

# AN7396K

## Sound signal processing with built-in Spatializer IC

### Overview

Spatializer Audio Processor is a signal processing technology, monopolized by Desper Products, Inc., that was developed for commercial electronics and multimedia markets, and is based on Desper's "PRO Spatializer" that is a 3-D audio production system for business use. The AN7396K utilizes the innovative technology adopted in that system. It provides sound enhancement effect and sound expansion with the conventional 2-speaker stereo system. Moreover, the AN7396K is a sound processing IC which incorporates the I<sup>2</sup>C Bus-controllable mute, sound AGC, bass reinforcement, tone (bass and treble), balance, and volume circuits.

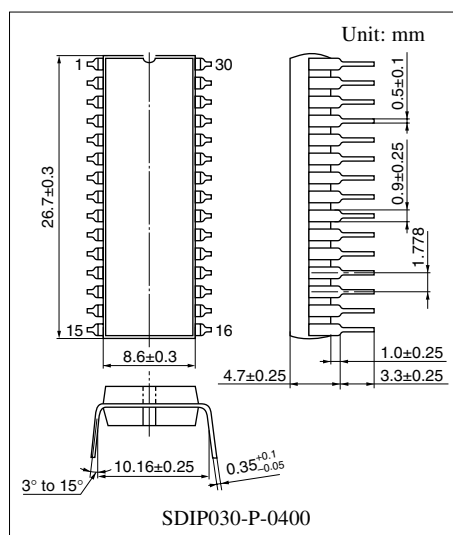
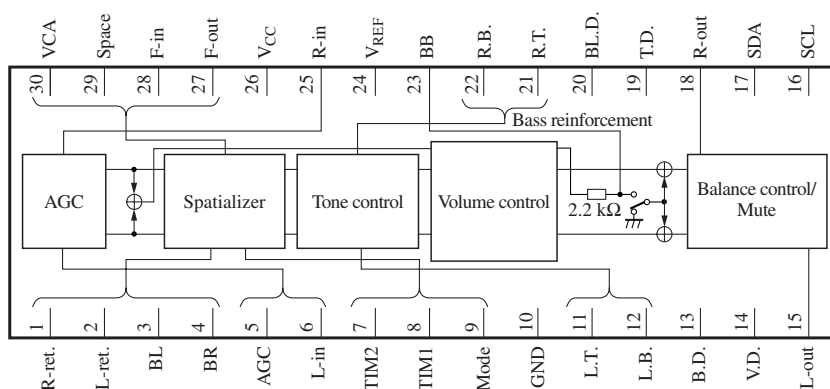
### Features

- Provides deep 3-D sound with conventional 2-speaker system.
- Performs optimal processing to the sound source recorded with surround-effect so as not to give double effects.
- Provides the functions of muting, AGC, bass reinforcement, tone, balance, and volume control.
- Supports I<sup>2</sup>C Bus controls.

### Applications

- Televisions, videos, audio equipment, and game machines

### Block Diagram



Note) Spatializer® and the device trademark of circle-in-square are owned by Desper Products Inc..

This product can be used with the consent of the Desper Products Inc..

Under the terms of the agreement between Matsushita Electronics and Desper Products Inc., no technical information on the Spatializer, which is applied to this product, shall be provided.

## ■ Pin Descriptions

Pin No.	Description	Pin No.	Description
1	R-ret.	16	I <sup>2</sup> C communication clock
2	L-ret.	17	I <sup>2</sup> C communication data
3	BL out	18	R-ch. output
4	BR out	19	Treble DAC output
5	AGC	20	Balance DAC output
6	L-ch. input	21	R-ch. treble F <sub>C</sub> set
7	TIM2	22	R-ch. bass F <sub>C</sub> set
8	TIM1	23	Bass MIX F <sub>C</sub> adjustment
9	Mode DAC output	24	1/2 V <sub>CC</sub>
10	GND	25	R-ch. input
11	L-ch. treble F <sub>C</sub> set	26	Power supply
12	L-ch. bass F <sub>C</sub> set	27	F-out
13	Bass DAC output	28	F-in
14	Volume DAC output	29	Space
15	L-ch. output	30	VCA

## ■ Absolute Maximum Ratings

Parameter	Symbol	Rating	Unit
Supply voltage	V <sub>CC</sub>	11.0	V
Supply current	I <sub>CC</sub>	90	mA
Power dissipation	P <sub>D</sub>	990	mW
Operating ambient temperature *	T <sub>opr</sub>	−25 to +75	°C
Storage temperature *	T <sub>stg</sub>	−55 to +150	°C

Note) \*: Except for the operating ambient temperature and storage temperature, all ratings are for T<sub>a</sub> = 25°C.

