

# Needed for play testing:

A working prototype

# Needed for play testing:

~~A working prototype~~

An idea

Props

A script

Questions for users

# How to play test?



# Be like ZORK

# How to play test?



## Be like ZORK

**Describe what the user sees, hears, feels (observables).**

**Let the user tell you what they do.**

**Describe the result (in terms of observables)**

**DON'T tell the user what to think or what anything means.**

West of House

0/0

ZORK I: The Great Underground Empire  
Infocom interactive fiction - a fantasy  
story  
Copyright (c) 1981, 1982, 1983, 1984,  
1985, 1986 Infocom, Inc.  
All rights reserved.  
ZORK is a registered trademark of  
Infocom, Inc.  
Release 52 / Serial number 871125 /  
Interpreter 8 Version J

West of House  
You are standing in an open field west  
of a white house, with a boarded front  
door.  
There is a small mailbox here.  
>\_

## Be like ZORK

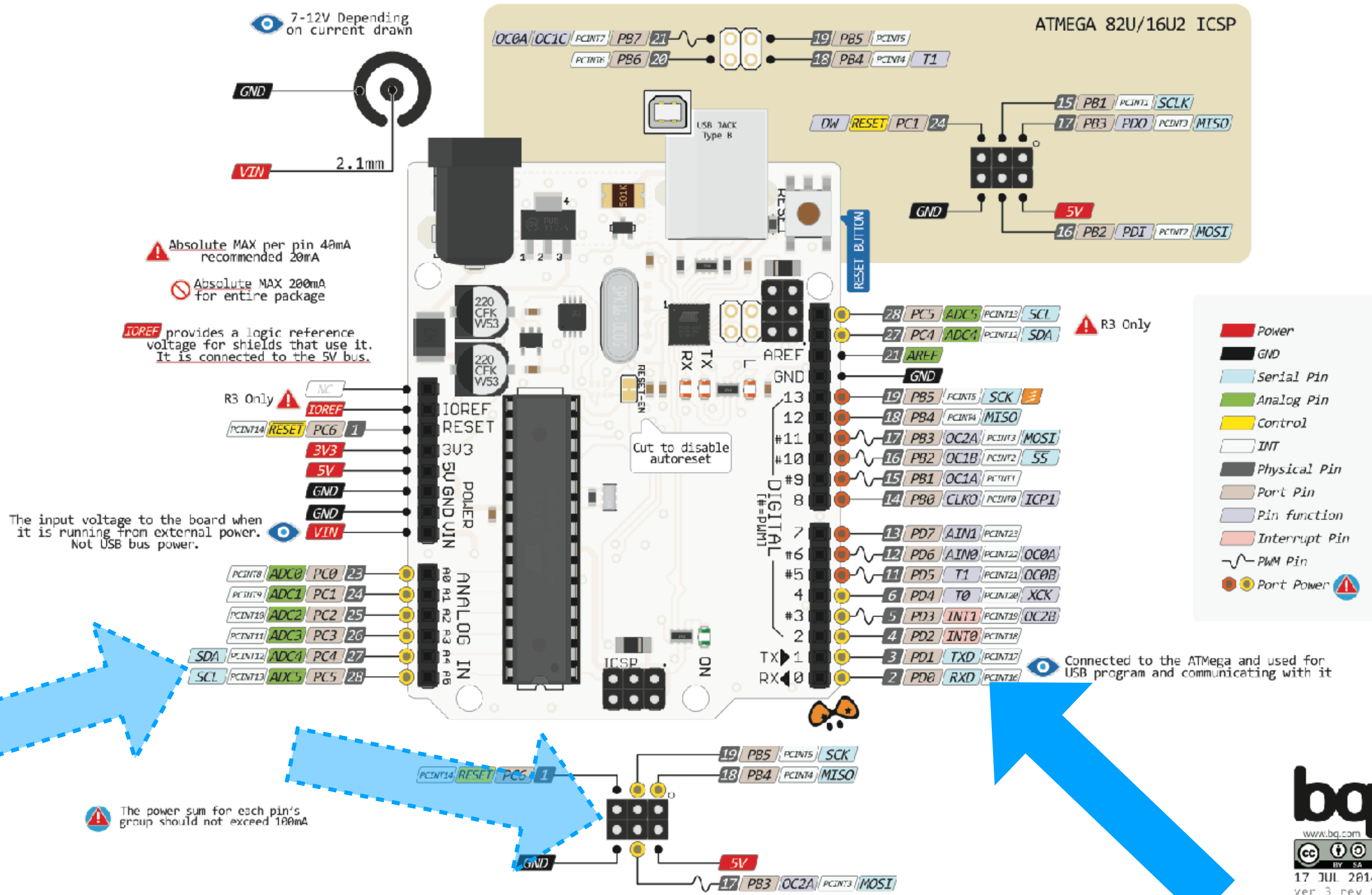
Describe what the user sees,  
hears, feels (observables).

Let the user tell you what  
they do.

Describe the result (in terms  
of observables)

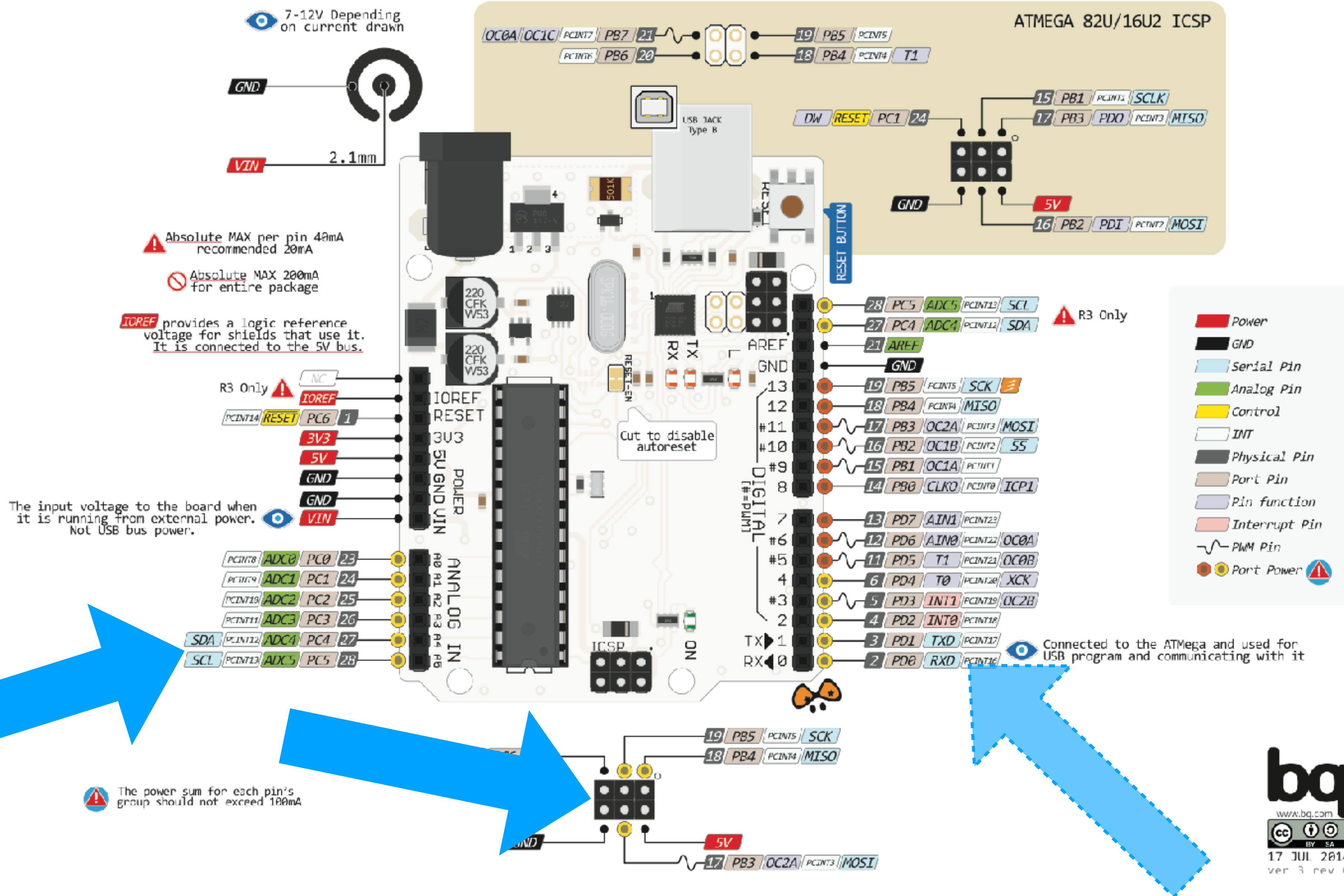
DON'T tell the user what to  
think or what anything  
means.

