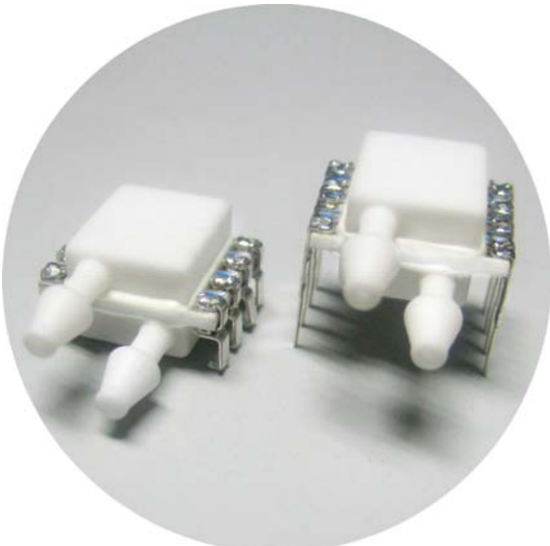
4515DO



Preliminary

- **PCB Mounted Pressure Transducers**
- **Pressure Ranges from 2 to 30inH20**
- **Ratiometric Digital Output**
- **Differential & Gage**
- **Temperature Compensated**
- **3.3V or 5.0 Vdc Supply Voltage**

DESCRIPTION

The 4515DO is a small, ceramic based, PCB mounted pressure transducer from Measurement Specialties. The transducer is built using Measurement Specialties' proprietary UltraStable™ process and the latest CMOS sensor conditioning circuitry to create a low cost, high performance Digital Output transducer designed to meet the strictest requirements from OEM customers.

The 4515DO is fully calibrated and temperature compensated with a total error band (TEB) of less than 1.0% over the compensated range. The sensor operates from single supply of either 3.3 or 5.0Vdc.

The rugged ceramic transducer is available in side port and top port version and can measure absolute or differential pressure from 0-2 to 0-30 inH20. The 1/8" barbed pressure ports mate securely with 3/32" ID tubing.

FEATURES

- PSI Pressure Ranges
- PCB Mountable
- Digital Output
- Barbed Pressure Ports

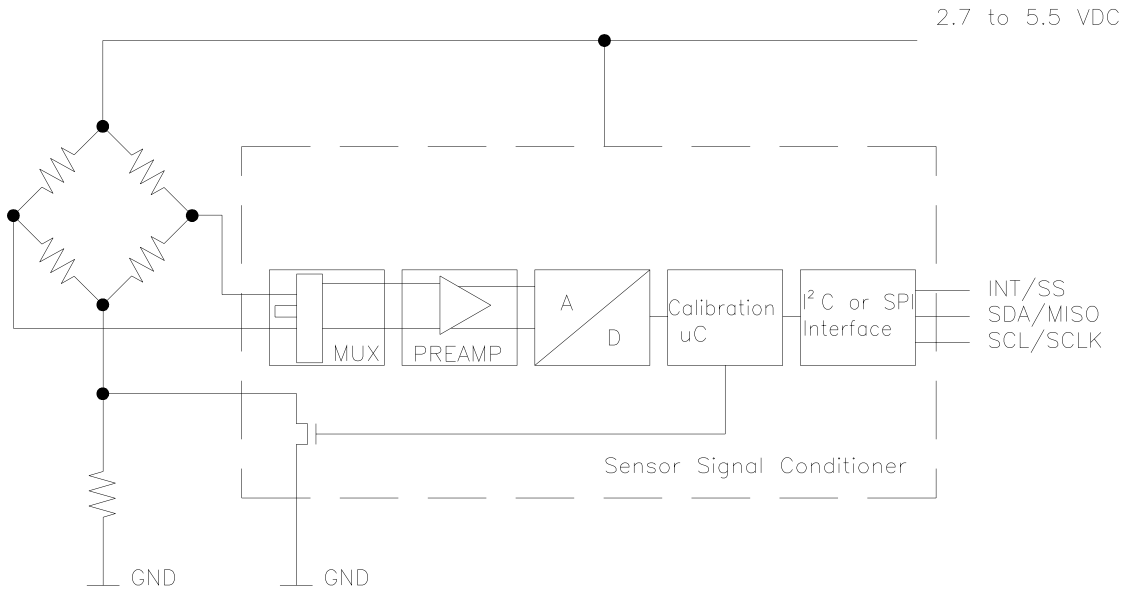
APPLICATIONS

- Blocked Filter Detection
- Altitude and Airspeed Measurements
- Medical Instruments
- Fire Suppression Systems
- Panel Meter

