Product name	:	USB host MP3 decoder
Model	:	BU9432-C1
Outline drawing	:	Figure-1
Terminal block diagram	:	Figure-2
Feature	:	BU9432-C1 is MP3 decoder IC which contains USB host function. It contains a system controller, USB host control function, and MP3 decode function necessary to compose USB Host player. In addition, it is also possible to compose the set only of this 1chip by building the headphone amplifier into.

MPEG Layer-3 audio decoding technology licensed from Fraunhofer IIS and Thomson.

USB host controller

・The USB2.0 Full speed HOST control function
・Mass Storage Class
・USB HUB is not supported

FAT analysis

・FAT16 and FAT32 are supported
・Number of folders unlimited
・Number of files

	Root folder	Subfolder
FAT16	512 files	65534 files
FAT32	65534 files	65534 files

・The folder depth limit is eight(including the root folder)
・File extension : .MP3, .MP2, .MP1(.MP2, .MP1 are possible to select)
・The memory size : 32M - 2TByte.

MP3 decoder

・MPEG audio 1, 2, and 2.5
・Layer 1, 2, and 3
・Sampling rate : 8k, 16k, 32k, 11.025k, 22.05k, 44.1k, 12k, 24k, and 48kHz
・Bit rate 8kbps-448kbps and VBR(Variable Bit Rate) (exclude a free format)
*The file of a bit rate is not playing by USB device type.

Sample rate converter

・All of sample rates are converted to 44.1kHz by the polyphase filter operation

System controller

・ Key input (PLAY / PAUSE / STOP / FF / FB / Folder+ / +10 / Volume+ / Volume-)
Serial input (PLAY / PAUSE / STOP / FF / FB / Folder+ / Folder- / +10 / －10)
Serial output (status output, folder number, file number, playing time information)
・Analyze Key and Serial command, and control USB device access, file analysis, MP3 decode, and headphone output
・LED controller : Playing, Pausing, Access, Error

Audio output

・Headphone AMP : 14mW/32Ω
・Remove POP noise at power supply ON
・Digital soft mute function

Menu key

・Digital volume key and serial command valid/invalidity selection,
maximum level of digital volume when selecting invalid
・MP2 and MP1 file playing selection
・Hidden attribute file playing selection

●Absolute maximum ratings (Ta=25℃)

Item	Symbol	Rating	Unit
Power-supply voltage (Analog block, IO)	V_{DD1MAX}	4.5	V
Power-supply voltage (CORE)	V_{DD2MAX}	2.1	V
Terminal Voltage	V_{INOUT}	-0.3～V_{DD1}+0.3	V
Storage Temperature Range	T_{stg}	-55～+125	℃
Operating Temperature Range	T_{opr}	-40～85	℃
Allowable dissipation*1	Pd	1000	mW

*1 For an operation with Ta=25℃ or more, it shall be reduced 10mW per ℃.

● Operation conditions

Item	Symbol	Rating	Unit	Applicable pins
Power Supply Voltage (Analog block, IO)	V_{DD1}	3.0～3.6	V	DVDDIO, DCVDD, DAVDD,AVDDC
Power Supply Voltage (CORE)	V_{DD2}	1.45～1.65	V	DVDD, BATT

* This product is not designed for protection against radioactive rays.

