

# R2A20168NP/SA/SP

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

R03DS0019EJ0100

Rev.1.00

2011.09.05

## Description

The R2A20168 is an integrated circuit semiconductor of CMOS structure with 8 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.

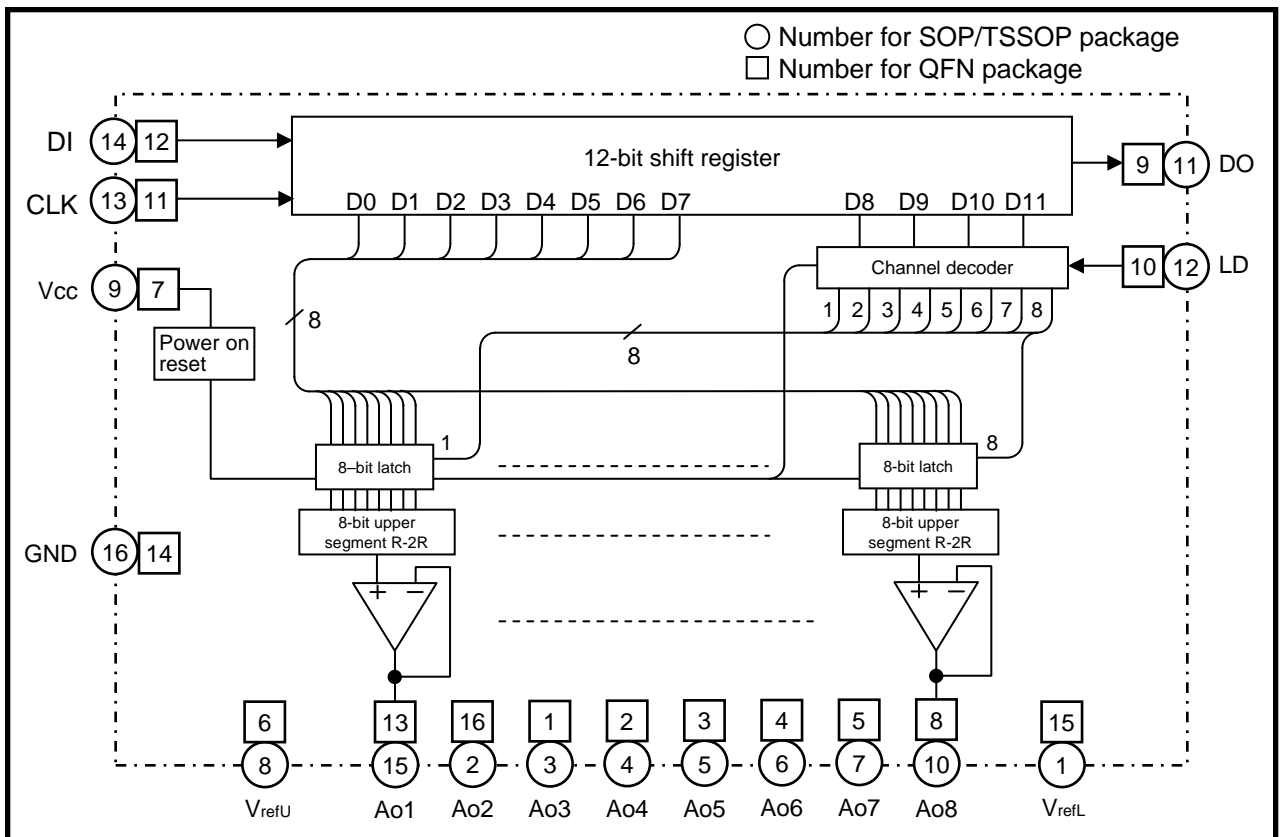
## Features

- Guarantee Nonlinearity error : +/-1.0LSB, Differential nonlinearity error : +/-0.7LSB
- 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)

