DATASHEET

AS23F-01BA-00

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History of Revision

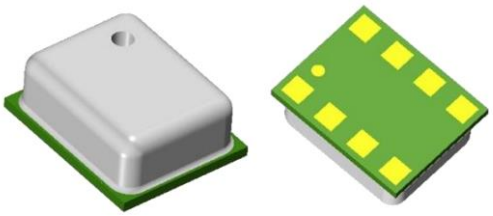
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1. OVERVIEW



1.1 Features

- Pressure temperature sensitivity: < 0.5Pa/K
- Average current consumption Standby: <1μA
- Supply voltage: VDDIO: 1.2 – 3.6 V, VDD: 1.7 – 3.6 V.
- Operating modes: Command (manual), Background (automatic), and Standby.
- FIFO: Stores up to 32 pressure or temperature measurements. Streaming or stop-on full mode. Optional interrupt on full or watermark interrupt.
- Interface: I2C with optional interrupt

- Waterproof and anti-corrosion
- Size: 2.5 x 2.0 x 1.0 mm

1.2 Applications

- Local weather station and Thermostat
- Air flow control
- Health and sports
- Outdoor navigation
- Indoor navigation
- Smart Home

1.3 Descriptions

The AS23F-01BA-00 is a monolithic digital barometric air pressure sensor die, comprising the full MEMS and ASIC system. The AS23F-01BA-00 is capable of measuring both air pressure and temperature, with high accuracy and low current consumption. Pressure sensing is carried out using a capacitive sensor element, guaranteeing high accuracy over temperature. The small chip dimensions and low current consumption make the AS23F-01BA-00 a perfect fit for mobile and consumer applications.

The pressure and temperature sensor elements are measured by a 24-bit ΣΔ ADC. Measurement results can be accessed over I2C or SPI, with an optional configurable interrupt and a result FIFO capable of holding 32 pressure and/or temperature measurements.

Each AS23F-01BA-00 contains dedicated fuse locations to allow for individual calibration of each unit and storing of calibration coefficients. These coefficients are used in the application to convert the measurement results to high accuracy pressure and temperature values.

The AS23F-01BA-00 contains a FIFO which can store up to 32 measurements. By using the FIFO, the host processor can remain in a sleep mode for a longer period of time between readouts, reducing the overall system power consumption. 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.

Parameter	Symbol	Min	Typ.	Max	Unit	Note / Test Condition
Pressure	Pa	300		1200	hPa	
Temperature	Ta	-40		85	℃	
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			0.5		hPa	Drift measured 72 hours after reflow. Minimum solder height 50um.
Long term stability			±1		hPa	12 months

1.4 Block Diagram

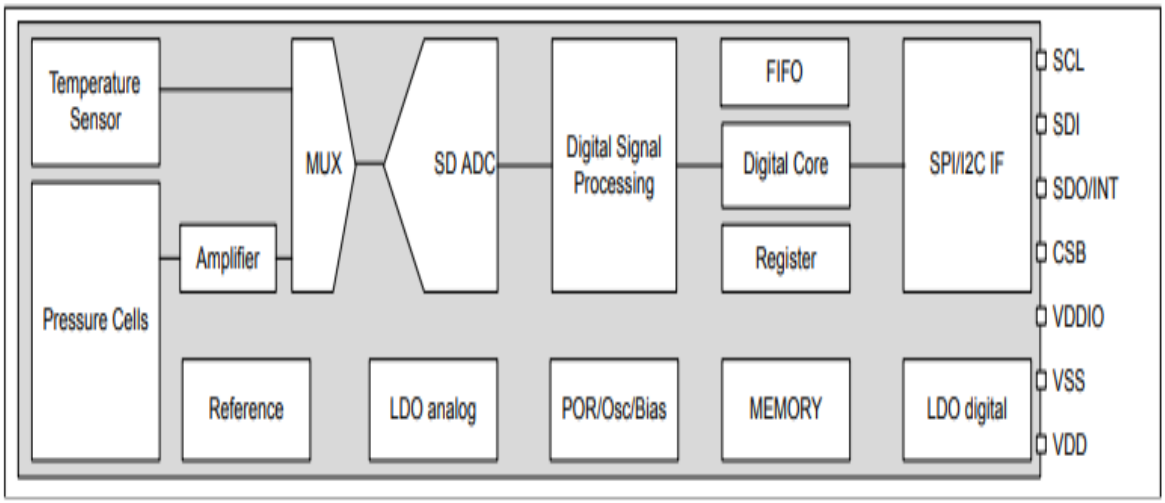


Figure 1: Functional Block Diagram

2. Electrical Specifications

2.1 Pressure and Temperature Characteristics

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

Table1: Pressure Output Characteristics @VDD=3.0V, T=25°C unless otherwise noted

Sensor Performances (VDD = 3.0 V)	Min	Typ	Max	Unit
Pressure Range	300		1200	hPa
Temperature Range	-40		85	°C
ADC		24		bit
Pressure sensor precision: (high precision mode).		± 0.005		hPa
Absolute Accuracy		± 1		hPa
Relative Accuracy		± 0.06		hPa
Temperature accuracy		± 0.4		°C
Measurement time for standard mode (16x).		27.6		ms
Measurement time for low precision mode.	3.6			ms
Average current consumption for pressure measurement[1)]		1.7		µA
Average current consumption for temperature measurement[1)]		2		µA

1) @1Hz sampling rate

2.2 Absolute Maximum Rating

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

Table2: Absolute Maximum Rating

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min	Typ	Max		
VDD and VDDIO	V_{DDxx_max}			4.25	V	
Voltage on any pin	Vmax			4.25	V	
Storage temperature	Ts	-40		125	℃	
Pressure	Pmax			10000	hPa	
ESD	V_{ESD_HBM}	-2		+2	kV	HBM (JS-001)
Attention: Stresses above the values listed as "Absolute Maximum Ratings" may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.						

2.3 Current consumption

Test conditions (unless otherwise specified in the table): VDD= 1.8V and VDDIO=1.8V.

Table 3Current 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}		1		μA	
Current Consumption. (1 measurement 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 register description for an overview of the current consumption in different combinations of measurement precision and rate.						

