

# R2A20169NP/SA/SP

8-bit 12ch D/A Converter with Buffer Amplifiers

R03DS0020EJ0300

Rev.3.00

Jul 25, 2013

## Description

The R2A20169 is an integrated circuit semiconductor of CMOS structure with 12 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.

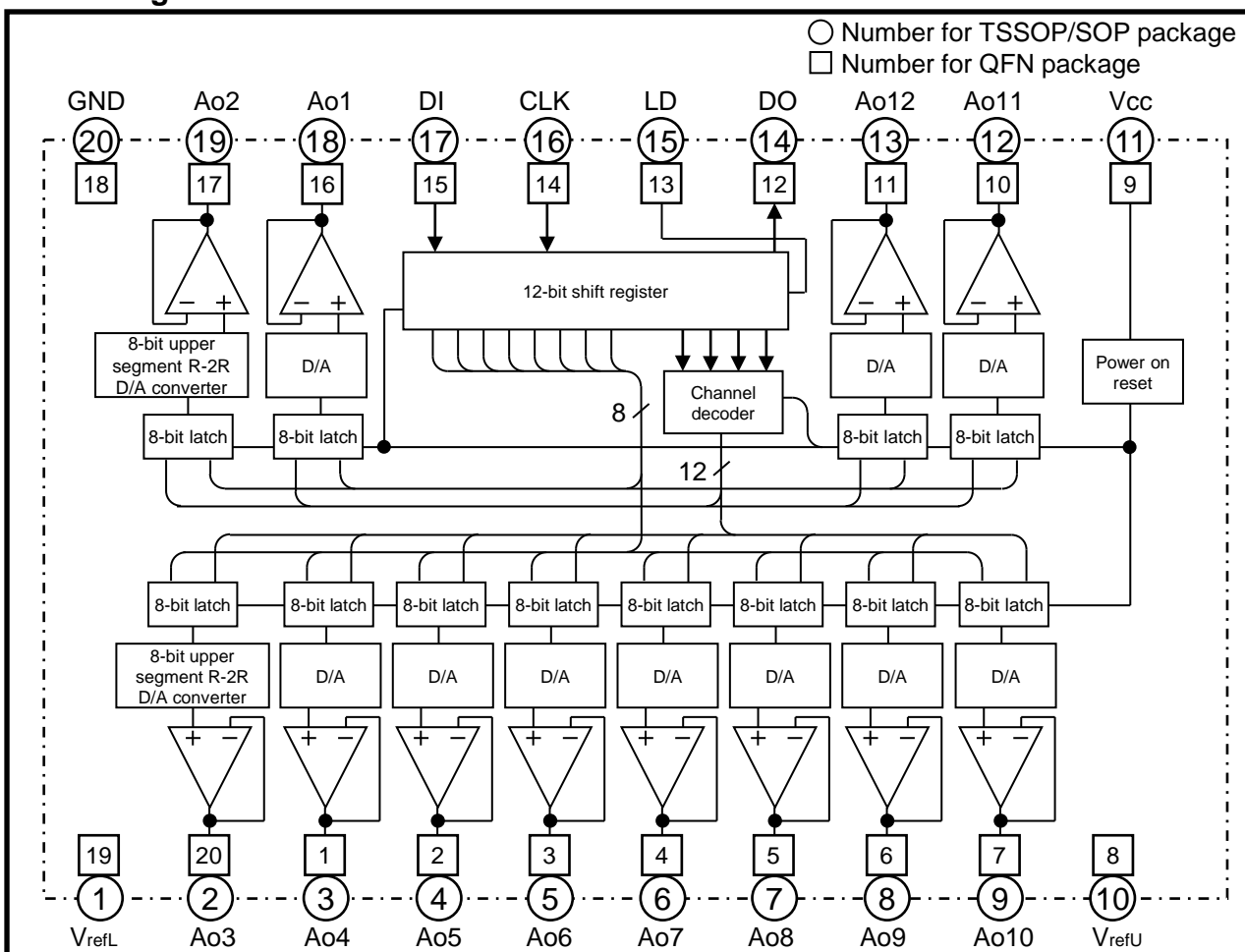
## Features

- 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 )
- High output current capacity: +/-1mA or Higher
- Very small size package line-up: QFN-20 (pin pitch: 0.5mm), TSSOP-20 (pin pitch 0.65mm)

