

# M62333P/FP, M62338P/FP

R03DS0038EJ0500

Rev.5.00

Jun 03, 2011

## 8-bit 3ch I<sup>2</sup>C BUS D/A Converter with Buffer Amplifiers

### Description

The M62333/M62338 is an integrated circuit semiconductor of CMOS structure with 3 channels of built in D/A converters with output buffer operational amplifiers.

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.

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

The M62333 and the M62338 differ only in their slave address.

### Features

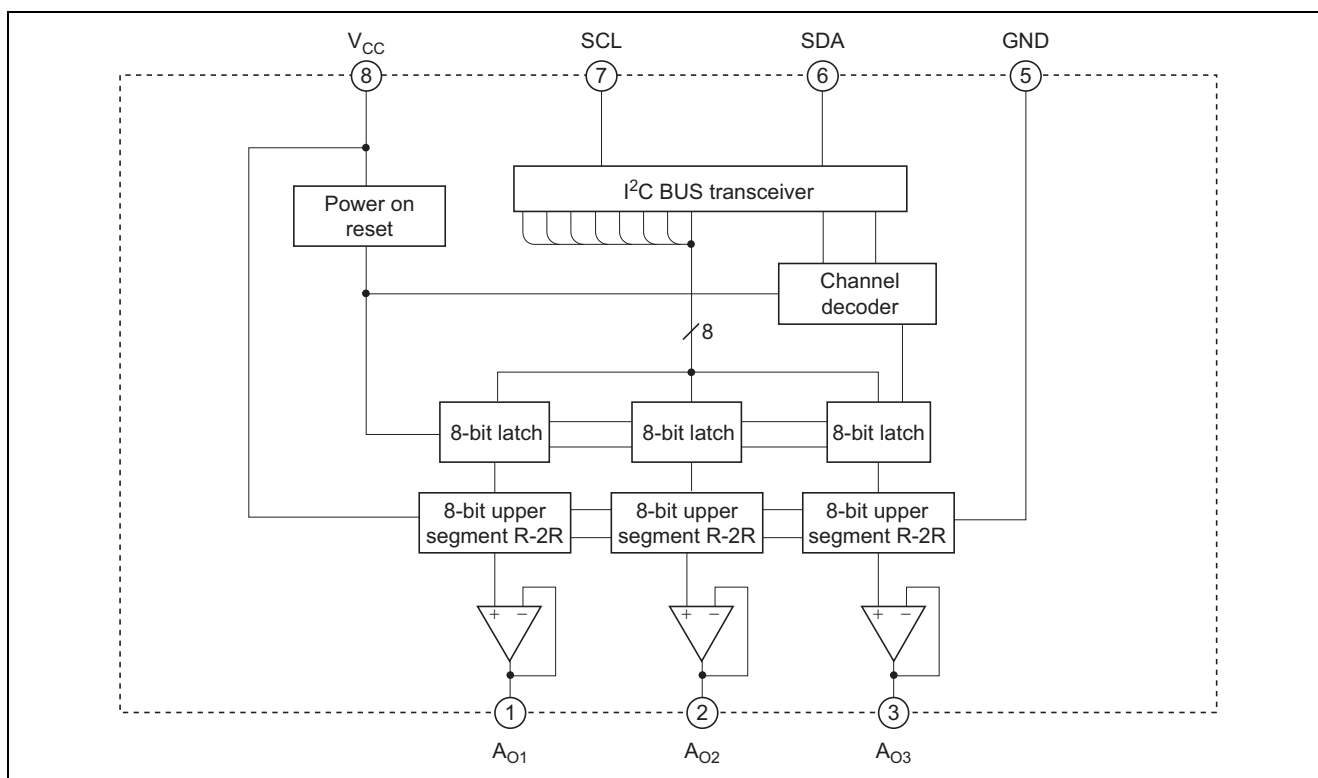
- Digital data transfer format: I<sup>2</sup>C BUS serial data method
- Output buffer operational amplifier: It operates in the whole voltage range from  $V_{CC}$  to ground.
- High output current drive capacity:  $\pm 1.0$  mA over

