

PJ85451 Datasheet

±1°C Remote and Local Temperature Sensor with Digital Interface In a DFN2x2-8 Package

Version: Rev.1.0

Release Date: 2025-12-12

General Description

The PJ85451 is a 2 channels (1 remote channel + 1 local channel) digital temperature sensor.

Temperature data can be read out directly via digital interface (compatible SMBus and I²C with speed up to 400 kHz) by MCU, Bluetooth Chip or SoC chip.

Each chip is specially calibrated $\pm 1.0^{\circ}\text{C}$ (Max.) accuracy for both remote and local channel over 0°C to 85°C temperature range in factory before shipment to customers.

It includes a high precision band-gap circuit, a 12-bit analog to digital converter that can offer 0.0625°C resolution, a calibration unit with non-volatile memory, and a digital interface block.

It has a feature of series resistance cancellation for remote channel. It also has non-ideality factor correction feature for remote channel by programming register.

Available Package : DFN2x2-8 package.

Features

- ◆ Operation Voltage : 1.7 V to 5.5 V
- ◆ Average Quiescent Current : 30 μA (Typ.) at 1 con/s, $V_{\text{CC}} = 3.3\text{ V}$
- ◆ Shutdown Current : 3.0 μA (Typ.)
- ◆ Temperature Accuracy without calibration for each channel :
 - $\pm 1^{\circ}\text{C}$ (Max.) from 0°C to 85°C
 - $\pm 2^{\circ}\text{C}$ (Max.) from -40°C to 125°C
- ◆ 12-bit ADC for 0.0625°C resolution
- ◆ Support continuous measurement mode or single measurement mode
- ◆ Series Resistance Cancellation
- ◆ n-Factor Correction
- ◆ Compatible with SMBus, 2-wire and I²C interface with speed up to 400 kHz
- ◆ External Diodes Fault detection
- ◆ Temperature Range: -40°C to 125°C

Applications

- ◆ Desktop & Notebook Computer
- ◆ Telecom, Industrial and Medical Equipments
- ◆ Servers
- ◆ CPU, FPGA

Ordering Information

Ordering Information

| Order PN | Accuracy | Marking ID | Green ⁽¹⁾ | Package | Packing | MPQ | Operation Temperature |
|-----------|----------|------------|----------------------|----------|-------------|-------|-----------------------|
| PJ85451QW | ±1°C | A3 W | Halogen free | DFN2x2-8 | Tape & Reel | 4,000 | -40°C ~+125°C |

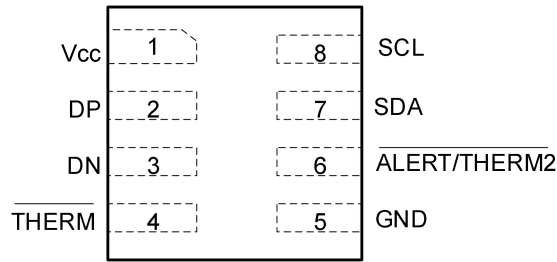
Note:

(1) MetaWells can meet RoHS 2.0/REACH requirement. So most package types MetaWells offers only states halogen free, instead of lead free.

Marking Information

| Marking ID | Package | Definition |
|------------|----------|-------------------------------|
| A3 W | DFN2x2-8 | A3: Product code W: Week code |

Pin Configuration



DFN2x2-8 (Top View)

Pin Description

| Terminal | | Description |
|----------|--------------------|--|
| Number | Name | |
| 1 | V _{CC} | Power supply input pin , using 0.1 μF low ESR ceramic capacitor to ground |
| 2 | DP | Remote sensor positive input pin , it could be positive node of Diode, or BJT transistor (diode-connected mode or transistor-connected mode). |
| 3 | DN | Remote sensor negative input pin , it could be negative node of Diode, or BJT transistor (diode-connected mode or transistor-connected mode). |
| 4 | /THERM | Open drain output with active low . Need a pull-up resistor to V _{CC} . If the measured temperature exceeds THERM-limit (programmable by user), this pin will be activated. This pin can be used to control Fan on/off. |
| 5 | GND | Ground pin . |
| 6 | /ALERT, /THERM2 | Open drain output with active low . Need a pull-up resistor to V _{CC} . If the measured temperature drops below the low-limit or exceeds high-limit, this pin will be activated. Both low-limit and high-limit are programmable by user. Also this pin can be used as the other THERM pin. |
| 7 | SDA | Digital interface data input or output pin , need a pull-up resistor to V _{CC} . |
| 8 | SCL | Digital interface clock input pin , need a pull-up resistor to V _{CC} . |

