

R2A20169NP/SA/SP

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

R03DS0020EJ0100

Rev.1.00

2011.09.05

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.

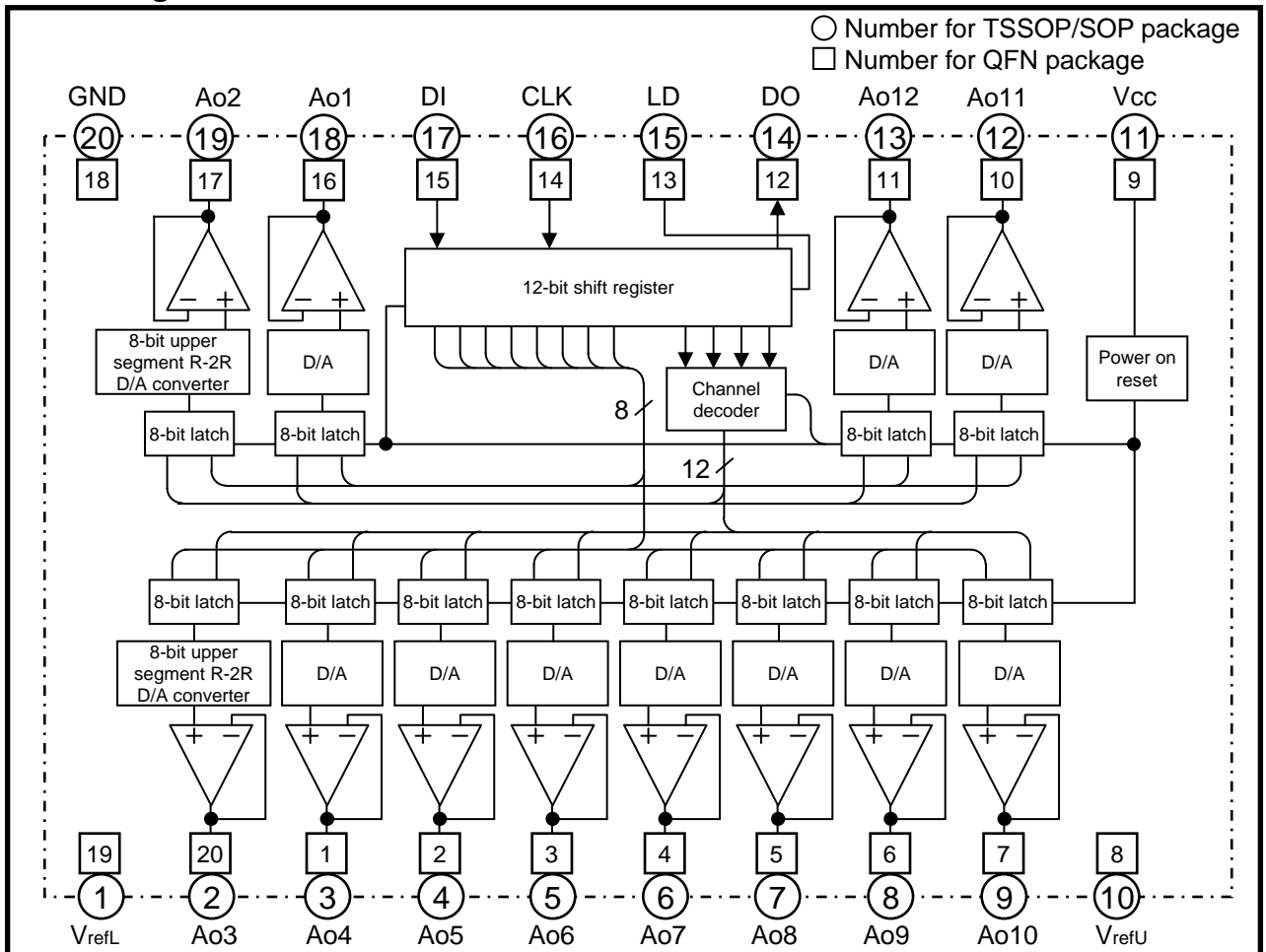
Features

- 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)

