

(<http://microbit.org>)

:developer community (\\)



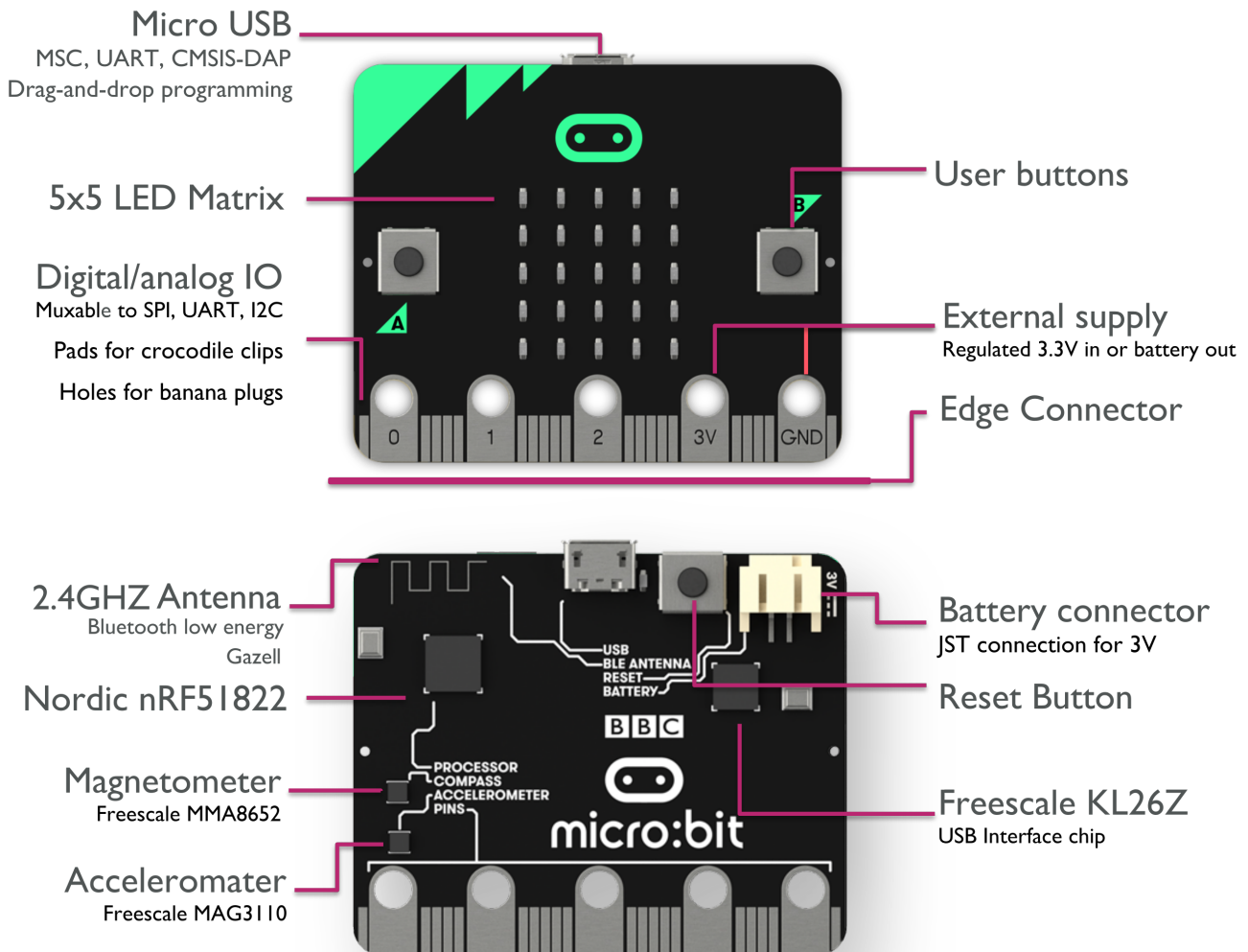
Hardware

Hardware Description

Please note, this site is recently created, and should be considered closer to a community wiki than a data-sheet. We've done our best to start with a correct set of information. If you find mistakes, please report them as bugs on GitHub here (<https://github.com/microbit-foundation/dev-docs/issues>)

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Getting Started With the micro:bit Hardware

The micro:bit hardware is based on the ARM-mbed platform. It has an application processor with lots of on-chip peripherals. Some off-chip peripherals are connected to this chip. There is an interface processor connected to the application processor, and it is the interface processors job to manage communications over the USB and to support the drag-and-drop code-flashing process. The interface processor does not connect to any of the micro:bit peripherals.

Two key pieces of information to help understand the internals of the micro:bit are:

- The schematics (./schematic), which shows the detailed component data and connectivity of the device.
- The reference design (./reference-design), which is a complete module design of a compatible micro:bit, and is designed to be a starting point for anyone interested in understanding the micro:bit or designing their own variant.

