![MIKROE logo]

13DOF CLICK

PID: MIKROE-3775
Weight: 18 g

13DOF Click is an advanced 13-axis motion tracking Click board™, which utilizes three different sensor ICs onboard: BME680, a digital gas, humidity, pressure and temperature sensor and BMM150, a geomagnetic sensor and a BMI088, small, versatile 6DoF sensor module. All integrated sensors ICs are made by Bosch Sensortec, featuring the state-of-the-art sensor technology processes, in order to fulfill the requirements for immersive gaming and navigation applications, which require highly accurate sensor data fusion. Besides that, 13DOF click is also perfectly suited for use in many other applications such as mobile phones, tablet PCs, GPS systems, Smart watches, Sport and fitness devices, and many more.

13DOF click is supported by a mikroSDK compliant library, which includes functions that simplify software development. This Click board™ comes as a fully tested product, ready to be used on a system equipped with the mikroBUS™ socket.

The BME680 is a digital 4-in-1 sensor with gas, humidity, pressure and temperature measurement based on proven sensing principles, housed in an extremely compact metal-lid LGA package. Its small dimensions and its low power consumption enable the integration in battery-powered or frequency-coupled devices, such as handsets or wearables. The BMM150 geomagnetic sensor, a three-axis geomagnetic sensor and the BMI088 sensor module, are both featured prominently and are key parts of this 13DOF Click board™.

HOW DOES IT WORK?

13DOF click is based on the BME680 and the BMM150 sensor ICs. Also, the click contains BMI088 - a small, versatile 6DoF sensor module from Bosch. Altogether, this Click board™ integrates a triaxial accelerometer, triaxial gyroscope, triaxial geomagnetic, gas, humidity, pressure and temperature sensors on the single board. This allows very high integration and very small dimensions, at an affordable cost. The output of each MEMS is processed, digitized and available through the I2C communication interface. The data can be oversampled by the sensor ICs by themselves, in order to achieve as reliable data readings as possible. As already mentioned, the features of this click are numerous.
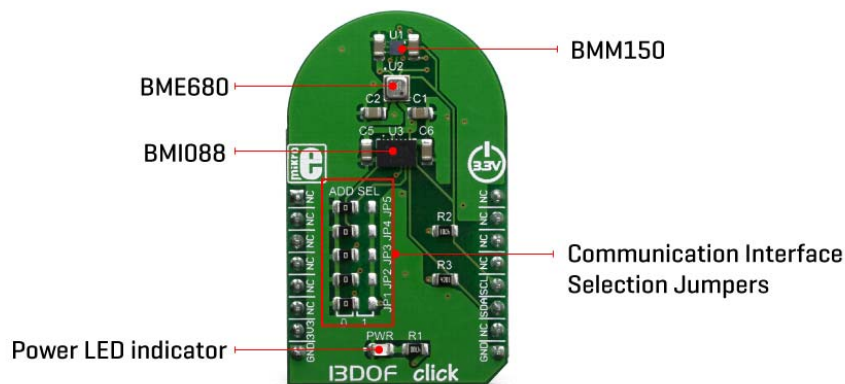
The BMM150 geomagnetic sensor from Bosch is a standalone sensor for consumer market applications. It allows measurements of the magnetic field in three perpendicular axes. The sensor is carefully tuned and a perfect match for the demanding requirements of all 3-axis mobile apps such as electronic compass, navigation or augmented reality.An application specific circuit (ASIC) converts the output of the geomagnetic sensor to digital results which can be read out over the industry standard digital I2C interface. Package and interfaces of the BMM150 have been designed to match a multitude of hardware requirements. As the sensor features an ultra-small footprint and a flat package, it is ingeniously suited for mobile applications, such as cell phones, handhelds, computer peripherals, man-machine interfaces, virtual reality features, game controllers, and other.

The BMI088 is an inertial measurement unit (IMU) for the detection of movements and rotations in 6 degrees of freedom (6DoF). It reflects the full functionality of a triaxial, low-g acceleration sensor and at the same time it is capable to measure angular rates. Both – acceleration and angular rate – in three perpendicular room dimensions, the x-, y- and z-axis. The BMI088 is designed to meet all requirements for consumer applications such as gaming and pointing devices, HMI and image stabilization (DSC and camera-phone). It also senses tilt, motion, inactivity and shock vibration in cell phones, handhelds, computer peripherals, HMI interfaces, virtual reality features and game controllers. An ASIC converts the output of the MEMS, developed, produced and tested in BOSCH facilities. To provide maximum performance and reliability each device is tested and ready-to-use calibrated.

On the other side, the BME680 - a small, high performance, low power, 4-in-1 sensor is in charge for the gas, humidity, pressure and temperature measurements. It also features very low power consumption, for example, 3.7 µA is typical at 1 Hz humidity, pressure and temperature measurement mode. It also features a very high accuracy humidity sensor (tolerance ±3% r.H. and hysteresis ±1.5% r.H.), pressure sensor with only 0.12 Pa RMS Noise (equivalent to to 1.7 cm of altitude) and a very low temperature offset drift, and a gas sensor with direct indoor air quality (IAQ) index output system. In principle, the IAQ index output is in an index that can have values between 0 and 500 with a resolution of 1 to indicate or quantify the quality of the air available in the surrounding. It greatly simplifies the categorization of the air quality measurements.

