Workshop on **Embedded Systems & IoT Technology**

Omega 2+: A Gate to The Future

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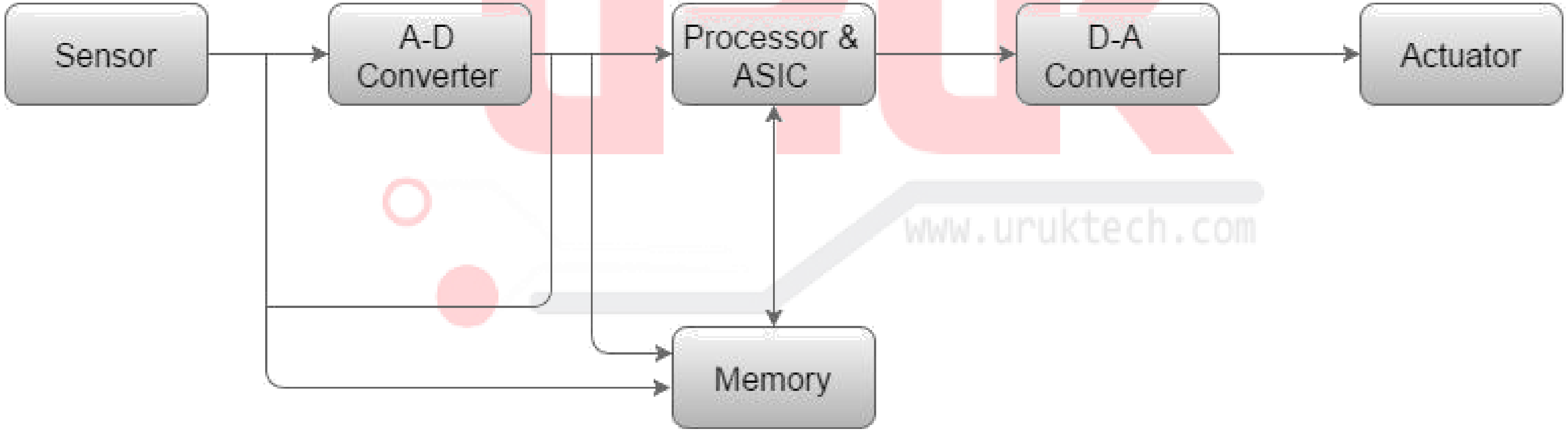
Outlines

- Embedded Systems Vs. IoT Systems.
- Microprocessors Vs. Microcontrollers.
- Development Boards Comparisons.
- Omega 2 & Omega 2+
  - History.
  - Specifications.
  - Networking.
  - Serial Protocols.
  - Docks.
  - Expansions.

Embedded Systems Vs. IoT Systems

What is an Embedded System

- An Embedded System is a microcontroller or microprocessor based system which is designed to perform specific task as an independent system or can be part of a larger mechanical or electrical system.



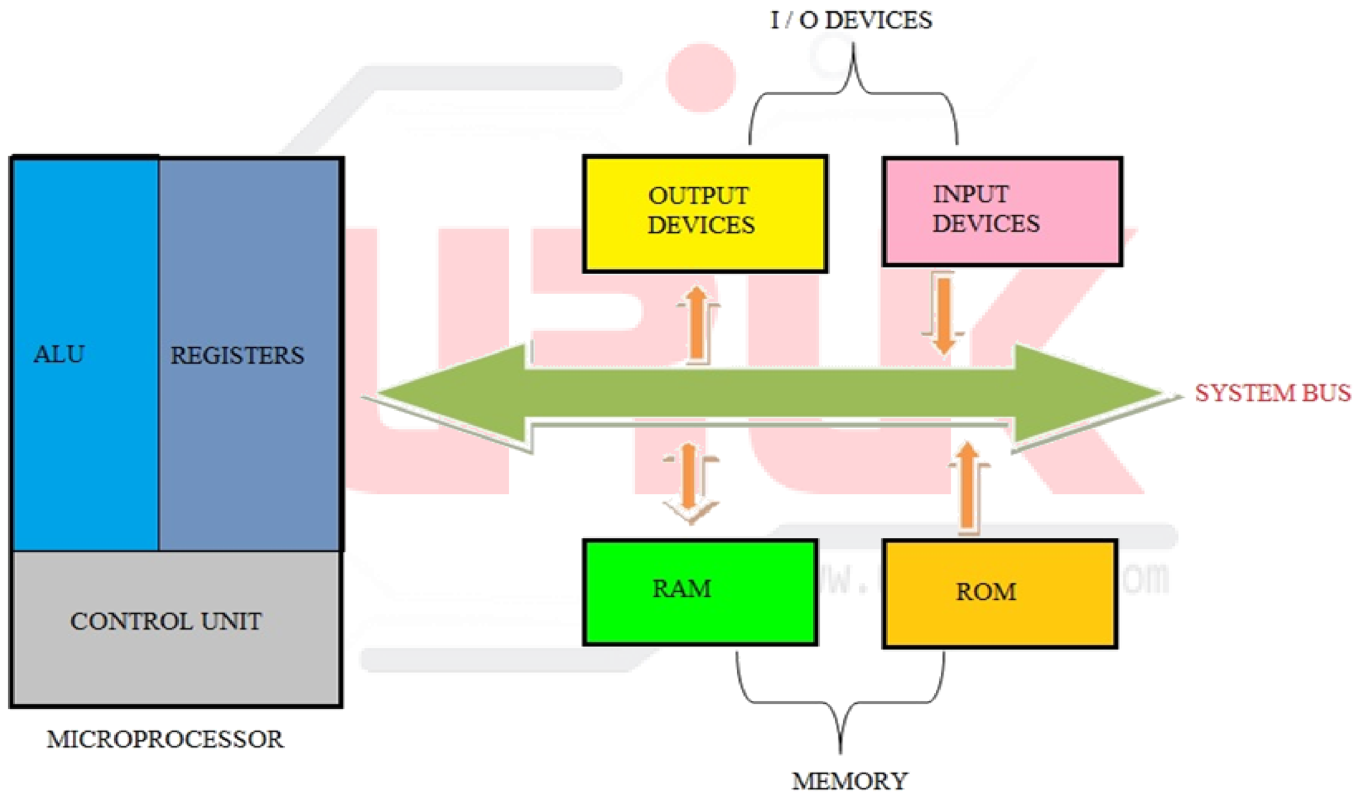
Embedded Systems Vs. IoT Systems

What is IoT?

- The **Internet If Things** (IoT) is the network of physical devices, vehicles, buildings and other items—embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data.