Hardware Description

nRF51 Application Processor

The nRF51 application processor is where user programs run. A single, complete application including user code, runtime code and bluetooth stack is loaded and run directly from on chip flash memory. All user accessible GPIO pins are provided by this processor. There is an onboard 2.4GHz radio engine used to provide Bluetooth capabilities via an off-chip aerial.

item	details
Model	Nordic nRF51822-QFAA-R rev 3 (https://www.nordicsemi.com/eng/Products/Bluetooth-low-energy/nRF51822)
Core variant	ARM Cortex-M0 32 bit processor (https://www.arm.com/products/processors/cortex-m/cortex-m0.php)
Flash ROM	256KB
RAM	16KB
Speed	16MHz
Debug	SWD, jlink/OB
More Info	here (../software)

Bluetooth Wireless Communication

The on board 2.4GHz transceiver supports Bluetooth communications via the Nordic S110 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.

item	details
Stack	Bluetooth 4.1 with Bluetooth low energy
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

item	details
Tx Power	-20dBm to 4dBm in 4 dB steps
Role	GAP Peripheral (http://bluetooth-mdw.blogspot.co.uk/2016/07/microbit-and-bluetooth-roles.html)
Congestion avoidance	Adaptive Frequency Hopping
Profiles	1 BBC micro:bit profile (https://lancaster-university.github.io/microbit-docs/ble/profile/)
More Info	here (../bluetooth)

Low Level Radio Communications

The on board 2.4GHz transceiver supports a number of other radio communications standards, including the proprietary Nordic Gazell protocol. This protocol provides a very simple small-packet broadcast radio interface between other devices that support this proprietary protocol, such as other micro:bit devices. The 'radio' interface that appears in a number of the languages on the micro:bit is built on top of this Gazell protocol. Additionally, the micro:bit runtime software adds a 'group code' to each data payload, allowing for simple user managed device addressing and filtering to take place.

item	details
Proto-col	Nordic Gazell (https://devzone.nordicsemi.com/documentation/nrf51/4.3.0/html/group__gzll__02__user__guide.html)
Freq band	2.4GHz
Channel rate	1Mbps or 2Mbps
Encryption	None
Channels	101 (0..100)
Group codes	255

item	details
Tx power	Eight user configurable settings from 0(-30dbm) to 7 (+4dbm)
Payload size	32 (standard) 255 (if reconfigured)
More Info	here (https://lancaster-university.github.io/microbit-docs/ubit/radio/)

Buttons

The two buttons on the front of the micro:bit, and the 1 button on the back, are tact momentary push to make buttons. The back button is connected to the KL26 interface processor and to the nRF51 processor for system reset purposes. This means that the application will reset regardless of if it is powered from USB or from battery.

Front buttons A and B can be programmed in the user application for any purpose. A and B are debounced by software, which also includes short press, long press, and 'both A+B' press detection. Buttons operate in a typical inverted electrical mode, where a pullup resistor ensures a logical '1' when the button is released, and a logical '0' when the button is pressed. Both A and B buttons are connected to GPIO pins that are also accessible on the micro:bit edge connector.

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

Display

The display is a 5x5 array of LEDs. It is connected to the micro:bit as a 3x9 matrix. Runtime software repeatedly refreshes this matrix at a high speed, such that it is within the user persistence of vision range, and no flicker is detected. This LED matrix is also used to sense ambient light, by repeatedly switching some of the LED drive pins into inputs and sampling the voltage decay time, which is roughly proportional to ambient light levels.

item	details
Type	minature surface mount red LED
Physical structure	5x5 matrix

item	details
Electrical structure	3x9
Intensity control	10 steps
Intensity range	TBC
Sensing	ambient light estimation via software algorithm
Sensing Range	TBC, 10 levels from off to full on
Colour sensitivity	red centric, red is 700nm

Accelerometer

The accelerometer is a separate chip that provides 3-axis sensing. It also includes some on board gesture detection (such as fall detection) in hardware, and additional gesture sensing (e.g. logo-up, logo-down, shake) via software algorithms. It is connected to the application processor via the I2C bus.

item	details
Model	Freescale MMA8653FC (http://www.nxp.com/products/sensors/accelerometers/3-axis-accelerometers/2g-4g-8g-low-g-10-bit-digital-accelerometer:MMA8653FC)
Features	3 axis, 2/4/8g ranges
Resolution	10 bits (0..1023)
Max output data rate	800Hz
On board gestures	'freefall'
Other gestures	Other gestures are implemented by software algorithms in the runtime.

