

# R2A20152NS/SP

8-bit 2ch D/A Converter with Buffer Amplifiers for I<sup>2</sup>C BUS (Corresponds to Fast mode)

R03DS0013EJ0100

Rev.1.00

2011.09.05

## Description

The R2A20152 is an integrated circuit semiconductor of CMOS structure with 2 channels of built in D/A converters with output buffer operational amplifiers. It is the characteristic improvement version of M62332.

The input interface is I<sup>2</sup>C Bus serial data method, and connects with a microcomputer with minimum wiring. It conforms FAST-MODE of I<sup>2</sup>C BUS Specifications.

The output circuit is composed of buffer operational amplifier with sync and source drive capacity of 1.0 mA or more, and it operates in the whole voltage range from VCC to ground.

## Features

- Guarantee Differential nonlinearity error : +/-0.7LSB, Nonlinearity error : +/-1.0LSB
- Digital data transfer format: I<sup>2</sup>C BUS serial data method (Corresponds to Fast mode: 400kHz)
- Output buffer operational amplifier: It operates in the whole voltage range from VCC to ground.
- High output current drive capacity: +/-1.0 mA over
- Very small size SON-8 package

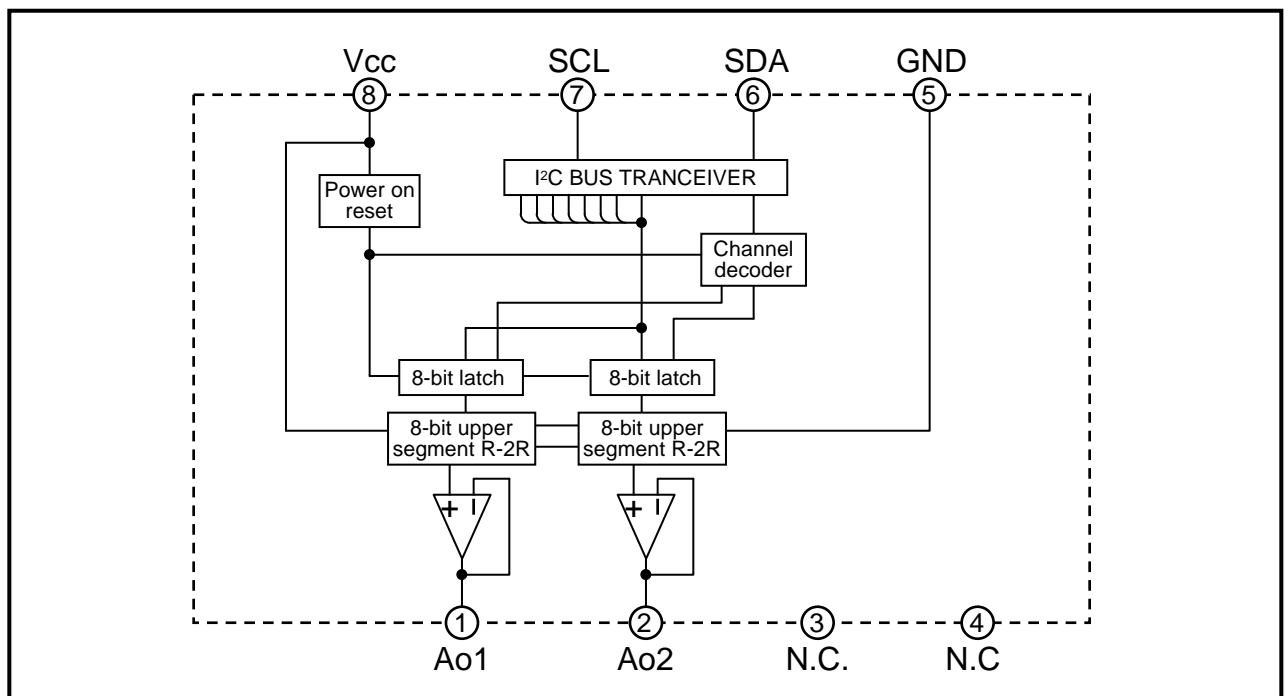
