Type AN06 (Preliminary)

Guideline of Digital Output for I²C Pressure Sensors

NOTE

Communication protocol may vary for different series of pressure sensors. Be sure to contact factory for proper I²C communication guideline.

Abstract

This application note describes in detail the digital output format of AN06 digital pressure sensors with I²C output.

Design considerations as well as hints for writing interface firmware with an MCU are given

After reading this application note the user should be able to:

Be able to issue commands to initiate a pressure measurement and read out the result

Calculate the transfer function for his/her respective sensor

Foreword

The digital pressure sensors represent the next generation in smart pressure sensing.

They are designed to be Microcontroller friendly and optimized for battery powered operation. Among their key features:

- **I²C** interface with different address options
- Sleep mode with **2µA** standby current
- Peak operating current of **2.5 mA (Vdd= 5V) and 2.2 mA (Vdd= 3V)**
- Low voltage operation from **2.7V** to 5.5V and as low as **2.4V** with de-rated accuracy.

I²C Communication Parameters

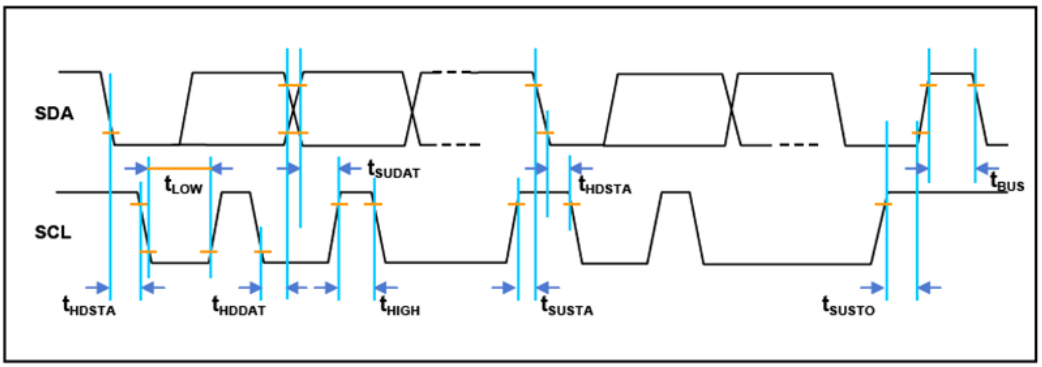
Parameters	Min	Typ	Max	Unit	Remarks
Voltage Level High		0	0.2	Vdd	
Voltage Level Low	0.8	0		Vdd	
SCL Clock Frequency	100		400	kHz	f_{SCL}
Start Condition Hold Time	0.1			μs	t_{HDSTA}
Minimum SCL clock Low width	0.6			μs	t_{LOW}
Minimum SCL clock High width	0.6			μs	t_{HIGH}
Start Condition Setup Time NOTE1	0.1			μs	t_{SUSTA}
Data Hold Time on SDA NOTE1	0			μs	t_{HDDAT}
Data Setup Time on SDA NOTE1	0.1			μs	t_{SUDAT}
Stop Condition Setup Time on SCL	0.1			μs	t_{SUSTO}
Bus free time between Start and Stop Condition	2			μs	t_{BUS}
Pull Up resistor on SDA & SCL	1.5			kΩ	

