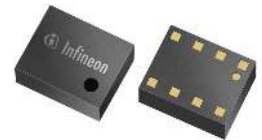


DPS310

Digital XENSIV™ Barometric Pressure Sensor for Portable Devices

Product Description

The DPS310 is a miniaturized Digital Barometric Air Pressure Sensor with a high accuracy and a low current consumption, capable of measuring both pressure and temperature. The pressure sensor element is based on a capacitive sensing principle which guarantees high precision during temperature changes. The small package makes the DPS310 ideal for mobile applications and wearable devices.



The internal signal processor converts the output from the pressure and temperature sensor elements to 24 bit results. Each unit is individually calibrated, the calibration coefficients calculated during this process are stored in the calibration registers. The coefficients are used in the application to convert the measurement results to high accuracy pressure and temperature values. The result FIFO can store up to 32 measurement results, allowing for a reduced host processor polling rate. Sensor measurements and calibration coefficients are available through the serial I²C or SPI interface. The measurement status is indicated by status bits or interrupts on the SDO pin.

Features

- **Operation range:** Pressure: 300 – 1200 hPa. Temperature: -40 – 85 °C.
- **Pressure sensor precision:** ± 0.002 hPa (or ±0.02 m) (high precision mode).
- **Relative accuracy:** ± 0.06 hPa (or ±0.5 m)
- **Absolute accuracy:** ± 1 hPa (or ±8 m)
- **Temperature accuracy:** ± 0.5°C.
- **Pressure temperature sensitivity:** 0.5Pa/K
- **Measurement time: Typical:** 27.6 ms for standard mode (16x). Minimum: 3.6 ms for low precision mode.
- **Average current consumption:** 1.7 µA for Pressure Measurement, 1.5µA for Temperature measurement @1Hz sampling rate, Standby: 0.5 µA.
- **Supply voltage:** VDDIO: 1.2 – 3.6 V, VDD: 1.7 – 3.6 V.
- **Operating modes:** Command (manual), Background (automatic), and Standby.
- **Calibration:** Individually calibrated with coefficients for measurement correction.
- **FIFO:** Stores up to 32 pressure or temperature measurements.
- **Interface:** I²C and SPI (both with optional interrupt)
- **Package dimensions:** 8-pin LGA, 2.0 mm x 2.5 mm x 1.0 mm.
- **Green Product (RoHS) Compliant**



Typical Applications

- **Indoor Navigation** (floor detection e.g. in shopping malls and parking garages)
- **Health and Sports** (accurate elevation gain and vertical speed)
- **Outdoor Navigation** (GPS start-up time and accuracy improvement, dead-reckoning e.g. in tunnels)
- **Weather Station** ('Micro-weather' and local forecasts)
- **HDD drivers**, (leak rate detection in hard disk drives)
- **Drones** (flight stability and height control)

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Definitions, acronyms and abbreviations

1 Definitions, acronyms and abbreviations

1.1 Definitions

An explanation of terms and definitions used in this datasheet.

Table 1

| Term | Definition/explanation |
|----------------------------------|---|
| Absolute accuracy | The absolute measurement accuracy over the entire measurement range. |
| Digital bit depth | The total bit depth used for conversion of the sensor input to the digital output. Measured in bits. |
| Digital resolution | The pressure value represented by the LSB change in output. This value should be much smaller than the sensor noise. |
| Full Scale Range (FSR) | The peak-to-peak measurement range of the sensor. |
| LSB | Least Significant Bit |
| Measurement time | The time required to acquire one sensor output result. This value determines the maximum measurement rate . |
| MSB | Most Significant Bit |
| Non-linearity | The deviation of measured output from the best-fit straight line, relative to 1000 hPa and 25 °C. |
| Output compensation | The process of applying an algorithm to the sensor output to improve the absolute accuracy of the sensor across temperature and to minimize unit to unit output variation. This algorithm makes use of both the temperature sensor readings and the individual calibration coefficients. |
| Precision (noise) | The smallest measurable change, expressed as rms, after sensor oversampling. |
| Pressure temperature coefficient | The pressure measurement deviation, after compensation, from expected measurement value due to temperature change from 25 °C. Measured in Pa/K. |
| Sensor calibration | The process, during the production test, where the sensor's measurement results are compared against reference values, and a set of calibration coefficients are calculated from the deviation. The coefficients are stored in the sensor's memory and are used in the output compensation. |
| Sensor oversampling rate (OSR) | Specifies the number of sensor measurements used internally to generate one sensor output result. |

Pin Configuration and Block Diagram

2 Pin Configuration and Block Diagram

2.1 Pin Configuration and Description

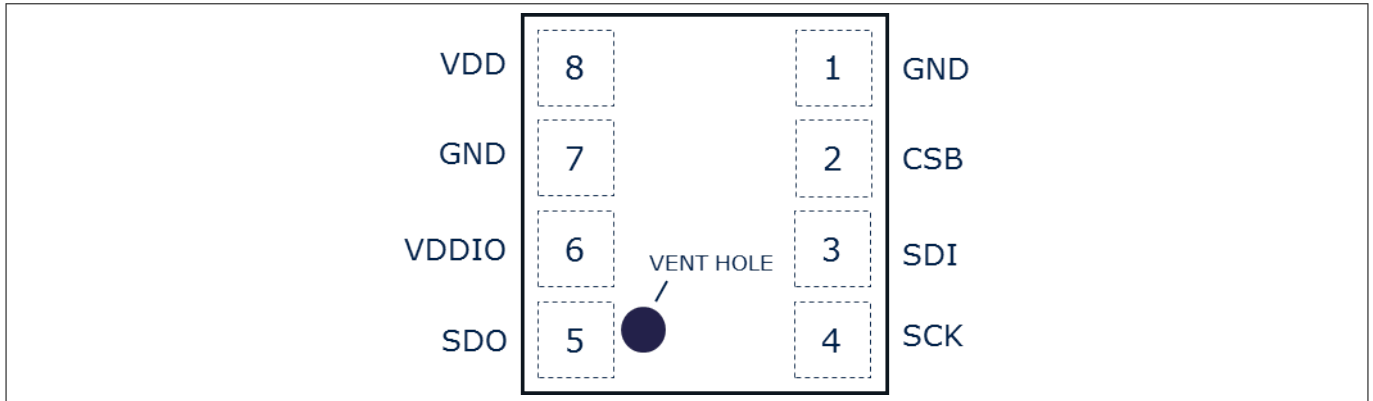


Figure 1 Pin configuration (top view, figure not to scale)

Table 2 Pin description

| Pin | Name | SPI 3-wire | SPI 3-wire with interrupt | SPI 4-wire | I ² C | I ² C with interrupt |
|-----|-------|---|---------------------------|--------------------------|--|--|
| 1 | GND | Ground | | | | |
| 2 | CSB | Chip select - active low | Chip select - active low | Chip select - active low | Not used - open (internal pull-up) or tie to VDDIO | Not used - open (internal pull-up) or tie to VDDIO |
| 3 | SDI | Serial data in/out | Serial data in/out | Serial data in | Serial data in/out | Serial data in/out |
| 4 | SCK | Serial Clock | | | | |
| 5 | SDO | Not used | Interrupt | Serial data out | Least significant bit in the device address. | Interrupt pin and least significant bit in the device address. |
| 6 | VDDIO | Digital supply voltage for digital blocks and I/O interface | | | | |
| 7 | GND | Ground | | | | |
| 8 | VDD | Supply voltage for analog blocks | | | | |

Specifications

2.2 Block Diagram

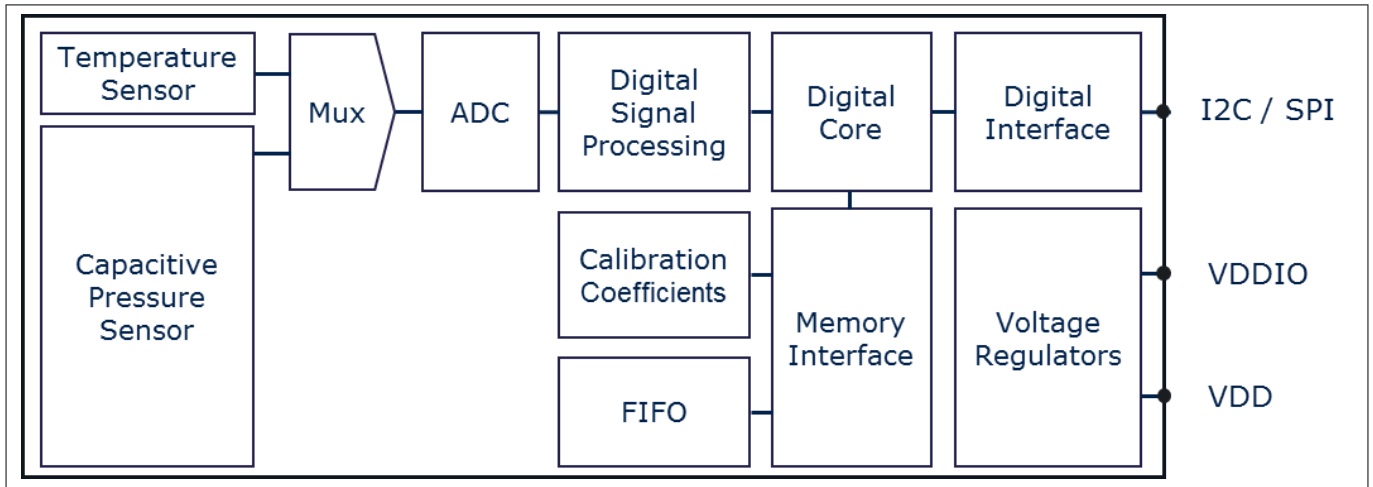


Figure 2

3 Specifications

3.1 Operating Range

The following operating conditions must not be exceeded in order to ensure correct operation of the device. All parameters specified in the following sections refer to these operating conditions, unless noted otherwise.

Table 3 Operating Range

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|-----------------------------|-------------|--------|------|------|------|--|
| | | Min. | Typ. | Max. | | |
| Pressure | P_a | 300 | | 1200 | hPa | |
| Temperature | T_a | -40 | | 85 | °C | |
| Supply voltage | V_{DD} | 1.7 | | 3.6 | V | |
| Supply voltage IO | V_{DDIO} | 1.2 | | 3.6 | V | |
| Supply voltage ramp-up time | t_{vddup} | 0.001 | | 5 | ms | Time for supply voltage to reach 90% of final value. |
| Solder drift ¹⁾ | | | 0.8 | | hPa | Minimum solder height 50um. |
| Long term stability | | | ±1 | | hPa | Depending on environmental conditions. |

¹ Effects of solder drift can be eliminated by one point calibration. See AN487.

Specifications

3.2 Absolute Maximum Ratings

Maximum ratings are absolute ratings. Exceeding any one of these values may cause irreversible damage to the integrated circuit.

Attention: *Stresses above the values listed as "Absolute Maximum Ratings" may cause permanent damage to the devices. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.*

Table 4 Absolute Maximum Ratings

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---------------------------------------|-----------------------|--------|------|--------|------|-----------------------|
| | | Min. | Typ. | Max. | | |
| V _{DD} and V _{DDIO} | V _{DDxx_max} | | | 4 | V | |
| Voltage on any pin | V _{max} | | | 4 | V | |
| Storage temperature | T _s | -40 | | 125 | °C | |
| Pressure | P _{max} | | | 10,000 | hPa | |
| ESD | V _{ESD_HBM} | -2 | | 2 | KV | HBM (JS001) |

3.3 Current Consumption

Test conditions (unless otherwise specified in the table): V_{DD}= 1.8V and V_{DDIO}=1.8V. Typ. values (P_A=1000hPa and T_A=25°C). Max./Min. values (P_A= 950-1050hPa and T_A=0...+65°C).

