



PRELIMINARY

## AUDIO PROCESSOR with SRS

### GENERAL DESCRIPTION

The NJW1140 is a sound processor includes all of the functions required to process the audio signal for TV, such as tone control, balance, volume, mute, and AGC functions.

Also the NJW1140 performs SRS 3D Stereo which regenerates 3D surround sound with only two speakers.

All of the internal status and variables are controlled by I<sup>2</sup>C BUS interface.

### PACKAGE OUTLINE

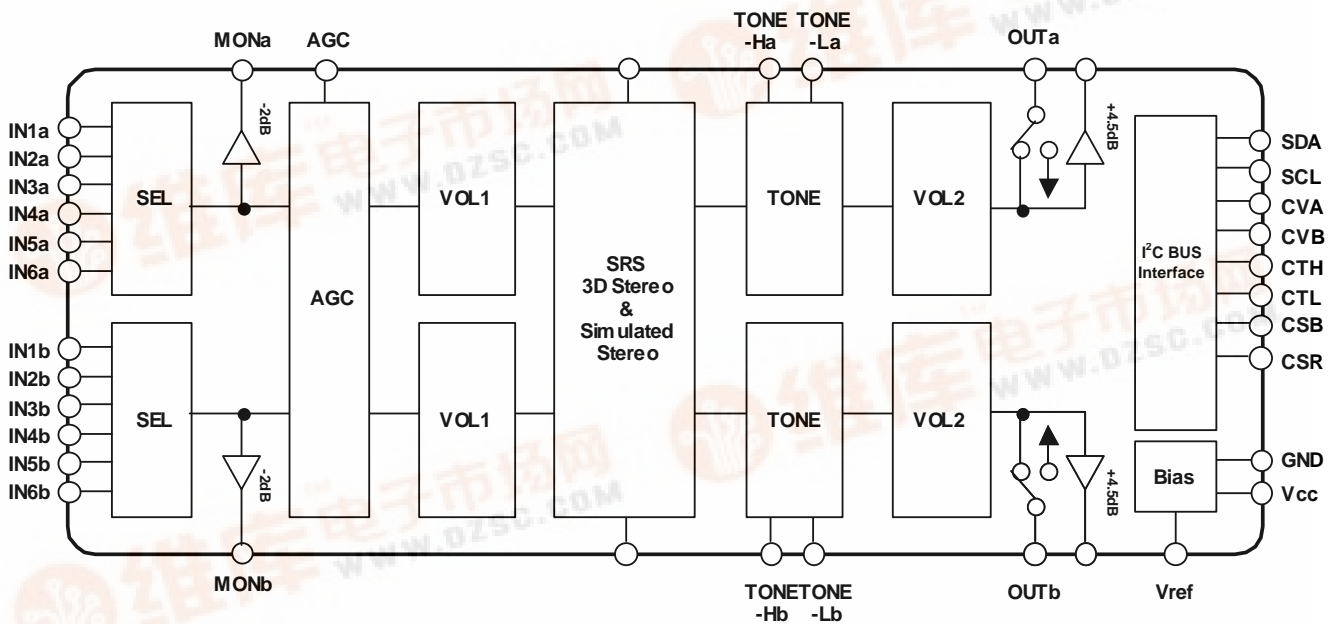


### FEATURES

- Operating Voltage 8 to 13V
- I<sup>2</sup>C BUS Interface
- Internal 6 Input Audio Selectors and Monitor Output
- The AGC circuit reduces volume difference among input sources.
- Variable AGC Compression Level via I<sup>2</sup>C (4-levels)
- Includes Dual Surround (SRS 3D Stereo and Simulated Stereo)
- Variable Surround Effect Level via I<sup>2</sup>C (SRS mode, 2-Levels)
- Low Noise VCA
- Bi-CMOS Technology
- Package Outline SOP40

