R2A20154NS/SP

8-bit 4ch D/A Converter with Buffer Amplifiers for I²C BUS (Corresponds to Fast mode)

R03DS0014EJ0100
Rev.1.00
2011.09.05

Description

The R2A20154 is an integrated circuit semiconductor of CMOS structure with 4 channels of built in D/A converters with output buffer operational amplifiers. It is the electrical characteristic improvement version of the M62334.

The input is 2-wires serial method is used for the transfer format of digital data to allow connection with a microcomputer with minimum wiring. This IC corresponds to Fast mode of I²C BUS standard.

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

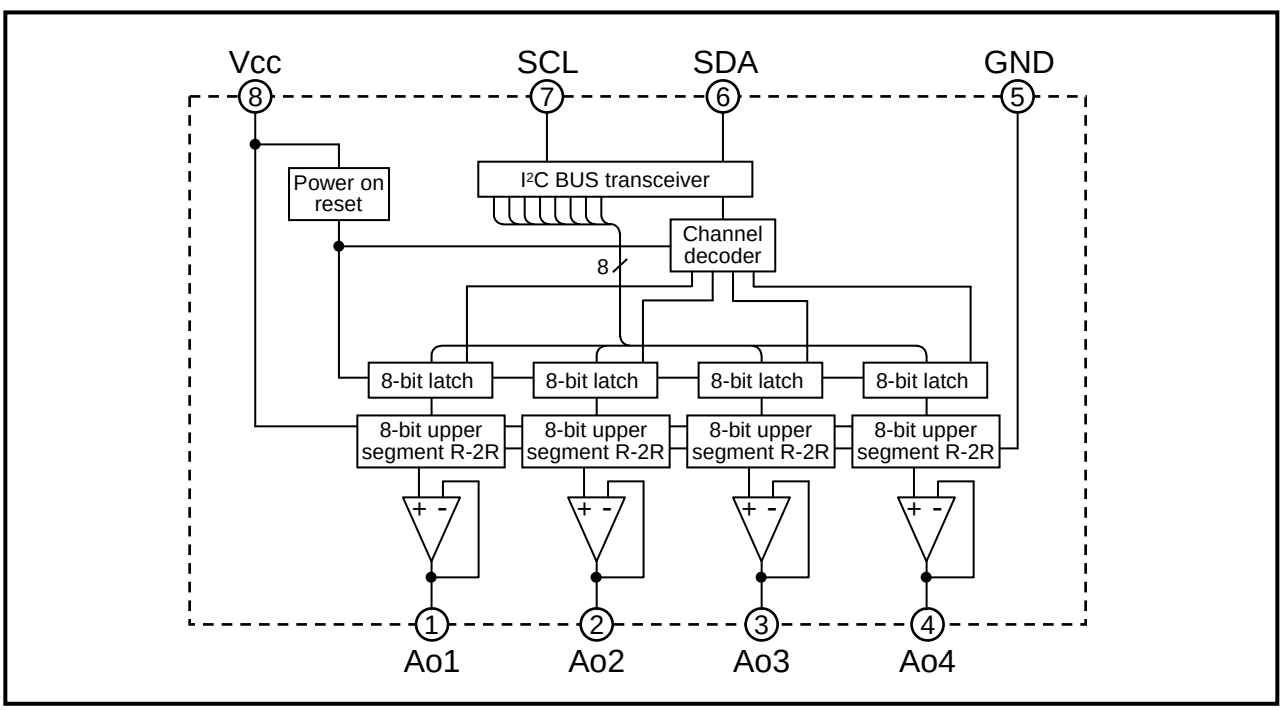
Features

- Guarantee Differential nonlinearity error : +/-0.7LSB, Nonlinearity error : +/-1.0LSB
- Digital data transfer format: I²C BUS serial data method (Corresponds to Fast mode: 400kHz)
- Output buffer operational amplifier
  It operates in the whole range from Vcc to ground.
- High output current drive capacity: 1mA over
- The very small size SON-8 package is added to the lineup.

