either USB or SD	Recognize both USB and SD		Recognize either USB or SD	Recognize both USB and SD		Recognize either USB or SD	Recognize both USB and SD
CHNG_DEV	×	○	×	×	○	×	×	○
GET_DIRECT	○	○	×	×	×	×	×	×
GET_NUMBER	○	○	×	×	×	×	×	×
GET_ID3	○	○	×	×	×	−	×	×
PAUSE	×	×	×	○	○	×	×	×
STOP	×	×	×	○	○	○	×	×
ABORT	×	×	○	×	×	○	×	×
VOL+	○	○	×	○	○	×	○	○
VOL-	○	○	×	○	○	×	○	○
PLAY_DIRECT	○	○	×	×	×	×	×	×
SET_DOUT	○	○	×	○	○	×	○	○
SET_NUMBER	○	○	×	×	×	×	×	×
SET_EQ	○	○	×	○	○	×	○	○
SET_VOL	○	○	×	○	○	×	○	○
SEL 12MOUT	○	○	×	○	○	×	○	○
SET_DIRECT	○	○	×	×	×	×	×	×

○ = Enabled × = Disabled

VI.4.2 Status output

The LSI outputs the operation information, such as internal status, play time information, folder information, file information and ID3Tag information, using the I2C interface.

The statuses as shown in Table VI.4.2.1 MODE3 status register map are output. There are two methods available: to read a desired number of bytes continuously from the OFFSET position and to read the data by one command without specifying the OFFSET position. Figure VI.4.2.2 shows the status output commands. Table VI.4.2.3 shows the enabled/disabled state of the status commands.

The status register has a ring buffer structure of OFFSET 0x00-0x7F. The OFFSET position is automatically incremented after reading byte data.

Status register outputs a byte data of OFFSET 0x00-0x7F by "Little Endian" format

Table IV.4.2.1 MODE3 Status Output

Offset	Status	bit7 (MSB)	bit6	bit5	bit4	bit3	bit2	bit1	bit0 (LSB)
0x00	STATUS1	ERROR 0: No error 1: Error occurs	SEARCH 0: Search stop 1: Searching	0	0	DEC_ERR 0: No error 1: Error occurs	STOP 0: Not stopped 1: Stopping	PAUSE 0: Not paused 1: Pausing	Play 0: Not played 1: Playing
0x01	STATUS2	USBINS 0: USB not connected 1: USB connection detected	SDINS 0: SD not connected 1: SD connection detected	USBFILE Playable file within USB memory 0: Absent 1: Present	SDFILE Playable file within SD memory 0: Absent 1: Present	MDEVUSB USB memory 0: Not recognized 1: Recognized	MDEVSD SD memory 0: Not recognized 1: Recognized	PDEVUSB PDEVUSB USB memory 0: Stopping 1: Playing/ID3Tag analyzing	PDEVSD PDEVUSB SD memory 0: Stopping 1: Playing/ID3Tag analyzing
0x02	STATUS3	BUSY Command Busy 0: Not BUSY 1: BUSY	MCHNG Tune number change detection 0: Tune ended/stopped 1: Playing	0	ID3READY ID3 information 0: Preparation not completed 1: Preparation completed	ID3RSID1 ID3Tag Version1 0: Present 1: Absent	ID3RSID2 ID3Tag Version2 0: Present 1: Absent	0	0
0x03	STATUS4	ANAEND 0: Analyzing 1: Analysis completed	FOLINF Folder information 0: Absent 1: Present	FOLFULL Folder buffer 0: Not FULL 1: FULL	FILEINF Folder information 0: Absent 1: Present	FILEFULL Folder buffer 0: Not FULL 1: FULL	0	0	0
0x04	STATUS5	12MOUT 12 MHz clock output 0: OFF 1: ON	0	0	0	0	0	0	0
0x05	VOLINF	0	0	0	VOLINF Sound volume information [4: 0]				
0x06	EQINF	EQINF Equalizer setting information 0000: OFF 0001: POPS 0010: JAZZ 0011: ROCK 0100: CLASSIC 0101: R&B 1000: BASS BOOST 1001: POPS+BASS 1010: JAZZ+BASS 1011: ROCK+BASS 1100: CLASSIC+BASS 1101: R&B+BASS 1111 BASS BOOST2				0	0	0	0
0x08	DOUT	0	0	0	0	0	0	0	DOUT Audio output 0: LINE output 1: I2S / SPDIF
0x09	DOUTINF	DOUTINF I2S format status 0x58: 32fs(Initial value) 0x59: 48fs 0x5B: 64fs							

0x0A	PFOLNL	00h	
0x0B	PFOLNH	00h	
0x0C	PFILENL	00h	
0x0D	PFILENH	00h	
0x0E	PSEC	Playing time second information [7:4]x10 second.	Playing time second information [3:0]x1second.
0x0F	PMIN	Playing time minute information [7:4]x10 min.	Playing time minute information [3:0]x1 min.
0x10	TFOLL	TFOLL Current folder total folder number lower-order byte [7:0]	
0x11	TFOLH	TFOLH Current folder total folder number upper-order byte [15:8]	
0x12	TFILEL	TFILEL Current folder total folder number lower-order byte [15:0] [7:0]	
0x13	TFILEH	TFILEH Current folder total folder number upper-order byte [15:0] [15:8]	
0x14	RESFOLL	RESFOLL Remaining analysis folder number lower-order byte [7:0]	
0x15	RESFOLH	RESFOLH Remaining analysis folder number upper-order byte [15:8]	
0x16	RESFILEL	RESFILEL Remaining analysis folder number lower-order byte [7:0]	
0x17	RESFILEH	RESFILEH Remaining analysis folder number upper-order byte [15:8]	
0x18	SETFOLL	SETFOLL Folder get setting value lower-order byte [7:0]	
0x19	SETFOLH	SETFOLH Folder acquisition setting value upper-order byte [15:8]	
0x1A	SETFILEL	SETFILEL Folder acquisition setting value lower-order byte [7:0]	
0x1B	SETFILEH	SETFILEH Folder get setting value upper-order byte [15:8]	
0x20 | 0x7F	COMAREA	COMAREA Data common area The content varies depending on the status read command.	

