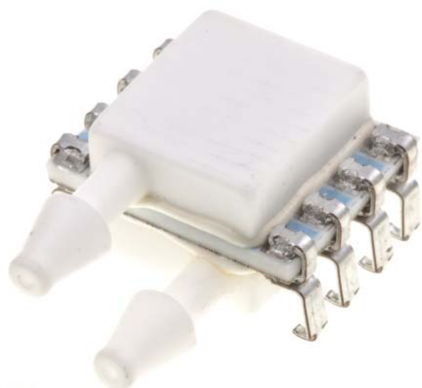
measurement SPECIALTIES™

MS4525DO



- **PCB Mounted Digital Output Transducer**
- **Combination Temperature and Pressure**
- **I^2C or SPI Protocol**
- **Differential, Gage, Absolute & Compound**
- **Temperature Compensated**
- **3.3 or 5.0 Vdc Supply Voltage**
- **Low Power Option Available (standby < 1uA)**

RoHS

DESCRIPTION

The MS4525DO 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 Pressure (14bit) and Temperature (11bit) transducer designed to meet the strictest requirements from OEM customers.

The MS4525DO is fully calibrated and temperature compensated with a total error band (TEB) of less than 1.0% over the compensated pressure range. The sensor operates from single supply of either 3.3 or 5.0Vdc and requires a single external component for proper operation.

The rugged ceramic transducer is available in side port, top port, and manifold mount and can measure absolute, gauge, differential or compound pressure from 1 to 150psi. 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

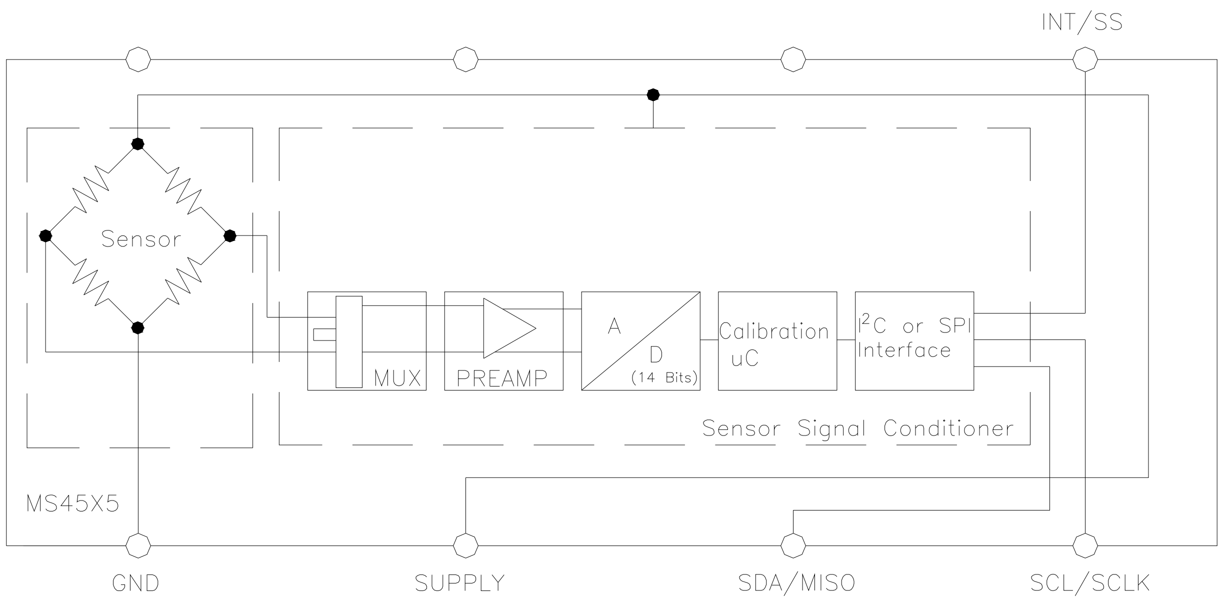
- Factory Automation
- Altitude and Airspeed Measurements
- Medical Instruments
- Leak Detection

STANDARD RANGE (PSI)

Pressure	Absolute	Gauge	Differential	Compound
1		DS, SS, TP, MM	DS, SS,TP, MM	
2		DS, SS, TP, MM	DS, SS,TP, MM	
5		DS, SS, TP, MM	DS, SS,TP ,MM	
15	SS, TP	DS, SS, TP, MM	DS, MM	SS, TP
30	SS, TP	DS, SS, TP, MM	DS, MM	SS, TP
50	SS, TP	DS, SS, TP, MM	DS, MM	SS, TP
100	SS, TP	DS, SS, TP, MM	DS, MM	SS, TP
150	SS, TP	DS, SS, TP, MM	DS, MM	SS, TP

See Package Configurations: DS= Dual Side Port, SS= Single Side Port, TP= Top Port, MM= Manifold Mount
Only I^2C Protocol is Available on "L" type Pin Styles; Reference Ordering Information for Details
Pin Style "L" is only available SS and MM port types.

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Parameter	Conditions	Min	Max	Unit	Notes
Supply Voltage	T_A = 25 °C	2.7	5.5	V	
Output Current	T_A = 25°C		3	mA	
Load Resistance (R_L)	T_A = 25°C	10		kΩ	
Storage Temperature		-40	+125	°C	
Humidity	T_A = 25°C		95	%RH	Non Condensing
Overpressure	T_A = 25 °C, both Ports	Not to Exceed 300		psi	
Burst Pressure	T_A = 25 °C, Port 1			psi	See Table 1
ESD	HBM	-4	+4	kV	EN 61000-4-2
Solder Temperature	250°C, 5 sec max.				