## ■ Recommended Operating Range

Parameter	Symbol	Range	Unit
Supply voltage	V <sub>CC</sub>	6.0 to 10.0	V

■ Electrical Characteristics at  $V_{CC} = 9\text{ V}$ ,  $T_a = 25^\circ\text{C} \pm 2^\circ\text{C}$

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Volume max. level *1	$VV_{\max}$	$V_{IN} = 1\text{ V[rms]}$ , $f = 1\text{ kHz}$	-1	0	1	dB
Volume 1/2 level *1	$VV_{1/2}$	$V_{IN} = 1\text{ V[rms]}$ , $f = 1\text{ kHz}$	-14.5	-12.5	-10.5	dB
Volume min. level *1	$VV_{\min}$	$V_{IN} = 1\text{ V[rms]}$ , $f = 1\text{ kHz}$	—	-100	-90	dB
Balance max. level *1	$VB_{\max}$	$V_{IN} = 1\text{ V[rms]}$ , $f = 1\text{ kHz}$	-1	0	1	dB
Balance min. level *1	$VB_{\min}$	$V_{IN} = 1\text{ V[rms]}$ , $f = 1\text{ kHz}$	—	-82	-80	dB
Bus bootstrap level	$V_{BB}$	$V_{IN} = 400\text{ mV[rms]}$ , $f = 50\text{ Hz}$	10	12.5	15	dB
Bus cut level	$V_{BC}$	$V_{IN} = 400\text{ mV[rms]}$ , $f = 50\text{ Hz}$	-13.5	-11.0	-8.5	dB
Treble bootstrap level	$V_{TB}$	$V_{IN} = 400\text{ mV[rms]}$ , $f = 20\text{ kHz}$	10	12.5	15	dB
Treble cut level	$V_{TC}$	$V_{IN} = 400\text{ mV[rms]}$ , $f = 20\text{ kHz}$	-13.5	-11.0	-8.5	dB
Circuit current *1	$I_{CCT}$	$V_{IN} = 0\text{ mV}$	45	65	90	mA
Total harmonic distortion max. *1	$THD_{\max}$	$V_{IN} = 1\text{ V[rms]}$ , $f = 1\text{ kHz}$	—	0.1	0.3	%
Maximum input voltage *1	$V_{I\max}$	$THD = 1\%$ , $f = 1\text{ kHz}$	2.0	2.2	—	V[rms]
Muting level *1	$VMUTE$	$V_{IN} = 1\text{ V[rms]}$ , $f = 1\text{ kHz}$	—	-100	-90	dB
Noise level at volume max. *2	$V_{N\max}$	$V_{IN} = 0\text{ mV}$ , $R_G = 4.7\text{ k}\Omega$	—	82	120	$\mu\text{V[rms]}$
Noise level at volume min. *2	$V_{N\min}$	$V_{IN} = 0\text{ mV}$ , $R_G = 4.7\text{ k}\Omega$	—	4	10	$\mu\text{V[rms]}$
Bass reinforcement max. level	$VXB_{\max}$	$V_{IN} = 400\text{ mV[rms]}$ , $f = 50\text{ Hz}$	7	9	11	dB
Bass reinforcement min. level	$VXB_{\min}$	$V_{IN} = 400\text{ mV[rms]}$ , $f = 50\text{ Hz}$	2	4	6	dB
Level at surround max. *1	$V_{SU1}$	$V_{IN} = 50\text{ mV[rms]}$ , $f = 1\text{ kHz}$	415	600	750	mV[rms]
Noise level at surround max. *2	$V_{SN}$	$V_{IN} = 0\text{ mV}$ , $R_G = 4.7\text{ k}\Omega$	—	110	150	$\mu\text{V[rms]}$
Total harmonic distortion at surround max. *1	$THD_{SU}$	$V_{IN} = 50\text{ mV[rms]}$ , $f = 1\text{ kHz}$	—	0.1	0.3	%
Crosstalk *2	$CT$	$V_{IN} = 1\text{ V[rms]}$ , $f = 1\text{ kHz}$	—	-78	-66	dB
Channel balance (max.) *1	$CB_{\max}$	$V_{IN} = 1\text{ V[rms]}$ , $f = 1\text{ kHz}$	-1	0	1	dB
Channel balance (1/4) *1	$CB_{1/4}$	$V_{IN} = 1\text{ V[rms]}$ , $f = 1\text{ kHz}$	-2	0	2	dB
AGC						
AGC gain 1 *1	$V_{AGC1}$	$V_{IN} = 50\text{ mV[rms]}$ , $f = 1\text{ kHz}$	77	110	150	mV[rms]
AGC gain 2 *1	$V_{AGC2}$	$V_{IN} = 1\text{ V[rms]}$ , $f = 1\text{ kHz}$	230	345	470	mV[rms]
I <sup>2</sup> C interface						
Sink current at ACK	$I_{ACK}$	The maximum value of sink current of pin 17 at ACK	2.0	10	—	mA
SCL, SDA signal input high-level	$V_{IHI}$		3.5	—	5.0	V
SCL, SDA signal input low-level	$V_{ILO}$		0	—	0.5	V
Maximum input frequency	$f_{I\max}$		—	—	100	Kbit/s

