Middle Power Class-D Speaker Amplifiers

Analog Input / BTL Output Class-D Speaker Amplifier

BD5423AEFS

No.10075EBT02

●Description

BD5423AEFS is a 17W + 17W stereo class-D power amplifier IC, developed for space-saving and low heat-generation applications such as low-profile TV sets. The IC employs state-of-the-art Bipolar, CMOS, and DMOS (BCD) process technology that eliminates turn-on resistance in the output power stage and internal loss due to line resistances up to an ultimate level. With this technology, the IC has achieved high efficiency of 90% (10W + 10W output with 8Ω load), which is the top class in the industry. The IC, in addition, employs a compact back-surface heat radiation type power package to achieve low power consumption and low heat generation and eliminates necessity of installing an external radiator, up to a total output of 34W. This product satisfies both needs for drastic downsizing, low-profile structures and powerful, high-quality playback of the sound system.

●Features

1) A high efficiency of 90% (10W + 10W output with 8Ω load), which is the highest grade in the industry and low heat-generation.
2) An output of 17W + 17W (12V, with 4Ω load) is allowed without an external heat radiator.
3) Driving a lowest rating load of 4Ω is allowed.
4) Pop noise upon turning power on/off and power interruption has been reduced.
5) High-quality audio muting is implemented by soft-switching technology.
6) An output power limiter function limits excessive output to speakers.
7) High-reliability design provided with built-in protection circuits against high temperatures, against VCC shorting and GND shorting, against reduced-voltage, and against applying DC voltage to speaker.
8) A master/slave function allowing synchronization of multiple devices reduces beat noises.
9) Adjustment of internal PWM sampling clock frequencies (250kHz to 400kHz) allows easy protective measures against unwanted radio emission to AM radio band.
10) A compact back-surface heat radiation type power package is employed. HTSSOP-A44 (5mm × 7.5mm × 1.0mm, pitch 0.8mm)

●Absolute Maximum Ratings

A circuit must be designed and evaluated not to exceed absolute maximum rating in any cases and even momentarily, to prevent reduction in functional performances and thermal destruction of a semiconductor product and secure useful life and reliability.

The following values assume Ta =25℃. For latest values, refer to delivery specifications.

Parameter	Symbol	Ratings	Unit	Conditions
Supply voltage	V_{CC}	+20	V	Pin 7, 8, 15, 16, 29, 30, 37, 38, 40 (Note 1, 2)
Power dissipation	P_d	2.0	W	(Note 3)
		4.5	W	(Note 4)
Input voltage for signal pin	V_{IN}	-0.2 ～ +7.2	V	Pin 1, 44 (Note 1)
Input voltage for control pin	V_{CONT}	-0.2 ～ Vcc+0.2	V	Pin 20, 24 (Note 1)
Input voltage for clock pin	V_{OSC}	-0.2 ～ +7.2	V	Pin 23 (Note 1)
Operating temperature range	T_{opr}	-40 ～ +85	℃	
Storage temperature range	T_{stg}	-55 ～ +150	℃	
Maximum junction temperature	T_{jmax}	+150	℃	

(Note 1) A voltage that can be applied with reference to GND (pins 11, 12, 33, 34, and 43)
(Note 2) Pd and Tjmax=150℃ must not be exceeded.
(Note 3) 70mm × 70mm × 1.6mm FR4 One-sided glass epoxy board (Back copper foil 0%) installed.
If used under Ta=25℃ or higher, reduce 16mW for increase of every 1℃. The board is provided with thermal via.
(Note 4) 70mm × 70mm × 1.6mm FR4 Both-sided glass epoxy board (Back copper foil 100%) installed.
If used under Ta=25℃ or higher, reduce 36mW for increase of every 1℃. The board is provided with thermal via.

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●Operating Conditions

The following values assume Ta =25℃. Check for latest values in delivery specifications.

Parameter	Symbol	Ratings	Unit	Conditions
Supply voltage	V_{CC}	+10～+16.5	V	Pin 7, 8, 15, 16, 29, 30, 37, 38, 40
Load resistance	R_L	4 ～ 16	Ω	(Note 5)

(Note 5) Pd should not be exceeded.

●Electrical Characteristics

Except otherwise specified T_a = 25℃, V_{CC} = 12V, f_{IN} = 1kHz, R_g = 0Ω, R_L = 8Ω、MUTEX="H", MS="L"
For latest values, refer to delivery specifications.

Parameter	Symbol	Limits	Unit	Conditions
Whole circuit				
Circuit current 1 (Sampling mode)	I_{CC1}	25	mA	With no signal
Circuit current 2 (Muting mode)	I_{CC2}	10	mA	MUTEX = “L”
Control circuit				
“H” level input voltage	V_{IH}	2.3～12	V	SDX, MUTEX, MS
“L” level input voltage	V_{IL}	0～0.8	V	SDX, MUTEX, MS
Audio circuit				
Voltage gain	G_V	28	dB	P_O = 1W
Maximum output power 1 (Note 6)	P_{O1}	10	W	THD+N = 10%, R_L = 8Ω
Maximum output power 2 (Note 6)	P_{O2}	17	W	THD+N = 10%, R_L = 4Ω
Total harmonic distortion (Note 6)	THD	0.1	%	P_O = 1W, BW=20Hz～20kHz
Crosstalk	CT	85	dB	P_O = 1W, Rg = 0Ω, BW = IHF-A
Output noise voltage (Sampling mode)	V_{NO}	80	μVrms	Rg = 0Ω, BW = IHF-A
Residual noise voltage (Muting mode)	V_{NOM}	1	μVrms	Rg = 0Ω, BW = IHF-A, MUTEX = “L”
Internal sampling clock frequency	F_{OSC}	250	kHz	MS = “L” (In master operation)

(Note 6) The rated values of items above indicate average performances of the device, which largely depend on circuit layouts, components, and power supplies. The reference values are those applicable to the device and components directly installed on a board specified by us.

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●Electrical characteristic curves (Reference data)

(1) Under Stereo Operation(R_L=8Ω)

