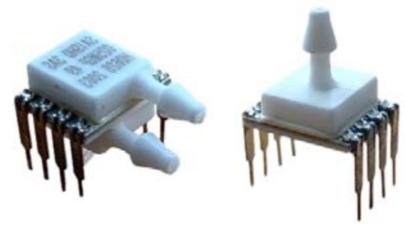
SA19HD



MEDICAL：
-Anesthesia machines
-Spirometers
-Nebulizers
-Hospital room air pressure

INDUSTRIAL：
-Variable Air Volume control
- Static duct pressure
- HVAC transmitters
-Clogged HVAC filter detection

DESCRIPTION

SA19HD High Accuracy Silicon Ceramic sensor is a piezoresistive silicon pressure sensor, offering an 24bits digital output for reading pressure over the specified full scale pressure span and temperature range. SA19HD Series is fully calibrated and temperature compensated for sensor offset, sensitivity, temperature effects, and non-linearity using an on-board Application Specific Integrated Circuit (ASIC). Calibrated output values for pressure are updated at approximately 1 kHz. SA19HD Series is calibrated over the temperature range of 0 °C to 60 °C. The sensor is characterized for operation from a single power supply from 1.68 to 3.6 Vdc.

These sensors measure differential and gage pressures. Differential versions allow application of pressure to either side of the sensing diaphragm. Gage versions are referenced to atmospheric pressure and provide an output proportional to pressure variations from atmosphere. SA19HD Series sensors are intended for use with non-corrosive, non-ionic working fluids. They are designed and manufactured according to standards in ISO 9001.

FEATURES

- Various package：SA19HD series pressure sensor is designed with various package such as Side port, DIP or SMT. Basis substrate is optional with ceramic or FR4 PCB. Pressure port is optional with either ceramic or PPS material.
- Small size：10mm*12.5mm compact package.
- Energy efficient: Extremely low power consumption，Supply voltage is from 1.68 to 3.6Volts
- RoHS compliant.
- Absolute, Differential and Gage pressure type.
- Wide variety of pressure ranges: Low pressure from ±1 mbar to±75 mbar, medium pressure from 1psi to 300psi, provide support for many unique applications.
- The 1/8” barbed pressure ports mate securely with 3/32” ID tubing.

- Customer orientation：Accuracy, Total error band and compensated temperature can be customized.
- Provides the sensor's true accuracy over a compensated range of -10 °C to 60 °C.
- Industry-leading long-term stability：Even after long-term use and thermal extremes, these sensors perform substantially better relative to stability than any other pressure sensor available in the industry today.
- Industry-leading accuracy: Extremely tight accuracy of ±0.25 %FSS BFSL (Full Scale Span Best Fit Straight Line)
- Industry-leading Total Error Band (TEB): Sensorall International specifies TEB—the most comprehensive, clear, and meaningful measurement—that provides the sensor's true accuracy over a compensated range of -10 °C to 60 °C.
- I2C- or SPI-compatible 24-bit digital output (min. 18-bit sensor resolution) accelerates performance through reduced conversion requirements and the convenience of direct interface to microprocessors or microcontrollers;
- Digital output types can offer 10%~90% output or 5%~95% output for optional.

STANDARD PRESSURE RANGE（INH2O,PSI,KPA,MBAR）

2 inH2O	Gauge, Differential	Digital output
5 inH2O	Gauge, Differential	Digital output
10 inH2O	Gauge, Differential	Digital output
20 inH2O	Gauge, Differential	Digital output
1PSI	Gauge, Differential	Digital output
2PSI	Gauge, Differential	Digital output
5PSI	Gauge, Differential	Digital output
15PSI	Gauge, Differential, Absolute	Digital output
30PSI	Gauge, Differential, Absolute	Digital output
50PSI	Gauge, Differential, Absolute	Digital output
100PSI	Gauge, Differential, Absolute	Digital output
150PSI	Gauge, Differential, Absolute	Digital output
300PSI	Gauge, Differential, Absolute	Digital output

5 mbar	Gauge, Differential	Digital output
10 mbar	Gauge, Differential	Digital output
25 mbar	Gauge, Differential	Digital output
50 mbar	Gauge, Differential	Digital output
5Kpa	Gauge, Differential	Digital output
10Kpa	Gauge, Differential	Digital output
35Kpa	Gauge, Differential	Digital output

100Kpa	Gauge, Differential	Digital output
200Kpa	Gauge, Differential	Digital output
400Kpa	Gauge, Differential	Digital output
1000Kpa	Gauge, Differential	Digital output
2000Kpa	Gauge, Differential	Digital output

MAXIMUM RATINGS[1]

Parameter	Min	Max	Unit
Supply Voltage (Vsupply)	-0.4	3.6	Vdc
Voltage on any pin	-0.3	Vsupply +0.3	V
Digital Interface clock frequency： I^2C SPI	 1	 3.4 20	MHZ
ESD susceptibility (Human body mode)		4	Kv
Storage Temperature	-40	125	℃
Soldering time and temperature Solder temperature（DIP） Peak reflow temperature (SMT)	 5s max， at 250℃ 15s max， at250℃		

