



AUDIO PROCESSOR with SOUND ENHANCEMENT and SRS 3D STEREO

■ GENERAL DESCRIPTION

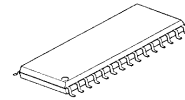
The NJW1155 is an audio processor that includes Sound enhancement (BBE) and SRS 3D Stereo. It includes all of the audio signal processing functions for TV such as tone control, balance, volume, mute, and AGC .

The SRS 3D stereo technology reproduces 3D stereo surround sound effect using only two speakers.

The sound enhancement regenerates high definitive and nearly real sound.

All of internal status and variables are controlled by I²C BUS interface.

■ PACKAGE OUTLINE

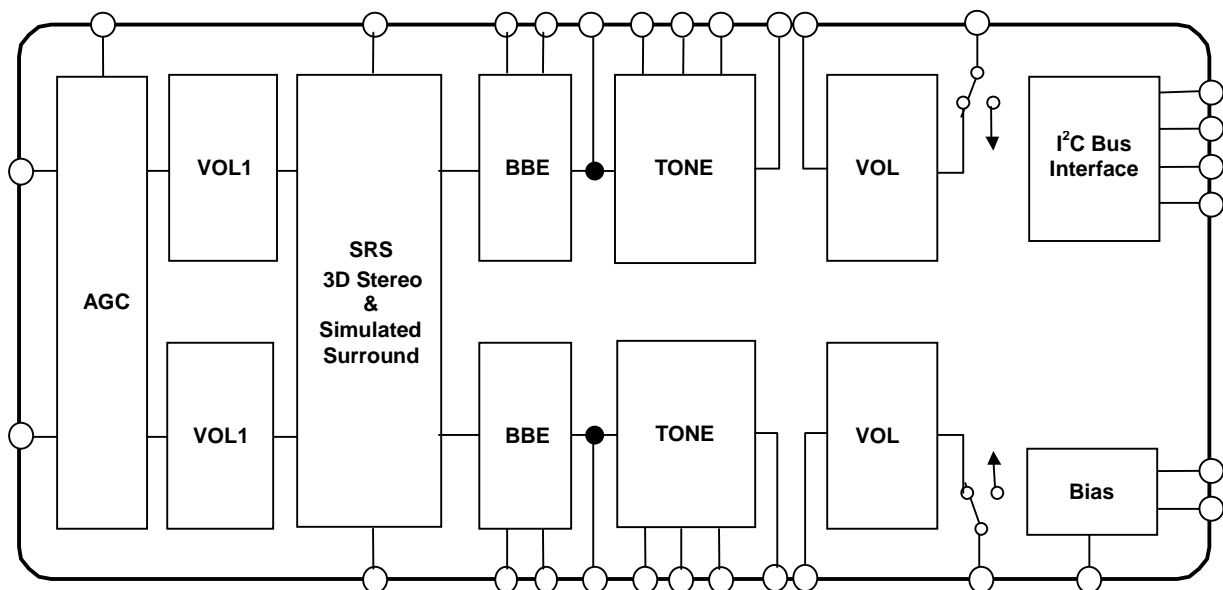


NJW1155M

■ FEATURES

- Operating Voltage 7.5 to 13V
- I²C BUS Interface
- BBE Sound Enhancement (Low Boost and High Boost: 15dB max.)
- AGC Circuit (It reduces volume difference among input sources.)
- SRS 3D Stereo
- Simulated Surround
- Bi-CMOS Technology
- Package Outline SDMP30

■ BLOCK DIAGRAM



■ PIN FUNCTION

1	INa	INb	30
2	BBE1a	BBE1b	29
3	BBE2a	BBE2b	28
4	TONEDC1a	TONEDC1b	27
5	TONEDC2a	TONEDC2b	26
6	TONE-Ha	TONE-Hb	25
7	TONE-La	TONE-Lb	24
8	OUTa	OUTb	23
9	AGC	SRS-FIL2	22
10	SRS/SS-FIL1	VREF	21
11	VOL2 INa	VOL2 INb	20
12	BBEOUTa	BBEOUTb	19
13	SDA	AUX0	18
14	SCL	AUX1	17
15	GND	Vcc	16

