**NeuroMaker Hand 2.0 and BioSensor Kit**

**Connecting to 3rd Party Hardwares**

## 1. Controlling the NeuroMaker Hand 2.0 using 3rd-Party Microcontrollers

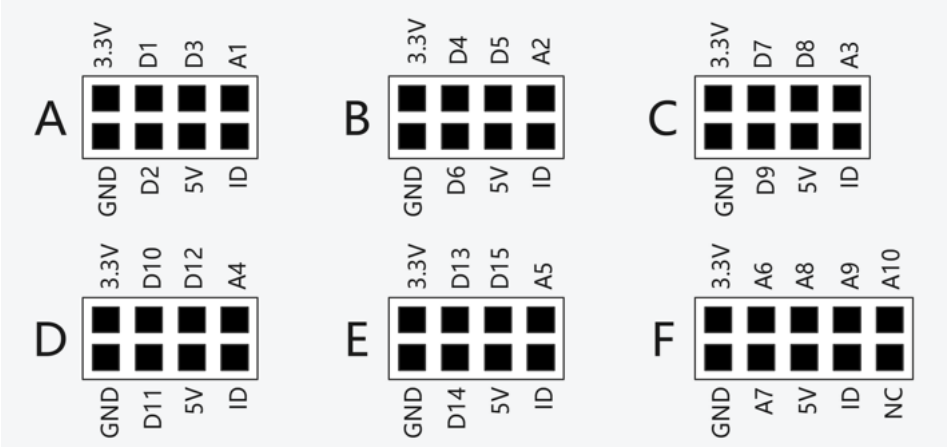



Figure 1.1: Port schematics on the NeuroMaker Core

3rd party Microcontrollers use the 10-pin port F to control the gestures of the NeuroMaker Hand 2.0.

### 1.1. Control Theory

When the NeuroMaker Core's F port detects a connected device, it initiates the gesture control program, continuously reading the voltage at interfaces A6-A10. The signal strength input to each control pin, which is the level of voltage, corresponds to the degree of finger bending. The bending of the fingers is dynamically calibrated according to the input voltage range, where the maximum degree of bending corresponds to the highest voltage in the dynamic range, and the straightened state of the fingers corresponds to the lowest voltage in the dynamic range.

## 1.2. Port F Pin Layout

| Pin | Function | Description |
|---|---|---|
| **3.3V** | 3.3V Output | Provide power to external device |
| **GND** | GND | GND |
| **A6** | Analog input[0-3.3v] | Controls thumb |
| **A7** | Analog input [0-3.3v] | Controls index finger |
| **A8** | Analog input [0-3.3v] | Controls middle finger |
| **A9** | Analog input [0-3.3v] | Controls ring finger |
| **A10** | Analog input [0-3.3v] | Controls little finger |
| **ID** | BioSensor Module Recognition ID 0v | Used to tell which BioSensor module is connected. |

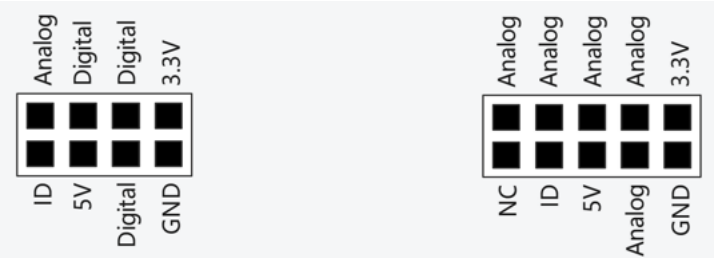
## 1.3. Connecting External Devices to Port F

1. Maintain a low voltage level of 0V at the ID pin.
2. Power on the NeuroMaker Core and switch to the extension mode. All LEDs should turn yellow.
3. Connect the device to the NeuroMaker Core with the 10-pin cable and observe the slow flashing status of the interface light after powering on.
4. Control the signal strength input to interfaces A6-A10 in real-time, where the range of finger bending varies linearly with the input voltage range.

## 2. Connecting NeuroMaker BioSensor Modules to 3rd Party Microcontrollers

The BioSensor module ports are divided into two types: the 8-pin standard interface module, corresponding to modules numbered from 01 to 12. The other type is the 10-pin interface module, corresponding to 5-channel flex sensor adapter board. An example is shown in the diagram:




8pin connector (Ports A-E) 10pin connector (Port F)

### 2.1. Bush Button Module

| Pin Definition | | | |
|---|---|---|---|
| **PIN** | NAME | TYPE | FUNCTION |
| **1** | +3.3V | P | 3.3V Input |
| **2** | GND | - | GND |
| **3** | STAT | DO | push down: LOW<br>push up: HIGH |
| **4** | NC | - | Empty |
| **5** | NC | - | Empty |
| **6** | NC | - | Empty |
| **7** | NC | - | Empty |
| **8** | ID | AO | Output 0.90±0.03V |

After the module is powered on, when the button is pressed, D0 outputs a digital LOW. When the button is released, D0 outputs a digital HIGH.