## Application

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

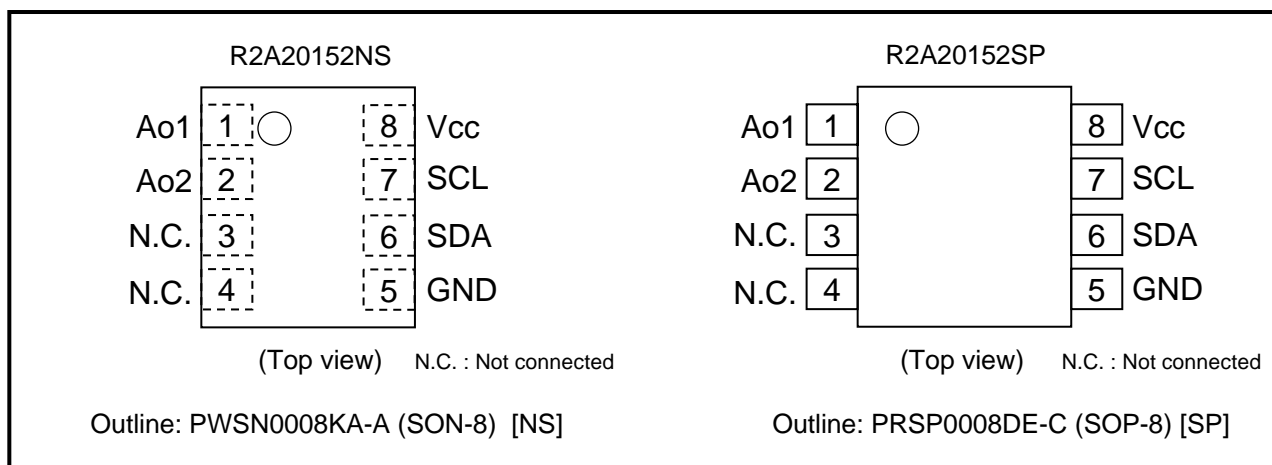
Signal gain control or automatic adjustment of LCD-TV, PDP-TV, LCD-monitor, or etc.

Blurring correction control or various control of the interchangeable lens of digital camera.

## Block Diagram



## Pin Arrangement



## Pin Description

Pin No.	Pin Name	Function
1	Ao1	8-bit resolution D-A converter output terminal (After power on, analog output of every channel is set in DAC data "00h")
2	Ao2	
3	N.C.	Not connected
4	N.C.	
5	GND	GND terminal
6	SDA	Serial data input terminal
7	SCL	Serial clock input terminal
8	Vcc	Power supply terminal

## Absolute Maximum Ratings

Ta= 25deg, unless otherwise noted)

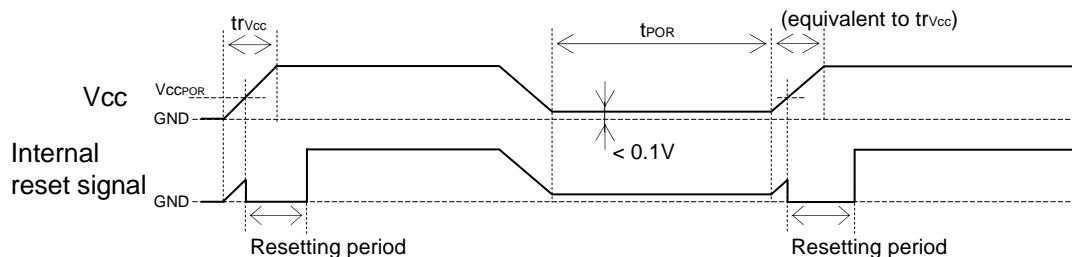
Item	Symbol	Condition	Ratings	Unit
Supply Voltage	V <sub>CC</sub>		-0.3 to +6.5	V
Input Voltage	V <sub>IN</sub>		-0.3 to V <sub>CC</sub> +0.3 < +6.5	V
Output Voltage	V <sub>O</sub>		-0.3 to V <sub>CC</sub> +0.3 < +6.5	V
Buffer amp. Output current	I <sub>AO</sub>	Continuous	-2.0 to +2.0	mA
Power dissipation	P <sub>d</sub>	Ta = +85deg	270(NS) / 272(SP)	mW
Thermal derating factor	K theta	Ta > +25deg	6.75(NS) / 6.8(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

