

# Solid State Pressure Sensor

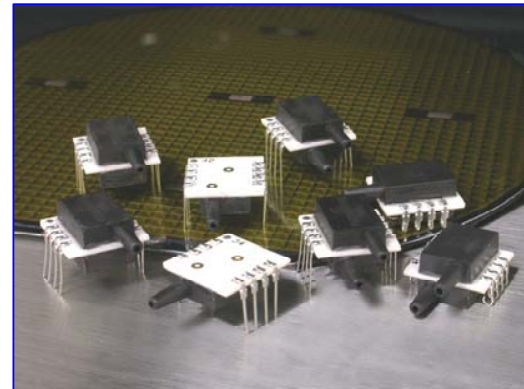
DIGITAL  
OUTPUT



## CCD Series – Model 54D

### FEATURES

- DIP or SMD Package
- Calibrated Span and Offset
- Multi-order Temperature compensation
- OWI, I<sup>2</sup>C or SPI Interface
- 3V or 5V Supply
- Customized Configuration upon request



### DESCRIPTION

The Series CCD Model 54D is a smart pressure transducer with digital output via 1-wire serial, I<sup>2</sup>C or SPI interface. Digital compensation of sensor offset, sensitivity, temperature drift and nonlinearity is accomplished in factory via an internal DSP running a correction algorithm with calibration coefficients stored in on-chip EEPROM.

A variety of characteristic configuration, including accuracy, sampling rate, temperature compensated range are available to provide simple and ready-to-use solution for a wide range of application. It can be operated in supply voltage of 2.7 to 5.5 V, and can be extended to 30V with an external JFET.

The Series CCD is available for pressure range from 0.15 psi to 150 psi. Special configuration as low as 2.5 mbar is also applicable. Please contact factory for detail.

# Ordering Information

Series CCD 54 Digital

**54D L - XXX G - X 0 X X**

**Series**

## Supply Voltage

Blank = 4.75 to 5.25 V  
L = 2.75 to 3.33 V

## Pressure range

### Medium Pressure

**003** = 0 ~ 3 psi

**005** = 0 ~ 5 psi

**007** = 0 ~ 7 psi

**015** = 0 ~ 15 psi

**030** = 0 ~ 30 psi

**050** = 0 ~ 50 psi

**100** = 0 ~ 100 psi

**150** = 0 ~ 150 psi

### Low Pressure

**L15** = 0 ~ 0.15 psi

**L30** = 0 ~ 0.3 psi

**L50** = 0 ~ 0.5 psi

**L70** = 0 ~ 0.7 psi

### Ultra-low Pressure

**L03** = 0 ~ 2.5 mbar

**L07** = 0 ~ 5 mbar

### Notes:

Custom ranges and units are available upon request. Please contact factory.

## Type of Pressure

**G:** Gage (Port B only)

**H:** Gage (Dual Port)

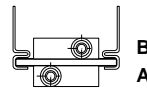
**A:** Absolute (Port A only)

**D:** Differential

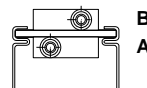
**I:** Negative Gage (Port B only)

## Leading Direction

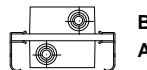
**1** = Leads opposite side as Port A



**2** = Leads same side as Port A



**3** = J-bend Leads same side as Port A



1. Port B is used for positive differential
2. Port A is used for absolute
3. Port B is used for gage

## Option

**0:** No special request

## Sampling Rate

**0** = 1 kHz  
**1** = 200 Hz  
**2** = 40 Hz  
**3** = 8 Hz

## Type of Output

**0** = 1-wire P

**1** = 1-wire P+T

**2** = 0.5 to 4.5 V

**3** = 0.2 to 4.8 V

**4** = N/A

**5** = 0 to 1 V

**6** = 0.2 to 4.7 V

**7** = N/A

**8** = I<sup>2</sup>C

**9** = SPI

**S** = Special

## NOTES:

1. Specifying differential pressure means a  $\pm$  pressure range.
2. Differential pressure can be specified to a maximum of +/- 150 psi.
3. Custom output, pressure range and temperature compensated range are available.
4. Negative gage normally has offset (0.5V) at 0 psi and full scale output (4.5V). Reverse is also applicable.
5. Accuracy may vary on pressure range
6. Minimum absolute pressure that can be specified is 15 psia
7. Medium is available for clean air. For other medium please contact factory.

## Characteristics

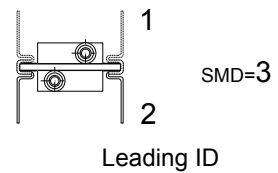
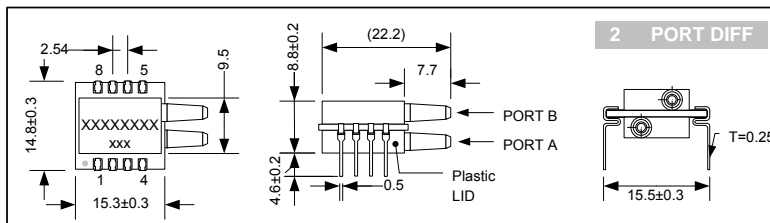
Unless otherwise specified, all parameters are measured at 3/5V, 25 °C and 60% RH

Parameters	Min	Typ	Max	Unit
Excitation <sup>1</sup>	2.75		5.25	V
Pressure range <sup>2</sup>	3		150	PSI
Resolution <sup>3</sup>	12			Bit
Accuracy <sup>3</sup>		±1.8		%FS, +1LSB
Zero Output <sup>4</sup>		0666		Hex
Full Scale Output <sup>4</sup>		3999		Hex
Warm-up Time		1	2	ms
Start-up Time			10	ms
Sampling Rate	8		1000	Hz
Temp - Compensating	0		50	°C
Temp - Operating	-20		+85	°C
Temp - Storage	-40		+125	°C
Over Pressure <sup>5</sup>			3X	Rated Pressure

