

micro:bit

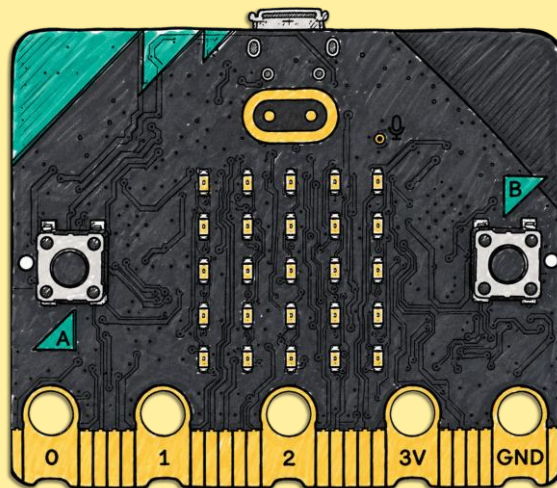


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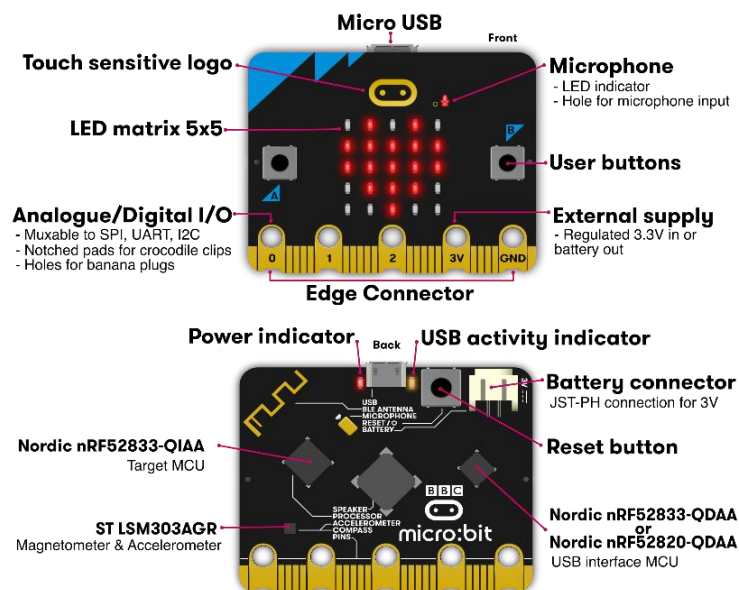
1. Introduction

The micro:bit is a small computer built on a single circuit board. It has a main processor, called the application processor, that runs programs and works with the different parts of the board. Some parts are built into the main processor, while others are connected to it.

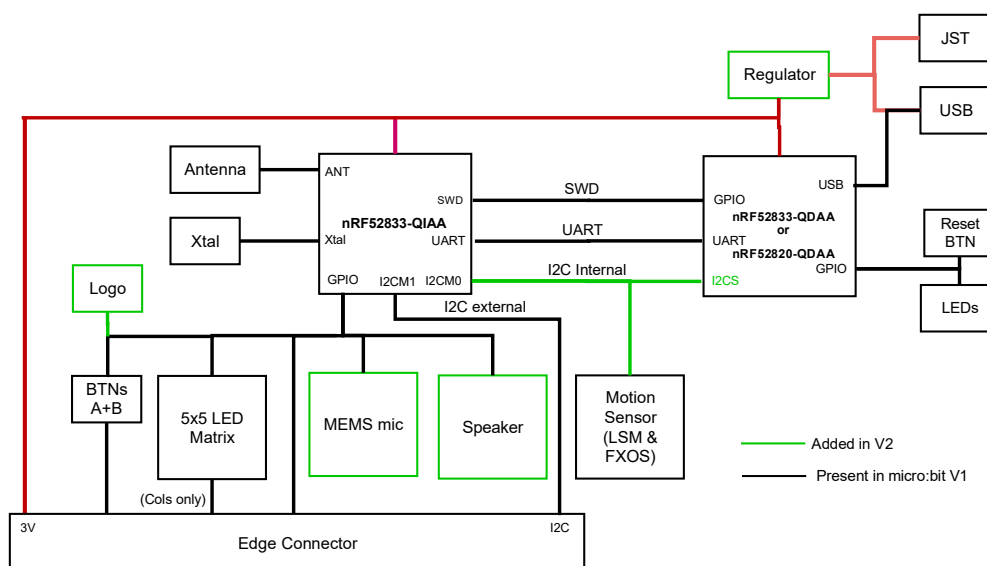
The micro:bit also has an interface processor. This processor helps the micro:bit communicate with a computer through a USB cable. For example, it helps transfer your code from your computer to the micro:bit when you drag and drop your program.

The interface processor does not control the micro:bit's other parts. Instead, it communicates with the main processor through a connection inside the board called the I²C bus.

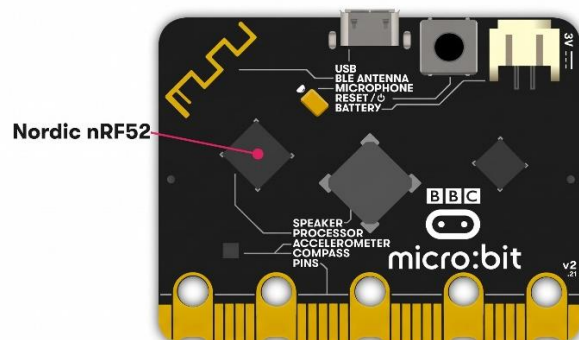
1.1 Hardware Block Diagram



1.2 Hardware block diagram



2. nRF52 Application Processor



The nRF52 application processor is the main chip that runs your programs on the micro:bit. Your program, along with the software needed to run it and the Bluetooth software, is stored in the chip's built-in memory called flash memory. The processor runs this software directly from that memory. The processor also controls all the GPIO pins you can use. These pins let you connect the micro:bit to other electronic parts, such as LEDs, sensors, and motors.

The nRF52 also has a built-in 2.4 GHz radio. This radio allows the micro to communicate wirelessly using Bluetooth or its own radio features. An antenna connected to the board helps send and receive these wireless signals.

