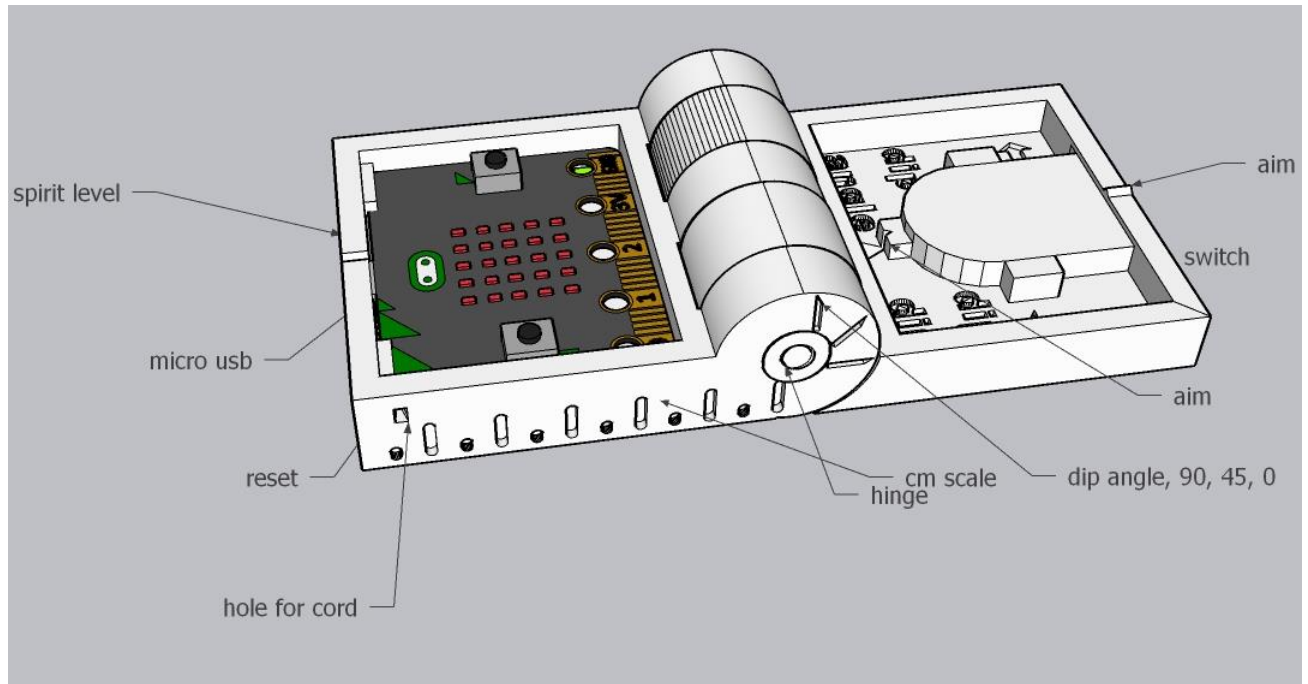


## User manual

### Geo:bit Digital Geological Compass



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## Getting to know your compass

When power is switched on, using the switch on the battery holder, a starting sequence is shown on the 5 \* 5 display. After that, the compass is in spirit level mode, and one led is lit mimicking a spirit level. After use, switch of the power and close lid.