**NOTES:**

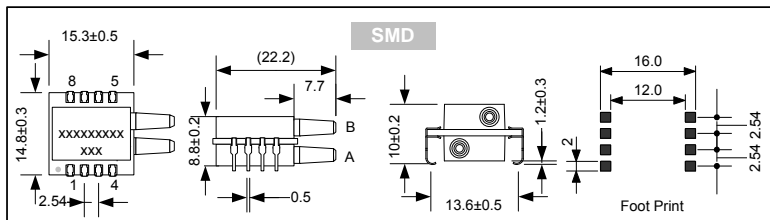
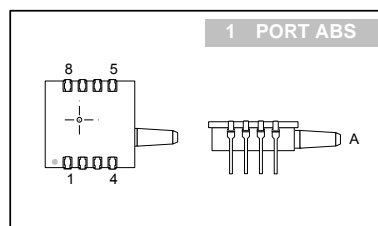
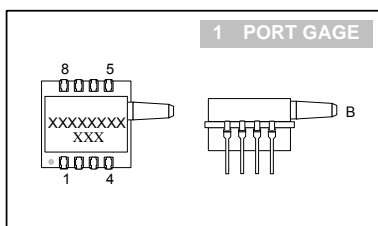
- 1. Supply 3V or 5V must be ordered separately.
- 2. Smaller range and other units are also available for ordering
- 3. Accuracy includes NOL, hysteresis, TCS and TCO over 0/50°C, BFSL definition
- 4. For differential pressure, offset = 2000 hex, FS = 666/3999
- 5. 1.2X for 150 psi
- 6. Wetted material: PA, RTV, Epoxy, ceramic, Au, nickel and silicon
- 7. Output is ratiometric to supply voltage
- 8. Output load resistance to Vss or Vdd: 2.5KΩ (min), 10KΩ (typ)

## Dimension



**NOTE:**

- 1. Port B is used for positive differential
- 2. Port A is used for absolute
- 3. Port B is used for gage
- 4. All dimensions are mm
- 5. Tube Size: Tygon tube, 4 (o.d.) 2.5 (i.d.) mm



Pin #	Description
1	N.C.
2	V <sub>SS</sub>
3	OUT
4	V <sub>DD</sub>
5~8	N.C.

**NOTES:**

- N.C. pins must be left floating
- A 0.1µf capacitor must be connected between V<sub>DD</sub> and V<sub>SS</sub>
- Package : 12 pcs/tube

## Characteristics

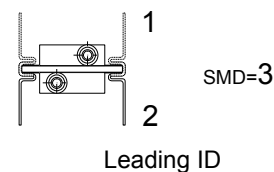
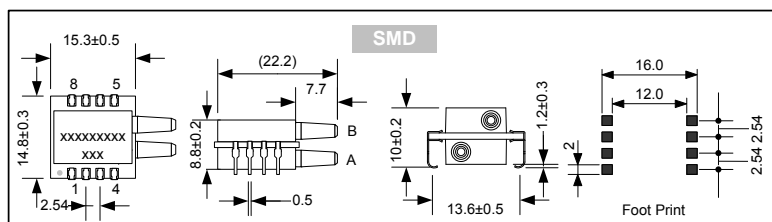
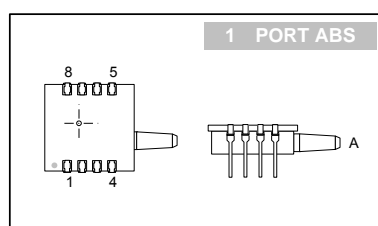
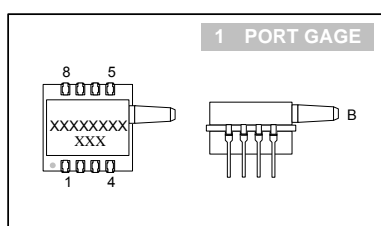
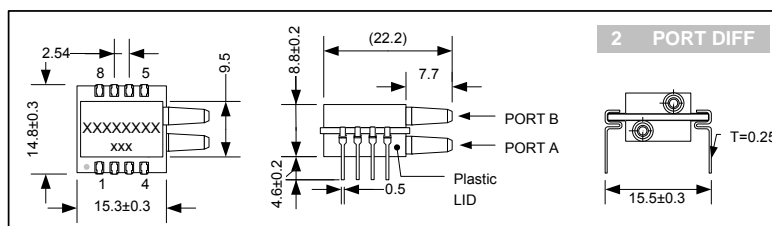
Unless otherwise specified, all parameters are measured at 3/5V, 25 °C and 60% RH

Parameters	Min	Typ	Max	Unit
Excitation <sup>1</sup>	2.75		5.25	V
Pressure range <sup>2</sup>	0.15		3	PSI
Resolution <sup>3</sup>	12			Bit
Accuracy <sup>3</sup>		±2.2		%FS, +1LSB
Zero Output <sup>4</sup>		0666		Hex
Full Scale Output <sup>4</sup>		3999		Hex
Warm-up Time		1	2	ms
Start-up Time			10	ms
Sampling Rate	8		1000	Hz
Temp - Compensating	0		50	°C
Temp - Operating	-20		+85	°C
Temp - Storage	-40		+125	°C
Over Pressure <sup>5</sup>			3X	Rated Pressure

NOTES:

- Supply 3V or 5V must be ordered separately.
- Smaller range and other units are also available for ordering
- Accuracy includes NOL, hysteresis, TCS and TCO over 0/50°C, BFSL definition
- For differential pressure, offset = 2000 hex, FS = 666/3999
- Over-pressure will vary on different range
- Wetted material: PA, RTV, Epoxy, ceramic, Au, nickel and silicon
- Output load resistance to Vss or Vdd: 2.5KΩ (min), 10KΩ (typ)
- Zeroing at installation is required

## Dimension



NOTE:

- Port B is used for positive differential
- Port A is used for absolute
- Port B is used for gage
- All dimensions are mm
- Tube Size: Tygon tube, 4 (o.d.) 2.5 (i.d.) mm

Pin #	Description
1	N.C.
2	V <sub>SS</sub>
3	OUT
4	V <sub>DD</sub>
5~8	N.C.