Application

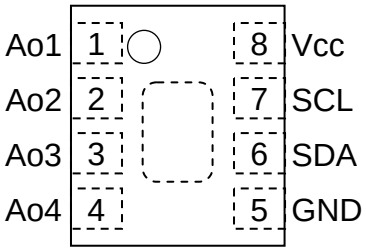
Conversion from digital data to analog control data for home-use and industrial equipment.
Signal gain control or automatic adjustment of LCD-TV, PDP-TV or LCD display-monitor.
Blurring correction control or various control of the interchangeable lens of digital camera

Block Diagram



Pin Arrangement

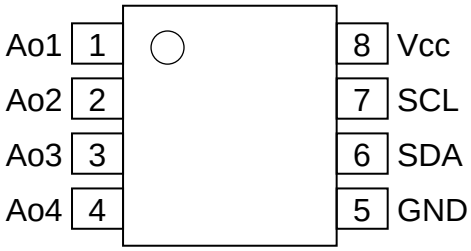
R2A20154NS



(Top view)

Outline: PWSN0008KA-A [NS]

R2A20154SP



(Top view)

Outline: PRSP0008DE-C [SP]

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	Ao3	
4	Ao4	
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= 25 deg unless otherwise noted)

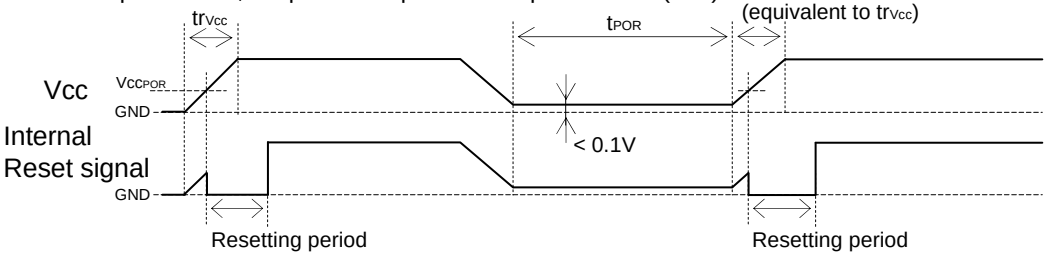
Item	Symbol	Condition	Ratings	Unit
Supply voltage	Vcc		-0.3 to +6.5	V
Input voltage	Vin		-0.3 to Vcc+0.3 < 6.5	V
Output voltage	Vo		-0.3 to Vcc+0.3 < 6.5	V
Buffer amplifier output current	I_{AO}	Continuous	-2.0 to +2.0	mA
Power dissipation	Pd	Ta = +85deg	270(NS) / 272(SP)	mW
Thermal derating factor	K theta	Ta > +25deg	6.75(NS) / 6.8(SP)	mW/deg
Operating temperature	Topr		-30 to +85	deg
Storage temperature	Tstg		-40 to +125	deg

Electrical Characteristics

(Vcc= +5V +/-10%, GND=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 = 500 kHz operation, I_{AO}=0µA, DATA: 6Ah (at maximum current)	-	0.8	2.0	mA
		SDA = SCL = GND, I_{AO}=0µA	-	0.5	1.5	mA
Supply voltage rise-up time *1	tr_{Vcc}	Vcc=0 to 2.7V	100	-	-	µs
Operating voltage of Internal resetting *1	Vcc_{POR}	Vcc=0 to 2.7V	-	1.5	1.9	V
Time period of re-power on (Power supply OFF → ON) *1	t_{POR}	Vcc < 0.1V	1	-	-	ms
Input leak current	I_{ILK}	V_{IN} = 0 to Vcc	-10	-	10	µA
Input low voltage	V_{IL}		0	-	0.2Vcc	V
Input high voltage	V_{IH}		0.8Vcc	-	Vcc	V
Hysteresis (SDA, SCL)	Vhys		0.5	0.8	-	V
Output low voltage (SDA)	V_{OL}	Isink = 3mA	-	-	0.4	V
Pulse width of spics	t_{SP}		0	-	50	ns
Buffer amplifier output voltage range	V_{AO}	I_{AO} =100µA	0.1	-	Vcc – 0.1	V
		I_{AO} =500µA	0.2	-	Vcc – 0.2	
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}	Vcc=5.12V (20mV/ LSB), without load (I_{AO} = 0µA)	-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 capacitate load	Co		-	-	0.1	µF
Buffer amplifier output impedance	Ro		-	5.0	-	Ω

