10. Annex: Biomaker Starter Kit
Specifications

Everything you ever wanted to know about the Open Smart Rich UNO R3 Arduino board used in the 2020 Biomaker Starter Kit.

Biomaker Starter Kit: Rich UNO R3 board & parts

The 2020 Biomaker starter kit consists of an extended Arduino board, a collection of electronic components, a small prototyping board and a programmable display. It is based on the Open-Smart Rich UNO R3 board, which contains a variety of embedded components, and is accompanied by a variety of electronic components and sensors which are useful for monitoring and programming of biological systems. Importantly, the connections to the board’s embedded components can be turned off using a DIP switch, meaning that information can be stored on the device even after shutdown. The board is Arduino UNO compatible, and can be programmed directly from the visual programming software, XOD.

Further, the board is available from Open Smart as a kit of components that includes a wide range of sensors and displays. The kit includes: the Arduino board and: IO Shield, Voltage sensor, Ultrasonic sensor, Touch sensor, Water sensor, PIR motion sensor, Rocker switch, NTC sensor, Light sensor, Slide Potentiometer, Vibration motor, Passive buzzer, Speaker, 8 LED bar, Eagle eyes LED, I2C 1602 LCD, 4-Digit display, microSD card (256MB), CR1220 button battery (40mAh), Infrared Remote Control (with one CR2032 battery), Micro SD card adapter, Infrared emitter, 40pin female to female cable, USB cable (50cm). The extended kit provides a wide range of sensors, actuators and displays that are programmable from XOD and can form the basis for an extended set of tutorials - as well as provide parts for applications.

In addition to this Open Smart kit, the 2020 Biomaker kit also contains several extra components, including: a prototyping shield, an additional shield with LCD display, an RGB LED ring, an OLED display, gas sensors and an LED traffic light.
Multifunctional Kit for Arduino
Rich UNO R3 Kit (B) with MP3 and Sensors

Prototyping Shield
Shield with I2C 16x2 LCD Display
I2C OLED 64x128 Display
RGB LED Ring
Gas Sensors
LED Traffic Light

Additional Components
1. **USB Power and Download Port**
   Type B USB connector, consistent with Arduino UNO R3, for ruggedness and long service life. USB interface driver chip: CH340G, compatible with win7, win8, linux, MAC OS. Use Arduino UNO bootloader.

2. **DC Jack Power Supply**
   Onboard 500mA resettable fuse to protect power supply from the USB port and the DC jack at the same time.

3. **4-Digit Display with Clock Point**
   A 4-digit tube (0.36 inches) that can display the clock point, it needs D10/D11 pins to control and display the integer, clock, stopwatch, score, etc.

4. **Buzzer Module**
   Inbuilt piezoelectric buzzer.

5. **RTC Clock Module**
   Based on DS1307 high-precision real-time clock module, I2C interface, the address is 0x68.
6. **LM75 Temperature Sensor**
   I2C interface temperature sensor, not only can measure the temperature, it can also set the temperature protection temperature, the address is 0x48.

7. **Infrared Receiver**
   Use D2 pin. It can receive the modulated infrared signal of 38KHz that is sent by the IR transmitter module and demodulate it into logic level, and it can complete the infrared remote control with the codec program.

8. **Reset Button**
   Reset switch that allows you to restart the programme without unplugging and plugging back in again.

9. **4-Channel Touch Sensor**
   Capacitive touch switch, only when you touch the corresponding position with your fingers, will the module corresponding pin (D3 / D4 / D5 / D6) output high level, otherwise it outputs low.

10. **Signal ON/OFF**
    Onboard DIP switch, you can disconnect the connection between the peripheral module on the board and the Atmega328P.

11. **ATmega328P Chip**
    Atmel ATmega328P microcontroller, working voltage: 5V, working current: 500mA (Max), IO logic voltage: 5V, 100% compatible with Arduino UNO R3 program, expansion shields, IDE.

12. **KNOB Sensor**
    Rotation angle sensor. A 10K ohm adjustable potentiometer knob angle sensor, use A0 pin, can be used for MP3 volume adjustment, 4-digit display brightness adjustment.

13. **Shield Interface**
    Onboard Arduino Shield interface, can plug in compatible expansion shields.