2.4 Pressure transfer function

Test conditions (unless otherwise specified):
VDD= 1.8V, VDDIO=1.8V. Typ. values (PA=1000hPa and TA=25° C).
Note:
Pressure accuracy and precision values are after individual unit calibration in package.
For application-specific requirements, advice on calibration and packaging is available.
Table 6 Pressure sensor transfer function

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min	Typ	Max		
Absolute pressure accuracy	Ap_abs		±100		Pa	PA=300-1200hPa TA=25...+65° C, excluding solder effects
			±300		Pa	PA=300-1200hPa TA=-10...+25° C, excluding solder effects
Relative pressure accuracy	Ap_rel		±6		Pa	Any ∆25 hPa in the range PA=800-1200hPa Any constant temperature in the range TA=20...+60° C
Pressure precision	Ap_prc		5.0		P_{aRMS}	Low Power
			1.2			Standard
			0.6			High Precision
Note: Pressure precision is measured as the average standard deviation. Please refer to the PSR_CFG register description for all precision mode options.						
Power supply rejection	Ap_psr			0.063	P_{aRMS}	50mVppsine wave, sweep from 100Hz to 5MHz
Pressure temperature sensitivity of calibrated measurements	Ap_tmp		0.5		Pa/K	1000hPa, 25...+40° C.
Pressure data resolution	Ap_res			0.06	P_{aRMS}	
Pressure measurement rate	f	1		128	Hz	
Pressure measurement time (including 1x decimation temperature measurement)	t		5.2		ms	Low Power (1x decimation)
			27.6			Standard (16x decimation)
			105			High Precision (64x decimation)
Note: The pressure measurement time (and thus the maximum rate) depends on the pressure measurement precision. Please refer to the PSR_CFG register description for an overview of the possible combinations of measurement precision and rate.						

3. Function Descriptions

The AS23F-01BA-00 is a versatile sensor, capable of providing fast, accurate pressure and temperature measurements at low current.

3.1 Operating modes

The AS23F-01BA-00 supports 3 different modes of operation: Standby, Command, and Background mode.

• Standby Mode

- Default mode a□er 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.

3.2 Mode transition diagram

The mode transition diagram is shown below.

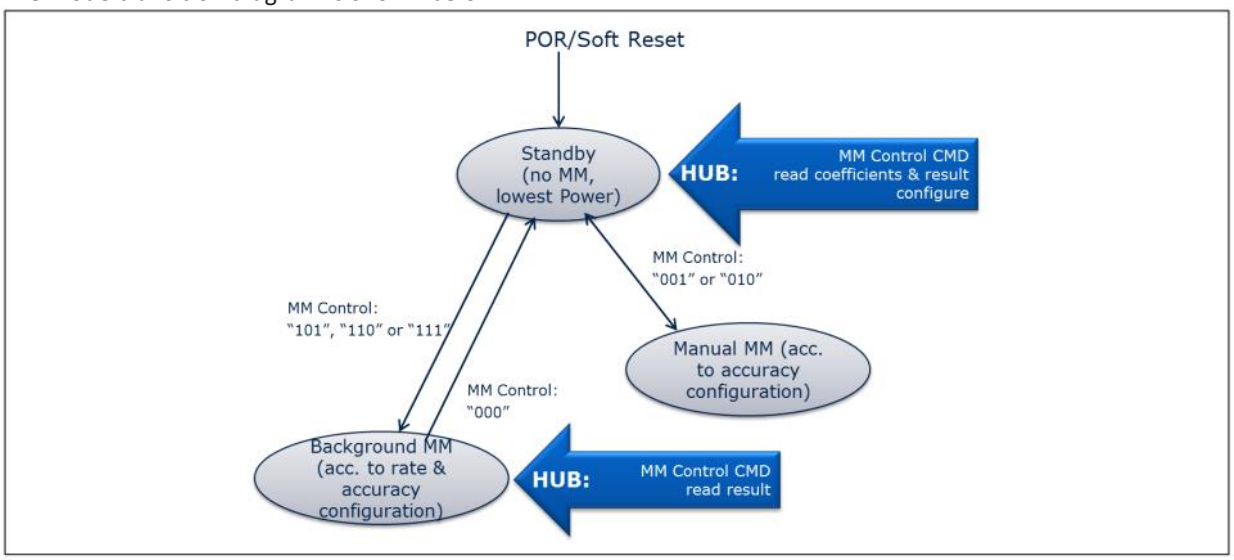


Figure 2 AS23F-01BA-00 mode transition diagram.

3.3 Start-up sequence

The AS23F-01BA-00 start-up sequence is shown below. This diagram shows when the registers are accessible for read/ write operations and also when the pressure/temperature measurements can start.

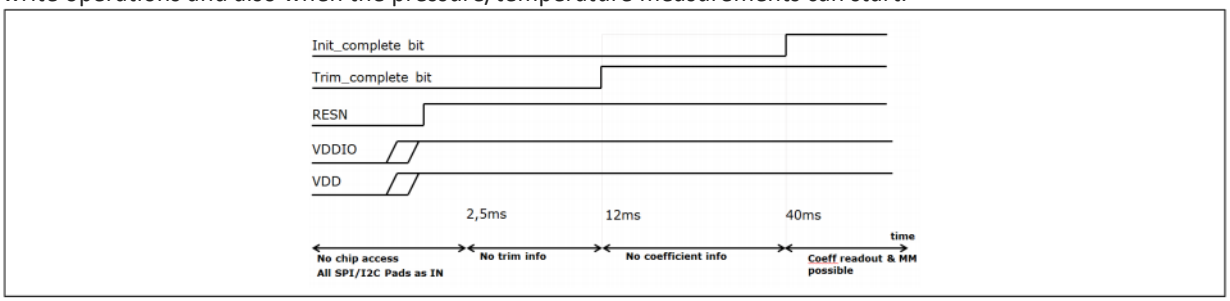


Figure 3 AS23F-01BA-00 start-up sequence.

3.4 Measurement precision and rate

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

The AS23F-01BA-00's measurement precision and rate (in background mode) can be configured to match the requirements of the application in which it is being used. This reduces current consumption of the sensor and the system.

In order to achieve a higher precision, the AS23F-01BA-00 will read the sensor multiple times (oversampling), and combine the readings into one result. This increases the current consumption and the measurement time, which again reduces the maximum measurement rate.
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.
Please note that the pressure sensor is temperature dependent. Temperature measurements must be made together with the pressure measurements in order to compensate for the temperature dependency. This reduces the maximum pressure measurement rate, since: Ratetemperature*Timetemperature + Ratepressure*Timepressure< 1 second. Measurement Settings and use case example 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.

