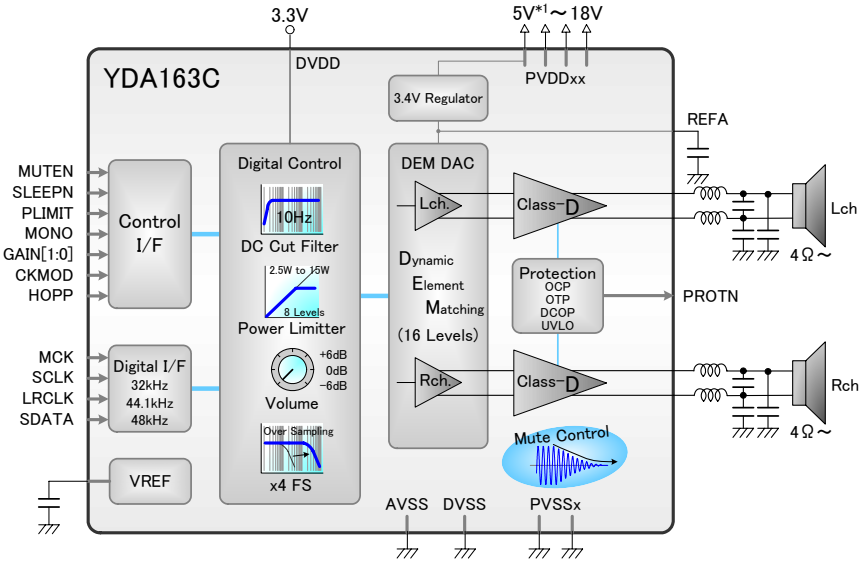
YDA163C

D-515D

DIGITAL INPUT STEREO 20W DIGITAL AUDIO POWER AMPLIFIER

■ Overview

YDA163C(D-515D) is a high-performance digital audio amplifier IC that delivers up to 20W×2ch, which has a digital audio interface, and is capable of operating at a supply voltage ranging from 5V[*1)] to 18V. YDA163C, having Yamaha original "Pure Pulse Direct Speaker Drive Circuit," allows a speaker to be directly connected to the output. In addition, this amplifier is insusceptible to supply voltage fluctuation because of a feedback-type digital amplifier, and have the feature with high power supply noise tolerance. As a result, power supply can be simplified and allowing a simple amplifier system with less external components to be configured. YDA163C has the following functions: power limit function, pop noise reduction function, overcurrent protection function for speaker output pins, internal overtemperature protection function, under voltage lockout, and DC detection function. And, YDA163C supports power limit setting of 3W (R_L=8Ω, Mode:7).



<YDA163C Overview>

(Note) *1: When operating at less than 8V (V_{DDP}), an 8Ω or more load must be used.

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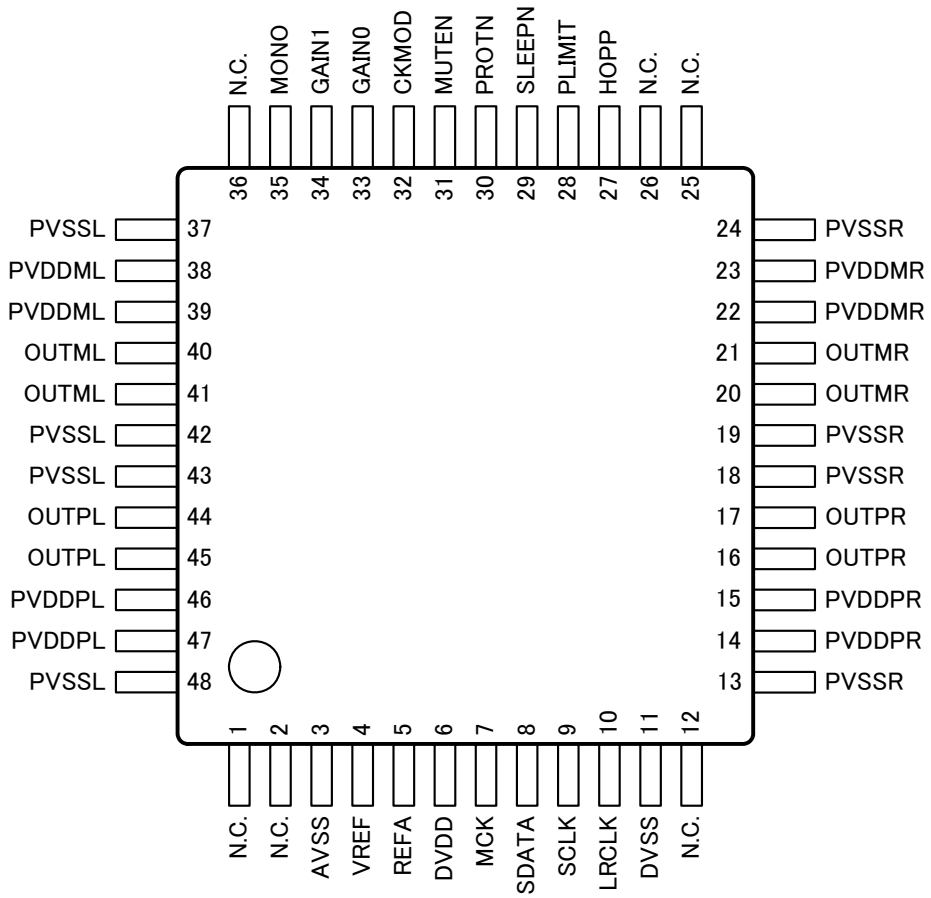
YDA163C CATALOG
CATALOG No. LSI-4DA163C20
2011.1

