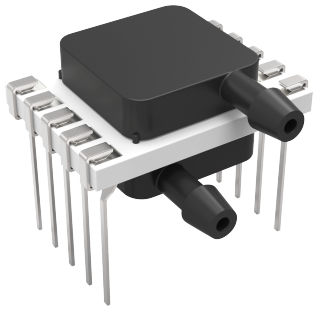
FPS SERIES PRESSURE SENSOR



Features

- Pressure Ranges from 0.1 to 2 inH2O (25 to 500 Pa)
- Pressure Sensor based on thermal micro-flow measurement
- Calibrated and Temperature compensated
- Analog Output and Digital SPI Interface
- High Flow Impedance
  - Very low flow-through leakage
  - High immunity to dust and humidity
  - No loss in sensitivity using long tubing
- RoHS and REACH compliant

Applications

- HVAC
- Medical

Media

- Air and other non-corrosive gasses

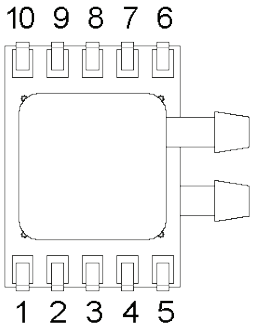
Pressure Sensor Characteristics

Device	Operating Pressure			Proof Pressure[5]	Burst Pressure[5]
FPSS025U	0.1 inH2O	0 - 25 Pa	0 - 0.25 mbar	30 psi (2 bar)	30 psi (2 bar)
FPSS050U	0.2 inH2O	0 - 50 Pa	0 - 0.50 mbar	30 psi (2 bar)	30 psi (2 bar)
FPSS100U	0.4 inH2O	0 - 100 Pa	0 - 1.00 mbar	30 psi (2 bar)	30 psi (2 bar)
FPSS250U	1.0 inH2O	0 - 250 Pa	0 - 2.50 mbar	30 psi (2 bar)	30 psi (2 bar)
FPSS500U	2.0 inH2O	0 - 500 Pa	0 - 5.00 mbar	30 psi (2 bar)	30 psi (2 bar)
FPSS025B	±0.1 inH2O	0 - ±25 Pa	0 - ±0.25 mbar	30 psi (2 bar)	30 psi (2 bar)
FPSS050B	±0.2 inH2O	0 - ±50 Pa	0 - ±0.50 mbar	30 psi (2 bar)	30 psi (2 bar)
FPSS100B	±0.4 inH2O	0 - ±100 Pa	0 - ±1.00 mbar	30 psi (2 bar)	30 psi (2 bar)
FPSS250B	±1.0 inH2O	0 - ±250 Pa	0 - ±2.50 mbar	30 psi (2 bar)	30 psi (2 bar)
FPSS500B	±2.0 inH2O	0 - ±500 Pa	0 - ±5.00 mbar	30 psi (2 bar)	30 psi (2 bar)

Gas Correction Factors[10] (Page 7)

Gas Type	Correction Factor
Dry Air	1.00
Oxygen (O_2)	1.07
Nitrogen (N_2)	0.97
Argon (Ar)	0.98
Carbon dioxide (CO_2)	0.56

Electrical Connection



Pin	Connection
1, 10	Do Not Connect
2	V_S
3	GND
4, 5	V_{out}
6	SCLK
7	MOSI
8	MISO
9	/CS

Note: Pins 1 and 10 are internally connected.

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Specifications

Pressure Sensor Maximum Ratings

Supply Voltage (V_S)	
FPS 3V	2.70 to 3.30 Vdc
FPS 5V	4.75 to 5.25 Vdc
Output Current	1 mA
Lead Specifications	
Average preheating temperature gradient	2.5 C/s
Soak time	Approx. 3 min
Time above 217°C	50 s
Time above 230°C	40 s
Time above 250°C	15 s
Peak Temperature	260°C
Cooling Temperature gradient	-3.5 C/s

Environmental Specifications

Temperature Ranges	
Compensated	0°C to 70°C
Operating	-20°C to 80 °C
Storage	-40°C to 80 °C
Humidity Limits	97% RH (non condensing)
Vibration[1]	20 g
Mechanical Shock[2]	500 g

Specification Notes

NOTE 1: SWEEP 20 TO 2000 HZ, 8 MIN, 4 CYCLES PER AXIS, MIL-STD-883, METHOD 2007.