(V<sub>CC</sub>= +5V +/-10%, GND=0V, Ta= -30 to +85deg, unless otherwise noted)

Item	Symbol	Test Condition	Ratings			Unit
			Min.	Typ.	Max.	
Supply voltage	V <sub>CC</sub>		2.7	5.0	5.5	V
Supply current	I <sub>CC</sub>	CLK = 500kHz, I <sub>AO</sub> = 0μA, DATA: 6Ah (at maximum current)	0	0.5	1.5	mA
		SDA = SCL = GND, I <sub>AO</sub> = 0μA	0	0.3	1.0	mA
Rise time of supply voltage *1	tr <sub>VCC</sub>	V <sub>CC</sub> = 0 to 2.7V	100	-	-	μs
Internal reset operating voltage *1	V <sub>CCPOR</sub>	V <sub>CC</sub> = 0 to 2.7V	-	1.5	1.9	V
Power supply restart interval (Power supply OFF → ON) *1	t <sub>POR</sub>	V <sub>CC</sub> < 0.1V	1	-	-	ms
Input leak current	I <sub>ILK</sub>	V <sub>IN</sub> = 0 to V <sub>CC</sub>	-10	-	10	μA
Input low voltage	V <sub>IL</sub>		0	-	0.2V <sub>CC</sub>	V
Input high voltage	V <sub>IH</sub>		0.8V <sub>CC</sub>	-	V <sub>CC</sub>	V
Hysteresis of Schmitt trigger input (SDA, SCL)	V <sub>hys</sub>		0.5	0.8	-	V
Output low voltage (SDA)	V <sub>OL</sub>	I <sub>sink</sub> = 3mA	-	-	0.4	V
Pulse width of spike noise	t <sub>SP</sub>		0	-	50	ns
Buffer amplifier output voltage range	V <sub>AO</sub>	I <sub>AO</sub> = 100μA	0.1	-	V <sub>CC</sub> - 0.1	V
		I <sub>AO</sub> = 500μA	0.2	-	V <sub>CC</sub> - 0.2	
Buffer amplifier output Drive range	I <sub>AO</sub>	Upper side saturation voltage = 0.3V, Lower side saturation voltage = 0.2V	-1.0	-	1.0	mA
Differential nonlinearity	SDL		-0.7	-	0.7	LSB
Nonlinearity	SL	V <sub>CC</sub> = 5.12V (20mV/LSB), without load ( I <sub>AO</sub> = 0μA )	-1.0	-	1.0	LSB
Zero code error	S <sub>ZERO</sub>		-2.0	-	2.0	LSB
Full scale error	S <sub>FULL</sub>		-2.0	-	2.0	LSB
Output capacitate load	C <sub>O</sub>		-	-	0.1	μF
Buffer amplifier output impedance	R <sub>O</sub>		-	5.0	-	ohm

\*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>).

