⊕ YAMAHA

YDA164 |PRELIMINARY|

D-510D

DIGITAL INPUT STEREO 15W DIGITAL AUDIO POWER AMPLIFIER

■ General Description

YDA164(D-510D) 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 8V to 18V.

YDA164, having "Pure Pulse Direct Speaker Drive Circuit" that drives a speaker directly by reducing distortion and noise due to PWM pulse outputs, realizes the highest degree of low-level distortion and noise characteristics in all of mobile digital amplifiers.

In addition, because of a feedback-type digital amplifier, this amplifier is insusceptible to supply voltage fluctuation, allowing for the use of a non-regulated power supply and allowing a simple amplifier system with less external components to be configured.

YDA164 has the following functions: power limit function, output disable function, overcurrent protection function for speaker output pins, internal overtemperature protection function, low-voltage malfunction prevention function, and DC detection function.

■ Features

· Supply Voltage Range	V_{DDP} 8V 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	15 W×2ch	(V_{DDP}=15V, R_L=8Ω, THD+N=10%)
	10 W×2ch	(V_{DDP}=12V, R_L=8Ω, THD+N=10%)
	20 W×2ch	(V_{DDP}=14V, R_L=4Ω, THD+N=10%)
· Max. Continuous Output	10 W×2ch	(V_{DDP}=12V, R_L=8Ω, Ta=70 ºC, 4-layer Board)
· Distortion Rate (THD+N)	0.05 %(TBD)	(V_{DDP}=12V, R_L=8Ω, Po=7.5W, 1kHz)
· Residual Noise	50 μVrms(TBD)	(V_{DDP}=12V, R_L=8Ω)
· S/N Ratio	105 dB(TBD)	(V_{DDP}=12V, R_L=8Ω)
· Efficiency	92 %(TBD)	(V_{DDP}=12V, R_L=8Ω)
· Channel Separation	80 dB	(V_{DDP}=12V, R_L=8Ω, 1kHz)

· Power Limit Function
· Gain Setting Function (3step: +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
· Over Temperature Protection Function
· DC Detection Function
· Low-voltage Malfunction Prevention Function
· Clock Detection Function
· Package   Lead-free 32-pin Plastic QFN (Stage Expose)

(Note)*1: This is the value measured based on Yamaha's implementation conditions.
        Please refer to Power Dissipation (Note) *1 on page 5.