NOTES:

- N.C. pins must be left floating
- A 0.1µf capacitor must be connected between V<sub>DD</sub> and V<sub>SS</sub>
- Package : 12 pcs/tube

## Characteristics

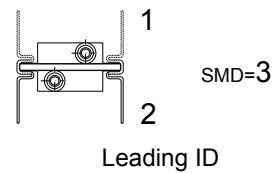
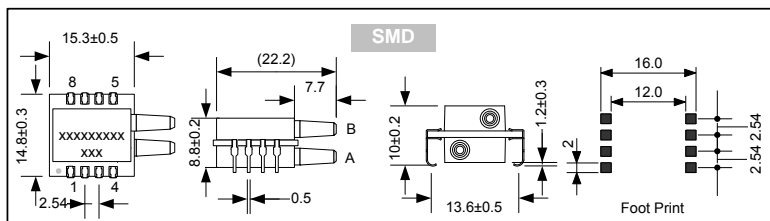
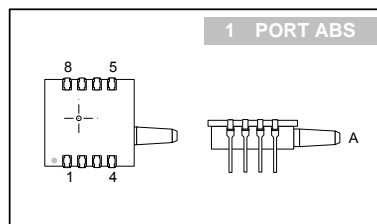
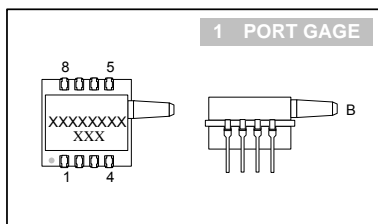
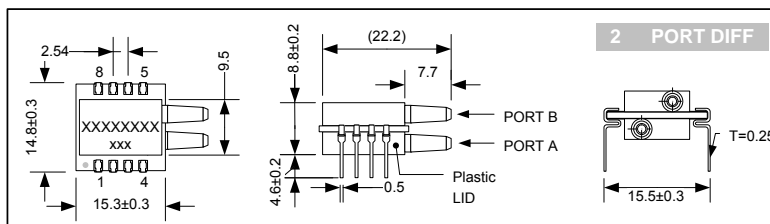
Unless otherwise specified, all parameters are measured at 3/5V, 25 °C and 60% RH

Parameters	Min	Typ	Max	Unit
Excitation <sup>1</sup>	2.75		5.25	V
Pressure range <sup>2</sup>	2.5		10	mbar
Resolution <sup>3</sup>	12		14	Bit
Accuracy <sup>4</sup>			±4.5	%FS, +1LSB
Zero Output <sup>5</sup>		0666		Hex
Full Scale Output <sup>5</sup>		3999		Hex
Warm-up Time		1	2	ms
Start-up Time <sup>6</sup>			10	ms
Sampling Rate	8		1000	Hz
Temp - Compensating	0		50	°C
Temp - Operating	-20		+85	°C
Temp - Storage	-40		+125	°C
Over Pressure <sup>7</sup>	5X			Rated Pressure

**NOTES:**

- Supply 3V or 5V must be ordered separately.
- Smaller range and other units are also available for ordering
- Vary with sensor configuration. Refer to individual data sheet.
- Accuracy includes NOL, hysteresis, TCS and TCO over 0/50°C, BFSL definition
- For differential pressure, offset = 2000 hex, FS = 666/3999
- Power up to output
- Over-pressure will vary on different range
- Wetted material: PA, RTV, Epoxy, ceramic, Au, nickel and silicon
- Output load resistance to Vss or Vdd: 2.5KΩ (min), 10KΩ (typ)
- Zeroing at installation is required

## Dimension



**NOTE:**

- Port B is used for positive differential
- Port A is used for absolute
- Port B is used for gage
- All dimensions are mm
- Tube Size: Tygon tube, 4 (o.d.) 2.5 (i.d.) mm

Pin #	Description
1	N.C.
2	V <sub>SS</sub>
3	OUT
4	V <sub>DD</sub>
5~8	N.C.

**NOTES:**

- N.C. pins must be left floating
- A 0.1µf capacitor must be connected between V<sub>DD</sub> and V<sub>SS</sub>
- Package : 12 pcs/tube

# Characteristics

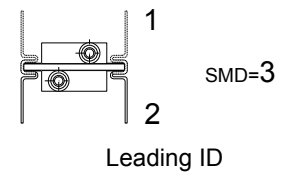
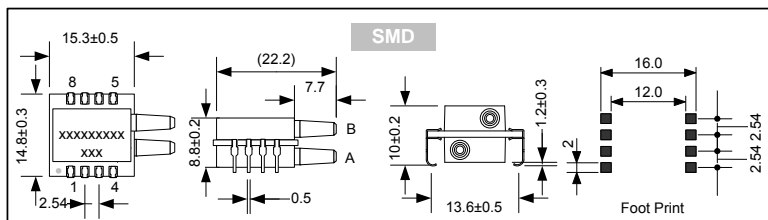
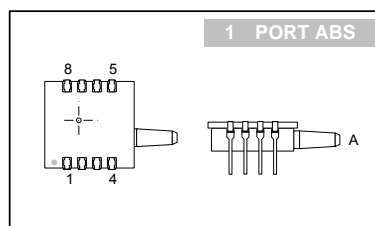
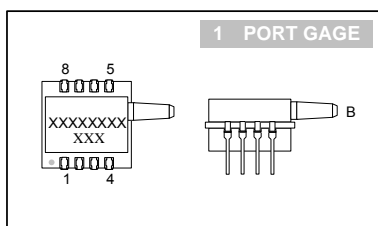
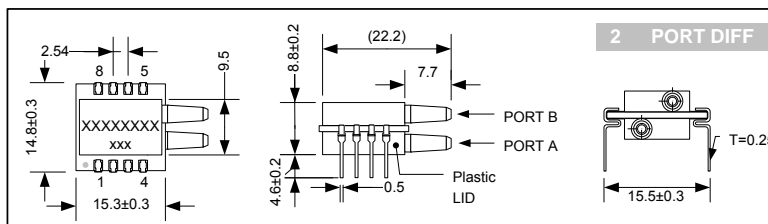
Unless otherwise specified, all parameters are measured at 3/5V, 25 °C and 60% RH

Parameters	Min	Typ	Max	Unit
Excitation <sup>1</sup>	2.75		5.25	
Pressure range <sup>2</sup>	3		150	PSI
Resolution <sup>3</sup>	12			Bit
Accuracy <sup>3</sup>		±1.8		%FS, +1LSB
Zero Output <sup>4</sup>		0666		Hex
Full Scale Output <sup>4</sup>		3999		Hex
Voltage Low Level		0	0.2	V <sub>DD</sub>
Voltage High Level	0.8	1		V <sub>DD</sub>
Output Lo-Level			0.1	V <sub>DDA</sub>
SCL clocking	100		400	KHZ
System Freq		1		MHZ
Update Rate	1		125	ms
Temp - Compensating	0		50	°C
Temp - Operating	-20		+85	°C
Temp - Storage	-40		+125	°C
Over Pressure <sup>6</sup>			3X	Rated Pressure

