NIPPON PRECISION CIRCUITS INC.

# SM6610 series

CMOS Monolithic Analog Output Temperature Sensor IC

## OVERVIEW

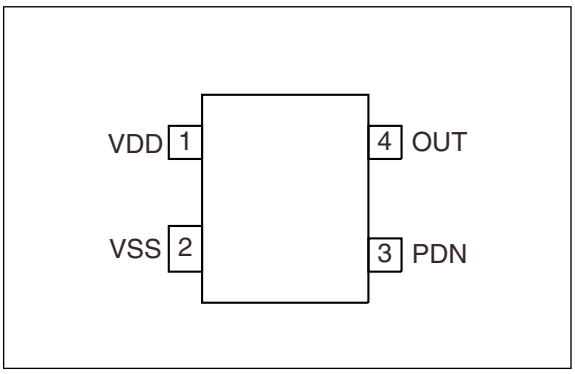
The SM6610 series are high-accuracy analog output temperature sensor ICs in ultra-small packages. They are implemented using CMOS for low-voltage operation and low-current consumption. They feature a power-down function whereby the device operates intermittently to further reduce current consumption.

## FEATURES

- High linearity: ± 0.5% typ. (Ta = – 20 to 80°C)
- Operating temperature range: – 40 to 100°C ($V_{DD}$ ≥ 2.7V)
- Maximum output current load: ± 250µA
- Output reference: VSS
- Low current consumption: 5.5µA typ. (Ta = 25°C)
- Low stand-by current: 0.5µA max.
- Very small plastic package: SC82AB
- Power down function
- Molybdenum-gate CMOS Process

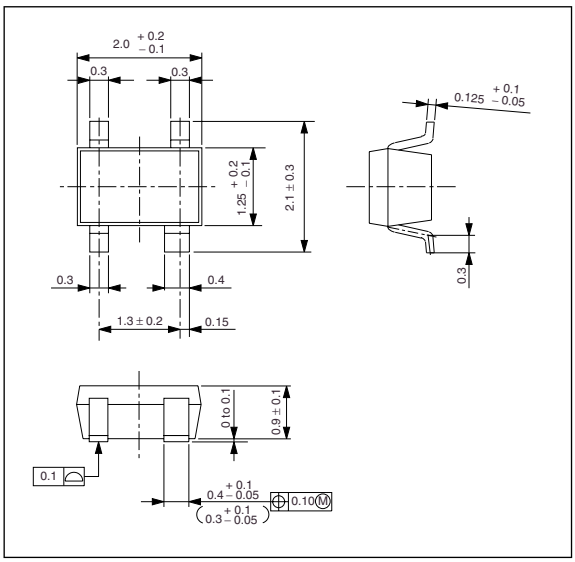
## PINOUT

(Top view)




## PACKAGE DIMENSIONS

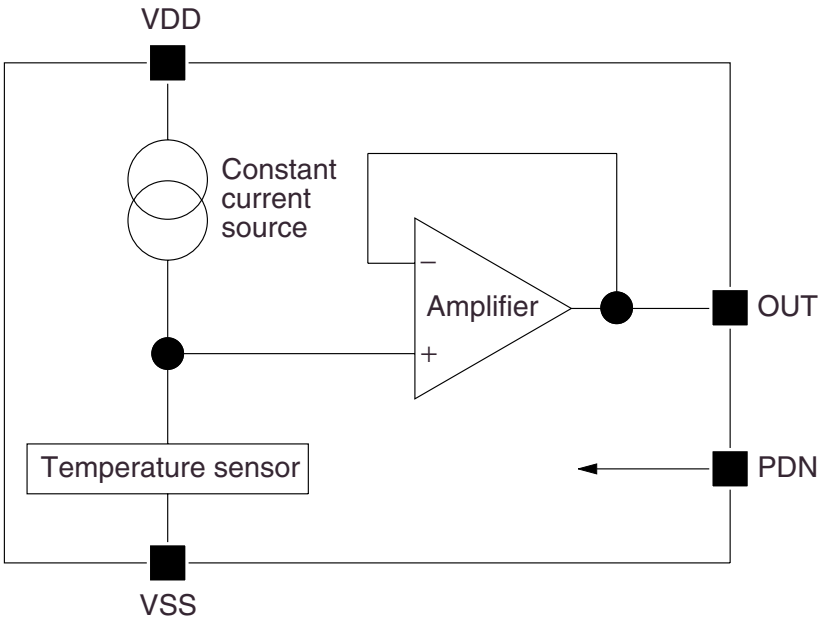
(Unit: mm)