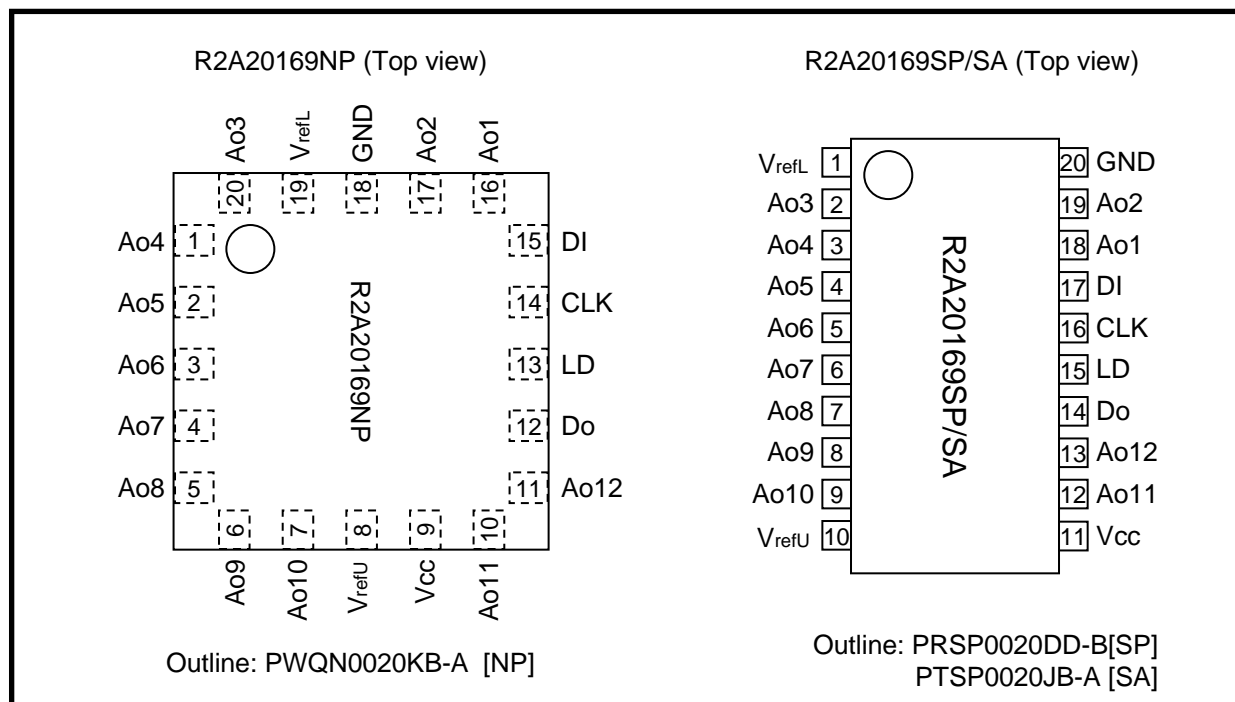
Application

- 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 | V _{cc} | Power supply terminal |
| 18 | 20 | GND | GND terminal |
| 8 | 10 | V _{refU} | D/A converter upper reference voltage input terminal |
| 19 | 1 | V _{refL} | D/A converter lower reference voltage input terminal |

Absolute Maximum Ratings

(Ta= +25deg unless otherwise noted)

