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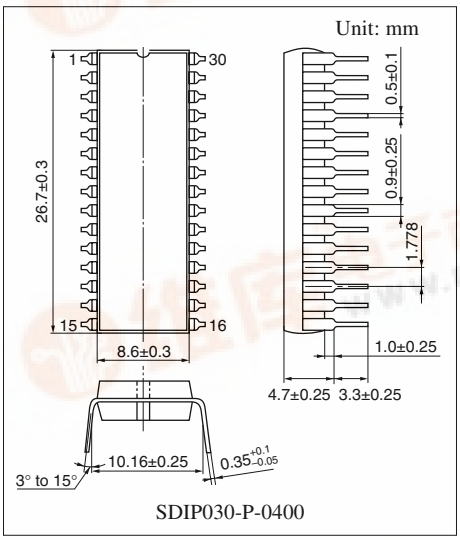
AN7396K

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

Note) The package of this product will be changed to lead-free type (SDIP030-P-0400B). See the new package dimensions section later of this datasheet.

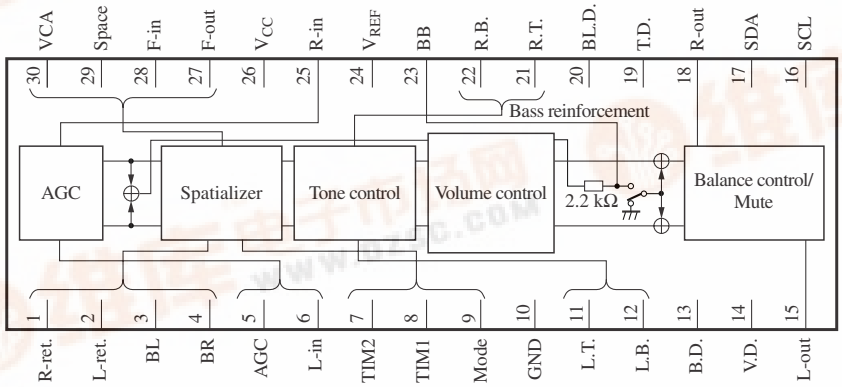
■ Features

- 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 Electric and Desper Products Inc., no technical information on the Spatializer, which is applied to this product, shall be provided.

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■ 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)

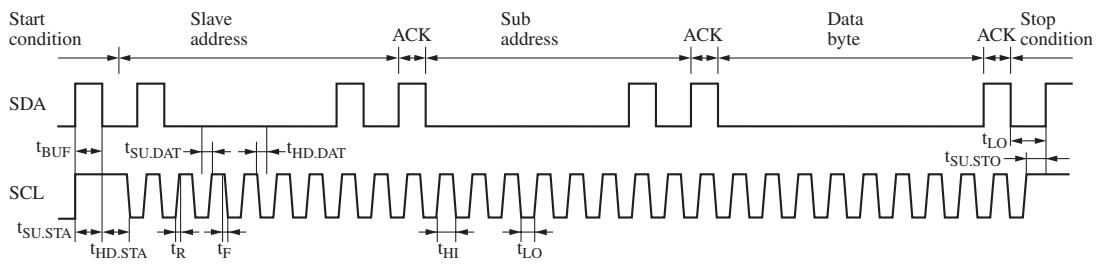
• Design reference data

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

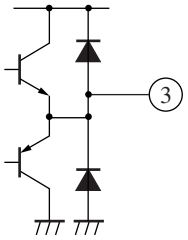
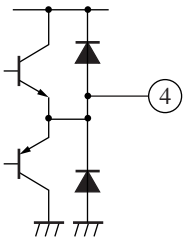
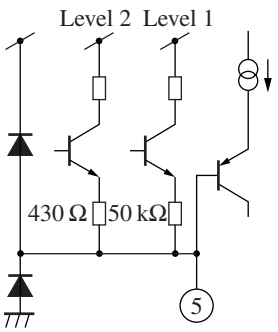
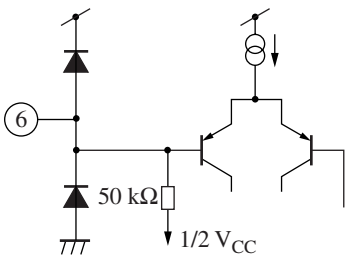
Parameter	Symbol	Conditions	Min	Typ	Max	Unit
I²C Interface						
Bus free before start	t_{BUF}		4.0	—	—	µs
Start condition set-up time	$t_{SU, STA}$		4.0	—	—	µs
Start condition hold time	$t_{HD, STA}$		4.0	—	—	µs
SCL/SDA low period	t_{LO}		4.0	—	—	µs
SCL high period	t_{HI}		4.0	—	—	µs
SCL/SDA rise time	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.