TABLE 1- BURST PRESSURE BY RANGE AND PACKAGE STYLE

Range	DS	SS, TP, MM	Unit
001	20	20	psi
002	20	20	psi
005	15	20	psi
015	45	90	psi
030	90	200	psi
050	150	300	psi
100	300	300	psi
150	300	300	psi

ENVIRONMENTAL SPECIFICATIONS

Parameter	Conditions
Mechanical Shock	Mil Spec 202F, Method 213B, Condition C, 3 Drops
Mechanical Vibration	Mil Spec 202F, Method 214A, Condition 1E, 1Hr Each Axis
Thermal Shock	100 Cycles over Storage Temperature, 30 minute dwell
Life	1 Million FS Cycles
MTTF	>10Yrs, 70 ºC, 10 Million Pressure Cycles, 120%FS Pressure

PERFORMANCE SPECIFICATIONS

Supply Voltage[1]: 5.0V or 3.3 Vdc

Reference Temperature: 25°C (unless otherwise specified)

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Pressure Accuracy	-0.25		0.25	%Span	2
Total Error Band (TEB)	-1.0		1.0	%Span	3,7
Temperature Accuracy		1.5		ºC	4
Supply Current		3		mA	7
Compensated Temperature	-10		85	ºC	5
Operating Temperature	-25		+105	ºC	
Output Pressure Resolution			14	bits	
Output Temperature Resolution	8		11	bits	
Response Time		0.5		mS	6
Start Time to Data Ready			8.4	mS	6
Weight		3		grams	
Media	Non-Corrosive Dry Gases Compatible with Ceramic, Silicon, Pyrex, PPS, RTV, Gold, Aluminum and Epoxy. See “Wetted Material by Port Designation” chart below.				

Notes

1. Proper operation requires an external capacitor placed as shown in Connection Diagram. Output is not ratiometric to supply voltage.
2. 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 pressure error band includes all accuracy errors, thermal errors over the compensated temperature range and span and offset calibration tolerances. For ideal sensor output with respect to input pressure and temperature, reference Transfer Function charts below. TEB values are valid only at the calibrated supply voltage.
4. The deviation from a best fit straight line (BFSL) fitted to the output measured over the compensated temperature range.
5. For errors beyond the compensated temperature range, see Extended Temperature Multiplier chart below.
6. Start time to data ready is the time to get valid data after POR (power on reset). The time to get subsequent valid data is then specified by the response time specification.
7. This product can be configured for custom OEM requirements, contact factory for lower power consumption or higher accuracy.

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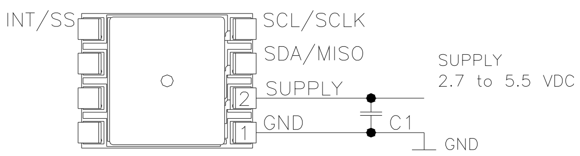
MS4525DO

CONNECTION DIAGRAM

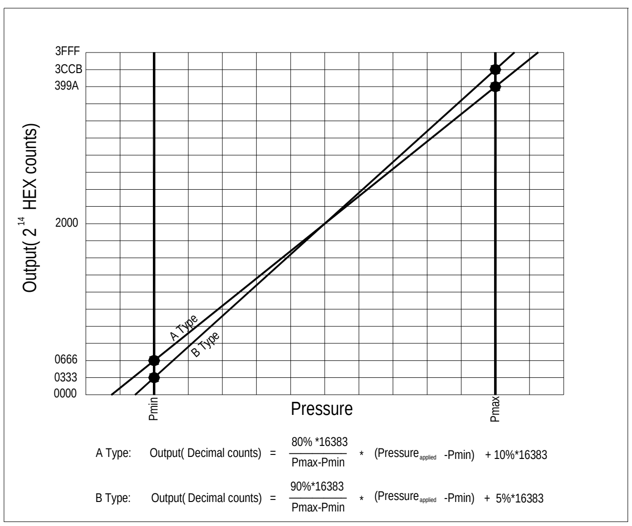


Notes

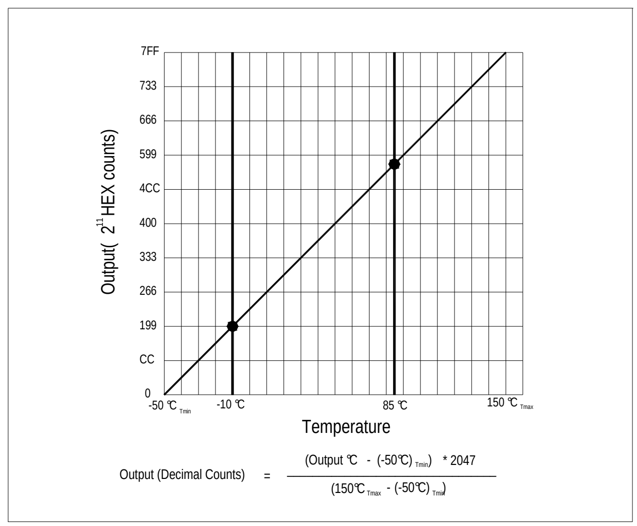
1. Place 100nF capacitor between Supply and GND to within 2 cm of sensor.

