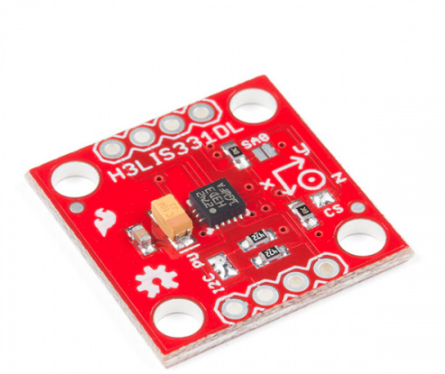
H3LIS331DL Accelerometer Breakout Hookup Guide

Introduction

The H3LIS331DL is a high-g accelerometer with I2C and SPI interface options. It offers an adjustable output range of 100, 200, or 400g, and an adjustable data rate of up to 1kHz.



SparkFun Triple Axis Accelerometer Breakout - H3LIS331DL

SEN-14480

Required Materials

Please check the wish list below for items required to follow this tutorial.

H3LIS331DL Hookup Guide SparkFun Wish List

SparkFun Triple Axis Accelerometer Breakout - H3LIS331DL
SEN-14480

Arduino Pro 328 - 3.3V/8MHz
DEV-10914
It's blue! It's skinny! It's the Arduino Pro! SparkFun's minimal design a…

Arduino Stackable Header Kit
PRT-10007
These headers are made to work with the Arduino Main Board, Ardui…

Breadboard - Mini Modular (Green)
PRT-12046
This green Mini Breadboard is a great way to prototype your small pro…

USB micro-B Cable - 6 Foot
CAB-10215
USB 2.0 type A to micro USB 5-pin. This is a new, smaller connector f…

SparkFun Beefy 3 - FTDI Basic Breakout
DEV-13746
This is SparkFun Beefy 3 FTDI Basic Breakout for the FTDI FT231X…

Break Away Headers - Straight
PRT-00116
A row of headers - break to fit. 40 pins that can be cut to any size. Us…

Jumper Wires Premium 6" M/M Pack of 10
PRT-08431
This is a SparkFun exclusive! These are 155mm long jumpers with m…

Tools

No special tools are required to follow this tutorial. You will need a soldering iron, solder, and general soldering accessories.

Soldering Iron - 30W (US, 110V)
TOL-09507

Solder Lead Free - 15-gram Tube
TOL-09163

Suggested Reading

We suggest reviewing the tutorials below to ensure that you're up-to-date with all of the skills necessary to follow this hookup guide.

How to Solder: Through-Hole Soldering
This tutorial covers everything you need to know about through-hole soldering.

Installing an Arduino Library
How do I install a custom Arduino library? It's easy!

Serial Peripheral Interface (SPI)
SPI is commonly used to connect microcontrollers to peripherals such as sensors, shift registers, and SD cards.

Logic Levels
Learn the difference between 3.3V and 5V devices and logic levels.

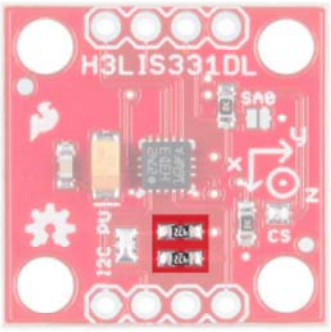
I2C
An introduction to I2C, one of the main embedded communications protocols in use today.

Hardware Overview

The H3LIS331DL breakout is fairly simple.

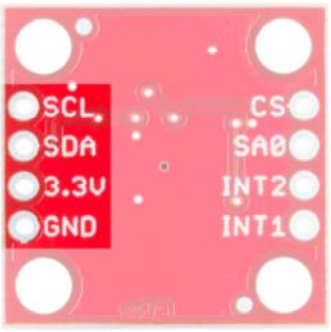
H3LIS331DL Sensor IC - This is the sensor IC. Its operating voltage only extends up to **3.6V**, so to use it with a 5V Arduino or Arduino clone, you'll need some kind of voltage translation! It is perfectly centered on the PCB.

