Robot-R-Us Singapore

LPS331AP Pressure/Altitude Sensor Carrier with Voltage Regulator

SG$8.70

Overview

This board is a compact (0.4â€³Â Ã—Â 0.9â€³) carrier for STâ€™s LPS331AP MEMS absolute pressure sensor, or barometer; we therefore recommend careful reading of theÂ [LPS331AP datasheet](#)Â (453k pdf) before using this product. The LPS331 is a great IC, but its small, leadless, LGA package makes it difficult for the typical student or hobbyist to use. It also operates at voltages below 3.6Â V, which can make interfacing difficult for microcontrollers operating at 5Â V. This carrier board addresses these issues by incorporating additional electronics, including a 3.3Â V voltage regulator and level-shifting circuits, while keeping the overall size as compact as possible. The board ships fully populated with its SMD components, including the LPS331AP, as shown in the product picture.

The LPS331 features embedded temperature compensation and has many configurable options, including selectable resolutions, a choice of output data rates, and two programmable external interrupt signals. Its pressure output has an absolute accuracy as low as Â±2Â mbar (0.2Â kPa), with RMS noise of 0.02Â mbar (0.002Â kPa) in the highest-resolution mode. Pressure and temperature sensor data are available through a digital interface, which can be configured to operate in either IÂ²C or SPI mode, and can be used for altimetry. (See the Sample Code section below for an Arduino library that can be used to turn this sensor into an altimeter).

The carrier board includes a low-dropout linear voltage regulator that provides the 3.3Â V required by the LPS331, which allows the sensor to be powered from a 2.5Â V to 5.5Â V supply. The regulator output is available on the VDD pin and can supply almost 150Â mA to external devices. The breakout board also includes a circuit that shifts the IÂ²C/SPI clock and data in lines to the same logic voltage level as the supplied VIN, making it simple to interface the board with 5Â V systems, and the boardâ€™s 0.1â€³ pin spacing makes it easy to use with standardÂ [solderless breadboards](#)Â and 0.1â€³ perfboards.

For sensor fusion applications, [AltIMU-10](#) inertial measurement unit combines the LPS331AP with an [L3GD20](#) 3-axis gyro and an [LSM303DLHC](#) 3-axis accelerometer and 3-axis magnetometer on a single board, providing ten independent readings that can be used to calculate an absolute orientation and altitude.