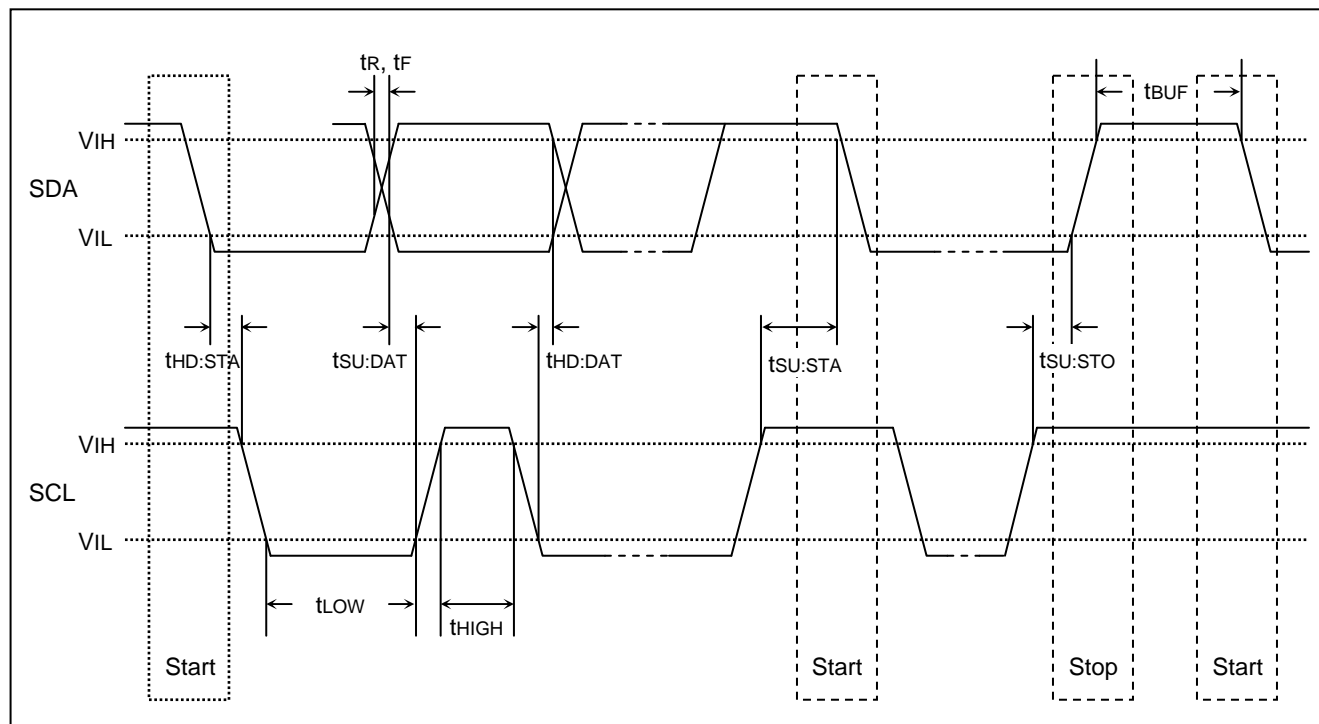


I<sup>2</sup>C BUS Line Characteristics

Item	Symbol	STANDARD MODE		FAST MODE		Unit
		Min.	Max.	Min.	Max.	
SCL clock frequency	f <sub>SCL</sub>	0	100	0	400	kHz
Time the bus must be free before a new transmission can start	t <sub>BUF</sub>	4.7	-	1.3	-	μs
Hold time (repeated) START condition After this period, the first clock pulse is generated.	t <sub>HD:STA</sub>	4.0	-	0.6	-	μs
LOW period of the SCL clock	t <sub>LOW</sub>	4.7	-	1.3	-	μs
HIGH period of the SCL clock	t <sub>HIGH</sub>	4.0	-	0.6	-	μs
Set-up time for a repeated START condition	t <sub>SU:STA</sub>	4.7	-	0.6	-	μs
Data hold time	t <sub>HD:DAT</sub>	0	3.45	0	0.9	μs
Data set-up time	t <sub>SU:DAT</sub>	250	-	100	-	ns
Rise time of both SDA and SCL signals	t <sub>R</sub>	-	1000	-	300	ns
Fall time of both SDA and SCL signals	t <sub>F</sub>	-	300	-	300	ns
Set-up time for STOP condition	t <sub>SU:STO</sub>	4.0	-	0.6	-	μs
Capacitive load of bus line	C <sub>b</sub>	-	400	-	400	pF

Above values correspond with input level (V<sub>IHmin</sub> / V<sub>ILmax</sub>).