NOTE 2: 5 SHOCKS, 3 AXES, MIL-STD-883E, METHOD 2002.4.

Performance Characteristics[4] for: FPSS025x, FPSS050x 5V Device

(V_S = 5.0 V_{DC} , T_A= 20 °C , P_{Abs} = 1 bara, calibrated in air, output signals analog and digital are non-ratiometric to Vs)

Common Characteristics		Min	Typ	Max	Units
Non-Linearity[9]		-	-	± (1% of reading + 0.5 % FSS)	-
Total Accuracy[3]	5 to 55°C	-	-	± (1.5% of reading + 1.5 % FSS)	-
	0 to 70°C	-	-	± (3.5% of reading +1.5 %FSS)	-
Noise Level$_{(RMS)}$		-	0.03	-	%FSS
Offset Warm-Up Shift		-	-	less than noise	-
Offset Long Term Stability[6]		-	±0.0002	±0.0004	inH2O/year
Current Consumption (no load)[8]		-	7	8	mA
Response Time (t_{63})		-	5	-	ms
Power-On Time		-	-	25	ms

Analog Output (Unidirectional Devices)

Characteristics		Min	Typ	Max	Units
Zero Pressure Offset		0.49	0.50	0.51	V
Full Scale Span		3.97	4.00	4.03	V
Full Scale Output		-	4.50	-	V
Thermal Effects	Offset @ 5 to 55°C	-	-	±20	mV
	Offset @ 0 to 70°C	-	-	±40	mV
Thermal Effects	Span @ 5 to 55°C	-	±1.25	±2	%FSS
	Span @ 0 to 70°C	-	±1.75	±2.75	%FSS

Performance Characteristics[4] (Cont'd)

Analog Output (Bidirectional Devices)

Characteristics		Min	Typ	Max	Units
Zero Pressure Offset		2.49	2.50	2.51	V
Full Scale Span		3.97	4.00	4.03	V
Output @ Max. Specified Pressure		-	4.50	-	V
Output @ Min. Specified Pressure		-	0.50	-	V
Thermal Effects	Offset @ 5 to 55°C	-	-	±15	mV
	Offset @ 0 to 70°C	-	-	±30	mV
Thermal Effects	Span @ 5 to 55°C	-	±1.25	±2	%FSS
	Span @ 0 to 70°C	-	±1.75	±2.75	%FSS

Digital Output

Characteristics		Min	Typ	Max	Units
Scale Factor (Digital Output)[7]	0.1 inH2O / ±0.1 inH2O	-	300	-	counts/0.001 inH2O
	0.2 inH2O / ±0.2 inH2O	-	150	-	counts/0.001 inH2O
Zero Pressure Offset Tolerance		-0.2	-	+0.2	%FSS
Full Scale Span Tolerance		-0.75	-	+0.75	%FSS
Thermal Effects	Offset @ 5 to 55°C	-	-	±60	counts
	Offset @ 0 to 70°C	-	-	±120	counts
Thermal Effects	Span @ 5 to 55°C	-	±1	±1.75	%FSS
	Span @ 0 to 70°C	-	±1.75	±2.75	%FSS

Performance Characteristics[4] for: FPSS100x, FPSS250x, FPSS500x 5V Device

(V_S = 5.0 V_{DC} , T_A = 20 °C , P_{Abs} = 1 bara, calibrated in air, output signals analog and digital are non-ratiometric to V_S)

Common Characteristics	Min	Typ	Max	Units
Non-Linearity[9]	-	-	± (1% of reading + 0.5 % FSS)	-
Total Accuracy[3] @ 5 to 55°C	-	-	± (1.5% of reading + 1.5 % FSS)	-
@ 0 to 70°C	-	-	± (3.5% of reading +1.5 %FSS)	-
Noise Level$_{(RMS)}$	-	0.03	-	%FSS
Offset Warm-Up Shift	-	-	less than noise	-
Offset Long Term Stability[6]	-	-	±0.1	%FSS/year
Current Consumption (no load)[8]	-	7	8	mA
Response Time (t_{63})	-	5	-	ms
Power-On Time	-	-	25	ms

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Performance Characteristics[4] (Cont'd)

Analog Output (Unidirectional Devices)