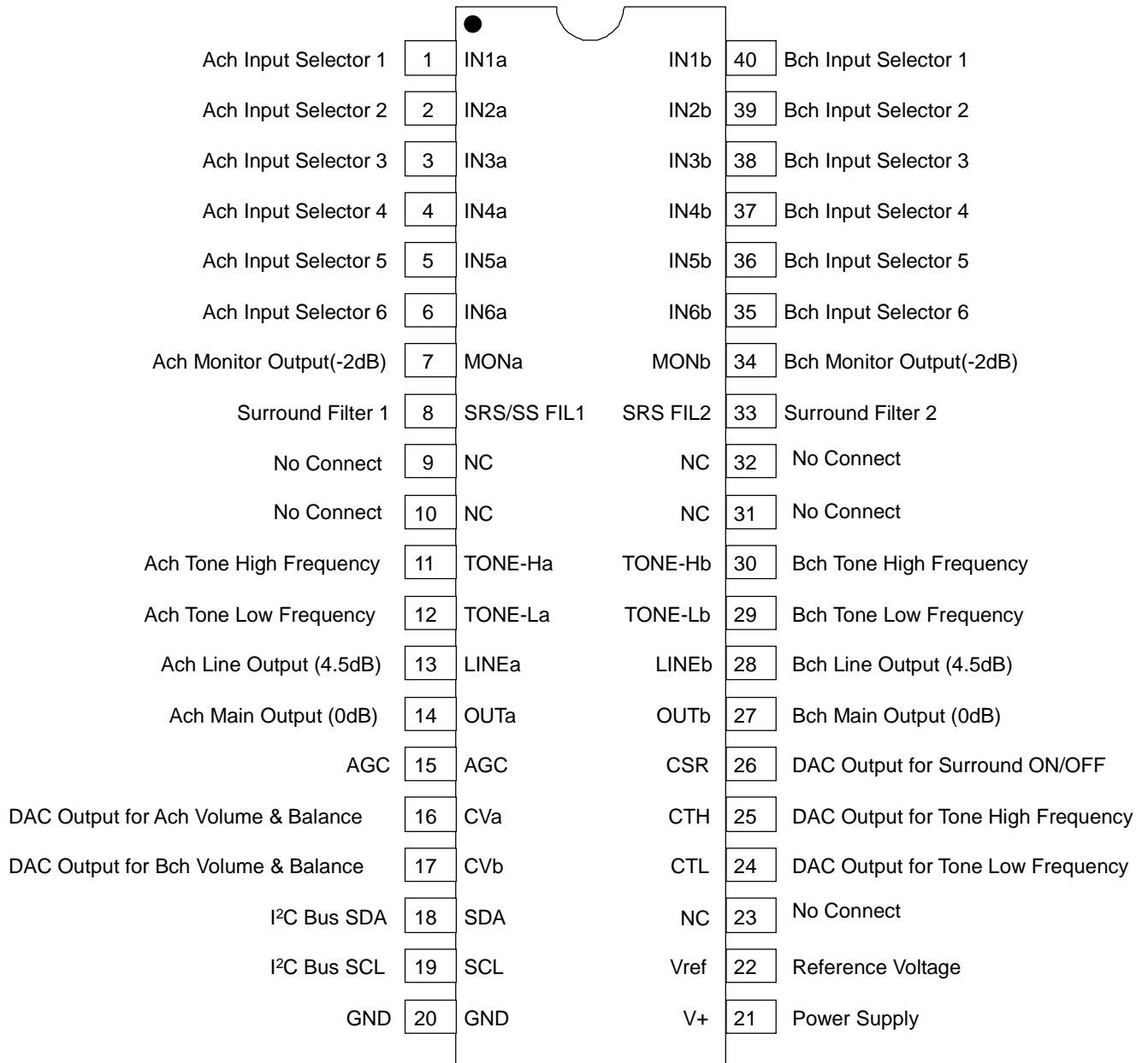
NJW1140GK1

### BLOCK DIAGRAM



# NJW1140

## ■ PIN CONFIGURATION



## ■ ABSOLUTE MAXIMUM RATINGS (Ta=25°C)

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

## ■ ELECTRICAL CHARACTERISTICS ( Ta=25°C, V<sup>+</sup>=9V, R<sub>g</sub>=600Ω, R<sub>L</sub>=47kΩ, Vin=100mVrms/1kHz)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Voltage	V <sup>+</sup>		8.0	9.0	13.0	V
Supply Current	I <sub>CC</sub>	No Signal	-	13	25	mA
Reference Voltage	V <sub>REF</sub>	No Signal	4.0	4.5	5.0	V
Maximum Input Voltage	V <sub>IM</sub>	VOL=-20dB, THD=1%	2.8	3.0	-	Vrms
Maximum Output Voltage1	V <sub>OM1</sub>	OUTPUT VOL=0dB, THD=1%	-	2.5	-	Vrms
Maximum Output Voltage2	V <sub>OM2</sub>	LINEOUT VOL=0dB, THD=1%	-	2.5	-	Vrms
MON OUT Gain	G <sub>VMON</sub>	MON OUT	-	-2.0	-	dB
LINEOUT Gain	G <sub>VLINE</sub>	LINEOUT, VOL=0dB	2.5	4.5	6.5	dB
Maximum Gain	G <sub>VMAX</sub>	VOL=0dB	-2.0	0.0	2.0	dB
Minimum Gain	G <sub>VMIN</sub>	VOL=Mute, Vin=1Vrms BW=400Hz to 30kHz	-	-	-70	dB
Channel Balance	G <sub>CB</sub>	VOL=0dB	-1.5	0.0	1.5	dB
Balance Level A-A	BAL <sub>AA</sub>	Full panning to Ach, OUTa	-2.0	0.0	2.0	dB
Balance Level A-B	BAL <sub>AB</sub>	Full panning to Ach, OUTb Vin=1Vrms BW=400Hz to 30kHz	-	-	-70	dB
Balance Level B-B	BAL <sub>BB</sub>	Full panning to Bch, OUTb	-2.0	0.0	2.0	dB
Balance Level B-A	BAL <sub>BA</sub>	Full panning to Bch, OUTa Vin=1Vrms BW=400Hz to 30kHz	-	-	-70	dB