Notes

1) Relative to SCL Edge

2) Combined low and high widths must equal or exceed minimum SCL period

3) All Timing is subject to a ±10% variation

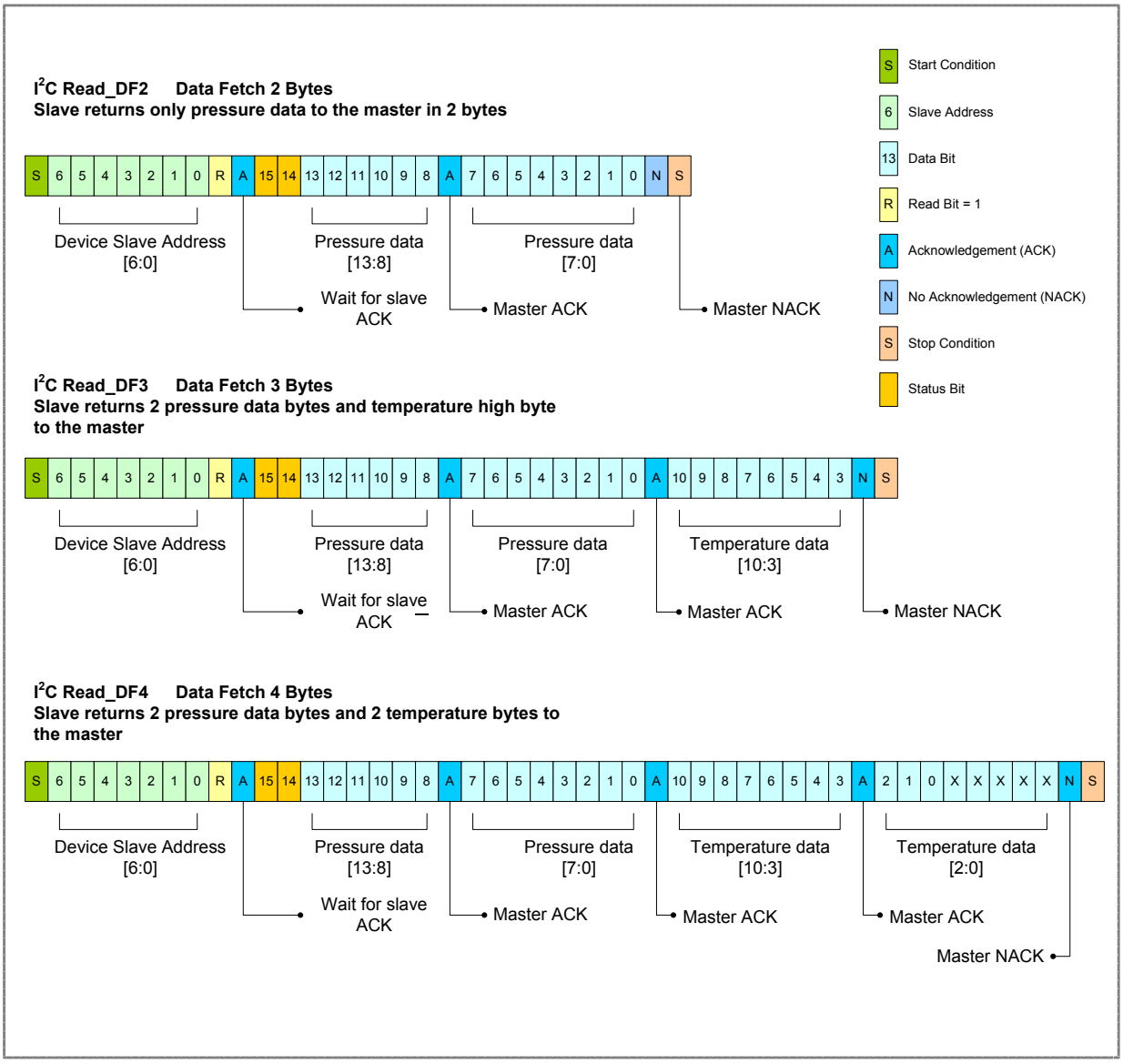


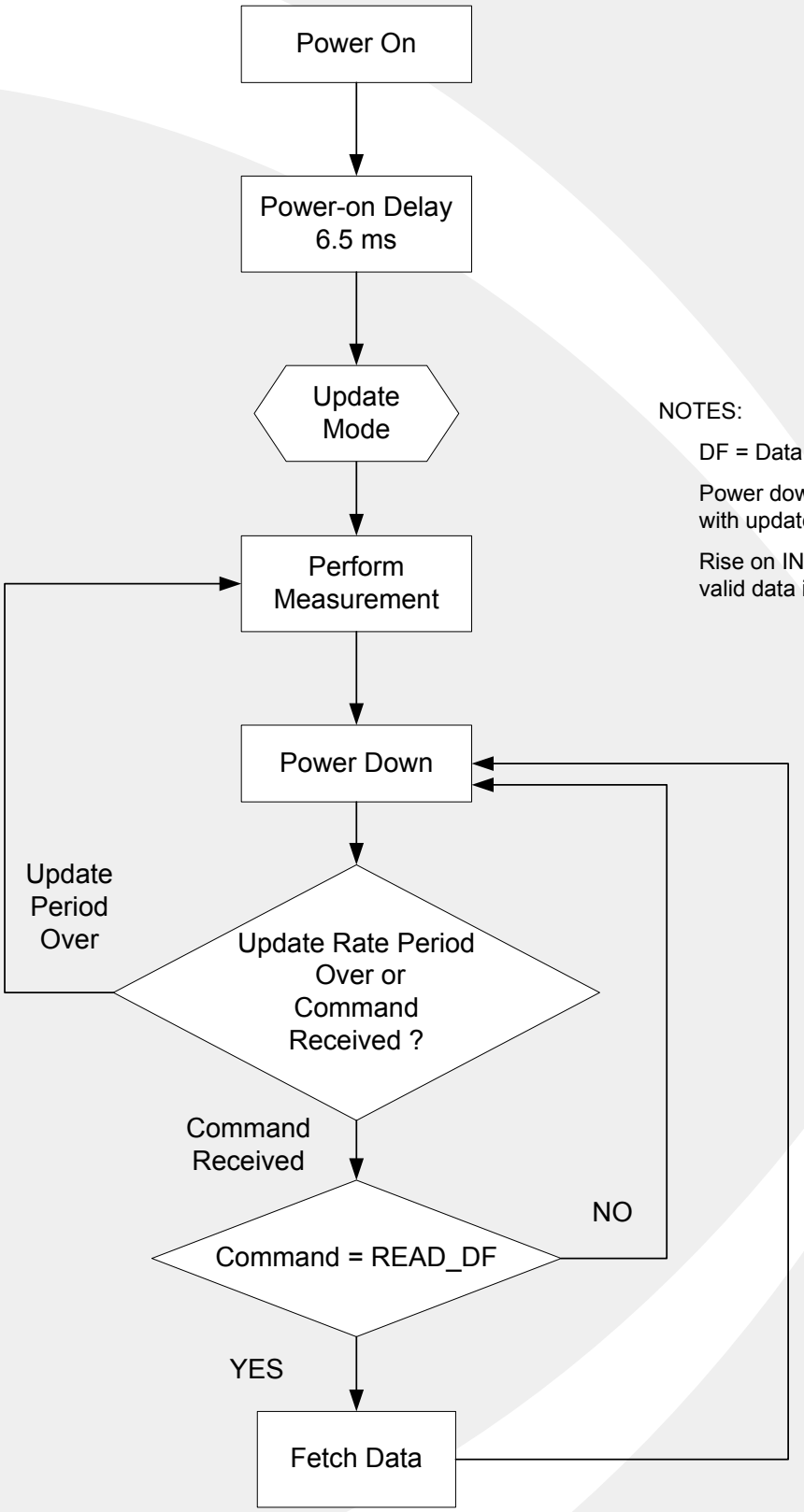
I²C Timing Diagram

Read Operation

For read operation. The I²C master command starts with the 7-bit slave address with the 8th bit = 1 (READ). The default slave address is 28H.

The slave will send an acknowledgement (ACK) upon successful identification. There are three read commands available for I²C, of which the structure of measurement packet are shown below.