**UNO PINOUT**

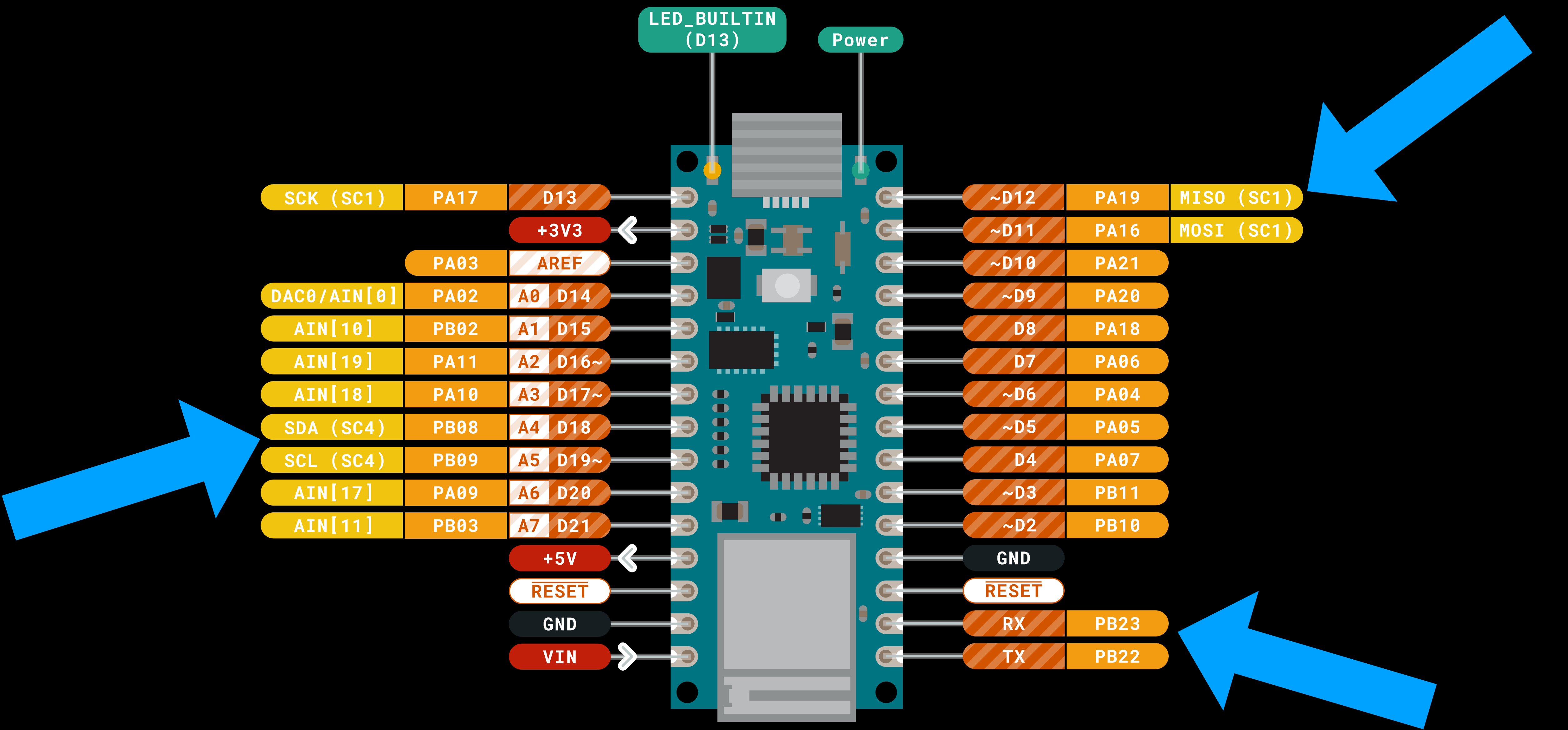


# Arduino can talk to the world three ways

# UNO PINOUT



Arduino can talk to the world three ways



Arduino can talk to the world three ways

# I2C

Inter-Integrated Circuit

## Pins

- **SDA** (data)
- **SCL** (clock)

Peripherals have unique address

All peripherals share both wires

**SDA** line is two-way

`Wire.h` library

(SCD30/others in demo)

# SPI

Serial Peripheral Interface

## Pins

- **MOSI** (data *from*  $\mu$ c)
- **MISO** (data *to*  $\mu$ c,)
- **SCK** (clock)
- **CS** (select, aka SS)

Peripherals selected with **SS**

Each peripheral needs new **SS** line

Separate lines for data direction

`SPI.h` library

(Sharp LCD display in demo)