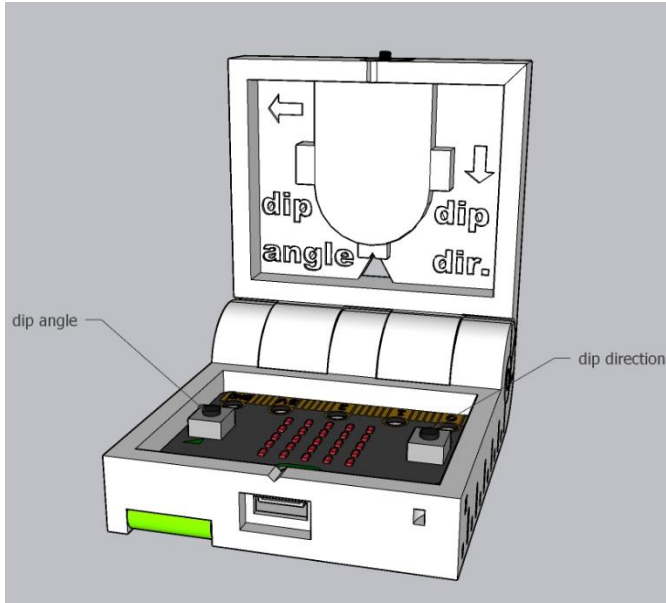


Figure 1:geo:bit, functions of the buttons

Power is supplied from CR2032 power cell, stored in the lid, as far as possible from the magnetic sensor on the micro:bit. The batteries can easily be replaced.

Three triangular sights in the compass casing help shooting a bearing. See section taking a bearing below)

A micro usb port is present on the front of the compass, a hole to access the micro:bit reset button is located on the bottom of the compass.

A ruler is printed on the right side of the base.

## Calibration

We use the build in magnetometer of the micro:bit to measure the magnetic field. Micro:bit measures three axes of the magnetic field and calculates the North direction from those. Before first use the compass must be calibrated, using the build-in calibration sequence, that requires rotating and tilting the compass in all directions so all the LEDs on the display are on. It is advised to check the calibration with an analogue compass. Calibration can be reinitiated at any time by pressing button A and B at the same time. The calibration is stored in Micro:bit's memory and remains there even when power is switched of. Resetting Micro:bit using the reset button, requires a new calibration.

The calibration algorithm has been published by Lancaster University on Github, and appears to be working well. However, it is always advisable to double check the calibration on a regular base.

Important is to calibrate the compass with the battery socket in place, since movement of metal objects will have an impact on the magnetic readings. Further, it is recommended to calibrate in the absence of metal objects, outdoors, away from magnetic interference from cars, mobile phone, power lines etc..

Declination of the True North from the geographical North can be programmed in the geo:bit's programme, its default is set to 0 degrees.

## Using the compass

### Bearing

The geo:bit compass can be used to shoot a bearing in the field. By aligning sights 1, 2 and 3 or 4 in a straight line, pressing button A, will display the direction of that vector, from the compass towards the user, if the direction of a far away object is needed with respect to the user, 180 degrees should be added or subtracted.

In a similar fashion inclination can be measured, using button B and viewing parallel to the long side of an open compass.

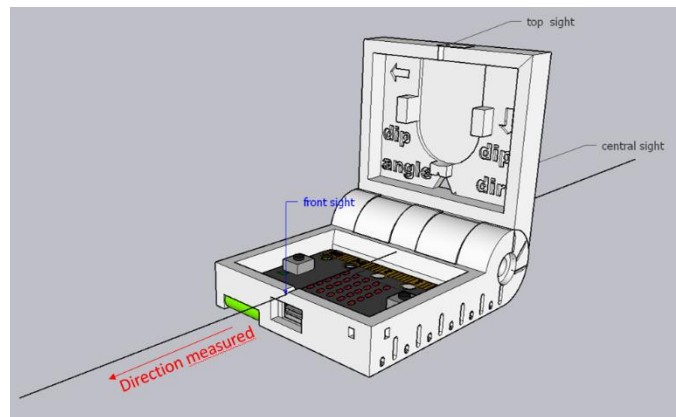


Figure 2: Shooting a bearing

### Reading the LED display

The led display is designed to display values in (almost) real time. We use the 25 LEDs as a bar graph, showing numbers up to 599, we only need 360 for a compass. The first column displays the hundreds, the second and third column display the ten's and the fourth and fifth column display the ones.

This method of displaying numbers is much faster than scrolling 3 digit numbers across the display, and allows to display the numbers in real time. Real time values are displayed as long as the button is pressed. It takes a little bit of practice to read the numbers in this fashion.

Even in direct sunlight the LEDs are readable, in darker conditions the readability surpasses that of a normal compass.