No.	Symbol	Function	No	Symbol	Function
1	INa	Ach Input	16	Vcc	Power Supply Pin
2	BBE1a	Ach BBE Filter1 (Process)	17	AUX1	Auxiliary Output1
3	BBE2a	Ach BBE Filter2 (Lo Contour)	18	AUX0	Auxiliary Output0
4	TONEDC1a	Ach Tone Output	19	BBE OUTb	Bch Output for the Other Accessories
5	TONEDC2a	Ach Volume2 Input	20	VOL2 INb	Bch Input from the Other Accessories
6	TONE-Ha	Ach Treble Filter	21	VREF	Reference Voltage
7	TONE-La	Ach Bass Filter	22	SRS-FIL2	SRS Surround Filter2
8	OUTa	Ach Output	23	OUTb	Bch Output
9	AGC	AGC Filter	24	TONE-Lb	Bch Bass Filter
10	SRS/SS-FIL1	SRS and Simulated Stereo Filter1	25	TONE-Hb	Bch Treble Filter
11	VOL2 INa	Ach Input From the Other Accessories	26	TONEDC2b	Bch Volume2 Input
12	BBE OUTa	Ach Output for the Other Accessories	27	TONEDC1b	Bch Tone Output
13	SDA	SDA Data Input (I ² C BUS)	28	BBE2b	Bch BBE Filter2 (Process)
14	SCL	SCL Data Input (I ² C BUS)	29	BBE1b	Bch BBE Filter1 (Lo Contour)
15	GND	GND	30	INb	Bch Input

■ ABSOLUTE MAXIMUM RATING (Ta=25°C)

PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	V ⁺	15	V
Power Dissipation	P _D	700	mW
Operating Temperature Range	Topr	-20 to +75	°C
Storage Temperature Range	Tstg	-40 to +125	°C

■ ELECTRICAL CHARACTERISTICS

(Ta=25°C, V+=9V, Rg=600Ω, R_L=47kΩ, Vin=100mVrms/1kHz unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Voltage	V ⁺		7.5	9.0	13.0	V
Supply Current	I _{CC}	No Signal	-	13	25	mA
Reference Voltage	V _{REF}	No Signal	4.0	4.5	5.0	V
Maximum Input Voltage	V _{IM}	VOL=-20dB, THD=10%	2.8	3.0	-	Vrms
Maximum Output Voltage	V _{OM}	OUTPUT VOL=0dB, THD=1%	-	2.5	-	Vrms
Channel Balance	G _{CB}	VOL=0dB	-	0.0	-	dB
Balance Boost A	BA _{BST}	CHS="0", BAL="11111"	-	0.0	-	dB
Balance Cut A	BA _{CUT}	CHS="1", BAL="11111" Vin = 1Vrms	-	-	-70	dB
Balance Boost B	BB _{BST}	CHS="1", BAL="11111"	-	0.0	-	dB
Balance Cut B	BB _{CUT}	CHS="0", BAL="11111" Vin = 1Vrms	-	-	-70	dB
Total Harmonic Distortion	THD	Vo=0.5Vrms BW=400Hz to 30kHz	-	0.005	0.01	%
Maximum Gain	G _{VMAX}	VOL= 0dB	-	0.0	-	dB
Minimum Gain	G _{VMIN}	VOL= MUTE	-	-	-70	dB
Channel Separation	CS	Vin = 2Vrms	-	-	-70	dB
Output Noise 1	V _{NO1}	VOL = 0dB A-weighted	-	-100 (10)	-90 (32)	dBV (μVrms)
Output Noise 2	V _{NO2}	VOL = MUTE A-weighted	-	-105 (5.6)	-95 (18)	dBV (μVrms)
AUX Output Voltage	V _{AUX}	Logic Output : High	4.5	-	5.0	V
		Logic Output : Low	0	-	0.3	

BW : Band Width

◆ TONE CONTROL

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
High Frequency Boost	HF _{BST}	BCT="1",TREB="1111", f=10kHz	12.5	15.0	17.5	dB
High Frequency Flat	HF _{FLT}	TRBE="0000",f=10kHz	-2.0	0.0	2.0	dB
High Frequency Cut	HF _{CUT}	BCT="0",TRBE="1111", f=10kHz	-17.5	-15.0	-12.5	dB
Low Frequency Boost	LF _{BST}	BCB="1",BASS="1111", f=100Hz	12.5	15.0	17.5	dB
Low Frequency Flat	LF _{FLT}	BASS="0000",f=100Hz	-2.0	0.0	2.0	dB
Low Frequency Cut	LF _{CUT}	BCB="0",BASS="1111", f=100Hz	-17.5	-15.0	-12.5	dB