Application Schematic

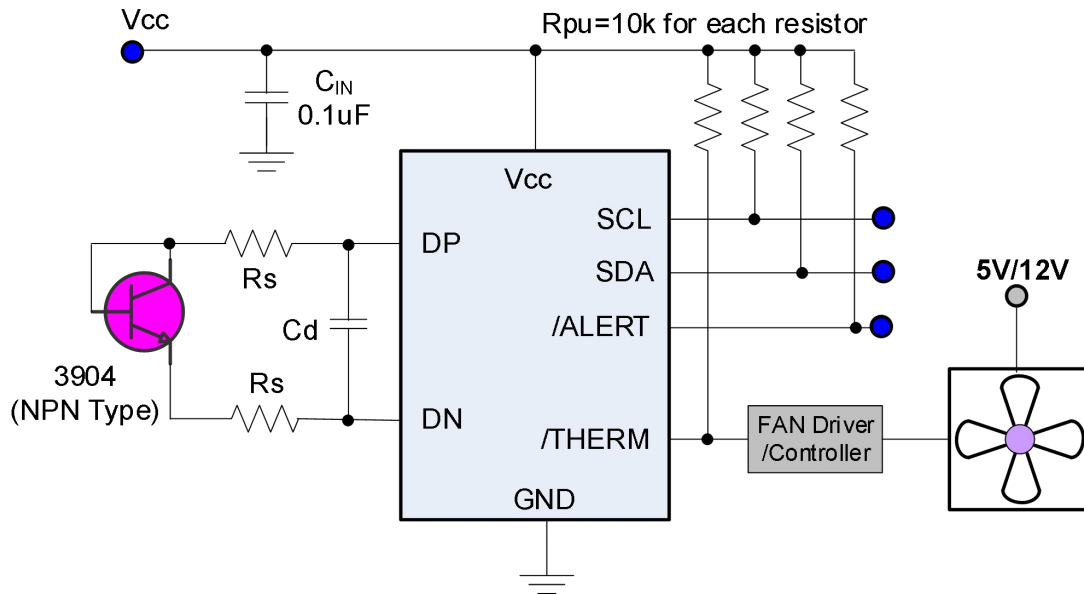


Figure-1. Typical Application of PJ85451

Function Block

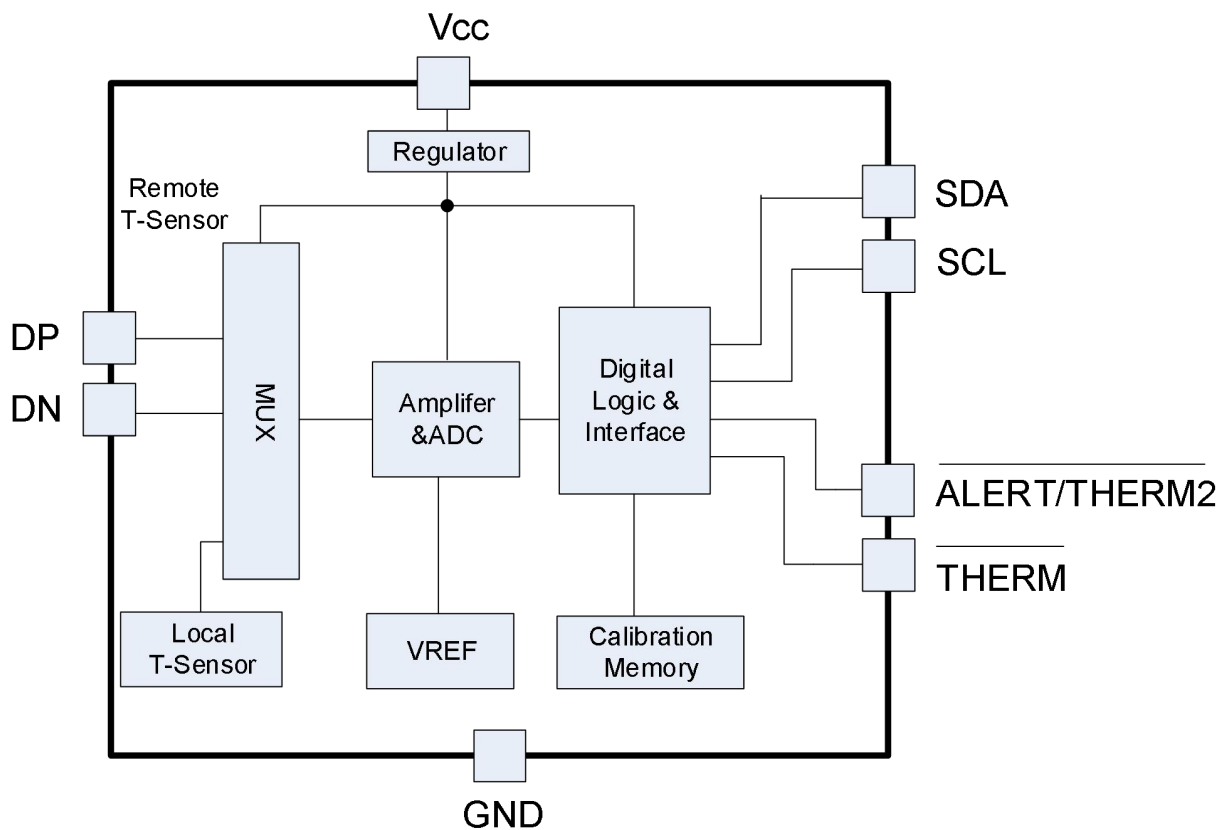


Figure-2. PJ85451 Function Block

Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted) ⁽¹⁾

| Parameter | | Min | Max | Units |
|--|------------------------------|------|--------------|-------|
| Supply Voltage | V_{CC} to GND | -0.3 | 6 | V |
| SDA, SCL Voltage | V_{SDA}/V_{SCL} to GND | -0.3 | 6 | V |
| DP Voltage | V_{DP} to GND | -0.3 | $V_{CC}+0.3$ | V |
| DN Voltage | V_{DN} to GND | -0.3 | 0.3 | V |
| /THERM, /ALERT Voltage | V_{THERM}/V_{ALERT} to GND | -0.3 | 6 | V |
| Operating junction temperature range | T_J | -50 | 150 | °C |
| Storage Temperature Range | T_{STG} | -65 | 150 | °C |
| Lead Temperature (Soldering, 10 Seconds) | T_{LEAD} | 260 | | °C |

(1) Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under recommended operating conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

Handling Ratings

| Parameter | Definition | Min | Max | Units |
|--------------------|---|-----|-----|-------|
| ESD ⁽¹⁾ | Human Body Model (HBM) ESD stress voltage ⁽²⁾ | -4 | 4 | kV |
| | Charged Device Model (CDM) ESD stress voltage ⁽³⁾ , all pins | -1 | 1 | kV |

- (1) Electrostatic discharge (ESD) to measure device sensitivity and immunity to damage caused by assembly line electrostatic discharges into the device.
- (2) Level listed above is the passing level per ANSI, ESDA, and JEDEC JS-001. JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
- (3) Level listed above is the passing level per EIA-JEDEC JESD22-C101. JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

Recommended Operating Conditions

| Parameter | | Min | Max | Units |
|-----------|-------------------------------|-----|-----|-------|
| V_{CC} | Supply Voltage | 1.7 | 5.5 | V |
| T_A | Operating Ambient temperature | -40 | 125 | °C |

Electrical Characteristics

Test Condition: $V_{CC} = 3.3\text{ V}$, $C_{IN} = 0.1\ \mu\text{F}$, unless otherwise specified, all limits are 100% test at $T_A = 25^\circ\text{C}$. ⁽¹⁾

| Parameter | | Test Conditions | Min | Typ | Max | Units |
|------------------|--|--|------------|-----------|----------------|--------------------|
| V_{CC} | Supply voltage range | | 1.7 | | 5.5 | V |
| T_{RAC} | Temperature Accuracy (Remote Channel) | $T_A = 0\text{ to }85^\circ\text{C}$ | -1.0 | | 1.0 | $^\circ\text{C}$ |
| | | $T_A = -40\text{ to }125^\circ\text{C}$ | -2.5 | | 2.5 | $^\circ\text{C}$ |
| T_{LAC} | Temperature Accuracy (Local Channel) | $T_A = 0\text{ to }85^\circ\text{C}$ | -1.0 | | 1.0 | $^\circ\text{C}$ |
| | | $T_A = -40\text{ to }125^\circ\text{C}$ | -2.0 | | 2.0 | $^\circ\text{C}$ |
| | Temperature Sensor versus supply (local or remote) | $V_{CC} = 1.7\text{ V to }5.5\text{ V}$ | | ± 0.1 | ± 0.25 | $^\circ\text{C/V}$ |
| $T_{RESOLUTION}$ | Temperature Resolution | | | 0.0625 | | $^\circ\text{C}$ |
| I_{AOC} | Average Operating Current | $V_{IN} = 3.3\text{ V}, 1.0\text{ con/s}$ | | 30 | 35 | μA |
| | | $V_{IN} = 5.0\text{ V}, 1.0\text{ con/s}$ | | 40 | 45 | μA |
| I_{SD} | Shutdown Current | Enable STB bit, force SDA/SCL to V_{CC} or GND | | 3 | 6 | μA |
| t_{CON} | Conversion time | For each channel | | 16 | | mS |
| C_{IL} | Logic Input Capacitance | SDA, SCL pin | | 3 | | pF |
| V_{IH} | Logic Input High Voltage | SDA, SCL pin | 1.4 | | $V_{CC} + 0.3$ | V |
| V_{IL} | Logic Input Low Voltage | SDA, SCL pin | -0.3 | | 0.45 | V |
| I_{INL} | Logic Input Current | SDA, SCL pin | -1.0 | | 1.0 | μA |
| I_{OLS} | Logic Output Sink Current | SDA, /ALERT pin, forced 0.2 V | | 5 | | mA |
| f_{CLK} | SCL frequency | Fast mode | $10^{(2)}$ | | 400 | KHz |
| t_{TOUT} | Timeout of detecting clock or data low period time | SMBus communication | | 30 | | mS |
| t_{LOW} | Clock low period time | | 1300 | | | nS |
| t_{HIGH} | Clock high period time | | 600 | | | nS |
| t_{BUF} | Bus free time | Between Stop and Start condition | 1300 | | | nS |
| $t_{HD:STA}$ | Hold time after Start condition | | 600 | | | nS |
| $t_{SU:STA}$ | Repeated Start condition setup time | | 600 | | | nS |
| $t_{SU:STO}$ | Stop condition setup time | | 600 | | | nS |
| $t_{HD:DAT}$ | Data Hold time | | 100 | | | nS |
| $t_{SU:DAT}$ | Data Setup time | | 100 | | | nS |
| t_F | Clock/Data fall time | | | | 300 | nS |
| t_R | Clock/Data rise time | | | | 1000 | nS |

(1) All devices are 100% production tested at $T_A = +25^\circ\text{C}$; all specifications over the automotive temperature range is guaranteed by design, not production tested.

(2) The minimal clock frequency, 10 kHz which is compatible to SMBus specification. There is no limitation for I²C protocol; the minimal frequency is limited by time-out feature with 30 ms in typical, we recommend the minimal frequency of clock to be no lower than 100 Hz.

