

10bit 10-channel D/A converter

BU2505FV

BU2505FV is a high-performance 10bit D/A converter IC that incorporates 10-channel of a R-2R system. Each channel output incorporates a Rail-to Rail output type output with buffer amplifier. This IC utilizes the TTL level input method. RESET pin can keep the output voltage in the lower reference voltage range. REVERSE pin can change the LSB/MSB of 10bit data. Small package (0.65mm pitch and 20pin) is adopted.

●Applications

DVD, CD-R, CD-RW, DVC, Digital camera, and other industrial equipments

●Features

- 1) High-performance 10bit D/A converter that incorporates 10-channel of a R-2R system.
- 2) RESET pin can keep output voltage of all channels within the lower reference voltage range.
- 3) Digital input compatible with TTL levels.
- 4) 14bit 3wire serial data + RESET signal input, and cascade connection is possible. LSB first / MSB first of 10bit data can be changed by REVERSE pin.

●Absolute maximum ratings (Ta=25°C)

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

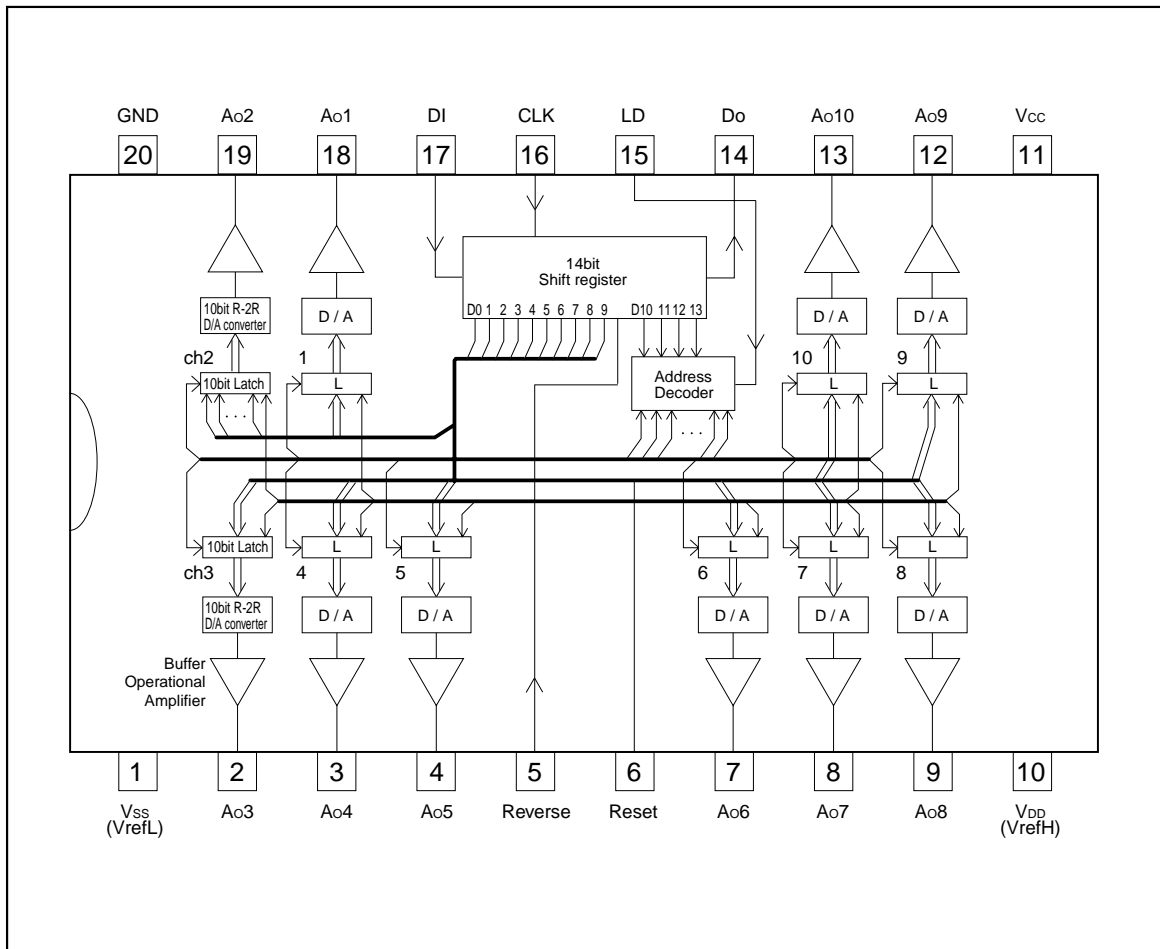
* Reduced by 4mW for each increase in Ta of 1°C over 25°C.

