Audio Accessory ICs for Mobile Devices

Mixer & Selector IC with PCM CODEC and 16bit D/A Converter

BU7861KN

No.10087EAT04

●Description

The "In/Output Selector with Built-in PCM Codec 16bit D/A Converter" LSI is ideal for improving the sound quality of and miniaturizing cellular phone handsets with music playback function, accumulating analog circuits for sound which application CPUs and bass band LSIs are not ideally able to handle.

●Features

1) Loaded with stereo 16bit audio D/A converter
2) Compatible with stereo and analog interfaces
3) Built-in stereo headphone amp (16Ω)
4) Lowpass correction circuit built into the headphone amp
5) Gain-adjustable volume built in
6) Flexible mixing function built in

●Applications

Portable information communication devices such as cellular phone handsets and PDA (Personal Digital Assistants)
Cellular phone handsets with music playback function

●Absolute maximum ratings

Parameter	Symbol	Ratings	Unit
Supply Voltage	DVDD AVDD, PVDD	-0.3 ～ 4.5	V
Power Dissipation	Pd	500 *1	mW
Operational Temperature Range	T_{OPR}	-25 ～ +80	℃
Storage Temperature Range	T_{STG}	-55 ～ +125	℃

*1 When used at over Ta=25℃, lessen by 5.0mW per 1℃ increase.

●Operating conditions

Parameter	Symbol	Ratings			Unit
		Min.	Typ.	Max.	
Digital Supply Voltage	DVDD	2.7	3.0	3.3	V
Analog Supply Voltage	AVDD	2.7	3.0	3.3	V
Power Supply Voltage	PVDD	2.7	3.0	3.3	V
PLL Synchronous Signal Frequency	FSYNC	—	8	—	kHz

●**Electrical characteristics** (Unless specified, Ta=25℃, DVDD=AVDD=3.0V, PVDD=3.0V, FSYNC=8kHz)

・Complete Block

Parameter	Symbol	Limits			Unit	Conditions
		Min.	Typ.	Max.		
Consumed Current 1	IDD1	―	0.1	10	μA	When all power down, FSYNC L fixed
Consumed Current 2	IDD2	―	0.8	1.2	mA	REFON,　FSYNC L fixed
Consumed Current 3	IDD3	―	1.7	2.6	mA	REFON+PLLON,　FSYNC=8kHz
Consumed Current 4	IDD4	―	1.6	2.4	mA	REFON+MICBON,　FSYNC L fixed
Consumed Current 5	IDD5	―	1.0	1.5	mA	REFON+EXTOUT,　FSYNC L fixed
Consumed Current 6	IDD6	―	5.9	9.0	mA	REFON+PLLON+VICON, FSYNC=8kHz
Consumed Current 7	IDD7	―	6.4	9.6	mA	REFON+PLLON+VICON+TONEON, FSYNC=8kHz
Consumed Current 8	IDD8	―	2.2	3.3	mA	REFON+RECON,　FSYNC L fixed
Consumed Current 9	IDD9	―	2.9	4.5	mA	REFON+HPON,　FSYNC L fixed
Consumed Current 10	IDD10	―	2.2	3.3	mA	REFON+ HPVOLON,　FSYNC L fixed
Consumed Current 11	IDD11	―	10.0	15.0	mA	DACON,　SYSCLK=256fs
Consumed Current 12	IDD12	―	18.0	27.0	mA	All power on FSYNC=8kHz　SYSCLK=256fs
Digital High Level Input Voltage	VIH	0.8×DVDD	―	―	V	
Digital Low Level Input Voltage	VIL	―	―	0.2×DVDD	V	
Digital High Level Input Current	IIH	―	―	10	μA	VIH=DVDD
Digital Low Level Input Current	IIL	-10	―	―	μA	VIL=0V
Digital High Level Output Voltage	VOH	DVDD -0.5	―	―	V	IOH=-1mA
Digital Low Level Output Voltage	VOL	―	―	0.5	V	IOL=1mA
Schmidt Input Hysteresis Width	Vhys	0.3	0.5	0.7	V	SYSCLK, BCLK, LRCLK, FSYNC, DSPCLK

・Sound Block

Parameter	Limits Min.	Limits Typ.	Limits Max.	Unit	Conditions
Frequency Characteristics	-3	—	+3	dB	Reference level (-20dB due to full scale) f=20Hz～20kHz -3dB band width
DAC Full Scale	1.4	1.8	2.2	V_{P-P}	0.6×VDD
Gain Error between Channels	-	-	±1.5	dB	Difference between Lch and Rch levels during DAC full scale
Distortion (No Bass Boost)	—	—	1	%	DAC input=-0.5dBFS, HP_VOL=-2dB, HP2_VOL=0dB
Distortion (With Bass Boost)	—	—	10	%	DAC input=-0.5dBFS, HP_VOL=-2dB, HP2_VOL=0dB
S/N	75	83	—	dB	During full scale HP_VOL, HP2_VOL=0dB, f=1kHz, A-weighted Stereo headphone amp included
Crosstalk	70	80	—	dB	Measures the leak from Lch to Rch during full-scale output. 1kHz BPF
Output Level during Mute	70	80	—	dB	1kHz BPF