14. **MP3 Player**
    Serial MP3 music player module is based on high-quality MP3 music chip, use D7 / D8 pins to be software serial port, you can send commands to switch songs, change the volume and play mode and other operations. The board kit contains TF card, speaker, CR1220 battery, infrared remote control, and these are the necessary accessories for MP3, DS1307, infrared receiver.
Open Smart Kit (B) Specifications

Water sensor
Easy to use moisture sensor module. Under normal circumstances, if the module does not touch the water line, water droplets or conductive objects, the signal pin of the module is held high by a 1M ohm pull-up resistor. When the module is exposed to water or rain droplets then that becomes low. Specifications: Operating voltage: DC3.3-5.5V. Operating current: less than 20mA. Dimension: 4.1 x 2.2cm.

NTC Thermistor sensor line + adapter module
Can be used to measure temperature directly in water. Widely used in temperature monitoring for indoor, outdoor, greenhouse, etc. You can plug the sensor onto the adapter module directly. Specifications: Working voltage: 2.2~12V DC. Working current: 0.5mA (max). Measuring range: -30~120°C. Accuracy: ±2% (4°C~50°C), ±3% (-15°C~80°C). B value: 3950K. R25: 10Kohm. Sampling resistor parameters: 10k ohm, 0.1%, 10ppm. Sensor
connector: XH2.54-2P. Lead length: 1m. Adapter output connector: standard electronic brick interface, 2.54mm-3P header.

**Ultrasonic sensor**
Distance measuring module for non-contact measurement. It has high measurement accuracy and its blind area is close (up to 2cm). Specifications: Arduino library ready: HCSR04 Ultrasonic. Working voltage: 3-5.5VDC. Static current: less than 2 mA. IO logic voltage: 3.3V / 5V. Induction angle: not more than 15 degrees. Detection range: 2-400 cm. Accuracy: 3mm. Adopt IO trigger by supplying at least a 10us sequence of high level signal. The module automatically sends an eight 40khz square wave and automatically detects whether to receive the returning pulse signal.

**Touch sensor**
This module is based on a touch detection IC (TTP223-BA6), and the touch IC is in trigger mode (Toggle Mode). On power-up, the module sends a low or high output level set by the board toggle switch. When in low or high power mode, the touch of a finger at the corresponding position will cause the module to output the opposite level (i.e. if the original output is high, it will output low after touching; if the original output is low, it will output high after touching). When in fast mode, the sensor will switch to low power mode after not being touched for 12 seconds. The module is covered by a thin paper surface (non-metallic) and can be installed into materials such as plastic, glass and non-metallic materials. As long as the touch button is in the correct location, you can hide the sensor in the walls, desktops etc. This module allows you to dispense with conventional mechanical push buttons and switches. Control Interface: A total of three pins (GND, VCC, SIG), GND to ground, VCC is the power supply, SIG is the digital signal output pin. Power light: a green LED that lights up if power is on. Touch area: A ring of concentric circles that looks similar to a fingerprint icon, this is the touch-sensitive region. Selector switch: when the switch is set to L the sensor is in low power mode; when the switch is set to H the sensor is in high power mode; when the switch is set to L the sensor is in low power mode; when the switch is set to AHBL the sensor is in fast mode. Specifications: Low power consumption. Power supply for 2 ~ 5.5V. Positive and negative can be used as a touch surface, DC can be an alternative to traditional self-locking switch.

**Voltage sensor**
The voltage detection module is based on the principle of a resistor divider. The measured voltage can be reduced, so that the ADC pin of the Arduino board can detect the voltage value after reduction, and the measured voltage can be calculated. The sampling resistor is a precision resistor, with precision of 0.5% and a temperature coefficient of 50PPM, in order to effectively ensure the detection accuracy. Specifications: Measurement Accuracy<= 1%. Measurement range up to 25 VDC.