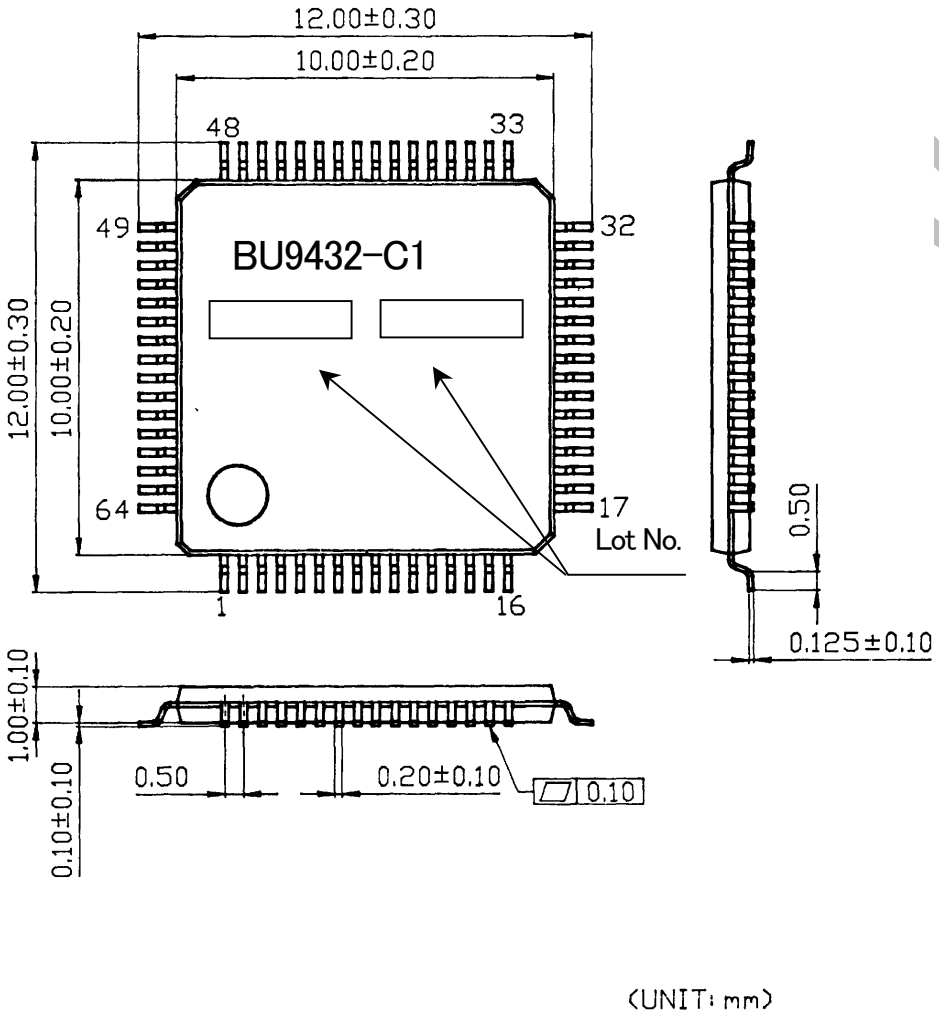
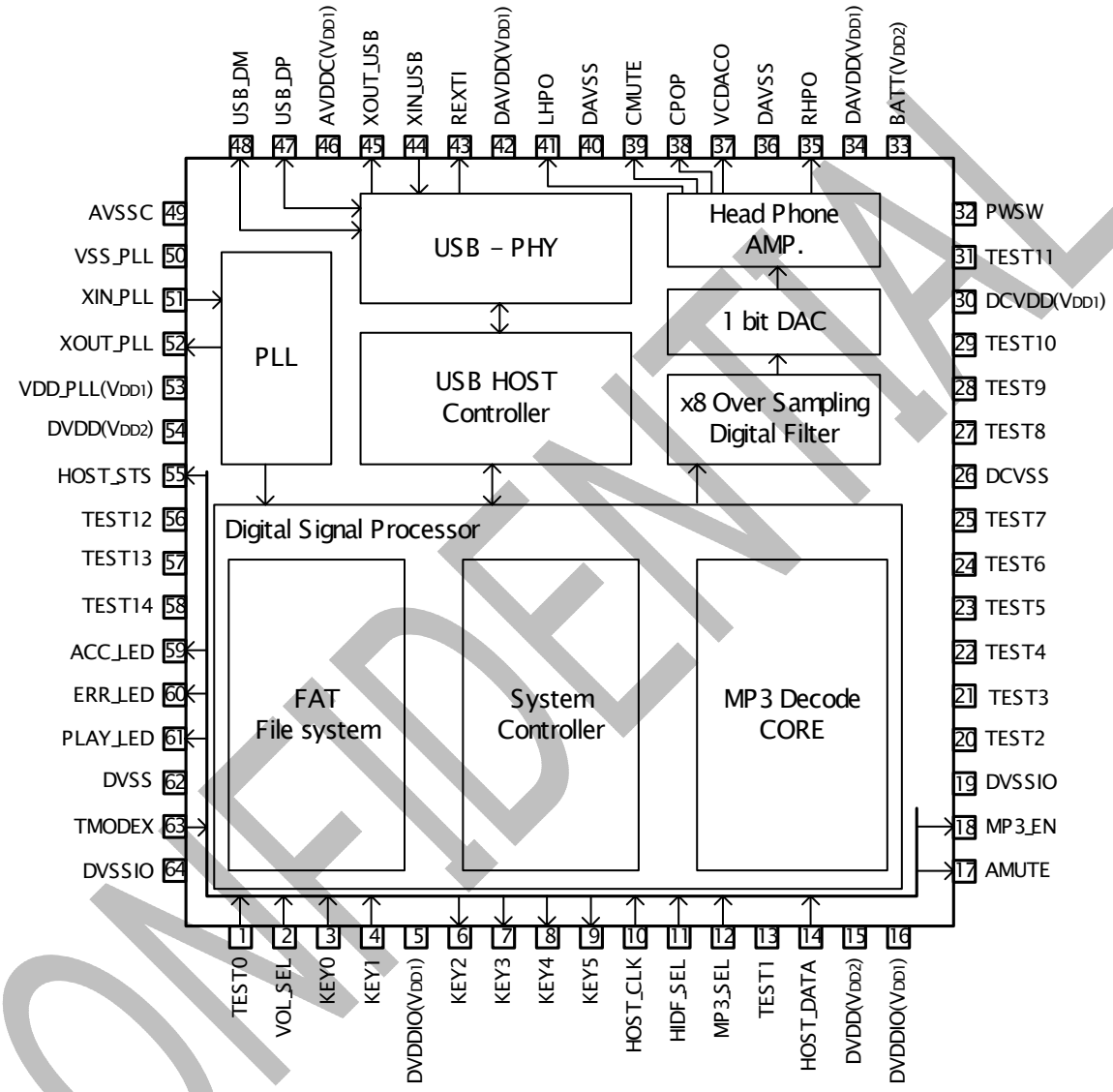