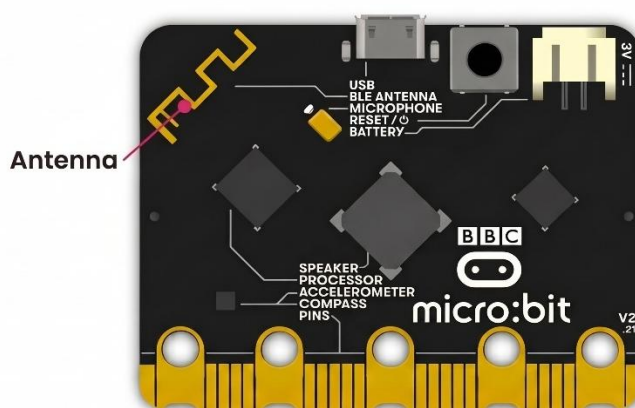
2.1 Specifications

Item	details
Model	Nordic nRF52833
Core variant	Arm Cortex-M4 32 bit processor with FPU
Flash ROM	512KB
RAM	128KB
Speed	64MHz
Debug	SWD
More Info	Software , nRF52 datasheet

3. Bluetooth Wireless Communication

The on board 2.4GHz transceiver supports Bluetooth communications via the Nordic S140 SoftDevice, which provides a fully qualified Bluetooth low energy stack. This allows the micro:bit to communicate with a wide range of Bluetooth devices, including smartphones and tablets.

To learn how to connect a micro:bit to your phone or tablet using Bluetooth, you can refer to Lesson 1 of the [Robots Unplugged course](#).



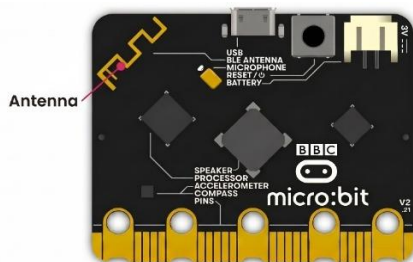
3.1 Specifications

Item	details
Stack	Bluetooth 5.1 with Bluetooth Low Energy(BLE)
Band	2.4GHz ISM (Industrial, Scientific and Medical) 2.4GHz..2.41GHz
Channels	50 2MHz channels, only 40 used (0 to 39), 3 advertising channels (37,38,39)
Sensitivity	-93dBm in Bluetooth low energy mode
Tx Power	-40dBm to 4dBm
Role	GAP Peripheral & GAP Central
Congestion avoidance	Adaptive Frequency Hopping
Profiles	BBC micro:bit profile
More Info	Bluetooth

4. Low level radio communications

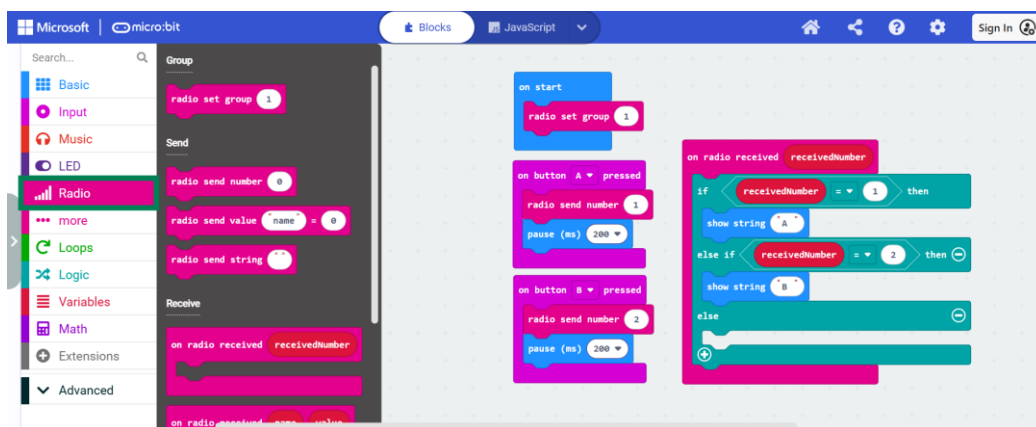
The micro:bit's built-in 2.4 GHz radio can do more than just Bluetooth communication. It can also send and receive small messages using a system called the micro:bit radio protocol. This protocol allows devices that support it, such as other micro:bit, to send short messages wirelessly to one another.

The micro:bit also adds a group code to each message. This code helps you choose which group of devices can receive your messages. By setting the same group code on the micro you want to communicate with, you can make it easier for them to share messages and ignore messages from other groups.



4.1 Sample Code

Download the sample code below onto two micro:bits and place them near each other.



Program Link: https://makecode.microbit.org/_2u3H7r9Af3eX

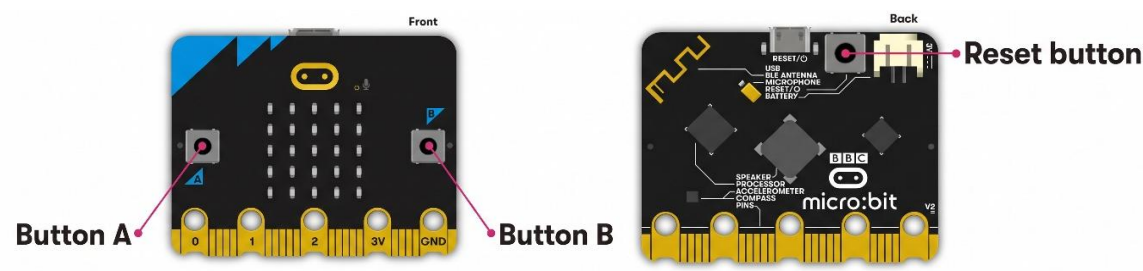
Result: Press A on one micro:bit. The other micro:bit should display A. Press B, and it should display B. Swap roles and try it the other way around.

4.2 Specifications

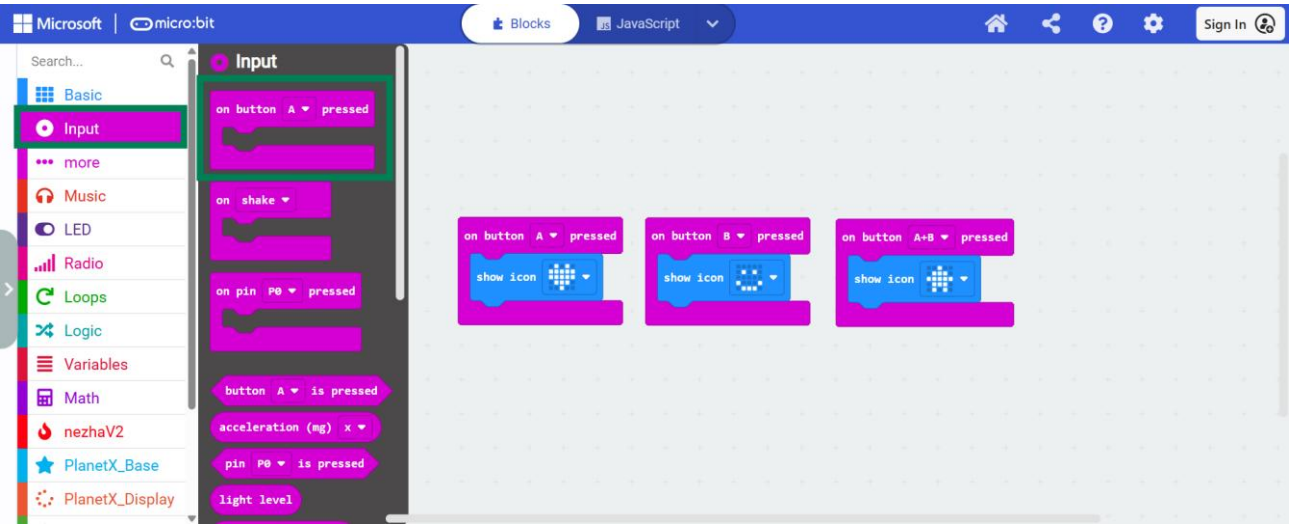
Item	details
Protocol	Micro:bit Radio
Freq band	2.4GHz
Channel rate	1Mbps or 2Mbps
Encryption	None
Channels	80 (0..80)
Group codes	255
Tx power	Eight user configurable settings from 0(-30dbm) to 7 (+4dbm)
Payload size	32 (standard) 255 (if reconfigured)
More Info	Micro:bit Radio

