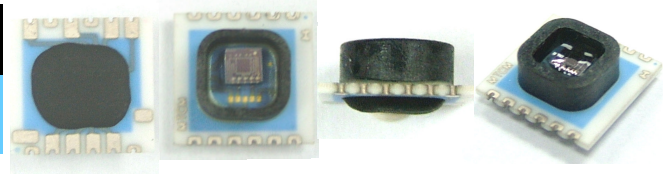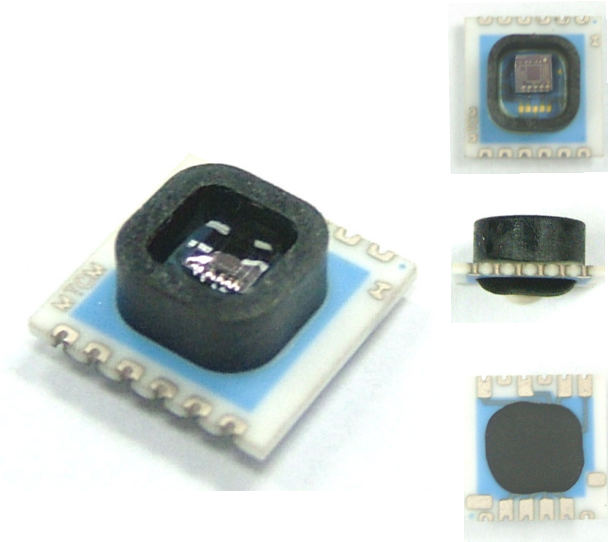# memstech

## MPS-300A

**Integrated, Absolute Pressure Sensor**

# Integrated, Absolute Pressure Sensor

The MPS-300A series pressure sensor is a hybrid device containing an absolute piezoresistive pressure sensing element and an ASIC for signal conditioning. The sensor element is fabricated using bulk micromachining technology.

The ASIC includes temperature and nonlinearity corrections as well as offset and span calibration incorporating a 16 bit digital signal path.

The device is digitally calibrated and tested over temperature to ensure that the relevant accuract and stability performance is met.

Output options include digital interfaces such as SPI and I2C as well as the traditional analogue output that can be interfaced to an external ADC.

Temperature readout is optionally available on digital SPI and I2C interface options.

## FEATURES

- Very low cost
- Excellent repeatability
- 100% factory tested and calibrated
- Stable and reliable
- High volume manufacturing

## THE MAIN FIELD OF APPLICATIONS

- ✓ Mobile altimeter/barometer
- ✓ Weather Forecast
- ✓ Wristwatch
- ✓ Air Balloon
- ✓ Blood Pressure Monitoring

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Signal Condition
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MEMSENZ™ III
Transduction Principle
Resistive
Processing Technology
Surface
Actuation Mechanism
Thermal
Signal Condition
Two chips

MEMSENZ™ IV
Transduction Principle
Capacitive
Processing Technology
Bulk
Actuation Mechanism
Sound
Signal Condition
Two chips

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## MPS-300A

### Integrated, Absolute Pressure Sensor

## TECHNICAL DATA

| Specification | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|
| Operating Temperature | -20 | - | 85 | ºC |
| Storage Temperature | -30 | - | 85 | ºC |
| Proof Pressure | - | - | 500 | kPa |
| | - | - | 5000 | hPa |
| | - | - | 75 | psi |
| Supply Voltage* | 2.7 | 3.0 | 3.3 | V |
| | 4.75 | 5.0 | 5.25 | V |

* Note: Both 3V and 5V versions are available. Product is calibrated and tested at 3V unless otherwise specified.

## BASIC PERFORMANCE

Temperature=22±2℃, Relative humidity=45±5%

| Specification | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|
| Supply Current  @ 3V | - | 3 | 4 | mA |
| Operating Temperature | -20 | - | 85 | ºC |
| Operating Pressure | 30 | - | 110 | kPaA |
| | 300 | - | 1100 | hPaA |
| | 4.35 | - | 16 | psiA |
| Warm Up Time | - | 25 | - | ms |
| Storage Temperature | -30 | - | 85 | ℃ |
| Power Supply Capacitor* | 100 | 220 | 470 | nF |