Table 5 Current Consumption

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|--|-------------------|--------|------|------|------|--------------------------------|
| | | Min. | Typ. | Max. | | |
| Peak Current Consumption | I _{peak} | | 345 | | μA | during Pressure measurement |
| | | | 280 | | μA | during Temperature measurement |
| Standby Current Consumption | I _{stb} | | 0.5 | | μA | |
| Current Consumption. (1 pressure and temperature measurements per second.) | I _{1Hz} | | 2.1 | | μA | Low precision |
| | | | 11 | | | Standard precision |
| | | | 38 | | | High precision |

Note: The current consumption depends on both pressure measurement precision and rate. Please refer to the [Pressure Configuration \(PRS_CFG\)](#) register description for an overview of the current consumption in different combinations of measurement precision and rate.

Specifications

3.4 Temperature Transfer Function

Test conditions (unless otherwise specified in the table): $V_{DD}=1.8V$ and $V_{DDIO}=1.8V$. Typ. values ($P_A=1000hPa$ and $T_A=25^\circ C$). Max./Min. values ($P_A=950-1050hPa$ and $T_A=0\dots+65^\circ C$).

Table 6 Temperature Transfer Function

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|------------------------------|--------------|--------|--------|------|------|-----------------------|
| | | Min. | Typ. | Max. | | |
| Temperature accuracy | A_t | | +/-0.5 | | °C | |
| Temperature data resolution | A_{t_res} | | 0.01 | | °C | |
| Temperature measurement rate | f | 1 | | 128 | Hz | |

Specifications

3.5 Pressure Transfer Function

Test conditions (unless otherwise specified in the table): $V_{DD}=1.8V$ and $V_{DDIO}=1.8V$. Typ. values ($P_A=1000hPa$ and $T_A=25^\circ C$).

Table 7 Pressure Transfer Function

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|----------------------------|--------------|--------|--------|------|------------|--|
| | | Min. | Typ. | Max. | | |
| Absolute pressure accuracy | A_{p_abs} | | +/-100 | | Pa | $P_A=300 - 1200hPa$; $T_A=0..+65^\circ C$; Excluding solder effects |
| Relative pressure accuracy | A_{p_rel} | | +/-6 | | Pa | Any $\Delta 1hPa$ in the range $P_A=800 - 1200hPa$; Any constant temperature in the range $T_A=20..+60^\circ C$ |
| Pressure precision | A_{p_prc} | | 1.0 | | Pa_{RMS} | Low Power |
| | | | 0.35 | | | Standard |
| | | | 0.2 | | | High Precision |

Note: Pressure precision is measured as the average standard deviation. Please refer to the [Pressure Configuration \(PRS_CFG\)](#) register description for all precision mode options.

| | | | | | | |
|---|--------------|---|------|-------|------------|--|
| Power supply rejection | A_{p_psr} | | | 0.063 | Pa_{RMS} | Measured with 217Hz square wave and broad band noise, $100mV_{pp}$ |
| Pressure temperature sensitivity of calibrated measurements | A_{p_tmp} | | 0.5 | | Pa/K | $1000hPa, 25..+65^\circ C$. |
| Pressure data resolution | A_{p_res} | | | 0.06 | Pa_{RMS} | |
| Pressure measurement rate | f | 1 | | 128 | Hz | |
| Pressure measurement time | t | | 5.2 | | ms | Low Power |
| | | | 27.6 | | | Standard |
| | | | 105 | | | High Precision |

Note: The pressure measurement time (and thus the maximum rate) depends on the pressure measurement precision. Please refer to the [Pressure Configuration \(PRS_CFG\)](#) register description for an overview of the possible combinations of measurement precision and rate.

Functional Description

3.6 Timing Characteristics

Table 8 Timing Characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|-------------------------------------|-------------------------|--------|------|------|------|---|
| | | Min. | Typ. | Max. | | |
| Start-up timing | | | | | | |
| Time to sensor ready | T _{Sensor_rdy} | | | 12 | ms | The SENSOR_RDY bit in the Measurement Configuration register will be set when the sensor is ready. |
| Time to coefficients are available. | T _{Coef_rdy} | | | 40 | ms | The COEF_RDY bit in the Measurement Configuration register will be set when the coefficients can be read out. |

Note: Start-up timing is measured from VDD > 1.2V & VDDIO > 0.6V or Soft Reset.

| | | | | | | |
|-------------------------|------------------|--|--|-----|-----|--|
| I ² C Clock. | f _{I2C} | | | 3.4 | MHz | |
| SPI Clock | f _{SPI} | | | 10 | MHz | |

4 Functional Description

4.1 Operating Modes

The DPS310 supports 3 different modes of operation: Standby, Command, and Background mode.

- Standby Mode
 - Default mode after power on or reset. No measurements are performed.
 - All registers and compensation coefficients are accessible.
- Command Mode
 - One temperature or pressure measurement is performed according to the selected precision.
 - The sensor will return to Standby Mode when the measurement is finished, and the measurement result will be available in the data registers.
- Background Mode
 - Pressure and/or temperature measurements are performed continuously according to the selected measurement precision and rate. The temperature measurement is performed immediately after the pressure measurement.
 - The FIFO can be used to store 32 measurement results and minimize the number of times the sensor must be accessed to read out the results.

Note: Operation mode and measurement type are set in the **Sensor Operating Mode and Status (MEAS_CFG)** register.

4.2 Mode transition diagram

The mode transition diagram is shown below.

Functional Description

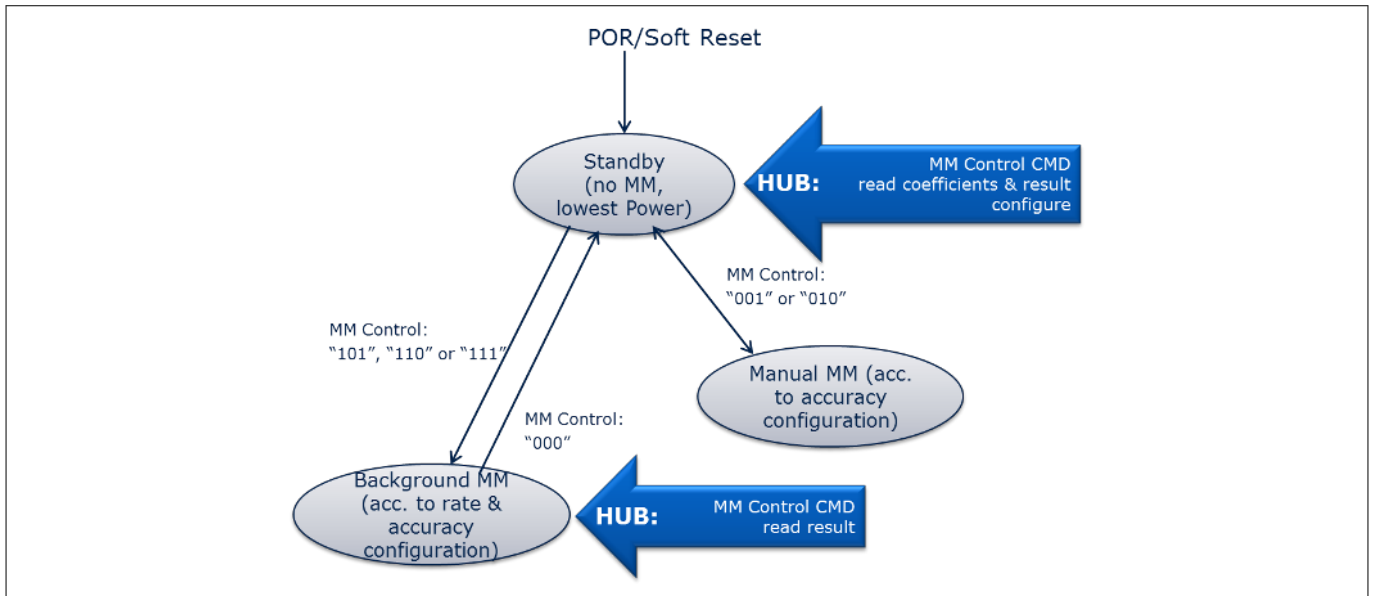


Figure 3 Mode transition diagram

4.3 Start-up sequence

The start-up sequence is shown below. This diagram shows when the registers are accessible for read and/or write and also when the Pressure/Temperature measurements can start.

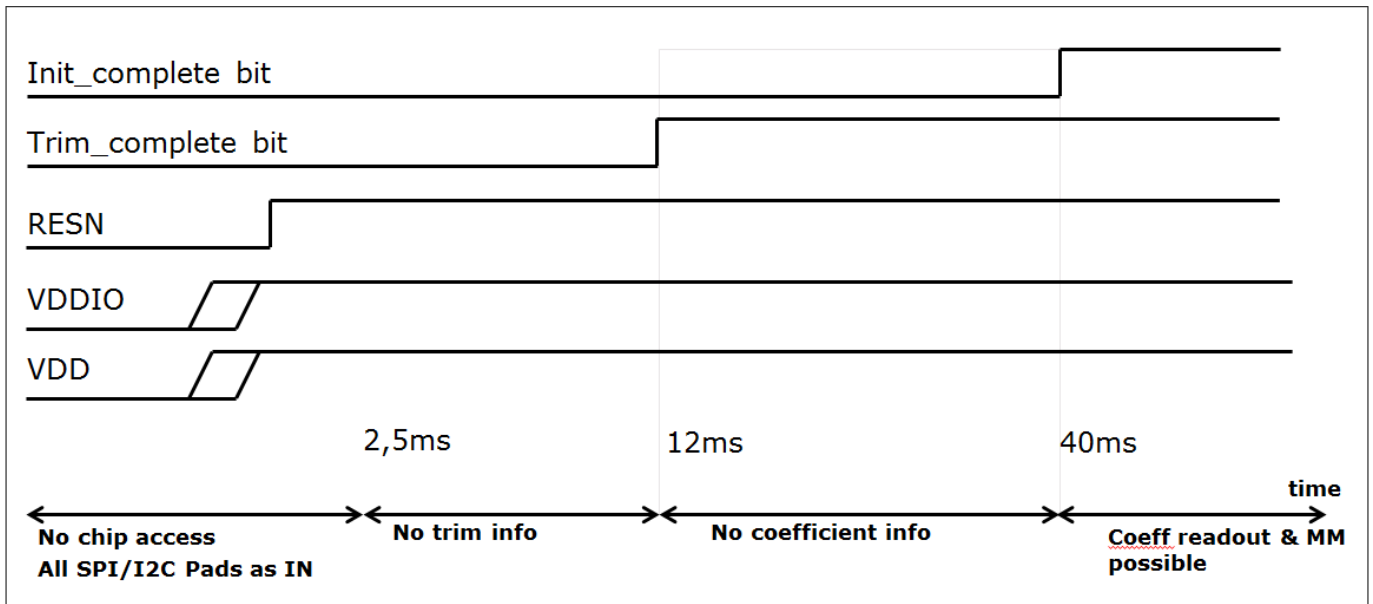


Figure 4 Start-up sequence

4.4 Measurement Precision and Rate

Different applications require different measurement precision and measurement rates. Some applications, such as weather stations, require lower precision and measurement rates than for instance indoor navigation and sports applications.

When the sensor DPS310 is in Background Mode, the measurement precision and rate can be configured to match the requirements of the application. This reduces current consumption of the sensor and the system.

Functional Description

In order to achieve a higher precision, the sensor DPS310 will read multiple times (oversampling), and combine the readings into one result. This increases the current consumption and also the measurement time, reducing the maximum possible measurement rate. It is necessary to balance the accuracy and data rate required for each application with the allowable current consumption.

The measurement precision, rate and time is set in the [Pressure Configuration \(PRS_CFG\)](#) and [Temperature Configuration \(TMP_CFG\)](#) registers. The register descriptions contain information about the current consumption and the possible combinations of measurement precision, time, and rate.

