Getting to know the Arduino IDE

JUST WHAT IS THIS ARDUINO THING ANYWAY?

I’ve heard about Arduino, what the heck is it?

- Arduino is a development *environment*
  - Combination of hardware and software
  - Hardware based on Atmel AVR processors
  - Software
    - High level programming language
    - Compiler / Loader
    - Lots and lots of libraries!
    - It’s all open source!
- Community
- YOU can monitor and control all manner of stuff

More on Arduino

- Created by the “Arduino team”
  - Massimo Banzi
  - David Cuartielles
  - Tom Igoe
  - Gianluca Martino
  - Daniela Antonietti
  - David A. Mellis
- Uses GNU Project principles of Open Source
  - Free Software Foundation
  - “GNU’s Not Unix!”
  - GNU General Public License

The Hardware

- Arduino board uses a *microcontroller*
  - Often called “single board computer” – wrong!
  - What are the differences?
- A *computer (or microcomputer)* would have:
  - Operating system or monitor
  - External memory / storage
  - Physical I/O is through external hardware
  - Example: 68000 family, Intel 80x86, Pentium, etc
- So, how is a *microcontroller* different?

Microcontroller

- Most functions contained on chip
  - No operating system
  - Self contained I/O – analog and digital
  - Specialized internal functions
    - Counter
    - Timer
- Used for dedicated applications
  - Control device
    - Thermostat / lighting control
    - Microwave oven
  - Embedded control functions in larger systems

Common Microcontroller Interfaces

- Digital
  - I/O ports
  - Different logic levels: 5 V vs. 3.3 V
- Analog
  - A/D input
  - PWM output
- Timing
  - Counter
  - Timer

Common Microcontroller Interfaces (continued)

- Communications
  - USB - Universal Serial Bus
  - SPI – Serial Peripheral Interface
  - I2C – Inter Integrated Circuit
  - Ethernet – wired and wireless
  - Other wireless systems
    - Xbee
    - ZigBee
    - Bluetooth
  - Serial RS-232

What about Raspberry Pi and BeagleBone??

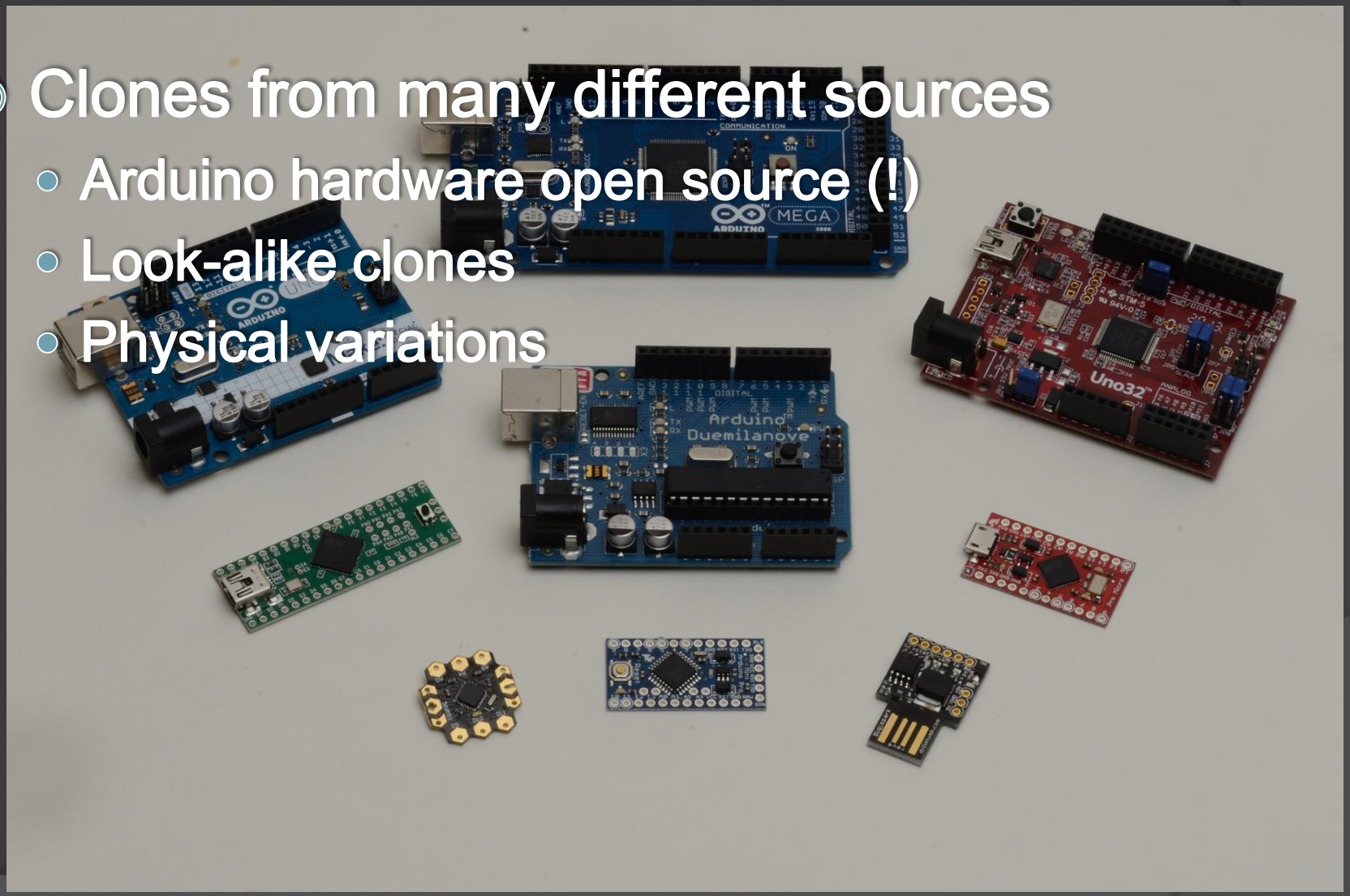
- R-Pi and BB are single board *computers*
  - Self-contained video, audio and networking
  - USB interfaces for keyboard, mouse, etc
  - Come with OS – typically Linux
- For example: BeagleBone Black
  - Connect over USB – it's a Web server!
  - Manage through browser
- Not compatible with Arduino ….
  - But they can do all of the same things
  - Just a more complex environment