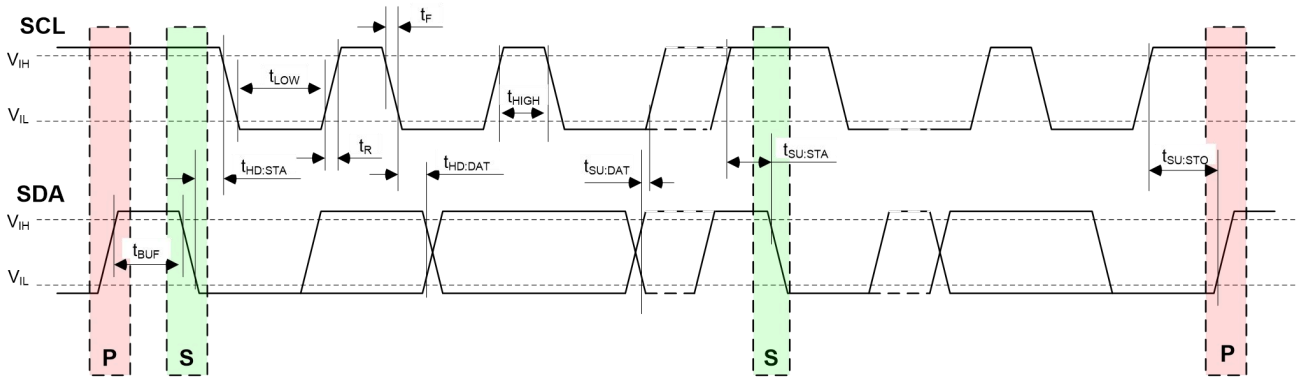


Figure-3. SMBus/I²C Timing Diagram

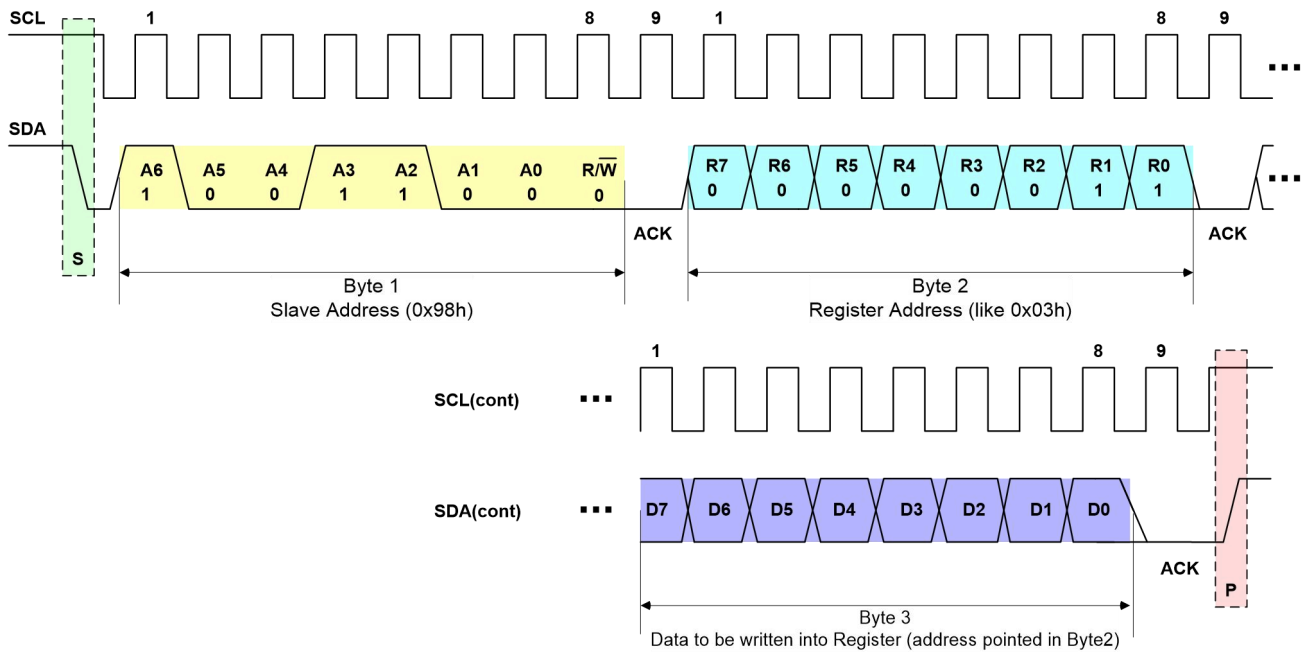


Figure-4. SMBus/I²C 1-Byte Write Timing Diagram

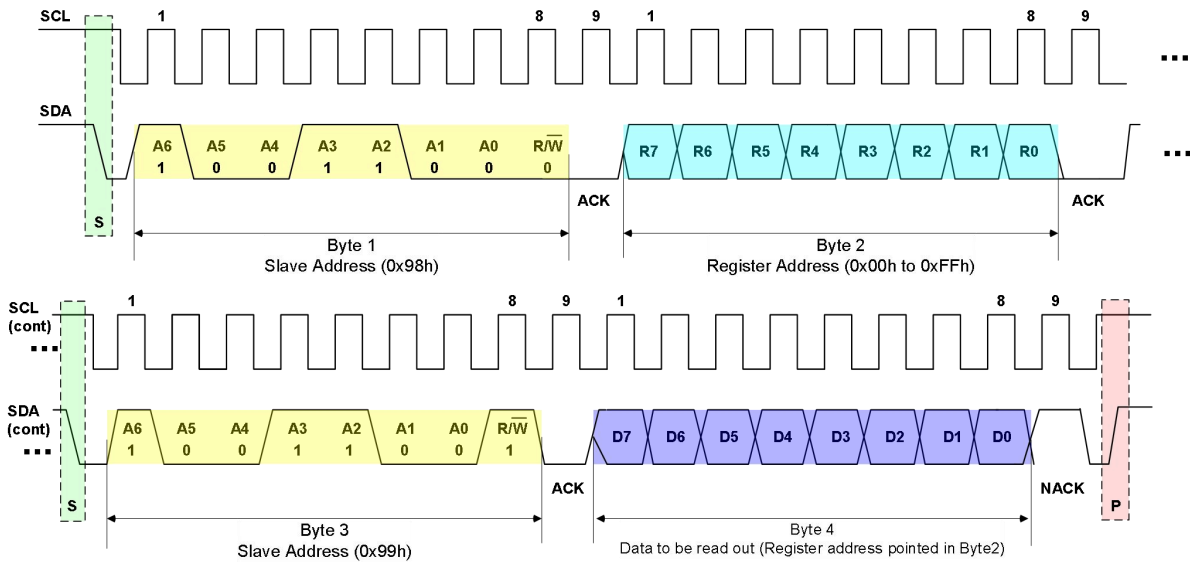


Figure-5. SMBus/I²C 1-Byte Read Timing Diagram

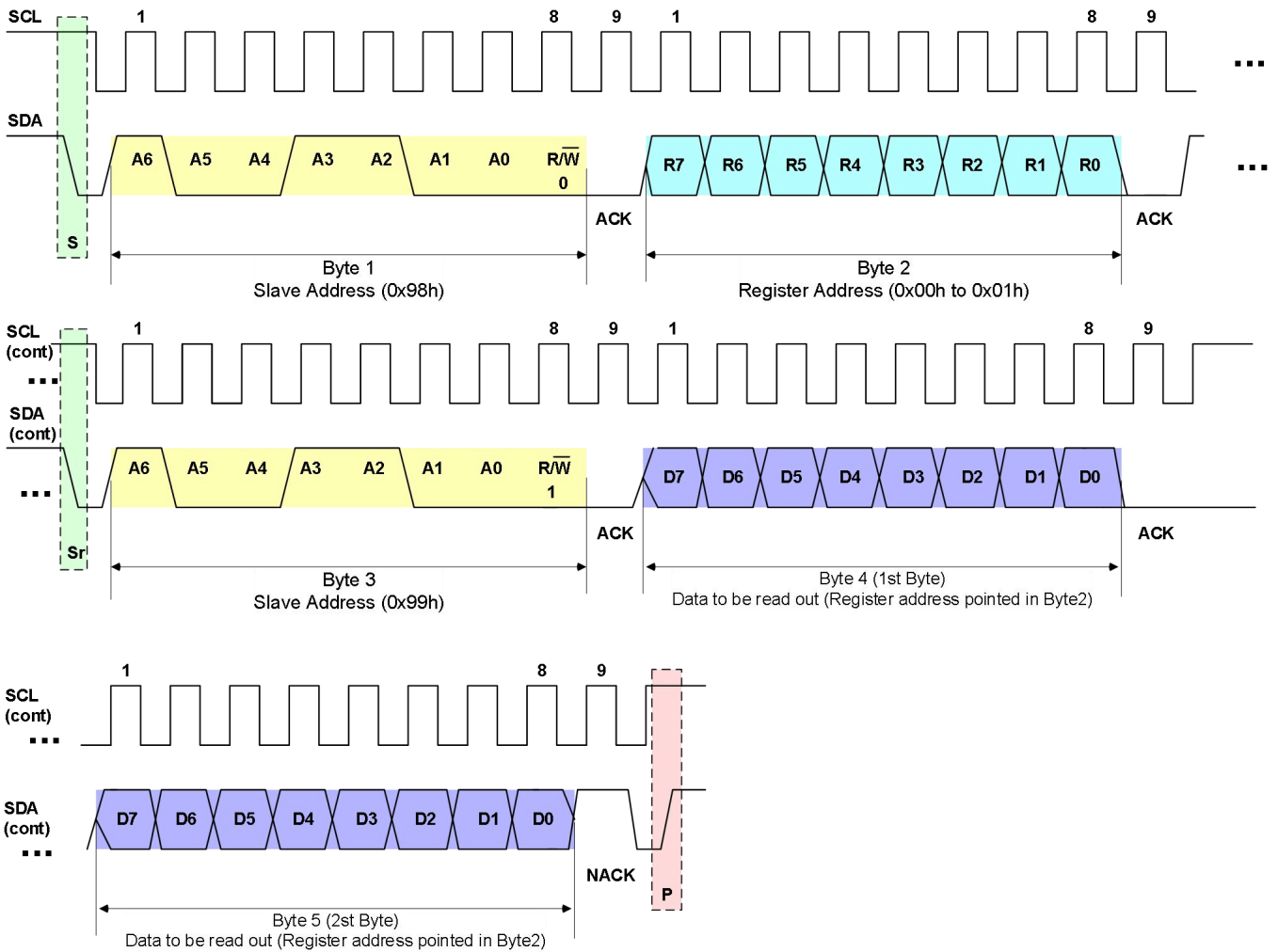


Figure-6. SMBus/I²C 2-Byte Read Timing Diagram

Function Description

Overview

The chip can sense 1 remote channel temperature and 1 local channel temperature and convert them into digital data by a 12-bit ADC. For remote channel, DP pin and DN pin has to connect PN junction, which could be a diode or a transistor (PNP or NPN type, can be diode-connected or transistor-connected). If user does not use the remote channel, please keep DP and DN pins short together.

Also the chip supports programmable high/low-limit temperature settings for both sensor channels independently. If the measured temperature of any channel drops below the low-limit or exceeds high-limit, ALERT pin will be asserted. If the measured temperature of any channel exceeds THERM limit, THERM pin will be asserted. For remote channels' high/low-limit temperature setup registers, there are 2 registers including MSB and LSB respectively. For THERM limit temperature setup register, there is a hysteresis temperature setup register, which affects both local and remote channels.

Digital Output of Temperature Data

The temperature measurement data is stored in Read Only temperature register for both local and remote channels. The temperature register is in 12-bit standard binary format (set RANGE bit as '0', bit2 of Config register) or 12-bit extended binary format (set RANGE bit as '1', bit2 of Config register) with 2-Bytes. This 2-Bytes Temperature data can be read at the same time in one reading cycle, 1st Byte is MSB followed by 2nd Byte, the LSB although their register address is not adjacent. For examples, local temperature, register address is 0x00 (MSB) and 0x15 (LSB). The relationship between Temperature data in Celsius degree and binary data is shown as below tables.

Table 1. Sensor Temperature in 12-bit Digital Data (RANGE bit = 0, default)

| Measured Temperature (°C) | Register Temperature (°C) | 12-bit Digital Output (HEX) | 8-bit Digital Output (BIN)(MSB) | 4-bit Digital Output (BIN)(LSB) |
|---------------------------|---------------------------|-----------------------------|---------------------------------|---------------------------------|
| +150.000 | +127.9375 | 0x7FF0 | 0 1 1 1, 1 1 1 1 | 1 1 1 1, 0 0 0 0 |
| +127.9375 | +127.9375 | 0x7FF0 | 0 1 1 1, 1 1 1 1 | 1 1 1 1, 0 0 0 0 |
| +100.500 | +100.500 | 0x6480 | 0 1 1 0, 0 1 0 0 | 1 0 0 0, 0 0 0 0 |
| +25.750 | +25.750 | 0x19C0 | 0 0 0 1, 1 0 0 1 | 1 1 0 0, 0 0 0 0 |
| 0.000 | 0.000 | 0x0000 | 0 0 0 0, 0 0 0 0 | 0 0 0 0, 0 0 0 0 |
| -25.750 | 0.000 | 0x0000 | 0 0 0 0, 0 0 0 0 | 0 0 0 0, 0 0 0 0 |