■ Features

- Supply Voltage Range V_{DDP} 5V[*1] to 18V
  V_{DD} 3.0V to 3.6V
- Input Digital Audio Interface (Stereo)
  Sampling Frequency: 32kHz, 44.1kHz, 48kHz
  Left-justified, MSB first, 1-bit delay, Digital Audio Data 24-bits
- Max. Instantaneous Output 15W×2ch (V_{DDP}=15V, R_L=8Ω, THD+N=10%)
  10W×2ch (V_{DDP}=12V, R_L=8Ω, THD+N=10%)
  20W×2ch (V_{DDP}=14V, R_L=4Ω, THD+N=10%)
- Max. Continuous Output 15W[*2]×2ch (V_{DDP}=15V, R_L=8Ω, Ta=70 ºC, 4-layer Board)
  10W[*2]×2ch (V_{DDP}=12V, R_L=8Ω, Ta=70 ºC, 4-layer Board)
- Distortion Ratio (THD+N) 0.05% (V_{DDP}=12V, R_L=8Ω, Po=4.5W, 1kHz)
- Residual Noise 50μVrms (V_{DDP}=12V, R_L=8Ω)
- S/N Ratio 105dB (V_{DDP}=12V, R_L=8Ω)
- Efficiency 92% (V_{DDP}=12V, R_L=8Ω, Po=10W)
- Channel Separation 80 dB (V_{DDP}=12V, R_L=8Ω, 1kHz)
- Power Limit Function (Supports power limit setting of 3W (R_L=8Ω, Mode:7))
- Gain Setting Function (3steps: +6dB/0dB/-6dB)
- Stereo/Monaural Switching Function
- Output Mute Function (Quick Mute/Quick Start)
- Sleep Function
- Pop Noise Reduction Function
- Carrier Clock Frequency Hopping Function
- Overcurrent Protection Function (OCP)
- Over Temperature Protection Function (OTP)
- Under voltage lockout (UVLO)
- DC Detection Function (DCDET)
- Clock Detection Function (CKDET)
- Package Lead-free 48-pin Plastic SQFP (Stage die pad) : YDA163C-SZ

(Note) *1: When operating at less than 8V (V_{DDP}), an 8Ω or more load must be used.
*2: These values are based on evaluations on a Yamaha's PCB board implementation.
Please refer to Power Dissipation (Note) *1 on page 6.