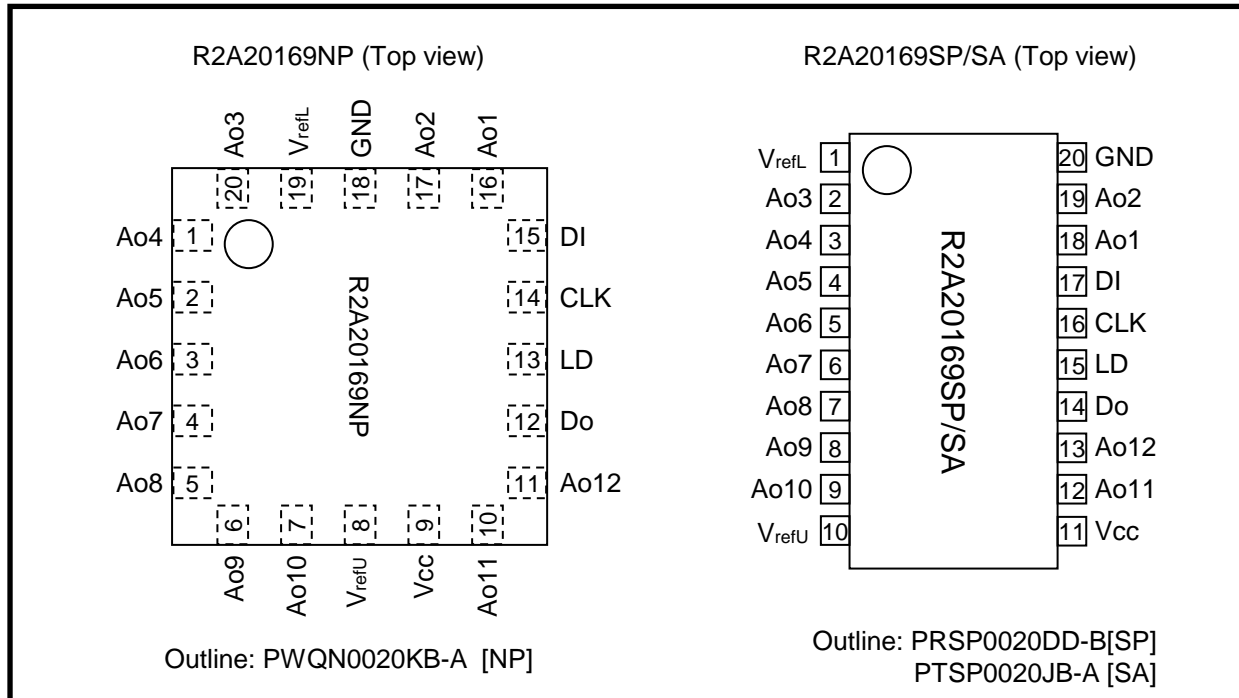
## Application

- Conversion from digital data to analog control data for home-use and industrial equipment.

## Block Diagram



## Pin Arrangement



## Pin Description

Pin No.		Pin Name	Function
[QFN]	[TSSOP /SOP]		
15	17	DI	Serial data input terminal. (Input serial data with a 12-bit data length.)
12	14	Do	Serial data output terminal (Data is sequentially output from the MSB bit.)
14	16	CLK	Serial clock input terminal (Input signal from DI terminal is input to 12-bit shift register at rise of serial clock.)
13	15	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.)
16	18	Ao1	8-bit resolution D/A converter output terminals (After power-on, all channels are reset and DAC data 00h is output.)
17	19	Ao2	
20	2	Ao3	
1	3	Ao4	
2	4	Ao5	
3	5	Ao6	
4	6	Ao7	
5	7	Ao8	
6	8	Ao9	
7	9	Ao10	
10	12	Ao11	
11	13	Ao12	
9	11	Vcc	Power supply terminal
18	20	GND	GND terminal
8	10	VrefU	D/A converter upper reference voltage input terminal
19	1	VrefL	D/A converter lower reference voltage input terminal

## Absolute Maximum Ratings

(Ta= +25deg unless otherwise noted)