●Recommended operating conditions (Ta=25°C)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Supply voltage	V _{CC}	4.5	-	5.5	V

Optical disc ICs

●Block diagram

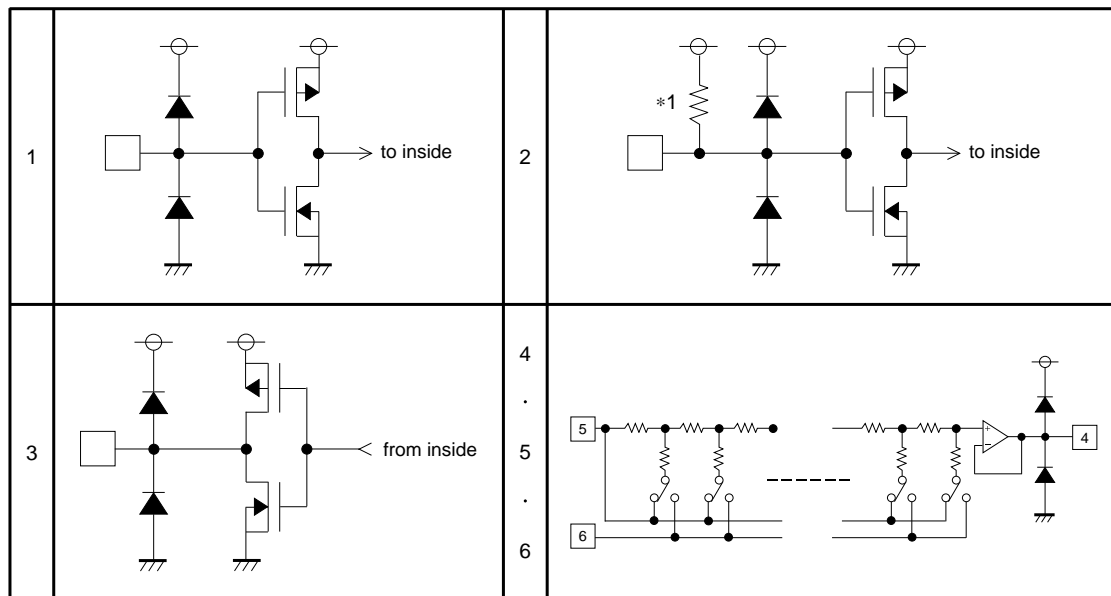


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●Pin descriptions

Pin No.	Pin name	Analog / Digital	I / O	Function	Equivalent Circuit
1	Vss	Analog	–	D/A converter lower reference voltage input terminal	6
2	Ao3	Analog	O	10bit D/A converter output terminal (CH3)	4
3	Ao4	Analog	O	10bit D/A converter output terminal (CH4)	4
4	Ao5	Analog	O	10bit D/A converter output terminal (CH5)	4
5	Reverse	Digital	I	It is inverted about the data designation 10bit LSB and MSB.	2
6	Reset	Digital	I	The analog output of all channels is fixed for "L".	2
7	Ao6	Analog	O	10bit D/A converter output terminal (CH6)	4
8	Ao7	Analog	O	10bit D/A converter output terminal (CH7)	4
9	Ao8	Analog	O	10bit D/A converter output terminal (CH8)	4
10	VDD	Analog	–	D/A converter upper reference voltage input terminal	5
11	VCC	–	–	Power supply terminal	–
12	Ao9	Analog	O	10bit D/A converter output terminal (CH9)	4
13	Ao10	Analog	O	10bit D/A converter output terminal (CH10)	4
14	Do	Digital	O	Terminal to output LSB data of 14-bit shift register	3
15	LD	Digital	I	When H-level signal is input to this terminal, the value stored in 14-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 14-bit shift register at rise of shift clock pulse	1
17	DI	Digital	I	Serial data input terminal to input 14-bit long serial data	1
18	Ao1	Analog	O	10bit D/A converter output terminal (CH1)	4
19	Ao2	Analog	O	10bit D/A converter output terminal (CH2)	4
20	GND	–	–	GND terminal	–

●Input / Output terminal equivalent circuits



*1 At the time of V_{CC}=5.0V, 25kΩ. (It alters by the applied voltage.)