**NOTES:**

- Supply 3V or 5V must be ordered separately.
- Smaller range and other units are also available for ordering
- Accuracy includes NOL, hysteresis, TCS and TCO over 0/50°C, BFSL definition
- For differential pressure, offset = 2000 hex, FS = 666/3999
- Minimum pull-up on SDA and SCL is 1KΩ
- 1.2X for 150 psi
- Wetted material: PA, RTV, Epoxy, ceramic, Au, nickel and silicon
- The factory setting for I2C slave address is 0x28

## Dimension



**NOTE:**

- Port B is used for positive differential
- Port A is used for absolute
- Port B is used for gage
- All dimensions are mm
- Tube Size: Tygon tube, 4 (o.d.) 2.5 (i.d.) mm

Pin #	Description
1	N.C.
2	V <sub>DD</sub>
3	INT
4	SDA
5	SCL
6	N.C.
7	N.C.
8	V <sub>SS</sub>

**NOTES:**

- N.C. pins must be left floating
- A 0.1uF capacitor must be connected between V<sub>DD</sub> and V<sub>SS</sub>
- Package : 12 pcs/tube

# Characteristics

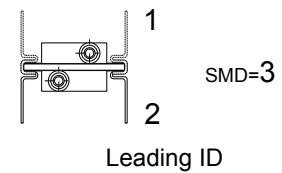
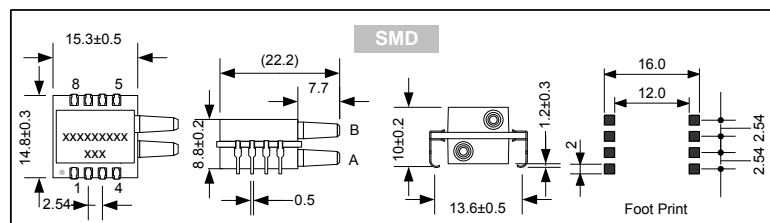
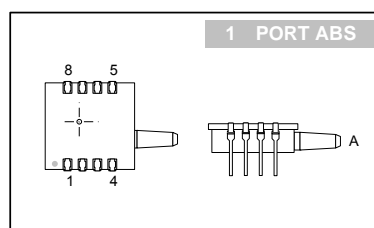
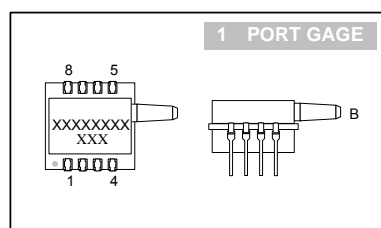
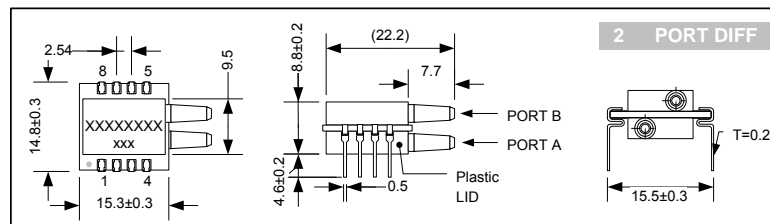
Unless otherwise specified, all parameters are measured at 3/5V, 25 °C and 60% RH

Parameters	Min	Typ	Max	Unit
Excitation <sup>1</sup>	2.75		5.25	
Pressure range <sup>2</sup>	0.15		3	PSI
Resolution <sup>3</sup>	12			Bit
Accuracy <sup>3</sup>		±2.2		%FS, +1LSB
Zero Output <sup>4</sup>		0666		Hex
Full Scale Output <sup>4</sup>		3999		Hex
Voltage Low Level		0	0.2	V <sub>DD</sub>
Voltage High Level	0.8	1		V <sub>DD</sub>
Output Lo-Level			0.1	V <sub>DDA</sub>
SCL clocking	100		400	KHZ
System Freq		1		MHZ
Update Rate	1		125	ms
Temp - Compensating	0		50	°C
Temp - Operating	-20		+85	°C
Temp - Storage	-40		+125	°C
Over Pressure <sup>6</sup>			3X	Rated Pressure

NOTES:

- Supply 3V or 5V must be ordered separately.
- Smaller range and other units are also available for ordering
- Accuracy includes NOL, hysteresis, TCS and TCO over 0/50°C, BFSL definition
- For differential pressure, offset = 2000 hex, FS = 666/3999
- Minimum pull-up on SDA and SCL is 1KΩ
- Over-pressure will vary on different range
- Wetted material: PA, RTV, Epoxy, ceramic, Au, nickel and silicon
- The factory setting for I2C slave address is 0x28
- Zeroing at installation is required

## Dimension



NOTE:

- Port B is used for positive differential
- Port A is used for absolute
- Port B is used for gage
- All dimensions are mm
- Tube Size: Tygon tube, 4 (o.d.) 2.5 (i.d.) mm

Pin #	Description
1	N.C.
2	V <sub>DD</sub>
3	INT
4	SDA
5	SCL
6	N.C.
7	N.C.
8	V <sub>SS</sub>

NOTES:

- N.C. pins must be left floating  
**A 0.1uf capacitor must be connected between V<sub>DD</sub> and V<sub>SS</sub>**  
 Package : 12 pcs/tube