13DOF click supports I2C communication interface, allowing it to be used with a wide range of different MCUs. The I2C slave address for the communication can be selected by moving SMD jumpers grouped under the COMM SEL to an appropriate position.

This Click Board™ is designed to be operated only with 3.3V logic level. A proper logic voltage level conversion should be performed before the Click board™ is used with MCUs with logic levels of 5V.

SPECIFICATIONS

Type	Motion
Applications	It is a perfect solution for development of different types of motion detection and MotionTracking™ applications: motion-based game controllers, 3D and gesture controllers, IoT applications, wearable motion sensing applications, and similar applications.
On-board modules	BMM150 - geomagnetic sensor from Bosch, BME680 – Low power gas, pressure, temperature and humidity sensor from Bosch,

	BMI088 – small, versatile 6Dof sensor module from Bosch
Interface	I2C
Click board size	M (42.9 x 25.4 mm)
Input Voltage	3.3V

PINOUT DIAGRAM

This table shows how the pinout on 13DOF click corresponds to the pinout on the mikroBUS™ socket (the latter shown in the two middle columns).

Notes	Pin	mikro BUS				Pin	Notes
	NC	1	AN	PWM	16	NC	
	NC	2	RST	INT	15	NC	
	NC	3	CS	RX	14	NC	
	NC	4	SCK	TX	13	NC	
	NC	5	MISO	SCL	12	**SCL**	I2C Clock
	NC	6	MOSI	SDA	11	**SDA**	I2C Data
Power Supply	**3.3V**	7	3.3V	5V	10	NC	
Ground	**GND**	8	GND	GND	9	**GND**	Ground

ONBOARD SETTINGS AND INDICATORS

Label	Name	Default	Description
LD1	PWR	-	Power LED Indicator
JP1-JP5	ADD SEL	Left	Slave I2C address LSB selection: left position 0, right position 1

SOFTWARE SUPPORT

We provide a library for the 13DOF click on our LibStock page, as well as a demo application (example), developed using MikroElektronika compilers. The demo can run on all the main MikroElektronika development boards.

Library Description
The library covers all the necessary functions to control 13DOF click board. Library performs a standard I2C interface communication.

Key functions:

- `float c13dof_bme680_getAmbientData( uint8_t dataIn )` - Get BME680 ambient data function.
- `void c13dof_bmm150_readGeoMagData( int16_t *magX, int16_t *magY, int16_t *magZ, uint16_t *resHall )` - Get BMM150 Geomagnetic sensors data function.
- `void c13dof_bmi088_readAccel( int16_t *accelX, int16_t *accelY, int16_t *accelZ )` - Read Accel X-axis, Y-axis and Z-axis function.

Examples description
The application is composed of three sections :

- System Initialization - Initializes I2C and start to write log.

- Application Initialization - Initialization driver enables - I2C, initializes BME680 Low power gas, pressure, temperature & humidity sensor, BMI088 6-axis Motion Tracking Sensor and BMM150 Geomagnetic Sensor, also write log.

