YAMAHA

YDA161

D-715D

DIGITAL INPUT STEREO 15W DIGITAL AUDIO POWER AMPLIFIER

■ General Description

YDA161(D-715D) is a high-performance digital audio amplifier IC that delivers up to 15W×2ch, which has a digital audio interface, and is capable of operating at a supply voltage ranging from 8V to 26.4V.
YDA161, 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 standard of low-level distortion and noise characteristics among digital amplifier ICs in the same class.
In addition, this amplifier is insusceptible to supply voltage fluctuation because of a feedback-type digital amplifier, allowing for the use of a non-regulated power supply and also allowing a simple amplifier system with less external components to be configured.
YDA161 has power limit function that was developed by Yamaha's unique digital amplifier technique.
YDA161 has the following functions: output disable function, overcurrent protection function for speaker output pins, internal over temperature protection function, low-voltage malfunction prevention function, and DC detection function.

■ Features

・Supply Voltage Range	V_{DDP}	8.0V to 26.4V
・Input	Digital Audio Interface (Stereo) Sampling Frequency: 32kHz, 44.1kHz, 48kHz, 88.2kHz, 96kHz, 176.4kHz, 192kHz Left-justified, MSB first, 1-bit delay, 24-bits Digital Audio Data	
・Max. Instantaneous Output	15 W×2ch	(V_{DDP}=24V, R_L=8Ω, THD+N=10%)
・Max. Continuous Output	10 W[*1]×2ch	(V_{DDP}=24V, R_L=8Ω, T_A=70 ºC)
・Distortion Rate (THD+N)	0.1 %	(V_{DDP}=24V, R_L=8Ω, Po=7.5W, 1kHz, BW=20kHz)
・Residual Noise	80 μVrms	(V_{DDP}=24V, R_L=8Ω)
・S/N Ratio	100 dB	(V_{DDP}=24V, R_L=8Ω)
・Efficiency	84 %	(V_{DDP}=24V, R_L=8Ω, Po=10W)
・Channel Separation	75 dB	(V_{DDP}=24V, R_L=8Ω, 1kHz)
・PSRR	70 dB	(V_{DDP}=24V, Vripple=200mV, 1kHz)
・Power Limit Function	(4W, 5W, 5.5W, 10W, 11W, 15W, 16.5W @8Ω)	
・Stereo/Monaural Switching Function		
・Output Mute Function		
・Pop Noise Reduction Function		
・Overcurrent Protection Function		
・Over Temperature Protection Function		
・DC Detection Function		
・Low-voltage Malfunction Prevention Function		
・Clock Detection Function		
・Package	Lead-free 48-pin Plastic LQFP (Stage Expose)	

(Note)*1: This is the value measured under Yamaha's implementation conditions.
Please refer to Absolute Maximum Rating (Note) *1 on page 5.