* Note: Power supply capacitor is highly recommended for noise reduction

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## MPS-300A
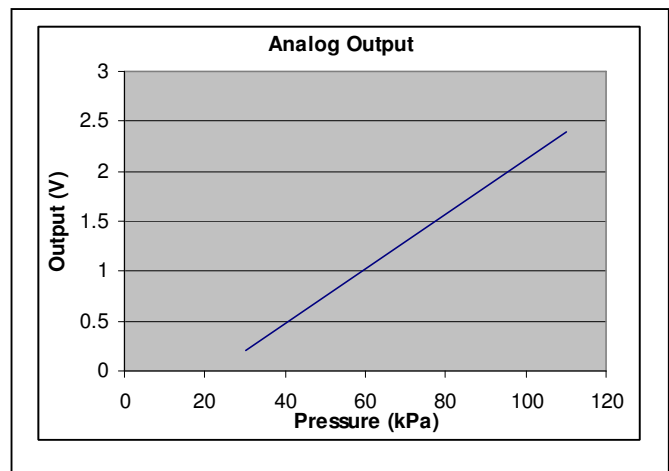
### Integrated, Absolute Pressure Sensor

### SPI / I2C OUTPUT – INTERFACE OPTIONS S & I

| Specification | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|
| SPI Clock Rate | - | - | 1 | MHz |
| Zero Pressure Output (Offset) | - | 888 | - | Hex |
| Full Scale Output | - | 6666 | - | Hex |
| Full Scale Span | - | 5DDE | - | Hex |
| Accuracy (25 ±3℃ & 75-110 kPa) | - | - | ±0.3 | %FS |
| Accuracy (0-85℃ & 75-110 kPa) | - | - | ±0.5 | %FS |
| Pressure Resolution | - | 0.02 | - | kPa |
| Sensitivity | - | 12C | - | Hex/kPa |
| | - | 1E | - | Hex/hPa |
| | - | 817 | - | Hex/psi |
| Response Time | - | 1 | 5 | ms |
| Temperature Sensing Range | -20 | - | 85 | ºC |
| Temperature Output @ 0 ºC | | 204E | | Hex |
| Temperature Output @ 85 ºC | | 7330 | | Hex |

### ANALOG OUTPUT – INTERFACE OPTION A

| Specification | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|
| Zero Pressure Output (Offset) | 0.178 | 0.200 | 0.222 | V |
| Full Scale Output | 2.378 | 2.400 | 2.422 | V |
| Full Scale Span | - | 2.20 | - | V |
| Accuracy (25±3℃ & 75-110 kPa) | - | - | ± 0.3 | %FS |
| Accuracy (0-85℃ & 75-110 kPa) | - | - | ± 0.5 | %FS |
| Pressure Resolution | - | 0.02 | - | kPa |
| Sensitivity @ 3V | - | 36.36 | - | mV/kPa |
| | - | 3.36 | - | mV/hPa |
| | - | 5.27 | - | mV/psi |

Typical sensor transfer function (Vcc=3V)

Analog Output (graph of Output (V) vs Pressure (kPa))

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Two chips

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Bulk
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Sound
Signal Condition
Two chips

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## MPS-300A

### Integrated, Absolute Pressure Sensor

## ELECTRICAL & PIN LAYOUT
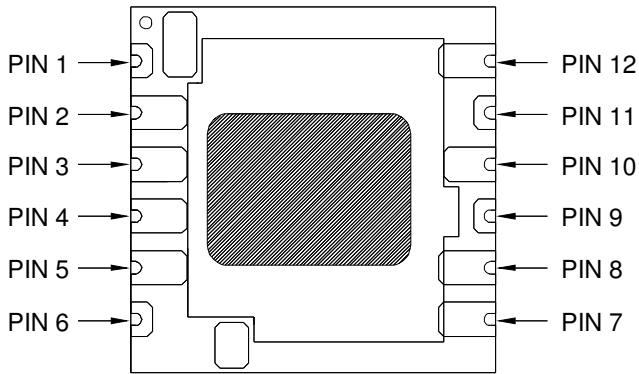


| Pad | Symbol | Description |
|-----|--------|-------------|
| 1 | NC | No Connect |
| 2 | IO1 | SPI data out (Interface Option S) |
| 3 | IO2 | SPI chip select (Interface Option S) |
| 4 | SCL | I²CLK & SPI Clock (Interface Options I & S) |
| 5 | SDA | Data I/O for I² C & data in for SPI (Interface Options I & S) |
| 6 | NC | No Connect |
| 7 | Vdd | Power Supply Positive Connection |
| 8 | Vss | Power Supply Negative Connection |
| 9 | NC | No Connect |
| 10 | OUT | Analogue output |
| 11 | NC | No Connect |
| 12 | Vss | Power Supply Negative Connection |