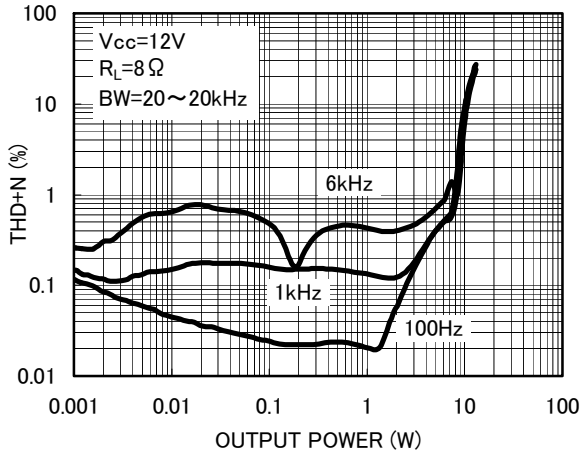


Fig. 1 THD+N － Output power

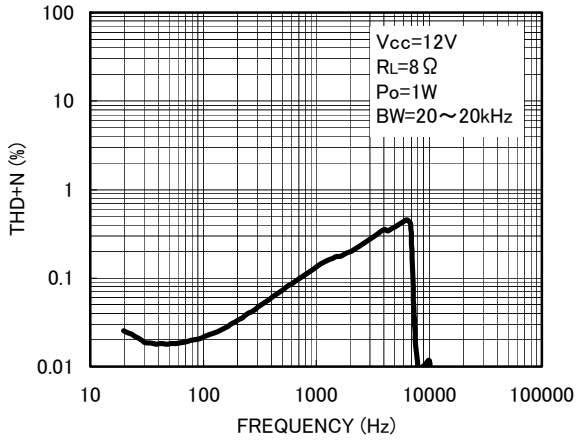


Fig. 2 THD+N － Frequency

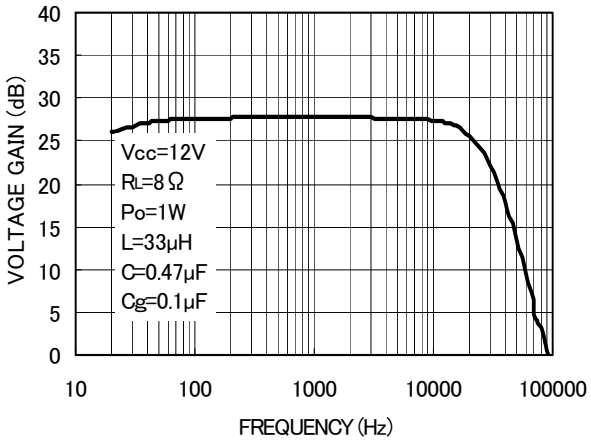


Fig. 3 Voltage gain - Frequency

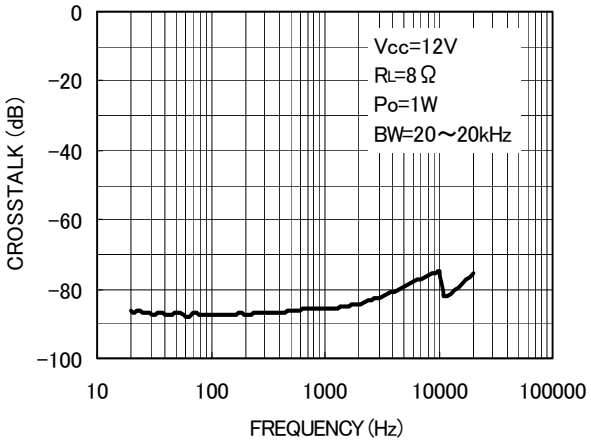


Fig. 4 Crosstalk - Frequency

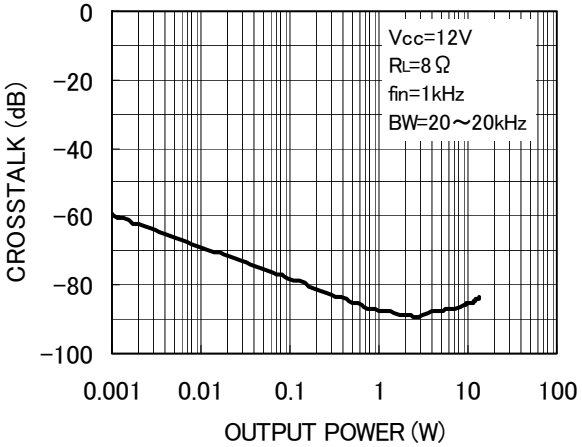


Fig. 5 Crosstalk - Output power

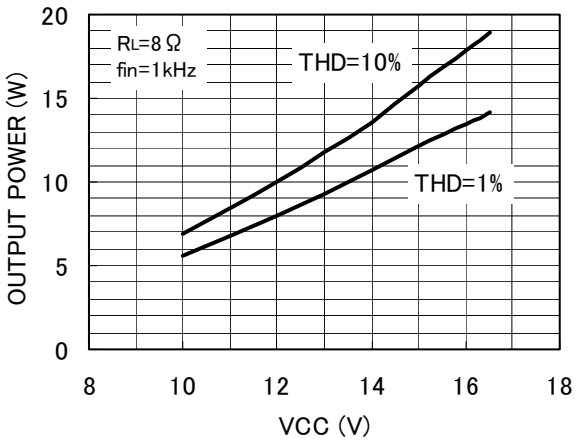


Fig. 6 Output power - Power supply voltage

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●Electrical characteristic curves (Reference data) – Continued