## ORDERING INFORMATION

| Device | Output center voltage [V] (Ta = 25°C) | Temperature coefficient [mV/°C] | Operating voltage [V] | Accuracy [°C] | Package |
|---|---|---|---|---|---|
| SM6610AH | 1.930 | – 10.7 | 4.0 to 5.5 | ± 5.0 | SC82AB |
| SM6610BH | 1.450 | – 8.2 | 2.4 to 5.5 | ± 5.0 | |
| SM6610LH | 1.930 | – 10.7 | 4.0 to 5.5 | ± 3.0 | |
| SM6610MH | 1.450 | – 8.2 | 2.4 to 5.5 | ± 3.0 | |

## BLOCK DIAGRAM




## PIN DESCRIPTION

| Number | Name | Description |
|---|---|---|
| 1 | VDD | Positive power supply |
| 2 | VSS | Ground |
| 3 | PDN[1] | Power down control. Power down when LOW. |
| 4 | OUT | Sensor output |

1. Connect PDN to VDD when the power down function is not used.

# SPECIFICATIONS

## Absolute Maximum Ratings

$V_{SS}$ = 0V

| Parameter | Symbol | Condition | Rating | Unit |
|---|---|---|---|---|
| Supply voltage range | $V_{DD}$ | | – 0.5 to 7.0 | V |
| Input voltage range | $V_{IN}$ | | – 0.5 to $V_{DD}$ + 0.5 | V |
| Output voltage range | $V_{OUT}$ | | – 0.5 to $V_{DD}$ + 0.5 | V |
| Storage temperature range | $T_{stg}$ | | – 55 to 125 | °C |
| Power dissipation | $P_D$ | | 10 | mW |

## Recommended Operating Conditions

$V_{SS}$ = 0V

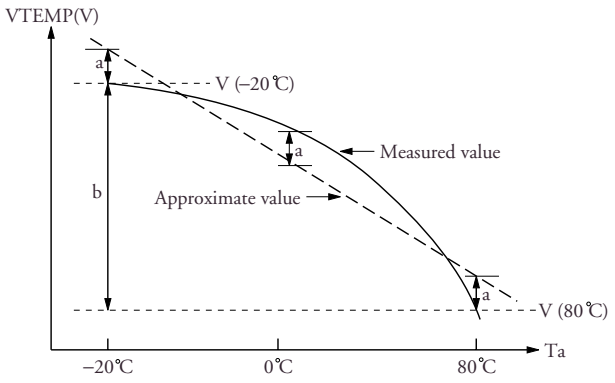
| Parameter | Symbol | Condition | | Rating | Unit |
|---|---|---|---|---|---|
| Supply voltage range | $V_{DD}$ | AH, LH version | | 4.0 to 5.5 | V |
| | | BH, MH version | | 2.4 to 5.5 | V |
| Operating temperature range | $T_{opr}$ | AH, LH version | | – 40 to 100 | °C |
| | | BH, MH version | $V_{DD}$ = 2.4 to 2.7V | – 20 to 100 | °C |
| | | | $V_{DD}$ = 2.7 to 5.5V | – 40 to 100 | °C |

## DC Characteristics

$V_{DD}$ = 5.0 V, $V_{SS}$ = 0 V, Ta = – 40 to 100 °C unless otherwise noted.