**Slide potentiometer**
Module with 3P-2.54MM interface incorporates a linear variable resistor with a maximum resistance of 10K ohm. When you move the slider from one side to the other, its output voltage will range from 0 V to the VCC you apply. Especially suitable for volume control, lighting regulator and other DIY projects. Specifications: Working voltage: 3~12V DC. Working Current: 0.24mA. Slide stroke: 30mm.
**Rocker switch**
Module is based on a 2 feet 2 files rocker switch control module. The switch outputs at high level when you press the ON side, and outputs at low level when pressing the OFF side. Suitable for 3.3V and 5V.

**Vibration motor**
This is a mini vibration motor suitable as a non-audible indicator. When the input is high, the motor will vibrate just like your cell phone on silent mode. Specifications: Rated Voltage: 5.0VDC. Working Voltage: 3.0 - 5.3VDC. Rated Rotate Speed: Min. 9000RPM. Rated Current: Max. 60mA. Starting Current: Max. 90mA. Starting Voltage: DC 3.7V. Insulation Resistance: 10Mohm.

**PIR motion sensor**
HC-SR501 human infrared sensor module, based on infrared technology. High sensitivity, high reliability, low power consumption, ultra-low voltage operation mode. Widely used in various auto-sensing electrical equipment, especially battery-powered automatic control products. Infrared sensor with control circuit board, the sensitivity and holding time can be adjusted. Specifications: Working Voltage Range: DC 4.5V - 20V. Current drain:<60uA. Voltage Output: High/Low level signal:3.3V TTL output. Detection distance: 3 - 7M(can be adjusted). Detection range: <140°. Delay time: 5-200S (can be adjusted, default 5s +3%). Blockade time: 2.5 S (default). Trigger: L: Non-repeatable trigger H: Repeat Trigger (default). Working temperature:-20-+80°C.

**Light sensor**
The light sensor module uses the GL5528 photoresistor to detect the light intensity of the environment. The resistance of the sensor decreases when the light intensity of the environment increases. The chip LM358 is used as a voltage follower to enable you to get accurate data. Specifications: low power consumption.

**Infrared emitter**
Module is based on the infrared emission control module 940. The infrared signal emitted by the transmitter tube is at 940nm wavelength. The signal can be acquired by an infrared receiver module a few meters away, and demodulation, encoding and decoding process can be achieved with the remote control function. Specifications: Level control interface, power supply for 5V or 3.3V
**Dupont line 1*40P**
Female-to-female hook-up wires.

**MicroSD card adapter**
The module is a Micro SD card reader module. It uses the SPI interface via the file system driver and microcontroller system to read and write files on a microSD card. The kit comes with a microSD card and the Arduino IDE can be used directly to complete the library card initialization and read-write. Supports microSD card and microSDHC card (high-speed card). The level conversion circuit board that can interface is 5V or 3.3V. Communication interface is a standard SPI interface. Control Interface: A total of six pins (GND, VCC, MISO, MOSI, SCK, CS), GND to ground, VCC is the power supply, MISO, MOSI, SCK is the SPI bus, CS is the chip select/slave select signal pin. 3.3V regulator circuit: LDO regulator output 3.3V as level converter chip. Level conversion circuit: microSD card into the direction of signals into 3.3V, microSD card toward the direction of the control interface MISO signal is also converted to 3.3V, general AVR microcontroller system can read the signal. Specifications:
4.5V - 5.5V, 3.3V voltage regulator circuit board. Positioning holes: 4 M2 screws positioning hole diameter of 2.2mm. Size: 45 x 28mm. Net weight: 6g.

**4 digit display**
The module is based on a decimal point display module, it displays four digital tubes (0.36 inches). The driver IC is TM1637, two signal lines can be used to make MCU control the four-digit 8-segment LED. Can be used to display a clock, decimals, letters etc.
Specifications: 4-digit red alpha-numeric display with decimal point; Working voltage: 3.3~5.5V DC; Working current: 80mA (MAX).

**Passive buzzer**
This is 5V passive buzzer module, and it is a piezoelectric speaker. The user can set the PWM output frequency and duration to produce different tones and beats according to the song numbered musical notation. Specifications: Operating voltage: 3.3 - 5.2VDC. Operating Current: 25mA (max).