■ Pin Assignments



< 48 pin SQFP Top View >

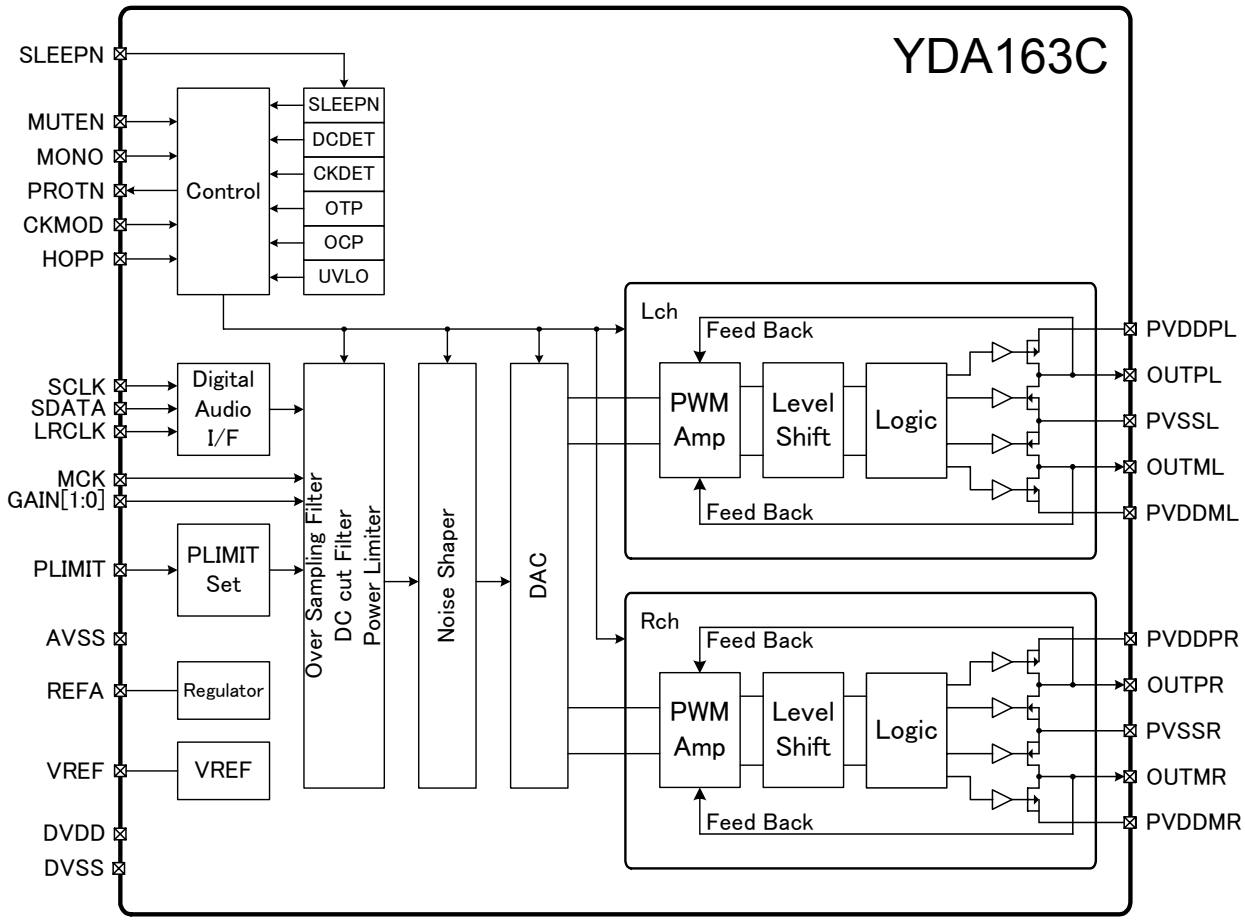
■ Pin Descriptions

No.	Name	I/O[*1)]	Function
1	N.C.	–	No Connection pin. This pin must be left open or connected to GND.
2	N.C.	–	No Connection pin. This pin must be left open or connected to GND.
3	AVSS	GND	Analog GND
4	VREF	AO	Analog Reference Voltage Output
5	REFA	AO	Internal Regulator Output
6	DVDD	DVDD power	Digital Power
7	MCK	I	Master Clock Input Pin
8	SDATA	I	Audio Data Input Pin
9	SCLK	I	Bit Clock Input Pin
10	LRCLK	I	Word Clock Input Pin
11	DVSS	GND	Digital GND
12	N.C.	–	No Connection pin. This pin must be left open or connected to GND.
13	PVSSR	GND	GND for the digital amplifier output (Rch)
14	PVDDPR	PVDD power	Power for the digital amplifier output (Rch+)
15	PVDDPR	PVDD power	Power for the digital amplifier output (Rch+)
16	OUTPR	O	Digital Amplifier Output (Rch+)
17	OUTPR	O	Digital Amplifier Output (Rch+)
18	PVSSR	GND	GND for the digital amplifier output (Rch)
19	PVSSR	GND	GND for the digital amplifier output (Rch)
20	OUTMR	O	Digital Amplifier Output (Rch-)
21	OUTMR	O	Digital Amplifier Output (Rch-)
22	PVDDMR	PVDD power	Power for the digital amplifier output (Rch-)
23	PVDDMR	PVDD power	Power for the digital amplifier output (Rch-)
24	PVSSR	GND	GND for the digital amplifier output (Rch)
25	N.C.	–	No Connection pin. This pin must be left open or connected to GND.
26	N.C.	–	No Connection pin. This pin must be left open or connected to GND.
27	HOPP	I	PWM Carrier Frequency Hopping setting pin
28	PLIMIT	I	Power Limit setting pin
29	SLEEPN	I	Sleep Reset pin[*2)]
30	PROTN	O/D	Error Flag Output pin
31	MUTEN	I	Mute pin
32	CKMOD	I	Clock Mode setting pin
33	GAIN0	I	Gain setting pin 0
34	GAIN1	I	Gain setting pin 1
35	MONO	I	Stereo/Mono setting pin
36	N.C.	–	No Connection pin. This pin must be left open or connected to GND.
37	PVSSL	GND	GND for the digital amplifier output (Lch)
38	PVDDML	PVDD power	Power for the digital amplifier output (Lch-)
39	PVDDML	PVDD power	Power for the digital amplifier output (Lch-)
40	OUTML	O	Digital Amplifier Output (Lch-)
41	OUTML	O	Digital Amplifier Output (Lch-)
42	PVSSL	GND	GND for the digital amplifier output (Lch)
