# First Sensor ⑤

LHD ULTRA series – digital low differential pressure sensors

The LHD ULTRA differential low pressure sensors are based on thermal flow measurement of gas through micro-flow channels integrated within the silicon sensor chip. This feature-rich module uses dual micro-flow channels to effectively maximize the dynamic range of the sensor. The highly-sensitive sensing element is able to accurately resolve sub-pascal variations at low pressures, while the second element extends the measurement range up to 5000 pascals. An on-board microcontroller with accurate 24-bit ADC provides signal processing including stitching of the response of two sensing elements, linearization, and temperature compensation. The LHD ULTRA sensors are the ideal tool for applications that demand high precision, extended measurement range, and the convenience of a single device.
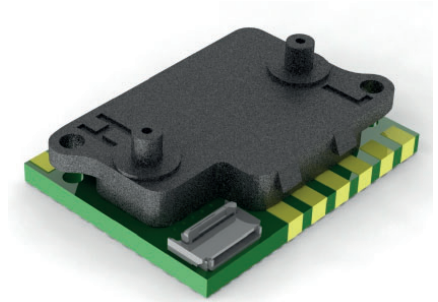
Features

– Pressure ranges from 1250 to 5000 Pa (5 to 20 inH2O) with resolution of ~0.05 Pa (0.0002 inH2O) at low pressure
– Pressure sensor based on thermal micro-flow measurement
– High flow impedance
  – very low flow-through leakage
  – high immunity to dust and humidity
  – no loss in sensitivity using long tubing
– Outstanding long-term stability and precision with patented real-time offset compensation and linearization techniques
– Outstanding total accuracy better than typ. 1.5% of measured value (typical) from 1% to 100% of full scale
– On-board temperature sensor and barometer
– Pin-configurable digital I²C or SPI output
– Operating temperature range -40...+85 °C
– Low profile surface mount package with auxiliary flat cable connector
– Pressure ports for direct manifold assemblies
– Highly versatile to fit to application-specific mounting adaptors and manifolds
– Minimized internal volume and manifold mount option allow for fast gas purge time

Certificates

– Quality Management System according to EN ISO 13485 and EN ISO 9001
– RoHS and REACH compliant
– Moisture sensitivity level 3 test

Media compatibility

Air and other non-corrosive gases

Applications

Medical
– Ventilators
– Spirometers
– CPAP
– Sleep diagnostic equipment
– Nebulizers
– Oxygen conservers/concentrators
– Insufflators/endoscopy

Industrial
– HVAC
  – VAV
  – Filter monitoring
  – Burner control
– Fuel cells
– Gas leak detection
– Fume hood
– Instrumentation
– Security systems

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Maximum ratings

Parameter	Min.	Max.	Unit
Supply voltage V_s	3.0	3.6	V_{DC}
Soldering recommendations [1, 2]			
Reflow soldering, peak temperature		245	°C
Wave soldering, pot temperature		260	°C
Hand soldering, tip temperature		370...425	°C
Temperature ranges [3]			
Compensated	-20	+85	°C
Operating	-40	+85	°C
Storage	-40	+85	°C
Humidity limits (non-condensing)		97	%RH
Vibration [4]		20	g
Mechanical shock [5]		500	g

Pressure sensor characteristics

Part no.	Operating pressure	Scale factor	Proof pressure [6]	Burst pressure [6]
LHD ULTRAM012UB3S	0...1250 Pa / 0...12.5 mbar (5 inH_2O)			
LHD ULTRAM025UB3S	0...2500 Pa / 0...25 mbar (10 inH_2O)			
LHD ULTRAM050UB3S	0...5000 Pa / 0...50 mbar (20 inH_2O)	256 counts / Pa	2 bar (30 psi)	5 bar (75 psi)
LHD ULTRAM012BB3S	0...±1250 Pa / 0...±12.5 mbar (5 inH_2O)			
LHD ULTRAM025BB3S	0...±2500 Pa / 0...±25 mbar (10 inH_2O)			
LHD ULTRAM050BB3S	0...±5000 Pa / 0...±50 mbar (20 inH_2O)			

Gas correction factors [7]

Gas type	Correction factor
Dry air	1.0
Oxygen (O_2)	1.07
Nitrogen (N_2)	0.97
Argon (Ar)	0.98
Carbon dioxide (CO_2)	0.56

Specification notes
(1) Recommendations only. Actually reflow settings depend on many factors, for example, number of oven heating and cooling zones, type of solder paste/flux used, board and component size, as well as component density. It is the responsibility of the customer to fine tune their processes for optimal results.
(2) Handling instruction: Products are packaged in vacuum sealed moisture barrier bag with a floor life of 168hours (<30C, 60% R.H.). If floor life or environmental conditions have been exceeded prior to reflow assembly, baking is recommended. Recommended bake-out procedure is 72 hours @ 60C.
(3) For temperature ranges above 85 °C please contact First Sensor.