| -40.000 | 0.000 | 0x0000 | 0 0 0 0, 0 0 0 0 | 0 0 0 0, 0 0 0 0 |

Table 2. Sensor Temperature in 12-bit Digital Data (RANGE bit = 1, default)

| Measured ⁽¹⁾ Temperature (°C) | Register Temperature (°C) | 12-bit Digital Output (HEX) | 8-bit Digital Output (BIN)(MSB) | 4-bit Digital Output (BIN)(LSB) |
|--|---------------------------|-----------------------------|---------------------------------|---------------------------------|
| +191.9375 | +255.9375 | 0xFFFF | 1 1 1 1, 1 1 1 1 | 1 1 1 1, 0 0 0 0 |
| +150.000 | +214.000 | 0xD600 | 1 1 0 1, 0 1 1 0 | 0 0 0 0, 0 0 0 0 |
| +127.9375 | +191.9375 | 0xBFF0 | 1 0 1 1, 1 1 1 1 | 1 1 1 1, 0 0 0 0 |
| +100.500 | +164.500 | 0xA480 | 1 0 1 0, 0 1 0 0 | 1 0 0 0, 0 0 0 0 |
| +25.750 | +89.750 | 0x59C0 | 0 1 0 1, 1 0 0 1 | 1 1 0 0, 0 0 0 0 |
| 0.000 | +64.000 | 0x4000 | 0 1 0 0, 0 0 0 0 | 0 0 0 0, 0 0 0 0 |
| -25.750 | +38.250 | 0x2640 | 0 0 1 0, 0 1 1 0 | 0 1 0 0, 0 0 0 0 |
| -40.000 | +24.000 | 0x1800 | 0 0 0 1, 1 0 0 0 | 0 0 0 0, 0 0 0 0 |
| -64.000 | 0.000 | 0x0000 | 0 0 0 0, 0 0 0 0 | 0 0 0 0, 0 0 0 0 |

(1) Measured Temperature (°C) = Register Temperature (°C) – 64(°C)

Temperature Higher than 128°C

When measured temperature of local and/or remote channels is equal or higher than 128°C, set RANGE (bit2 of Config Register) as '1' will extend the temperature range from 0°C to 127°C into -64°C to 191°C. The difference is bit7 of temperature MSB data is used as 128°C in extended format. Once this bit is set as '1', user has to note that:

- 1). the actual measured temperature is calculated by register temperature minus 64°C;
- 2). It has to keep high/low-limit alert temperature registers as the same format as temperature data always;
- 3). although the expression temperature is -64°C to 191°C in this mode, for this sensor chip, it is better to keep within -40°C to 125°C, for external thermal diodes or transistors, it is better to keep within -55°C to 150°C.

Table 3. Temperature Range Setup

| Bit2 (RANGE) of Config Register | Temperature Range (°C) | Register Range (HEX, MSB only) |
|---------------------------------|------------------------|--------------------------------|
| 0 (default) | 0 to 127 | 0x00 to 0x7F |
| 1 | -64 to 191 | 0x00 to 0xFF |

Also the offset register for remote channel will affect the temperature register data directly whatever in default or extended mode. For example,

RT_OFS_MSB = 0x00 (0), RT_MSB = 0x19 (25), temperature is 25°C;

Set RT_OFS_MSB = 0x10 (16), then RT_MSB becomes 0x29 (41), temperature is still 41°C - 16°C = 25°C, assuming ambient temperature has no change; however temperature data gets 41°C, which is caused by plus offset data.

| | OFFSET Register Address | | | |
|----------------|-------------------------|---------|------|---------|
| | MSB | Default | LSB | Default |
| Remote Channel | 0x11 | 0x00 | 0x12 | 0x00 |

