# NOVA® SENSOR

# NPB 102
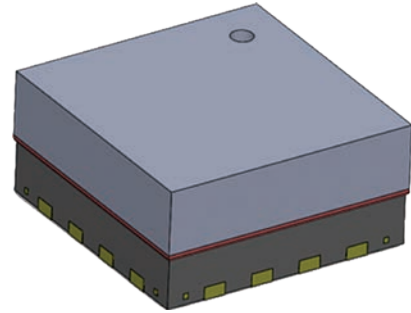## Digital Output Absolute Pressure Sensor



## Applications

- Automobile Applications - Thermal Runaway Detection, Infotainment, and Enhanced GPS Navigation
- Mobile Devices - Smart Phones, Smart Watches, and Tablets
- Indoor and Outdoor Navigation
- Altimeter and Barometer for Portable Devices
- Weather Station Equipment
- Leisure and Sports
- Hard Disk Drive (HDD)
- Weather Forecast
- Consumer Drones

## Features

- Absolute Pressure Range: 260 mBar to 1260 mBar and 50kPa to 200kPa (Other pressure ranges available upon request)
- AECQ-100 Qualified
- Pressure Resolution: 18-bit, Temperature Resolution: 16-bit
- Operating Temperature: –40°C to +125°C
- Pressure Accuracy (Total Error Band):
    ± 2%FSO (0 to +85°C)
    ± 3%FSO (-40 to +125°C)
- Interface: I²C (SPI available upon request)
- Operating Range: 1.7V ~ 3.6V
- Small size package
- Package: 4x4mm QFN
- Fully-calibrated and compensated
- Digital compensation via 26-bit internal digital signal processor (DSP) running a correction

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# Overview

- The NPB 102 is an absolute pressure sensor with digital output for low cost applications.

- With a standard 4x4 mm QFN package, it is ideally suited for automobile (AECQ-100 Qualified), portable electronics and space-constrained applications.

- A wide operating temperature range from -40°C to +125°C fits well with demanding environmental requirements.

- NPB-102 employs a MEMS pressure sensor with a signal-conditioning IC to provide accurate pressure measurement from 26kPa to 200kPa.

- The NPB 102 not only compensates and calibrates the pressure element, but also provides a corrected temperature output using an internal sensor.

- The measured and corrected bridge values are provided at the digital output pins through an I²C interface.

- Digital compensation of the signal offset, sensitivity, temperature and non-linearity is accomplished via 26-bit internal digital signal processor (DSP) running a correction algorithm.

- Calibration coefficients are stored on-chip in highly reliable, nonvolatile, multiple-time programmable (MTP) memory.

# Specifications

## Absolute Maximum Ratings

| Symbol | Parameter | Limits | | | Unit |
|--------|-----------|--------|---------|------|------|
| | | Min. | Typical | Max. | |
| $V_{DD}$ | Analog Supply Voltage | -0.4 | - | 3.63 | V |
| $I_{IN}$ | Input Current except RES &SS | -100 | - | 100 | mA |
| $P_{OVR}$ | Overpressure (Pressure element only,non-hermetic package) | - | - | 400 | kPa |
| $V_{HBM1}$ | ESD-HBM | 4000 | - | - | V |
| $T_{STOR}$ | StorageTemperature | -50 | - | 130 | °C |

## Operating Conditions

| Symbol | Parameter | | Limits | | | Unit |
|--------|-----------|--|--------|---------|------|------|
| | | | Min. | Typical | Max. | |
| $V_{DD}$ | Supply Voltage | | 1.68 | - | 3.63 | V |
| $tv_{DD}$ | VDD RiseTime | | - | - | 200 | us |
| $t_{STA1}$ | Start up Time | $V_{DD}$ ramp up to communication | - | - | 1 | ms |
| $t_{STA2}$ | | $V_{DD}$ ramp up to operation | - | - | 2.5 | ms |
| $t_{WUP1}$ | Wake up Time | Sleep to Active communication | - | - | 0.5 | ms |
| $t_{WUP2}$ | | Sleep to Active operation | - | - | 2 | ms |
| $I_{VDD}$ | Current Consumption | Active State | - | 1050 | 1500 | uA |
| | | Sleep Mode ≤125°C | - | 50 | 750 | nA |
| $P_{OPR}$ | Operating Pressure Range | NPB-102X-0126A | 26 | - | 126 | kPa |
| | | NPB-102X-0200A | 50 | - | 200 | kPa |
| $T_{OPR}$ | Operating Temperature Range | | -40 | - | 125 | °C |
| | Media Compatibility: | Compatible with exposed materials-thermosetplastic, epoxy and silicone | | | | |