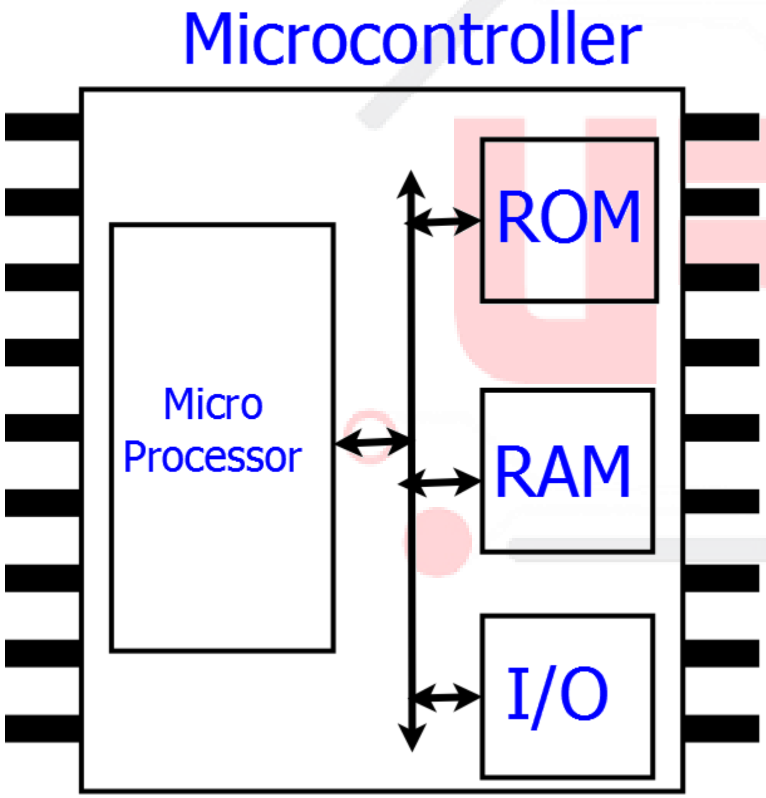
Microprocessor Vs. Microcontroller

What is a Microprocessor?



Microprocessor Vs. Microcontroller

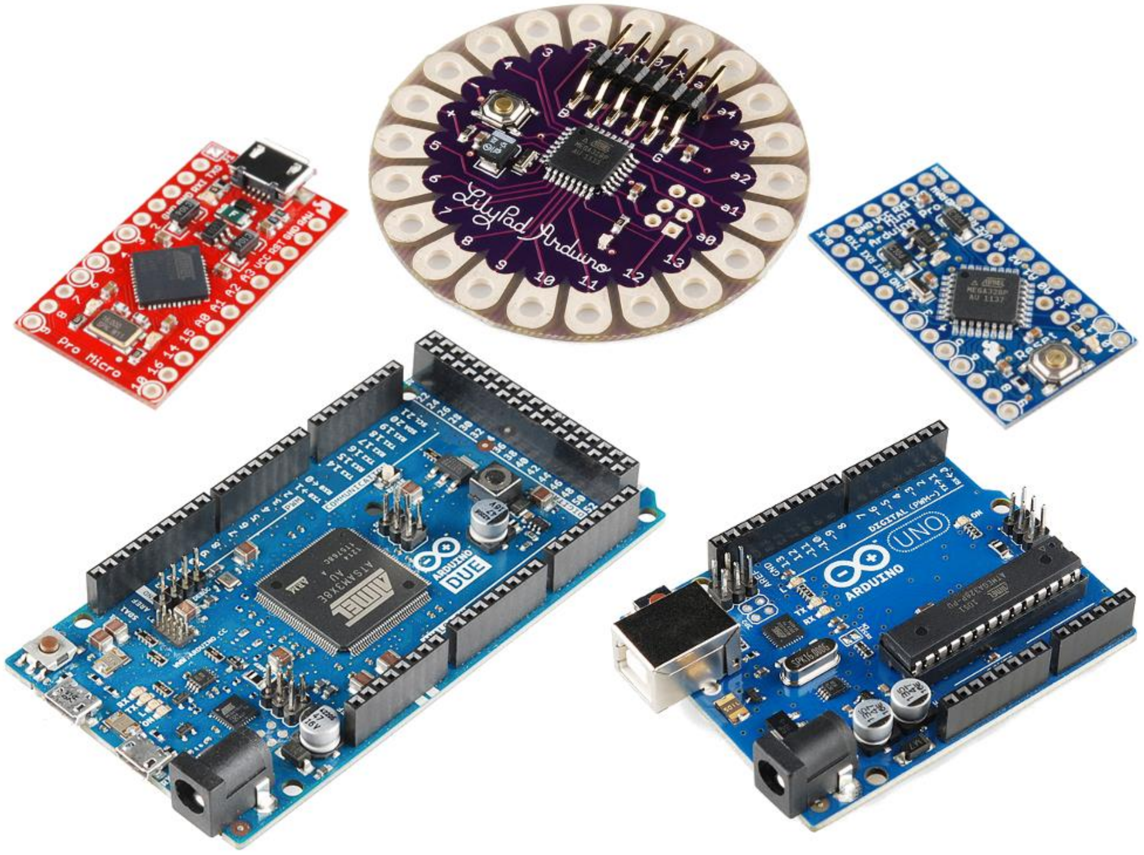
What is a Microcontroller?



Development Platforms

What is Arduino?

- It is a small computer in which CPU, memory unit (RAM, ROM), I/O peripherals, timers, counters, are embedded in one integrated circuit(IC).



Development Platforms

What is Raspberry Pi?

- It is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse.
- It is capable of doing everything you'd expect a digital computer to do.

IoT Computer

- An IoT computer is a Linux computer designed specifically for use in building connected hardware applications meant for IoT.

- The Omega 2 IoT computer is meant to be a development platform for all things IoT, whether you want to experiment, build yourself some sweet gadgets for fun, or prototype and create an IoT product.

- The Omega2 can be categorized as something in between Arduino and Raspberry Pi.

What makes Omega 2 an IoT computer?

- Small form factor.
- Power efficiency.
- Processing, networking, and encryption capabilities.
- Flexibility that comes from running a Linux OS.
    - Support for many programming languages and many simulations processes.

Comparisons

Arduino Vs. Omega2+

- Advantages of Omega2+:
  - It is powered by a full processor, not a microcontroller.
  - Runs a full Linux (soft) real-time operating system.
    - Support many programming languages.
    - Has a filesystem with storage.
  - Networking (wireless and wired) support built-in, can be programmed.
- Disadvantages:
  - Support for analog inputs and outputs.
  - Provide cycle accurate signals for controlling very low level hardware.

Comparisons

Raspberry Pi Vs. Omega2+

- The Omega is more similar to the Raspberry Pi, since they're both computers.
- Being an IoT computer, the Omega does some things differently from the Raspberry Pi single-board computer:
  - Comes with on-board storage and the OS preloaded .
  - Built-in Wi-Fi radio and capabilities.
  - Lower power consumption.

Comparisons

Raspberry Pi Vs. Omega2+

- Since the Omega is not a general purpose computer, there are a few things the Raspberry Pi family can do that the Omega cannot:
  - Output HD Video: The Omega's IoT-centric purpose means it can drive smaller screen, but not a computer monitor or TV.
  - Run a graphical Linux desktop: The Omega is not a general purpose computer; it is meant for use-cases that prioritize connectivity and lower power consumption.
  - The Raspberry Pi SoCs have more processing power: The Omega Prioritizes power efficiency over processing performance.

Omega 2+ ....

- The Omega is more powerful and flexible than an Arduino UNO, and it provides internet and network connectivity right out of the box.

However

- it is not as powerful as the Raspberry Pi and cannot output video to TVs to monitors, since it is geared toward power efficiency and out-of-the-box usage with the built-in storage, preloaded OS, and Wi-Fi networking.