(4) Sweep 20 to 2000 Hz, 8 min, 4 cycles per axis, MIL-STD-883, Method 2007.
(5) 5 shocks, 3 axes, MIL-STD-883E, Method 2002.4.
(6) The max. common mode pressure is 5 bar.
(7) For example with a LHD ULTRAM025... sensor measuring CO_2 gas, at full-scale output the actual pressure will be:

$\Delta P_{eff} = \Delta P_{Sensor}$ x gas correction factor = 2500 Pa x 0.56 = 1400 Pa
ΔP_{eff} = True differential pressure
ΔP_{Sensor} = Differential pressure as indicated by output signal

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Performance characteristics [8]

(V_S=3.3 V_{DC}, T_A=20 °C, P_{Abs}=1 bara, calibrated in air, output signal is non-ratiometric to V_S)

Parameter			Min.	Typ.	Max.	Unit
Current consumption	Low-power mode (default)	active		4.5	6.5	
		sleep		0.2	0.75	mA
	Continuous mode			4.5	6.5	
Response time (t_{63}) [9]				4		
Power-on time					25	ms

1250 Pa, 2500 Pa, 5000 Pa devices

Parameter		Min.	Typ.	Max.	Unit
Noise level (RMS)			±0.05		Pa
Offset warm-up shift				less than noise	
Offset repeatability			±0.02		Pa
Span repeatability [11, 12]			±0.25		% of reading
Zero pressure offset accuracy [11]			±0.1	±0.5	Pa
Span accuracy [10, 11]			±1.5	±3	% of reading
Thermal effects (-20...85 °C)	Offset			±0.6	Pa
	Span		±0.3	±0.5	% of reading per 10 °C
Resolution < 150 Pa			0.05		
Resolution > 150 Pa (1250 Pa devices)			0.7		
Resolution > 150 Pa (2500 Pa devices)			1.2		Pa
Resolution > 150 Pa (5000 Pa devices)			2.5		

Temperature sensor

Parameter	Min.	Typ.	Max.	Unit
Scale factor (digital output) [10]		54		counts/°C

On-board barometer

Parameter	Min.	Typ.	Max.	Unit
Pressure range	300		1100	
Relative accuracy	-0.12		+0.12	hPa
Absolute accuracy	-1		+1	

Specification notes (cont.)

(8) The sensor includes an on-board barometer to automatically correct the output of the sensor for variations in common-mode pressure. There is an optional mode of operation that removes this compensation, should the end user require it for their application. The calculation used to make this correction is as follows::

$\Delta P_{eff} = \Delta P_{Sensor}$ x 1 bara/P_{abs}
ΔP_{eff} = True differential pressure
ΔP_{Sensor} = Differential pressure as indicated by output voltage
P_{abs} = Current absolute common mode pressure

(9) Initial signal output after power-on time: 15 ms (see I²C-protocol)
(10) The digital output signal is a signed, two complement integer.
(11) Zero pressure offset accuracy and span accuracy are uncorrelated uncertainties.
They can be added according to the principles of error propagation.
(12) Span accuracy below 1% of full scale is limited by the intrinsic noise of the sensor.

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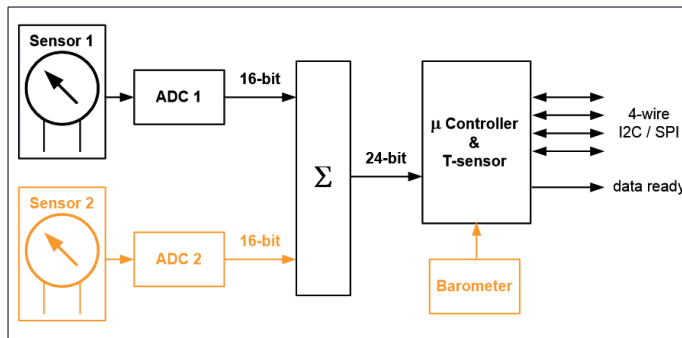
LHD ULTRA internal architecture
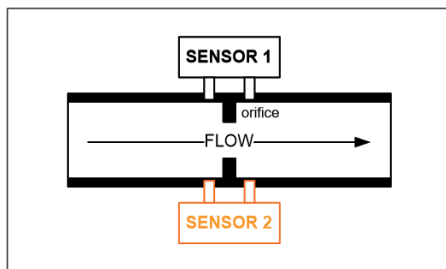