Total Harmonic Distortion	THD	Vo=0.5Vrms BW=400Hz to 30kHz	-	-	0.5	%
Input Selector Cross Talk	CT	Vin=1Vrms BW=400Hz to 30kHz	-	-	-70	dB
Channel Separation	CS	Vin=1Vrms BW=400Hz to 30kHz	-	-	-70	dB
Output Noise 1	V <sub>NO1</sub>	VOL=0dB BW=400Hz to 30kHz	-	-90 (31.6)	-85 (56.2)	dBV (μVrms)
Output Noise 2	V <sub>NO2</sub>	VOL=Mute BW=400Hz to 30kHz	-	-106 (5.0)	-96 (15.8)	dBV (μVrms)
Output Noise 3	V <sub>NO3</sub>	LINEOUT, VOL=0dB BW=400Hz to 30kHz	-	-85 (56.2)	-80 (100)	dBV (μVrms)
Output Noise 4	V <sub>NO4</sub>	LINEOUT, VOL=Mute BW=400Hz to 30kHz	-	-101 (8.9)	-91 (28.2)	dBV (μVrms)

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## ■ ELECTRICAL CHARACTERISTICS ( Ta=25°C, V<sup>+</sup>=9V, R<sub>g</sub>=600Ω, R<sub>L</sub>=47kΩ, V<sub>in</sub>=100mVrms/1kHz)

### ● TONE CONTROL (Tone Control-ON)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
High Frequency Boost	HF <sub>BST</sub>	TREBLE=+15dB, f=10kHz	12.5	15.0	17.5	dB
High Frequency Flat	HF <sub>FLT</sub>	TRBE=0dB, f=10kHz	-2.0	0.0	2.0	dB
High Frequency Cut	HF <sub>CUT</sub>	TREBLE=-15dB, f=10kHz	-17.5	-15.0	-12.5	dB
Low Frequency Boost	LF <sub>BST</sub>	BASS=+15dB, f=100Hz	12.5	15.0	17.5	dB
Low Frequency Flat	LF <sub>FLT</sub>	BASS=0dB, f=100Hz	-2.0	0.0	2.0	dB
Low Frequency Cut	LF <sub>CUT</sub>	BASS=-15dB, f=100Hz	-17.5	-15.0	-12.5	dB