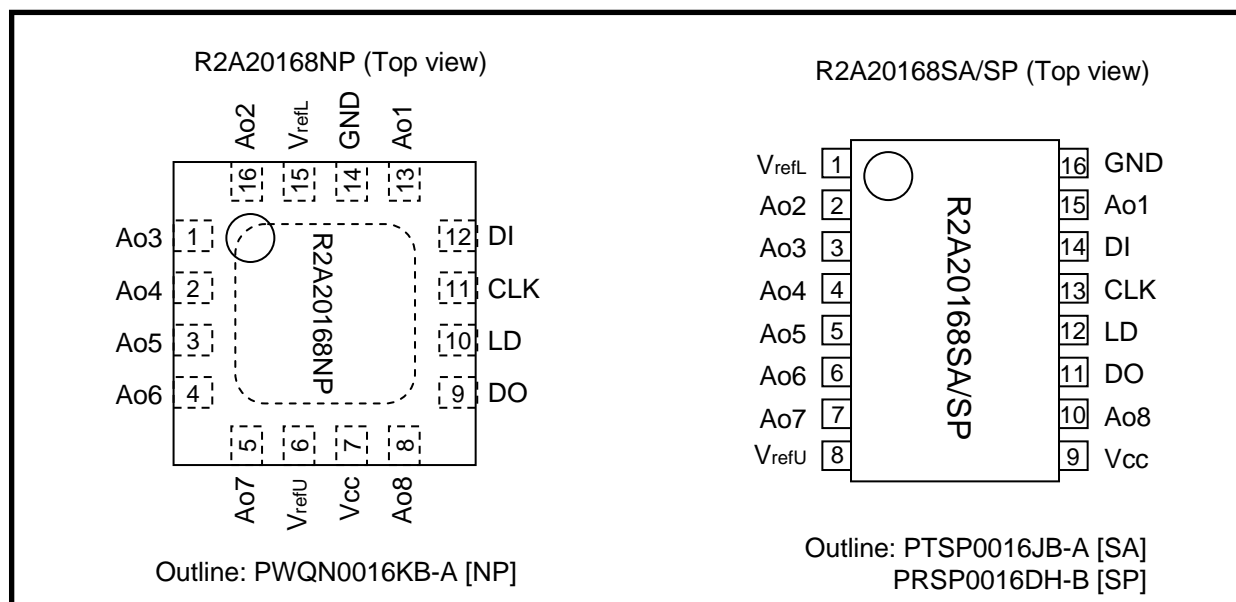
## Application

- 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 /SOP]		
12	14	DI	Serial data input terminal. ( Input serial data with a 12-bit data length )
11	13	CLK	Serial clock input terminal (Input signal from DI terminal is input to 12-bit shift register at rise of serial clock.)
10	12	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.)
9	11	Do	Serial data output terminal (Data is sequentially output from the MSB bit.)
13	15	Ao1	8-bit resolution D/A converter output terminals (After power on, all channels are reset and DAC data 00h is output.)
16	2	Ao2	
1	3	Ao3	
2	4	Ao4	
3	5	Ao5	
4	6	Ao6	
5	7	Ao7	
8	10	Ao8	
7	9	Vcc	Power supply terminal
14	16	GND	GND terminal
6	8	VrefU	D/A converter upper reference voltage input terminal
15	1	VrefL	D/A converter lower reference voltage input terminal

## Absolute Maximum Ratings

(Ta= +25deg unless otherwise noted)

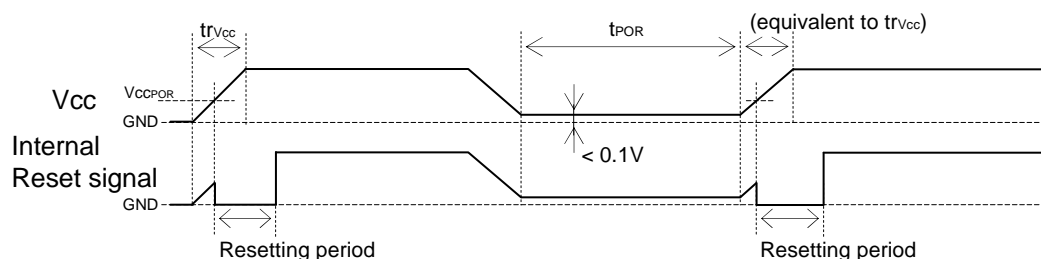
Item	Symbol	Conditions	Ratings	Unit
Supply voltage	Vcc		-0.3 to +6.5	V
D/A converter upper reference voltage	VrefU		-0.3 to +6.5	V
D/A converter lower reference voltage	VrefL		-0.3 to +6.5	V
Buffer amplifier output current	I <sub>AO</sub>	Continuous	-2.0 to +2.0	mA
Input voltage	V <sub>in</sub>		-0.3 to Vcc+0.3 <+6.5	V
Output voltage	V <sub>o</sub>		-0.3 to Vcc+0.3 <+6.5	V
Power dissipation	P <sub>d</sub>	Ta= +85deg	290(NP) / 150(SA) / 300(SP)	mW
Thermal derating factor	K theta	Ta> +25deg	7.25(NP) / 3.75(SA) / 7.5(SP)	mW/deg
Operating temperature	T <sub>opr</sub>		-30 to +85	deg
Storage temperature	T <sub>stg</sub>		-40 to +125	deg

## Electrical Characteristics

« Digital Part » (Vcc, VrefU = +5V +/-10%, Vcc&gt;VrefU, GND, VrefL =0V, Ta= -30 to +85deg, Unless otherwise noted)

Item	Symbol	Test conditions	Limits			Unit
			Min	Typ	Max	
Supply voltage	Vcc		2.7	5.0	5.5	V
Supply current	I <sub>cc</sub>	CLK =1MHz, Vcc =5V, I <sub>AO</sub> =0μA	-	0.4	1.2	mA
Input leak current	I <sub>ILK</sub>	V <sub>IN</sub> = 0 to Vcc	-10	-	10	μA
Input low voltage	V <sub>IL</sub>		-	-	0.2Vcc	V
Input high voltage	V <sub>IH</sub>		0.8Vcc	-	-	V
Output low voltage	V <sub>OL</sub>	4.0V < Vcc, I <sub>oL</sub> = 2.0mA	-	-	0.4	V
		Vcc < 4.0V, I <sub>oL</sub> = 1.5mA	-	-	0.4	V
Output high voltage	V <sub>OH</sub>	I <sub>oH</sub> = -400μA	Vcc - 0.4	-	-	V
Supply voltage rise time *1	t <sub>rVcc</sub>	Vcc = 0 to 2.7V	100	-	-	μs
Internal reset operating voltage *1	V <sub>CCPOR</sub>	Vcc = 0 to 2.7V	-	1.5	1.9	V
Power supply restart interval (Power supply OFF → ON) *1	t <sub>POR</sub>	Vcc < 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<sub>POR</sub>).