STANDARD RANGES

Range	Gauge	Differential
0 to 2	•	•
0 to 4	•	•
0 to 5	•	•
0 to 10	•	•
0 to 20	•	•
0 to 30	•	•

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Parameter	Conditions	Min	Max	Unit	Notes
Supply Voltage	T_A = 25 °C	2.7	5.7	V	1
Output Current	Ta = 25°C		3	mA	
Voltage on any Pin	Ta = 25°C	-0.3	Vsupply + 0.3	V	
Storage Temperature		-40	+125	°C	
Humidity	T_A = 25°C		95		Non Condensing
Overpressure	T_A = 25 °C, both Ports		100	psi	
Burst Pressure	T_A = 25 °C, Port B		3X		
ESD	HBM	-4	+4	kV	
Solder Temperature	250°C, 5 sec max.				

ENVIRONMENTAL SPECIFICATIONS

Parameter	Conditions
Mechanical Vibration	Mil Spec 202F, Method 213B, Condition C, 3 Drops
Mechanical Shock	Mil Spec 202F, Method 214A, Condition 1E, 1Hr Each Axis
Thermal Shock	100 Cycles over Operating Temperature, 30 minute dwell
Life	1 Million FS Cycles,

PERFORMANCE SPECIFICATIONS

Supply Voltage[1]: 5.00V or 3.3 Vdc
Ambient Temperature: 25°C (unless otherwise specified)

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Accuracy	-0.25		0.25	%Span	2
Total Error Band (TEB)	-1.0		1.0	%Span	3
Quiescent Current		3		mA	
Compensated Temperature	0		+60	ºC	
Operating Temperature	-10		+85	ºC	
Output Resolution	12			bits	
Response Time		1.5		mS	4
Start Time to Data Ready		4.3		mS	4
Weight		3		grams	
Media	Non-Corrosive Dry Gases Compatible with Silicon, Pyrex, RTV, Gold, Ceramic, Nickel, and Aluminum				

