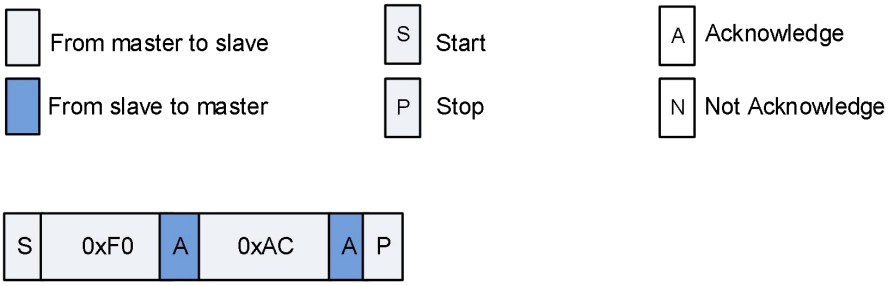
SMP3011 Digital Pressure Sensor--I²C

Communication Instruction

SMP3011Digital Pressure Sensor use the I²C bus protocol to communicate with external device. All data communication starts from MSB, The default address of 7bit I2C device is 0x78. SMP3011 is a slave device of I2C , The master device can communicate with it by using the following formats of commands.

1. Dispatch command

Dispatch command "0xF0" means the default address of 7bits I²C is 0x78，The last 1bit is 0means that master device is dispatching command.

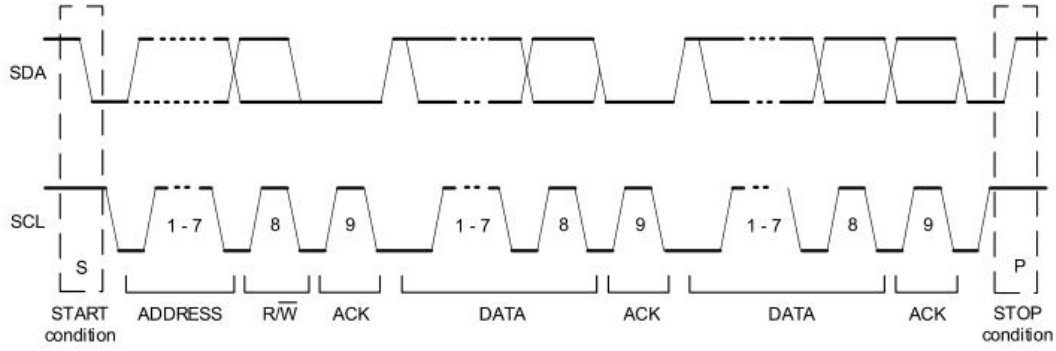


2. Wait

After sending the write command, it needs to wait for a period of time before sending the read command, because it needs a period of time to complete the whole measurement internally. The waiting time depends on the [13:11] pressure oversampling rate of OTP (address: 0x14) and [15:14] temperature oversampling rate of OTP(address: 0x14) .Refer to the attached form 1 and form 2, The waiting time will be tP+tT.

The waiting time does not need to be calculated. You can judge whether the acquisition has been completed by reading the IIC status continuously.

3. I²C Interface time



● START Condition

SDA changes from idle high state to low state, and SCL remains high. If the start condition is sent repeatedly during the transmission, the transmission will restart without the middle stop bit.

●Address Bits

During the first byte transmission, the first 7-bits provide the specified address of the device, which is 0x78 by default. The device at this address will answer this communication.

●Read/Write Direction Bit

During the transmission of the first byte, the last bit indicates the direction of communication. “0” indicates the write operation of the main device, and “1” indicates the read operation of the main device. If the master requests to read from the slave, the master will control the SDA line output data in subsequent bytes.

●Data Byte

All other bytes, except address and read / write bits, transmit data bytes considered as communication on SDA.

●Acknowledge or Not Acknowledge Bit

The reply bit is used to tell the sender that the byte has been received. When the device receives the data, it needs to answer each byte, including the address byte. At this time, the bus device sending data stops driving the SDA line and the SDA line is pulled high. Do not answer a byte, the receiving device does not need to do anything. In response to a byte, the receiving device needs to pull down the SDA.

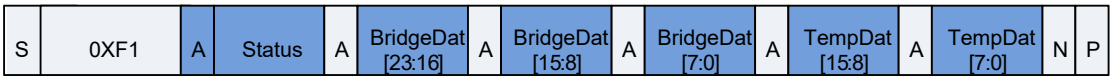
A receiving slave does not need to answer if the slave is not an addressed device or the device cannot process the bytes received. The master does not answer if it is receiving and wants to end communication. If you encounter no response. The device needs to generate a stop bit to transmit data.

