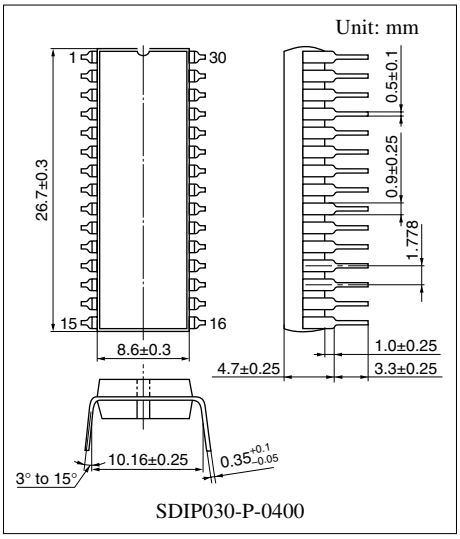
AN7396K

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 I²C Bus-controllable mute, sound AGC, bass reinforcement, tone (bass and treble), balance, and volume circuits.



SDIP030-P-0400

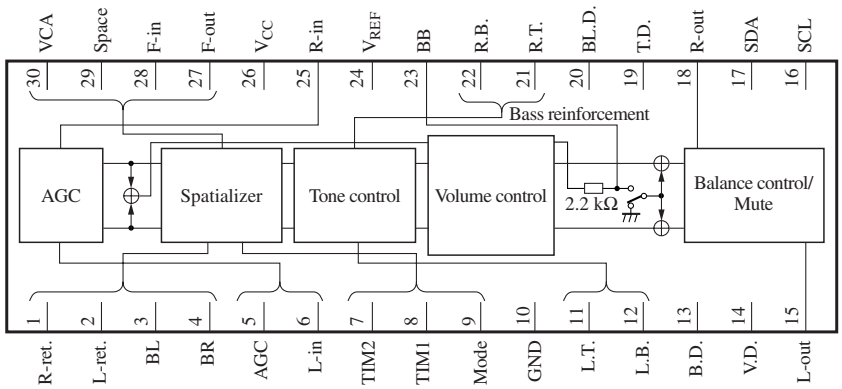
■ Features

- 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 I²C 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^2C communication clock
2	L-ret.	17	I^2C 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_C set
7	TIM2	22	R-ch. bass F_C set
8	TIM1	23	Bass MIX F_C adjustment
9	Mode DAC output	24	1/2 V_{CC}
10	GND	25	R-ch. input
11	L-ch. treble F_C set	26	Power supply
12	L-ch. bass F_C 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_{CC}	11.0	V
Supply current	I_{CC}	90	mA
Power dissipation	P_D	990	mW
Operating ambient temperature *	T_{opr}	−25 to +75	°C
Storage temperature *	T_{stg}	−55 to +150	°C

Note) ∗: Except for the operating ambient temperature and storage temperature, all ratings are for T_a = 25°C.