OPERATING SPECIFICATIONS

Parameter	Min	Typical	Max	Unit
Supply Voltage (Vsupply) 3.3	1.68	3.3 [2]	3.6	Vdc
Supply current 3.3 Vdc		3		mA
Compensated temperature range[3]	0	-	60	℃
Operating temperature range [4]	-40	-	125	℃
Startup time（power up to data ready）	-	2.5	4	ms
Response time	-	1	-	ms
I^2C/SPI voltage level low	-	-	0.2	V_{supply}
I^2C/SPI voltage level low	0.8	-	-	V_{supply}
Pull up on SDA/MISO, SCL/SCLK, SS	1	-	-	Kohm
Accuracy [5]	-	-	±0.25	%FSS
Orientation Sensitivity[6]	-	-	±0.15	%FSS [8]

Total Error Band (TEB)[7]	-1%	-	1%	%FSS
Over Pressure		>3		Times
Burst Pressure		>5		Times
OUTPUT RESOLUTION	24	-	-	Bits

ENVIRONMENT SPECIFICATIONS

Parameter	Characteristic
Humidity： Gases only	0% to 95% RH，non condensing
Vibration	MIL-STD-202F，Method 214，Condition F（20.7 g random）
Shock	MIL-STD-202F，Method 213B，Condition F
Life [9]	1million cycles to working pressure min
Solder reflow	J-STD-020D. Moisture sensitivity level 1

WETTED MATERIAL[9]

Parameter	PortA（Pressure port）	PortB（Reference）
Cover	PPS or Ceramic	PPS or Ceramic
Substrate	Alumina ceramic or FR4	Alumina Ceramic or FR4
Adhesives	Epoxy, silicone	Epoxy, silicone
Electrical components	Ceramic, solder, silicon	Ceramic, solder, silicon

Notes:

1. Maximum ratings are the extreme limits the device can withstand without damage to the product. Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability.
2. The sensor is not reverse polarity protected. Incorrect application of supply voltage or ground to the wrong pin may cause electrical failure.
3. The compensated temperature range is the temperature range over which the sensor will produce an output proportional to pressure within the specified performance limits.
4. The operating temperature range is the temperature range over which the sensor will produce an output proportional to pressure but may not remain within the specified performance limits.
5. Accuracy: The maximum deviation in output from a Best Fit Straight Line (BFSL) fitted to the output measured over the pressure range at 25 °C Includes all errors due to pressure non-linearity, pressure hysteresis, and non-repeatability.
6. Orientation sensitivity: The maximum change in offset of the sensor due to a change in position or orientation relative to Earth’s gravitational field.
7. Total Error Band: The maximum deviation from the ideal transfer function over the entire compensated temperature and pressure range. Includes all errors due to offset, full scale span, pressure non-

linearity, pressure hysteresis, repeatability, thermal effect on offset, thermal effect on span, and thermal hysteresis.

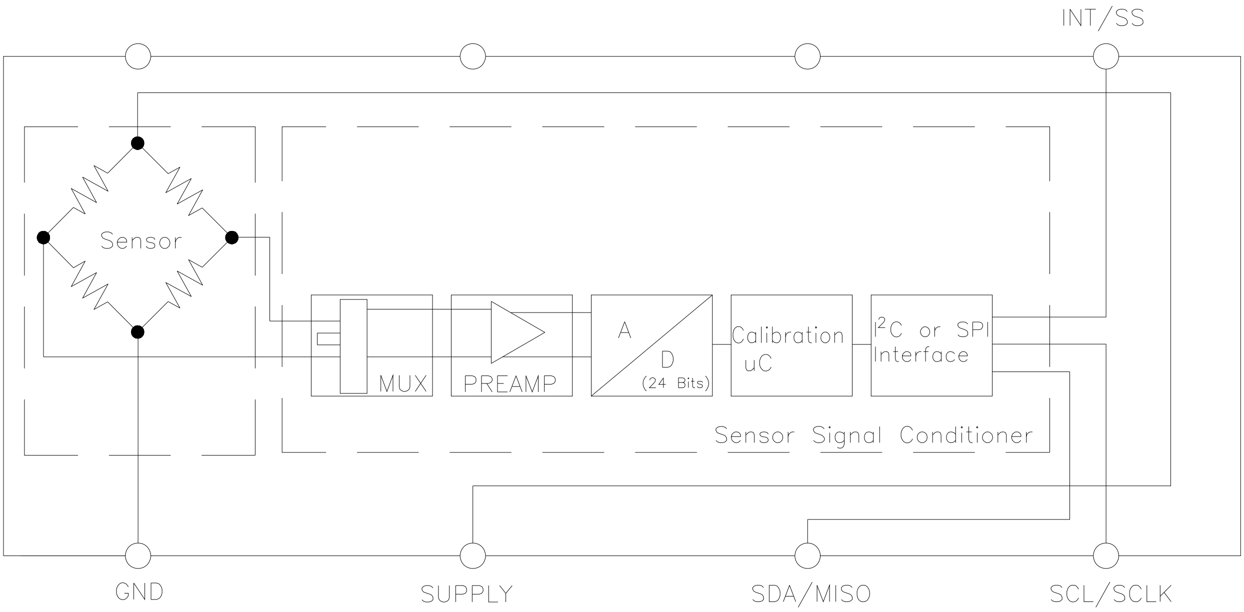
8. Full Scale Span (FSS): The algebraic difference between the output signal measured at the maximum (Pmax.) and minimum (Pmin.) limits of the pressure range.
9. Life may vary depending on specific application in which sensor is utilized.
10. Contact Sensorall International Sales and Service for detailed material information.
11. Total Error Band After Auto-Zero: The maximum deviation from the ideal transfer function over the entire compensated pressure range at a constant temperature and supply voltage for a minimum of 24 hours after an auto-zero operation. Includes all errors due to full scale span, pressure non-linearity, pressure hysteresis, and thermal effect on span
12. Working Pressure: The maximum pressure that may be applied to any port of the sensor in continuous use. This pressure may be outside the operating pressure range limits (Pmin. to Pmax.) in which case the sensor may not provide a valid output until pressure is returned to within the operating pressure range. Tested to 1 million cycles, min.
13. Overpressure: The absolute maximum rating for pressure which may safely be applied to the product for it to remain in specification once pressure is returned to the operating pressure range. Exposure to higher pressures may cause permanent damage to the product. Unless otherwise specified this applies to all available pressure ports at any temperature with the operating temperature range. Tested to 10,000 cycles, minimum.
14. Burst Pressure: The maximum pressure that may be applied to any port of the product without causing escape of pressure media. Product should not be expected to function after exposure to any pressure beyond the burst pressure.
15. Common Mode Pressure: The maximum pressure that can be applied simultaneously to both ports of a differential pressure sensor without causing changes in specified performance.
16. Customized design please contact Sensorall International sales.