5. Buttons

The micro:bit has three tactile push buttons: two on the front (A and B) and one on the back. The back button is connected to both the interface processor and the nRF52 processor. It is used to reset the system, restarting the program whether the micro:bit is powered by USB or a battery. The front buttons, A and B, can be programmed to perform different tasks. The software detects button presses and helps prevent false signals caused by button bouncing. It can also detect short presses, long presses, and pressing both A and B together. Both A and B are connected to GPIO pins that are also available through the micro:bit's edge connector.



5.1 Sample Code



Program Link: https://makecode.microbit.org/_VH4M6ue3q85w

Result: Press A on the micro:bit, and it should display a heart icon. Press B, and it should display a smiley face icon. Press A and B together, and it should display a house icon.

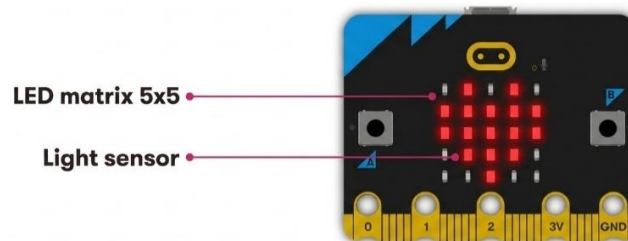
5.2 Specifications

Item	details
Type	2 tactile user buttons, 1 tactile system button
Debounce	(A & B) software debounced, 54ms period
Pullup	(A & B) external 4K7, (System) 10K

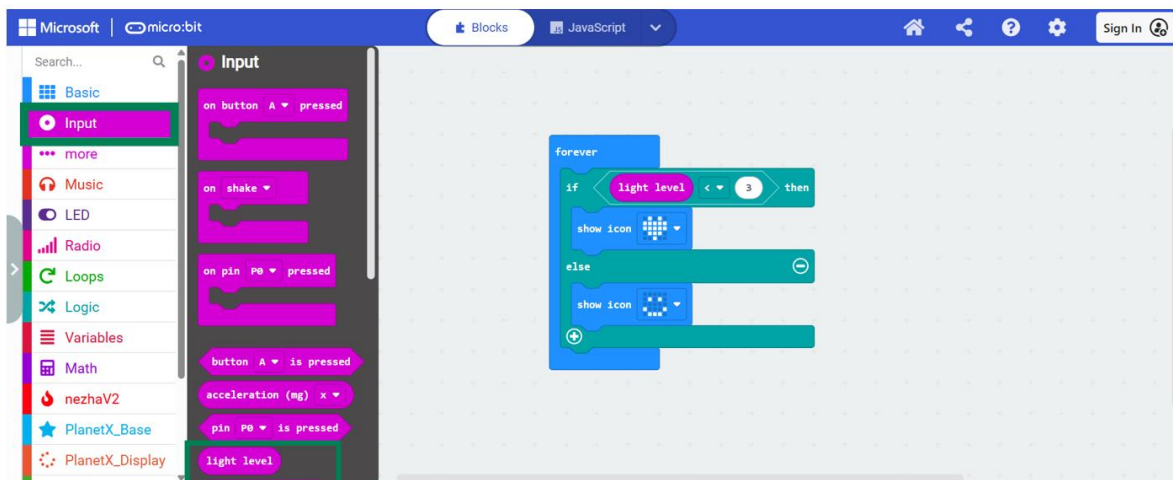
6. Display

The display is made up of 25 LEDs arranged in a 5×5 grid. The LEDs are connected in a matrix, and the runtime software refreshes them very quickly so that they appear to stay on without flickering.

The LED matrix can also be used to detect the surrounding light level. The software briefly switches some of the LED pins to input mode and measures how long the voltage takes to drop. This time is roughly related to the amount of light around the micro.



6.1 Sample Code



Program Link: https://makecode.microbit.org/_J0kPpyaF3LfM

Result: The micro:bit constantly checks the light level in a forever loop, displaying a heart icon if the level is less than 3 to indicate that it is dark. When you shine a flashlight on the device, the light level increases to 3 or higher, which triggers the else condition and causes the micro:bit to display a smiley face icon instead.

6.2 Specifications

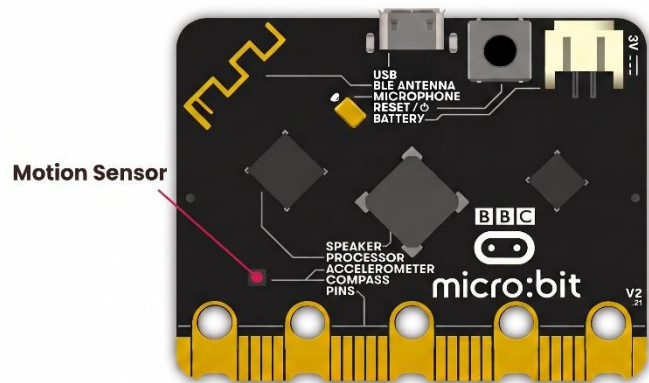
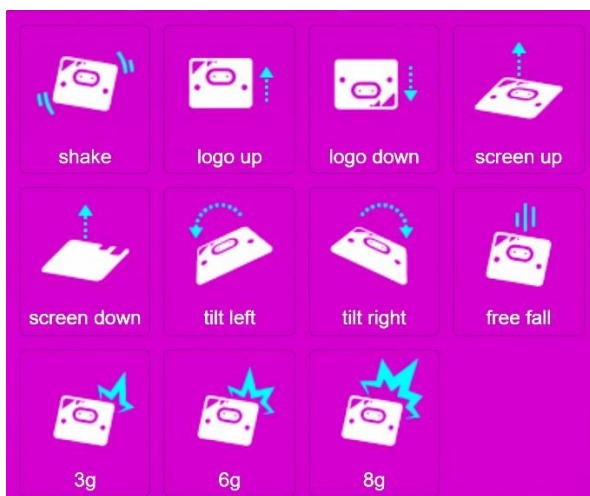
Item	details
Type	miniature surface mount red LED
Physical structure	5x5 matrix
Electrical structure	5x5
Intensity control	Software controlled up to 255 steps
Sensing	ambient light estimation via software algorithm
Sensing Range	TBC, 10 levels from off to full on
Colour sensitivity	red centric, red is 700nm

