

# 8bit 12-channel D/A converter

## BU2500FV / BU2501FV

BU2500FV / BU2501FV is a 12ch high-performance 8bit D/A converter which adopts the R-2R system. The BU2500FV utilizes a 5V supply voltage and the BU2501FV a 3V. Each channel output incorporates a Rail to Rail output type buffer amplifier. Three wire serial data input and cascade connection is possible. Small package (0.65mm pitch and 20pin) is adopted.

### ●Applications

CD-R, CD-RW, DVC, Digital camera and industrial equipment

### ●Features

- 1) High-performance 8bit 12-channel D/A converter adopting the R-2R system.
- 2) Output of each channel incorporates a Rail to Rail output type buffer amplifier.
- 3) Digital input compatible with TTL levels.
- 4) 12bit 3wire serial data input, cascade connection is possible.
- 5) Buffer amplifier of each channel is highly-stable. Prevents oscillation even with capacitance loads.

### ●Absolute maximum ratings (Ta=25°C)

Parameter	Symbol	Limits	Unit
Supply voltage	V <sub>CC</sub>	-0.3~+6.0	V
Upper reference voltage of D/A converter	V <sub>DD</sub>	-0.3~+6.0	V
Input voltage	V <sub>IN</sub>	-0.3~+6.0	V
Output voltage	V <sub>OUT</sub>	-0.3~+6.0	V
Power dissipation	P <sub>d</sub>	400*	mW
Operating temperature	T <sub>opr</sub>	-25~+85	°C
Storage temperature	T <sub>stg</sub>	-55~+125	°C

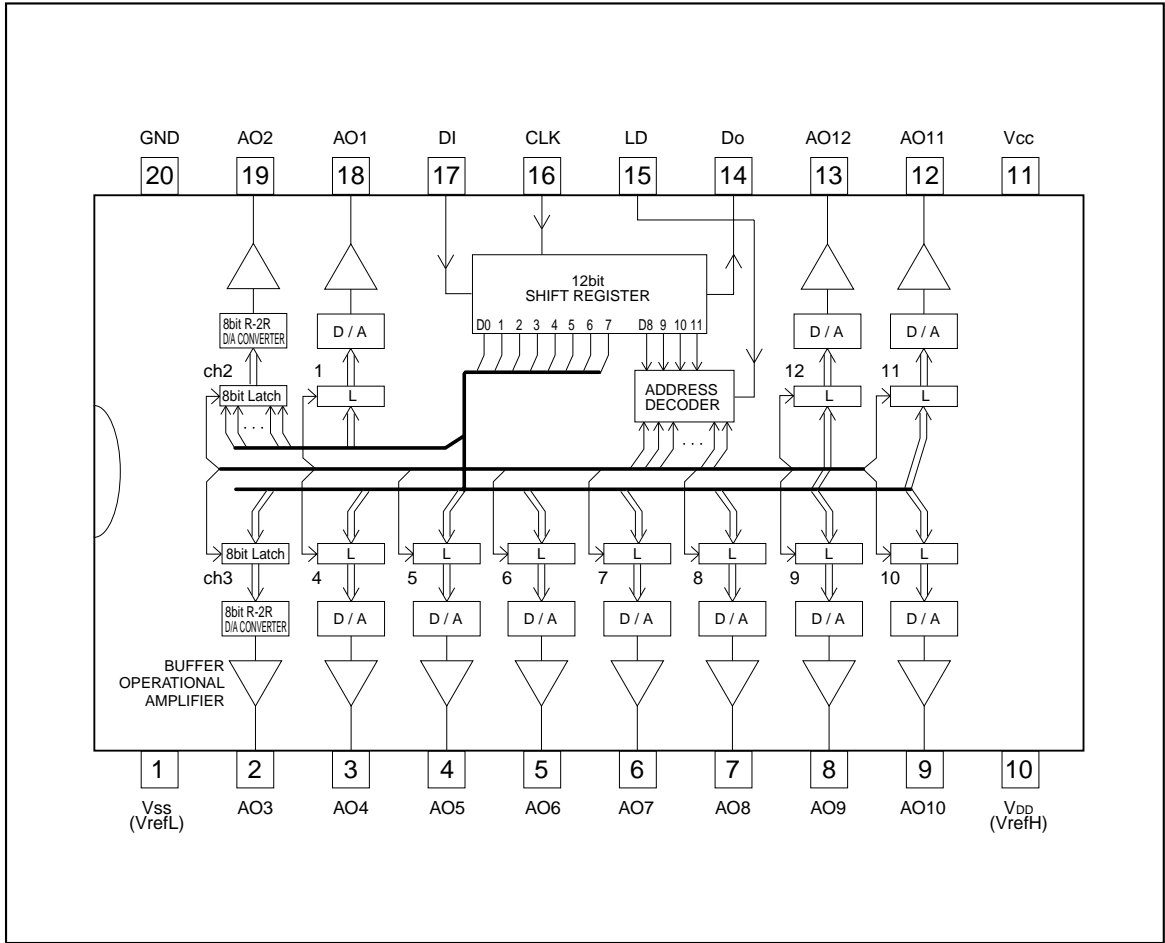
\* Reduced by 4mW for each increase in Ta of 1°C over 25°C.