43	PVSSL	GND	GND for the digital amplifier output (Lch)
44	OUTPL	O	Digital Amplifier Output (Lch+)
45	OUTPL	O	Digital Amplifier Output (Lch+)
46	PVDDPL	PVDD power	Power for the digital amplifier output (Lch+)
47	PVDDPL	PVDD power	Power for the digital amplifier output (Lch+)
48	PVSSL	GND	GND for the digital amplifier output (Lch)

(Note) *1: I: Input pin, O: Output pin, A: Analog pin, O/D: Open-Drain output pin
PVDD power pins should be connected each other on the board. Likewise, GND pins should be also connected each other on it.

*2: A voltage for supplying SLEEP pin with H level should be applied not from REFA pin output but from an external power supply.

■ Block Diagram



< YDA163C Block Diagram >

■ Electrical Characteristics

● Absolute Maximum Ratings *1)

Item		Symbol	Min.	Max.	Unit
Power Supply pin (PVDD) Voltage Range		V_{DDP}	–0.3	21.6	V
Power Supply pin (DVDD) Voltage Range		V_{DD}	–0.3	4.6	V
Input Pin Voltage Range*2)		V_{IN1}	–0.3	4.6	V
HOPP, HORL Pins Voltage Range		V_{IN2}	–0.3	V_{DD}+0.3	V
Junction Temperature		Tjmax	–	150	ºC
Storage Temperature		T_{STG}	–40	150	ºC
Speaker Impedance	$V_{DDP} \geqq 8V$	R_{LS}	3.2	–	Ω
	$V_{DDP} < 8V$	R_{LS}	6.4	–	Ω

(Note) *1: Absolute Maximum Ratings are values which must not be exceeded to guarantee device reliability and life, and when using a device in excess of the ratings for even a moment, it may immediately cause damage to the device or may significantly deteriorate its reliability.

*2: Input Pins: MUTEN, MCK, SCLK, LRCLK, SDATA, CKMOD, GAIN[1:0], SLEEPN, and PLIMIT

● Power Dissipation

Item		Symbol	Condition		Min.	Max.	Unit
Power Dissipation	4-layer board	P_{D25}	Thermal resistance θja =19℃/W	T_A=25℃	–	6.51*1)	W
		P_{D70}		T_A=70℃	–	4.21*1)	W
		P_{D85}		T_A=85℃	–	3.4*1)	W
	2-layer board	P_{D25}	Thermal resistance θja =33.6℃/W	T_A=25℃	–	3.72*2)	W
		P_{D70}		T_A=70℃	–	2.38*2)	W
		P_{D85}		T_A=85℃	–	1.93*2)	W

(Note) *1: Board layer: 4 layers, Size: 136[mm]× 85[mm], copper foil thickness: 35[μm],
Copper foil ratio: 379%, Exposed Stage: Soldered to the board,
Thermal Via (ϕ 0.5mm): 25(5×5) from the exposed stage side to internal layers (VSS layer) and B side