Warning：

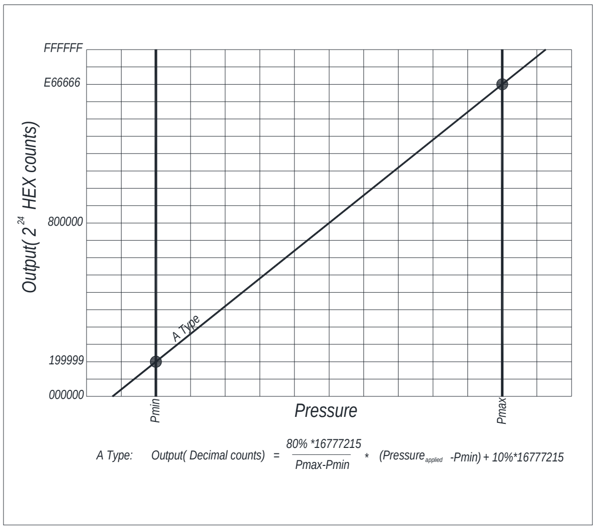
Please follow below instructions to avoid possible product damage

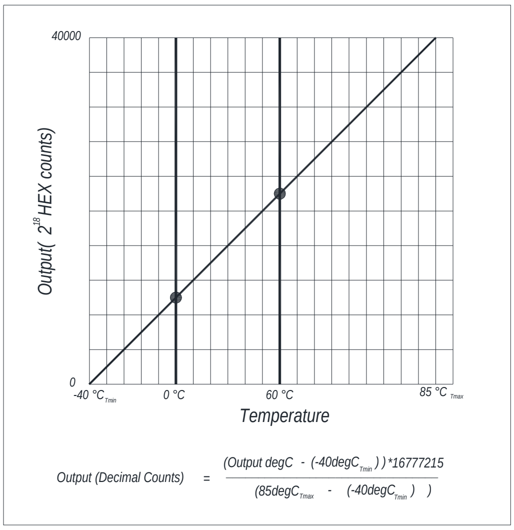
- Make sure fluid only be used for port A, port B is not compatible with liquid, need contact customer service for liquid compatibility customization for port B.
- Make sure liquid fluid do not contain particles. All SA19HD sensor is connected to sealed device, the particles will accumulate inside the sensor and cause device damage or impact the sensor output.
- Suggest to place the port A upside down so the particles in the system will not enter into port A and will not stay in the sensor.
- Make sure the liquid fluid will not cause any residual after dry out, accumulated residuals may impact the sensor output, it is very hard to clean and remove the residuals.