### ●Recommended operating conditions (Ta=25°C)

Parameter	Symbol	Limits	Unit
Supply voltage (BU2500FV)	V <sub>CC</sub>	4.5~5.5	V
Supply voltage (BU2501FV)	V <sub>CC</sub>	2.7~3.6	V

Optical disc ICs

●Block diagram

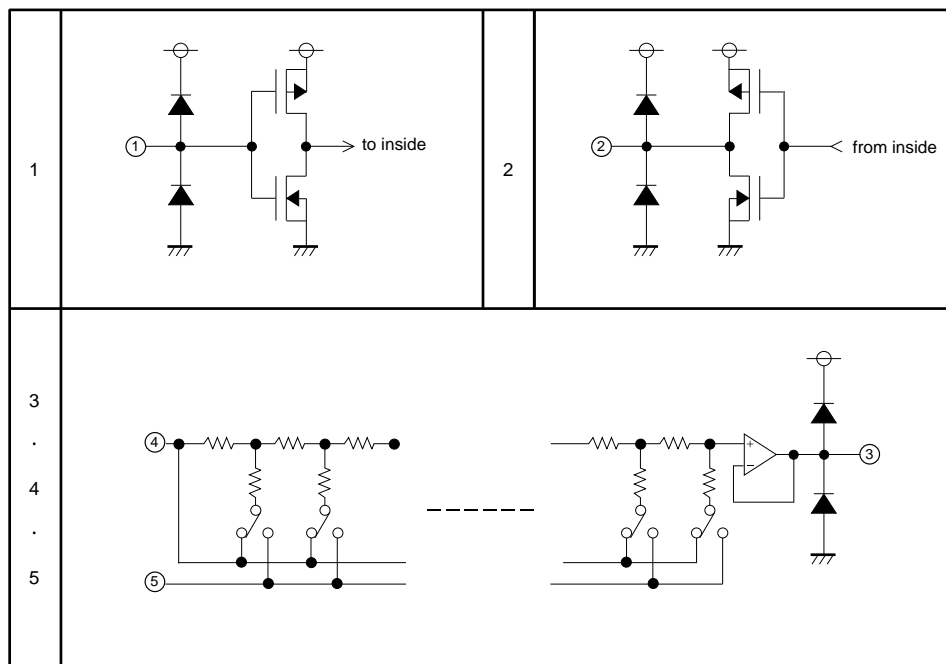


Optical disc ICs

●Pin descriptions

Pin No.	Pin name	Analog / Digital	I / O	Function	Circuit
1	Vss	Analog	-	D/A converter lower reference voltage input terminal	5
2	Ao3	Analog	O	8bit D/A converter output terminal (CH3)	3
3	Ao4	Analog	O	8bit D/A converter output terminal (CH4)	3
4	Ao5	Analog	O	8bit D/A converter output terminal (CH5)	3
5	Ao6	Analog	O	8bit D/A converter output terminal (CH6)	3
6	Ao7	Analog	O	8bit D/A converter output terminal (CH7)	3
7	Ao8	Analog	O	8bit D/A converter output terminal (CH8)	3
8	Ao9	Analog	O	8bit D/A converter output terminal (CH9)	3
9	Ao10	Analog	O	8bit D/A converter output terminal (CH10)	3
10	VDD	Analog	-	D/A converter upper reference voltage input terminal	4
11	Vcc	-	-	Power supply terminal	-
12	Ao11	Analog	O	8bit D/A converter output terminal (CH11)	3
13	Ao12	Analog	O	8bit D/A converter output terminal (CH12)	3
14	Do	Digital	O	Terminal to output MSB data of 12-bit shift register	2
15	LD	Digital	I	When H-level signal is input to this terminal, the value stored in 12-bit shift register is loaded in decoder and D/A converter output register.	1
16	CLK	Digital	I	Shift clock input terminal. Input signal at DI pin is input to 12-bit shift register at rise of shift clock pulse	1
17	DI	Digital	I	Serial data input terminal to input 12-bit long serial data	1
18	Ao1	Analog	O	8bit D/A converter output terminal (CH1)	3
19	Ao2	Analog	O	8bit D/A converter output terminal (CH2)	3
20	GND	-	-	GND terminal	-

●Input / Output terminal equivalent circuits



## Optical disc ICs

## ●Electrical characteristics

## • Digital characteristics

BU2500FV (unless otherwise noted,  $V_{CC}=5V$ ,  $V_{refH}=5V$ ,  $V_{refL}=0V$ ,  $T_a=25^{\circ}C$ )