« Analog Part » (  $V_{CC}$ ,  $V_{refU} = +5V \pm 10\%$ ,  $V_{CC} > V_{refU}$ ,  $GND$ ,  $V_{refL} = 0V$ ,  $T_a = -30$  to  $+85$ deg, 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	-	1.0	2.0	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	$S_{DL}$	$V_{refU} = 4.79V$ , $V_{refL} = 0.95V$ , $V_{CC} = 5.5V$ (15mV/LSB), Without load ( $I_{AO} = 0\mu A$ )	-0.7	-	0.7	LSB
Nonlinearity	$S_L$		-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	$\mu F$
Buffer amplifier output impedance	$R_o$		-	5.0	-	ohm

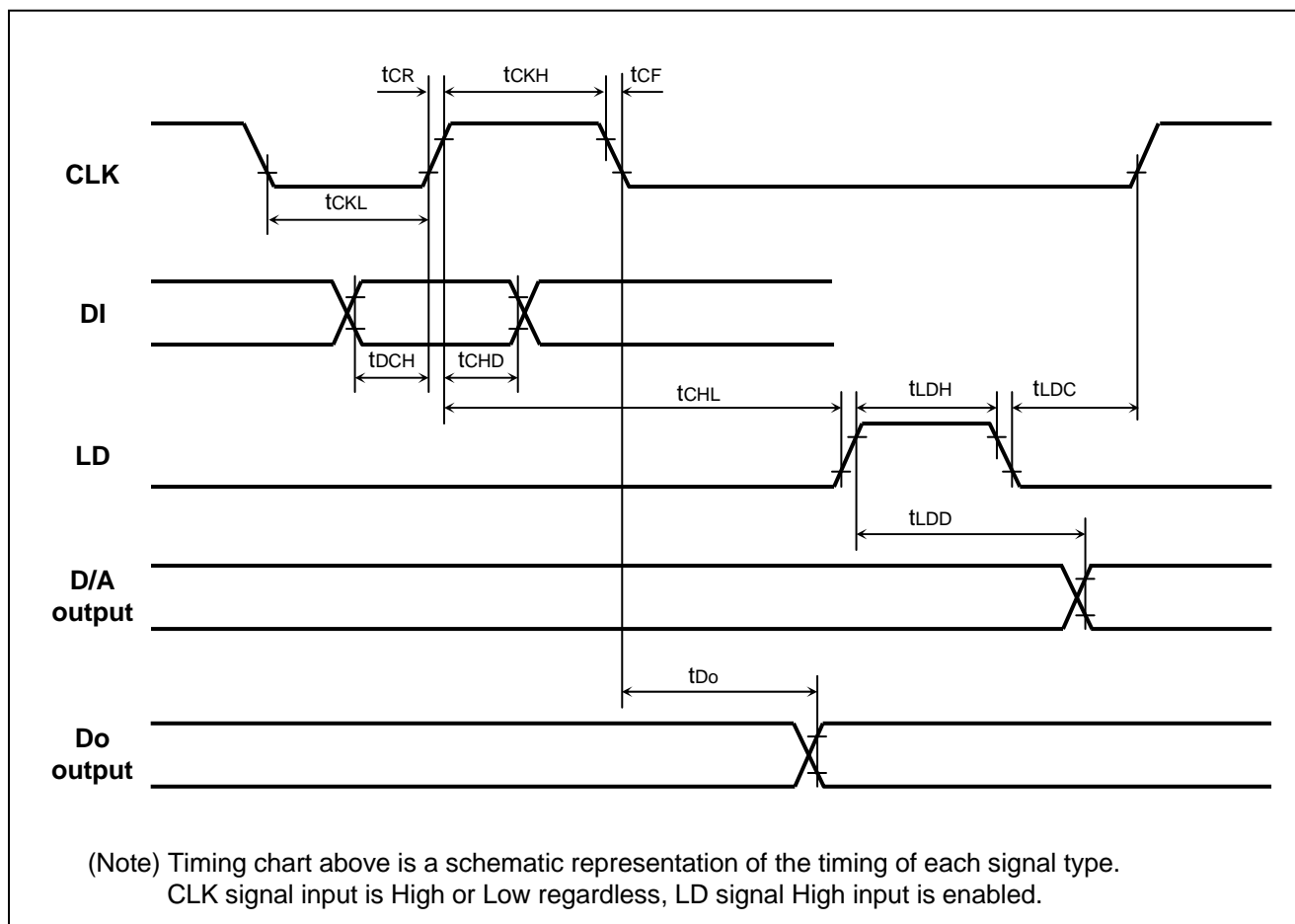
\*2 : The output does not necessary be the value with the reference voltage setting range.  
The output value is determined by the buffer amplifier output voltage range ( $V_{AO}$ ).