> The contents of this booklet are target specifications and they might be changed without notice. Please confirm the finalized specifications again before the use of this LSI.
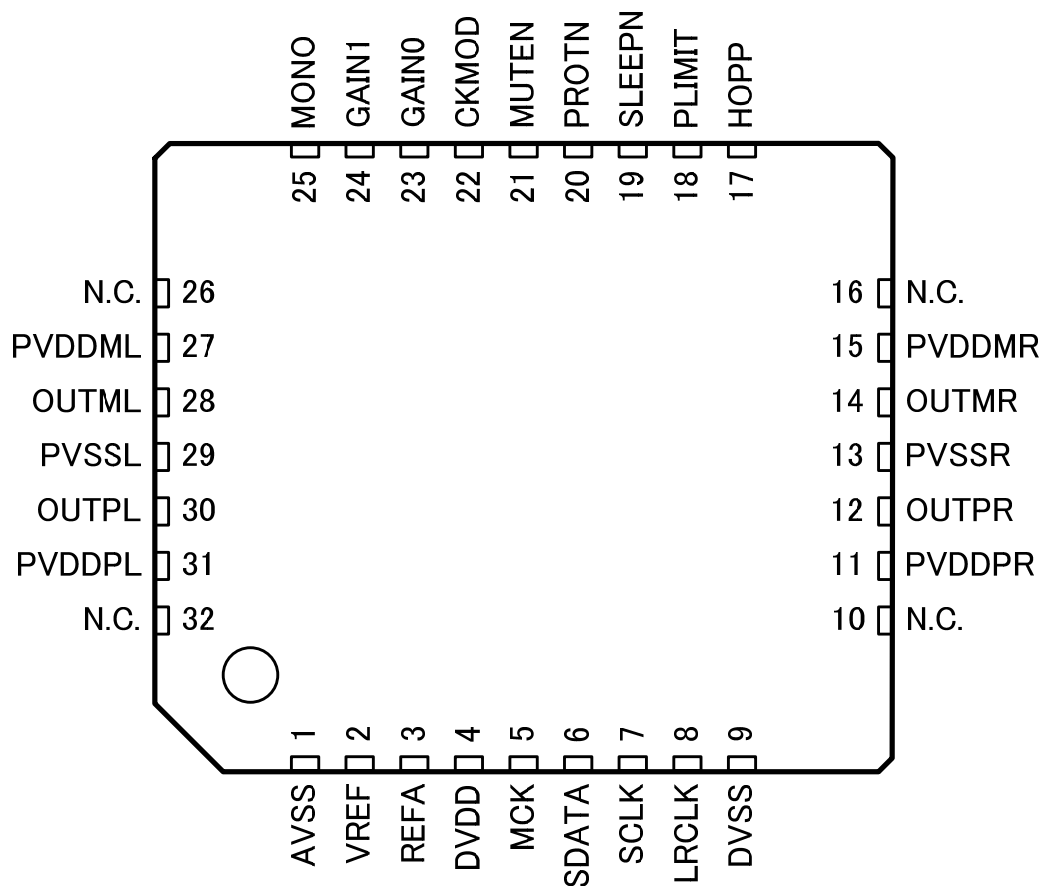
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■ Block Diagram

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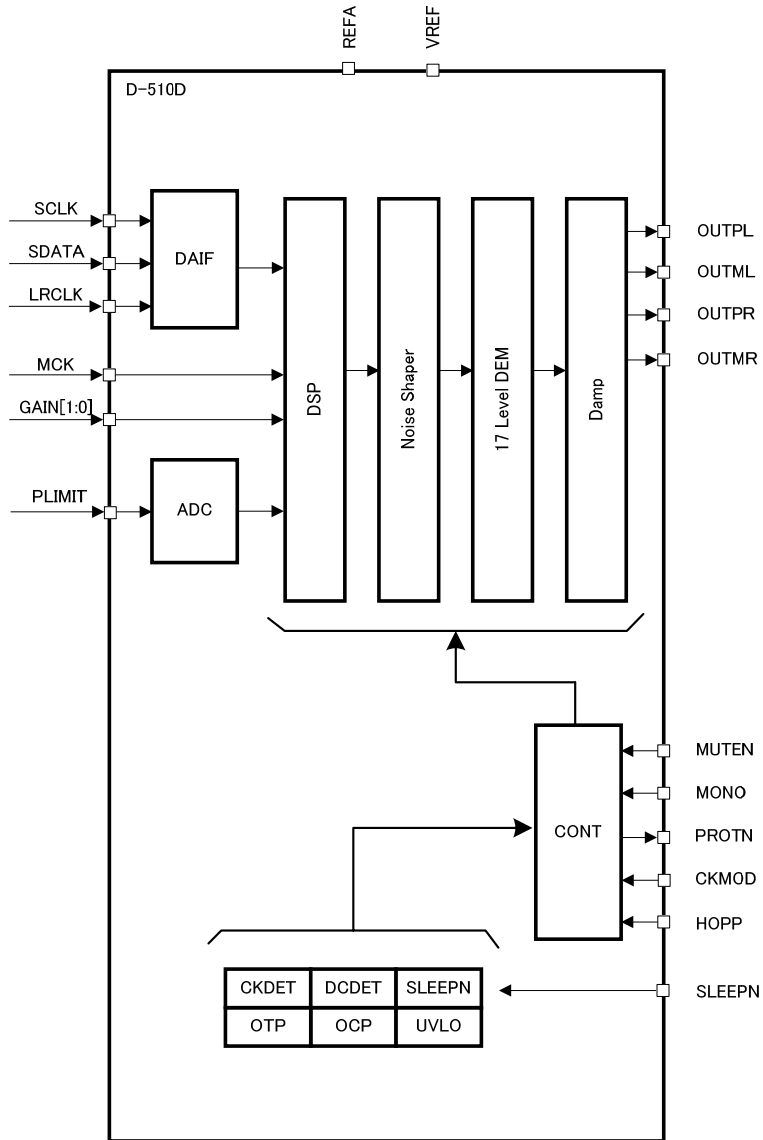
■ Pin Configuration