## Characteristics

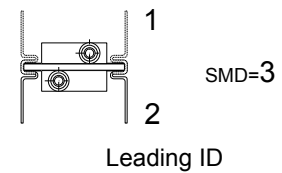
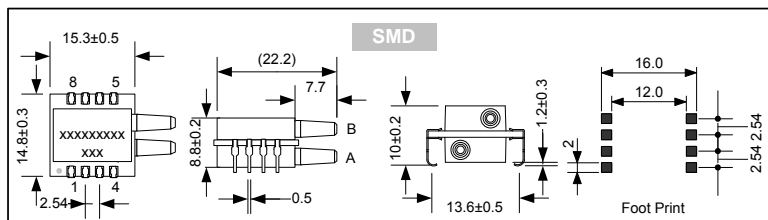
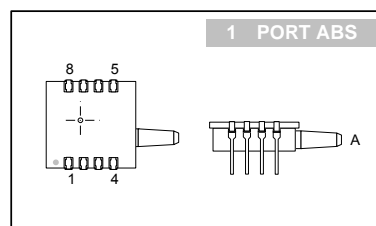
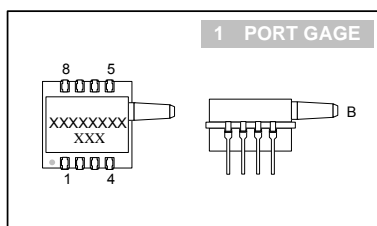
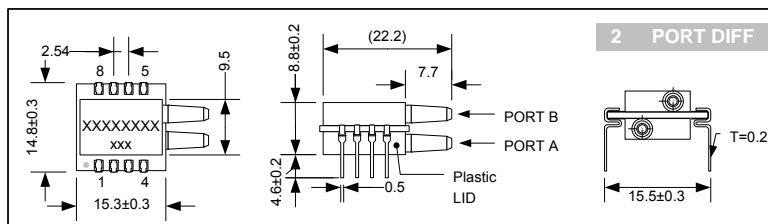
Unless otherwise specified, all parameters are measured at 3/5V, 25 °C and 60% RH

Parameters	Min	Typ	Max	Unit
Excitation <sup>1</sup>	2.75		5.25	
Pressure range <sup>2</sup>	2.5		10	mbar
Resolution <sup>3</sup>	12			Bit
Accuracy <sup>3</sup>			±4.5	%FS, +1LSB
Zero Output <sup>4</sup>		0666		Hex
Full Scale Output <sup>4</sup>		3999		Hex
Voltage Low Level		0	0.2	V <sub>DD</sub>
Voltage High Level	0.8	1		V <sub>DD</sub>
Output Lo-Level			0.1	V <sub>DDA</sub>
SCL clocking	100		400	KHz
System Freq		1		MHZ
Update Rate	1		125	ms
Temp - Compensating	0		50	°C
Temp - Operating	-20		+85	°C
Temp - Storage	-40		+125	°C
Over Pressure <sup>6</sup>	5X			Rated Pressure

**NOTES:**

- Supply 3V or 5V must be ordered separately.
- Custom range and other units are available for ordering
- May vary with sensor configuration
- Accuracy includes NOL, hysteresis, TCS and TCO over 0/50°C, BFSL definition
- For differential pressure, offset = 2000 hex, FS = 666/3999
- Minimum pull-up on SDA and SCL is 1KΩ
- Over-pressure may vary from pressure ranges
- Wetted material: PA, RTV, Epoxy, ceramic, Au, nickel and silicon
- The factory setting for I2C slave address is 0x28
- Zeroing at installation is required

## Dimension



**NOTE:**

- Port B is used for positive differential
- Port A is used for absolute
- Port B is used for gage
- All dimensions are mm
- Tube Size: Tygon tube, 4 (o.d.) 2.5 (i.d.) mm

Pin #	Description
1	N.C.
2	V <sub>DD</sub>
3	INT
4	SDA
5	SCL
6	N.C.
7	N.C.
8	V <sub>SS</sub>

**NOTES:**

- N.C. pins must be left floating  
**A 0.1uF capacitor must be connected between V<sub>DD</sub> and V<sub>SS</sub>**  
 Package : 12 pcs/tube



## Communication Interface

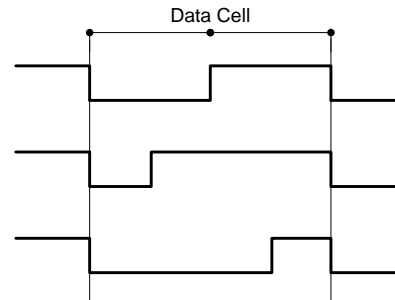
Manchester codes by a transition at the cell boundary are used to represent the binary values of pressure and temperature.

### Bit Encoding

Start Bit  $\Rightarrow$  50% duty cycle used to set up strobe time

Logic 1  $\Rightarrow$  75% duty cycle

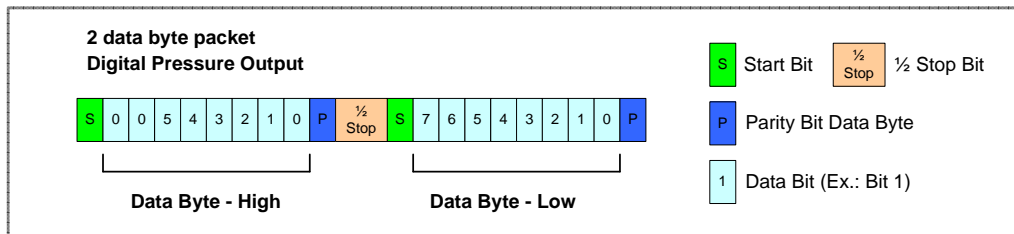
Logic 0  $\Rightarrow$  25% duty cycle



### Read Operation

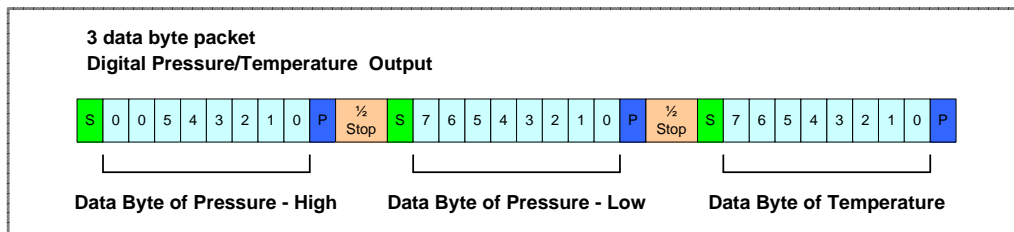
There are two modes (DPT digital pressure output with temperature, and DTO digital pressure out only) available for the output of transducer.