Enabling temperature measurements allows for compensation of temperature drift in the pressure measurement. The rates of these measurements can be set independently, but temperature compensation is more accurate when temperature and pressure measurements are taken together. This reduces the maximum pressure measurement rate, since: $\text{Rate}_{\text{temperature}} * \text{Time}_{\text{temperature}} + \text{Rate}_{\text{pressure}} * \text{Time}_{\text{pressure}} < 1$ second. [Measurement Settings and Use Case Examples](#) contains a table with examples of combinations of pressure and temperature precision and rates for different use cases.

In the figure below is described the Temperature and Pressure measurements sequence in background mode.

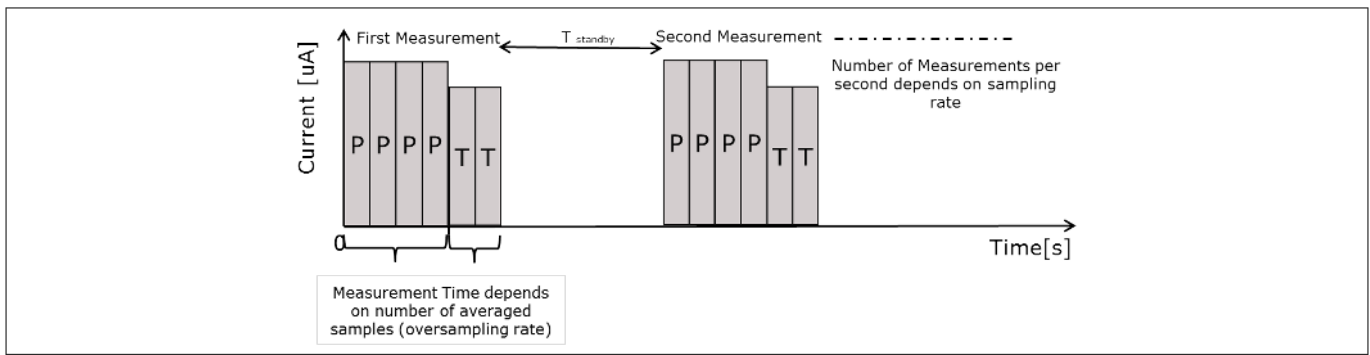


Figure 5 Background mode temperature and pressure measurements sequence

4.5 Sensor Interface

The DPS310 can be accessed as a slave device through mode '11' SPI 3-wire, SPI 4-wire, or I²C serial interface.

- I²C interface
 - The sensor's default interface.
 - The sensor's address is 0x77 (default) or 0x76 (if the SDO pin is pulled-down to GND).
- SPI interface
 - The sensor will switch to SPI configuration if it detects an active low on the CSB pin. SPI 4-wire is the default SPI interface.
 - To enable SPI 3-wire configuration, a bit must be set in the [Interrupt and FIFO configuration \(CFG_REG\)](#) register after start up.

More details about digital interfaces are available in the [Digital interfaces](#).

4.6 Interrupt

The sensor DPS310 can generate an interrupt when a new measurement result is available and/or when the FIFO is full. The sensor uses the SDO pin for the interrupt signal, and interrupt is therefore not supported if the interface is 4-wire SPI.

The interrupt is enabled and configured in the [Interrupt and FIFO configuration \(CFG_REG\)](#) register. In I²C configuration the SDO pin serves as both interrupt and as the least significant bit in the device address. If the SDO pin is pulled low the interrupt polarity must be set to active high and vice-versa.

The interrupt status can be read from the [Interrupt Status \(INT_STS\)](#) register.

Functional Description

4.7 Result Register Operation

After starting the measurements, the latest pressure and temperature raw data will be available in their respective result registers. Temperature measurement can be skipped. The temperature measurements can be disabled if there is a requirement to measure pressure rapidly, but it will make accurate temperature drift compensation impossible.

All measurement data can be read in a single command using auto-increment read. When FIFO is disabled, reading the result register will not affect the register value, it will only be updated when a new measurement is completed. When FIFO is enabled, the pressure result register will update to the next value in the FIFO after each read. When all of the FIFO values have been read, the result register will be set to 0x800000.

4.8 FIFO Operation

The DPS310 FIFO can store the last 32 measurements of pressure or temperature. This reduces the overall system power consumption as the host processor does not need to continuously poll data from the sensor but can go into standby mode for longer periods of time.

The FIFO can store any combination of pressure and temperature results, according to the background mode measurement rate settings. The pressure rate can for instance be set 4 times higher than the temperature rate and thus only every fifth result will be a temperature result. The measurement type can be seen in the result data. The sensor will set the least significant bit to:

- '1' if the result is a pressure measurement.
- '0' if it is a temperature measurement.
- The sensor uses 24 bits to store the measurement result. Because this is more bits than is needed to cover the full dynamic range of the pressure sensor, using the least significant bit to label the measurement type will not affect the precision of the result.

The FIFO can be enabled in the Interrupt and FIFO configuration register. The data from the FIFO is read out from the Pressure Data (PRS_Bn) registers regardless of whether the next result in the FIFO is a temperature or a pressure measurement.

When a measurement has been read out, the FIFO will auto increment and place the next result in the data register. A flag will be set in the FIFO Status register when the FIFO is empty and all following reads will return 0x800000.

If the FIFO is full, the FIFO_FULL bit in the FIFO Status (FIFO_STS) will be set. If the INT_FIFO bit in the Interrupt and FIFO configuration register (CFG_REG) is set, an interrupt will also be generated when the FIFO is full.

The FIFO will stop recording measurements results when it is full.

4.9 Calibration and Measurement Compensation

The sensor DPS310 is a calibrated sensor and contains calibration coefficients. These are used in the application (for instance by the host processor) to compensate the measurement results for sensor non-linearities.

The sections that follow describe how to calculate the compensated results and convert them into Pa and °C values.

Functional Description

4.9.1 How to Calculate Compensated Pressure Values

Steps

1. Read the pressure calibration coefficients (c00, c10, c20, c30, c01, c11, and c21) from the Calibration Coefficient register.

Note: The coefficients read from the coefficient register are 2's complement numbers.

2. Choose scaling factors kT (for temperature) and kP (for pressure) based on the chosen precision rate. The scaling factors are listed in [Table 9](#).
3. Read the pressure and temperature result from the registers or FIFO.

Note: The measurements read from the result registers (or FIFO) are 24 bit 2's complement numbers. Depending on the chosen measurement rates, the temperature may not have been measured since the last pressure measurement.

4. Calculate scaled measurement results.

$$\begin{aligned} T_{\text{raw_sc}} &= T_{\text{raw}}/kT \\ P_{\text{raw_sc}} &= P_{\text{raw}}/kP \end{aligned}$$

5. Calculate compensated measurement results.

$$P_{\text{comp}}(\text{Pa}) = c00 + P_{\text{raw_sc}} * (c10 + P_{\text{raw_sc}} * (c20 + P_{\text{raw_sc}} * c30)) + T_{\text{raw_sc}} * c01 + T_{\text{raw_sc}} * P_{\text{raw_sc}} * (c11 + P_{\text{raw_sc}} * c21)$$

4.9.2 How to Calculate Compensated Temperature Values

Steps

1. Read the temperature calibration coefficients (c0 and c1) from the [Calibration Coefficients \(COEF\)](#) register.

Note: The coefficients read from the coefficient register are 12 bit 2's complement numbers.

2. Choose scaling factor kT (for temperature) based on the chosen precision rate. The scaling factors are listed in [Table 9](#).
3. Read the temperature result from the temperature register or FIFO.

Note: The temperature measurements read from the temperature result register (or FIFO) are 24 bit 2's complement numbers.

Functional Description

4. Calculate scaled measurement results.

$$T_{raw_sc} = T_{raw}/kT$$

5. Calculate compensated measurement results.

$$T_{comp} (°C) = c0*0.5 + c1*T_{raw_sc}$$

4.9.3 Compensation Scale Factors

Table 9 Compensation Scale Factors

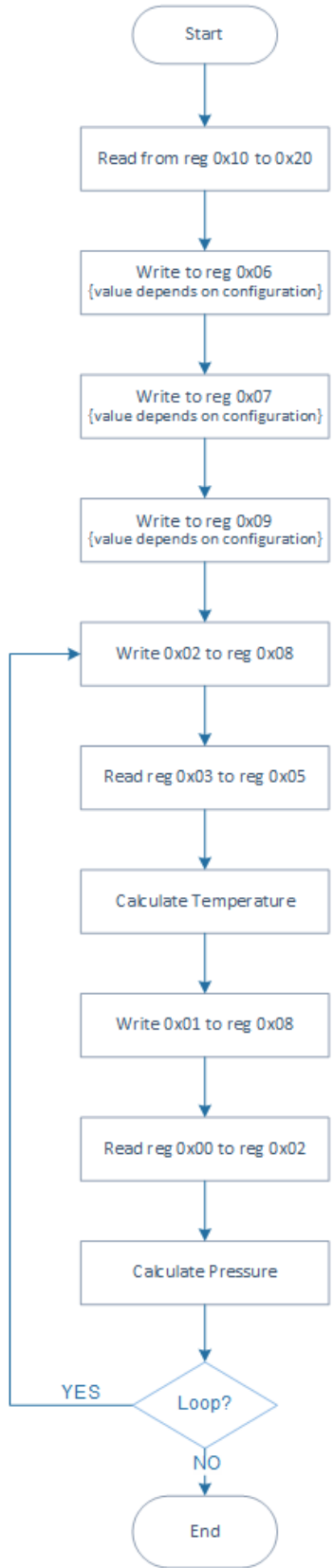
| Oversampling Rate | Scale Factor (kP or kT) | Result shift (bit 2and 3 address 0x09) |
|---------------------------|-------------------------|---|
| 1 (single) | 524288 | 0 |
| 2 times (Low Power) | 1572864 | 0 |
| 4 times | 3670016 | 0 |
| 8 times | 7864320 | 0 |
| 16 times (Standard) | 253952 | enable pressure or temperature shift |
| 32 times | 516096 | enable pressure or temperature shift |
| 64 times (High Precision) | 1040384 | enable pressure or temperature shift |
| 128 times | 2088960 | enable pressure or temperature shift |

4.9.4 Pressure and Temperature calculation flow

The flow chart below describes the Pressure and Temperature calculate

Figure 6 Pressure and temperature calculation flow

Functional Description



See also [How to Calculate Compensated Pressure Values](#) and [How to Calculate Compensated Temperature Values](#)

Applications

5 Applications

5.1 Measurement Settings and Use Case Examples

Table 10 Measurement Settings and Use Case Examples (TBD)

| Use Case | Performance | Pressure Register Configuration Address: 0x06 | Temperature Register Configuration Address: 0x07 | Other |
|---|--|--|---|---|
| Weather Station (Low power) | 5 Pa precision. 1 pr sec. 3 uA | 0x01 | 0x80 | Start background measurements (addr 0x08) |
| Indoor navigation (Standard precision, background mode) | 10 cm precision. 2 pr sec. 22 uA | 0x14 | 0x90 | Enable P shift (addr 0x09) Start background measurements (addr 0x08) |
| Sports (High precision, high rate, background mode) | 5 cm precision 4 pr sec. 200 uA | 0x26 | 0xA0 | Enable P shift (addr 0x09) Start background measurements (addr 0x08) |

Applications

5.2 Application Circuit Example

The examples application circuit uses the I²C and SPI serial interface. The SDO pin can be used for interrupt or to set least significant bit of the device address. The DPS310 analog core supply voltage is internally regulated, guaranteeing robustness to external VDD supply variations within the specified range. The simplest voltage supply solution is to connect VDD and VDDIO to 1.8V supply and add a suitable decoupling capacitor to reduce VDD ripple below 50mVpp.