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Power supply current	$I_{CC}$	–	0.5	1.5	mA	CLK=1MHz operation, $V_{CC}=5V$ , $I_{AO}=0\mu A$
Input leak current	$I_{ILK}$	–5	–	5	$\mu A$	$V_{IN}=0\sim V_{CC}$
Input voltage "L"	$V_{IL}$	–	–	0.8	V	
Input voltage "H"	$V_{IH}$	2.0	–	–	V	
Output voltage "L"	$V_{OL}$	0	–	0.4	V	$I_{OL}=2.5mA$
Output voltage "H"	$V_{OH}$	4.6	–	5	V	$I_{OH}=-2.5mA$

BU2501FV (unless otherwise noted,  $V_{CC}=3V$ ,  $V_{refH}=3V$ ,  $V_{refL}=0V$ ,  $T_a=25^{\circ}C$ )

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Power supply current	$I_{CC}$	–	0.4	1.2	mA	CLK=1MHz operation, $V_{CC}=3V$ , $I_{AO}=0\mu A$
Input leak current	$I_{ILK}$	–5	–	5	$\mu A$	$V_{IN}=0\sim V_{CC}$
Input voltage "L"	$V_{IL}$	–	–	0.48	V	
Input voltage "H"	$V_{IH}$	1.2	–	–	V	
Output voltage "L"	$V_{OL}$	0	–	0.4	V	$I_{OL}=2.5mA$
Output voltage "H"	$V_{OH}$	2.6	–	3	V	$I_{OH}=-2.5mA$

## Optical disc ICs

## • Analog characteristics

BU2500FV (unless otherwise noted,  $V_{CC}=5V$ ,  $V_{refH}=5V$ ,  $V_{refL}=0V$ ,  $T_a=25^\circ C$ )

Parameter		Symbol	Min.	Typ.	Max.	Unit	Conditions
Consumption current		IrefH	–	0.9	1.8	mA	$V_{refH}=5V$ , $V_{refL}=0V$ Data condition : Maximum current
D/A converter Upper reference voltage		VrefH	3.0	–	5	V	Reference voltage can not always be set to any value in this range, because it is restricted to the buffer amplifier output voltage range.
D/A converter Lower reference voltage		VrefL	0	–	1.5	V	
Buffer amplifier Output voltage range		VAO	0.1	–	4.9	V	$I_{AO}=\pm 100\mu A$
			0.2	–	4.8		$I_{AO}=+500\mu A$
Buffer amplifier Output drive range		IAO	–1	–	1	mA	Upper saturation voltage=0.3V Lower saturation voltage=0.2V
Accuracy	Differential non-linearity error	SDL	–1.0	–	1.0	LSB	$V_{refH}=4.79V$ , $V_{refL}=0.95V$ $V_{CC}=5.5V$ (15mV / LSB) Without load ( $I_{AO}=+0$ )
	Non-linearity error	SL	–1.5	–	1.5		
	Zero code error	SZERO	–2	–	2		
	Full scale error	SFULL	–2	–	2		
Output capacitive load		CO	–	–	10	$\mu F$	
Pull-up I/O-cell internal R value		RO	–	5	15	$\Omega$	