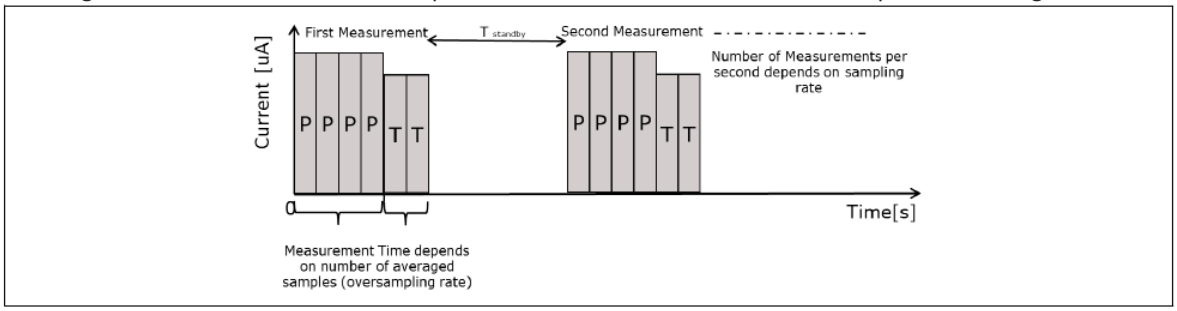


Figure 4 Background mode temperature and pressure measurements sequence

3.4 Sensor interface

The AS23F-01BA-00 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 CFG_REG register after start up.

More details about digital interfaces are available in the Digital interfaces section.

3.5 Interrupt

The AS23F-01BA-00 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.

3.6 Result Register Operation

After starting the measurements the latest Pressure and Temperature raw data will be available into Result registers, separate register for Temperature and Pressure. Temperature measurement can be skipped. Skipping the measurement can be useful to measure Pressure extremely rapidly.

All measurement data can be read in single command using auto-increment read. After reading the results registers all data will be available there until new measurement will be done. In case of using FIFO, after a read the register content will be 0x800000. The new results that may be produced will not interfere when reading Results Register.

3.7 FIFO operation

The AS23F-01BA-00 can store the last 32 measurements of pressure or temperature. This reduces the overall system power consumption when 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 will store any combination of temperature and pressure measurements since the measurement rate of temperature and pressure can be set up independently in Background Mode. 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 (CFG_REG) register. The data from the FIFO is read out from the Pressure Data (PRS_Bn) registers regardless of 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 (FIFO_STS) register when the FIFO is empty and all following reads will return 0x800000.

If the FIFO runs full a flag will be set in the FIFO Status (FIFO_STS) register and the sensor will generate an interrupt if this has been enabled in the Interrupt and FIFO configuration (CFG_REG) register.

The FIFO will stop to store data after filled with 32 values.

3.8Calibration and Measurement Compensation

The AS23F-01BA-00 contains the OTP's fuses which can be used to calibrate the sensor and also calibration coefficients values to be set.

See Pressure Sensor Calibration Method Application Note fore more details about calibration procedure and fusing. The calibration coefficients are used in the application (for instance by the host processor) to compensate the measurement results for sensor non-linearity. The sections that follow, describe how to calculate the compensated results and convert them into Pa and °C values.

4 How to calculate compensation pressure values

Steps

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

Note: The coefficients read from the coefficient register are 16 bit 2´s complement numbers.

2. Read the 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.

3. Choose scaling factors kT (for temperature) and kP (for pressure) based on the chosen precision rate. The scaling factors are listed in Table 7.

4. 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.

5. Calculate scaled measurement results.

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

6 Calculate compensated measurement results.

Pcomp(Pa) = c00+ Praw_sc*(c10 + Praw_sc *(c20+ Praw_sc *c30)) + Traw_sc* c01+ Traw_sc *Praw_sc *(c11+ Praw_sc *c21)

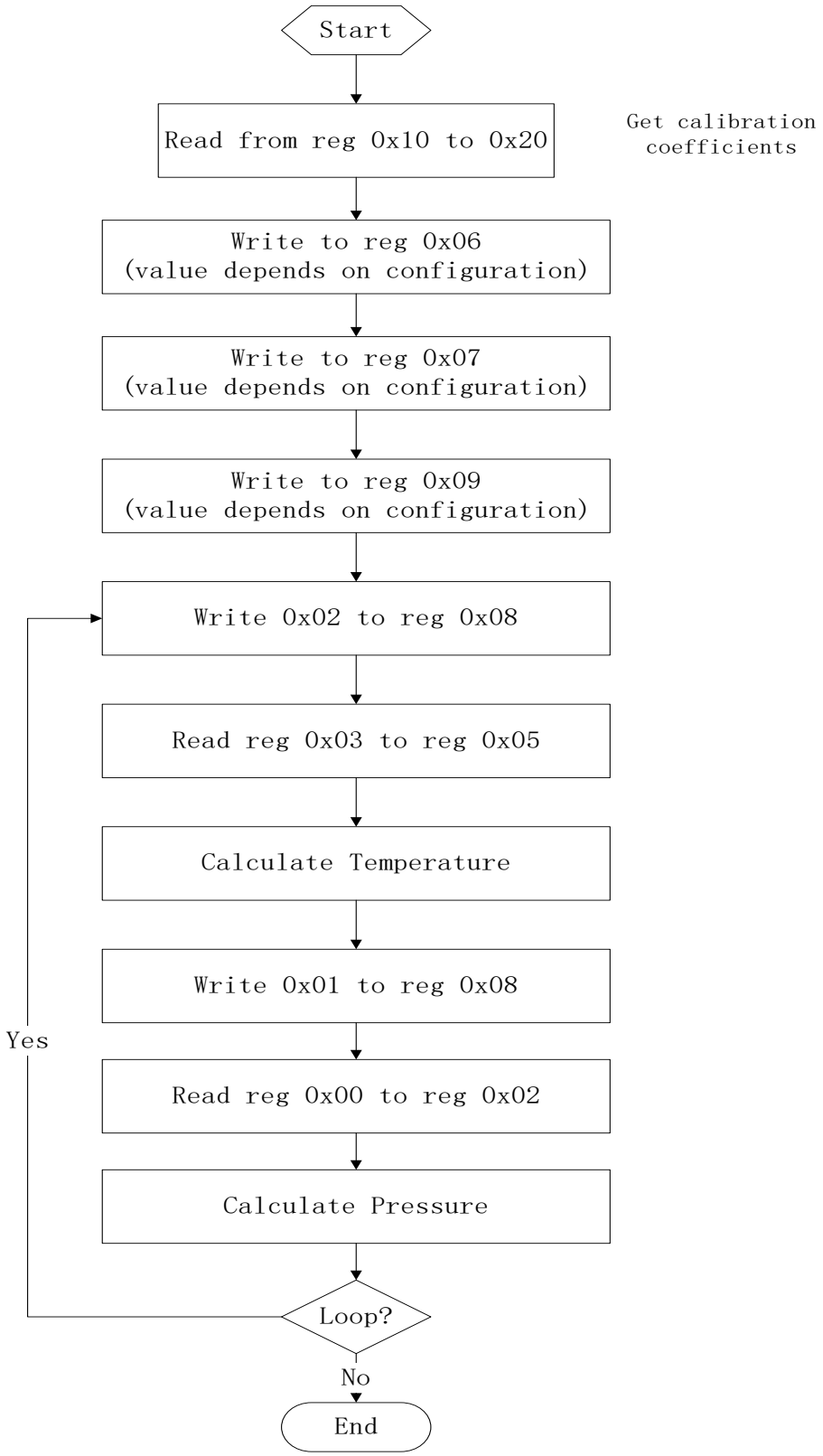
Tcomp (°C) = c0*0.5 + c1*Traw_sc

4.1Compensation Scale Factors

Table 7 Compensation Scale Factors

Oversampling Rate	Scale Factor (kP or kT)
1 (single)	524288
2 times (Low Power)	1572864
4 times	3670016
8 times	7864320
16 times (Standard)	253952
32 times	516096
64 times (High Precision)	1040384
128 times	2088960