| Parameter | Symbol | Condition | | Rating min | Rating typ | Rating max | Unit |
|---|---|---|---|---|---|---|---|
| Current consumption | $I_{DD}$ | No load, Ta = + 25 °C | | – | 5.5 | 10.0 | µA |
| Output voltage | $V_{OUT}$ | Ta = – 30 °C | AH version | 2.456 | 2.509 | 2.563 | V |
| | | Ta = + 25 °C | | 1.877 | 1.930 | 1.984 | V |
| | | Ta = + 100 °C | | 1.065 | 1.118 | 1.172 | V |
| | | Ta = – 30 °C | BH version | 1.850 | 1.891 | 1.932 | V |
| | | Ta = + 25 °C | | 1.409 | 1.450 | 1.491 | V |
| | | Ta = + 100 °C | | 0.784 | 0.825 | 0.866 | V |
| | | Ta = – 30 °C | LH version | 2.477 | 2.509 | 2.541 | V |
| | | Ta = + 25 °C | | 1.898 | 1.930 | 1.962 | V |
| | | Ta = + 100 °C | | 1.086 | 1.118 | 1.150 | V |
| | | Ta = – 30 °C | MH version | 1.867 | 1.891 | 1.915 | V |
| | | Ta = + 25 °C | | 1.425 | 1.450 | 1.475 | V |
| | | Ta = + 100 °C | | 0.801 | 0.825 | 0.849 | V |
| Temperature coefficient[1] | $T_C$ | Ta = – 30 to + 100 °C | AH, LH version | – 11.1 | – 10.7 | – 10.3 | mV/°C |
| | | | BH, MH version | – 8.5 | – 8.2 | – 7.9 | mV/°C |
| Linearity[2] | $N_L$ | Ta = – 20 to + 80 °C | | – | ± 0.5 | – | % |
| Maximum capacitive load | $C_L$ | | | – | – | 100 | pF |
| Maximum output current load | $I_L$ | $V_{DD}$ = 2.4V | BH, MH version | – | – | ± 50 | µA |
| | | $V_{DD}$ = 4.5V | All versions | – | – | ± 250 | µA |
| Start up time | $t_D$ | $C_L$ = 100pF | AH, LH version | – | – | 300 | µs |
| | | | BH, MH version | – | – | 200 | µs |
| PDN Input voltage | $V_{IH}$ | | | $V_{DD}$ – 0.3 | – | – | V |
| | $V_{IL}$ | | | – | – | $V_{SS}$ + 0.3 | V |

1. Temperature coefficient: $T_C = (V_{OUT}$ (@100°C) – $V_{OUT}$ (@– 30°C))/130
2. Linearity: $N_L = (a/b) \times 100$
   a: Maximum deviation between measured and approximate value in the range of – 20 °C to + 80°C.
   b: Measured value difference between the values at – 20 °C and + 80°C.