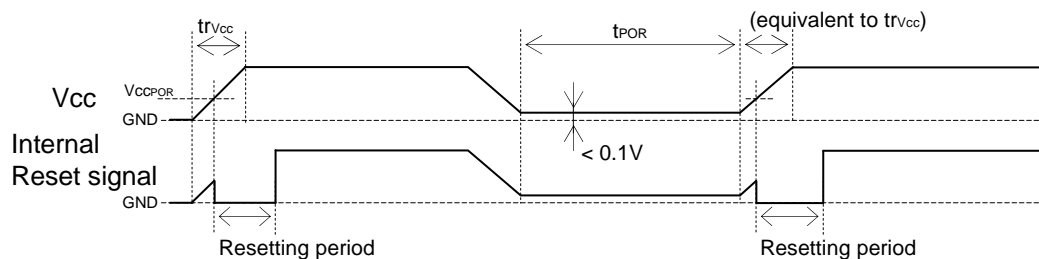
| Item | Symbol | Conditions | Ratings | Unit |
|---------------------------------------|-------------------|------------|------------------------------------|--------|
| Supply voltage | V _{CC} | | -0.3 to +6.5 | V |
| D/A converter upper reference voltage | V _{refU} | | -0.3 to +6.5 | V |
| D/A converter 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) / 300(SP) | mW |
| Thermal derating factor | K theta | Ta> +25deg | 7.25(NP) / 3.75(SA) / 7.5(SP) | 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 | - | 0.6 | 1.8 | 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 → 2.7V | 100 | - | - | μs |
| Internal reset operating voltage *1 | V _{CCPOR} | V _{CC} = 0 → 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 $+85deg$, 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} | | $0.7V_{CC}$ | - | 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 | μF |
| Buffer amplifier output impedance | R_o | | - | 5.0 | - | ohm |

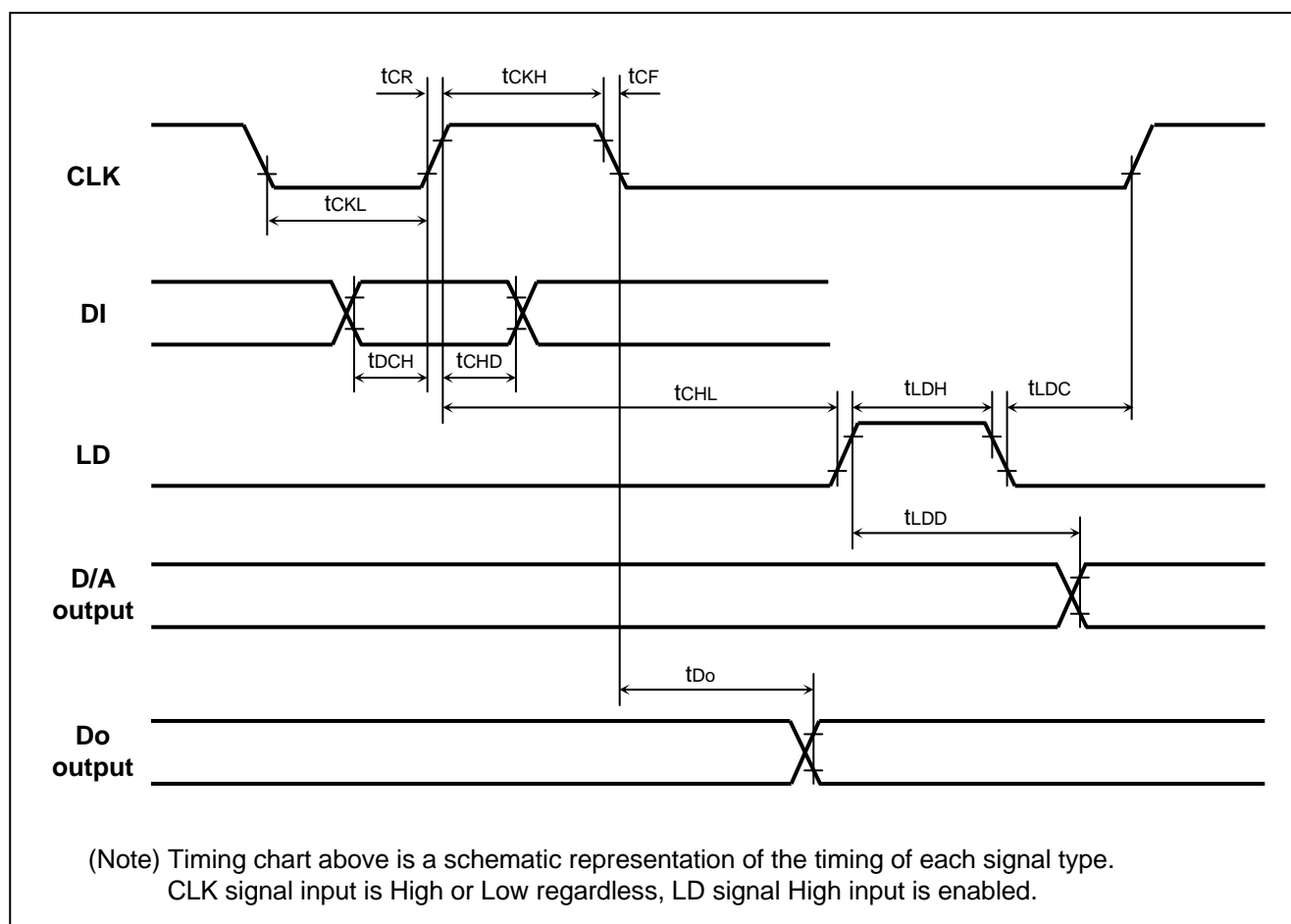
*2 : The output does not necessary be the value with the reference voltage setting range.
The output value is determined by the buffer amplifier output voltage range (V_{AO}).