*2: Board layer: 2 layers, Size: 136[mm] × 85[mm], copper foil thickness: 35[μm],
Copper foil ratio: 187%, Exposed Stage: Soldered to the board,
Thermal Via (ϕ 0.5mm) : 25(5×5) from the exposed stage side to B side

● Recommended Operating Conditions

Item	Symbol	Condition	Min.	Max.	Unit
Supply Voltage (PVDD)	V_{DDP}	5*2)	–	18	V
Supply Voltage (DVDD)	V_{DD}	3.0	3.3	3.6	V
Digital pins*1) Input Voltage H level	V_{IN}	2.0	3.3	3.6	V
SLEEPN pin Input Voltage H level	V_{IN}	2.2	3.3	3.6	V
Ambient Operating Temperature	T_A	–40	25	85	℃

(Note) *1: Digital Pins: MUTEN, MCK, SCLK, LRCLK, SDATA, CKMOD, GAIN[1:0], HOPP, and MONO
*2: When operating at less than 8V (V_{DDP}), an 8Ω or more load must be used.

● DC characteristics

(V_{DDP} = 5V to 18V, V_{DD} = 3.0V to 3.6V, V_{SS} = 0V, T_A = –40℃ to 85℃, unless otherwise specified)

Item		Symbol	Condition	Min.	Typ.	Max.	Unit
PVDD pin	Startup Threshold Voltage	V_{HUVLH}	–	–	4.3	–	V
	Shutdown Threshold Voltage	V_{HUVLL}	–	–	4.15	–	V
DVDD pin	Startup Threshold Voltage	V_{LUVLH}	–	–	2.0	–	V
	Shutdown Threshold Voltage	V_{LUVLL}	–	–	2.0	–	V
Digital pins*1)	Input Voltage H level	V_{IH}	–	2.0	–	–	V
	Input Voltage L level	V_{IL}	–	–	–	0.8	V
	Input Impedance	R_{IN_D}	–	3.3	–	–	MΩ
SLEEPN pin	Input Voltage H level	V_{IH}	–	2.2	–	–	V
	Input Voltage L level	V_{IL}	–	–	–	0.5	V
	Input Impedance	R_{IN_D}	–	3.3	–	–	MΩ
PROTN pin Output Voltage		V_{OL}	I_{OL}=2mA	–	–	0.4	V
REFA pin Output Voltage		V_{REFA}	–	–	3.4	–	V
VREF pin Output Voltage		V_{REF}	–	–	V_{REFA} /2	–	V
PVDD Current Consumption	at idling state	I_{DDPP}	V_{DDP} =12V, No load	–	22	–	mA
	at power-down state (SLEEPN=L)	I_{DDPS}	V_{DDP} =12V, No load, T_A = 25℃	–	7	–	μA
	at mute state (MUTEN=L)	I_{DDPM}	V_{DDP} =12V, No load	–	12	–	mA
DVDD Current Consumption	at idling state	I_{DDP}	V_{DD} =3.3V	–	9	–	mA
	at power-down state (SLEEPN=L)	I_{DDS}	V_{DD} =3.3V, T_A = 25℃	–	45	–	μA
	at mute state (MUTEN=L)	I_{DDM}	V_{DD} =3.3V	–	9	–	mA

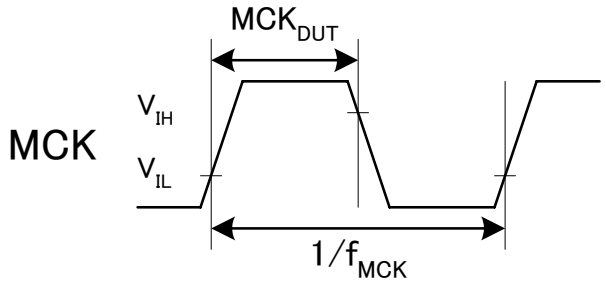
(Note) *1: Digital Pins: MUTEN, MCK, SCLK, LRCLK, SDATA, CKMOD, GAIN[1:0], HOPP, and MONO