### ● SUB-TONE CONTROL (Sub-Tone Control-ON)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
High Frequency Boost	SHF <sub>BST</sub>	SUB-TREBLE=+3dB, f=10kHz	2.0	3.0	4.0	dB
High Frequency Flat	SHF <sub>FLT</sub>	SUB-TREBLE=0dB, f=10kHz	-2.0	0.0	2.0	dB
High Frequency Cut	SHF <sub>CUT</sub>	SUB-TREBLE=-3dB, f=10kHz	-4.0	-3.0	-2.0	dB
Low Frequency Boost	SLF <sub>BST</sub>	SUB-BASS=+3dB, f=100Hz	2.0	3.0	4.0	dB
Low Frequency Flat	SLF <sub>FLT</sub>	SUB-BASS=0dB, f=100Hz	-2.0	0.0	2.0	dB
Low Frequency Cut	SLF <sub>CUT</sub>	SUB-BASS=-3dB, f=100Hz	-4.0	-3.0	-2.0	dB

### ● AGC (AGC-ON)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
AGC BOOST	AGC <sub>BST</sub>	V <sub>in</sub> =50mVrms	1.5	3.5	5.5	dB
AGC FLAT 1	AGC <sub>FLT1</sub>	V <sub>in</sub> =300mVrms	-2.5	0.0	2.5	dB
AGC FLAT 2	AGC <sub>FLT2</sub>	V <sub>in</sub> =400mVrms	-2.5	0.0	2.5	dB
AGC FLAT 3	AGC <sub>FLT3</sub>	V <sub>in</sub> =500mVrms	-2.5	0.0	2.5	dB
AGC FLAT 4	AGC <sub>FLT4</sub>	V <sub>in</sub> =600mVrms	-2.5	0.0	2.5	dB