## Timing Chart

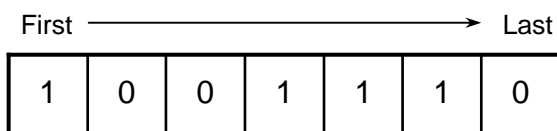


## I<sup>2</sup>C BUS Format

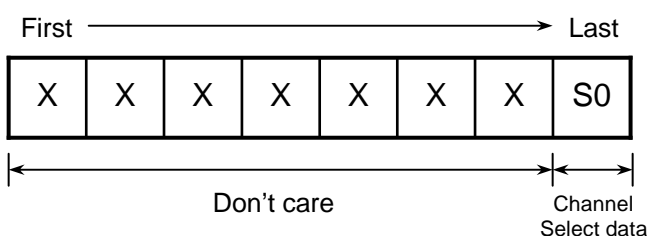
STA	Slave address	W	A	Sub address	A	DAC data	A	STP
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Note: STA: START condition, W: write (SDA = Low), A: acknowledge bit, STP: STOP condition

- Slave address



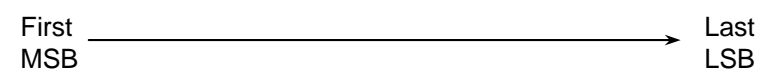
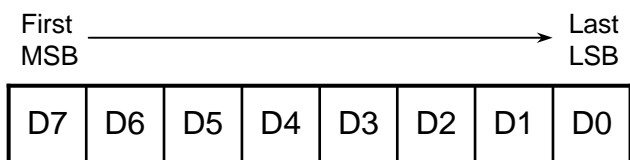
- Sub address



Channel select data

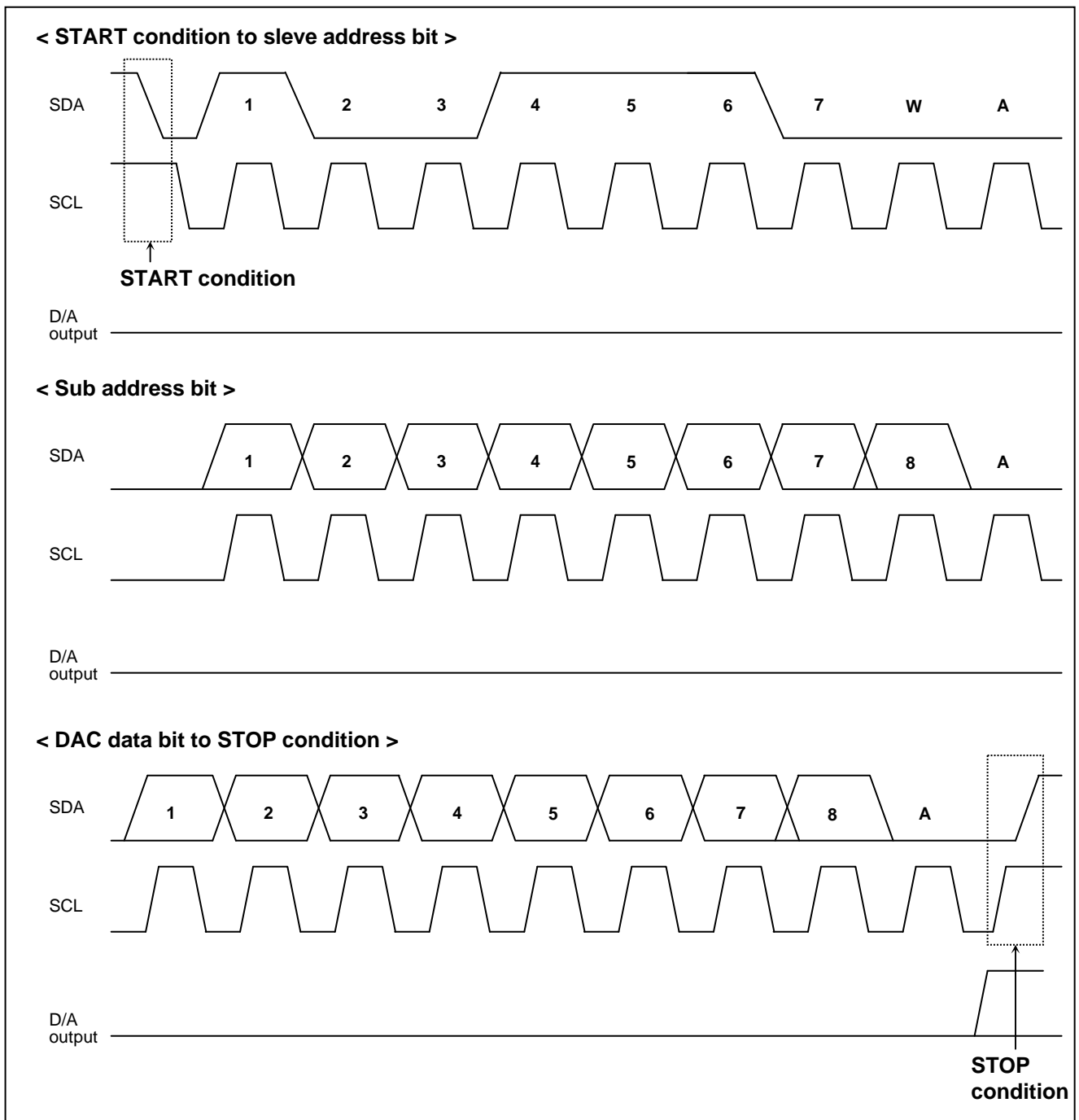
S0	Channel Selection
0	ch1 selection
1	ch2 selection