■ Recommended Operating Range

Parameter	Symbol	Range	Unit
Supply voltage	V_{CC}	6.0 to 10.0	V

■ Electrical Characteristics at V_{CC} = 9 V, T_a = 25°C ± 2°C

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Volume max. level *1	VV_{max}	V_{IN} = 1 V[rms], f = 1 kHz	–1	0	1	dB
Volume 1/2 level *1	$VV_{1/2}$	V_{IN} = 1 V[rms], f = 1 kHz	–14.5	–12.5	–10.5	dB
Volume min. level *1	VV_{min}	V_{IN} = 1 V[rms], f = 1 kHz	—	–100	–90	dB
Balance max. level *1	VB_{max}	V_{IN} = 1 V[rms], f = 1 kHz	–1	0	1	dB
Balance min. level *1	VB_{min}	V_{IN} = 1 V[rms], f = 1 kHz	—	–82	–80	dB
Bus bootstrap level	V_{BB}	V_{IN} = 400 mV[rms], f = 50 Hz	10	12.5	15	dB
Bus cut level	V_{BC}	V_{IN} = 400 mV[rms], f = 50 Hz	–13.5	–11.0	–8.5	dB
Treble bootstrap level	V_{TB}	V_{IN} = 400 mV[rms], f = 20 kHz	10	12.5	15	dB
Treble cut level	V_{TC}	V_{IN} = 400 mV[rms], f = 20 kHz	–13.5	–11.0	–8.5	dB
Circuit current *1	I_{CCT}	V_{IN} = 0 mV	45	65	90	mA
Total harmonic distortion max. *1	THD_{max}	V_{IN} = 1 V[rms], f = 1 kHz	—	0.1	0.3	%
Maximum input voltage *1	V_{Imax}	THD = 1%, f = 1 kHz	2.0	2.2	—	V[rms]
Muting level *1	VMUTE	V_{IN} = 1 V[rms], f = 1 kHz	—	–100	–90	dB
Noise level at volume max. *2	V_{Nmax}	V_{IN} = 0 mV, R_G = 4.7 kΩ	—	82	120	µV[rms]
Noise level at volume min. *2	V_{Nmin}	V_{IN} = 0 mV, R_G = 4.7 kΩ	—	4	10	µV[rms]
Bass reinforcement max. level	VXB_{max}	V_{IN} = 400 mV[rms], f = 50 Hz	7	9	11	dB
Bass reinforcement min. level	VXB_{min}	V_{IN} = 400 mV[rms], f = 50 Hz	2	4	6	dB
Level at surround max. *1	V_{SU1}	V_{IN} = 50 mV[rms], f = 1 kHz	415	600	750	mV[rms]
Noise level at surround max. *2	V_{SN}	V_{IN} = 0 mV, R_G = 4.7 kΩ	—	110	150	µV[rms]
Total harmonic distortion at surround max. *1	THD_{SU}	V_{IN} = 50 mV[rms], f = 1 kHz	—	0.1	0.3	%
Crosstalk *2	CT	V_{IN} = 1 V[rms], f = 1 kHz	—	–78	–66	dB
Channel balance (max.) *1	CB_{max}	V_{IN} = 1 V[rms], f = 1 kHz	–1	0	1	dB
Channel balance (1/4) *1	$CB_{1/4}$	V_{IN} = 1 V[rms], f = 1 kHz	–2	0	2	dB
AGC						
AGC gain 1 *1	V_{AGC1}	V_{IN} = 50 mV[rms], f = 1 kHz	77	110	150	mV[rms]
AGC gain 2 *1	V_{AGC2}	V_{IN} = 1 V[rms], f = 1 kHz	230	345	470	mV[rms]
I²C 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_{Imax}		—	—	100	Kbit/s

Note) ∗1: The DIN audio filter is used.
∗2: The A-curve filter is used.

■ Electrical Characteristics at V_{CC} = 9 V, T_a = 25°C ± 2°C (continued)