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BU2501FV (unless otherwise noted,  $V_{CC}=3V$ ,  $V_{refH}=3V$ ,  $V_{refL}=0V$ ,  $T_a=25^\circ C$ )

Parameter		Symbol	Min.	Typ.	Max.	Unit	Conditions
Consumption current		IrefH	–	0.6	1.2	mA	$V_{refH}=3V$ , $V_{refL}=0V$ Data condition : Maximum current
D/A converter Upper reference voltage		VrefH	2.1	–	3	V	Reference voltage can not always be set to any value in this range, because it is restricted to the buffer amplifier output voltage range.
D/A converter Lower reference voltage		VrefL	0	–	0.9	V	
Buffer amplifier Output voltage range		VAO	0.1	–	2.9	V	$I_{AO}=\pm 100\mu A$
			0.2	–	2.8		$I_{AO}=+500\mu A$ , $-200\mu A$
Buffer amplifier Output drive range		IAO	–0.3	–	1	mA	Upper saturation voltage=0.4V Lower saturation voltage=0.4V
Accuracy	Differential non-linearity error	SDL	–1.0	–	1.0	LSB	$V_{refH}=2.61V$ , $V_{refL}=0.05V$ $V_{CC}=2.76V$ (10mV / LSB) Without load ( $I_{AO}=+0$ )
	Non-linearity error	SL	–1.5	–	1.5		
	Zero code error	SZERO	–2	–	2		
	Full scale error	SFULL	–2	–	2		
Output capacitive load		CO	–	–	10	$\mu F$	
Pull-up I/O-cell internal R value		RO	–	5	15	$\Omega$	

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## Optical disc ICs

## • AC characteristics

BU2500FV (unless otherwise noted,  $V_{CC}=5V$ ,  $V_{refH}=5V$ ,  $V_{refL}=0V$ ,  $T_a=25^{\circ}C$ )

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Clock "L" pulse width	tCKL	150	–	–	ns	
Clock "H" pulse width	tCKH	150	–	–		
Clock rise time	tcr	–	–	150		
Clock fall time	tcf	–	–	–		
Data set up time	tDCH	20	–	–		
Data hold time	tCHD	40	–	–		
LD set up time	tCHL	150	–	–		
LD hold time	tLDC	100	–	–		
LD "H" pulse duration	tLDH	70	–	–		
Data output delay time	tDO	70	–	350		CL=100pF
D/A output setting time	tLDD	–	80	250	μS	CL≤1000pF $V_{AO} : 0.5V \leftrightarrow 4.5V$ The time until the becomes the final value of 1/2 LSB.

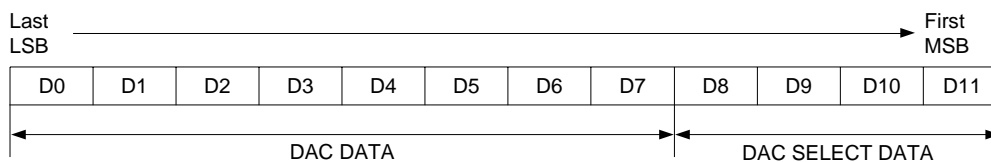
BU2501FV (unless otherwise noted,  $V_{CC}=3V$ ,  $V_{refH}=3V$ ,  $V_{refL}=0V$ ,  $T_a=25^{\circ}C$ )

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Clock "L" pulse width	tCKL	150	–	–	ns	
Clock "H" pulse width	tCKH	150	–	–		
Clock rise time	tcr	–	–	150		
Clock fall time	tcf	–	–	–		
Data set up time	tDCH	20	–	–		
Data hold time	tCHD	40	–	–		
LD set up time	tCHL	150	–	–		
LD hold time	tLDC	100	–	–		
LD "H" pulse duration	tLDH	70	–	–		
Data output delay time	tDO	70	–	350		CL=100pF
D/A output setting time	tLDD	–	70	250	μS	CL≤1000pF $V_{AO} : 0.1V \leftrightarrow 2.6V$ The time until the becomes the final value of 1/2 LSB.

