

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.

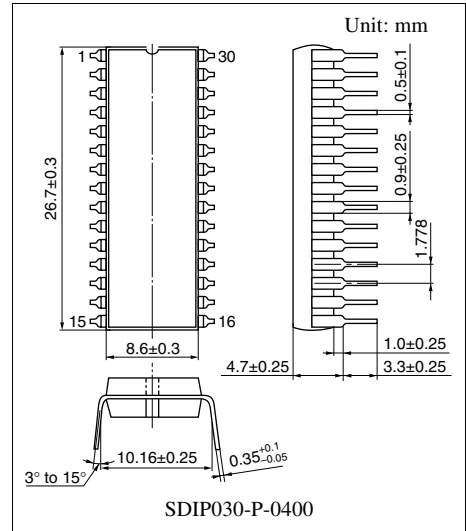
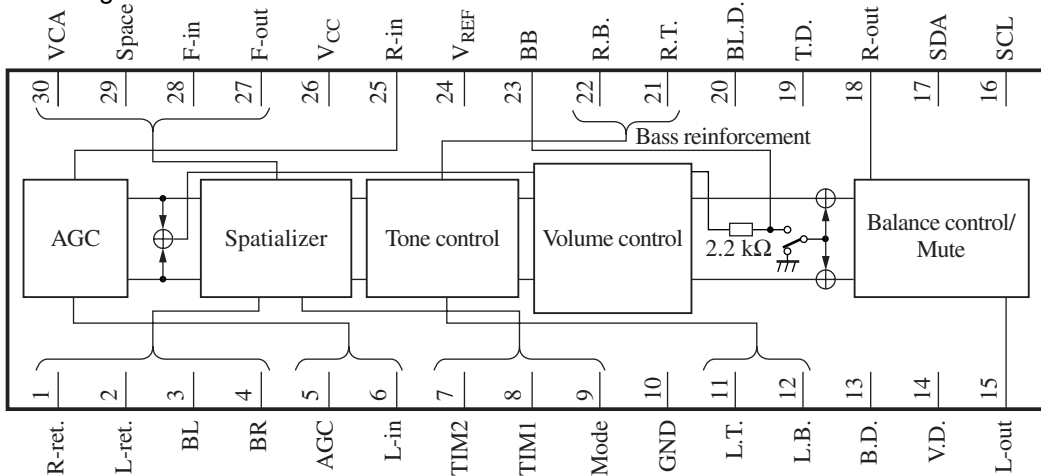
■ Features

- 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



■ Pin Descriptions

Pin No.	Description	Pin No.	Description
1	R-ret.	16	I ² C communication clock
2	L-ret.	17	I ² 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 _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 $V_{CC} = 9\text{ V}$, $T_a = 25^\circ\text{C} \pm 2^\circ\text{C}$

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]
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	$f_{I\max}$		—	—	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)