◆ AGC CONTROL(AGC-ON)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
AGC Boost	AGC _{BST}	Vin=50mVrms, f=1kHz	1.5	3.5	5.5	dB
AGC Flat1	AGC _{FLT1}	Vin=150mVrms, f=1kHz	-2.5	0.0	2.5	dB
AGC Flat2	AGC _{FLT2}	Vin=300mVrms, f=1kHz	-2.5	0.0	2.5	dB
AGC Flat3	AGC _{FLT3}	Vin=400mVrms, f=1kHz	-2.5	0.0	2.5	dB
AGC Flat4	AGC _{FLT4}	Vin=540mVrms, f=1kHz	-2.5	0.0	2.5	dB
AGC Cut	AGC _{CUT}	Vin=2Vrms, f=1kHz	-14	-10	-6.0	dB

◆ BBE(BBE-ON)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
BBE Low Frequency Boost Range	BBE _{LOW}	BBE-Low="1111", f = 50Hz	-	15.0	-	dB
BBE High Frequency Boost Range	BBE _{HIGH}	BBE-High="1111", f = 10KHz	-	15.0	-	dB

◆ SIMULATED SURROUND (Simulated Surround-ON, f=1kHz)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
SURROUND SIM A	SR _{SIMA}	Ain+Bin → Aout	1.0	3.0	5.0	dB
SURROUND SIM B	SR _{SIMB}	Ain+Bin → Bout	1.0	3.0	5.0	dB

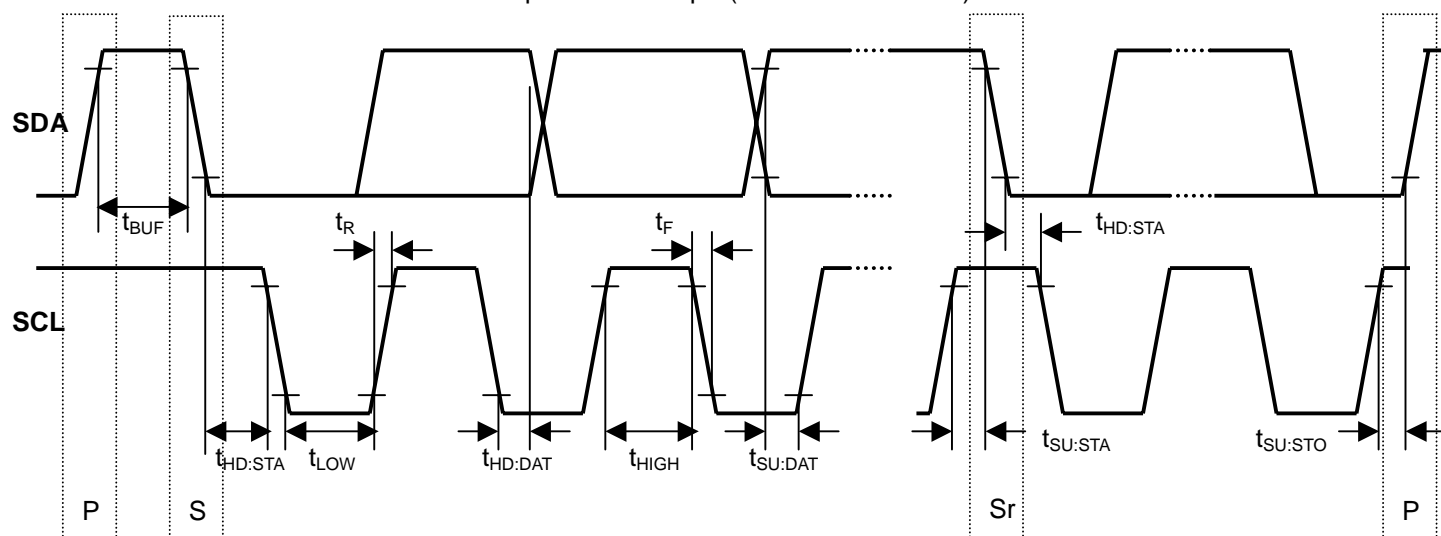
◆ SRS 3D-Stereo (SRS 3D Stereo-ON, f=125Hz)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
SRS GAIN HIGH 1	SRS _{GH1}	Ain → Aout, Mode=High	10.0	12.0	14.0	dB
SRS GAIN HIGH 2	SRS _{GH2}	Bin → Bout, Mode=High	10.0	12.0	14.0	dB
SRS GAIN LOW 1	SRS _{GL1}	Ain → Aout, Mode=Low	4.0	6.0	8.0	dB
SRS GAIN LOW 2	SRS _{GL2}	Bin → Bout, Mode=Low	4.0	6.0	8.0	dB
SRS GAIN HIGH 3	SRS _{GH3}	Bin → Aout, Mode=High	6.8	8.8	10.8	dB
SRS GAIN HIGH 4	SRS _{GH4}	Ain → Bout, Mode=High	6.8	8.8	10.8	dB