**IO expansion shield**
The sensor shield (IO expansion board) is compatible with Arduino UNO, Rich UNO R3, Leonardo and Mega2560. It is a connection bridge between the electronic building block modules and the Arduino board. It extends the SPI interface, UART interface, I2C interface, PWM interface and analog interface of the Arduino board, so that DIY enthusiasts and Arduino interactive designers can quickly attach modules to the Arduino board and accelerate project development. On-board reset circuit, power and reset indicator.

**LED bar module**
This is an LED display module with 8 LEDs on-board. Low level signals will light the corresponding LED. Especially suitable for MCU IO tests and experiments and multi-channel wireless control indicators. Specifications: Operating voltage: 3 - 5.5VDC. Operating Current: 24mA (max). Active level: High level. Number of LEDs: 8. Display colours: yellow-green (D0 / D1), blue (D2 / D3), yellow (D4 / D5), red (D6 / D7).

**Eagle eye LED module**
The module is a high efficiency green piranha LED module. Give a high signal to light up the Piranha LED. Specifications: Power supply 3.3 ~ 5.5V DC. High drive currents needed.

**I2C 1602 LCD module**
The module is a 2 line, 16 character LCD module with I2C interface. It is a basic character LCD screen for lots of applications. It is compatible with Arduino UNO R3 and Mega2560 and it can be used to display real time clock, temperature and humidity or any other text. Specifications: I2C Address: 0x27. Resolution: 80 * 16. Display Size: 2.6 inch. Power: 4.5~5.5V. Current: 80mA. Interface level: 5V.
**Additional Components**

**Prototyping shield**
Used in conjunction with the Arduino board, the ProtoShield prototype expansion board can be used to assemble custom circuits for prototyping. It allows direct mounting of soldered components on the board, or connection through a mini breadboard. The breadboard is mounted via a double-sided adhesive pad. ProtoShield prototype expansion board includes two buttons and two LED circuits can be used directly. All of the pins and the power leads are Arduino-compatible.

**Shield with I2C 16x2 LCD Display**
LCD screen that can display two lines and 16 characters of text. This module also included two touch-sensitive keys, and several additional pins to input extra components. It is compatible with Arduino UNO R3 and Mega2560 and it can be used to display a real time clock, temperature and humidity or other text. Its backlight can help you to read the screen clearly in the dark environment. There are also two touch keys onboard, and an I2C interface for RTC module, a digital interface, four analog input pins that can be connected to the temperature measurement module (DS18B20), or temperature and humidity module (DHT11 or DHT22), etc. Specifications: I2C Address: 0x38. Operating voltage: 4.5~5.2V. Interface logic level: 5V. Operating current : 80mA (MAX). Backlight color: White. Char color: White. Display Size: 2.6 inch. Applications: Thermometers, Meters, DIY projects, etc.
I2C OLED 64x128 Display
This is an OLED monochrome 128x64 dot matrix display module with I2C Interface. Compared to LCD, OLED screens are way more competitive, which has a number of advantages such as high brightness, self-emission, high contrast ratio, wide viewing angle, wide temperature range, and low power consumption. Specifications: Interface: I2C interface. Resolution: 128*64. Angle of view: >160 degree. Display color: White. Display dimension: 1.3inch. Driver IC: SH1106. Working voltage: 3.3V~5VDC. Working current: 25mA (Max). Applications: smart watch, MP3, thermometer, instruments, DIY projects, etc..

RGB LED Ring
16-bit rainbow LED based on ws2811 RGB LED. It is compatible with Arduino products - just write a simple program, and it can produce different colors. Specifications: cascadable. Standard electronic building blocks interface, a single IO to control. Chipset: WS2811 (built-in LED). LED type: 5050 full color highlight RGB LED. Operating Voltage: 4.5~5.5V.

Gas Sensors
This is a commonly used gas sensor module kit that contains the most popular smoke sensor MQ-2, an alcohol sensor MQ3 and a carbon monoxide sensor.

MQ-2 Smoke Sensor
MQ-2 specifications: Type: Smoke Sensor. Detection Target: Liquefied petroleum gas, natural gas, coal gas, smoke. Effect: it can be used to detect smoke or combustible gas concentration, and in applied alarms. Operating voltage: 5V. Analog output (AO): the higher the concentration of combustible gas, the higher the output voltage. Digital output (DO): Adjustable concentration alarms by potentiometer. When the concentration exceeds the threshold you set, it outputs low level, otherwise high level output, and it can be connected to microcontroller or relay modules.