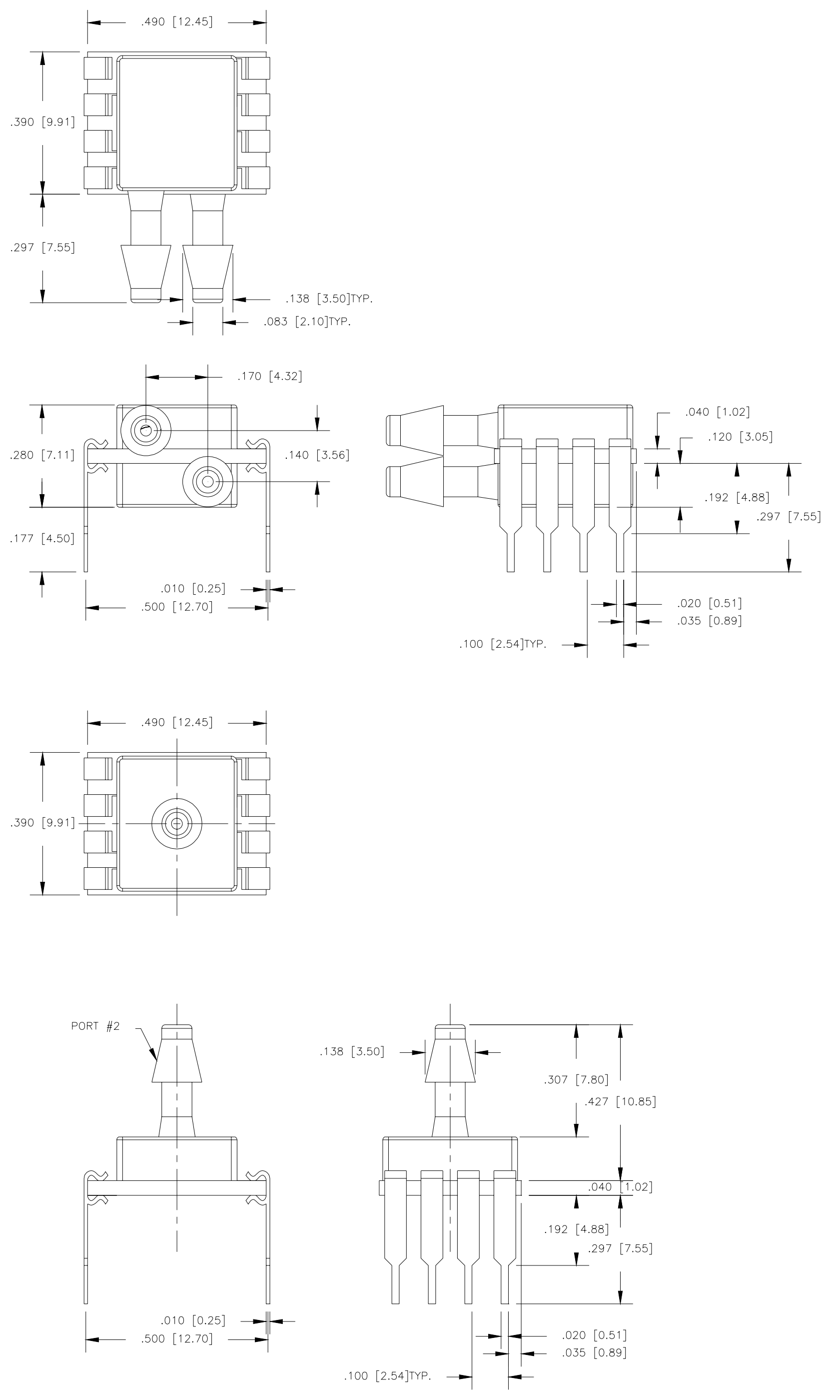
Notes

1. Output is ratiometric to supply voltage.
2. Accuracy: The maximum deviation from a best fit straight line (BFSL) fitted to the output measured over the pressure range at 25C. Includes all errors due to pressure non linearity, hysteresis, and non repeatability.
3. Total error band includes all accuracy errors, thermal errors over the compensated temperature range and span and offset calibration tolerances.
4. This product can be configured for custom OEM requirements, contact factory for lower power consumption or higher accuracy.

DIMENSIONS

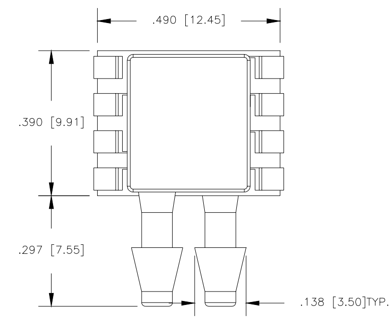
MODEL 4515DO-PSVOI-XXXYP (with through hole pins)

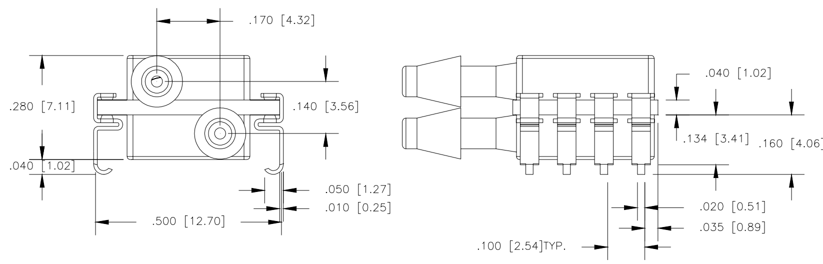
DIMENSIONS ARE IN INCHES [mm]

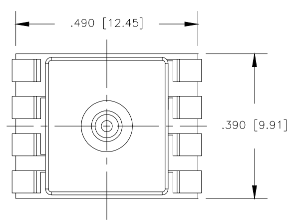


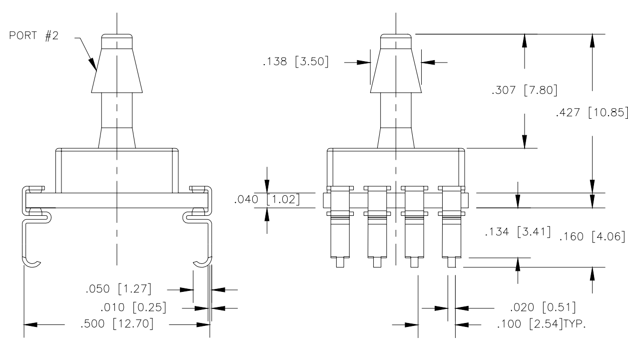
MODEL 4515DO-PSV0I-XXXYS (with J lead pins)