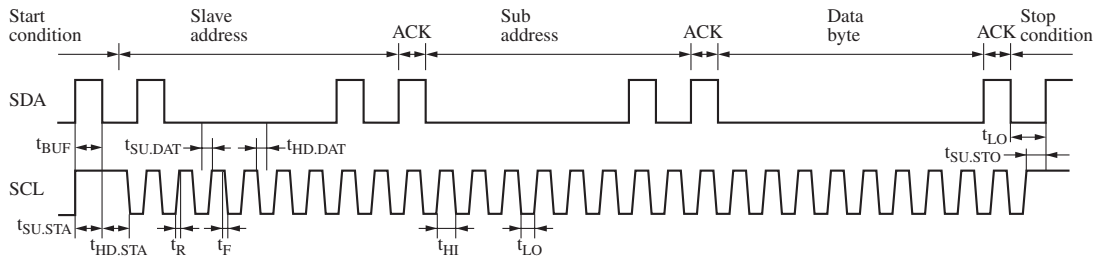
• Design reference data

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

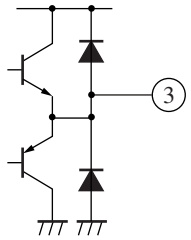
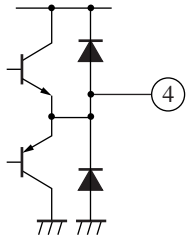
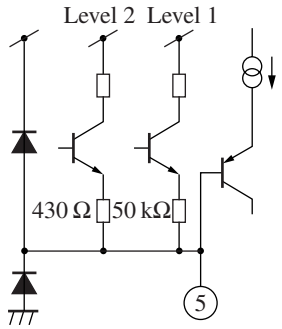
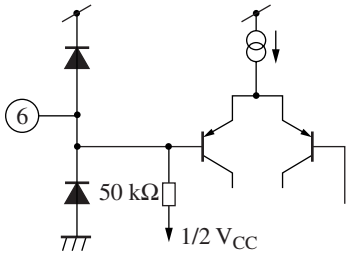
Parameter	Symbol	Conditions	Min	Typ	Max	Unit
I²C Interface						
Bus free before start	t_{BUF}		4.0	—	—	µs
Start condition set-up time	$t_{SU, STA}$		4.0	—	—	µs
Start condition hold time	$t_{HD, STA}$		4.0	—	—	µs
SCL/SDA low period	t_{LO}		4.0	—	—	µs
SCL high period	t_{HI}		4.0	—	—	µs
SCL/SDA rise time	t_R		—	—	1.0	µs
SCL/SDA fall time	t_F		—	—	0.35	µs
Data set-up time (write)	$t_{SU, DAT}$		0.25	—	—	µs
Data hold time (write)	$t_{HD, DAT}$		0	—	—	µs
Acknowledge set-up time	$t_{SU, ACK}$		—	—	3.5	µs
Acknowledge hold time	$t_{HD, ACK}$		0	—	—	µs
Stop condition set-up time	$t_{SU, STO}$		4.0	—	—	µs
DAC						
6-bit DAC DNLE	L_6	1 LSB = (Data(max.) – Data(00))/63	0.1	1.0	1.9	$\frac{LSB}{step}$
AGC gain 3 (Sub address 04H: 05H) *1	V_{AGC3}	V_{IN} = 100 mV[rms], f = 1 kHz	—	150	—	mV[rms]
AGC gain 4 (Sub address 04H: 03H) *1	V_{AGC4}	V_{IN} = 140 mV[rms], f = 1 kHz	—	200	—	mV[rms]
AGC gain 5 (Sub address 04H: 01H) *1	V_{AGC5}	V_{IN} = 200 mV[rms], f = 1 kHz	—	250	—	mV[rms]
AGC gain 6 (Sub address 04H: 07H) *1	V_{AGC6}	V_{IN} = 280 mV[rms], f = 1 kHz	—	350	—	mV[rms]
AGC gain 7 (Sub address 04H: 03H) *1	V_{AGC7}	V_{IN} = 500 mV[rms], f = 1 kHz	180	290	430	mV[rms]

Note) ∗1: The DIN audio filter is used.

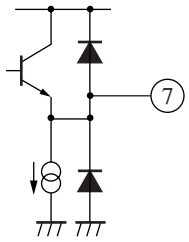
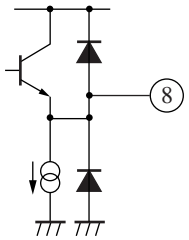
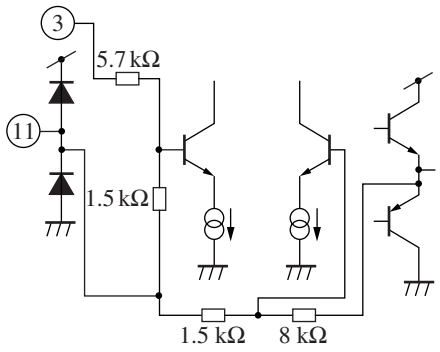
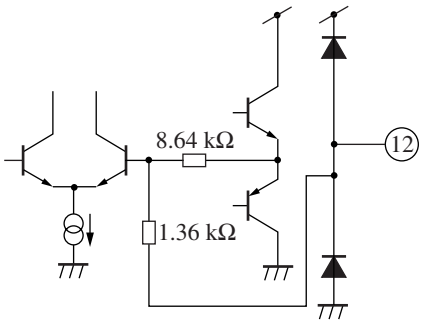
• DAC timing chart