Optical disc ICs

●Circuit operations

• Data format



D0	D1	D2	D3	D4	D5	D6	D7	D/A output
0	0	0	0	0	0	0	0	$(V_{refH}-V_{refL}) / 256 \times 1 + V_{refL}$
1	0	0	0	0	0	0	0	$(V_{refH}-V_{refL}) / 256 \times 2 + V_{refL}$
0	1	0	0	0	0	0	0	$(V_{refH}-V_{refL}) / 256 \times 3 + V_{refL}$
1	1	0	0	0	0	0	0	$(V_{refH}-V_{refL}) / 256 \times 4 + V_{refL}$
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
0	1	1	1	1	1	1	1	$(V_{refH}-V_{refL}) / 256 \times 255 + V_{refL}$
1	1	1	1	1	1	1	1	$V_{refH}$

\*  $V_{refH}=V_{DD}$   $V_{refL}=V_{SS}$

D8	D9	D10	D11	DAC selection
0	0	0	0	Don't Care
0	0	0	1	AO1 selection
0	0	1	0	AO2 selection
0	0	1	1	AO3 selection
0	1	0	0	AO4 selection
0	1	0	1	AO5 selection
0	1	1	0	AO6 selection
0	1	1	1	AO7 selection
1	0	0	0	AO8 selection
1	0	0	1	AO9 selection
1	0	1	0	AO10 selection
1	0	1	1	AO11 selection
1	1	0	0	AO12 selection
1	1	0	1	Don't Care
1	1	1	0	Don't Care
1	1	1	1	Don't Care