DIMENSIONS ARE IN INCHES [mm]

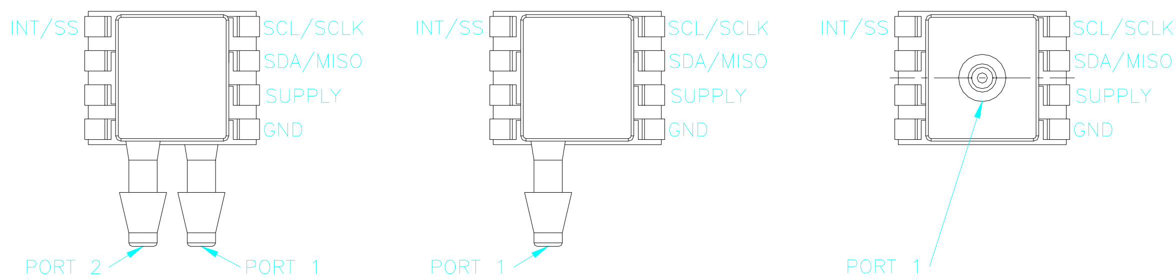








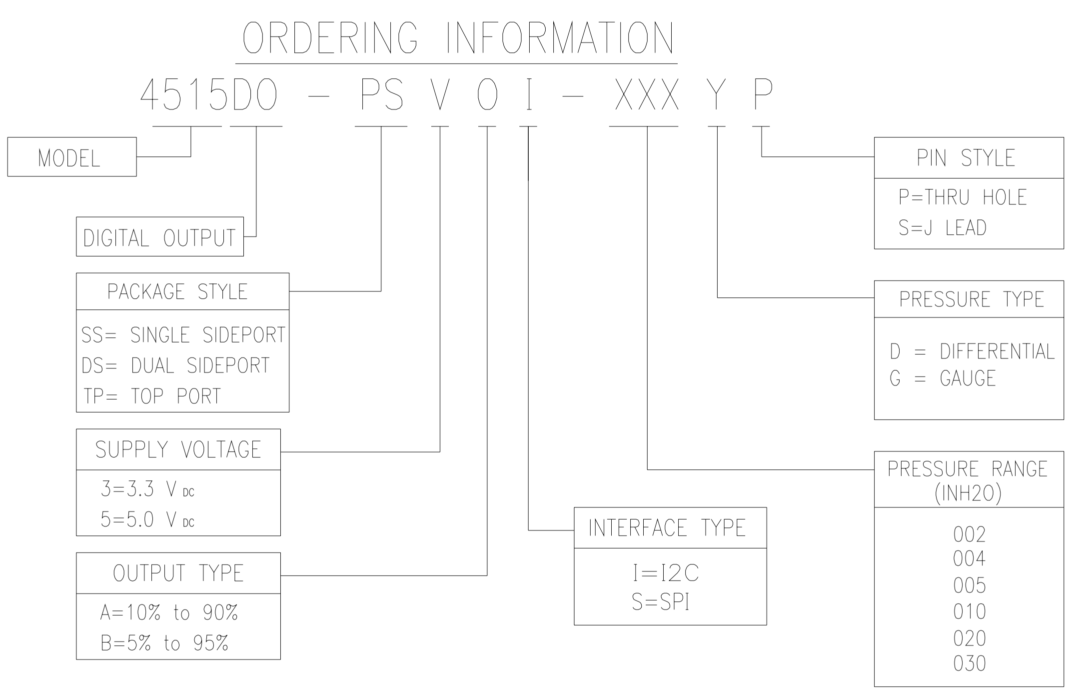
PIN CONFIGURATION



Model 4515DO–DSVOI–XXXYP   Model 4515DO–SSVOI–XXXYP   Model 45 15DO–TPVOI–XXXYP

Pin Name	Pin	Function
GND	1	Ground
SUPPLY	2	Positive Supply Voltage
SDA/MISO	3	I2C Data/SPI Data
SCL/SCLK	4	I2C Clock/SPI Clock
INT/SS	5	I2C Interrupt/SPI Chip Selection

ORDERING INFORMATION



Pressure Type	Description
Differential	Output is 50% of supply voltage when Port 1=Port 2. Output swings positive when Port 1> Port 2
Gauge	Output is proportional to difference between ambient pressure and Port 1. Output swings positive when Port 1> Port 2