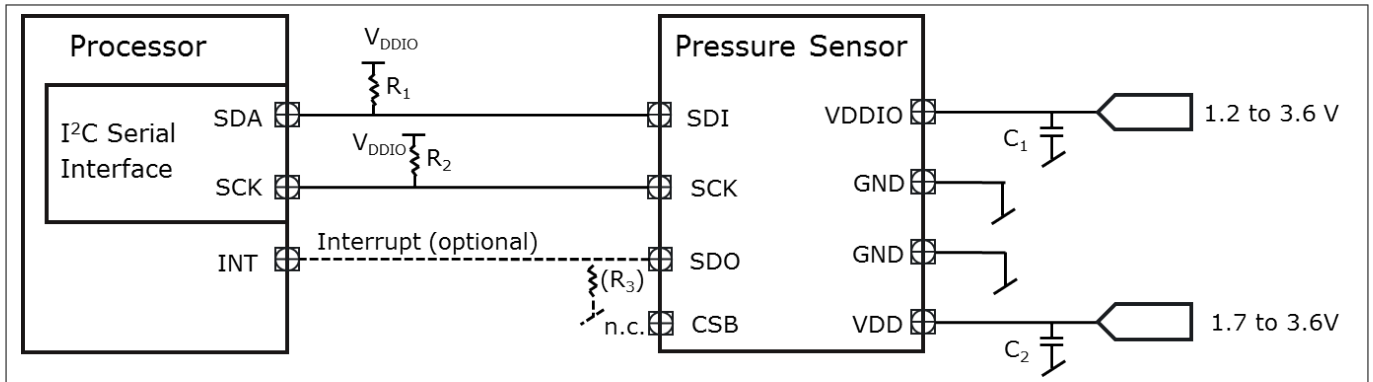


Figure 7 Application Circuit Example using the I²C serial interface.

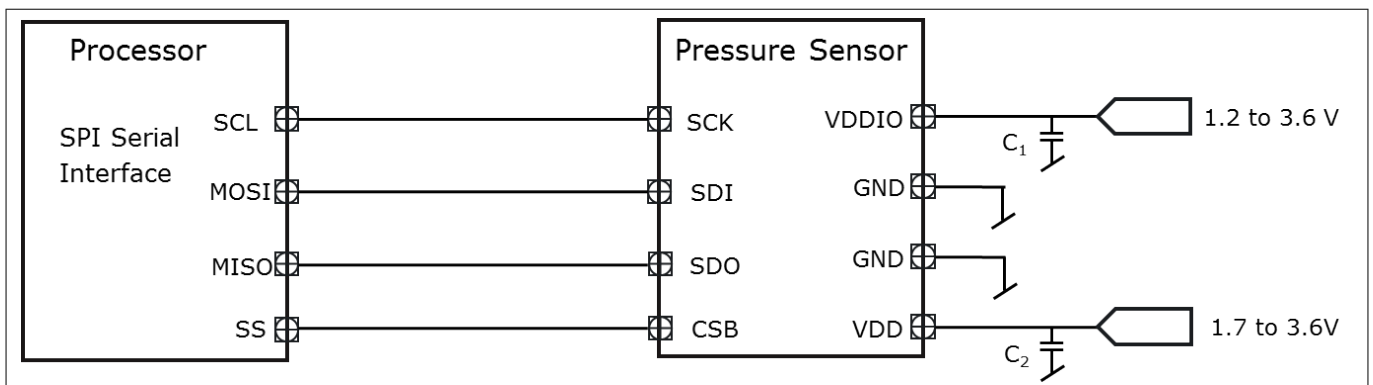


Figure 8 Application Circuit Example using the SPI 4-wires serial interface

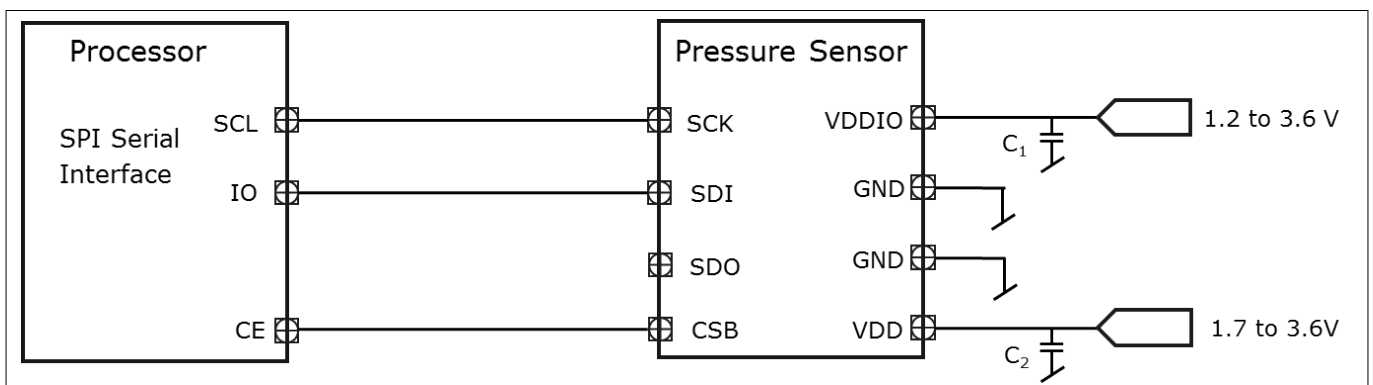


Figure 9 Application Circuit Example using the SPI 3-wire serial interface

Digital interfaces

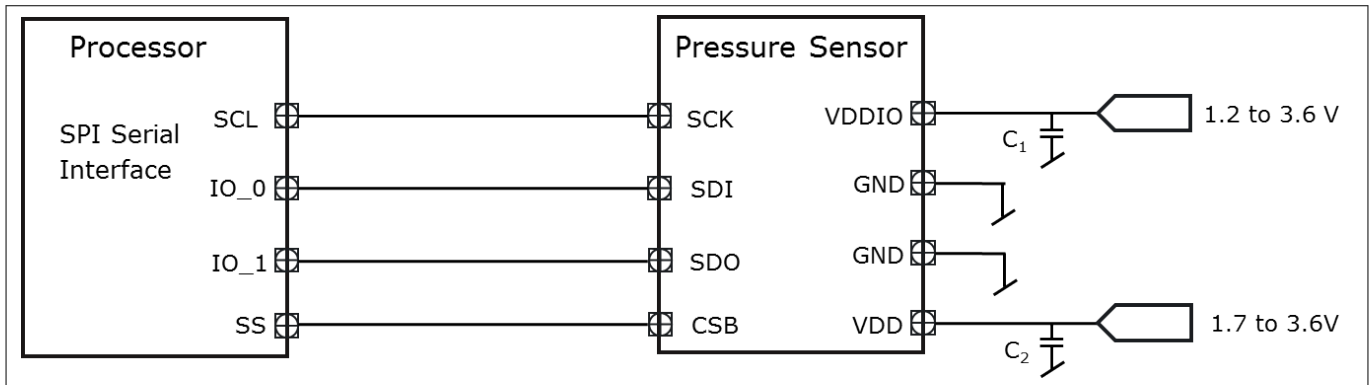


Figure 10 Application Circuit Example using the SPI 3-wire with interrupt interface

Table 11 Component Values

| Component | Symbol | Values | | | Unit | Note / Test Condition |
|---------------------------|---------------------------------|--------|------|------|------|--|
| | | Min. | Typ. | Max. | | |
| Pull-up/down Resistor | R ₁ , R ₂ | | | 10 | KΩ | |
| | R ₃ | | | 100 | KΩ | R ₃ is optional and will set the address to 0x76 instead of 0x77. |
| Supply Blocking Capacitor | C ₁ , C ₂ | 100 | 100 | | nF | The blocking capacitors should be placed as close to the package pins as possible. |

5.3 IIR filtering

The air pressure is slowly changing due to weather conditions or short term changing like air turbulence created by a fan, slamming a door or window. All these disturbances can be suppressed or triggered on the software application level by implementing different IIR filtering.

Same sensor can be used by different software applications applying different IIR filtering to the raw data like low pass, high pass or band pass filtering.

6 Digital interfaces

The DPS310 measurement data, calibration coefficients, Product ID and configuration registers can be accessed through both the I²C and SPI serial interfaces.

The SPI interface can be configured to operate in 3-wire or 4-wire mode. In I²C and SPI 3-wire, an interrupt output can be implemented on the SDO pin. The SPI interface support mode '11' only (CPOL=CPHA='1') in 4-wire and 3-wire configuration. The following commands are supported: single byte write, single byte read and multiple byte read using auto increment from a specified start address. The interface selection is done based on CSB pin status. If CSB is connected to V_{DDIO}, the I²C interface is active. If CSB is low, the SPI interface is active. After the CSB has been pulled down once the I²C interface is disabled until the next power-on-reset.

Digital interfaces

6.1 I2C Interface

The I²C slave interface is compatible with Philips I²C Specification version 2.1. The I²C interface supports standard, fast and high speed mode.

The sensor's address is 0x77 (if SDO pin is left floating or pulled-up to VDDIO) or 0x76 (if the SDO pin is pulled-down to GND). The I²C interface uses the pins described in [Table 2](#)

The basic timing is shown in the diagram below:

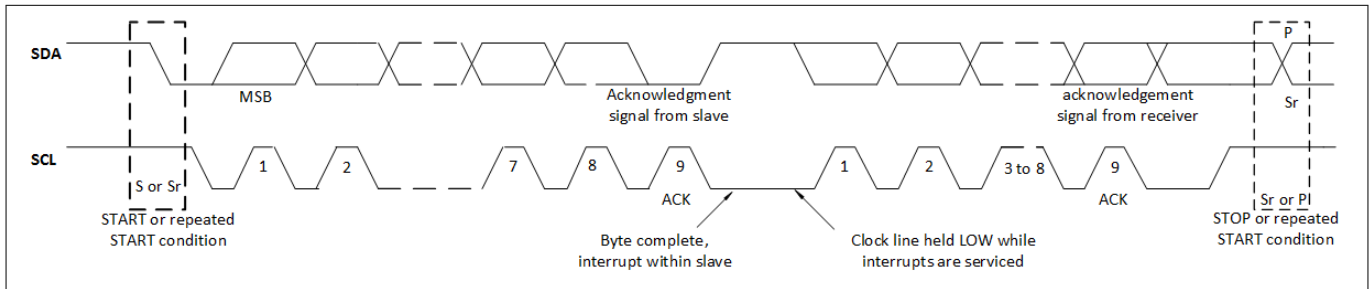


Figure 11 I2C timing diagram

In one access, without stop, incremental read (address is auto increment) and auto-incremental write is supported. The read and write access is described below:

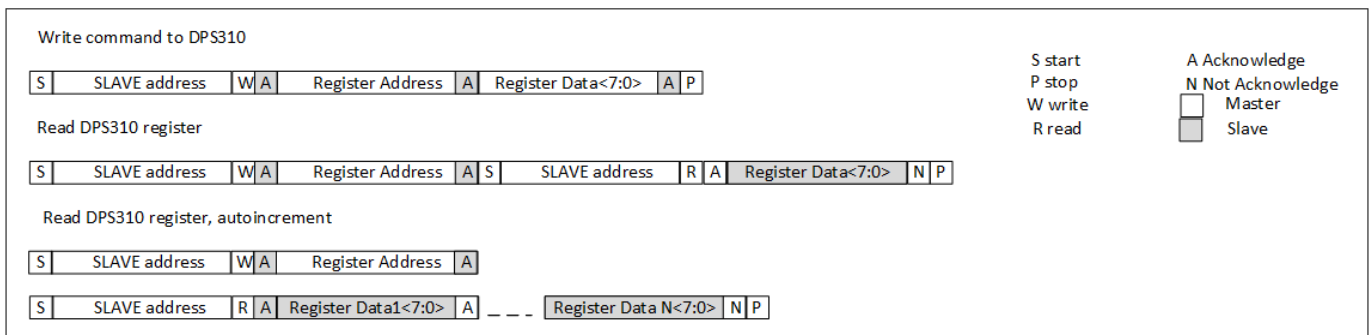


Figure 12 I2C write and read commands

6.2 SPI Interface

The SPI interface is compatible with SPI mode '11' (CPOL = CPHA = '1'. The SPI interface has two modes: 4-wire and 3-wire.