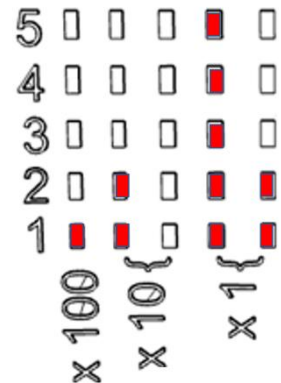


Figure 3: Example of the LED display showing the number 127

### Waterproof

The compass is not waterproof, and care should be taken when using it in wet conditions, water can permanently damage the electronic components of the compass.

## Orientation of planar features

There are two often used methods for defining the orientation of a plane in space. Strike / dip measures the orientation of a horizontal line in the plane we want to define, in the figure below, that

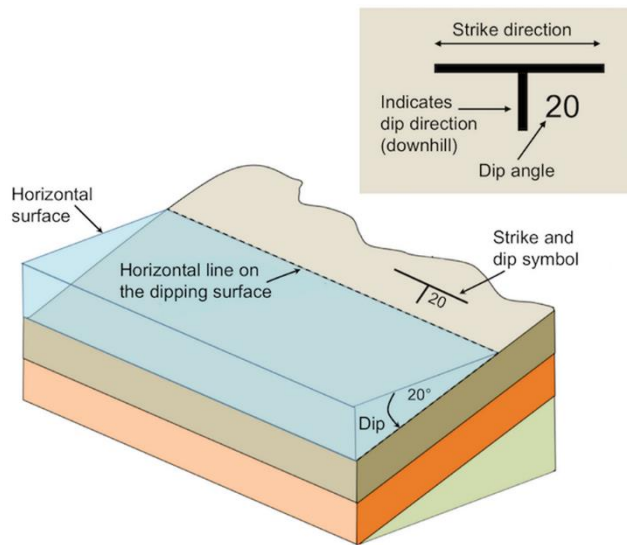


Figure 4: Orientation of a plane, strike/ dip and dip direction/ dip angle, Source: Karla Panchuk (2018) CC BY 4.0.

is either to left or to the right. Often the right hand rule is applied, meaning that if you put your right hand with the palm on the strata, fingers pointing down dip, then your thumb indicates the strike direction.

This compass uses dip direction, as indicated in the figure, which is the steepest line in a plane, and by definition perpendicular to the strike, and pointing downwards. The compass can easily be adapted to show strike by subtracting 90 degrees.

I favour dip direction and dip angle, but realise that many American text books use strike dip.

Dip angle is a measure of the steepness of a plane, and measures the angle between the

horizontal and the steepest line. It is very important to measure the dip angle parallel to the dip direction, the steepest line.

To avoid confusion in field notes, my students write their measurements in the following format: S = XXX/YY, where S0 indicates the nature of the planar feature measured, sedimentary (S0), metamorphic or structural (S1 and further), then 3 digits for the dip direction, so 30Degrees NNE is written as 030, a slash and two digits for the dip angle.

## Measuring orientation of a plane

When measuring the orientation of a sedimentary layer, metamorphic foliation or another planar feature, we open the compass, and place the lid on the plane we need to measure. While holding the lid on the plane, we rotate the compass until the base is horizontal. Similar to a spirit level or bubble level, we can rotate the compass base until the led is in the centre of the display (Fig. 1.).

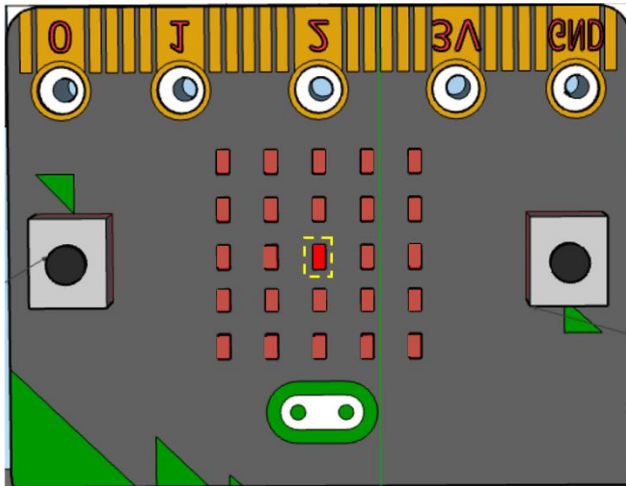


Figure 5: Levelling the compass base.