The Hardware

- Arduino boards from simple to powerful
  - Dozens of different boards
  - Different IO configurations
  - Physical size
  - Open Source Hardware = lots of variations!
  - Sources:
    - SparkFun Electronics
    - Maker Shed
    - Adafruit
    - Seeed studios
    - OSEPP

All shapes and sizes!

- Clones from many different sources
  - Arduino hardware open source (!)
  - Look-alike clones
  - Physical variations



Most common: Uno

- Processor: Atmel ATmega328 / 16 MHz clock
- 14 digital I/O pins, 6 are PWM outputs
- 6 analog inputs
- 32 KB Flash (- .5 KB for bootloader)
- 2 KB SRAM
- 1 KB EEPROM
- USB, ICSP header
- Power jack
  - Power from USB or jack
  - Internal regulator –
    - 7-12 VDC input
    - Regulated 5 and 3.3 VDC
- 5 V logic levels
- Source 40 mA per pin

Other common: Mega 2560

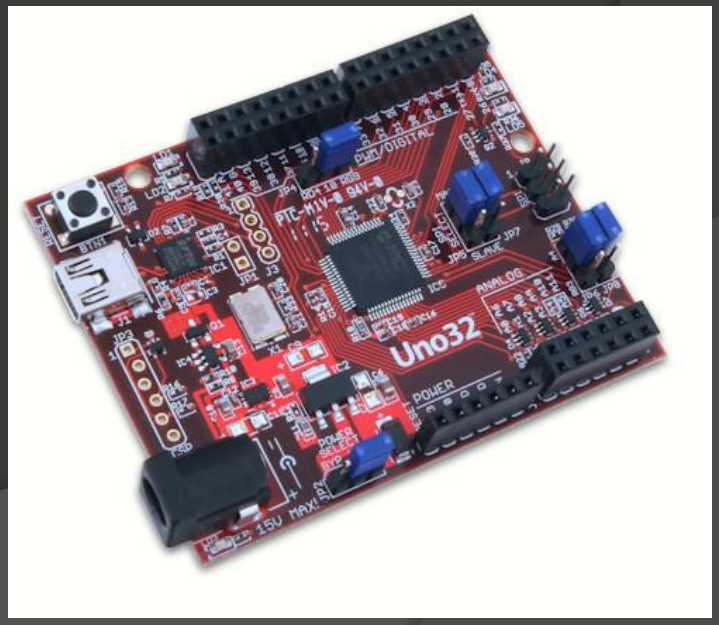
- Based on Atmel ATmega2560 / 16 MHz clock
- 54 digital I/O pins, 15 as PWM
- 16 analog inputs
- 256 KB Flash (- 8 KB bootloader)
- 8 KB SRAM
- 4 KB EEPROM
- 4 UARTS
- USB and ICSP
- Power from USB or jack
- internal regulator
  - 7-12 VDC input
  - Regulated 5 and 3.3 VDC
- 5 V logic
- Source 40 mA per pin

Other interesting variants

- Arduino Micro
  - Processor: Atmel ATmega32u4 / 16 MHz clock
  - 20 digital I/O pins, 6 are PWM outputs
  - 12 analog inputs
  - 32 KB Flash (4 KB for bootloader)
  - 2.5 KB SRAM
  - 1 KB EEPROM
  - USB, ICSP header
  - Power jack
    - Power from USB or jack
    - Internal regulator –
      - 7-12 VDC input
      - Regulated 5 and 3.3 VDC
  - 5 V logic levels
  - Source 40 mA per pin