Figure 1

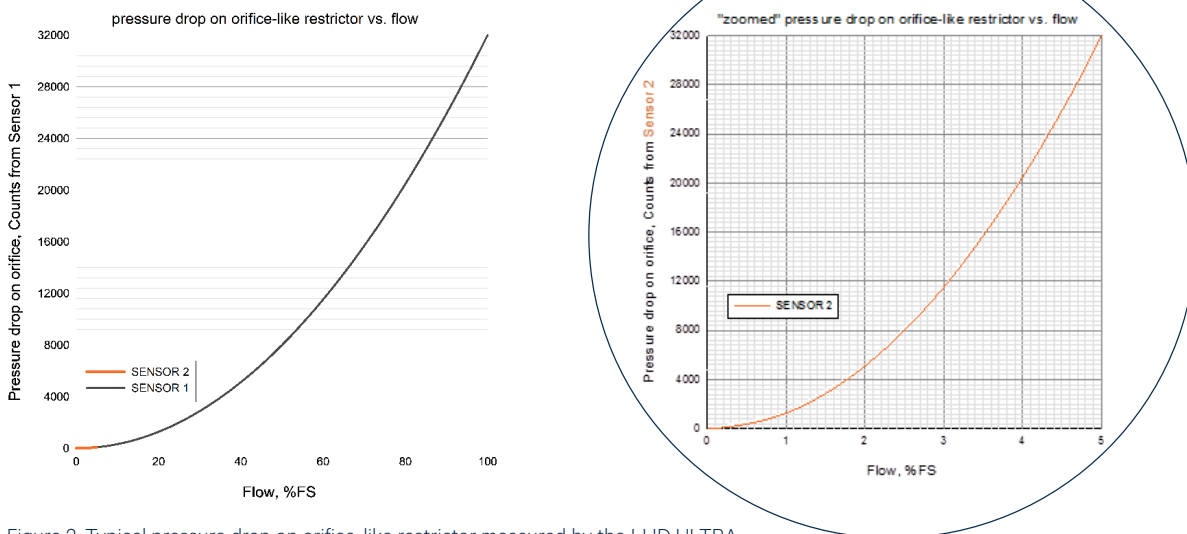## Application example

Figure 2

Figure 2. Typical pressure drop on orifice-like restrictor measured by the LHD ULTRA -

(a) response from Sensor 1 (i. e. full range), (b) response from Sensor 2 (i. e. zoomed-in view).

Note, flow steps around zero create barely detectable steps in pressure drop on the orifice, hence requiring improved ("zoomed") resolution for a pressure sensor (Sensor 2).

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Pad/pin description

PCB Pad	Connector pin	Name	Function
1	4	ADR0/-CS	I2C hardware address 0 or SPI Chip Select (active low).
2	5	ADR1/SCLK	I2C hardware address 1 or SPI clock.
3	6	SCL/MISO	I2C serial clock or SPI MISO (Master In Slave Out) data.
4	7	SDA/MOSI	I2C serial data or SPI MOSI (Master Out Slave In) data.
5	8	Ready	Sends a pulse every time new data is ready for host.
6	3	Sel	Select between I²C (connect to GND) or SPI (connect to Vs)
7	-	Rse2	Reserved for internal use. Do not connect.
8	-	Rse3	Reserved for internal use. Do not connect.
9	-	Rse4	Reserved for internal use. Do not connect.
10	-	Rse5	Reserved for internal use. Do not connect.
11	-	Rse6	Reserved for internal use. Do not connect.
12	2	GND	GND, connect to 0V.
13	1	Vs	Power, connect to 3.3V.
14	-	JTAG-data	Reserved for internal use. Do not connect.
15	-	JTAG-clock	Reserved for internal use. Do not connect.
16	-	Rse7	Reserved for internal use. Do not connect.
17	-	Rse8	Reserved for internal use. Do not connect.

Sensor communication

The sensor supports 2 communication interfaces: I²C (slave) and SPI (slave), sharing the same I/O pins.
The interface mode is selected in the device startup by sampling pin 6 (Sel). Low level on pin 6 invokes I²C interface mode; high level on pin6 invokes SPI interface mode.

1.   I²C communication

1.1   I²C connections

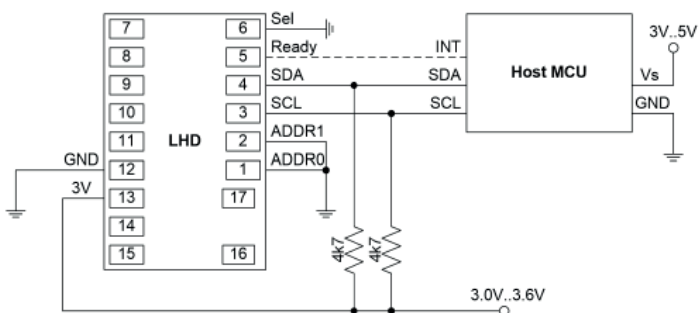Basic I²C connections are shown in Figures 3. and 4.

Figure 3. I²C connections with external pull-ups

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Basic I²C connections are shown in Figures 3. and 4. (cont.)

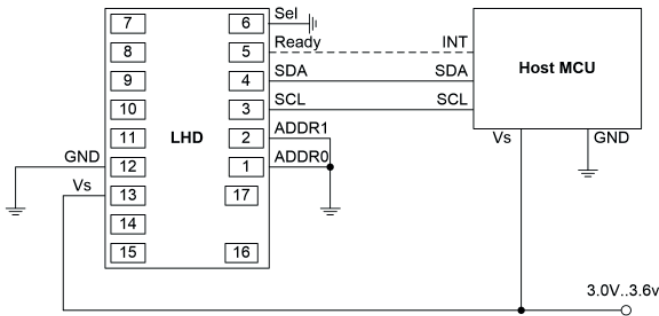
Figure 4. I²C connections with internal pull-ups

Pin assignment in I²C interface mode is shown in Table 1.

Sensor´s pin	Direction	Function
1 (ADDR0)	Input	Address selection bit 0
2 (ADDR1)	Input	Address selection bit 1
3 (SCL)	Input/Open drain output	I2C clock
4 (SDA)	Input/Open drain output	I2C data
5 (Ready)	Output (push-pull)	Ready (active high)

Table 1. Sensor communication pins in I²C mode

The interface pins SCL, SDA require pull-up resistors (external or internal).
Note that the voltage on the pull-up resistors cannot exceed sensor's Vcc, so if the host processor is powered with +5V, it cannot use internal pull ups.