Fig.1 Outline drawing



(TOP VIEW)

Fig.2 Terminal block diagram

●Description of Terminal

No.	Name	I/O	Circuit	Description of terminals
1	TEST0	I	A	The pull-up in VDD1 system power supply terminal (TEST PIN)
2	VOL_SEL	I	A	VOL operation selection (H : VOL+, －Validity, L : VOL+, －Invalidity)
3	KEY0	I	A	Matrix 0 for KEY operation terminal
4	KEY1	I	A	Matrix 1 for KEY operation terminal
5	DVDDIO	-	-	IO power supply terminal (VDD1)
6	KEY2	O	A	Matrix 2 for KEY operation terminal
7	KEY3	O	A	Matrix 3 for KEY operation terminal
8	KEY4	O	A	Matrix 4 for KEY operation terminal
9	KEY5	O	A	Matrix 5 for KEY operation terminal
10	HOST_CLK	I	A	Host serial command clock input terminal
11	HIDF_SEL	I	A	Hidden file playback selection (H: playback, L: not playback)
12	MP3_SEL	I	A	MPEG Audio Layer selection (H: Only MP3 is playback, L: MP1, MP2, and MP3 can be playback)
13	TEST1	I	A	The pull-up in VDD1 system power supply terminal (TEST PIN)
14	HOST_DATA	I	A	Host serial command data input terminal
15	DVDD	-	-	CORE power supply terminal (VDD2)
16	DVDDIO	-	-	IO power supply terminal (VDD1)
17	AMUTE	O	A	Audio mute output terminal (H: Mute release, L: Mute)
18	MP3_EN	O	A	MP3 playback standby terminal (H: system initialization)
19	DVSSIO	-	-	IOGND terminal
20	TEST2	-	-	The pull-up in VDD2 system power supply terminal (TEST PIN)
21	TEST3	-	-	The pull-down in DCVSS terminal (TEST PIN)
22	TEST4	-	-	The pull-up in VDD2 system power supply terminal (TEST PIN)
23	TEST5	-	-	The pull-down in DCVSS terminal (TEST PIN)
24	TEST6	-	-	The pull-up in VDD2 system power supply terminal (TEST PIN)
25	TEST7	-	-	The pull-down in DCVSS terminal (TEST PIN)
26	DCVSS	-	-	GND terminal
27	TEST8	-	-	OPEN (TEST_PIN)
28	TEST9	-	-	OPEN (TEST_PIN)
29	TEST10	-	-	OPEN (TEST_PIN)
30	DCVDD	-	-	Power supply terminal (VDD1)
31	TEST11	-	-	OPEN (TEST_PIN)
32	PWSW	I	B	Connect to DCVSS.
33	BATT	-	-	Power supply terminal (VDD2)
34	DAVDD	-	-	Head Phone AMP power supply terminal (VDD1)
35	RHPO	O	C	Head Phone AMP Rch output terminal
36	DAVSS	-	-	Head Phone AMP GND terminal
37	VCDACO	O	C	Head Phone AMP reference voltage output terminal
38	CPOP	O	D	Head Phone AMP POP noise prevention output terminal
39	CMUTE	O	D	Head Phone AMP Soft mute output terminal
40	DAVSS	-	-	Head Phone AMP GND terminal
41	LHPO	O	C	Head Phone AMP Lch output terminal
42	DAVDD	-	-	Head Phone AMP power supply terminal (VDD1)
43	REXTI	O	E	USB bias resistor (12kΩ) connecting terminal
44	XIN_USB	I	F	X'tal(12MHz) connecting input terminal
45	XOUT_USB	O	F	X'tal(12MHz) connecting terminal
46	AVDDC	-	-	USB power supply terminal (VDD1)
47	USB_DP	I/O	G	USB D+ I/O terminal
48	USB_DM	I/O	G	USB D- I/O Terminal
49	AVSSC	-	-	USB GND terminal
50	VSS_PLL	-	-	PLL GND terminal
51	XIN_PLL	I	H	X'tal(16.9344MHz) connecting input terminal
52	XOUT_PLL	O	H	X'tal(16.9344MHz) connecting terminal