● AC Characteristics

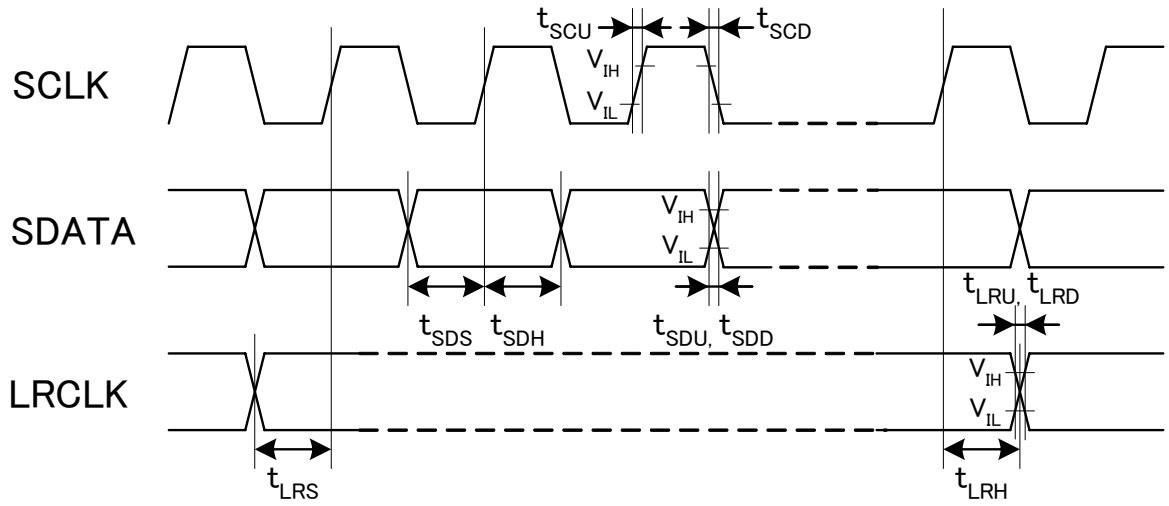
(V_{DDP} = 5V to 18V, V_{DD} = 3.0V to 3.6V, V_{SS} = 0V, T_A = –40℃ to 85℃, unless otherwise specified)

Item		Symbol	Min.	Typ.	Max.	Unit
MCK	Input Frequency*1)	f_{MCK}	Typ × 0.95	11.290 12.288 16.384 22.579 24.576	Typ × 1.05	MHz
	Duty	MCK_{DUT}	40	—	60	%
SCLK	Input Frequency	f_{SCLK}	—	64 × fs	—	—
	Rise Time	t_{SCU}	—	—	15	ns
	Fall Time	t_{SCD}	—	—	15	ns
LRCLK	Input Frequency	f_S	—	32 44.1 48	—	kHz
	Setup Time	t_{LRS}	10	—	—	ns
	Hold Time	t_{LRH}	10	—	—	ns
	Rise Time	t_{LRU}	—	—	15	ns
	Fall Time	t_{LRD}	—	—	15	ns
SDATA	Setup Time	t_{SDS}	10	—	—	ns
	Hold Time	t_{SDH}	10	—	—	ns
	Rise Time	t_{SDU}	—	—	15	ns
	Fall Time	t_{SDD}	—	—	15	ns
MUTE Recovery Time (fs=48kHz)		t_{mrcv}	—	5.3	—	ms

(Note) *1: Refer to YDA163C Application manual “Table 6-1 Carrier Clock Frequency” at page 16 for the MCK Input Frequency.



< Master Clock Input Timing >



< Digital Audio Interface Timing >

● Analog Characteristics

(V_{DDP} = 12V, V_{DD} = 3.3V, V_{SS} = 0V, T_A = 25℃, R_L = 8Ω, unless otherwise specified)

