MfrPartNumber	Allied#
NPI-19A-015A2	73182630
NPI-19A-030A2	73182631
NPI-19A-050A2	73182632
NPI-19A-100A2	73182633
NPI-19A-200A2	73182634
NPI-19A-300A2	73182635
NPI-19A-002G2	73182636
NPI-19A-005G2	73182637
NPI-19A-015G2	73182638
NPI-19A-030G2	73182639
NPI-19A-050G2	73182640
NPI-19A-100G2	73182641
NPI-19A-200G2	73182642
NPI-19A-300G2	73182643
NPI-19J-015A2	73182644
NPI-19J-030A2	73182645
NPI-19J-050A2	73182646
NPI-19J-100A2	73182647
NPI-19J-200A2	73182648
NPI-19J-300A2	73182649
NPI-19J-002G2	73182650
NPI-19J-005G2	73182651
NPI-19J-015G2	73182652
NPI-19J-030G2	73182653
NPI-19J-050G2	73182654
NPI-19J-100G2	73182655
NPI-19J-200G2	73182656
NPI-19J-300G2	73182657
NPI-19M-015A2	73182658
NPI-19M-030A2	73182659
NPI-19M-050A2	73182660
NPI-19M-100A2	73182661
NPI-19M-200A2	73182662
NPI-19M-300A2	73182663
NPI-19M-002G2	73182664
NPI-19M-005G2	73182665
NPI-19M-015G2	73182666
NPI-19M-030G2	73182667
NPI-19M-050G2	73182668
NPI-19M-100G2	73182669
NPI-19M-200G2	73182670
NPI-19M-300G2	73182671

NPI-19 I2C Digital Pressure Sensor

Application Guide

Amphenol

Dec 2022

Advanced Sensors

1. General Description

The NPI I2C digital pressure sensors combines Amphenol Advanced Sensors' SenStable® silicon fusion bonded pressure die technology with packaged electronics to provide highly stable, amplified and calibrated pressure measurement.

2. Output Characteristics

2.1 Pressure Output Options

The NPI-19 I2C product is available in a range of pressure ratings, pressure configurations. The nominal output ranges for standard product ranges are detailed in Tables 1 and 2 below.

Table 1: Available Pressure Output Ranges for Standard Products

Device series	Units	Absolute/Gauge		Excitation
NPI-19 I2C	Counts	1638	14745	3.3 V

Table 2: Output Transfer Function

Pressure	% Output	Decimal Counts	Hexadecimal Counts
Pmin	10	1638	0x0666
Pmid	50	8192	0x2000
Pmax	90	14746	0x399A

