

HDI Series

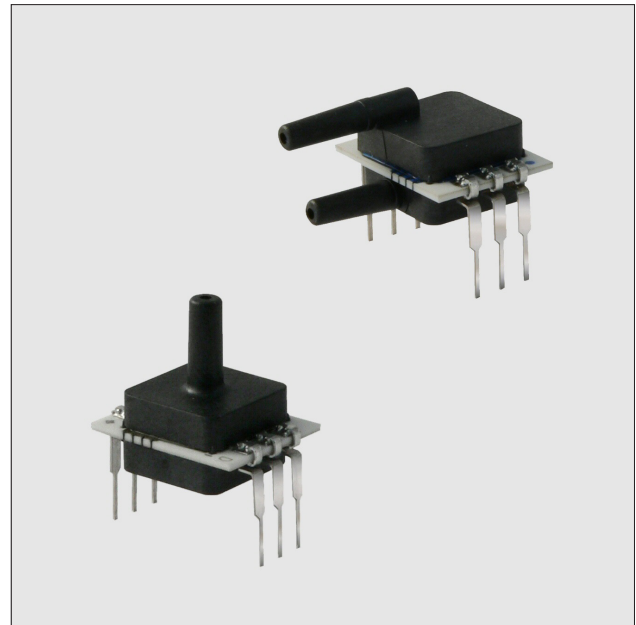
Amplified pressure sensors

FEATURES

- 10 mbar to 5 bar, absolute, gage or differential pressure
- Digital I²C-bus and analog output
- Precision ASIC signal conditioning
- Calibrated and temperature compensated
- SMT and DIP housings
- RoHS compliant

MEDIA COMPATIBILITY

To be used with non-corrosive, non-ionic working fluids such as clean dry air, dry gases and the like.



SPECIFICATIONS

Maximum ratings

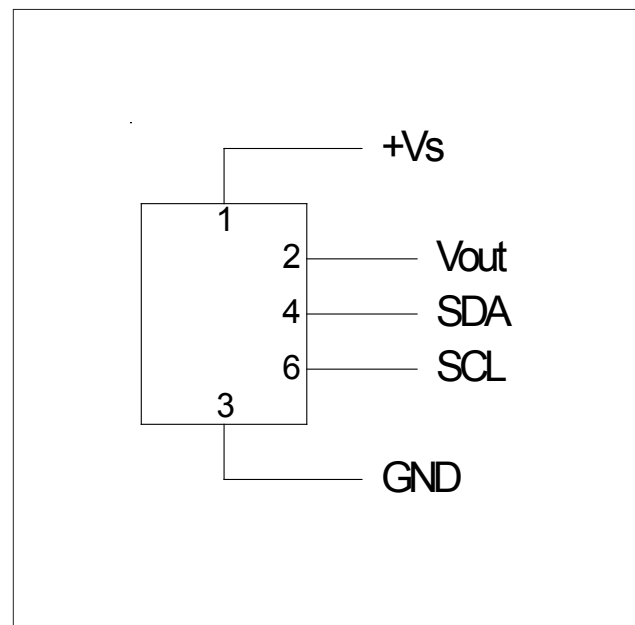
| | |
|----------------------|--|
| Supply voltage V_s | |
| HDI...3 | 2.7 ... 3.3 V_{DC} |
| HDI...5 | 4.5 ... 5.5 V_{DC} max. 6.50 V_{DC} |

| | |
|----------------|------|
| Output current | |
| Sink | 1 mA |
| Source | 1 mA |

| | |
|---|-----------|
| Lead specifications | |
| Average preheating temperature gradient | 2.5 K/s |
| Soak time | ca. 3 min |
| Time above 217°C | 50 s |
| Time above 230°C | 40 s |
| Time above 250°C | 15 s |
| Peak temperature | 260°C |
| Cooling temperature gradient | -3.5 K/s |

| | |
|---------------------------------|-----------------|
| Temperature ranges ⁵ | |
| Compensated | 0 ... +85 °C |
| Operating | -20 ... +85 °C |
| Storage | -40 ... +125 °C |