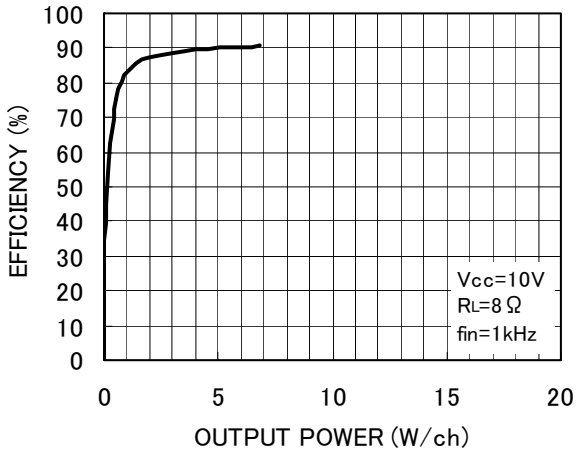


Fig. 7 Efficiency - Output power

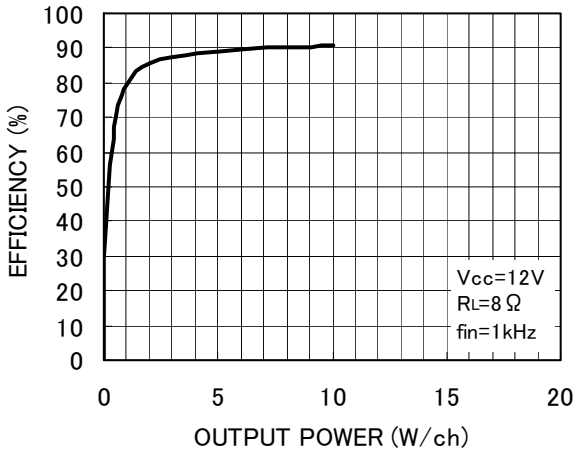


Fig. 8 Efficiency - Output power

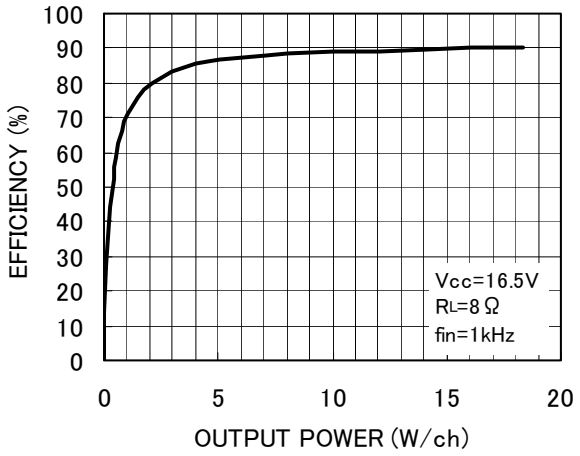


Fig. 9 Efficiency - Output power

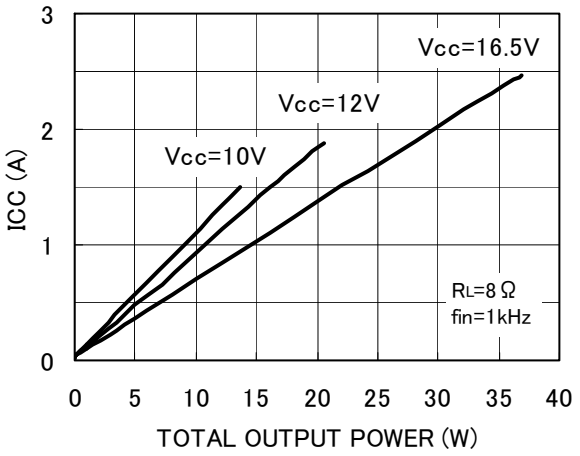


Fig. 10 Current consumption - Output power

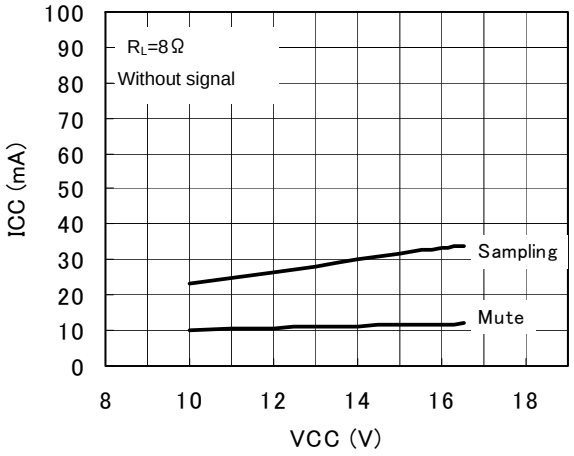


Fig. 11 Current consumption - Power supply voltage

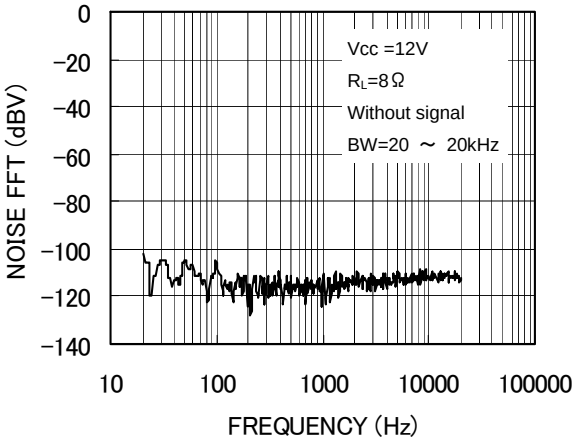


Fig. 12 FFT of Output Noise Voltage

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●Electrical characteristic curves (Reference data) – Continued

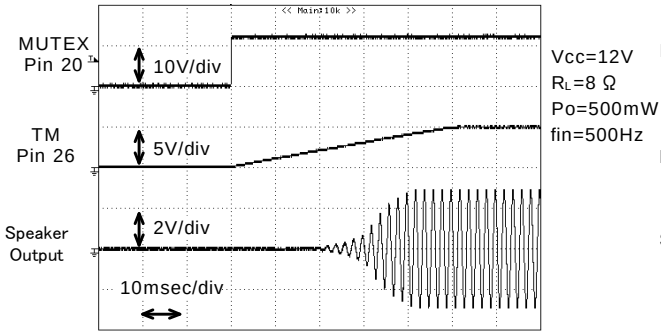


Fig. 13 Wave form when Releasing Soft-mute

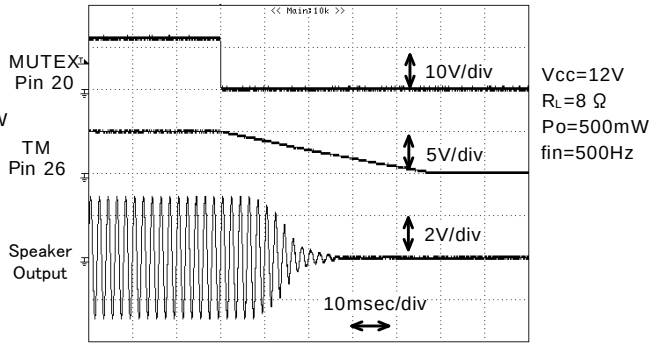


Fig. 14 Wave form when Activating Soft-mute

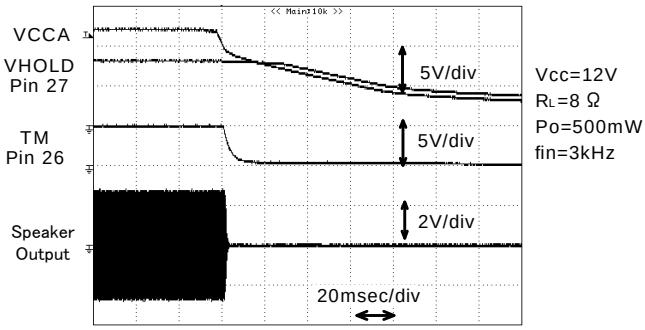


Fig. 15 Wave form on Instantaneous Power Interruption (20msec / div)

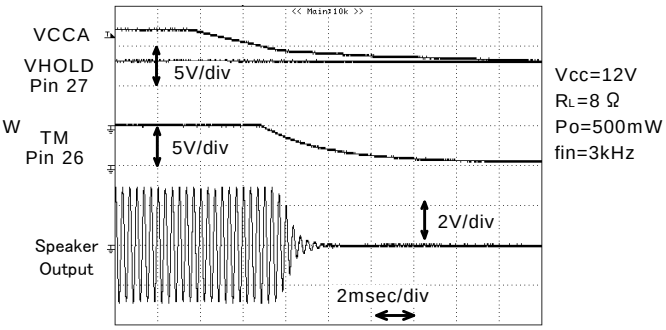


Fig. 16 Wave form on Instantaneous Power Interruption (2msec / div)

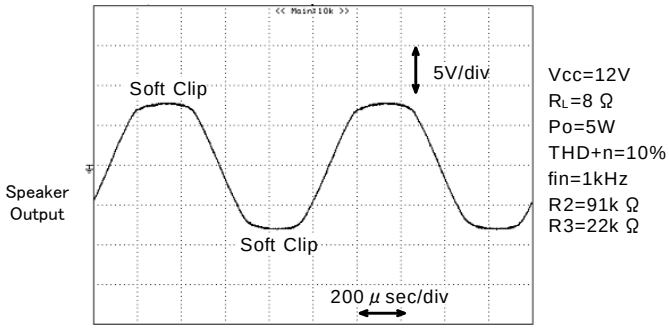


Fig. 17 Wave form on Output Power Limiter function (Po = 5W)

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●Electrical characteristic curves (Reference data) – Continued

(2)Under Stereo Operation(RL=6Ω)