Register Map (All registers are shown as below table.) ⁽¹⁾
Table 4. PJ85451 Register Map

| Address | Register Name | Attribution | Default Data | BIT | | | | | | | |
|---------|---------------------|-------------|--------------|----------------|------|--------|------|--------------|-------|------|------|
| | | | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 0x00 | LT_MSB | R/O | N/A | LT11 | LT10 | LT9 | LT8 | LT7 | LT6 | LT5 | LT4 |
| 0x01 | RT_MSB | R/O | N/A | RT11 | RT10 | RT9 | RT8 | RT7 | RT6 | RT5 | RT4 |
| 0x02 | STATUS | R/O | N/A | ADC_B | LTHA | LTLA | RTHA | RTLA | RDO | RTHM | LTHM |
| 0x03 | Config | R/O | 0x00 | ALTMASK | STB | ALT_TM | RSV | RSV | RANGE | RSV | RSV |
| 0x04 | Conv_Rate | R/O | 0x08 | RSV | RSV | RSV | RSV | CR3 | CR2 | CR1 | CR0 |
| 0x05 | LT_HAT | R/O | 0x55 | LTHAT[7:0] | | | | | | | |
| 0x06 | LT_LAT | R/O | 0x00 | LTLAT[7:0] | | | | | | | |
| 0x07 | RT_HAT_MSB | R/O | 0x55 | RTHAT[11:4] | | | | | | | |
| 0x08 | RT_LAT_MSB | R/O | 0x00 | RTLAT[11:4] | | | | | | | |
| 0x09 | Config | R/W | 0x00 | ALTMASK | STB | ALT_TM | RSV | RSV | RANGE | RSV | RSV |
| 0x0A | Conv_Rate | R/W | 0x08 | RSV | RSV | RSV | RSV | CR3 | CR2 | CR1 | CR0 |
| 0x0B | LT_HAT | R/W | 0x55 | LTHAT[7:0] | | | | | | | |
| 0x0C | LT_LAT | R/W | 0x00 | LTLAT[7:0] | | | | | | | |
| 0x0D | RT_HAT_MSB | R/W | 0x55 | RTHAT[11:4] | | | | | | | |
| 0x0E | RT_LAT_MSB | R/W | 0x00 | RTLAT[11:4] | | | | | | | |
| 0x0F | One_Shot | W/O | | X | X | X | X | X | X | X | X |
| 0x10 | RT_LSB | R/O | N/A | RT3 | RT2 | RT1 | RT0 | 0 | 0 | 0 | 0 |
| 0x11 | RT_OFS_MSB | R/W | 0x00 | RT_OFS[11:4] | | | | | | | |
| 0x12 | RT_OFS_LSB | R/W | 0x00 | RT_OFS[3:0] | | | | 0 | 0 | 0 | 0 |
| 0x13 | RT_HAT_LSB | R/W | 0x00 | RTHAT[3:0] | | | | 0 | 0 | 0 | 0 |
| 0x14 | RT_LAT_LSB | R/W | 0x00 | RTLAT[3:0] | | | | 0 | 0 | 0 | 0 |
| 0x15 | LT_LSB | R/O | N/A | LT3 | LT2 | LT1 | LT0 | 0 | 0 | 0 | 0 |
| 0x19 | RT_THERM_LIMIT | R/W | 0x6C | RT_THERM[7:0] | | | | | | | |
| 0x20 | LT_THERM_LIMIT | R/W | 0x55 | LT_THERM[7:0] | | | | | | | |
| 0x21 | THERM_HYS | R/W | 0x0A | THERM_HYS[7:0] | | | | | | | |
| 0x22 | ALT_CON | R/W | 0x01 | SMBTO | 0 | 0 | 0 | ALT_CON[2:0] | | | 1 |
| 0x23 | n_Factor_Correction | R/W | 0x00 | RT_nFC[7:0] | | | | | | | |
| 0xFE | Manufactory ID | R/O | 0x59 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 |

(1) R/W -- Readable/Writable; R/O -- read only; W/O -- write only; X -- do not care whatever '0' or '1'. RSV -- Reserved; N/A -- Not applicable.

Register Description

LT, Local Channel Temperature Data Register, including LT_MSB, LT_LSB Data

- Register Address: 0x00 (LT_MSB), 0x15 (LT_LSB)
- Register Attribution: Read only
- Default Data: N/A

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|--------------------------|----------------------|------|-----|-----|-----|-----|-----|-----|
| Name: LT_MSB | LT [11:4] | | | | | | | |
| Temperature Data (°C) | 0/128 ⁽¹⁾ | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| 12-bit format Definition | LT11 | LT10 | LT9 | LT8 | LT7 | LT6 | LT5 | LT4 |

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|--------------------------|----------|------|-------|--------|---|---|---|---|
| Name: LT_LSB | LT [3:0] | | | | | | | |
| Temperature Data (°C) | 0.5 | 0.25 | 0.125 | 0.0625 | 0 | 0 | 0 | 0 |
| 12-bit format Definition | LT3 | LT2 | LT1 | LT0 | 0 | 0 | 0 | 0 |

(1) RANGE bit = 0, bit7 is used as 0 always; RANGE bit = 1, bit7 is used as 128°C;

LT [11:4], it is local channel MSB data, plus LT [3:0], local channel LSB data forms complete local channel temperature data with 12-bit, 0.0625°C resolution. The chip also supports reading 2-bytes command for temperature data via I²C bus. For examples, user can read 2-bytes from register address, 0x00, and then 2-bytes temperature data (MSB and LSB) can be obtained by once reading command. The 1st byte data is from register address 0x00, and the 2nd byte data is from register address 0x15. Similarly usage for remote channel, user can also read 2-bytes temperature data from register address 0x01 for remote channel. User can obtain both MSB and LSB temperature data for remote channel. This feature can make sure temperature data is integrated and proper, comes from the same time of ADC conversion.

RT, Remote Channel Temperature Data Register, including RT_MSB, RT_LSB Data

- Register Address: 0x01 (RT_MSB), 0x10 (RT_LSB)
- Register Attribution: Read only
- Default Data: N/A

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|--------------------------|-----------|------|-----|-----|-----|-----|-----|-----|
| Name: RT_MSB | RT [11:4] | | | | | | | |
| Temperature Data (°C) | 0/128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| 12-bit format Definition | RT11 | RT10 | RT9 | RT8 | RT7 | RT6 | RT5 | RT4 |

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|--------------------------|----------|------|-------|--------|---|---|---|---|
| Name: RT_LSB | RT [3:0] | | | | | | | |
| Temperature Data (°C) | 0.5 | 0.25 | 0.125 | 0.0625 | 0 | 0 | 0 | 0 |
| 12-bit format Definition | RT3 | RT2 | RT1 | RT0 | 0 | 0 | 0 | 0 |

RT [11:4], it is remote channel MSB data, plus RT [3:0], remote channel LSB data forms complete remote channel temperature data with 12-bit, 0.0625°C resolution.

STATUS, to indicate the chip alert status

- Register Address: 0x02
- Register Attribution: Read only
- Default Data: N/A

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---------|-------|------|------|------|-------|-----|------|------|
| Name | ADC_B | LTHA | LTLA | RTHA | RTL A | RDO | RTHM | LTHM |
| Default | N/A | | | | | | | |

| BIT | Name | Description |
|-----|-------|--|
| 7 | ADC_B | 1 – means ADC is busy for temperature converting |
| 6 | LTHA | 1 – means temperature in local channel is higher than that of setup in local channel high-limit register, alert active |
| 5 | LTLA | 1 – means temperature in local channel is lower than or equal to that of setup in local channel low-limit register, alert active |
| 4 | RTHA | 1 – means temperature in remote channel is higher than that of setup in remote channel high-limit register, alert active |
| 3 | RTL A | 1 – means temperature in remote channel is lower than or equal to that of setup in remote channel low-limit register, alert active |
| 2 | RDO | 1 – means remote channel diode is open/disconnected |
| 1 | RTHM | 1 – means remote channel THERM alarm active |
| 0 | LTHM | 1 – means local channel THERM alarm active |

Config, Configuration Setup Register

- Register Address & Attribution: 0x03 (R/O), 0x09 (R/W)
- Default Data: 0x00 after POR

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|------------|--------|-----|--------|-----|-----|-------|-----|-----|
| Definition | ALTMSK | STB | ALT_TM | RSV | RSV | RANGE | RSV | RSV |
| Default | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

◆ ALTMSK, ALERT trigger event mask bit

This bit allows user to mask ALERT trigger event.

Set this bit as '1', means mask ALERT trigger event caused by the temperature (local or remote) exceeds high/low-limit register value, or remote channel thermal diode is open. The default is 0, means ALERT trigger happens once triggered.

◆ STB, Standby bit

This bit allows user to shut down the chip and to make the chip enter into standby mode once writing '1'. The default value is '0' which sets the chip to be in normal RUN mode. During shutdown mode, the temperature data is kept at that of last time, no more update, and all function blocks are turned-off except interface. Setting SD bit as '0' can allow the chip be out of shutdown mode. In shutdown mode, the quiescent current is about 3.0 μ A.

◆ ALT_TM, PIN6 configured bit

- This bit allows user to configure PIN6 as ALERT or THERM2 function.
- Set this bit as '0', PIN6 is configured as ALERT pin;
- Set this bit as '1', PIN6 is configured as 2nd THERM (THEM2) pin;

◆ RANGE, Extended temperature range bit

This bit allows user to select standard format with 12-bit binary (RANGE = 0) or extended format 12-bit (RANGE = 1) temperature data. When this bit is set as default as '0', the temperature resolution is 0.0625°C and temperature range is around 128°C from 0°C to +127.9375°C. When this bit is set as '1', the temperature resolution is still 0.0625°C and temperature range is around 256°C from -64°C to +191.9375°C.