ELECTRICAL CONNECTION



HDI Series

Amplified pressure sensors

PRESSURE SENSOR CHARACTERISTICS

(T_A=25 °C, RH=50 %)

| Part no. | Operating pressure | Proof pressure ¹ | Burst pressure ² |
|----------------|--------------------|-----------------------------|-----------------------------|
| HDIM010...B... | 0...±10 mbar | 150 mbar | 200 mbar |
| HDIM020...B... | 0...±20 mbar | 150 mbar | 200 mbar |
| HDIM050...B... | 0...±50 mbar | 550 mbar | 800 mbar |
| HDIM100...B... | 0...±100 mbar | 1 bar | 1.5 bar |
| HDIM200...B... | 0...±200 mbar | 1 bar | 1.5 bar |
| HDIM500...B... | 0...±500 mbar | 1 bar | 1.5 bar |
| HDIB001...B... | 0...±1 bar | 2 bar | 3 bar |
| HDIM010...U... | 0...10 mbar | 150 mbar | 200 mbar |
| HDIM020...U... | 0...20 mbar | 150 mbar | 200 mbar |
| HDIM050...U... | 0...50 mbar | 550 mbar | 800 mbar |
| HDIM100...U... | 0...100 mbar | 1 bar | 1.5 bar |
| HDIM200...U... | 0...200 mbar | 1 bar | 1.5 bar |
| HDIM500...U... | 0...500 mbar | 1 bar | 1.5 bar |
| HDIB001...U... | 0...1 bar | 2 bar | 3 bar |
| HDIB002...U... | 0...2 bar | 4 bar | 6 bar |
| HDIB005...U... | 0...5 bar | 7 bar | 7 bar |
| HDI0611AR... | 600...1100 mbar(a) | 2 bara | 3 bara |
| HDI0811AR... | 800...1100 mbar(a) | 2 bara | 3 bara |

Other pressure ranges are available on request. Please contact First Sensor.

1. Proof pressure is the maximum pressure which may be applied without causing durable shifts of the electrical parameters of the sensing element.
2. Burst pressure is the maximum pressure which may be applied without causing damage to the sensing element or leaks to the housing.
3. Full Scale Span (FSS) is the algebraic difference between the output signal for the highest and lowest specified pressure.
4. Total accuracy is the combined error from offset and span calibration, linearity, pressure hysteresis, and temperature effects. Linearity is the measured deviation based on a straight line. Hysteresis is the maximum output difference at any point within the operating pressure range for increasing and decreasing pressure. Calibration errors include the deviation of offset and full scale from nominal values.
5. Extended temperature ranges on request. Please contact First Sensor.
6. Max. delay time between pressure change at the pressure die and signal change at the output.
7. The response time depends on the adjusted internal A/D resolution of the sensor. For 12 bit it is typ. 0.5 ms. Other A/D resolutions and response time are available on request. Please contact First Sensor for further information.
8. Sensors with lower current consumption are available on request. Please contact First Sensor for further information.

HDI Series

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PERFORMANCE CHARACTERISTICS

($V_S=5.0 V_{DC}$, $T_A=25\text{ }^\circ\text{C}$, $RH=50\%$, analog output signal is **ratiometric** to V_S , digital output signal is **not ratiometric** to V_S)

All HDI...P5 devices ($V_S = 5.0$)

| Characteristics | Min. | Typ. | Max. | Units |
|--|------------------------|------|------|-------|
| Total accuracy (0...85°C) ⁴ | all barometric devices | | ±1.0 | %FSS |
| | all other devices | | ±0.5 | |
| Response delay ^{6,7} | | 0.5 | | ms |
| A/D resolution ⁷ | | 12 | | bit |
| D/A resolution | | | 11 | |
| Current consumption ⁸ | | 5 | | mA |

All HDI...R...P5 (barometric devices)

| Characteristics | Min. | Typ. | Max. | Units |
|-------------------------------------|-------|-------|-------|--------|
| ANALOGUE PERFORMANCE CHARACTERISTIC | | | | |
| Output at min. specified pressure | 0.46 | 0.50 | 0.54 | V |
| Full scale span (FSS) ³ | | 4.00 | | |
| Full scale output | 4.46 | 4.50 | 4.54 | |
| DIGITAL PERFORMANCE CHARACTERISTIC | | | | |
| Output at min. specified pressure | 3015 | 3277 | 3539 | counts |
| Full scale span (FSS) ³ | | 26214 | | |
| Full scale output | 29228 | 29490 | 29752 | |