### Application

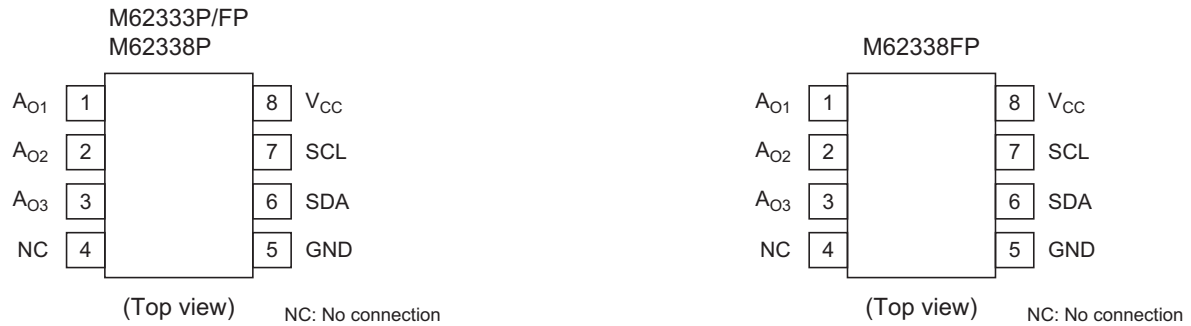
Conversion from digital data to analog control data for home-use and industrial equipment.

Signal gain control or automatic adjustment of Display-monitor or CTV.

### Block Diagram



## Pin Arrangement



Outline: PRDP0008AA-A (8P4) [P] (not recommend for new design)

PRSP0008DE-C [FP] (recommend)

PRSP0008DA-A (8P2S-A) [FP] (not recommend for new design)

Outline: PRSP0008DA-A (8P2S-A)

## Pin Description

| Pin No. | Pin Name        | Function                                       |
|---------|-----------------|------------------------------------------------|
| 6       | SDA             | Serial data input terminal                     |
| 7       | SCL             | Serial clock input terminal                    |
| 1       | A <sub>01</sub> | 8-bit resolution D/A converter output terminal |
| 2       | A <sub>02</sub> |                                                |
| 3       | A <sub>03</sub> |                                                |
| 8       | V <sub>CC</sub> | Power supply terminal                          |
| 5       | GND             | GND terminal                                   |

## Absolute Maximum Ratings

| Item                  | Symbol    | Ratings                | Unit |
|-----------------------|-----------|------------------------|------|
| Supply voltage        | $V_{CC}$  | -0.3 to 7.0            | V    |
| Input voltage         | $V_{in}$  | -0.3 to $V_{CC} + 0.3$ | V    |
| Output voltage        | $V_O$     | -0.3 to $V_{CC} + 0.3$ | V    |
| Power dissipation     | $P_d$     | 417 (P) / 272 (FP)     | mW   |
| Operating temperature | $T_{opr}$ | -20 to 85              | °C   |
| Storage temperature   | $T_{stg}$ | -40 to 125             | °C   |

## Electrical Characteristics

( $V_{CC} = +5\text{ V} \pm 10\%$ ,  $GND = 0\text{ V}$ ,  $T_a = -20\text{ to }85^\circ\text{C}$  unless otherwise noted)