Pins ADDR[0..1] must be connected to either GND or sensor's Vcc. The sensor's address on I2C bus is defined by ADDR[0..1] pins as shown in Table 2.

ADDR1	ADDR0	Sensor´s address (hex), 7-bit notation	Sensor´s address (hex), 8-bit notation
0	0	58	B0
0	1	59	B2
1	0	5A	B4
1	1	5B	B6

Table 2. I²C ADDR pins and base address selection

Pin "Ready" is a push-pull output; its use is optional and is discussed further.

1.2   I²C write command sequence

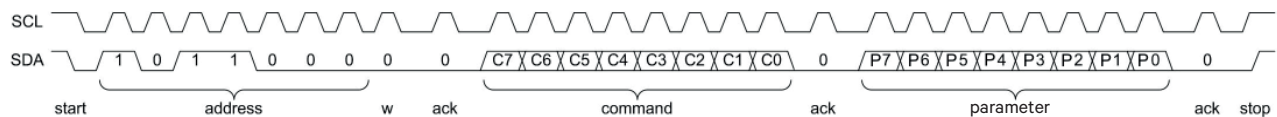Write command sequence is shown in Figure 5.5

Figure 4. I²C write command sequence

The user-level I²C commands are given in Table 3.

Acronym	Value (hex)	Description	Type	Bytes to read	Section
I2C_CMD_RESET	11	Reset	W	0	
I2C_CMD_GET_SIG	23	Read sensor's elecronic signature	WR	2...64	1.6
I2C_CMD_GET_DATA	26	Blocking read (24-bit output)	WR	3...7	1.4
I2C_CMD_CONV	27	Start conversion/non-blocking read (24-bit output)	WR	3...7	1.5

Table 3. Basic set of I²C commands

Acronym	Value (hex)	Description	Section
NO_BAROMETRIC_CORRECTION	1	No barometric correction applied at output; for mass-flow applications	1.8
BAROMETRIC_CORRECTION[12]	3	Barometric correction is applied at the output; for differential pressure applications	1.9

Table 4: Optional parameter bytes for specifying output format

1.3   I²C read data sequence

After sending a command marked as WR in table 2, the host processor may read data from the sensor.
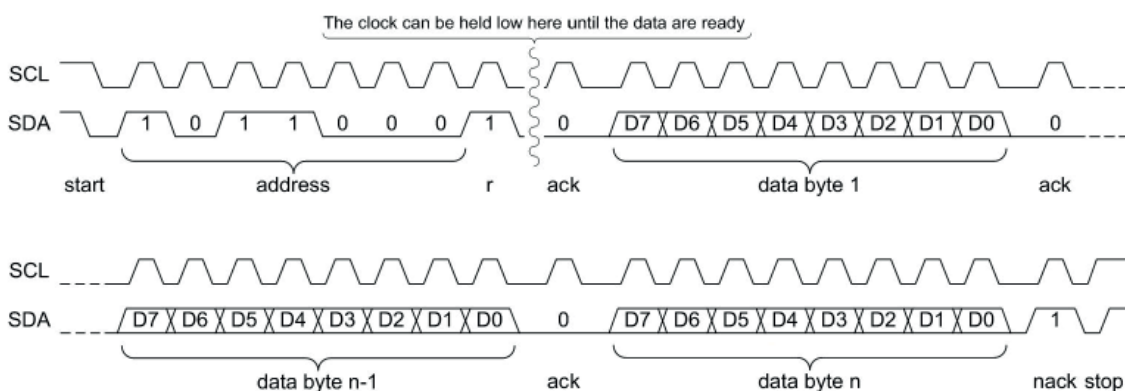

Figure 6. I2C read data sequence

Specification notes (cont.)
(12) If no parameter is passed, then a default value of 3 is applied to the
        command.

1.4   Blocking read operation

The sensor I²C interface uses so called "clock stretching" for the synchronization with host processor: the sensor keeps the SCL line low until it is ready to continue I²C communication.
The host must tolerate clock stretching delays >= 18 ms to work with the sensor.
To perform single or multiple blocking read operations, the host supporting clock stretching must perform the following steps:.

Step	Description
(1)	Issue command setting mode (hex)26 (24-bit blocking conversion)
Optional	Send parameter byte from table 4 to set output mode of the sensor. If excluded, the output will be BAROMETRIC_CORRECTION by default.
(2)	Initiate read data operation reading 2..7 bytes of data
(3)	After the sensor receives its own address with "read" bit set, it holds the clock low before the acknowledgement bit until the data are ready. The first conversion takes about 15 ms, subsequent conversions take ~4 ms
(4)	After the clock is released, the host finishes the data read
…	If more data conversions are required, repeat steps (2)..(4)