Omega2+

History

- 2014: Onion launched the original Omega.
- 2016: Omega2 and Omega2+ were launched with different specs, lower cost, and fully FCC (Federal Communications Commission) certified.

Omega2+

Specifications

	Omega2	Omega2+
Processor	580MHz MIPS CPU	580MHz MIPS CPU
Memory	64MB Memory	**128MB Memory**
Storage	16MB Storage	**32MB Storage**
USB	USB 2.0	USB 2.0
MicroSD Slot	No	**Yes**
WiFi adapter	b/g/n Wi-Fi	b/g/n Wi-Fi
Operating Voltage	**3.3V**	**3.3V**

Omega2+

SoC

- The Omega2 uses Mediatek MT7688AN System-on-a-chip.
- The processor is MIPS 42KEc, little endian, 32-bit RISC core at 580MHz.
- 64KB I-Cache and 32KB D-Cache.

- The lower clock speed and the MIPS architecture of the SoC lend to the Omega's low power consumption and low heat generation. This makes it ideal for use in the space and energy constrained use cases common for IoT applications.

Omega2+
Memory and Storage

- Memory:
  - The Omega2 comes with 128MB of memory and the Omega2+ with 256MB. Both use DDR2 DRAM.
- Storage:
  - The onboard SPI flash memory refereed as storage since it provides persistent, non-volatile memory. It is where the OS, programs, and all other files stored.
  - The Omega2 comes with 16MB flash storage while the Omega2+ has 32MB.

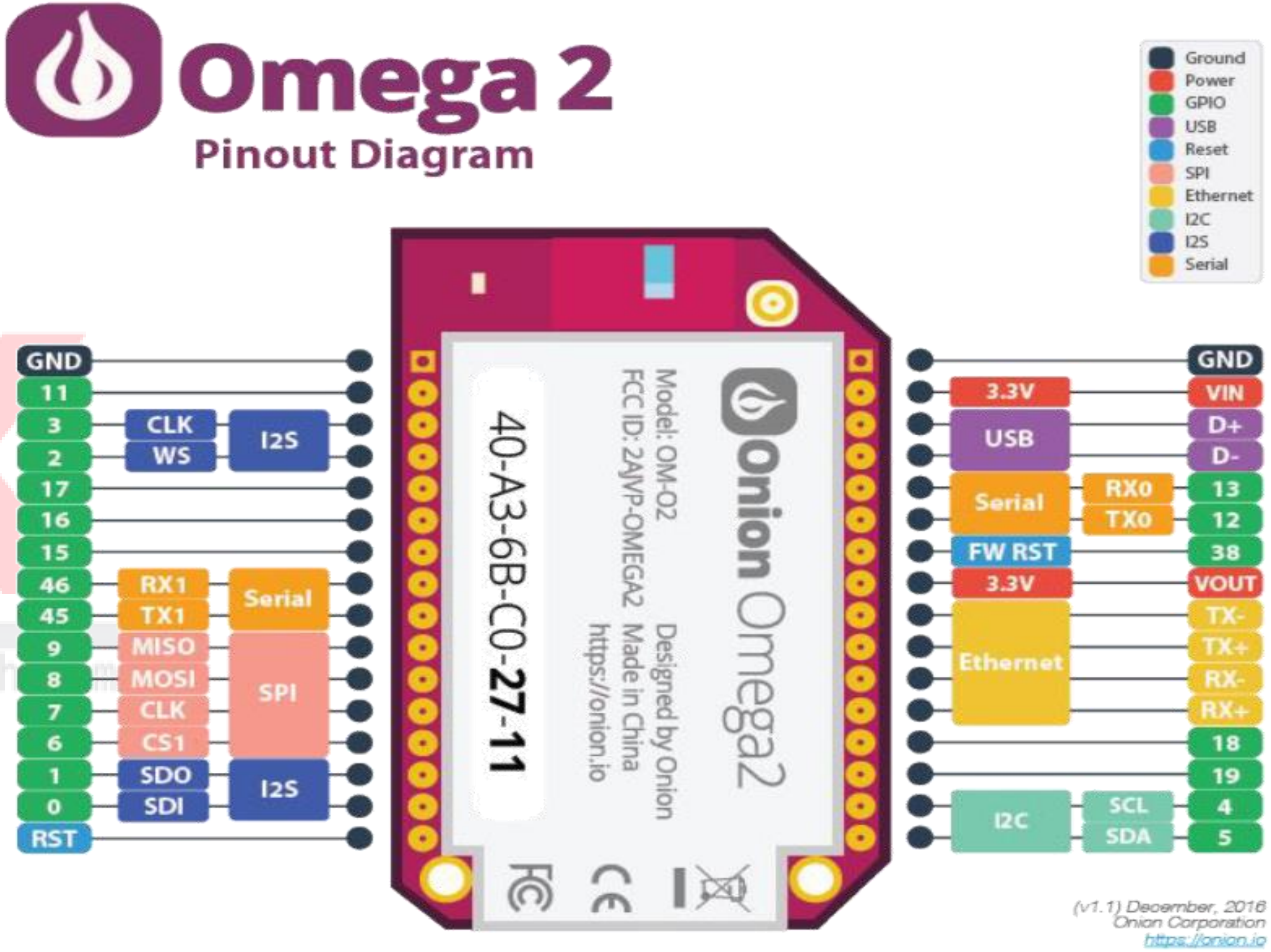
Omega 2+ Networking

Wi-Fi and Ethernet

- Wi-Fi:
  - The Omega supports 2.4GHz IEEE 802.11 b/g/n Wi-Fi with 150 Mbps PHY data rate.
  - The antenna is 1T1R meaning it is used for both transmitting and receiving by virtual time multiplexing.
  - There is also a u.FL connector for external antennas.
- Ethernet:
  - The Omega supports 10M/100M wired Ethernet network connectivity when used with a Dock and Ethernet expansion.

GPIO and GPIO's mapping

- The Omega2 has twelve General Purpose Input/Output (GPIO) pins that can be controlled by the user. The GPIOs are laid out in two banks:



Electrical Characteristics

- The Omega's GPIOs are 3.3V not 5V tolerant. The current limit is 8mA (source or sink)

Parameter	Minimum (V)	Maximum (V)
Input HIGH	2.0	3.6
Input LOW	-0.3	0.8
Output HIGH	2.4	3.3
Output LOW	—	0.4

Serial Protocols

I2C

- I2C is a master-slave bus protocol that allows a master device to interact with and control multiple slave devices.
  - It is fast and reliable and only uses two data lines.
  - The Omega acts as an I2C bus master, issuing commands and reading responses from other devices and chips.
  - Ex: The Omega controls the Servo, Relay, and OLED expansion using I2C.

Serial Protocols

UART

- The Universal Asynchronous Receiver Transmitter (UART) protocol is supported.
- The UART is meant for direct communication between two devices, with no concept of master or a slave.
- It uses two data lines: one for transmitting and one for receiving.
- The Omega has two separate UARTs.