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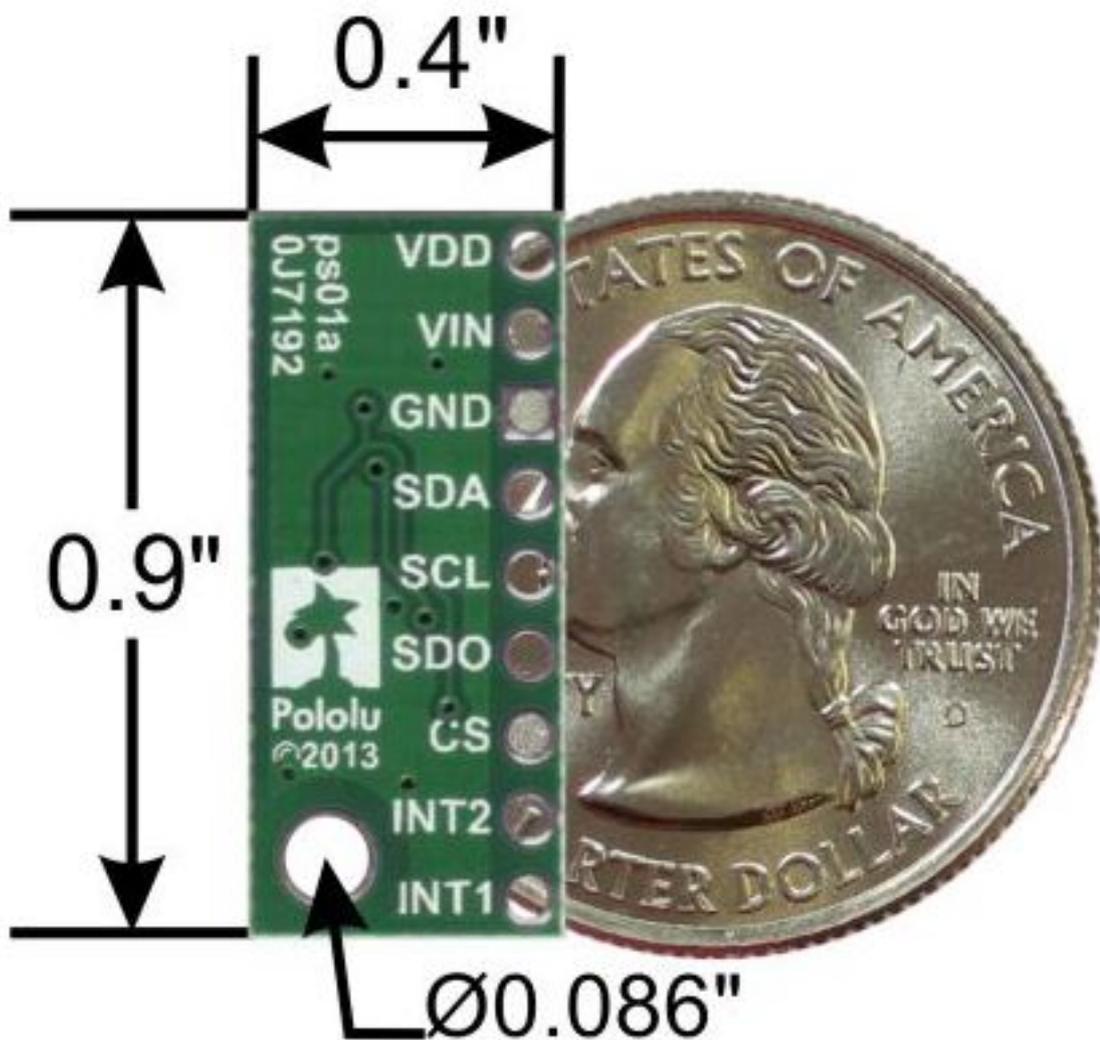
Specifications

- Dimensions: 0.4″ × 0.9″ × 0.1″ (10 mm × 23 mm × 3 mm)
- Weight without header pins: 0.6 g (0.02 oz)
- Operating voltage: 2.5 V to 5.5 V
- Supply current: 2 mA
- Output format (I²C/SPI): 24-bit pressure reading (4096 LSb/mbar)
- Sensitivity range: 260 mbar to 1260 mbar (26 kPa to 126 kPa)

Included components

A 1Ã—9 strip ofÂ [0.1â€³ header pins](#)Â and a 1Ã—9 strip ofÂ [0.1â€³ right-angle header pins](#)Â are included, as shown in the picture below. You can solder the header strip of your choice to the board for use withÂ [custom cables](#)Â orÂ [solderless breadboards,](#) or you can solder wires directly to the board itself for more compact installations.