## AC Characteristics

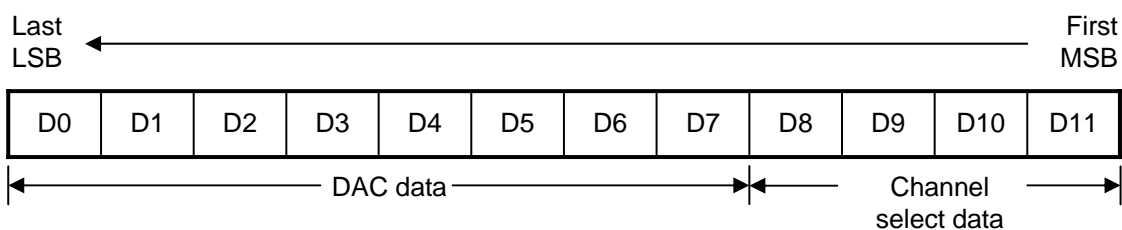
(  $V_{CC}, V_{refU} = +5V \pm 10\%$ ,  $V_{CC} \geq V_{refU}$ ,  $GND = V_{refL} = 0V$ ,  $T_a = -30$  to  $+85$ deg, unless otherwise noted )

Item	Symbol	Test conditions	Limits			Unit
			Min	Typ	Max	
Clock frequency	$f_{CLK}$		-	1.0	10	MHz
Clock low pulse width	$t_{CKL}$		40	-	-	ns
Clock high pulse width	$t_{CKH}$		40	-	-	ns
Clock rise time	$t_{CR}$		-	-	200	ns
Clock fall time	$t_{CF}$		-	-	200	ns
Data setup time	$t_{DCH}$		4	-	-	ns
Data hold time	$t_{CHD}$		30	-	-	ns
LD setup time	$t_{CHL}$		40	-	-	ns
LD hold time	$t_{LDC}$		40	-	-	ns
LD high pulse width	$t_{LDH}$		40	-	-	ns
Data output delay time	$t_{DO}$	$C_L < 100$ pF	-10	-	50	ns
D/A output settling time	$t_{LDD}$	$T_a = 25$ deg, $C_L < 100$ pF, $V_{AO}: 0.5 \leftarrow \rightarrow 4.5$ V, The time until the output becomes the final value of 1/2 LSB.	-	-	150	$\mu$ s

## Timing Chart



## Digital Data Format



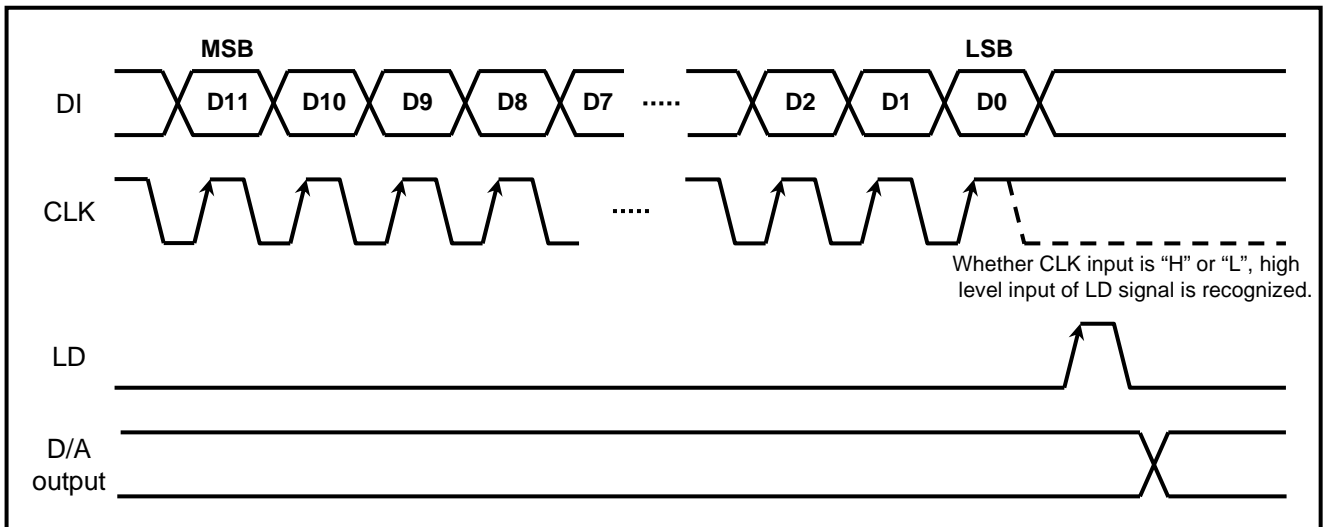
### Channel select data

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	Ao7 select
1	0	0	0	Ao8 select
1	0	0	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	$(V_{\text{refU}} - V_{\text{refL}}) / 256 \times 1 + V_{\text{refL}}$
1	0	0	0	0	0	0	0	$(V_{\text{refU}} - V_{\text{refL}}) / 256 \times 2 + V_{\text{refL}}$
0	1	0	0	0	0	0	0	$(V_{\text{refU}} - V_{\text{refL}}) / 256 \times 3 + V_{\text{refL}}$
1	1	0	0	0	0	0	0	$(V_{\text{refU}} - V_{\text{refL}}) / 256 \times 4 + V_{\text{refL}}$
:	:	:	:	:	:	:	:	:
0	1	1	1	1	1	1	1	$(V_{\text{refU}} - V_{\text{refL}}) / 256 \times 255 + V_{\text{refL}}$
1	1	1	1	1	1	1	1	$V_{\text{refU}}$