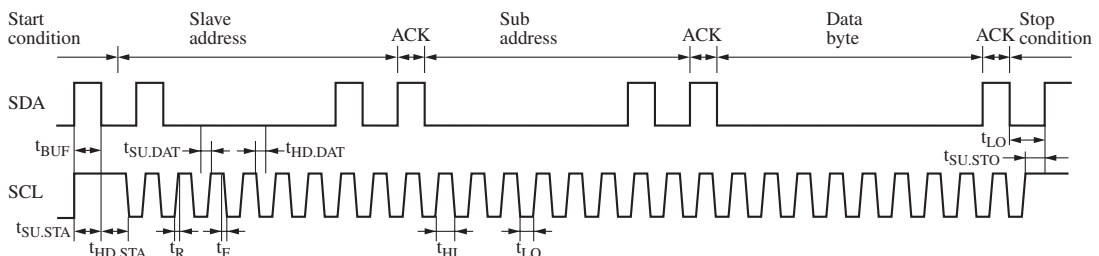
• Design reference data

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

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
I²C Interface						
Bus free before start	t_{BUF}		4.0	—	—	μs
Start condition set-up time	$t_{\text{SU, STA}}$		4.0	—	—	μs
Start condition hold time	$t_{\text{HD, STA}}$		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)	$t_{\text{SU, DAT}}$		0.25	—	—	μs
Data hold time (write)	$t_{\text{HD, DAT}}$		0	—	—	μs
Acknowledge set-up time	$t_{\text{SU, ACK}}$		—	—	3.5	μs
Acknowledge hold time	$t_{\text{HD, ACK}}$		0	—	—	μs
Stop condition set-up time	$t_{\text{SU, STO}}$		4.0	—	—	μs
DAC						
6-bit DAC DNLE	L_6	1 LSB = (Data(max.) - Data(00))/63	0.1	1.0	1.9	$\frac{\text{LSB}}{\text{step}}$
AGC gain 3 (Sub address 04H: 05H) *1	V_{AGC3}	$V_{\text{IN}} = 100\text{ mV[rms]}$, $f = 1\text{ kHz}$	—	150	—	mV[rms]
AGC gain 4 (Sub address 04H: 03H) *1	V_{AGC4}	$V_{\text{IN}} = 140\text{ mV[rms]}$, $f = 1\text{ kHz}$	—	200	—	mV[rms]
AGC gain 5 (Sub address 04H: 01H) *1	V_{AGC5}	$V_{\text{IN}} = 200\text{ mV[rms]}$, $f = 1\text{ kHz}$	—	250	—	mV[rms]
AGC gain 6 (Sub address 04H: 07H) *1	V_{AGC6}	$V_{\text{IN}} = 280\text{ mV[rms]}$, $f = 1\text{ kHz}$	—	350	—	mV[rms]
AGC gain 7 (Sub address 04H: 03H) *1	V_{AGC7}	$V_{\text{IN}} = 500\text{ mV[rms]}$, $f = 1\text{ kHz}$	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 ² 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 ² C data. 1.1 to 2.3
14	V.D.		Volume DAC output	This parameter fluctuates with I ² C data. 2 to 3.8
15	L-out		L-ch. output	4.5
16	SCL		I ² C Bus clock input	—
17	SDA		I ² C Bus data input	—

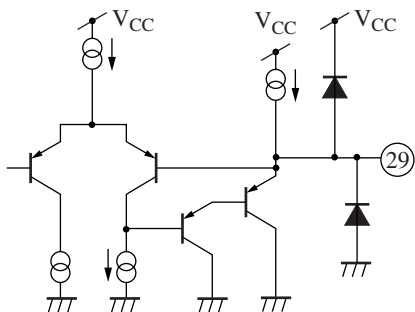
■ Terminal Equivalent Circuits at $V_{CC} = 9\text{ V}$, $T_a = 25^\circ\text{C}$ (continued)

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

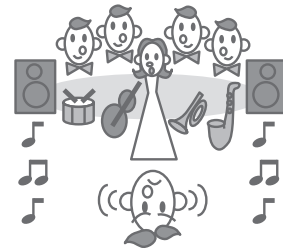
■ Terminal Equivalent Circuits at $V_{CC} = 9\text{ V}$, $T_a = 25^\circ\text{C}$ (continued)