AC Characteristics

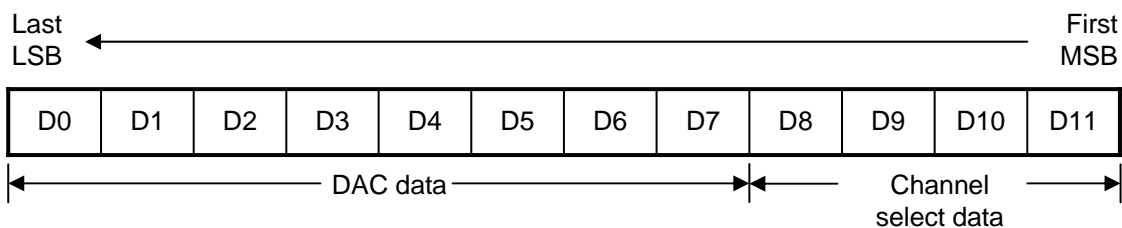
(V_{CC} , $V_{refU} = +5V \pm 10\%$, $V_{CC} > V_{refU}$, $GND = V_{refL} = 0V$, $T_a = -30$ to $+85$ deg, unless otherwise noted)

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

Timing Chart



Digital Data Format



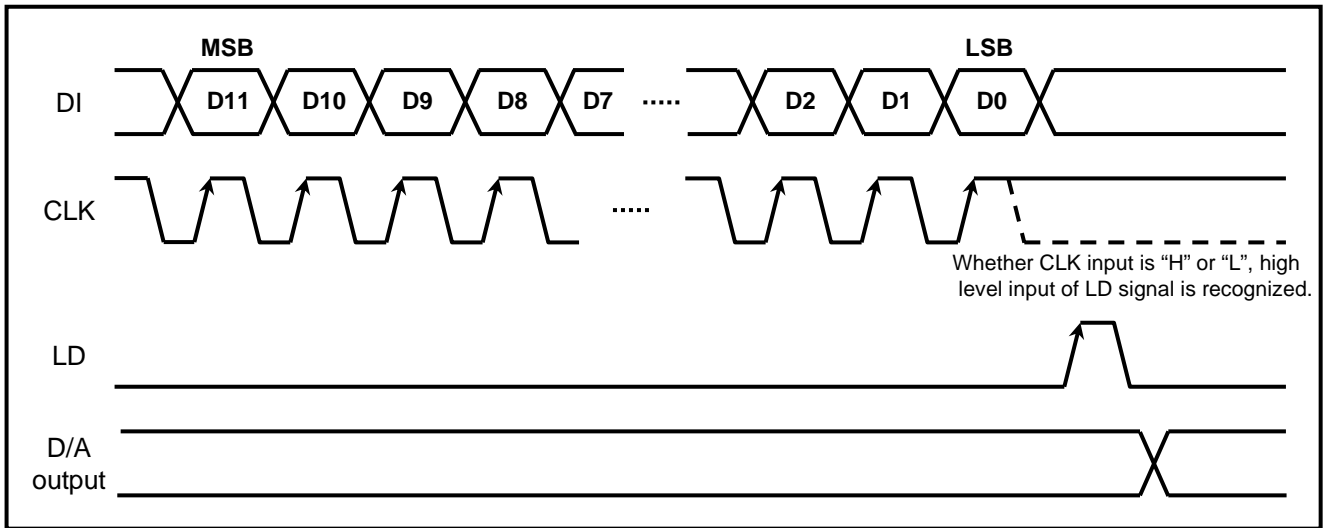
Channel select data

| 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 | 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_{refU} |

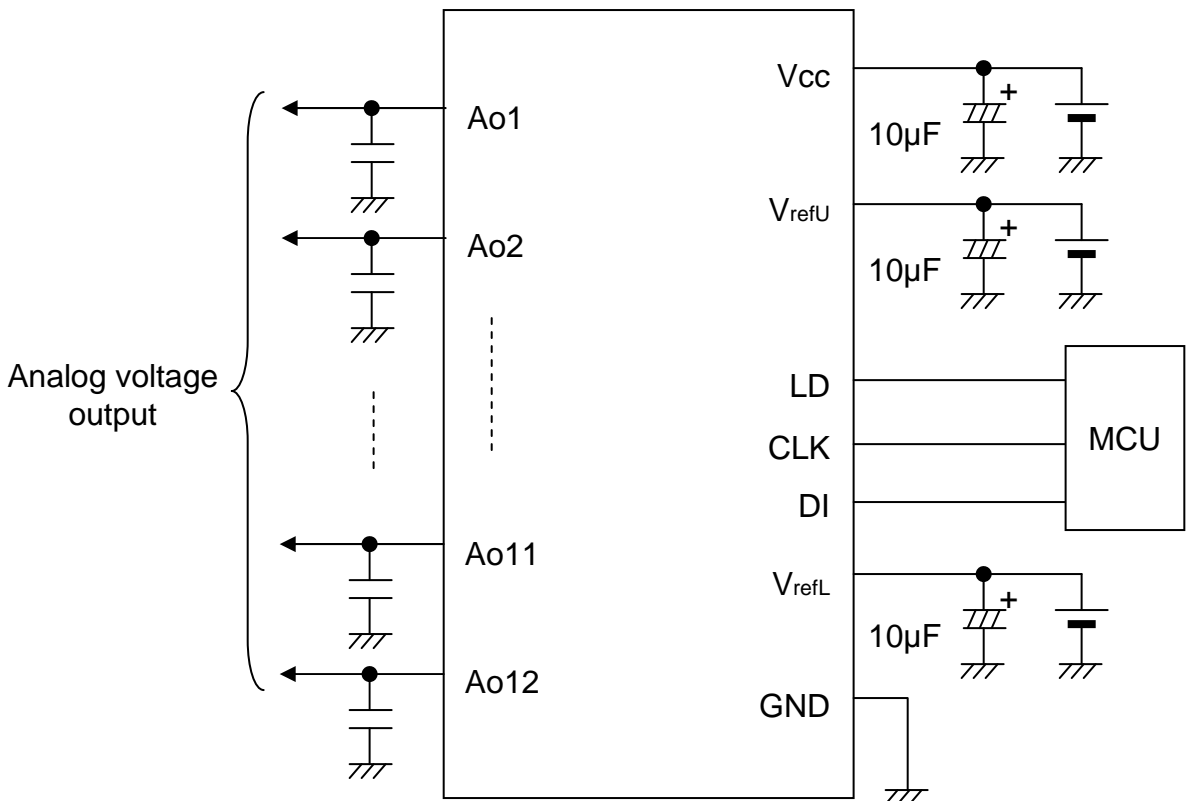
Data Timing Chart (Model)