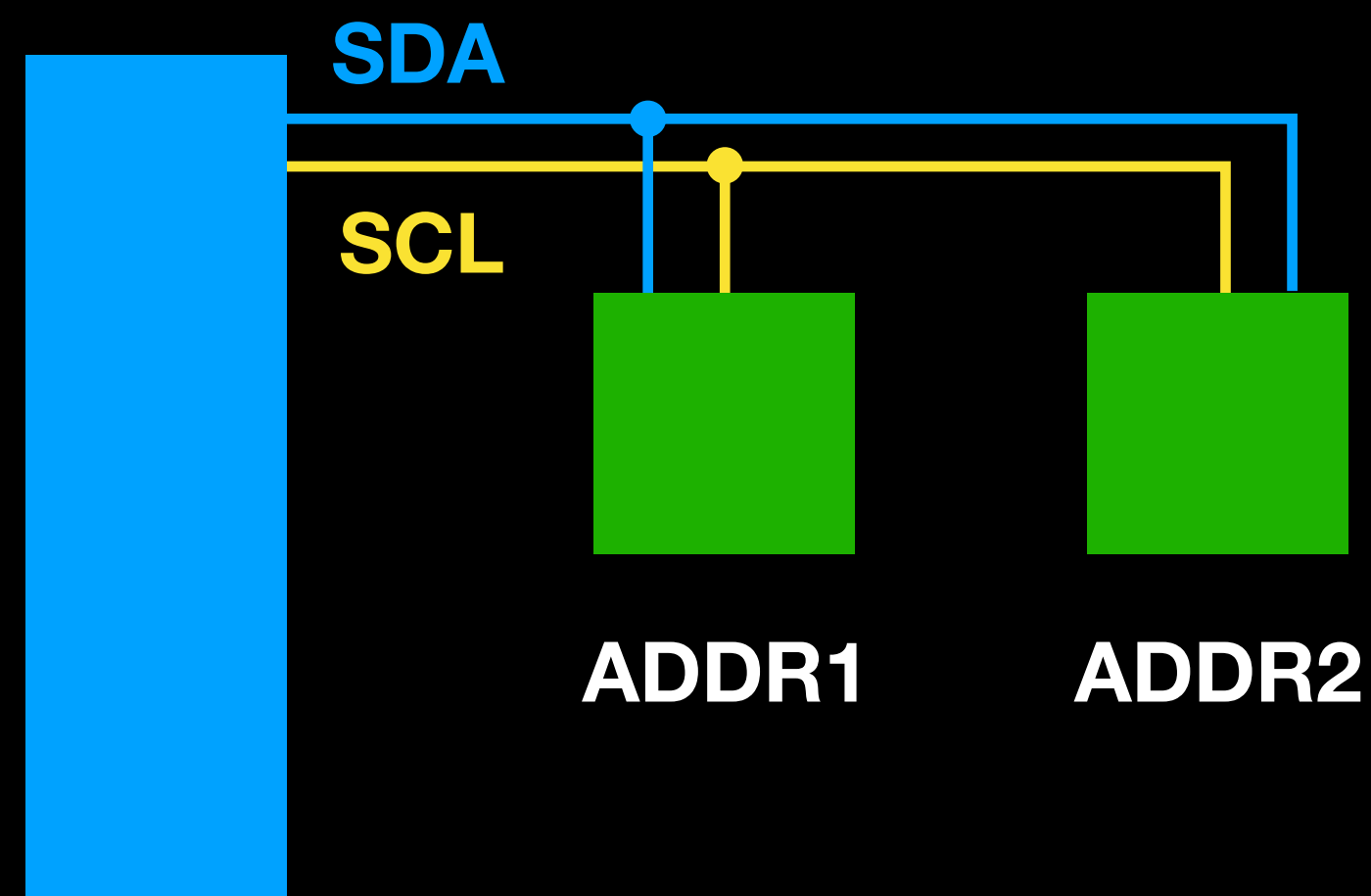
Legacy language (“Master”/“Slave”) in flux,  
Alternative: “Central” and “Peripheral” (e.g.  
COPI), or “Data”, “DIN”, and/or “DOUT” with  
direction inferred from context.

# I2C

Inter-Integrated Circuit

## Pins

- **SDA** (data)
- **SCL** (clock)

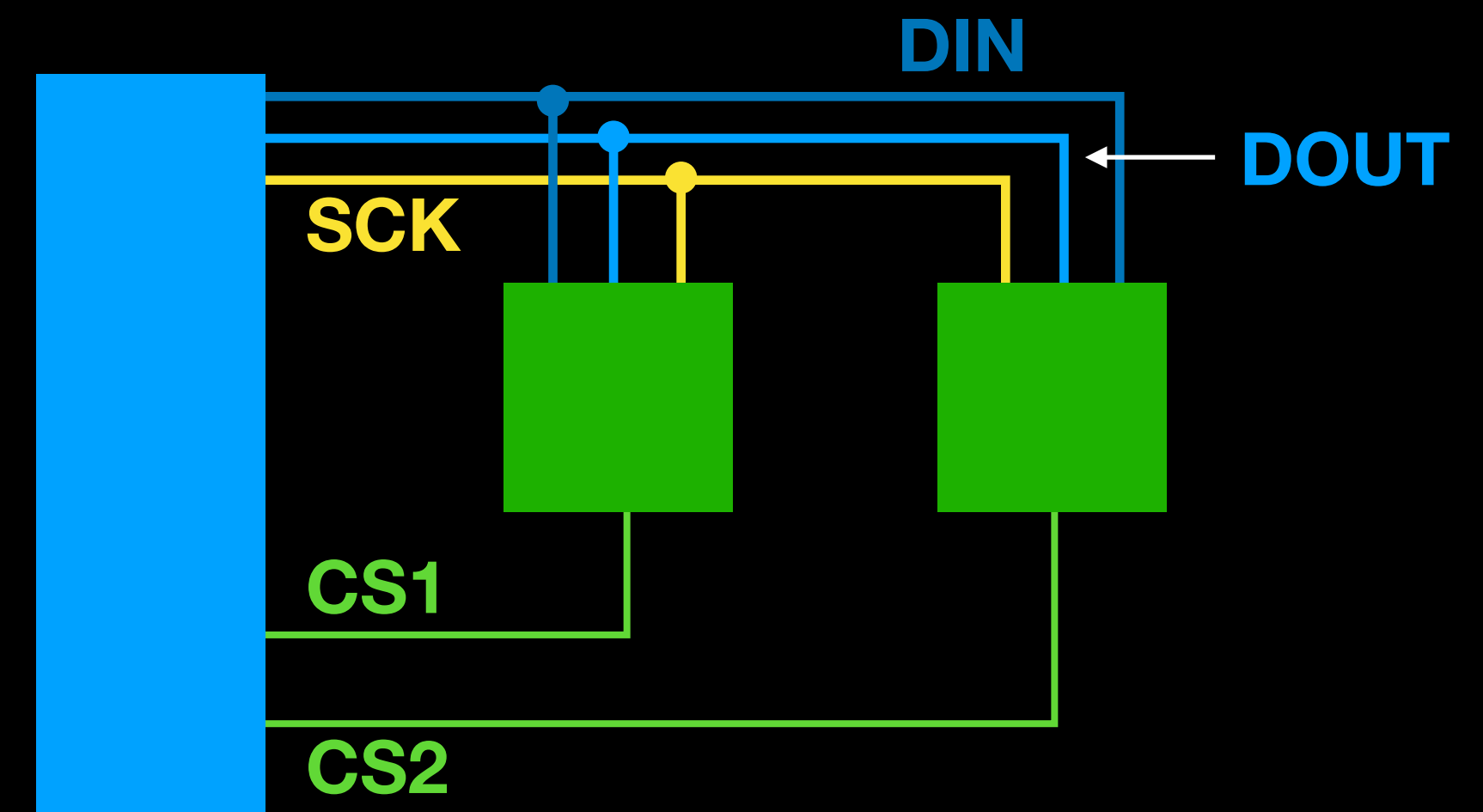


# SPI

Serial Peripheral Interface

## Pins

- **MOSI** (or DOUT, data *from*  $\mu c$ )
- **MISO** (of DIN, data *to*  $\mu c$ ,)
- **SCK** (clock)
- **CS** (select, aka SS)