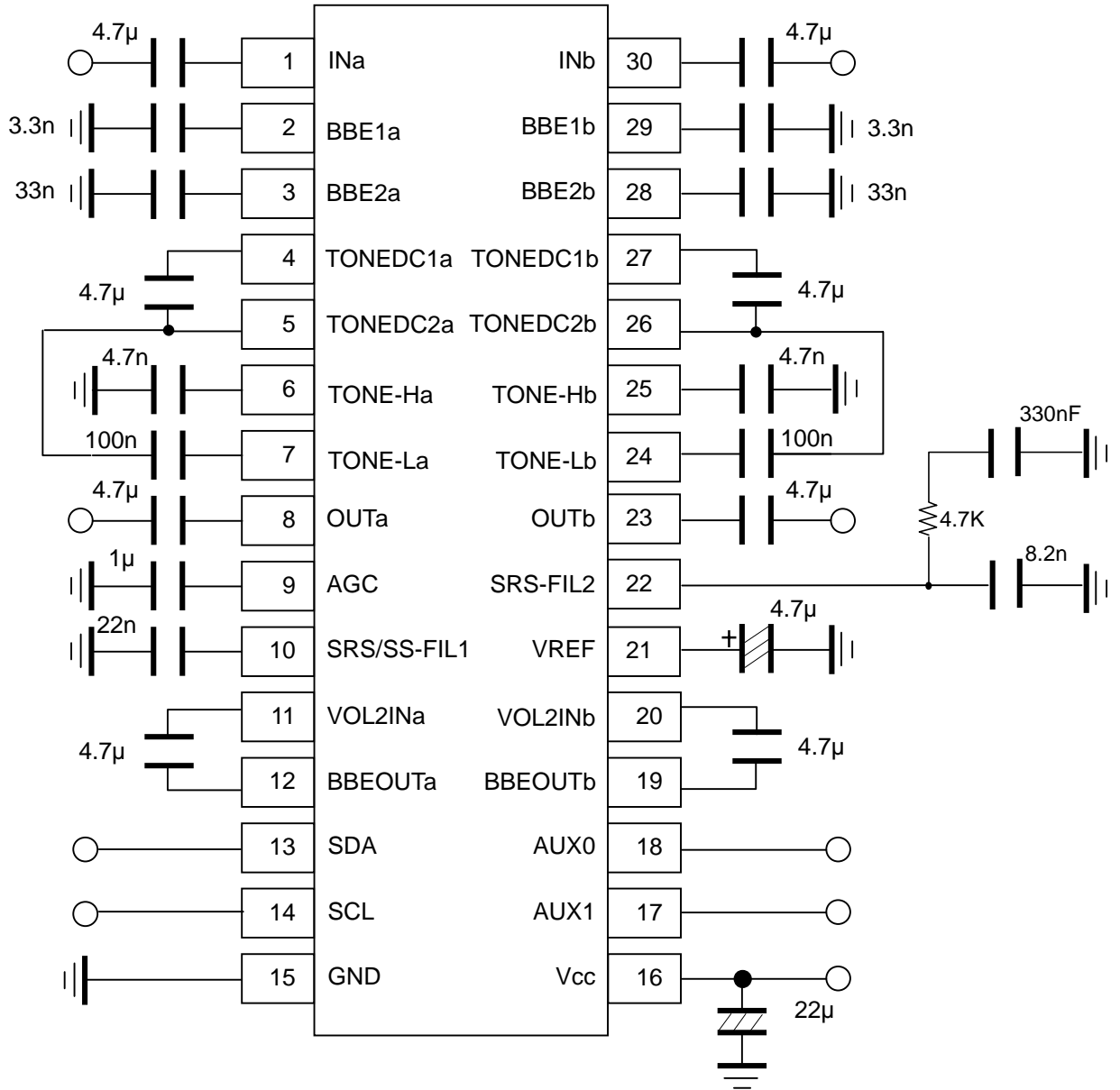
■ I²C BUS BLOCK CHARACTERISTICS (SDA,SCL)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
High Level Input Voltage	V _{IH}	3.0	-	5.0	V
Low Level Input Voltage	V _{IL}	0	-	1.5	V
High Level Input Current	I _{IH}	-	-	10	μA
Low Level Input Current	I _{IL}	-	-	10	μA
Low Level Output Voltage (3mA at SDA pin)	V _{OL}	0	-	0.4	V
Maximum Output Current	I _{OL}	-3.0	-	-	mA
Maximum Clock Frequency	f _{SCL}	-	-	100	kHz
Data Change Minimum Waiting Time	t _{BUF}	4.7	-	-	μs
Data Transfer Start Minimum Waiting Time	t _{HD:STA}	4.0	-	-	μs
Low Level Clock Pulse Width	t _{LOW}	4.7	-	-	μs
High Level Clock Pulse Width	t _{HIGH}	4.0	-	-	μs
Minimum Start Preparation Waiting Time	t _{SU:STA}	4.7	-	-	μs
Minimum Data Hold Time	t _{HD:DAT}	0	-	3.45	μs
Minimum Data Preparation Time	t _{SU:DAT}	250	-	-	ns
Rise Time	t _R	-	-	1.0	μs
Fall Time	t _F	-	-	300	ns
Minimum Stop Preparation Waiting Time	t _{SU:STO}	4.0	-	-	μs