Magnetometer

The magnetometer is a separate chip that provides magnetic field strength sensing. A software algorithm in the standard runtime uses the on board accelerometer to turn these readings into a board orientation independent compass reading. The compass must be calibrated before use, and the calibration process is automatically initiated by the runtime software. This device is connected to the application processor via the I2C bus.

item	details
Model	Freescall MAG3110 (http://www.nxp.com/products/sensors/magnetometers/sample-data-sets-for-inertial-and-magnetic-sensors/high-accuracy-3d-magnetometer:MAG3110)
Max up- date rate	80Hz
Full Scale range	1000uT
Sensi- tivity	0.10uT

Temperature Sensing

The nRF51 application processor has an on board core temperature sensor. This is exposed via the standard runtime software, and provides an estimate of ambient temperature.

item	details
Type	on-core nRF51
Sensing range	-25C .. 75C
Resolution	0.25C steps
Accuracy	+/-4C (uncalibrated)
More Info	here (https://lancaster-university.github.io/microbit-docs/ubit/thermometer/)

General Purpose Input/Output Pins

The edge connector brings out many of the GPIO circuits of the application processor. Some of these circuits are shared with other functions of the micro:bit, but many of these extra circuits can be re-allocated to general purpose use if some software features are turned off. Note: the nRF51 data sheet states that GPIO pins may be in std-drive (0.5mA) and high-drive (5mA) mode, with a maximum of 3 pins in high-drive mode at any one time.

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 assigned to the on board 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 data sheet (/hardware/edgeconnector_ds/)
Pitch	1.27mm, 80 way double sided.
Pads	5 pads, with 4mm holes
More Info	here (/hardware/edgeconnector/)

Power Supply

Power to the micro:bit may be provided via the USB connection, via the interface chip (which has an on-board regulator), or via a battery plugged into the top connector. It is also possible (with care) to power the micro:bit from the 3V pad at the bottom. The 3V pad at the bottom can be used to supply a small amount of power external circuits.

item	details
Operating range	1.8V .. 3.6V
USB current	120mA max
Onboard Peripherals budget	30mA
Battery connector	JST X2B-PH-SM4-TB
Battery current	TBC
Max current provided via edge connector	90mA
More Info	here (./powersupply)

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.

item	details
Model	Freescale MKL26Z128VFM4 (http://www.nxp.com/webapp/search.part-paramdetail.framework?PART_NUMBER=MKL26Z128VFM4)
Core variant:	ARM Cortex-M0+ (https://www.arm.com/products/processors/cortex-m/cortex-m0plus.php)
Flash ROM	128KB
RAM	16KB
Speed	16MHz
Debug capabilities	SWD
More Info	here (/software/daplink-interface/)

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 protocol for host debugging of application programs.

item	details
Connector	USB micro, MOLEX_47346-0001
USB version	1.1 Full Speed device
Speed	12Mbit/sec
USB classes supported	Mass Storage Class (MSC) (https://en.wikipedia.org/wiki/USB_mass_storage_device_class) Communications Device Class (CDC) (https://en.wikipedia.org/wiki/USB_communications_device_class)
More Info	here (/software/daplink-interface/)

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 4 signal wires. The KL26 interface processor code can also be debugged via it's integral SWD software debug interface, for example to load initial bootloader code into this processor at manufacturing time, or to recover a lost bootloader.

item	details
Proto-col	CMSIS-DAP
Op-tions	JLink/OB (via different firmware)
More Info	here (https://docs.mbed.com/docs/mbed-os-handbook/en/latest/debugging/debugging_microbit/)

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.

item	details
Dimensions	5cm(w) 4cm(h)
Weight	5g

Links

Schematic ([./schematic](#))

Reference Design ([./reference-design](#))

Nordic NRF51 datasheet (http://infocenter.nordicsemi.com/pdf/nRF51822_PS_v3.1.pdf)

Freescale KL26 reference manual

(http://cache.freescale.com/files/microcontrollers/doc/ref_manual/KL26P121M48SF4RM.pdf)

Freescale KL26Z data sheet

(http://www.nxp.com/docs/pcn_attachments/16440_KL26P64M48SF5_Rev.4.pdf)

Freescale MMA8652 accelerometer datasheet

(http://cache.freescale.com/files/sensors/doc/data_sheet/MMA8652FC.pdf)

Freescale MAG3110 magnetometer datasheet

(http://cache.freescale.com/files/sensors/doc/data_sheet/MAG3110.pdf)

Technical Specifications 1 (<http://www.bbc.co.uk/mediacentre/mediapacks/microbit/specs>)

Technical Specifications 2

(<http://www.bbc.co.uk/mediacentre/mediapacks/microbit/thebbcmicrobit>)

Safety Advice (<https://www.microbit.co.uk/safety-advice>)

I2C specification (http://cache.nxp.com/documents/user_manual/UM10204.pdf)

SPI 'specification' (https://en.wikipedia.org/wiki/Serial_Peripheral_Interface_Bus)

ARM mbed overview (<https://www.mbed.com/en/about-mbed/what-mbed/>)

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