From other sources

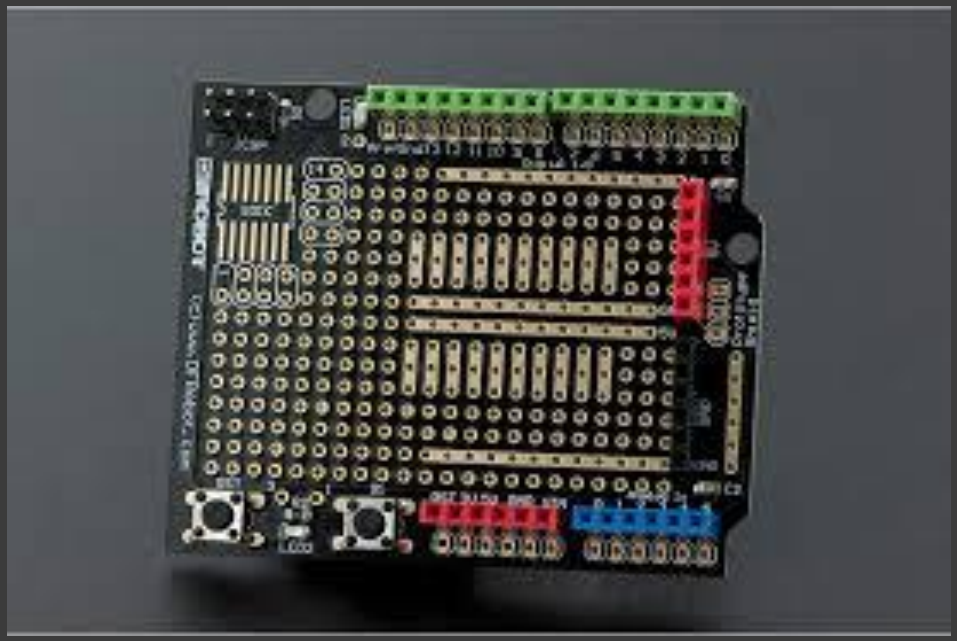
- Digilent chipKIT Uno32
  - Not really Arduino, but mostly compatible
  - Supplied with special IDE (MPIDE)
  - Microchip® PIC32MX320F128 processor
    - 80 MHz 32-bit MIPS
    - 128 KB Flash
    - 16 KB SRAM
  - 42 IO pins
  - 12 analog in



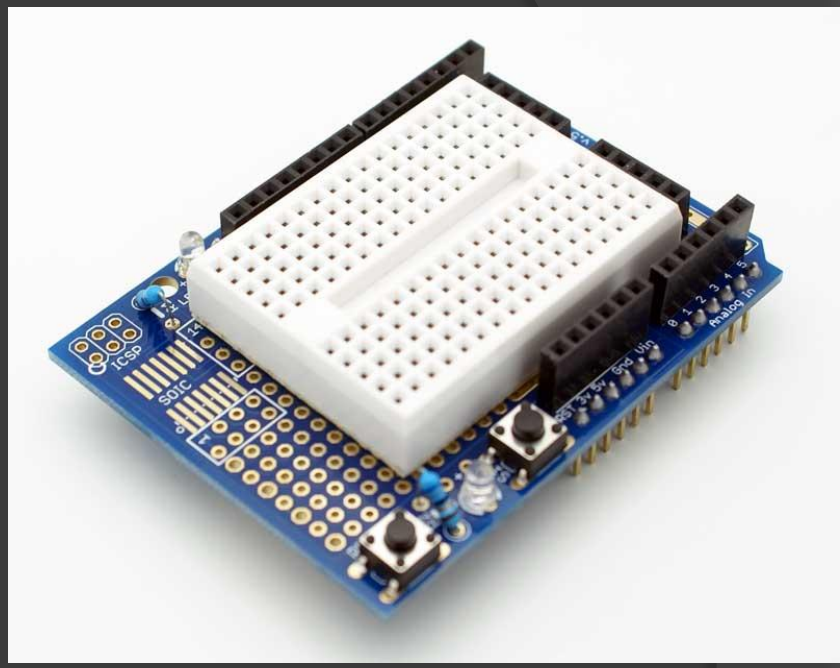
How to interface the world

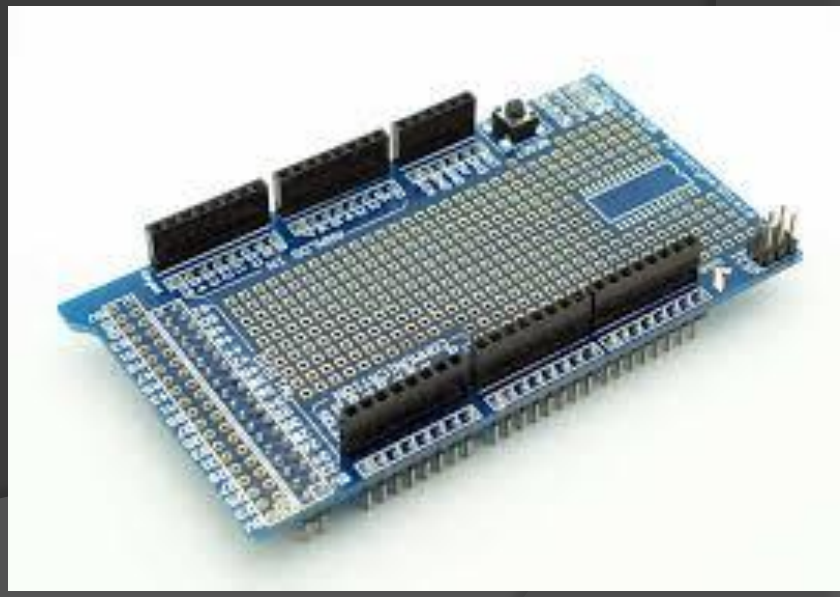
- Arduino “Shields”
  - Standardized layout of Arduino board
  - Shields provide space for other functions
  - Stackable – creates an “Arduino Sandwich”
- Commercial shields
  - Motor control
  - Visual – LCD / bitmap graphics
  - Radio – Xbee, ZigBee, Wi-Fi, GSM
  - Ethernet (wired and wireless)