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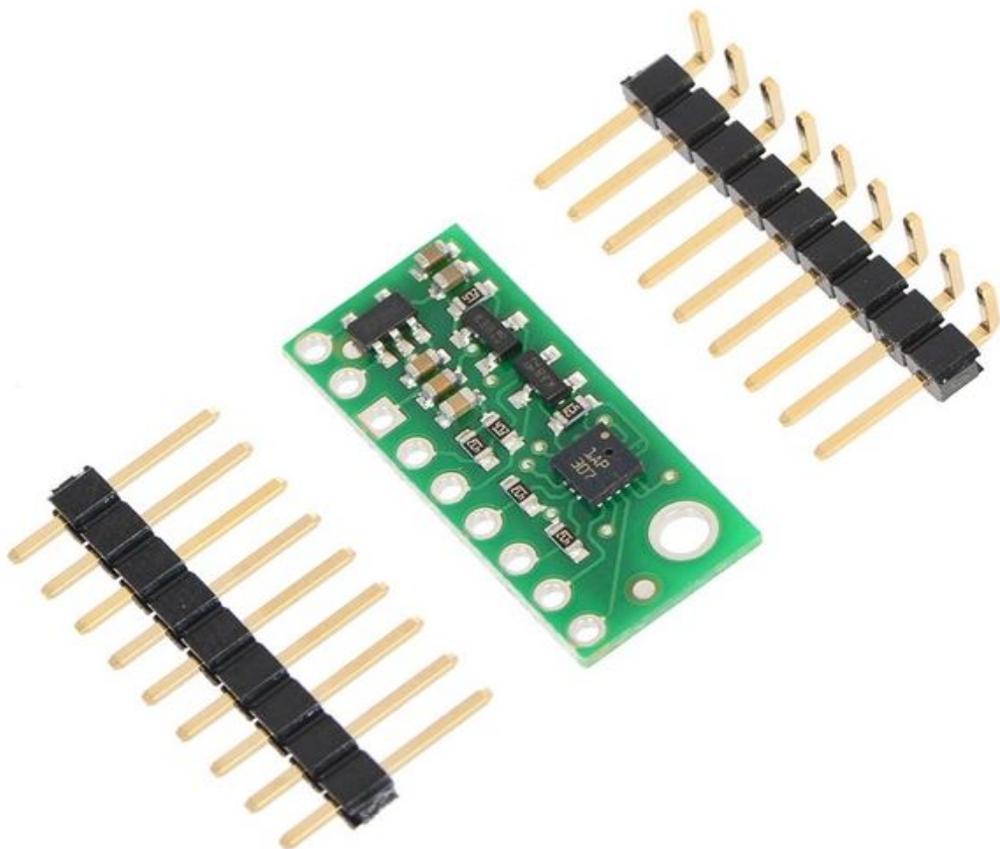
The board has one mounting hole that works with #2 and M2Â [screws](#)Â (not included).

Using the LPS331

Connections

Regardless of the interface being used to communicate with the LPS331AP, its VIN pin should be connected to a 2.5Â V to 5.5Â V source, and GND should be connected to 0 volts. (Alternatively, if you are using the sensor with a 3.3Â V system, you can leave VIN disconnected and bypass the built-in regulator by connecting 3.3Â V directly to VDD.)

A minimum of two logic connections are necessary to use the LPS331 in IÂ²C mode (this is the default mode): SCL and SDA. These should be connected to an IÂ²C bus operating at the same logic level as VIN.

To use the LPS331 in the default SPI mode, four logic connections are required: SPC, SDI, SDO, and CS. These should be connected to an SPI bus operating at the same logic level as VIN. The SPI interface operates in 4-wire mode by default, with SDI and SDO on separate pins, but it can be configured to use 3-wire mode so that SDO shares a pin with SDI.
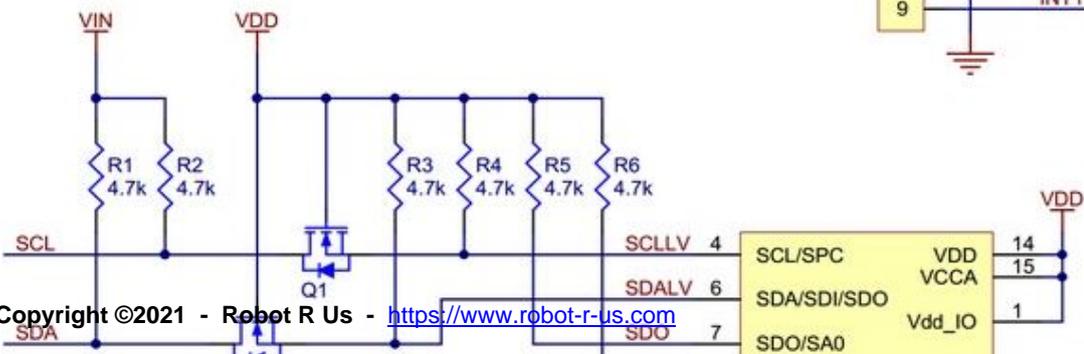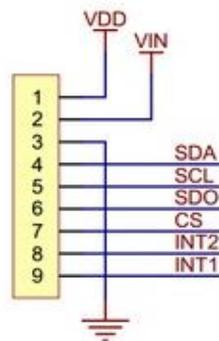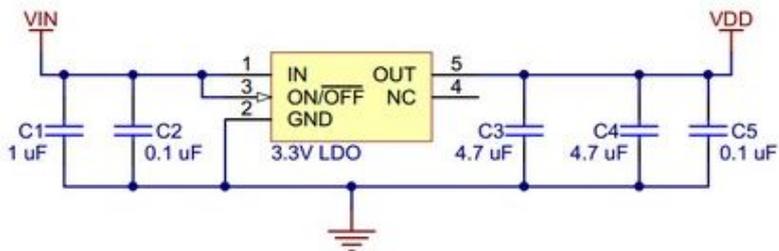
VDD (3.3V Out)