Table 5. Steps of consecutive blocking read

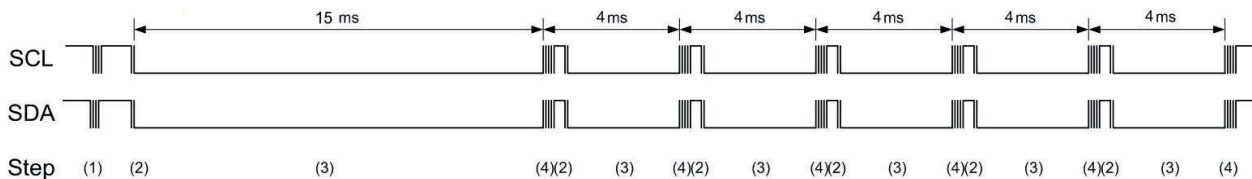The general timing of consecutive blocking read (defined by sensor's clock stretching) is shown below:

Figure 7. Consecutive blocking read operation steps

1.5   Non-blocking read operation

Hosts not supporting the clock stretching may use non-blocking read operation with optional use of "Ready" pin to synchronize operation timing with the sensor.
To not invoke bitwise clock stretching, the host must limit its I2C clock rate to a maximum of 100 kHz and comply with certain timing restrictions.
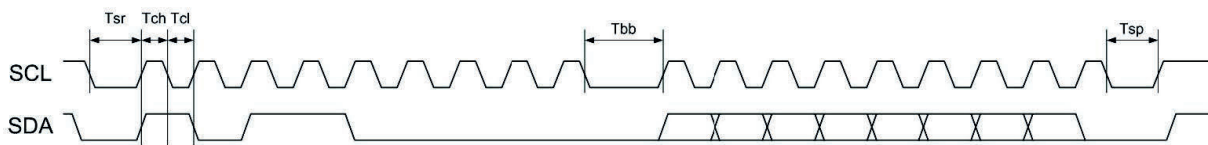

Figure 8. Transfer timing parameters

Parameter	Description	Minimum value
Tst	Start condition to address	5 µs
Tch	Clock high	5 µs
Tcl	Clock low	5 µs
Tbb	Byte-to-byte gap	20 µs
Tsp	Last clock to stop condition	5 µs

Table 6. Minimum timing requirements for I2C interface w/o clock stretching invoked

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To perform single/multiple non-blocking conversions, the host MCU must:

Step	Description
(1)	Issue command setting mode (hex)27 (24-bit non-blocking conversion)
Optional	Send parameter byte from table 4 to set output mode of the sensor. If excluded, the output will be BAROMETRIC_CORRECTION by default.
(2)	Wait for low-to-high transition on "Ready" pin. The first conversion takes about 15 ms, subsequent conversions take ~4 ms
(3)	Initiate data read sequence; it should not hold the clock.
...	If more data conversions are required, repeat steps (1)..(3)

Table 7. Steps of consecutive blocking read

The timing of consecutive non-blocking read (defined by sensor's "Ready" signal) is schematically shown below:
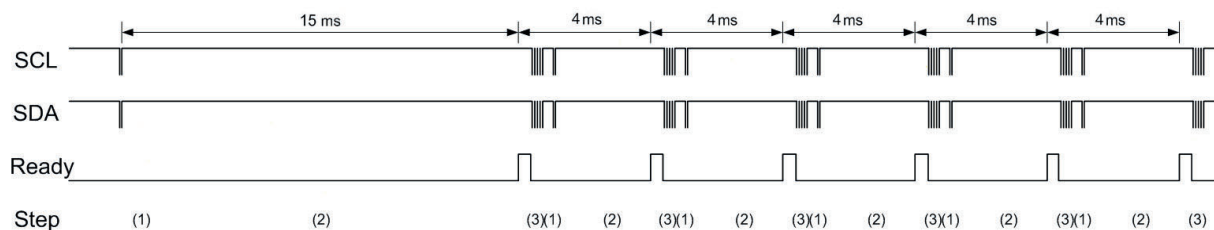

Figure 9. Consecutive non-blocking read operation steps

Between the command and data read steps the bus is not locked and may be used for communication with other devices. However, if the host tries to read or write another command into the same sensor before "Ready" is set, the bus may be locked.
Note that in not-blocking operation the data read and the next command operation must be completed within roughly 2 ms "opportunity window" counted from low-to high transition on "Ready" pin, in order to get the next conversion time shortened to 4 ms.
If the maximum conversion rate is not required, using "Ready" signal is not necessary; the host may just send a non-blocking read command, wait for >= 18 ms and read the data.

1.6   Data format
– Blocking or non blocking read commands sent with parameters 0x1 or 0x3 will return 24 bit signed, twos compliment output values in Pa/256 .
– Final output in Pa can be obtained by dividing the result by 256.
– Values are returned least significant byte first. A total of 7 bytes of data are returned including:
    – 24 bit pressure conversion
    – 16 bit signed twos compliment temperature measured by built in sensor after offset subtraction and correction
    – 16 bit signed twos compliment voltage after offset subtraction and correction

1.7   Output compensation: No barometric pressure correction
– Results obtained when passing parameter 0x1 do not have common-mode pressure compensation applied at the output .
– This operating mode is intended for applications where mass flow measurement is desired.

1.8   Output compensation: Barometric pressure correction (default)
– Results obtained when passing parameter 0x3 have common-mode pressure compensation applied at the output .
– This operating mode is intended for applications where differential pressure measurement is desired.

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1.9 Reading electronic signature (I2C_CMD_GET_SIG)

An electronic version of the device's serial number is stored in flash memory and is retrievable with the command 0x23. The contents of the electronic signature are as follows.