Characteristics		Min	Typ	Max	Units
Zero Pressure Offset		0.49	0.50	0.51	V
Full Scale Span		3.97	4.00	4.03	V
Full Scale Output		-	4.50	-	V
Thermal Effects	Offset @ 5 to 55°C	-	-	±10	mV
	Offset @ 0 to 70°C	-	-	±12	mV
Thermal Effects	Span @ 5 to 55°C	-	±1	±1.75	%FSS
	Span @ 0 to 70°C	-	±2	±2.75	%FSS

Analog Output (Bidirectional Devices)

Characteristics		Min	Typ	Max	Units
Zero Pressure Offset		2.49	2.50	2.51	V
Full Scale Span		3.97	4.00	4.03	V
Output @ Max. Specified Pressure		-	4.50	-	V
Output @ Min. Specified Pressure		-	0.50	-	V
Thermal Effects	Offset @ 5 to 55°C	-	-	±10	mV
	Offset @ 0 to 70°C	-	-	±12	mV
Thermal Effects	Span @ 5 to 55°C	-	±1	±1.75	%FSS
	Span @ 0 to 70°C	-	±2	±2.75	%FSS

Digital Output

Characteristics		Min	Typ	Max	Units
Scale Factor (Digital Output)[7]	0.4 inH2O / ±0.4 inH2O	-	75	-	counts/0.001 inH2O
	1.0 inH2O / ±1.0 inH2O	-	30	-	counts/0.001 inH2O
	2.0 inH2O / ±2.0 inH2O	-	15	-	counts/0.001 inH2O
Zero Pressure Offset Tolerance		-0.1	-	+0.1	%FSS
Full Scale Span Tolerance		-0.75	-	+0.75	%FSS
Thermal Effects	Offset @ 5 to 55°C	-	-	±30	counts
	Offset @ 0 to 70°C	-	-	±60	counts
Thermal Effects	Span @ 5 to 55°C	-	±1	±1.75	%FSS
	Span @ 0 to 70°C	-	±2	±2.75	%FSS

Performance Characteristics[4] for: FPSS025x, FPSS050x 3V Device

(Vs = 3.0 V_{DC} , T_A = 20 °C , P_{Abs} = 1 bara, calibrated in air, output signals analog and digital are non-ratiometric to Vs)

Common Characteristics		Min	Typ	Max	Units
Non-Linearity[9]		-	-	± (1% of reading + 0.5 % FSS)	-
Total Accuracy[3]	@ 5 to 55°C	-	-	± (1.5% of reading + 1.5 % FSS)	-
	@ 0 to 70°C	-	-	± (3.5% of reading +1.5 %FSS)	-
Noise Level$_{(RMS)}$		-	0.03	-	%FSS
Offset Warm-Up Shift		-	-	less than noise	-
Offset Long Term Stability[6]		-	±0.0002	±0.0004	inH2O/year
Current Consumption (no load)[8]		-	14	16	mA
Response Time (t_{63})		-	5	-	ms
Power-On Time		-	-	25	ms

Analog Output (Unidirectional Devices)

Characteristics		Min	Typ	Max	Units
Zero Pressure Offset		0.29	0.30	0.31	V
Full Scale Span		2.37	2.40	2.43	V
Full Scale Output		-	2.70	-	V
Thermal Effects	Offset @ 5 to 55°C	-	-	±20	mV
	Offset @ 0 to 70°C	-	-	±40	mV
Thermal Effects	Span @ 5 to 55°C	-	±1.25	±2	%FSS
	Span @ 0 to 70°C	-	±1.75	±2.75	%FSS

Analog Output (Bidirectional Devices)

Characteristics		Min	Typ	Max	Units
Zero Pressure Offset		1.49	1.50	1.51	V
Full Scale Span		2.37	2.40	2.43	V
Output @ Max. Specified Pressure		-	2.70	-	V
Output @ Min. Specified Pressure		-	0.30	-	V
Thermal Effects	Offset @ 5 to 55°C	-	-	±15	mV
	Offset @ 0 to 70°C	-	-	±30	mV
Thermal Effects	Span @ 5 to 55°C	-	±1.25	±2	%FSS
	Span @ 0 to 70°C	-	±1.75	±2.75	%FSS

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Performance Characteristics[4] (Cont'd)