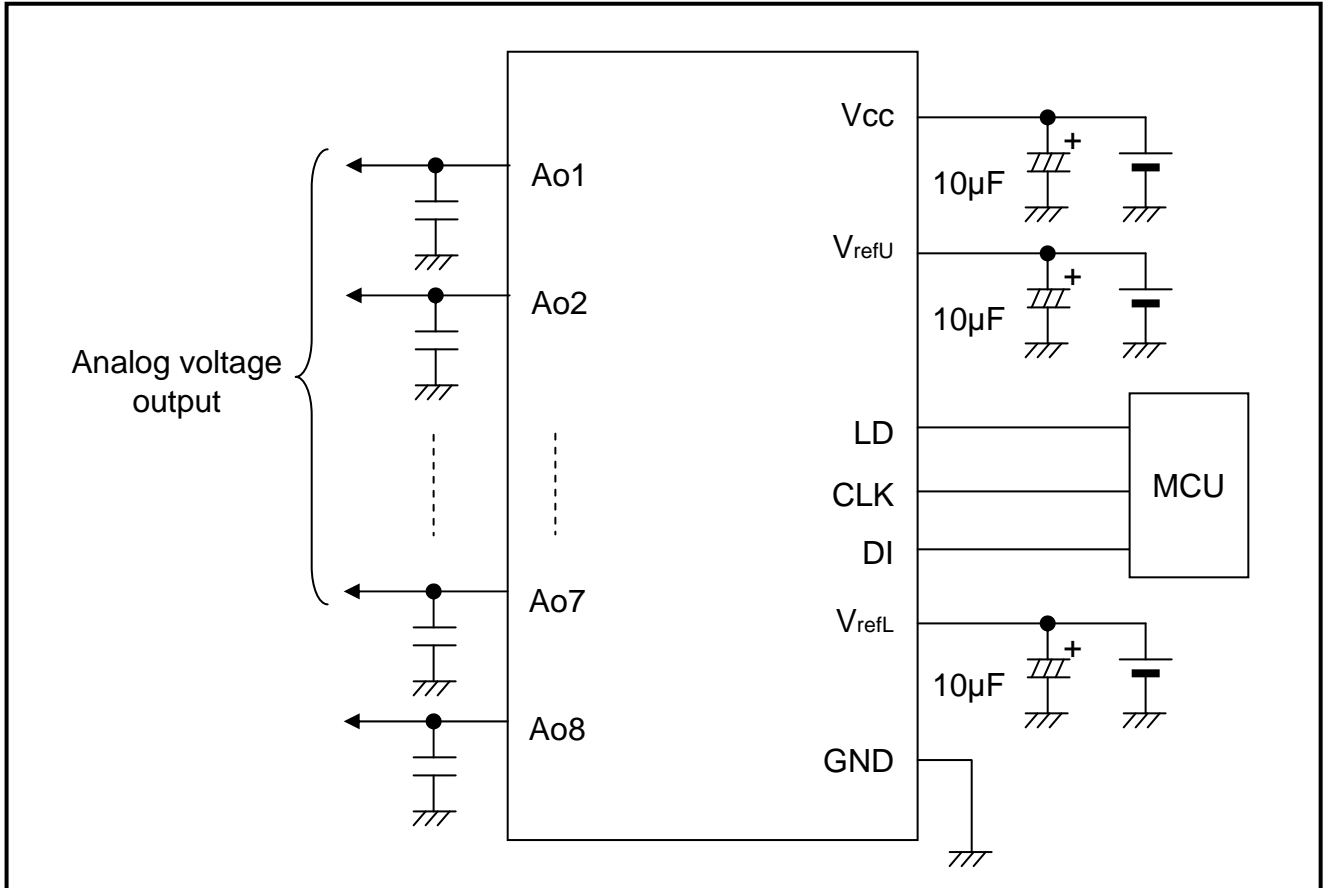
### Data Timing Chart ( Model )