7. Motion Sensor

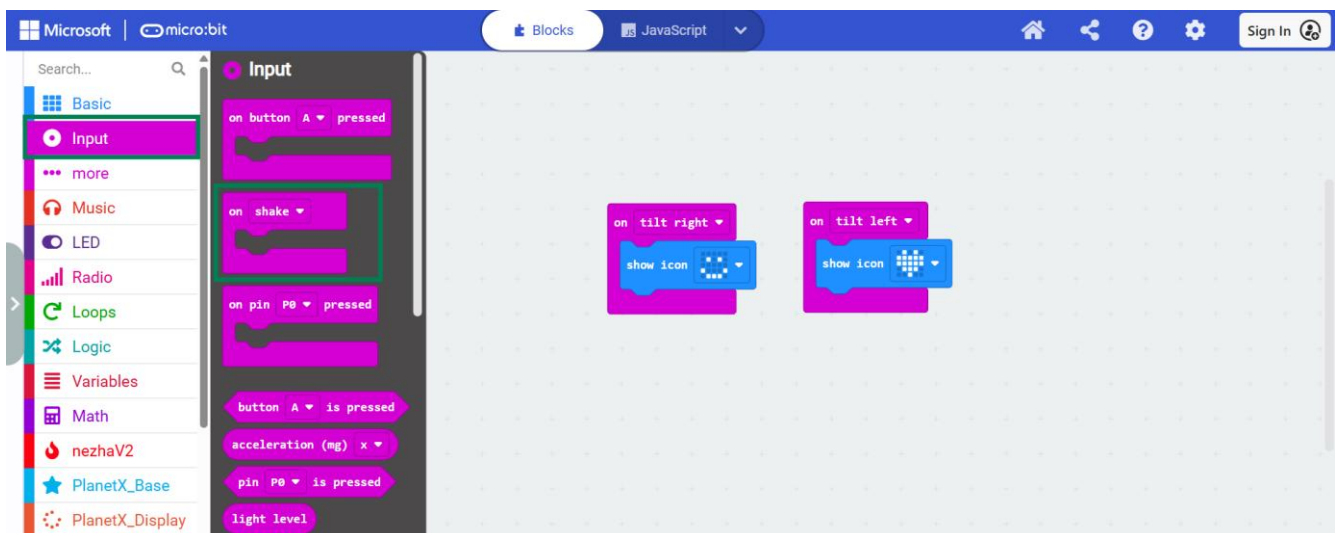
The micro:bit has a motion sensor that combines an accelerometer and a magnetometer. The accelerometer detects movement in three directions, while the magnetometer measures magnetic fields. The sensor can detect some gestures, such as falling, directly in its hardware. Other gestures, such as logo-up, logo-down, and shaking, are detected using software.

The micro:bit also uses the accelerometer to calculate a compass reading that works regardless of the board's orientation. Before using the compass, you must calibrate it. The runtime software starts the calibration process automatically. The motion sensor communicates with the application processor through the I²C bus.

The micro:bit board supports two possible motion sensors: the ST LSM303AGR and the NXP FXOS8700CQ. Only one of these sensors is fitted on a board, and the micro-DAL automatically detects which sensor is present.



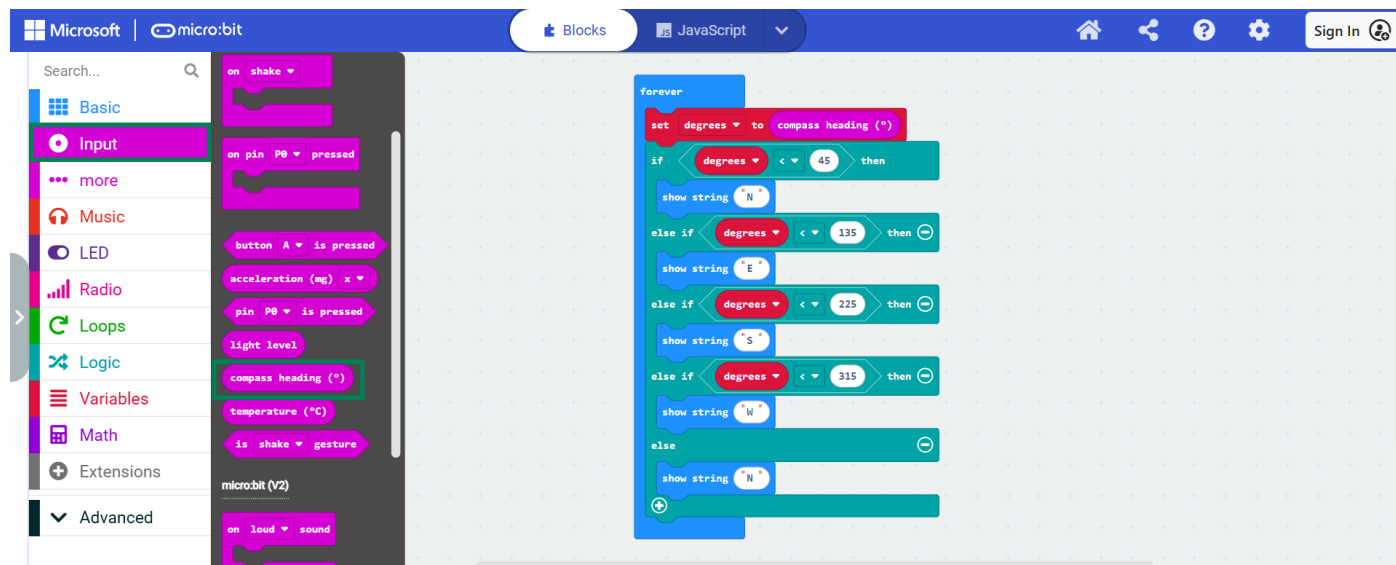
7.1 Sample Code 1



Program Link: https://makecode.microbit.org/_eufcieLULXax

Result: Tilt the micro:bit to the right, and it should display a smiley face icon. Tilt it to the left, and it should display a heart icon.