Table VI. 4.2.2 MODE3 Status Output Commands

Command name	Command		Status output bytes	Status
	1st byte	2nd byte		
READ_BUFF	0x5E	OFFSET	1	· This command outputs the specified OFFSET byte data from status buffer.
READ_STATUS	0x5F	0x00	5	· This command outputs OFFSET 0x00-0x04 of status buffer.
READ_PLAY_INFO		0x01	6	· This command outputs OFFSET 0x0A-0x0F of status buffer.
READ_VOL		0x02	1	· This command outputs OFFSET 0x05 of status buffer.
READ_EQ		0x03	1	· This command outputs OFFSET 0x06 of status buffer.
READ_ID3_TITLE		0x04	64	· This command outputs the data of ID3Tag Title.
READ_ID3_ARTIST		0x05	64	· This command outputs the data of ID3Tag Artist.
READ_ID3_ALBUM		0x06	64	· This command outputs the data of ID3Tag Album.
READ_FILE_NAME		0x07	64	· This command outputs the data of playing MP3 file name. see VI.1.4
READ_FOLDER_NAME		0x08	64	· This command outputs the data of folder name includes playing MP3 file. see VI.1.4
READ_NUMBER		0x0A	4	· This command outputs OFFSET 0x10-0x13 of status buffer.
READ_REST_NUM		0x0B	4	· This command outputs OFFSET 0x14-0x17 of status buffer.
READ_SET_NUM		0x0C	4	· This command outputs OFFSET 0x18-0x1B of status buffer.
READ_FOLDER_INFO		0x0D	76	· This command outputs the result of folder analysis by "GET_DIRECT" command. see VI.4.3.
READ_FILE_INFO		0x0E	76	· This command outputs the result of file analysis by "GET_DIRECT" command. see VI.4.3.
READ_CLAS		0x0F	4	· This command outputs the data of file cluster number. Use to check file when "PLAY_DIRECT".

Table **VI**.4.2.3

	After recognizing device	Analyzing	During play of device	Searching	Error
READ_BUFF	○	○	○	○	○
READ_STATUS	○	○	○	○	○
READ_PLAY_INFO	○	×	○	×	○*
READ_VOL	○	×	○	×	○
READ_EQ	○	×	○	×	○
READ_ID3_TITLE	○	×	○	×	×
READ_ID3_ ARTIST	○	×	○	×	×
READ_ID3_ALBUM	○	×	○	×	×
READ_FILE_NAME	○	×	○	×	×
READ_FOLDER_NAME	○	×	○	×	×
READ_NUMBER	○	×	×	×	×
READ_REST_NUM	○	×	×	×	×
READ_SET_NUM	○	×	×	×	×
READ_FOLDER_INFO	○	×	×	×	×
READ_FILE_INFO	○	×	×	×	×
READ_CLAS	○	×	×	×	×

○ = Enabled × = Disabled

*"READ_PLAY_INFO" command when an error occurs can be received.
However, status output may not send correct data.

VI.4.3 Folder information/file information

For analysis performed by “ANA_START” command, read 76 bytes from the status register “COMAREA (0x20-0x6B)” using status commands “READ_FOLDER_INFO” and “READ_FILE_INFO”.Each of the status register structures when “READ_FOLDER_INFO” and “READ_FILE_INFO” are sent is shown below.

(1) Folder information

When the folder is specified using “SET_DIRECT”, the LSI allows you to fetch the folder information from the memory device at “GET_DIRECT” and read folder information using “READ_FOLDER_INFO”.
Table VI.4.3.1 shows the status register structure.

Table VI.4.3.1 Folder Information Register Structure

Status OFFSET	Folder information
0x20-0x25	Access data [6 bytes]
0x26-0x27	Reserve [2 bytes]
0x28-0x2B	Cluster number [4 bytes]
0x2C-0x6B	Folder name [64 bytes]

i. Access data : Shows the position where the folder information is written in the memory.
ii. Reserve : All “0s” are output.
iii. Cluster number : Shows the cluster number where the folder information is written in the memory.
iv. Folder name : Outputs the folder name from the leftmost position.

(2) Folder information

When the folder is specified using SET_DIRECT, the LSI allows you to fetch the folder information from the memory device at GET_DIRECT and read folder information using READ_FILE_INFO.
Table VI.4.3.2 shows the status register structure.

Table VI.4.3.2 File Information Register Structure

Status OFFSET	File information
0x20-0x25	Access data [6 bytes]
0x26-0x27	Reserve [2 bytes]
0x28-0x2B	Cluster number [4 bytes]
0x2C-0x6B	File name [64 bytes]

i. Access data : Shows the position where the folder information is written in the memory.
ii. Reserve : All “0s” are output.
iii. Cluster number : Shows the cluster number where the folder information is written in the memory.
iv. File name : Outputs the folder name from the leftmost position.

VII. Revision history

Revision No.	Date	Revised by	Revising points
1.0	Jan/12/2007	H.Funakoshi	Rev. 1.0 Release