・Driver Amp Block

Parameter			Limits Min.	Limits Typ.	Limits Max.	Unit	Conditions
Microphone Amp	Gain Configurable Range (THD≦1%)		40	—	—	dB	f=100Hz～3.4kHz
Microphone Amp	Maximum Output Voltage (THD≦1%)		—	1.0	—	Vrms	MICO terminal, f=1kHz
Microphone Amp	S/N		60	66	—	dB	C-Message
Microphone Amp	PSRR	100Hz	12	20	—	dB	0.2V_{P-P} superimposed to supply COMIN 1.0µF, MICIN no input
Microphone Amp	PSRR	1kHz	25	35	—	dB	
Receiver Amp	Load		26	32	—	Ω	
Receiver Amp	Maximum Output Power (THD≦1%)		31.25	45	—	mW	RL=32Ω, f=1kHz
Receiver Amp	S/N		80	90	—	dB	RL=32Ω, C-Message
Receiver Amp	Offset Voltage		—	5	100	mV	
Receiver Amp	PSRR	100Hz	65	77	—	dB	0.2V_{P-P} superimposed to supply COMIN 1.0µF
Receiver Amp	PSRR	1kHz	60	70	—	dB	
Stereo Headphone Amp	Load		12	16	—	Ω	
Stereo Headphone Amp	Maximum Output Power (THD≦1%)		15	25	—	mW	R_L=16Ω, f=1kHz
Stereo Headphone Amp	PSRR	100Hz	15	26	—	dB	0.2V_{P-P} superimposed to supply COMIN 1.0µF, HP_Vol=0dB
Stereo Headphone Amp	PSRR	1kHz	40	48	—	dB	
SPOUT Terminal	Maximum Output Voltage (THD≦1%)		0.707	—	—	Vrms	RL=10kΩ, f=1kHz
EXTOUT Terminal	Maximum Output Voltage (THD≦1%)		0.707	—	—	Vrms	RL=3kΩ, f=1kHz

・Codec Block

Parameter		Limits Min.	Limits Typ.	Limits Max.	Unit	Conditions
Transmitting Side Reference Input Level	MICIN→ DSPOUT	0.44	0.50	0.56	Vrms	When 1020Hz, sine wave, 0dBm0 transmitting MIC amp gain 0dB, Tx_Vol 0dB
	EXTIN→ DSPOUT	0.119	0.135	0.151	Vrms	When 1020Hz, sine wave, 0dBm0 transmitting Amp gain 11.37dB, Tx_Vol 0dB
Receiving Side Reference Input Level	DSPIN→ RECP	0.44	0.50	0.56	Vrms	At 1020Hz, sine wave, 0dBm0 input Rx_Vol 0dB
	DSPIN→ SPOUT	0.44	0.50	0.56	Vrms	At 1020Hz, sine wave, 0dBm0 input Rx_Vol 0dB
	DSPIN→ EXTOUT	0.44	0.50	0.56	Vrms	At 1020Hz, sine wave, 0dBm0 input Rx_Vol 0dB
Pass Gain	EXTIN→ RECN	2.4	3.2	4.0	dB	EXTIN input, Rx_testline path Rx_Vol 0dB
	EXTIN→ SPOUT	2.4	3.2	4.0	dB	EXTIN input, Rx_testline path SPRX_Vol 0dB
Transmitter Signal vs. General Power Distortion MICIN→DSPOUT	-45dBm0	24	—	—	dB	1020Hz, sine wave, MIC amp gain 0dB Tx_Vol 0dB, C-MESSAGE
	-40dBm0	29	—	—		
	0, -30dBm0	35	—	—		
Receiver Signal vs. General Power Distortion DSPIN→RECP	-45dBm0	24	—	—	dB	1020Hz, sine wave Rx_Vol 0dB, C-MESSAGE
	-40dBm0	29	—	—		
	0, -30dBm0	35	—	—		
Transmitter Transmission Level MICIN→DSPOUT	-55dBm0	-0.9	—	0.9	dB	1020Hz, -10dBm0 typical MIC amp gain 0dB Tx_Vol 0dB, C-MESSAGE
	-50dBm0	-0.6	—	0.6		
	0, -40dBm0	-0.3	—	0.3		
Receiver Transmission Level DSPIN→RECP	-55dBm0	-0.9	—	0.9	dB	1020Hz, -10dBm0 typical Rx_Vol 0dB, C-MESSAGE
	-50dBm0	-0.6	—	0.6		
	0, -40dBm0	-0.3	—	0.3		
Transmitter Transmission Loss F Special MICIN→DSPOUT	0.06kHz	24	—	—	dB	1020Hz, 0dBm0 at transmission MIC amp gain 0dB Tx_Vol 0dB
	0.2kHz	0	—	2.5		
	0.3～3.0kHz	-0.3	—	0.3		
	3.4kHz	-0.3	—	0.9		
	3.6kHz	0	—	—		
	3.78kHz	6.5	—	—		
Receiver Transmission Loss F Special DSPIN→RECP	0.3～3.0kHz	-0.3	—	0.5	dB	1020Hz, 0dBm0 at input Rx_Vol 0dB
	3.4kHz	-0.3	—	0.9		
	3.6kHz	0.0	—	—		
	3.78kHz	6.5	—	—		
Noise during idle transmission	MICIN→ DSPOUT	—	—	-65	dBm0	MIC amp gain 0dB Tx_Vol 0dB, C-MESSAGE
Noise during idle reception	DSPIN→ REC[P-N]	—	—	-75	dBV	DSPIN ALL0 Rx_Vol 0dB, C-MESSAGE
Crosstalk (Transmitter→ Receiver)	MICIN→ REC[P-N]	60	70	—	dB	1020Hz, 0dBm0 at transmission MIC amp gain 0dB DSPIN ALL0 Tx_Vol 0dB Rx_Vol 0dB ST_MT OFF
Crosstalk (Receiver→ Transmitter)	DSPIN→ DSPOUT	63	68	—	dB	1020Hz, 0dBm0 at input, 2040Hz component MIC amp gain 30dB Tx_Vol 0dB Rx_Vol 0dB ST_MT ON
RX Higher Harmonic Component	Distortion 2^{nd} to 5^{th} time	40	50	—	dB	1020Hz, sine wave, 0dBm0 at input Rx_Vol 0dB