Digital Output

Characteristics		Min	Typ	Max	Units
Scale Factor (Digital Output)[7]	0.1 inH2O / ±0.1 inH2O	-	300	-	counts/0.001 inH2O
	0.2 inH2O / ±0.2 inH2O	-	150	-	counts/0.001 inH2O
Zero Pressure Offset Tolerance		-0.2	-	+0.2	%FSS
Full Scale Span Tolerance		-0.75	-	+0.75	%FSS
Thermal Effects	Offset @ 5 to 55°C	-	-	±60	counts
	Offset @ 0 to 70°C	-	-	±120	counts
Thermal Effects	Span @ 5 to 55°C	-	±1	±1.75	%FSS
	Span @ 0 to 70°C	-	±1.75	±2.75	%FSS

Performance Characteristics[4] for: FPSS100x, FPSS250x, FPSS500x 3V Device

(V_S = 3.0 V_{DC} , T_A = 20 °C , P_{Abs} = 1 bara, calibrated in air, output signals analog and digital are non-ratiometric to V_S)

Common Characteristics		Min	Typ	Max	Units
Non-Linearity[9]		-	-	± (1% of reading + 0.5 % FSS)	-
Total Accuracy[3]	5 to 55°C	-	-	± (1.5% of reading + 1.5 % FSS)	-
	0 to 70°C	-	-	± (3.5% of reading +1.5 %FSS)	-
Noise Level$_{(RMS)}$		-	0.03	-	%FSS
Offset Warm-Up Shift		-	-	less than noise	-
Offset Long Term Stability[6]		-	-	±0.1	%FSS/year
Current Consumption (no load)[8]		-	14	16	mA
Response Time (t_{63})		-	5	-	ms
Power-On Time		-	-	25	ms

Analog Output (Unidirectional Devices)

Characteristics		Min	Typ	Max	Units
Zero Pressure Offset		0.29	0.30	0.31	V
Full Scale Span		2.37	2.40	2.43	V
Full Scale Output		-	2.70	-	V
Thermal Effects	Offset @ 5 to 55°C	-	-	±10	mV
	Offset @ 0 to 70°C	-	-	±12	mV
Thermal Effects	Span @ 5 to 55°C	-	±1	±1.75	%FSS
	Span @ 0 to 70°C	-	±2	±2.75	%FSS

Performance Characteristics[4] (Cont'd)

Analog Output (Bidirectional Devices)

Characteristics		Min	Typ	Max	Units
Zero Pressure Offset		1.49	1.50	1.51	V
Full Scale Span		2.37	2.40	2.43	V
Output @ Max. Specified Pressure		-	2.70	-	V
Output @ Min. Specified Pressure		-	0.30	-	V
Thermal Effects	Offset @ 5 to 55°C	-	-	±10	mV
	Offset @ 0 to 70°C	-	-	±12	mV
Thermal Effects	Span @ 5 to 55°C	-	±1	±1.75	%FSS
	Span @ 0 to 70°C	-	±2	±2.75	%FSS

Digital Output

Characteristics		Min	Typ	Max	Units
Scale Factor (Digital Output)[7]	0.4 inH2O / ±0.4 inH2O	-	75	-	counts/0.001 inH2O
	1.0 inH2O / ±1.0 inH2O	-	30	-	counts/0.001 inH2O
	2.0 inH2O / ±2.0 inH2O	-	15	-	counts/0.001 inH2O
Zero Pressure Offset Tolerance		-0.1	-	+0.1	%FSS
Full Scale Span Tolerance		-0.75	-	+0.75	%FSS
Thermal Effects	Offset @ 5 to 55°C	-	-	±30	counts
	Offset @ 0 to 70°C	-	-	±60	counts
Thermal Effects	Span @ 5 to 55°C	-	±1	±1.75	%FSS
	Span @ 0 to 70°C	-	±2	±2.75	%FSS

Specification Notes (Cont'd)

NOTE 3: TOTAL ACCURACY IS THE COMBINED ERROR FROM OFFSET AND SPAN CALIBRATION, LINEARITY, PRESSURE HYSTERESIS AND TEMPERATURE EFFECTS.