## TYPCAL PERFORMANCE CHARACTERISTICS (Reference value)

### SM6610AH, LH

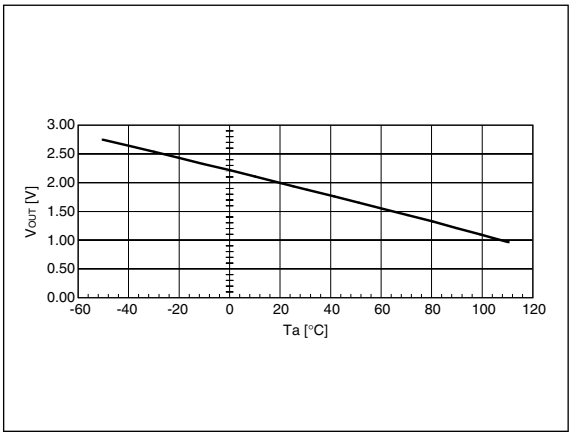



Figure 1. Temperature vs. Output voltage

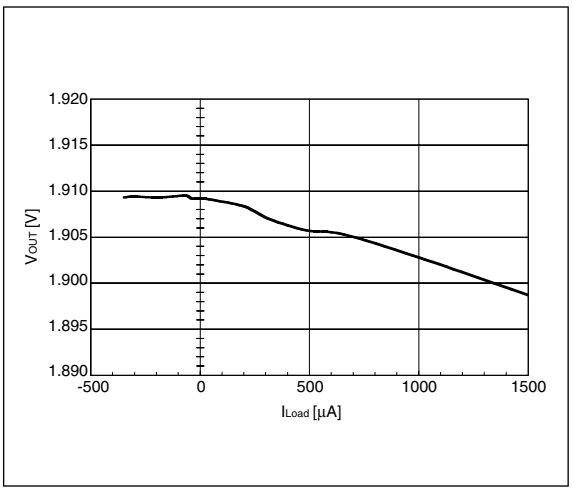



Figure 2. Load current vs. Output voltage
(Ta = 25°C, $V_{DD}$ = 4.0V)

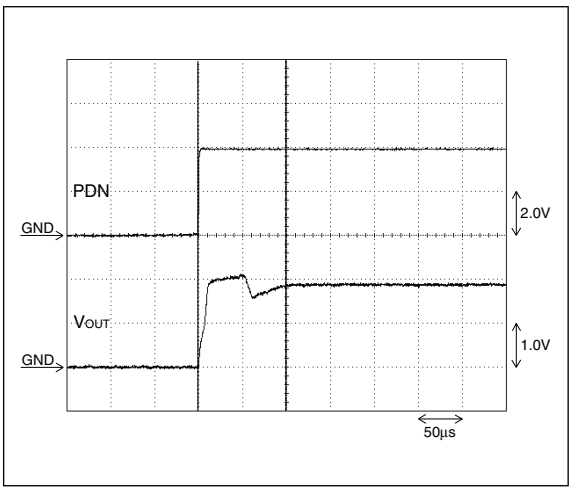



Figure 3. PDN start up response
(Ta = 25°C, $V_{DD}$ = 4.0V, $C_L$ = 100pF)

### SM6610BH, MH

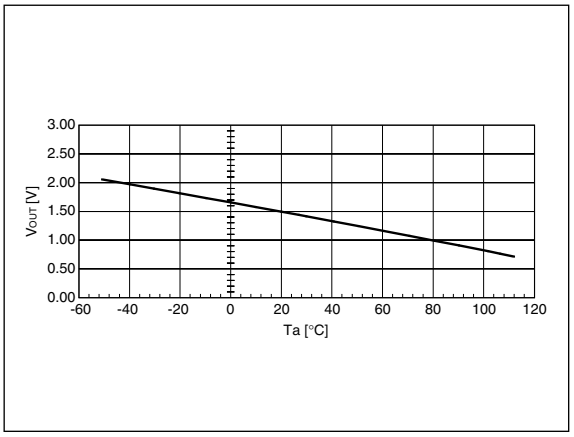



Figure 4. Temperature vs. Output voltage

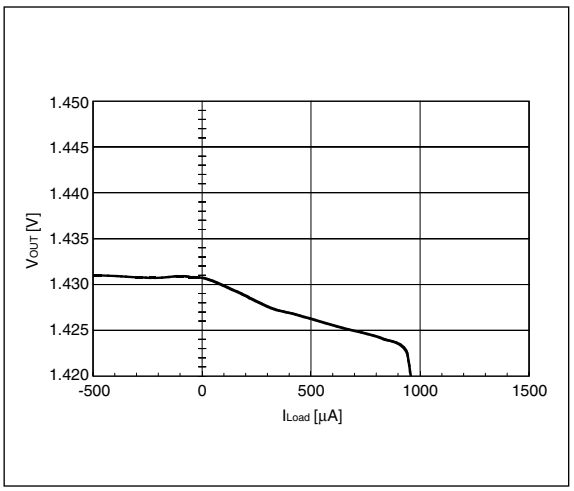



Figure 5. Load current vs. Output voltage
(Ta = 25°C, $V_{DD}$ = 2.4V)