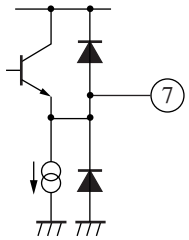
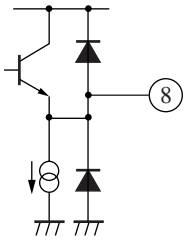
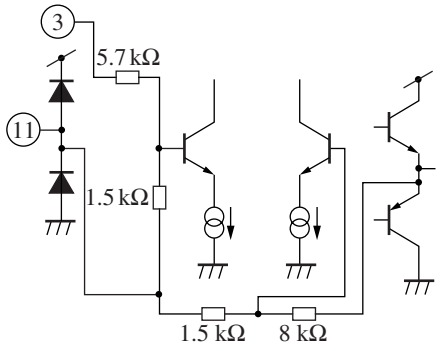
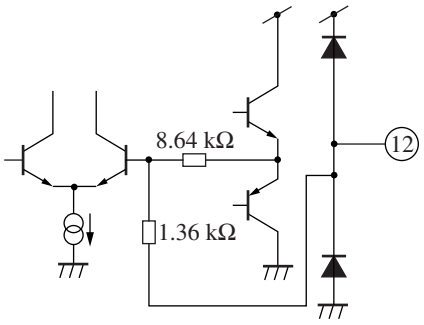
• DAC timing chart



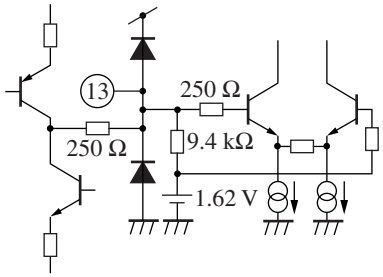
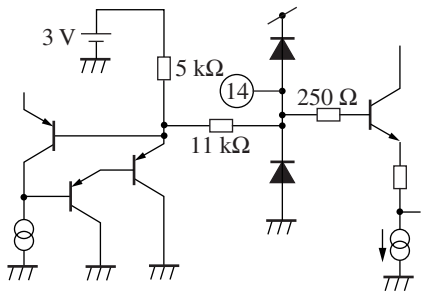
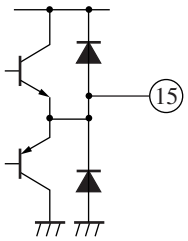
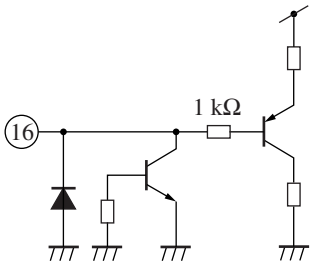
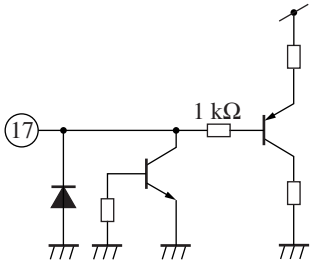
■ Terminal Equivalent Circuits at V_{CC} = 9 V, T_a = 25°C

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

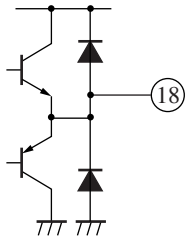
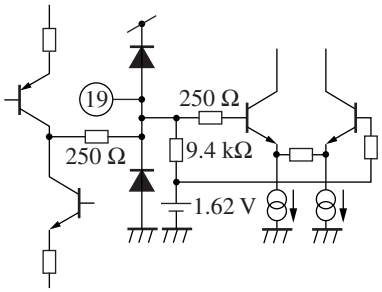
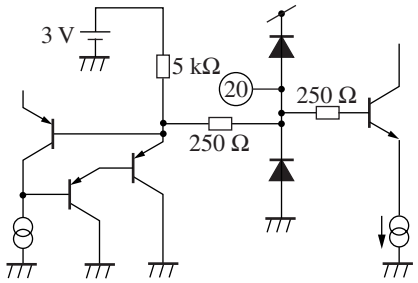
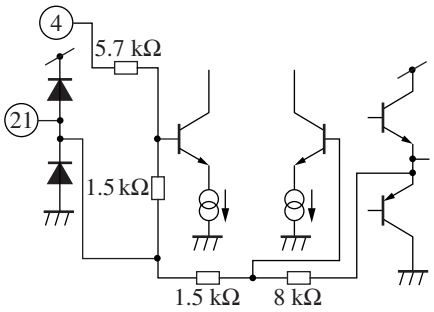
■ Terminal Equivalent Circuits at V_{CC} = 9 V, T_a = 25°C (continued)