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## MPS-300A

### Integrated, Absolute Pressure Sensor

## SPECIFICATION NOTES

1. Operating and storage temperature to strictly not exceed stated values.
2. Pressure unit conversion --- 1 atm=101.325 kPa=1013.25 hPa=14.504 psi.
3. Operating pressure and temperature. The nominal pressure under which the device can be exposed under normal operating conditions. Unless explicitly stated, other specifications are rated over the operating pressure and temperature ranges.
4. Proof pressure and temperature. The extremes of temperature and pressure that the device can withstand without performance degradation.
5. Supply Voltage is the nominal operating voltage. The device output is ratio metric (scales with the supply) within the stated range.
6. Stated Warm up time is a recommended time after power up before measurement stability is reached within the rated accuracy range.
7. All outputs are measured with a nominal 4.7k load on the output pin, and with the power supply decoupled by 16uF electrolytic / 0.1uF ceramic capacitor pair, with an applied power supply within 5mV of the nominal value at temperature of T=25±5℃
8. Accuracy represents the expected deviation of the sensor value from the ideal linear behavior over temperature and pressure, and includes thermal and pressure linearity and hysteresis effects over the life of the sensor. This is validated using accelerated aging techniques such as high temperature biased life, thermal cycling and thermal and pressure cycling tests.
9. Offset stability represents the proportion of the deviation in offset (zero pressure output) at fixed temperature T=25±5℃, over the life of the sensor, and includes the effects of thermal and pressure hysteresis as well as other sources of drift.
10. Device operating lifetime is verified using accelerated aging techniques.

## PRODUCT OPTIONS

| Option | Interface | Calibration Power Supply | Parameters available for readout |
|---|---|---|---|
| A | Analogue | 3V | Pressure |
| A5 | Analogue | 5V | Pressure |
| I | Digital I$^2$C | 3V | Pressure |
| I5 | Digital I$^2$C | 5V | Pressure |
| IT | Digital I$^2$C | 3V | Pressure and Temperature |
| IT5 | Digital I$^2$C | 5V | Pressure and Temperature |
| S | Digital SPI | 3V | Pressure |
| S5 | Digital SPI | 5V | Pressure |
| ST | Digital SPI | 3V | Pressure and Temperature |
| ST5 | Digital SPI | 5V | Pressure and Temperature |