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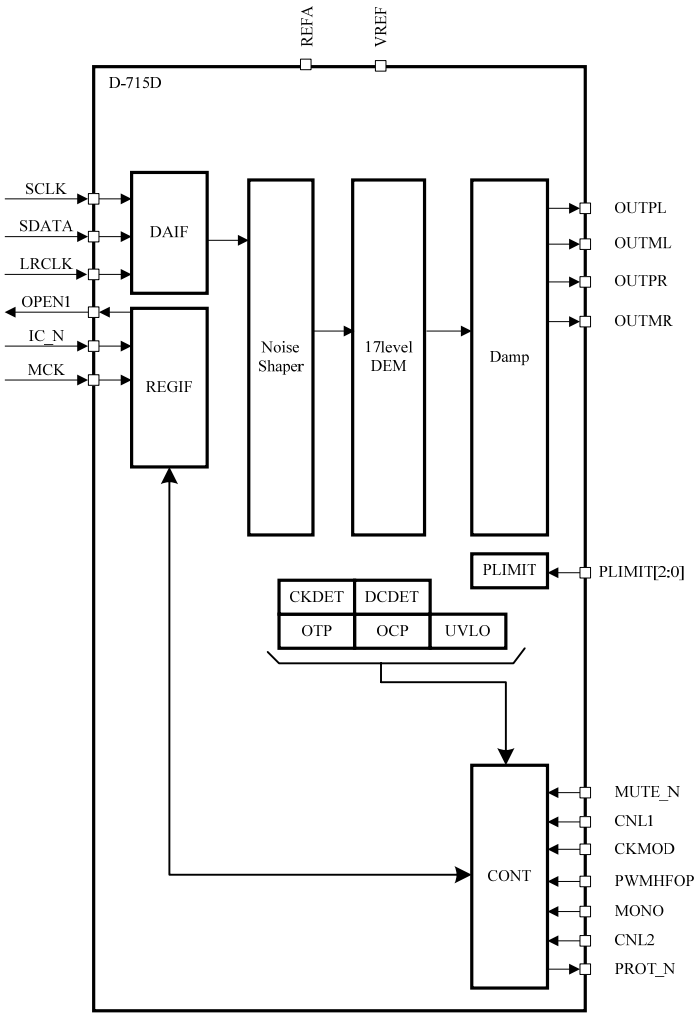
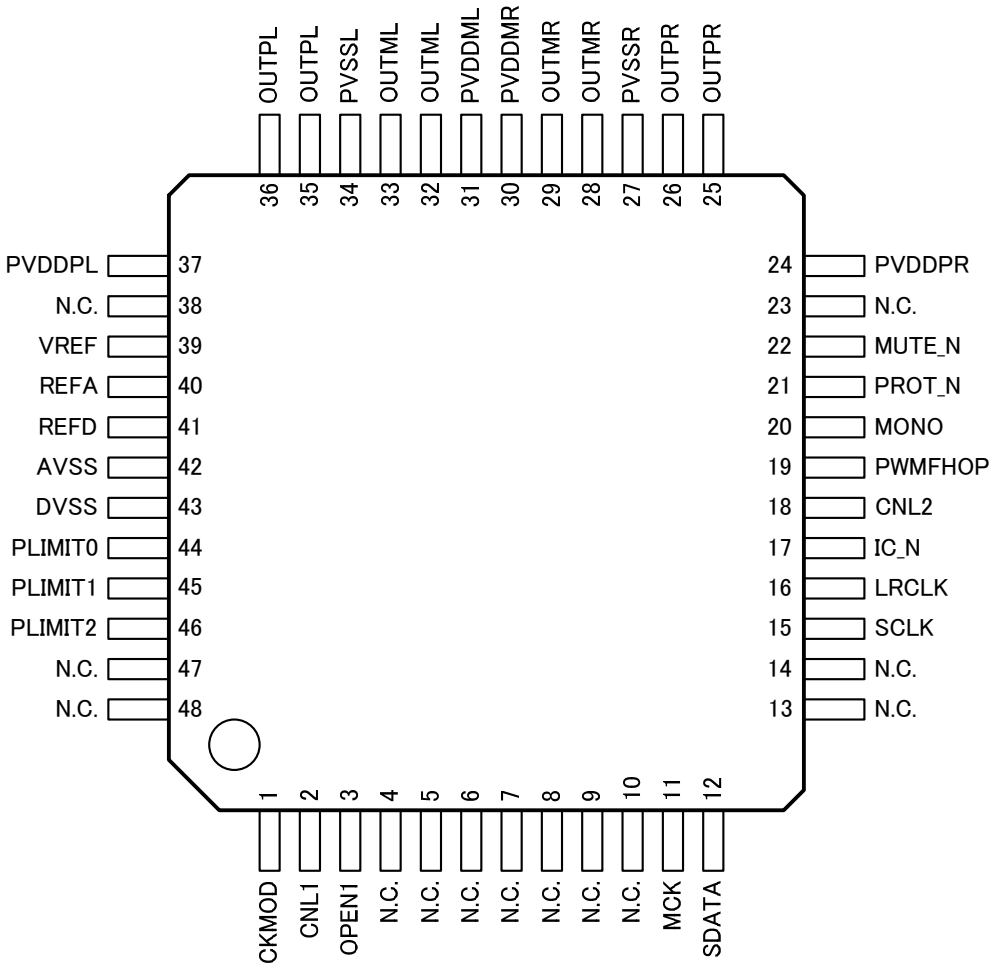
YDA161 CATALOG
CATALOG No.: LSI-4DA161A20
2009.9