2.2 Pressure Output Characteristics

All NPI-19 digital pressure sensors are factory calibrated to give a defined linear change in output over a specified range of pressures. Outside this range, the output varies with pressure but with unspecified accuracy.
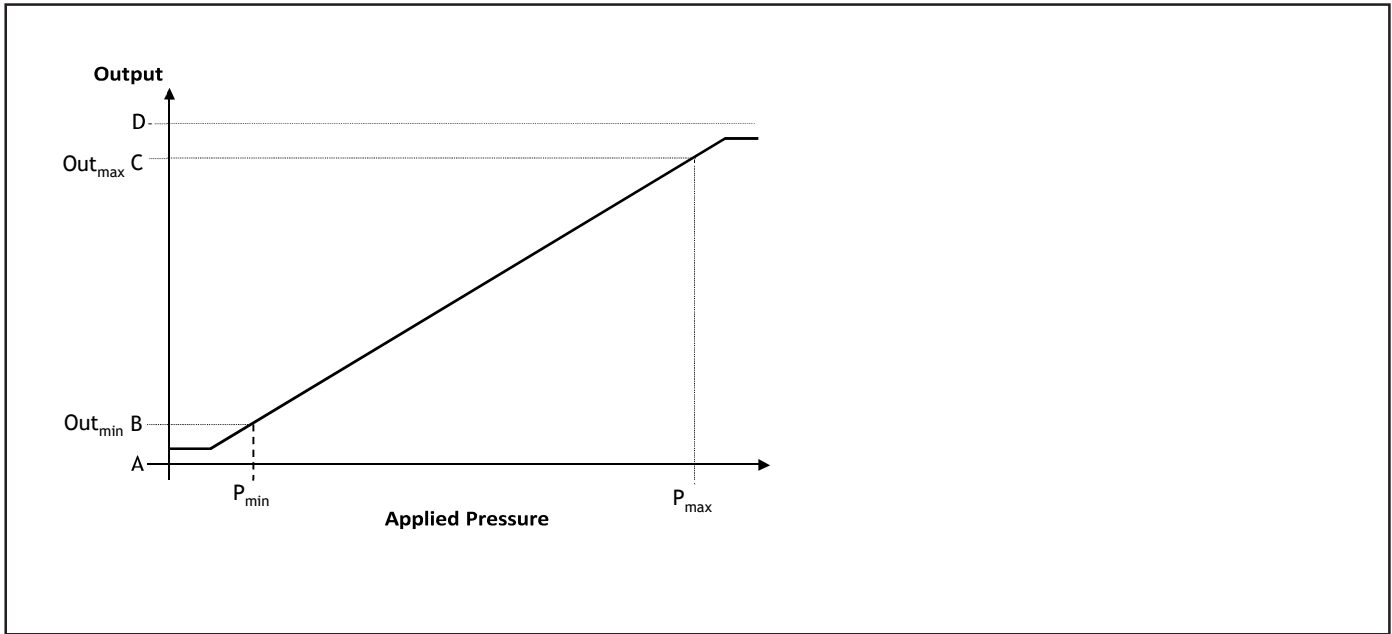

Figure 1: Output Characteristic of Calibrated Types

Pressure can be calculated from the sensor output using the following formula:

$$P = P_{min} + \left(\frac{Out - Out_{min}}{Out_{max} - Out_{min}}\right) \cdot (P_{max} - P_{min})$$