7.2 Sample Code 2



Program Link: https://makecode.microbit.org/_WTWhPg9fLwz

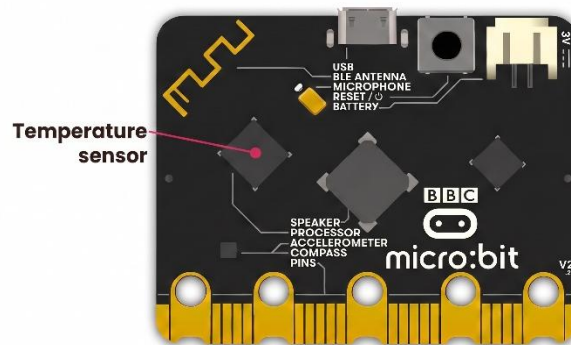
Result: Point the micro:bit North (a heading less than 45 degrees or 315 degrees and above), and it should display the letter "N". Rotate it to the East (heading less than 135 degrees), and it should display "E". Rotate it South (heading less than 225 degrees), and it should display "S". Rotate it West (heading less than 315 degrees), and it should display "W". Turn the micro:bit around to see the letters change as it acts like a compass.

7.3 Specifications

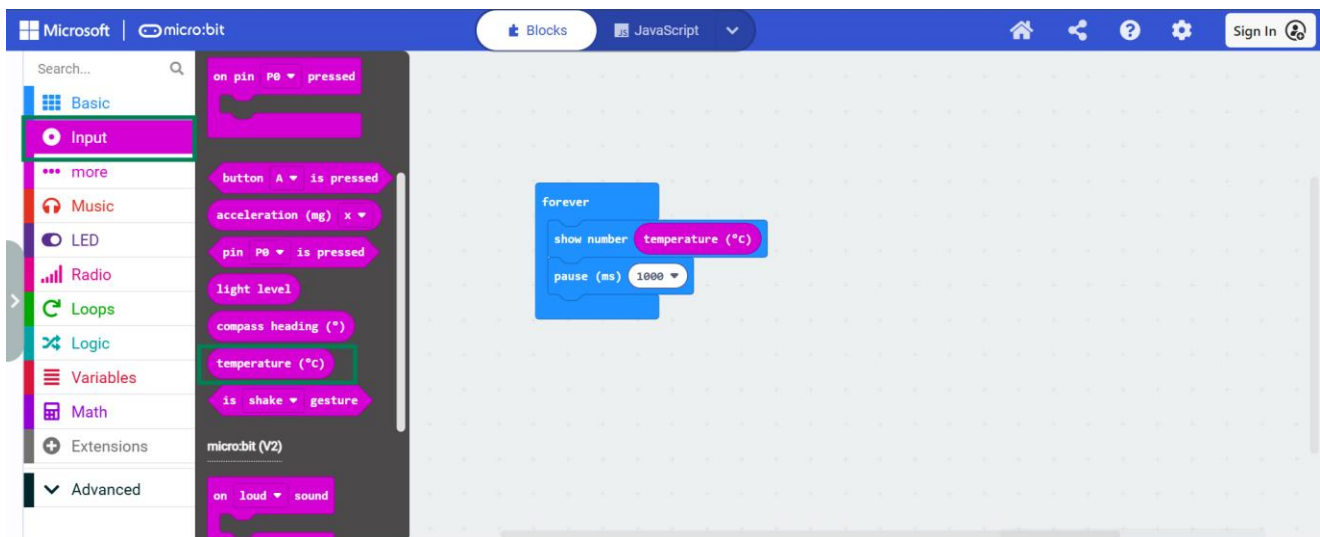
Item	details
Model	<u>LSM303AGR</u>
Features	3 magnetic field and 3 acceleration axes , 2/4/8/16g ranges
Resolution	8/10/12 bits
On board gestures	'freefall'
Other gestures	Other gestures are implemented by software algorithms in the runtime.

8. Temperature sensing

The nRF52 application processor has a built-in temperature sensor. The runtime software allows you to read its measurements to get an estimate of the surrounding temperature.



8.1 Sample Code



Program Link: https://makecode.microbit.org/_b20CfMDRu5h0

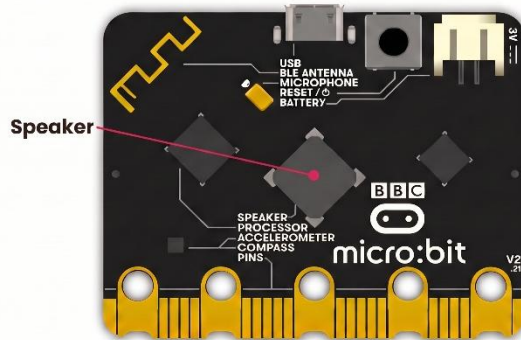
Result: Leave the micro:bit on, and it should continuously display the current temperature in Celsius. The display will pause for one second (1000 milliseconds) before updating the number again.

8.2 Specifications

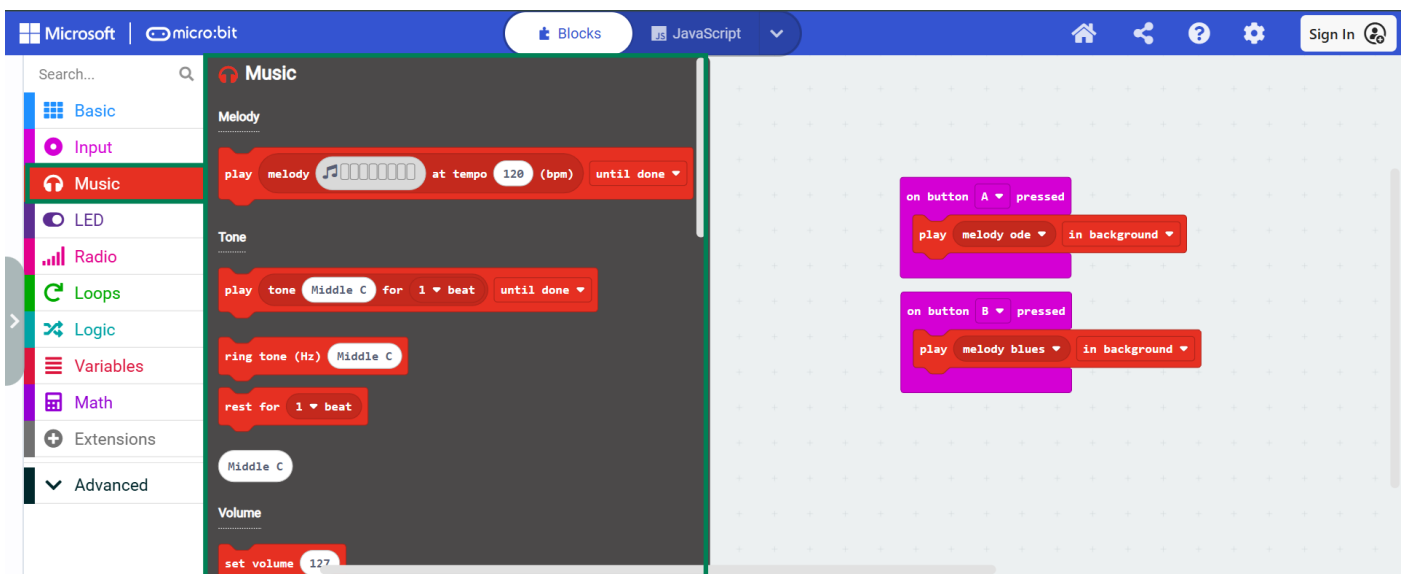
Item	details
Type	on-core nRF52
Sensing range	-40C .. 105C
Resolution	0.25C steps
Accuracy	+/-5C (uncalibrated)
More Info	DAL Thermometer

9. Speaker

You can connect an external speaker to the micro:bit's pins or use its built-in speaker to play sounds.