■ Block Diagram



■ Pin Configuration



< 48-pin LQFP Top View>

■ Pin Function

No.	Name	I/O	Function
1	CKMOD	I	Clock Mode Setting
2	CNL1	I	Connect this pin to GND.
3	OPEN1	O	Leave this pin open.
4	N.C.	—	No Connection pin. Connect this pin to GND. *1)
5	N.C.	—	No Connection pin. Connect this pin to GND. *1)
6	N.C.	—	No Connection pin. Connect this pin to GND. *1)
7	N.C.	—	No Connection pin. Connect this pin to GND. *1)
8	N.C.	—	No Connection pin. Connect this pin to GND. *1)
9	N.C.	—	No Connection pin. Connect this pin to GND. *1)
10	N.C.	—	No Connection pin. Connect this pin to GND. *1)
11	MCK	I	Master Clock Input
12	SDATA	I	Audio Data Input
13	N.C.	—	No Connection pin. Connect this pin to GND. *1)
14	N.C.	—	No Connection pin. Connect this pin to GND. *1)
15	SCLK	I	Bit Clock Input
16	LRCLK	I	Word Clock Input
17	IC_N	I	Reset pin
18	CNL2	I	Connect this pin to GND.
19	PWMFHOP	I	PWM Carrier Hopping Setting pin
20	MONO	I	Monaural Setting pin
21	PROT_N	O/D	Error Flag Output pin
22	MUTE_N	I	Mute pin
23	N.C.	—	No Connection pin. Leave this pin open.
24	PVDDPR	PVDD	Digital Amplifier Output Power Supply (Rch+)
25	OUTPR	O	Digital Amplifier Output (Rch+)
26	OUTPR	O	Digital Amplifier Output (Rch+)
27	PVSSR	PVSS	Digital Amplifier Output GND (Rch)
28	OUTMR	O	Digital Amplifier Output (Rch-)
29	OUTMR	O	Digital Amplifier Output (Rch-)
30	PVDDMR	PVDD	Digital Amplifier Output Power Supply (Rch-)
31	PVDDML	PVDD	Digital Amplifier Output Power Supply (Lch-)
32	OUTML	O	Digital Amplifier Output (Lch-)
33	OUTML	O	Digital Amplifier Output (Lch-)
34	PVSSL	PVSS	Digital Amplifier Output GND (Lch)
35	OUTPL	O	Digital Amplifier Output (Lch+)
36	OUTPL	O	Digital Amplifier Output (Lch+)
37	PVDDPL	PVDD	Digital Amplifier Output Power Supply (Lch+)
38	N.C.	—	No Connection pin. Leave this pin open.
39	VREF	A	Analog Reference Output
40	REFA	A	Reference Output
41	REFD	I	Digital Reference Voltage
42	AVSS	VSS	Analog GND
43	DVSS	VSS	Digital GND
44	PLIMIT0	I	Power Limit Setting pin 0
45	PLIMOT1	I	Power Limit Setting pin 1
46	PLIMIT2	I	Power Limit Setting pin 2
47	N.C.	—	No Connection pin. Connect this pin to GND. *1)
48	N.C.	—	No Connection pin. Connect this pin to GND. *1)

(Note) I: Input pin, O: Output pin, A: Analog pin, O/D: Open-Drain output pin

*1: Using these N.C. pins (No.4 to 10, 13, 14, 47, and 48) as patterns for connecting between the bottom heat pad and peripheral GND patterns make heat radiation efficiency more effective.