5 Pressure and Temperature Calculation Flow



6 Applications

6.1 Measurement settings and use case examples

The AS23F-01BA-00 provides versatile pressure measurements for a wide range of applications. The requirements of these applications can be very different, and so the AS23F-01BA-00 can be quickly configured with a couple of register writes to ensure the speed, accuracy and current consumption are in line with the application priorities.

Table 11 Measurement settings and use case examples

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)

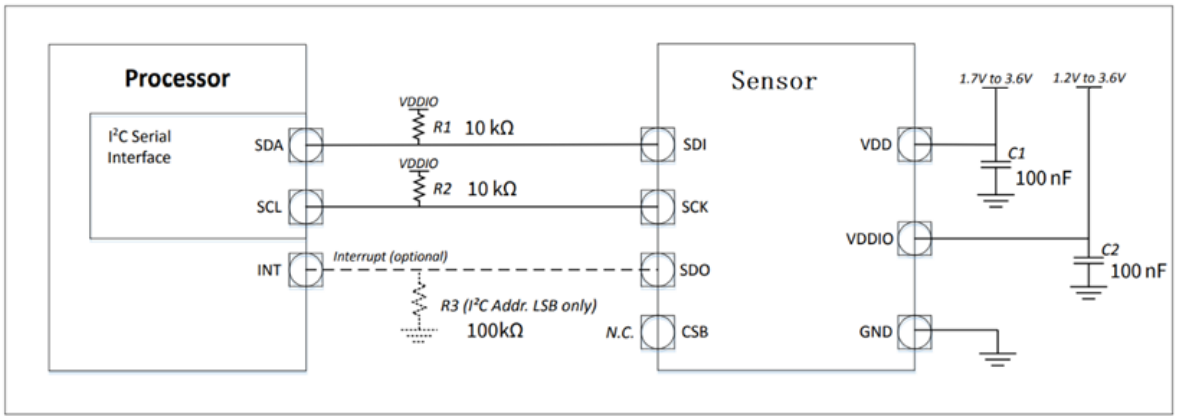
6.2 Application circuit examples

The example application circuits below demonstrate the connection of the I2C and SPI serial interfaces.

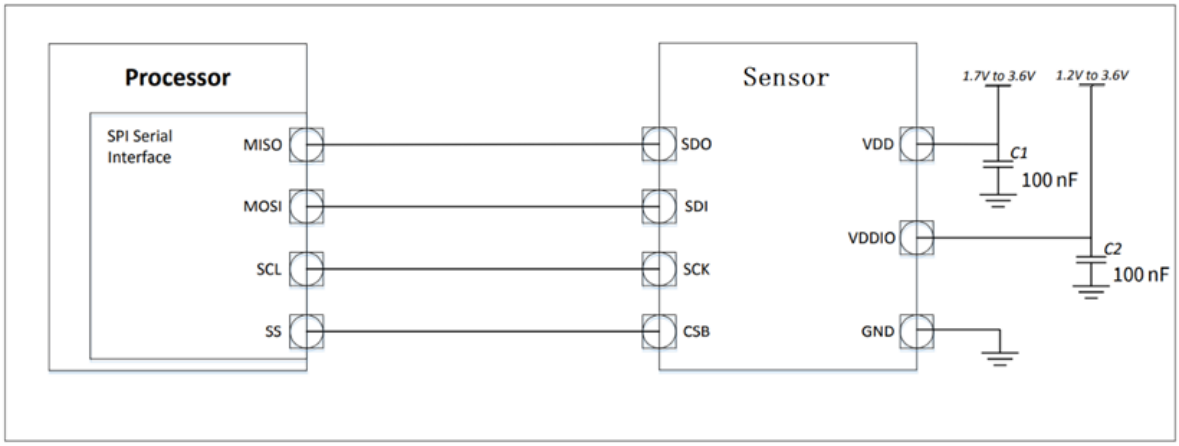
- In I2C mode, the SDO pin can be used for interrupt output and/or to set the least significant bit of the device address.
- In 3-wire SPI mode, the SDO pin can be used for interrupt output.
- In 4-wire SPI mode, the SDO pin can only be used as the serial data output.

The AS23F-01BA-00 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.

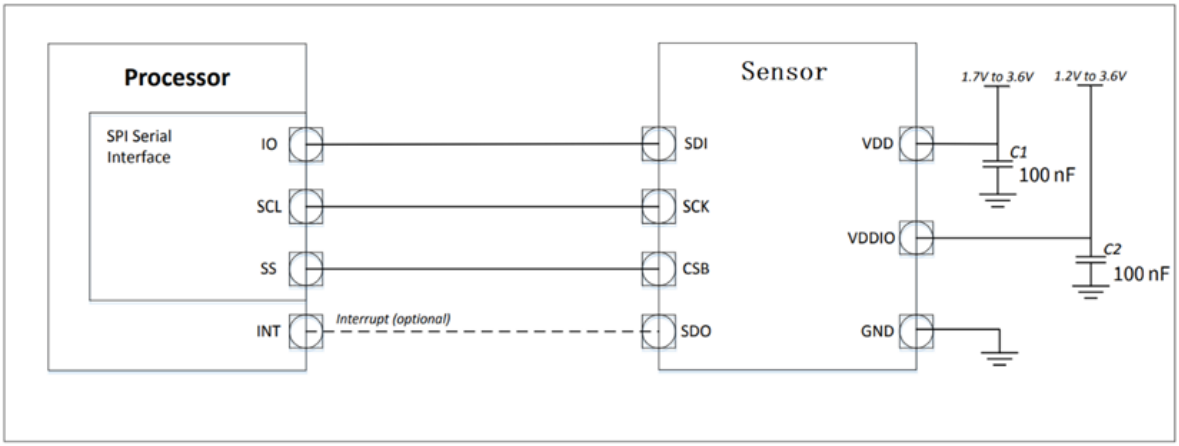
6.3 Application Circuit



Application circuit example using the I2C serial interface



Application circuit example using the SPI 4-wires serial interface



Application circuit example using the SPI 3-wire serial interface

7 Digital interfaces

The AS23F-01BA-00 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 only supports mode '11' (CPOL=CPHA='1') in 4-wire and 3-wire configuration.
The following commands are supported by the I2C interface:

- Single byte read
- Single byte write
- Multi-byte read, with automatic register increment
- Multi-byte write, with automatic register increment

The following commands are supported by the SPI interface:

- Single byte read
- Single byte write
- Multi-byte read, with automatic register increment

Note: Multi-byte write is not supported by the SPI interface.
The communication interface is selected using the CSB pin:

- If CSB is connected to VDDIO, the I2C interface is active.
- If CSB is connected to ground, the SPI interface is active.

Once CSB has been pulled down, the I2C interface is disabled until the next power-on-reset.
If CSB is high, the I2C interface is selected by addressing the AS23F-01BA-00 over the I2C bus. After this, the I2C interface is locked, and pulling down CSB will not activate the SPI interface. The SPI interface can only be selected by pulling CSB low after the next power-on-reset, before the AS23F-01BA-00 is addressed over I2C.

7.1 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 the 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 pads described in the Pad configuration section. Refer to Application circuit examples for connection instructions.

The basic timing is shown in the diagram below:

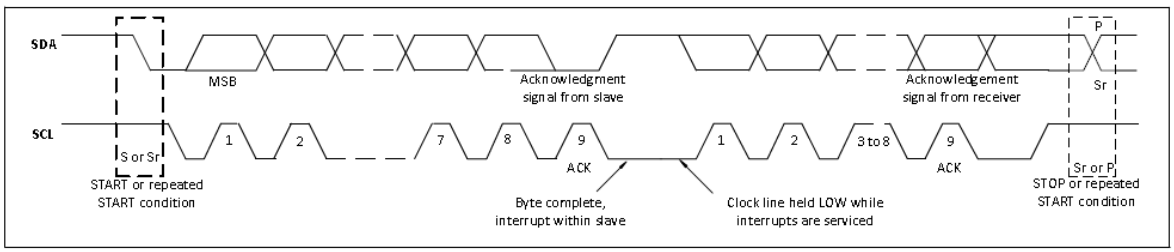


Figure 10 I2C timing diagram

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

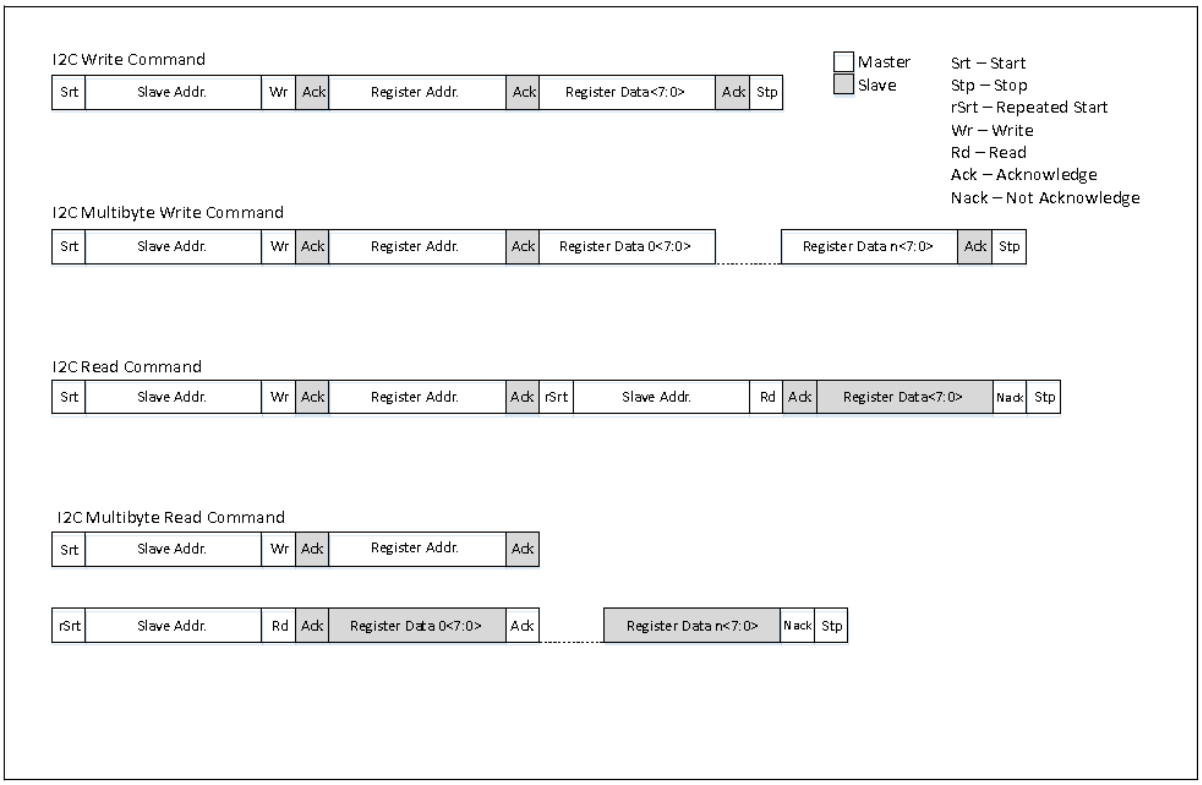


Figure 11 I2C write and read commands

7.2 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 for 3-wire and 4-wire SPI is similar. The 3-wire SPI protocol uses a single shared data line, the 4-wire SPI protocol uses separate Serial Data Out (SDO) and Serial Data In (SDI) data lines. The naming of these data lines refers to the direction of data respective to the slave device.

3-wire SPI mode is selected by setting bit [0] in the CFG_REG register to '1'.