BLOCK DIAGRAM



PRESSURE AND TEMPERATURE TRANSFER





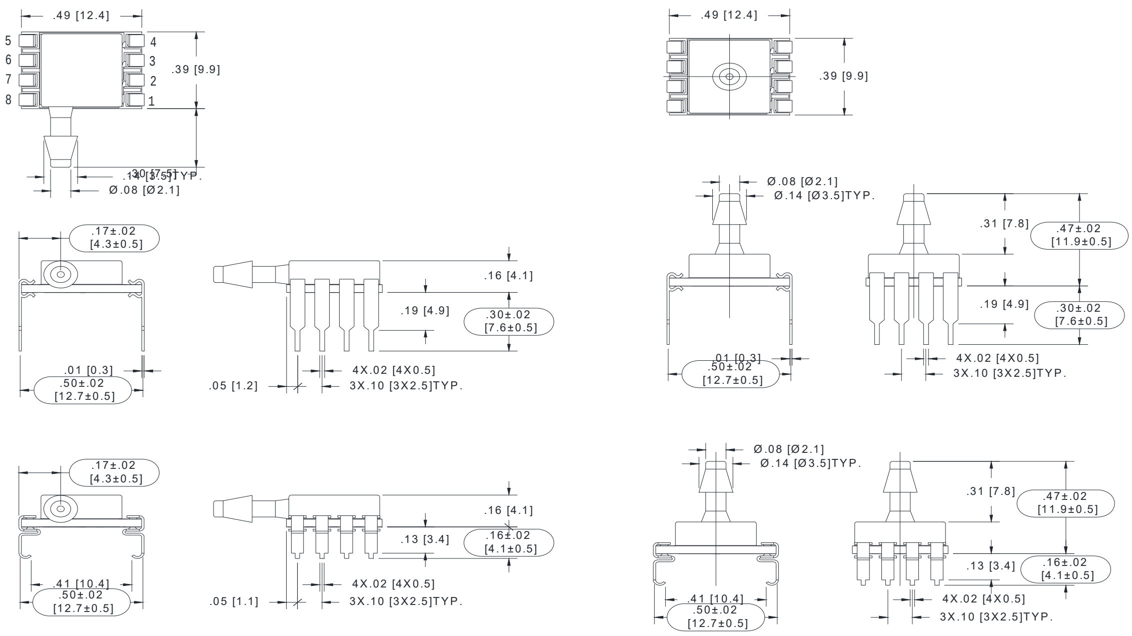
PRESSURE TYPES

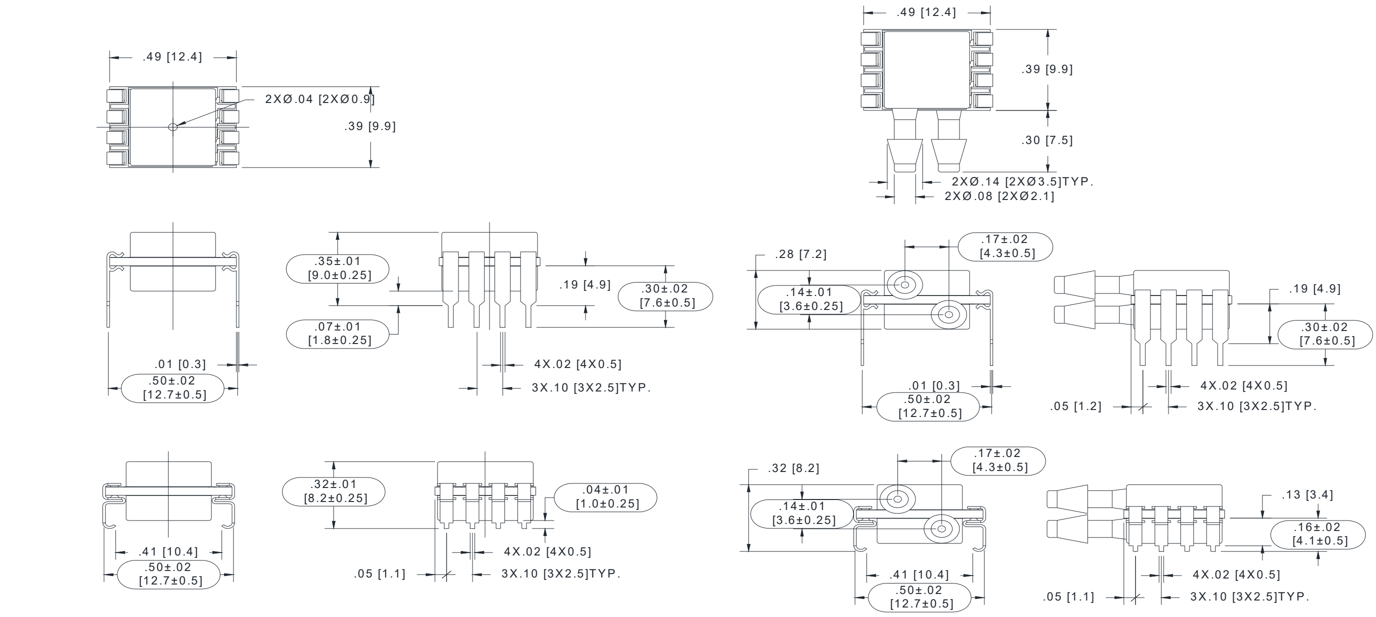
Pressure type	Comments
Gauge	Output is proportional to the difference between applied pressure and atmospheric (ambient) pressure. Pmin. is set at atmospheric pressure.
Differential	Output is proportional to the difference between the pressures applied to each port (Port A ~Port B). 50% point of transfer function set at Port A = Port B.
Absolute	Output is proportional to the difference between applied pressure and absolute zero pressure pressure. Pmin. is set at absolute zero pressure.