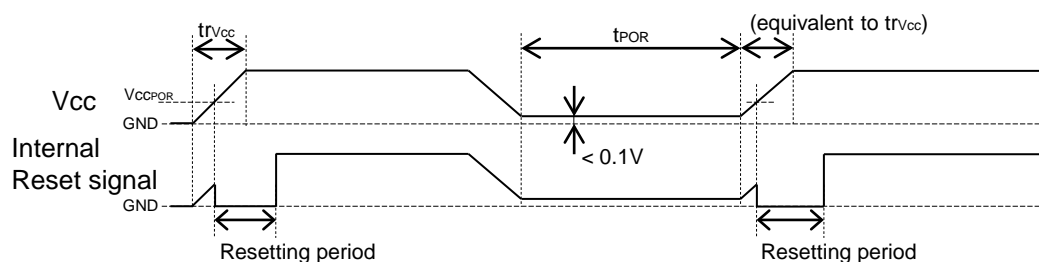
Item	Symbol	Conditions	Ratings	Unit
Supply voltage	Vcc		-0.3 to +6.5	V
D/A converter upper reference voltage	VrefU		-0.3 to +6.5	V
D/A converter lower reference voltage	VrefL		-0.3 to +6.5	V
Buffer amplifier output current	IAO	Continuous	-2.0 to +2.0	mA
Input voltage	Vin		-0.3 to Vcc+0.3 <+6.5	V
Output voltage	Vo		-0.3 to Vcc+0.3 <+6.5	V
Power dissipation	Pd	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	Topr		-30 to +85	deg
Storage temperature	Tstg		-40 to +125	deg

## Electrical Characteristics

« Digital Part » (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	
Supply voltage	Vcc		2.7	5.0	5.5	V
Supply current	Icc	CLK = 1MHz, Vcc =5V, IAO =0μA	-	0.6	1.8	mA
Input leak current	IILK	VIN = 0 to Vcc	-10	-	10	μA
Input low voltage	VIL		-	-	0.2Vcc	V
Input high voltage	VIH	4.0V < Vcc	0.5Vcc	-	-	V
		Vcc < 4.0V	0.8Vcc	-	-	V
Output low voltage	VOL	4.0V < Vcc, IOL =2.0 mA	-	-	0.4	V
		Vcc < 4.0V, IOL =1.5 mA	-	-	0.4	V
Output high voltage	VOH	Ioh = -400 μA	Vcc - 0.4	-	-	V
Supply voltage rise time *1	trVcc	Vcc = 0 @ 2.7V	100	-	-	μs
Internal reset operating voltage *1	VCCPOR	Vcc = 0 @ 2.7V	-	1.5	1.9	V
Power supply restart interval (Power supply OFF à ON) *1	tPOR	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 (tPOR).



« 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	-	1.5	3.0	mA
D/A converter upper reference voltage range *2	$V_{refU}$	$V_{CC} \geq 4.5V$	3.5	-	$V_{CC}$	V
		$V_{CC} < 4.5V$	$0.7V_{CC}$	-	$V_{CC}$	
D/A converter lower reference voltage range *2	$V_{refL}$	$V_{CC} \geq 4.5V$	GND	-	$V_{CC}-3.5$	V
		$V_{CC} < 4.5V$	GND	-	$0.3V_{CC}$	
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