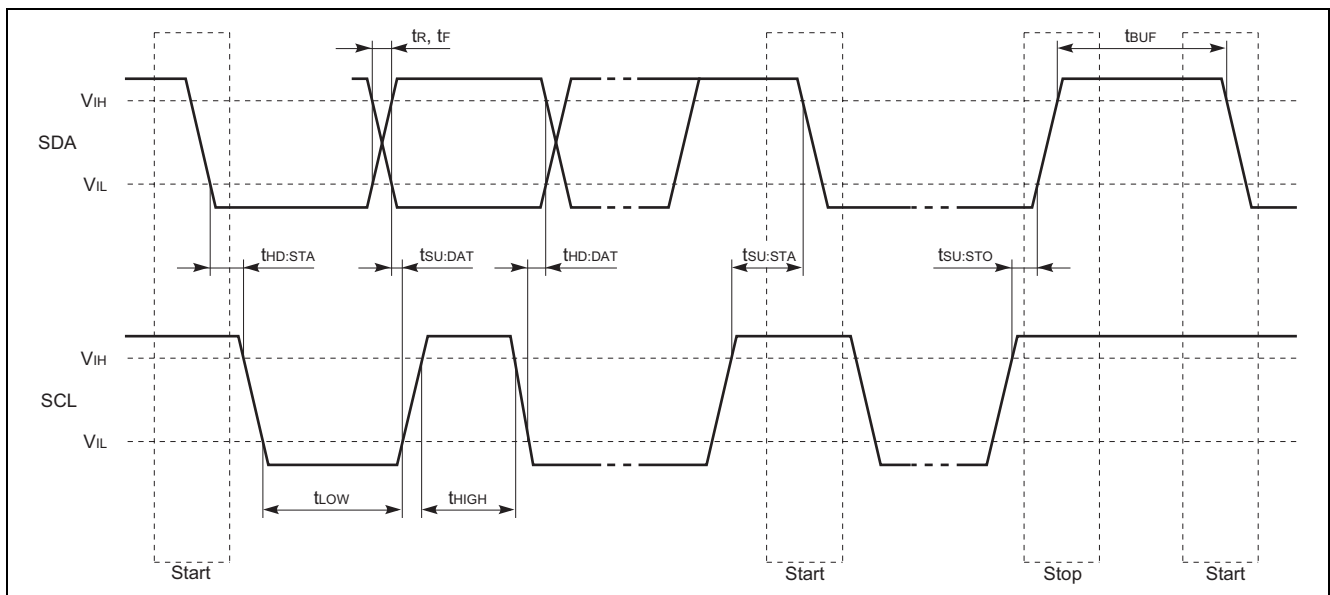
| Item                                  | Symbol     | Limits       |     |                | Unit          | Test Conditions                                                                            |
|---------------------------------------|------------|--------------|-----|----------------|---------------|--------------------------------------------------------------------------------------------|
|                                       |            | Min          | Typ | Max            |               |                                                                                            |
| Supply voltage                        | $V_{CC}$   | 2.7          | 5.0 | 5.5            | V             |                                                                                            |
| Supply current                        | $I_{CC}$   | 0            | 0.9 | 2.7            | mA            | CLK = 500 kHz operation, $I_{AO} = 0\text{ }\mu\text{A}$<br>Data: 6Ah (at maximum current) |
|                                       |            | 0            | 0.6 | 1.8            | mA            | SDA = SCL = GND, $I_{AO} = 0\text{ }\mu\text{A}$                                           |
| Output low voltage (SDA)              | $V_{OL}$   | —            | —   | 0.4            | V             | $I_{sink} = 3\text{ mA}$                                                                   |
| Input leak current                    | $I_{ILK}$  | -10          | —   | 10             | $\mu\text{A}$ | $V_{IN} = 0\text{ to }V_{CC}$                                                              |
| Input low voltage                     | $V_{IL}$   | —            | —   | $0.2 V_{CC}$   | V             |                                                                                            |
| Input high voltage                    | $V_{IH}$   | $0.8 V_{CC}$ | —   | —              | V             |                                                                                            |
| Buffer amplifier output voltage range | $V_{AO}$   | 0.1          | —   | $V_{CC} - 0.1$ | V             | $I_{AO} = \pm 100\text{ }\mu\text{A}$                                                      |
|                                       |            | 0.2          | —   | $V_{CC} - 0.2$ | V             | $I_{AO} = \pm 500\text{ }\mu\text{A}$                                                      |
| Buffer amplifier output drive range   | $I_{AO}$   | -1.0         | —   | 1.0            | mA            | Upper side saturation voltage = 0.3 V<br>Lower side saturation voltage = 0.2 V             |
| Differential nonlinearity             | $S_{DL}$   | -1.0         | —   | 1.0            | LSB           | $V_{CC} = 5.12\text{ V}$ (20 mV/LSB)<br>without load ( $I_{AO} = 0$ )                      |
| Nonlinearity                          | $S_L$      | -1.5         | —   | 1.5            | LSB           |                                                                                            |
| Zero code error                       | $S_{ZERO}$ | -2.0         | —   | 2.0            | LSB           |                                                                                            |
| Full scale error                      | $S_{FULL}$ | -2.0         | —   | 2.0            | LSB           |                                                                                            |
| Output capacitate load                | $C_O$      | —            | —   | 0.1            | $\mu\text{F}$ |                                                                                            |
| Buffer amplifier output impedance     | $R_O$      | —            | 5.0 | —              | $\Omega$      |                                                                                            |