I²C BUS Load Condition: Pull up resistance 4kΩ (Connected to +5V)
Load capacitance 200pF (Connected to GND)

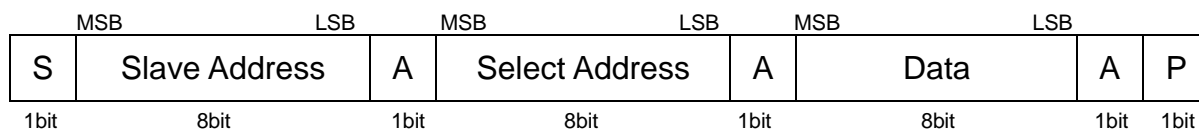


APPLICATION CIRCUIT



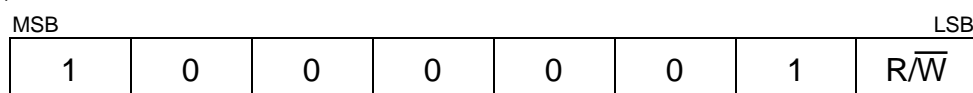
■ DEFINITION OF I²C REGISTER

◆ I²C BUS FORMAT



S: Starting Term
A: Acknowledge Bit
P: Ending Term

◆ SLAVE ADDRESS



R/W=0: Receive Only
R/W=1: No Output Data

◆ CONTROL REGISTER TABLE

The select address sets each function (Volume, Balance, AGC, Surround, Tone Control, BBE, AUX).
The auto increment function cycles the select address as follows.
00H→01H→02H→03H→04H→05H→00H

Select Address	BIT							
	D7	D6	D5	D4	D3	D2	D1	D0
00H	VOL							
01H	CHS	BAL				AGC	SUR	
02H	BCB	BASS			BCSB	Don't care	Don't care	
03H	BCT	TREB			BCST	Don't care	Don't care	
04H	BBE(Lo Contour)				BBE(Process)			
05H	OUT	Don't care	Don't care	SUR0	AGC1	AGC0	AUX1	AUX0

◆ CONTROL REGISTER DEFAULT VALUE

Control register default value is all "0".