■ Electrical Characteristics

● Absolute Maximum Ratings

Item	Symbol	Condition	Min.	Max.	Unit
Power Supply pin (PVDD) Voltage Range	V_{DDP}	–	–0.3	30	V
Power Dissipation	P_{D25}	T_A=25℃, Heat resistance=15.8ºC/W *1)	–	7.91	W
	P_{D70}	T_A=70℃, Heat resistance=15.8ºC/W *1)		5.06	
	P_{D85}	T_A=85℃, Heat resistance=15.8ºC/W *1)		4.11	
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: A value based on the following device mounting conditions:
Board: 4 layers, Size: 136[mm] × 85[mm], copper foil thickness: 35[µm], Wiring density: 380%,
Exposed stage: soldered on the board,
Heat dissipation through hole(φ0.5mm): 64 (8×8) from the exposed stage side to the opposite side.

● Recommended Operating Conditions

Item	Symbol	Min.	Typ.	Max.	Unit
Supply Voltage (PVDD)	V_{DDP}	8	–	26.4	V
Ambient Operating Temperature	T_A	–40	25	85	ºC

(Note) Use the device within the recommended operating conditions.

● DC Characteristics

(V_{DDP} = 8V to 26.4V, V_{SS} = 0V, T_A = –40 ºC to 85 ºC unless otherwise specified)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
PVDD Start-up Threshold Voltage	V_{HUVLH}	–	–	6.85	–	V
PVDD Shut-down Threshold Voltage	V_{HUVLL}	–	–	6.75	–	V
DC Detection Voltage	V_{DCDET}	V_{DDP}=24V, T_A=25℃	–	3.0	–	V
DC Detection Time	t_{DCDET}	–	–	1.5	–	s
Automatic Recovery Time	t_{ERRCYC}	–	–	4.5	–	s
Digital pins *1) Input Voltage H level	V_{IH}	–	2.0	–	V_{REFA}+0.3	V
Digital pins *1) Input Voltage L level	V_{IL}	–	–0.3	–	0.8	V
PROT_N *2) Output Voltage	V_{OL}	I_{OL}=2mA	–	–	0.4	V
REFA Output Voltage	V_{REFA}	–	3.25	3.4	3.55	V
VREF Output Voltage	V_{REF}	–	–	V_{REFA} /2	–	V
PVDD Consumption Current (digital amplifier oscillated) *3)	I_{DDP}	V_{DDP} =24V, R_L=8Ω, T_A=25℃	–	34	–	mA
PVDD Consumption Current (digital amplifier stopped) *4)	I_{DDS}	V_{DDP} =24V, R_L=8Ω, T_A=25℃	–	21	–	mA

(Note) *1: Digital pins: MUTE_N, SCLK, LRCLK, SDATA, CKMOD, CNL1, CNL2, PLIMIT[2:0], PWMFHOP, and MONO.

*2: PROT_N is an open-drain output. When pulling up it, the other end of the pull-up resistor should be connected to the power lower than 3.6V so as not to apply a voltage in excess of 3.6V to PROT_N pin.

*3: Conditions: Stereo mode, fs=48kHz, MCK=12.288MHz, PWMFHOP=L, MUTE_N=H

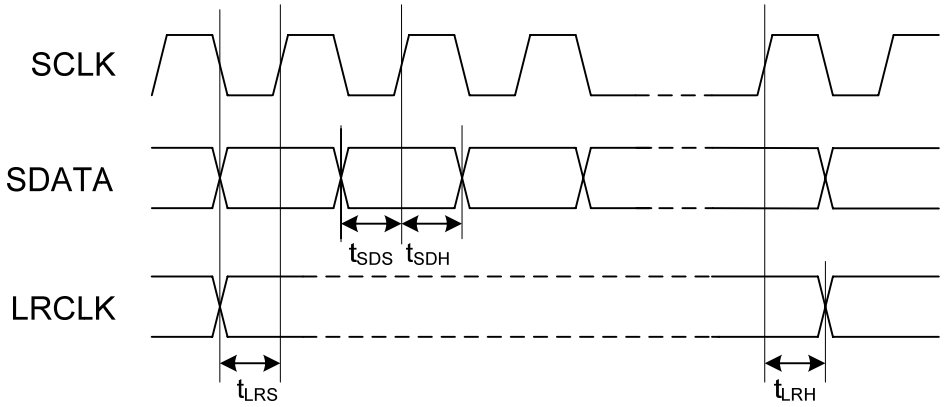
*4: Conditions: Stereo mode, fs=48kHz, MCK=12.288MHz, PWMFHOP=L, MUTE_N=L