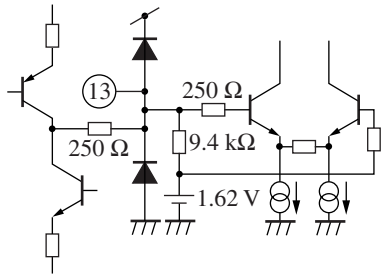
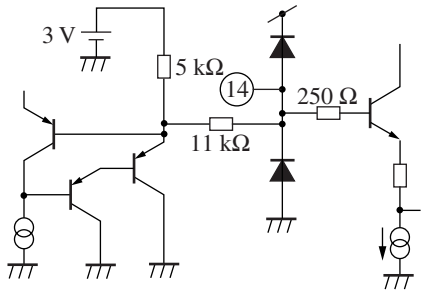
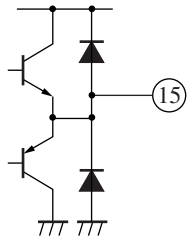
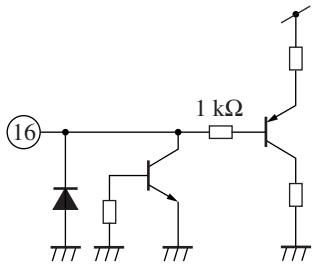
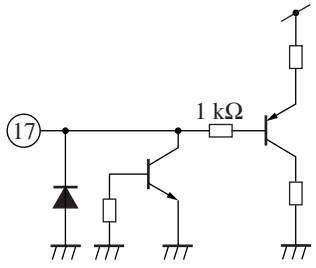
■ Terminal Equivalent Circuits at V_{CC} = 9 V, T_a = 25°C

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

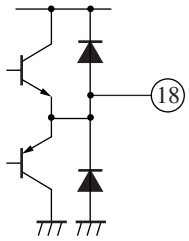
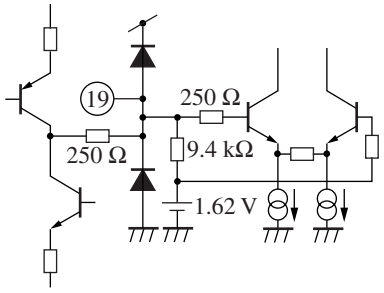
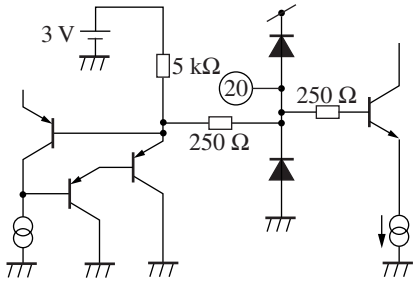
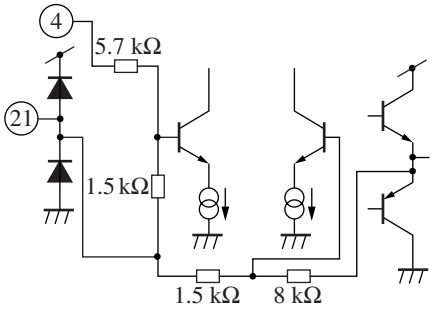
■ Terminal Equivalent Circuits at V_{CC} = 9 V, T_a = 25°C (continued)

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^2C 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

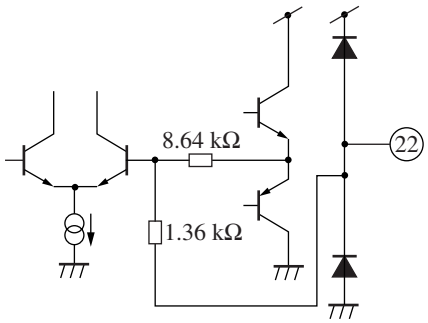
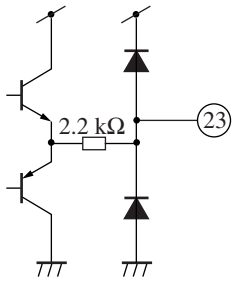
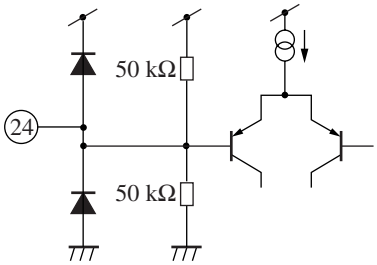
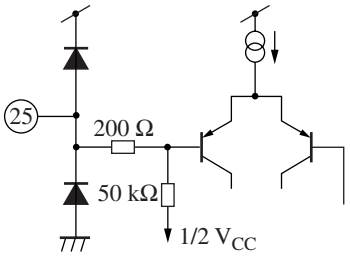
■ Terminal Equivalent Circuits at V_{CC} = 9 V, T_a = 25°C (continued)