NOTE 4: THE SENSOR IS CALIBRATED WITH A COMMON MODE PRESSURE OF 1 BAR ABSOLUTE. DUE TO THE MASS FLOW BASED MEASURING PRINCIPLE, VARIATIONS IN ABSOLUTE COMMON MODE PRESSURE NEED TO BE COMPENSATED ACCORDING TO THE FOLLOWING FORMULA:

$$\Delta P_{eff} = \Delta P_{sensor} \times \frac{14.5\ psia}{P_{abs}}$$

ΔP_{eff} = True differential pressure
ΔP_{sensor} = Differential pressure as indicated by output voltage
ΔP_{abs} = Current absolute common mode pressure

NOTE 5: THE MAX. COMMON MODE PRESSURE IS 30 PSI

NOTE 6: FIGURE BASED ON ACCELERATED LIFETIME TEST CORRESPONDING TO 1 YEAR OF LIFE.

NOTE 7: THE DIGITAL OUTPUT SIGNAL IS A SIGNED, TWO'S COMPLEMENT INTEGER. NEGATIVE PRESSURES WILL RESULT IN A NEGATIVE OUTPUT.

NOTE 8: PLEASE CONTACT ALL SENSORS CORPORATION FOR LOW POWER OPTIONS.

NOTE 9: NON-LINEARITY REFERS TO A TERMINAL BASED FSL (FITTING STRAIGHT LINE) GOING THROUGH THE ACTUAL ZERO PRESSURE READING.

NOTE 10: FOR EXAMPLE WITH A FPSS500... SENSOR MEASURING CO_2 GAS, AT FULL-SCALE OUTPUT THE ACTUAL PRESSURE WILL BE 2.00 INH2O X 0.56 = 1.12 INH2O.

$$\Delta P_{eff} = \Delta P_{sensor} \times \text{gas correction factor}$$

ΔP_{eff} = True differential pressure
ΔP_{sensor} = Differential pressure as indicated by output voltage

NOTE 11: FOR CORRECT OPERATION OF FPS 3V DEVICES, THE DEVICE DRIVING THE SPI BUS MUST HAVE A MINIMUM DRIVE CAPABILITY OF ± 2 mA.

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SPI - SERIAL PERIPHERAL INTERFACE

Note: It is important to adhere to the communication protocol in order to avoid damage to the Sensor.

Introduction

The FPS serial interface is a high-speed data input and output communication port that is asynchronous to the internal conversion cycle. The serial interface operates in 3-wire SPI mode. In this setup, the MOSI and MISO pins are tied together, forming a bidirectional data line to the master microcontroller. The remaining serial interface connections consist of chip select (/CS) and serial clock (SCLK).

Care should be taken to ensure that the sensor is properly connected to the master microcontroller. Refer to the manufacturer's datasheet for more information regarding physical connections.

Signal control

The serial interface is enabled by asserting /CS low. The serial input clock, SCLK, is gated internally to begin accepting the input data at MOSI, or sending the output data on MISO. When /CS rises, the data clocked into MOSI is loaded into an internal register.

Note: If SPI communication is not required (i.e. only analog output is being used) pins 6 to 8 must be connected to ground and pin 9 to Vs. Failure to do so may result in damage to the sensor.

Fig. 1 : Data Transfer

Data read

When powered on, the sensor begins to continuously measure pressure. To initiate data transfer from the sensor, the following three unique bytes must be written sequentially, MSB first, to the MOSI pin (see Fig. 1):

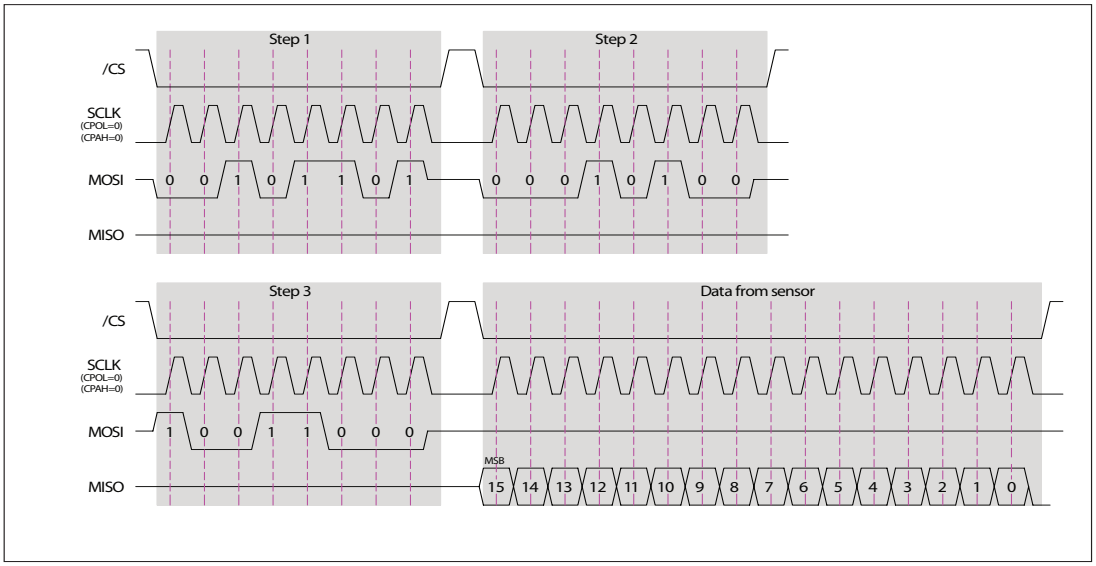
Step	Hexadecimal	Binary	Description
1	0x2D	B00101101	Poll current pressure measurement
2	0x14	B00010100	Send result to data register
3	0x98	B10011000	Read data register

