

# DIGITAL TEMPERATURE SENSOR

# PX-7021

±0.1 °C accuracy from 1.4 µA, with an I<sup>2</sup>C and SMBus interface, in a 2 × 2 mm package

PRELIMINARY

**±0.1 °C**  
ACCURACY, -20 °C TO 50 °C

**1.4 µA**  
AT ONE READING A SECOND

**2 × 2 mm**  
8-PIN DFN PACKAGE

## 1 Features

- ±0.1 °C maximum error from -20 °C to 50 °C
- ±0.3 °C maximum error from -40 °C to 125 °C
- 16-bit result, with a resolution of 0.0078 °C
- 1.4 µA at one reading a second, 0.1 µA in shutdown
- Supply from 1.6 V to 5.5 V, 5.5 V-tolerant interface
- I<sup>2</sup>C and SMBus, from 1 kHz to 1 MHz, with bus timeout
- Eight bus addresses, selected by three pins
- Alert output, in comparator or interrupt mode
- 8-pin DFN, 2 × 2 mm, with an exposed pad (Figure 1)

## 2 Applications

- Cold-chain loggers for vaccines and fresh food
- Wearable and home thermometry
- Battery packs, chargers and power banks
- Thermostats and building controls
- Thermal protection for processors and power stages
- Laboratory and medical instruments

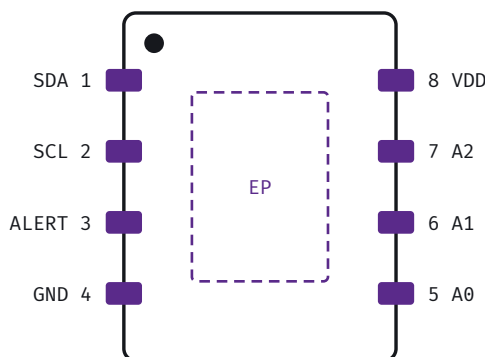


Figure 1. Pin configuration, 8-pin DFN, top view.

## 3 Description

The PX-7021 is a digital temperature sensor for coin-cell designs that must read within a tenth of a degree. A 16-bit converter reads an on-chip bandgap sensor, and every part is trimmed at two temperatures on the production line, so the board needs no calibration and the host no look-up table: one step of the result is 1/128 °C.

Between conversions the sensor sleeps: at one reading a second it draws 1.4 µA on average. Two limit registers drive the open-drain **ALERT** output, which can wake a sleeping host when the temperature leaves a window.

Figure 2 shows the typical circuit, with one decoupling capacitor and the bus pull-ups. With its address pins tied to ground the sensor answers at 48h.

**Preview** Engineering samples of the DFN versions are available now. The limits in Table 1 are preliminary and may change before production release.

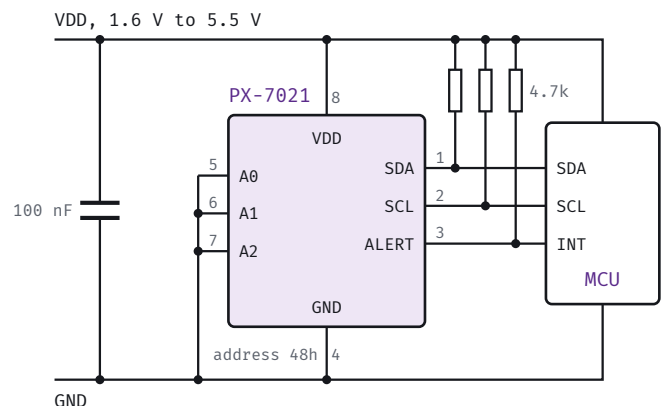


Figure 2. Typical application, bus address 48h.

**Table 1.** Electrical characteristics,  $V_{DD} = 1.6\text{ V to }5.5\text{ V}$  and  $T_A = -40\text{ °C to }125\text{ °C}$  unless noted