# Specifications *(cont.)*

## Performance Specifications

Unless otherwise specified: 3.3VDC Supply Voltage,Room Temperature

| Symbol | Parameter | Limits | | | | Notes |
| --- | --- | --- | --- | --- | --- | --- |
| | | Min | Typical | Max | Unit | |
| $t_{RES}$ | Response Time | - | 3.7 | - | ms | 270Hz update rate |
| $P_{TEB}$ | Pressure Accuracy (Total Error Band) | -2.0 | - | +2.0 | %FSO | 0~85°C |
| | | -3.0 | - | +3.0 | %FSO | -40~0°C & 85~125°C |
| $T_{EB}$ | Temperature Accuracy | - | ±4 | - | °C | -40~125°C |
| $f_{C,I2C}$ | I²C Clock Frequency | - | - | 3.4 | MHz | |
| $f_{C,SPI}$ | SPI Clock Frequency | - | 1 | 10 | MHz | |
| $f_{C,I2C}$ | I²C Slave Address | - | 0x27 | - | Hex | |
| $P_{BIT}/T_{BIT}$ | Output Data Bits | - | - | 24 | bit | |

## I²C Commands

The I²C read command supported by the NPB-102 are listed in the table below. The command to read an address in the user memory is the same as its address.

| Command (Byte) | Return | Description |
| --- | --- | --- |
| AA$_{HEX}$ | 24-bit formatted fully corrected sensor measurement data + 24-bit corrected temperature data | Measure Triggers full measurement cycle and calculation and storage of data in interface (configurations from MTP) |

## General Status Byte

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Meaning | 0 | Powered | Busy | Mode | | Memory Error | Config Setup | ALU Saturation |

## Mode Status Byte

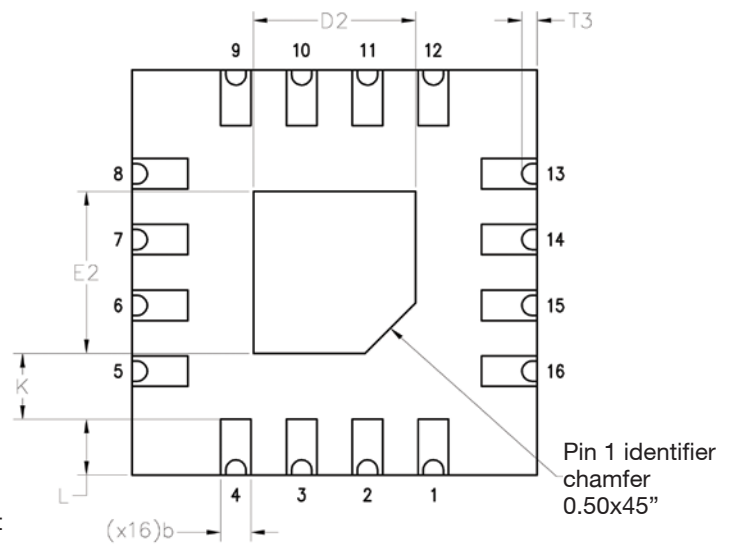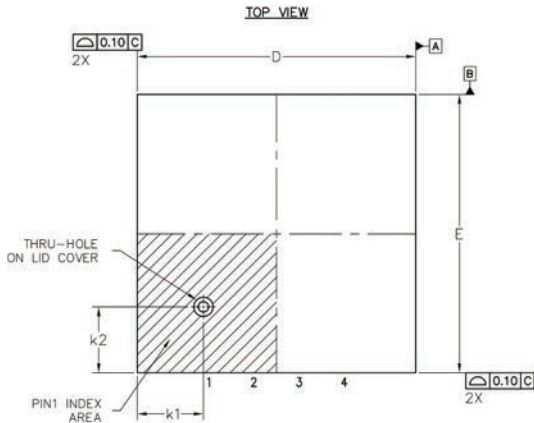| Status [4:3] | 00 | 01 | 10 | 11 |
| --- | --- | --- | --- | --- |
| Mode | Normal Mode | Command Mode | Reserved | Command Mode and Reserved |