PRESSURE AND TEMPERATURE TRANSFER FUNCTION

Pressure Transfer Functions



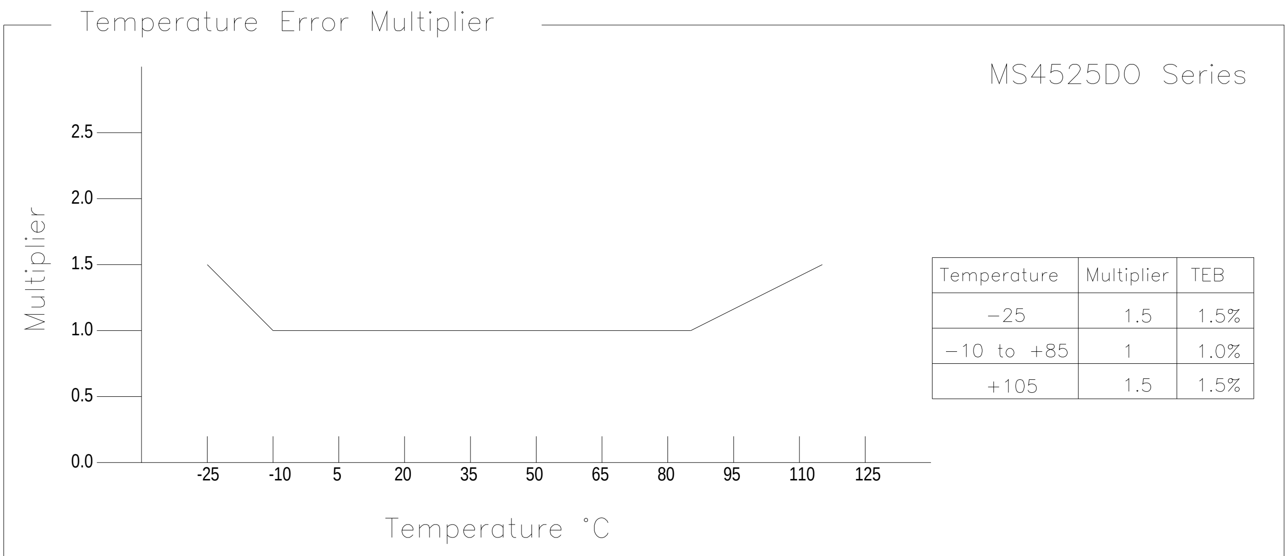
Temperature Transfer Functions



Temperature Output vs Counts

Output °C	Digital Counts (decimal)	Digital Counts (hex)
−50	0	0 X 0000
0	511	0 X 01FF
10	614	0 X 0266
25	767	0 X 02FF
50	1023	0 X 03FF
85	1381	0 X 0565
150	2047	0 X 07FF

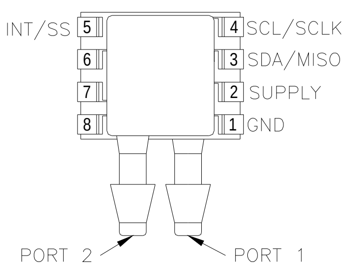
EXTENDED TEMPERATURE MULTIPLIER CHART



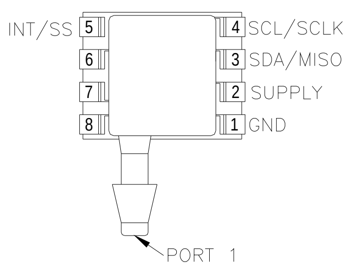
Temperature	Multiplier	TEB
−25	1.5	1.5%
−10 to +85	1	1.0%
+105	1.5	1.5%

NOTE: The Multiplier is a linear response from −10°C to −25°C and from 85°C to 105°C.

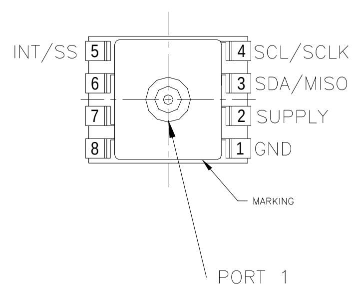
PACKAGE, PINOUT & PRESSURE TYPE CONFIGURATION



MS4525DO−DSvoixxxyP



MS4525DO−SSvoixxxyP



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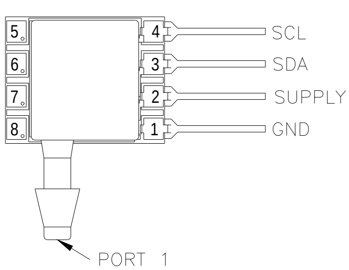
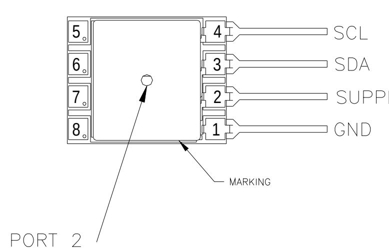
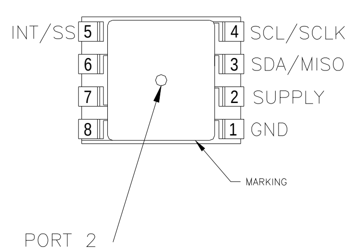


MS4525DO−SSvoixxxyL



MS4525DO −MMvoixxxyL



MS4525DO−MMvoixxxyP

MS4525DO

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 Select

Pressure Type	Pmin	Pmax	Description
Absolute	0psiA	+Prange	Output is proportional to the difference between 0psiA (Pmin) and pressure applied to Port 1.
Differential/ Bidirectional	-Prange	+Prange	Output is proportional to the difference between Port 1 and Port 2. Output swings positive when Port 1> Port 2. Output is 50% of total counts when Port 1=Port 2.
Gauge	0psiG	+Prange	Output is proportional to the difference between 0psiG (Pmin) and Port 1. Output swings positive when Port 1> Port 2.
Compound	-15psiG	+Prange	Output is proportional to the difference between -15psiG pressure (Pmin) and pressure applied to Port 1.

Prange is equal to the maximum full scale pressure specified in the ordering information.

WETTED MATERIAL BY PORT DESIGNATION

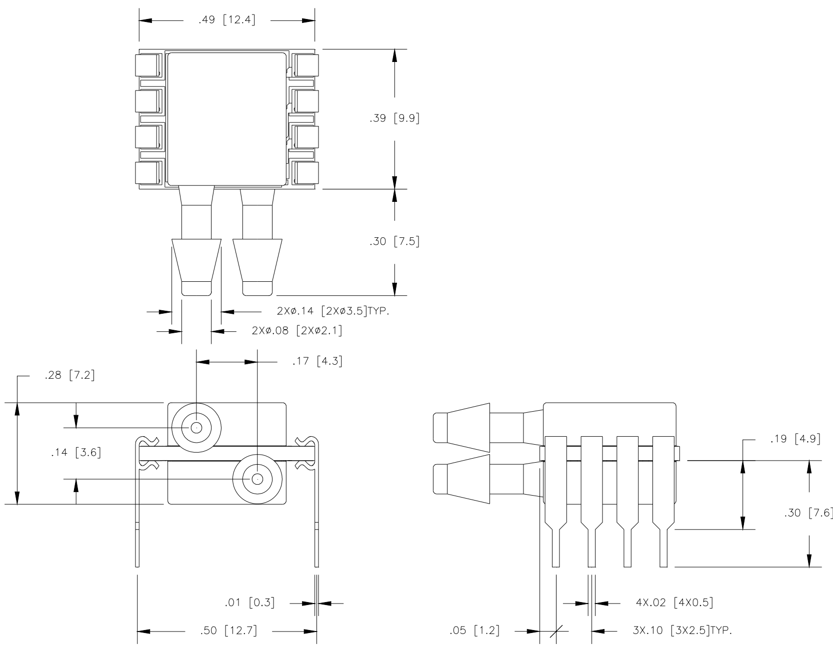
		Material							
Style	Port	PPS	Ceramic	Silicon	Pyrex	RTV	Gold	Aluminum	Epoxy
DS, MM	Port 1	X	X	X	X	X			X
	Port 2	X	X	X	X	X	X	X	X
SS, TP	Port 1	X	X	X	X	X	X	X	X

