

R2A20166NP/SA

8-bit 6ch D/A Converter with Buffer Amplifiers

R03DS0018EJ0100

Rev.1.00

2011.09.05

Description

The R2A20166 is an integrated circuit semiconductor of CMOS structure with 6 channels of built in D/A unnecessary and enabling configuration of a system with few component parts.

Serial data transfer type input can easily be used through a combination of three lines: DI, CLK, and LD.

Outputs incorporate buffer op-amps that have a drive capacity of 1 mA or above for both sink source, and can operate over the entire voltage range from almost ground to Vcc (0 to 5V), making peripheral elements unnecessary and enabling configuration of a system with few component parts.

Very small QFN package is added to lineup. It is suitable for a small mounting and reduces the mounting area.

Features

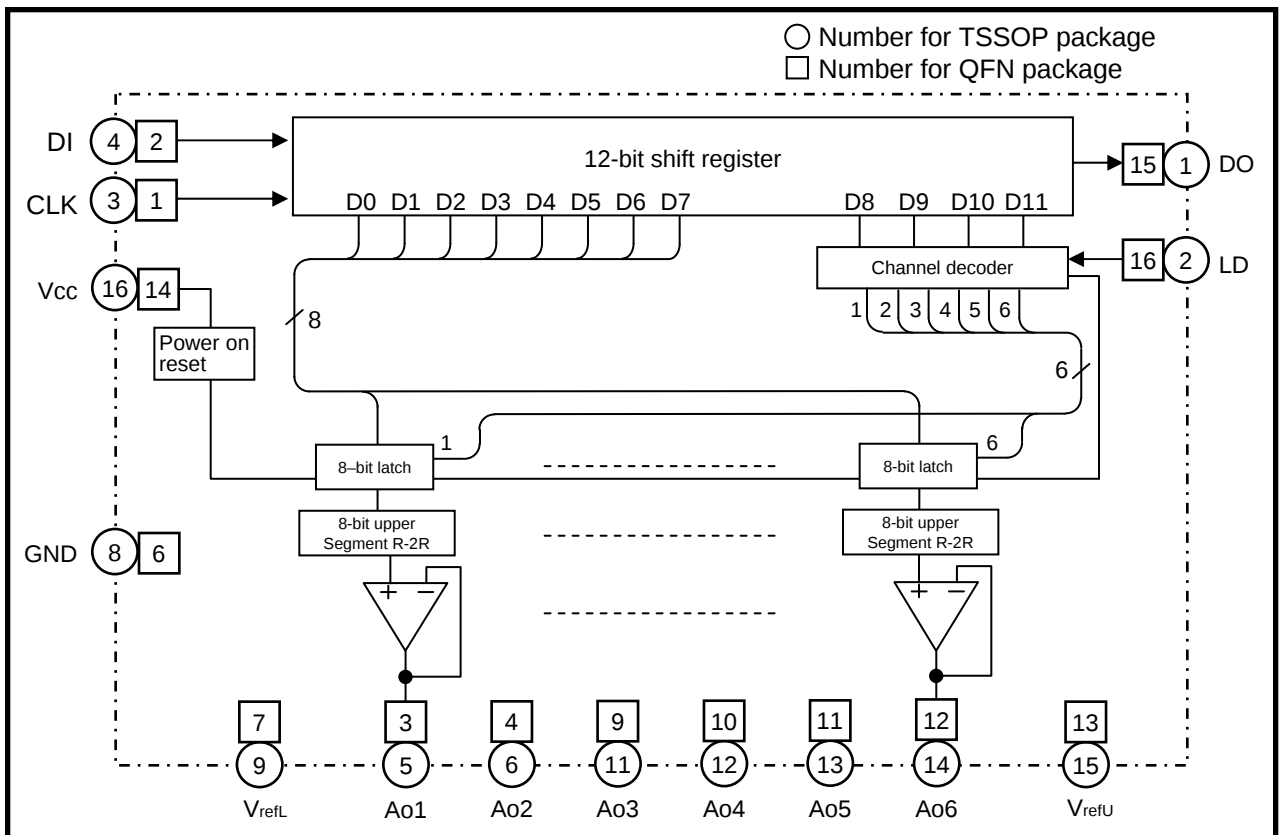
- Guarantee Nonlinearity error : $\pm 1.0\text{LSB}$, Differential nonlinearity error : $\pm 0.7\text{LSB}$
- Data transfer format: 12-bit serial data input type by 3 wire (DI, SCK, LD)
- Output buffer op-amps: Operable over entire voltage range from almost ground to Vcc (0 to 5V)
- Very small size package line-up: QFN-16(pin pitch: 0.5mm), TSSOP-16 (pin pitch 0.65mm)