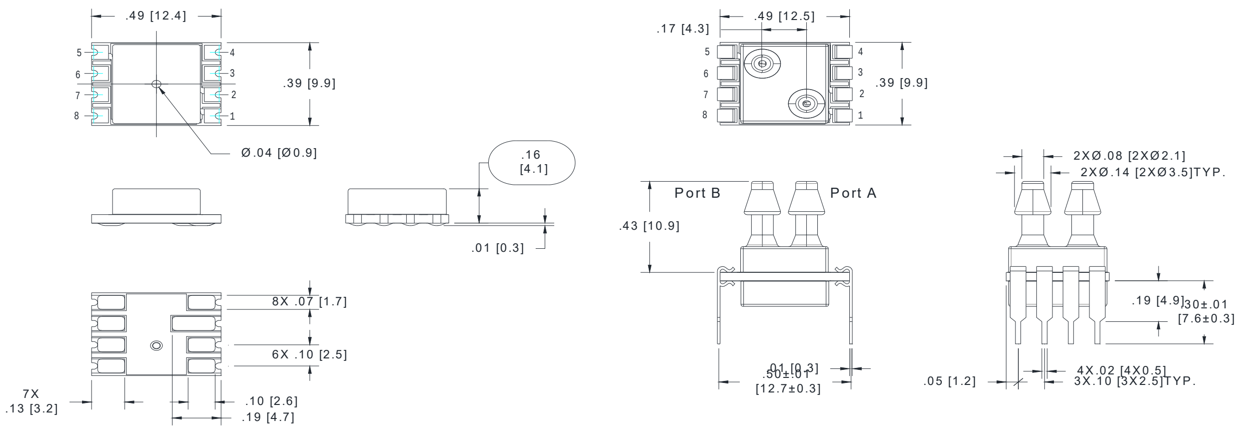
CONNETION DIAGRAM

See below pin number	Pin	1	2	3	4	5	6	7	8
	I2C/SPI	GND	V+	SDA/MOSI	SCL/SCLK	SS	N/A	N/A	MISO

DIMENSION DRAWING（INCH［MILLIMETER］）







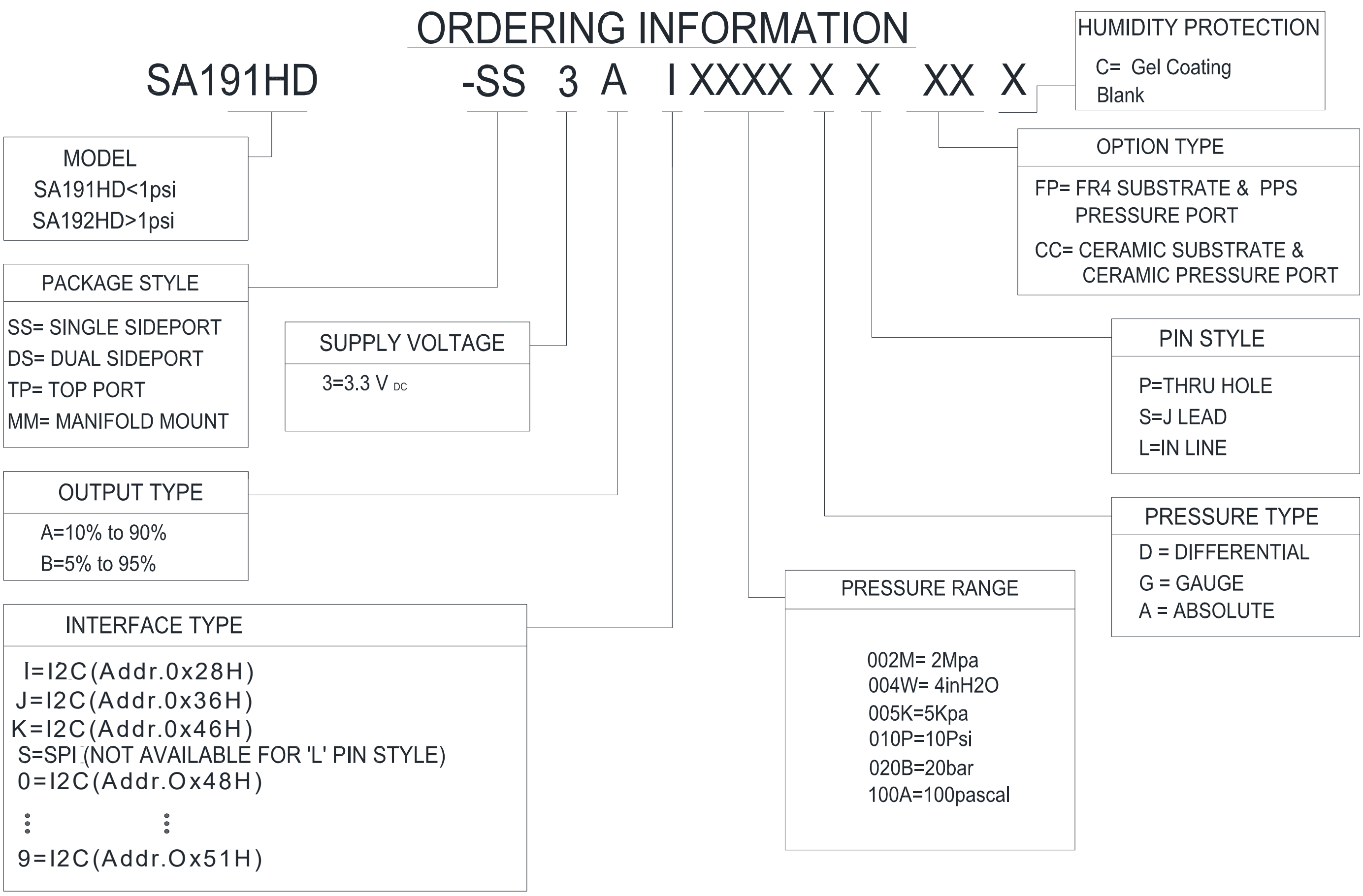
NOTES：

-For differential，when pressure in port A is greater than pressure in port B, output is greater than 50% of 16777215；when pressure in port A is equal to the pressure in port B, output is equal to 50% of 16777215.