< 32-pin QFN Top View>

■ Pin Function

No.	Name	I/O	Function
1	AVSS	GND	Analog GND
2	VREF	AO	Analog Reference Voltage Output
3	REFA	AO	Internal Regulator Output
4	DVDD	DVDD power	Digital Power
5	MCK	I	Master Clock Input Pin
6	SDATA	I	Audio Data Input Pin
7	SCLK	I	Bit Clock Input Pin
8	LRCLK	I	Word Clock Input Pin
9	DVSS	GND	Digital GND
10	N.C.	—	No Connection pin. Do not connect anything.
11	PVDDPR	PVDD power	Power for the digital amplifier output (Rch+)
12	OUTPR	O	Digital Amplifier Output (Rch+)
13	PVSSR	GND	GND for the digital amplifier output (Rch)
14	OUTMR	O	Digital Amplifier Output (Rch-)
15	PVDDMR	PVDD power	Power for the digital amplifier output (Rch-)
16	N.C.	—	No Connection pin. Do not connect anything.
17	HOPP	I	PWM Carrier Frequency Hopping setting pin
18	PLIMIT	I	Power Limit setting pin
19	SLEEPN	I	Sleep Reset pin [1]
20	PROTN	O/D	Error Flag Output pin
21	MUTEN	I	Mute pin
22	CKMOD	I	Clock Mode setting pin
23	GAIN0	I	Gain setting pin 0
24	GAIN1	I	Gain setting pin 1
25	MONO	I	Stereo/Mono setting pin
26	N.C.	—	No Connection pin. Do not connect anything.
27	PVDDML	PVDD power	Power for the digital amplifier output (Lch-)
28	OUTML	O	Digital Amplifier Output (Lch-)
29	PVSSL	GND	GND for the digital amplifier output (Lch)
30	OUTPL	O	Digital Amplifier Output (Lch+)
31	PVDDPL	PVDD power	Power for the digital amplifier output (Lch+)
32	N.C.	—	No Connection pin. Do not connect anything.

(Note) 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.

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

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■ Electrical Characteristics

● Absolute Maximum Ratings

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[1]	V_{IN1}	−0.3	4.6	V
HOPP, MONO 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	R_{LS}	3.2	–	Ω

(Note) 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.

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

● Power Dissipation

Item	Symbol	Condition	Min.	Max.	Unit
Power Dissipation	P_{D25}	T_A=25℃, Heat resistance=20.7℃/W, 4-layer board	–	6.03[1]	W
	P_{D70}	T_A=70℃, Heat resistance=20.7℃/W, 4-layer board	–	3.86[1]	W
	P_{D85}	T_A=85℃, Heat resistance=20.7℃/W, 4-layer board	–	3.14[1]	W
	P_{D25}	T_A=25℃, Heat resistance=44℃/W, 2-layer board	–	2.84[2]	W
	P_{D70}	T_A=70℃, Heat resistance=44℃/W, 2-layer board	–	1.82[2]	W
	P_{D85}	T_A=85℃, Heat resistance=44℃/W, 2-layer board	–	1.48[2]	W

(Note) *1: Board layer: 4 layers, Size: 136[mm]× 85[mm], copper foil thickness: 35[μm]、
   Copper foil ratio: 377%, Exposed Stage: Soldered to the board,
   Heat Dissipation Through-Hole (φ0.5mm): 9(3×3) 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: 185%, Exposed Stage: Soldered to the board,
   Heat Dissipation Through-Hole (φ0.5mm) : 9(3×3) from the exposed stage side to B side