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

■ Conceptual Explanation of Spatializer Operation

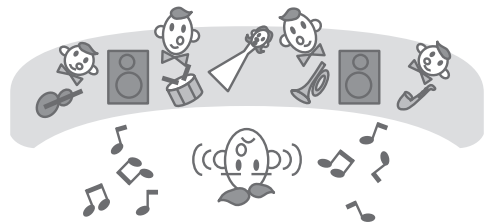
• Normal stereo

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



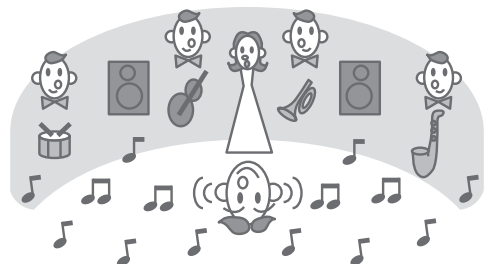
• Conventional surround

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



• Spatializer

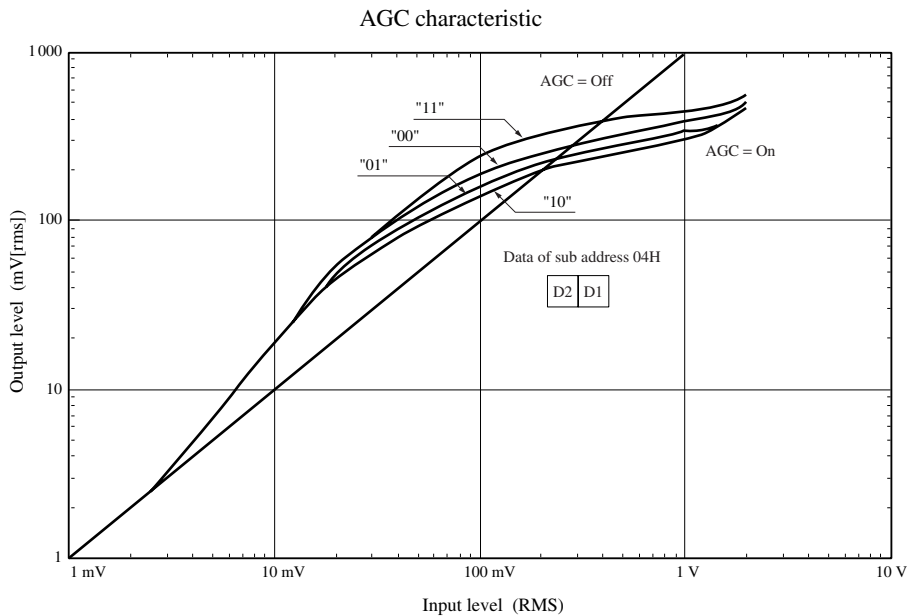
The sound expands toward the outside of the two speakers, and yet their positions are stable and an expanded, deep sound are gotten.



■ 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.



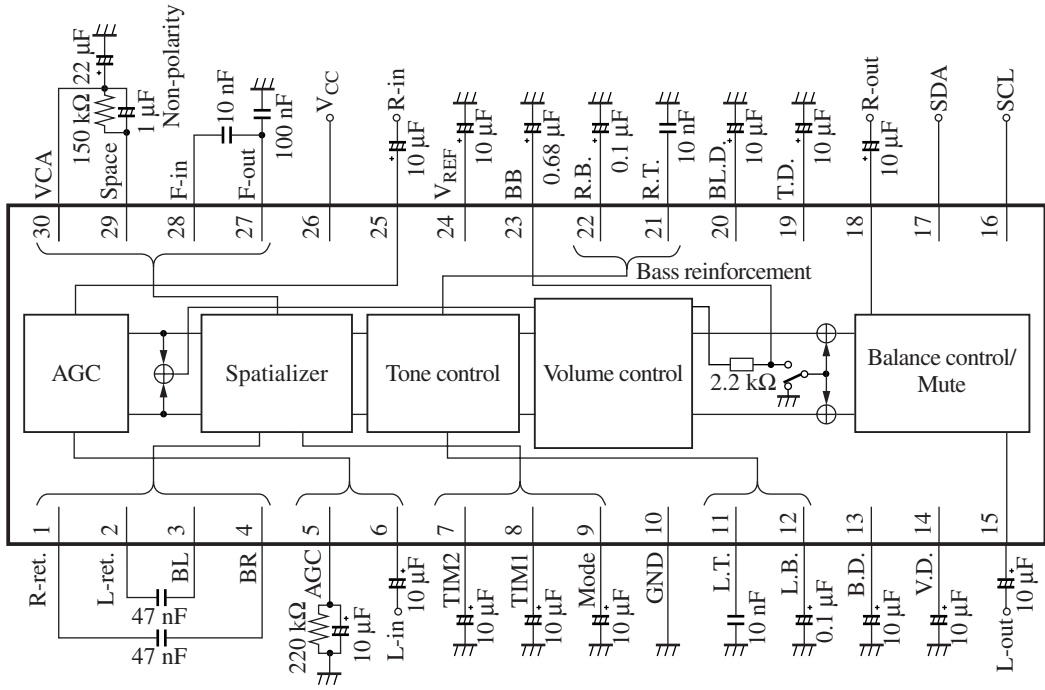
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- License agreement (To be agreed between you and Desper Products Inc.)

■ Application Circuit Examples

- Bass reinforcement circuit example



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