where   P = calculated pressure

                  Out = measured sensor output

2.3 Pressure Accuracy

The measurement accuracy of calibrated NPI-19 Digital pressure sensor is defined in terms of percentage of full scale (FS) over a specified compensated temperature range. Standard parts are specified to be ±1.0%. This accuracy figure is a total error band and includes all errors due to offset, span, linearity and temperature, as illustrated in Figure 2 below.
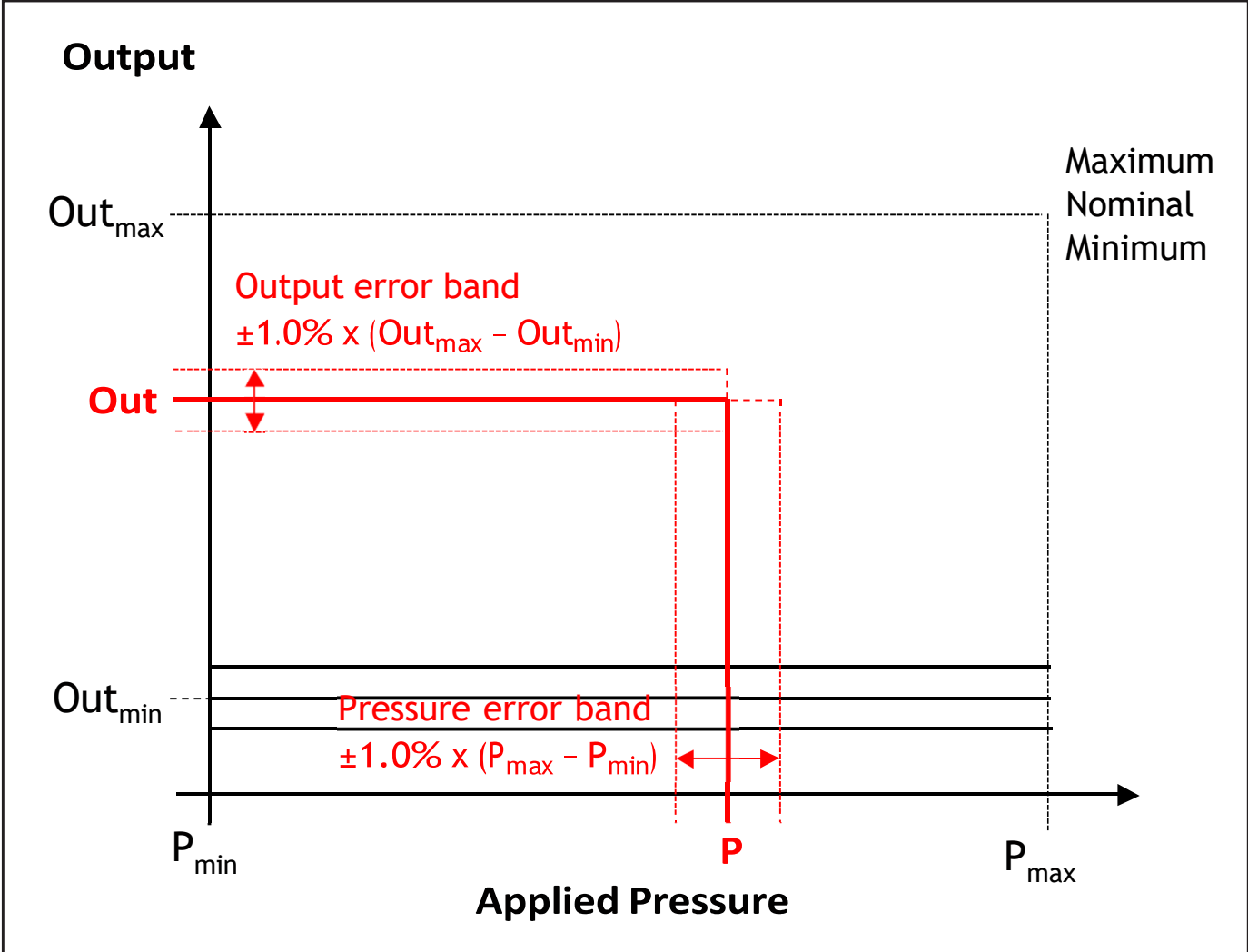