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

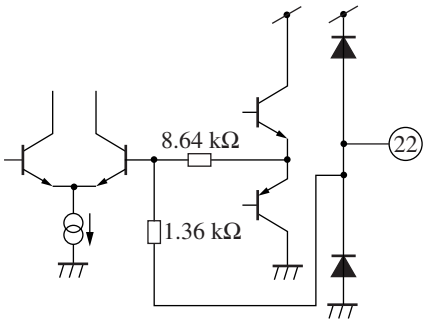
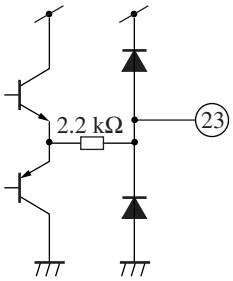
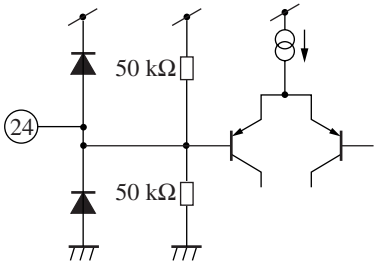
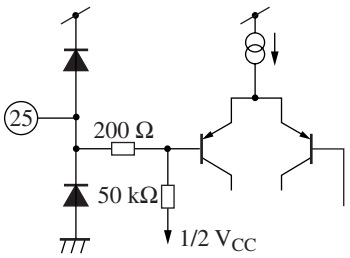
■ Terminal Equivalent Circuits at V_{CC} = 9 V, T_a = 25°C (continued)

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	—

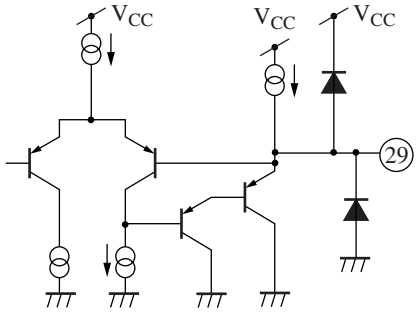
■ Terminal Equivalent Circuits at V_{CC} = 9 V, T_a = 25°C (continued)

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 I²C data. 1.1 to 2.3
20	BL.D.		Balance DAC output	This parameter fluctuates with I²C 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

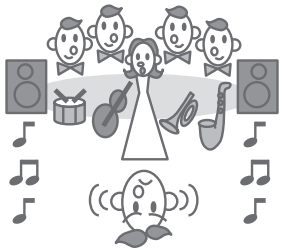
■ Terminal Equivalent Circuits at V_{CC} = 9 V, T_a = 25°C (continued)

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

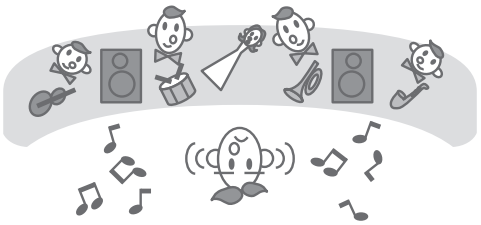
• Normal stereo

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



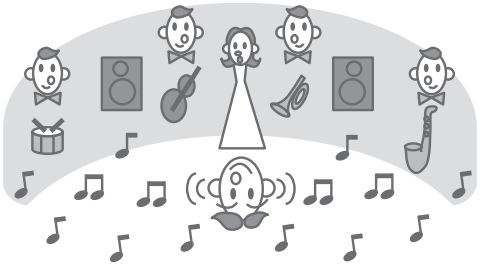
• Conventional surround

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.