・Pass Switch Block

Parameter		Limits Min.	Typ.	Max.	Unit	Conditions
Mute Level	※1	70	80	―	dB	Configured at each mute SW Measured at 1kHz BPF
	※2	70	80	―	dB	Configured at each mute SW Leakage amount to each test line during normal usage Measured at 1kHz BPF

Receiving side is muted digitally by VIC_MT and SPVIC_MT.
※1 MIC_SEL, MIC_MT, EXTIN_MT, MEL_MT, VIC_MT, REC_MT, ST_MT, HSJL_MT, HSJR_MT, SPVIC_MT, SPMEL_VOL, EXTOUT_SEL, TONE_MT, SOUND_MT, DIG_MT, AIN_MT, HP_SMT, SPOUT_SMT, EXTOUT_SMT, REC_SMT, HPR_MT, HPL_MT
※2 Tx_test1, Tx_test2, Rx_test1, Rx_test2, REC_TST, HPR_TST, HPL_TST

・DTMF/TONE Generator Block

Parameter	Symbol	Limits Min.	Typ.	Max.	Unit	Conditions
Output Level	V_{DTMF_L}	-15.3	-14.3	-13.3	dBV	f:DTMF_L TONE→RECP MEL_Vol 0dB Rx_Vol 0dB
	V_{DTMF_H}	-12.8	-11.8	-10.8	dBV	f:DTMF_H TONE→RECP MEL_Vol 0dB Rx_Vol 0dB
	V_{TONE_L}	-15.3	-14.3	-13.3	dBV	f: designated TONE, low band TONE→RECP MEL_Vol 0dB Rx_Vol 0dB
	V_{TONE_H}	-12.8	-11.8	-10.8	dBV	f: designated TONE, high band TONE→RECP MEL_Vol 0dB Rx_Vol 0dB
Tone Distortion	S_{DTN}	―	―	-38	dB	f=1kHz (designated TONE) TONE→REC[P-N] MEL_Vol 0dB Rx_Vol 0dB C-Message

・Microphone Bias Block

Parameter	Symbol	Limits Min.	Typ.	Max.	Unit	Conditions
Output Voltage	VO	1.8	2.0	2.2	V	Io=500μA
Maximum Output Current	IO	2	―	―	mA	
Load Stability	ΔVO1	―	14.0	30	mV	Io=100μA～2mA
Output Noise Voltage	N	―	-109	-90	dBV	C-Message Io=500μA

●Reference data

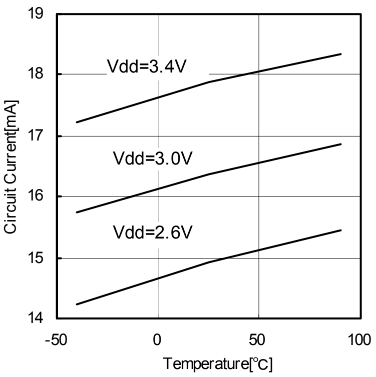


Fig.1 Operational Current (All On)