### Precaution For Use

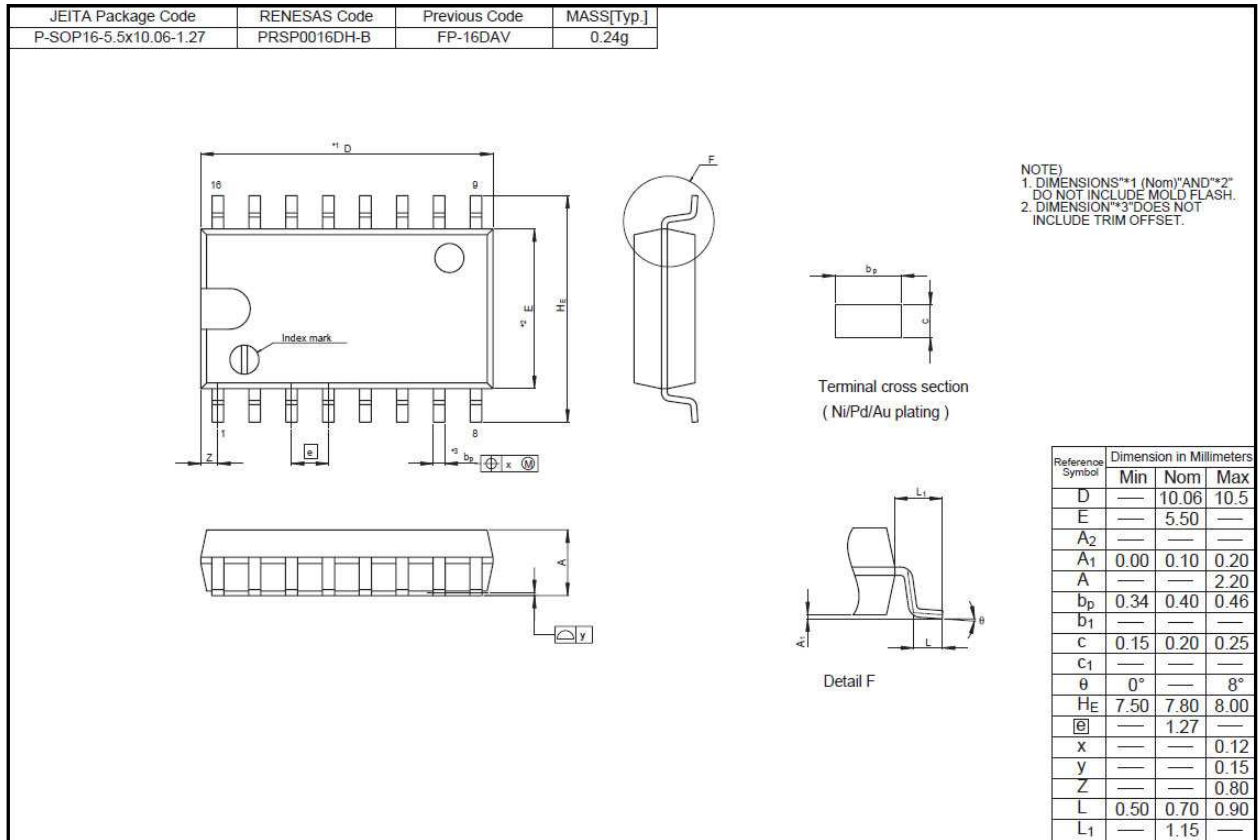
- There are three terminals ( $V_{CC}$ ,  $V_{refU}$ ,  $V_{refL}$ ) that should be impressed a constant voltage. When ripple or spike noise is input to this terminal, there is fear that the accuracy of D/A conversion becomes lower and this IC malfunction. So, when use this IC, please connect capacitor between these terminals ( $V_{CC}$ ,  $V_{refU}$ ,  $V_{refL}$ ) 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 ( 0.1 $\mu$ F Max ) among output to GND for every noise elimination.