The entire 16 bit content of the FPS register is then read out on the MISO pin, MSB first, by applying 16 successive clock pulses to SCLK with /CS asserted low. Note that the value of the FPS is held at zero for internal signal processing purposes. This is below the noise threshold of the sensor and thus its fixed value does not affect sensor performance and accuracy.

From the digital sensor output the actual pressure value can be calculated as follows:

$$\text{Pressure [inH2O]} = \frac{\text{digital output [counts]}}{\text{scale factor } \left[\frac{\text{counts}}{\text{inH2O}}\right]}$$

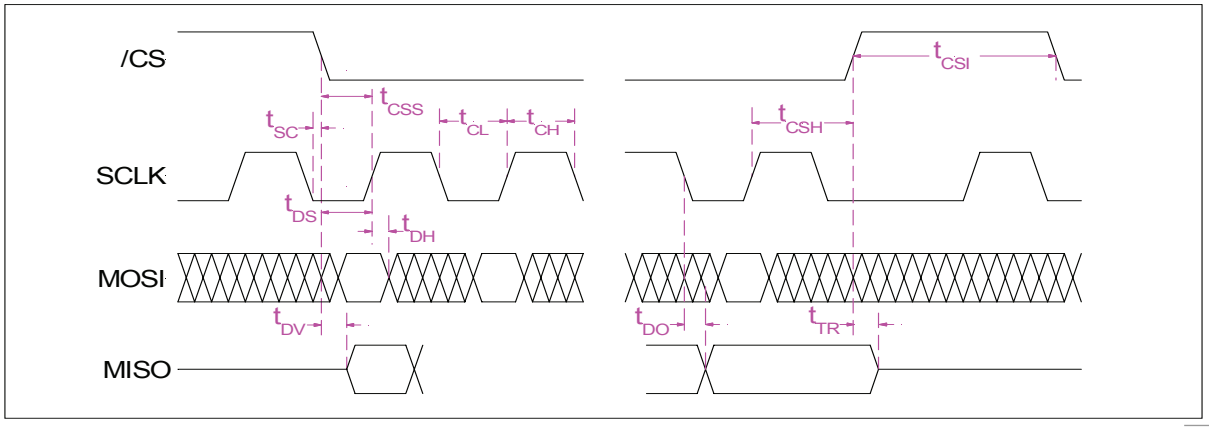
So for a 1.0 inH2O sensor (FPSS250B...) with a scale factor of 120 a digital output of 30,000 counts (7530'h) calculates to a positive pressure of 1.0 inH2O. Similarly, a digital output of -30,000 counts (8AD0'h) calculates to a negative pressure of -1.0 inH2O.