"X" Indicates Wetted Material

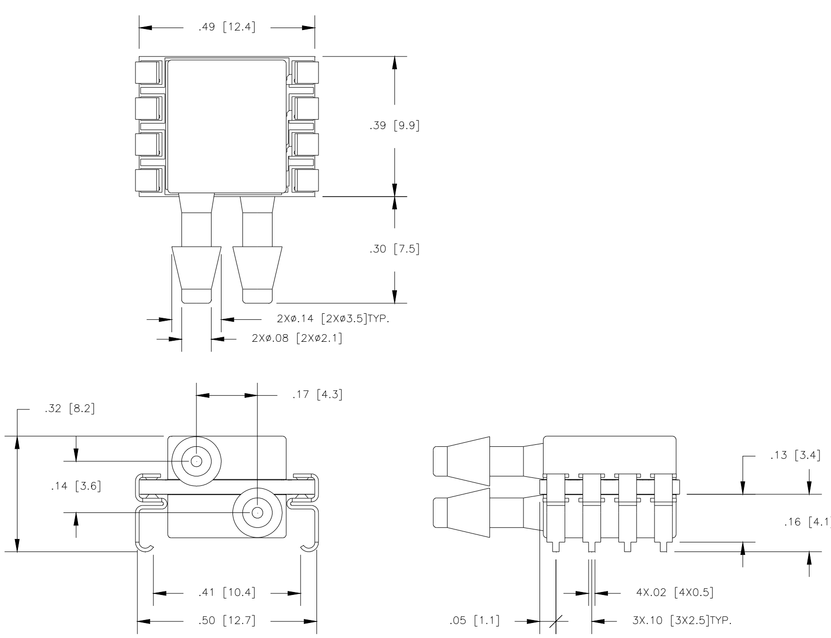
DIMENSIONS

DIMENSIONS ARE IN INCHES [mm]

Model MS4525DO−DSvoixxxyP

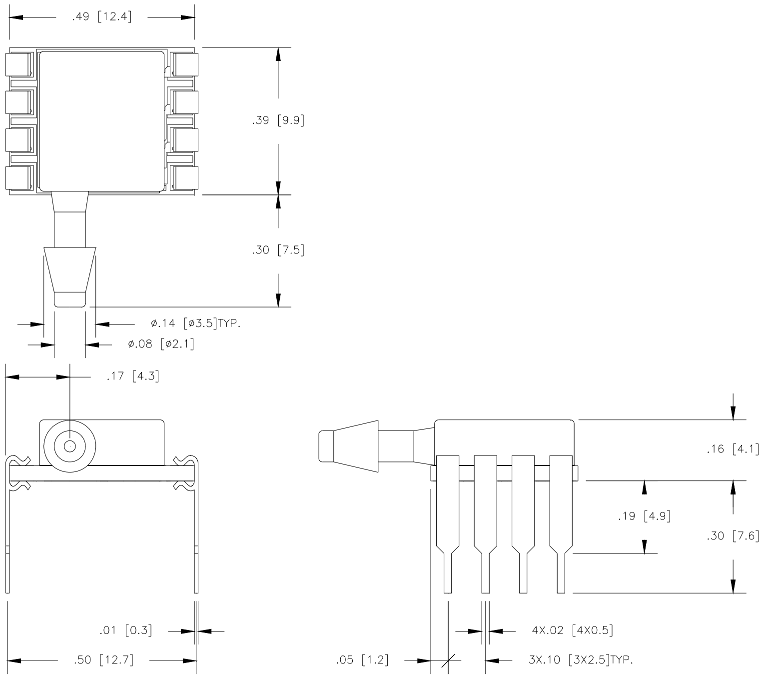


Model MS4525DO−DSvoixxxyS

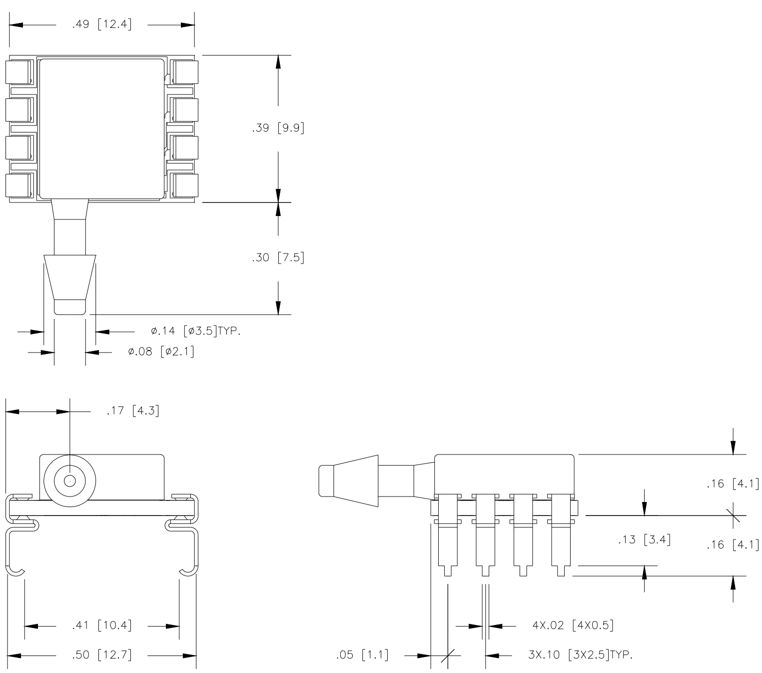


DIMENSIONS ARE IN INCHES [mm]