I²C Pull-up Resistors - The board includes pull-up resistor so you don't need to add them externally.



I²C Pull-up Resistor Isolation Jumper - If necessary, the I²C pull-up resistors can be removed from the circuit by removing the solder from this jumper.

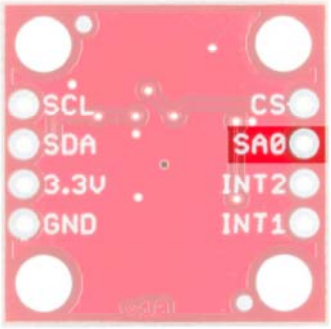
SparkFun Standard I²C Header - Most boards which can be communicated to via I²C use this pinout, making it easy to stack them or connect them in a daisy chain.



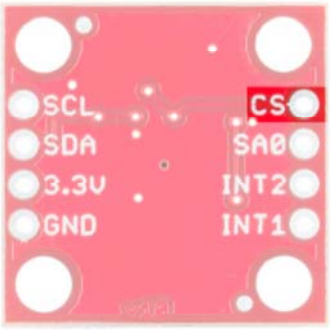
SA0 Jumper - Closing this jumper changes the I²C address of the sensor from 0x19 to 0x18.

CS Jumper - Removing the solder from this jumper enables SPI mode. When the part's CS line is low at boot, it enables SPI mode.

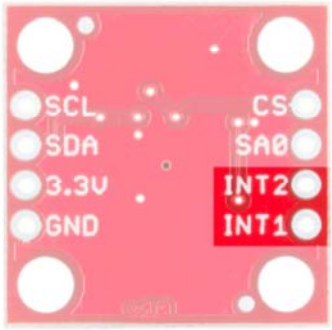
SA0 Pin - When the chip is in SPI mode, this goes from being the address select pin to being the MISO pin.



CS Pin - Chip select for SPI mode. Unused in I²C mode.



Interrupt Pins - These pins are tied to interrupts that can be setup by the software library to trigger on various conditions.



Library Overview

Here's a list of the functions supported by the Arduino library for the LIS331 family.

`begin(comm_mode mode)` - Sets the communications mode to be used by the library (`LIS331::USE_I2C` or `LIS331::USE_SPI`), sets the power mode to normal, enables the axes, sets the sampling rate to 50Hz, and resets all the other registers to 0.

`setI2CAddr(address)` - Sets the I²C address. By default this is going to be 0x19. If the SA0 jumper is soldered closed, it is 0x18. **This function must be called before `begin()` so the library knows what address to use for communications.**

`setSPICSPin(pin)` - Sets the SPI mode chip select pin. **This function must be called before `begin()` so the library knows which pin to use for communications.**

`axesEnable(bool enable)` - Pass `true` to enable the axes or `false` to disable them.

`setPowerMode(power_mode pmode)` - Sets the power mode of the chip. This affects the data rate as well. Options are:

- **`LIS331::POWER_DOWN`** - Minimizes chip power usage but no data or communications are possible
- **`LIS331::NORMAL`** - Normal power mode. Data rate is set by the `setODR()` function.
- **`LIS331::LOW_POWER_0_5HZ`** - Low power mode, 0.5Hz data rate.
- **`LIS331::LOW_POWER_1HZ`** - Low power mode, 1Hz data rate.
- **`LIS331::LOW_POWER_2HZ`** - Low power mode, 2Hz data rate.
- **`LIS331::LOW_POWER_5HZ`** - Low power mode, 5Hz data rate.
- **`LIS331::LOW_POWER_10HZ`** - Low power mode, 10Hz data rate.

`setODR(data_rate drate)` - Sets the data rate for the part, when in normal power mode only. Options are:

- **`LIS331::DR_50HZ`** - Set the data rate to 50Hz.
- **`LIS331::DR_100HZ`** - Set the data rate to 100Hz.
- **`LIS331::DR_400HZ`** - Set the data rate to 400Hz.
- **`LIS331::DR_1000HZ`** - Set the data rate to 1000Hz.