Select Address	BIT							
	D7	D6	D5	D4	D3	D2	D1	D0
00H	0	0	0	0	0	0	0	0
01H	0	0	0	0	0	0	0	0
02H	0	0	0	0	0	0	0	0
03H	0	0	0	0	0	0	0	0
04H	0	0	0	0	0	0	0	0
05H	0	0	0	0	0	0	0	0

■INSTRUCTION CODE

a) MASTER VOLUME SETTING

Select Address	BIT							
	D7	D6	D5	D4	D3	D2	D1	D0
00H	VOL							

The volume control for both Ach and Bch(0.33dB/step).

The volume is consisted of volume1 and volume2 and the level is divided into half to each volume1 and volume2.

b) BALANCE, AGC AND SURROUND SETTING

Select Address	BIT							
	D7	D6	D5	D4	D3	D2	D1	D0
01H	CHS	BAL					AGC	SUR

- CHS : Channel select for balance control

“0” : Ach “Bch is attenuated”

“1” : Bch “Ach is attenuated”

- BAL : Balance control for both Ach and Bch(1dB/Step)

The balance is consisted of volume1 and volume2 and the level is divided into half to each volume1 and volume2.

- AGC : AGC switch

“0” : AGC OFF

“1” : AGC ON (Default Setting : 150mVrms)

- SUR : Surround mode switch

“0” : Surround OFF

“1” : Surround ON(Default Setting : Surround Effect1)

c)TONE CONTROL BASS SETTING

Select Address	BIT								
	D7	D6	D5	D4	D3	D2	D1	D0	
02H	BCB	BASS					BCSB	Don't Care	Don't Care

- BCB : Boost cut select for Bass control

“0” : Cut

“1” : Boost

- BASS: BASS control

Cut Level : -15dB to 0dB(1dB/Step)

Boost Level : 0dB to +15dB(1dB/Step)

- BCSB : Boost cut select for SUB-BASS control

“0” : Cut

“1” : Boost

d) TONE CONTROL TREBLE SETTING

Select Address	BIT								
	D7	D6	D5	D4	D3	D2	D1	D0	
03H	BCT	TREB				BCST	Don't Care	Don't Care	

- BCT : Boost cut select for Treble control
 "0" : Cut
 "1" : Boost
- TREB: Treble control(1dB/step)
 Cut Level : -15dB to 0dB(1dB/Step)
 Boost Level : 0dB to +15dB(1dB/Step)
- BCST : Boost cut select for Sub-Treble control
 "0" : Cut
 "1" : Boost

e) BBE Boost Level Setting

Select Address	BIT							
	D7	D6	D5	D4	D3	D2	D1	D0
04H	BBE(Lo Contour)				BBE(Process)			

- BBE Lo Contour : 0dB to 15dB(1dB/step)
- BBE Process : 0dB to 15dB (1dB/step)

When all bits are "0"(=00H), BBE becomes off

f) OUTPUT AND AUXILIARY SETTING

Select Address	BIT							
	D7	D6	D5	D4	D3	D2	D1	D0
05H	OUT	Don't Care	Don't Care	SUR0	AGC1	AGC0	AUX1	AUX0

- OUT: ON/OFF Switch for OUTPUT
 "0" : OFF
 "1" : ON

•Surround Setting

Surround Function	SUR0(05H:D4)	SUR(01H:D0),	Remarks
Surround OFF	0	0	Surround OFF
Surround Effect1	0	1	SRS 3D-Stereo – Low Mode
Surround Effect2	1	1	SRS 3D-Stereo – High Mode
Simulated Stereo	1	0	Simulated Stereo

•AGC Level Setting

AGC Level	AGC1(D3)	AGC0(D2)
150mVrms	0	0
300mVrms	0	1
400mVrms	1	0
540mVrms	1	1

- AUX1/AUX0: Auxiliary port High/Low
 "0" : Logic output "Low"
 "1" : Logic output "High"

■MASTER VOLUME (Select Address : 00H)