●Stop Condition

SDA changes from low state to high state, and SCL remains high. End I 2C communication.

4. Reading

To ensure that the time interval between writing and reading instructions is longer than the measured time, the calibration data can be read out. The reading format is shown in Figure 2. 0xf1 in the read command indicates that the default address of 7bits I2C device is 0x78, and the last 1bit is 1 indicates the read operation of the main device. The read calibration data is 6 bytes in total, including 1 byte status word, 3 bytes bridge calibration value and 2 bytes temperature calibration value.



Form 3 I2C reads 5-byte calibrated bridge and temperature value

Any response from the I 2C interface starts with the status byte, followed by the data, which is returned based on the previous instruction. If the I 2 c read instruction is repeated, the same data will be read multiple times. If the next command is not an I 2 c read command, the previous data is invalid.

5. Conversion

Percentage output (%)	Digital quantity (decimal)	Digital quantity (hexadecimal)
0	0	0x000000
10	1677722	0x19999A
15	2516582	0x266666
85	14260633	0xD99999
90	15099494	0xE66666
100	16777215	0xFFFFFF

Form 4-- 24 bit AD output percentage

A. **After reading the calibration data, you need to make a simple conversion of the unsigned number in percentage form.**

For the convenience of understanding, we assume that the read calibration data is:

0x04 0x9b 0xb0 0xc5 0x56 0XAA

0x04 is the status word Bit5 is 1 indicating that I2C is busy for the last time and needs to wait for some time. If bit5 is 0, the device is not busy and can read data. For a detailed description of each bit of the status word, see the appendix.

0x9b 0xb0 0xc5 three bytes are bridge calibration values

0x56 0XAA two bytes are temperature calibration values

B. Conversion of bridge calibration value

The conversion of 0x9b 0xb00xc5 to decimal number is 10203333. Since the read calibration data is expressed as a percentage, this percentage is numerically equal to the ratio of the maximum value (16777214) of the decimal number converted by us to the 24 bits unsigned number. Therefore, the following calculation can be carried out during the conversion of the percentage

10203333/16777216*100%=60.8166%

Product output：15%~85%

This calculation assumes that the range used in calibration is 20Kpa-120Kpa

Pressure Output value=[（60.8166%-15%）/70%] *（120-20）+20=85.45229 Kpa

C. **Conversion of temperature calibration value：** The conversion of 0x56 0XAA to decimal number is 22186. Since the read calibration data is expressed as a percentage, this percentage is numerically equal to the ratio of the decimal number converted by us to the maximum value (65535) of 16bits unsigned number. Therefore, the following calculation can be carried out when converting the percentage

22186/65536*100%=33.85%

The temperature calibration range is defined as -40℃—150℃

Calibration value=（150—（-40））*33.85%—40=24.32℃

Appendix

Form 1 Comparison table of pressure oversampling rate and measurement time

OSR_Pressure[13:11]（binary system）	Corresponding oversampling rate	Measure timet_P(ms)
000	32768	203
001	16384	105
010	8192	56
011	4096	31
100	2048	19
101	1024	13
110	512	10

Form 2 Comparison table of temperature oversampling rate and measurement time

OSR_Temperature[15:14]（binary system）	Corresponding oversampling rate	Measure timet_T(ms)
00	2048	19
01	4096	31
10	8192	56
11	16384	105

Form 3 StatusByte bit description

Bit number	Meaning	Description
Bit7	Retain	Fixed as 0
Bit6	(Power indication)	1 Equipment on power（V_{DDB} on）； 0 Power Off
Bit5	(Busy indication)	1 The device is busy, indicating that the data required to be read by the latest I2C command is not valid. If the device is busy, the new command will not be processed. 0 indicates that the data required to be read by the latest I2C command is ready to be read
Bit4	Retain	Fixed as 0
Bit[3]	(Mode Status)	0 NOR mode 1 CMD mode
Bit2	(Memory integrity/error flag)	0 indicates that the OTP memory data integrity test (CRC) passed 1 indicates that the integrity test failed. The data integrity test is only calculated once during power on (POR), so the new CRC value written can only be used after the following POR.
Bit1	Retain	Fixed as 0
Bit0	Retain	Fixed as 0