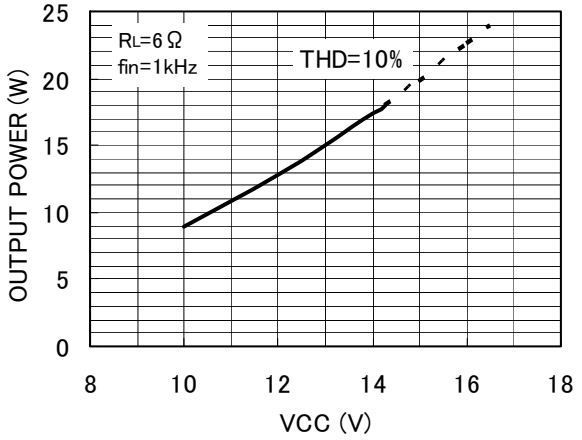


Fig. 18 Output power - Power supply voltage

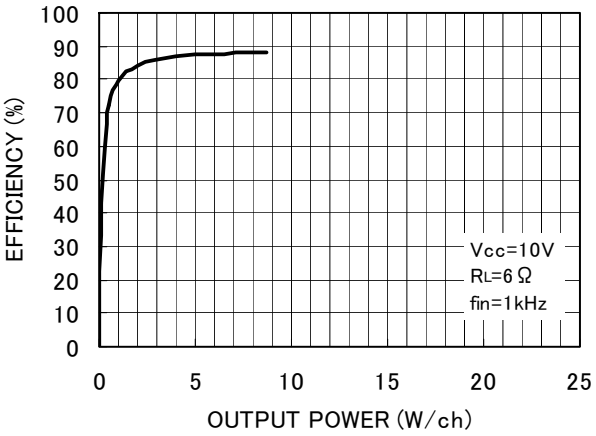


Fig. 19 Efficiency - Output power

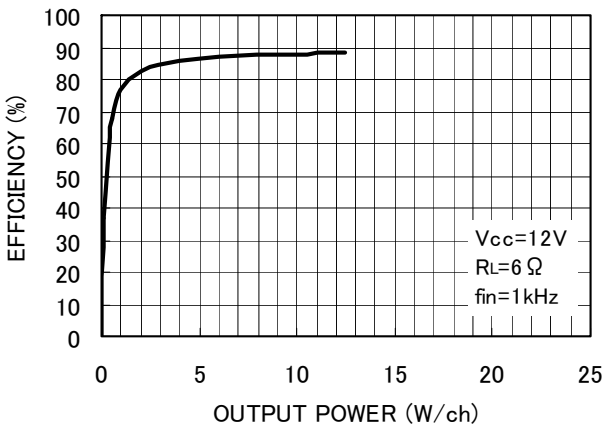


Fig. 20 Efficiency - Output power

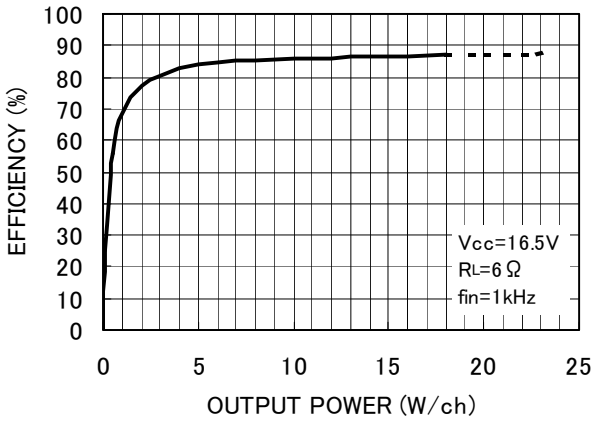


Fig. 21 Efficiency - Output power

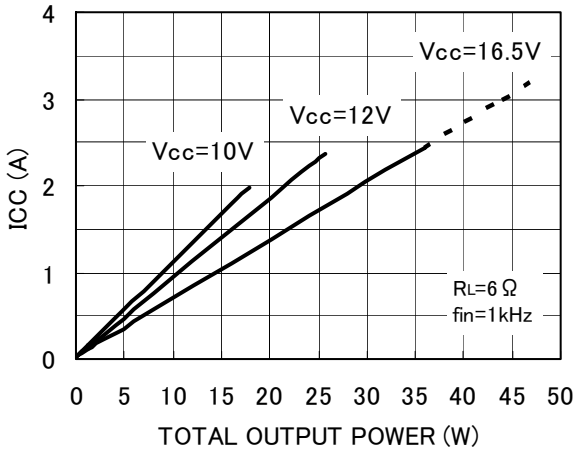


Fig. 22 Current consumption - Output power

Dotted lines of the graphs indicate continuous output power to be obtained on musical signal source or by installing additional heat sinks.

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●Electrical characteristic curves (Reference data) – Continued

(3) Under Stereo Operation(R_L=4Ω)

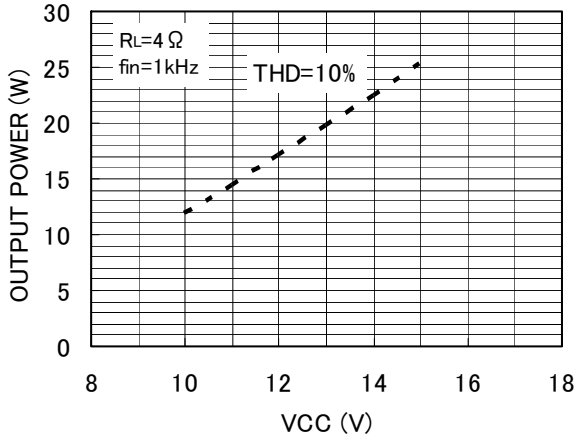


Fig. 23 Output power - Power supply voltage

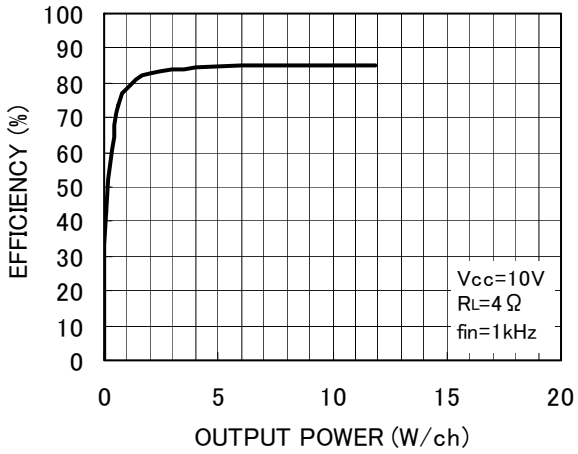


Fig. 24 Efficiency - Output power

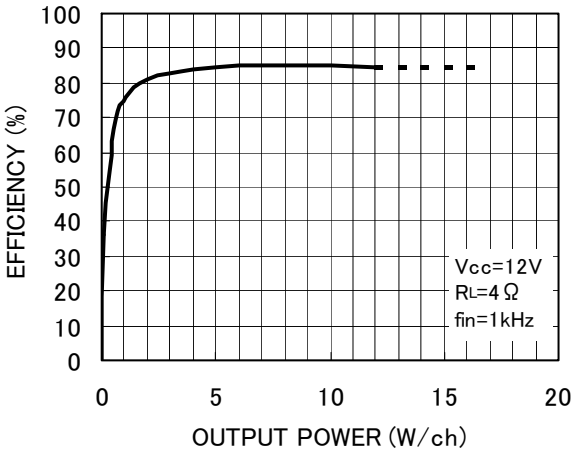


Fig. 25 Efficiency - Output power

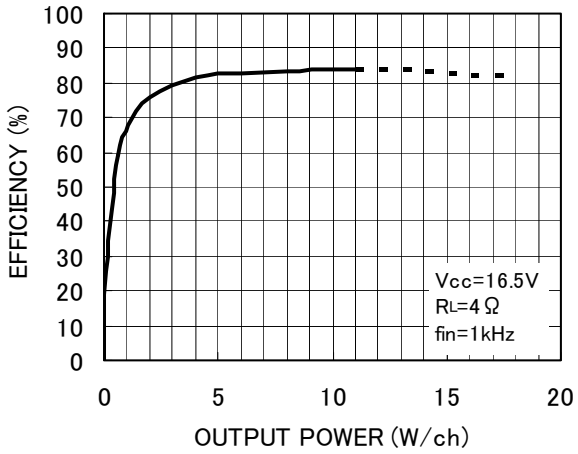


Fig. 26 Efficiency - Output power

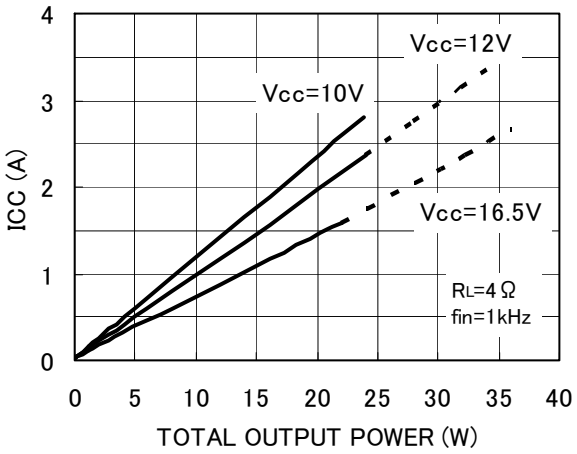


Fig. 27 Current consumption - Output power

Dotted lines of the graphs indicate continuous output power to be obtained on musical signal source or by installing additional heat sinks.