`readAxes(int16_t &x, int16_t &y, int16_t &z)` - Pass three `int16_t` variables to this function and those variables will be populated with the appropriate value from the accelerometer.

`convertToG(maxScale, reading)` - Converts from raw data to an actual g-reading. The first parameter is the maximum reading for the current mode, as set by the `setFullScale()` function. Options are 6/12/24g for the LIS331HH and 100/200/400g for the H3LIS331DL.

`setHighPassCoeff(high_pass_cutoff_freq_cfg hpcoeff)` - Set the coefficient for the high pass filter. The actual cutoff frequency is dependent upon the data rate set by `setODR()`. The cutoff frequency is (fs)/(6*Hpc), where fs is the sampling frequency and Hpc is the high pass coefficient as set by these constants:

- **`LIS331::HPC_8`** - Sets coefficient to 8.
- **`LIS331::HPC_16`** - Sets coefficient to 16.
- **`LIS331::HPC_32`** - Sets coefficient to 32.
- **`LIS331::HPC_64`** - Sets coefficient to 64.

`enableHPF(bool enable)` - `true` to enable, `false` to disable.

`HPFOOnIntPin(bool enable, intSource)` - Does the high pass filter apply to the signal the interrupt is based on? `true` to enable, `false` to disable, and the second parameter is 1 or 2 depending on which interrupt you wish to apply this setting to.

`intActiveHigh(bool enable)` - Pass `true` to set the interrupt pin to active high, `false` to set it as active low. Default value is active high.

`intPinMode(pp_od _pinMode)` - Are the interrupt pins open-drain or push pull? Pass `LIS331::PUSH_PULL` or `LIS331::OPEN_DRAIN`.

`intSrcConfig(int_sig_src src, pin)` - What sort of thing triggers an interrupt, and which pin shows the interrupt. The options are:

- **`LIS331::INT_SRC`** - Interrupt source is the same as the pin number.
- **`LIS331::INT1_2_SRC`** - Either interrupt will be reflected on the pin.
- **`LIS331::DRDY`** - The “new data ready” signal will be reflected on the pin.
- **`LIS331::BOOT`** - The boot mode status of the part is reflected on the pin.

`setFullScale(fs_range range)` - Sets the range of the part, as listed below:

- **`LOW_RANGE`** - +/-6g for the LIS331HH or +/-100g for the H3LIS331DH.
- **`MED_RANGE`** - +/-12g for the LIS331HH or +/-200g for the H3LIS331DH.
- **`HIGH_RANGE`** - +/-24g for the LIS331HH or +/-400g for the H3LIS331DH.

`bool newXData()` - returns `true` if new X data is available since last read of X data register.

`bool newYData()` - same as `newXData()` for Y axis.

`bool newZData()` - same as `newZData()` for Z axis.

`enableInterrupt(int_axis axis, trig_on_level trigLevel, interrupt, bool enable)` - `axis` can be `LIS331::X_AXIS`, `LIS331::Y_AXIS`, or `LIS331::Z_AXIS`. `trigLevel` can be `LIS331::TRIG_ON_HIGH` or `LIS331::TRIG_ON_LOW`, `interrupt` can be 1 or 2, and `enable` is `true` to enable the interrupt and `false` to disable it.

`setIntDuration(duration, intSource)` - `duration` can be any value from 0-127, and represents the time in number of samples that the sensor must read above or below the threshold set by the user. `intSource` is 1 or 2.

`setIntThreshold(threshold, intSource)` - `threshold` is the absolute magnitude above or below which an interrupt will occur, divided by 16. It can range from 0-127. `intSource` is 1 or 2.