## Calculating Pressure & Temperature Output

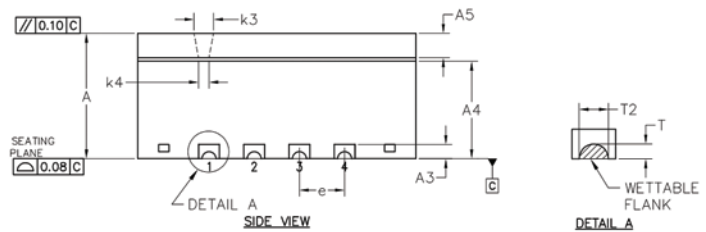$$Pressure\ [kPa] = 1.25 \times (P_{max} - P_{min}) \times (P_{count} \div 16777216 - 0.1) + P_{min}$$

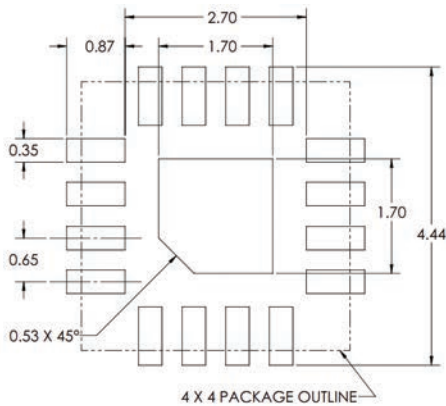$$Temperature\ [C] = 169 \times (T_{count} \div 16777216) - 41$$

# Package Information



TOP VIEW

1. Dimensions in mm.

2. Footprint is only a recommendation, subject to test by the customer.

3. Stencil design and volume of solder used is the responsibility of the user.



Pin 1 identifier chamfer 0.50x45"

Bottom View



DETAIL A
SIDE VIEW

WETTABLE FLANK
DETAIL A



4 X 4 PACKAGE OUTLINE

PCB Layout Footprint

| Symbol | Common | | | | | |
|---|---|---|---|---|---|---|
| | Dimensions mm | | | Dimensions in. | | |
| | Min. | Nom. | Max. | Min. | Nom. | Max. |
| A | | 1.80 | | | 0.071 | |
| A3 | | 0.203 Ref | | | 0.008 Ref | |
| A4 | | 1.40 Ref | | | 0.055 Ref | |
| A5 | | 0.35 Ref | | | 1.014 Ref | |
| b | 0.25 | 0.30 | 0.35 | 0.010 | 0.012 | 0.014 |
| D | 3.90 | 4.00 | 4.10 | 0.154 | 0.157 | 0.161 |
| D2 | 1.50 | 1.60 | 1.70 | 0.059 | 0.063 | 0.067 |
| E | 3.90 | 4.00 | 4.10 | 0.154 | 0.157 | 0.161 |
| E2 | 1.50 | 1.60 | 1.70 | 0.059 | 0.063 | 0.067 |
| e | | 0.65 BSC | | | 0.026 BSC | |
| L | 0.45 | 0.55 | 0.65 | 0.018 | 0.022 | 0.026 |
| K | 0.60 | 0.650 | 0.07 | 0.024 | 0.026 | 0.003 |
| k1 | 0.85 | 0.95 | 1.05 | 0.033 | 0.037 | 0.041 |
| k2 | 0.85 | 0.95 | 1.05 | 0.033 | 0.037 | 0.041 |
| k3 | 0.18 | - | 0.28 | 0.007 | - | 0.011 |
| k4 | 0.10 | - | 0.15 | 0.004 | - | 0.006 |
| T | 0.05 | 0.10 | 0.15 | 0.002 | 0.004 | 0.006 |
| T2 | 0.15 | 0.20 | 0.25 | 0.006 | 0.008 | 0.010 |
| T3 | 0.05 | 0.15 | 0.25 | 0.002 | 0.006 | 0.010 |