NOTES:

DF = Data Fetch

Power down duration will vary with update rate

Rise on INT indicating new valid data is ready

System Working Flow
I^2C Interface

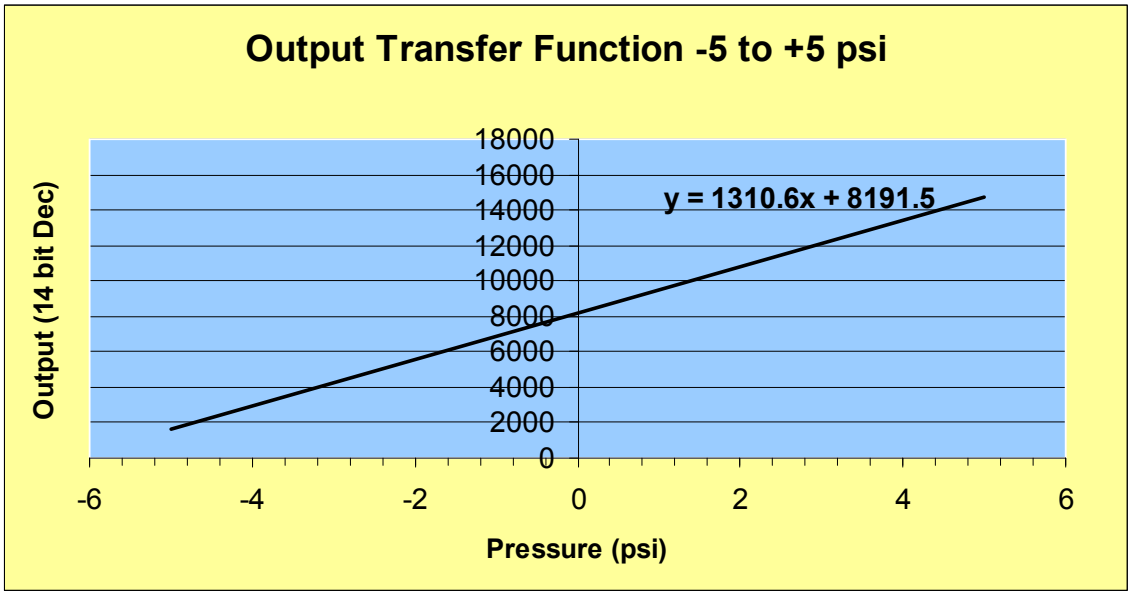
How to Interpret the Pressure/Temperature Value

All digital pressure sensors have been calibrated to a straight line transfer function. Temperature and non-linearity compensation are already included and are transparent to the user. The pressure value can be easily obtained by inserting the output into the transfer function. The process is explained below.