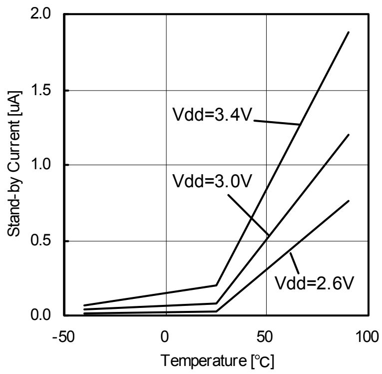


Fig.2 Static Consumed Current

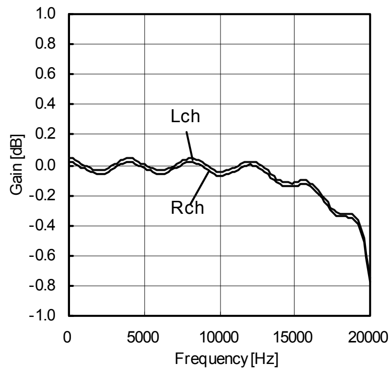


Fig.3 16bit D/A Converter Frequency characteristics@ 0dBFS

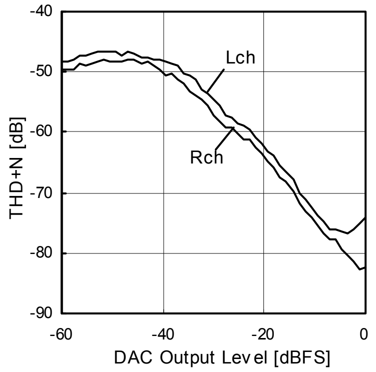


Fig.4 16bit D/A Converter Distortion @ 1kHz

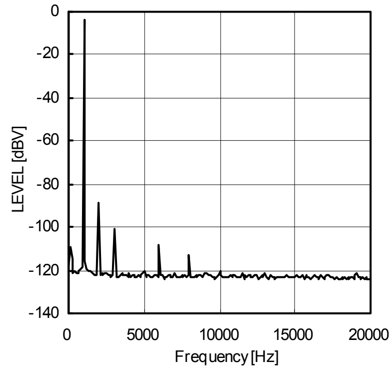


Fig.5 16bit D/A Converter FFT @ 0dBFS, 1kHz

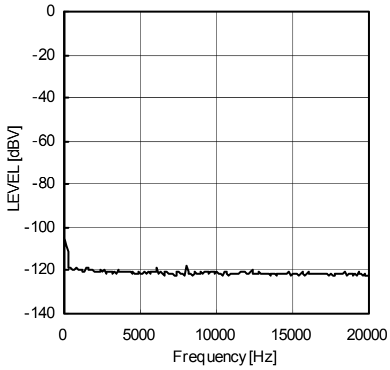


Fig.6 16bit D/A Converter FFT @ 0FS

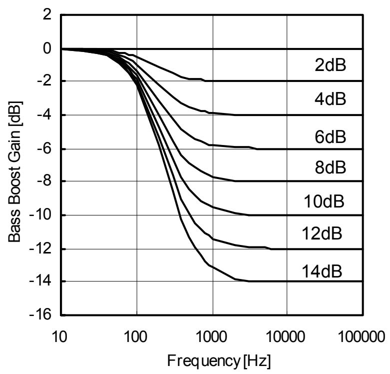


Fig.7 Bus Boost Frequency Characteristics

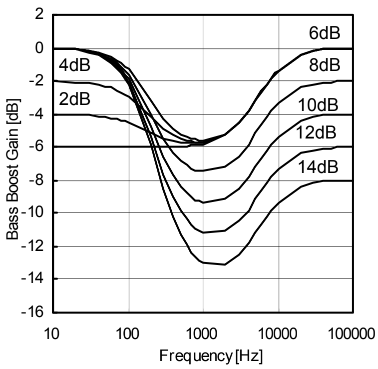


Fig.8 Bus Boost + High Pass Emphasis Frequency Characteristics

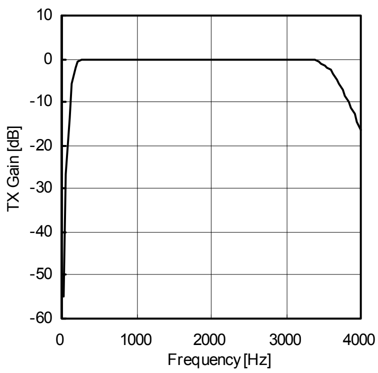


Fig.9 Voice CODEC TX Frequency Characteristics

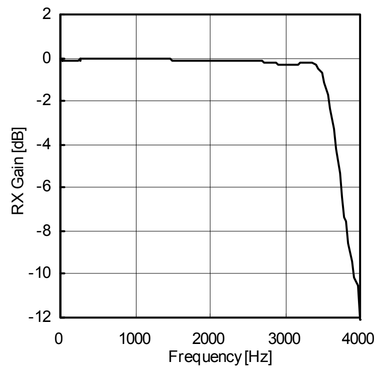


Fig.10 Voice CODEC RX Frequency Characteristics

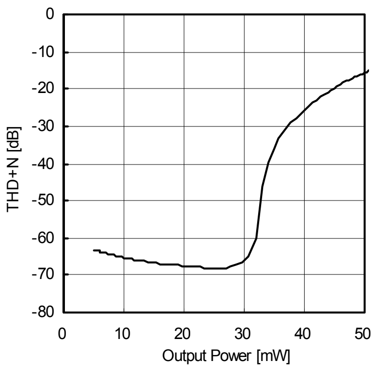


Fig.11 Headphone Amp Output Characteristics @ vdd=3.0V, 1kHz

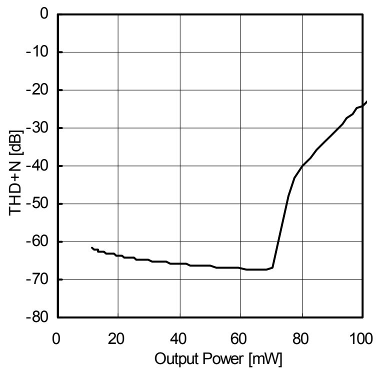


Fig.12 Receiver Amp Output Characteristics @ vdd=3.0V, 1kHz

●Block diagrams

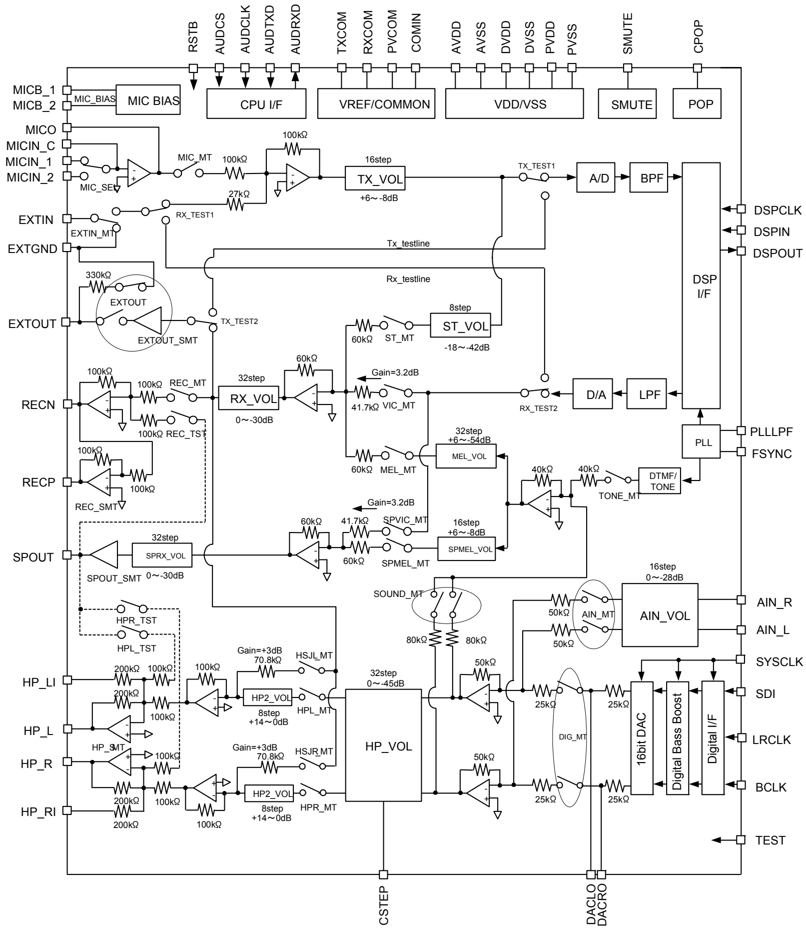


