LaACES
Student
Ballooning
Course

SparkFun Triple Axis Accelerometer & Gyroscope

Capabilities, construction, hardware and software interfacing

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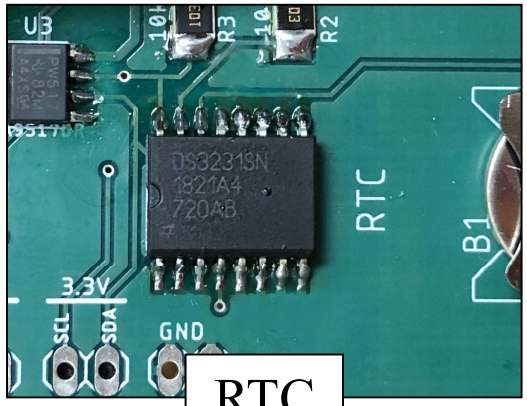
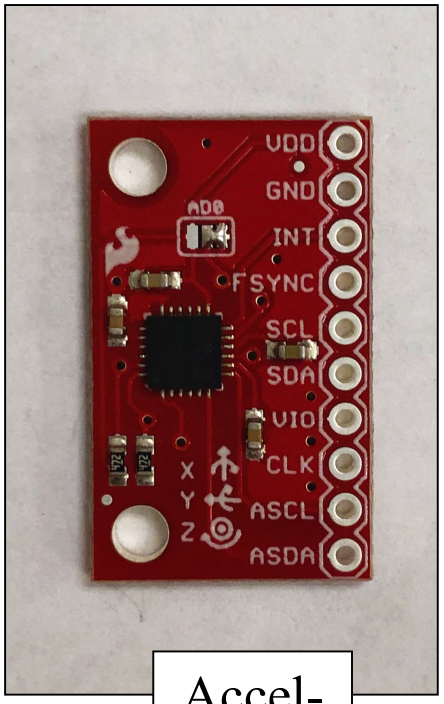
RTC & Accel. – Gyro Combo

The Accel.-Gyro & the RTC communicate with the Arduino Mega using serial communication via an I2C bus.



RTC



Accel-Gyro

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RTC Overview
Lets explore how RTCs work:

- Quartz crystal oscillators are the standard time keeping method in today's electronics for their accuracy and low cost.
- Quartz crystals are *piezoelectric,* which is a fancy word for a material that generates electricity when deformed *or* is deformed when electricity is applied to it.
- A battery applies a voltage to the crystal which causes the quartz to deform (vibrate) like a tuning fork. The subsequent electrical pulses produced are interpreted as a frequency to tell time.

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RTC Overview Continued:

- The crystal requires very little power so the tiny-compact battery suppling the voltage can easily last years!
- Most RTC quartz frequencies range from 65- 500 [kHz], but the RTC's on satellites, the Space Shuttle, & the ISS have frequencies in the MHz for precision.

❖ Fun fact: dogs can hear the lower quartz oscillation frequencies used in thumb drives, watches, cellphones, etc. {The crystal oscillates regardless if the device is powered off!}

K-9 unit used to find "hidden electronics"

RTC Communication

- 400kHz I2C Interface
- The I2C interface is accessible whenever either V_{CC} or V_{BAT} is at a valid level.
- Real-Time Clock Counts Seconds, Minutes, Hours, Date of the Month, Month, Day of the Week, and Year, with Leap-Year Compensation.
- 3.3 V operation

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How I2C Communication Works

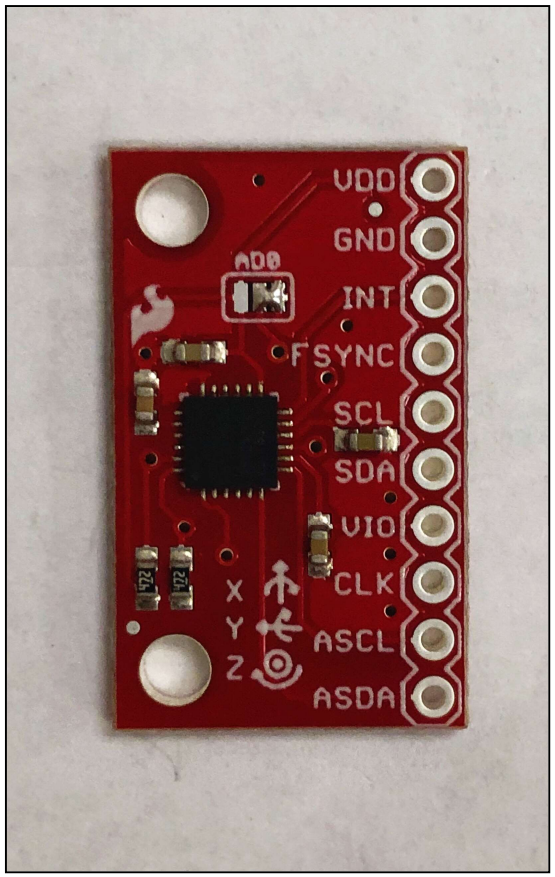
A good visual analogy:

- You plug a power strip into a wall to connect multiple devices to one outlet. The I2C bus is a virtual power strip plugged into the Mega, and you can plug in devices at will for access to the Mega.
- Yet, the I2C bus is a “smart” power strip. To prevent confusion, it gives each device an identification number and only allows one device at a time to talk to the Mega.
- Both the RTC and Gyro/Accelerometer use I2C to communicate.

MPU Overview

The MPU is located on a SparkFun breakout board, and combines a 3-axis gyroscope and 3-axis accelerometer. It communicates to non-internal components via a I2C at 400kHz or SPI at 1MHz.

The MPU operates from VDD power supply voltage range of 2.3V-3.4V. Also, the MPU provides a VLOGIC reference pin which sets the logic levels of its I2C interface.



Sensor Communication

- The gyro has 3 16-bit ADCs for digital output.
- Each ADC's sample rate is programmable from 8,000 samples per second, down to 3.9 samples per second
- The gyroscope has programmable ranges of ±250, ±500, ±1000 degrees per second (dps)
  - The accelerometer has 3 16-bit ADCs (one for the x, y, & z axes respectively) for digital output.
  - Accelerometer programmable ranges of ±2g, ±4g, ±8g, and ±16

Sensor Communication

- The accelerometer has three 16-bit ADCs (one for the x, y, & z axes respectively) for digital output.
- Accelerometer programmable ranges of ±2g, ±4g, ±8g, and ±16
- I2C Digital-output of 6 or 9-axis MotionFusion data in rotation matrix, quaternion, Euler Angle, or raw data format

How the sensors work

Accelerometer

The sensor has sets of flexible conducting plates in all three axes{plural for axis}. G-forces warp the flexible plates and the change in conductance is registered as acceleration.

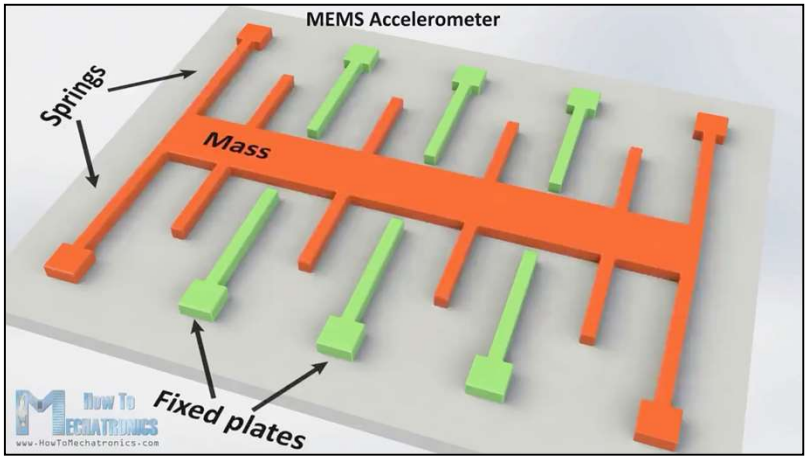
Gyroscope

In principle, it works just like the accelerometer, but is more complex. The change in conductance on the plates is caused by the Coriolis effect instead of g-forces.

Accelerometer Operation

The accelerometer works by registering the change in capacitance between fixed plates. Change in capacitance occurs when a mass attached to a set of springs moves in response to the g-forces accelerating it.

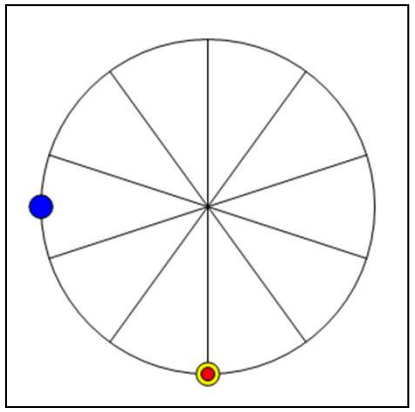
Click play on the video to the right.



Gyroscope Operation

Internally, the gyro works similar to the accelerometer, but instead of g-forces causing the spring-mass system to move the *Coriolis* effect causes it to move. The Coriolis effect occurs when an object has a forward velocity, but is traveling on a body that is rotating.

The Coriolis effect is why hurricanes spin. The storm has a forward velocity, but is on a planet that is spinning. Below are a few animations of the Coriolis effect in action.



Breakout board pin layout