*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}).

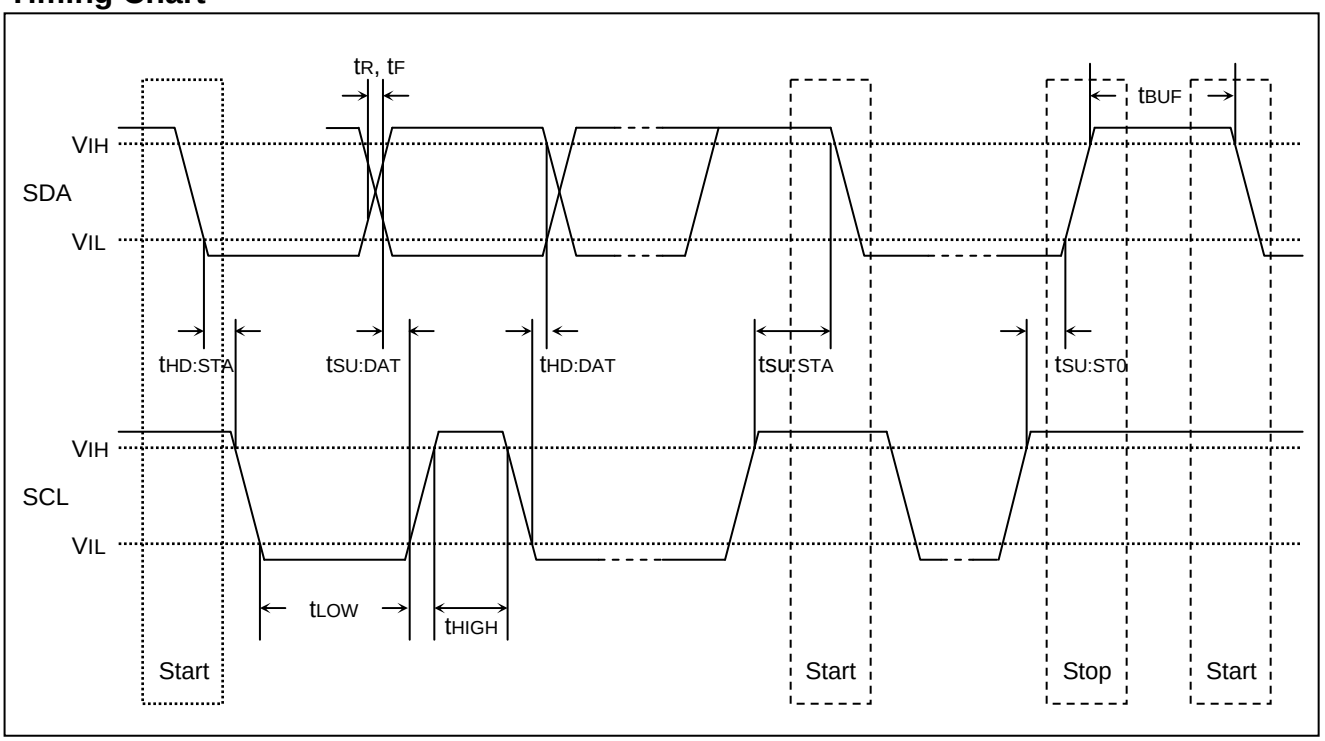


I²C BUS Line Characteristics

Item	Symbol	STANDARD MODE		FAST MODE		Unit
		Min.	Max.	Min.	Max.	
SCL clock frequency	f_{SCL}	0	100	0	400	kHz
Free time: the bus must be free before a new transmission can start	t_{BUF}	4.7	-	1.3	-	µs
Hold time START condition after this period, the first Clock pulse is generated	$t_{HD:STA}$	4.0	-	0.6	-	µs
Low period of the clock	t_{LOW}	4.7	-	1.3	-	µs
High period of the clock	t_{HIGH}	4.0	-	0.6	-	µs
Set-up time for START condition. Only relevant for a repeated START condition.	$t_{SU:STA}$	4.7	-	0.6	-	µs
Data Hold time	$t_{HD:DAT}$	0	3.45	0	0.9	µs
Data Set-up time	$t_{SU:DAT}$	250	-	100	-	ns
Rise time of SDA and SCL signals	t_R	-	1000	-	300	ns
Fall time of SDA and SCL signals	t_F	-	300	-	300	ns
Set-up time for STOP condition	$t_{SU:STO}$	4.0	-	0.6	-	µs
Capacitive load of bus line	Cb	-	400	-	400	pF

All of above value are corresponds to V_{IH}min and V_{IL}max.

Timing Chart



I²C BUS Format

STA	Slave address	W	A	Sub address	A	DAC data	A	STP

Note: STA: start condition, A: acknowledge bit, W: write (SDA=Low), STP: stop condition

- Slave address

First → Last

1	0	0	1	1	0	0

- Sub address

First → Last

X	X	X	X	X	X	S1	S0

Don't care — Channel Select data

Channel select data

S1	S0	Channel selection
0	0	ch1 selection
0	1	ch2 selection
1	0	ch3 selection
1	1	ch4 selection