Optical disc ICs

●Electrical characteristics

• Digital characteristics (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}	–	0.85	2.8	mA	CLK=10MHz operated, $V_{CC}=5V$, $I_{AO}=0\mu A$
Input leak current	I_{ILK}	–5	–	5	μA	$V_{IN}=0-V_{CC}$
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	$I_{OH}=-2.5mA$

• Analog characteristics (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	I_{refH}	–	4.5	7.5	mA	$V_{refH}=5V$, $V_{refL}=0V$ Data condition : Maximum current	
D/A converter Upper reference voltage	V_{refH}	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	V_{refL}	0	–	1.5	V		
Buffer amplifier Output voltage range	V_o	0.1 0.2	–	4.9 4.75	V	$I_o=\pm 100\mu A$ $I_o=+1.0mA$	
Buffer amplifier Output drive range	I_o	–2	–	2	mA	Upper saturation voltage=0.35V Lower saturation voltage=0.23V	
Accuracy	Differential non-linearity error	S_{DL}	–1.0	–	1.0	LSB	$V_{refH}=4.796V$, $V_{refL}=0.7V$ $V_{CC}=5.5V$ (4mV/LSB) Without load ($I_o=+0mA$)
	Non-linearity error	S_L	–3.5	–	3.5		
	Zero code error	S_{ZERO}	–25	–	25	mV	
	Full scale error	S_{FULL}	–25	–	25		
Buffer amplifier Output impedance	R_o	–	5	15	Ω		
Pull-up I/O-cell internal R value	R_{up}	12.5	25	37.5	k Ω	$V_{IN} : 0V$ (Resistance value alters by the applied voltage.)	

©This product is not designed for protection against radioactive rays.

Optical disc ICs

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

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Reset "L" pulse width	t_{RTL}	50	–	–	ns	
Clock "L" pulse width	t_{CKL}	50	–	–		
Clock "H" pulse width	t_{CKH}	50	–	–		
Clock rise time	t_{cr}	–	–	50		
Clock fall time	t_{cf}	–	–	–		
Data set up time	t_{DCH}	20	–	–		
Data hold time	t_{CHD}	40	–	–		
LD set up time	t_{CHL}	50	–	–		
LD hold time	t_{LDC}	50	–	–		
LD "H" pulse duration	t_{LDH}	50	–	–		
Data output delay time	t_{DO}	–	–	200		
D/A output setting time	t_{LDD}	–	7	20	μs	$C_L \leq 1000pF$ $V_o : 0.5V \leftrightarrow 4.5V$ The time until the becomes the final value of 1/2 LSB.

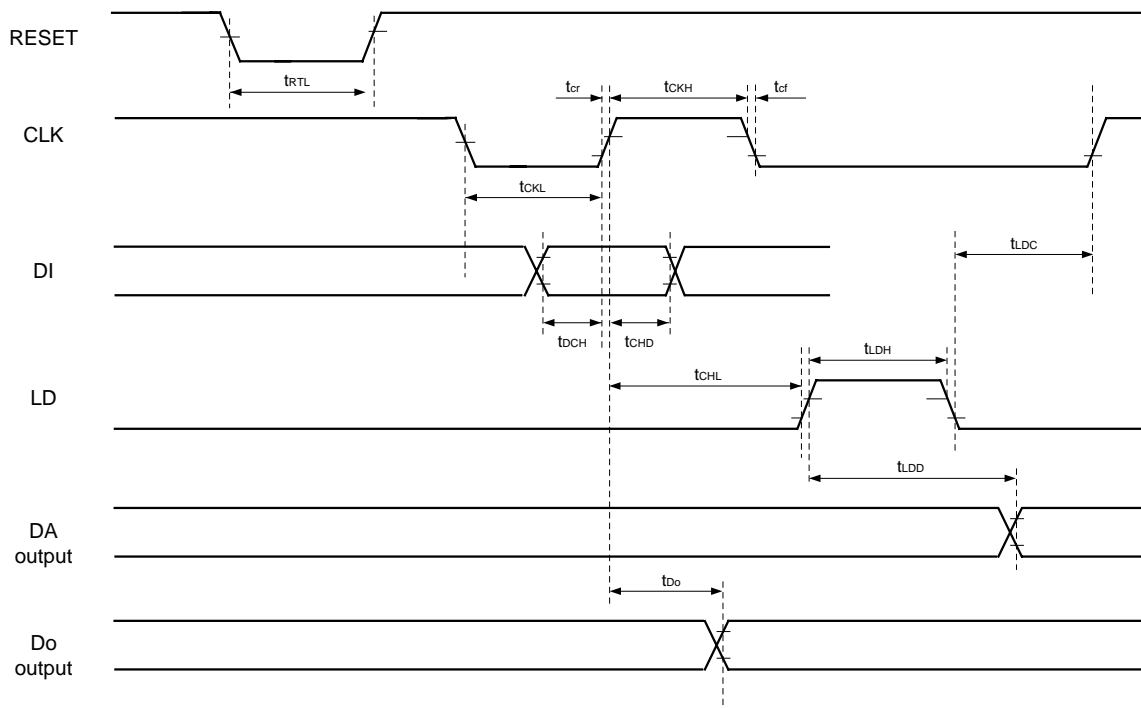
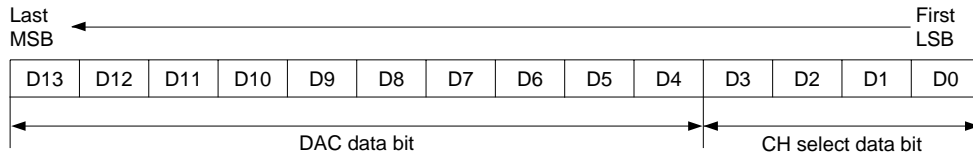