-For Gauge type A output, when pressure in port A is greater than pressure in port B, output is greater than 10% of 16777215；when pressure in port A is equal to the pressure in port B, output is equal to 10% of 16777215.

-Port A is always given positive pressure during calibration.

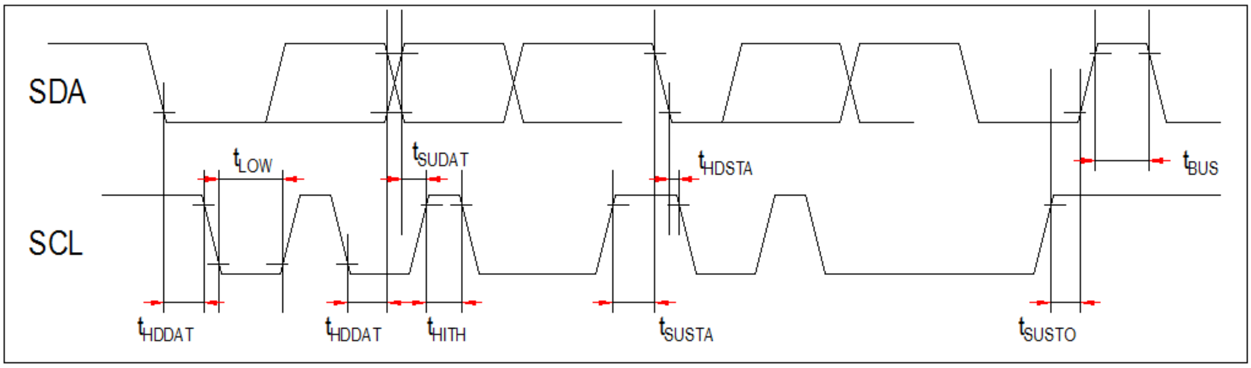
ORDERING INFORMATION



I2C SPI INTERFACE PARAMETERS & TIMING DIAGRAM

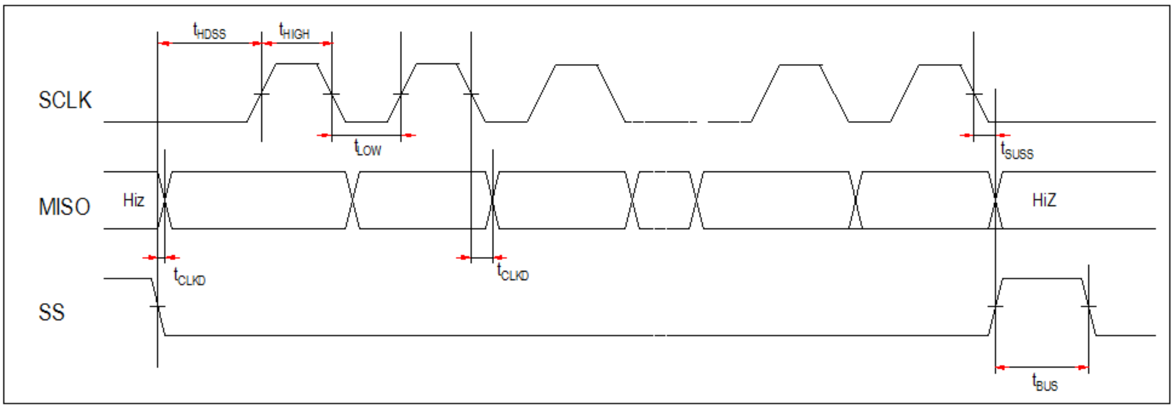
I2C INTERFACE PARAMETERS					
PARAMETERS	SYMBOL	MIN	TYP	MAX	UNITS
SCLK CLOCK FREQUENCY	FSCL	100		400	KHz
START CONDITION HOLD TIME RELATIVE TO SCL EDGE	tHDSTA	0.1			uS
MINIMUM SCL CLOCK LOW WIDTH @1	tLOW	0.6			uS
MINIMUM SCL CLOCK HIGH WIDTH @1	tHIGH	0.6			uS
START CONDITION SETUP TIME RELATIVE TO SCL EDGE	tSUSTA	0.1			uS
DATA HOLD TIME ON SDA RELATIVE TO SCL EDGE	tHDDAT	0			uS
DATA SETUP TIME ON SDA RELATIVE TO SCL EDGE	tSUDAT	0.1			uS
STOP CONDITION SETUP TIME ON SCL	tSUSTO	0.1			uS
BUS FREE TIME BETWEEN STOP AND START CONDITION	tBUS	2			uS
@1 COMBINED LOW AND HIGH WIDTHS MUST EQUAL OR EXCEED MINIMUM SCL PERIOD.					