- DAC data

First MSB → Last LSB

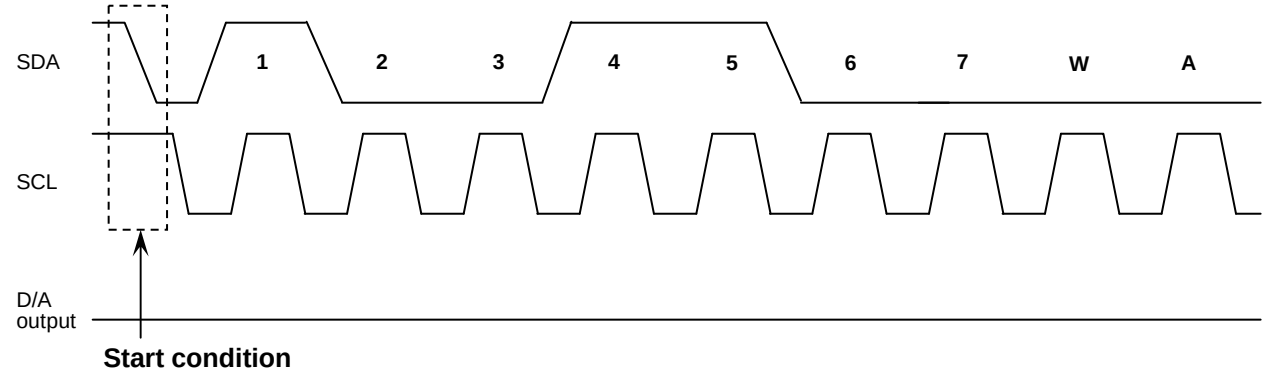
D7	D6	D5	D4	D3	D2	D1	D0

First MSB → Last LSB

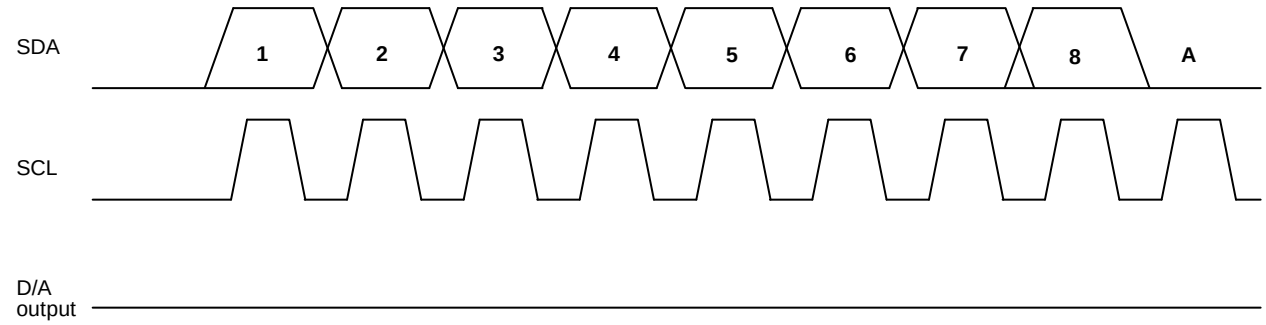
D7	D6	D5	D4	D3	D2	D1	D0	DAC output
0	0	0	0	0	0	0	0	Vcc/256 x 1
0	0	0	0	0	0	0	1	Vcc/256 x 2