Serial Protocols
UART

- By default UART0 is configured to provide a serial interface to the Omega's command line.
- UART1 is exposed on the expansion header, and is free to be used to communicate with other devices.
  - On the Arduino Dock2, it is hard-wired to the ATmega microcontroller for direct and reliable communication.

Serial Protocols

SPI

- The Serial Peripheral Interface (SPI) protocol is:
  - a four-wire.
  - master-slave.
  - synchronous communication protocol.
  - can run at high speeds and transfer lots of data.
- It is generally used to connect microprocessors or microcontrollers to sensors, memory, and other peripherals.
- The SPI Master can have multiple connected SPI slaves, but each requires its own *Slave Select* (also known as *Chip Select*).
- The Omega uses SPI to communicate with the on-board flash memory that is used as storage.

Serial Protocols

SPI

Signal	Description	Omega GPIO
SCK	System Clock	7
MOSI	Master Out, Slave In - Data sent from the Master to the Slave	8
MISO	Master In, Slave Out - Data sent from the Slave to the Master	9
CS0	Chip Select 0	Internally connected to flash storage
CS1	Chip Select 1	6

Software

- The Omega2 runs an Onion-customized version of the LEDE (Linux Embedded Development Environment) Operating System, a distribution based on OpenWRT.
- The Omega's OS comes equipped as a web server by default, so that other devices on the local network can interact with the Omega through a browser.

Software

Supported Programming Languages

- C & C++.
- Python.
- NodeJS.
- Rust.
- Ruby.
- PHP.
- Perl.
- GoLang.

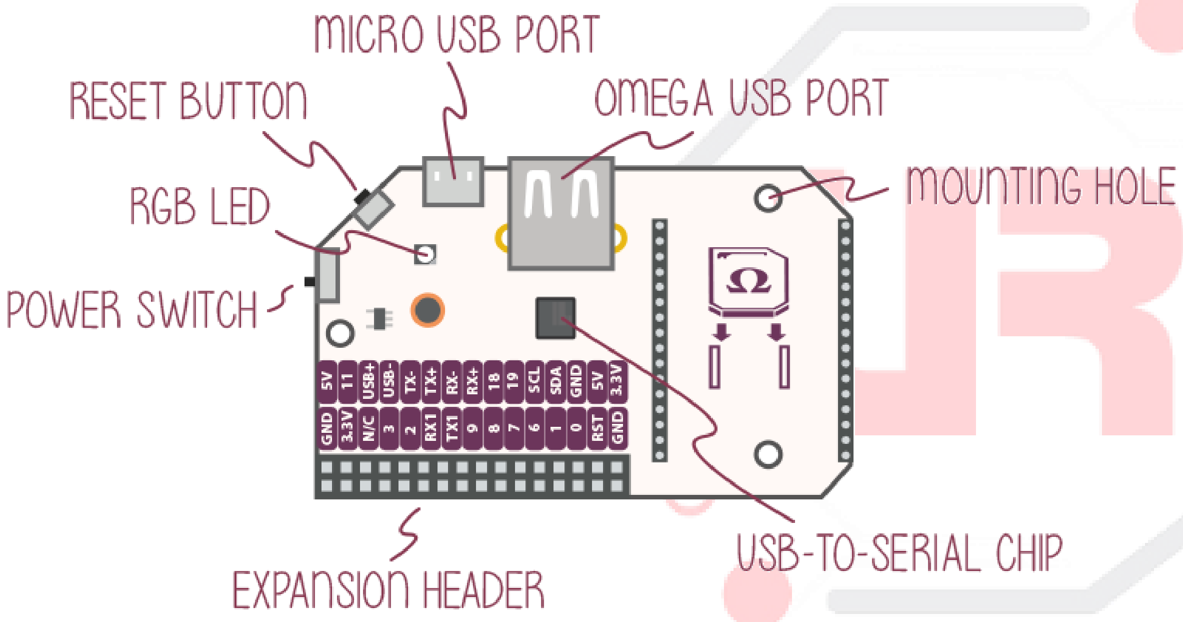
Docks

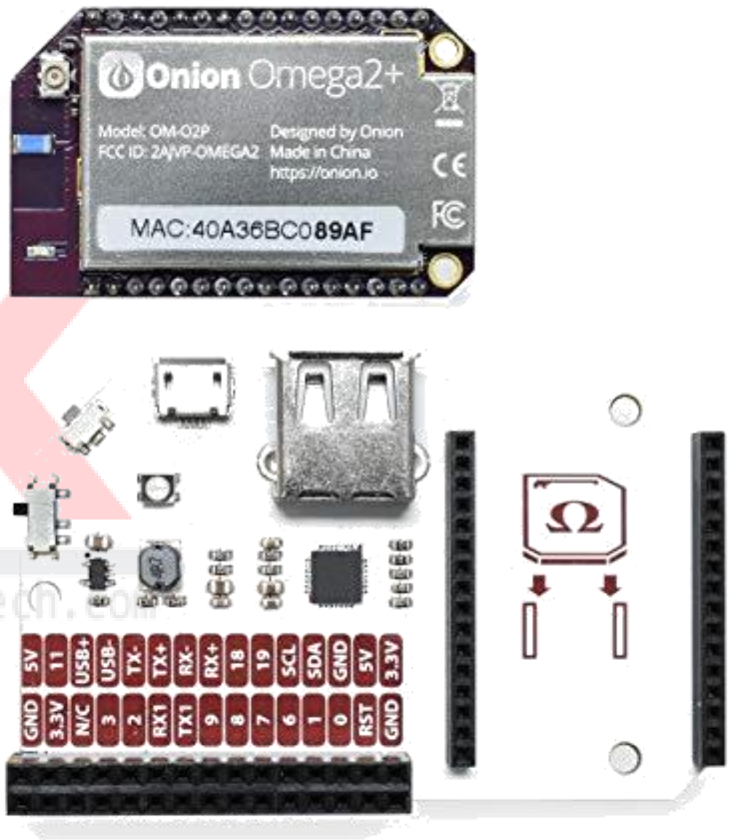
Expansion Dock

- The Expansion Dock can be considered the main Dock for the Omega.
- it has the Expansion Header that exposes the Omega’s GPIOs.
- It features an on-board USB-to-Serial chip that allows serial connectivity to the Omega’s command line terminal through the Micro-USB port.
- The serial terminal can be used to access the bootloader in case the Omega’s OS is corrupted or cannot successfully boot.
- It also provides a USB Type-A plug for connecting USB devices to the Omega.