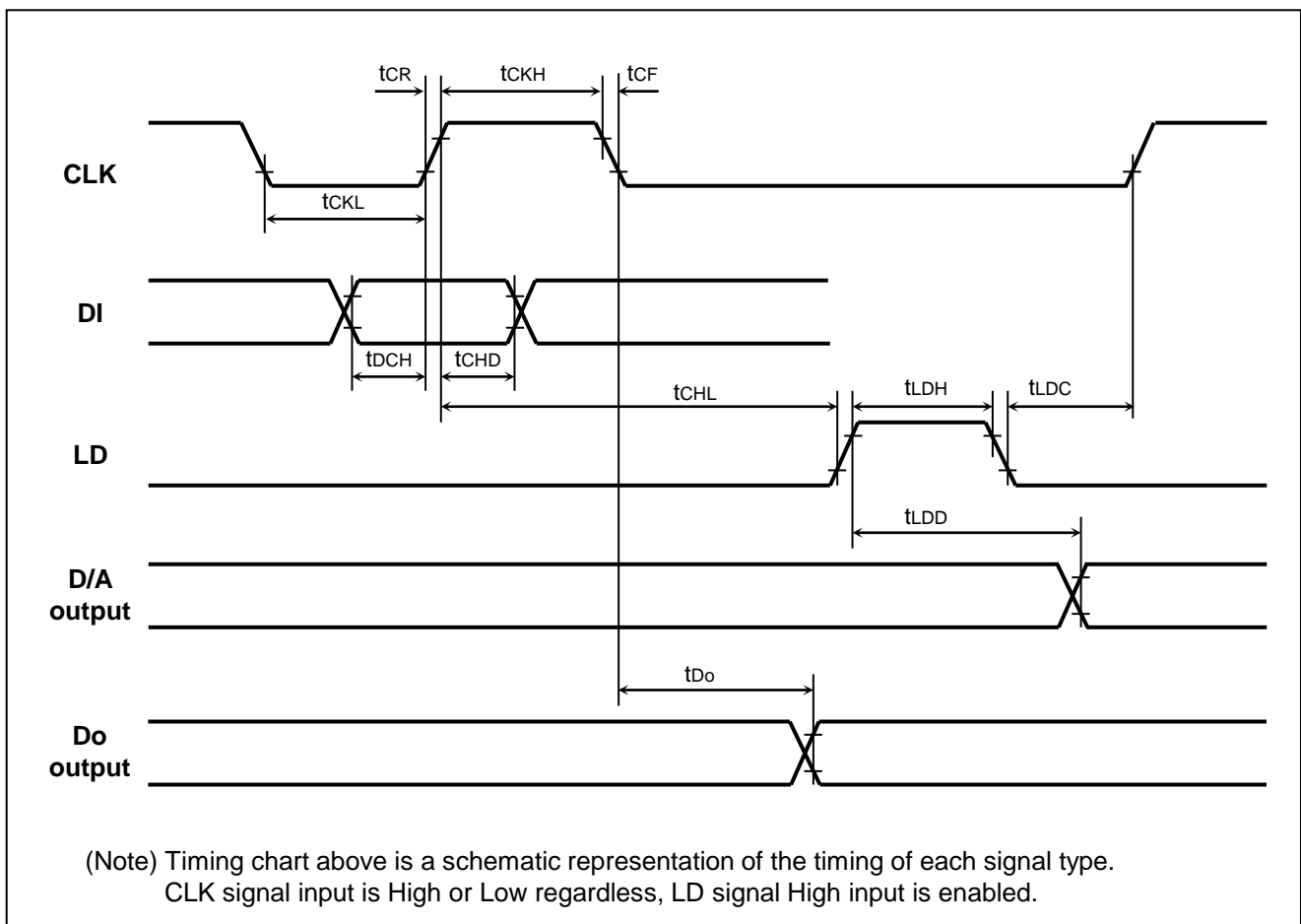
\*2 : The output does not necessary be the value with the reference voltage setting range.  
The output value is determined by the buffer amplifier output voltage range ( $V_{AO}$ ).

## AC Characteristics

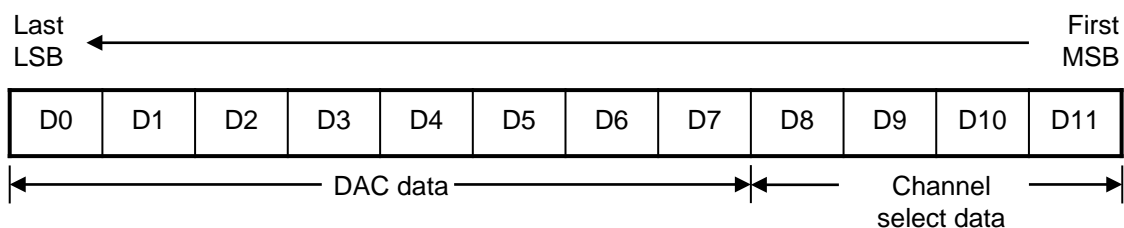
(  $V_{CC}$ ,  $V_{refU} = +5V \pm 10\%$ ,  $V_{CC} > V_{refU}$ ,  $GND = V_{refL} = 0V$ ,  $T_a = -30$  to  $+85$ deg, unless otherwise noted )

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, $V_{AO}: 0.5 \rightarrow @ 4.5V$ , The time until the output becomes the final value of 1/2 LSB.	-	-	150	$\mu$ s