For DPO mode, the transducer first transmits the high byte of pressure data followed by the low byte. The pressure data is 14-bits in resolution, so the upper two bits of the high byte are always zero padded. There is a half stop bit interval between bytes in a packet. That means for the time of half a bit width, the signal level is in high level.



DPO - Digital Pressure Output

For DPT mode, the pressure and temperature will be transmitted as 3 data packets.



DPT - Digital Pressure/Temperature Output

## Timing

The baud rate (transmission frequency) of the Manchester coded bit stream is determined during factory calibration and depends on the update rate and thus response time that the customer specifies for the transducer. If no response time is specified by the customer the default response time of 5ms (200Hz) will be selected.

There are a total of 4 different update rates listed below. Using the two faster update rates will result in the baud rate being 32kHz and the two slower update rates will result in the baud rate being set to 8kHz.

Update Rate	Response Time	Baud Rate	Idle Time Between Data
1000 Hz	1 ms	32kHz	1ms
200 Hz	5 ms	32kHz	4.85ms
40 Hz	25 ms	8kHz	22.5ms
8 Hz	125 ms	8kHz	118ms

### Hints for Writing Firmware:

The Baud rates (8kHz and 32kHz respectively) will vary +/- 10% with the supply voltage and across temperature. It is strongly recommended that any firmware used to read the digital pressure and temperature readings first use the **start bit** which is 50% high and 50% low to determine the exact frequency before decoding the digital output.

The idle time is the time in between data packets where no transmission occurs (the output is always high when idle).

### Suggested Algorithm:

Connect the output of the sensor to a pin of a microcontroller capable of causing an interrupt on a falling edge. When the falling edge is detected this causes a branch into an ISR which is a counting loop incrementing until a rising edge is detected in the output. Now based on the number of counts the frequency can be determined.

Now that the frequency is known the ISR can simply wait for the appropriate time before sampling the other bits.

## How to Interpret the Pressure Value

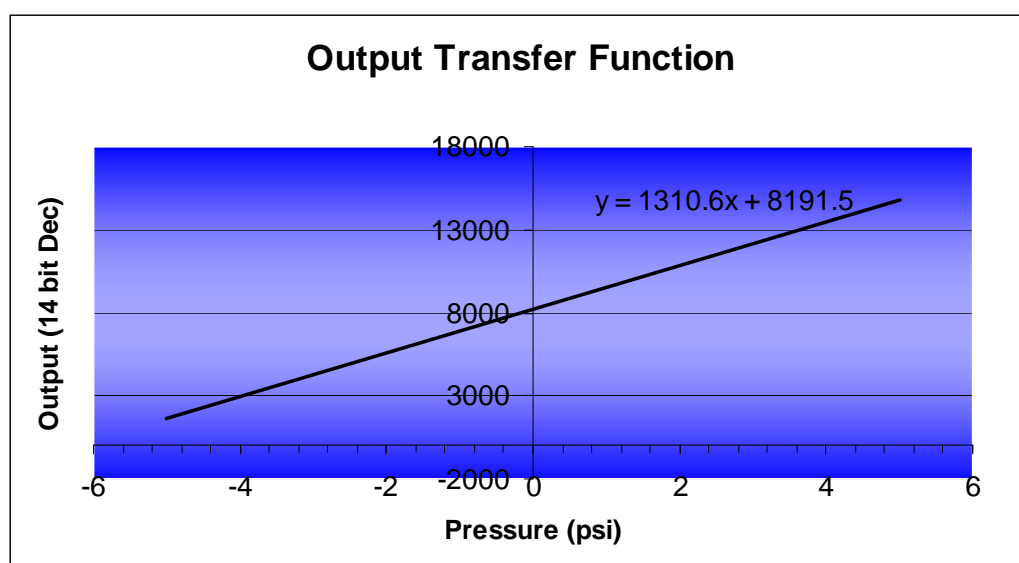
The CCD series pressure sensors have been calibrated to a straight line transfer function. The pressure value can be easily obtained by inserting the output into the transfer function. The process is explained below.

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. If in doubt please consult the factory.

## Obtaining the transfer function:

The transfer function is a straight line equation in the standard form  $y=mx+c$ , where  $y$  and  $x$  are  $x,y$  coordinates,  $m$  is the gradient and  $c$  is the  $y$ -axis intercept.

To compute your straight line transfer function you will simply need the 2 sets of  $x,y$  coordinates. These will be supplied to you with outputs of 10%FS and 90% FS by default (custom outputs are available on request).

Example:

Pressure = 0 psi, Output 10% FS

Pressure = 100 psi, Output 90% FS

First we note that the output is 14 bits ie. 0x0000 to 0x3FFF.  
In decimal this becomes 0 to 16383.

10% FS is 1638  
90% FS is 14745

First we find the gradient  $m$ , of our straight line.

$$\begin{aligned} m &= (y_2-y_1)/(x_2-x_1) \\ &= (14745-1638)/(100\text{psi}-0\text{psi}) \\ &= 131.07 \end{aligned}$$

Now we substitute this in and we get:

$$y = 131.07x+c$$

We substitute  $y=1638$  when  $x=0$  and we get

$$c = 1638$$

Which leaves us with our transfer function:

$$y = 131.07x + 1638 \text{ where } y \text{ is the output in Hex and } x \text{ is the corresponding pressure}$$

Note that the pressure  $x$ , can be specified in any units bar, psi...etc in which case the transfer function will only be valid for that particular pressure unit.