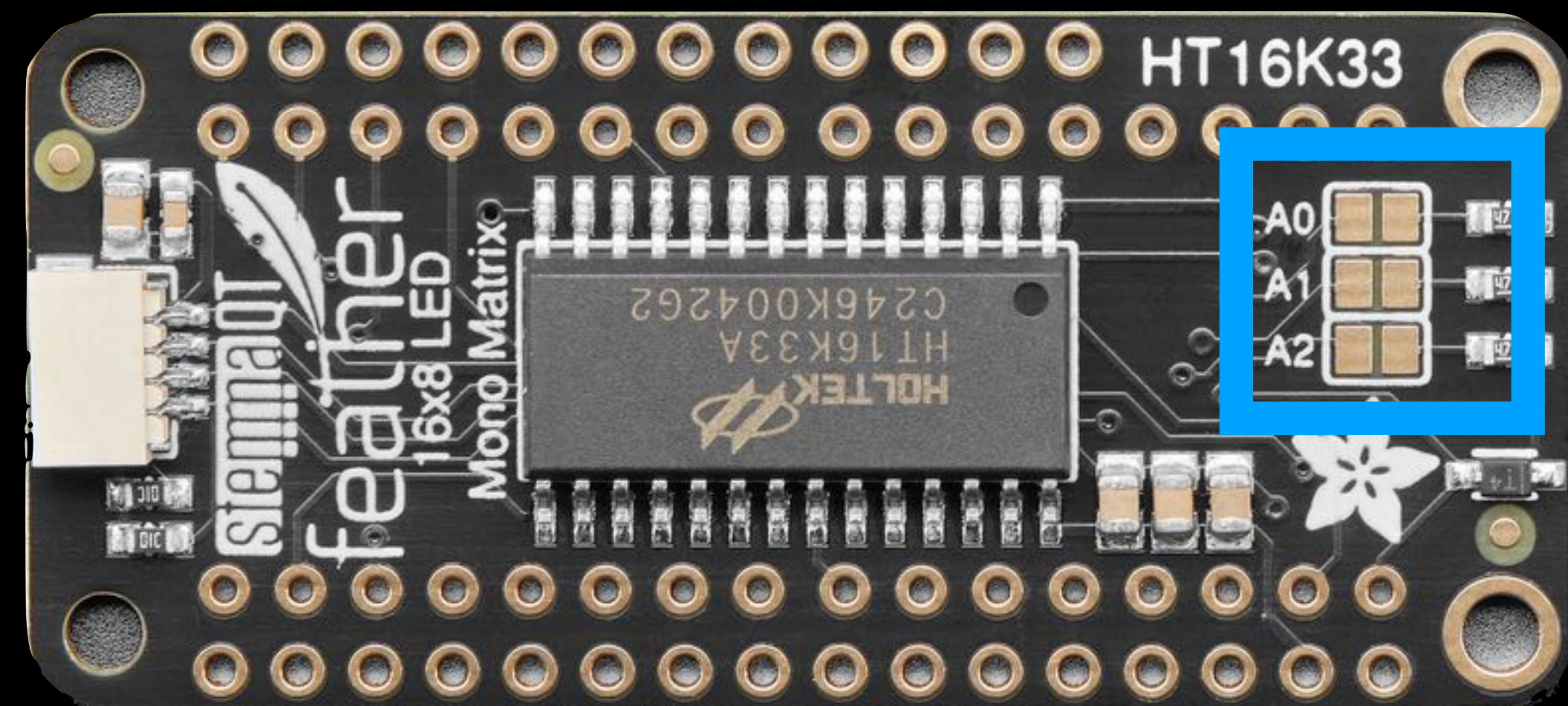
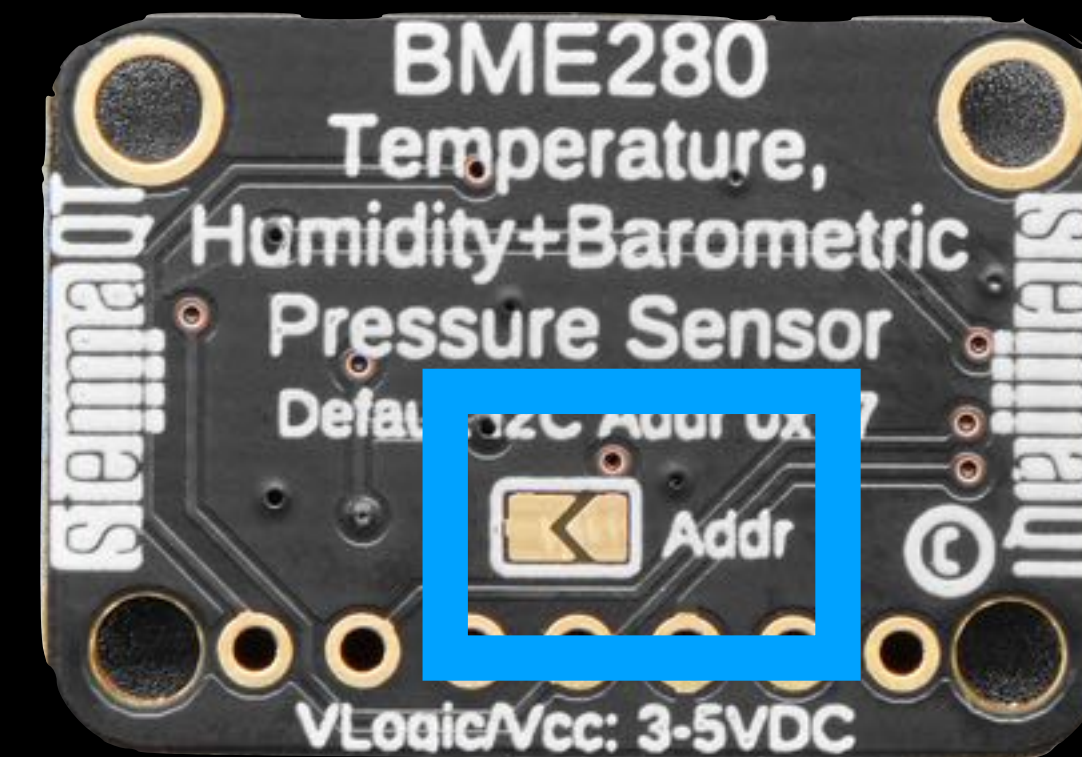
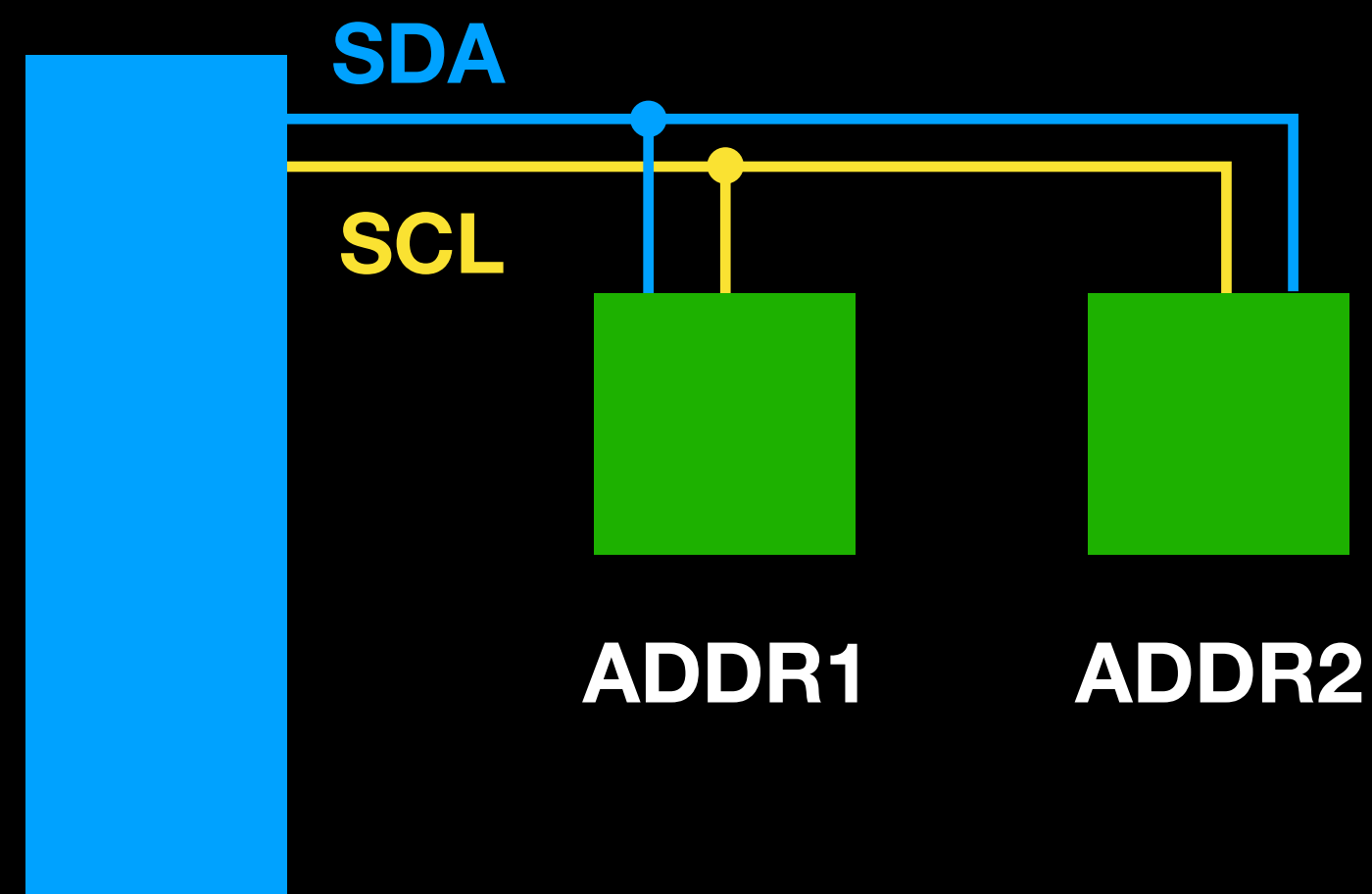