AGC CUT	AGC <sub>CUT</sub>	V <sub>in</sub> =2Vrms	-14	-10	-6.0	dB

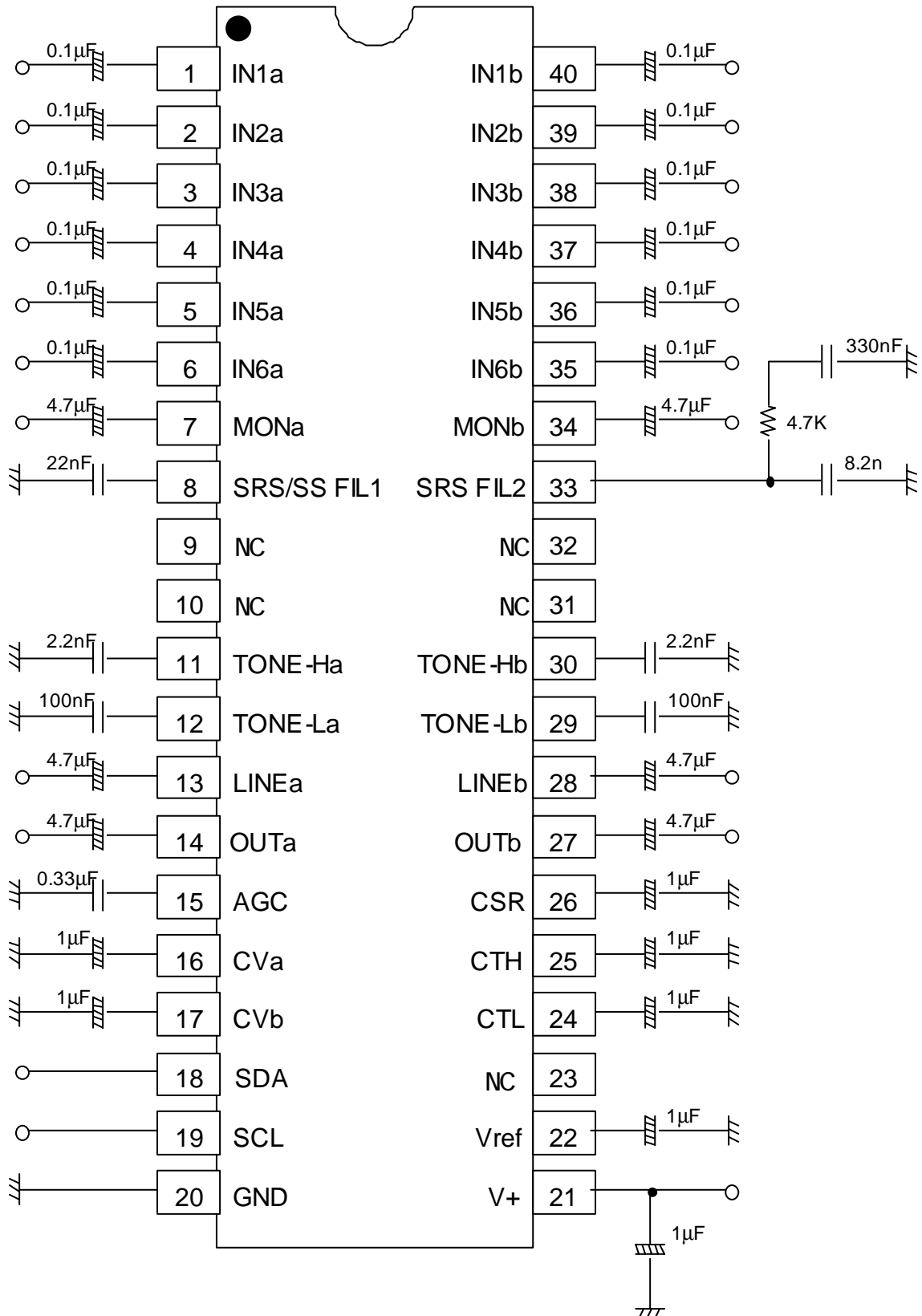
### ● SIMULATED SURROUND (Simulated Surround-ON, f=1kHz)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
SURROUND SIM A	SR <sub>SIMA</sub>	A <sub>in</sub> +B <sub>in</sub> → A <sub>out</sub>	1.0	3.0	5.0	dB
SURROUND SIM B	SR <sub>SIMB</sub>	A <sub>in</sub> +B <sub>in</sub> → B <sub>out</sub>	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 <sub>GH1</sub>	A <sub>in</sub> → A <sub>out</sub> , Mode=High	10.0	12.0	14.0	dB
SRS GAIN HIGH 2	SRS <sub>GH2</sub>	B <sub>in</sub> → B <sub>out</sub> , Mode=High	10.0	12.0	14.0	dB
SRS GAIN LOW 1	SRS <sub>GL1</sub>	A <sub>in</sub> → A <sub>out</sub> , Mode=Low	7.0	9.0	11.0	dB
SRS GAIN LOW 2	SRS <sub>GL2</sub>	B <sub>in</sub> → B <sub>out</sub> , Mode=Low	7.0	9.0	11.0	dB
SRS GAIN HIGH 3	SRS <sub>GH3</sub>	B <sub>in</sub> → A <sub>out</sub> , Mode=High	6.8	8.8	10.8	dB
SRS GAIN HIGH 4	SRS <sub>GH4</sub>	A <sub>in</sub> → B <sub>out</sub> , Mode=High	6.8	8.8	10.8	dB