I2C INTERFACE TIMING DIAGRAM



SPI INTERFACE PARAMETERS					
PARAMETERS	SYMBOL	MIN	TYP	MAX	UNITS
SCLK CLOCK FREQUENCY	FSCL	50		800	KHz
SS DROP TO FIRST CLOCK EDGE	tHDSS	2.5			uS
MINIMUM SCL CLOCK LOW WIDTH @1	tLOW	0.6			uS
MINIMUM SCL CLOCK HIGH WIDTH @1	tHIGH	0.6			uS
CLOCK EDGE TO DATA TRANSITION	tCLKD	0		0.1	uS
RISE OF SS RELATIVE TO LAST CLOCK EDGE	tSUSS	0.1			uS
BUS FREE TIME BETWEEN RISE AND FALL OF SS	tBUS	2			uS
@1 COMBINED LOW AND HIGH WIDTHS MUST EQUAL OR EXCEED MINIMUM SCLK PERIOD.					

SPI INTERFACE TIMING DIAGRAM



ADC Conversion Times for a Single Analog—to—Digital Conversion

Resolution (Bits)	Conversion Time in µs (typical)
12	140
13	185
14	250
15	335
16	470
17	640
18	890
19	1250
20	1760
21	2460
22	3480
23	4890
24	6940

I2C/SPI PROGRAMING SAMPLE

I2C （SA192HD-DS-001DP）

```
#include "I2C.h"
#include "main.h"
#include "stm32l0xx_hal.h"

float Pdisplay=0;
u32 Tdisplay=0;
float Pmax=6894.757;
float Pmin=-6894.757;
float Pspan=13421772.8;
u32 Pvalue=0;
float Tmax=85;
float Tmin=-40;
u32 Tspan=13421773;
u32 Tvalue=0;

void delay_us(long int time)
{
  long int i=8*time;
  while(i--);
}

void delay_ms(long int time)//1372@4M 686@2M 343@1M
{
  long int i=1372*time;
  while(i--);
}

void IIC_Init(void)
{
  GPIO_InitTypeDef GPIO_InitStruct;

  /* GPIO Ports Clock Enable */
  __HAL_RCC_GPIOA_CLK_ENABLE();

  /*Configure GPIO pin Output Level */
  HAL_GPIO_WritePin(GPIOA, SCL_Pin|SDA_Pin, GPIO_PIN_RESET);
```

```
 /*Configure GPIO pins : PAPin PAPin */
 GPIO_InitStruct.Pin = SCL_Pin|SDA_Pin;
 GPIO_InitStruct.Mode = GPIO_MODE_OUTPUT_PP;
 GPIO_InitStruct.Pull = GPIO_NOPULL;
 GPIO_InitStruct.Speed = GPIO_SPEED_FREQ_LOW;
 HAL_GPIO_Init(GPIOA, &GPIO_InitStruct);
}

void SDA_IN()
{
	GPIO_InitTypeDef  GPIO_InitStructure;
	GPIO_InitStructure.Pin = SDA_Pin;
 GPIO_InitStructure.Mode = GPIO_MODE_INPUT;
 GPIO_InitStructure.Pull = GPIO_NOPULL;
 //GPIO_InitStructure.Alternate = GPIO_PuPd_UP;
 GPIO_InitStructure.Speed = GPIO_SPEED_FREQ_MEDIUM;
 HAL_GPIO_Init(GPIOA, &GPIO_InitStructure);
}

void SDA_OUT()
{
	GPIO_InitTypeDef  GPIO_InitStructure;
	GPIO_InitStructure.Pin = SDA_Pin;
 GPIO_InitStructure.Mode = GPIO_MODE_OUTPUT_PP;
 GPIO_InitStructure.Pull = GPIO_NOPULL;
	GPIO_InitStructure.Speed = GPIO_SPEED_FREQ_MEDIUM;
 HAL_GPIO_Init(GPIOA, &GPIO_InitStructure);
}

void IIC_Start(void)
{
	SDA_OUT();
	IIC_SDA_ON;
	IIC_SCL_ON;
	delay_us(4);
	IIC_SDA_OFF;//START:when CLK is high,DATA change form high to low
	delay_us(4);
	IIC_SCL_OFF;
}
```

```
void IIC_Stop(void)
{
	SDA_OUT();//sda
	IIC_SCL_OFF;
	IIC_SDA_OFF;//STOP:when CLK is high DATA change form low to high
	delay_us(4);
	IIC_SCL_ON;
	IIC_SDA_ON;
	delay_us(4);
}
unsigned char IIC_Wait_Ack(void)
{
	unsigned char ucErrTime=0;
	SDA_IN();
	IIC_SDA_ON;delay_us(1);
	IIC_SCL_ON;delay_us(1);
	while(HAL_GPIO_ReadPin(GPIOA, SDA_Pin))
	{
		ucErrTime++;
		if(ucErrTime>250)
		{
			IIC_Stop();
			return 1;
		}
	}
	IIC_SCL_OFF;
	return 0;
}

void IIC_Ack(void)
{
	IIC_SCL_OFF;
	SDA_OUT();
	IIC_SDA_OFF;
	delay_us(2);
	IIC_SCL_ON;
	delay_us(2);
	IIC_SCL_OFF;
}
```

```
void IIC_NAck(void)
{
        IIC_SCL_OFF;
        SDA_OUT();
        IIC_SDA_ON;
        delay_us(2);
        IIC_SCL_ON;
        delay_us(2);
        IIC_SCL_OFF;
}

void IIC_Send_Byte(unsigned char txd)
{
   unsigned char t;
             SDA_OUT();
   IIC_SCL_OFF;
   for(t=0;t<8;t++)
   {
                        if(txd&0x80)
                        {IIC_SDA_ON;}
                        else
                        {IIC_SDA_OFF;}
      txd<<=1;
             delay_us(2);
             IIC_SCL_ON;
             delay_us(2);
             IIC_SCL_OFF;
             delay_us(2);
   }
}
unsigned char IIC_Read_Byte(unsigned char ack)
{
        unsigned char i,receive=0;
        SDA_IN();//SDA
   for(i=0;i<8;i++ )
        {
      IIC_SCL_OFF;
      delay_us(2);
             IIC_SCL_ON;
```

```
        receive<<=1;
        if(HAL_GPIO_ReadPin(GPIOA, SDA_Pin))receive++;
                delay_us(1);
    }
    if (!ack)
        IIC_NAck();//nACK
    else
        IIC_Ack(); //ACK
    return receive;
}

unsigned char temp[7];
void Get_Value()
{
        IIC_Start();
        IIC_Send_Byte(0x50);
        IIC_Wait_Ack();
        IIC_Send_Byte(0xaa);
        IIC_Wait_Ack();
        IIC_Stop();
        delay_ms(17);

        IIC_Start();
        IIC_Send_Byte(0x51);
        IIC_Wait_Ack();
        temp[0]=IIC_Read_Byte(1);
        temp[1]=IIC_Read_Byte(1);
        temp[2]=IIC_Read_Byte(1);
        temp[3]=IIC_Read_Byte(1);
        temp[4]=IIC_Read_Byte(1);
        temp[5]=IIC_Read_Byte(1);
        temp[6]=IIC_Read_Byte(0);
        IIC_Stop();

                if(temp[0]==0x40)
                {
                        Pvalue=temp[1]*256*256+temp[2]*256+temp[3];
                        Tvalue=temp[4]*256*256+temp[5]*256+temp[6];
                }
```

```
        Tdisplay=(Tvalue-1677721.6)/Tspan*(Tmax-Tmin)+Tmin;
        Pdisplay=(Pvalue-1677721.6)/Pspan*(Pmax-Pmin)+Pmin;
}


float pressure;
float filt(unsigned char N)
{
    u8 count;
    float sum=0;
    float value_buf[N];
    for (count=0;count<N;count++)
    {
        Get_Value();
        value_buf[count] = Pdisplay;
        sum += value_buf[count];
    }
    pressure=sum/N;

    return  pressure;
}
```