Fig.13 BU7861KN Block Diagram

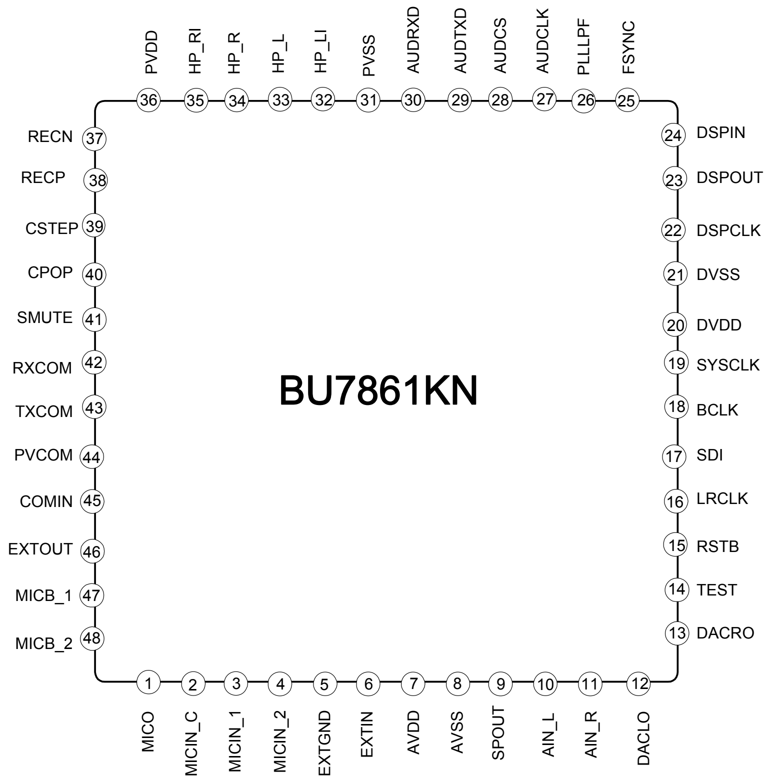


Fig.14 BU7861KN Pin Placement Diagram

● **Lowpass correction circuit**

The headphone output terminal (either HP_X or HPX_OUT) has a built-in "lowpass correction circuit" to correct lowpass decay, comprised of output coupling capacity and headphone impedance.

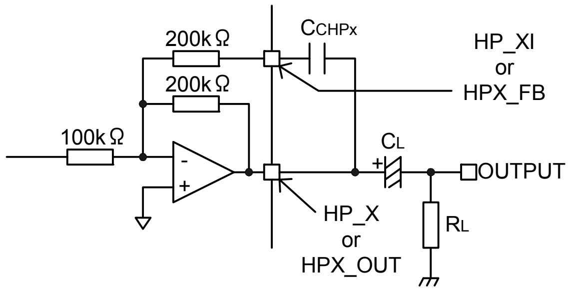


Fig.15 Headphone Output Section Equivalent Circuit

Lowpass Cut-off Frequency	fC= 1/(2・π・CL・RL)
Lowpass Boost Frequency	fBOOST = 1/(2・π・CCHPx・200kΩ)
Boost Gain	ABOOST = 20・log((200 kΩ+1/(2・π・f・CCHPx))/100 kΩ)
	(Maximum lowpass boost is 6dB.)

The constant configuration calculates the lowpass cut-off frequency fC after confirming the output coupling capacity C_L and headphone impedance R_L used. CCHPx is determined in order for the lowpass cut-off frequency fC and lowpass boost frequency fBOOST to roughly correspond. The recommended constants are CL = 100μF, when RL = 16Ω and CCHPx = 6800pF.

The chart below shows the frequency characteristics (calculated values) during recommended constant use.