● AC Characteristics

(V_{DDP} = 8V to 26.4V, V_{SS} =0V, T_A = –40 ºC to 85 ºC unless otherwise specified)

Item	Symbol	Min.	Typ.	Max.	Unit
SCLK Input Frequency	f_{CKEXT}	64	–	64	fs
LRCLK Input Frequency	fs	32	–	192	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
Startup Time*1)	t_{wu}	–	–	1.1	s
Free-running Clock Frequency	f_{CK}	–	330	–	kHz
MUTE Recovery Time	t_{mrcv}	–	–	2.4	ms

(Note) *1: The time from power-on to the start of oscillation (through IC_N=L→H, MUTE_N=L→H)



● Analog Characteristics

(V_{DDP} = 24V, V_{SS} = 0V, T_A = 25 ºC unless otherwise specified)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Maximum Momentary Output (THD+N=10%)	Po	V_{DDP}=24V, R_L=8Ω	–	15	–	W
Maximum Continuous Output	Po	V_{DDP}=24V, R_L=8Ω, T_A=70 ºC, 4-layer board	–	10	–	W
Voltage Gain *1)	Av	–	–	22.58	–	dB
Total Harmonic Distortion (BW:20kHz)	THD+N	R_L=8Ω, PO=7.5W	–	0.1	–	%
Residual Noise (BW:20kHz A-Filter) *2) *4) *5)	Vn	R_L=8Ω	–	80	–	µVrms
S/N Ratio (BW:20kHz A-Filter) *2)	SNR	R_L=8Ω	–	100	–	dB
Channel Separation (L vs R) *2)	CS	1kHz	–	75	–	dB
PSRR (PVDD applied) *2)	PSRR	Vripple=200mV, f=1kHz	–	70	–	dB
Maximum Efficiency	η	R_L=8Ω, Po=10W	–	84	–	%
Output Offset Voltage (Stereo) *3)	Vo	–	–	–	11	mV

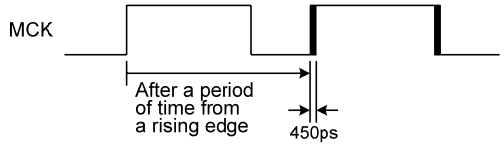
(Note) All analog characteristics were measured by using Yamaha evaluation board. Depending upon pattern layout etc., its characteristics may vary.

*1: Ratio between full-scale input of 0dBFS and output amplitude of 13.46Vrms = 22.58dBV.

*2: Except the period of time of PWMFHOP=H.

*3: Offset voltage is indicated by 3σ for max.