Dock

Expansion Dock





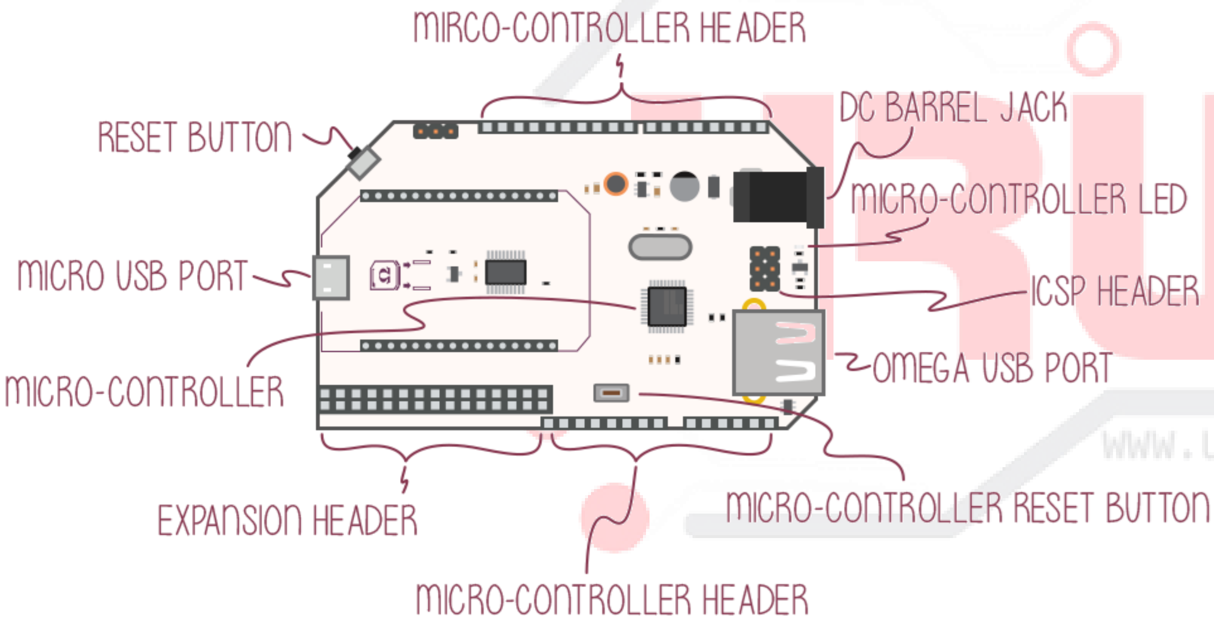
Docks

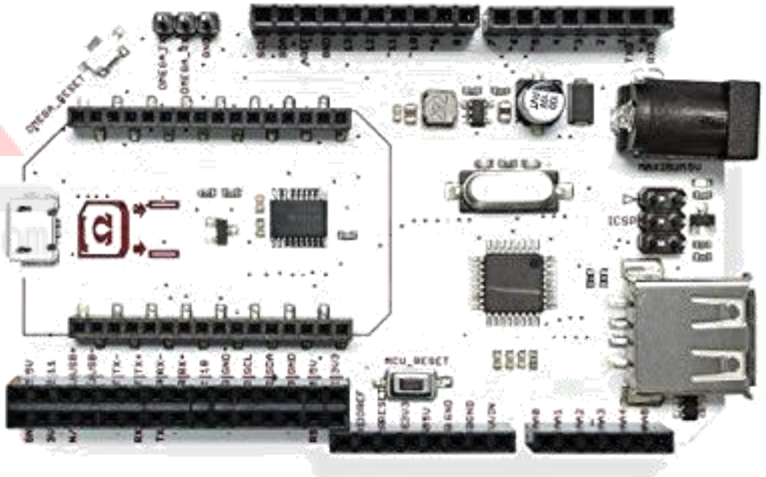
Arduino Dock

- The Arduino Dock 2 features the ATmega328P microcontroller that can be programmed by the Omega to work in tandem as a co-processor.
- The Omega and ATmega328P can communicate using I2C and a serial UART connection.
- The Arduino Dock 2 exposes the microcontroller pins in the same header design as the Arduino Uno, so it can be used with any existing Arduino Shields.
- It also features the Expansion Header that exposes the Omega’s GPIOs, allowing the use of all Omega Expansions.
- Also present is a USB Type-A socket for connecting USB devices to the Omega.

Docks

Arduino Dock





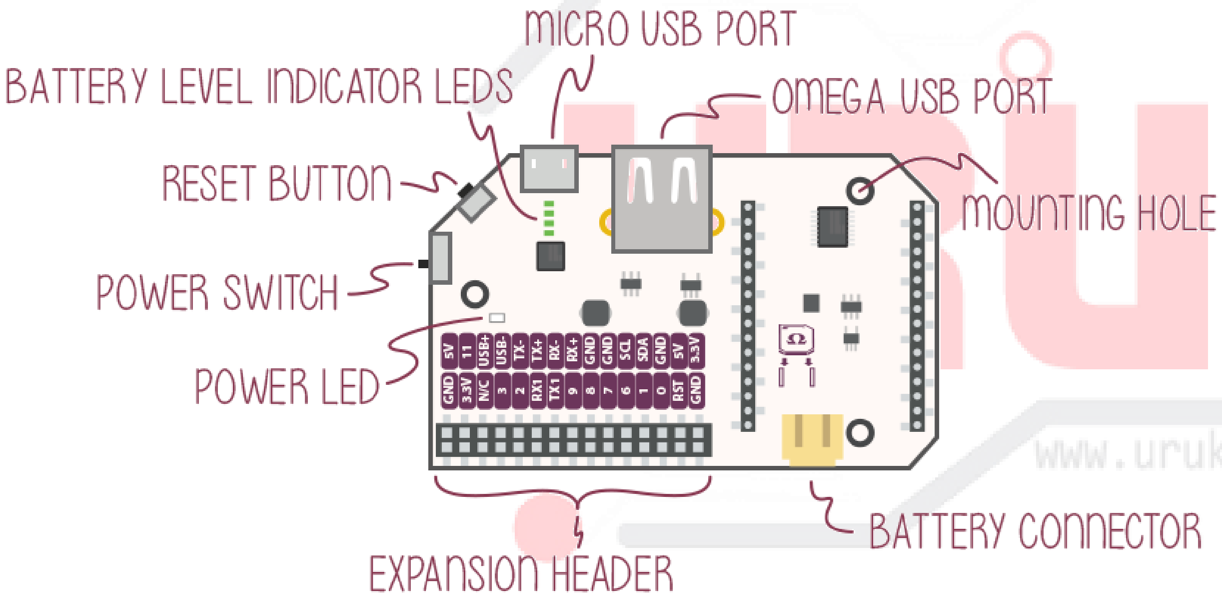
Docks

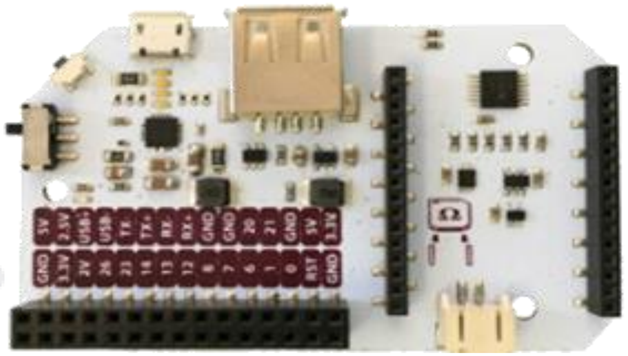
Power Dock

- The Power Dock offers the mobility that comes with powering the Omega with any 3.7V LiPo (Lithium ion Polymer) battery.
- When plugged into power with a Micro-USB cable, it will charge up the battery.
- If no battery is present, the Omega can be powered with just the Micro-USB, similar to the Expansion Dock.
- Like the other Docks, it has a USB Type-A socket for connecting USB devices to the Omega.