All HDI...U...P5 (unidirectional devices)

| Characteristics | Min. | Typ. | Max. | Units |
|------------------------------------|-------|-------|-------|--------|
| ANALOG PERFORMANCE CHARACTERISTIC | | | | |
| Zero pressure offset | 0.48 | 0.50 | 0.52 | V |
| Full scale span (FSS) ³ | | 4.00 | | |
| Full scale output | 4.48 | 4.50 | 4.52 | |
| DIGITAL PERFORMANCE CHARACTERISTIC | | | | |
| Zero pressure offset | 3146 | 3277 | 3408 | counts |
| Full scale span (FSS) ³ | | 26214 | | |
| Full scale output | 29359 | 29490 | 29621 | |

All HDI...B...P5 (bidirectional devices)

| Characteristics | Min. | Typ. | Max. | Units | |
|------------------------------------|----------------------------|-------|-------|--------|-------|
| ANALOG PERFORMANCE CHARACTERISTIC | | | | | |
| Zero pressure offset | 2.48 | 2.50 | 2.52 | V | |
| Full scale span (FSS) ³ | | 4.00 | | | |
| Output | at max. specified pressure | 4.48 | 4.50 | | 4.52 |
| | at min. specified pressure | 0.48 | 0.50 | | 0.52 |
| DIGITAL PERFORMANCE CHARACTERISTIC | | | | | |
| Zero pressure offset | 16252 | 16384 | 16515 | counts | |
| Full scale span (FSS) ³ | | 26214 | | | |
| Output | at max. specified pressure | 29359 | 29490 | | 29621 |
| | at min. specified pressure | 3146 | 3277 | | 3408 |

HDI Series

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PERFORMANCE CHARACTERISTICS

($V_S=3.0 V_{DC}$, $T_A=25\text{ }^\circ\text{C}$, $RH=50\%$, analog output signal is **ratiometric** to V_S , digital output signal is **not ratiometric** to V_S)

All HDI...P3 devices ($V_S = 3.0$)

| Characteristics | Min. | Typ. | Max. | Units |
|--|------------------------|------|------|-------|
| Total accuracy (0...85°C) ⁴ | all barometric devices | | ±1.0 | %FSS |
| | all other devices | | ±0.5 | |
| Response delay ^{6,7} | | 0.5 | | ms |
| A/D resolution ⁷ | | 12 | | bit |
| D/A resolution | | | 11 | |
| Current consumption ⁸ | | 3 | | mA |

All HDI...R...P3 (barometric devices)

| Characteristics | Min. | Typ. | Max. | Units |
|-------------------------------------|-------|-------|-------|--------|
| ANALOGUE PERFORMANCE CHARACTERISTIC | | | | |
| Output at min. specified pressure | 0.23 | 0.25 | 0.27 | V |
| Full scale span (FSS) ³ | | 2.00 | | |
| Full scale output | 2.23 | 2.25 | 2.27 | |
| DIGITAL PERFORMANCE CHARACTERISTIC | | | | |
| Output at min. specified pressure | 2512 | 2731 | 2949 | counts |
| Full scale span (FSS) ³ | | 21845 | | |
| Full scale output | 24357 | 24575 | 24794 | |

All HDI...U...P3 (unidirectional devices)

| Characteristics | Min. | Typ. | Max. | Units |
|------------------------------------|-------|-------|-------|--------|
| ANALOG PERFORMANCE CHARACTERISTIC | | | | |
| Zero pressure offset | 0.24 | 0.25 | 0.26 | V |
| Full scale span (FSS) ³ | | 2.00 | | |
| Full scale output | 2.24 | 2.25 | 2.26 | |
| DIGITAL PERFORMANCE CHARACTERISTIC | | | | |
| Zero pressure offset | 2621 | 2731 | 2840 | counts |
| Full scale span (FSS) ³ | | 21845 | | |
| Full scale output | 24466 | 24575 | 24684 | |