- DAC data



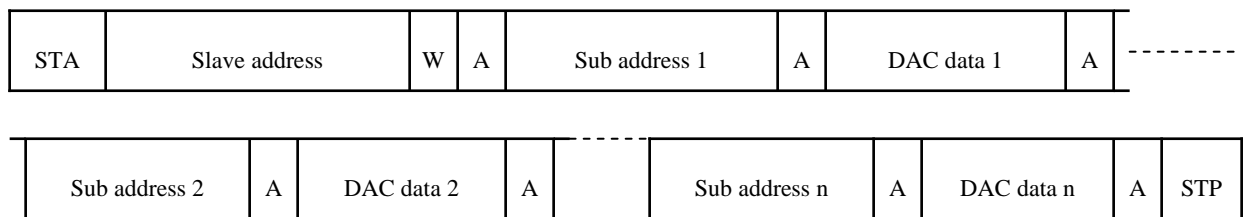
D7	D6	D5	D4	D3	D2	D1	D0	DAC output
0	0	0	0	0	0	0	0	$V_{cc} / 256 \times 1$
0	0	0	0	0	0	0	1	$V_{cc} / 256 \times 2$
0	0	0	0	0	0	1	0	$V_{cc} / 256 \times 3$
0	0	0	0	0	0	1	1	$V_{cc} / 256 \times 4$
:	:	:	:	:	:	:	:	:
1	1	1	1	1	1	1	0	$V_{cc} / 256 \times 255$
1	1	1	1	1	1	1	1	$V_{cc}$

## Data Timing Chart SCL and SDA (Model)



- **START condition** With SCL at High, SDA goes from High to Low.
- **STOP condition** With SCL at High, SDA goes from Low to High.  
( Under normal condition, SDA must be changed, when SCL is Low. )
- **Acknowledge bit** The receiving IC has to pull down SDA line whenever receive slave data  
(Transmitting IC releases the SDA line just then transmit 8-bit data.)

