SparkFun Triple Axis Accelerometer & Gyroscope

Capabilities, construction, hardware and software interfacing
RTC &
Accel. – Gyro Combo

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

• The crystal requires very little power so the tiny-compact battery supplying 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!}
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
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.
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.
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 $\pm 250$, $\pm 500$, $\pm 1000$ 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 $\pm 2g$, $\pm 4g$, $\pm 8g$, and $\pm 16$
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. 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