Application

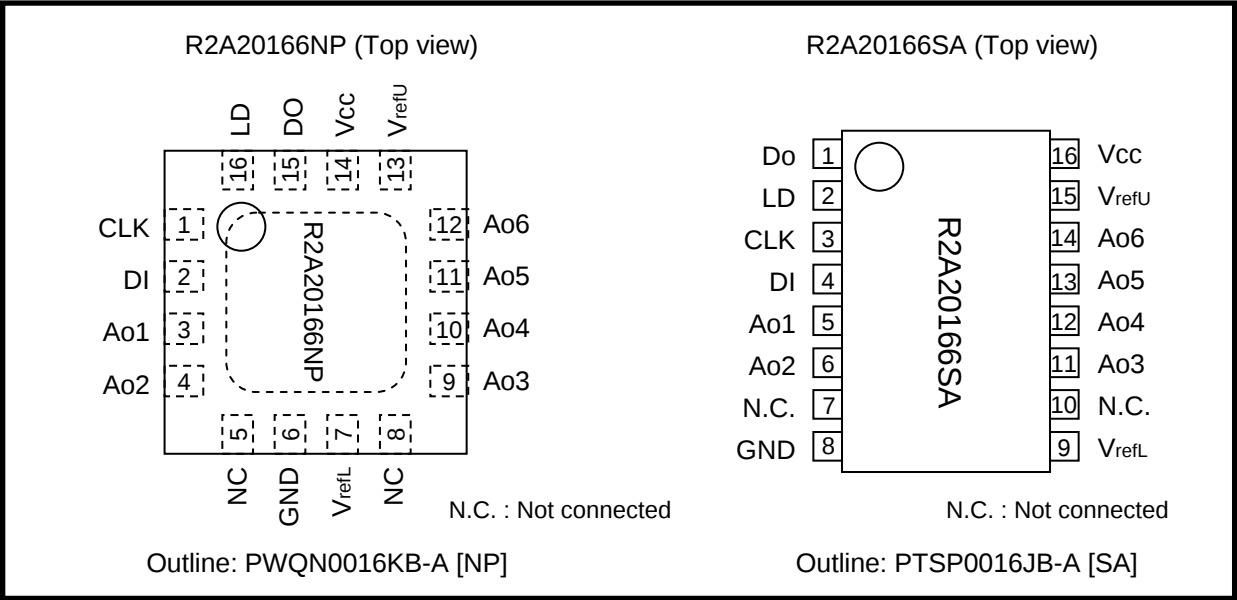
- Conversion from digital data to analog control data for home-use and industrial equipment.
- Signal gain control or automatic adjustment of LCD-TV, PDP-TV or LCD display-monitor.
- Blurring correction control or various control of the interchangeable lens of digital still camera.
- Automatic adjustment by combination with microcomputer and EEPROM.

(substitution of half fixed resistance)

Block Diagram



Pin Arrangement



Pin Description

Pin No.		Symbol	Function
[QFN]	[TSSOP]		
2	4	DI	Serial data input terminal. (Input serial data with a 12-bit data length)
1	3	CLK	Serial clock input terminal (Input signal from DI terminal is input to 12-bit shift register at rise of serial clock.)
16	2	LD	Load terminal (When High level is input to LD terminal, value in 12-bit shift register is loaded into decoder and 8-bit latch.)
15	1	Do	Serial data output terminal (Data is sequentially output from the MSB bit.)
3	5	Ao1	8-bit resolution D/A converter output terminals (After power on, all channels are reset and DAC data 00h is output.)
4	6	Ao2	
9	11	Ao3	
10	12	Ao4	
11	13	Ao5	
12	14	Ao6	
14	16	Vcc	Power supply terminal
6	8	GND	GND terminal
13	15	VrefU	D/A converter upper reference voltage input terminal
7	9	VrefL	D/A converter lower reference voltage input terminal
5	7	N.C.	Not connected
8	10	N.C.	Not connected

Absolute Maximum Ratings

(Ta = +25deg unless otherwise noted)