Serial Interface Specification

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Internal Oscillator Clock Frequency	f_{ICLK}	OSC(4:0)=00000	3.3	4.15	5.3	MHZ
External Clock Frequency	f_{ECLK}	V_{CKSEL}=0 Min.	-	0.2	-	MHZ
		Max.	-	5	-	MHZ
External Master Clock Input Low Time	$f_{ECLKIN\ LO}$	$t_{ECLK}=1/f_{ECLK}$	40	-	60	$\%t_{ECLK}$
External Master Clock Input High Time	$f_{ECLKIN\ HI}$	$t_{ECLK}=1/f_{ECLK}$	40	-	60	$\%t_{ECLK}$
SCLK Setup to Falling Edge /CS	t_{SC}	-	30	-	-	ns
/CS Falling Edge to SCLK Rising Edge Setup Time	t_{CSS}	-	30	-	-	ns
/CS Idle Time	t_{CSI}	f_{CLK}= 4 MHZ	1.5	-	-	µs
SCLK Falling Edge to Data Valid Delay	t_{DO}	C_{LOAD}=15 pF	-	-	80	ns
Data Valid to SCLK Rising Edge Setup Time	t_{DS}	-	30	-	-	ns
Data Valid to SCLK Rising Edge Hold Time	t_{DH}	-	30	-	-	ns
SCLK High Pulse Width	t_{CH}	-	100	-	-	ns
SCLK Low Pulse Width	t_{CI}	-	100	-	-	ns
/CS Rising Edge to SCLK Rising Edge Hold Time	t_{CSH}	-	30	-	-	ns
/CS Falling Edge to Output Enable	t_{DV}	C_{LOAD}=15 pF	-	-	25	ns
/CS Rising Edge to Output Disable	t_{TR}	C_{LOAD}=15 pF	-	-	25	ns
FPS (5 V Supply)						
Maximum Output Load Capacities	C_{LOAD}	R_{LOAD}= ∞, Phase Margin > 55 °	-	200	-	pF
Input Voltage, Logic HIGH	V_{IH}	-	0.8 x Vs	-	-	V
Input Voltage, Logic LOW	V_{IL}	-	-	-	0.2 x Vs	V
Output Voltage, Logic HIGH	V_{OH}	R_{LOAD}= ∞,	Vs-0.1	-	-	V
		R_{LOAD}= 2 k Ω,	Vs-0.15	-	-	V
Output Voltage, Logic LOW	V_{OL}	R_{LOAD}= ∞,	-	-	0.5	V
		R_{LOAD}= 2 k Ω,	-	-	0.2	V
FPS (3 V Supply)[11]						
Maximum Output Load Capacities	C_{LOAD}	R_{LOAD}= 1 k Ω,	-	15	-	pF
Input Voltage, Logic HIGH	V_{IH}	-	0.65 x Vs	-	-	V
Input Voltage, Logic LOW	V_{IL}	-	-	-	0.35 x Vs	V
Output Voltage, Logic HIGH	V_{OH}	I_O= -20 µA	Vs-0.4	-	-	V
Output Voltage, Logic LOW	V_{OL}	I_O=20 µA	-	-	0.4	V