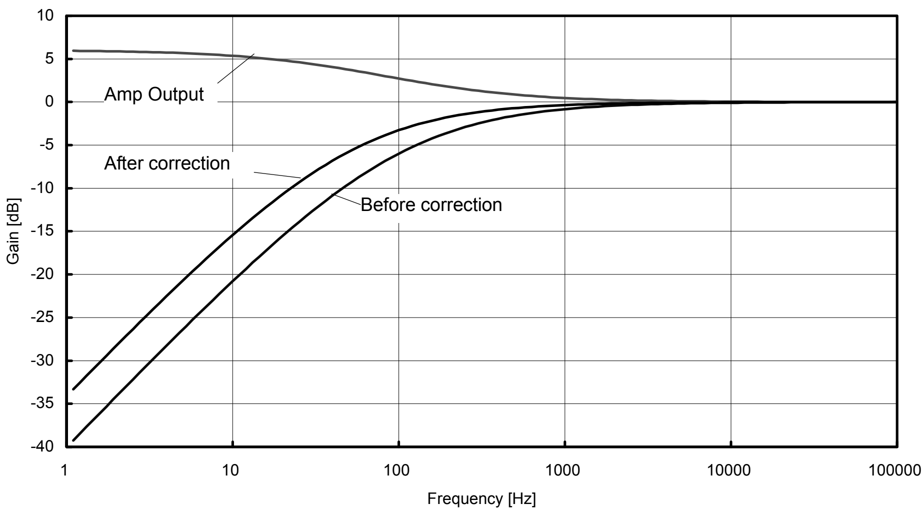


Fig.16 Low pass Correction Circuit Frequency Characteristics

●Recommended circuits

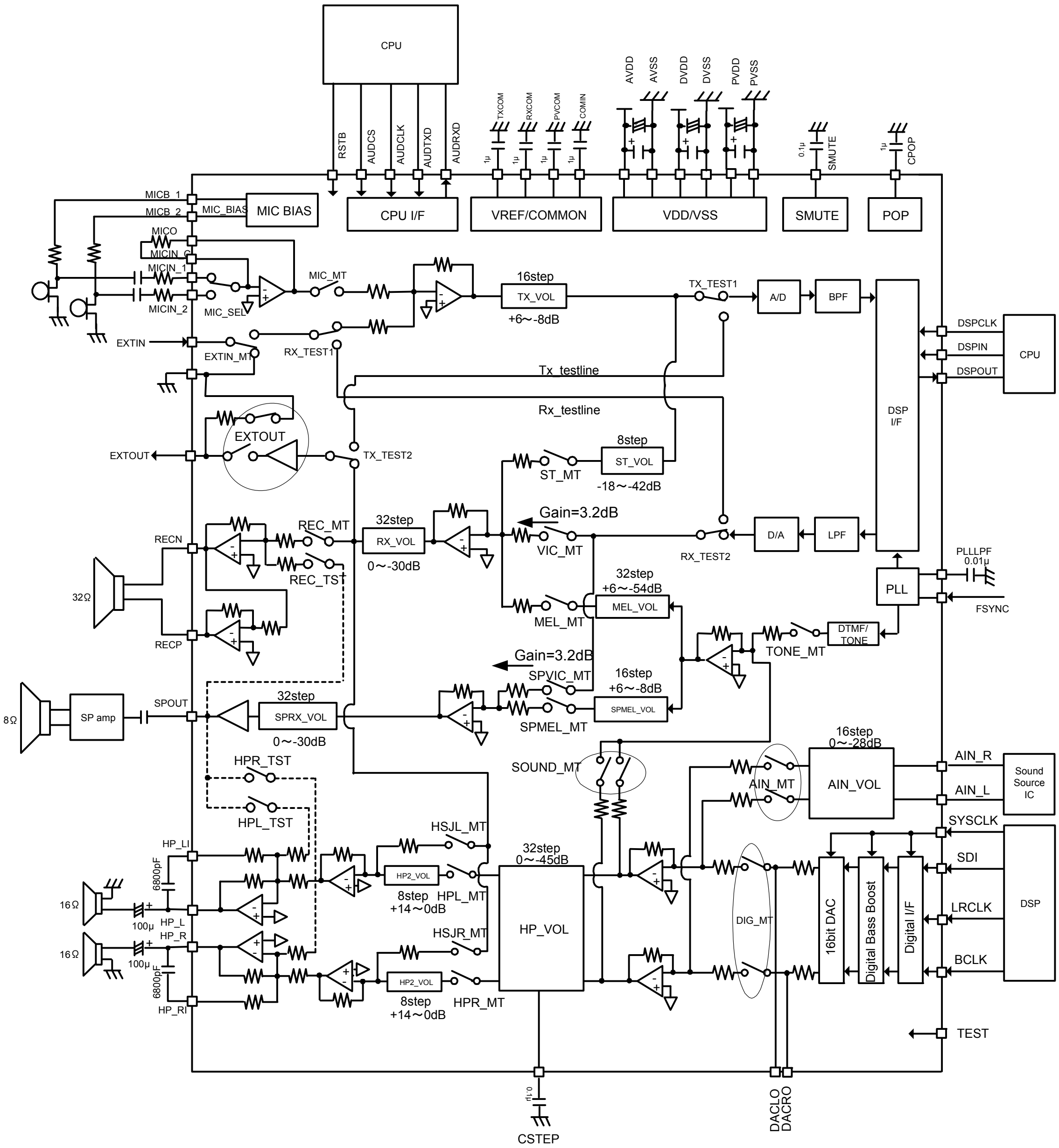


Fig.17 Recommended Circuit

●Input/output equivalent circuit figure

No	Terminal name	I/O	Analog/ Digital	Terminal function	Power source	Circuit figure
1	MICO	O	Analog	MIC output	AVDD	E
2	MICIN_C	O	Analog	MIC Selection output	AVDD	E
3	MICIN_1	I	Analog	MIC1 input	AVDD	E
4	MICIN_2	I	Analog	MIC2 input	AVDD	E
5	EXTGND	O	Analog	External ground	AVDD	E
6	EXTIN	I	Analog	External input	-	H
7	AVDD	-	Analog	Power source for analog	-	I
8	AVSS	-	Analog	GND for analog	AVDD	I
9	SPOUT	O	Analog	Speaker output	AVDD	E
10	AIN_L	I	Analog	Melody input terminal Lch	AVDD	D
11	AIN_R	I	Analog	Melody input terminal Rch	AVDD	D
12	DACLO	I	Analog	DAC Lch LPF Condenser connected terminal	AVDD	F
13	DACRO	I	Analog	DAC Rch LPF Condenser connected terminal	AVDD	F
14	TEST	I	Digital	Please connect to DVSS	DVDD	A
15	RSTB	I	Digital	L:Reset input	DVDD	A
16	LRCLK	I	Digital	LRCLK terminal 44.1kHz(fs) for DAC	DVDD	B
17	SDI	I	Digital	SDI terminal for DAC	DVDD	A
18	BCLK	I	Digital	BCLK terminal 2.8224MHz(64fs) for DAC	DVDD	B
19	SYSCLK	I	Digital	SYSCLK terminal 11.2896MHz(256fs) for DAC	DVDD	B
20	DVDD	-	Digital	The power source for digital	-	I
21	DVSS	-	Digital	GND for digital	DVDD	I
22	DSPCLK	I	Digital	PCMClock input for PCM signal	DVDD	B
23	DSPOUT	O	Digital	PCMsignal input	DVDD	C
24	DSPIN	I	Digital	PCM signal input	DVDD	A
25	FSYNC	I	Digital	8kHz The reference clock for PLL	DVDD	B
26	PLLLPF	O	Analog	Condenser connected terminal for PLL	DVDD	F
27	AUDCLK	I	Digital	CPU I/F clock input terminal	DVDD	A
28	AUDCS	I	Digital	The chip selection terminal for CPU I/F (H active)	DVDD	A