Typical shields

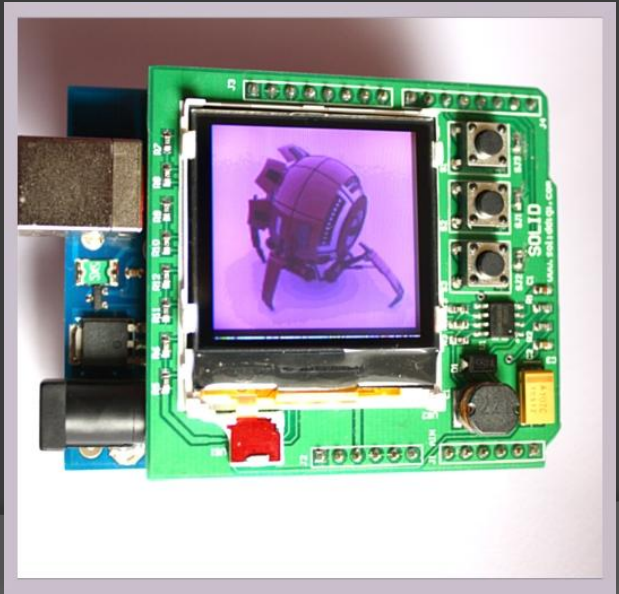


Prototyping shields



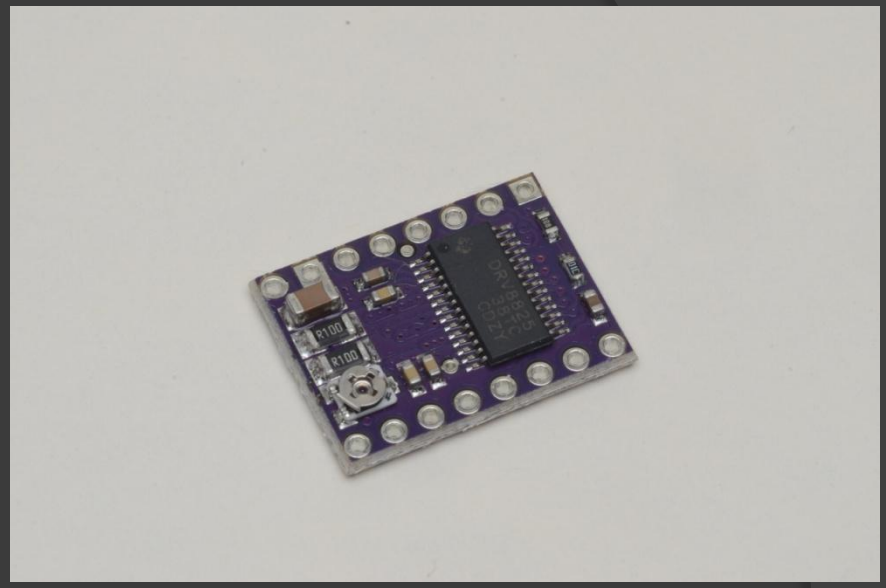


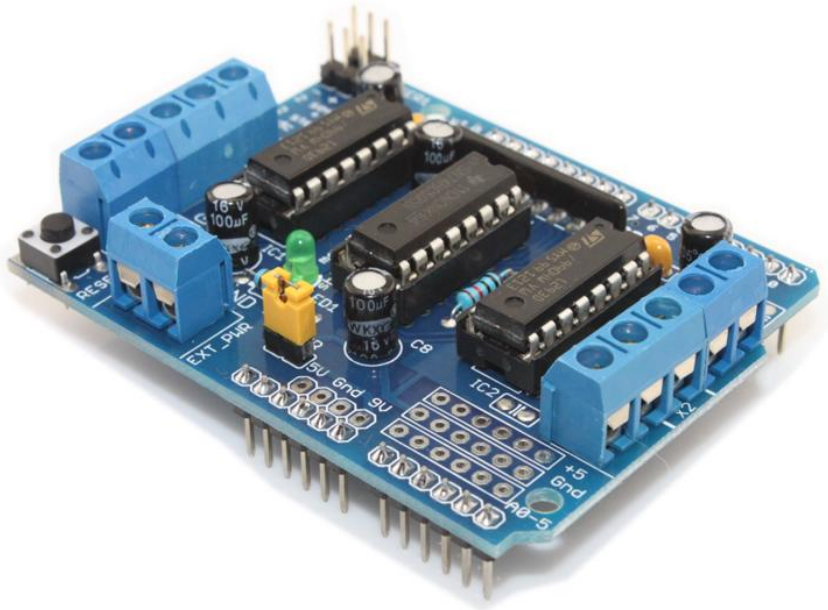
Display shields



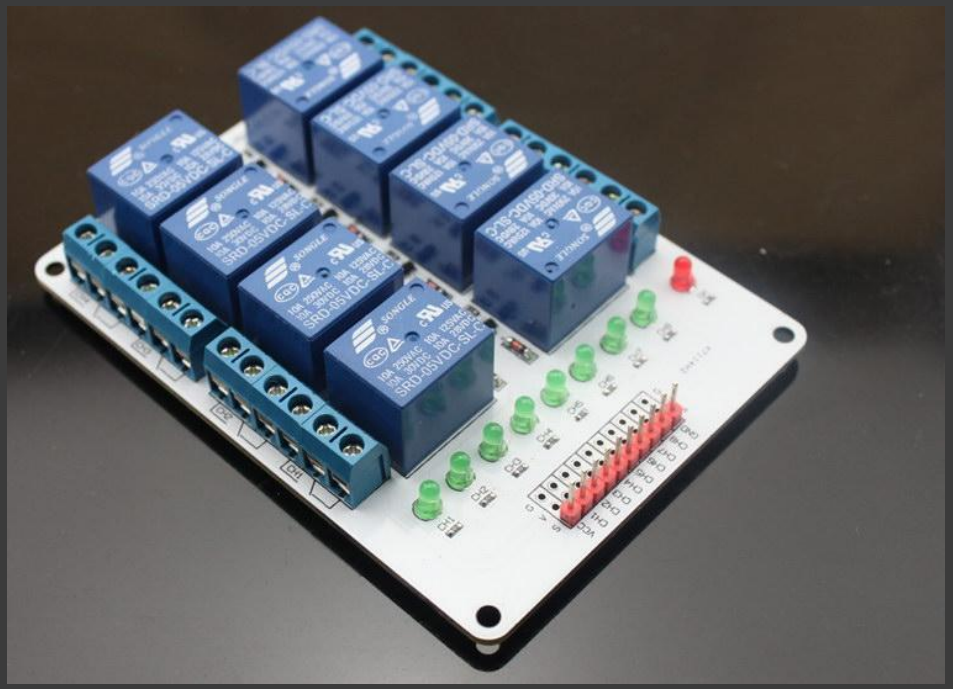
Motor shields

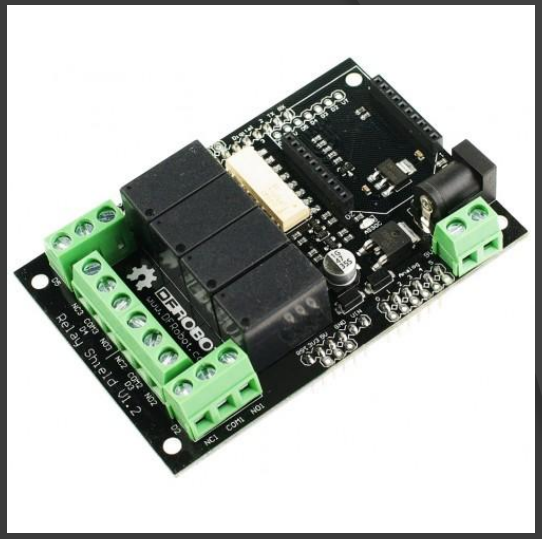
Servo, Stepper and DC

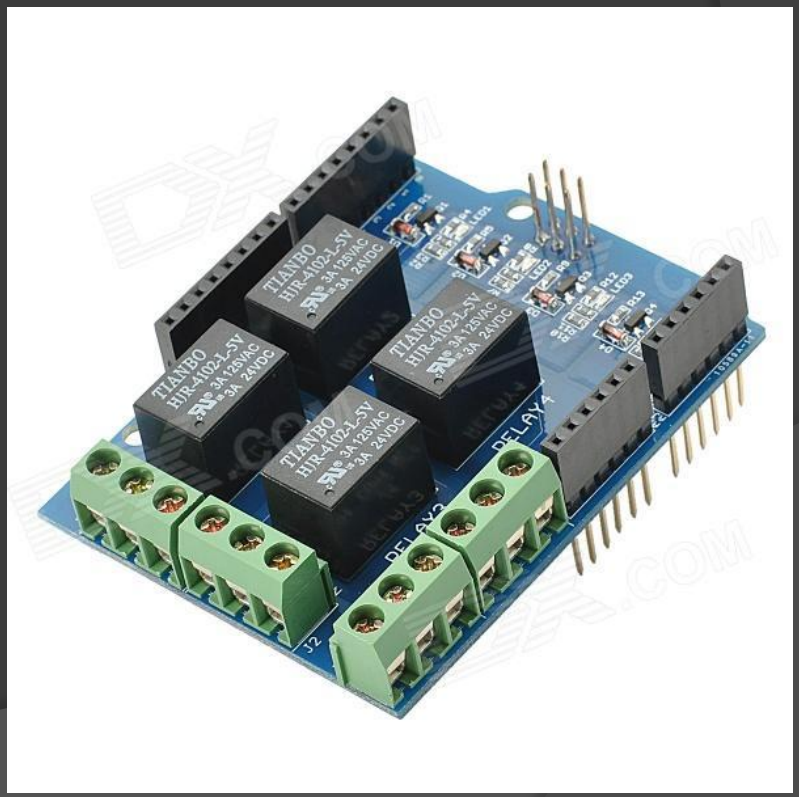