The SPI interface uses the pads described in the Pad configuration section. Refer to Application circuit examples for connection instructions. The SPI protocol is shown in the diagram below:

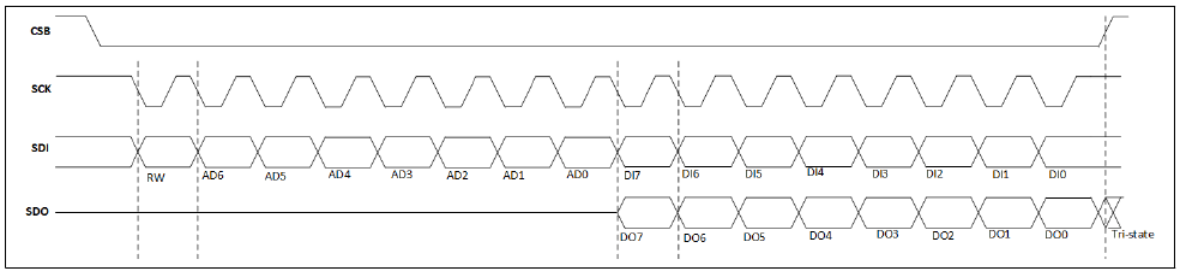


Figure 12 SPI protocol, 4-wire without interrupt

7.3 Interface parameter specification

7.3.1 General interface parameters

The general interface parameters are given in the table below:

Table 13 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^2C bus load capacitor	Cb			400	pF	On SDI and SCK

7.3.2 I2C timing parameters

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.

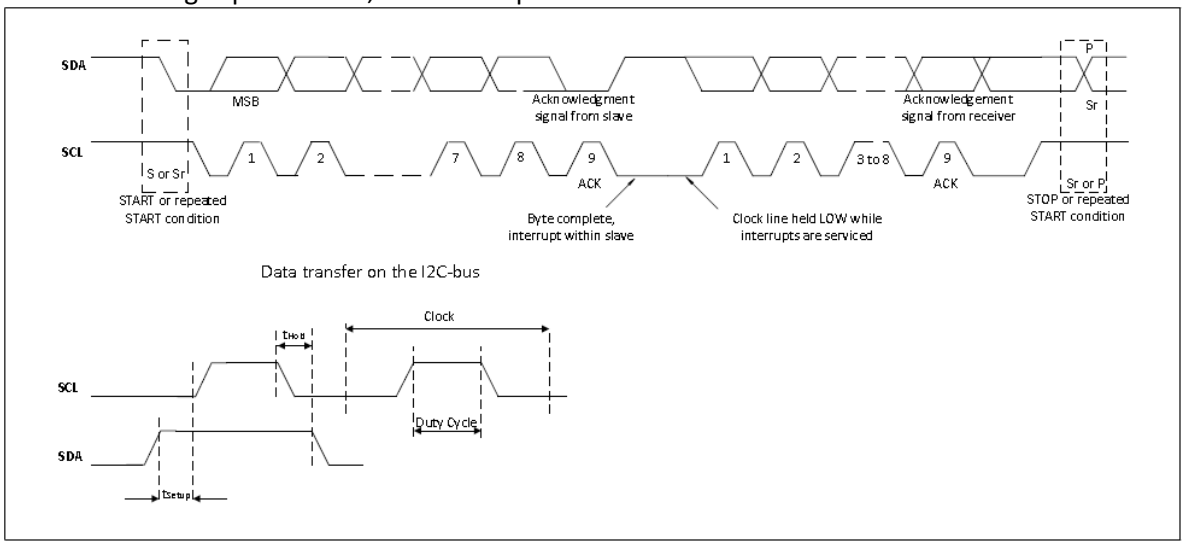


Figure 14 I2C timing diagram

Table 14 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,

7.3.3 SPI timing parameters

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.

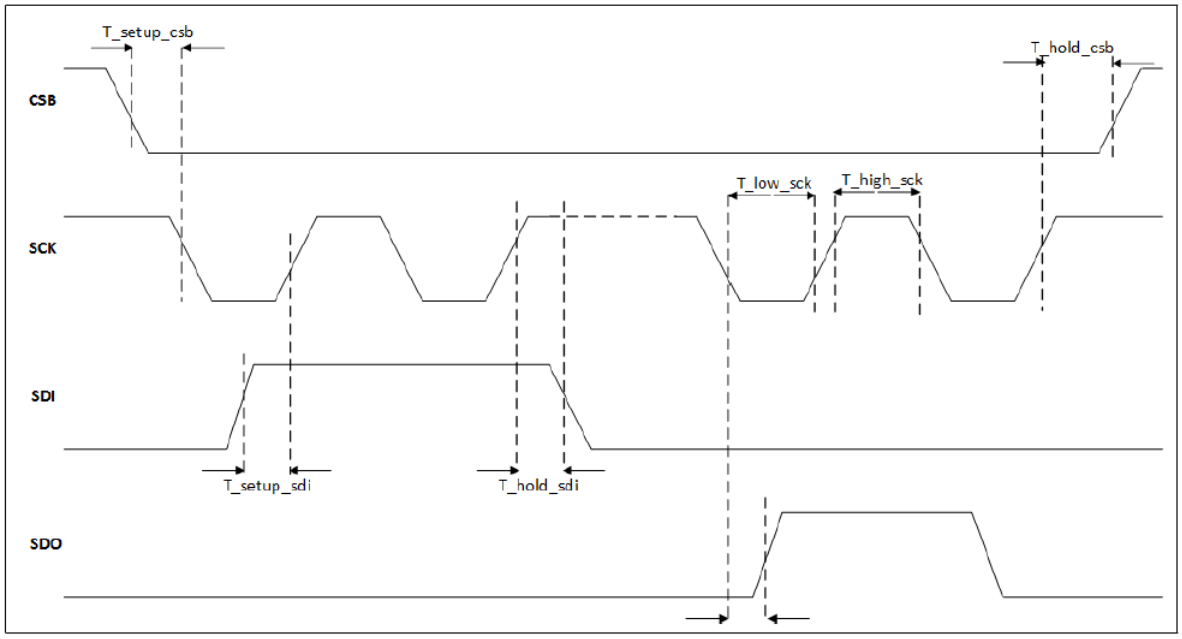


Figure 15 SPI timing diagram

Table 15 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	

8 AS23F-01BA-00 Register map

The AS23F-01BA-00 user registers are listed and described below. The calibration coefficient registers can be found in the Calibration coefficients section.

Table 16 AS23F-01BA-00 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_CRTL [2:0] (rw)			00_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

Attention: To ensure correct functionality, registers not listed in this register map must not be accessed.

Table 17 PSR_B2 bit fields

Bit Name	Bits	Type	Description
Pressure measurement MSB <23:16>	<7:0>	R	Pressure measurement result bits 23 to 16.

Table 18 PSR_B1 bit fields

Bit Name	Bits	Type	Description
Pressure measurement LSB <15:8>	<7:0>	R	Pressure measurement result bits 15 to 8.

Table 19 PSR_B0 bit fields

Bit Name	Bits	Type	Description
Pressure measurement XLSB <7:0>	<7:0>	R	Pressure measurement result bits 7 to 0.