Note) \*1: The DIN audio filter is used.

\*2: The A-curve filter is used.

# ■ Electrical Characteristics at $V_{CC} = 9\text{ V}$ , $T_a = 25^\circ\text{C} \pm 2^\circ\text{C}$ (continued)

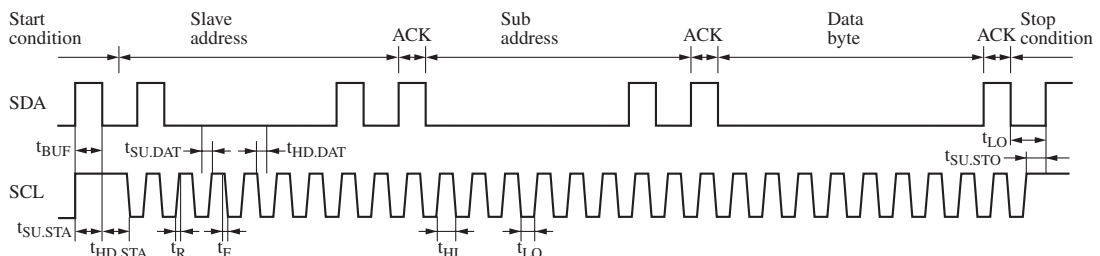
## • Design reference data

Note) The characteristics listed below are theoretical values based on the IC design and are not guaranteed.