● Recommended Operating Conditions

Item	Symbol	Condition	Min.	Max.	Unit
Supply Voltage (PVDD)	V_{DDP}	8	–	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}	2.0	3.3	3.6	V
Ambient Operating Temperature	T_A	−40	25	85	ºC

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

● DC Characteristics

(V_{DDP} = 8V 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
PVDD pin Shutdown Threshold Voltage	V_{HUVLL}	–	–	4.15	–	V
VDD pin Startup Threshold Voltage	V_{LUVLH}	–	–	2.0	–	V
VDD pin Shutdown Threshold Voltage	V_{LUVLL}	–	–	2.0	–	V
Digital pins [*1] Input Voltage H level	V_{IH}	–	2.0	-	–	V
Digital pins [*1] Input Voltage L level	V_{IL}	–	–	-	0.8	V
Digital pins [*1] Input Impedance	$R_{IN\,D}$	–	3.3	-	–	MΩ
SLEEPN pin Input Voltage H level	V_{IH}	–	2.0	-	–	V
SLEEPN pin Input Voltage L level	V_{IL}	–	–	-	0.7	V
SLEEPN pin Input Impedance	$R_{IN\,D}$	–	3.3	-	–	MΩ
PROTN Output Voltage	V_{OL}	I_{OL}=2mA	–	-	0.4	V
REFA Output Voltage	V_{REFA}	–	–	3.4	–	V
VREF Output Voltage	V_{REF}	–	–	V_{REFA} /2	–	V
PVDD Consumption Current at idling state	I_{DDPP}	V_{DDP} =12V, No load	–	22	–	mA
PVDD Consumption Current at power-down state (SLEEPN=L)	I_{DDPS}	V_{DDP} =12V, No load	–	7	–	μA
PVDD Consumption Current at mute state (MUTEN=L)	I_{DDPM}	V_{DDP} =12V, No load	–	12	–	mA
DVDD Consumption Current at idling state	I_{DDP}	V_{DD} =3.3V	–	9	–	mA
DVDD Consumption Current at power-down state (SLEEPN=L)	I_{DDS}	V_{DD} =3.3V	–	45	–	μA
DVDD Consumption Current 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} = 8V 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
LRCLK Input Frequency	fs	32	–	48	kHz
LRCLK Setup Time	t_{LRS}	10	–	–	ns
LRCLK Hold Time	t_{LRH}	10	–	–	ns
SDATA Setup Time	t_{SDS}	10	–	–	ns
SDATA Hold Time	t_{SDH}	10	–	–	ns
MUTE Recovery Time (fs=48kHz)	t_{mrcv}	–	5.3	–	ms

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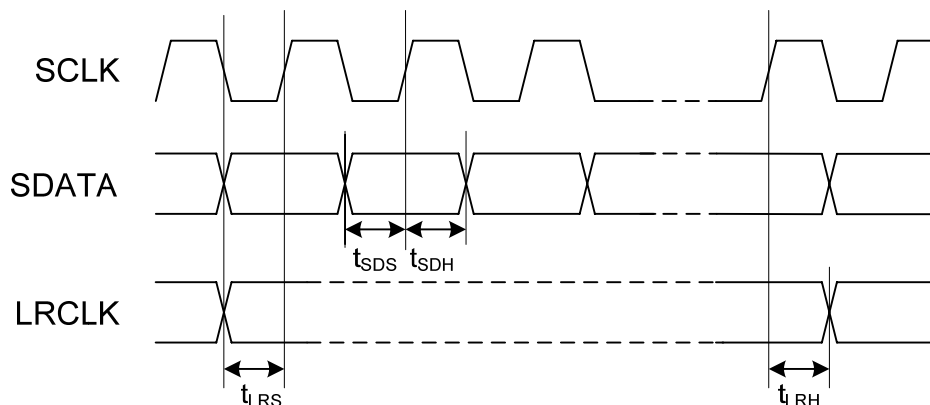
● Analog Characteristics