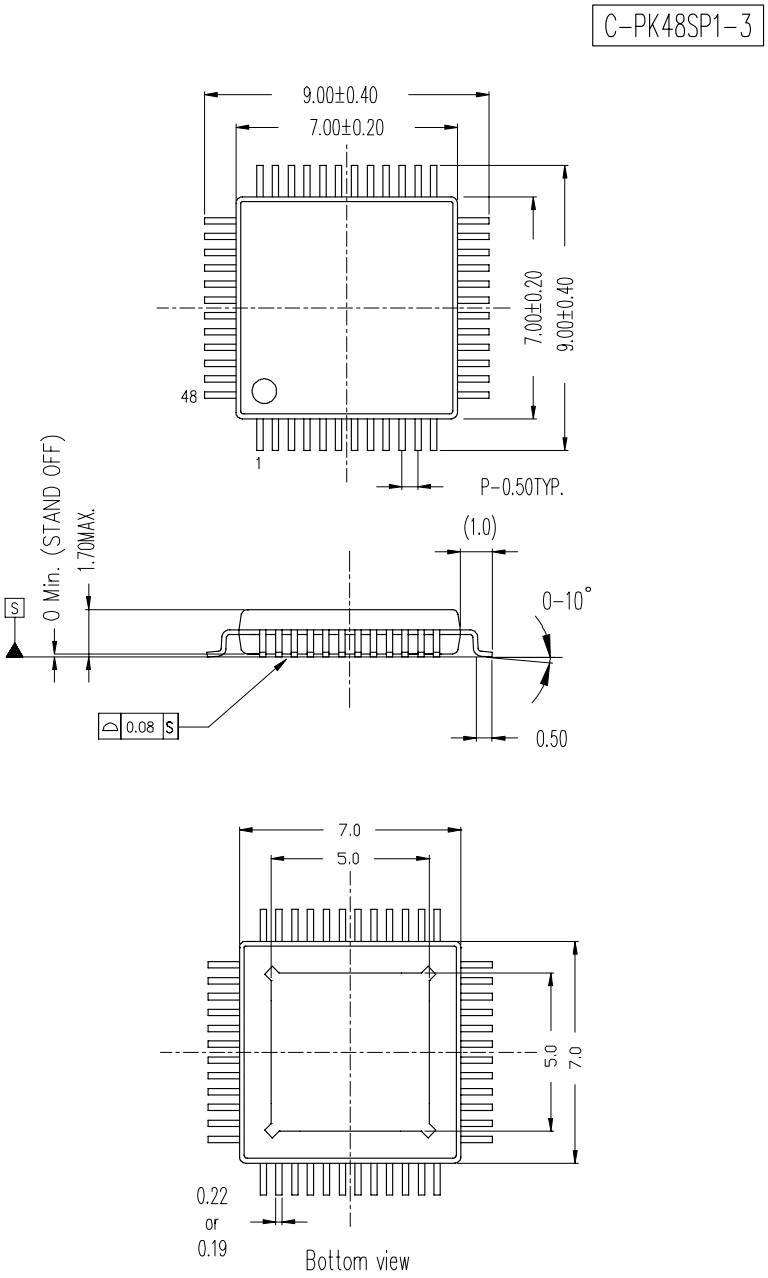
Item		Symbol	Condition	Min.	Typ.	Max.	Unit
Maximum Instantaneous Output	Stereo	Po	V_{DDP}=14V, R_L=4Ω, THD+N=10%	–	20	–	W
			V_{DDP}=15V, R_L=8Ω, THD+N=10%	–	15	–	W
	Monaural	Po	V_{DDP}=15V, R_L=4Ω, THD+N=10%	–	25	–	W
Maximum Continuous Output	Stereo	Po	V_{DDP}=15V, R_L=8Ω, T_A=70℃, 4-layer board	–	15	–	W
			V_{DDP}=12V, R_L=8Ω, T_A=70℃, 4-layer board	–	10	–	W
	Monaural	Po	V_{DDP}=15V, R_L=4Ω, T_A=70℃, 4-layer board	–	25	–	W
Total Harmonic Distortion	Stereo	THD+N	R_L=8Ω, Po=4.5W	–	0.05	–	%
	Monaural	THD+N	R_L=8Ω, Po=4.5W	–	0.05	–	%
Residual Noise*1)	Stereo	Vn	R_L=8Ω, A-Weighted Filter	–	50	–	μVrms
	Monaural	Vn	R_L=8Ω, A-Weighted Filter	–	50	–	μVrms
S/N Ratio*1)	Stereo	SNR	R_L=8Ω, A-Weighted Filter	–	105	–	dB
	Monaural	SNR	R_L=8Ω, A-Weighted Filter	–	105	–	dB
Channel Separation (L vs R)*1)		CS	R_L=8Ω,1kHz	–	80	–	dB
PSRR*1)	Stereo	PSRR	PVDD applied, Vripple=200mV,f=1kHz	–	60	–	dB
	Monaural	PSRR	PVDD applied, Vripple=200mV,f=1kHz	–	60	–	dB
Maximum Efficiency	Stereo	η	R_L=8Ω, Po=10W	–	92	–	%
			R_L=4Ω, Po=15W	–	88	–	%
	Monaural	η	R_L=8Ω, Po=10W	–	93	–	%
			R_L=4Ω, Po=20W	–	93	–	%
Output Offset Voltage (Stereo)*2)		Vo	–	–	2	6	mV
Frequency Characteristics		f	20Hz	–1	0	1	dB
			20kHz	–3	0	1	dB

(Note) All analog characteristics were measured by using Yamaha evaluation board. Depending upon pattern layout etc., its characteristics may vary.