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●Pin Assignment

Top View

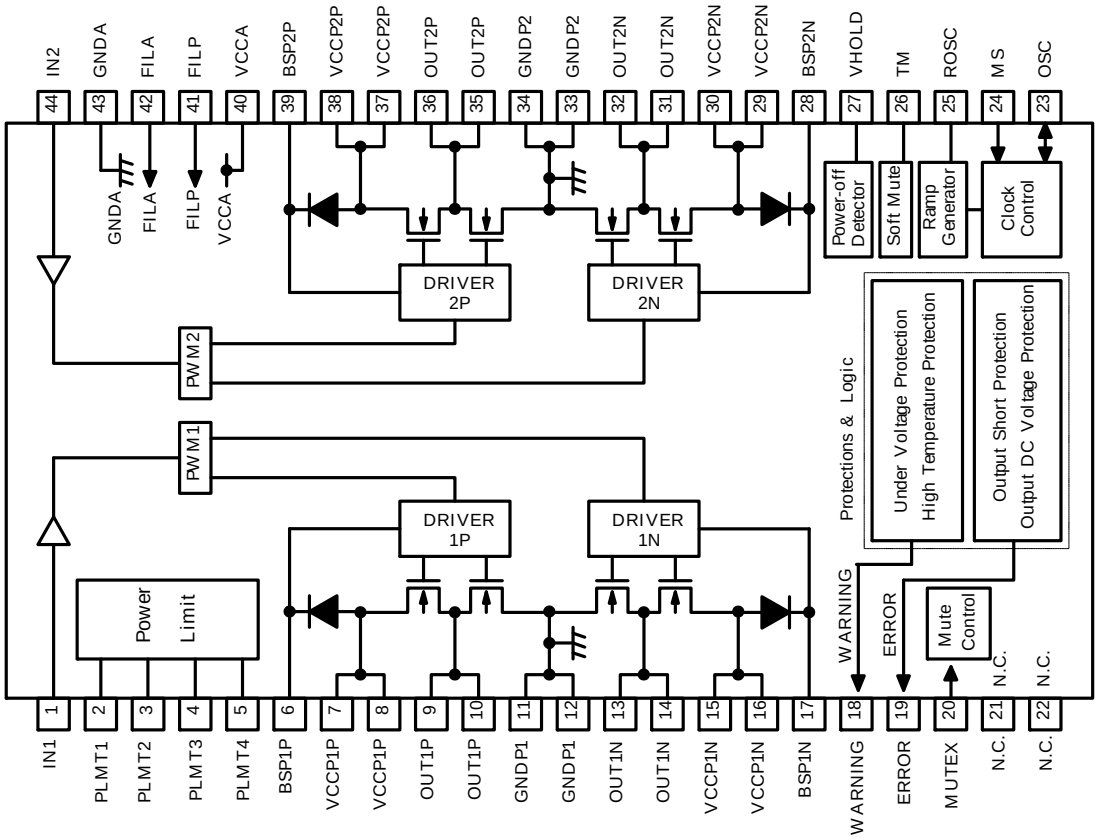


Fig. 28 Pin Assignment Diagram

●Outer Dimensions and Inscriptions

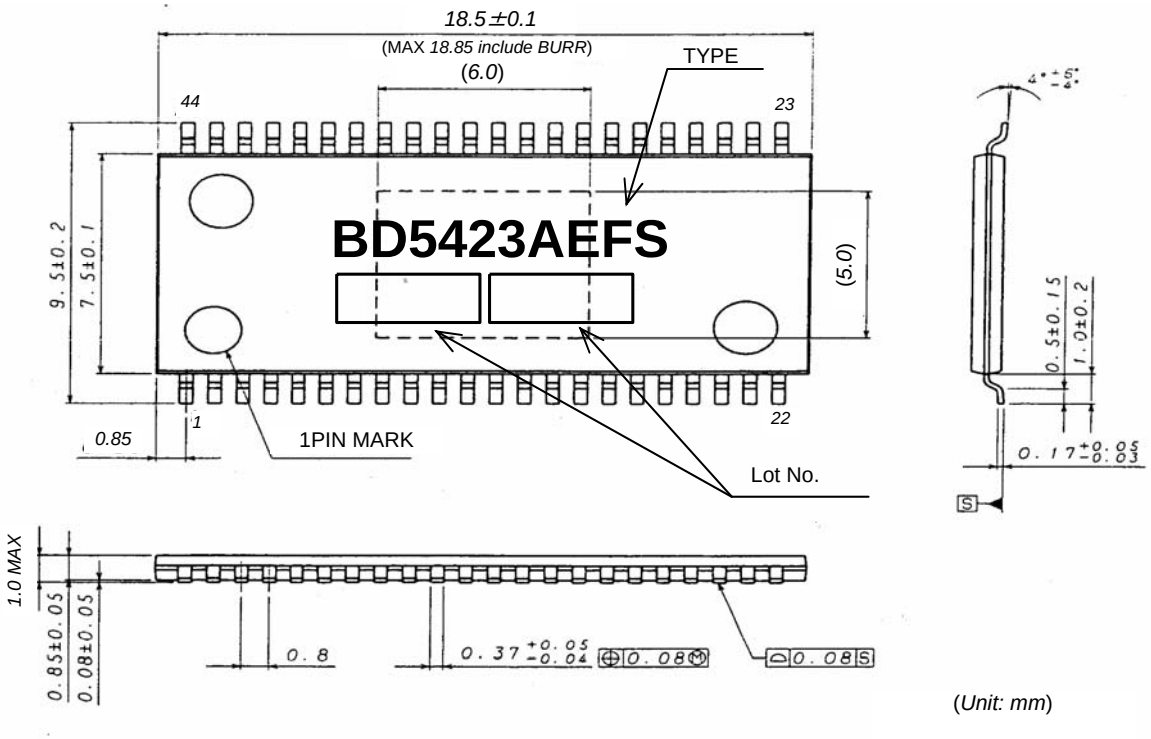
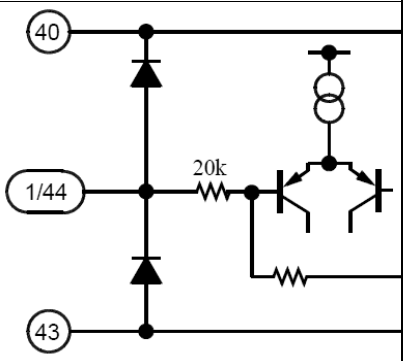
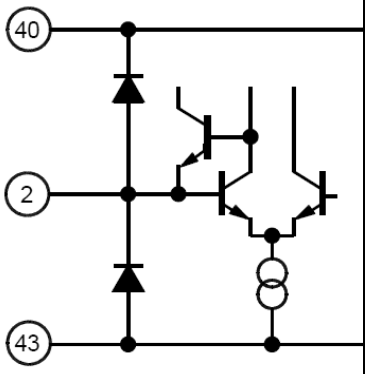
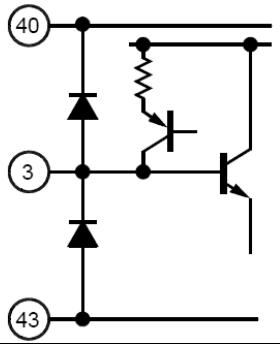
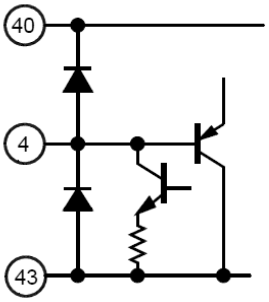
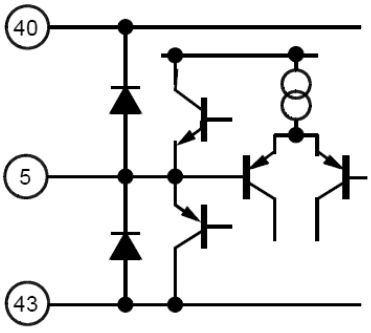