# Pin Description
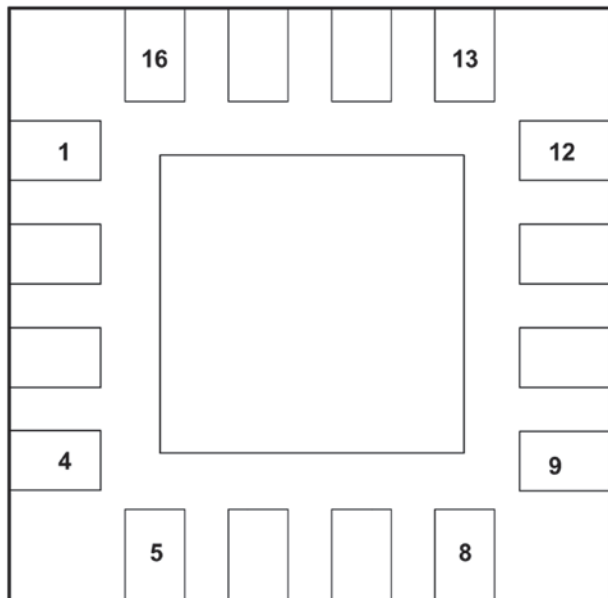


| Pin No. | Name | Description |
|---------|------|-------------|
| 1 | VDD | Ground |
| 2 | RES | Reset |
| 3 | EOC | End of conversion |
| 4 | MISO | Data output for SPI |
| 5 ~ 8 | - | Not connected |
| 9 | SCL/SCLK | Clock for $I^2C$/SPI |
| 10 | SDA/MISO | Data for $I^2C$/SPI |
| 11 | SS | Slave select for SPI |
| 12 ~ 15 | - | Not connected |
| 16 | VDD | Supply voltage |

# I²C Communications Interface

## I²C

In I²C Mode, each command is started as shown in Figure 1. Only the number of bytes that is needed for the command has to be sent. After the execution of a command (busy = 0) the expected data can be read as illustrated in Figure 3, or if no data are returned by the command the next command can be sent. The status can be read at any time as described in Figure 2.
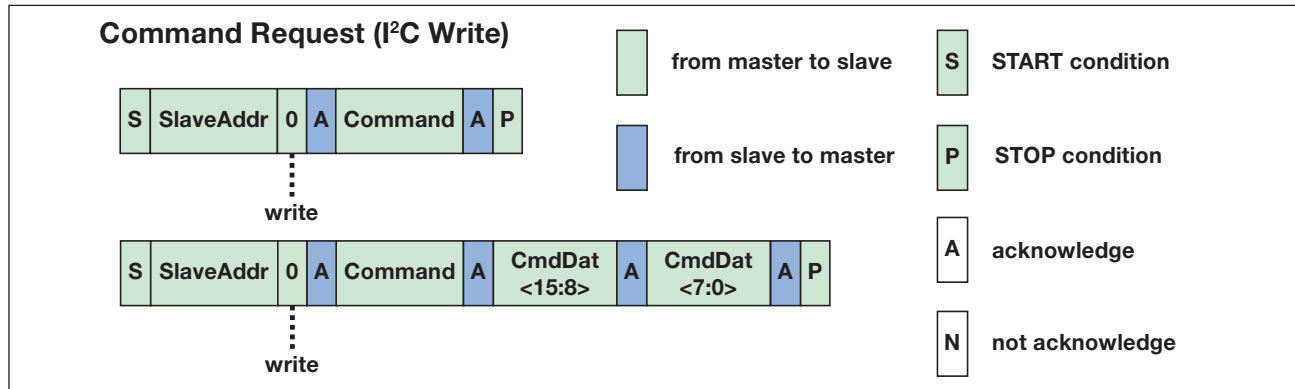
**Command Request (I²C Write)**
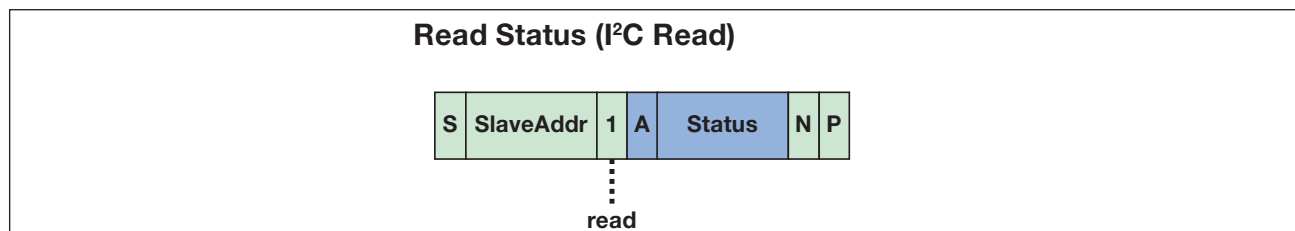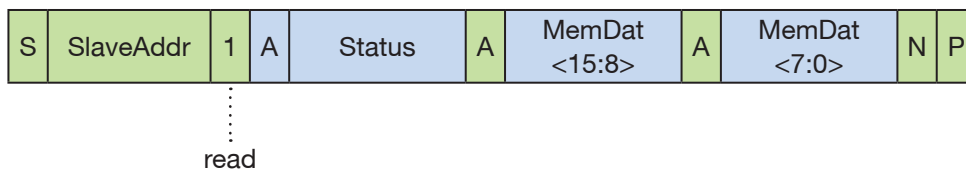
| S | SlaveAddr | 0 | A | Command | A | P |