All HDI...B...P3 (bidirectional devices)

| Characteristics | Min. | Typ. | Max. | Units |
|------------------------------------|----------------------------|-------|-------|--------|
| ANALOG PERFORMANCE CHARACTERISTIC | | | | |
| Zero pressure offset | 1.24 | 1.25 | 1.26 | V |
| Full scale span (FSS) ³ | | 2.00 | | |
| Output | at max. specified pressure | | 2.26 | |
| | at min. specified pressure | | 0.26 | |
| DIGITAL PERFORMANCE CHARACTERISTIC | | | | |
| Zero pressure offset | 13545 | 13653 | 13762 | counts |
| Full scale span (FSS) ³ | | 21845 | | |
| Output | at max. specified pressure | | 24684 | |
| | at min. specified pressure | | 2840 | |

I²C BUS

Introduction

The HDI is capable to generate a digital output signal. The device runs a cyclic program, which will store a corrected pressure value with 12 bit resolution about every 250 µs within the output registers of the internal ASIC. In order to use the sensor for digital signal readout, it should be connected to a bidirectional I²C-bus.

According to the I²C-bus specification, the bus is controlled by a master device, which generates the clock signal, controls the bus access and generates START and STOP conditions. The HDI is designed to work as a slave, hence it will only respond to requests from a master device.

Digital I²C interface

The HDI complies with the following protocol (Fig. 1):

Bus not busy: During idle periods both data line (SDA) and clock line (SCL) remain HIGH.

START condition (S): HIGH to LOW transition of SDA line while clock (SCL) is HIGH is interpreted as START condition. START conditions are always generated by the master. Each initial request for a pressure value has to begin with a START condition.

STOP condition (P): LOW to HIGH transition of SDA line while clock (SCL) is HIGH determines STOP condition. STOP conditions are always generated by the master. More than one request for the current pressure value can be transmitted without generation of intermediate STOP condition.

DATA valid (D): State of data line represents valid data when, after START condition, data line is stable for duration of HIGH period of clock signal. Data on line must be changed during LOW period of clock signal. There is one clock pulse per bit of data.

Acknowledge (A): Data is transferred in pieces of 8 bits (1 byte) on serial bus, MSB first. After each byte receiving device – whether master or slave – is obliged to pull data line LOW as acknowledge for reception of data. Master must generate an extra clock pulse for this purpose. When acknowledge is missed, slave transmitter becomes inactive. It is on master either to send last command again or to generate STOP condition in that case.

Slave address: The I²C-bus master-slave concept requires a unique address for each device. The HDI has a preconfigured slave address (1111000xb). By factory programming it is possible to define a secondary slave address additional to the general one. According to I²C specification 127 different addresses are available. The sensor will then listen to both slave addresses. After generating a START condition the master sends the address byte containing a 7 bit address followed by a data direction bit (R/W). A "0" indicates a transmission from master to slave (WRITE), a "1" indicates a data request (READ).

DATA operation: The sensor starts to send 2 data bytes containing the current pressure value as a 15 bit information placed in the output registers.