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Pinout

PIN	Description
VDD	Regulated 3.3Â VÂ **output**. Almost 150 mA is available to power external components. (If you want to bypass the internal regulator, you can instead use this pin as a 3.3Â V input with VIN disconnected.)
VIN	This is the main 2.5Â V to 5.5Â V power supply connection. The SCL/SPC and SDA/SDI level shifters pull the IÂ²C and SPI bus high bits up to this level.
GND	The ground (0 V) connection for your power supply. Your IÂ²C or SPI control source must also share a common ground with this board.
SDA/SDI/SDO	Level-shifted IÂ²C data line and SPI data in line (also doubles as SDO in 3-wire mode): HIGH is VIN, LOW is 0Â V
SCL/SPC	Level-shifted IÂ²C/SPI clock line: HIGH is VIN, LOW is 0Â V
SDO/SA0	SPI data out line in 4-wire mode: HIGH is VDD, LOW is 0Â V.Â *This output is not level-shifted.*Â Also used as an input to determine IÂ²C slave address (see below).
CS	SPI enable (chip select). Pulled up to VDD to enable IÂ²C communication by default; drive low to begin SPI communication.
INT2	Programmable interrupt, a 3.3-V-logic-level output.Â *This output is not level-shifted.*
INT1	Programmable interrupt, a 3.3-V-logic-level output.Â *This output is not level-shifted.*

Schematic Diagram

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VIN

IN   OUT   5
1
3
ON/OFF   NC   4
2
GND

C1
1 uF

C2
0.1 uF

3.3V LDO

C3
4.7 uF

C4
4.7 uF

C5
0.1 uF

VDD

VDD   VIN

1
2
3
4   SDA
5   SCL
6   SDO
7   CS
8   INT2
9   INT1

VIN   VDD

R1
4.7k

R2
4.7k

R3
4.7k

R4
4.7k

R5
4.7k

R6
4.7k

SCL

Q1

SDA

VDD

SCLLV   4   SCL/SPC   VDD   14

SDALV   6   SDA/SDI/SDO   VCCA   15

SDO   7   SDO/SA0   Vdd_IO   1

The above schematic shows the additional components the carrier board incorporates to make the LPS331AP easier to use, including the voltage regulator that allows the board to be powered from a 2.5 V to 5.5 V supply and the level-shifter circuit that allows for IÂ²C and SPI communication at the same logic voltage level as VIN. This schematic is also available as a[downloadable PDF](#)Â (156k pdf).

IÂ²C Communication

With the CS pin in its default state (pulled up to VDD), the LPS331AP can be configured and its pressure reading can be queried through the IÂ²C bus. Level shifters on the IÂ²C clock (SCL) and data (SDA) lines enable IÂ²C communication with microcontrollers operating at the same voltage as VIN (2.5 V to 5.5 V). A detailed explanation of the IÂ²C interface on the LPS331 can be found in itsÂ [datasheet](#)Â (453k pdf), and more detailed information about IÂ²C in general can be found in[NXPâ€™s IÂ²C-bus specification](#)Â (371k pdf).