Sequence	Parameter	Size	Data type	Comment
0-1	Firmware version	2 bytes	byte[2] array	byte[1] -> major version number, byte[0] -> minor version number
2-12	Part number (11 characters)	11 bytes	char[12] array	
13-19	Lot number (7 characters)	7 bytes	char[7] array	e.g. CV7T001
20-21	Pressure range	2 bytes	unsigned int	0 to 65535, MSB-first
22	Output type	1 byte	char	e.g. U or B
23-24	Scale factor	2 bytes	unsigned int	0 to 65535, MSB-first
25-26	Calibration ID	2 bytes	2 x 2 char	e.g. AA
27	Week number	1 byte	short int	0 to 255
28	Year number	1 byte	short int	0 to 255
29-30	Sequence number	2 bytes	unsigned int	o to 65535, MSB-first
31-63	Reserved	33 bytes	OxFF	Reserved for future use

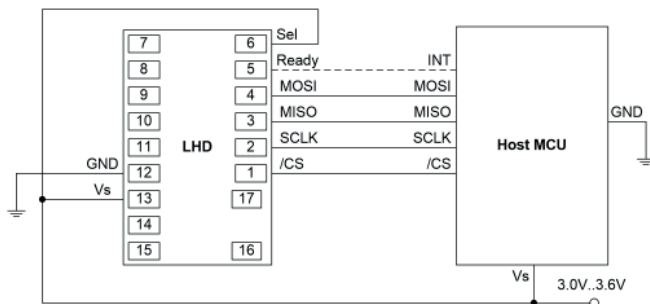Table 8. Electronic signature

2. SPI communication

Figure 10. Basic SPI connections

Pin assignment in SPI mode is shown in Table 9.

Sensor´s pin	Direction	Function
1 (/CS)	Input	Chip select (active low)
2 (SCLK)	Input	SPI clock
3 (MISO)	Output (push-pull)	Master in, slave out
4 (MOSI)	Input	Master out, slave in
5 (Ready)	Output (push-pull)	Ready (active high)

Table 9. Sensor communication pins in SPI mode

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2.1 SPI transfer operation

Sensor supports only SPI mode 1 (CPOL = 0, CPHA = 1), i.e. the clock has positive polarity, the data are changed on the rising front and sampled on the falling front of the clock as shown in Figure 11. Maximum SPI clock rate is 1 MHz.
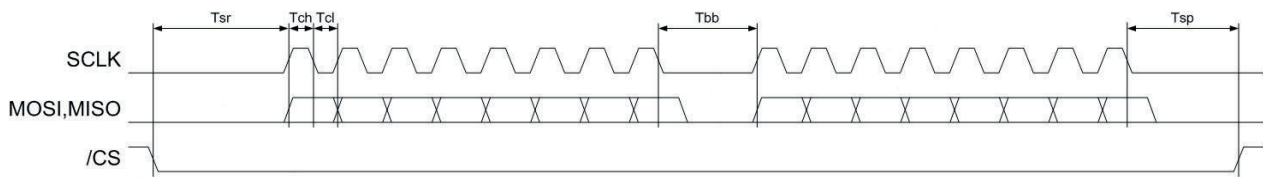The device is sensitive to SPI timing. Recommended minimum time values are given in Table 10.

Figure 11. Basic SPI transfer timing

Parameter	Description	Minimum value
Tsr	/CS low to first clock	60 µs
Tch	Clock high	0.5 µs
Tcl	Clock low	0.5 µs
Tbb	Byte-to-byte gap	10 µs
Tsp	Last clock to /CS high	10 µs

Table 10. Timing requirements for SPI interface

2.2 SPI transfer protocol

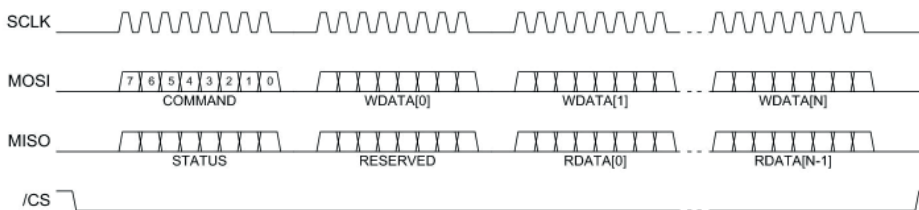Generalized view of transfer protocol is shown in Figure 12.

Figure 12. Generalized view of an SPI packet transfer

Packet length depends on the command; minimum packet length is 1 byte (master sends a command and sensor sends its status).

2.2.1 STATUS register

Status register bits are given in Table 11.