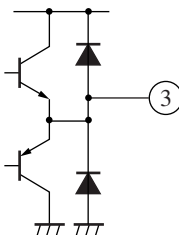
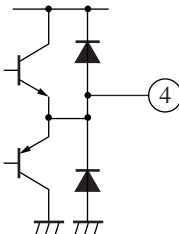
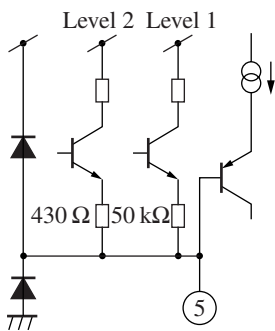
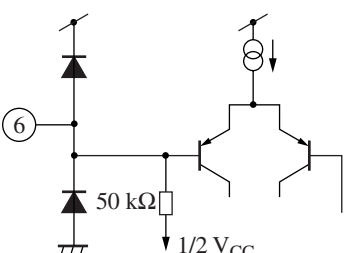
Parameter	Symbol	Conditions	Min	Typ	Max	Unit
<b>I<sup>2</sup>C Interface</b>						
Bus free before start	$t_{BUF}$		4.0	—	—	$\mu\text{s}$
Start condition set-up time	$t_{SU, STA}$		4.0	—	—	$\mu\text{s}$
Start condition hold time	$t_{HD, STA}$		4.0	—	—	$\mu\text{s}$
SCL/SDA low period	$t_{LO}$		4.0	—	—	$\mu\text{s}$
SCL high period	$t_{HI}$		4.0	—	—	$\mu\text{s}$
SCL/SDA rise time	$t_R$		—	—	1.0	$\mu\text{s}$
SCL/SDA fall time	$t_F$		—	—	0.35	$\mu\text{s}$
Data set-up time (write)	$t_{SU, DAT}$		0.25	—	—	$\mu\text{s}$
Data hold time (write)	$t_{HD, DAT}$		0	—	—	$\mu\text{s}$
Acknowledge set-up time	$t_{SU, ACK}$		—	—	3.5	$\mu\text{s}$
Acknowledge hold time	$t_{HD, ACK}$		0	—	—	$\mu\text{s}$
Stop condition set-up time	$t_{SU, STO}$		4.0	—	—	$\mu\text{s}$
<b>DAC</b>						
6-bit DAC DNLE	$L_6$	1 LSB = (Data(max.) – Data(00))/63	0.1	1.0	1.9	$\frac{\text{LSB}}{\text{step}}$
AGC gain 3 (Sub address 04H: 05H) *1	$V_{AGC3}$	$V_{IN} = 100\text{ mV[rms]}$ , $f = 1\text{ kHz}$	—	150	—	mV[rms]
AGC gain 4 (Sub address 04H: 03H) *1	$V_{AGC4}$	$V_{IN} = 140\text{ mV[rms]}$ , $f = 1\text{ kHz}$	—	200	—	mV[rms]
AGC gain 5 (Sub address 04H: 01H) *1	$V_{AGC5}$	$V_{IN} = 200\text{ mV[rms]}$ , $f = 1\text{ kHz}$	—	250	—	mV[rms]
AGC gain 6 (Sub address 04H: 07H) *1	$V_{AGC6}$	$V_{IN} = 280\text{ mV[rms]}$ , $f = 1\text{ kHz}$	—	350	—	mV[rms]
AGC gain 7 (Sub address 04H: 03H) *1	$V_{AGC7}$	$V_{IN} = 500\text{ mV[rms]}$ , $f = 1\text{ kHz}$	180	290	430	mV[rms]

Note) \*1: The DIN audio filter is used.

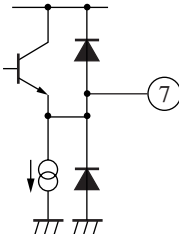
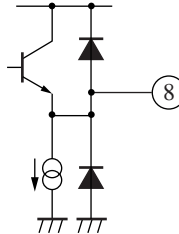
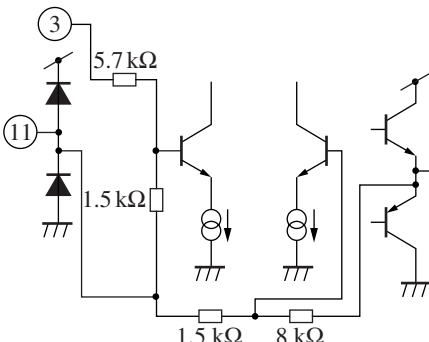
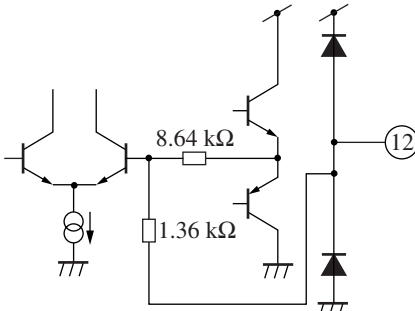
## • DAC timing chart



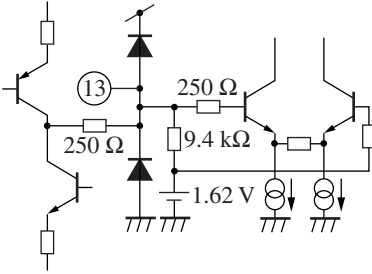
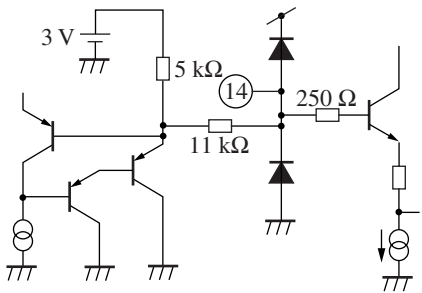
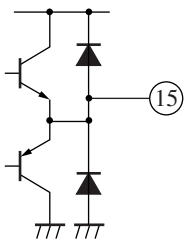
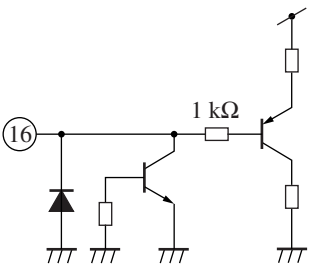
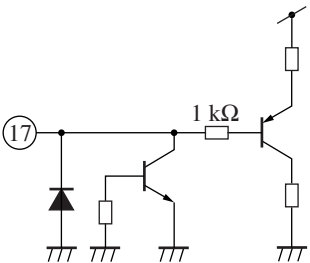
■ Terminal Equivalent Circuits at  $V_{CC} = 9\text{ V}$ ,  $T_a = 25^\circ\text{C}$