Fig. 29 Outer Dimensions and Inscriptions of HTSSOP-A44 Package

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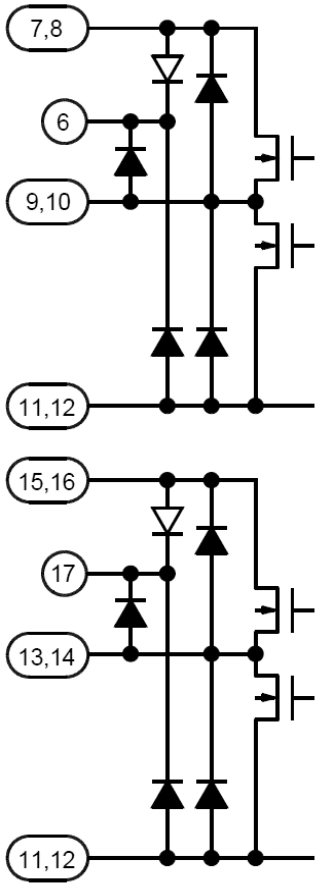
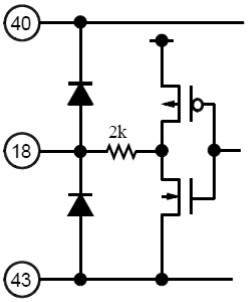
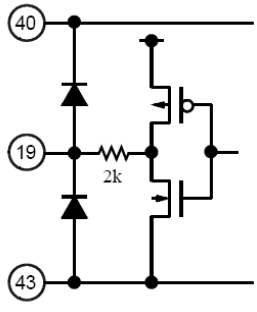
●**Explanation of Pin Functions (Provided pin voltages are typical values.)**

No.	Symbol	Pin voltage	Pin description	Internal equalizing circuit
1 44	IN1 IN2	3.5V	ch1 Analog signal input pin ch2 Analog signal input pin Input audio signal via a capacitor.	
2	PLMT1	3.5V	Voltage-to-current conversion pin for output power limiter function Connect a register.	
3	PLMT2	-	Current-to-voltage conversion pin for output power limiter function Connect a register.	
4	PLMT3	-	Current-to-voltage conversion pin for output power limiter function Connect a register.	
5	PLMT4	3.5V	Bias pin for output power limiter function Connect a register and a capacitor.	

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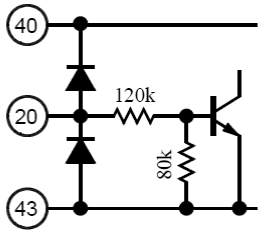
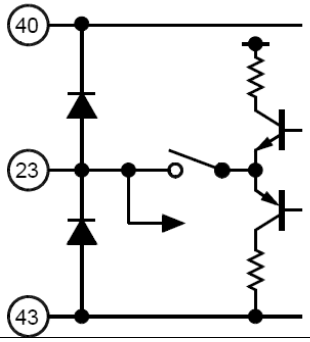
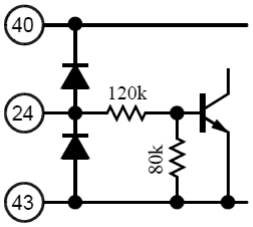
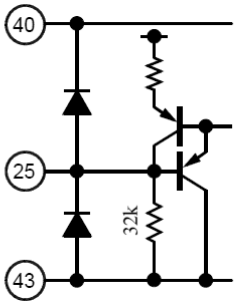
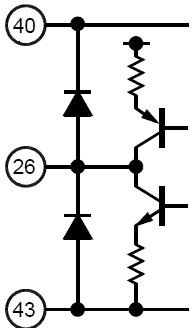
●**Explanation of Pin Functions (continued)**

No.	Symbol	Pin voltage	Pin description	Internal equalizing circuit
6	BSP1P	-	ch1 positive bootstrap pin Connect a capacitor.	
7, 8	VCCP1P	Vcc	ch1 positive power system power supply pin	
9, 10	OUT1P	Vcc～0V	ch1 positive PWM signal output pin Connect with output LPF.	
11, 12	GNDP1	0V	ch1 power system GND pin	
13, 14	OUT1N	Vcc～0V	ch1 negative PWM signal output pin Connect with output LPF.	
15, 16	VCCP1N	Vcc	ch1 negative power system power supply pin	
17	BSP1N	-	ch1 negative bootstrap pin Connect a capacitor.	
18	WARNING	H: 5V L: 0V	Warning output pin Pin to notify operation warning. H: Under warning L: Normal operation Connect a resister.	
19	ERROR	H: 5V L: 0V	Error output pin A pin for notifying operation errors. H: Error L: Normal operation Connect a resister.	

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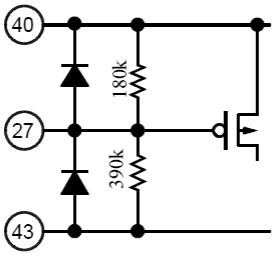
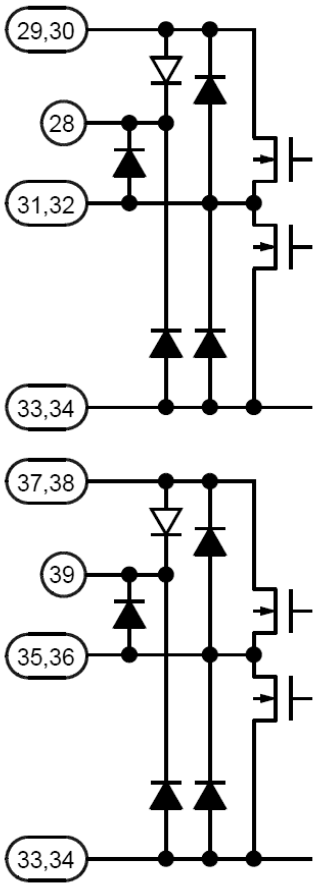
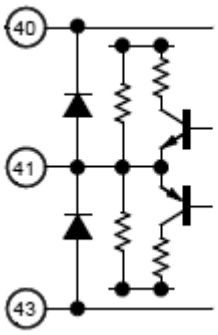
●**Explanation of Pin Functions (continued)**

No.	Symbol	Pin voltage	Pin description	Internal equalizing circuit
20	MUTEX	-	Audio mute control pin H: Mute off L: Mute on	
21, 22	N.C.	-	N.C. pin Nothing is connected with IC internal circuit.	
23	OSC	-	Sampling clock signal input/output pin When using two or more sampling clocks, connect via a capacitor.	
24	MS	-	Master/Slave switching pin Switching of master/slave functions on a sampling clock signal. H: Slave operation L: Master operation	
25	ROSC	5.6V	Internal PWM sampling clock frequency setting pin Usually the pin is used open. To adjust an internal sampling clock frequency, connect a resister.	
26	TM	0～5V	Audio muting constant setting pin Connect a capacitor.	

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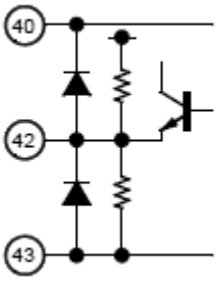
●**Explanation of Pin Functions (continued)**

No.	Symbol	Pin voltage	Pin description	Internal equalizing circuit
27	VHOLD	0.68×Vcc	Instantaneous power interruption detecting voltage setting pin Connect a capacitor. To adjust a detecting voltage, connect a resister.	
28	BSP2N	-	ch2 negative bootstrap pin Connect a capacitor.	
29, 30	VCCP2N	Vcc	ch2 negative power system power supply pin	
31, 32	OUT2N	Vcc～0V	ch2 negative PWM signal output pin Connect an output LPF.	
33, 34	GNDP2	0V	ch2 power system GND pin	
35, 36	OUT2P	Vcc～0V	ch2 positive PWM signal output pin Connect an output LPF.	
37, 38	VCCP2P	Vcc	ch2 positive power system power supply pin	
39	BSP2P	-	ch2 positive bootstrap pin Connect a capacitor.	
40	VCCA	Vcc	Analog system power pin	
41	FILP	$\frac{Vcc+35}{12}$	PWM system bias pin Connect a capacitor.	