The protocol is the same for both. The 3-wire mode is selected by setting '1' to the register [Interrupt and FIFO configuration \(CFG_REG\)](#)

The SPI interface uses the pins like in the [Table 2](#) Refere to [Application Circuit Example](#) for connections instructions. The SPI protocol is shown in the diagram below:

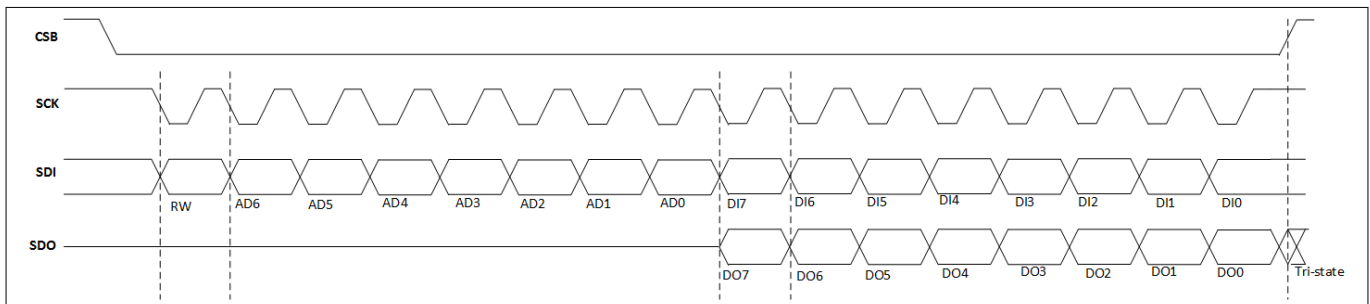


Figure 13 SPI protocol, 4-wire without interrupt

Digital interfaces

A SPI write is carried out by setting CSB low and sending a control byte followed by register data. The control byte consist of the SPI register address (full register address without bit 7) and the write command (bit7 = RW = '0'). Setting CSB high ends the transaction. The SPI write protocol is described in the diagram below.

A SPI read is initiated by setting CSB low and sending a single control byte. The control byte consist of the SPI register address (= full register address without bit 7) and the read command (bit7 = RW = '1'). After writing the control byte, data is sent out of the SDO pin (SDI in 3-wire mode); the register address is automatically incremented. Sending CSB high ends the SPI read transaction. The SPI read protocol is shown in the diagram below:

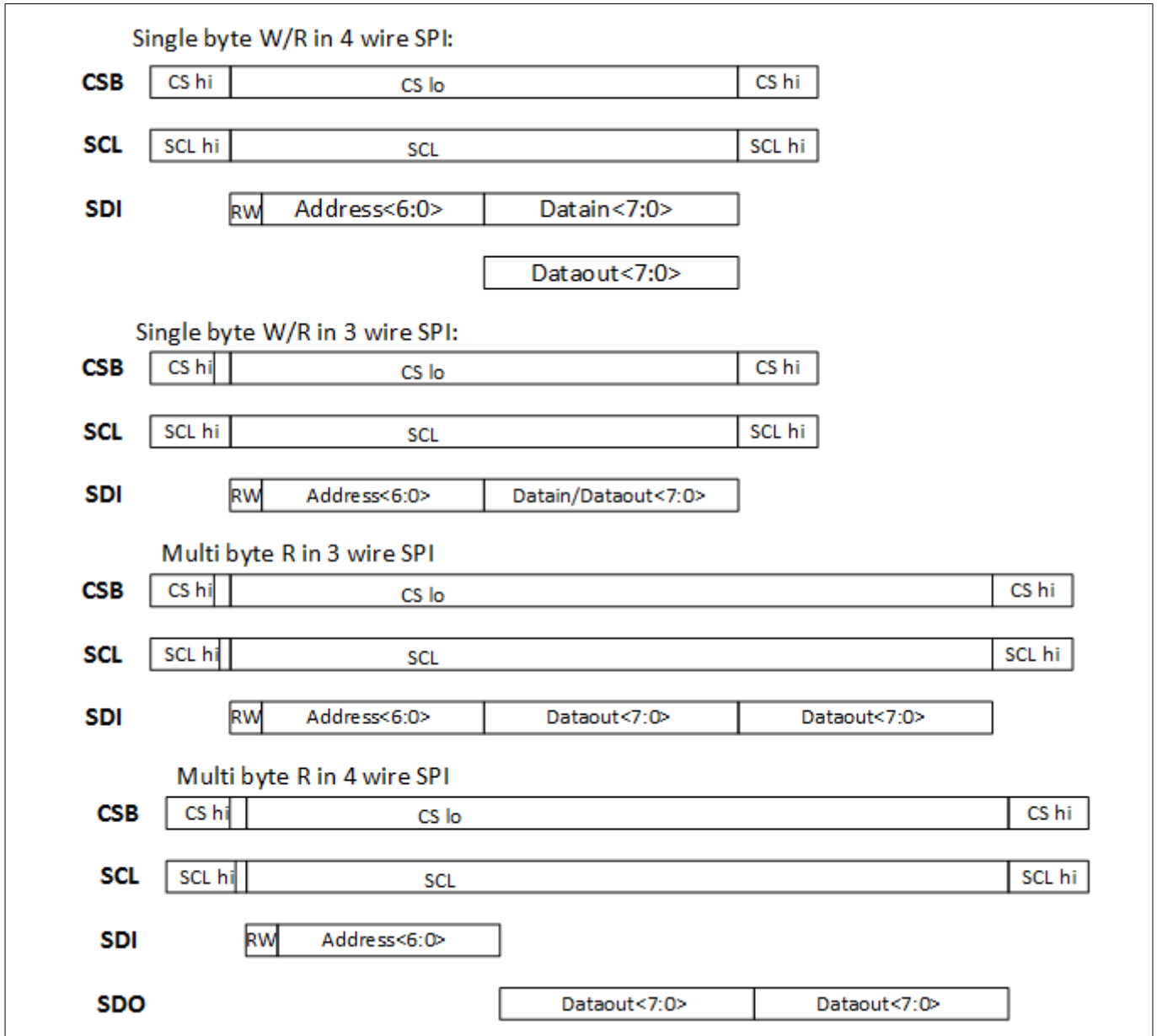


Figure 14 SPI write, read protocol diagrams

Digital interfaces

6.3 Interface parameters specification

6.3.1 General interface parameters

The general interface parameters are given in the table below:

Table 12 Interface parameters

| Parameter | Symbol | Values | | | Unit | Note or Test Condition |
|--|---------------|----------------------------|------|----------------------------|------|---|
| | | Min. | Typ. | Max. | | |
| Input voltage for low logic level at input pins | Vlow_in | | | 0.3 * V _{DDIO} | V | V _{DDIO} =1.2V to 3.6V |
| Input voltage for high logic level at input pins | Vhigh_in | 0.7 * V _{DDIO} | | | V | V _{DDIO} =1.2V to 3.6V |
| Output - low level for I2C | Vlow_SDI | | | 0.1 * V _{DDIO} | V | V _{DDIO} =1.8V, iol=2mA |
| Output voltage for low level at pin SDI for I2C | Vlow_SDI_1.2 | | | 0.2* V _{DDIO} | V | V _{DDIO} =1.20V, iol=1.3mA |
| Output voltage for high level at pins SDO, SDI | Vhigh_out | 0.8 * V _{DDIO} | | | V | V _{DDIO} =1.8V, iol=1mA (SDO, SDI) |
| Output voltage for high level at pins SDO, SDI | Vhigh_out_1.2 | 0.6 * V _{DDIO} | | | V | V _{DDIO} =1.2V, iol=1mA (SDO, SDI) |
| Pull-up resistor | Rpull | 60 | 120 | 180 | kohm | Internal pull-up resistance to V _{DDIO} |
| I ² C bus load capacitor | Cb | | | 400 | pF | On SDI and SCK |

6.3.1.1 I2C timings

The I²C timing is shown in the diagram below and corresponding values are given in the table below. The naming refers to I²C Specification version 2.1, the abbreviations used "S&F mode" = standard and fast mode, "HS mode" = high speed mode, Cb = bus capacitance on SDA line.

Digital interfaces

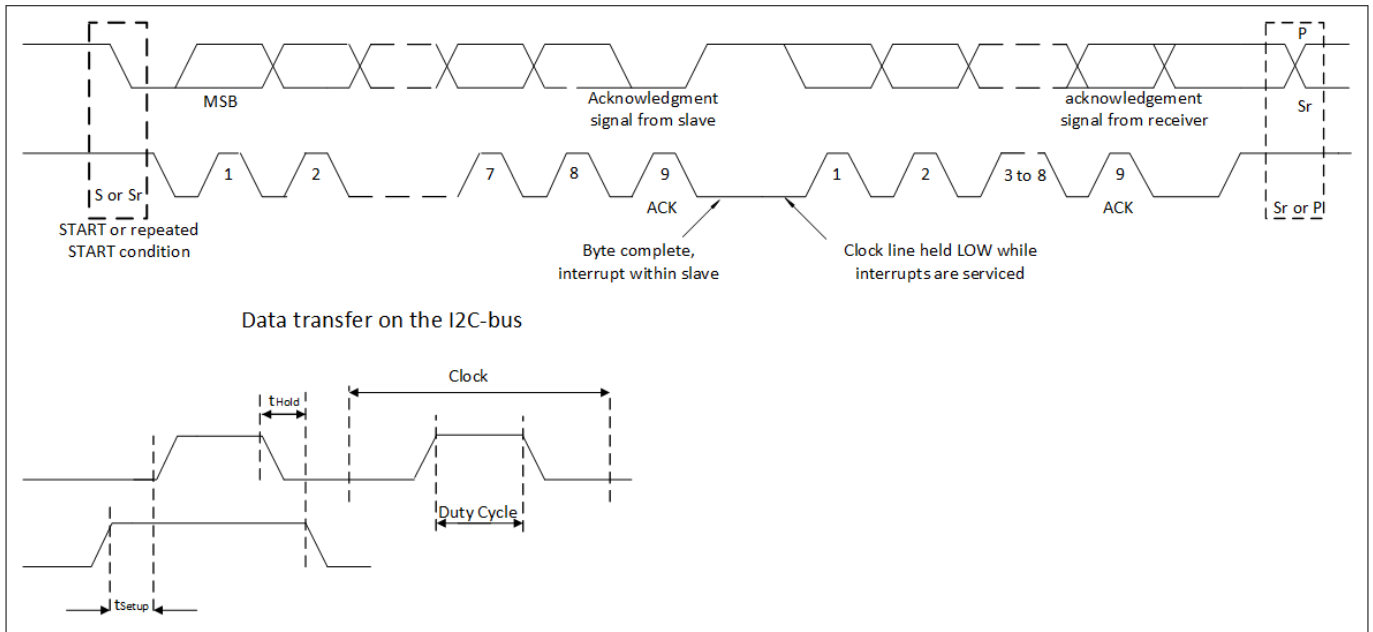


Figure 15 I²C timing diagram

Table 13 I²C timings

| Parameter | Symbol | Values | | | Unit | Note or Test Condition |
|----------------------------|--------------------|--------|------|------|------|------------------------|
| | | Min. | Typ. | Max. | | |
| Data setup time on SDI pin | t _{Setup} | 20 | | | ns | S&F mode |
| | | 5 | | | ns | HS mode |
| Data hold time on SDI pin | t _{Hold} | 0 | | | ns | S&F&HSmode, |
| Duty Cycle | DC | | | 70 | % | S&F mode, |
| | | | | 55 | % | HS mode, |

Digital interfaces

6.3.1.2 SPI timings

The SPI timing diagram is shown in the figure below and the corresponding values are given in the table below. All timings apply both to 4-wire and 3-wire SPI.