		VOL							
Gain(dB)	HEX	D7	D6	D5	D4	D3	D2	D1	D0
0	FF	1	1	1	1	1	1	1	1
-1	FC	1	1	1	1	1	1	0	0
-2	F9	1	1	1	1	1	0	0	1
-3	F6	1	1	1	1	0	1	1	0
-4	F3	1	1	1	1	0	0	1	1
-5	F0	1	1	1	1	0	0	0	0
-6	ED	1	1	1	0	1	1	0	1
-7	EA	1	1	1	0	1	0	1	0
-8	E7	1	1	1	0	0	1	1	1
-9	E4	1	1	1	0	0	1	0	0
-10	E1	1	1	1	0	0	0	0	1
-11	DE	1	1	0	1	1	1	1	0
-12	DB	1	1	0	1	1	0	1	1
-13	D8	1	1	0	1	1	0	0	0
-14	D5	1	1	0	1	0	1	0	1
-15	D2	1	1	0	1	0	0	1	0
-16	CF	1	1	0	0	1	1	1	1
-17	CC	1	1	0	0	1	1	0	0
-18	C9	1	1	0	0	1	0	0	1
-19	C6	1	1	0	0	0	1	1	0
-20	C3	1	1	0	0	0	0	1	1
-21	C0	1	1	0	0	0	0	0	0
-22	BD	1	0	1	1	1	1	0	1
-23	BA	1	0	1	1	1	0	1	0
-24	B7	1	0	1	1	0	1	1	1
-25	B4	1	0	1	1	0	1	0	0
-26	B1	1	0	1	1	0	0	0	1
-27	AE	1	0	1	0	1	1	1	0
-28	AB	1	0	1	0	1	0	1	1
-29	A8	1	0	1	0	1	0	0	0
-30	A5	1	0	1	0	0	1	0	1
-31	A2	1	0	1	0	0	0	1	0
-32	9F	1	0	0	1	1	1	1	1
-33	9C	1	0	0	1	1	1	0	0
-34	99	1	0	0	1	1	0	0	1
-35	96	1	0	0	1	0	1	1	0
-36	93	1	0	0	1	0	0	1	1
-37	90	1	0	0	1	0	0	0	0
-38	8D	1	0	0	0	1	1	0	1
-39	8A	1	0	0	0	1	0	1	0
-40	87	1	0	0	0	0	1	1	1
-41	84	1	0	0	0	0	1	0	0
-42	81	1	0	0	0	0	0	0	1

■MASTER VOLUME (Select Address : 00H)

		VOL							
Gain(dB)	HEX	D7	D6	D5	D4	D3	D2	D1	D0
-43	7E	0	1	1	1	1	1	1	0
-44	7B	0	1	1	1	1	0	1	1
-45	78	0	1	1	1	1	0	0	0
-46	75	0	1	1	1	0	1	0	1
-47	72	0	1	1	1	0	0	1	0
-48	6F	0	1	1	0	1	1	1	1
-49	6C	0	1	1	0	1	1	0	0
-50	69	0	1	1	0	1	0	0	1
-51	66	0	1	1	0	0	1	1	0
-52	63	0	1	1	0	0	0	1	1
-53	60	0	1	1	0	0	0	0	0
-54	5D	0	1	0	1	1	1	0	1
-55	5A	0	1	0	1	1	0	1	0
-56	57	0	1	0	1	0	1	1	1
-57	54	0	1	0	1	0	1	0	0
-58	51	0	1	0	1	0	0	0	1
-59	4E	0	1	0	0	1	1	1	0
-60	4B	0	1	0	0	1	0	1	1
-61	48	0	1	0	0	1	0	0	0
-62	45	0	1	0	0	0	1	0	1
-63	42	0	1	0	0	0	0	1	0
-64	3F	0	0	1	1	1	1	1	1
-65	3C	0	0	1	1	1	1	0	0
-66	39	0	0	1	1	1	0	0	1
-67	36	0	0	1	1	0	1	1	0
-68	33	0	0	1	1	0	0	1	1
-69	30	0	0	1	1	0	0	0	0
-70	2D	0	0	1	0	1	1	0	1
-71	2A	0	0	1	0	1	0	1	0
-72	27	0	0	1	0	0	1	1	1
-73	24	0	0	1	0	0	1	0	0
-74	21	0	0	1	0	0	0	0	1
-75	1E	0	0	0	1	1	1	1	0
-76	1B	0	0	0	1	1	0	1	1
-77	18	0	0	0	1	1	0	0	0
-78	15	0	0	0	1	0	1	0	1
-79	12	0	0	0	1	0	0	1	0
-80	0F	0	0	0	0	1	1	1	1
-81	0C	0	0	0	0	1	1	0	0
-82	09	0	0	0	0	1	0	0	1
-83	06	0	0	0	0	0	1	1	0
-84	03	0	0	0	0	0	0	1	1
Mute	00	0	0	0	0	0	0	0	0