Pin No.	Pin name	Equivalent circuit	Description	Voltage (V)
1	R-ret.	—	R return	4.5
2	L-ret.	—	L return	4.5
3	BL out		L-ch. Spatializer output	4.5
4	BR out		R-ch. Spatializer output	4.5
5	AGC		AGC level sensor	This parameter fluctuates with the input level. 0.5 to 2.0
6	L-in		L-ch. input	4.5

**■ Terminal Equivalent Circuits at  $V_{CC} = 9\text{ V}$ ,  $T_a = 25^\circ\text{C}$  (continued)**

Pin No.	Pin name	Equivalent circuit	Description	Voltage (V)
7	TIM2		RMS detector 2	0.6
8	TIM1		RMS detector 1	0.6
9	MD	—	Mode DAC output	This parameter fluctuates with I <sup>2</sup> C data. 0.7 to 2.4
10	GND	—	Ground	0
11	L.T.		L-ch. treble $F_C$ set	4.5
12	L.B.		L-ch. bass $F_C$ set	4.5

■ Terminal Equivalent Circuits at  $V_{CC} = 9\text{ V}$ ,  $T_a = 25^\circ\text{C}$  (continued)

Pin No.	Pin name	Equivalent circuit	Description	Voltage (V)
13	B.D.		Bass DAC output	This parameter fluctuates with I <sup>2</sup> C data. 1.1 to 2.3
14	V.D.		Volume DAC output	This parameter fluctuates with I <sup>2</sup> C data. 2 to 3.8
15	L-out		L-ch. output	4.5
16	SCL		I <sup>2</sup> C Bus clock input	—
17	SDA		I <sup>2</sup> C Bus data input	—

**■ Terminal Equivalent Circuits at  $V_{CC} = 9\text{ V}$ ,  $T_a = 25^\circ\text{C}$  (continued)**

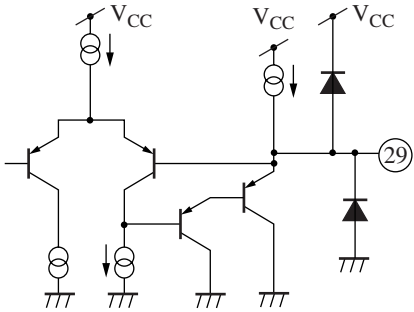
Pin No.	Pin name	Equivalent circuit	Description	Voltage (V)
18	R-out		R-ch. output	4.5
19	T.D.		Treble DAC output	This parameter fluctuates with I <sup>2</sup> C data. 1.1 to 2.3
20	BL.D.		Balance DAC output	This parameter fluctuates with I <sup>2</sup> C data. 2 to 3
21	R.T.		R-ch. treble F <sub>C</sub> set	4.5



■ Terminal Equivalent Circuits at  $V_{CC} = 9\text{ V}$ ,  $T_a = 25^\circ\text{C}$  (continued)

Pin No.	Pin name	Equivalent circuit	Description	Voltage (V)
22	R.B.		R-ch. bass $F_C$ set	4.5
23	BB		Bass MIX gain adjustment	4.5
24	$V_{REF}$		Reference voltage stabilization	4.5
25	R-in		R-ch. input	4.5
26	$V_{CC}$	None	Power supply	$V_{CC}$
27	F-out	—	F out	4.5
28	F-in	—	F in	4.5

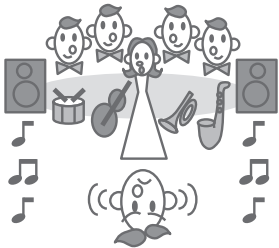
■ Terminal Equivalent Circuits at  $V_{CC} = 9\text{ V}$ ,  $T_a = 25^\circ\text{C}$  (continued)