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●**Explanation of Pin Functions (continued)**

No.	Symbol	Pin voltage	Pin description	Internal equalizing circuit
42	FILA	3.5V	Analog signal system bias pin Connect a capacitor.	
43	GNDA	0V	Analog system power supply pin	

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●Application Circuit Diagram.

・Vcc=10V～16.5V

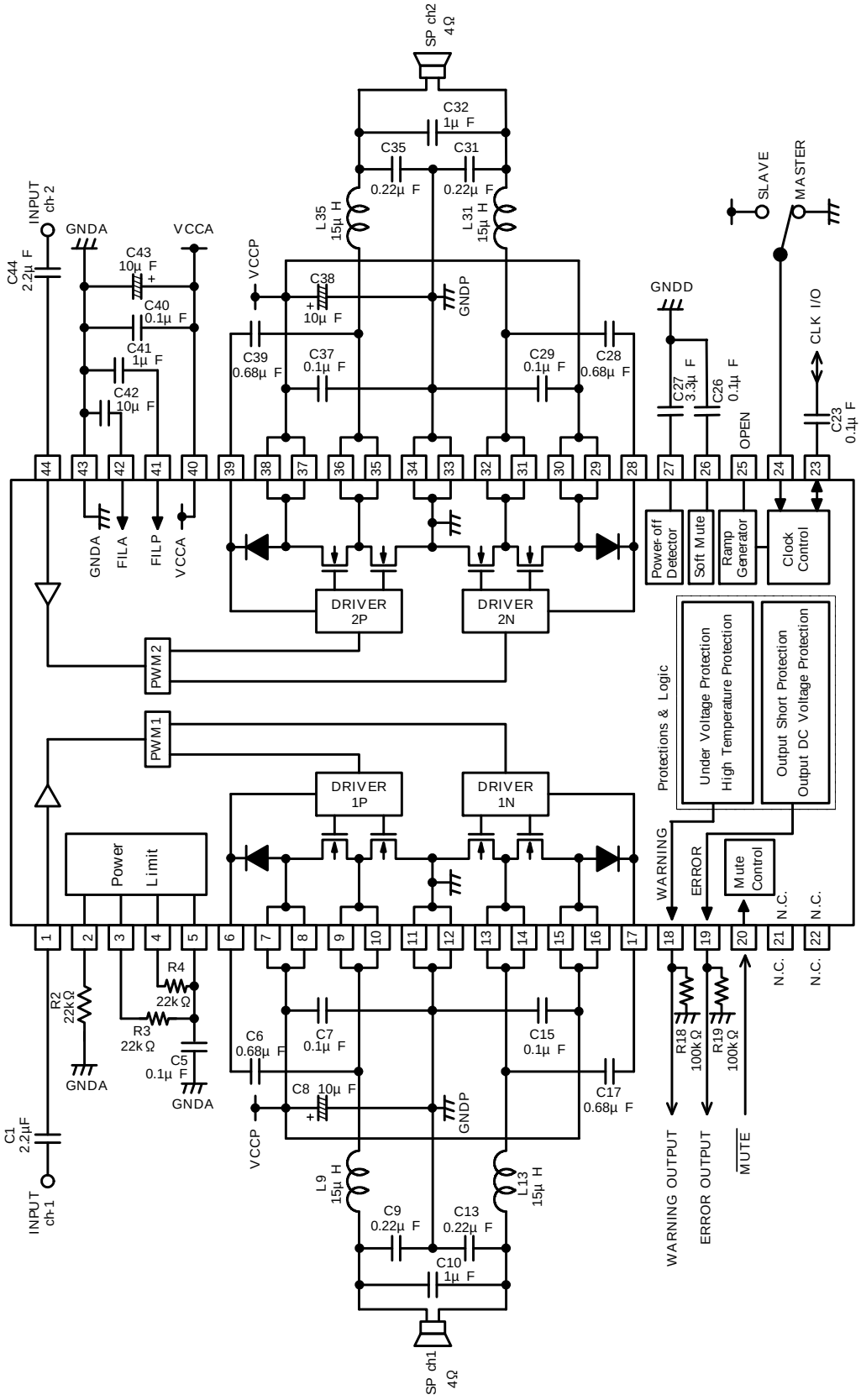


Fig. 30 Circuit diagram under stereo operation with 4-Ω load

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Table 1 BOM list for stereo operation with 4-Ω load

No.	Item	Part Number	Vendor	Configuration		Value	Rated voltage	Tolerance	Temperature characteristics	Quantity	Reference
				mm	inch						
1	IC	BD5423AEFS	ROHM	HTSSOP-A44		-	-	-	-	1	IC1
2	C	GRM219B31E684KA88D	MURATA	2012	0805	0.68μF	25V	±10%	±10%	4	C6, C17, C28, C39
3	C	GRM188R11H104KA93	MURATA	1608	0603	0.1μF	50V	±10%	±10%	5	C7, C15, C29, C37, C40
4	C	GRM31MB11H224KA01	MURATA	3216	1206	0.22μF	50V	±10%	±10%	4	C9, C13, C31, C35
5	C	25ST225M3216	Rubycon	3225	1210	2.2μF	25V	±20%	±5%	2	C1, C44
6	C	50ST105M3225	Rubycon	3225	1210	1μF	50V	±20%	±5%	2	C10, C32
7	C	GRM21BB31E335KA75	MURATA	2012	0805	3.3μF	25V	±10%	±10%	1	C27
8	C	GRM188B11E104KA	MURATA	1608	0603	0.1μF	25V	±10%	±10%	3	C5, C23, C26
9	C	GRM21BB11C105KA	MURATA	2012	0805	1μF	16V	±10%	±10%	1	C41
10	C	GRM21BB31C106KE15	MURATA	2012	0805	10μF	16V	±10%	±10%	1	C42
11	C	25SVPD10M	SANYO	6666	2626	10μF	25V	±20%	±25%	3	C8, C38, C43
12	R	MCR01MZPF2202	ROHM	1005	0402	22kΩ	50V	±1%	±200ppm/℃	3	R2, R3, R4
13	R	MCR01MZPF1003	ROHM	1005	0402	100kΩ	50V	±1%	±200ppm/℃	2	R18, R19

No.	Item	Part Number	Vendor	Configuration	Value	Tolerance	DC Resistance	Rated DC Current	Quantity	Reference
				mm						
14	L	7G09B-150M	SAGAMI	10×9×10	15μH×2	±20%	44mΩmax.	4.1A max.	2	L9, L13, L31, L35

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●Notes for use

1. About absolute maximum ratings
   If an applied voltage or an operating temperature exceeds an absolute maximum rating, it may cause destruction of a device. A result of destruction, whether it is short mode or open mode, is not predictable. Therefore, provide a physical safety measure such as fuse, against a special mode that may violate conditions of absolute maximum ratings.

2. About power supply line
   As return of current regenerated by back EMF of output coil happens, take steps such as putting capacitor between power supply and GND as a electric pathway for the regenerated current. Be sure that there is no problem with each property such as emptied capacity at lower temperature regarding electrolytic capacitor to decide capacity value. If the connected power supply does not have sufficient current absorption capacity, regenerative current will cause the voltage on the power supply line to rise, which combined with the product and its peripheral circuitry may exceed the absolute maximum ratings. It is recommended to implement a physical safety measure such as the insertion of a voltage clamp diode between the power supply and GND pins.

3. Potential of GND (11, 12, 33, 34, and 43 pins)
   Potential of the GND terminal must be the lowest under any operating conditions.