Pin No.	Pin name	Equivalent circuit	Description	Voltage (V)
13	B.D.		Bass DAC output	This parameter fluctuates with I²C data. 1.1 to 2.3
14	V.D.		Volume DAC output	This parameter fluctuates with I²C data. 2 to 3.8
15	L-out		L-ch. output	4.5
16	SCL		I²C Bus clock input	—
17	SDA		I²C Bus data input	—

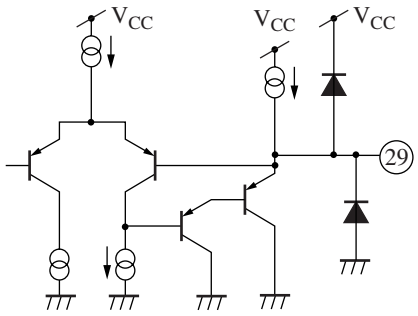
■ Terminal Equivalent Circuits at V_{CC} = 9 V, T_a = 25°C (continued)

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^2C data. 1.1 to 2.3
20	BL.D.		Balance DAC output	This parameter fluctuates with I^2C data. 2 to 3
21	R.T.		R-ch. treble F_C set	4.5

■ Terminal Equivalent Circuits at V_{CC} = 9 V, T_a = 25°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

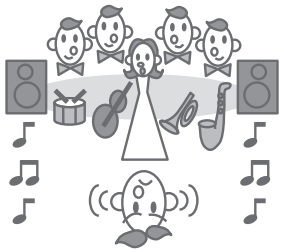
■ Terminal Equivalent Circuits at V_{CC} = 9 V, T_a = 25°C (continued)

Pin No.	Pin name	Equivalent circuit	Description	Voltage (V)
29	Space		Space	This parameter fluctuates with I²C data. 2 to 3
30	VCA	—	VCA	This parameter fluctuates with I²C data. 2 to 3

■ Conceptual Explanation of Spatializer Operation

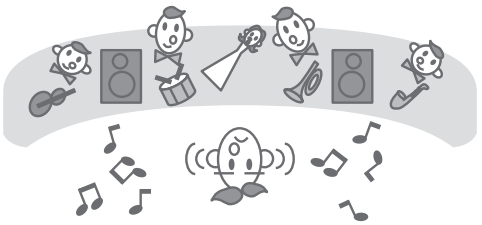
• Normal stereo

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



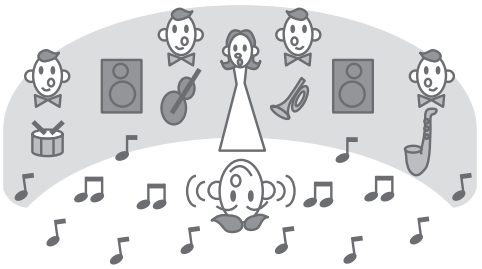
• Conventional surround

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.