## Timing Chart



## Digital Data Format



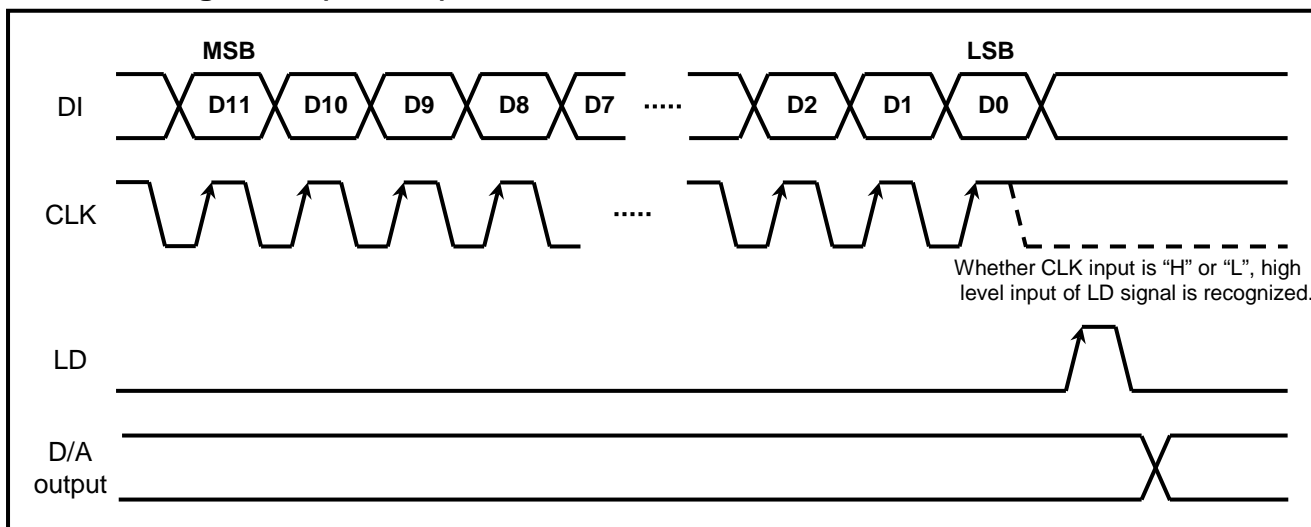
### Channel select data

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	Ao9 select
1	0	1	0	Ao10 select
1	0	1	1	Ao11 select
1	1	0	0	Ao12 select
1	1	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	$V_{\text{refU}}$