Figure 2: Accuracy of Calibrated NPI-19 Digital Pressure Sensor

3. Digital Output (I²C)

3.1 General

NPI pressure sensor provides digital output data using the industry standard I²C protocol. Bit rates up to 400 kHz are supported, compatible with the Standard-mode (Sm) and Fast-mode (Fm) standards. Devices are supplied with a slave address of 0x28 as standard.
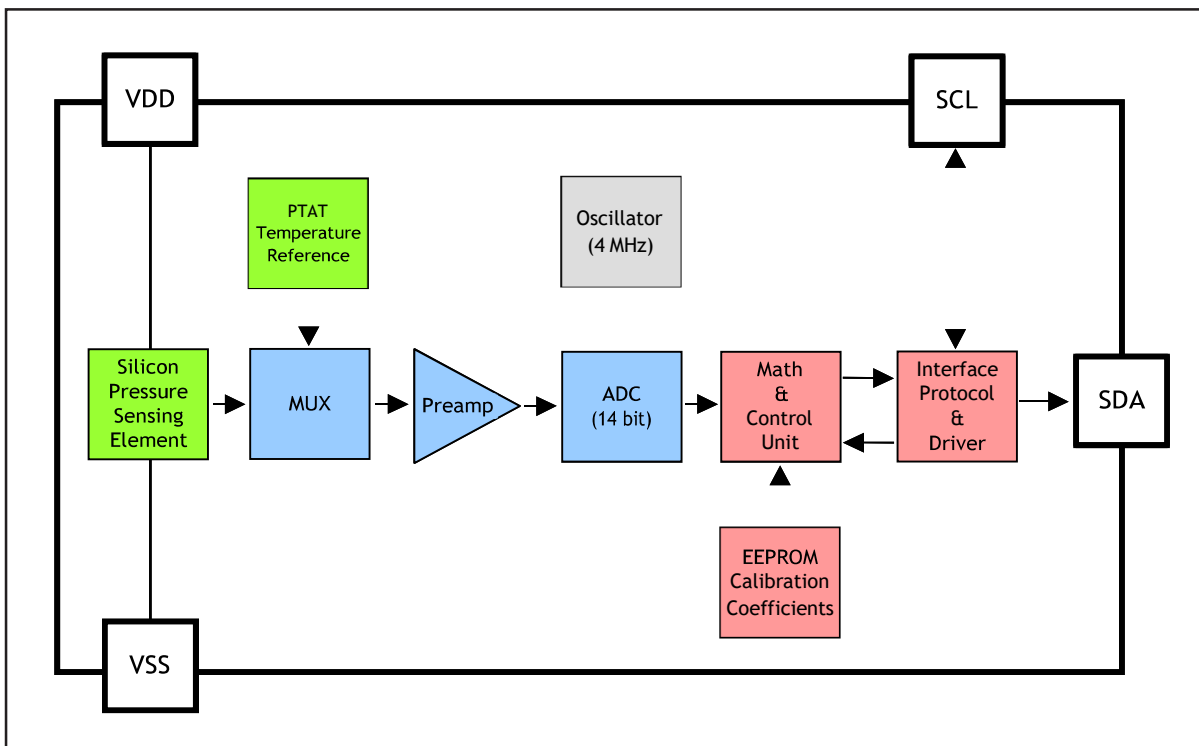
3.2 Block Diagram

Figure 3: Block Diagram of NPI pressure sensor

3.3 I²C Timing

Table 3: I²C Timing Parameters

Parameter	Symbol	Min	Max	Units
SCL clock frequency	f_{SCL}	100	400	kHz
Start condition hold time relative to SCL edge	t_{HDSTA}	0.1		µs
Minimum SCL clock low width*	t_{LOW}	0.6		µs
Minimum SCL clock high width*	t_{HIGH}	0.6		µs
Start condition setup time relative to SCL edge	t_{SUSTA}	0.1		µs
Data hold time on SDA relative to SCL edge	t_{HDDAT}	0		µs
Data setup time on SDA relative to SCL edge	t_{SUDAT}	0.1		µs
Stop condition setup time on SCL	t_{SUSTO}	0.1		µs
Bus free time between stop and start condition	t_{BUS}	2		µs

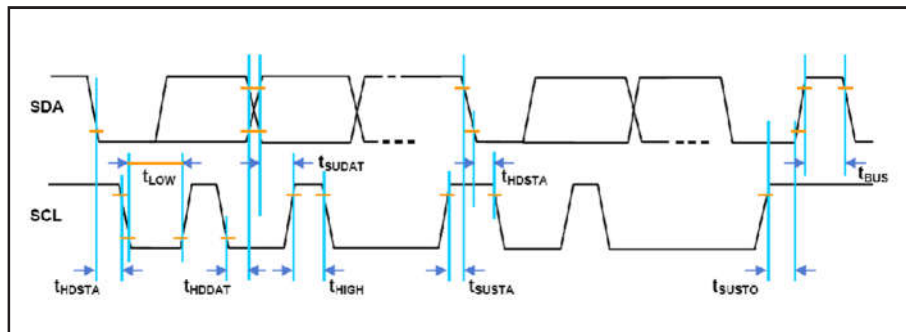** Combined low and high widths must equal or exceed minimum SCL period.*

Figure 4: I²C Timing Diagram

Two conditions can cause communication errors:

- Sending a start-stop condition without any transitions on the SCL line (no clock pulses in between) creates a communication error for the following communication, even if the next start condition is correct and the clock pulse is applied.