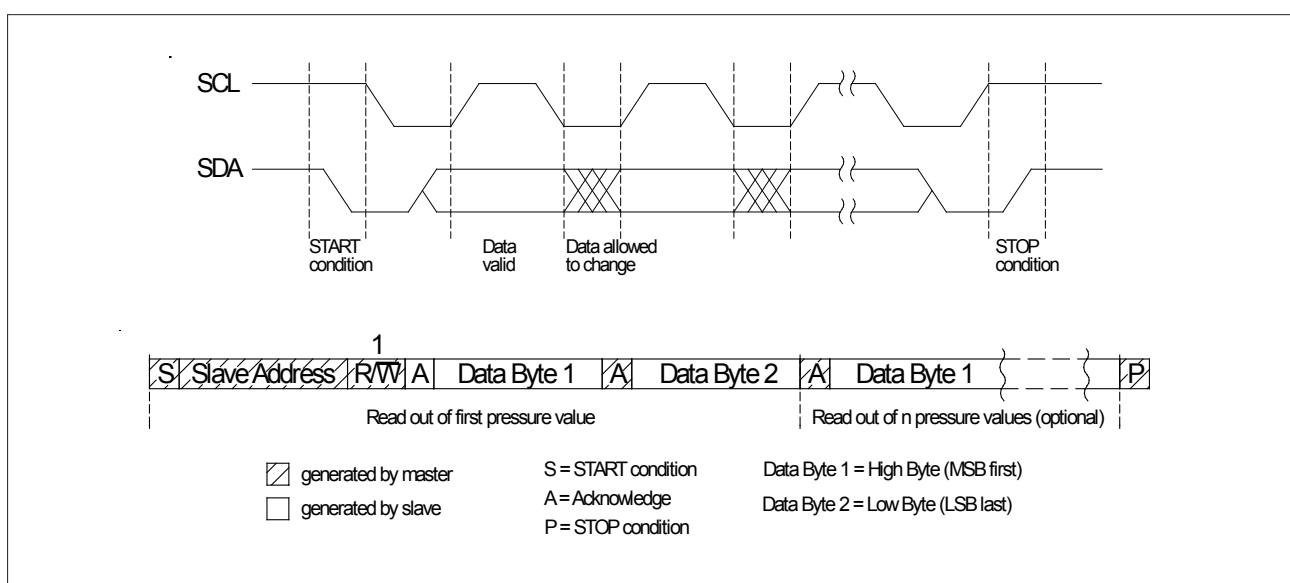


Fig. 1: I²C bus protocol

I²C Interface Parameters

| Parameter | Symbol | Min. | Typ. | Max. | Unit |
|--|---------------------|------|------|------|---------------------|
| Input high level | | 90 | | 100 | % of V _s |
| Input low level | | 0 | | 10 | |
| Output low level | | | | 10 | |
| Pull-up resistor | | 500 | | | Ω |
| Load capacitance @ SDA | C _{SDA} | | | 400 | pF |
| Input capacitance @ SDA/SCL | C _{I2C IN} | | | 10 | |
| SCL clock frequency | F _{SCL} | 100* | | 400 | kHz |
| Bus free time between STOP and START condition | t _{BUF} | 1.3 | | | μs |
| Hold time (repeated) START condition, to first clock pulse | t _{HD,STA} | 0.8 | | | |
| LOW period of SCL | t _{LOW} | 1.3 | | | |
| HIGH period of SCL | t _{HIGH} | 0.6 | | | |
| Setup time repeated START condition | t _{SU,STA} | 1 | | | |
| Data hold time | t _{HD,DAT} | 0 | | | |
| Data setup time | t _{SU,DAT} | 0.2 | | | |
| Rise time of both SDA and SCL | t _R | | | 0.3 | |
| Fall time of both SDA and SCL | t _F | | | 0.3 | |
| Setup time for STOP condition | t _{SU,STO} | 0.6 | | | |

* recommended

Note: First Sensor recommends communication speeds of at least 100 kHz (max. 400 kHz). Please contact us for further information.