# I2C

Inter-Integrated Circuit

Pins

- **SDA** (data)
- **SCL** (clock)



If you use more than one of the same device on one I2C bus, you must modify the address. Some devices allow this through special I2C instructions and/or have address offset pads

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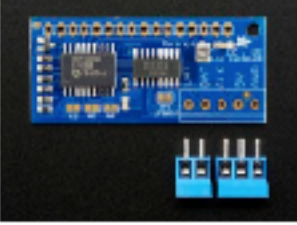
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I2C / SPI character LCD backpack

PRODUCT ID: 292

LCD backpacks reduce the number of pins needed to connect to an LCD. LCDs are a fun and easy way to have your microcontroller or project talk back to you. Character LCDs are common, and easy to get, available in lots of colors and sizes. We've written tutorials on using character LCDs with an...

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I2C Driver by Excamera Labs

PRODUCT ID: 4257

I2C Driver is an easy-to-use, open source tool for controlling I2C devices and a great tool to help with quick driver development and debugging. It works with Windows, Mac, and Linux, and has a built-in color screen that shows a live dashboard of all the I2C...

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TCA9548A I2C Multiplexer

PRODUCT ID: 277

The TCA9548 is a 4-to-1 I2C multiplexer, and you want to wire up two or three more or then to your Arduino when you realize that this chip has a fixed I2C address, and from what I know about I2C you cannot have two devices with the same address in the same I2C bus. Just plug it in...

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Adafruit I2C Non-Volatile FRAM Breakout - 256Kbit / 32KByte

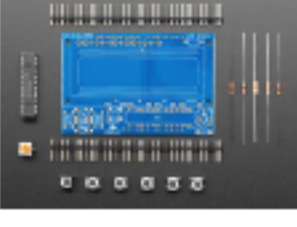
PRODUCT ID: 1030

FRAM, or Ferroelectric Ram, is the coolest new data storage method that all the tech magazines are talking about. On disk, on flash, on the other hand, but FRAM is pretty damn cool too. It's similar to dynamic random-access...

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Adafruit I2C Controlled + Keypad Shield Kit for 16x2 LCD

PRODUCT ID: 710

This new Adafruit shield makes it easy to use a 16x2 character LCD. The 16x2 Character LCD is NOT, repeat, NOT, included. We really like the range of LCDs we stock in the shop, such as our 16x2 blue & white as well as the fancy RS4...

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MPL3115A2 - I2C Barometric Pressure/Altitude/Temperature Sensor

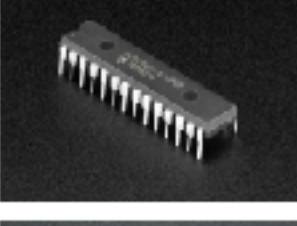
PRODUCT ID: 1893

This pressure sensor from Precision is a great low-cost sensing solution for precision measurement of barometric pressure and altitude. The MPL3115A2 has a typical 1.5 Pascal resolution, which can resolve altitude at 0.2 meters...

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MCP23017 - I2C 16 input/output port expander

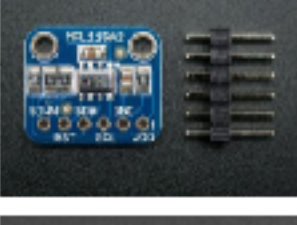
PRODUCT ID: 757

Add another 16 pins to your microcontroller using a MCP23017 port expander. The MCP23017 uses two 7416s (these can be shared with other I2C devices), and in exchange gives you 16 general purpose pins. You can set each of 16 pins to be input, output, or input with a pullup. There's even the...

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MPL115A2 - I2C Barometric Pressure/Temperature Sensor

PRODUCT ID: 992

This pressure sensor from Precision is a great low-cost sensing solution for measuring barometric pressure. At 1.5 hPa resolution, it's not as precise as our serial pressure sensor, the BMP280 series, which has up to 0.05 hPa...

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MCP23008 - I2C 8 input/output port expander

PRODUCT ID: 755

Add another 8 pins to your microcontroller using a MCP23008 port expander. The MCP23008 uses two 7416s (these can be shared with other I2C devices), and in exchange gives you 8 general purpose pins. You can set each of 8 pins to be input, output, or input with a pullup. There's even the...

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Adafruit BME280 I2C or SPI Temperature Humidity Pressure Sensor

PRODUCT ID: 2652

Adafruit has stepped up their game with their new BME280 sensor, an environmental sensor with temperature, barometric pressure, and humidity. This sensor is great for all sorts of weather/environmental sensing and can...

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SPIDriver by Excamera Labs

PRODUCT ID: 4258

SPIDriver is an easy-to-use tool for controlling SPI devices and a great tool to help with quick driver development and debugging. It works with Windows, Mac, and Linux, and has a built-in color screen that shows a live dashboard of all the SPI...

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I2C / SPI character LCD backpack

PRODUCT ID: 292

LCD backpacks reduce the number of pins needed to connect to an LCD. LCDs are a fun and easy way to have your microcontroller or project talk back to you. Character LCDs are common, and easy to get, available in lots of colors and sizes. We've written tutorials on using character LCDs with an...

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Adafruit SPI Non-Volatile FRAM Breakout - 64Kbit / 8KByte

PRODUCT ID: 1030

FRAM, or Ferroelectric Ram, is the coolest new data storage method that all the tech magazines are talking about. On disk, on flash, on the other hand, but FRAM is pretty damn cool too. It's similar to dynamic random-access...

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CD DVD Spindle Motor

PRODUCT ID: 3832

Who's that a record? Turn it over! No it's not! This is a DVD/CD spindle motor that spins discs inside a CD or DVD player that turns the disc around really fast. These motors have some great benefits that make them easier to use than 3V or 5V style DC brushless ones...

NOTIFY ME

\$1.95

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Monochrome 128x32 SPI OLED graphic display

PRODUCT ID: 561

These displays are small, only about 1" diagonal, but very readable due to the high contrast of an OLED display. This display is made of 128x32 individual white OLED pixels, each of which is turned on or off by its controller chip. Because the display makes its own light, no backlight is required...

