Chapter # 15

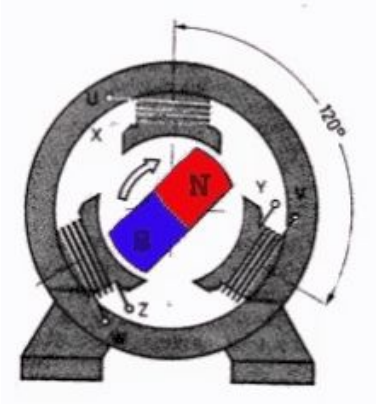
LED COMPASS

Compass

A compass is an instrument used for navigation and orientation that shows direction relative to the geographic cardinal directions. Usually, a diagram called a compass rose shows the directions north, south, east, and west on the compass face as abbreviated initials.

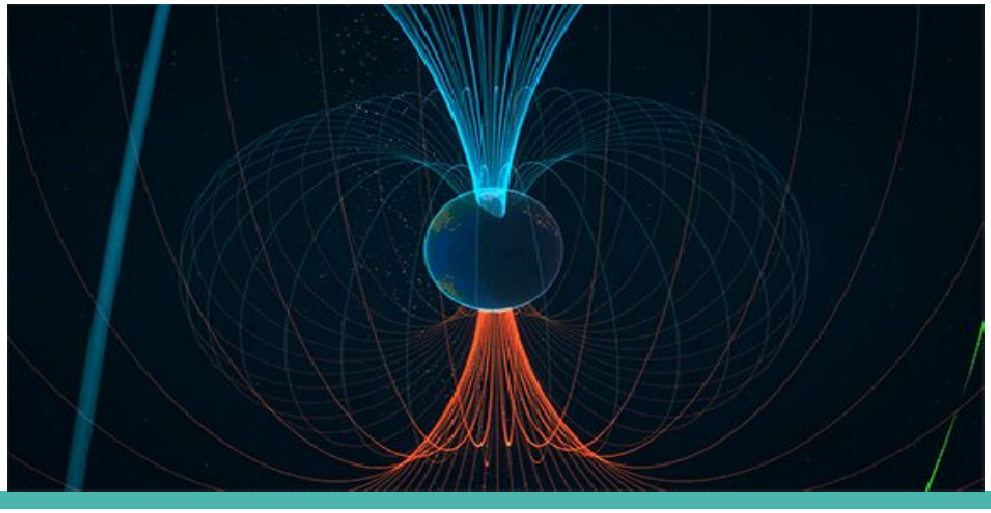
Working of a Compass

Compasses work so effortlessly because their design allows the magnet to respond freely to Earth's magnetic field. Earth itself is like a giant magnet that creates its own magnetic field. The north end of a **compass** is drawn to align with Earth's magnetic North Pole.



Earth’s Magnetic Field

Earth's magnetic field, also known as the **geomagnetic field**, is the magnetic field that extends from the Earth's interior out into space, where it interacts with the solar wind, a stream of charged particles emanating from the Sun.

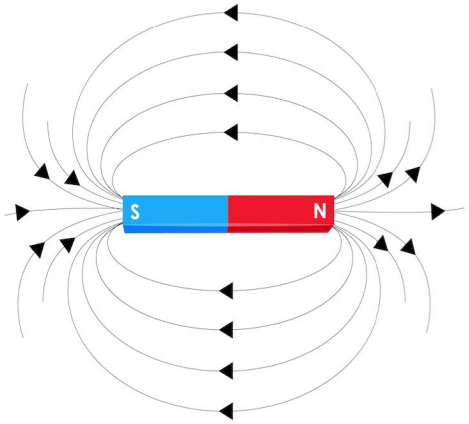


LED Compass

We'll implement a compass using the LEDs on the F3. Like proper compasses, our LED compass must point north somehow. It will do that by turning on one of its eight LEDs; the on LED should point towards north.