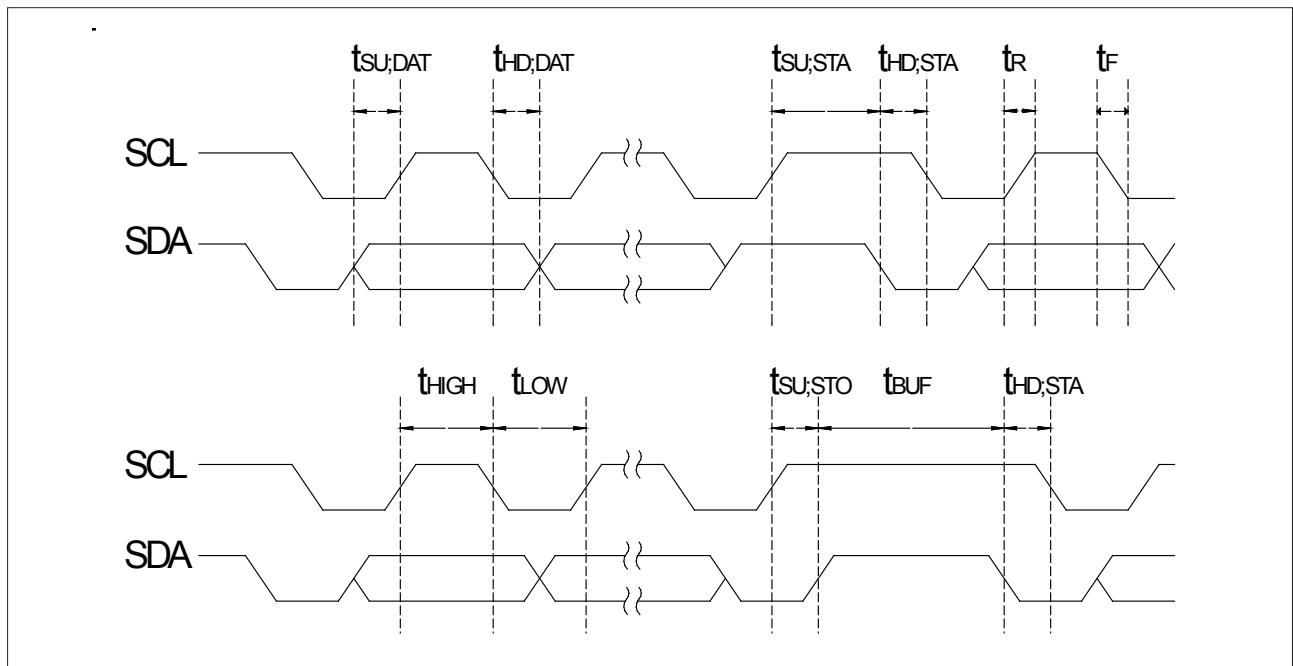


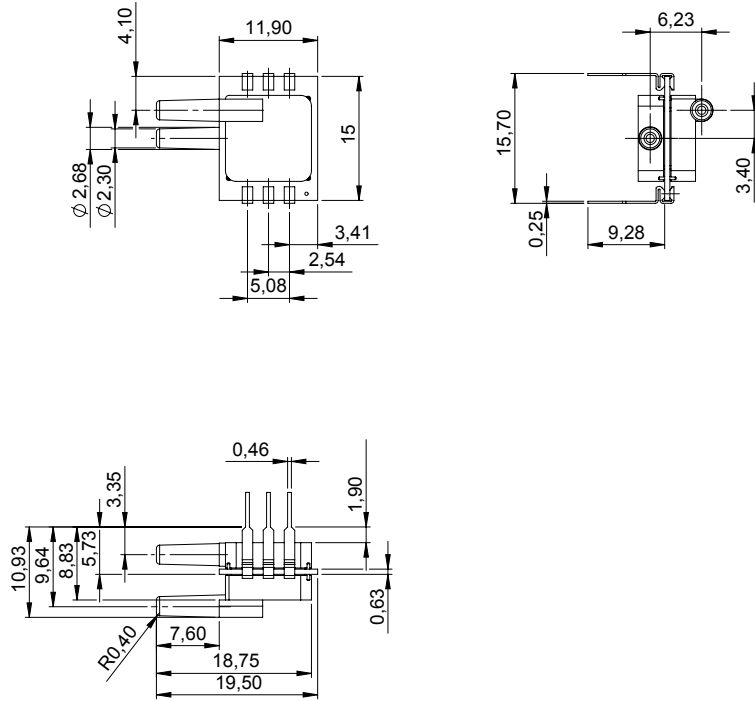
Fig. 2: Timing characteristics

HDI Series

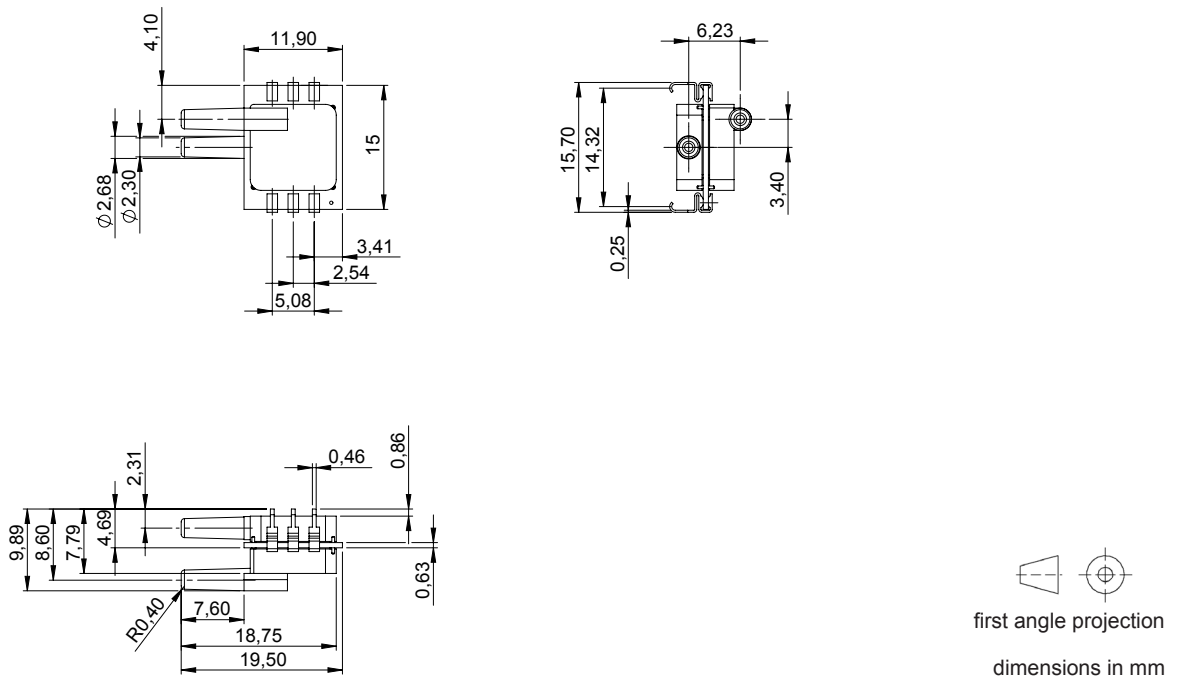
Amplified pressure sensors

PHYSICAL DIMENSIONS

HDI...F... (DIP, 2 ports same side)