Relay shields

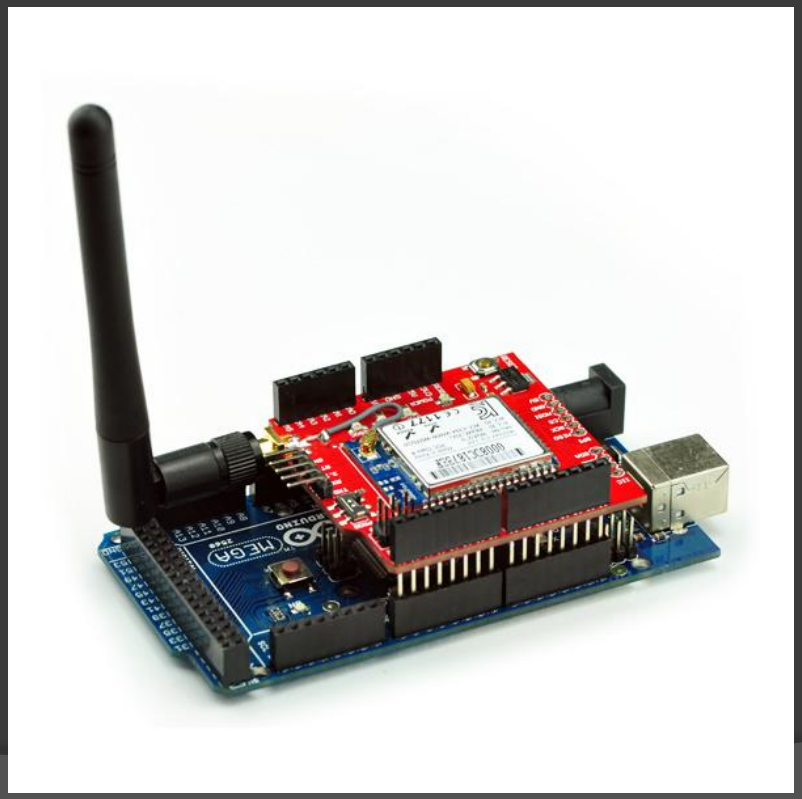






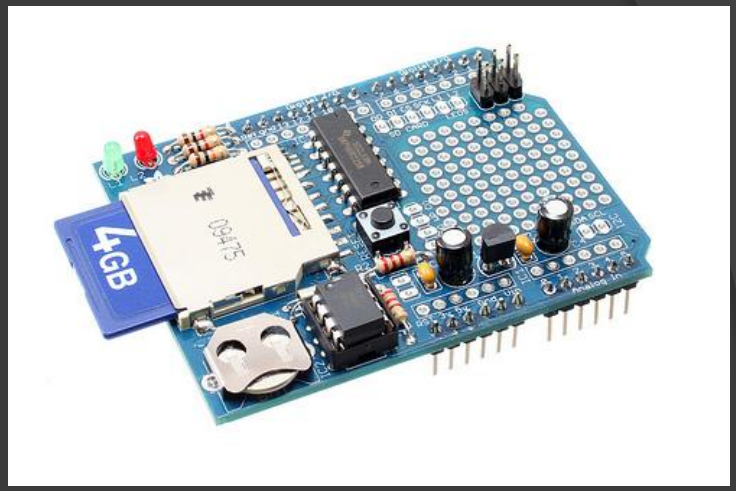
Ethernet shields

Wired and wireless

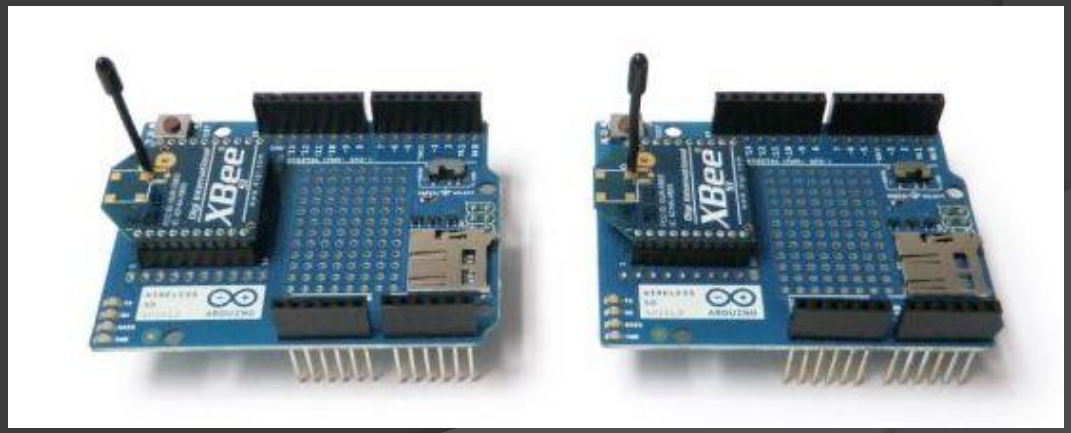


Misc shields

XBee “Breakout” Module



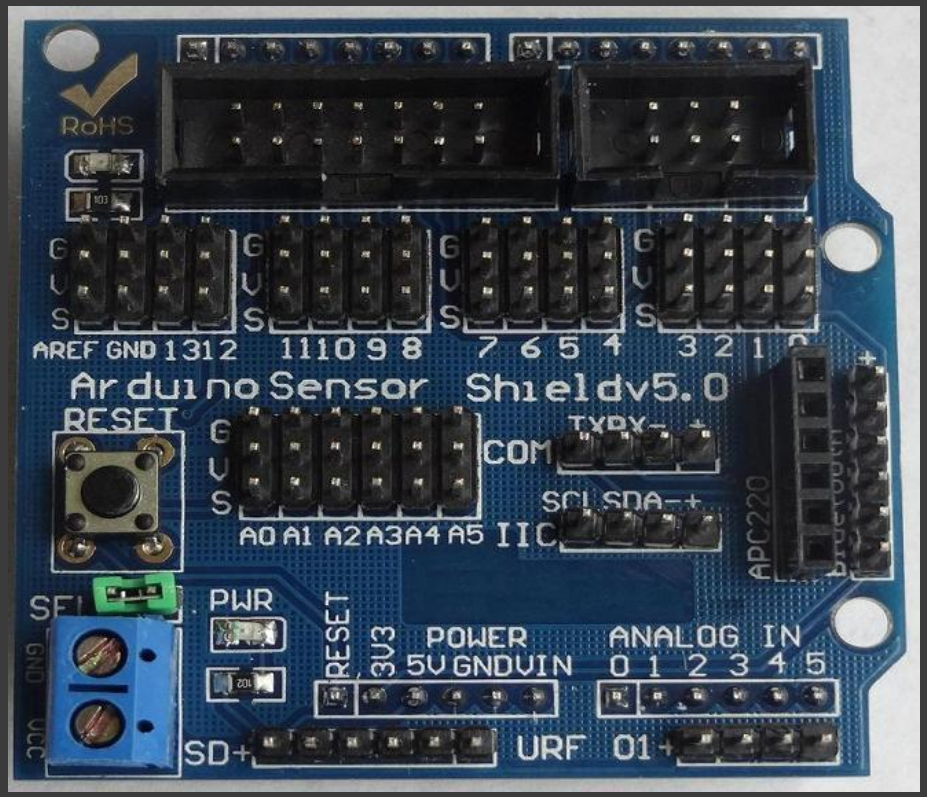
Datalogger



XBee Wireless shields

Sensor shields

Sensor Interconnect Shield