| Parameter                  | Symbol                              | Conditions         | Value                   |        |              | Unit   |
|----------------------------|-------------------------------------|--------------------|-------------------------|--------|--------------|--------|
|                            |                                     |                    | Min                     | Typ    | Max          |        |
| Temperature sensor         | Accuracy <sup>1</sup>               | $T_{ACC}$          | -20 °C to 50 °C         | -0.1   | ±0.05        | 0.1 °C |
|                            |                                     |                    | -40 °C to 125 °C        | -0.3   | ±0.1         | 0.3 °C |
|                            | Resolution                          | 16-bit result      |                         | 0.0078 |              | °C     |
|                            | Repeatability <sup>2</sup>          | 1 Hz, 100 readings |                         | ±0.008 |              | °C     |
|                            | Long-term drift <sup>2</sup>        | 500 h at 125 °C    |                         | 0.02   |              | °C     |
| Power supply               | Supply voltage                      | $V_{DD}$           | 1.6                     | 3.3    | 5.5          | V      |
|                            | Average supply current <sup>3</sup> | $I_{DD}$           | 1 conversion per second | 1.4    | 2.5          | µA     |
|                            | Supply current, converting          | $I_{CONV}$         |                         | 120    | 175          | µA     |
|                            | Shutdown current                    | $I_{SD}$           | bus idle                | 0.1    | 0.5          | µA     |
|                            | Power-on reset threshold            | $V_{POR}$          | $V_{DD}$ rising         | 1.2    | 1.45         | V      |
| Conversion                 | Conversion time                     | $t_{CONV}$         | 16-bit result           | 10.5   | 12           | ms     |
|                            |                                     |                    | 12-bit result           | 3.1    | 3.6          | ms     |
|                            | Conversion rate                     | $f_{CONV}$         | continuous mode         | 0.25   | 8            | Hz     |
| Digital inputs and outputs | High-level input voltage            | $V_{IH}$           | 0.7 $V_{DD}$            |        |              | V      |
|                            | Low-level input voltage             | $V_{IL}$           |                         |        | 0.3 $V_{DD}$ | V      |
|                            | Low-level output voltage            | $V_{OL}$           | 3 mA sink               |        | 0.4          | V      |
|                            | Input leakage current               | $I_{IN}$           | -1                      |        | 1            | µA     |
|                            | Pin capacitance                     | $C_{IN}$           |                         | 3      |              | pF     |
| Serial interface           | Clock frequency                     | $f_{SCL}$          | Fast-mode Plus          | 1      | 1000         | kHz    |
|                            | Bus timeout                         | $t_{TIMEOUT}$      | SMBus mode              | 25     | 30           | 35 ms  |

Typical values at 3.3 V and 25 °C. <sup>1</sup> Tested at 25 °C and 50 °C, the rest by characterization. <sup>2</sup> Characterized, not tested in production. <sup>3</sup> One conversion a second, bus idle.

## 4 Specifications

### ABSOLUTE MAXIMUM RATINGS

- Supply voltage,  $V_{DD}$  to GND: **-0.3 V to 6 V**
- SDA, SCL and ALERT to GND: **-0.3 V to 6 V**
- A0 to A2 to GND: **-0.3 V to  $V_{DD} + 0.3\text{ V}$**
- Current into any pin: **±10 mA**
- Storage temperature: **-60 °C to 150 °C**
- Electrostatic discharge, human-body model: **±2 kV**

Stress beyond these ratings can damage the device for good. Design to the operating conditions below.

### 4.1 Recommended operating conditions

Operate the sensor from 1.6 V to 5.5 V, at ambient temperatures from -40 °C to 125 °C, with less than 50 mV of ripple on the supply. The bus pull-ups may return to

any supply up to 5.5 V, so a sensor run from 1.8 V can share a bus with 5 V parts without a level shifter.

### 4.2 Electrical characteristics

**Table 1** lists the limits over the full supply and temperature range. Typical values are the mean of the characterization lots at 3.3 V and 25 °C; they are not guaranteed. Accuracy is tested on every part at 25 °C and 50 °C; values marked <sup>2</sup> come from characterization only.

## 5 Pin configuration and functions

**Figure 1** shows the package from above. A dot on the top face marks pin 1, and the pins count counterclockwise from it. The exposed pad under the package is the sensor's thermal path to the board: solder it to a ground pour. **Table 2** describes each pin.

Table 2. Pin functions

| Pin                     | Name  | Type | Description                                                          |
|-------------------------|-------|------|----------------------------------------------------------------------|
| <b>Power</b>            |       |      |                                                                      |
| 8                       | VDD   | P    | Supply, 1.6 V to 5.5 V. Decouple with 100 nF within 2 mm of the pin. |
| 4                       | GND   | G    | Ground.                                                              |
| EP                      | EP    | G    | Exposed pad, the thermal path to the board. Solder it to ground.     |
| <b>Serial interface</b> |       |      |                                                                      |
| 1                       | SDA   | I/O  | Serial data, open drain, 5.5 V-tolerant.                             |
| 2                       | SCL   | I    | Serial clock, Schmitt-trigger input.                                 |
| 3                       | ALERT | O    | Alert output, open drain. Leave it open when unused.                 |
| <b>Address select</b>   |       |      |                                                                      |
| 5                       | A0    | I    | Address bit 0. Tie to GND or $V_{DD}$ , never leave it floating.     |
| 6                       | A1    | I    | Address bit 1. Tie to GND or $V_{DD}$ .                              |
| 7                       | A2    | I    | Address bit 2. Tie to GND or $V_{DD}$ .                              |

Types: P power, G ground, I input, O open-drain output, I/O open-drain input and output.