### Standard Application Circuit

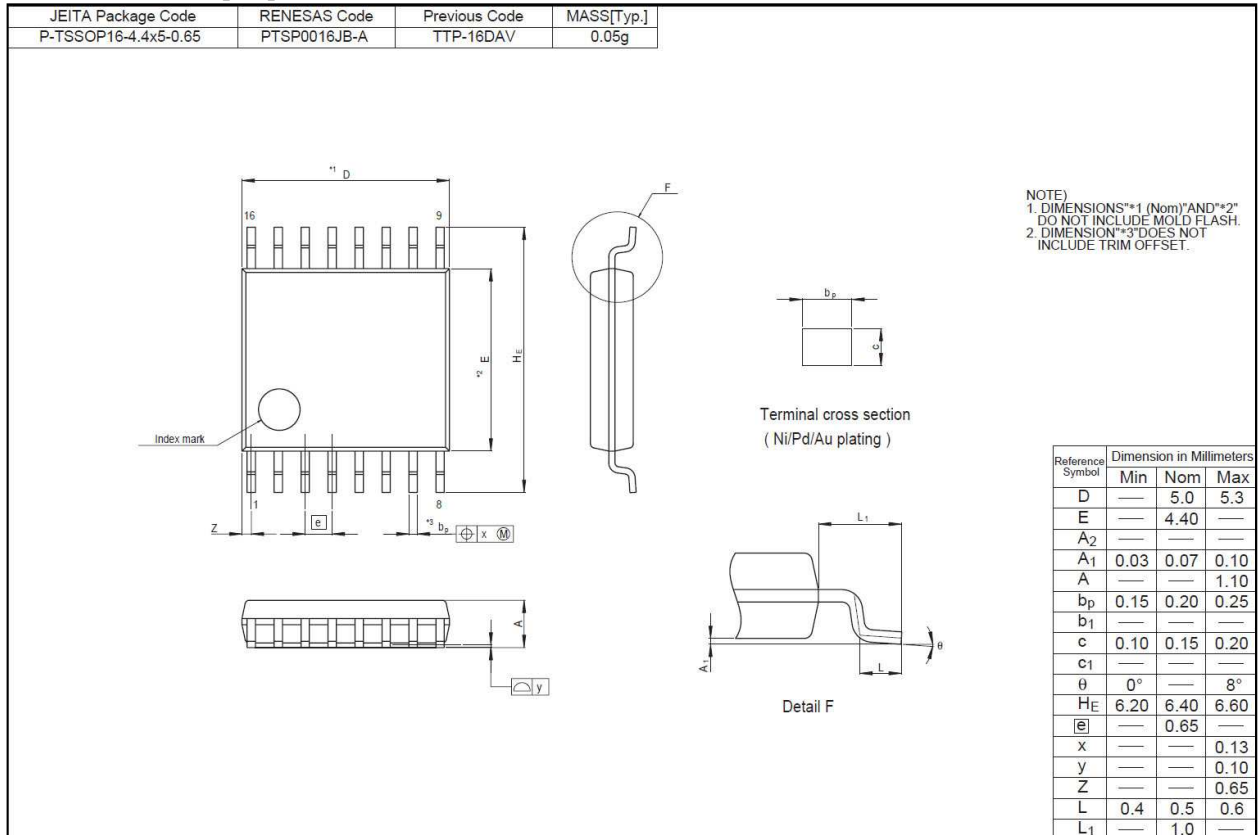


### Package Dimensions

#### PRSP0016DH-B [SP]

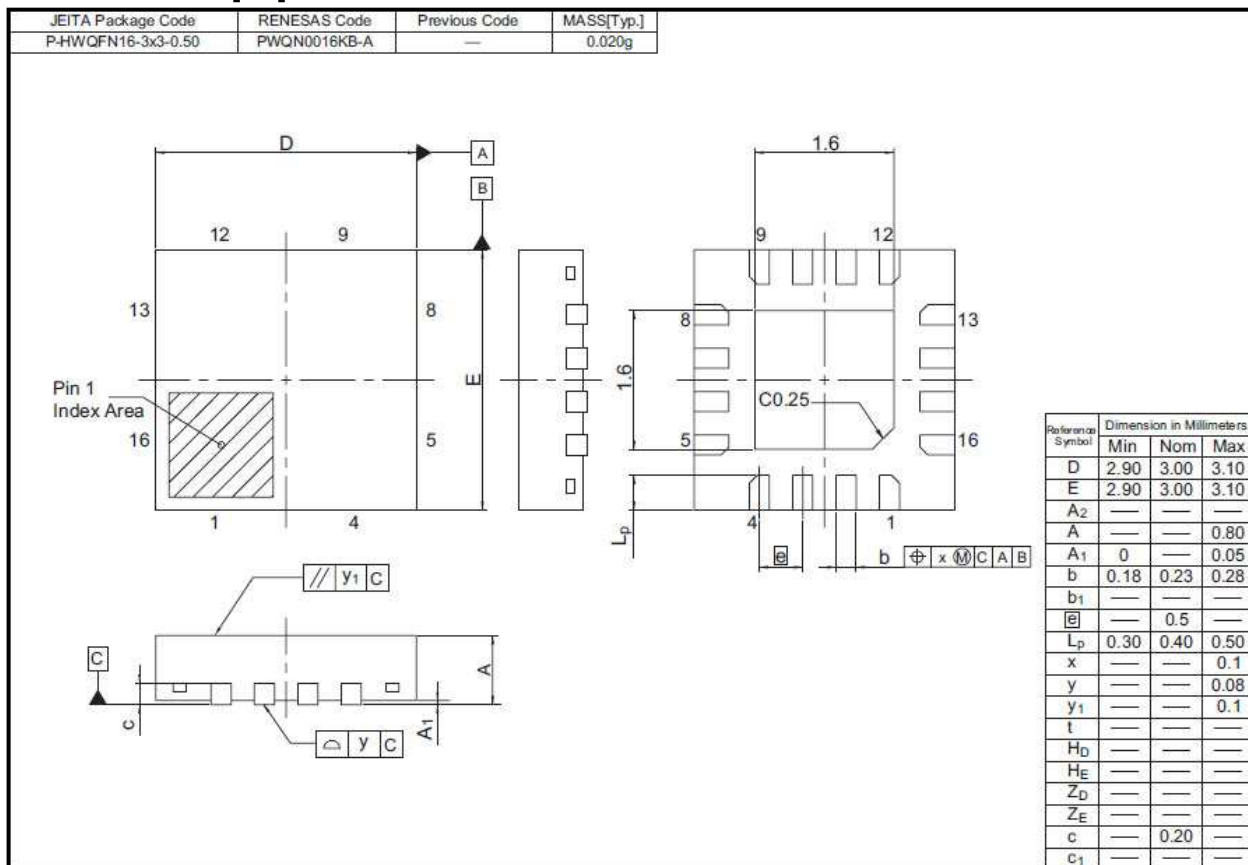


#### PTSP0016JB-A [SA]





## PWQN0016KB-A [NP]



## Ordering Information

Order part No.	Package Name	Package Code	Package type No.	Packing/Quantity
R2A20168SP	SOP-16	PRSP0016DH-B	SP	Embossed Taping/2,000 pcs.
R2A20168SA	TSSOP-16	RTSP0016JB-A	SA	Embossed Taping/2,000 pcs.
R2A20168NP	QFN-16	PWQN0016KB-A	NP	Embossed Taping/3,000 pcs.