Sensors:

- Analog ambient light
- Digital Capacitive Touch
- Temperature
- Digital Magnetic
- Digital Vibration
- Digital Tilt
- Big Push Button
- Analog Grayscale
- LED Lighting

The Software

- The Arduino IDE (Integrated Development Environment)
  - Editor
  - Compiler
  - Loader
- Free download
- Based on C and C++

Arduino IDE

- Free download from arduino.cc
- Combines:
  - File management i.e. libraries, source
  - Editor
  - Compiler
  - Loader

Program Structure

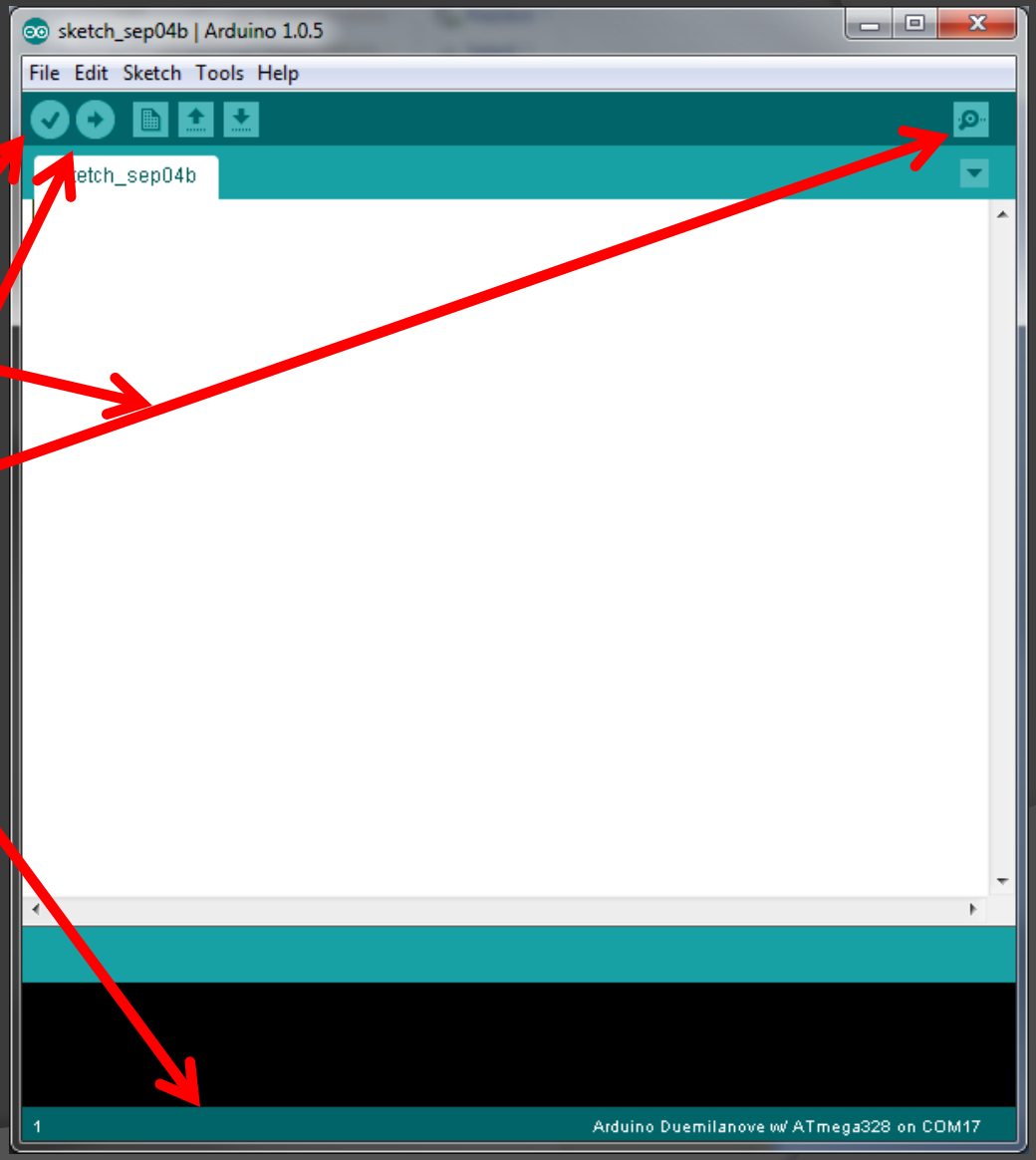
- Five essential steps to executing a program:
  - Initialization
  - Input
  - Processing
  - Output
  - Termination
- Provides the structure for >any< solution