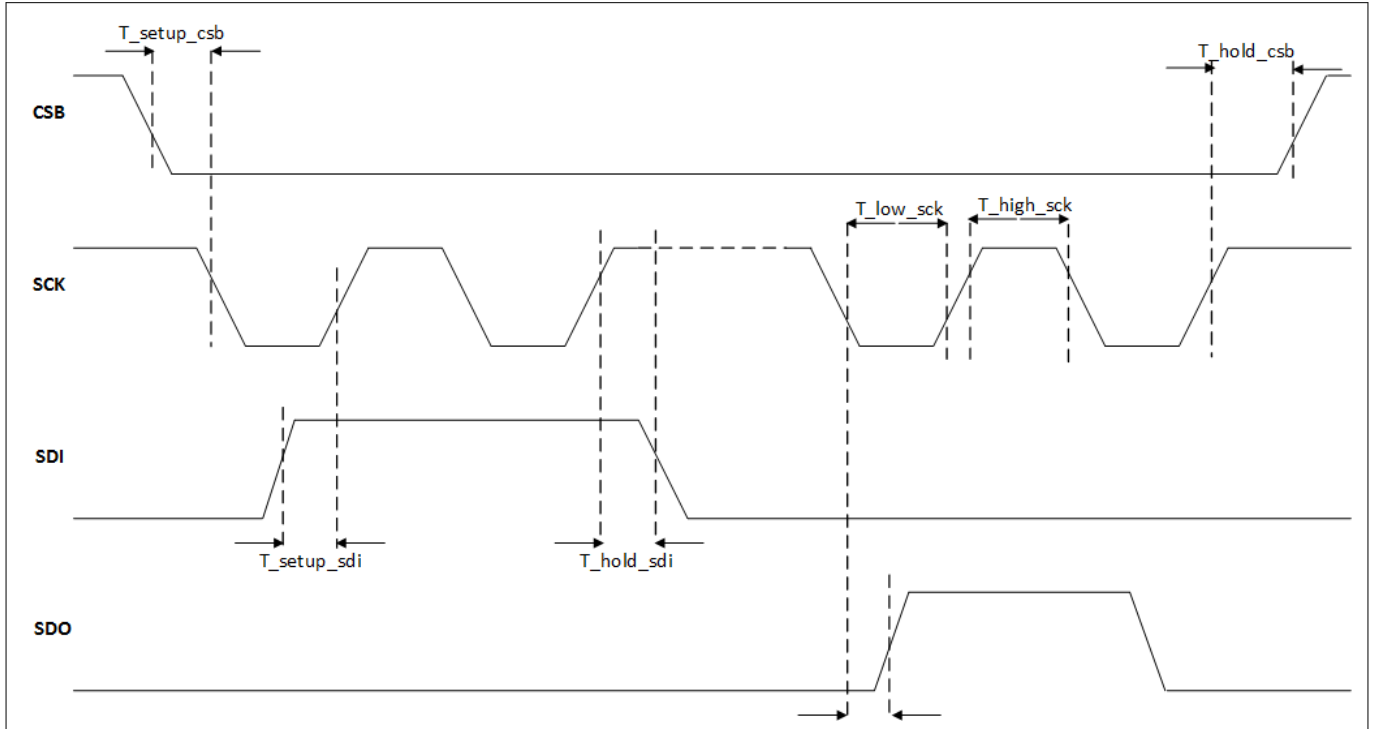


Figure 16 SPI timing diagram

Table 14 SPI timings

| Parameter | Symbol | Values | | | Unit | Note or Test Condition |
|---------------------|-------------|--------|------|------|------|-------------------------------|
| | | Min. | Typ. | Max. | | |
| Duty Cycle (Thigh%) | SPI_DC | 30 | | | % | V _{DDIO} = 1.2V |
| | | 20 | | | % | V _{DDIO} = 1.8V/3.6V |
| SDI setup time | T_setup_sdi | 2 | | | ns | |
| SDI hold time | T_hold_sdi | 2 | | | ns | |
| Clock | SPI_CLK | | | 10 | MHz | |
| CSB setup time | T_setup_csb | 15 | | | ns | |
| CSB hold time | | 15 | | | ns | |

Register Map

7 Register Map

Table 15 Register Map

| Register Name | Addr. | bit7 | bit6 | bit5 | bit4 | bit3 | bit2 | bit1 | bit0 | Reset State |
|---------------|-----------|------------------------------|---------------------|-------------|-------------|--------------------|----------------------|---------------|-----------------|-----------------|
| PSR_B2 | 0x00 | PSR[23:16] (r) | | | | | | | | 00 _h |
| PSR_B1 | 0x01 | PSR[15:8](r) | | | | | | | | 00 _h |
| PSR_B0 | 0x02 | PSR[7:0](r) | | | | | | | | 00 _h |
| TMP_B2 | 0x03 | TMP[23:16] (r) | | | | | | | | 00 _h |
| TMP_B1 | 0x04 | TMP[15:8] (r) | | | | | | | | 00 _h |
| TMP_B0 | 0x05 | TMP[7:0] (r) | | | | | | | | 00 _h |
| PRS_CFG | 0x06 | - | PM_RATE [2:0] (rw) | | | PM_PRC [3:0] (rw) | | | | 00 _h |
| TMP_CFG | 0x07 | TMP_EXT (rw) | TMP_RATE [2:0] (rw) | | | TM_PRC [3:0] (rw) | | | | 00 _h |
| MEAS_CFG | 0x08 | COEF_RDY (r) | SENSOR_RDY (r) | TMP_RDY (r) | PRS_RDY (r) | - | MEAS_CTRL [2:0] (rw) | | | C0 _h |
| CFG_REG | 0x09 | INT_HL (rw) | INT_SEL [2:0] (rw) | | | TMP_SHIFT_EN (rw) | PRS_SHIFT_EN (rw) | FIFO_EN (rw) | SPI_MODE (rw) | 00 _h |
| INT_STS | 0x0A | - | - | - | - | - | INT_FIFO_FULL (r) | INT_TMP (r) | INT_PRS (r) | 00 _h |
| FIFO_STS | 0x0B | - | - | - | - | - | - | FIFO_FULL (r) | FIFO_EMPTY (r) | 00 _h |
| RESET | 0x0C | FIFO_FLUSH (w) | - | - | - | SOFT_RST [3:0] (w) | | | 00 _h | |
| Product ID | 0x0D | REV_ID [3:0] (r) | | | | PROD_ID [3:0] (r) | | | | 10 _h |
| COEF | 0x10-0x21 | < see register description > | | | | | | | | XX _h |
| Reserved | 0x22-0x27 | Reserved | | | | | | | | XX _h |
| COEF_SRCE | 0x28 | TMP_COEF_SRCE (r) | Reserved | | | | | | | XX _h |

8 Register description

8.1 Pressure Data (PRS_Bn)

The Pressure Data registers contains the 24 bit (3 bytes) 2's complement pressure measurement value.

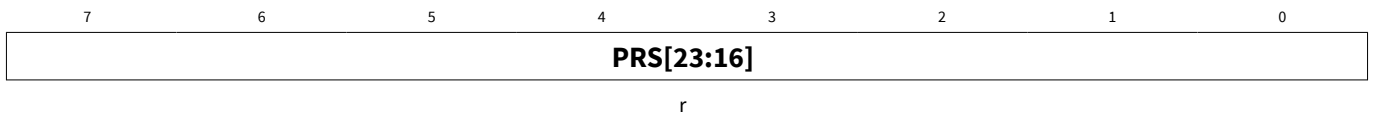
If the FIFO is enabled, the register will contain the FIFO pressure and/or temperature results. Otherwise, the register contains the pressure measurement results and will not be cleared after read.

Register description

8.1.1 PRS_B2

The highest byte of the three bytes measured pressure value.

PRS_B2 **Address:** 00_H
 Pressure (MSB data) **Reset value:** 00_H

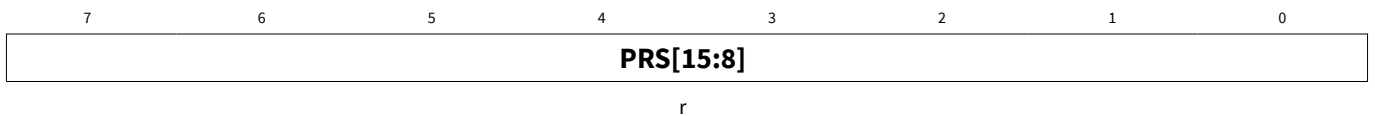


| Field | Bits | Type | Description |
|------------|------|------|---|
| PRS[23:16] | 7:0 | r | MSB of 24 bit 2's complement pressure data. |

8.1.2 PRS_B1

The middle byte of the three bytes measured pressure value.

PRS_B1 **Address:** 01_H
 Pressure (LSB data) **Reset value:** 00_H



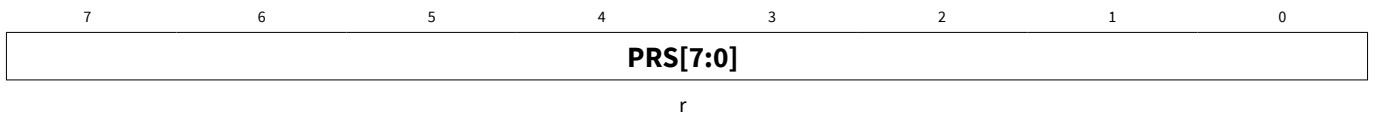
| Field | Bits | Type | Description |
|-----------|------|------|---|
| PRS[15:8] | 7:0 | r | LSB of 24 bit 2's complement pressure data. |

Register description

8.1.3 PRS_B0

The lowest byte of the three bytes measured pressure value.

PRS_B0 **Address:** 02_H
 Pressure (XLSB data) **Reset value:** 00_H



| Field | Bits | Type | Description |
|----------|------|------|--|
| PRS[7:0] | 7:0 | r | XLSB of 24 bit 2's complement pressure data. |

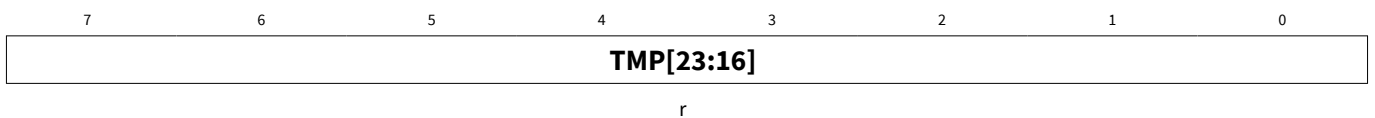
8.2 Temperature Data (TMP_Tn)

The Temperature Data registers contain the 24 bit (3 bytes) 2's complement temperature measurement value (unless the FIFO is enabled, please see FIFO operation) and will not be cleared after the read.

8.2.1 TMP_B2

The highest byte of the three bytes measured temperature value.

TMP_B2 **Address:** 03_H
 Temperature (MSB data) **Reset value:** 00_H



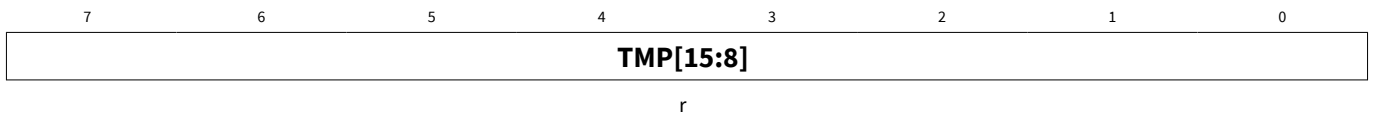
| Field | Bits | Type | Description |
|------------|------|------|--|
| TMP[23:16] | 7:0 | r | MSB of 24 bit 2's complement temperature data. |

Register description

8.2.2 TMP_B1

The middle byte of the three bytes measured temperature value.