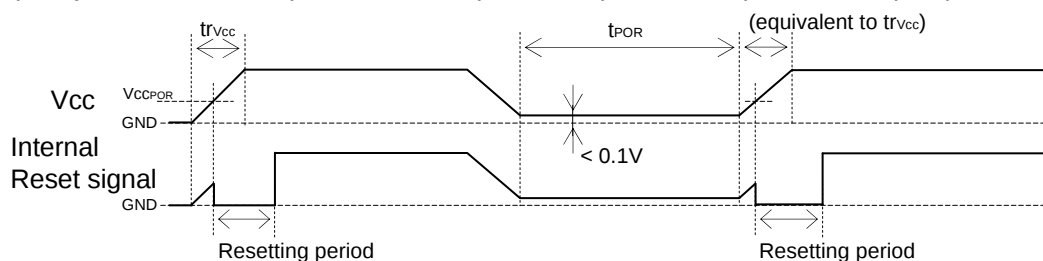
Item	Symbol	Conditions	Ratings	Unit
Supply voltage	V _{CC}		-0.3 to +6.5	V
D/A converter upper reference voltage	V _{refU}		-0.3 to +6.5	V
D/A converter lower reference voltage	V _{refL}		-0.3 to +6.5	V
Buffer amplifier output current	I _{AO}	Continuous	-2.0 to +2.0	mA
Input voltage	V _{in}		-0.3 to V _{CC} +0.3 <+6.5	V
Output voltage	V _o		-0.3 to V _{CC} +0.3 <+6.5	V
Power dissipation	P _d	Ta = +85deg	290(NP) / 150(SA)	mW
Thermal derating factor	K theta	Ta > +25deg	7.25(NP) / 3.75(SA)	mW/deg
Operating temperature	T _{opr}		-30 to +85	deg
Storage temperature	T _{stg}		-40 to +125	deg

Electrical Characteristics

« Digital Part » (V_{CC}, V_{refU} = +5V +/-10%, V_{CC} > V_{refU}, GND, V_{refL} = 0V, Ta = -30 to +85deg, Unless otherwise noted)

Item	Symbol	Test conditions	Limits			Unit
			Min	Typ	Max	
Supply voltage	V _{CC}		2.7	5.0	5.5	V
Supply current	I _{CC}	CLK = 1MHz, V _{CC} = 5V, I _{AO} = 0μA	-	0.35	1.1	mA
Input leak current	I _{ILK}	V _{IN} = 0 to V _{CC}	-10	-	10	μA
Input low voltage	V _{IL}		-	-	0.2V _{CC}	V
Input high voltage	V _{IH}	4.0V < V _{CC}	0.5V _{CC}	-	-	V
		V _{CC} ≤ 4.0V	0.8V _{CC}	-	-	V
Output low voltage	V _{OL}	4.0V < V _{CC} , I _{OL} = 2.0 mA	-	-	0.4	V
		V _{CC} < 4.0V, I _{OL} = 1.5 mA	-	-	0.4	V
Output high voltage	V _{OH}	I _{OH} = -400 μA	V _{CC} - 0.4	-	-	V
Supply voltage rise time *1	t _{rVCC}	V _{CC} = 0 to 2.7V	100	-	-	μs
Internal reset operating voltage *1	V _{CCPOR}	V _{CC} = 0 to 2.7V	-	1.5	1.9	V
Power supply restart interval (Power supply OFF → ON) *1	t _{POR}	V _{CC} < 0.1V	1	-	-	ms

*1 : When power supply is turned on, internal circuit is initialized by power on reset circuit. But, if re-powered on quickly, initialize is not operate. So, keep the time period of re-powered on (t_{POR}).



« Analog Part » (V_{CC} , $V_{refU} = +5V \pm 10\%$, $V_{CC} > V_{refU}$, GND , $V_{refL} = 0V$, $T_a = -30$ to $+85^{\circ}C$, unless otherwise noted)