0	0	0	0	0	0	1	0	Vcc/256 x 3
0	0	0	0	0	0	1	1	Vcc/256 x 4
:	:	:	:	:	:	:	:	:
1	1	1	1	1	1	1	0	Vcc/256 x 255
1	1	1	1	1	1	1	1	Vcc

Data Timing Chart SCL and SDA (Model)

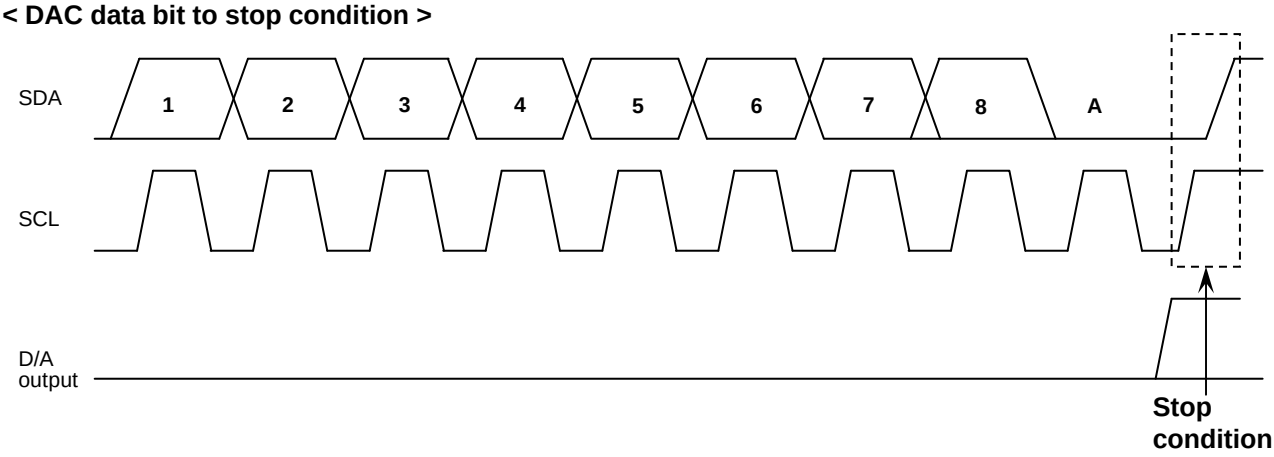
< Start condition to slave address bit >