Pin No.	Pin name	Equivalent circuit	Description	Voltage (V)
29	Space		Space	This parameter fluctuates with $I^2C$ data. 2 to 3
30	VCA	—	VCA	This parameter fluctuates with $I^2C$ data. 2 to 3

■ Conceptual Explanation of Spatializer Operation

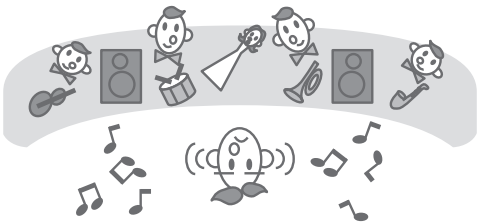
• Normal stereo

All sounds are heard from only between two speakers, right and left.



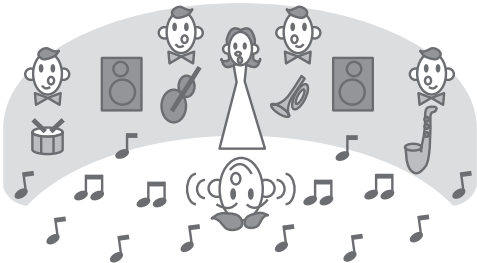
• Conventional surround

The sound expands toward the outside of the speaker system, but the sound position comes apart mostly in the conventional systems.



• Spatializer

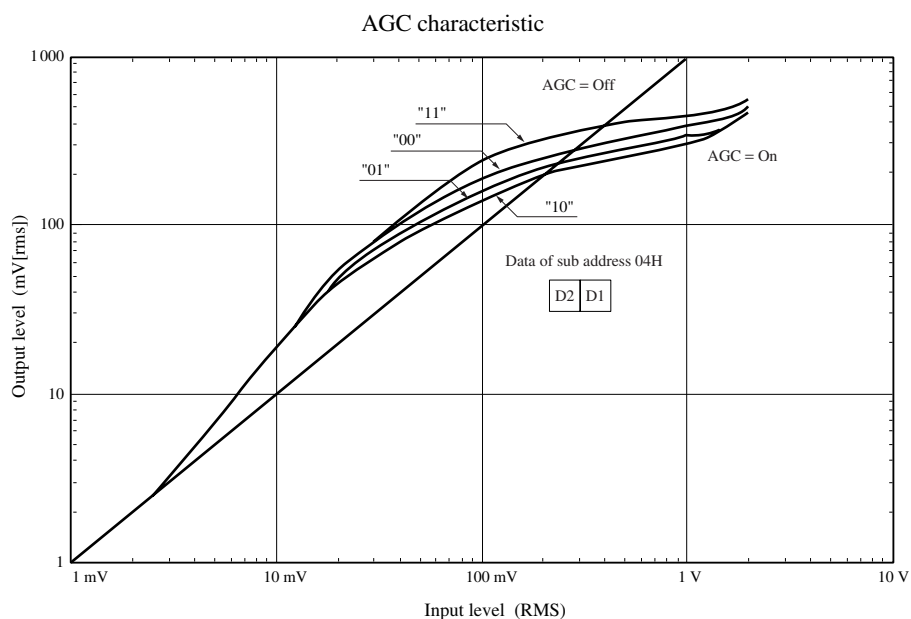
The sound expands toward the outside of the two speakers, and yet their positions are stable and an expanded, deep sound are gotten.