Docks

Power Dock





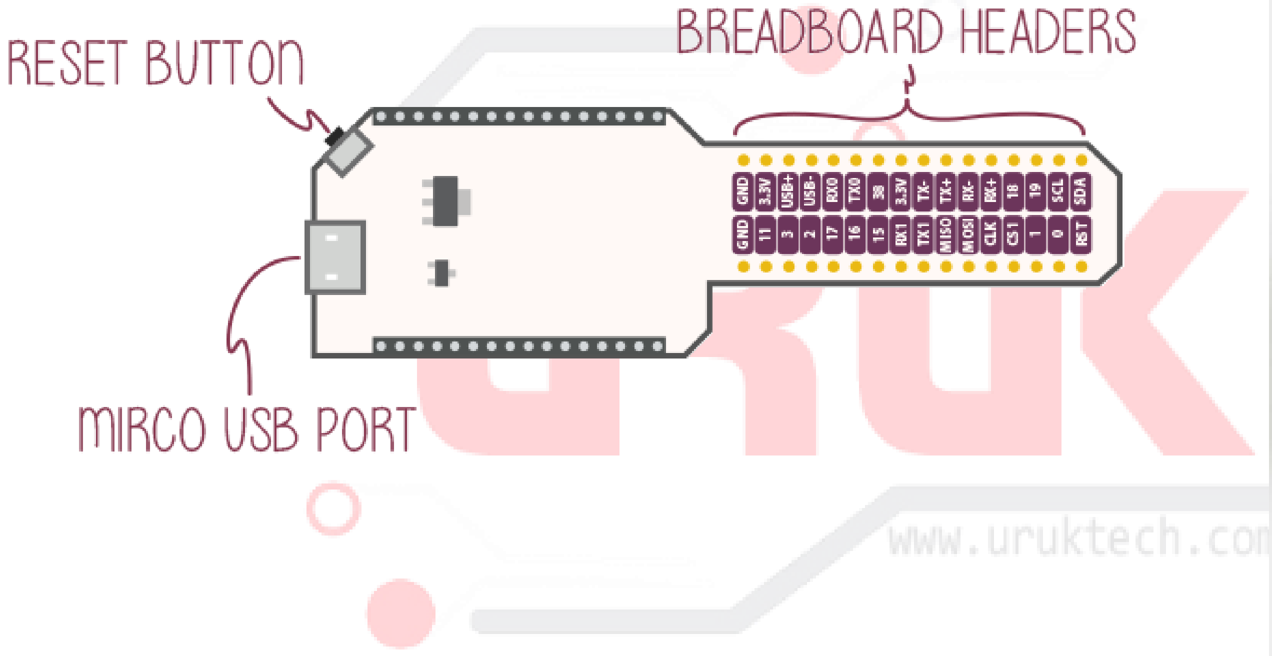
Docks

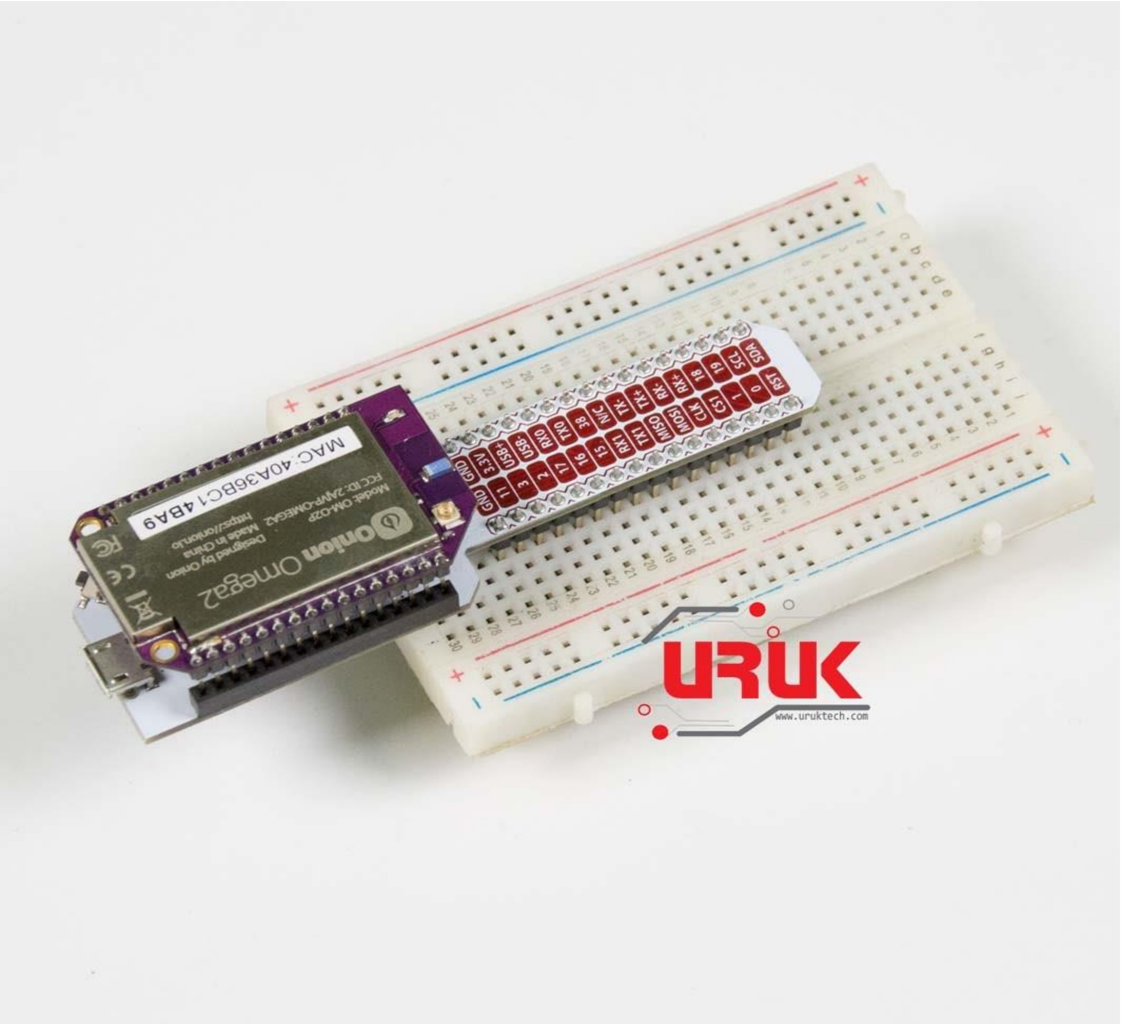
Breadboard Dock

- The Breadboard dock allows the user to plug their Omega directly into a breadboard.
- The Omega can be powered with a Micro-USB 5V supply since the breadboard has a voltage regulator, or it can be provided with 3.3V directly from the breadboard.
- The Omega's pins are mapped 1-to-1 to the breadboard headers, so it's about as close as you can get to plugging the Omega directly into a breadboard.