Item	Symbol	Test conditions	Limits			Unit
			Min	Typ	Max	
Current dissipation	I_{refU}	$V_{refU}=5V$, $V_{refL}=0V$, $I_{AO}=0\mu A$, Data condition: at maximum current	-	0.8	1.6	mA
D/A converter upper reference voltage range *2	V_{refU}		$0.7V_{CC}$	-	V_{CC}	V
D/A converter lower reference voltage range *2	V_{refL}		GND	-	$0.3V_{CC}$	V
Buffer amplifier output voltage range	V_{AO}	$I_{AO} = \pm 100 \mu A$	0.1	-	$V_{CC} - 0.1$	V
		$I_{AO} = \pm 500 \mu A$	0.2	-	$V_{CC} - 0.2$	V
Buffer amplifier output drive range	I_{AO}	Upper side saturation voltage = 0.3V, Lower side saturation voltage = 0.2V	-1.0	-	1.0	mA
Differential nonlinearity	SDL	$V_{refU} = 4.79V$, $V_{refL} = 0.95V$, $V_{CC} = 5.5V$ (15mV/LSB), Without load ($I_{AO} = 0\mu A$)	-0.7	-	0.7	LSB
Nonlinearity	SL		-1.0	-	1.0	LSB
Zero code error	S_{ZERO}		-2.0	-	2.0	LSB
Full scale error	S_{FULL}		-2.0	-	2.0	LSB
Output capacitive load	C_O		-	-	0.1	μF
Buffer amplifier output impedance	R_O		-	5.0	-	ohm

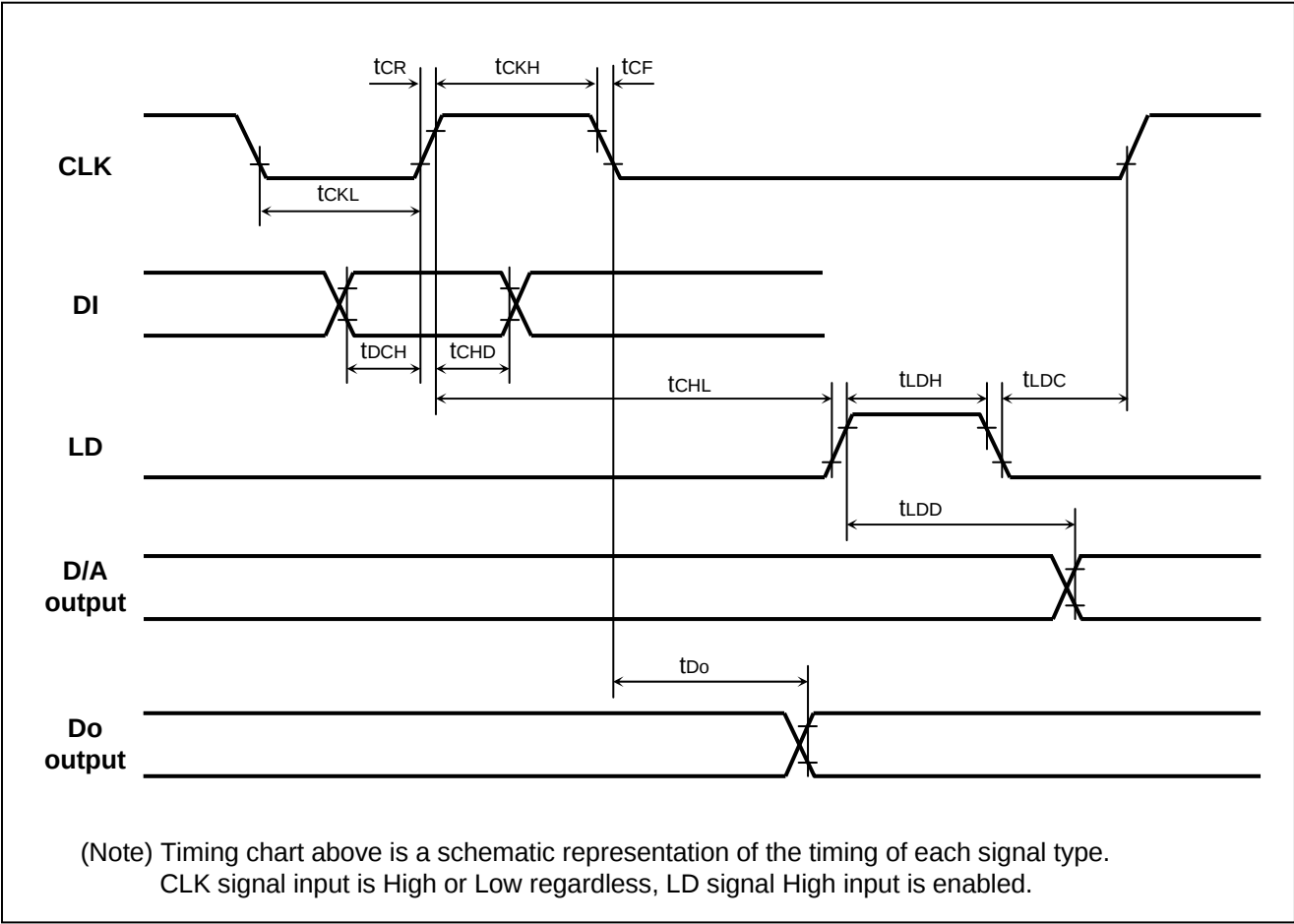
*2 : The output does not necessary be the value with the reference voltage setting range.
The output value is determined by the buffer amplifier output voltage range (V_{AO}).