Fig.1

Optical disc ICs

●Circuit operations

- Digital data format [Reverse = open or VCC short setting (data : LSB first)]



D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D/A output
0	0	0	0	0	0	0	0	0	0	VrefL
0	0	0	0	0	0	0	0	0	1	$(V_{refH}-V_{refL}) / 1024 \times 1 + V_{refL}$
0	0	0	0	0	0	0	0	1	0	$(V_{refH}-V_{refL}) / 1024 \times 2 + V_{refL}$
0	0	0	0	0	0	0	0	1	1	$(V_{refH}-V_{refL}) / 1024 \times 3 + V_{refL}$
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
1	1	1	1	1	1	1	1	1	0	$(V_{refH}-V_{refL}) / 1024 \times 1022 + V_{refL}$
1	1	1	1	1	1	1	1	1	1	$(V_{refH}-V_{refL}) / 1024 \times 1023 + V_{refL}$

* VrefH=V_{DD} VrefL=V_{SS}

D3	D2	D1	D0	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	Don't Care
1	1	0	0	Don't Care
1	1	0	1	Don't Care
1	1	1	0	Command for test
1	1	1	1	Command for test

- Timing chart (MODEL)

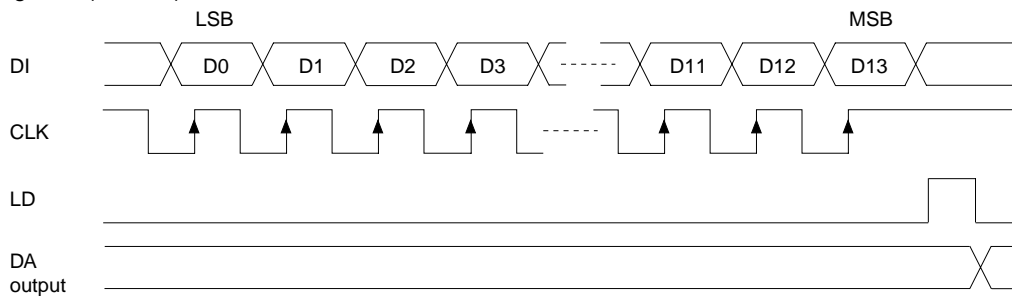
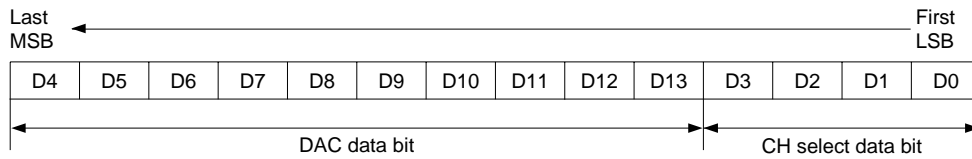


Fig.2

Optical disc ICs

• Digital data format [Reverse = L setting (data : MSB first)]



D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D / A output
0	0	0	0	0	0	0	0	0	0	VrefL
1	0	0	0	0	0	0	0	0	0	$(V_{refH}-V_{refL}) / 1024 \times 1 + V_{refL}$
0	1	0	0	0	0	0	0	0	0	$(V_{refH}-V_{refL}) / 1024 \times 2 + V_{refL}$
1	1	0	0	0	0	0	0	0	0	$(V_{refH}-V_{refL}) / 1024 \times 3 + V_{refL}$
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
0	1	1	1	1	1	1	1	1	1	$(V_{refH}-V_{refL}) / 1024 \times 1022 + V_{refL}$
1	1	1	1	1	1	1	1	1	1	$(V_{refH}-V_{refL}) / 1024 \times 1023 + V_{refL}$