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

| Item                                                                                 | Symbol       | Min | Max  | Unit    |
|--------------------------------------------------------------------------------------|--------------|-----|------|---------|
| SCL clock frequency                                                                  | $t_{SCL}$    | 0   | 100  | kHz     |
| Time the bus must be free before a new transmission can start                        | $t_{BUF}$    | 4.7 | —    | $\mu$ s |
| Hold time START condition<br>(After this period, the first clock pulse is generated) | $t_{HD:STA}$ | 4.0 | —    | $\mu$ s |
| Low period of the clock                                                              | $t_{LOW}$    | 4.7 | —    | $\mu$ s |
| High period of the clock                                                             | $t_{HIGH}$   | 4.0 | —    | $\mu$ s |
| Set-up time for START condition<br>(Only relevant for a repeated START condition)    | $t_{SU:STA}$ | 4.7 | —    | $\mu$ s |
| Hold time DATA                                                                       | $t_{HD:DAT}$ | 0   | —    | $\mu$ s |
| Set-up time DATA                                                                     | $t_{SU:DAT}$ | 250 | —    | ns      |
| Rise time of both SDA and SCL lines                                                  | $t_R$        | —   | 1000 | ns      |
| Fall time of both SDA and SCL lines                                                  | $t_F$        | —   | 300  | ns      |
| Set-up time for STOP condition                                                       | $t_{SU:STO}$ | 4.0 | —    | $\mu$ s |

Note: Transmitter must internally provide at least a hold time to bridge the undefined region (300 ns Max) of the falling edge of SCL.

## Timing Chart



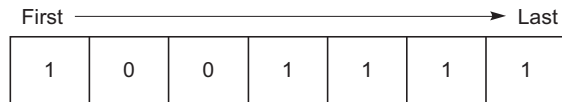
## I<sup>2</sup>C BUS Format

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

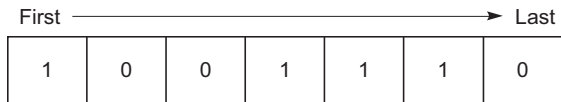
Note: STA: start condition, A: affirmation bit, W: write (SDA = Low), STP: stop condition