write

| S | SlaveAddr | 0 | A | Command | A | CmdDat <15:8> | A | CmdDat <7:0> | A | P |

write

□ from master to slave     S | START condition

■ from slave to master     P | STOP condition

A | acknowledge

N | not acknowledge

Figure 1 - I²C Command Request

**Read Status (I²C Read)**

| S | SlaveAddr | 1 | A | Status | N | P |

read

Figure 2 - I²C Read Status

## Read Data (I²C Read)

(a) Example: after the completion of a Memory Read command

| S | SlaveAddr | 1 | A | Status | A | MemDat <15:8> | A | MemDat <7:0> | N | P |

read

(b) Example: after the completion of a Measure command (AA_HEX)

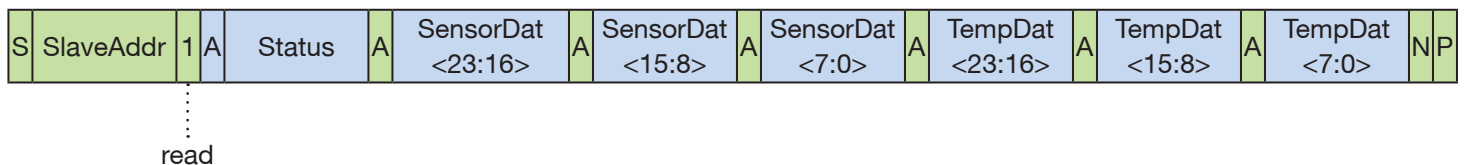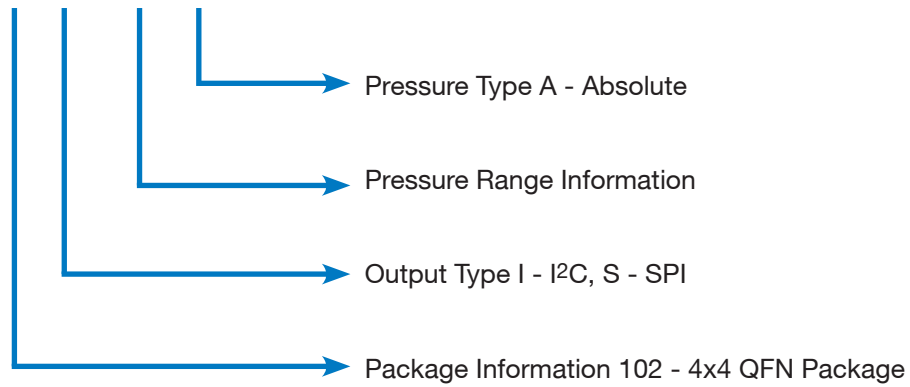| S | SlaveAddr | 1 | A | Status | A | SensorDat <23:16> | A | SensorDat <15:8> | A | SensorDat <7:0> | A | TempDat <23:16> | A | TempDat <15:8> | A | TempDat <7:0> | N | P |

read

Figure 3 - I²C Read Data

All mandatory I²C-bus protocol features are implemented. Optional features like clock stretching, 10-bit slave address, etc., are not supported by the sensor's interface.

In I²C-High Speed Mode, a command consists of a fixed length of three bytes.

# Ordering Information

**NPB-102X-XXXX**

Pressure Type A - Absolute

Pressure Range Information

Output Type I - I$^2$C, S - SPI

Package Information 102 - 4x4 QFN Package

| Part Number | Description |
| --- | --- |
| NPB-102I-0126A | 26-126kPa, I$^2$C output |
| NPB- 102I - 0200A | 50-200kPa, I$^2$C output |

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