Model MS4525DO-SSvoixxxyP

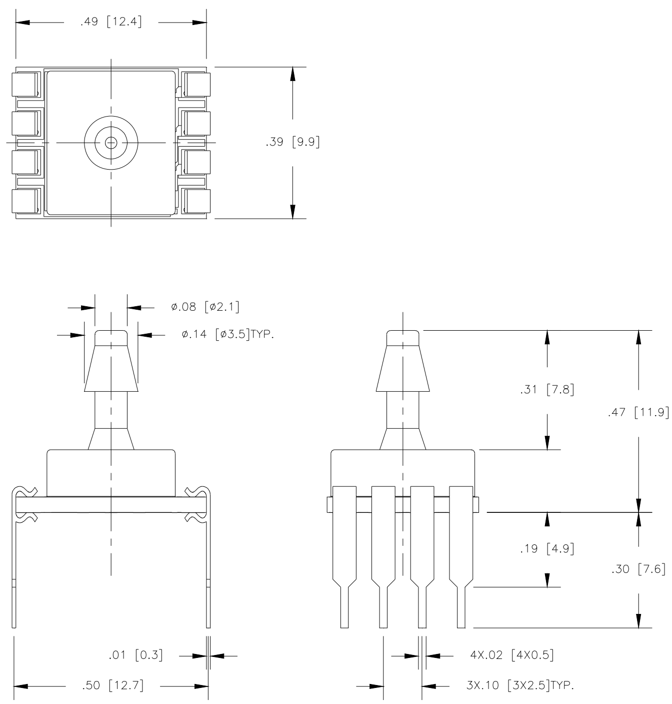


Model MS4525DO-SSvoixxxyS

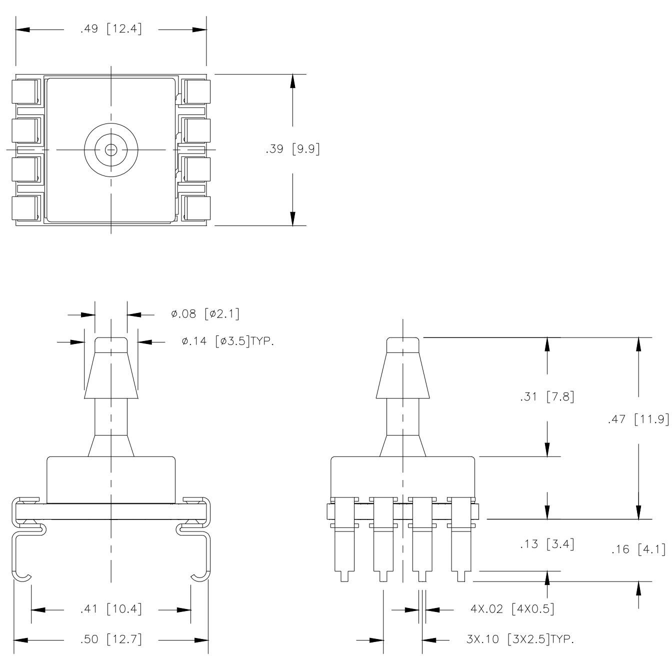


DIMENSIONS ARE IN INCHES [mm]

Model MS4525DO–TPvoixxxyP



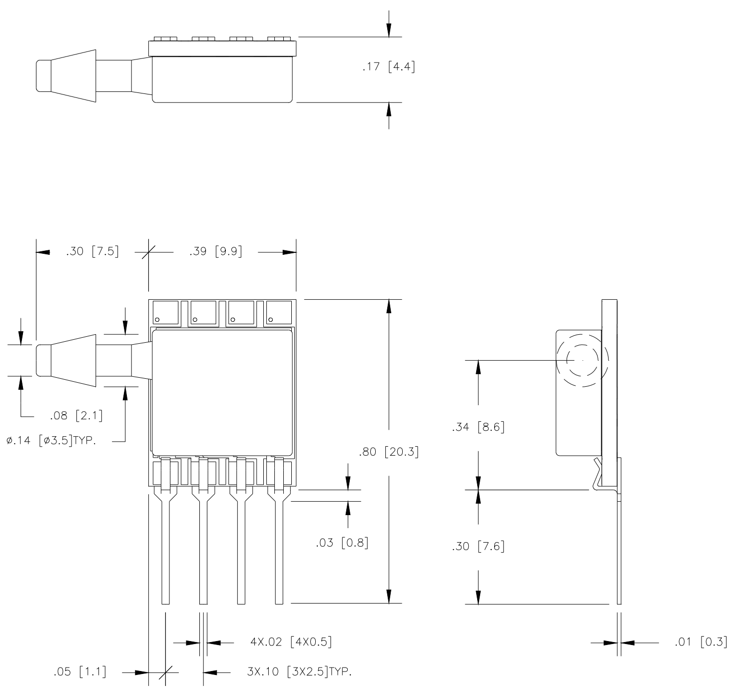
Model MS4525DO–TPvoixxxyS



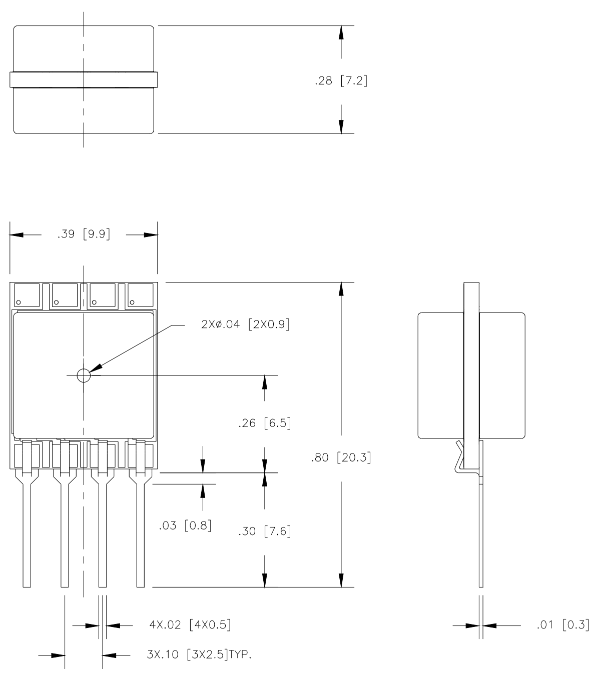
MS4525DO

DIMENSIONS ARE IN INCHES [mm]