< Sun address bit >

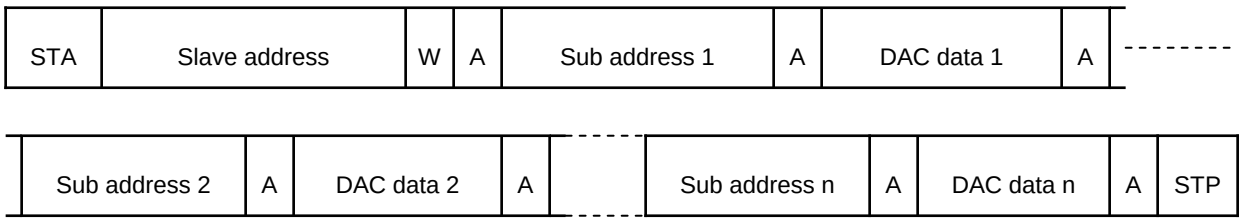


< DAC data bit to stop condition >



- Start condition With SCL at High, SDA line goes from High to Low
- Stop condition With SCL at High, SDA line goes from Low to High
  (Under normal circumstance, SDA is changed when SCL is Low)
- Acknowledge bit The receiving IC has to pull down SDA line whenever receive slave data.
  (The transmitting IC releases the SDA line just then transmit 8-bit data.)

Digital Data Format

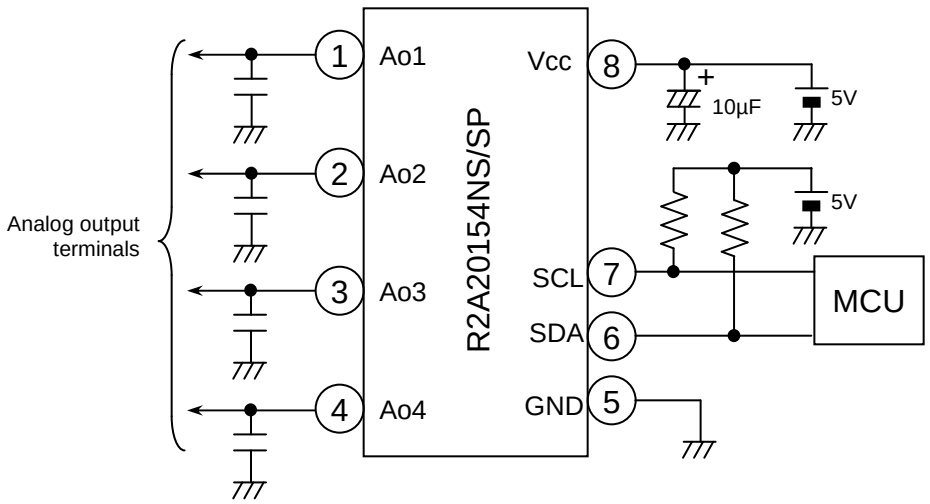


After the Start condition, the transmitting IC accesses the slave IC by Slave address, and transmits the data to each channel by two bites (Sub address and DAC data).

Precaution For use

- 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 converter is down, So, when use this device, please connect capacitor among Vcc to 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 µF Max) among output to GND for every noise elimination.