53	VDD_PLL	-	-	PLL power supply terminal (VDD1)
54	DVDD	-	-	CORE power supply terminal (VDD2)
55	HOST_STS	O	A	Host serial command status output terminal
56	TEST12	I	A	The pull-up in VDD1 system power supply terminal (TEST PIN)
57	TEST13	I	A	The pull-up in VDD1 system power supply terminal (TEST PIN)
58	TEST14	I	A	The pull-up in VDD1 system power supply terminal (TEST PIN)
59	ACC_LED	O	A	LED lighting output when USB memory is being accessed
60	ERR_LED	O	A	Error generation LED lighting output
61	PLAY_LED	O	A	LED lighting output at PLAY
62	DVSS	-	-	CORE GND terminal
63	TMODEX	I	I	Test mode input terminal
64	DVSSIO	-	-	IO GND terminal

● Terminal equivalent circuit diagram

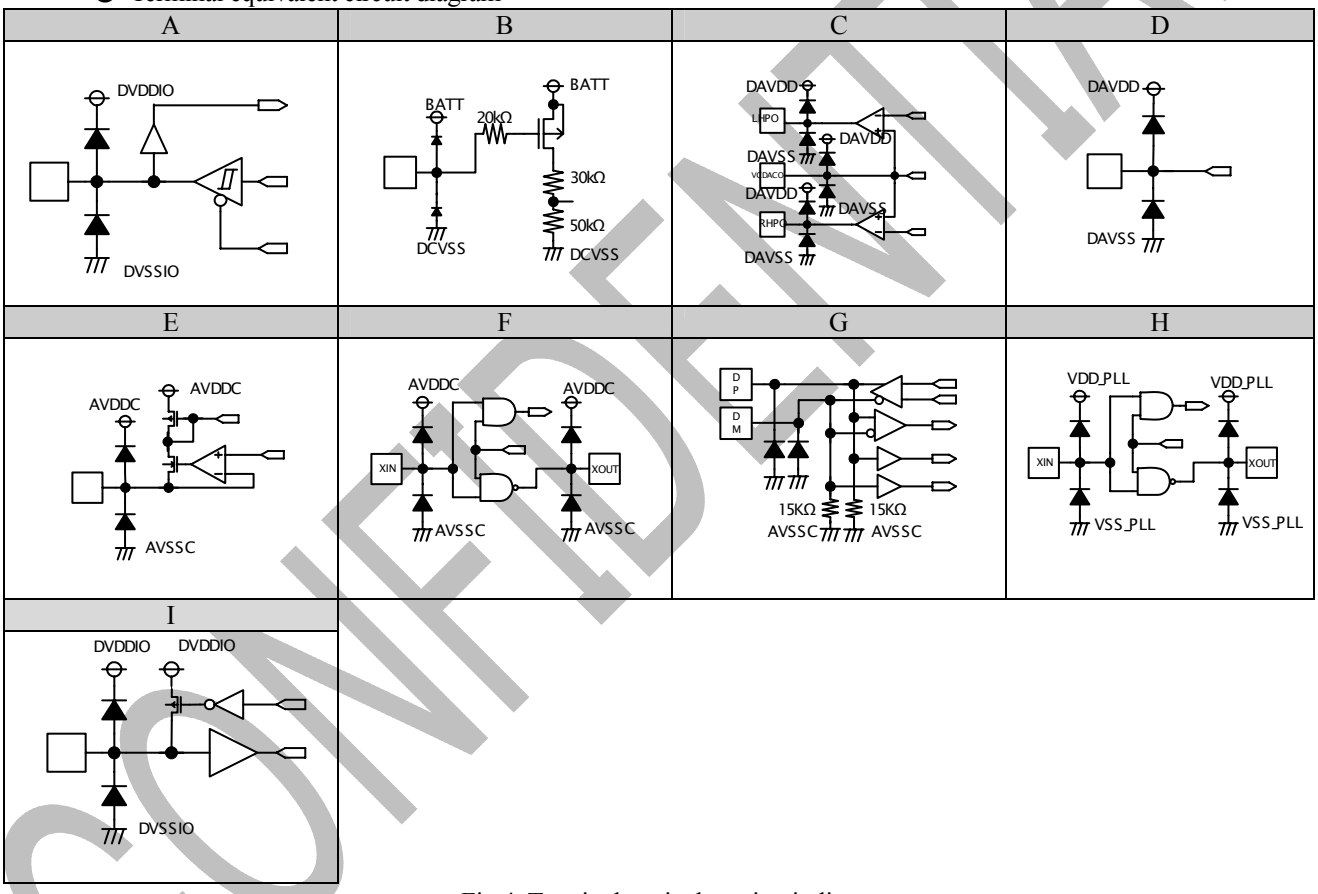


Fig.4 Terminal equivalent circuit diagram

●Electric characteristic

DC characteristics (Ta=25℃, V_{DD1} = 3.3V, V_{DD2} = 1.6V, XIN_PLL=16.9344MHz, XIN_USB=12.0MHz unless otherwise specified)

Item	Symbol	Limit			Unit	Applicable pins, condition
		MIN.	TYP.	MAX.		
Total						
Circuit Current (VDD1)	I_{DD1}	-	31.0	60.0	mA	*1
Circuit Current (VDD2)	I_{DD2}	-	23.0	40.0	mA	*2
Logic						
H-level input voltage 1	V_{IH1}	V_{DD1}*0.7	-	-	V	*3
L-level input voltage 1	V_{IL1}	-	-	V_{DD1}*0.3	V	*3
H-level input voltage 2	V_{IH2}	V_{DD1}*0.7	-	-	V	*4
L-level input voltage 2	V_{IL2}	-	-	V_{DD1}*0.3	V	*4
H-level output voltage 1	V_{OH1}	V_{DD1}−0.4	-	-	V	I_{OH}=-0.6mA, *5