Conv_Rate, Conversion Rate Setup Register of ADC

- Register Address & Attribution: 0x04 (Read Only) and 0x0A (Read/Write)
- Default Data: 0x08

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---------|----------|---|---|---|-----------------|---|---|---|
| Name | Reserved | | | | Conv_Rate [3:0] | | | |
| Default | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |

| BIT | NAME | Description | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|------|-----------------|---|------|--------|---------------------|------|--------|----|------|-------|---|------|------|---|------|-----|---|------|-----|---|------|-----|-----|------|-----|------|------|-----|-------|------|----|------------------|------|----|--------|
| 7:4 | Reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3:0 | Conv_Rate [3:0] | Conversion Rate Selection, <table border="1"> <thead> <tr> <th>Code</th> <th>Cons/s</th> <th>Conversion Time (s)</th> </tr> </thead> <tbody> <tr><td>0000</td><td>0.0625</td><td>16</td></tr> <tr><td>0001</td><td>0.125</td><td>8</td></tr> <tr><td>0010</td><td>0.25</td><td>4</td></tr> <tr><td>0011</td><td>0.5</td><td>2</td></tr> <tr><td>0100</td><td>1.0</td><td>1</td></tr> <tr><td>0101</td><td>2.0</td><td>0.5</td></tr> <tr><td>0110</td><td>4.0</td><td>0.25</td></tr> <tr><td>0111</td><td>8.0</td><td>0.125</td></tr> <tr><td>1000</td><td>16</td><td>0.0625 (default)</td></tr> <tr><td>1001</td><td>16</td><td>0.0625</td></tr> </tbody> </table> | Code | Cons/s | Conversion Time (s) | 0000 | 0.0625 | 16 | 0001 | 0.125 | 8 | 0010 | 0.25 | 4 | 0011 | 0.5 | 2 | 0100 | 1.0 | 1 | 0101 | 2.0 | 0.5 | 0110 | 4.0 | 0.25 | 0111 | 8.0 | 0.125 | 1000 | 16 | 0.0625 (default) | 1001 | 16 | 0.0625 |
| Code | Cons/s | Conversion Time (s) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0000 | 0.0625 | 16 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0001 | 0.125 | 8 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0010 | 0.25 | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0011 | 0.5 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0100 | 1.0 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0101 | 2.0 | 0.5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0110 | 4.0 | 0.25 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0111 | 8.0 | 0.125 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1000 | 16 | 0.0625 (default) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1001 | 16 | 0.0625 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

LT_HAT, Local Channel high-limit ALERT Temperature

- Register Address & Attribution: 0x05 (Read Only) and 0x0B (Read/Write)
- Default Data: 0x55, which means the local high-limit alert temperature is 85°C

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---------------|--------------|----|----|----|---|---|---|---|
| Name | LT_HAT [7:0] | | | | | | | |
| Data [°C] | 0/128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| Default: 0x55 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |

LT_LAT, Local Channel low-limit ALERT Temperature

- Register Address & Attribution: 0x06 (Read Only) and 0x0C (Read/Write)
- Default Data: 0x00, which means the local low-limit alert temperature is 0°C

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---------------|--------------|----|----|----|---|---|---|---|
| Name | LT_LAT [7:0] | | | | | | | |
| Data [°C] | 0/128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| Default: 0x00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

RT_HAT_MSB, Remote Channel high-limit ALERT Temperature MSB Data

- Register Address & Attribution: 0x07 (Read Only) and 0x0D (Read/Write)
- Default Data: 0x55, which means the remote high-limit alert temperature is 85°C

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---------------|------------------|----|----|----|---|---|---|---|
| Name | RT_HAT_MSB [7:0] | | | | | | | |
| Data [°C] | 0/128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| Default: 0x55 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |

RT_LAT_MSB, Remote Channel low-limit ALERT Temperature MSB Data

- Register Address & Attribution: 0x08 (Read Only) and 0x0E (Read/Write)
- Default Data: 0x00, which means the remote channel low-limit alert temperature is 0°C

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---------------|--------------|----|----|----|---|---|---|---|
| Name | LT_LAT [7:0] | | | | | | | |
| Data [°C] | 0/128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| Default: 0x00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

One-shot, One shot Conversion Start Register

- Register Address: 0x0F
- Register Attribution: Write only
- Default Data: N/A after POR

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|------------|---|---|---|---|---|---|---|---|
| Definition | x | x | x | x | x | x | x | x |

This register allows user to perform one time temperature conversion for all channels when the device is in shutdown mode, by writing any value into this register. The device returns to shutdown mode again once it completes the one time conversion. This feature is used for reducing power consumption when continuous temperature monitoring is not necessary. One-shot command is ignored issued during a conversion.

RT_LSB, Remote Channel Temperature LSB Data

- Register Address: 0x10
- Register Attribution: Read only
- Default Data: 0x00 after POR

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-----------------------|---|------|-------|--------|----------|---|---|---|
| Name | RT [3:0], LSB data, plus MSB data RT [11:4] forms complete remote channel Temperature Data. | | | | | | | |
| Temperature Data (°C) | 0.5 | 0.25 | 0.125 | 0.0625 | Reserved | | | |

RT_OFS_MSB, Remote Channel OFFSET Temperature MSB Data

- Register Address: 0x11
- Register Attribution: Read/Write
- Default Data: 0x00 after POR

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-----------------------|---|----|----|----|---|---|---|---|
| Name | RT_OFS [11:4], Remote Channel Offset Temperature MSB data, plus LSB data RT_OFS [3:0] forms complete Offset Temperature Data. | | | | | | | |
| Temperature Data (°C) | 0/128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |

The data contributed by complete offset temperature register (RT_OFS_MSB + RT_OFS_LSB) will be added into remote channel temperature data. For example,

RT_OFS_MSB = 0x05h; RT_OFS_LSB = 0x00h;

Offset temperature data is +5.0°C, assume the original remote channel temperature data is 20.0°C, plus this offset, the final temperature data will be 25.0°C. The minimum offset data can be programmed is -128°C, and the maximum is +127.9375°C.

RT_OFS_LSB, Remote Channel OFFSET Temperature LSB Data

- Register Address: 0x12
- Register Attribution: Read/Write
- Default Data: 0x00 after POR

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-----------------------|---|------|-------|--------|----------|---|---|---|
| Name | RT_OFS [11:4], Remote Channel Offset Temperature MSB data, plus LSB data RT_OFS [3:0] forms complete Offset Temperature Data. | | | | | | | |
| Temperature Data (°C) | 0.5 | 0.25 | 0.125 | 0.0625 | Reserved | | | |

RT_HAT_LSB, Remote Channel high-limit ALERT Temperature LSB Data

- Register Address: 0x13
- Register Attribution: Read/Write
- Default Data: 0x00

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-----------------------|--------------|------|-------|--------|----------|---|---|---|
| Name | RT_HAT [3:0] | | | | Reserved | | | |
| Temperature Data (°C) | 0.5 | 0.25 | 0.125 | 0.0625 | | | | |
| Default | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Combined with **RT_HAT_MSB (Add = 0x0D)** which forms complete high alert temperature data for remote channel. The minimum temperature data can be programmed is -128°C , and the maximum is $+127.9375^{\circ}\text{C}$.

RT_LAT_LSB, Remote Channel low-limit ALERT temperature LSB Data

- Register Address: 0x14
- Register Attribution: Read/Write
- Default Data: 0x00

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-----------------------|--------------|------|-------|--------|----------|---|---|---|
| Name | RT_LAT [3:0] | | | | Reserved | | | |
| Temperature Data (°C) | 0.5 | 0.25 | 0.125 | 0.0625 | | | | |
| Default | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Combined with **RT_LAT_MSB (Add = 0x0E)** which forms complete low alert temperature data for remote channel. The minimum temperature data can be programmed is -128°C , and the maximum is $+127.9375^{\circ}\text{C}$.