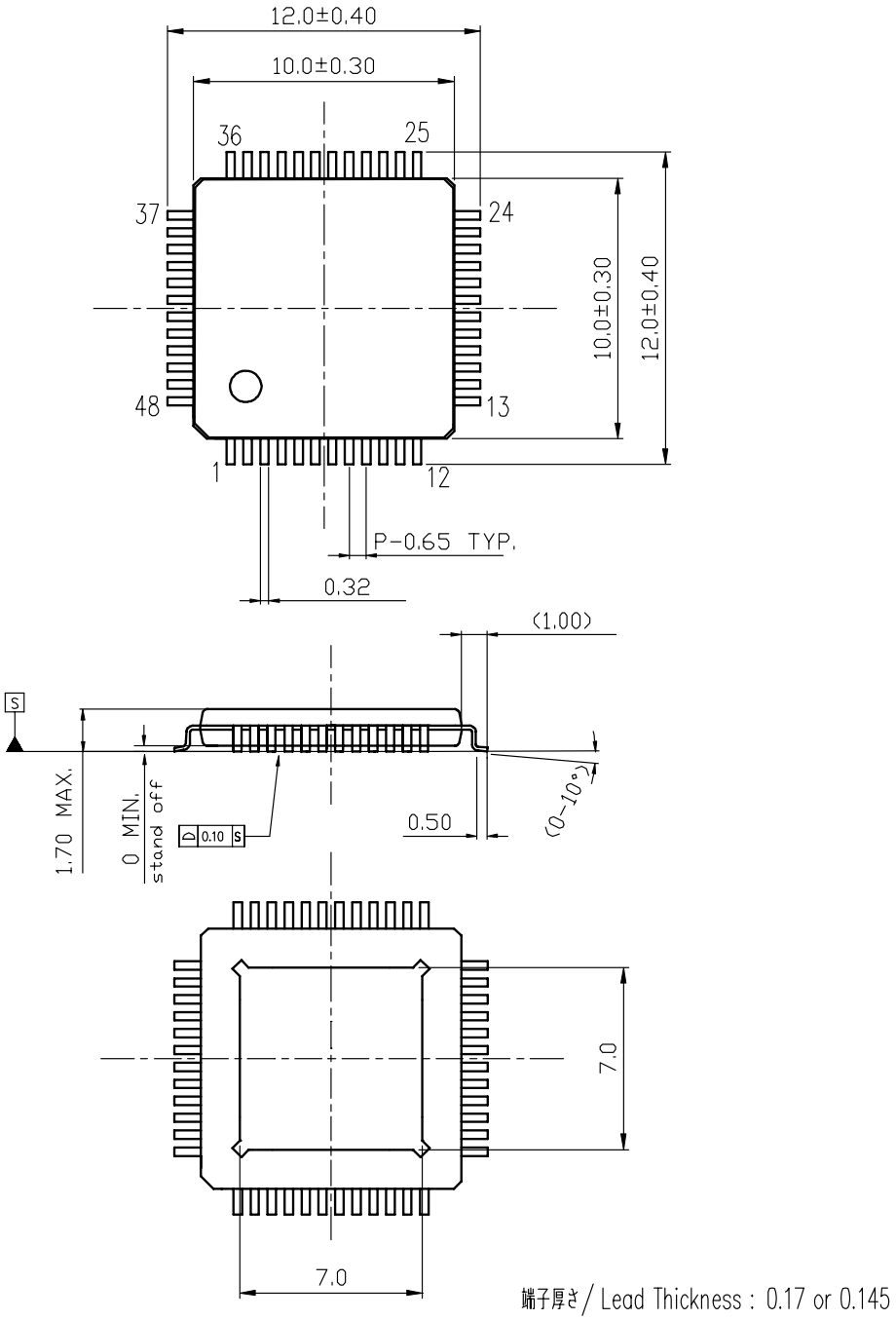
*4: Condition: MCK jitter 450ps (Peak to Peak).
See the following figure:



*5: Condition: no signal input (SDATA=L (fixed))

■ Package Dimensions

C-PK48VP1-1



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.

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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. 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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AGENT

YAMAHA CORPORATION

Address Inquiries to :
Semiconductor Sales & Marketing Department

■Head Office 203, Matsunokijima, Iwata,
Shizuoka, 438-0192, Japan
Tel. +81-539-62-4918 Fax.+81-539-62-5054

■Tokyo Office 2-17-11, Takanawa, Minato-ku,
Tokyo, 108-8586, Japan
Tel. +81-3-5488-5431 Fax.+81-3-5488-5088

■Osaka Office Universal City Wako Bldg.
6-2-82, Shimaya, Konohana-ku,
Osaka, 554-0024, Japan
Tel. +81-6-6465-0325 Fax.+81-6-6465-0391

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