Optical disc ICs

• Data timing

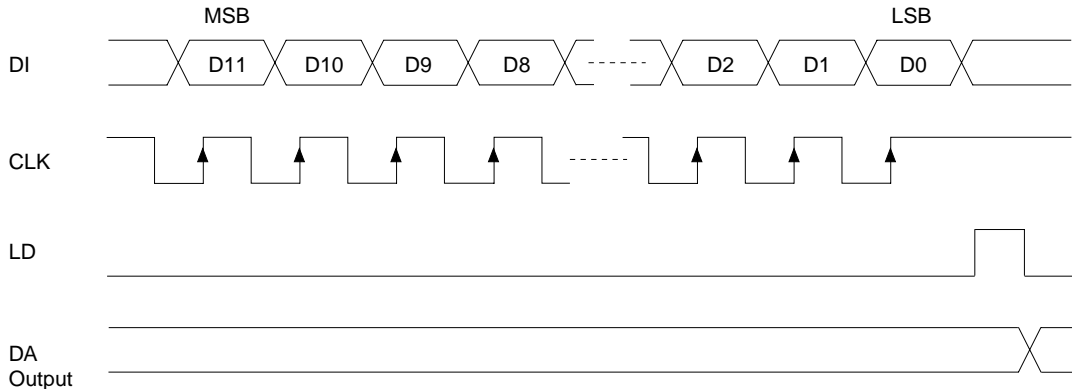


Fig.1

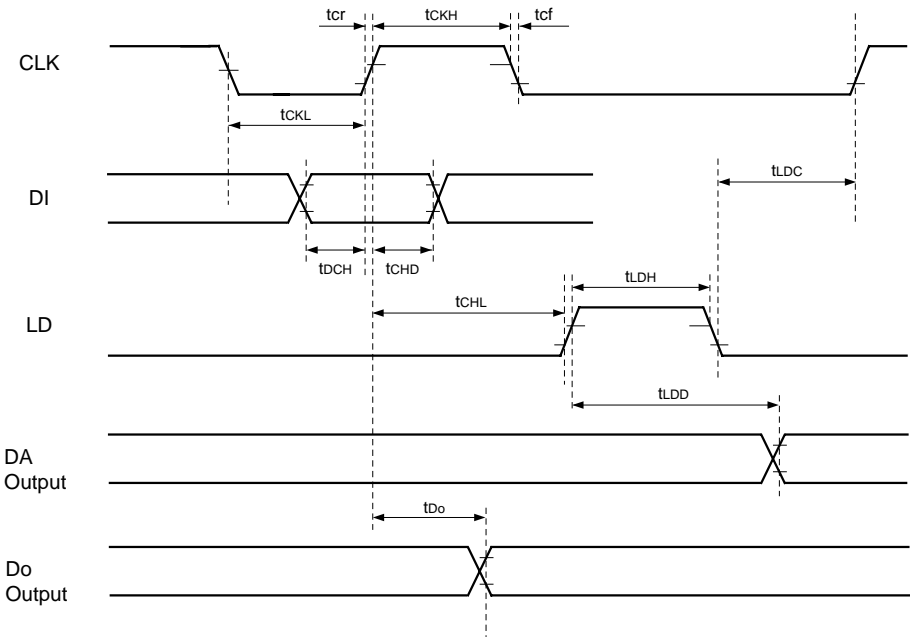


Fig.2

## Optical disc ICs

## ●Application circuit

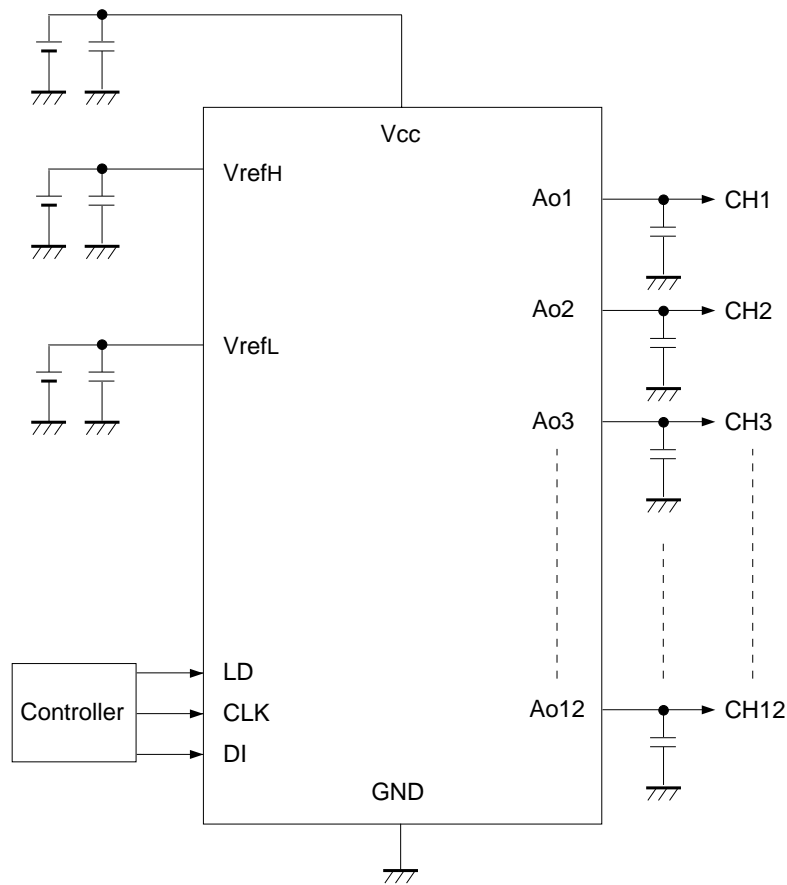


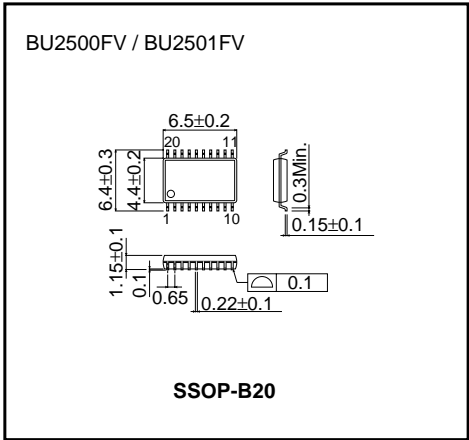
Fig.3

## ●Operation notes

- There are 3 different type of power supply terminal and 1 type of GND terminal in this IC. Each of these terminals requires the constant power supply for operating.
- Pile up ripple and noise to these power supply terminals, it can't keep the accuracy of the D/A converter. Therefore external bypass capacitor recommend to set as close as possible to the terminals between VDD and GND in order to stabilizes the D/A converter.
- The capacitor between output and GND recommend to set under 100pF including parasitic capacitor in order to reduces jitter from layout of the output line and noise.

Optical disc ICs

●External dimensions (Units : mm)





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