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

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Maximum Momentary Output (Stereo, THD+N=10%)	Po	V_{DDP}=14V, R_L=4Ω	–	20	–	W
		V_{DDP}=15V, R_L=8Ω	–	15	–	W
Maximum Momentary Output (Monaural, THD+N=10%）	Po	V_{DDP}=15V, R_L=4Ω	–	30	–	W
Maximum Continuous Output (Stereo)	Po	V_{DDP}=12V, R_L=8Ω, T_A=70℃, 4-layer board	–	10	–	W
Maximum Continuous Output (Monaural)	Po	V_{DDP}=15V, R_L=4Ω, T_A=70℃, 4-layer board	–	15	–	W
Total Harmonic Distortion (Stereo)	THD+N	R_L=8Ω, Po=7.5W	–	0.05(TBD)	–	%
Total Harmonic Distortion (Monaural)	THD+N	R_L=8Ω, Po=7.5W	–	0.05(TBD)	–	%
Residual Noise (Stereo, A-Weight Filter) [1]	Vn	R_L=8Ω	–	50(TBD)	–	μVrms
Residual Noise (Monaural, A-Weight Filter) [1]	Vn	R_L=8Ω	–	50(TBD)	–	μVrms
S/N Ratio (Stereo, A-Weight Filter) [1]	SNR	R_L=8Ω	–	105(TBD)	–	dB
S/N Ratio (Monaural, A-Weight Filter) [1]	SNR	R_L=8Ω	–	105(TBD)	–	dB
Channel Separation (L vs R) [1]	CS	1kHz	–	80(TBD)	–	dB
PSRR(Stereo), PVDD applied)	PSRR	Vripple=200mV,f=1kHz	–	60	–	dB
PSRR(Monaural, PVDD applied)	PSRR	Vripple=200mV,f=1kHz	–	60	–	dB
Maximum Efficiency (Stereo)	η	R_L=8Ω	–	92(TBD)	–	%
	η	R_L=4Ω	–	88(TBD)	–	%
Maximum Efficiency (Monaural)	η	R_L=8Ω,Po=20W	–	93(TBD)	–	%
	η	R_L=4Ω,Po=20W	–	93(TBD)	–	%
Output Offset Voltage (Stereo)[2]	Vo	–	–	2	6(TBD)	mV
Frequency Characteristics	f	20Hz	–1	0	1	dB
	f	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 off-set voltage is represented by taking typ. as σ and max. as 3σ.