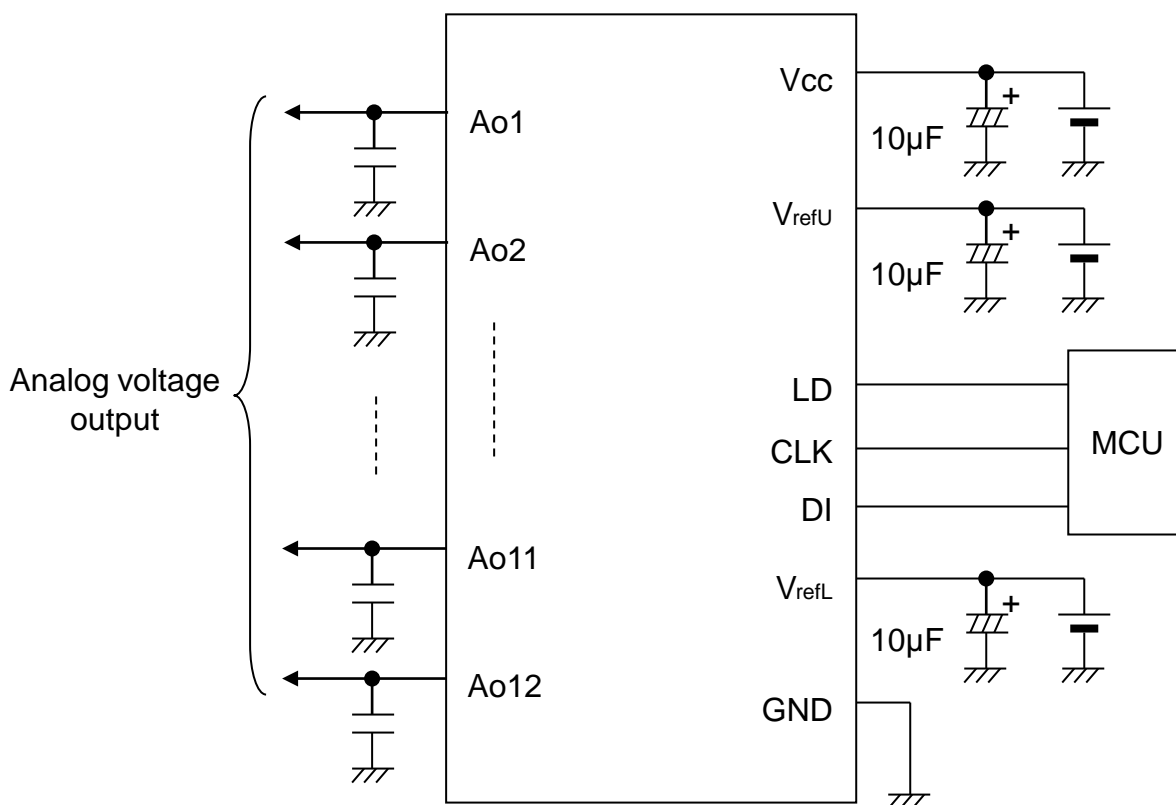
**Data Timing Chart ( Model )**



**Precaution For use**

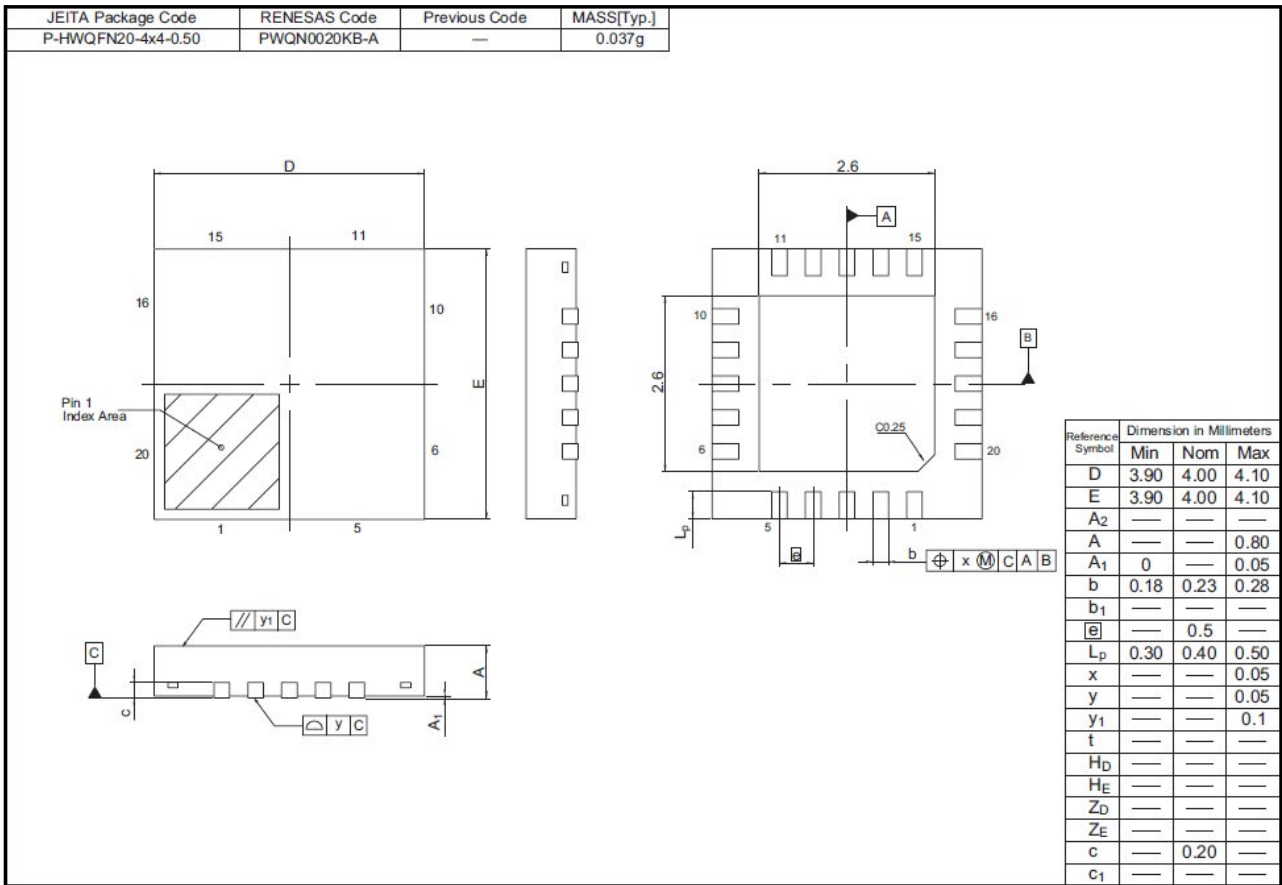
- There are three terminals ( $V_{CC}$ ,  $V_{refU}$ ,  $V_{refL}$ ) that should be impressed a constant voltage. When ripple or spike noise is input to this terminal, there is fear that the accuracy of D/A conversion becomes lower and this IC malfunction. So, when use this IC, please connect capacitor 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**