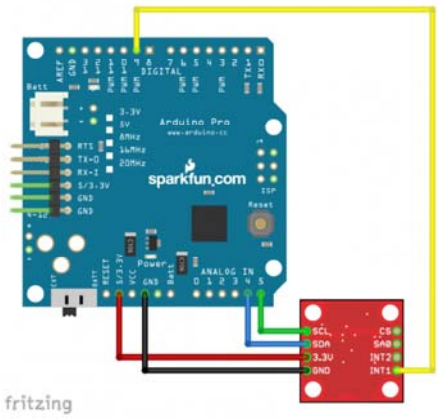
Examples

Hardware Hookup

The H3LIS331DL supports I²C, SPI, and three-wire SPI data transfer. The library supports I²C and SPI mode. Obviously, since SPI requires four wires and I²C only requires two, there are different circuit configurations for each mode. Now would be a good time to solder the female headers to the Arduino Pro 3.3V/8MHz and breakaway headers to the H3LIS331DL sensor before connecting the boards together.

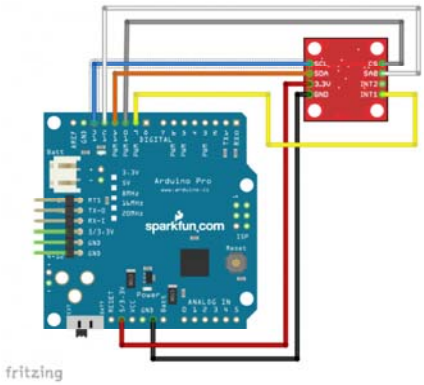
I²C Mode

The board is labeled for I²C mode. Here you can see it connected to a 3.3V Arduino Pro. Note that connecting the board to a 5V Arduino can damage it.



SPI Mode

In SPI mode, the SDA pin becomes MOSI, the SCL pin becomes clock, the address select pin SA0 become MISO, and the CS pin is used for chip select.



Example Code

Note: This example assumes you are using the latest version of the Arduino IDE on your desktop. If this is your first time using Arduino, please review our tutorial on installing the Arduino IDE. If you have not previously installed an Arduino library, please check out our installation guide.

You will also need FTDI drivers installed in order to upload code to the Arduino Pro. If this is your first time using an FTDI, make sure to follow our tutorial: USB Serial Driver Quick Install.

To follow along with the examples, the code requires the LIS331 Arduino library. Make sure that the library has been installed.

SPARKFUN LIS331 ARDUINO LIBRARY

For the most part, the example code for SPI mode and I²C mode is identical. The only part that differs is the intial setup where you configure the pins to be used and the library's settings.

I²C Mode Setup

Here's an example of the same section of code from an I²C configured system. It's important to note that order matters here: `Wire.begin()` and `xl.setI2CAddr()` must be called before `xl.begin()`.

```
#include "SparkFun_LIS331.h"
#include <Wire.h>

LIS331 xl;

void setup()
{
  // put your setup code here, to run once:
  pinMode(9,INPUT);       // Interrupt pin input
  Wire.begin();
  xl.setI2CAddr(0x19);    // This MUST be called BEFORE .begin
() so
                          //  .begin() can communicate with th
e chip
  xl.begin(LIS331::USE_I2C); // Selects the bus to be used an
d sets
                          //  the power up bit on the accelero
meter.
                          //  Also zeroes out all acceleromete
r
                          //  registers that are user writabl
e.
```

SPI Mode Setup

Here we have the first few lines of an SPI mode sketch. Again, order is important: `pinMode()`, `SPI.begin()`, and `xl.setSPICSPin()` functions must all be called before the `xl.begin()` function is called.

```
#include "SparkFun_LIS331.h"
#include <SPI.h>

LIS331 xl;

void setup()
{
  // put your setup code here, to run once:
  pinMode(9,INPUT);       // Interrupt pin input
  pinMode(10, OUTPUT);    // CS for SPI
  digitalWrite(10, HIGH); // Make CS high
  pinMode(11, OUTPUT);    // MOSI for SPI
  pinMode(12, INPUT);     // MISO for SPI
  pinMode(13, OUTPUT);    // SCK for SPI
  SPI.begin();
  xl.setSPICSPin(10);     // This MUST be called BEFORE .begin
() so
                          //  .begin() can communicate with th
e chip
  xl.begin(LIS331::USE_SPI); // Selects the bus to be used an
d sets
                          //  the power up bit on the accelero
meter.
                          //  Also zeroes out all acceleromete
r
                          //  registers that are user writabl
e.
```