2.2. IR Obstacle Sensor

| Pin Definition | | | |
|---|---|---|---|
| **PIN** | NAME | TYPE | FUNCTION |
| **1** | +3.3V | P | 3.3V Input |
| **2** | GND | - | GND |
| **3** | STAT | DO | Object detected within threshold: LOW<br>NO object within threshold: HIGH |
| **4** | NC | - | Empty |
| **5** | NC | - | Empty |
| **6** | NC | - | Empty |
| **7** | IRO | AO | The infrared sensor outputs the distance to obstacles. |
| **8** | ID | AO | Output 0.10±0.03V |

When the detected object distance is within the threshold range (which can be adjusted by rotating the screw), the D0 pin outputs a digital LOW (0V). Otherwise, it outputs a digital HIGH (3.3V).

2.3. RGB LED Module

| Pin Definition | | | |
|---|---|---|---|
| **PIN** | NAME | TYPE | FUNCTION |
| **1** | +3.3V | P | 3.3V Input |
| **2** | GND | - | GND |
| **3** | R | - | Negative end of the red light diode. |
| **4** | G | - | Negative end of the green light diode. |
| **5** | B | - | Negative end of the blue light diode. |
| **6** | NC | - | Empty |
| **7** | NC | - | Empty |
| **8** | ID | AO | Output 0.70±0.03V |

After connecting the LED module, the brightness of the red, green, and blue lights of the module is controlled separately through the RGB pins. Each RGB pin is controlled by a PWM waveform generated by the NeuroMaker Core to manage the color of the lights. Therefore, it is necessary to feed the R, G, and B pins to PWM signals with a controllable duty cycle.

2.4. Temperature Sensor

| Pin Definition | | | |
|---|---|---|---|
| **PIN** | NAME | TYPE | FUNCTION |
| **1** | +3.3V | P | 3.3V Input |
| **2** | GND | - | GND |
| **3** | DQ | DIO | Data Input/Output. Open-drain 1-Wire interface pin. |
| **4** | NC | - | Empty |
| **5** | NC | - | Empty |
| **6** | NC | - | Empty |
| **7** | NC | - | Empty |
| **8** | ID | AO | Output 0.40±0.03V |

Use 1-wire communication protocol with the DS18B20 temperature chip. Refer to the official document below:

https://www.analog.com/media/en/technical-documentation/data-sheets/ds18b20.pdf

2.5. Color Sensor

| Pin Definition | | | |
|---|---|---|---|
| **PIN** | NAME | TYPE | FUNCTION |
| **1** | +3.3V | P | 3.3V Input |
| **2** | GND | - | GND |
| **3** | SDA | DIO | I 2C serial data I/O terminal — serial data I/O for I2C |
| **4** | SCL | DI | I 2C serial clock input terminal — clock signal for I2C serial data |
| **5** | INT | DO | Interrupt — open drain (active low) |
| **6** | NC | - | Empty |
| **7** | LED_C | DI | Controls the LED supplementary light. Input HIGH to turn on LED. |
| **8** | ID | AO | Output 0.60±0.03V |

After powering on, communicate directly with the color sensor in the color module via the I2C bus protocol to read the real-time color values R, G, B, and C. For details, see the chip (TCS34725) manual.
https://pdf1.alldatasheet.com/datasheet-pdf/view/894928/AMSCO/TCS34725.html

## 2.6. Rotary Dial Module

| Pin Definition | | | |
|---|---|---|---|
| **PIN** | NAME | TYPE | FUNCTION |
| **1** | +3.3V | P | 3.3V Input |
| **2** | GND | - | GND |
| **3** | NC | - | Empty |
| **4** | NC | - | Empty |
| **5** | NC | - | Empty |
| **6** | NC | - | Empty |
| **7** | Res_adc | AO | Analog Output |
| **8** | ID | AO | Output 0.80V±0.03V |

After connecting to the power supply, by rotating the potentiometer, the simulated output terminal Res_adc outputs a varying voltage, with the output voltage changing linearly as it rotates.

## 2.7. Sound Sensor

| Pin Definition | | | |
|---|---|---|---|
| **PIN** | NAME | TYPE | FUNCTION |
| **1** | +3.3V | P | 3.3V Input |
| **2** | GND | - | GND |
| **3** | STAT | DO | Sound volume higher than threshold: LOW<br>Sound volume lower than threshold: HIGH |
| **4** | NC | - | Empty |
| **5** | NC | - | Empty |
| **6** | NC | - | Empty |
| **7** | MO | AO | Mic signal output |
| **8** | ID | AO | Output 0.30V±0.03V |

STAT is a pin that indicates the status of sound exceeding a threshold level. It outputs a digital LOW when the detected sound exceeds the threshold range, and outputs a digital HIGH otherwise.

MO is the output for the amplitude voltage of the sound signal, representing the voltage signal converted from real-time sound.