L-level output voltage 1	V_{OL1}	-	-	0.4	V	I_{OL}=0.6mA, *5
H-level output voltage 2	V_{OH2}	V_{DD1}−0.4	-	-	V	I_{OH}=-1.6mA, *6
L-level output voltage 2	V_{OL2}	-	-	0.4	V	I_{OL}=1.6mA, *6
H-level output voltage 3	V_{OH3}	V_{DD1}−1.0	-	-	V	I_{OH}=-0.6mA, *7
L-level output voltage 3	V_{OL3}	-	-	1.0	V	I_{OL}=0.6mA, *7
USB interface						
H-level input voltage	V_{IHUSB}	V_{DD1}*0.6	-	-	V	*8
L-level input voltage	V_{ILUSB}	-	-	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-level output voltage	V_{OHUSB}	V_{DD1}−0.5	-	-	V	*8
L-level output voltage	V_{OLUSB}	-	-	0.3	V	*8
Rise/Fall time	T_r/T_f	-	11	-	ns	*8,output capacitance 50pF
Voltage of crossing point	V_{CRS}	-	V_{DD1}/2	-	V	*8,output capacitance 50pF
Range of differential input	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
Head Phone AMP						
Distortion rate	THD	-	0.03	-	%	1kHz, 0dB, sine, *9
Dynamic range	DR	-	88	-	dB	1kHz, -60dB, sine, *9
S/N ratio	S/N	-	93	-	dB	*9
Max output level	V_{smax}	-	0.67	-	Vrms	RL=32Ω, 1kHz, 0dB, sine, *9

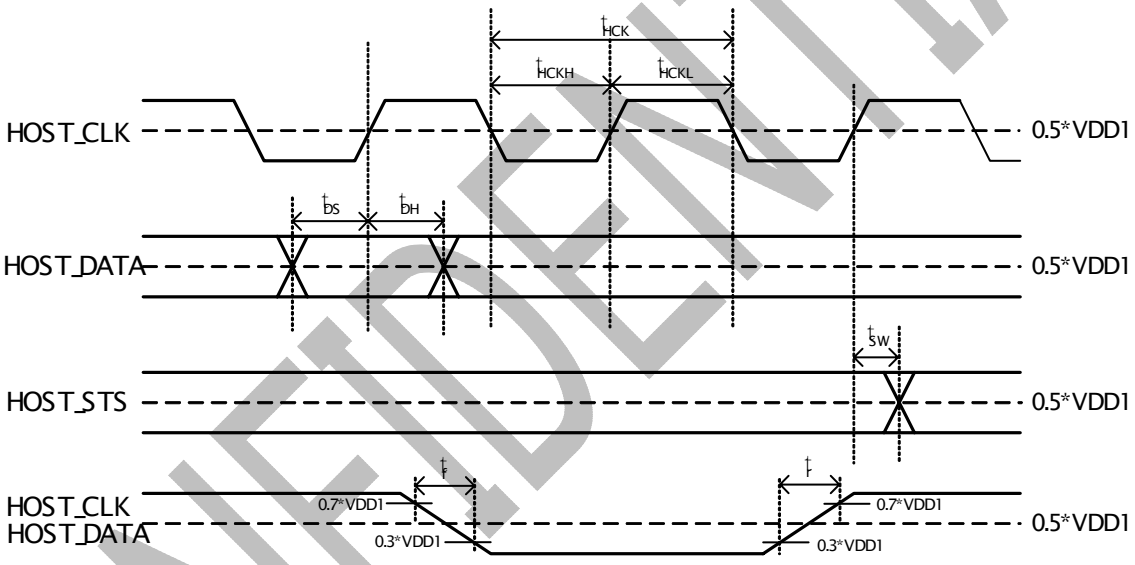
*1 3.3V system IO, Analog power supply (DVDDIO, DCVDD, DAVDD, AVDDC)
*2 1.6V system CORE power supply (DVDD, BATT)
*3 VOL_SEL, KEY0-1, HOST_CLK, HIDF_SEL, MP3_SEL, HOST_DATA,
*4 XIN_PLL, XIN_USB
*5 KEY2-5, AMUTE, MP3_EN, HOST_STS
*6 ACC_LED, ERR_LED, PLAY_LED
*7 XOUT_PLL, XOUT_USB
*8 USB_DP, USB_DM
*9 LHPO, RHPO