SPI

```
#include "main.h"
#include "stm32l0xx_hal.h"
#include "SPI.h"
#include "delay.h"

//MODE   0  0
void spi_write(u8 spi_dat)
{
  unsigned char n;
  for(n=0;n<8;n++)
  {
    OLED_SCLK_Clr();
    if(spi_dat&0x80)
      OLED_SDIN_Set();
    else
      OLED_SDIN_Clr();
    spi_dat<<=1;
```

```
      OLED_SCLK_Set();
   }
   OLED_SCLK_Clr();
}

u8 spi_read()
{
   unsigned char n ,dat;

   for(n=0;n<8;n++)
   {
      OLED_SCLK_Clr();
      dat<<=1;
      if(READ_MISO)
         dat|=0x01;
      else
         dat&=0xfe;
      OLED_SCLK_Set();
   }
   OLED_SCLK_Clr();
   return dat;
}

u8 SPIx_ReadWriteByte(u8 TxData)
{
         u8 i,RxData=0,num=0x80;
         for (i=0;i<0x08;i++)
         {
                  OLED_SCLK_Clr();
                  if(TxData&num)
                           OLED_SDIN_Set();
                  else
                           OLED_SDIN_Clr();
                  if(num>0x01)
                           num=num>>1;
                  delay_ms(4);
                  OLED_SCLK_Set();
                  if(READ_MISO)
                           RxData|=0x01;
                  if(i<7)
```

```
                        RxData=RxData<<1;
                delay_ms(4);
        }
        OLED_SCLK_Clr();
        return RxData;
}

unsigned char Soft_Buf_Pressure[7];
void ReadSSDL()
{
        OLED_SCLK_Clr();
        SS_OFF;
        delay_us(5);
 spi_write(0xAA);
        spi_write(0x00);
 spi_write(0x00);
        SS_ON;
 delay_ms(20);
        SS_OFF;
        Soft_Buf_Pressure[0] = SPIx_ReadWriteByte(0xf0);
        Soft_Buf_Pressure[1] = SPIx_ReadWriteByte(0x00);
        Soft_Buf_Pressure[2] = SPIx_ReadWriteByte(0x00);
        Soft_Buf_Pressure[3] = spi_read();
        Soft_Buf_Pressure[4] = spi_read();
        Soft_Buf_Pressure[5] = spi_read();
        Soft_Buf_Pressure[6] = spi_read();
        SS_ON;
        delay_us(5);
}
```