## AN05 (Preliminary)

# Digital Output Description for I<sup>2</sup>C Pressure Sensors (I Series)

**This Application Note applies to the following pressure sensors:**

CCD Series 53I and 54I

MAP Series 36I

SLP Series 33I and 35I

SPD Series 34I

### Abstract:

This application note describes in detail the digital output format of Sensormate's I Series digital pressure sensors with I<sup>2</sup>C 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 I Series pressure sensors from Sensormate Enterprise represent the next generation in digital pressure sensing. Designed to be Microcontroller friendly and optimized for battery powered operation. Among the key features:

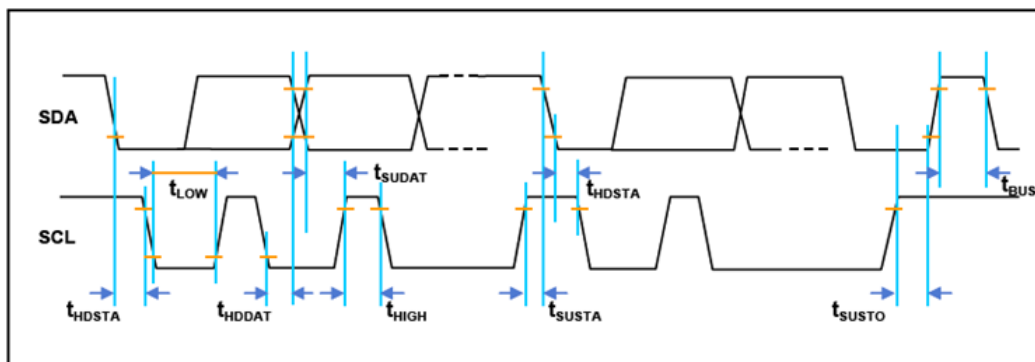
- I<sup>2</sup>C interface with different address options
- Sleep mode with **2μA** standby current
- Peak operating current of **2mA**
- Low voltage operation from **2.7V** to 5.5V and as low as **2.4V** with de-rated accuracy.

## I<sup>2</sup>C Communication Parameters

Parameters	Min	Typ	Max	Unit	Remarks
Voltage Low Level		0	0.2	Vdd	
Voltage High Level	0.8	1		Vdd	
SCL Clock Frequency		100		kHz	$f_{SCL}$
Start Condition Hold Time	0.1			$\mu s$	$t_{HDSTA}$
Minimum SCL clock Low width	0.6			$\mu s$	$t_{LOW}$
Minimum SCL clock High width	0.6			$\mu s$	$t_{HIGH}$
Start Condition Setup Time	0.1			$\mu s$	$t_{SUSTA}$
Data Hold Time on SDA	0			$\mu s$	$t_{HDDAT}$
Data Setup Time on SDA	0.1			$\mu s$	$t_{SUDAT}$
Stop Condition Setup Time on SCL	0.1			$\mu s$	$t_{SUSTO}$
Bus free time between Start and Stop Condition	1.0			$\mu s$	$t_{BUS}$
Pull Up resistor on SDA & SCL	1.5			k $\Omega$	

### 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  $\pm 10\%$  variation



I<sup>2</sup>C Timing Diagram

## Sensor Operation

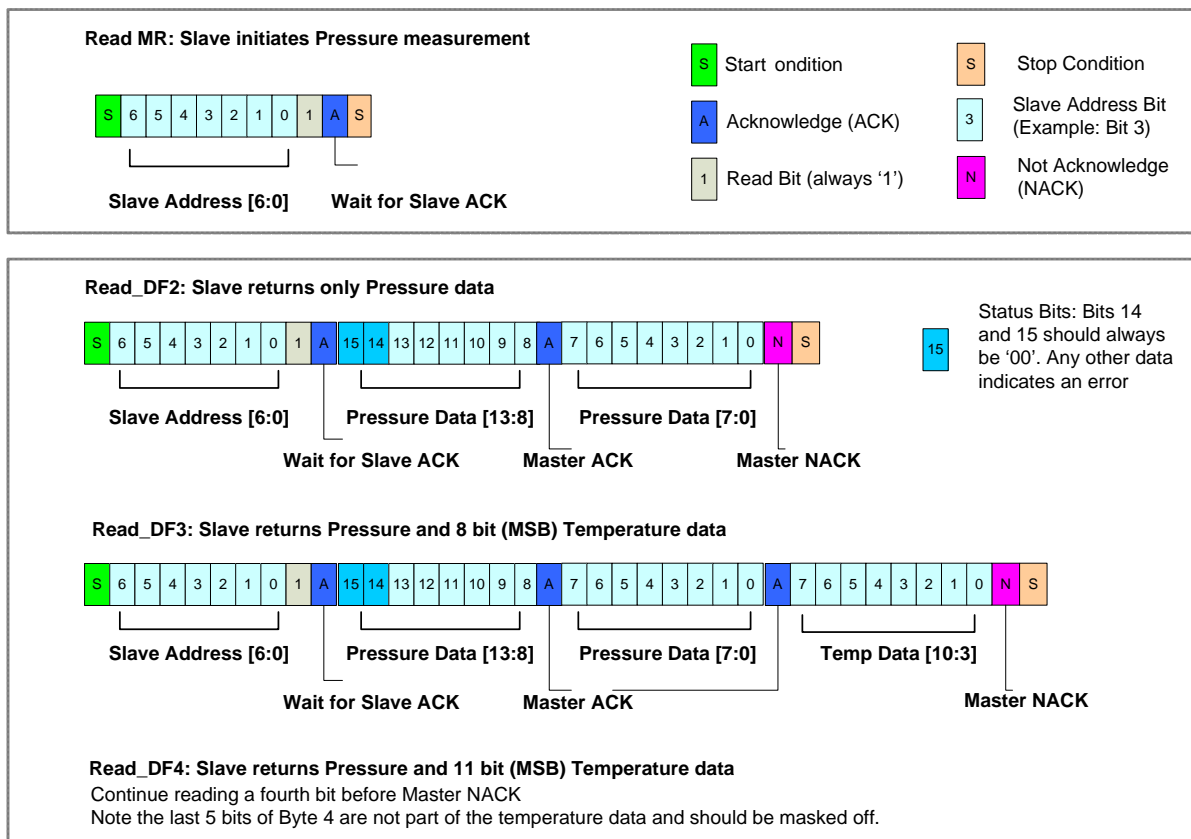
The operation of Sensormate's I Series pressure sensors are detailed by the ASM chart on the following page.

Upon power on the sensor performs various reset and initialization functions. This will take 6 ms before entering into 'Sleep Mode'. The sensor remains in this mode whenever not in use to conserve power.

To initiate a pressure measurement, the I<sup>2</sup>C master issues a Read\_MR command. This prompts the sensor to initiate a pressure measurement. The process takes 25 ms to complete the measurement after which it re-enters Sleep Mode.

After the result is ready it can be read out using Read\_DF2 or Read\_DF3 commands depending on what data is required to be read.