TMP_B1 **Address:** 04_H
 Temperature (LSB data) **Reset value:** 00_H

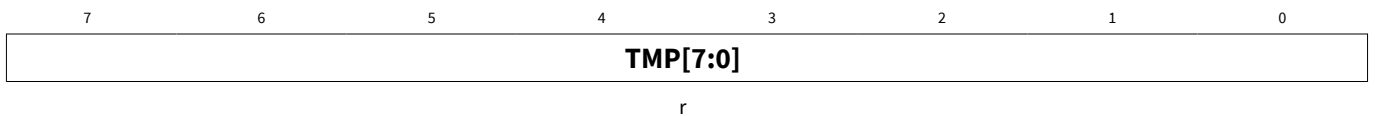


| Field | Bits | Type | Description |
|-----------|------|------|--|
| TMP[15:8] | 7:0 | r | LSB of 24 bit 2's complement temperature data. |

8.2.3 TMP_B0

The lowest part of the three bytes measured temperature value.

TMP_B0 **Address:** 05_H
 Temperature (XLSB data) **Reset value:** 00_H



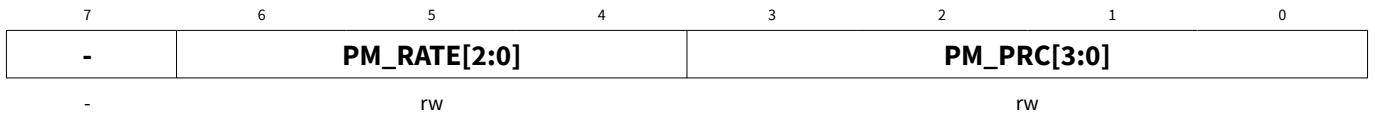
| Field | Bits | Type | Description |
|----------|------|------|---|
| TMP[7:0] | 7:0 | r | XLSB of 24 bit 2's complement temperature data. |

Register description

8.3 Pressure Configuration (PRS_CFG)

Configuration of pressure measurement rate (PM_RATE) and resolution (PM_PRC).

PRS_CFG **Address:** 06_H
 Pressure measurement configuration **Reset value:** 00_H



| Field | Bits | Type | Description |
|--------------|------|------|---|
| - | 7 | - | Reserved. |
| PM_RATE[2:0] | 6:4 | rw | Pressure measurement rate: 000 - 1 measurements pr. sec. 001 - 2 measurements pr. sec. 010 - 4 measurements pr. sec. 011 - 8 measurements pr. sec. 100 - 16 measurements pr. sec. 101 - 32 measurements pr. sec. 110 - 64 measurements pr. sec. 111 - 128 measurements pr. sec. <i>Applicable for measurements in Background mode only</i> |
| PM_PRC[3:0] | 3:0 | rw | Pressure oversampling rate: 0000 - Single. (Low Precision) 0001 - 2 times (Low Power). 0010 - 4 times. 0011 - 8 times. 0100 *) - 16 times (Standard). 0101 *) - 32 times. 0110 *) - 64 times (High Precision). 0111 *) - 128 times. 1xxx - Reserved |

*) Note: Use in combination with a bit shift. See [Interrupt and FIFO configuration \(CFG_REG\)](#) register

Register description

Table 16 Precision (Pa_{RMS}) and pressure measurement time (ms) versus oversampling rate

| Oversampling (PRC[3:0]) | Single (0000) | 2 times (0001) | 4 times (0010) | 8 times (0011) | 16 times (0100) | 32 times (0101) | 64 times (0110) | 128 times (0111) |
|--------------------------------|---------------|----------------|----------------|----------------|-----------------|-----------------|-----------------|------------------|
| Measurement time (ms) | 3.6 | 5.2 | 8.4 | 14.8 | 27.6 | 53.2 | 104.4 | 206.8 |
| Precision (Pa _{RMS}) | 2.5 | 1 | 0.5 | 0.4 | 0.35 | 0.3 | 0.2 | |

Table 17 Estimated current consumption (uA)

| Oversampling (PRC[3:0]) | Single (0000) | 2 times (0001) | 4 times (0010) | 8 times (0011) | 16 times (0100) | 32 times (0101) | 64 times (0110) | 128 times (0111) |
|--------------------------------------|--|----------------|----------------|----------------|-----------------|-----------------|-----------------|------------------|
| Measurements pr sec. (PM_RATE([2:0]) | | | | | | | | |
| 1 (000) | 2.1 | 2.7 | 3.8 | 6.1 | 11 | 20 | 38 | 75 |
| 2 (001) | | | | | | | | |
| 4 (010) | | | | | | | | |
| 8 (011) | Note: The current consumption can be calculated as the Measurement Rate * Current Consumption of 1 measurement per. sec. | | | | | | | n.a. |
| 16 (100) | | | | | | | n.a. | n.a. |
| 32 (101) | | | | | | n.a. | n.a. | n.a. |
| 64 (110) | | | | | n.a. | n.a. | n.a. | n.a. |
| 128 (111) | | | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |

Note: The table shows the possible combinations of Pressure Measurement Rate and oversampling when no temperature measurements are performed. When temperature measurements are performed the possible combinations are limited to $Rate_{temperature} \times Measurement\ Time_{temperature} + Rate_{pressure} \times Measurement\ Time_{pressure} < 1\ second$.

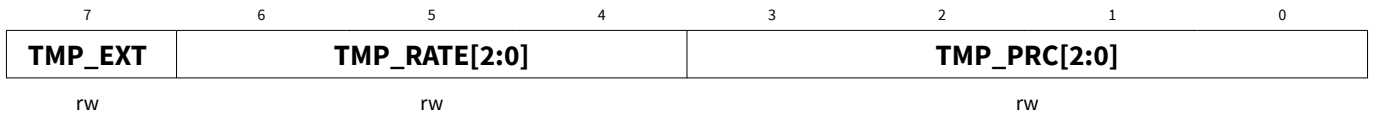
The temperature measurement time versus temperature oversampling rate is similar with pressure measurement time versus pressure oversampling rate

Register description

8.4 Temperature Configuration(TMP_CFG)

Configuration of temperature measurement rate (TMP_RATE) and resolution (TMP_PRC).

TMP_CFG **Address:** 07_H
 Temperature measurement configuration **Reset value:** 00_H



| Field | Bits | Type | Description |
|---------------|------|------|--|
| TMP_EXT | 7 | rw | Temperature measurement 0 - Internal sensor (in ASIC) 1 - External sensor (in pressure sensor MEMS element) <i>Note: It is highly recommended to use the same temperature sensor as the source of the calibration coefficients. Please see the Coefficient Source register</i> |
| TMP_RATE[2:0] | 6:4 | rw | Temperature measurement rate: 000 - 1 measurement pr. sec. 001 - 2 measurements pr. sec. 010 - 4 measurements pr. sec. 011 - 8 measurements pr. sec. 100 - 16 measurements pr. sec. 101 - 32 measurements pr. sec. 110 - 64 measurements pr. sec. 111 - 128 measurements pr. sec.. <i>Applicable for measurements in Background mode only</i> |
| TMP_PRC[2:0] | 3:0 | rw | Temperature oversampling (precision): 0000 - single. (Default) - Measurement time 3.6 ms. <i>Note: Following are optional, and may not be relevant:</i> 0001 - 2 times. 0010 - 4 times. 0011 - 8 times. 0100 - 16 times. 0101 - 32 times. 0110 - 64 times.. 0111 - 128 times. 1xxx - Reserved. |

Register description

8.5 Sensor Operating Mode and Status (MEAS_CFG)

Setup measurement mode.

MEAS_CFG **Address:** 08_H
 Measurement configuration **Reset value:** C0_H

| | | | | | | | |
|-----------------|-------------------|----------------|----------------|---|------------------|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| COEF_RDY | SENSOR_RDY | TMP_RDY | PRS_RDY | - | MEAS_CTRL | | |
| r | r | r | r | - | rw | | |

| Field | Bits | Type | Description |
|------------|------|------|--|
| COEF_RDY | 7 | r | Coefficients will be read to the Coefficients Registers after start-up: 0 - Coefficients are not available yet. 1 - Coefficients are available. |
| SENSOR_RDY | 6 | r | The pressure sensor is running through self initialization after start-up. 0 - Sensor initialization not complete 1 - Sensor initialization complete It is recommend not to start measurements until the sensor has completed the self intialization. |
| TMP_RDY | 5 | r | Temperature measurement ready 1 - New temperature measurement is ready. Cleared when temperature measurement is read. |
| PRS_RDY | 4 | r | Pressure measurement ready 1 - New pressure measurement is ready. Cleared when pressurement measurement is read. |
| - | 3 | - | Reserved. |
| MEAS_CTRL | 2:0 | rw | Set measurement mode and type: <i>Standby Mode</i> 000 - Idle / Stop background measurement <i>Command Mode</i> 001 - Pressure measurement 010 - Temperature measurement 011 - na. 100 - na. <i>Background Mode</i> 101 - Continous pressure measurement 110 - Continous temperature measurement 111 - Continous pressure and temperature measurement |

Register description

8.6 Interrupt and FIFO configuration (CFG_REG)

Configuration of interrupts, measurement data shift, and FIFO enable.

CFG_REG **Address:** 09_H
 Configuration register **Reset value:** 00_H

| | | | | | | | |
|---------------|-----------------|----------------|----------------|----------------|----------------|----------------|-----------------|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| INT_HL | INT_FIFO | INT_TMP | INT_PRS | T_SHIFT | P_SHIFT | FIFO_EN | SPI_MODE |
| rw | rw | rw | rw | rw | rw | rw | rw |

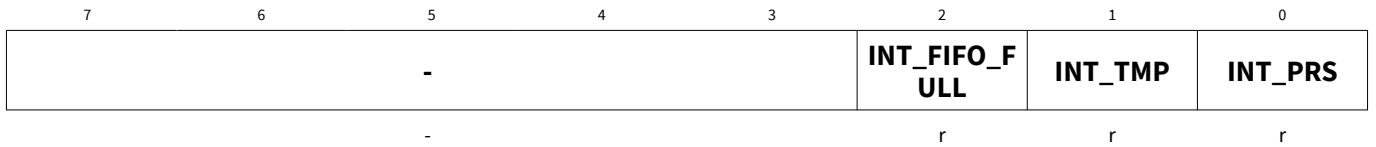
| Field | Bits | Type | Description |
|----------|------|------|---|
| INT_HL | 7 | rw | Interrupt (on SDO pin) active level: 0 - Active low. 1 - Active high. |
| INT_FIFO | 6 | rw | Generate interrupt when the FIFO is full: 0 - Disable. 1 - Enable. |
| INT_TMP | 5 | rw | Generate interrupt when a temperature measurement is ready: 0 - Disable. 1 - Enable. |
| INT_PRS | 4 | rw | Generate interrupt when a pressure measurement is ready: 0 - Disable. 1 - Enable. |
| T_SHIFT | 3 | rw | Temperature result bit-shift 0 - no shift. 1 - shift result right in data register. <i>Note: Must be set to '1' when the oversampling rate is >8 times.</i> |
| P_SHIFT | 2 | rw | Pressure result bit-shift 0 - no shift. 1 - shift result right in data register. <i>Note: Must be set to '1' when the oversampling rate is >8 times.</i> |
| FIFO_EN | 1 | rw | Enable the FIFO: 0 - Disable. 1 - Enable. |
| SPI_MODE | 0 | rw | Set SPI mode: 0 - 4-wire interface. 1 - 3-wire interface. |

Register description

8.7 Interrupt Status (INT_STS)

Interrupt status register. The register is cleared on read.