Docks

Breadboard Dock





Expansions

- The Expansions are the key to the Omega’s modularity and flexibility since they add specific functionality to the system.
- As long as the Dock used with the Omega has an Expansion Header, it can support plug and play Omega Expansions. Docks that support Expansions:
  - Expansion Dock:
  - Arduino Dock:
  - Power Dock:

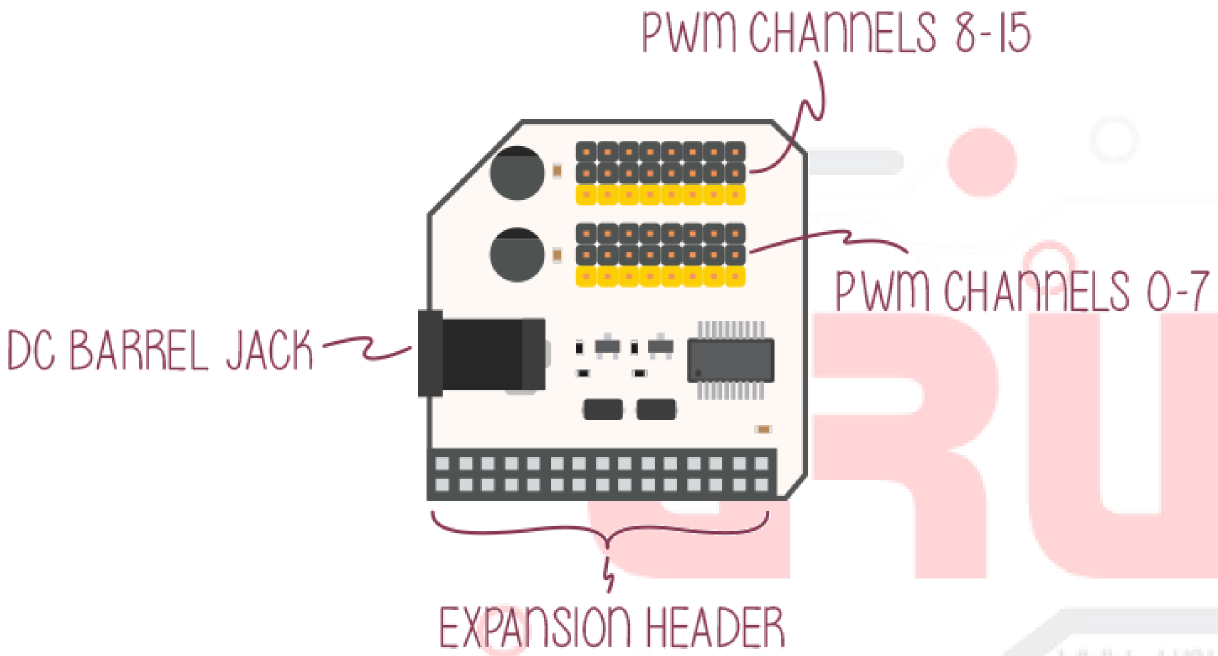
Expansions

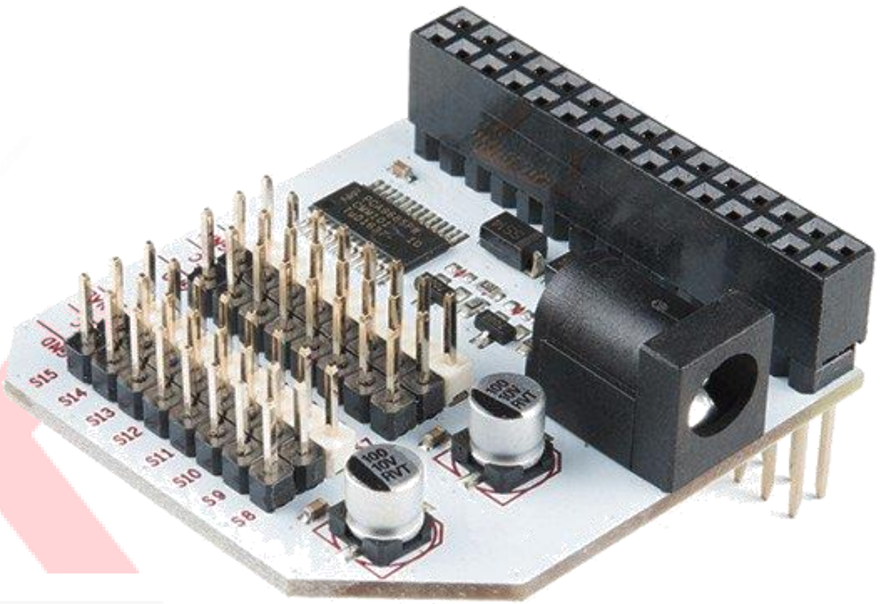
Servo (PWM)

- Generate up to 16 different, free-running Pulse Width Modulated (PWM) signals.
- The PWM signals are driven by the Dock's 5V power supply by default, it also supports using an external supply (up to 12V DC) to drive the PWM signals.
- Use it to control Servos, LEDs, transistors, anything that supports PWM.
- The on-board oscillator supports generating PWM signals at frequencies in the range of 24 Hz to 1526 Hz. The default frequency is 50.

Expansion

Servo (PWM)





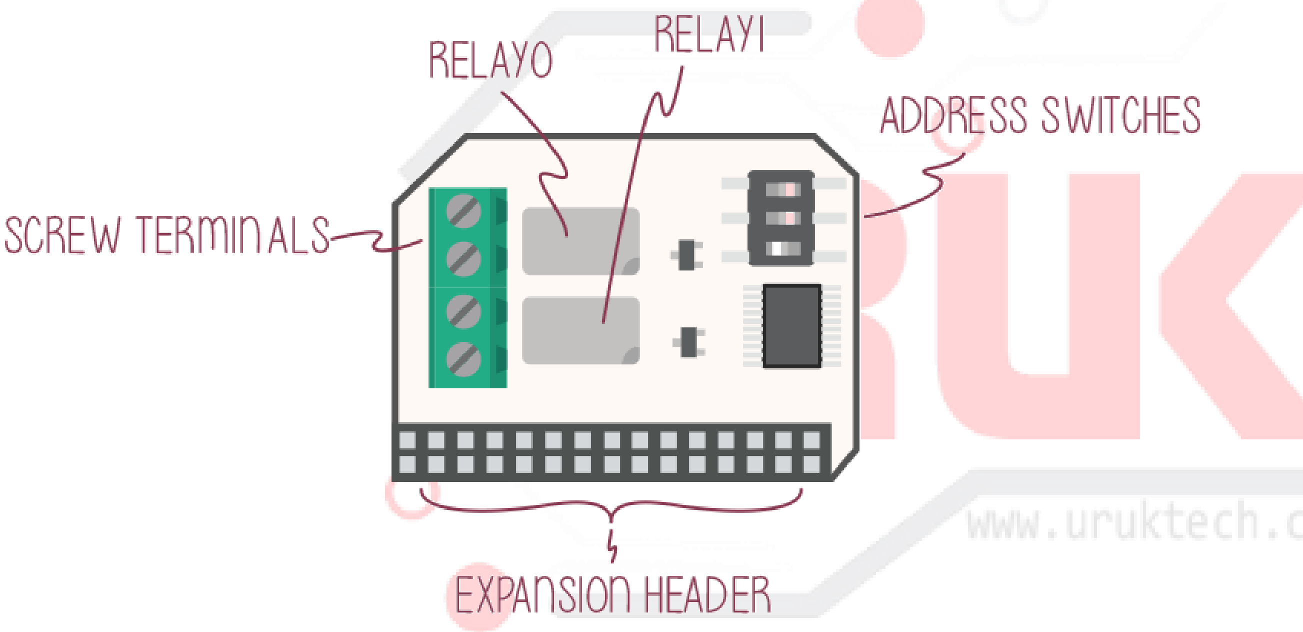
Expansion

Relay

- Use two electromechanical relays to switch external, independent, and potentially much higher-voltage circuits with the Relay Expansion.
- The relays can switch up to 60W, and are rated for a maximum current of 2A and a maximum voltage of 220V DC or 250V AC.
- It includes an I2C address switch, allowing the use of up to eight (8) Relay Expansions with a single Omega, giving the user control of up to 16 external circuits.