AC Characteristics

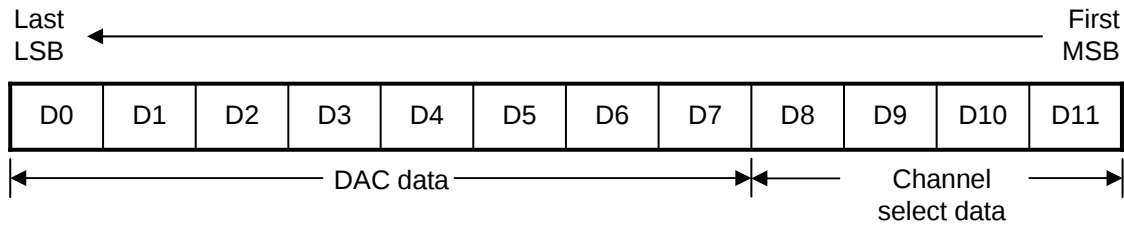
(VCC,VrefU = +5V+/-10%, VCC ≥ VrefU, GND=VrefL = 0V, Ta = -30 to +85deg, unless otherwise noted)

Item	Symbol	Test conditions	Limits			Unit
			Min	Typ	Max	
Clock frequency	fCLK		-	1.0	10	MHz
Clock low pulse width	tCKL		40	-	-	ns
Clock high pulse width	tCKH		40	-	-	ns
Clock rise time	tCR		-	-	200	ns
Clock fall time	tCF		-	-	200	ns
Data setup time	tDCH		4	-	-	ns
Data hold time	tCHD		30	-	-	ns
LD setup time	tCHL		40	-	-	ns
LD hold time	tLDC		40	-	-	ns
LD high pulse width	tLDH		40	-	-	ns
Data output delay time	tDO	CL < 100 pF	-10	-	50	ns
D/A output settling time	tLDD	Ta=25deg, CL<100pF, VAO: 0.5↔4.5V, The time until the output becomes the final value of 1/2 LSB.	-	-	150	μs