HDI...E... (SMD, 2 ports same side)

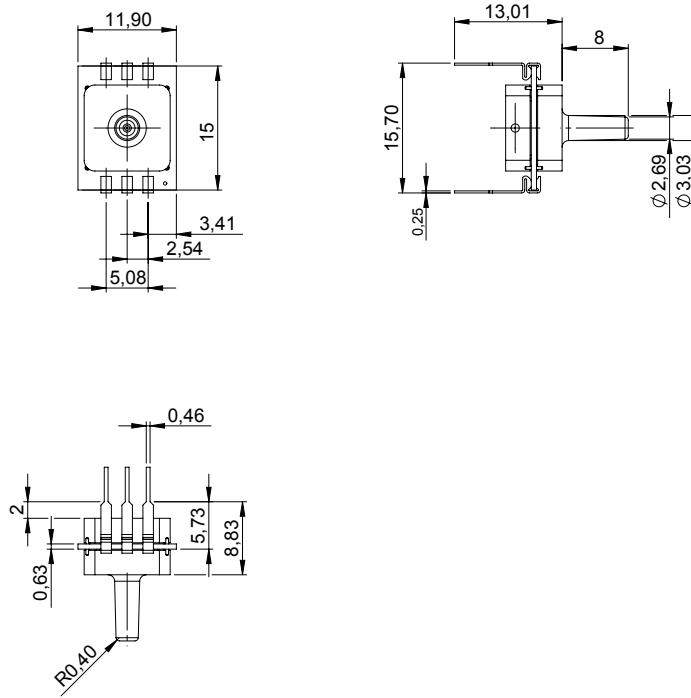


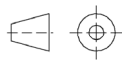
HDI Series

Amplified pressure sensors

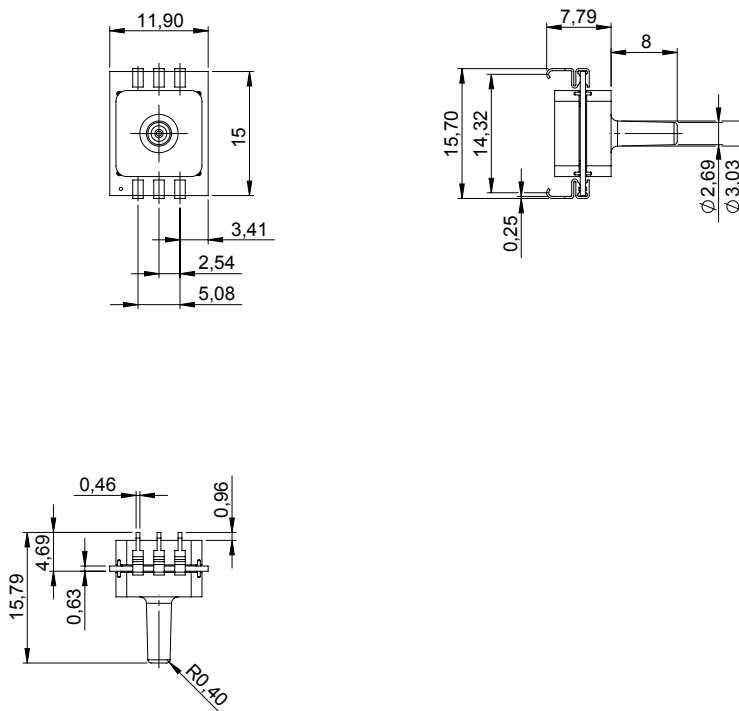
PHYSICAL DIMENSIONS (cont.)