Model MS4525DO–SSvoixxxyL

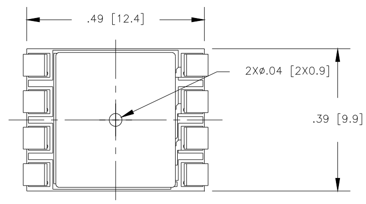


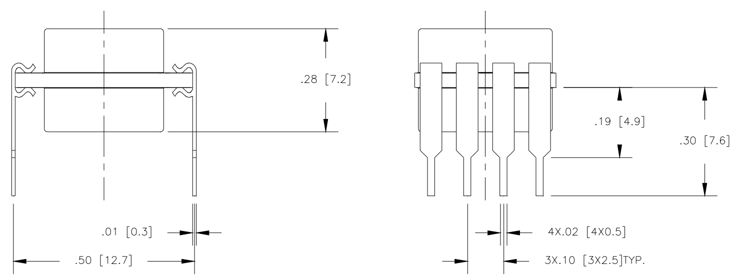
Model MS4525DO–MMvoixxxyL



DIMENSIONS ARE IN INCHES [mm]

Model MS4525DO-MMvoixxxyP





I²C AND SPI INTERFACE SPECIFICATIONS

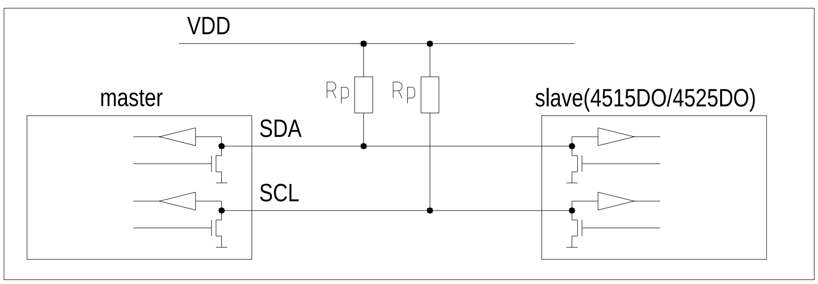
1. I²C Interface Specification

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, 4.7kΩ 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, 0x36 or 0x46 depending on the interface type selected from the ordering information. 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, 0x6D, 0x8D respectively, based on the ordering information.

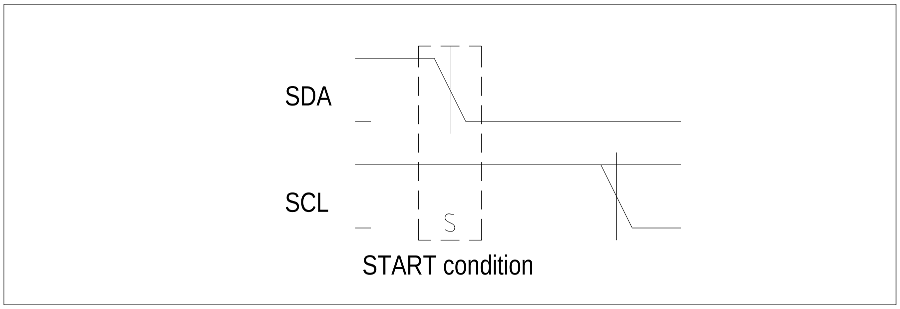
1.3 INT/SS Pin

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.

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).