Timing Chart



Digital Data Format



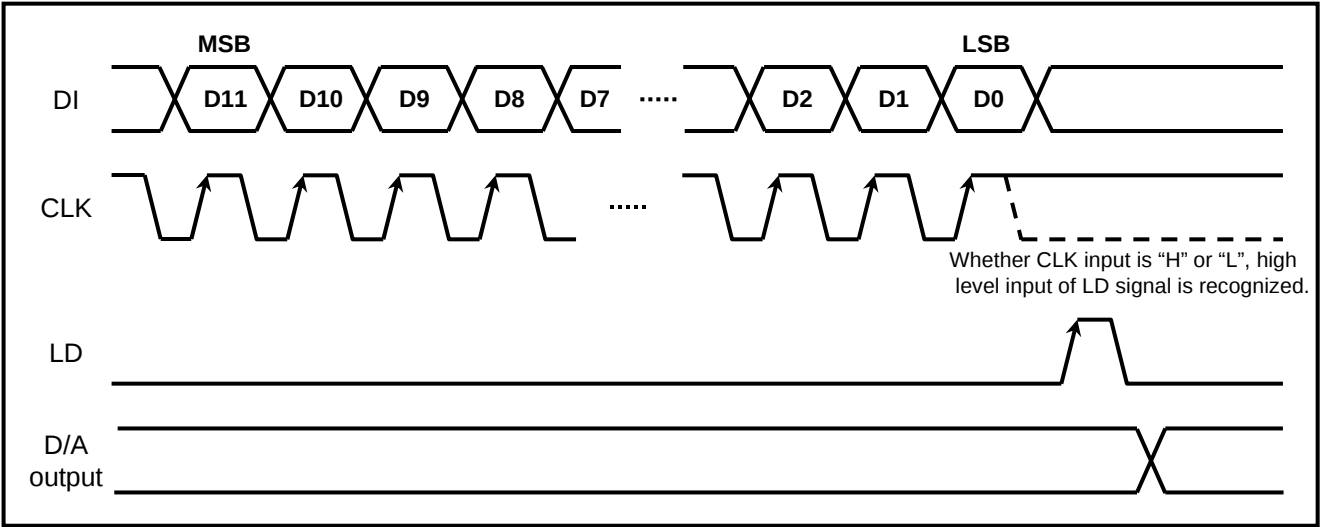
Channel select data

D8	D9	D10	D11	Chanel Selection
0	0	0	0	Don't care
0	0	0	1	Ao1 select
0	0	1	0	Ao2 select
0	0	1	1	Ao3 select
0	1	0	0	Ao4 select
0	1	0	1	Ao5 select
0	1	1	0	Ao6 select
0	1	1	1	Don't care
:	:	:	:	:
1	1	1	0	Don't care
1	1	1	1	Don't care

DAC data

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

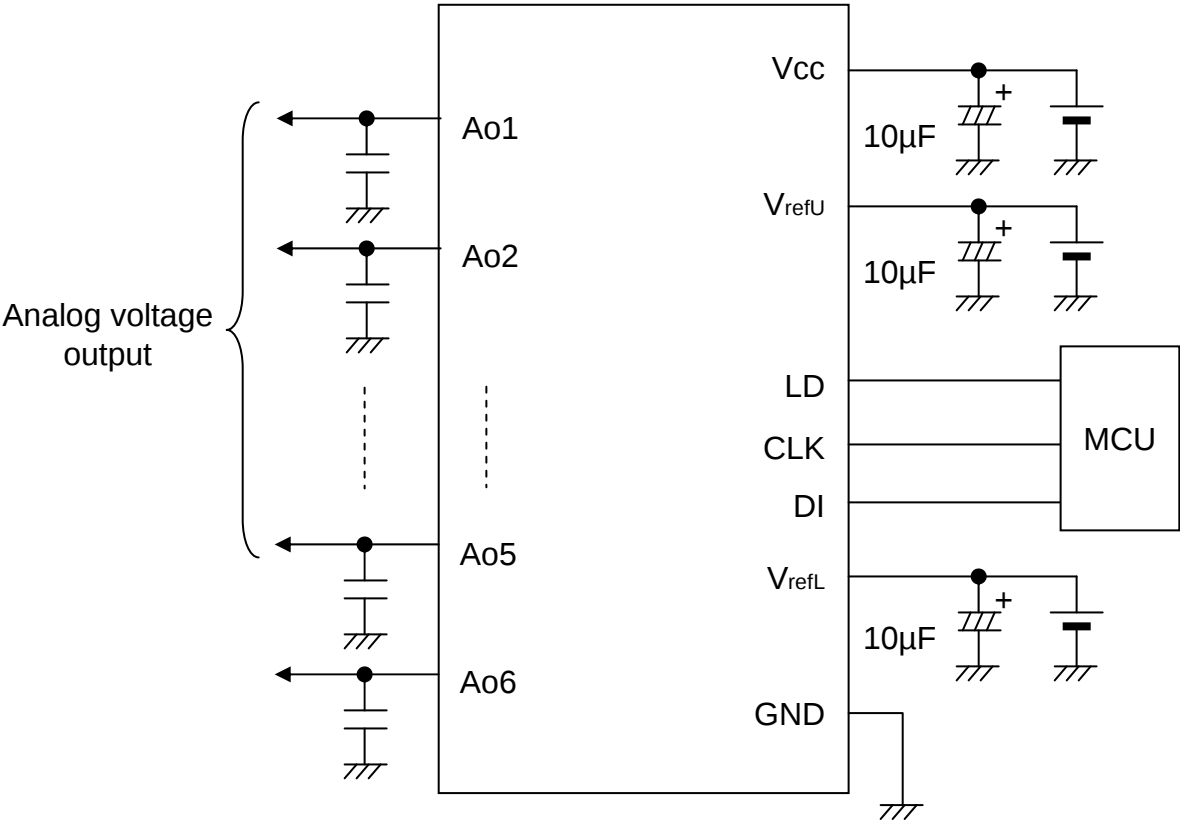
Data Timing Chart (Model)



Precaution For Use

- There are three terminals (Vcc, VrefU, VrefL) that should be impressed a constant voltage. When ripple or spike noise is input to this terminal, there is fear that the accuracy of D/A conversion becomes lower and this IC malfunction. So, when use this IC, please connect capacitor between these terminals (Vcc, VrefU, VrefL) and GND for stable D/A conversion.
- This IC's output amplifier has an advantage to capacitive load, So, it's no problem at device action when connect capacitor (0.1μF Max) among output to GND for every noise elimination.