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Adafruit Bluefruit LE SPI Friend - Bluetooth Low Energy (BLE)

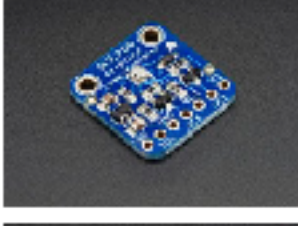
PRODUCT ID: 2638

What if you like to work with SPI but don't have Bluetooth Low Energy in your robot, or other electronics project? Hack your way with BLE now! Included in modern smart phones and tablets, it's fun to add wireless connectivity. So what...

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\$17.50

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Adafruit BME280 I2C or SPI Temperature Humidity Pressure Sensor

PRODUCT ID: 2652

Adafruit has stepped up their game with their new BME280 sensor, an environmental sensor with temperature, barometric pressure, and humidity. This sensor is great for all sorts of weather/environmental sensing and can...

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Adafruit BMP280 I2C or SPI Barometric Pressure & Altitude Sensor

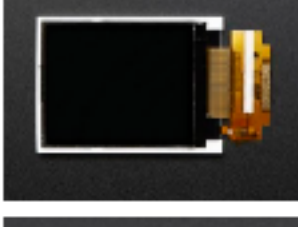
PRODUCT ID: 2651

Adafruit has stepped up their game with their new BMP280 sensor, an environmental sensor with temperature, barometric pressure, and humidity. This sensor is great for all sorts of weather/environmental sensing and can...

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1.8" SPI TFT display, 160x128 18-bit color - ST7735R driver

PRODUCT ID: 1016

We just love this little 1.8" TFT display, with nice TFT color (up to 16-bit per pixel), 160x128 resolution, two white LED backlight that runs on 3.3V and a very easy SPI interface that requires only 4 or 5 digital pins to send pixels to...

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MCP3008 - 8-Channel 10-Bit ADC With SPI Interface

PRODUCT ID: 855

Need to add analog inputs? This chip will add 8 channels of 10-bit analog input to your microcontroller or microcontroller project. It's super easy to use, and uses SPI so only 4 pins are required. We chose this chip at a great...

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**I2C EEPROM - 256k Bit (24LC256)**  
COM-00525  
\$1.95  
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**SparkFun Differential I2C Breakout - PCA9615 (Qwiic)**  
BOB-14589  
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★★★★★ 7

**I2C DRIVER**  
DEV-15457  
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**LinkM - USB to I2C**  
COM-05903  
\$29.95

**SparkFun I2C DAC Breakout - MCP4725**  
BOB-12918  
\$4.95  
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**BlinkM - I2C Controlled RGB LED**  
COM-06579  
\$12.95  
★★★★★ 2

**BlinkM MaxM - I2C Controlled RGB LED**  
COM-09000  
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**SparkFun Qwiic Adapter**  
DEV-14495  
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**SparkFun Micro OLED Breakout (Qwiic)**  
LCD-14532  
\$16.95  
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**Qwiic Thermocouple Amplifier - MCP9600**  
SPX-15508  
\$19.95

**SparkFun Qwiic Keypad - 12 Button**  
COM-15290  
\$9.95  
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**SparkFun Qwiic Shield for Arduino**  
DEV-14359  
\$24.95

**SparkFun Qwiic Quad Relay**  
COM-15102  
\$24.95

**SparkFun GPS Breakout - XA1110 (Qwiic)**  
COM-15103  
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**SparkFun Qwiic Single Relay**  
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★★★★ & Up  
★★★★ & Up  
★★★ & Up  
★★ & Up  
★ & Up  
All Ratings

**PRICE:**  
All prices  
\$0 - \$10  
\$10 - \$20  
\$20 - \$30  
\$30 - \$40  
\$40 - \$50  
\$50 - \$75  
\$75 - \$100  
\$100 +  
\$ to \$

**SPI Buffer Saver**  
SPX-14923  
\$2.95

**SPI Driver Core**  
DEV-15458  
\$31.95

**LCD Touchscreen HAT for Raspberry Pi - TFT 3.5in. (480x320)**  
LCD-14776  
\$24.95  
★★★★★ 2

**Bus Pirate - v3.6a**  
BOB-17940  
\$29.95  
★★★★★ 14

**SparkFun Flexible Grayscale OLED Breakout - 1.8" (128x160)**  
LCD-14806  
\$50.95

**SparkFun TFT LCD Breakout - 1.8" (128x160)**  
LCD-15148  
\$29.95

**USB Logic Analyzer - 25MHz/8-Channel**  
TOL-15033  
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★★★★★ 3

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COM-10079  
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\$20.95  
★★★★★ 1A

**Pixhawk 4 Flight Controller**  
BOB-14841  
\$249.95  
★★★★★ 1

**SparkFun 16x2 SerLCD - RGB on Black 3.3V**  
LCD-14073  
\$19.95  
★★★★★ 1

**SparkFun Triple Axis Magnetometer Breakout - MLX90393 (Qwiic)**  
SPX-14571  
\$14.95

**SparkFun Transparent Graphical OLED Breakout (Qwiic)**  
LCD-15173  
\$39.95  
★★★★★ 2

**SparkFun gator:bit**  
DEV-14484  
\$20.95

**SparkFun 16x2 SerLCD - Black on RGB 3.3V**  
LCD-14072  
\$19.95  
★★★★★ 4

**SparkFun 20x4 SerLCD - Black on RGB 3.3V**  
LCD-14074  
\$24.95  
★★★★★ 3

**SparkFun VR IMU Breakout - BNO080 (Qwiic)**  
SEN-14686  
\$34.95

**SparkFun 9DoF IMU Breakout - LSM9DS1**  
SEN-13284  
\$15.95  
★★★★★ 10

**SparkFun gator:bit v2.0 - micro:bit Carrier Board**  
DEV-15162  
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| <input type="checkbox"/> |       | Mfr. Part # 92C-HUTMP<br>Mouser Part # 992-I2C-HUTMP       | Grainger                   | Industrial Humidity Sensors I2C Humidity and Temperature Sensor | <a href="#">Datasheet</a> | 2 In Stock      | 1: \$26.95                                                                                                | Min: 1<br>Mult: 1                |
| <input type="checkbox"/> |       | Mfr. Part # VICS-VZ-RATE<br>Mouser Part # 523-MICS-VZ-68TE | Amphenol<br>SGX Sensortech | Air Quality Sensors I2C Output VOC Module                       | <a href="#">Datasheet</a> | 213 In Stock    | 1: \$25.15<br>5: \$29.00<br>10: \$21.71<br>25: \$20.00<br>60: View                                        | Min: 1<br>Mult: 1                |
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| <input type="checkbox"/> |       | Mfr. Part # HDC1000DMR<br>Mouser Part # 696-HDC2000DMR     | Texas Instruments          | Board Mount Humidity Sensors A95S-HDC2000DMR                    | <a href="#">Datasheet</a> | 12,756 In Stock | Cut Tape<br>1: \$3.09<br>10: \$2.72<br>100: \$2.23<br>250: \$2.09<br>Reel                                 | Min: 1<br>Mult: 1<br>Reel: 3,000 |

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±1-4 %  
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±0.3 C  
±1 C