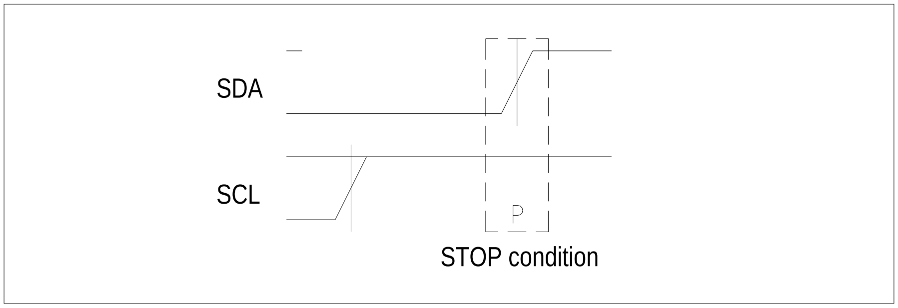
I²C Transmission start Condition



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

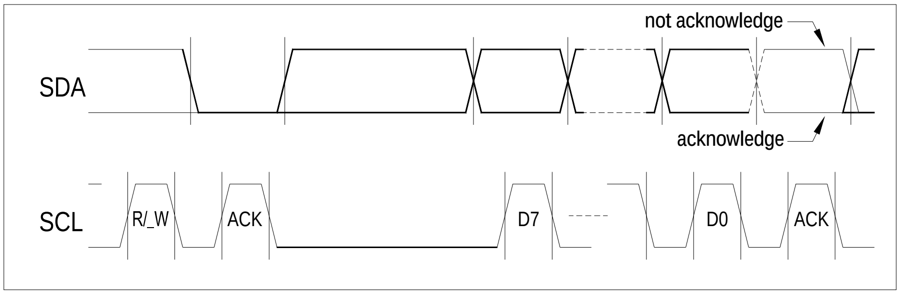


A LOW to HIGH transition on the SDA line while SCL is HIGH

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

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

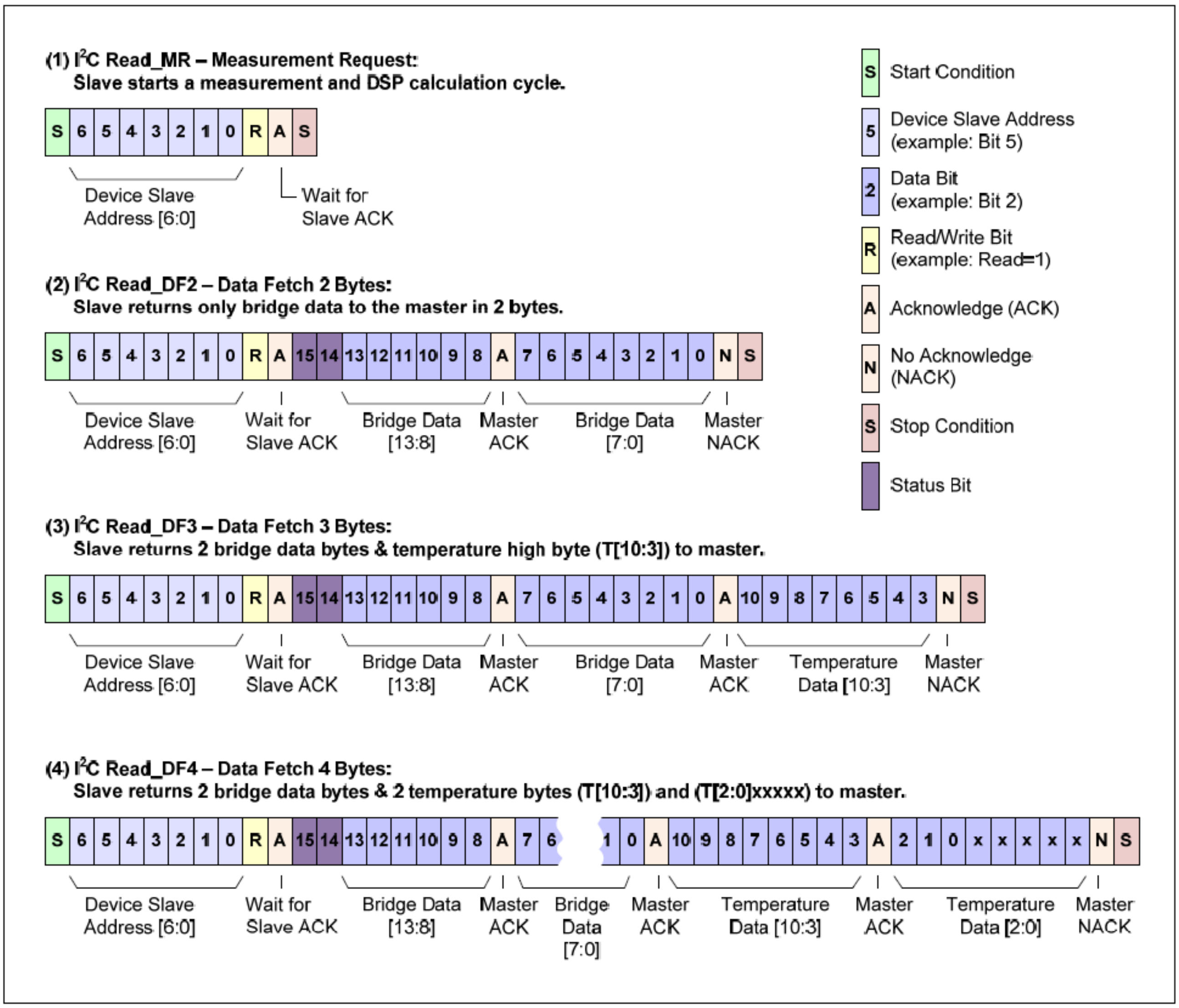


Figure 1.6 – I2C Measurement Packet Reads

1.6.1 I²C Read_DF (Data Fetch)

For Data Fetch commands, the number of data bytes returned by the sensor 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).

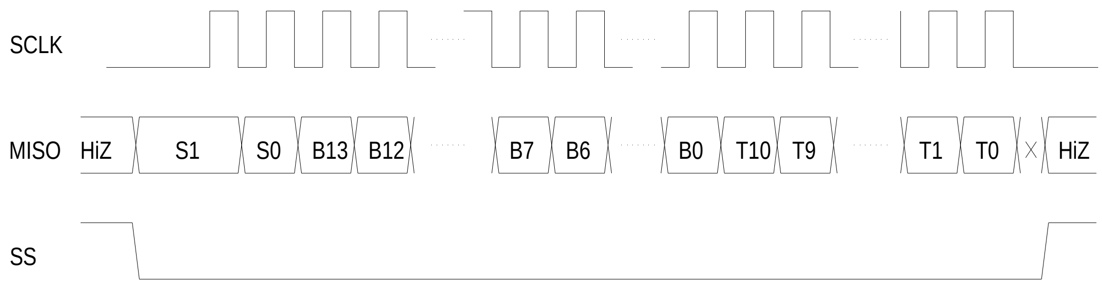
The two status bits (Bit 15 and Bit 14) give an indication of stale or valid data depending on their value. A returned value of 00 indicate “normal operation and a good data packet” while a returned value of 10 indicates “stale data that has been already fetched”. Users that use “status bit” polling should select a frequency slower than 20% more than the response time.

2. SPI Interface Specification

The SPI interface of sensor must be programmed for falling-edge MISO change.