LT_LSB, Local Channel Temperature LSB Data

- Register Address: 0x15
- Register Attribution: Read only
- Default Data: 0x00

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-----------------------|---|------|-------|--------|----------|---|---|---|
| Name | LT [3:0], LSB data, plus MSB data LT [11:4] forms complete local channel Temperature Data | | | | | | | |
| Temperature Data (°C) | 0.5 | 0.25 | 0.125 | 0.0625 | Reserved | | | |

RT_THERM_LIMIT, Remote Channel THERM limit Temperature Setup

- Register Address: 0x19
- Register Attribution: Read/Write
- Default Data: 0x6C, which means high-limit, is set as 108°C for remote channel

LT_THERM_LIMIT, Local Channel THERM limit Temperature Setup

- Register Address: 0x20
- Register Attribution: Read/Write
- Default Data: 0x55, which means high-limit is set as 85°C for local channel

THERM_HYS, THERM Temperature Hysteresis Window

- Register Address: 0x21
- Register Attribution: Read/Write
- Default Data: 0x0A, stands for 10°C, the temperature range is -128°C to 127°C

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-----------|--|----|----|----|---|---|---|---|
| Name | THERM_HYS [7:0], range can be set from -128°C to 127°C | | | | | | | |
| Data [°C] | SIGN | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| Default | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |

ALT_CON, ALERT Consecutive Setup

- Register Address: 0x22
- Register Attribution: Read/Write
- Default Data: 0x01

| BIT | NAME | Description |
|-----|---------------|---|
| 7 | SMBTO | 0 – to disable SMBus time out; 1 – to enable SMBus time out; |
| 6:4 | RSV | Reserved |
| 3-0 | ALT_CON [3:0] | To setup the number of consecutive times to trig ALERT condition, 0000 – 1 0001 – 2 0011 – 3 0111 – 4 |

n-Factor_Correction, Remote Channel non-ideality Factor Correction Register

- Register Address: 0x23
- Register Attribution: Read/Write
- Default Data: 0x00

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|------------|------------------------------------|---|---|---|---|---|---|---|
| Name | Remote channel n-factor correction | | | | | | | |
| Definition | RT_nFC [7:0] | | | | | | | |
| Default | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

This chip allows user to select a different n-factor value changing the slope of remote channel temperature over full temperature range. This feature can be used to fit different remote PN junction. The register default value is 0x00 after POR, and n-Factor is 1.008.

| Hex (Register) | N _{DEC} | Binary | n _{NEW} |
|----------------|------------------|-----------|------------------|
| 0x7F | 127 | 0111 1111 | 0.950204 |
| 0x0A | 10 | 0000 1010 | 1.003195 |

| | | | |
|------|------|-----------|----------|
| 0x08 | 8 | 0000 1000 | 1.004152 |
| 0x06 | 6 | 0000 0110 | 1.005111 |
| 0x04 | 4 | 0000 0100 | 1.006072 |
| 0x02 | 2 | 0000 0010 | 1.007035 |
| 0x01 | 1 | 0000 0001 | 1.007517 |
| 0x00 | 0 | 0000 0000 | 1.00800 |
| 0xFF | -1 | 1111 1111 | 1.008483 |
| 0xFE | -2 | 1111 1110 | 1.008967 |
| 0xFC | -4 | 1111 1100 | 1.009935 |
| 0xFA | -6 | 1111 1010 | 1.010905 |
| 0xF8 | -8 | 1111 1000 | 1.011877 |
| 0xF6 | -10 | 1111 0110 | 1.012851 |
| 0x80 | -128 | 1000 0000 | 1.073828 |

In above table, the column 'Hex' is the data to be written into n-Factor register, the related n-Factor is shown in column 'n_{NEW}'. For example, if writing data 0x0A into Register address 0x23, then n-Factor will be changed into 1.003195 from default 1.008. The relationship between register data and n can be expressed by below equation.

$$n_{NEW} = \frac{1.008 \times 2088}{2088 + N_{DEC}}$$

n_{NEW}, final n value after writing new data into register.

N_{DEC}, Register data expressed in Decimal, which is in two's complement format.

Manufactory ID

- Register Address: 0xFE
- Register Attribution: Read only
- Default Data: 0x59 after POR

SMBus Digital Interface

Slave Address

The SMBus or I²C slave address of this device is 10011000b (0x98h in HEX) in write mode, and 10011001b (0x99h in HEX) in read mode. If 2 or more of these devices in one SMBus are used, customers have to select thermal channel with different slave address. Please contact MetaWells sales for more information.

| | A6 | A5 | A4 | A3 | A2 | A1 | A0 | R/W |
|-------|----|----|----|----|----|----|----|-----|
| Read | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 |
| Write | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |

Timeout

The chip supports SMBus timeout. If the data (SDA PIN) or clock (SCL PIN) is held low for longer than 30 ms (Typ.), the chip will reset its SMBus protocol and be ready for a new transmission when the timeout feature is enabled, SMBTO bit is set as '1'.

SMBus Protocol

The chip supports four standard SMBus protocols Send Byte, Read Byte, Write Byte and Receive Byte, shown as below tables.

Write Byte

| S | Slave Add | R/W | ACK | Reg Add | ACK | Reg Data | ACK | P |
|---|-----------|-----|-----|-----------|-----|----------|-----|---|
| | | 0 | 0 | Like 0x09 | 0 | XXh | 0 | |

Read Byte

| S | Slave Add | R/W | ACK | Reg Add | ACK | S | Slave Add | R/W | ACK | Reg Data | NACK | P |
|---|-----------|-----|-----|-----------|-----|---|-----------|-----|-----|------------------|------|---|
| | | 0 | 0 | Like 0x00 | 0 | | | 1 | 0 | XXh ¹ | 1 | |

Send Byte

| S | Slave Add | R/W | ACK | Reg Add | ACK | P |
|---|-----------|-----|-----|---------|-----|---|
| | | 0 | 0 | XXh | 0 | |

Receive Byte

| S | Slave Add | R/W | ACK | Reg Add | NACK | P |
|---|-----------|-----|-----|---------|------|---|
| | | 1 | 0 | XXh | 1 | |

Here S means SMBus Start to communication with master, P, means communication STOP. Slave Add, means the chip's slave address. Reg Add, means pointed Register Address. Reg Data, means data to be written into register or read from register. For this chip, there is a 1 byte data for each register address, so generally reading or writing operation is based on 1-Byte. For temperature data, it is permitted to read 2 bytes for reading operation, then the MSB and LSB data will be obtain one time.

Compatible with I²C

The chip is compatible with both SMBus and I²C. And the major difference between SMBus and I²C are shown as below. For more information, refer to SMBus specification v2.0 and I²C specification v2.1.

- 1). This chip supports I²C fast mode (400 kHz) and standard mode (100 kHz), which can cover SMBus maximum frequency 100 kHz.
- 2). For SMBus protocol, the minimum frequency is 10 kHz. There is no such limitation for I²C.
- 3). For SMBus protocol, slave device will reset if hold clock at '0' longer than 30 ms. There is no timeout for I²C.

Applications Information

How to Improve Temperature Accuracy

The temperature measurement of the chip is based on semiconductor physics principle. Forward voltage of diode is a function of temperature. The formula is shown as below.

$$V_F = \frac{kT}{q} \ln\left(\frac{I_F}{I_S}\right)$$

Here,

V_F – forward voltage

I_F – forward current

I_S – reverse saturation current

k – Boltzmann constant

T – Temperature in K

q – Electric charge constant

To cover wide temperature range, i.e. -40°C to 125°C , a very small voltage variation is corresponding to every degree C temperature change. MetaWells has applied many ways to improve measurement accuracy in chip circuits design, such as compensation, trimming etc. In real system design, however, some factors that can increase measurement error need to be considered. Most issues that usually occur are highlighted as below.

Noise between V_{CC} and GND, DP and DN

It is very necessary to place a low ESR ceramic cap (C_{IN}) between V_{CC} and GND pin to filter digital noise, although suppression noise circuit has been built inside the chip. This filter cap should be placed as close as possible to the chip. The recommended capacitance is $0.1 \mu\text{F}$.

In most applications, the remote diode could be located in noise environment. Generally $200 \mu\text{V}$ stands for about 1°C , any common-mode noise between DP and DN pin will cause temperature measurement error. The better way to use serial resistor (R_s) plus Differential Capacitor (C_d) to filter noise coupled to DP, DN wire. The sensor chip built-in serial resistor cancellation circuits which can remove the temperature measurement error caused by R_s . The maximum resistance does not exceed 1.0 kohm for R_s . For the differential capacitor, it will affect setup and sampling time of AD converter, so the maximum capacitance does not exceed 1000 pF . For example, $R_s = 50 \text{ ohm}$, $C_d = 100 \text{ pF}$.