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## MPS-300A

### Integrated, Absolute Pressure Sensor

## I²C Interface Description (Option I)

For I²C communication only two pins are used namely SDA (Pin 5) and SCL (Pin 4). The sensor behaves as a slave in this communication.
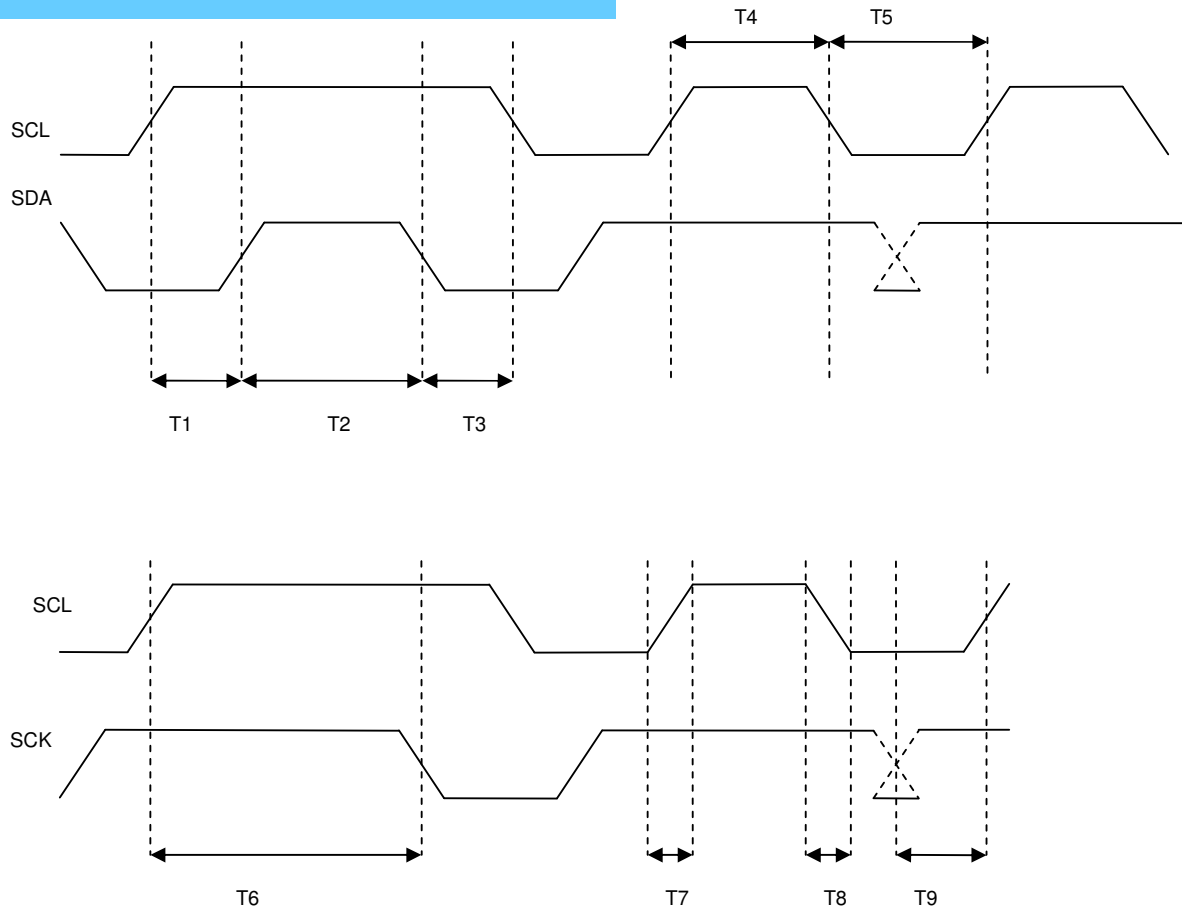
The I²C protocol is defined as follows:

i)   Idle period : During inactivity the SDA and SCL are pulled to supply voltage Vdd
ii)  Start Condition: A high to low transition on SDA while SCL is high indicates a start condition. Every command has to be initiated by a start condition sent by the master. A master can always generate a start condition
iii) Stop Condition: A low to high transition on SDA while SCL is high indicates a stop condition. A command has to be closed by a stop condition to start processing the command routine inside the Sensor
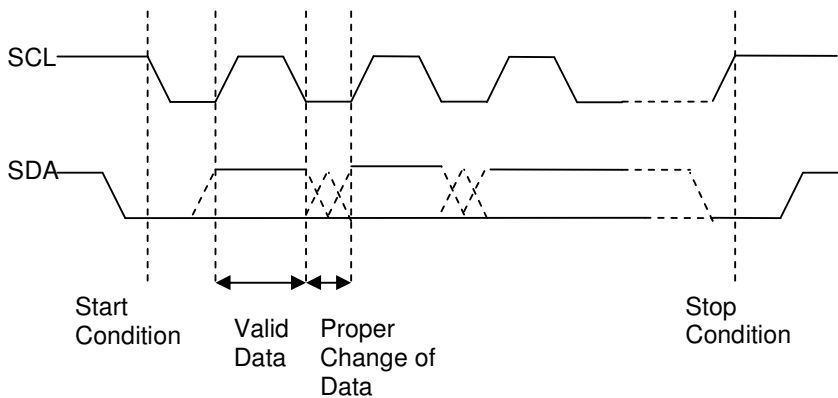


iv)  Valid Data: Data is transmitted in bytes (8 bits), MSB first. SDA transmits the data, while SCL clocks the data. Each byte transmitted is followed by an acknowledge bit. A bit is transferred by pulling SCL low, placing the data on SDA, then clocking SCL from high to low. Transmitted bits are valid after a start condition only if SDA keeps at constant level during the high period of SCL. The SDA level has to change only when clock signal SCL is low.
v)   Acknowledge Bit: Acknowledge after a transmitted byte is necessary. The transmitting device must generate an acknowledge related clock pulse. The receiver (slave or master) pulls down the SDA line during the acknowledge clock pulse. If no acknowledge is generated by the receiver the transmitting device will become inactive. A transmitting master can abort the transmission by generating a stop condition and may repeat the command.
vi)  Addressing: the slave address of the sensor is hard wired 7 bit address 0x78. This address cannot be changed. The master sends the address byte containing the 7 bit slave address followed by a read/write byte. '1' indicates a read and '0' indicates a write. The write operation is used exclusively by the manufacturer for calibration purposes and should not be used by the customer.
vii) Read Operation: After power on the master should send a read request to the sensor according to the figure below. The master must generate the transmission clock on SCL and followed by the acknowledge bit for each data byte except the last which is sent by the sensor.