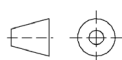
HDI...Z... (DIP, 1 port axial)




 first angle projection
 dimensions in mm

HDI...Y... (SMD, 1 port axial)



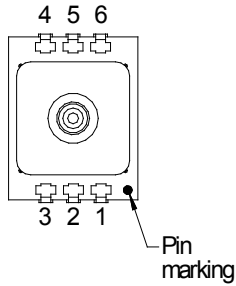

 first angle projection
 dimensions in mm

HDI Series

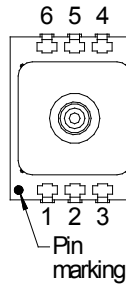
Amplified pressure sensors

ELECTRICAL CONNECTION (cont.)

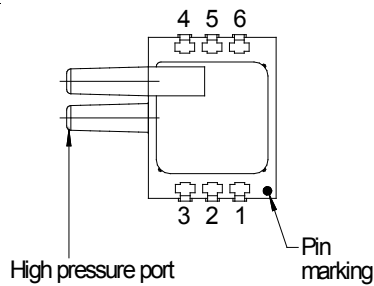
**HDI...A...
(absolute)**



**HDI...G...
(gage)**



**HDI...D...
(differential)**



| Pin | Connection |
|-----|------------|
| 1 | +Vs |
| 2 | +Vout |
| 3 | GND |
| 4 | SDA |
| 5 | I / C* |
| 6 | SCL |

* Internal connection.
Do not connect for any reason

ORDERING INFORMATION

| Options | Series | Pressure range | | Pressure mode | | Calibration | | Housing | | Porting | | Grade | | Voltage | |
|----------|--------|----------------|-----------------|-------------------|--------------|---|----------------|--|------------------------|---------|----------|-------|-------|---------|-----|
| | HDI | 0611 | 600...1100 mbar | A* | Absolute | B* | Bidirectional | F* | DIP, 2 ports same side | 8 | Straight | P | Prime | 5 | 5 V |
| | | 0811 | 800...1100 mbar | D | Differential | U | Unidirectional | E* | SMD, 2 ports same side | | | | | 3 | 3 V |
| | | M010 | 10 mbar | G | Gage | R** | Barometric | Z** | DIP, 1 port axial | | | | | | |
| | | M020 | 20 mbar | | | | | Y** | SMD, 1 port axial | | | | | | |
| | | M050 | 50 mbar | | | | | | | | | | | | |
| | | M100 | 100 mbar | | | | | | | | | | | | |
| | | M200 | 200 mbar | | | | | | | | | | | | |
| | | M500 | 500 mbar | | | | | | | | | | | | |
| | | B001 | 1 bar | | | | | | | | | | | | |
| | | (B001A) | 1 bara | | | | | | | | | | | | |
| | | B002 | 2 bar | | | | | | | | | | | | |
| | | B005 | 5 bar | | | | | | | | | | | | |
| | | | | * only from 1 bar | | * only up to 1 bar ** for pressure ranges 0611, 0811 | | * standard for differential devices, "D" ** standard for absolute and gage devices, "A" and "G" | | | | | | | |
| Example: | | HDI | M050 | G | | U | | Z | | 8 | | P | | 5 | |

Note: Not all possible sensor configurations are active products. MOQ may apply.

Custom specific pressure ranges and mechanical or electronic sensor modifications are widely available. Please contact First Sensor for further information.

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