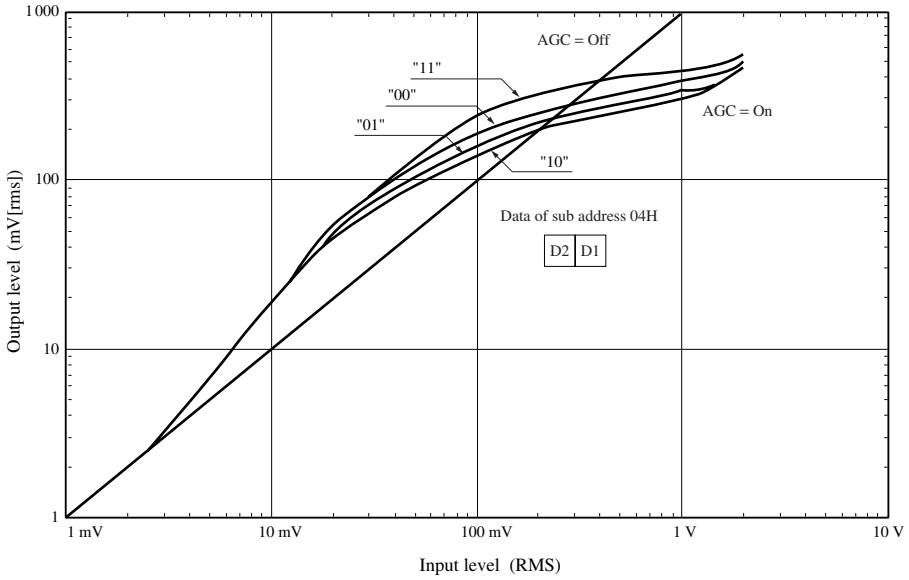


■ Precautions in Use and Application Method

• Method of setting AGC control

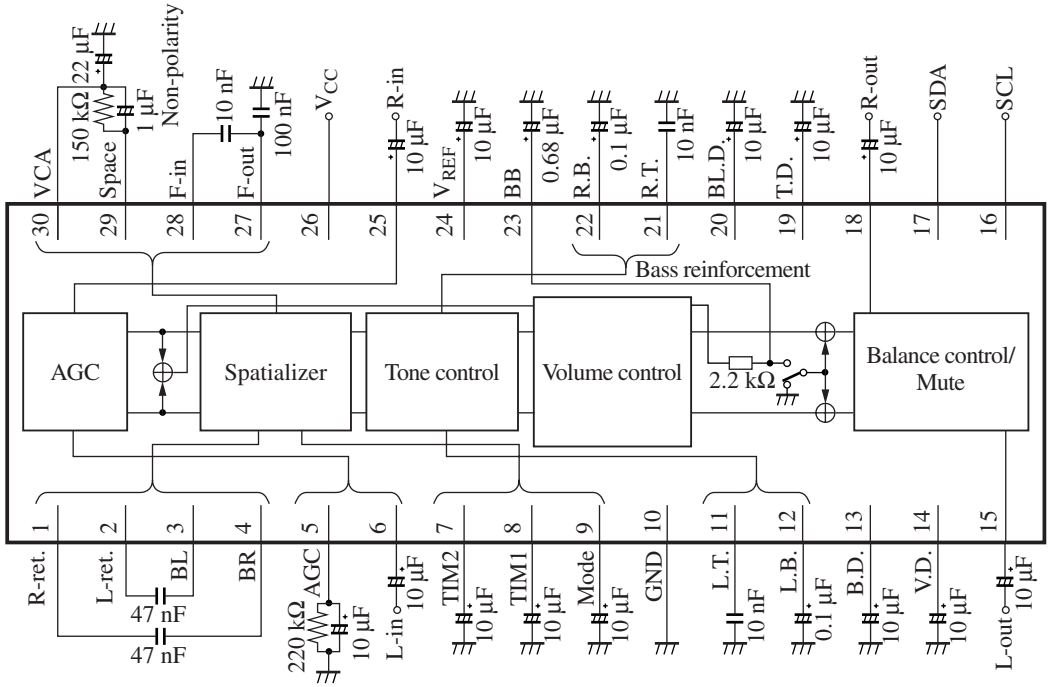
Turning on AGC, AGC is set to 0 dB for small signals, “Bootstrap” for medium signals, and “Gain Reduction” for large signals. The AGC input-output characteristics can be controlled by I²C as follows.