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## MPS-300A

### Integrated, Absolute Pressure Sensor





## TIMING SPECIFICIATIONS (I$^2$C INTERFACE)

| Parameter | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| SCL Clock Frequency | $f_{scl}$ | - | - | 400 | kHz |
| Bus Free time between start and stop condition | T2 | 1.3 | - | - | μs |
| Hold Time Start Condition | T3 | 0.6 | - | - | μs |
| High Period SCL/SDA | T4 | 1.3 | - | - | μs |
| Low Period SCL/SDA | T5 | 1.3 | - | - | μs |
| Setup Time Stop Condition | T1 | 0.6 | - | - | μs |
| Setup Time Repeated Start Condition | T6 | 0.6 | - | - | μs |
| Rise Time SCL/SDA | T7 | 0.3 | - | - | μs |
| Fall Time | T8 | 0.3 | - | - | μs |
| Data Setup Time | T9 | 0.1 | - | - | μs |

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## MPS-300A

### Integrated, Absolute Pressure Sensor

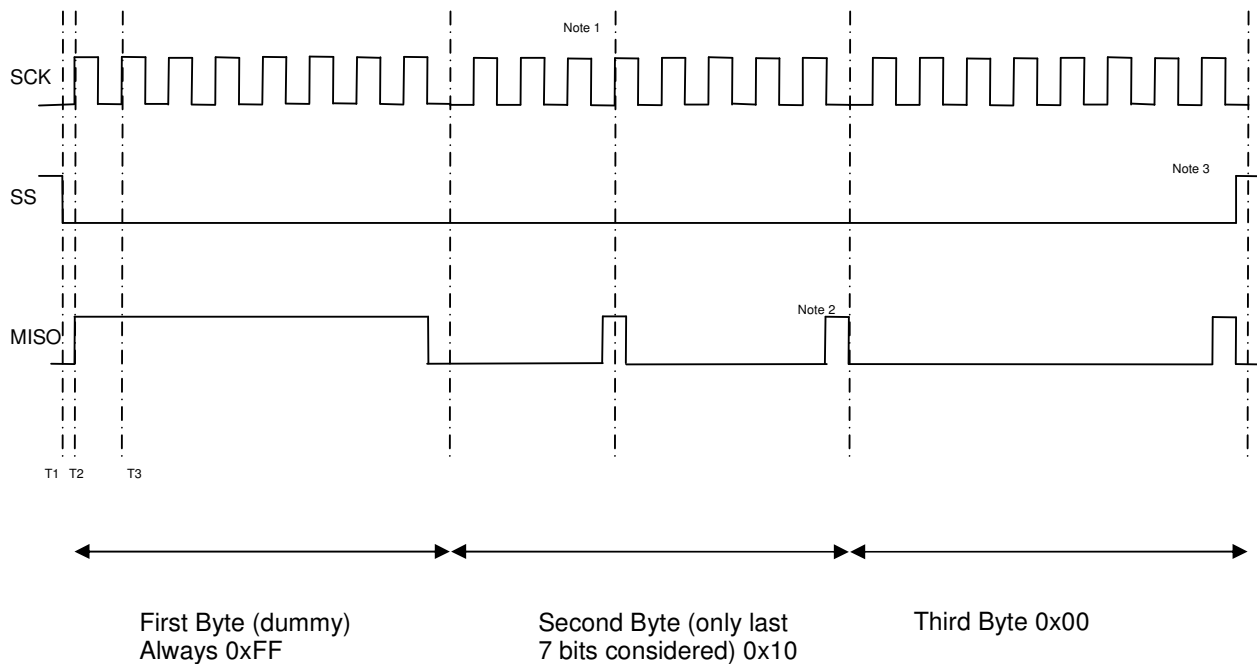## SPI INTERFACE DESCRIPTION – OPTIONS

**SPI Pin Signals**

There are four I/O signals associated with SPI transfers: SCK (pin 4), MISO (pin 2), MOSI (used by the manufacturer for calibration purposes only) and SS (pin 3). SCK is an input pin for the clock signal from the master which synchronizes the data transfer between the master and slave devices. Slave devices ignore the SCK signal unless the SS pin is active low. Data is shifted on the rising edge of the SCK signal and is sampled on the opposite edge where the data is stable.