2.1 SPI Read_DF (Data Fetch)

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

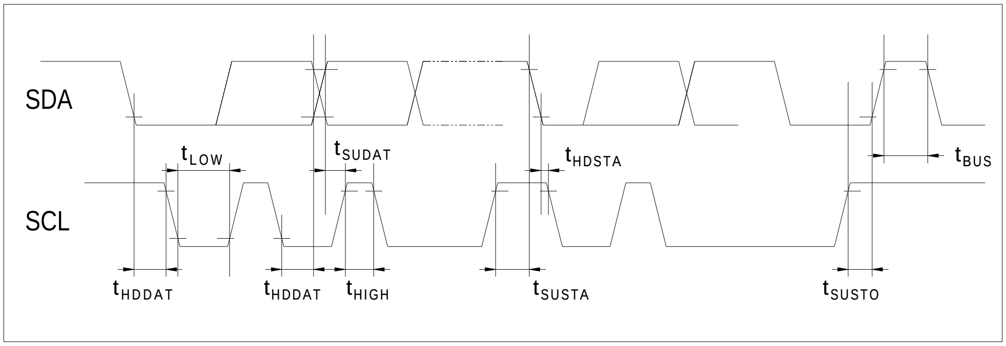
TIMING DIAGRAMS

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

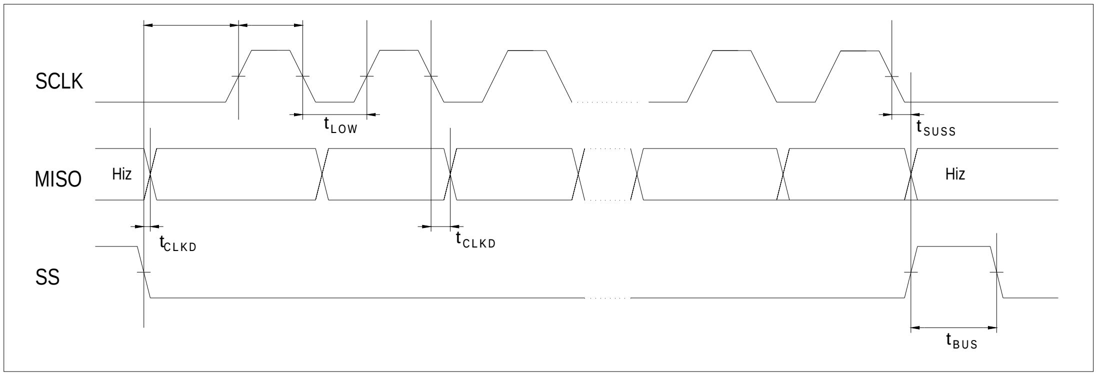


SPI INTERFACE PRRAMETERS

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

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

SPI TIMING DIAGRAM



AVAILABLE OPTIONS

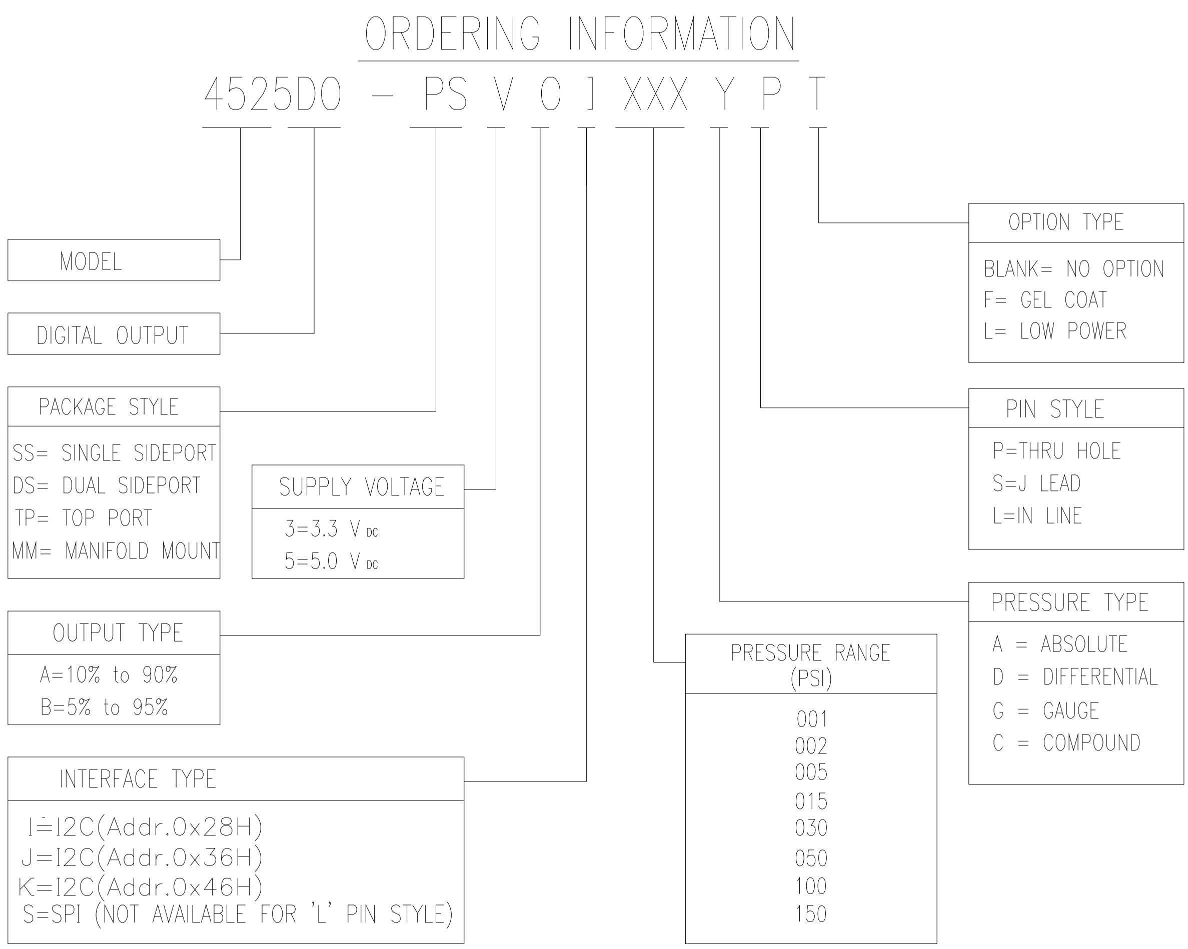
Gel Coat (-F Option)

The MS45x5 is designed for non ionic and clean dry air applications. Select this option for added protection in high humidity or slightly corrosive environments with the application of a silicone gel elastomer to sensor and ASIC. For questions concerning media compatibility, contact the factory.

Low Power (-L Option)

Select this option for battery powered or handheld device applications. In this configuration, the sensor and calibration microcontroller are powered down, drawing a current of ~ 0.6uA (Vs=5.0 Vdc). When the master sends a **Read MR** (measurement request) command (I^2C or SPI); the sensor is "awaken" and begins the measurement cycle; data is then placed onto the output registers. The sensor and calibration microcontroller are powered down again, awaiting the **Read DF** (data fetch) command from the master. Reference Figure 1.6 and Section 1.6 for command details.

ORDERING INFORMATION



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