29	AUDTXD	I	Digital	CPU I/FData input terminal	DVDD	A
30	AUDRXD	O	Digital	CPU I/FData output terminal	DVDD	C
31	PVSS	-	Analog	GND for Headphone and receiver	PVDD	I
32	HP_LI	I	Analog	Lch head phone amplifier revision terminal in low limits	PVDD	F
33	HP_L	O	Analog	Lch Head phone amplifier output terminal	PVDD	E
34	HP_R	O	Analog	Rch Head phone amplifier output terminal	PVDD	E
35	HP_RI	I	Analog	Rch head phone amplifier revision terminal in low limits	PVDD	F
36	PVDD	-	Analog	Power source for Headphone and receiver	-	I
37	RECN	O	Analog	Receiver output	PVDD	E
38	RECP	O	Analog	Receiver output	PVDD	E
39	CSTEP	O	Analog	Step noise decrease terminal when volume is variable	AVDD	F
40	CPOP	O	Analog	Pop sound decrease terminal	AVDD	F
41	SMUTE	O	Analog	Constant terminal when soft mute	AVDD	F
42	RXCOM	O	Analog	Receiving standard voltage output	AVDD	E
43	TXCOM	O	Analog	Transmit standard voltage output	AVDD	E
44	PVCOM	O	Analog	PATH standard voltage output	AVDD	E
45	COMIN	I	Analog	Standard voltage input terminal	AVDD	G
46	EXTOUT	O	Analog	External output	-	H
47	MICB_1	O	Analog	MIC BIAS output1	AVDD	E
48	MICB_2	O	Analog	MIC BIAS output2	AVDD	E

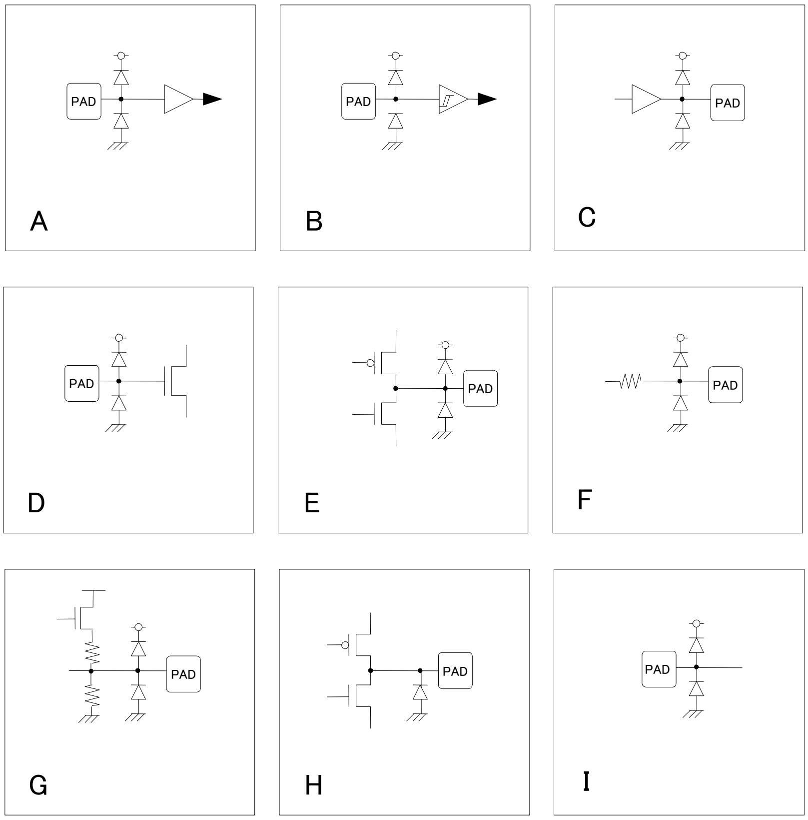


Fig.18 Terminal equivalent circuit figure

●Notes for use

1) Absolute maximum ratings
When applied voltage (VDD and VIN), and the operating temperature range (Topr) and the like it exceeds absolute maximum rating, there is a possibility of destroying, Because it cannot specify destructive mode such as short circuit or opening, when special mode which exceeds absolute maximum rating is supposed, that physical safety measure such as a fuse should be implemented.