AGC characteristic

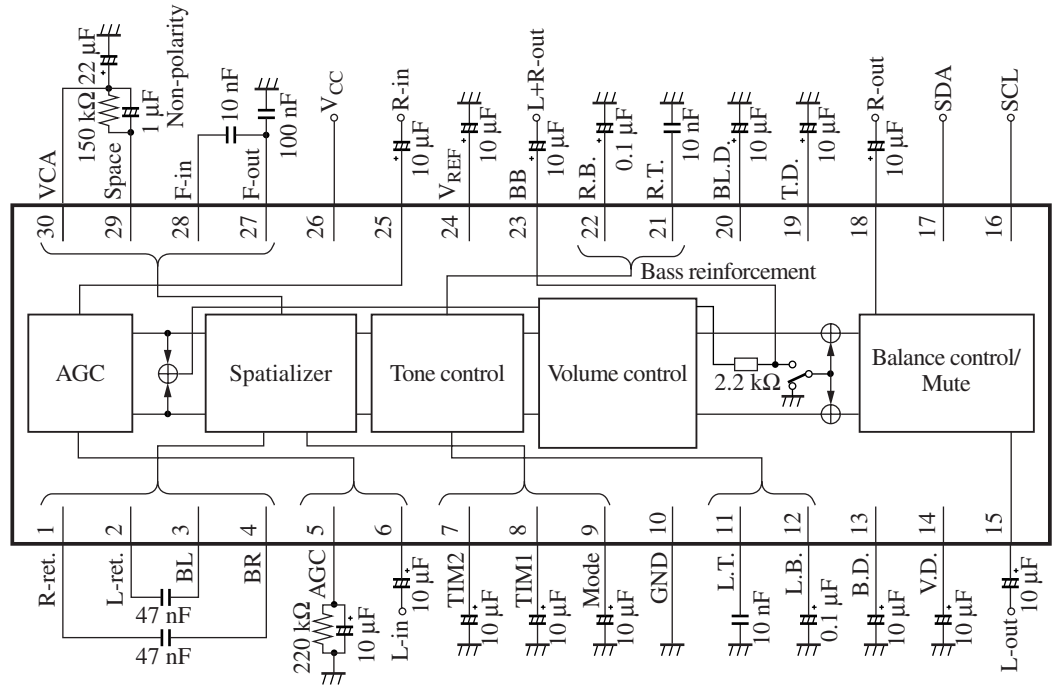


■ Application Circuit Examples

• Bass reinforcement circuit example



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



Request for your special attention and precautions in using the technical information and semiconductors described in this material

(1) An export permit needs to be obtained from the competent authorities of the Japanese Government if any of the products or technologies described in this material and controlled under the "Foreign Exchange and Foreign Trade Law" is to be exported or taken out of Japan.

(2) The technical information described in this material is limited to showing representative characteristics and applied circuit examples of the products. It does not constitute the warranting of industrial property, the granting of relative rights, or the granting of any license.

(3) The products described in this material are intended to be used for standard applications or general electronic equipment (such as office equipment, communications equipment, measuring instruments and household appliances).
Consult our sales staff in advance for information on the following applications:
- Special applications (such as for airplanes, aerospace, automobiles, traffic control equipment, combustion equipment, life support systems and safety devices) in which exceptional quality and reliability are required, or if the failure or malfunction of the products may directly jeopardize life or harm the human body.
- Any applications other than the standard applications intended.

(4) The products and product specifications described in this material are subject to change without notice for reasons of modification and/or improvement. At the final stage of your design, purchasing, or use of the products, therefore, ask for the most up-to-date Product Standards in advance to make sure that the latest specifications satisfy your requirements.

(5) When designing your equipment, comply with the guaranteed values, in particular those of maximum rating, the range of operating power supply voltage and heat radiation characteristics. Otherwise, we will not be liable for any defect which may arise later in your equipment.
Even when the products are used within the guaranteed values, redundant design is recommended, so that such equipment may not violate relevant laws or regulations because of the function of our products.

(6) When using products for which dry packing is required, observe the conditions (including shelf life and after-unpacking standby time) agreed upon when specification sheets are individually exchanged.

(7) No part of this material may be reprinted or reproduced by any means without written permission from our company.

Please read the following notes before using the datasheets

A. These materials are intended as a reference to assist customers with the selection of Panasonic semiconductor products best suited to their applications.
Due to modification or other reasons, any information contained in this material, such as available product types, technical data, and so on, is subject to change without notice.
Customers are advised to contact our semiconductor sales office and obtain the latest information before starting precise technical research and/or purchasing activities.

B. Panasonic is endeavoring to continually improve the quality and reliability of these materials but there is always the possibility that further rectifications will be required in the future. Therefore, Panasonic will not assume any liability for any damages arising from any errors etc. that may appear in this material.

C. These materials are solely intended for a customer's individual use.
Therefore, without the prior written approval of Panasonic, any other use such as reproducing, selling, or distributing this material to a third party, via the Internet or in any other way, is prohibited.

2001 MAR