Expansion

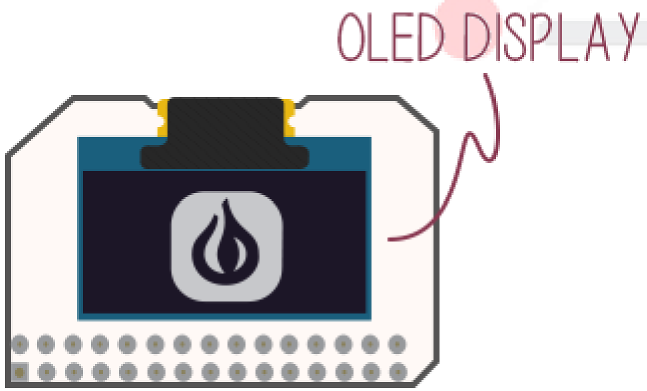
Relay

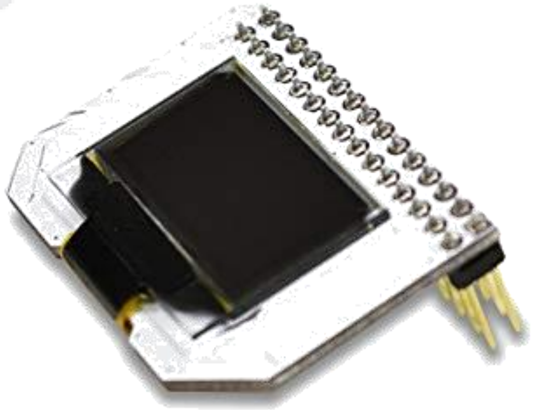


Expansion

OLED

- The OLED Expansion is a low-power 0.96" monocrome OLED screen with a 128x64 resolution.
- The pixel brightness is adjustable, as well as inversion of white and black.

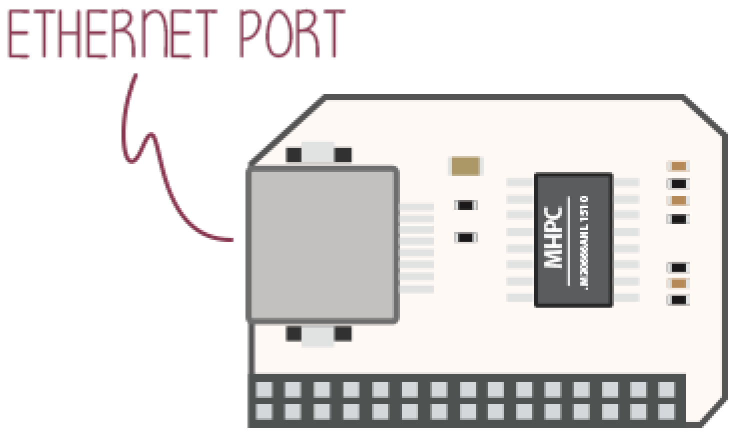


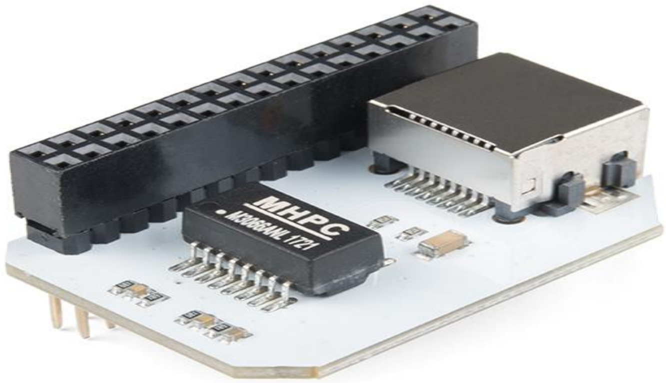


Expansions

Ethernet

- Add an Ethernet port for wired network connectivity with the Ethernet Expansion.
- The Omega has a 10/100 Ethernet port, meaning it supports transmissions at 10 Mbps and 100 Mbps.

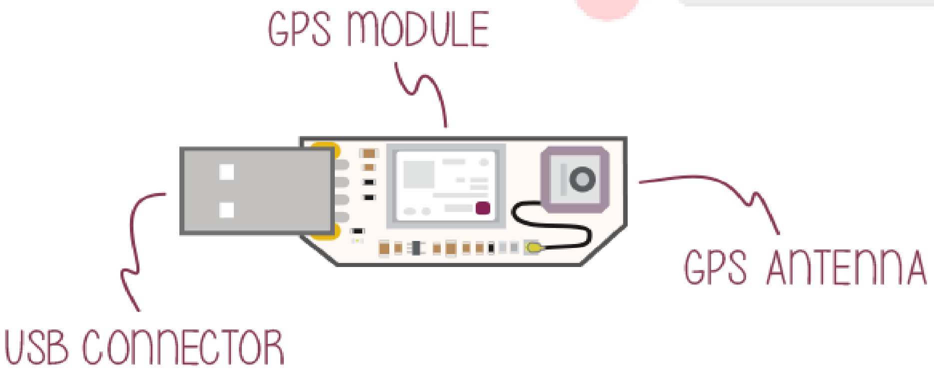


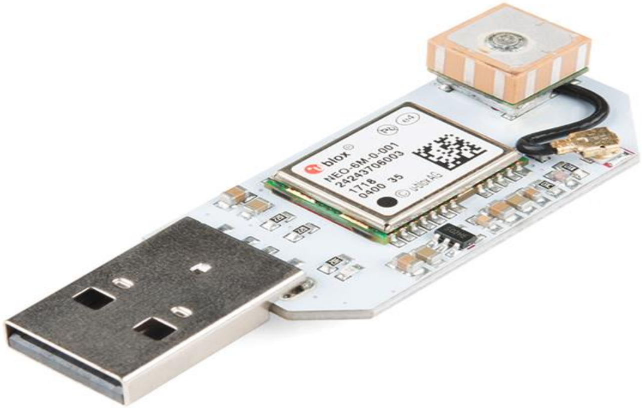


Expansions

GPS

- The USB-based GPS Expansion provides location data from the Global Positioning System (GPS) satellites.
- The on-board antenna is connecting using a u.FL antenna connector, meaning that it can be easily unplugged and replaced with a larger, more powerful antenna.





Thank you …

Q&A