●AC characteristic

(Ta=25℃, V_{DD1} = 3.3V, V_{DD2} = 1.6V, XIN_PLL=16.9344MHz, XIN_USB=12.0MHz unless otherwise specified.)

Serial command (HOST_CLK, HOST_DATA, and HOST_STS)

Item	Symbol	Limit			Unit
		MIN.	TYP.	MAX.	
Clock frequency	f_{HCK}	0.5	-	5	kHz
Clock pulse	t_{HCK}	200	-	2000	us
Width of clock pulse (H)	t_{HCKH}	100	-	1000	us
Width of clock pulse (L)	t_{HCKL}	100	-	1000	us
Setup time	t_{DS}	1	-	-	us
Hold time	t_{DH}	50	-	-	us
HOST_STS output delay	t_{SW}	50	-	-	us
Rise time	t_r	-	-	1	us
Fall time	t_f	-	-	1	us



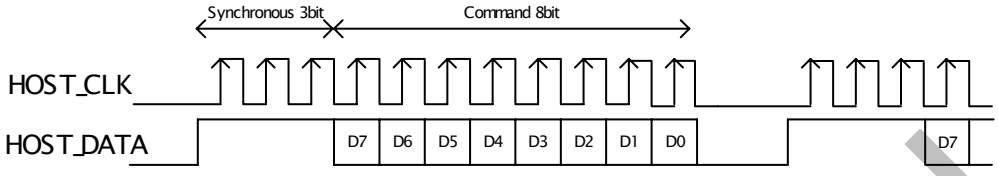
* When clock pulse is over 2ms, the command and status output may be invalid.
* It is necessary over 22ms of the command interval.
  (It is necessary over 5ms from the status output to the next command.)
* It takes 80ms at most from the skip command(FF,FB,FOL+,FOL-,+10,－10) to setting the ACCESS bit(S52).
* The status output is invalid when MP3_EN=H
* The status output is L-fixed in less than 50ms after USB device connecting.

●Serial interface

Terminal: HOST_CLK, HOST_DATA, HOST_STS

Command

It receives the data sent by the host by the following formats as a command.

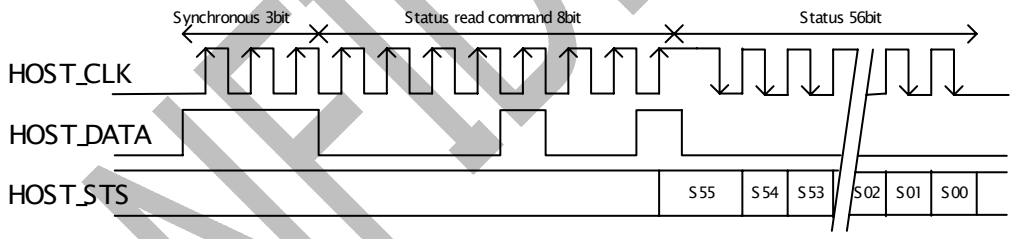


Command list

Command	Data D7-D0
PLAY	0x01
PAUSE	0x02
STOP	0x03
FF	0x04
FB	0x05
FOL+	0x06
FOL-	0x08
Status read	0x09
+10	0x0A
-10	0x0B
VOL+	0x0C
VOL-	0x0D

Status

It transmits internal status to the host by the following formats.



* Transmit 56 status clocks.