2) Recommendation operating range
If it is this range, it is the range which almost can obtain the quality of according to expectation. Concerning electric quality , being something which is guaranteed under condition of each item. Even inside the recommendation operating range, voltage, temperature characteristic is shown.

3) About the opposite connection of the power source connector
There is a possibility of destroying LSI with the opposite connection to the power source connector. Please administer the measure such as the diode is inserted between power source and the power source terminal of LSI outside as the protection for opposite connection destruction.

4) About the power source line
At the time of designing the baseplate pattern, as for wiring of the power source/GND line, please make sure to become low impedance. At that time, even digital type power source and analog type power source being the same electric potential, please separate digital type power source pattern and analog type power source pattern, control the turning of digital noise to the analog power source due to the common impedance of wiring pattern. Concerning the GND line, please consider the similar pattern design. In addition, concerning all power source terminals of LSI, the condenser is inserted between power source and the GND terminal, in the case of electrolysis condenser use, please decide constant with sufficient verification in regard to the fact of without being problem in qualities of the condenser which is used, such as the capacity pulling out happens in low temperature.

5) About GND voltage
As for electric potential of the GND terminal regarding what ever working condition, please make sure to become lowest electric potential. In addition, please really verify that does not have the terminal which becomes electric potential below GND include transient phenomenon

6) About the short circuit between the terminal and error installing
The occasion where you install in the set baseplate, please pay attention to the direction and the position gap of LSI sufficiently. when you install with mistake, there is a possibility of LSI destroying. In addition, there is a possibility of destruction concerning when it short-circuits e.g. due to the foreign material enters between the terminal and between terminal and power source and GND.

7) About the operation in the strong electromagnetic field
As for the use in the strong electromagnetic field, being to be a possibility of doing the malfunction, please note.

8) About the testing with the set baseplate
When inspecting with the set baseplate, the condenser is connected to the LSI terminal whose impedance is low, because there is a possibility of stress depending on LSI, please be sure to do discharge in every process. In addition, when installing and removing the tool in inspection process, by all means with power source as off to connect, to inspect, to remove. Furthermore, As a static electricity measure, please note to administer the earth and the conveyance and preservation in the case of assemble process sufficiently.

9) About each input terminal
With respect to the structure of LSI, the parasitic element is formed inevitably by the relationship of electric potential. It causes the interference of circuit operation due to the fact that the parasitic element operates, the malfunction, even can become cause of destruction. Therefore, e.g., the voltage which is lower than GND in the input terminal is impressed, please note sufficiently not to do the method where the parasitic element operates. In addition, When not impress power supply voltage in LSI, please do not impress voltage in the input terminal. Furthermore, when power supply voltage is impressed even, as for each input terminal, please make voltage below power supply voltage or within guaranteed performance of electric quality.

10) About GND wiring pattern
When there are both small signal GND and a heavy-current GND, it separates small signal GND pattern from heavy-current GND pattern, in order that the pattern wiring and the voltage change caused by large current do not change the voltage of small-signal GND, it is recommended to carry out the one-point grounding at the reference point of set.. Please be careful of not to fluctuate the GND wiring pattern of external parts

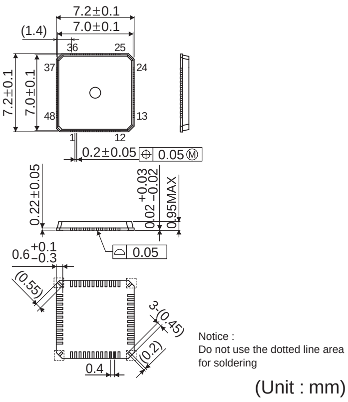
11) When in the external condenser, the ceramic condenser is used, please decide the constant on the consideration of the nominal capacity decrease caused by direct current bias and the change of the capacity due to temperature etc.

●Ordering part number

B	D		7	8	6	1		K	N	-	E	2

- B D: Part No.
- 7 8 6 1: Part No.
- K N: Package, KN: UQFN48
- E 2: Packaging and forming specification, E2: Embossed tape and reel

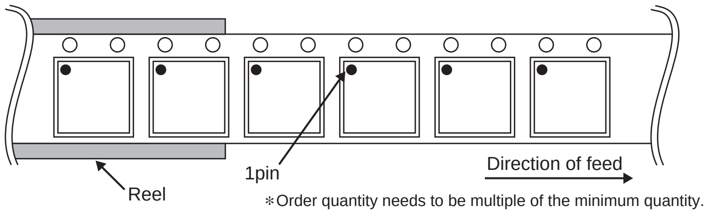
UQFN48



(Unit : mm)

<Tape and Reel information>

Tape	Embossed carrier tape (with dry pack)
Quantity	2500pcs
Direction of feed	E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand)



∗Order quantity needs to be multiple of the minimum quantity.

Notes

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