Table 20 TMP_B2 bit fields

Bit Name	Bits	Type	Description
Temperature measurement MSB <23:16>	<7:0>	R	Temperature measurement result bits 23 to 16.

Table 21 TMP_B1 bit fields

Bit Name	Bits	Type	Description
Temperature measurement LSB <15:8>	<7:0>	R	Temperature measurement result bits 15 to 8.

Table 22 TMP_B0 bit fields

Bit Name	Bits	Type	Description
Temperature measurement XLSB <7:0>	<7:0>	R	Temperature measurement result bits 7 to 0.

Table 23 PSR_CFG bit fields

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. *Applicable for measurements in Background mode only*
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

Table 24 TEMP_CFG bit fields

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

Table 25 MEAS_CFG bit fields

Field	Bits	Type	Description
COEF_RDY	7	r	Coefficients will be read to the Coefficents 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: *Standby Mode* 000 - Idle / Stop background measurement *Command Mode* 001 - Pressure measurement 010 - Temperature measurement 011 - na. 100 - na. *Background Mode* 101 - Continous pressure measurement 110 - Continous temperature measurement 111 - Continous pressure and temperature measurement

Table 26 CFG_REG bit fields

Field	Bits	Type	Description
INT_HL	7	rw	Interupt (on SDO pin) active level: 0 - Active low. 1 - Active high.
INT_FIFO	6	rw	Generate interupt when the FIFO is full: 0 - Disable. 1 - Enable.
INT_TMP	5	rw	Generate interupt when a temperature measurement is ready: 0 - Disable. 1 - Enable.
INT_PRS	4	rw	Generate interupt 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. *Note: Must be set to '1' when the oversampling rate is >8 times.*
P_SHIFT	2	rw	Pressure result bit-shift 0 - no shift. 1 - shift result right in data register. *Note: Must be set to '1' when the oversampling rate is >8 times.*
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.

Table 27 INT STS bit fields

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

Table 28 FIFO_STS bit fields

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

Table 29 Soft Reset and FIFO flush (RESET)

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 though the same sequences as in power-on reset.

Table 30 Product and revision ID

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

8.1 Calibration coefficients

The AS23F-01BA-00 Calibration coefficients register contains the 2´s complement coefficients that are used to calculate the compensated pressure and temperature values.

The following tables shows the recommended register layout of the calibration coefficients. It is recommended to block read these coefficient registers and then parse according to the bit label lings in the table.

Table31AS23F-01BA-00 Temperature Calculation Coefficients

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

Table32 AS23F-01BA-00 Pressure Measurement 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 := reg0x1D + reg0x1C * 2^ 8
if (C20 > (2^15 - 1))
  C20 := C20 - 2^16
end if