LSI-4DA164A00

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■ Package Dimensions

C-PK32QP2-2

6.20±0.30
6.00±0.20
5.00±0.20
5.20±0.30
P-0.5TYP.
1.00MAX.
0MIN. (STAND OFF)
0.60
32
1
S
0.05 S
3.40
4.40
0.22

端子厚さ：0.22TYP.
LEAD THICKNESS
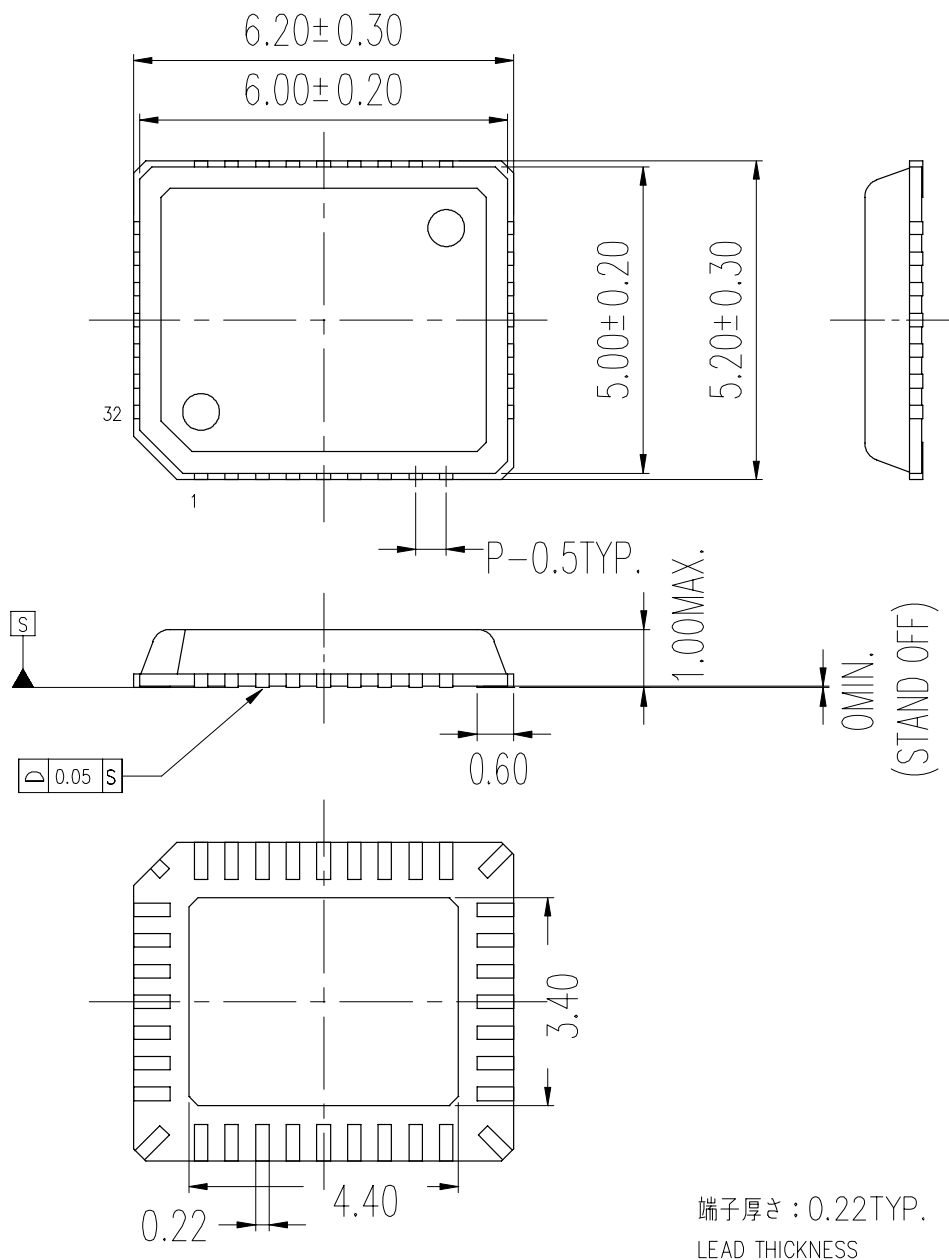
カッコ内の寸法値は参考値です。
モールド外形寸法はバリを含みません。
単位： mm

The 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.

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PRECAUTIONS AND INSTRUCTIONS FOR SAFETY

⚠	WARNING
🚫 Prohibited	Do not use the device under stresses beyond those listed in Absolute Maximum Ratings (current, voltages, safety operation ranges, temperature, etc.). 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 causes of 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, in case of the occurrence of unusual speaker output due to a malfunction or failure. A speaker radiates 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 radiation characteristics degrade rapidly, thereby leading to voice-coil burnout, smoke, or ignition of a speaker even if it is used within the rated input value.

⚠	CAUTION
🚫 Prohibited	Do not use Yamaha products in a position close 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 user 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 (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 overcurrent protection circuit etc. so that it does not keep on flowing during operation or 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 start of the protection circuit.
❗ Instructions	Use a stable power supply. The use of unstable 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 possibility 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.

Notice The specification given here are provisional and subject to change without prior notice. Please confirm the latest documentation before using this product.