## 2.8. Hall Sensor

| Pin Definition | | | |
|---|---|---|---|
| **PIN** | NAME | TYPE | FUNCTION |
| **1** | +3.3V | P | 3.3V Input |
| **2** | GND | - | GND |
| **3** | STAT | DO | Magnetic field intensity higher than threshold: LOW<br>Magnetic field intensity lower than threshold: HIGH |
| **4** | NC | - | Empty |
| **5** | NC | - | Empty |
| **6** | NC | - | Empty |
| **7** | MAGO | AO | Output magnetic field intensity |
| **8** | ID | AO | Output 0.50V±0.03V |

The STAT pin provides feedback on whether the magnetic force of an object approaching the sensor exceeds a threshold. For example, when a magnet approaches, the STAT pin outputs a digital LOW; otherwise, it outputs a digital HIGH. The threshold range can be manually adjusted using the screw.

## 2.9. Ultrasonic Distance Sensor

| Pin Definition | | | |
|---|---|---|---|
| **PIN** | NAME | TYPE | FUNCTION |
| **1** | +3.3V | P | 3.3V Input |
| **2** | GND | - | GND |
| **3** | ECHO | DO | The distance measurement pulse output, ECHO, has a high level width that corresponds to the round-trip time of the ultrasound. This means the duration of the digital HIGH signal on the ECHO pin directly represents the time it takes for the ultrasonic pulse to travel to the object and back to the sensor. |
| **4** | TRIG | DI | To trigger distance measurement, input a digital HIGH pulse greater than 10 microseconds. This pulse starts the measurement process by initiating the transmission of ultrasonic waves. |
| **5** | NC | - | Empty |
| **6** | NC | - | Empty |
| **7** | NC | - | Empty |
| **8** | ID | AO | Output 0.20V±0.03V |

1. After powering on, send a high-level pulse greater than 10 microseconds through the TRIG pin to start triggering the ultrasonic detection signal.
2. Detect the time interval between the returned ECHO waveform and the transmitted waveform through an interrupt.
3. Calculate the distance using the time interval with the formula: L = T / 340 / 2 (where the speed of sound in air is 340 m/s).

## 2.10. EMG Sensor

| Pin Definition | | | |
|---|---|---|---|
| **PIN** | NAME | TYPE | FUNCTION |
| **1** | +3.3V | P | 3.3V Input |
| **2** | GND | - | GND |
| **3** | FR | DI | Fast Restore Control Input. Drive FR high to enable fast recovery mode; otherwise, drive it low. |
| **4** | EMG_ADC | AO | Raw EMG Signal Output |
| **5** | LO_STAT | DO | Lead off state output pin, acts as follows:<br>High: Lead on<br>Low: Lead off |
| **6** | NC | - | Empty |
| **7** | DACO | AO | EMG muscle signal intensity output （0-3.3v） |
| **8** | ID | AO | Output 1.20V±0.03V |

EMG_ADC Outputs the raw EMG signal.
DAC0 outputs a voltage range from 0 to 3.3 volts to represent the strength of the electromyography (EMG) signal. A higher voltage indicates a stronger EMG signal. Here, the voltage only represents the intensity of the signal.

## 2.11. Single Channel Flex Sensor Adapter Board

| Pin Definition | | | |
|---|---|---|---|
| **PIN** | NAME | TYPE | FUNCTION |
| **1** | +3.3V | P | 3.3V Input |
| **2** | GND | - | GND |
| **3** | NC | - | Empty |
| **4** | NC | - | Empty |
| **5** | NC | - | Empty |
| **6** | NC | - | Empty |
| **7** | VO | AO | Output the voltage corresponding to bending |
| **8** | ID | AO | Output 1.0V±0.03V |

When a single-channel board is connected to just one flex sensor and powered on, the VO interface reflects changes in the sensor's bend. More bending results in a higher output voltage, while less bending results in a lower voltage.

## 2.12. 5 Channel Flex Sensor Adapter Board

| Pin Definition | | | |
|---|---|---|---|
| **PIN** | NAME | TYPE | FUNCTION |
| **1** | +3.3V | P | 3.3V Input |
| **2** | GND | - | GND |
| **3** | VO1 | AO | The voltage from flex sensor connected to port1 |
| **4** | VO2 | AO | The voltage from flex sensor connected to port2 |
| **5** | VO3 | AO | The voltage from flex sensor connected to port3 |
| **6** | NC | - | Empty |
| **7** | VO5 | AO | The voltage from flex sensor connected to port5 |
| **8** | ID | AO | Output 1.1V±0.03V |
| **9** | VO4 | AO | The voltage from flex sensor connected to port4 |
| **10** | NC | - | Empty |

Similar to the single-channel adapter board, this setup can simultaneously connect to five flex sensors. Each sensor's degree of bending corresponds to changes in the voltage amplitude at outputs VO1 to VO5 respectively.