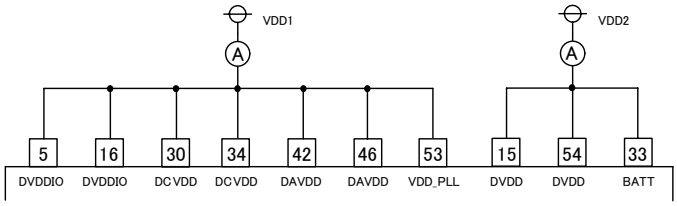
Status list

Status Bit	Name	Description
S55	PLAY	Playing
S54	PAUSE	Pausing
S53	STOP	Stopping
S52	ACCESS	Accessing the memory for the file search
S51	ERROR	Error occurring.
S50-S48	-	-
S47-S32	Folder number	The number of the playing folder, 1-65535, Binary format
S31-S16	File number	The number of the playing file, 1-65535, Binary format
S15-S8	Playing time(minute)	Playing time information (minute), BCD format
S7-S0	Playing time(second)	Playing time information (second), BCD format

●Measurement circuit chart

1. Total

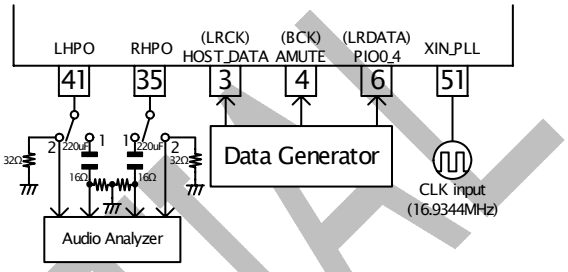
Measurement item	Circuit current consumption



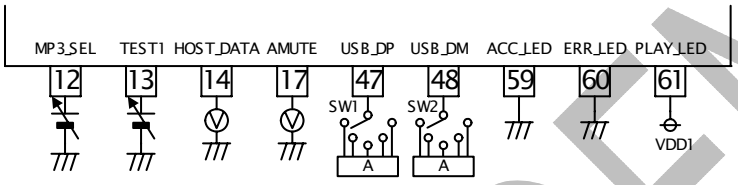
2.Head Phone Amp

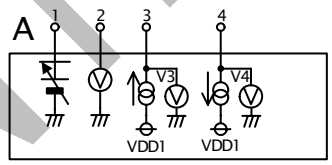
Set terminal	TMODEX	ACC_LED	ERR_LED	PLAY_LED
Input setting	L	L	H	L

Measurement item	SW condition
Distortion rate	1
Dynamic range	1
S/N ratio	1
Max output level	2