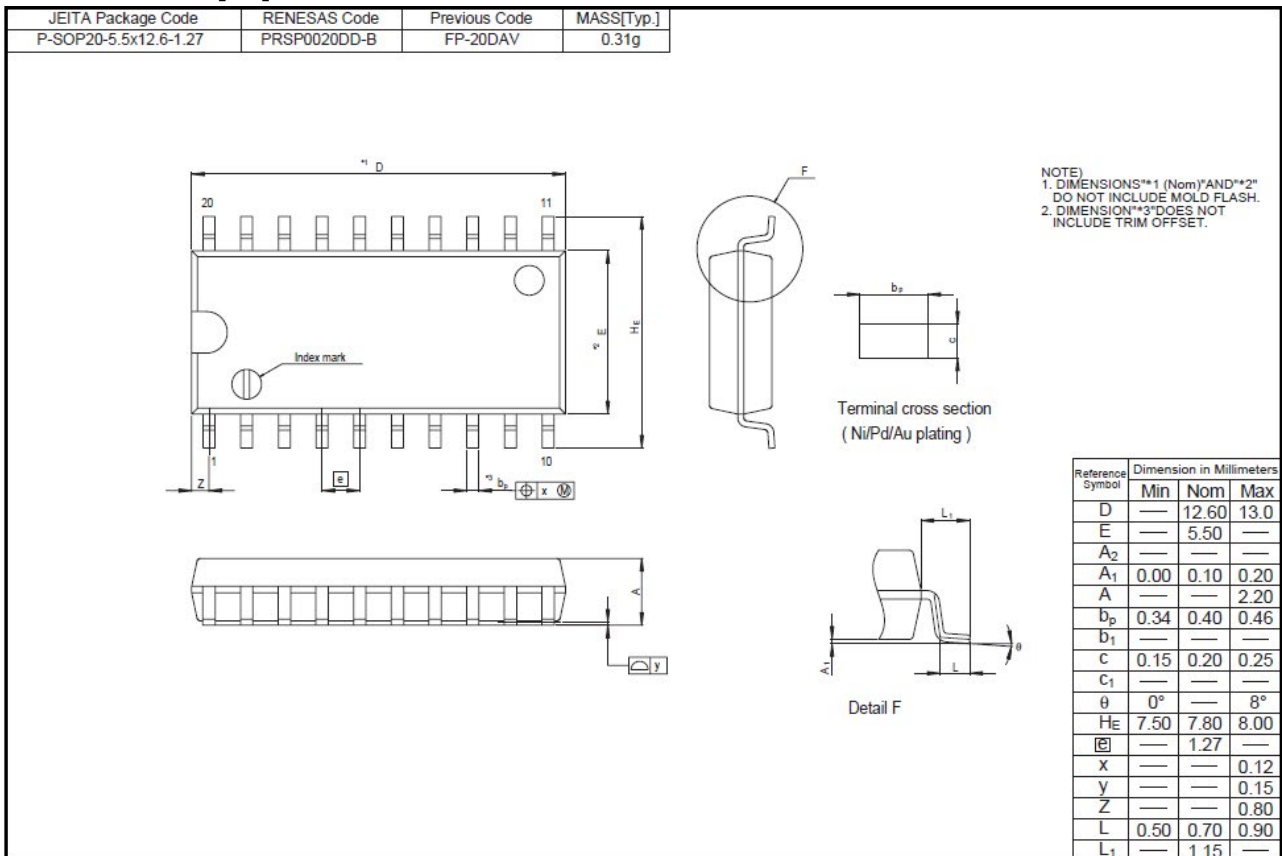


Package Dimensions

PWQN0020KB-A [NP]