The MISO and MOSI data pins are used for transmitting and receiving serial data. For the slave the MOSI is the data input line and the MOSI is the data output line. Once selected by the master the slave optionally drives data out its MOSI pin to the MISO of the master. The MOSI pin of the MTCM is solely for manufacturer's use and the customer is advised to disconnect this in their application.

The SS pin is used by the master to enable the SPI slave for a transfer. If the SS pin of a slave is inactive (High), the device ignores SCK clocks and keeps the MISO output pin in a high impedance state. The MBAP is always the slave and it is assumed in most cases the master is a microcontroller (MCU).

## READING THE PRESSURE AND TEMPERATURE (OPTION ST)

To read the pressure/temperature value, power up the device and wait for > 25ms. After that read the data from the MISO pin. Five bytes have to be read out. MSB is transmitted first. The first byte is a dummy byte always set to 0xFF. For the second and fourth byte only the last seven bits should be considered with the eighth bit (the MSB) always set to binary 0. The third and fifth byte should be read as normal, MSB first. The pressure and temperature results are both 15 bit binary words. The second and third byte make up the 15 bit pressure word and the fourth



First Byte (dummy)
Always 0xFF

Second Byte (only last
7 bits considered) 0x10

Third Byte 0x00

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## MPS-300A

### Integrated, Absolute Pressure Sensor

| Parameter | Description | Min | Typ | Max |
|-----------|-------------|-----|-----|-----|
| T1-T2 | SS delay before first SCK Pulse | 1µs | - | - |
| T2-T3 | SCK Clock Period | 1µs | - | - |

Note 1: Data must be sampled on the rising edge of the SCK

Note 2: There will be a dummy pulse starting from the middle of the 7th, 15th and 23rd SCK pulses lasting until after the next falling edge of the SCK. This pulse should be ignored.

Note 3: At the end of the transfer (24 clocks) the SS must be reasserted (brought high then low again) to begin another transfer.
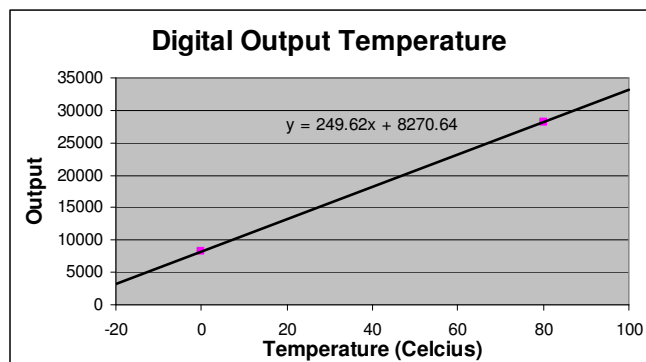
## Converting Digital Values to Engineering Units (SPI and I2C)

**Digital Output (I2C and SPI)**

$y = 300.37x - 6826.67$

(chart: Output (Dec) vs Pressure (kPa))
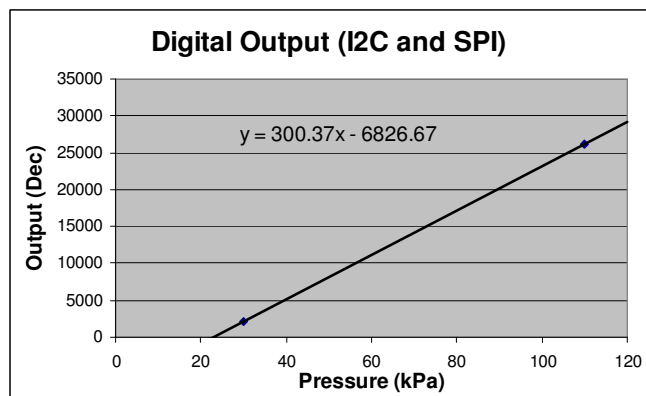
Conversion of Digital value to Engineering Units:

1. Digital value decimal
2. Add 6826.67
3. Divide by 300.37
4. result is in kPa

The chart at the left shows the transfer function used to calibrate the Digital output of the sensor pressure reading.