B7	B6	B5	B4	B3	B2	B1	B0
1	0	NEWBAR	NEWDATA	CONV	CONT	COMP	1

Table 13. STATUS register bits

Bit 0:
 Reads as 1
Bit 1 (COMP):
 0 = No common mode pressure correction applied to output (see section 2.6)
 1 = Common mode pressure correction applied to output (see section 2.7)
Bit 2 (CONT):
 0 = single shot conversion mode
 1 = Continous conversion mode
Bit 3 (CONV):
 0 = Idle
 1 = Conversion in progress
 This bit is set when the conversion command is received. This bit is reset as soon as the conversion is completed (for continuous mode – when the sensor receives SPS_CMD_STOP and the last conversion is completed).
Bit 4 (NEWDATA):
 0 = No new data
 1 = New conversion data available in buffer
 This bit is set each time the new data is calculated (which also sets high level on "Ready" pin). It is reset when the sensor receives SPS_CMD_GET_DATA command.
Bit 5 (NEWBAR):
 0 = No new barometer data
 1 = New barometer data was calculated by sensor
 The common-mode barometer data are calculated on every third conversion cycle of continuous conversion, setting this bit. It is reset when the sensor receives SPS_CMD_GET_BAR command.
Bit 6:
 Reads as 0
Bit 7:
 Reads as 1
 Bits 6 and 7 provide the signature, which can be used to monitor sensor's STATUS response validity.

2.2.2 Host commands

A list of user-level commands is given in Table 10.

Acronym	Value (hex)	Description	Write bytes	Read bytes	Section
SPS_CMD_NONE	0	No action (read STATUS)	0	0	2.2.3
SPS_CMD_RESET	1	Reset	0	0	2.2.4
SPS_CMD_CONV	4	Start conversion	0..1	0	2.2.5
SPS_CMD_STOP	5	Stop continuous conversion	0	0	2.2.6
SPS_CMD_GET_DATA	6	Get PS data after conversion	0	0..8	2.2.7
SPS_CMD_GET_BAR	7	Get barometer data after conversion	0	0..6	2.2.8
SPS_CMD_GET_SIG	C	Read sensor´s electronic signature	0	0...64	2.2.9

Table 12. SPI user-level commands

The detailed description of commands is given below

2.2.3 SPS_CMD_NONE

SPS_CMD_NONE command does not affect the internal state of the sensor; it can be used to read sensor's STATUS register.

2.2.4 SPS_CMD_RESET

This command resets sensor and forces its rebooting

2.2.5 SPS_CMD_CONV

Starts a new conversion. This command has a single byte parameter WDATA[0] with the following format:

B7	B6	B5	B4	B3	B2	B1	B0
-	-	-	-	-	CONT	COMP	1

Table 13. SPS_CMD_CONV command parameter

Bit 0:
  Always passed as 1
Bit 1 (COMP):
  0 = No common mode pressure correction applied to output (see section 2.6)
  1 = Common mode pressure correction applied to output (see section 2.7)
Bit 2 (CONT):
  0 = single shot conversion mode
  1 = Continous conversion mode

2.2.6 SPS_CMD_STOP

Stops the continuous conversion mode. The current conversion will still be finished.

2.2.7 SPS_CMD_GET_DATA

Reads the last conversion data

RDATA byte	PA = 1
0	Do not use
1	Pressure bits 7..0
2	Pressure bits 15..8
3	Pressure bits 23..16
4	Sensor's temperature bits 7..0
5	Sensor's temperature bits 15..8
6	Sensor's Vcc bits 7..0
7	Sensor's Vcc bits 15..8

Table 14. Data read by SPS_CMD_GET_DATA command

Here:
– Pressure reading – signed twos-complement 24-bit value. Final output in Pa can be obtained by dividing the result by 256.
– Sensor's temperature – signed twos-compliment 16-bit value measured by built-in sensor after offset subtraction and correction.
– Sensor's Vcc – signed twos-compliment sensor's supply voltage conversion result with offset and correction applied.

2.2.8 SPS_CMD_GET_BAR

Reads the last barometer data (common-mode pressure and calibrated temperature).

RDATA	Value
0	Common-mode pressure bits 7..0
1	Common-mode pressure bits 15..8
2	Common-mode pressure bits 23..16
3	Common-mode pressure bits 31..24
4	Barometer temperature bits 7..0
5	Barometer temperature bits 15..8

Table 15. Data read by SPS_CMD_GET_BAR command

Here:

– Common-mode pressure – unsigned 32-bit common-mode calibrated pressure in Pa,
– Barometer temperature – signed twos-complement 16-bit calibrated temperature measured by barometer in oC/100

2.2.9 SPS_CMD_GET_SIG

Reads the device electronic signature.

Sequence	Parameter	Size	Data type	Comment
0-1	Firmware version	2 bytes	byte[2] array	byte[1] -> major version number, byte[0] -> minor version number
2-12	Part number (11 characters)	11 bytes	char[12] array	
13-19	Lot number (7 characters)	7 bytes	char[7] array	e.g. CV7T001
20-21	Pressure range	2 bytes	unsigned int	0 to 65535, MSB-first
22	Output type	1 byte	char	e.g. U or B
23-24	Scale factor	2 bytes	unsigned int	0 to 65535, MSB-first
25-26	Calibration ID	2 bytes	2 x 2 char	e.g. AA
27	Week number	1 byte	short int	0 to 255
28	Year number	1 byte	short int	0 to 255
29-30	Sequence number	2 bytes	unsigned int	o to 65535, MSB-first
31-63	Reserved	33 bytes	OxFF	Reserved for future use

Table 16 = table 8. Electronic signature

2.3 SPI synchronization

The host may verify if the conversion is complete by two ways:
1.   By checking "Ready" pin state
2.   By periodically reading STATUS register and checking CONV (or NEWDATA) bit

To perform single or multiple conversions, the host must perform the following steps:

Step	Description
(1)	Issue SPS_CMD_CONV command with CONT bit equal to 0
(2)	Wait for low-to-high transition on "Ready" pin OR read STATUS register once every millisecond with 20 ms timeout until NEWDATA bit is set. The first conversion takes about 15 ms, subsequent conversions take ~4 ms
(3)	Issue SPS_CMD_GET_DATA command, read full or partial data buffer
...	If more data conversions are required, repeat steps (1)..(3)

Table 17. Single or multiple conversions with SPI interface

First Sensor ⑥

LHD ULTRA series – digital low differential pressure sensors

To perform continuous 4-ms data conversion, the host must perform the following steps:

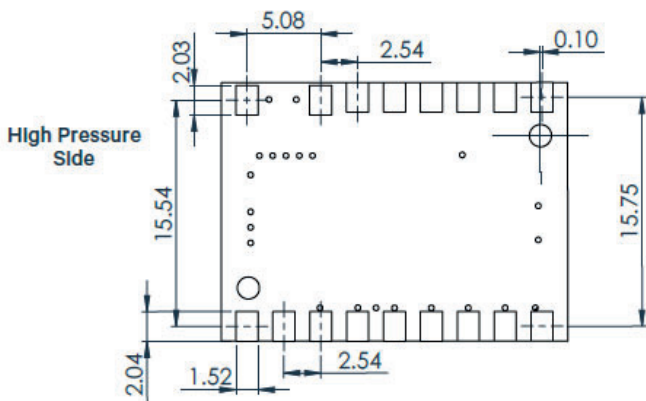| Step	Description
(1)	Issue SPS_CMD_CONV command with CONT bit equal to 1
(2)	Wait for low-to-high transition on "Ready" pin OR read STATUS register once every millisecond with 20 ms timeout until NEWDATA bit is set.
(3)	Issue SPS_CMD_GET_DATA command, read full or partial data buffer
...	Repeat steps (2)..(3) as required
(4)	Issue SPS_CMD_STOP command to stop the conversion

Table 18. Continuous conversion with SPI interface
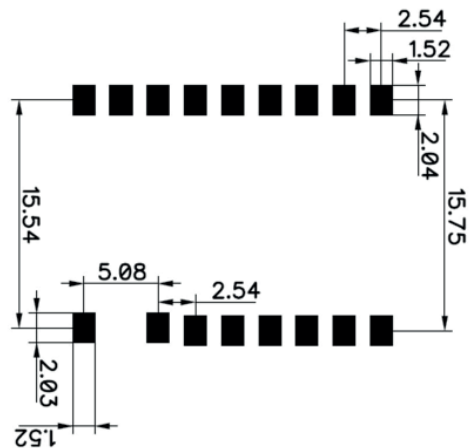
Dimensional drawing
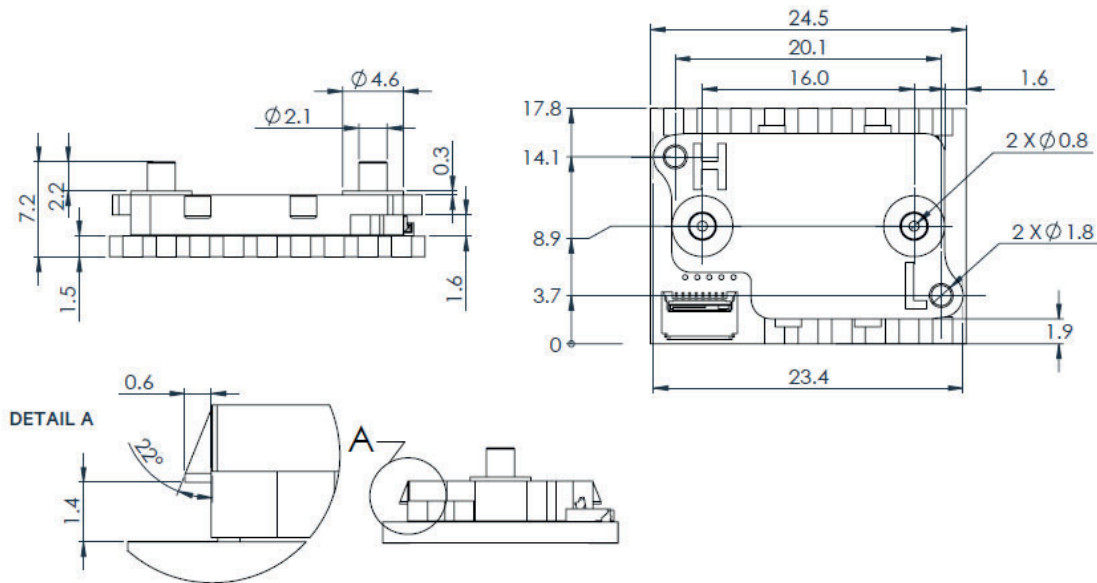
dimensions in mm
for reference only

First Sensor

LHD ULTRA series – digital low differential pressure sensors

Sensor bottom view

High Pressure Side

Sensor PCB footprint

dimensions in mm

Sensor top mount guide

0-80 Mounting screws (McMaster part no 92185A054)

LHD ULTRA lid

Unthreaded spacer (McMaster Part no 92510A377)