In IÂ²C mode, the sensorâ€™s 7-bit slave address has its least significant bit (LSb) determined by the voltage on the SA0 pin. The carrier board pulls SA0 to VDD through a 4.7 kÎ© resistor, making the LSb 1 and setting the slave address to 1011101b by default. If the pressure sensorâ€™s selected slave address happens to conflict with some other device on your IÂ²C bus, you can drive SA0 low to set the LSb to 0.

The IÂ²C interface on the LPS331 is compliant with the IÂ²C fast mode (400 kHz) standard. In our tests of the board, we were able to communicate with the chip at clock frequencies up to 400 kHz; higher frequencies might work but were not tested. It is missing 50 ns spike suppression on the clock and data lines, and additional pull-ups on the clock and data lines might also be necessary to achieve compliant signal timing characteristics.

SPI Communication

To communicate with the LPS331AP in SPI mode, the CS pin (which the board pulls to VDD through a 4.7 kÎ© resistor) must be driven low before the start of an SPI command and allowed to return high after the end of the command. Level shifters on the SPI clock (SPC) and data in (SDI) lines enable SPI communication with microcontrollers operating at the same voltage as VIN (2.5 V to 5.5 V).

In the default 4-wire mode, the pressure sensor transmits data to the SPI master on a dedicated data out (SDO) line that isÂ notÂ level-shifted. If the SPI interface is configured to use 3-wire mode instead, the SDI line doubles as SDO and is driven by the LPS331 when it transmits data to the master. A detailed explanation of the SPI interface on the LPS331 can be found in itsÂ [datasheet](#)(453k pdf).

Sample Code

We have written a basicÂ [Arduino library for the LPS331](#)Â that makes it easy to interface this sensor with anÂ [Arduino](#). The library makes it simple to configure the LPS331 and read the raw pressure data through IÂ²C, and it provides functions for calculating altitude based on the measured pressure for those looking to use this sensor as an altimeter.

Protocol Hints

The datasheet provides all the information you need to use this sensor, but picking out the important details can take some time. Here are some pointers for communicating with and configuring the LPS331AP that we

hope will get you up and running a little bit faster:

- The pressure sensor is powered down by default. You have to turn it on by writing the appropriate value to the CTRL_REG1 register to choose an output data rate.

You can enable the same auto-increment feature in SPI mode by asserting the second bit (bit 1, called the MS bit in the datasheet) of an SPI command.

- You can read or write multiple registers in a single IÂ²C command by asserting the most significant bit of the register address to enable address auto-increment.

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File downloads [LPS331AP datasheet](#)Â (453k pdf)Datasheet for the ST LPS331AP MEMS pressure sensor. [LPS331AP pressure/altitude sensor carrier with voltage regulator schematic diagram](#)Â (156k pdf)Printable schematic diagram for the LPS331AP pressure/altitude sensor carrier with voltage regulator.[AN4159: hardware and software guidelines for the LPS331AP](#)Â (663k pdf)Application note from ST with hardware and software guidelines for use of the LPS331AP pressure sensor.[UM10204 IÂ²C-bus specification and user manual](#)Â (371k pdf)The official specification for the IÂ²C-bus, which is maintained by NXP.

Recommended links [LPS331 Arduino library](#)This is a library for theÂ [Arduino](#)Â that interfaces with theÂ [Pololu LPS331AP pressure/altitude sensor carrier](#)Â as well as the pressure sensor IC on the[AltIMU-10](#). It makes it simple to read the raw pressure data from the sensor, and it provides functions to help calculate altitude based on the measured pressure.[LPS331AP pressure sensor test flight](#)Testing theÂ [LPS331AP pressure sensor](#)Â as an altimeter in an airplane.
[Vendor Information](#)

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