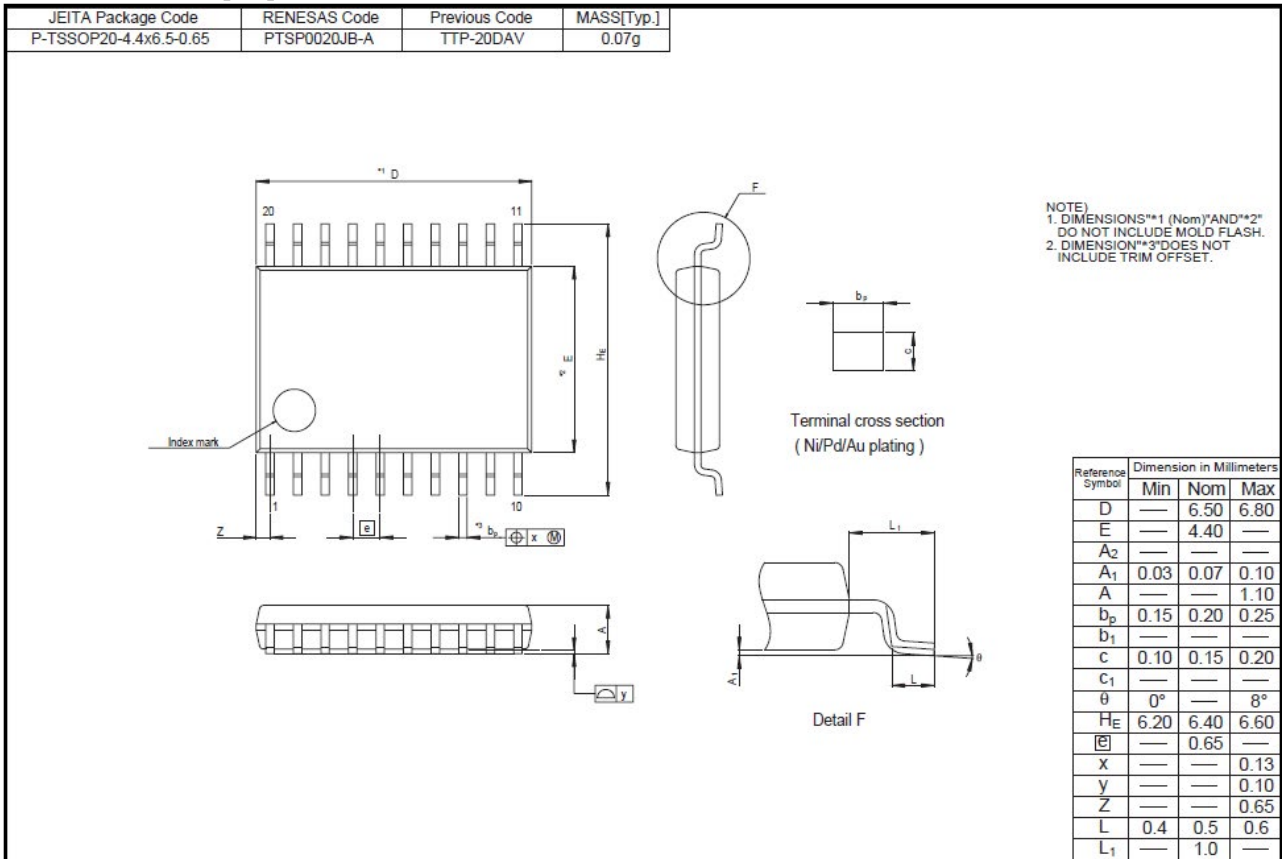


PRSP0020DD-B [SP]





**PTSP0020JB-A [SA]**



**Ordering Information**

Order part No.	Package Name	Package Code	Package type No.	Packing/Quantity
R2A20169SP#W5	SOP-20	PRSP0020DD-B	SP	Embossed Taping/2,000 pcs.
R2A20169SA#W5	TSSOP-20	RTSP0020JB-A	SA	Embossed Taping/2,000 pcs.
R2A20169NP#W5	QFN-20	PWQN0020KB-A	NP	Embossed Taping/2,500 pcs.

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