## 6 Detailed description

A host talks to the PX-7021 through eleven registers, listed with their reset values in Table 3. Two-byte registers are read and written most significant byte first.

### 6.1 Temperature conversion

A conversion takes 10.5 ms at 16 bits and 3.1 ms at 12 bits. In continuous mode the sensor starts a new conversion at the programmed rate, from one every four seconds to eight a second, and sleeps in between; in one-shot mode it converts once, stores the result and shuts down again. The result register always holds the last complete reading, so a read never catches a conversion halfway.

The result is a signed 16-bit value in steps of  $1/128$  °C. Values above 7FFFh are negative: 1900h reads as 50 °C, and E700h as -50 °C.

### 6.2 Serial interface

The sensor is a target on an I<sup>2</sup>C or SMBus bus, at clock rates up to 1 MHz. Tie each of A0, A1 and A2 to ground or to the supply to choose one of eight addresses, from 48h to 4Fh. In SMBus mode a clock held low for more than 30 ms resets the interface, so a host that crashes in mid-transfer

Table 3. Register map

| Addr.                | Register | Reset | Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|----------------------|----------|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Measurement</b>   |          |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 00h                  | TEMP     | 8000h | The last complete result, read only. <ul style="list-style-type: none"> <li>8000h until the first result</li> <li>Signed, in steps of <math>1/128</math> °C</li> <li>At 12 bits, bits 3 to 0 read zero</li> <li>Two bytes, most significant first</li> </ul>                                                                                                                                                                                                   |
| 04h                  | STATUS   | 00h   | Flags, read only. Reading STATUS releases ALERT in interrupt mode. <ul style="list-style-type: none"> <li>Bit 7, BUSY: still converting</li> <li>Bit 6, HIGH: a result crossed THIGH</li> <li>Bit 5, LOW: a result crossed TLOW</li> <li>Bit 4, TRIM: the trim check failed at power-on</li> </ul>                                                                                                                                                             |
| <b>Configuration</b> |          |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 01h                  | CONFIG   | 0000h | Operating mode and alert behavior. <ul style="list-style-type: none"> <li>Bits 15 and 14, MODE: continuous, one-shot or shutdown</li> <li>Bit 13, RES: a 12-bit result instead of 16 bits</li> <li>Bit 12, AVG: each result averages eight readings</li> <li>Bits 11 and 10, FAULTS: 1, 2, 4 or 6 results beyond a limit before ALERT asserts</li> <li>Bit 9, POL: ALERT active high</li> <li>Bit 8, INT: interrupt mode instead of comparator mode</li> </ul> |
| 05h                  | RATE     | 02h   | Conversion rate in continuous mode. <ul style="list-style-type: none"> <li>00h to 05h: 0.25, 0.5, 1, 2, 4 or 8 conversions a second</li> <li>Higher values read back as 05h</li> </ul>                                                                                                                                                                                                                                                                         |
| 06h                  | ONESHOT  | 00h   | Any write starts one conversion. <ul style="list-style-type: none"> <li>Shuts down again afterwards</li> <li>Ignored in continuous mode</li> </ul>                                                                                                                                                                                                                                                                                                             |
| 07h                  | OFFSET   | 0000h | Added to every result, in the format of TEMP. <ul style="list-style-type: none"> <li>From -8 °C to 8 °C</li> <li>Cleared by a power-on reset</li> </ul>                                                                                                                                                                                                                                                                                                        |
| <b>Limits</b>        |          |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 02h                  | TLOW     | F600h | Low limit, in the format of TEMP. <ul style="list-style-type: none"> <li>-20 °C after reset</li> <li>Keep it below THIGH</li> </ul>                                                                                                                                                                                                                                                                                                                            |
| 03h                  | THIGH    | 3C00h | High limit, in the format of TEMP. <ul style="list-style-type: none"> <li>120 °C after reset</li> <li>In comparator mode, ALERT releases below TLOW</li> </ul>                                                                                                                                                                                                                                                                                                 |

Continued on the next page

Table 3. Register map (continued)

| Addr.          | Register | Reset | Contents                                                                                                                                         |
|----------------|----------|-------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| Identification |          |       |                                                                                                                                                  |
| 0Eh            | SERIAL   | —     | A 48-bit number unique to each part, read only. <ul style="list-style-type: none"><li>Read six bytes, from 0Eh</li></ul>                         |
| FEh            | MAKER    | 5058h | Manufacturer, read only: PX in ASCII.                                                                                                            |
| FFh            | DEVICE   | 7021h | Device, read only. <ul style="list-style-type: none"><li>Bits 15 to 4: the part number, 702h</li><li>Bits 3 to 0: the silicon revision</li></ul> |

Reset values apply at power-on and after a general-call reset.

cannot lock the bus. The sensor also answers the I<sup>2</sup>C general-call reset command.