## ■ Precautions in Use and Application Method

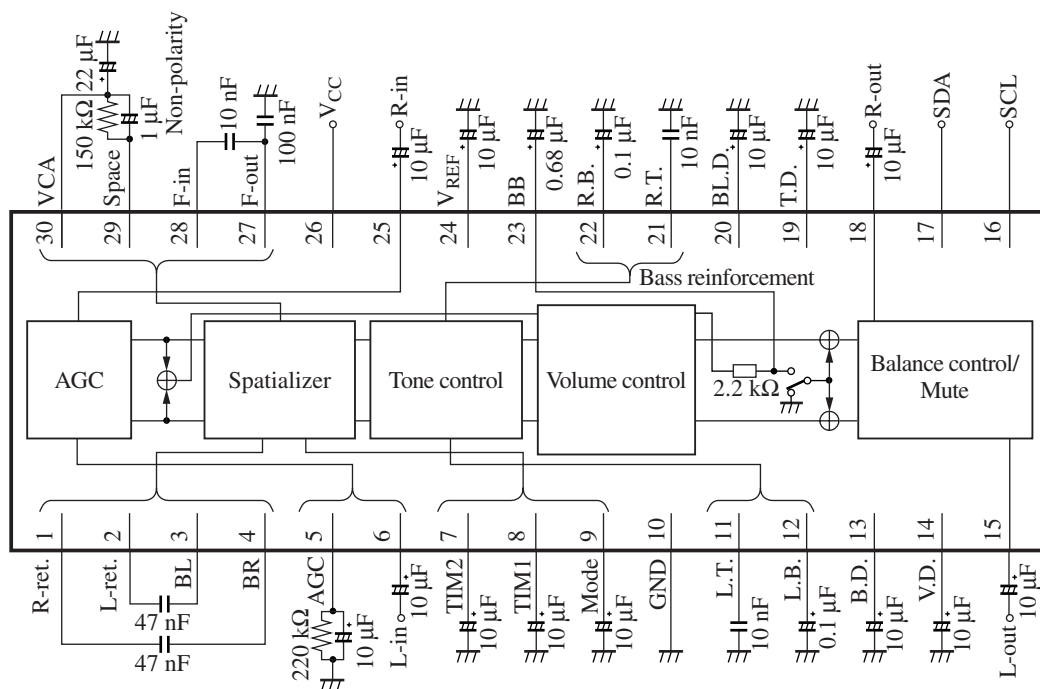
### • Method of setting AGC control

Turning on AGC, AGC is set to 0 dB for small signals, “Bootstrap” for medium signals, and “Gain Reduction” for large signals. The AGC input-output characteristics can be controlled by I<sup>2</sup>C as follows.

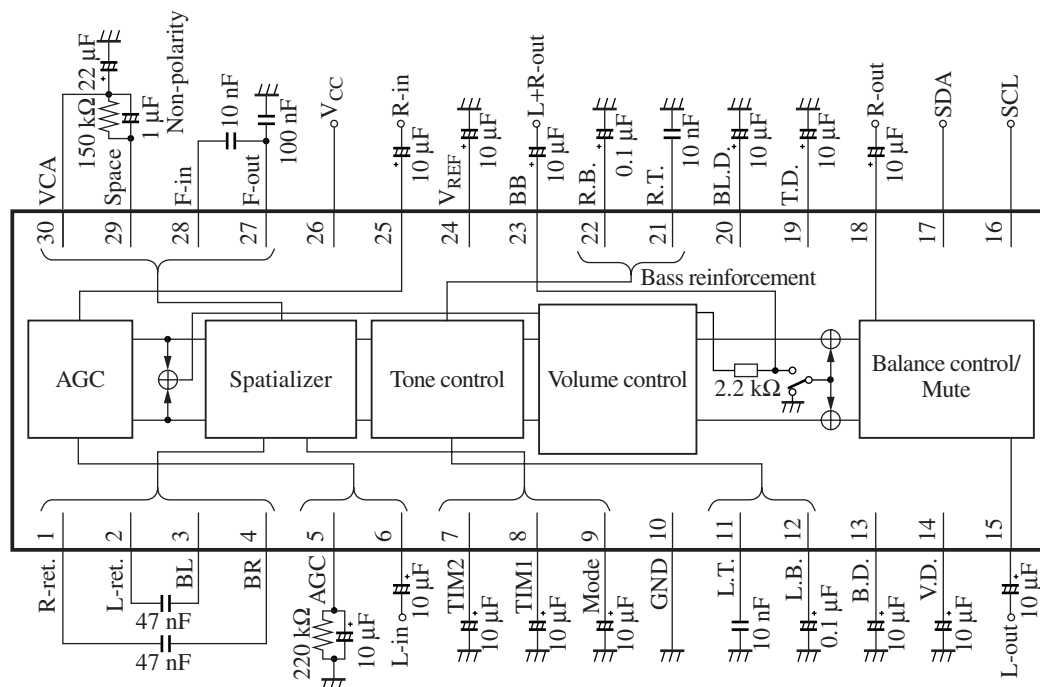


## ■ Application Circuit Examples

- Bass reinforcement circuit example



- Application circuit example of obtaining L+R output instead of bass reinforcement



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