The pressure value is read out as a 14-bit word. The word corresponds to 0x0000 to 0x3FFF in Hex or 0 to 16383 in Decimal.

The first step is to convert the Hex value to Decimal. The calculator supplied with Microsoft Windows will easily do this.

The next step is to port the decimal value into the straight line function shown in the chart below.



The following example is for a -5 to +5 psi transfer function:

The output word is 0x1ABC.

The output word is translated into decimal which is 6844

The decimal word is then inserted into the equation which gives:

6844 = 1310.6x + 8191.5 where x is the pressure in psi

We then compute x = -1.028 psi

*Note: The transfer function varies for each pressure range. Make sure you use the correct function. The transfer functions for standard ranges are found on the next page

Transfer Function

To obtain the transfer function we start with the two parameters found in the sensor datasheet shown again below for convenience.

Parameters	Min	Typ	Max	Unit
Zero Output		0666		Hex
Full Scale Output		3996		Hex

Zero output = 0x0666 and Full Scale output = 0x3996.

The total output resolution is 14 bits or 0x3FFF.

We convert these into decimal for convenience:
Zero output = 1638, Full Scale output = 14742 and Total output resolution = 16383

Note that 1638 is 10% of total resolution and 14742 is 90% of total resolution so only 80% of the total 14 bit resolution is used to represent the required FS.

Now we correlate the outputs to the pressure range (see ordering guide in datasheet on how to specify pressure range). The example below refers to the output function on the previous page.

Parameter	Corresponding Pressure	Hex	Decimal
Zero Output	-5 psi	0x0666	1638
Full Scale Output	+ 5 psi	0x3996	14742

So taking the coordinates (-5 psi , 1638 counts) and (+5 psi, 14742 counts) we can calculate the corresponding straight line transfer function by calculating the gradient and Y-axis intercept.

In this case it is Y = 1310.6X + 8191.5 where Y=Digital output in Decimal and X= pressure in psi

Temperature Transfer Function:

Temperature Range	Transfer Function
-50 to 150 °C	y = 1.275x + 63.75 (8 bit (MSB) version)
-50 to 150 °C	y = 10.24x + 512 (11 bit version)

Note: The temperature transfer function is the same regardless of the pressure range chosen. The temperature output is not intended for high accuracy measurements but is instead an additional function provided at no extra cost.

Application Circuit Example

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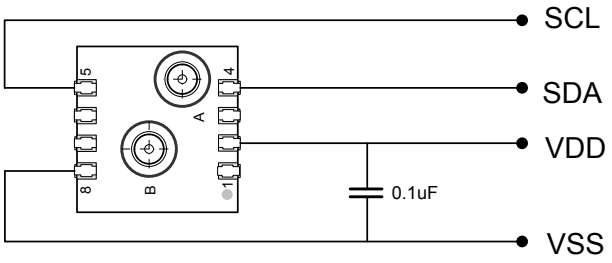

Pin #	Description
1	N.C.
2	V_{DD}
3	INT
4	SDA
5	SCL
6	N.C
7	N.C.
8	V_{SS}

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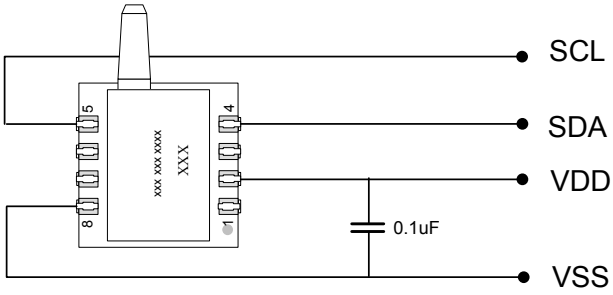
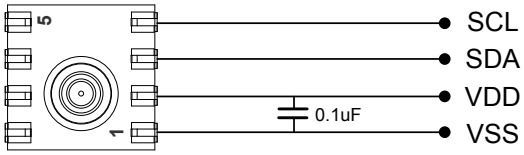


Pin #	Description
1	N.C.
2	V_{DD}
3	INT
4	SDA
5	SCL
6	N.C
7	N.C.
8	V_{SS}

MCD 70 72



Pin #	Description
1	V_{SS}
2	Vdd
3	SDA
4	SCL
5	INT

NOTEs:

A 0.1uF capacitor must be connected between Vdd and Vss

Detial for digital ouput interface configuration, please refer to Application Guide

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