850 uA  
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+100 C

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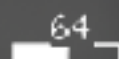
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| <input type="checkbox"/> |       | Mfr. Part # HH71-000-001<br>Mouser Part # 746-HH-7131-000-001 | Honeywell | Board Mount Humidity Sensors SPI 3% RH SOIC8 Condensation Filtered    | <a href="#">Datasheet</a> | 506 In Stock | 1: \$6.94<br>10: \$7.41<br>25: \$6.61<br>100: \$5.81<br>1,000: View                                      | Min: 1<br>Mult: 1                |
| <input type="checkbox"/> |       | Mfr. Part # HH51-000-001<br>Mouser Part # 709-HH51-000-001    | Honeywell | Board Mount Humidity Sensors SP 14% RH SOIC-8 SMD Hygroscopic Filter  | <a href="#">Datasheet</a> | 215 In Stock | Cut Tape<br>1: \$11.79<br>10: \$9.81<br>25: \$8.89<br>100: \$8.07<br>500: View<br>Reel<br>1,000: \$7.76  | Min: 1<br>Mult: 1<br>Reel: 1,000 |
| <input type="checkbox"/> |       | Mfr. Part # HH71-000-001<br>Mouser Part # 786-HH71-000-001    | Honeywell | Board Mount Humidity Sensors SOIC 8 SMD w/Filter Non-condensing       | <a href="#">Datasheet</a> | 400 In Stock | Cut Tape<br>1: \$6.52<br>10: \$6.27<br>25: \$5.96<br>100: \$5.21<br>Reel<br>1,000: \$4.63<br>2,000: View | Min: 1<br>Mult: 1<br>Reel: 1,000 |