Standard Application Circuit



Ordering Information

Order part No.	Package Name	Package Code	Package type No.	Packing/Quantity
R2A20166SA	TSSOP-16	RTSP0016JB-A	SA	Embossed Taping/2,000 pcs.
R2A20166NP	QFN-16	PWQN0016KB-A	NP	Embossed Taping/3,000 pcs.

PTSP0016JB-A [SA]

Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
D	—	5.0	5.3
E	—	4.40	—
A ₂	—	—	—
A ₁	0.03	0.07	0.10
A	—	—	1.10
b _p	0.15	0.20	0.25
b ₁	—	—	—
c	0.10	0.15	0.20
c ₁	—	—	—
θ	0°	—	8°
H _E	6.20	6.40	6.60
ⓔ	—	0.65	—
x	—	—	0.13
y	—	—	0.10
Z	—	—	0.65
L	0.4	0.5	0.6
L ₁	—	1.0	—

JEITA Package Code	RENESAS Code	Previous Code	MASS[Typ.]
P-HWQFN16-3x3-0.50	PWQN0016KB-A	—	0.020g

Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
D	2.90	3.00	3.10
E	2.90	3.00	3.10
A ₂	—	—	—
A	—	—	0.80
A ₁	0	—	0.05
b	0.18	0.23	0.28
b ₁	—	—	—
⌀	—	0.5	—
L _p	0.30	0.40	0.50
x	—	—	0.1
y	—	—	0.08
y ₁	—	—	0.1
t	—	—	—
H _D	—	—	—
H _E	—	—	—
Z _D	—	—	—
Z _E	—	—	—
c	—	0.20	—
c ₁	—	—	—

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Renesas Electronics America Inc.
2880 Scott Boulevard Santa Clara, CA 95050-2554, U.S.A.
Tel: +1-408-588-6000, Fax: +1-408-588-6130

Renesas Electronics Canada Limited
1101 Nicholson Road, Newmarket, Ontario L3Y 9C3, Canada
Tel: +1-905-898-5441, Fax: +1-905-898-3220

Renesas Electronics Europe Limited
Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K
Tel: +44-1628-585-100, Fax: +44-1628-585-900

Renesas Electronics Europe GmbH
Arcadiastrasse 10, 40472 Düsseldorf, Germany
Tel: +49-211-65030, Fax: +49-211-6503-1327

Renesas Electronics (China) Co., Ltd.
7th Floor, Quantum Plaza, No.27 ZhiChunLu Haidian District, Beijing 100083, P.R.China
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

Renesas Electronics (Shanghai) Co., Ltd.
Unit 204, 205, AZIA Center, No.1233 Lujiazui Ring Rd., Pudong District, Shanghai 200120, China
Tel: +86-21-5877-1818, Fax: +86-21-6887-7858 / -7898

Renesas Electronics Hong Kong Limited
Unit 1601-1613, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong
Tel: +852-2886-9318, Fax: +852 2886-9022/9044

Renesas Electronics Taiwan Co., Ltd.
13F, No. 363, Fu Shing North Road, Taipei, Taiwan
Tel: +886-2-8175-9600, Fax: +886 2-8175-9670

Renesas Electronics Singapore Pte. Ltd.
1 harbourFront Avenue, #06-10, Keppel Bay Tower, Singapore 098632
Tel: +65-6213-0200, Fax: +65-6278-8001

Renesas Electronics Malaysia Sdn.Bhd.
Unit 906, Block B, Menara Amcorp, Amcorp Trade Centre, No. 18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia
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Renesas Electronics Korea Co., Ltd.
11F., Samik Laved' or Bldg., 720-2 Yeoksam-Dong, Kangnam-Ku, Seoul 135-080, Korea
Tel: +82-2-558-3737, Fax: +82-2-558-5141