## APPLICATION CIRCUIT $\mu$

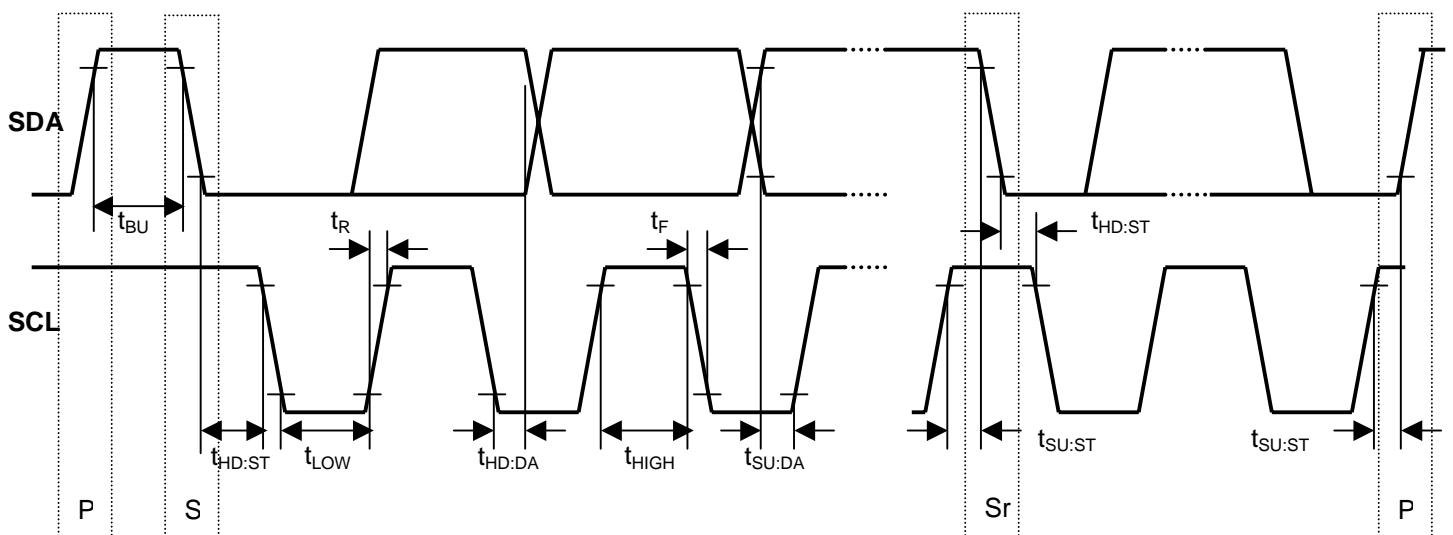


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## ■ I<sup>2</sup>C BUS Block CHARACTERISTICS (SDA, SCL)

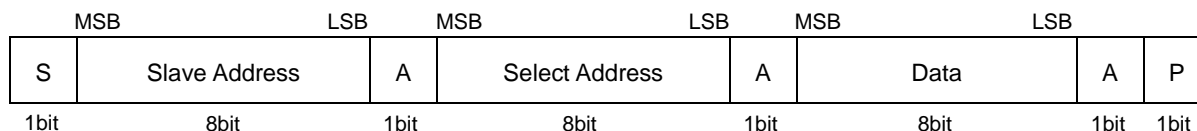
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
High Level Input Voltage	V <sub>IH</sub>	3.0	-	5.0	V
Low Level Input Voltage	V <sub>IL</sub>	0	-	1.5	V
High Level Input Current	I <sub>IH</sub>	-	-	10	μA
Low Level Input Current	I <sub>IL</sub>	-	-	10	μA
Low Level Output Voltage (3mA at SDA pin)	V <sub>OL</sub>	0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

I<sup>2</sup>C BUS Load Condition: Pull up resistance 4kΩ (Connected to +5V)  
Load capacitance 200pF (Connected to GND)



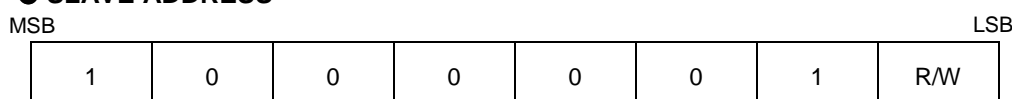
## ■ DEFINITION OF I<sup>2</sup>C REGISTER

### ● I<sup>2</sup>C BUS FORMAT



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

### ● SLAVE ADDRESS



R/W=0: Receive Only

### ● CONTROL REGISTER TABLE

The select address sets each function (Volume, Balance, AGC, Surround, Tone Control).

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					SR1	SR0	
02H	BCB	BASS				BCSB	SUB-BASS		
03H	BCT	TREB				BCST	SUB-TREB		
04H	Don't Care								
05H	OUT	SEL			AGC1	AGC0	AGC	Don't Care	

### ● CONTROL REGISTER DEFAULT VALUE

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

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## ■ I<sup>2</sup>C CONTROL COMMAND DESCRIPTION

### ● MASTER VOLUME CONTROL

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

The attenuator is consisted of both the Volume1 and Volume2. The total attenuation level is summing of each attenuation level of the Volume1 and Volume2. The attenuation for both the Volume1 and Volume2 are always synchronized to have the same attenuation levels for each other, and are not controllable independently for each other.

- "VOL" : Sets the total attenuation level for the both Ach and Bch (up to 84dB, 0.33dB/step)

### ● CHANNEL BALANCE AND SURROUND MODE CONTROL

Select Address	BIT							
	D7	D6	D5	D4	D3	D2	D1	D0
01H	CHS	BAL					SR1	SR0

#### ◆ Channel Balance Control

To control the balance between Ach and Bch, the both commands "CHS" and "BAL" should be set. For example, to move a sound image to Ach-side, Bch should be attenuated with no attenuation on Ach. The command "CHS" defines the channel should be attenuate, and the command "BAL" defines the attenuation level itself. The attenuation for the balance control is consisted of the both Volume1 and Volume2, has the same structure with Master Volume Control described above.