INT_STS **Address:** 0A_H
 Interrupt status **Reset value:** 00_H



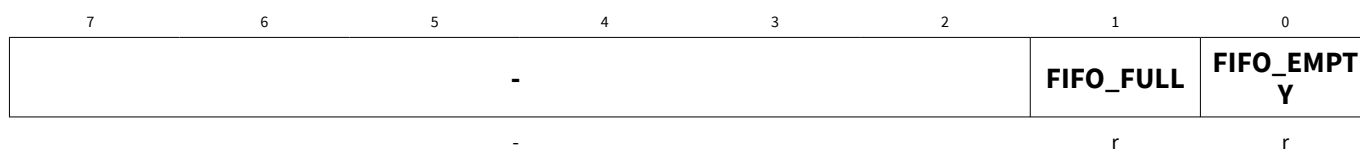
| Field | Bits | Type | Description |
|---------------|------|------|---|
| - | 7:3 | - | Reserved. |
| INT_FIFO_FULL | 2 | r | Status of FIFO interrupt 0 - Interrupt not active 1 - Interrupt active |
| INT_TMP | 1 | r | Status of temperature measurement interrupt 0 - Interrupt not active 1 - Interrupt active |
| INT_PRS | 0 | r | Status of pressure measurement interrupt 0 - Interrupt not active 1 - Interrupt active |

Register description

8.8 FIFO Status (FIFO_STS)

FIFO status register

FIFO_STS **Address:** 0B_H
 FIFO status register **Reset value:** 00_H



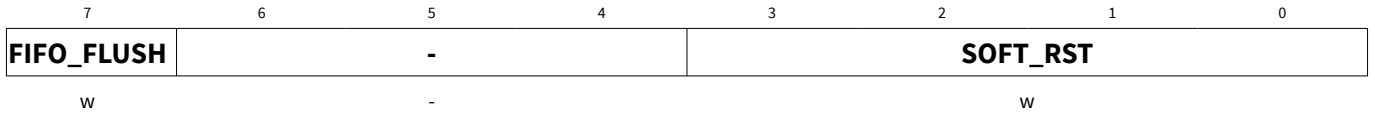
| Field | Bits | Type | Description |
|------------|------|------|--|
| - | 7:2 | - | Reserved. |
| FIFO_FULL | 1 | r | 0 - The FIFO is not full 1 - The FIFO is full |
| FIFO_EMPTY | 0 | r | 0 - The FIFO is not empty 1 - The FIFO is empty |

Register description

8.9 Soft Reset and FIFO flush (RESET)

Flush FIFO or generate soft reset.

RESET **Address:** 0C_H
 FIFO flush and soft reset **Reset value:** 00_H



| Field | Bits | Type | Description |
|------------|------|------|---|
| FIFO_FLUSH | 7 | w | FIFO flush 1 - Empty FIFO After reading out all data from the FIFO, write '1' to clear all old data. |
| - | 6:4 | - | Reserved. |
| SOFT_RST | 3:0 | w | Write '1001' to generate a soft reset. A soft reset will run through the same sequences as in power-on reset. |

8.10 Product and Revision ID (ID)

Product and Revision ID.

ID **Address:** 0D_H
 Product and revision ID **Reset value:** 0x10_H



| Field | Bits | Type | Description |
|---------|------|------|-------------|
| REV_ID | 7:4 | r | Revision ID |
| PROD_ID | 3:0 | r | Product ID |

Register description

8.11 Calibration Coefficients (COEF)

The Calibration Coefficients register contains the 2’s complement coefficients that are used to calculate the compensated pressure and temperature values.

Table 18 Calibration Coefficients

| Coefficient | Addr. | bit7 | bit6 | bit5 | bit4 | bit3 | bit2 | bit1 | bit0 |
|-------------|-------|-------------|------|------|------|-------------|------|------|------|
| c0 | 0x10 | c0 [11:4] | | | | | | | |
| c0/c1 | 0x11 | c0 [3:0] | | | | c1 [11:8] | | | |
| c1 | 0x12 | c1[7:0] | | | | | | | |
| c00 | 0x13 | c00 [19:12] | | | | | | | |
| c00 | 0x14 | c00 [11:4] | | | | | | | |
| c00/c10 | 0x15 | c00 [3:0] | | | | c10 [19:16] | | | |
| c10 | 0x16 | c10 [15:8] | | | | | | | |
| c10 | 0x17 | c10 [7:0] | | | | | | | |
| c01 | 0x18 | c01 [15:8] | | | | | | | |
| c01 | 0x19 | c01 [7:0] | | | | | | | |
| c11 | 0x1A | c11 [15:8] | | | | | | | |
| c11 | 0x1B | c11 [7:0] | | | | | | | |
| c20 | 0x1C | c20 [15:8] | | | | | | | |
| c20 | 0x1D | c20 [7:0] | | | | | | | |
| c21 | 0x1E | c21 [15:8] | | | | | | | |
| c21 | 0x1F | c21 [7:0] | | | | | | | |
| c30 | 0x20 | c30 [15:8] | | | | | | | |
| c30 | 0x21 | c30 [7:0] | | | | | | | |

Note: Generate the decimal numbers out of the calibration coefficients registers data:

$$C20 := \text{reg0x1D} + \text{reg0x1C} * 2^8$$

if (C20 > (2¹⁵ - 1))

$$C20 := C20 - 2^{16}$$

end if

$$C0 := (\text{reg0x10} * 2^4) + ((\text{reg0x11} / 2^4) \& 0x0F)$$

if (C0 > (2¹¹ - 1))

$$C0 := C0 - 2^{12}$$

end if

Package Dimensions

8.12 Coefficient Source

States which internal temperature sensor the calibration coefficients are based on: the ASIC temperature sensor or the MEMS element temperature sensor. The coefficients are only valid for one sensor and it is highly recommended to use the same temperature sensor in the application. This is set-up in the Temperature Configuration register.

TMP_COEF_SRCE **Address:** 28_H
 Temperature Coefficients Source **Reset value:** XX_H

| | | | | | | | |
|----------------------|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| TMP_COEF_SRCE | | - | | | | | |
| r | | | | | | | |

| Field | Bits | Type | Description |
|---------------|------|------|--|
| TMP_COEF_SRCE | 7 | r | Temperature coefficients are based on: 0 - Internal temperature sensor (of ASIC) 1 - External temperature sensor (of pressure sensor MEMS element) |
| - | 6:0 | - | Reserved |

9 Package Dimensions

The sensor package is a 8-pin PG-VLGA-8-1, 2.0 x 2.5 x 1 mm³, with 0.65 mm pitch.

10 Package Handling

Further Information please refer to the attached “Digital Barometric Pressure Sensor_ Package Handling”. It describes the package handling and delivery format.

11 Reflow soldering and board assembly

The Infineon pressure sensors are qualified in accordance with the IPC/JEDEC J-STD-020D-01. The moisture sensitivity level of pressure sensor is rated as MSL1. For PCB assembly of the sensor the widely used reflow soldering using a forced convection oven is recommended.

The soldering profile should be in accordance with the recommendations of the solder paste manufacturer to reach an optimal solder joint quality. The reflow profile shown in figure below is recommended for board manufacturing with Infineon pressure sensors.

Figure 17 Reflow profile

Reflow soldering and board assembly

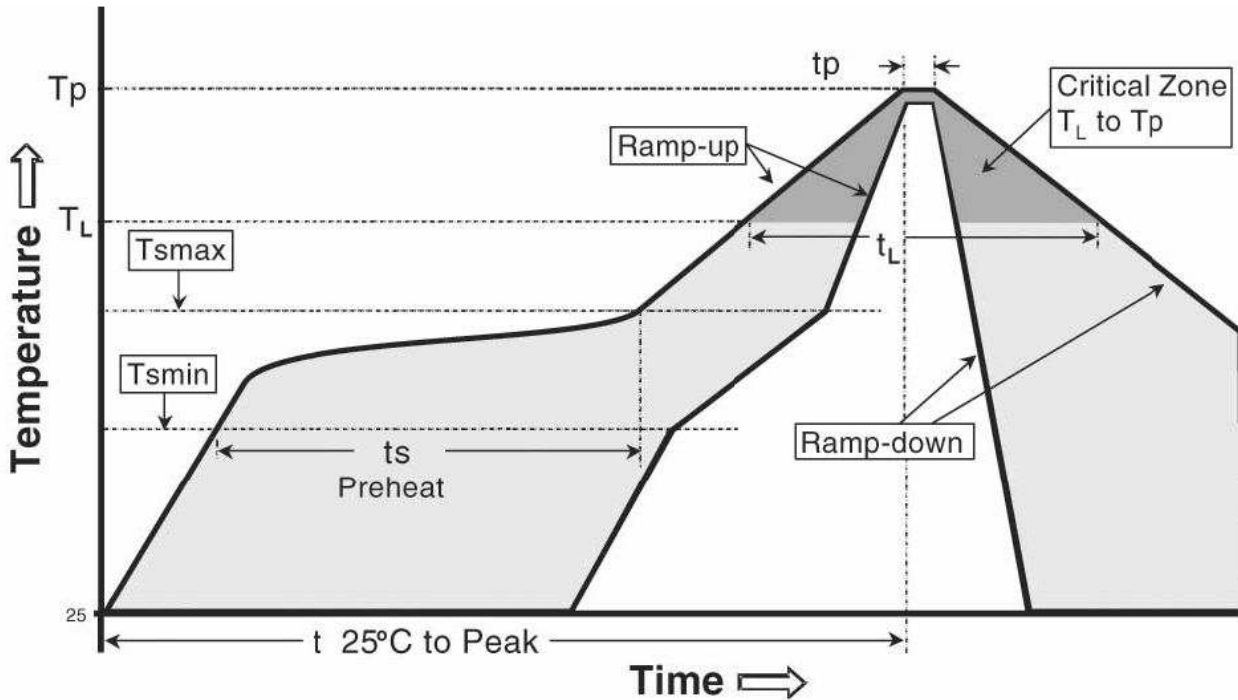


Table 19 Reflow profile limits

| Profile feature | Pb-Free assembly | Sn-Pb Eutectic assembly |
|--|------------------|-------------------------|
| Preheat/Soak | | |
| Temperature Min (T_{smin}) | 150 °C | 100 °C |
| Temperature Max (T_{smax}) | 200 °C | 150 °C |
| Time (T_{smin} to T_{smax}) (t_s) | 60-120 seconds | 60-150 seconds |
| Peak Temperature (T_p) | 260°C +0°C/-5°C | 235°C +0°C/-5°C |
| Time within 5°C of actual peak temperature (t_p)* | 20-40 seconds | 10-30 seconds |
| Ramp-down rate | 6 °C/second max. | 6 °C/second max. |
| Time 25°C to peak temperature | 8 minutes max. | 6 minutes max. |
| * Tolerance for peak profile temperature (T_p) is defined as a supplier minimum and a user maximum | | |

Note: For further information please consult the 'General recommendation for assembly of Infineon packages' document which is available on the Infineon Technologies web page

Revision History

The Infineon pressure sensors can be handled using industry standard pick and place equipment. Care should be taken to avoid damage to the sensor structure as follows:

- Do not pick the sensor with vacuum tools which make contact with the sensor vent port hole
- The sensor's vent hole should not be exposed to vacuum, this can destroy or damage the MEMS
- Do not blow air into the sensor vent hole. If an air blow cleaning process is used, the vent hole must be sealed to prevent particle contamination.
- It is recommended to perform the PCB assembly in a clean room environment in order to avoid sensor contamination.
- Air blow and ultrasonic cleaning procedures shall not be applied to MEMS pressure sensors. A non-clean paste is recommended for the assembly to avoid subsequent cleaning steps. The MEMS sensor can be severely damaged by cleaning substances.
- To prevent the blocking or partial blocking of vent hole during PCB assembly, it is recommended to cover the sound port with protective tape during PCB sawing or system assembly.
- Do not use excessive force to place the sensor on the PCB. The use of industry standard pick and place tools is recommended in order to limit the mechanical force exerted to the package.

Revision History

Major changes since previous revision

Revision History

| Reference | Description |
|-----------|--|
| 1.0 | Initial released |
| 1.1 | Title update; table 7 update; add reflow soldering chapter |
| 1.2 | Package dimensions typo fix |

Known Issues List

Known Issues

| Product and Revision ID | Description |
|-------------------------|-------------|
| | |

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Edition 2020-10-15

Published by

Infineon Technologies AG

81726 Munich, Germany

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Document reference

IFX-sch1406115644540

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