Precaution For use

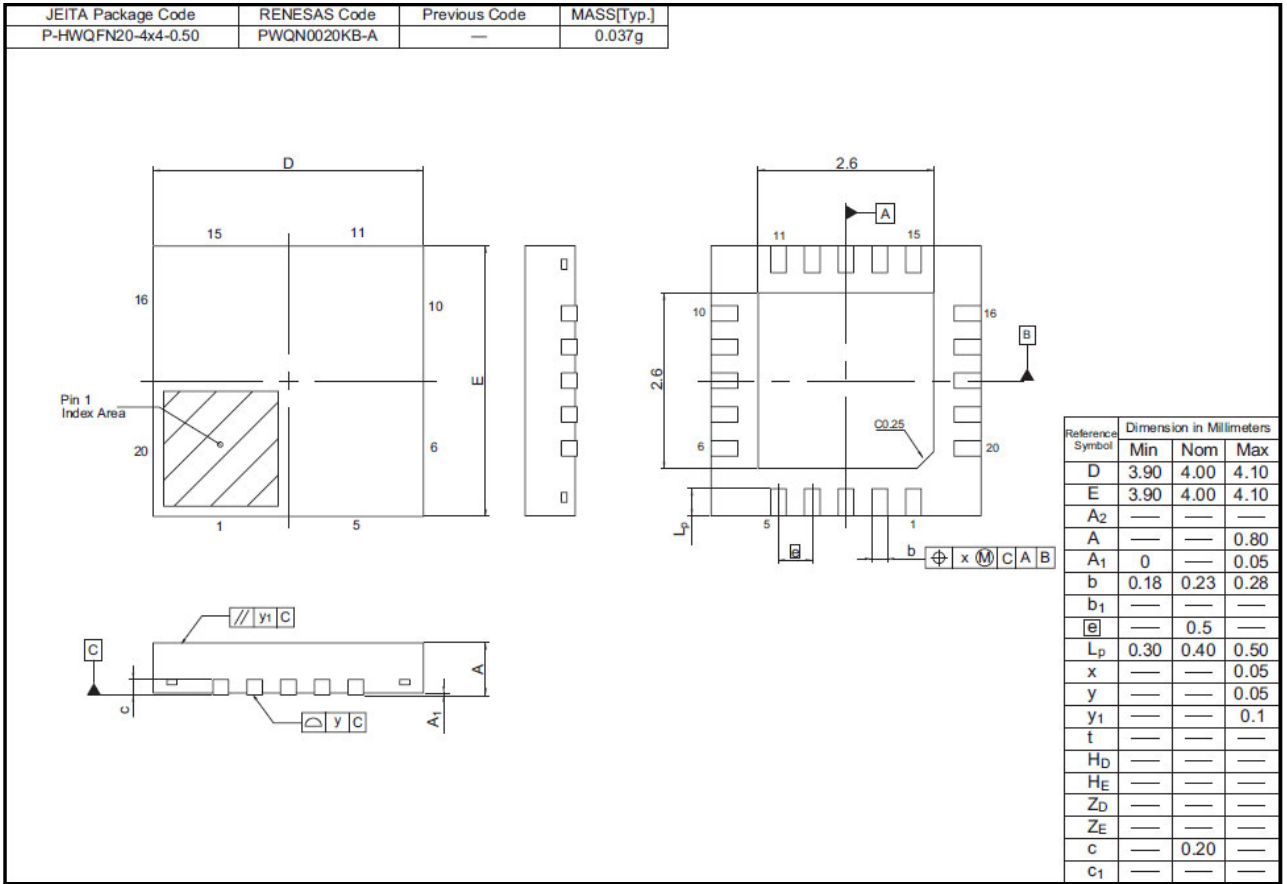
- There are three terminals (V_{CC} , V_{refU} , V_{refL}) that should be impressed a constant voltage. When ripple or spike noise is input to this terminal, there is fear that the accuracy of D/A conversion becomes lower and this IC malfunction. So, when use this IC, please connect capacitor between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