- Restart condition – a falling SDA edge during data transmission when the SCL line is still high will cause the next communication to fail.

In both situations, an additional start condition should be sent to restore communication.
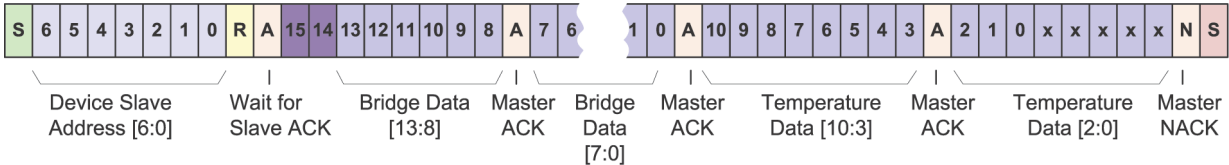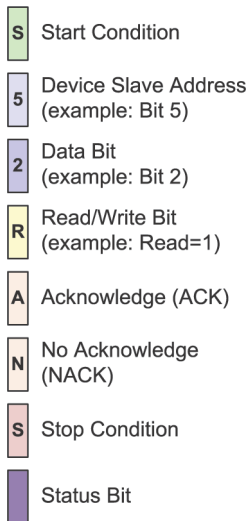
3.4 Data Read Operations

To read data from the NPI-19 digital sensor, the I^{2}C master device sends 8 bits — the 7 bit slave address (0x28 forstandard devices) and the 8th bit = 1 to designate a read request. The NPI-19 digital sensor then sends acknowledge (ACK) to indicate success.
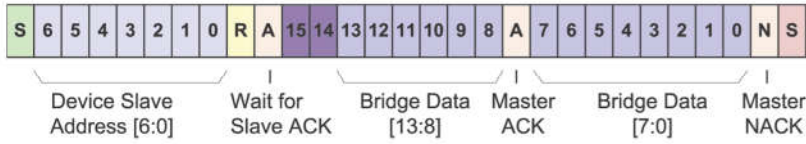
The NPI-19 digital sensor has three I^{2}C read commands:

Read_DF2: Pressure (2 bytes)
Read_DF3: Pressure (2 bytes) +
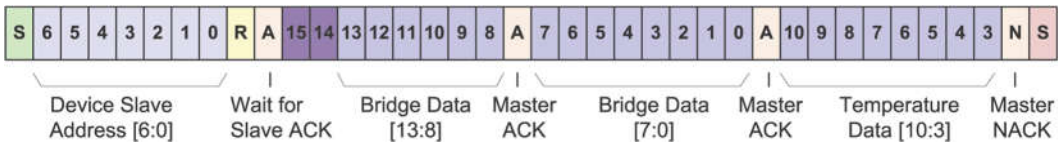Temperature (1 byte)Read_DF4:
Pressure (2 bytes) + Temperature (2
bytes)

The number of data bytes returned by the NPI-19 digital sensor is determined by when the I^{2}C master device sendsthe NACK and stop conditions as shown in Figure 5 below.

S	Start Condition
5	Device Slave Address (example: Bit 5)
2	Data Bit (example: Bit 2)
R	Read/Write Bit (example: Read=1)
A	Acknowledge (ACK)
N	No Acknowledge (NACK)
S	Stop Condition
	Status Bit

S	6	5	4	3	2	1	0	R	A	15	14	13	12	11	10	9	8	A	7	6		1	0	A	10	9	8	7	6	5	4	3	A	2	1	0	x	x	x	x	x	N	S

Device Slave Address [6:0] | Wait for Slave ACK | Bridge Data [13:8] | Master ACK | Bridge Data [7:0] | Master ACK | Temperature Data [10:3] | Master ACK | Temperature Data [2:0] | Master NACK

Read_DF2: Data Fetch 2 Bytes

Read_DF3: Data Fetch 3 Bytes

Read_DF4: Data Fetch 4 Bytes

Figure 5: I2C Data Packet Read