Fig. 2 : Timing Diagram



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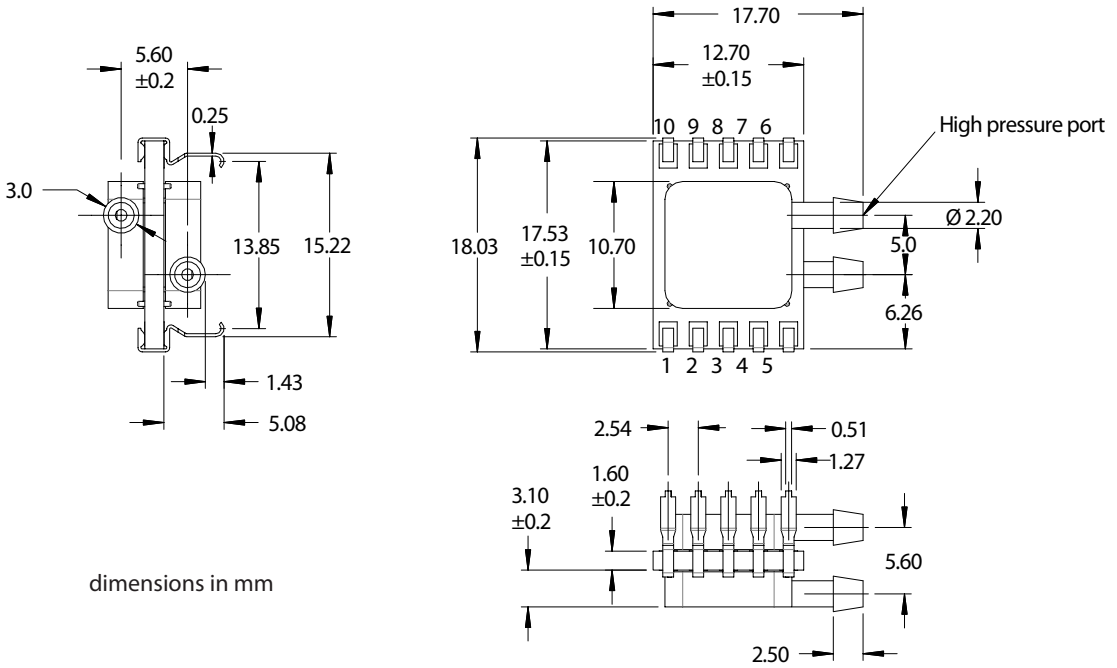
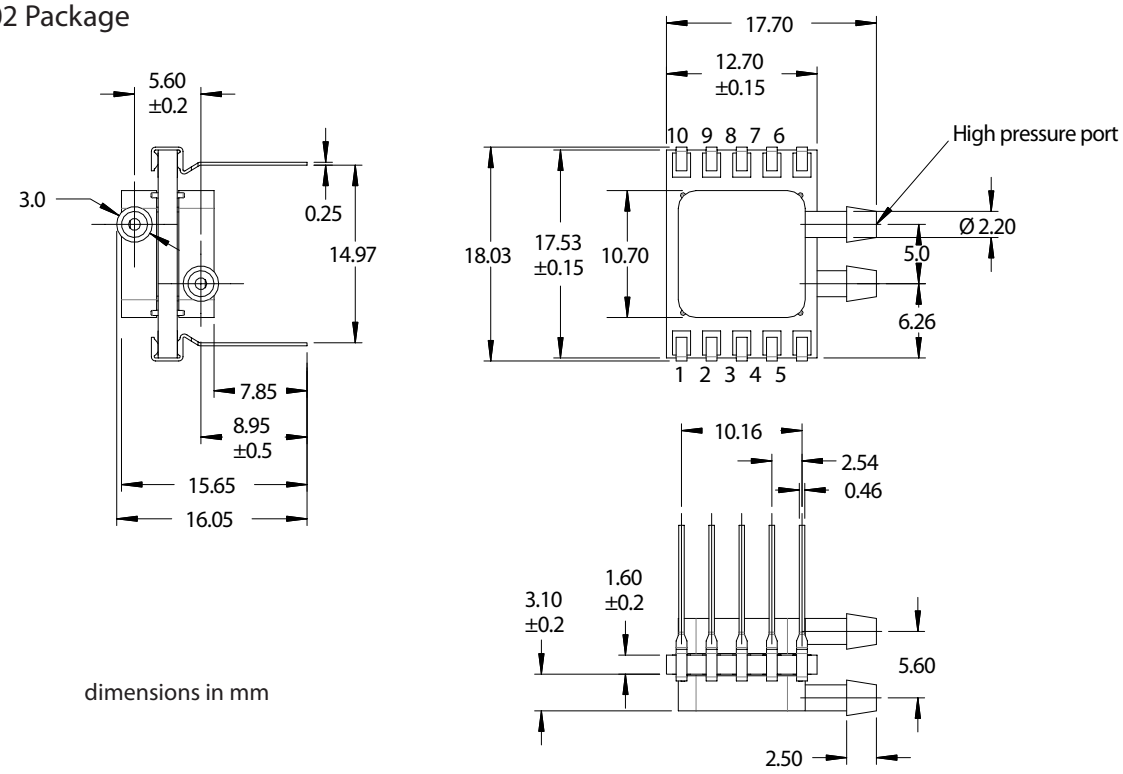
Package Drawings

FA01 Package



dimensions in mm

FA02 Package



dimensions in mm

How To Order

	Series		Pressure Range		Calibration		Housing		Output		Grade	
Options	FPS	**S025**	0.1 inH2O (25 Pa)	**B**	Differential (Bidirectional)	**E**	FA01 SMT, 2 ports same side	**3**	non-ratiometric, 3 V supply	**S**	High
		S050	0.2 inH2O (50 Pa)	**U**	Gage (Unidirectional)	**F**	FA02 DIP, 2 ports	**6**	non-ratiometric, 5 V supply		
		S100	0.4 inH2O (100 Pa)								
		S250	1 inH2O (250 Pa)								
		S500	2 inH2O (500 Pa)								

Example:	**FPS**	**S250**	**B**	**F**	**6**	**S**

ALL SENSORS
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