Magnetic Field

A **magnetic field** is a vector **field** that describes the **magnetic** influence of electric charges in relative motion and magnetized materials. The effects of **magnetic fields** are commonly seen in permanent **magnets**, which pull on **magnetic** materials (such as iron) and attract or repel other **magnets.**



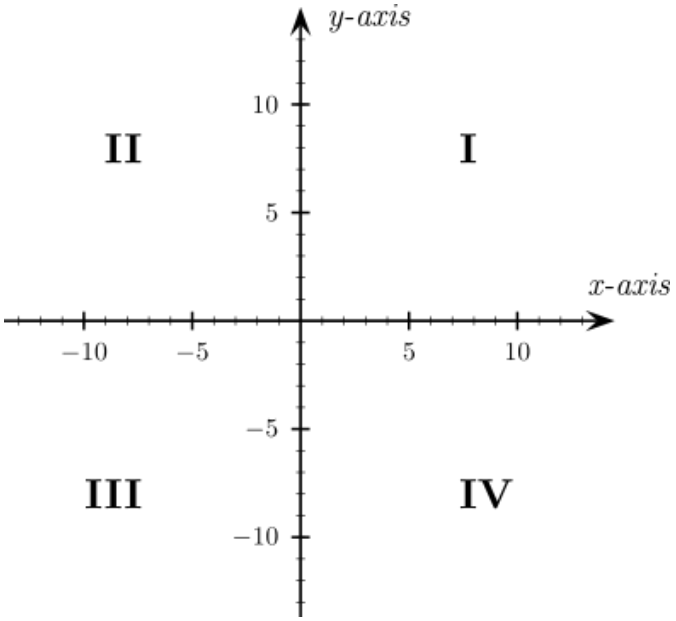
LSM303DLHC Package

Magnetic fields have both a magnitude, measured in Gauss or Teslas, and a *direction*. The magnetometer on the F3 measures both the magnitude and the direction of an external magnetic field but it reports back the *decomposition* of said field along *its axes*. As shown in console.

```
$ # itmdump terminal
(..)
I16x3 { x: 45, y: 194, z: -3 }
I16x3 { x: 46, y: 195, z: -8 }
I16x3 { x: 47, y: 197, z: -2 }
```

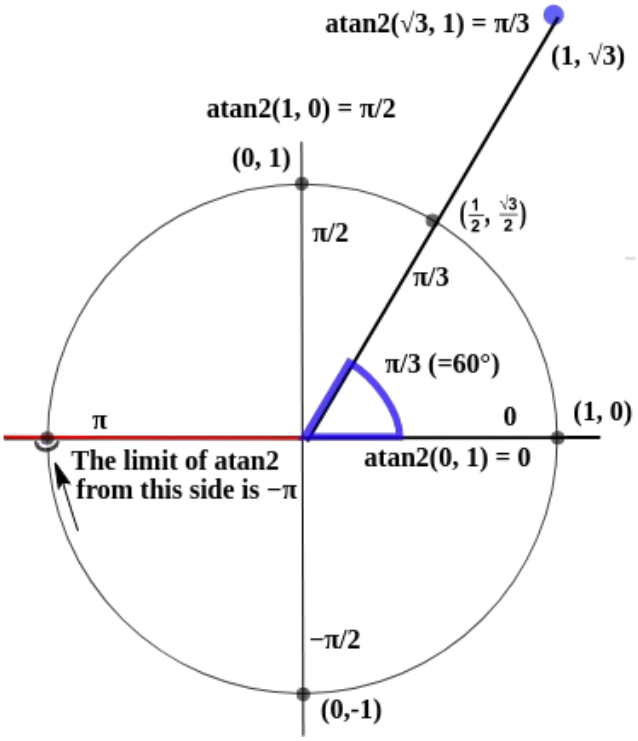
Take 1

If we only looked at the signs of the X and Y components we could determine to which quadrant the magnetic field belongs to.



Take 2

We'll use math to get the precise angle that the magnetic field forms with the X and Y axes of the magnetometer. We'll use the atan2 function. This function returns an angle in the -PI to PI range.



Magnitude

- The number that the magnetic_field function reports are unit-less.
- We convert those values to Gauss.
- *Magnetic gain setting* that has different values according to the values of the GN bits. By default, those GN bits are set to 001.
- We need to do is divide the X, Y and Z values that the sensor outputs by its corresponding *gain*.
- The magnitude of the Earth's magnetic field is in the range of 250 mG to 650 mG (the magnitude varies depending on your geographical location)

Calibration

- The direction of the Earth's magnetic field with respect to the magnetometer should change but its magnitude should not
- The magnetometer indicates that the magnitude of the magnetic field changes as the board rotates.
- The calibration involves quite a bit of math (matrices).
- Let's record the readings of the magnetometer while we slowly rotate the board in different directions.

Conclusion

- Reading values from magnetometer.
- Design LED Compass.
- Calculate its Magnitude.
- Calibrate the sensor to get accurate Readings.