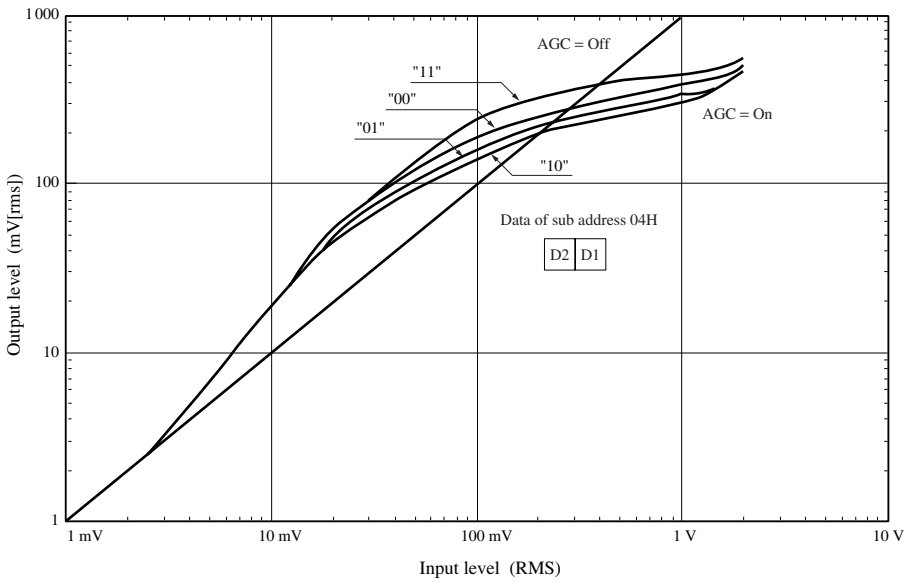


■ Precautions in Use and Application Method

• Method of setting AGC control

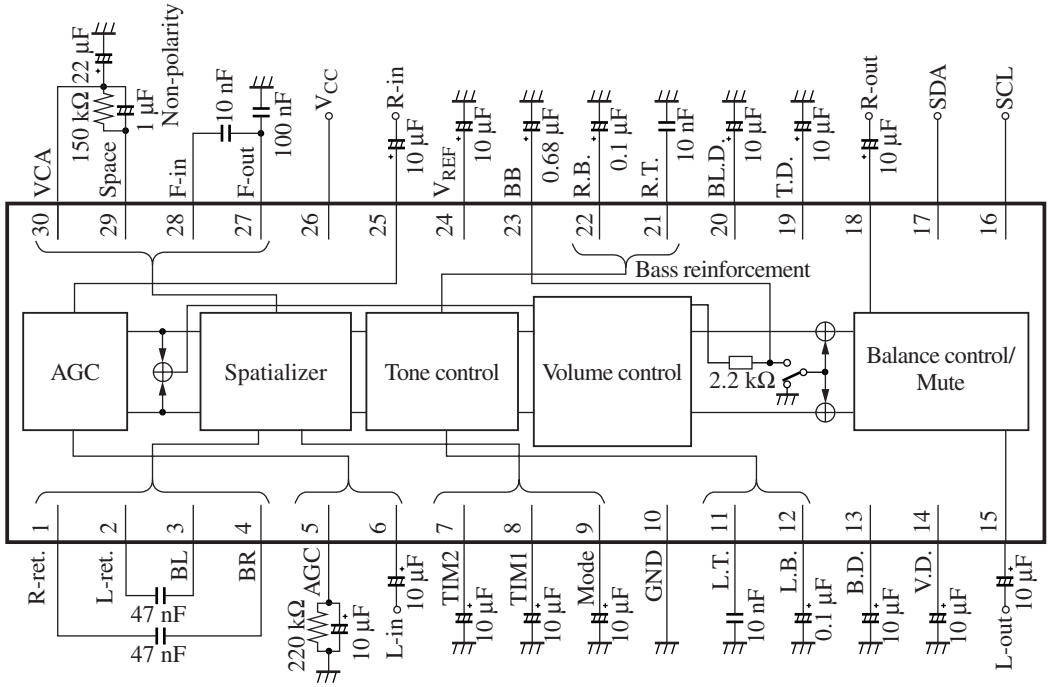
Turning on AGC, AGC is set to 0 dB for small signals, “Bootstrap” for medium signals, and “Gain Reduction” for large signals. The AGC input-output characteristics can be controlled by I^2C as follows.