## Notice

- All information included in this document is current as of the date this document is issued. Such information, however, is subject to change without any prior notice. Before purchasing or using any Renesas Electronics products listed herein, please confirm the latest product information with a Renesas Electronics sales office. Also, please pay regular and careful attention to additional and different information to be disclosed by Renesas Electronics such as that disclosed through our website.
- Renesas Electronics does not assume any liability for infringement of patents, copyrights, or other intellectual property rights of third parties by or arising from the use of Renesas Electronics products or technical information described in this document. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
- You should not alter, modify, copy, or otherwise misappropriate any Renesas Electronics product, whether in whole or in part.
- Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation of these circuits, software, and information in the design of your equipment. Renesas Electronics assumes no responsibility for any losses incurred by you or third parties arising from the use of these circuits, software, or information.
- When exporting the products or technology described in this document, you should comply with the applicable export control laws and regulations and follow the procedures required by such laws and regulations. You should not use Renesas Electronics products or the technology described in this document for any purpose relating to military applications or use by the military, including but not limited to the development of weapons of mass destruction. Renesas Electronics products and technology may not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations.
- Renesas Electronics has used reasonable care in preparing the information included in this document, but Renesas Electronics does not warrant that such information is error free. Renesas Electronics assumes no liability whatsoever for any damages incurred by you resulting from errors in or omissions from the information included herein.
- Renesas Electronics products are classified according to the following three quality grades: "Standard", "High Quality", and "Specific". The recommended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below. You must check the quality grade of each Renesas Electronics product before using it in a particular application. You may not use any Renesas Electronics product for any application categorized as "Specific" without the prior written consent of Renesas Electronics. Further, you may not use any Renesas Electronics product for any application for which it is not intended without the prior written consent of Renesas Electronics. Renesas Electronics shall not be in any way liable for any damages or losses incurred by you or third parties arising from the use of any Renesas Electronics product for an application categorized as "Specific" or for which the product is not intended where you have failed to obtain the prior written consent of Renesas Electronics. The quality grade of each Renesas Electronics product is "Standard" unless otherwise expressly specified in a Renesas Electronics data sheets or data books, etc.  
"Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; and industrial robots.  
"High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control systems; anti-disaster systems; anti-crime systems; safety equipment; and medical equipment not specifically designed for life support.  
"Specific": Aircraft; aerospace equipment; submersible repeaters; nuclear reactor control systems; medical equipment or systems for life support (e.g. artificial life support devices or systems), surgical implantations, or healthcare intervention (e.g. excision, etc.), and any other applications or purposes that pose a direct threat to human life.
- You should use the Renesas Electronics products described in this document within the range specified by Renesas Electronics, especially with respect to the maximum rating, operating supply voltage range, movement power voltage range, heat radiation characteristics, installation and other product characteristics. Renesas Electronics shall have no liability for malfunctions or damages arising out of the use of Renesas Electronics products beyond such specified ranges.
- Although Renesas Electronics endeavors to improve the quality and reliability of its products, semiconductor products have specific characteristics such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Further, Renesas Electronics products are not subject to radiation resistance design. Please be sure to implement safety measures to guard them against the possibility of physical injury, and injury or damage caused by fire in the event of the failure of a Renesas Electronics product, such as safety design for hardware and software including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult, please evaluate the safety of the final products or system manufactured by you.
- Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. Please use Renesas Electronics products in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. Renesas Electronics assumes no liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
- This document may not be reproduced or duplicated, in any form, in whole or in part, without prior written consent of Renesas Electronics.
- Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products, or if you have any other inquiries.  
(Note 1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its majority-owned subsidiaries.  
(Note 2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.



### SALES OFFICES

Renesas Electronics Corporation

<http://www.renesas.com>

Refer to "<http://www.renesas.com/>" for the latest and detailed information.

**Renesas Electronics America Inc.**  
2880 Scott Boulevard Santa Clara, CA 95050-2554, U.S.A.  
Tel: +1-408-586-6000, Fax: +1-408-586-6130

**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: +65-6276-8001

**Renesas Electronics Malaysia Sdn.Bhd.**  
Unit 906, Block B, Menara Amcorp, Amcorp Trade Centre, No. 18, Jin Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia  
Tel: +60-3-7955-9390, Fax: +60-3-7955-9510

**Renesas Electronics Korea Co., Ltd.**  
11F., Samik Lavied' or Bldg., 720-2 Yeoksam-Dong, Kangnam-Ku, Seoul 135-080, Korea  
Tel: +82-2-558-3737, Fax: +82-2-558-5141