Holding the compass steady, with spirit led in the centre, we can press button A to read the orientation of the dip direction. As long as button is pressed the compass keeps reading and displaying the direction. See section X on how to read the display. The micro:bit reads the 3 directions of the internal magnetometer, and uses a calibration ellipsoid to determine the North. See section on calibration to calibrate the compass.

Reading the dip angle, is achieved by placing the compass on its side, with the lid fully opened, similar to using an analogue clinometer. The arrow printed on the lid, indicating dip angle points towards the rock surface.

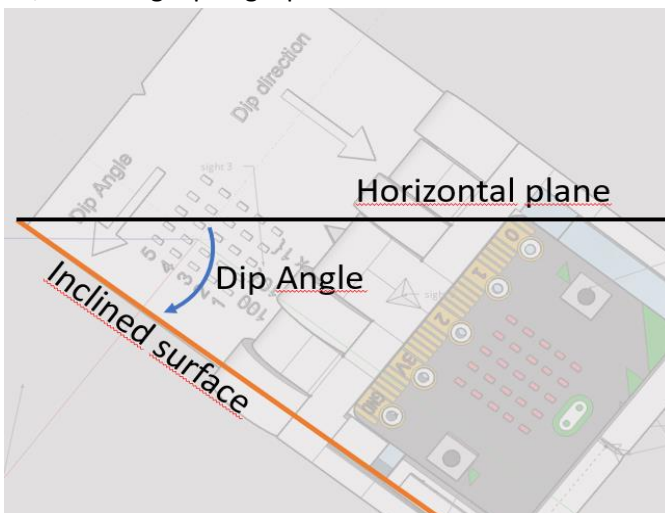


Figure 7: Measuring dip angle

The position of the led is based on readings of the gravitational field, by the build in accelerometer. X and Y axis should be zero, so that the micro:bit is perpendicular to the Z axis (Fig 2.) .

When the compass base is horizontal, the top of the compass lid is automatically horizontal (strike direction), and the sides of the lid, automatically indicate the steepest line in the plane we want to measure; the dip direction. The dip direction is pointing downwards towards the reader, along the arrow printed in the lid.

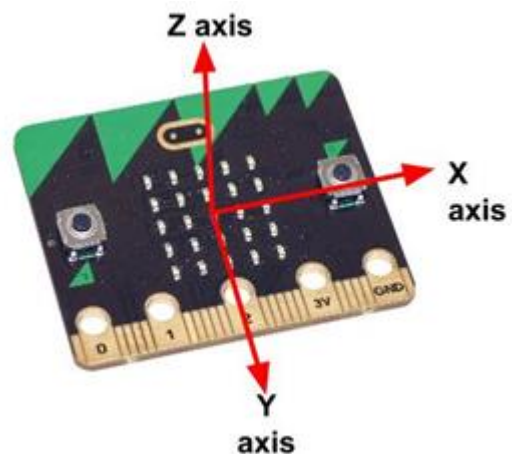


Figure 6: Orientation of the three axes of the accelerometer

Pressing micro:bit button B shows the dip angle. We can read the number displayed by the leds in a similar fashion to the dip direction. The dip angle is based on the ratio between the measurements of the accelerometer for the X and Y axis, and is very accurate.

### Measuring a line

Place the side of the lid parallel to the lineation, while holding the side of the lid parallel to the line rotate and tilt the compass base until the spirit level indicates horizontality. Then measure the plunge direction, by pressing Button A, the downward direction of the line is measured. The plunge, can be measured when the compass is completely opened and the long side of the compass is parallel to the line, and the compass is vertical, pressing button yields the plunge.

IMAGE NEEDED

The digital geological compass is published using Creative Commons. Software (github) and design using Mu micropython editor and sketchup free for the casing. A prototype was printed by AUC 3D printing lab. Building instructions, and further technical details are published on Instructables.com. Please feel free to further develop this concept.