MQ-3 Alcohol Sensor
MQ-3 specifications: Type: Alcohol Sensor. Detection Target: alcohol. Effect: it can be used to detect the concentration of ethanol vapor, used in police alcohol measuring devices. Operating voltage: 5V. Digital output (DO): Adjustable concentration alarms by potentiometer, when the concentration exceeds the threshold you set, it outputs low level, otherwise high level output, and it can be connected to microcontroller or relay modules.

MQ-7 Carbon Monoxide Sensor
MQ-7 specifications: Type: Carbon Monoxide Sensor. Detection Target: carbon monoxide or other gases containing carbon monoxide. Function: used to detect the concentration of carbon monoxide, it can be applied to coal gas poisoning alarm devices. Operating voltage: 5V. Analog output AO: the higher the concentration of carbon monoxide, the higher the output voltage. Digital output DO: Adjustable concentration alarms by potentiometer, when the concentration exceeds the threshold you set, it outputs low level, otherwise high level output, and it can be connected to microcontroller or relay modules.

LED Traffic Light
This is a mini-traffic light display module, high brightness, very suitable for the production of a traffic light system model. Specifications: Number of lights: 3. Light color: red, yellow and green. Active level: high level. Operating voltage: 5V / 3.3V. Operating current: When you
use 5V high level output, the red light 13mA, yellow light 13mA, green light 25mA. Can be connected to the motherboard’s PWM pin to control the brightness of the light.

Rich UNO R3 documentation

Downloads

Websites
A guide to setting up the Rich UNO R3
A review of the Rich UNO R3 board

Video Tutorials
A series of video tutorials that demonstrate the use of the Open Smart Rich UNO R3 board. These tutorials use the Arduino IDE, rather than the XOD IDE, but general principles may apply.

Setup the board: (https://www.youtube.com/watch?v=ius67kv00c4)
Lesson 1: Touch and sound (https://www.youtube.com/watch?v=MlZWIYSZMyc)
Lesson 2: Number display (https://www.youtube.com/watch?v=UMAgzA1H3Z4)
Lesson 3: Touch and display (https://www.youtube.com/watch?v=Ec4I5b8wjco)
Lesson 4: Touch and debounce (https://youtu.be/-jydAbAgL4M)
Lesson 5: Temperature measurement and display (https://youtu.be/OnK0XlkGV-c)
Lesson 6: Flashing number display (https://youtu.be/NlpJ4E6cYJE)
Lesson 7: Knob angle (https://youtu.be/pNXol90HKAs)
Lesson 8: Knob to control brightness (https://youtu.be/TYgp9VBcYIo)
Lesson 9: Clock input (https://youtu.be/oK9-NryMSs4)
Lesson 10: Clock display (https://youtu.be/NzyGNtRFGKw)
Lesson 11: Test for infrared keyboard (https://youtu.be/kWK1-_tZvWE)
Lesson 12: Infrared remote control and display (https://youtu.be/n66YLMcpraA)
Lesson 13: Play an mp3 song (https://youtu.be/-_soOUNMJWkc)
Lesson 14: Play a song with its file name (https://youtu.be/IHyw6L4Bco)
Lesson 15: Knob control of volume (https://youtu.be/wqivbWiNbM)
Lesson 16: Touch control of mp3 playback (https://youtu.be/-26Gr6VdLY)
Lesson 17: Infrared remote control of mp3 playback (https://youtu.be/JQqMmYRKs)
Lesson 19: Speak value of Pi (https://youtu.be/-ak7Tiwqmm)
Lesson 21: Speak clock time (https://youtu.be/gscubR2FS68)
Lesson 22: Speak time and temperature (https://youtu.be/q2ImlQFzojA)

Additional tutorials can be found at: https://www.youtube.com/channel/UCM_mzBFIDyMUnltB88c61WQ/videos

Hardware suppliers
All components were sourced from Open-Smart: https://open-smart.aliexpress.com
A list of components and their costs (correct as of 23/03/2020) can be found in the table below.

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<th>Item</th>
<th>Cost</th>
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