**NUNOMO**  
QUN MK2

IN OUT  
MIDI



Q-Mk2 v3.00  
90:VCF Volume 

DIAL SHORTCUTS

SHIFT + SEQ PLAY - BPM  
MODE PLAY - REC VOL  
SYSTEM - VCF VOLUME  
PARAM - CUTOFF  
REC - LFO TUNE

SHIFT

IN  
OUT

FM  
MIXER  
SYSTEM

CUT

PASTE

ENV3/4  
PROB

NO

OK



OSC1  
PIANO



OSC2  
MODIFY



MIX  
ON/OFF



ENV1/2  
VEL



SWITCH  
TUNE



LFO  
WIDTH



VCF  
CFG



OTHER  
GRANULAR

SEQ  
PLAY



BPM

MODE

PLAY/RECALL

SYSTEM

PARAM/MUTE



DUMP



NOTE OFF



INITIALIZE

LOOPER

REC/TRACK

PLAY/SCENE

STOP



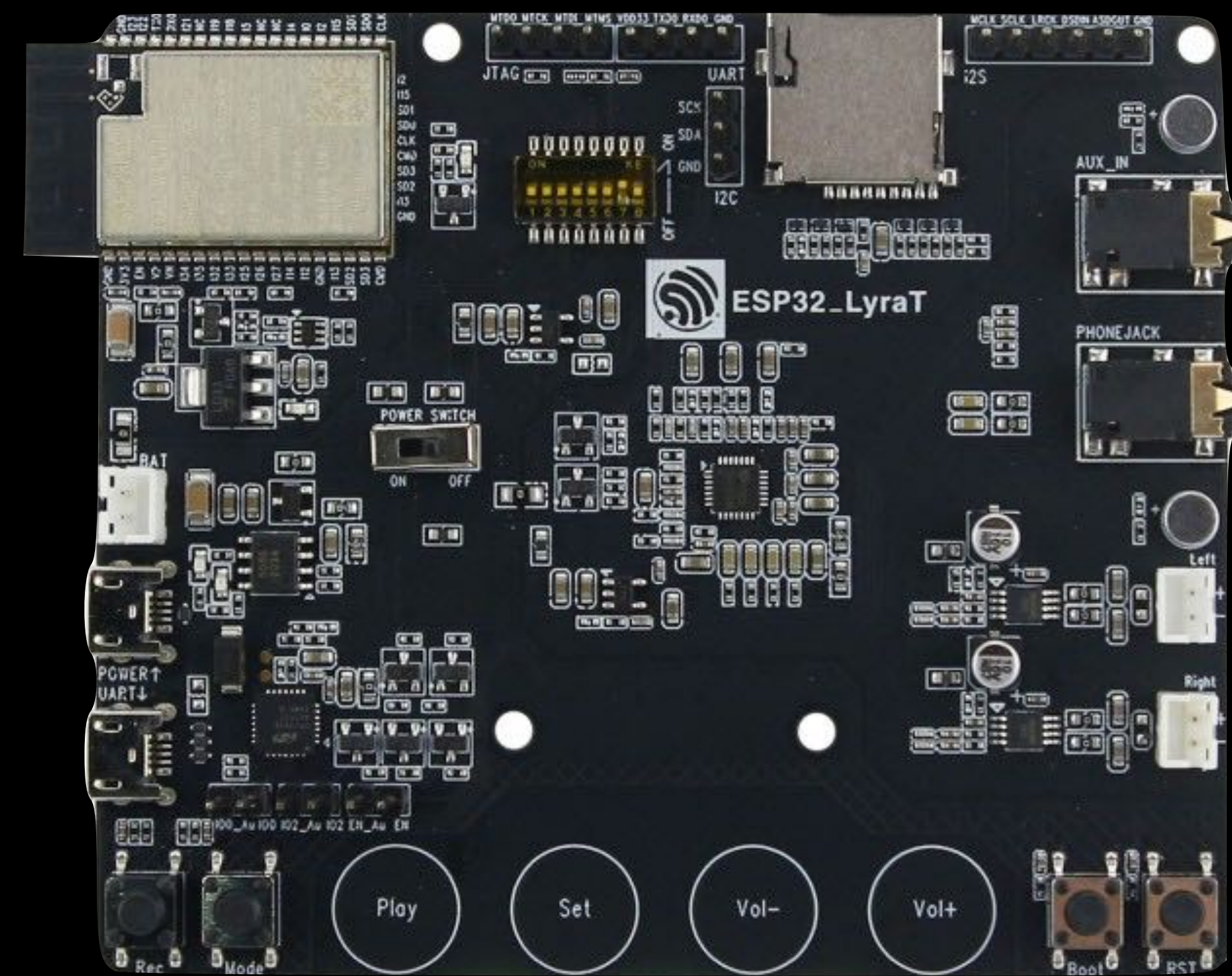
SAVE



LOAD



DELETE



NUNOMO  
QUN MK2

Q-mk2 v3.00

90:VCF Volume

64

DIAL SHORTCUTS

SHIFT + SEQ PLAY - BPM  
MODE PLAY - REC VOL  
SYSTEM - VCF VOLUME  
PARAM - CUTOFF  
REC - LFO TUNE

SHIFT

FM  
MIXER  
SYSTEM

NO

CUT

PASTE

ENV3/4  
PROB

OK

OSC1  
PIANO

OSC2  
MODIFY

MIX  
ON/OFF

ENV1/2  
VEL

SWITCH  
TUNE

LFO  
WIDTH

VCF  
CFG

OTHER  
GRANULAR

SEQ  
PLAY

BPM

MODE  
PLAY/RECALL

SYSTEM

PARAM/MUTE

DUMP

NOTE OFF

INITIALIZE

REC/TRACK

LOOPER  
PLAY/SCENE

STOP

SAVE

LOAD

DELETE

Play

Set

Vol-

Vol+



ESP32\_LyraT

POWER SWITCH

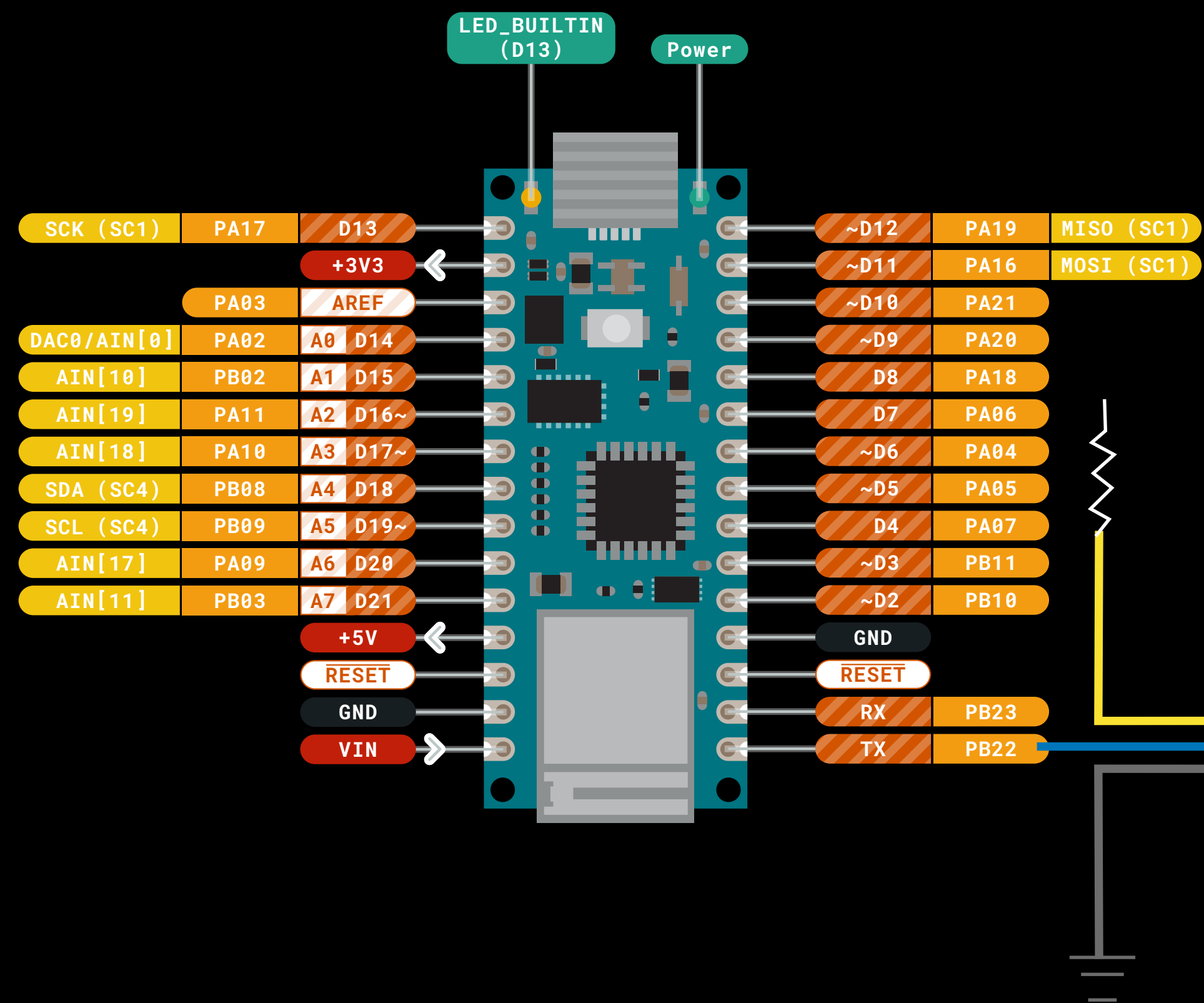
ON

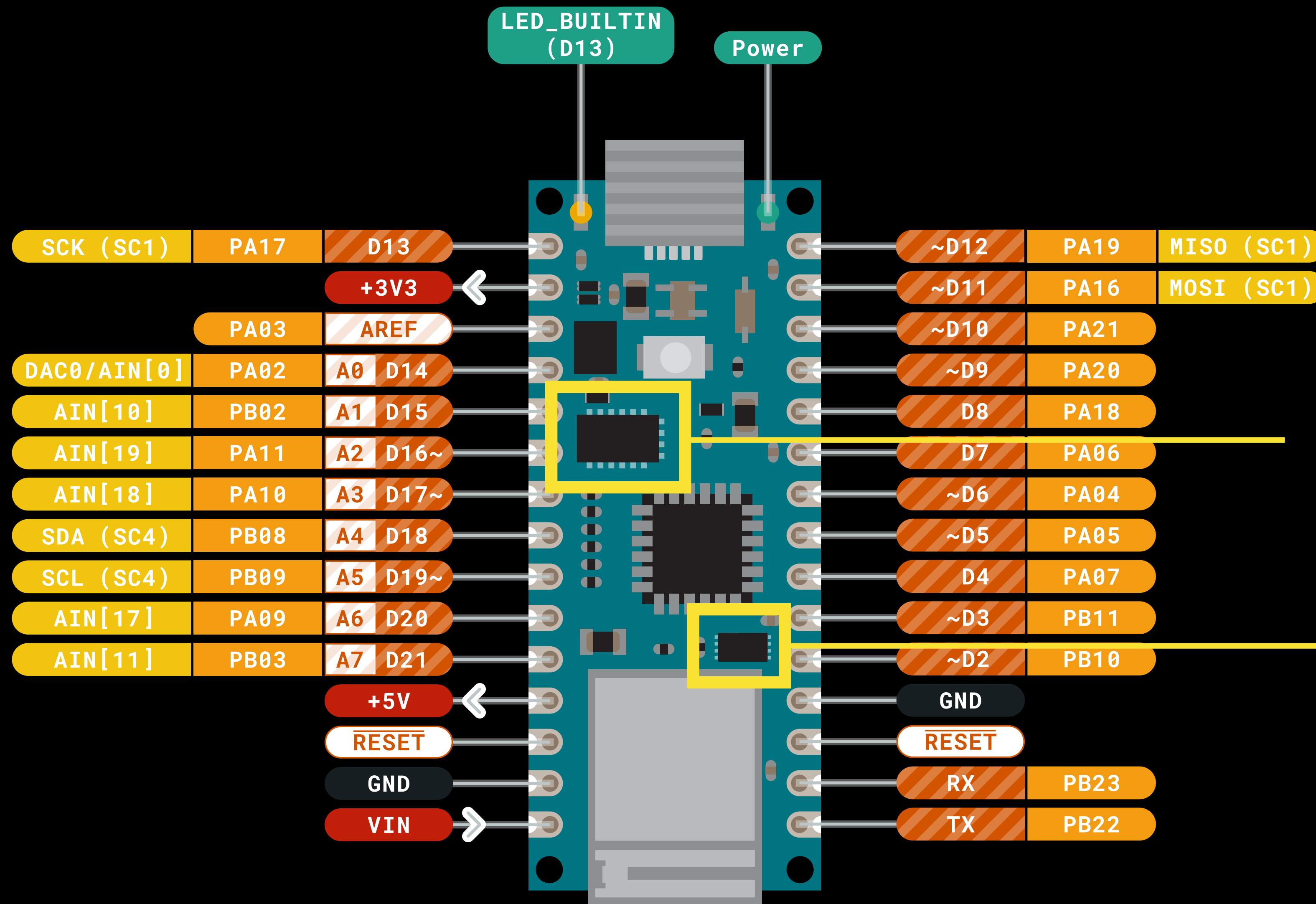
OFF

POWER↑  
UART↓

Vol-

Vol+





ATECC608A Cryptography chip at 0x6A

LSM6DS3 6-DOF IMU at 0x6A

```
Scanning...
I2C device found at address 0x60 !
I2C device found at address 0x6A !
done
```

```
Scanning...
I2C device found at address 0x60 !
I2C device found at address 0x6A !
done
```