9.1 Sample Code



Program Link: https://makecode.microbit.org/_Hvh8hTAX31sV

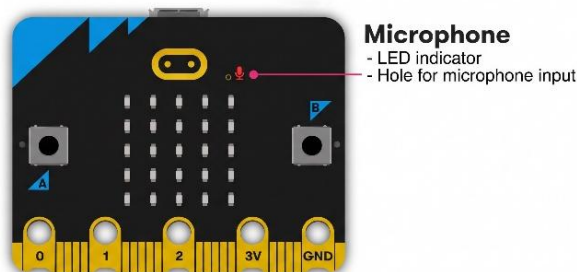
Result: press button A on the micro:bit, and it should play the "ode" melody in the background. Press button B, and it should play the "blues" melody in the background instead.

9.2 Specifications

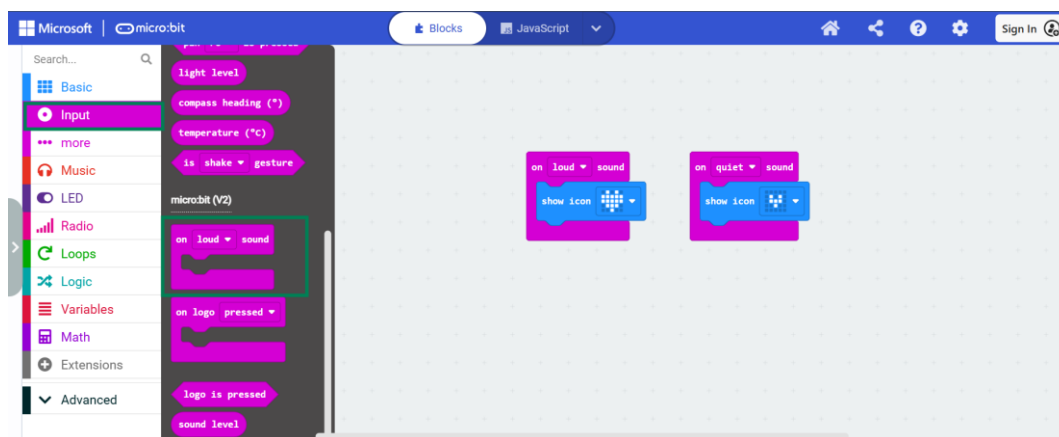
Item	details
Type	JIANGSU HUANENG MLT-8530
SPL	80dB @ 5V, 10cm
Self-resonant frequency	2700Hz
More Info	Datasheet
Type	JIANGSU HUANENG MLT-8530

10. Microphone

The micro has a built-in microphone that detects sounds. An LED on the front lights up to show when the microphone is active. The microphone is connected to the micro through a circuit that helps it capture sound signals.



10.1 Sample Code



Program Link: https://makecode.microbit.org/_Fvw5xk2vsL62

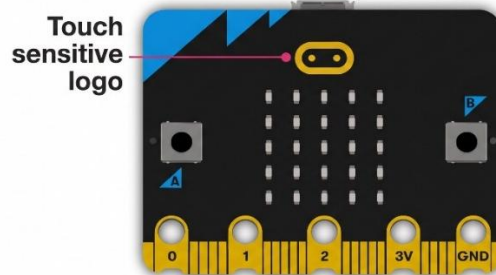
Result: Make a loud noise near the micro:bit, and it should display a large heart icon. Keep things quiet, and it should display a small heart icon. Try clapping and then staying silent to see the shapes change on the screen.

10.2 Specifications

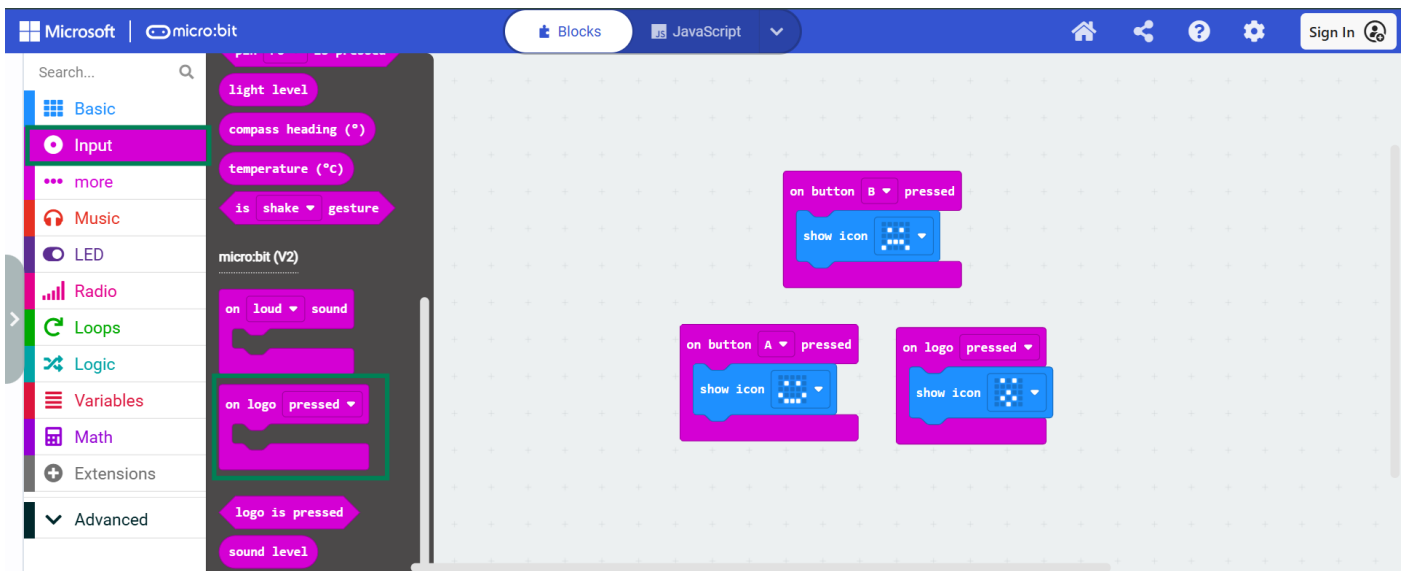
Item	details
Type	Knowles SPU0410LR5H-QB-7 MEMS
Sensitivity	-38dB $\pm$ 3dB @ 94dB SPL
SNR	63dB
AOP	118db SPL
Frequency range	100Hz ~ 80kHz
Polar pattern	Omnidirectional
More Info	Datasheet

11. Touch Logo

The micro:bit's touch-sensitive logo can detect when it is touched, pressed, released, or long-pressed. You can use these actions to control your programs.