6.3 Alert output

The ALERT pin compares every result with the limits in THIGH and TLOW. In comparator mode it stays asserted while the temperature is above THIGH and releases once it falls below TLOW, which gives a thermostat its hysteresis. In interrupt mode it asserts once per crossing, and releases when the host reads STATUS, or when the sensor answers a read of the SMBus alert response address.

7 Packaging and ordering

Figure 3 draws the package and its land pattern: the DFN-8 body is 2 mm square and 0.55 mm high, with a 0.5 mm pin pitch and a 0.8 × 1.5 mm exposed pad. Table 4 lists the versions and their order codes. The top of each part carries its number over a date code, YWWL: the year, the work week and the lot.

Parts are rated at moisture sensitivity level 1, so they need no dry storage, and survive three reflow cycles at a peak of 260 °C. Reflow shifts the reading by less than 0.02 °C.

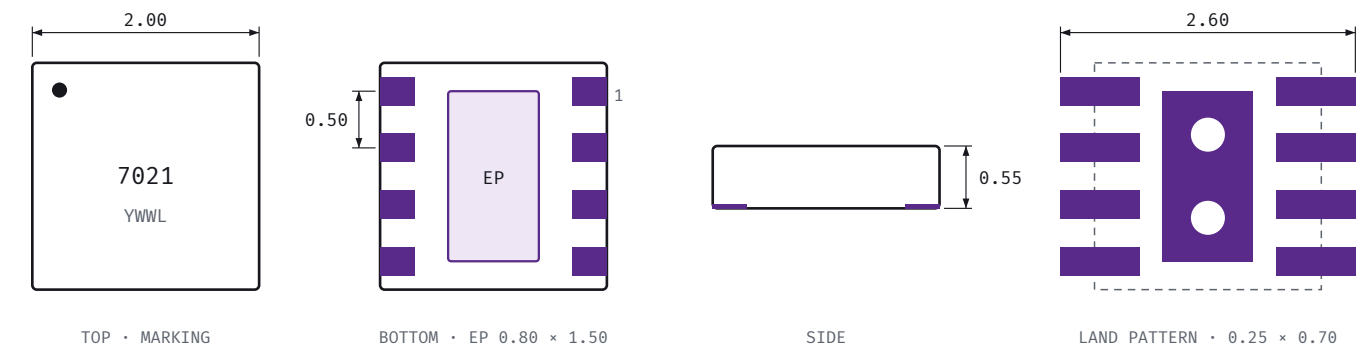


Figure 3. Package outline and land pattern, 8-pin DFN, in mm.

Table 4. Order codes

| Order code    | Package               | Packing       | Status    |
|---------------|-----------------------|---------------|-----------|
| PX-7021-DFN-R | DFN-8, 2 × 2 mm       | Reel of 3000  | Preview   |
| PX-7021-DFN-T | DFN-8, 2 × 2 mm       | Cut tape, 250 | Preview   |
| PX-7021-CSP-R | WLCSP-4, 0.8 × 0.8 mm | Reel of 5000  | Planned   |
| PX-7021-EVM   | Evaluation board      | Box of 1      | Available |

WLCSP-4: fixed address 48h, no ALERT output.

8 Layout guidelines

The sensor measures the copper under its exposed pad. For air temperature, place it at the edge of the board, away from regulators and processors, and cut slots in the board around it so that heat from the rest of the circuit reaches it slowly. For the temperature of a surface, do the opposite: a solid pour and a row of vias carry heat from the surface to the pad. Keep the decoupling capacitor on the same side of the board as the sensor and close to its supply pin: 2 mm at most.

9 Revision history

Rev. 0.3, September 2026: preliminary release, with limits from the first characterization lots. Adds the WLCSP-4 version and the SMBus timeout.

Rev. 0.2, May 2026: advance information for early customers, with typical values only.

Rev. 0.1, February 2026: product brief, with the target accuracy and supply current.

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