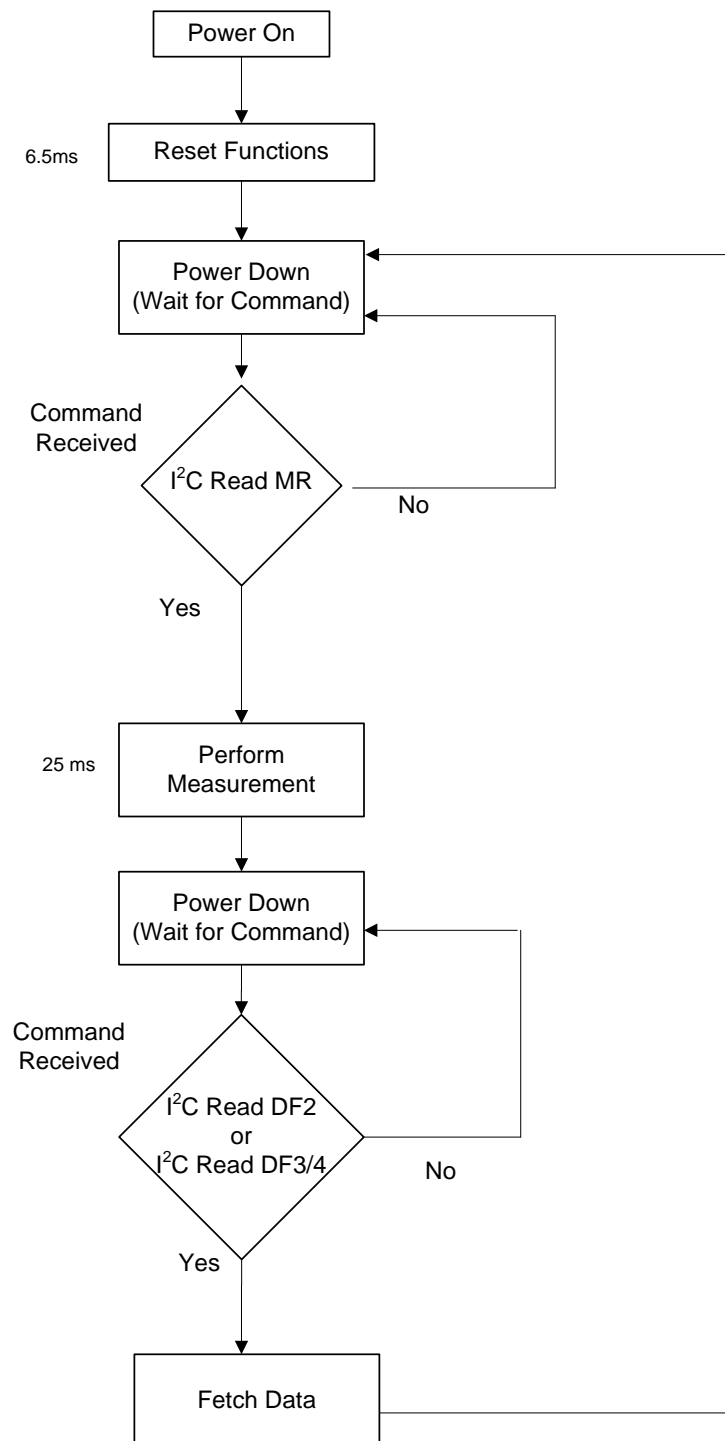
After the read command, the sensor returns to the Sleep Mode and waits for the next command to initiate pressure measurement.



### I<sup>2</sup>C Packet Reading

Note: We do not guarantee the accuracy of the Temperature output but instead provide it as an added feature at no extra cost.

## Working Mode Description





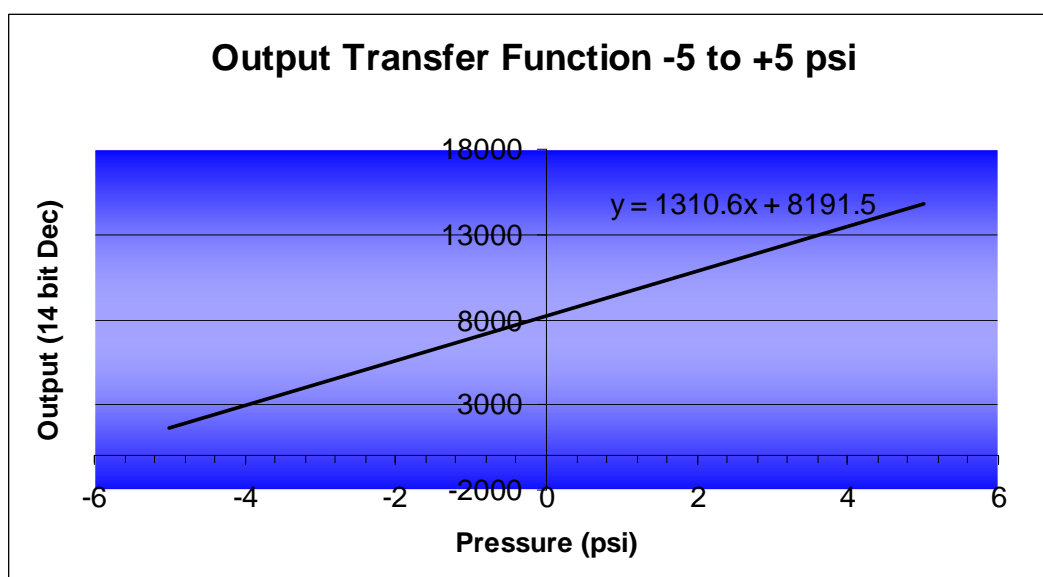
## How to Interpret the Pressure/Temperature Value

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.

## Effective Resolution

While the resolution is stated as 14 bits in the datasheet it is impossible to attain this resolution in practice.

14 bits is merely the resolution of the internal Analog to Digital converter (ADC) of the ASIC used to achieve the digital compensation and output.

In practice its resolution will be lower than 14 bits with quantization noise and amplification errors that result in a non-perfect match of the input range of the ADC to the sensor being compensated.

Therefore the guaranteed resolution of Sensormate sensors is 0.05% FS or 11 bits.

In most cases the software designed to read the pressure word should (where possible) allow for an averaging of 2-8 readings. The exact resolution versus sampling speed should be determined by the customer as it is very much dependent on the application.

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