**Digital Output Temperature**

$y = 249.62x + 8270.64$

(chart: Output vs Temperature (Celcius))

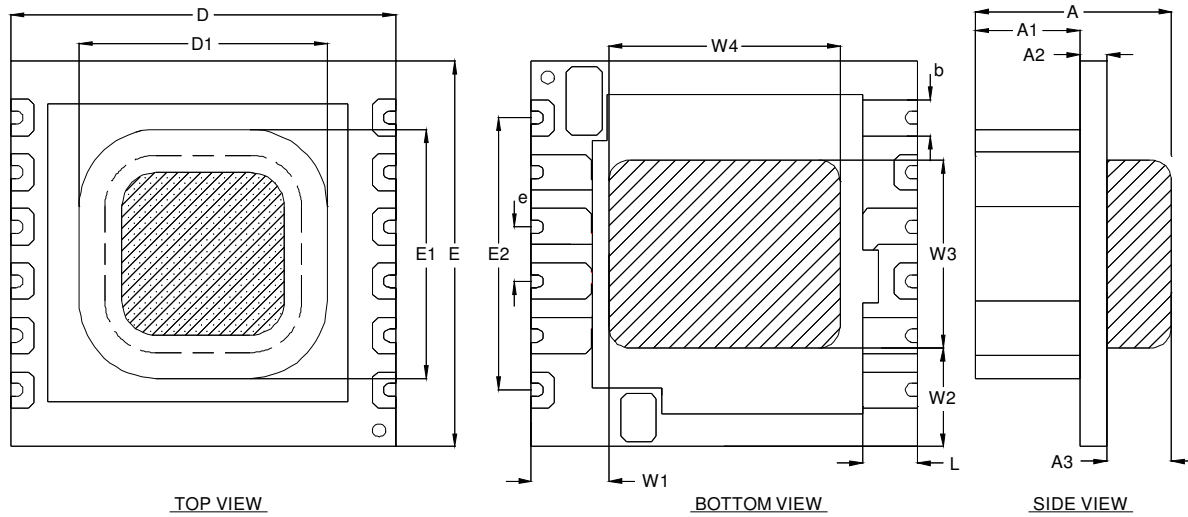Conversion of Digital value to Engineering Units:

5. Digital value decimal
6. Subtract 8270.64
7. Divide by 249.62
8. result is in C

The chart at the left shows the transfer function used to calibrate the Digital output of the sensor temperature reading.

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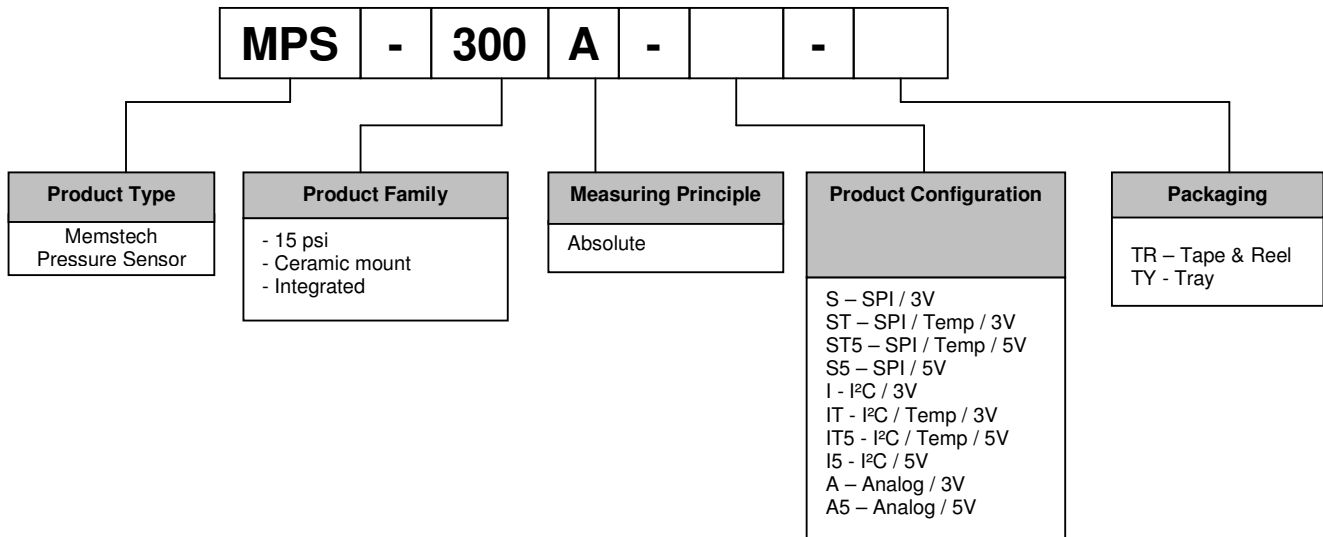Signal Condition
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## MPS-300A