*1: Except the case of HOPP=H

*2: An offset voltage is represented by taking typ. as σ and max. as 3σ.

■ Package Information



端子厚さ/Lead Thickness : 0.15 or 0.17

モールドコーナー形状は、この図面と若干異なるタイプもあります。
カッコ内の寸法値は参考値です。
モールド外形寸法はバリを含みません。
単位 : mm

The shape of the molded corner may slightly differ from the shape in this diagram.
The figure in the parentheses ( ) should be used as a reference.
Plastic body dimensions do not include resin burr.
UNIT: mm

注） 表面実装LSIは、保管条件、及び半田付けについての特別な配慮が必要です。
詳しくはヤマハ代理店までお問い合わせください。

Note: The storage and soldering of LSIs for surface mounting need special consideration.
For detailed information, please contact your local Yamaha agent.

PRECAUTIONS AND INSTRUCTIONS FOR SAFETY

	WARNING
Prohibited	Do not use the device under stresses beyond those listed in Absolute Maximum Ratings. Such stresses may become causes of breakdown, damages, or deterioration, causing explosion or ignition, and this may lead to fire or personal injury.
Prohibited	Do not mount the device reversely or improperly and also do not connect a supply voltage in wrong polarity. Otherwise, this may cause current and/or power-consumption to exceed the absolute maximum ratings, causing personal injury due to explosion or ignition as well as causing breakdown, damages, or deterioration. And, do not use the device again that has been improperly mounted and powered once.
Prohibited	Do not short between pins. In particular, when different power supply pins, such as between high-voltage and low-voltage pins, are shorted, smoke, fire, or explosion may take place.
Instructions	As to devices capable of generating sound from its speaker outputs, please design with safety of your products and system in mind, such as the consequences of unusual speaker output due to a malfunction or failure. A speaker dissipates heat in a voice-coil by air flow accompanying vibration of a diaphragm. When a DC signal (several Hz or less) is input due to device failure, heat dissipation characteristics degrade rapidly, thereby leading to voice-coil burnout, smoking or ignition of the speaker even if it is used within the rated input value.

	CAUTION
Prohibited	Do not use Yamaha products in close proximity to burning materials, combustible substances, or inflammable materials, in order to prevent the spread of the fire caused by Yamaha products, and to prevent the smoke or fire of Yamaha products due to peripheral components.
Instructions	Generally, semiconductor products may malfunction and break down due to aging, degradation, etc. It is the responsibility of the designer to take actions such as safety design of products and the entire system and also fail-safe design according to applications, so as not to cause property damage and/or bodily injury due to malfunction and/or failure of semiconductor products.
Instructions	The built-in DSP may output the maximum amplitude waveform suddenly due to malfunction from disturbances etc. and this may cause damage to headphones, external amplifiers, and human body (the ear). Please pay attention to safety measures for device malfunction and failure both in product and system design.
Instructions	As semiconductor devices are not nonflammable, overcurrent or failure may cause smoke or fire. Therefore, products should be designed with safety in mind such as using overcurrent protection circuits to control the amount of current during operation and to shut off on failure.
Instructions	Products should be designed with fail safe in mind in case of malfunction of the built-in protection circuits. Note that the built-in protection circuits such as overcurrent protection circuit and high-temperature protection circuit do not always protect the internal circuits. In some cases, depending on usage or situations, such protection circuit may not work properly or the device itself may break down before the protection circuit kicks in.
Instructions	Use a robust power supply. The use of an unrobust power supply may lead to malfunctions of the protection circuit, causing device breakdown, personal injury due to explosion, or smoke or fire.
Instructions	Product's housing should be designed with the considerations of short-circuiting between pins of the mounted device due to foreign conductive substances (such as metal pins etc.). Moreover, the housing should be designed with spatter prevention etc. due to explosion or burning. Otherwise, the spattered substance may cause bodily injury.
Instructions	The device may be heated to a high temperature due to internal heat generation during operation. Therefore, please take care not to touch an operating device directly.

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