I2C AND SPI INTERFACE SPECIFICATIONS

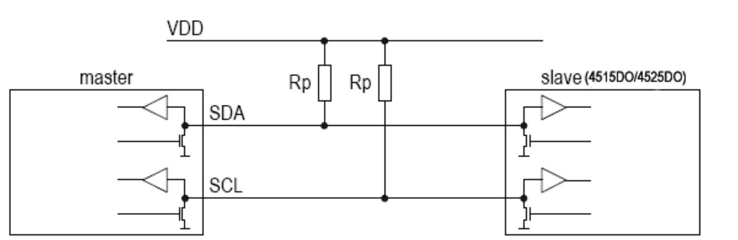
1. I2C interface Specification

The serial interface of the 4515DO/4525DO series is optimized in terms of sensor readout and power consumption when the factory setting for I2C. For detailed specifications of the I2C protocol, see The I2C Bus Specification, Version 2.1, January 2000.

1.1 Interface connection-external

Bi-directional bus lines are implemented by the devices (master and slave) using open-drain output stages and a pull-up resistor connected to the positive supply voltage. The recommended pull-up resistor value depends on the system setup (capacitance of the circuit or cable and bus clock frequency). In most cases, 1 kΩ is a reasonable choice. The capacitive loads on SDA and SCL line have to be the same. It is important to avoid asymmetric capacitive loads.

I²C Transmission Start Condition



Both bus lines, SDA and SCL, are bi-directional and therefore require an external pull-up resistor

1.2 I2C Address

The I2C address consists of a 7-digit binary value. The factory setting for I2C slave address is 0x28. The address is always followed by a write bit (0) or read bit (1).The default hexadecimal I2C header for read access to the sensor is therefore 0x51.

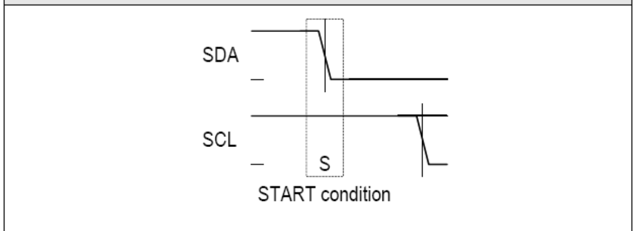
1.3 INT/SS pin

When programmed as an I2C device, the INT/SS pin operates as an interrupt. The INT/SS pin rises when new output data is ready and falls when the next I2C communication occurs. It is most useful if the part is configured in Sleep Mode to indicate to the system that a new conversion is ready.

1.4 Transfer sequences

Transmission START Condition (S): The START condition is a unique situation on the bus created by the master, indicating to the slaves the beginning of a transmission sequence (the bus is considered busy after a START).

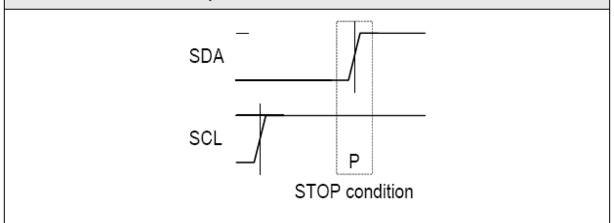
I²C Transmission Start Condition



A HIGH to LOW transition on the SDA line while SCL is HIGH

Transmission STOP Condition (P): The STOP condition is a unique situation on the bus created by the master, indicating to the slaves the end of a transmission sequence (the bus is considered free after a STOP).

I²C Transmission Stop Condition

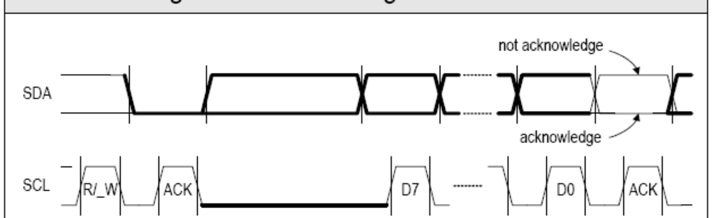


A LOW to HIGH transition on the SDA line while SCL is HIGH.

Acknowledge (ACK) / Not Acknowledge (NACK): Each byte (8 bits) transmitted over the I2C bus is followed by an acknowledge condition from the receiver. This means that after the master pulls SCL low to complete the transmission of the 8th bit, SDA will be pulled low by the receiver during the 9th bit time. If after transmission of the 8th bit the receiver does not pull the SDA line low, this is considered to be a NACK condition.