### Integrated, Absolute Pressure Sensor

## PHYSICAL DIMENSIONS (9mm by 9mm, square cap)



TOP VIEW

BOTTOM VIEW

SIDE VIEW

| SYMBOLS | MILLIMETER<br>e = 1.27mm BASIC | | | INCHES<br>e = 0.050" BASIC | | |
|---|---|---|---|---|---|---|
| | MINIMUM | NOMINAL | MAXIMUM | MINIMUM | NOMINAL | MAXIMUM |
| A | 4.372 | 4.535 | 4.698 | 0.1721 | 0.1785 | 0.1850 |
| A1 | 2.350 | 2.400 | 2.450 | 0.0925 | 0.0945 | 0.0965 |
| A2 | 0.572 | 0.635 | 0.698 | 0.0225 | 0.0250 | 0.0275 |
| A3 | 1.450 | 1.500 | 1.550 | 0.0571 | 0.0591 | 0.0611 |
| b | 0.788 | 0.838 | 0.888 | 0.0310 | 0.0330 | 0.0350 |
| D | 8.950 | 9.000 | 9.050 | 0.3520 | 0.3540 | 0.3560 |
| D1 | 5.750 | 5.800 | 5.850 | 0.2263 | 0.2283 | 0.2303 |
| E | 8.950 | 9.000 | 9.050 | 0.3520 | 0.3540 | 0.3560 |
| E1 | 5.750 | 5.800 | 5.850 | 0.2263 | 0.2283 | 0.2303 |
| E2 | --- | 6.350 | --- | --- | 0.2500 | --- |
| L | 1.220 | 1.270 | 1.320 | 0.0480 | 0.0500 | 0.0520 |
| W1 | 1.750 | 1.800 | 1.850 | 0.0690 | 0.0709 | 0.0728 |
| W2 | 2.250 | 2.300 | 2.350 | 0.0886 | 0.0906 | 0.0925 |
| W3 | 4.342 | 4.392 | 4.442 | 0.1709 | 0.1729 | 0.1750 |
| W4 | 5.342 | 5.392 | 5.442 | 0.2103 | 0.2123 | 0.2143 |

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## MPS-300A

### Integrated, Absolute Pressure Sensor

## HOW TO SPECIFY PART NUMBER

| MPS | - | 300 | A | - | | - | |
|-----|---|-----|---|---|---|---|---|

**Product Type**

Memstech
Pressure Sensor

**Product Family**

- 15 psi
- Ceramic mount
- Integrated

**Measuring Principle**

Absolute

**Product Configuration**

S – SPI / 3V
ST – SPI / Temp / 3V
ST5 – SPI / Temp / 5V
S5 – SPI / 5V
I - I²C / 3V
IT - I²C / Temp / 3V
IT5 - I²C / Temp / 5V
I5 - I²C / 5V
A – Analog / 3V
A5 – Analog / 5V

**Packaging**

TR – Tape & Reel
TY - Tray

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USA  **Srini Naidu** Executive Director, 42503 Steeple View, Northville MI 48167  **Tel:** 734 560 5506  **Fax:** 734 420 3004  Emai**l:** srini@memstech.com

WORLWIDE  **Bryan Bryan K Patmon** Chief Marketing Officer   **Email:** bkpatmon@memstech.com
Singapore: 85, Science Park Drive, #01-02/02, The Cavendish, Singapore 118259.  Tel: +65-6822 6889   Fax: +65-6779 3711   **Email**: bkpatmon@memstech,com
Malaysia: PTD 43005 Jalan Perindustrian Murni 11, Taman Perindustrian Murni, 81400 Senai, Johor , Malaysia **Tel:** +607– 5996323  **Fax:** +607- 598 6388

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**SALES TERMS:**
MemsTech's Standard Sales Terms apply. Price and specifications are subject to change without notice.

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