■BALANCE(Select Address : 01H)

Channel Select (CHS)	D7
Ach(Bch is attenuated)	0
Bch(Ach is attenuated)	1

Gain(dB)	BAL				
	D6	D5	D4	D3	D2
0	0	0	0	0	0
-1	0	0	0	0	1
-2	0	0	0	1	0
-3	0	0	0	1	1
-4	0	0	1	0	0
-5	0	0	1	0	1
-6	0	0	1	1	0
-7	0	0	1	1	1
-8	0	1	0	0	0
-9	0	1	0	0	1
-10	0	1	0	1	0
-11	0	1	0	1	1
-12	0	1	1	0	0
-13	0	1	1	0	1
-14	0	1	1	1	0
-15	0	1	1	1	1
-16	1	0	0	0	0
-17	1	0	0	0	1
-18	1	0	0	1	0
-19	1	0	0	1	1
-20	1	0	1	0	0
-21	1	0	1	0	1
-22	1	0	1	1	0
-23	1	0	1	1	1
-24	1	1	0	0	0
-25	1	1	0	0	1
-26	1	1	0	1	0
-27	1	1	0	1	1
-28	1	1	1	0	0
-29	1	1	1	0	1
-30	1	1	1	1	0
Mute	1	1	1	1	1

■TONE CONTROL BASS (Select Address : 02H)

Bass Cut or Boost	BCB
	D7
Cut	0
Boost	1

		BASS			
		D6	D5	D4	D3
Cut Gain(dB)	Boost Gain(dB)				
-15	15	1	1	1	1
-14	14	1	1	1	0
-13	13	1	1	0	1
-12	12	1	1	0	0
-11	11	1	0	1	1
-10	10	1	0	1	0
-9	9	1	0	0	1
-8	8	1	0	0	0
-7	7	0	1	1	1
-6	6	0	1	1	0
-5	5	0	1	0	1
-4	4	0	1	0	0
-3	3	0	0	1	1
-2	2	0	0	1	0
-1	1	0	0	0	1
0	0	0	0	0	0

■TONE CONTROL TREBLE (Select Address : 03H)

Treble Cut or Boost	BCT
	D7
Cut	0
Boost	1

		TREB			
		D6	D5	D4	D3
Cut Gain(dB)	Boost Gain(dB)				
-15	15	1	1	1	1
-14	14	1	1	1	0
-13	13	1	1	0	1
-12	12	1	1	0	0
-11	11	1	0	1	1
-10	10	1	0	1	0
-9	9	1	0	0	1
-8	8	1	0	0	0
-7	7	0	1	1	1
-6	6	0	1	1	0
-5	5	0	1	0	1
-4	4	0	1	0	0
-3	3	0	0	1	1
-2	2	0	0	1	0
-1	1	0	0	0	1
0	0	0	0	0	0


■BBE (Lo Contour) / (Process) Gain Code (Select Address : 04H)

		Lo Contour				Process			
Cut Gain(dB)	Boost Gain(dB)	D7	D6	D5	D4	D3	D2	D1	D0
-15	15	1	1	1	1	1	1	1	1
-14	14	1	1	1	0	1	1	1	0
-13	13	1	1	0	1	1	1	0	1
-12	12	1	1	0	0	1	1	0	0
-11	11	1	0	1	1	1	0	1	1
-10	10	1	0	1	0	1	0	1	0
-9	9	1	0	0	1	1	0	0	1
-8	8	1	0	0	0	1	0	0	0
-7	7	0	1	1	1	0	1	1	1
-6	6	0	1	1	0	0	1	1	0
-5	5	0	1	0	1	0	1	0	1
-4	4	0	1	0	0	0	1	0	0
-3	3	0	0	1	1	0	0	1	1
-2	2	0	0	1	0	0	0	1	0
-1	1	0	0	0	1	0	0	0	1
0	0	0	0	0	0	0	0	0	0

■NOTE

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