If an ACK is missing during a slave to master transmission, the slave aborts the transmission and goes into idle mode.

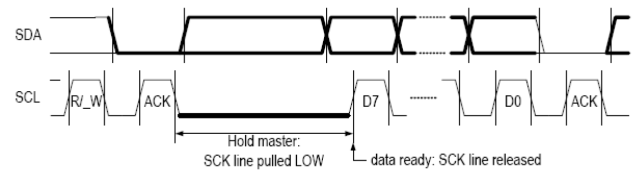
I²C Acknowledge / Not Acknowledge



Each byte is followed by an acknowledge or a not acknowledge, generated by the receiver

Handshake procedure (Hold Master): In a master-slave system, the master dictates when the slaves will receive or transmit data. However, in some situations a slave device may need time to store received data or prepare data to be transmitted. Therefore, a handshake procedure is required to allow the slave to indicate termination of internal processing

I^{2}C Hold Master



After the SCL pulse for the acknowledge signal, the SDP600 series sensor (slave) can pull down the SCL line to force the master into a wait state. By releasing the SCL line, the sensor indicates that its internal processing is completed and transmission can resume. (The bold lines indicate that the sensor controls the SDA/SCL lines.)

1.5 Data transfer format

Data is transferred in byte packets in the I2C protocol, which means in 8-bit frames. Each byte is followed by an acknowledge bit. Data is transferred with the most significant bit (MSB) first.

A data transfer sequence is initiated by the master generating the Start condition (S) and sending a header byte. The I2C header consists of the 7-bit I2C device address and the data direction bit (R/_W).

The value of the R/_W bit in the header determines the data direction for the rest of the data transfer sequence. If R/_W = 0 (WRITE) the direction remains master-to-slave, while if R/_W = 1 (READ) the direction changes to slave-to-master after the header byte.

1.6 Command Set and data Transfer Sequences

The I2C master command starts with the 7bit slave address with the 8th bit =1 (READ).The sensor as the slave sends an acknowledge (ACK) indicating success. The sensor has four I2C read commands: Read_MR, Read_DF2, Read_DF3, and Read_DF4.Figure 1.6 shows the structure of the measurement packet for three of the four I2C read commands, which are explained in sections 1.6.1 and 1.6.2