11.1 Sample Code

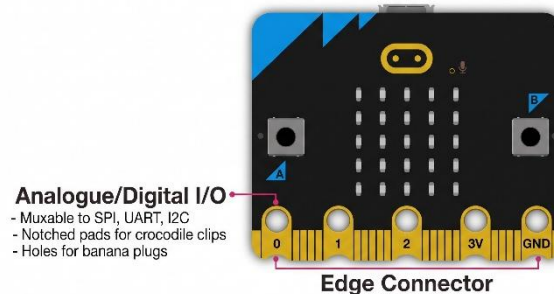


Program Link: <https://makecode.microbit.org/UaCJ25Do9DEc>

Result: Press button A on the micro:bit, and it should display a happy face icon. Press button B, and it should display a sad face icon. Press the micro:bit logo, and it should display a surprised face icon.

12. General purpose input/output pins

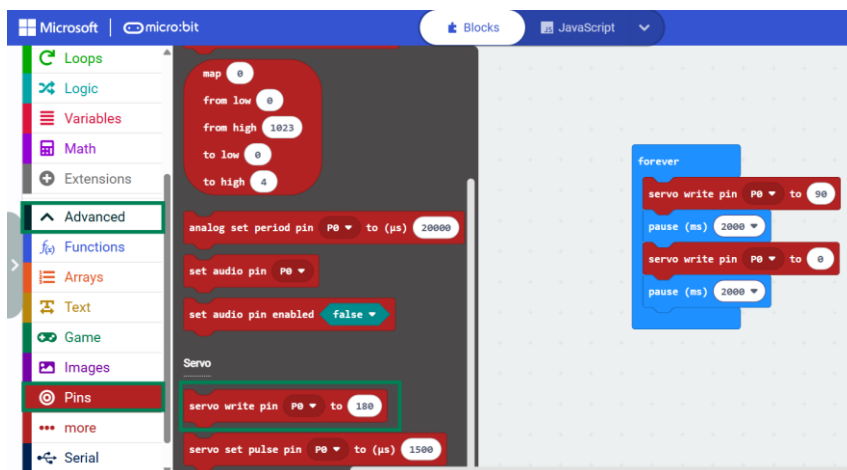
The micro:bit's edge connector provides access to many of the processor's GPIO pins, which you can use to connect external components. Some pins are shared with other micro:bit features, but they can be used for other purposes if certain software features are turned off.



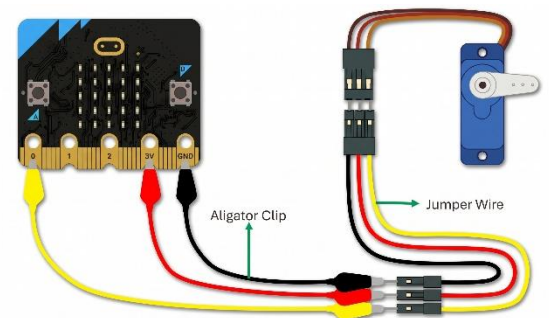
12.1 Sample Code

***Note:** We can connect third-party components to the micro:bit to make our projects more interactive. In this example, we are using a servo motor to show how the micro:bit can control an external device. The connection setup is shown in the picture below.

Hardware Connection: First, take the red alligator clip and bite onto the "3V" hole on your micro:bit. Connect the other end to the red wire to give the motor its power. Next, take the black alligator clip and grab onto the "GND" hole. Connect the other end to the black wire, which helps safely complete the power circle. Finally, take the yellow alligator clip and clip it to the "0" hole. Connect the other end to the yellow wire. This is the special wire that sends messages to tell the motor exactly how to move.

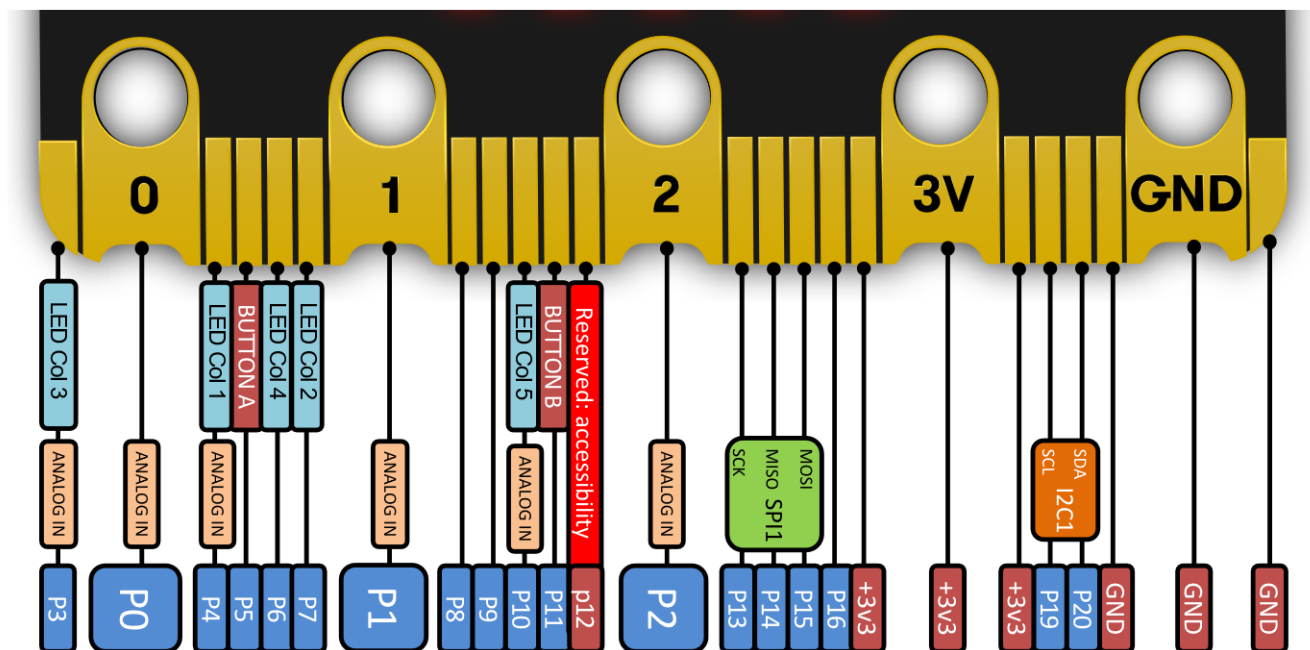


Program Link: https://makecode.microbit.org/_PfV4utAaxKbk



Result: Connect a servo to pin P0, and it should continuously alternate between 90 degrees and 0 degrees, pausing for two seconds at each position.