4. About thermal design
   Perform thermal design with sufficient margins, in consideration of maximum power dissipation Pd under actual operating conditions. This product has an exposed frame on the back of the package, and it is assumed that the frame is used with measures to improve efficiency of heat dissipation. In addition to front surface of board, provide a heat dissipation pattern as widely as possible on the back also.
   A class-D power amplifier has heat dissipation efficiency far higher than that of conventional analog power amplifier and generates less heat. However, extra attention must be paid in thermal design so that a power dissipation Pdiss should not exceed the maximum power dissipation Pd.

Maximum power dissipation	$Pd = \frac{T_{jmax} - Ta}{\theta_{ja}}$ [W]	Tjmax: Maximum temperature junction = 150[℃] Ta: Operating ambient temperature [℃] θ ja: Package thermal resistance [℃/W]
Power dissipation	$P_{diss} = Po\left(\frac{1}{\eta} - 1\right)$ [W]	Po: Output power [W] η : Efficiency

5. About operations in strong electric field
   Note that the device may malfunction in a strong electric field.

6. Thermal shutdown (TSD) circuit
   This product is provided with a built-in thermal shutdown circuit. When the thermal shutdown circuit operates, the output transistors are placed under open status. The thermal shutdown circuit is primarily intended to shut down the IC avoiding thermal runaway under abnormal conditions with a chip temperature exceeding Tjmax = 150℃, and is not intended to protect and secure an electrical appliance. Accordingly, do not use this circuit function to protect a customer's electrical appliance.

7. About shorting between pins and installation failure
   Be careful about direction and displacement of an LSI when installing it onto the board. Faulty installation may destroy the LSI when the device is energized. In addition, a foreign matter getting in between LSI pins, pins and power supply, and pins and GND may cause shorting and destruction of the LSI.

8. About power supply startup and shutdown
   When starting up a power supply, be sure to place the MUTEX pin (pin 20) at “L” level. When shutting down a power supply also, be sure to place the pin at “L” level. Those processes reduce pop noises generated upon turning on and off the power supply. In addition, all power supply pins must be started up and shut down at the same time.

9. About WARNING output pin (pin 18) and ERROR output pin (pin 19)
   A WARNING flag is output from the WARNING output pin upon operation of the high-temperature protection function and under-voltage protection function. And an ERROR flag is output from the ERROR output pin upon operation of VCC/GND shorting protection function and speaker DC voltage applying protection function. These flags are the function which the condition of this product is shown in. The use which aimed at the protection except for this product is prohibition.

10. About N.C. pins (pins 21 and 22)
    The N.C. (Non connection) pins are not connected with an internal circuit. Leave the pins open or connect them to GND.

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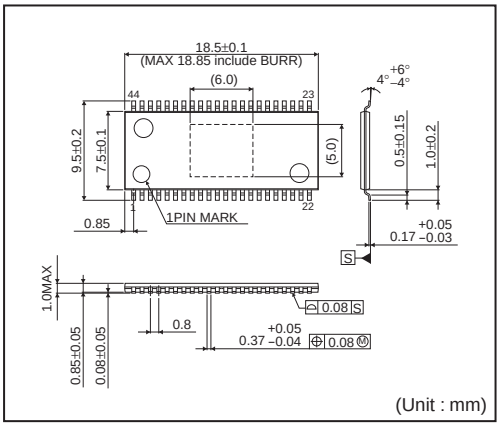
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●Ordering part number

B	D	5	4	2	3	A	E	F	S	-	E	2

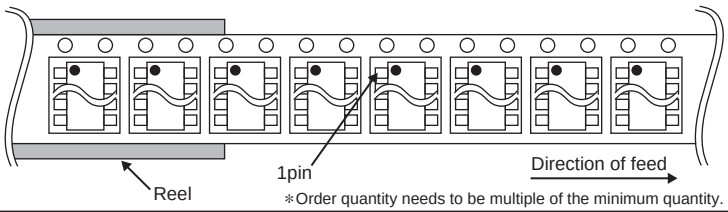
- Part No. (BD)
- Part No. (5423A)
- Package: EFS:HTSSOP-44
- Packaging and forming specification: E2: Embossed tape and reel

HTSSOP-A44



<Tape and Reel information>

Tape	Embossed carrier tape (with dry pack)
Quantity	1500pcs
Direction of feed	E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand)



∗Order quantity needs to be multiple of the minimum quantity.

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1. Our Products are designed and manufactured for application in ordinary electronic equipments (such as AV equipment, OA equipment, telecommunication equipment, home electronic appliances, amusement equipment, etc.). If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment (Note 1), transport equipment, traffic equipment, aircraft/spacecraft, nuclear power controllers, fuel controllers, car equipment including car accessories, safety devices, etc.) and whose malfunction or failure may cause loss of human life, bodily injury or serious damage to property ("Specific Applications"), please consult with the ROHM sales representative in advance. Unless otherwise agreed in writing by ROHM in advance, ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of any ROHM's Products for Specific Applications.

(Note1) Medical Equipment Classification of the Specific Applications

JAPAN	USA	EU	CHINA
CLASSⅢ	CLASSⅢ	CLASSⅡb	CLASSⅢ
CLASSⅣ		CLASSⅢ	

2. ROHM designs and manufactures its Products subject to strict quality control system. However, semiconductor products can fail or malfunction at a certain rate. Please be sure to implement, at your own responsibilities, adequate safety measures including but not limited to fail-safe design against the physical injury, damage to any property, which a failure or malfunction of our Products may cause. The following are examples of safety measures:
   [a] Installation of protection circuits or other protective devices to improve system safety
   [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure

3. Our Products are designed and manufactured for use under standard conditions and not under any special or extraordinary environments or conditions, as exemplified below. Accordingly, ROHM shall not be in any way responsible or liable for any damages, expenses or losses arising from the use of any ROHM's Products under any special or extraordinary environments or conditions. If you intend to use our Products under any special or extraordinary environments or conditions (as exemplified below), your independent verification and confirmation of product performance, reliability, etc, prior to use, must be necessary:
   [a] Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
   [b] Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
   [c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl_2, H_2S, NH_3, SO_2, and NO_2
   [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
   [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
   [f] Sealing or coating our Products with resin or other coating materials
   [g] Use of our Products without cleaning residue of flux (even if you use no-clean type fluxes, cleaning residue of flux is recommended); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
   [h] Use of the Products in places subject to dew condensation

4. The Products are not subject to radiation-proof design.

5. Please verify and confirm characteristics of the final or mounted products in using the Products.

6. In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse. is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.

7. De-rate Power Dissipation (Pd) depending on Ambient temperature (Ta). When used in sealed area, confirm the actual ambient temperature.

8. Confirm that operation temperature is within the specified range described in the product specification.

9. ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

Precaution for Mounting / Circuit board design

1. When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.

2. In principle, the reflow soldering method must be used; if flow soldering method is preferred, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

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Precautions Regarding Application Examples and External Circuits

1. If change is made to the constant of an external circuit, please allow a sufficient margin considering variations of the characteristics of the Products and external components, including transient characteristics, as well as static characteristics.

2. You agree that application notes, reference designs, and associated data and information contained in this document are presented only as guidance for Products use. Therefore, in case you use such information, you are solely responsible for it and you must exercise your own independent verification and judgment in the use of such information contained in this document. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of such information.

Precaution for Electrostatic

This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of Ionizer, friction prevention and temperature / humidity control).

Precaution for Storage / Transportation

1. Product performance and soldered connections may deteriorate if the Products are stored in the places where:
   - [a] the Products are exposed to sea winds or corrosive gases, including Cl2, H2S, NH3, SO2, and NO2
   - [b] the temperature or humidity exceeds those recommended by ROHM
   - [c] the Products are exposed to direct sunshine or condensation
   - [d] the Products are exposed to high Electrostatic

2. Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.

3. Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.

4. Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

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Precaution for Disposition

When disposing Products please dispose them properly using an authorized industry waste company.

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