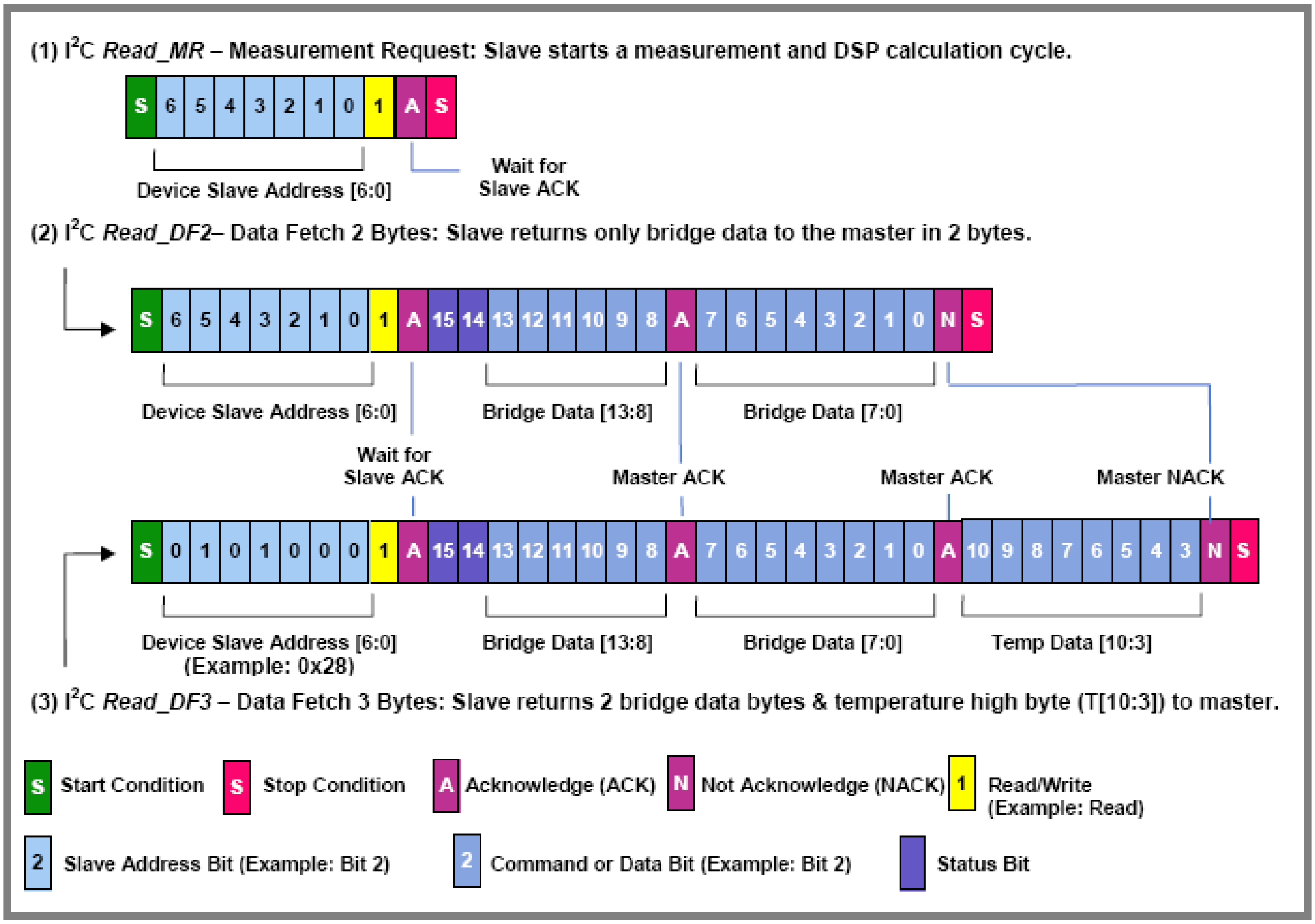


Figure 1.6 – I2C Measurement Packet Reads

1.6.1 I2C Read_MR (Measurement Request)

The Read_MR (see example 1 in Figure 1.6) communication contains only the slave address and the READ bit(1) sent by the master. After the sensor responds with the slave ACK, the master must create a stop condition. This is only used in Sleep Mode (see section 3.1.2) to wake up the device and start a complete measurement cycle (including the special measurements) followed by the DSP calculations and writing the results to the digital output register.

Note: The I2C Read_MR function can also be accomplished using the I2C Read_DF2 or Read_DF3 command and ignoring the “stale” data that will be returned.

1.6.2 I2C Read_DF (Data Fetch)

For Data Fetch commands, the number of data bytes returned by the RBiciLite™ is determined by when the master sends the NACK and stop condition. For the Read_DF3 data fetch command (Data Fetch 3 Bytes; see example 3 in Figure 1.6), the sensor returns three bytes in response to the master sending the slave address and the READ bit (1): two bytes of bridge data with the two status bits as the MSBs and then 1 byte of temperature data (8-bit accuracy). After receiving the required number of data bytes, the master sends the NACK and stop condition to terminate the read operation. For the Read_DF4 command, the master delays sending the NACK and continues reading an additional final byte to acquire the full corrected 11-bit temperature measurement. In this case, the last 5 bits of the final byte of the packet are undetermined and should be masked off in the application. The Read_DF2 command is used if corrected temperature is not required. The master terminates the READ operation after the two bytes of bridge data (see example 2 in Figure 1.6).

2. SPI interface Specification

The SPI interface of sensor can be programmed for falling-edge MISO change or rising-edge MISO change.
2.1 SPI Read_MR (Measurement Request) A special SPI Read_MR command is used for waking up the part in Sleep Mode. It performs a measurement cycle including the special measurements and a correction calculation. The SPI Read_MR command only requires that the SS line be dropped low for a minimum of 8μs then raised high again. The riseof SS will trigger the part to power up and perform the measurements.