Standard Application Circuit

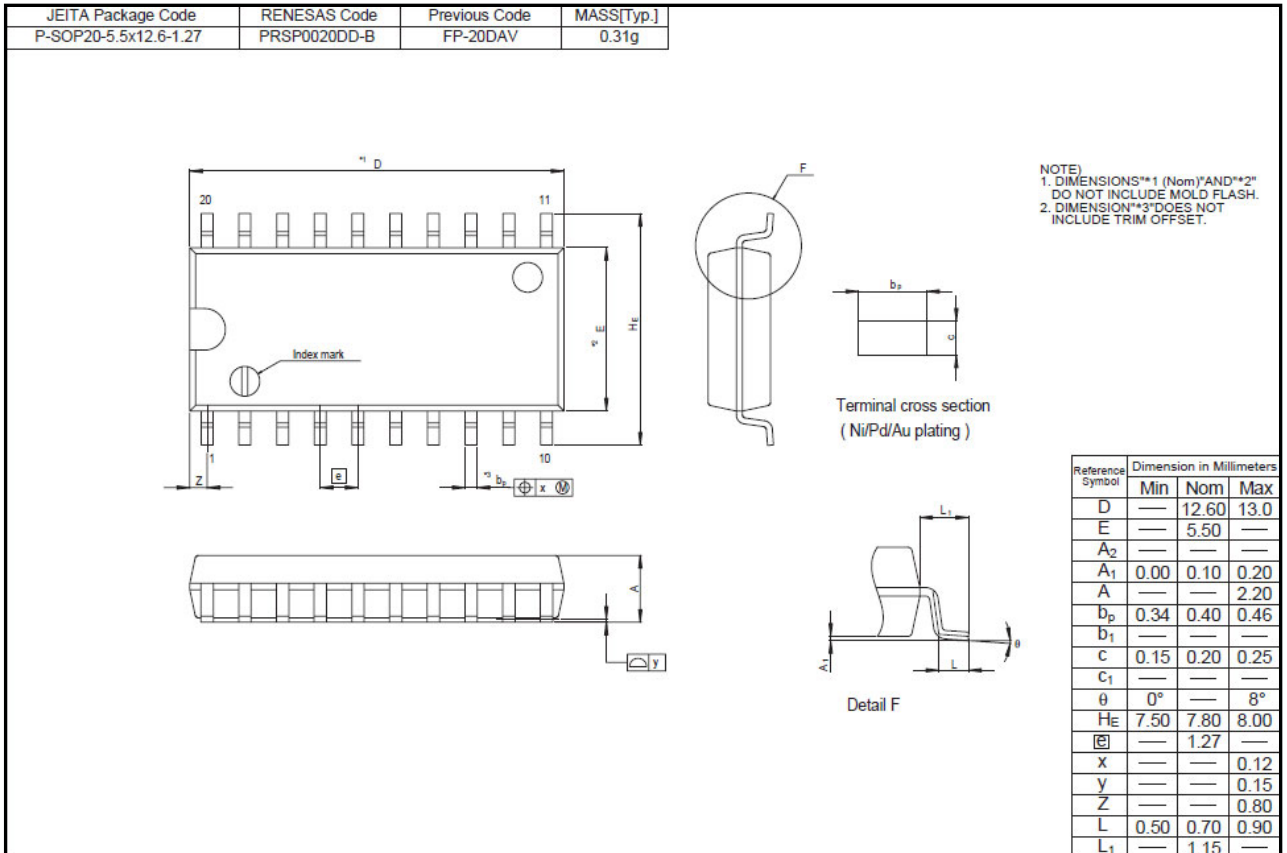


Package Dimensions

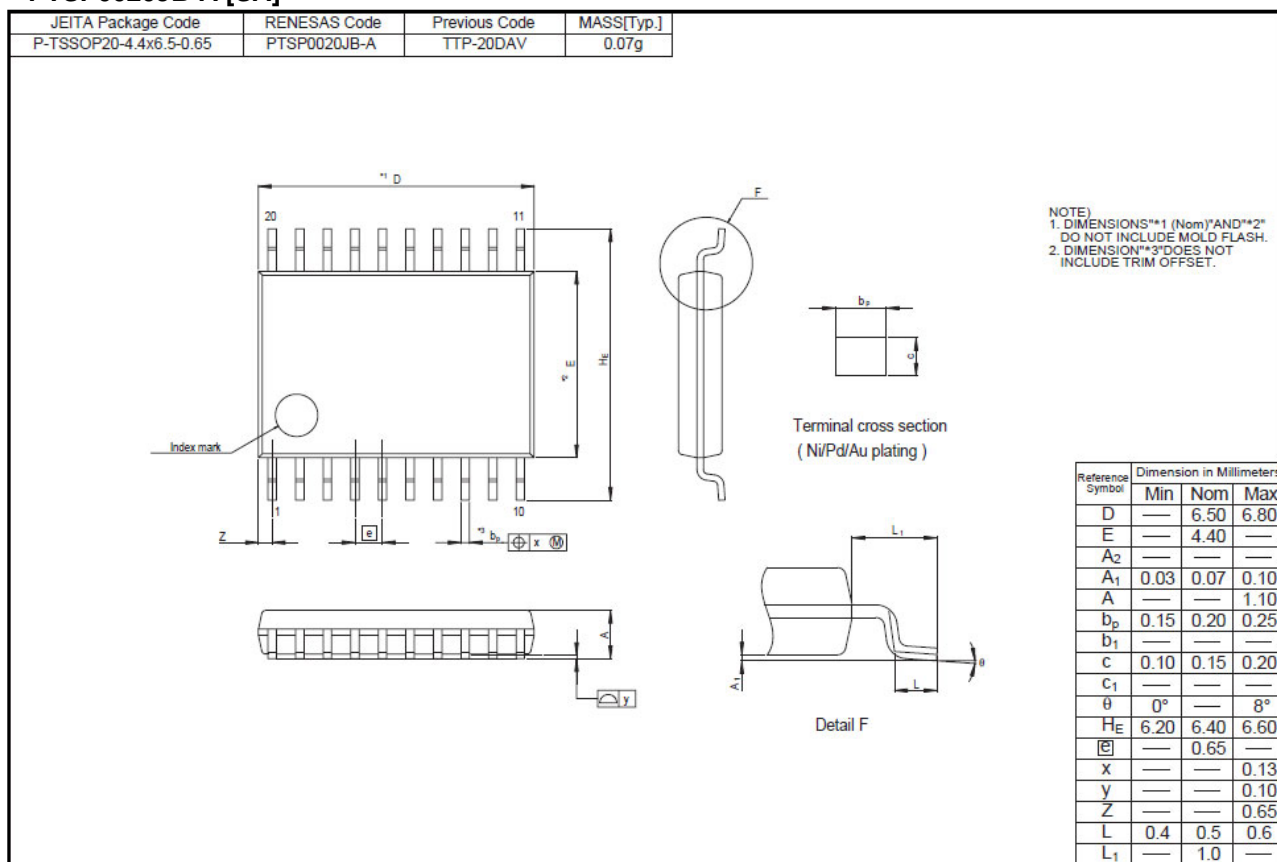
PWQN0020KB-A [NP]



PRSP0020DD-B [SP]



PTSP0020JB-A [SA]



Ordering Information

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

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