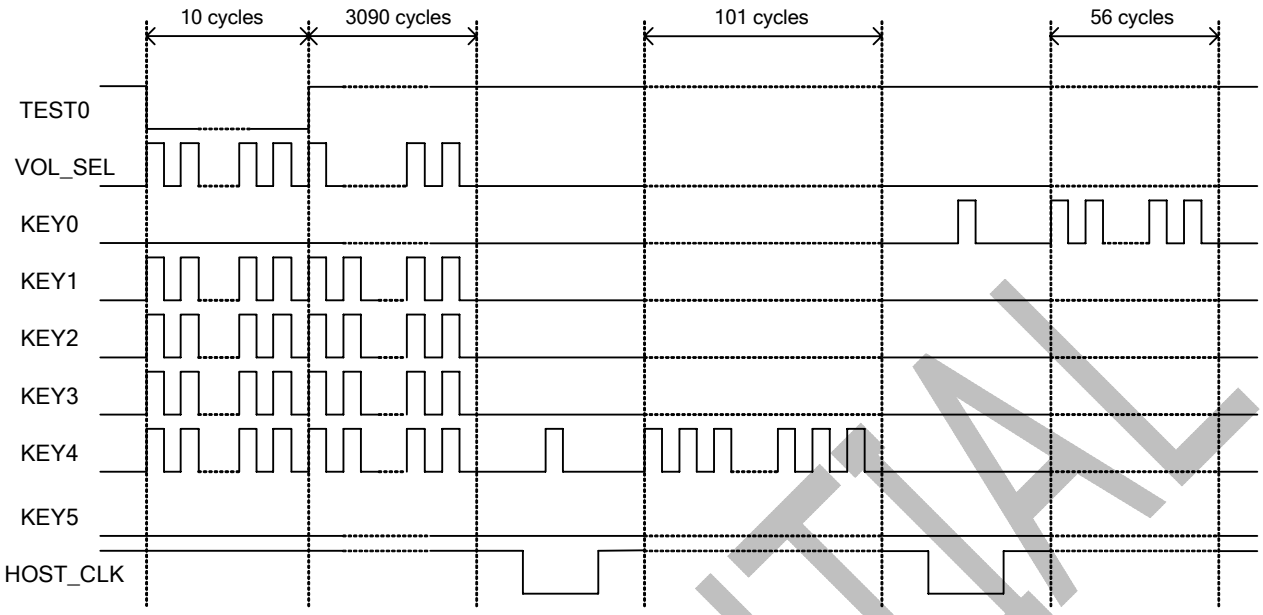


3.USB interface





Measurement item	Measurement condition				Measuring method
	12	13	SW1	SW2	
Input voltage	GND	—	1	1	The monitor terminal of USB_DP is 17. The monitor terminal of USB_DM is 14.
Output voltage	V_{DD1}	GND	4	3	USB_DP=L output I_3=0mA USB_DM=H output I_4=0mA
	V_{DD1}	V_{DD1}	3	4	USB_DP=L output I_3=0mA USB_DM=H output I_4=0mA
Output impedance	V_{DD1}	GND	4	3	$(V_{L23}-V_{L13})/8mA$: ($V_3=V_{L13}$ at I_3=2mA, $V_3=V_{L23}$ at I_3=10mA) $(V_{H14}-V_{H24})/8mA$: ($V_4=V_{H14}$ at I_4=2mA, $V_4=V_{H24}$ at I_4=10mA)
	V_{DD1}	V_{DD1}	3	4	$(V_{L13}-V_{L23})/8mA$: ($V_3=V_{L13}$ at I_3=2mA, $V_3=V_{L23}$ at I_3=10mA) $(V_{H24}-V_{H14})/8mA$: ($V_4=V_{H14}$ at I_4=2mA, $V_4=V_{H24}$ at I_4=10mA)
Pull-down resistance	GND	—	3	3	It calculates measuring V_3 at I_3=0.1333mA
Range of differential input Differential input sensitivity	—	—	1	1	USB_DP=0.9V, USB_DM=0.7V After the pattern of Figure 5 is input, H output of HIDF_SEL is confirmed. USB_DP=2.6V, USB_DM=2.4V After the pattern of Figure 5 is input, H output of HIDF_SEL is confirmed. USB_DP=0.7V, USB_DM=0.9V After the pattern of Figure 5 is input, L output of HIDF_SEL is confirmed. USB_DP=2.4V, USB_DM=2.6V After the pattern of Figure 5 is input, L output of HIDF_SEL is confirmed.



One cycle: Min100ns

Figure-5 Range of differential input, Differential input sensitivity test pattern

● Directions

(1) Power on Reset

Please note the following points to operate power-on reset with which internal is generated normally when the power supply starts.

①After 1.6V power supply are turned on, 3.3V power supply are turned on, when the power supply starts.

②Power-on reset might not operate normally when 1.6V power supply are momentarily turned off. In this case, please turn on the power supply again by the method of ① after turning off all power supply system.

(2) Absolute Maximum Ratings

An excess in the absolute maximum ratings, such as power supply voltage, operating temperature range, etc., can break down devices, thus making impossible to identify breaking mode such as a short circuit or an open circuit. If any special mode exceeding the absolute maximum ratings is assumed, consideration should be given to take physical safety measures including the use of fuses, etc.

(3) Power supply line

Design PCB pattern to provide low impedance for the wiring between the power supply and the GND lines. In this regard, for the digital block power supply and the analog block power supply, even though these power supplies has the same level of potential, separate the power supply pattern for the digital block from that for the analog block, thus suppressing the diffraction of digital noises to the analog block power supply resulting from impedance common to the wiring patterns. For the GND line, give consideration to design the patterns in a similar manner.

Furthermore, for all power supply terminals to ICs, mount a capacitor between the power supply and the GND terminal. At the same time, in order to use an electrolytic capacitor, thoroughly check to be sure the characteristics of the capacitor to be used present no problem including the occurrence of capacity dropout at a low temperature, thus determining the constant.

(4) Operation in strong electromagnetic field

Be noted that using ICs in the strong electromagnetic field can malfunction them.

(5) Input terminals

In terms of the construction of IC, parasitic elements are inevitably formed in relation to potential. The operation of the parasitic element can cause interference with circuit operation, thus resulting in a malfunction and then breakdown of the input terminal. Therefore, pay thorough attention not to handle the input terminals, such as to apply to the input terminals a voltage lower than the GND respectively, so that any parasitic element will operate. Furthermore, do not apply a voltage to the input terminals when no power supply voltage is applied to the IC. In addition, even if the power supply voltage is applied, apply to the input terminals a voltage lower than the power supply voltage or within the guaranteed value of electrical characteristics.