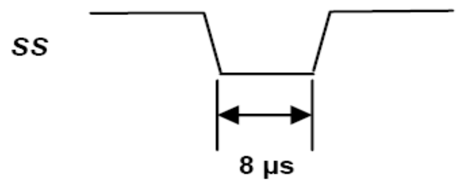
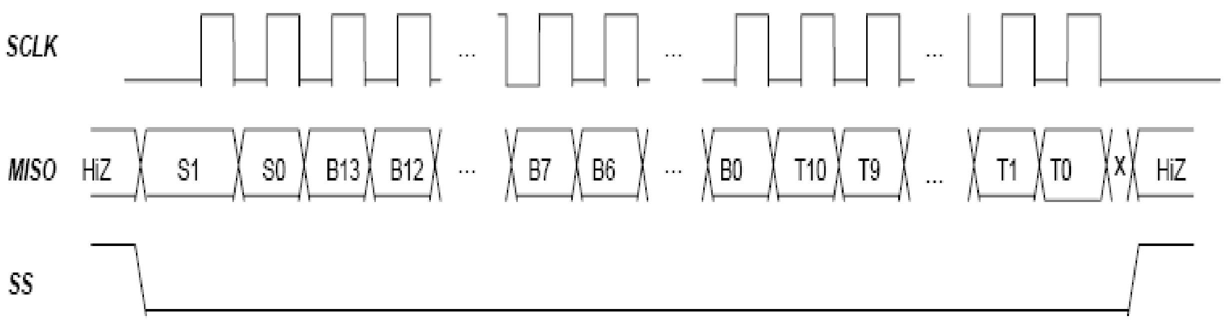


Figure 2.1– SPI Read_MR

Note: The SPI Read_MR function can also be accomplished using the SPI Read_DF command and ignoring the "stale" data that will be returned.

2.2 SPI Read_DF (Data Fetch)

For simplifying explanations and illustrations, only falling edge SPI polarity will be discussed in the following sections. The SPI interface will have data change after the falling edge of SCLK. The master should sample MISO on the rise of SCLK. The entire output packet is 4 bytes (32 bits). The high bridge data byte comes first, followed by the low bridge data byte. Then 11 bits of corrected temperature (T[10:0]) are sent: first the T[10:3]byte and then the {T[2:0],xxxxx} byte. The last 5 bits of the final byte are undetermined and should be masked off in the application. If the user only requires the corrected bridge value, the read can be terminated after the 2nd byte. If the corrected temperature is also required but only at an 8-bit resolution, the read can be terminated after the 3rd byte is read.



Packet = [{S(1:0),B(13:8)}, {B(7:0)}, {T(10:3)},{T(2:0),xxxxx}] Where
S(1:0) = Status bits of packet (normal, command, busy, diagnostic)
B(13:8) = Upper 6 bits of 14-bit bridge data.
B(7:0) = Lower 8 bits of 14-bit bridge data.
T(10:3) = Corrected temperature data (if application does not require corrected temperature, terminate read early)
T(2:0),xxxxx =. Remaining bits of corrected temperature data for full 11-bit resolution
HiZ = High impedance

Figure 2.2 – SPI Output Packet with Falling Edge SPI_Polarity

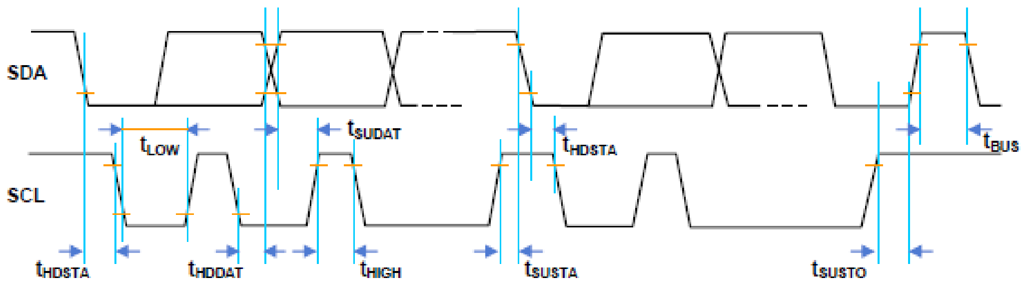
TIMING DIAGRAM

I2C INTERFACE PRRAMETERS

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 Timing Diagram



SPI INTERFACE PRRAMETERS

PARAMETERS	SYMBOL	MIN	TYP	MAX	UNITS
SCLK CLOCK FREQUENCY(4MHz CLOCK)	FSCL	50		800	KHz
SCLK CLOCK FREQUENCY(1MHz CLOCK)	FSCL	50		200	KHz
SS DROP TO FIRST CLOCK EDGE	tHDSS	2.5			uS
MINIMUM SCL CLOCK LOW WIDTH @2	tLOW	0.6			uS
MINIMUM SCL CLOCK HIGH WIDTH @2	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

@2 COMBINED LOW AND HIGH WIDTHS MUST EQUAL OR EXCEED MINIMUM SCLK PERIOD.

SPI Timing Diagram