After this point, the code for either mode of operation is the same. Note that this example code includes only the second half of the setup function, and if you're copy/pasting from this example, you must copy the other half of the setup function from one of the above code chunks.

```
  // This next section configures an interrupt. It will cause
pin
  //  INT1 on the accelerometer to go high when the absolute v
alue
  //  of the reading on the Z-axis exceeds a certain level fo
r a
  //  certain number of samples.
  xl.intSrcConfig(LIS331::INT_SRC, 1); // Select the source o
f the
                          //  signal which appears on pin INT
1. In
                          //  this case, we want the correspon
ding
                          //  interrupt's status to appear.
  xl.setIntDuration(50, 1); // Number of samples a value must
meet
                          //  the interrupt condition before a
n
                          //  interrupt signal is issued. At t
he
                          //  default rate of 50Hz, this is on
e sec.
  xl.setIntThreshold(2, 1); // Threshold for an interrupt. Thi
s is
                          //  not actual counts, but rather, a
ctual
                          //  counts divided by 16.
  xl.enableInterrupt(LIS331::Z_AXIS, LIS331::TRIG_ON_HIGH, 1,
true);
                          // Enable the interrupt. Parameters
indicate
                          //  which axis to sample, when to tr
igger
                          //  (in this case, when the absolut
e mag
                          //  of the signal exceeds the thresh
old),
                          //  which interrupt source we're con
figuring,
                          //  and whether to enable (true) or
disable
                          //  (false) the interrupt.
  Serial.begin(115200);
}

void loop()
{
  static long loopTimer = 0;
  int16_t x, y, z;
  if (millis() - loopTimer > 1000)
  {
    loopTimer = millis();
    xl.readAxes(x, y, z);  // The readAxes() function transfer
s the
                           //  current axis readings into the
three
                           //  parameter variables passed to i
t.
    Serial.println(x);
    Serial.println(y);
    Serial.println(z);
    Serial.println(xl.convertToG(100,x)); // The convertToG()
function
    Serial.println(xl.convertToG(100,y)); // accepts as parame
```

```
ters the
    Serial.println(xl.convertToG(100,z)); // raw value and th
e current
    Serial.println(" ");                // maximum g-rating.
  }
  if (digitalRead(9) == HIGH)
  {
    Serial.println("Interrupt");
  }
}
```

After placing the code into the Arduino IDE, select the board definition and COM port to upload. Once compiled, check out the sensor readings by opening up a serial monitor set to 115200 baud.

Resources and Going Further

Now that you've successfully got your H3LIS331DL up and running, it's time to incorporate it into your own project!

- For lower dynamic ranges (6-24g) SparkFun offers the LIS331 breakout board, which is library compatible with this one.

For more information, check out the resources below:

- Schematic
- Eagle Files (ZIP)
- H3LIS331DL Datasheet (PDF)
- Product Showcase Video
    - ShawnHymel's H3LIS331_Ball_Demo.ino - Code used for the Produce Showcase Demo.
- GitHub Repo
- Arduino Library Code Repo

Need some inspiration for your next project? Check out some of these related tutorials:

VL6180 Hookup Guide
Get started with your VL6180 based sensor or the VL6180 breakout board.

RedBoard Santa Trap
A fun holiday project to try for anyone looking to catch Santa on Christmas!

LSM6DS3 Breakout Hookup Guide
A hookup guide for the LSM6DS3, which features a 3-axis accelerometer, 3-axis gyroscope, and FIFO buffer.

LSM303C 6DoF Hookup Guide
A basic guide to get started with the LSM303C 6 Degrees of Freedom Breakout.