- "CHS" : Defines the channel should be attenuated

The channel should be attenuated	CHS (D7)
Bch	0
Ach	1

- "BAL" : Defines the attenuation level for the specified channel with command "CHS" (up to 30dB, 1dB/Step)

#### ◆ Surround Mode Control

- "SR1", "SR0" : Surround Mode Switch

Surround Mode	SR1 (D1)	SR0 (D0)
Surround OFF (Bypass)	0	0
Simulated Surround	0	1
SRS 3D-Stereo – High Mode	1	0
SRS 3D-Stereo – Low Mode	1	1



## ●BASS-TONE CONTROL SETTING

Select Address	BIT							
	D7	D6	D5	D4	D3	D2	D1	D0
02H	BCB	BASS				BCSB	SUB-BASS	

- "BCB" : Defines the Bass-Tone Control Mode as Boost or Cut

Bass Tone Control Mode	BCB (D7)
Cut	0
Boost	1

- "BASS" : Sets the Cut or Boost level for Bass-Tone Control(up to 15dB, 1dB/Step)

- "BCSB" : Defines the Sub-Bass-Tone Control Mode as Boost or Cut

Sub-Bass Tone Control Mode	BCSB (D2)
Cut	0
Boost	1

- "SUB-BASS" : Sets the Cut or Boost level for Sub-Bass-Tone Control(up to 3dB, 1dB/Step)

## ●TREBLE-TONE CONTROL SETTING

Select Address	BIT							
	D7	D6	D5	D4	D3	D2	D1	D0
03H	BCT	TREB				BCST	SUB-TREB	

- "BCT" : Defines the Treble-Tone Control Mode as Boost or Cut

Treble-Tone Control Mode	BCT (D7)
Cut	0
Boost	1

- "TREB" : Sets the Cut or Boost level for Treble-Tone Control(up to 15dB, 1dB/Step)

- "BCST" : Defines the Sub-Treble-Tone Control Mode as Boost or Cut

Sub-Treble-Tone Control Mode	BCST (D2)
Cut	0
Boost	1

- "SUB-TREB" : Sets the Cut or Boost level for Sub-Treble-Tone Control(up to 3dB, 1dB/Step)

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## ●OUTPUT ON/OFF, INPUT SELECTOR, AGC and BBE ON/OFF CONTROL

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

### ◆Output ON/OFF

- "OUT" : Output ON/OFF Switch

Output	OUT (D7)
Output OFF(Mute)	0
Output ON	1

### ◆Input Selector

- "SEL" : Input Selector Control

### ◆AGC Control

- "AGC1", "AGC0" : Set the AGC Flat Level
- "AGC" : AGC ON/OFF Switch

AGC Flat Level	AGC1 (D3)	AGC0 (D2)	AGC (D1)
300mVrms	0	0	1
400mVrms	0	1	1
500mVrms	1	0	1
600mVrms	1	1	1
AGC OFF	-	-	0

## ■ I<sup>2</sup>C CONTROL COMMAND SETTING TABLE

### ● MASTER VOLUME CONTROL(Select Address : 00H)

Gain (dB)	HEX	VOL							
		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

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(MASTER VOLUME CONTROL cont'd)

Gain (dB)	HEX	VOL							
		D7	D6	D5	D4	D3	D2	D1	D0
-41	84	1	0	0	0	0	1	0	0
-42	81	1	0	0	0	0	0	0	1
-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

●CHANNEL BALANCE CONTROL(Select Address : 01H)

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

# NJW1140

●BASS-TONE CONTROL(Select Address : 02H)  
/ TREBLE-TONE CONTROL(Select Address : 03H)

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


●SUB-BASS-TONE CONTROL(Select Address : 02H)  
/ SUB-TREBLE-TONE CONTROL(Select Address : 03H)

		SUB-BASS SUB-TREB	
Cut Gain(dB)	Boost Gain(dB)	D1	D0
0	0	0	0
-1	1	0	1
-2	2	1	0
-3	3	1	1

●Input Selector Control(Select Address : 05H)

		SEL		
Input Channel Selected		D6	D5	D4
1		0	0	0
2		0	0	1
3		0	1	0
4		0	1	1
5		1	0	0
6		1	0	1

## ■ NOTE

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