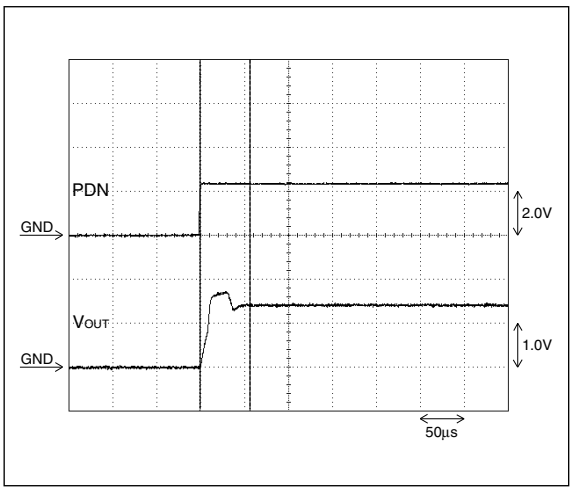
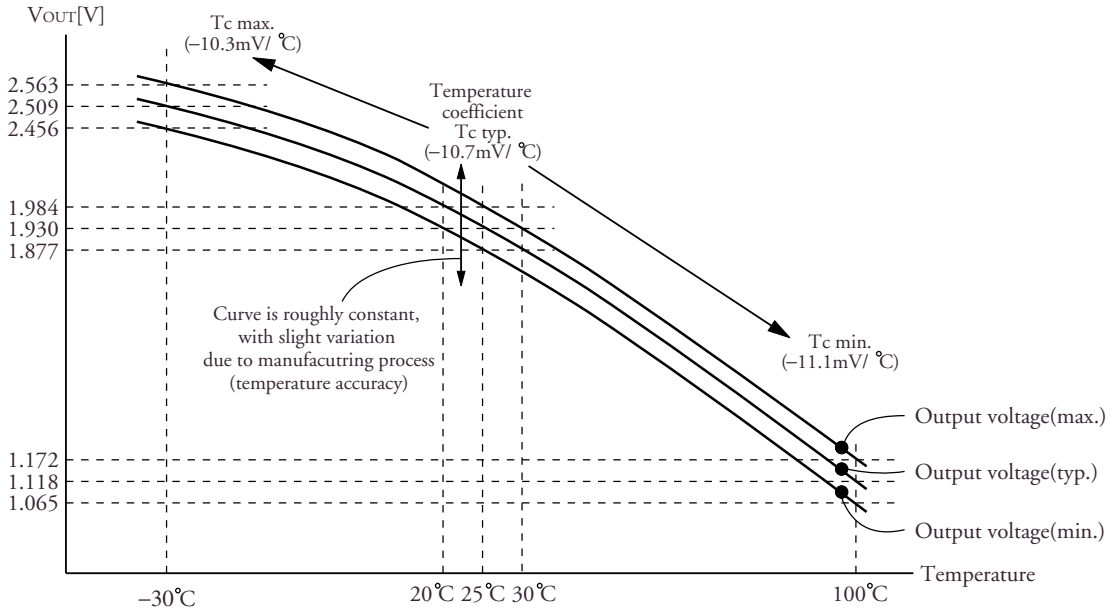



Figure 6. PDN start up response
(Ta = 25°C, $V_{DD}$ = 2.4V, $C_L$ = 100pF)

## TEMPERATURE ACCURACY, TEMPERATURE COEFFICIENT, AND LINEARITY

The SM6610 temperature coefficient is determined by the physical constants and the temperature of the circuit structure used. It does not depend on the variation between devices due to manufacturing processes. The temperature coefficient range from minimum to maximum is thus not caused by solid-state variations, but by the temperature.

The temperature vs. output voltage characteristic is not linear. The temperature coefficient is small at low temperatures (gentle gradient) and increases as the temperature gets higher (steep gradient). The temperature vs. output voltage characteristic curve shape is roughly fixed, however, the characteristic does change slightly due to the temperature accuracy of the device. The SM6610AH/BH have an accuracy of ± 5°C, and the SM6610LH/MH have an accuracy of ± 3°C. The curve for the SM6610AH is shown below.



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