C0 := (reg0x10 * 2^ 4) + ((reg0x11 / 2^4) & 0x0F)
if (C0 > (2^11 - 1))
  C0 := C0 - 2^12
end if
```

9. Package Outlines and Pin Configuration (GENERAL TOLERANCE ± 0.10mm)

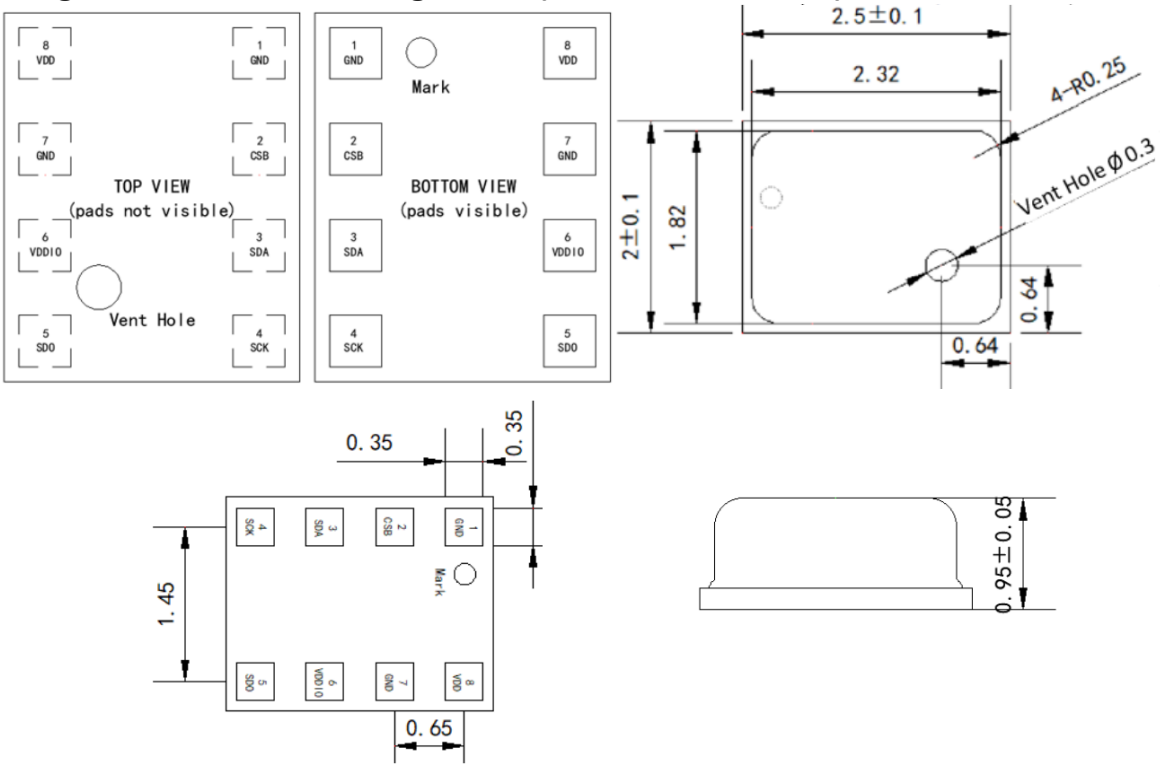


Figure5: Package Outlines

Pin	Name	SPI 3-wire	SPI 3-wire with interrupt	SPI 4-wire	I2C	I2C 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	SDA	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				

Figure 6: Pin Configuration and Description

10. Recommended Pad Layout

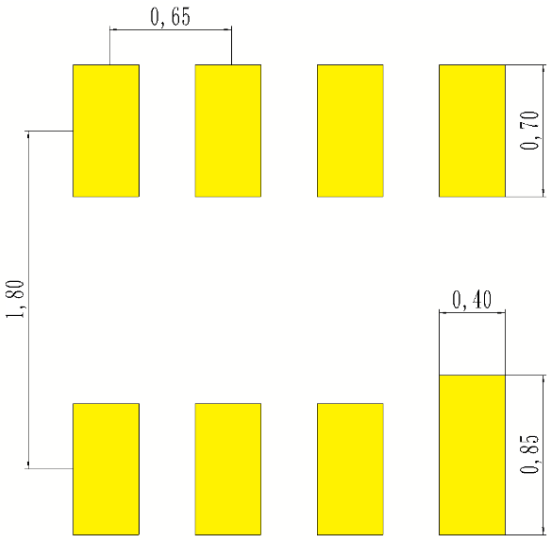


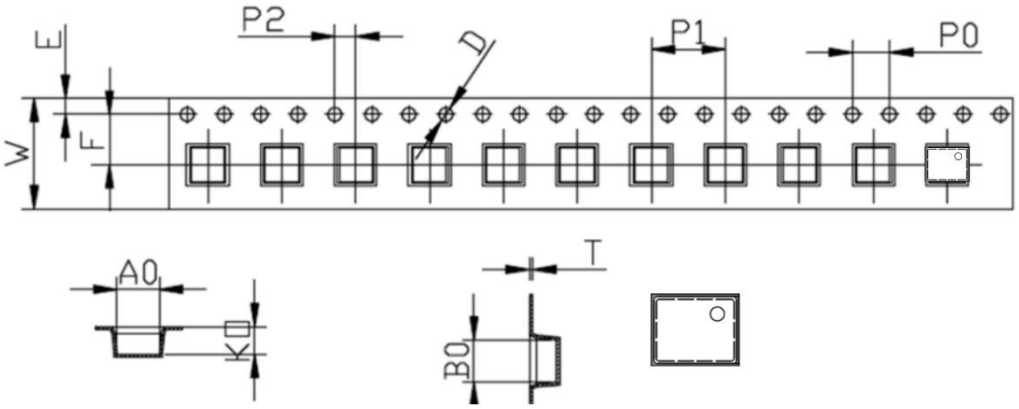
Figure7: Pad layout

11. Shipping Package

11.1

a) Tube

b) Tape & Reel



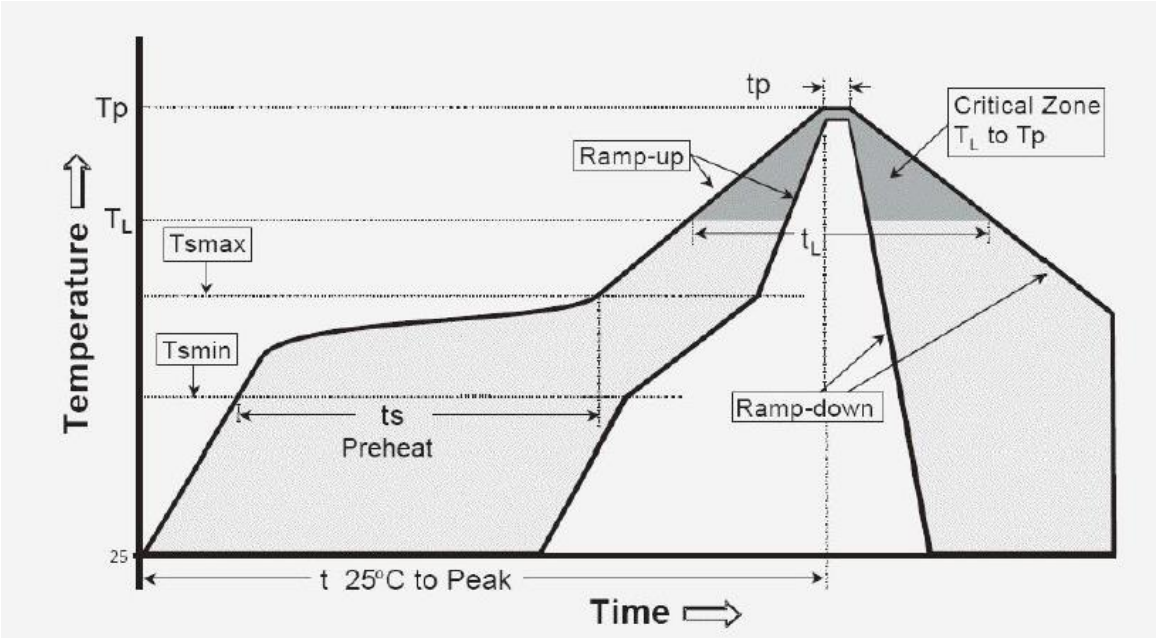
ITEM	W	A0	B0	K0	K1	P1	F	E	D	D1	P0	P2	T
DIM	12.0	3.60	3.60	3.0	0.00	8.0	5.5	1.75	1.5	0	4.0	2.0	0.35
TOLE	±0.3	±0.1	±0.1	±0.1	±0.1	±0.1	±0.05	±0.1	+0.1 -0.0	min	±0.1	±0.1	±0.05

11.2 Mark information



A1	39	5	11
Product Code	Sub-batch Number	Making Year	Order Number
A2			
no-SPI version			

12.Soldering Recommendation（IPC/JEDEC J-STD-020B (July 2002)）



IPC/JEDEC J-STD-020D	Pb-Free Assembly
Average Ramp-up rate（TL-Tp）	3℃/s（Max.）
Preheat –Temperature Min. (Tsmin) –Temperature Max. (Tsmax) –Time (Min. to Max.) (ts)	 140℃ 170℃ 60-180 seconds
Tsmax to TL –Tp	3℃/s（Max.）
Time maintained above: –Temperature (TL) –Time (tL)	 200℃ above 60-150 seconds
Peak temperature (Tp)	200~220℃
Time of Real peak temperature within 5℃ (tp)	40 seconds
Average Ramp-down rate（Tp-TL）	6℃/s（Max.）
Time 25℃ to peak temperature	8min.（Max.）

Note：

1) It is recommended that only one time reflow soldering, no more than two times.
2) After reflow soldering or other high temperature processes, wait for at least 48 hours (or as required by the data sheet) before data reading and processing.
3) Spot cleaning by hand if necessary, DO NOT wash or submerge sensor in cleaning liquid.
4) It is recommended to use the medium temperature solder paste.

13.LEGAL DISCLAIMER

1) For the export of products which are controlled items subject to foreign and domestic export laws and regulations, you must obtain approval and/or follow the formalities of such laws and regulations.

2) Products must not be used for military and/or antisocial purposes such as terrorism, and shallnot be supplied to any party intending to use the products for such purposes.

3) Unless provided otherwise, the products have been designed and manufactured for application to equipment and devices which are sold to end-users in the market.

4) Before using products, which were not specifically designed for use in automotive applications,please contact an AIOT sales representative.

5) This specification is subject to change without notice.

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