Application Example



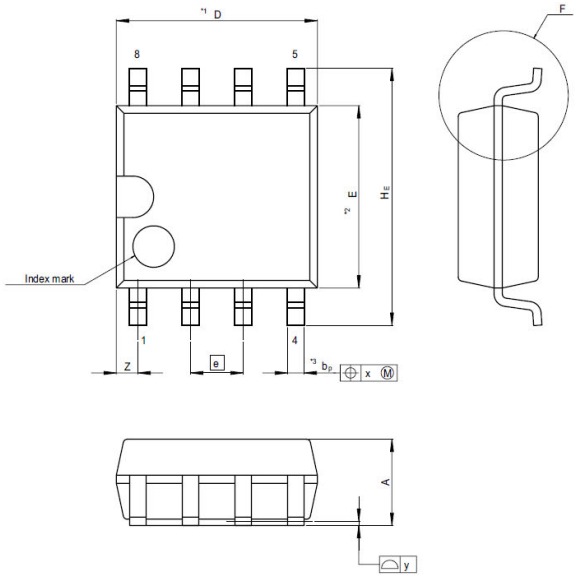
Ordering Information

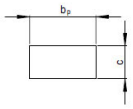
Order part No.	Package Name	Package Code	Package type No.	Packing/Quantity
R2A20154SP	SOP-8	PRSP0008DE-C	SP	Embossed Taping/2,500 pcs.
R2A20154NS	SON-8	PWSN0008KA-A	NS	Embossed Taping/5,000 pcs.

Package Dimensions

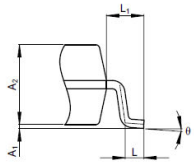
PRSP0008DE-C [SP]

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





Terminal cross section
(Ni/Pd/Au plating)



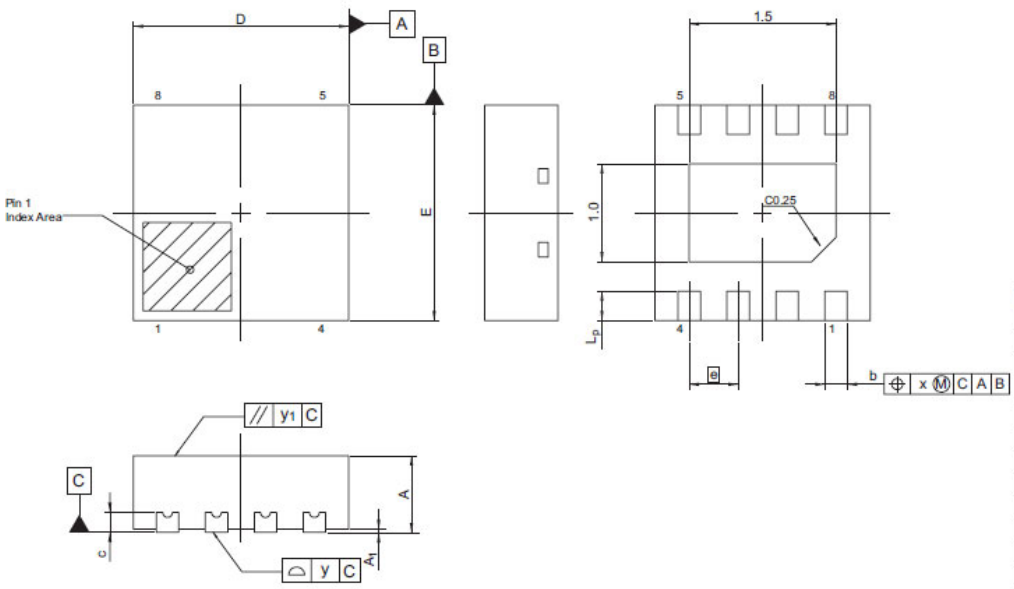
Detail F

NOTE)
1. DIMENSIONS"*1 (Nom)"AND"*2" DO NOT INCLUDE MOLD FLASH.
2. 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_2	—	1.85	—
A_1	0.00	0.1	0.20
A	—	—	2.03
b_p	0.34	0.4	0.46
b_1	—	—	—
c	0.15	0.20	0.25
c_1	—	—	—
θ	0°	—	8°
H_E	5.7	6.2	6.5
e	1.12	1.27	1.42
x	—	—	0.12
y	—	—	0.10
Z	—	—	0.75
L	0.25	0.45	0.65
L_1	—	0.90	—

PWSN0008KA-A[NS]

JEITA Package Code	RENESAS 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_2	—	—	—
A	—	—	0.80
A_1	0	—	0.05
b	0.18	0.23	0.28
b_1	—	—	—
e	—	0.5	—
L_p	0.20	0.30	0.40
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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