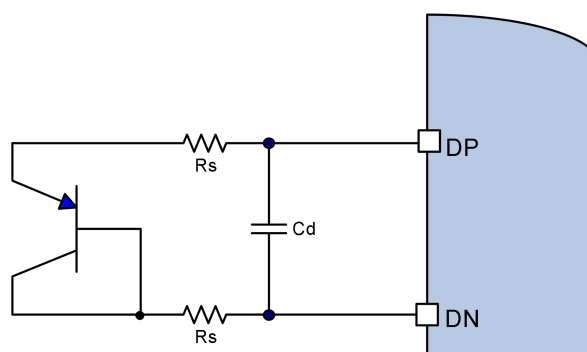


Figure-7. R_s and C_d for Remote Channel

Contact and Position

For remote channel, using parasitic PNP transistor of CPU/FPGA die as thermal transducer, it is ideal to monitor CPU/FPGA die temperature, and there is no contact issue. However using individual diode or transistor as thermal transducer, since there is always certain distance from target chip soldering on the same PCB, which caused temperature difference caused by thermal gradient. It is the better way to place individual diode or transistor with small package as close as target chip, or PCB bottom side of target chip.

Time Constant

It is very necessary to wait enough time for obvious temperature changing of target due to thermal time constant, e.g. food temperature could change from -20°C to 20°C when taken out of refrigerator, which could take over ten minutes to reach thermal equilibrium eventually. Enough time is still needed for the target to reach thermal equilibrium, even forcing temperature transient into target object. For this chip, the time constant of thermal transient is about 2.0 s. 5-7 times time constant, which means the temperature data after waiting for 10.0 s to 14.0 s is reliable once target temperature is changed every time.

Self-heating

For local sensor, self-heating could affect temperature measurement accuracy. It always brings positive error. It could be estimated as below steps.

Step-1, Estimating the chip power consumption, caused by average operating current and sink current at $P_d = V_{CC} \times I_{AOC} = 5.0 \text{ V} \times 40 \text{ } \mu\text{A} = 200 \text{ } \mu\text{W}$

(Assuming V_{CC} is 5.0 V, conversion rate is 1.0 Hz.)

Step-2, Estimating junction temperature error caused by power consumption,

$$\Delta T_j = P_d \times \theta_{J-A} = 200 \text{ } \mu\text{W} \times 120 \text{ } ^\circ\text{C}/\text{W} = 0.024 \text{ } ^\circ\text{C}$$

The temperature error caused by self-heating is about 0.024°C, which can be ignored in most applications.

For this package, thermal resistance of junction-to-air is 120°C /W.

PCB Layout

Cautions below are important to improve temperature measurement in PCB layout design.

Device placement

It is better to place the chip away from any thermal source (e.g. power device in board), high speed digital bus (e.g. memory bus), coil device (e.g. inductors) and wireless antenna (e.g. Bluetooth, WiFi, RF). It is recommended to place the chip close to the remote diode.

C_{IN} , Pull-up resistor

It is better to place C_{IN} as close as possible to V_{CC} and GND pins of the chip. The recommended C_{IN} value is 0.1 μF with low ESR ceramic cap although using multi caps, such as 1.0 μF plus 0.1 μF or 0.01 μF , is ok, which can suppress digital noise with different frequency range.

User has to put a pull-up resistor with 4.7 k to 10 k for SDA and SCL pins respectively. It is ok to use smaller resistors such as 2 k to 3 k in real application, if multi SMBus/I²C devices are used in the same bus.

Shield DP and DN, using Twisted Cable

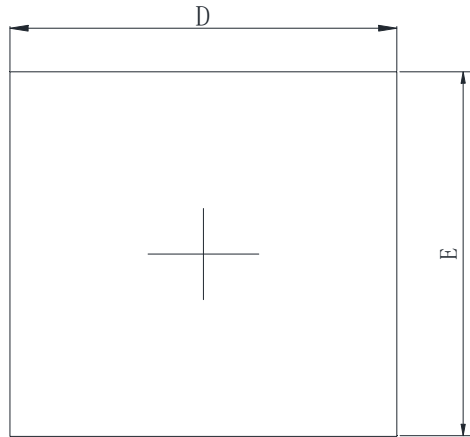
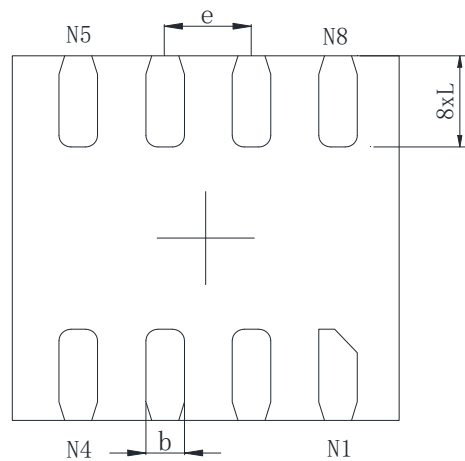
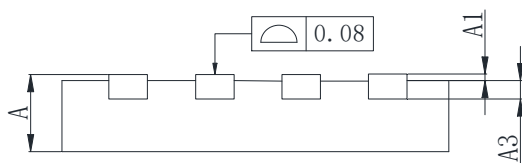
Another method is to use ground shield around the DP, DN pair trace, which could reduce digital noise. Route the DP and DN traces next to each other and shield them from adjacent signals through the use of ground guard traces. If using a multilayer PCB, bury these traces between ground or V_{CC} planes to shield them from extrinsic noise sources. 5 mil PCB traces are recommended. Twisted cable with shield is recommended for long distance

temperature measurement that uses a discrete diode or transistor as the remote sensor. Shield is shorted to ground.

Leakage from DP/DN to GND or V_{CC}

Another possibility caused temperature error is leakage path from DP/DN to GND or from DP/DN to V_{CC} . The leakage path caused by tight layout, assembly, splashing unclear water or some reason during production.

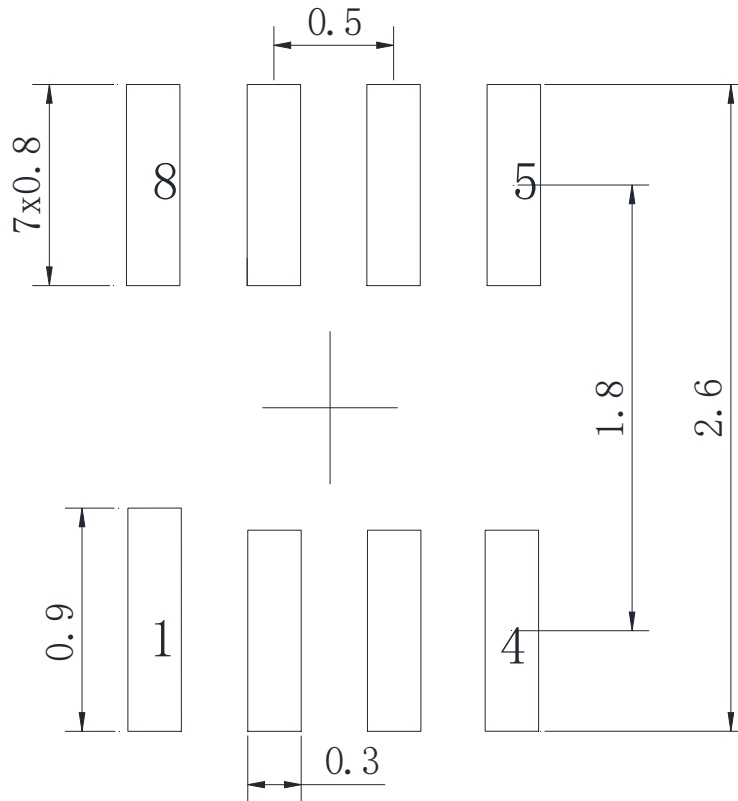
Package Outline Dimension – DFN2x2-8

DFN2x2-8 Unit (mm)

Top View

Bottom View

Side View

| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|--------|------------------------------|-------|-------------------------|-------|
| | Min. | Max. | Min. | Max. |
| A | 0.700 | 0.800 | 0.028 | 0.031 |
| A1 | 0.000 | 0.050 | 0.000 | 0.002 |
| A3 | 0.203REF. | | 0.008REF | |
| D | 1.900 | 2.100 | 0.075 | 0.083 |
| E | 1.900 | 2.100 | 0.075 | 0.083 |
| b | 0.200 | 0.300 | 0.008 | 0.012 |
| e | 0.500TYP. | | 0.020TYP | |
| L | 0.450 | 0.550 | 0.018 | 0.022 |

Package Outline Dimension – DFN2x2-8

DFN2x2-8 Unit (mm)



Notes:

- (1) All dimensions are in millimeter.
- (2) Recommend tolerance is within ± 0.1 mm.

Version History

| Version | Date | Changes |
|---------|------------|-----------------|
| Rev.1.0 | 2025-12-12 | Initial release |

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