AGC characteristic

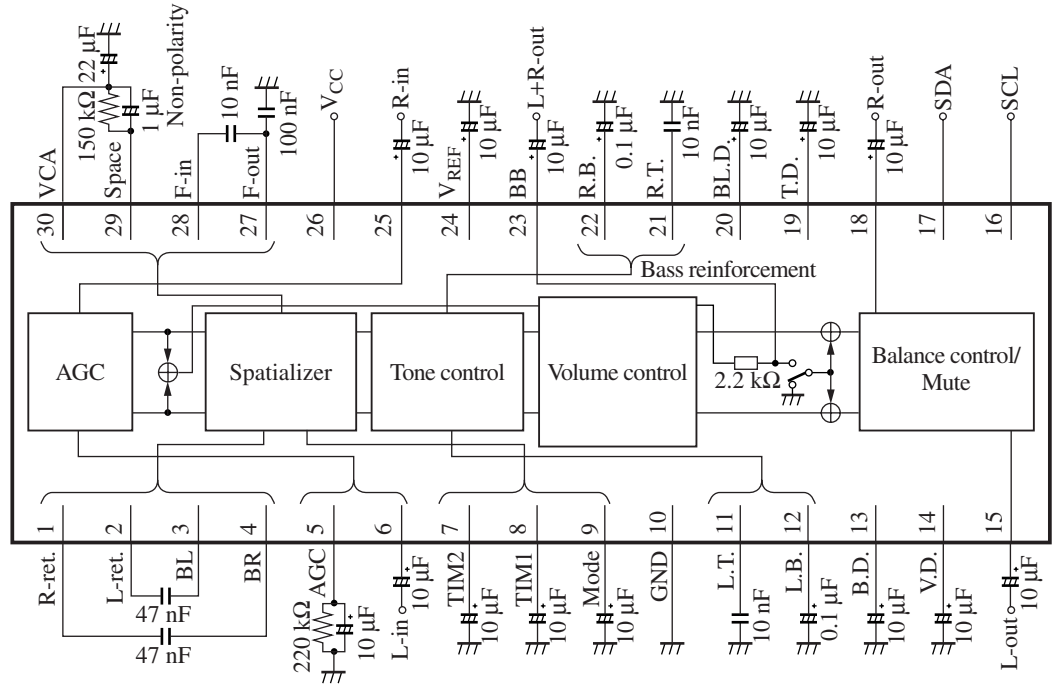


■ Application Circuit Examples

• Bass reinforcement circuit example

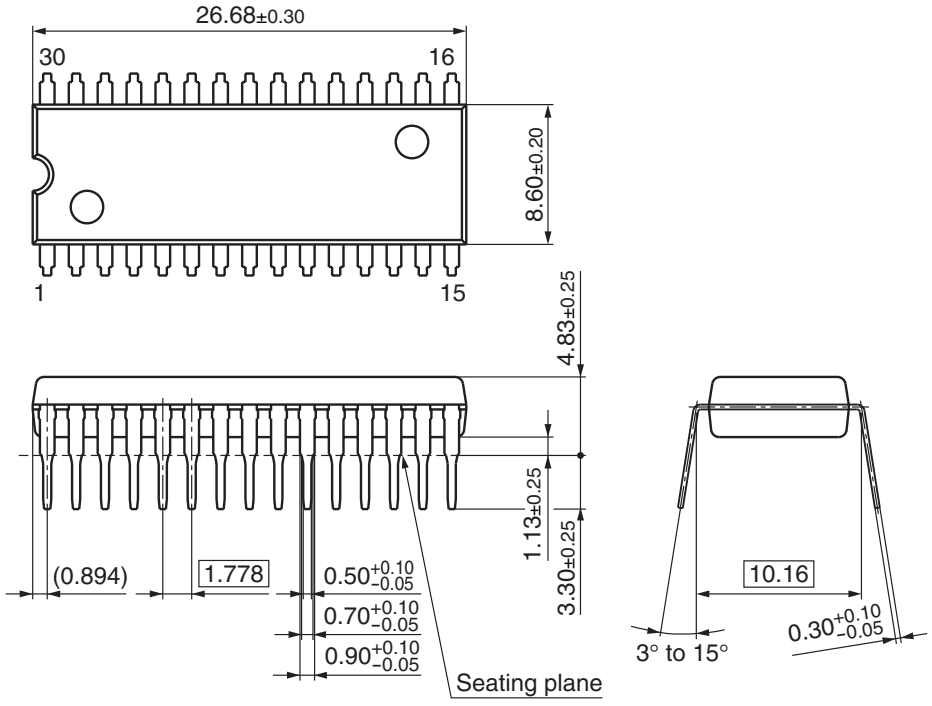


• Application circuit example of obtaining L+R output instead of bass reinforcement



■ New Package Dimensions (Unit: mm)

• SDIP030-P-0400B (Lead-free package)



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.

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