- Slave address

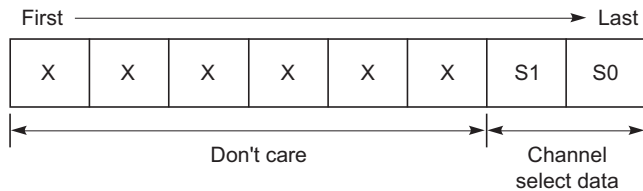
M62333



M62338



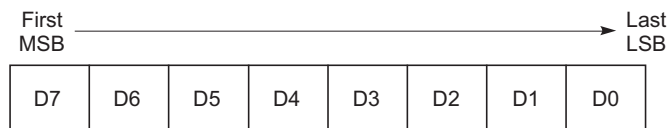
- Sub address



Channel select data

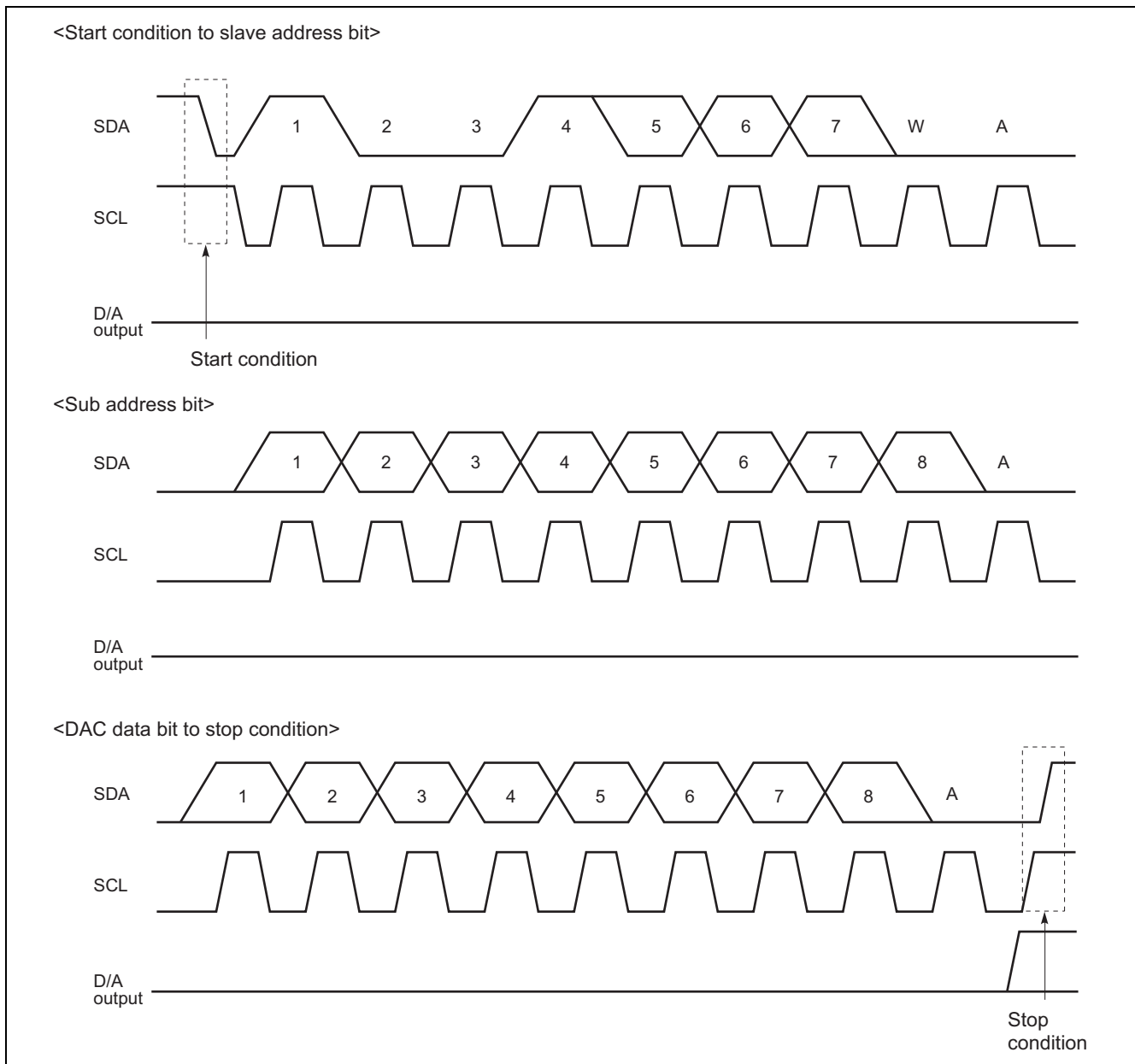
| S1 | S0 | Channel Selection |
|----|----|-------------------|
| 0  | 0  | ch1 selection     |
| 0  | 1  | ch2 selection     |
| 1  | 0  | ch3 selection     |
| 1  | 1  | Don't care        |

- DAC data



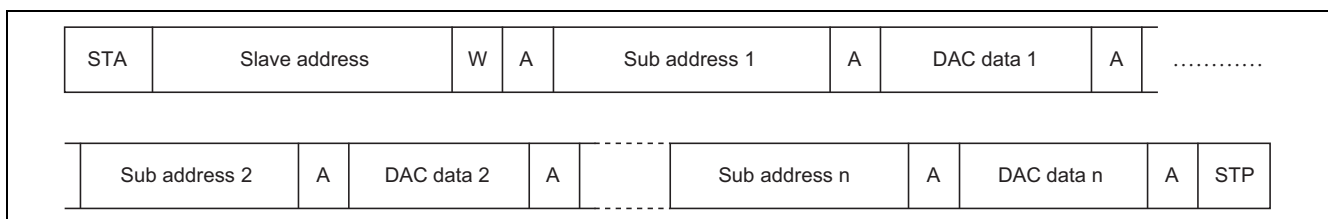
| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | DAC output                |
|----|----|----|----|----|----|----|----|---------------------------|
| 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | $V_{CC} / 256 \times 1$   |
| 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | $V_{CC} / 256 \times 2$   |
| 0  | 0  | 0  | 0  | 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  | $V_{CC}$                  |

## Timing Chart (Model)



- 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 circumstances, 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.)