* VrefH=VDD VrefL=Vss

D3	D2	D1	D0	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	Don't Care
1	1	0	0	Don't Care
1	1	0	1	Don't Care
1	1	1	0	Command for test
1	1	1	1	Command for test

• Timing chart (MODEL)

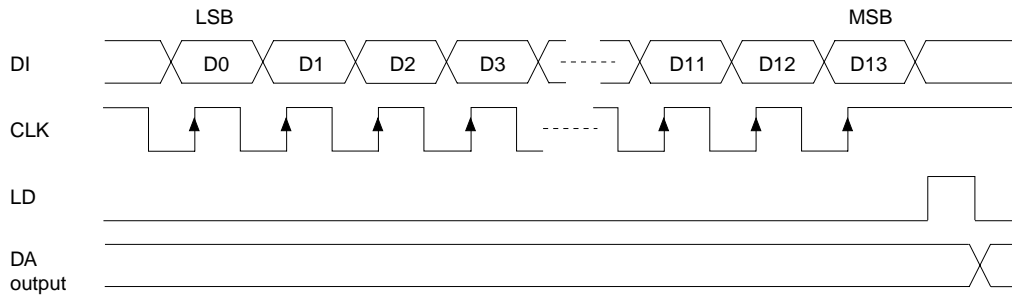


Fig.3

Optical disc ICs

●Application circuit

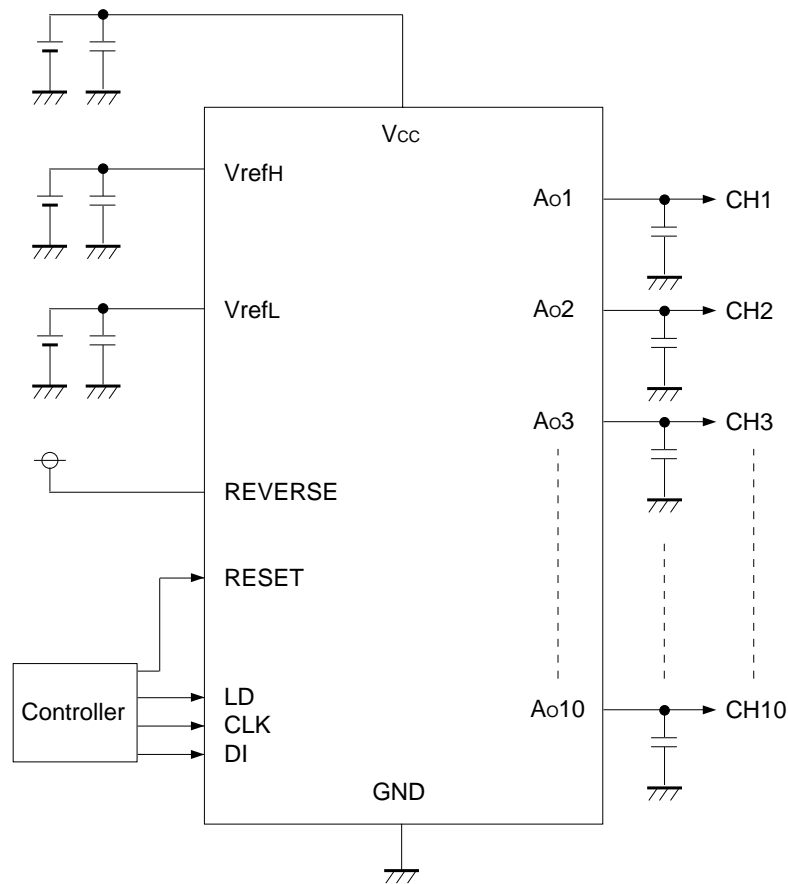


Fig.4

●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.
- LSB-first or MSB-first decoding are selected by REVERSE terminal. Therefore, REVERSE terminal should be set as "open" or "VDD short" at LSB-first mode, "GND short" at MSB-first mode.
- RESET terminal uses the I/O-cell of the internal pull-up resistance, adding a capacitor between this terminal and GND, this IC will have equivalent function as power-on-reset, by making a time-delay. When a reset signal is inputted from the controller, it is possible that the output of all channels are fixed on Low-level in the "L" section on the pulse.

Optical disc ICs

●External dimensions (Units : mm)