- Application Task - (code snippet) This is a example which demonstrates the use of 13DOF Click board. Measured and display temperature in degrees Celsius [°C], humidity data [%], pressure [mbar] and gas resistance data from the BME680 sensor. Measured and display Accel and Gyro data coordinates values for X-axis, Y-axis and Z-axis from the BMI088 sensor. Measured and display Geomagnetic data coordinates values for X-axis, Y-axis and Z-axis from the BMM150 sensor. Results are being sent to the Usart Terminal where you can track their changes. All data logs write on usb uart changes for every 2 sec.

```c
void applicationTask()
{
    temperature = c13dof_bme680_getTemperature();

    Delay_10ms();


    mikrobus_logWrite( "                        |      BME680      |", _LOG_LINE );

    mikrobus_logWrite( "-------------------------------------------------------", _LOG_LINE
);

    mikrobus_logWrite( "                  ", _LOG_TEXT );

    mikrobus_logWrite( " Temperature    : ", _LOG_TEXT );

    FloatToStr( temperature, logText );

    mikrobus_logWrite( logText, _LOG_TEXT );

    mikrobus_logWrite( degCel, _LOG_LINE );


    humidity = c13dof_bme680_getHumidity();

    Delay_10ms();

    mikrobus_logWrite( "                  ", _LOG_TEXT );

    mikrobus_logWrite( " Humidity       : ", _LOG_TEXT );

    FloatToStr( humidity, logText );

    mikrobus_logWrite( logText, _LOG_TEXT );

    mikrobus_logWrite( " %", _LOG_LINE );


    pressure = c13dof_bme680_getPressure();

    Delay_10ms();

    mikrobus_logWrite( "                  ", _LOG_TEXT );

    mikrobus_logWrite( " Pressure       : ", _LOG_TEXT );

    FloatToStr( pressure, logText );

    mikrobus_logWrite( logText, _LOG_TEXT );

    mikrobus_logWrite( " mbar", _LOG_LINE );


    gasRes = c13dof_bme680_getGasResistance();

    Delay_10ms();

    mikrobus_logWrite( "                  ", _LOG_TEXT );

    mikrobus_logWrite( " Gas Resistance : ", _LOG_TEXT );

    LongWordToStr( gasRes, logText );

    ltrim( logText );
```

```
    mikrobus_logWrite( logText, _LOG_LINE );
    mikrobus_logWrite( "------------------------------------------------------------", _LOG_LINE
);


    readyCheck = c13dof_bmm150_checkReady();


    while ( readyCheck != _C13DOF_BMM150_DATA_READY )
    {
        readyCheck = c13dof_bmm150_checkReady();
    }


    c13dof_bmi088_readAccel( &accelX, &accelY, &accelZ );
    Delay_10ms();
    c13dof_bmi088_readGyro( &gyroX, &gyroY, &gyroZ );
    Delay_10ms();
    c13dof_bmm150_readGeoMagData( &magX, &magY, &magZ, &RHall );
    Delay_10ms();



    mikrobus_logWrite( "                   BMI088                   |      BMM150", _LOG_LINE );
    mikrobus_logWrite( "------------------------------------------------------------", _LOG_LINE
);
    mikrobus_logWrite( "|     Accel      |        Gyro       |         Mag       |",_LOG_LINE
);
    mikrobus_logWrite( "------------------------------------------------------------", _LOG_LINE
);


    mikrobus_logWrite( " Accel X :", _LOG_TEXT );
    IntToStr( accelX, logText );
    mikrobus_logWrite( logText, _LOG_TEXT );
    mikrobus_logWrite( "  |  ", _LOG_TEXT );
    mikrobus_logWrite( " Gyro X :", _LOG_TEXT );
    IntToStr( gyroX, logText );
    mikrobus_logWrite( logText, _LOG_TEXT );
    mikrobus_logWrite( "  |  ", _LOG_TEXT );
    mikrobus_logWrite( " Mag X :", _LOG_TEXT );
    IntToStr( magX, logText );
    mikrobus_logWrite( logText, _LOG_TEXT );
    mikrobus_logWrite( "  |  ", _LOG_LINE );
```

```
    mikrobus_logWrite( " Accel Y :", _LOG_TEXT );

    IntToStr( accelY, logText );

    mikrobus_logWrite( logText, _LOG_TEXT );

    mikrobus_logWrite( "  |  ", _LOG_TEXT );

    mikrobus_logWrite( " Gyro Y :", _LOG_TEXT );

    IntToStr( gyroY, logText );

    mikrobus_logWrite( logText, _LOG_TEXT );

    mikrobus_logWrite( "  |  ", _LOG_TEXT );

    mikrobus_logWrite( " Mag Y :", _LOG_TEXT );

    IntToStr( magY, logText );

    mikrobus_logWrite( logText, _LOG_TEXT );

    mikrobus_logWrite( "  |  ", _LOG_LINE );


    mikrobus_logWrite( " Accel Z :", _LOG_TEXT );

    IntToStr( accelZ, logText );

    mikrobus_logWrite( logText, _LOG_TEXT );

    mikrobus_logWrite( "  |  ", _LOG_TEXT );

    mikrobus_logWrite( " Gyro Z :", _LOG_TEXT );

    IntToStr( gyroZ, logText );

    mikrobus_logWrite( logText, _LOG_TEXT );

    mikrobus_logWrite( "  |  ", _LOG_TEXT );

    mikrobus_logWrite( " Mag Z :", _LOG_TEXT );

    IntToStr( magZ, logText );

    mikrobus_logWrite( logText, _LOG_TEXT );

    mikrobus_logWrite( "  |  ", _LOG_LINE );

    mikrobus_logWrite( "----------------------------------------------------------", _LOG_LINE
);
    mikrobus_logWrite( "----------------------------------------------------------", _LOG_LINE
);


    Delay_1sec();

    Delay_1sec();
}
```

The full application code, and ready to use projects can be found on our LibStock page. Other mikroE Libraries used in the example:

- I2C
- UART
- Conversions

Additional notes and informations

Depending on the development board you are using, you may need USB UART click, USB UART 2 click or RS232 click to connect to your PC, for development systems with no UART to USB interface available on the board. The terminal available in all MikroElektronika compilers, or any other terminal application of your choice, can be used to read the message.

MIKROSDK

This Click board™ is supported with mikroSDK - MikroElektronika Software Development Kit. To ensure proper operation of mikroSDK compliant Click board™ demo applications, mikroSDK should be downloaded from the LibStock and installed for the compiler you are using.

For more information about mikroSDK, visit the official page.

https://www.mikroe.com/13dof-click/10-15-19