12.2 Specifications

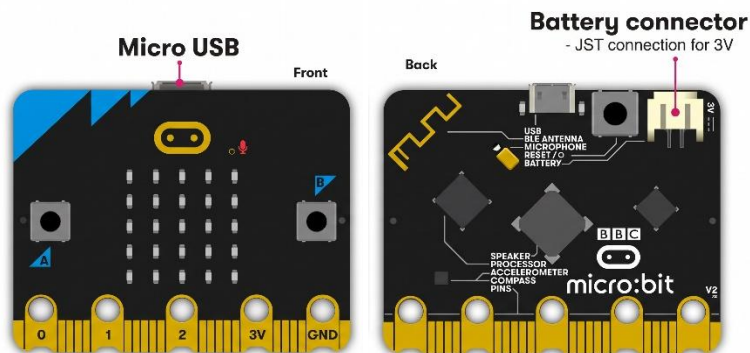


Item	Details
Rings	3 large IO rings and two large power rings, 4mm plug and crocodile clip compatible
GPIO features	19 assignable GPIO pins
	2 are dedicated to the external I2C interface
	6 are used for display or light sensing feature
	2 are used for on-board button detection
	1 is reserved for an accessibility interface
	19 may be assigned as digital input or digital output
	19 may be assigned for up to 3 simultaneous PWM channels
	19 may be assigned for 1 serial transmit and 1 serial receive channel
	6 may be assigned as analog input pins
	3 may be assigned to an optional SPI communications interface
	3 may be assigned for up to 3 simultaneous touch sensing inputs
ADC resolution	10 bit (0..1023)
Edge Connector	Edge connector
Pitch	1.27mm, 80 way double sided.
Pads	5 pads, with 4mm holes

13. Power Supply

The micro can be powered through a USB cable or by connecting a 3V battery pack to the battery connector. It can also be powered through the 3V and GND rings on the edge connector, but care is needed.

The 3V and GND rings can also provide power to external circuits. The board has a voltage regulator that can supply up to 300 mA and includes thermal protection to help protect against short circuits.



13.1 Specifications

Item	details
Operating range	1.8V .. 3.6V
Operating current (USB and battery)	300mA max
On-board Peripherals budget	90mA
Battery connector	JST S2B-PH-SM4-TB
Max current provided via edge connector	190mA
More Info	Power supply

14. Interface

The interface chip handles the USB connection, and is used for flashing new code to the micro:bit, sending and receiving serial data back and forth to your main computer.

Due to parts availability, two variants of the V2.2X devices exist, each using a different interface chip. A limited number of devices were built using the nRF52833-QDAA, while subsequent devices use the nRF52820-QDAA. As both chips belong to the same family, the same DAPLink firmware image runs on both variants, providing identical functionality.

14.1 Specifications

Item	details	
Model	nRF52833-QDAA	nRF52820-QDAA
Core variant	64 MHz Arm® Cortex®-M4F	64 MHz Arm® Cortex®-M4
Flash ROM	512KB (128kB use for firmware, 128kB reserved for non-volatile storage, rest unused)	256KB (128kB reserved for non-volatile storage)
RAM	128KB (only 32 KB used)	32KB
Speed	64MHz	64MHz
Debug capabilities	SWD	SWD
More Info	DAPLink , nRF52833 datasheet	DAPLink , nRF52820 datasheet

15. USB communications

The micro:bit has an on-board USB communications stack, that is built into the firmware of the interface chip. This stack provides the ability to drag and drop files onto the MICROBIT drive in order to load code into the application processor. It also allows serial data to be streamed to and from the micro:bit application processor over USB to an external host computer, and supports the CMSIS-DAP specification for host debugging of application programs.

15.1 Specifications

Item	details
Connector	USB micro, MCR-B-S-RA-SMT-CS5-TR
USB version	2.0 Full Speed device
Speed	12Mbit/sec
USB classes supported	Mass Storage Class (MSC)
	Communications Device Class (CDC)
	CMSIS-DAP HID & WinUSB
	WebUSB CMSIS-DAP HID
More Info	DAPLink

16. Debugging

The interface processor can be used with special host tools to debug code that is running on the application processor. It connects to the application processor via 2-pin Serial Wire Debug (SWD). The interface processor code can also be debugged via its internal SWD software debug interface, for example to load initial bootloader code into this processor at manufacturing time, or to recover a lost bootloader.

16.1 Specifications

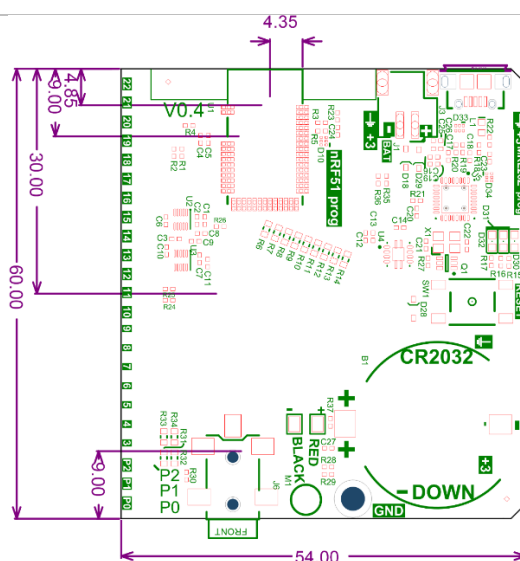
Item	details
Protocol	Serial Wire Debug (SWD)
Options	DAPLink (CMSIS-DAP)
	JLink/OB (via different firmware)

17. Mechanical

We have some [nice 2D and 3D CAD drawings and models of the micro:bit](#) including all the important dimensions. These models can be used as a basis for generating really nice marketing and project images of the micro:bit, but also as a basis for accurate manufacture of attachments e.g. via 3D printing.

17.1 Specifications

Item	details
Dimensions	51.60mm(w) 42.00mm(h) 11.65mm(d), button depth to board 4.55mm, speaker depth to board 3.00mm, JST connector to board 5.50mm
Weight	TBC



18. Additional Details and References



<https://tech.microbit.org/hardware/>

[BBC Technical Specifications](#)

[I2C specification](#)

[SPI 'specification'](#)

[Fritzing diagram, contributed by Kok Ho Huen](#)