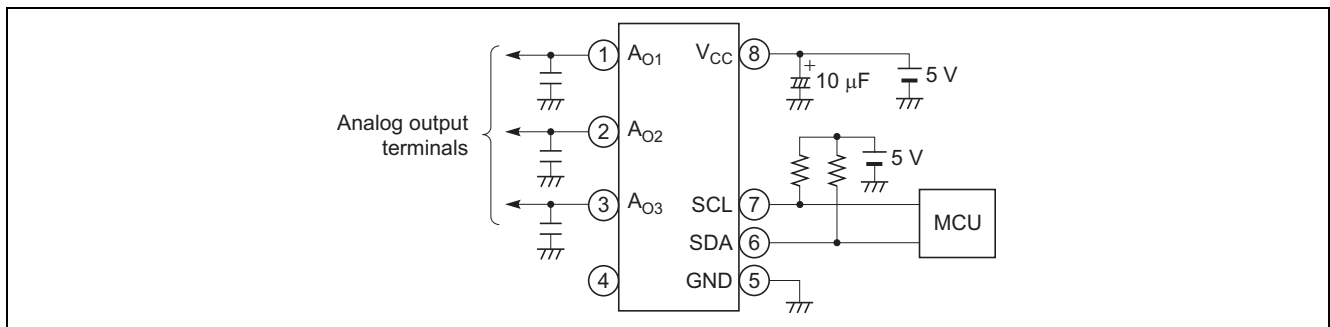
## Digital Data Formats



## Precaution for Use

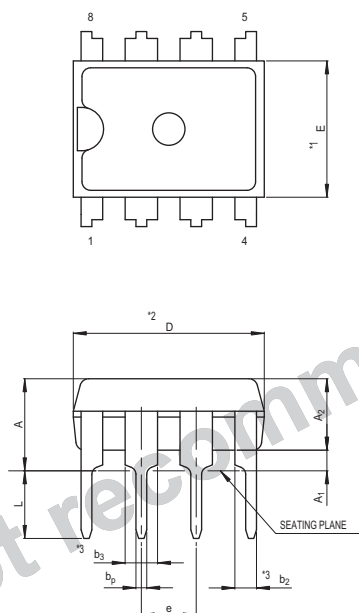
- Supply voltage terminal ( $V_{CC}$ ) is also used for D/A converter upper reference voltage setting. If ripple or spike is input this terminal, accuracy of D/A conversion is down. So, when use this device, please connect capacitor among  $V_{CC}$  to GND for stable D/A conversion.
- This IC's output amplifier has an advantage to capacitive load. So it's no problem at device action when connect capacitor (0.1  $\mu$ F Max) among output to GND for every noise eliminate.
- Purchase of Renesas's I<sup>2</sup>C components conveys a license under the Philips I<sup>2</sup>C Patent Rights to use these components an I<sup>2</sup>C system, provided that the system conforms to I<sup>2</sup>C Standard Specification as defined by Philips.

## Application Example



## Package Dimensions

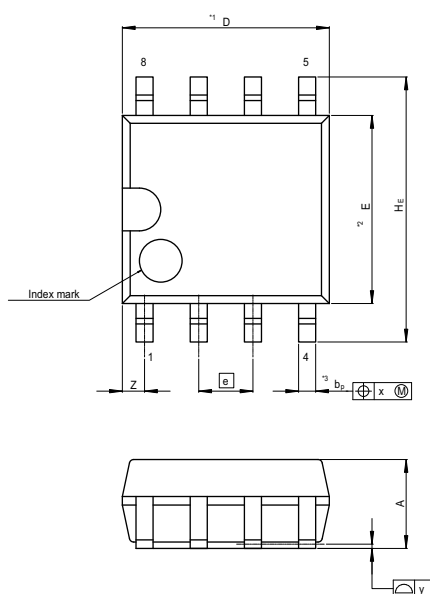
| JEITA Package Code   | RENESAS Code | Previous Code | MASS[Typ.] |
|----------------------|--------------|---------------|------------|
| P-DIP8-6.3x8.84-2.54 | PRDP0008AA-A | 8P4           | 0.5g       |