## Digital Data Formats

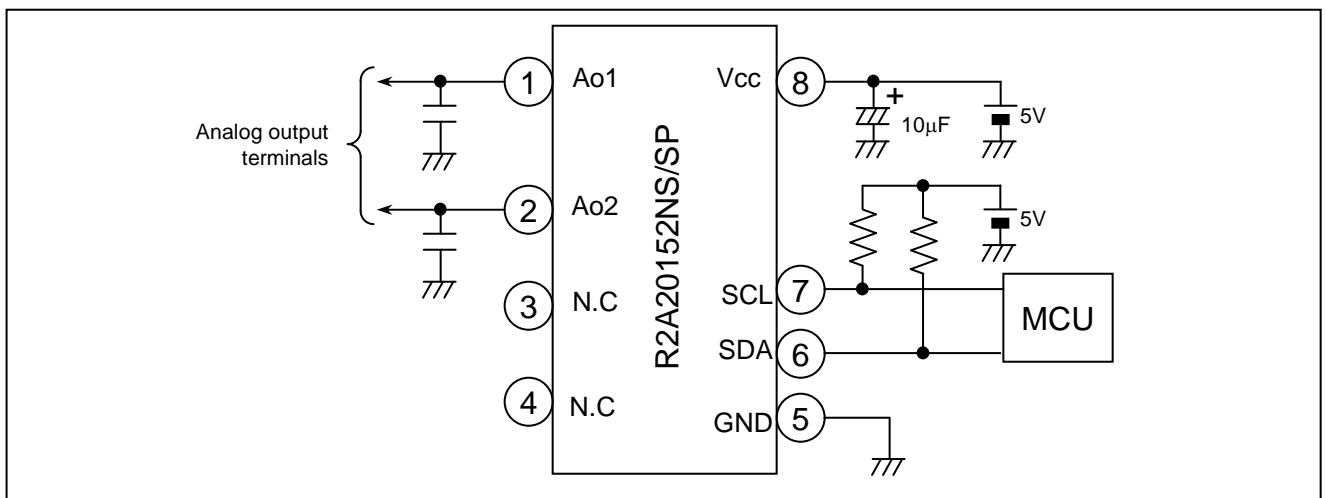


Note: After START condition, the master IC (MCU etc.) accesses the slave IC by slave address, and transmits the data to each channel by two bytes (sub address and DAC data).

## Precaution for Use

1. Supply voltage terminal (VCC) is also used for D/A converter upper reference voltage setting. If ripple or spike is input this terminal, accuracy of D/A conversion is down. So, when use this device, please connect capacitor among VCC to GND for stable D/A conversion.
2. This IC's output amplifier has an advantage to capacitive load. So it's no problem at device action when the capacitor (0.1 $\mu$ F Max) is connected 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
R2A20152SP	SOP-8	PRSP0008DE-C	SP	Embossed Taping/2,500 pcs.
R2A20152NS	SON-8	PWSN0008KA-A	NS	Embossed Taping/5,000 pcs.

# Package Dimensions

## PRSP0008DE-C [SP]

JEITA Package Code	RENEAS Code	Previous Code	MASS[Typ.]
P-SOP8-4.4x4.85-1.27	PRSP0008DE-C	—	0.1g

NOTE

- DIMENSIONS "1" (Nom) "AND" "2" DO NOT INCLUDE MOLD FLASH.
- DIMENSION "3" DOES NOT INCLUDE TRIM OFFSET.

Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
D	4.65	4.85	5.05
E	4.2	4.4	4.6
A <sub>2</sub>	—	1.85	—
A <sub>1</sub>	0.00	0.1	0.20
A	—	—	2.03
b <sub>p</sub>	0.34	0.4	0.46
b <sub>1</sub>	—	—	—
c	0.15	0.20	0.25
C <sub>1</sub>	—	—	—
θ	0°	—	8°
H <sub>E</sub>	5.7	6.2	6.5
Ⓢ	1.12	1.27	1.42
x	—	—	0.12
y	—	—	0.10
z	—	—	0.75
L	0.25	0.45	0.65
L <sub>1</sub>	—	0.90	—

## PWSN0008KA-A [NS]

JEITA Package Code	RENEAS Code	Previous Code	MASS[Typ.]
P-HWSON8-2.2x2.2-0.50	PWSN0008KA-A	—	0.011g

Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
D	2.10	2.20	2.30
E	2.10	2.20	2.30
A <sub>2</sub>	—	—	—
A	—	—	0.80
A <sub>1</sub>	0	—	0.05
b	0.18	0.23	0.28
b <sub>1</sub>	—	—	—
Ⓢ	—	0.5	—
L <sub>p</sub>	0.20	0.30	0.40
x	—	—	0.1
y	—	—	0.08
y <sub>1</sub>	—	—	0.1
t	—	—	—
H <sub>D</sub>	—	—	—
H <sub>E</sub>	—	—	—
Z <sub>D</sub>	—	—	—
Z <sub>E</sub>	—	—	—
c	—	0.20	—
C <sub>1</sub>	—	—	—



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