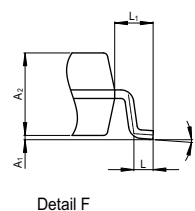
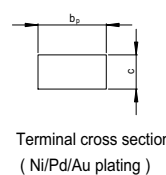
NOTE)  
 1. DIMENSIONS \*\*1\* AND \*\*2\*  
 DO NOT INCLUDE MOLD FLASH.  
 2. DIMENSION \*\*3\* DOES NOT  
 INCLUDE TRIM OFFSET.

| Reference Symbol | Min  | Nom  | Max  |
|------------------|------|------|------|
| e <sub>1</sub>   | 7.32 | 7.62 | 7.92 |
| D                | 8.7  | 8.9  | 9.1  |
| E                | 6.15 | 6.3  | 6.45 |
| A                | —    | —    | 4.5  |
| A <sub>1</sub>   | 0.51 | —    | —    |
| A <sub>2</sub>   | —    | 3.3  | —    |
| b <sub>p</sub>   | 0.4  | 0.5  | 0.6  |
| b <sub>2</sub>   | 0.9  | 1.0  | 1.3  |
| b <sub>3</sub>   | 1.4  | 1.5  | 1.8  |
| c                | 0.22 | 0.27 | 0.34 |
| θ                | 0°   | —    | 15°  |
| e                | 2.29 | 2.54 | 2.79 |
| L                | 3.0  | —    | —    |

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



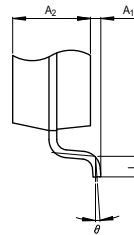
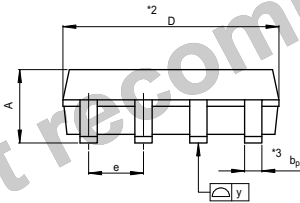
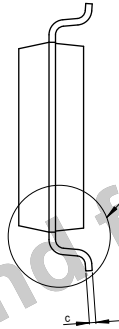
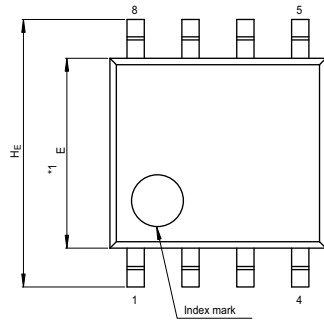
NOTE)  
 1. DIMENSIONS \*\*1\* (Nom) AND \*\*2\*  
 DO NOT INCLUDE MOLD FLASH.  
 2. DIMENSION \*\*3\* DOES NOT  
 INCLUDE TRIM OFFSET.



| Reference Symbol | 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  |
| ⓪                | 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 | —    |



|                    |              |               |            |
|--------------------|--------------|---------------|------------|
| JEITA Package Code | RENESAS Code | Previous Code | MASS[Typ.] |
| P-SOP8-4.4x5-1.27  | PRSP0008DA-A | 8P2S-A        | 0.07g      |



NOTE)  
1. DIMENSIONS \*\*1\* AND \*\*2\*  
DO NOT INCLUDE MOLD FLASH.  
2. DIMENSION \*\*3\* DOES NOT  
INCLUDE TRIM OFFSET.

| Reference<br>Symbol | Dimension in Millimeters |      |      |
|---------------------|--------------------------|------|------|
|                     | Min                      | Nom  | Max  |
| D                   | 4.8                      | 5.0  | 5.2  |
| E                   | 4.2                      | 4.4  | 4.6  |
| A <sub>2</sub>      | —                        | 1.5  | —    |
| A <sub>1</sub>      | 0.05                     | —    | —    |
| A                   | —                        | —    | 1.9  |
| b <sub>p</sub>      | 0.35                     | 0.4  | 0.5  |
| c                   | 0.13                     | 0.15 | 0.2  |
| $\theta$            | 0°                       | —    | 10°  |
| H <sub>E</sub>      | 5.9                      | 6.2  | 6.5  |
| e                   | 1.12                     | 1.27 | 1.42 |
| y                   | —                        | —    | 0.1  |
| L                   | 0.2                      | 0.4  | 0.6  |

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