Programming Languages

- Arduino *Sketches* (programs)
  - C programming language
  - Few words that have *special meaning*
  - No intrinsic I/O functions
- I/O is external to the language
  - Contained in C Standard Library
  - Allows you to write your own IO routines
- Arduino IDE uses C++ compiler
  - From Open Source group
  - C++ => Object Oriented Programming (OOP)
  - OOP = more complex / difficult = more powerful
  - Plain old C is much easier!!

Arduino IDE

- Tool bar
- Editing area
- Status bar
- Serial Monitor
- Compile
- Compile and Load



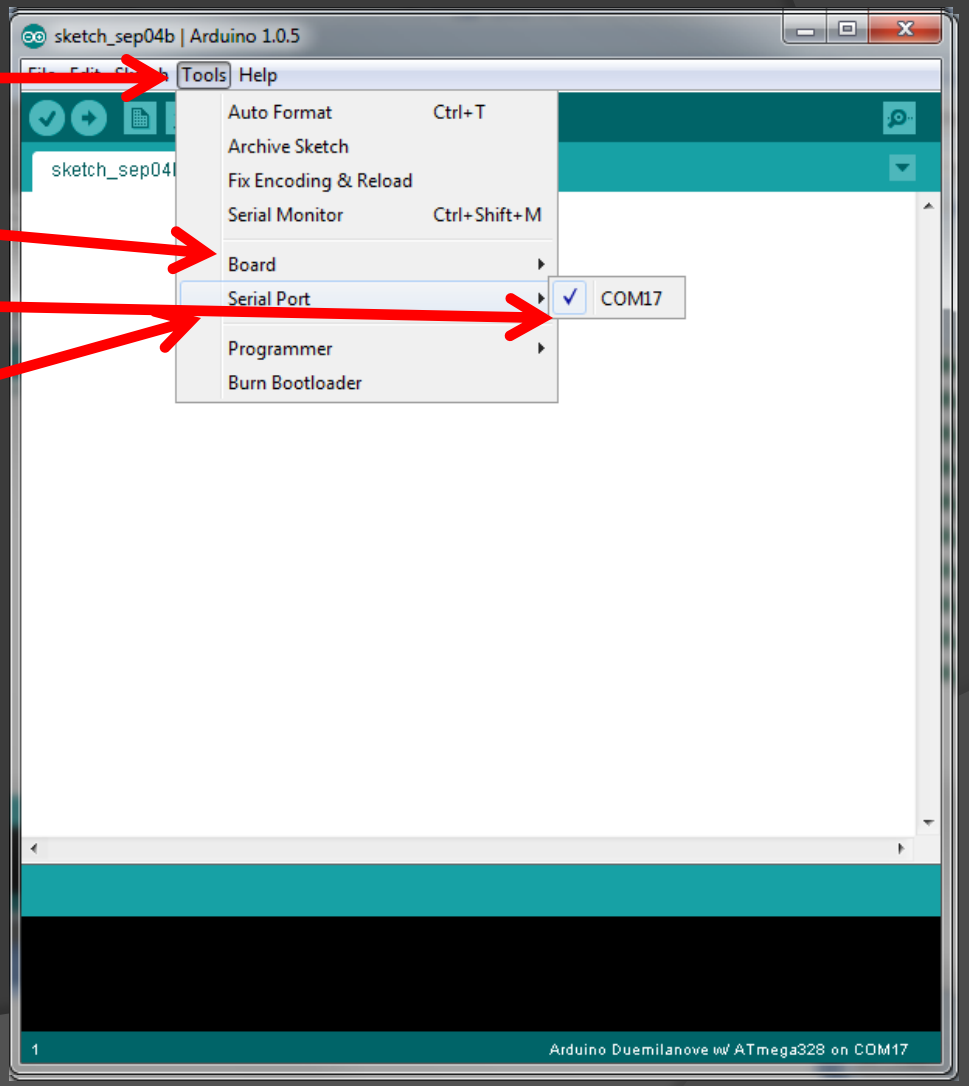
Select the board & serial port

"Tools"

"Board"

Pick your board

Select serial port

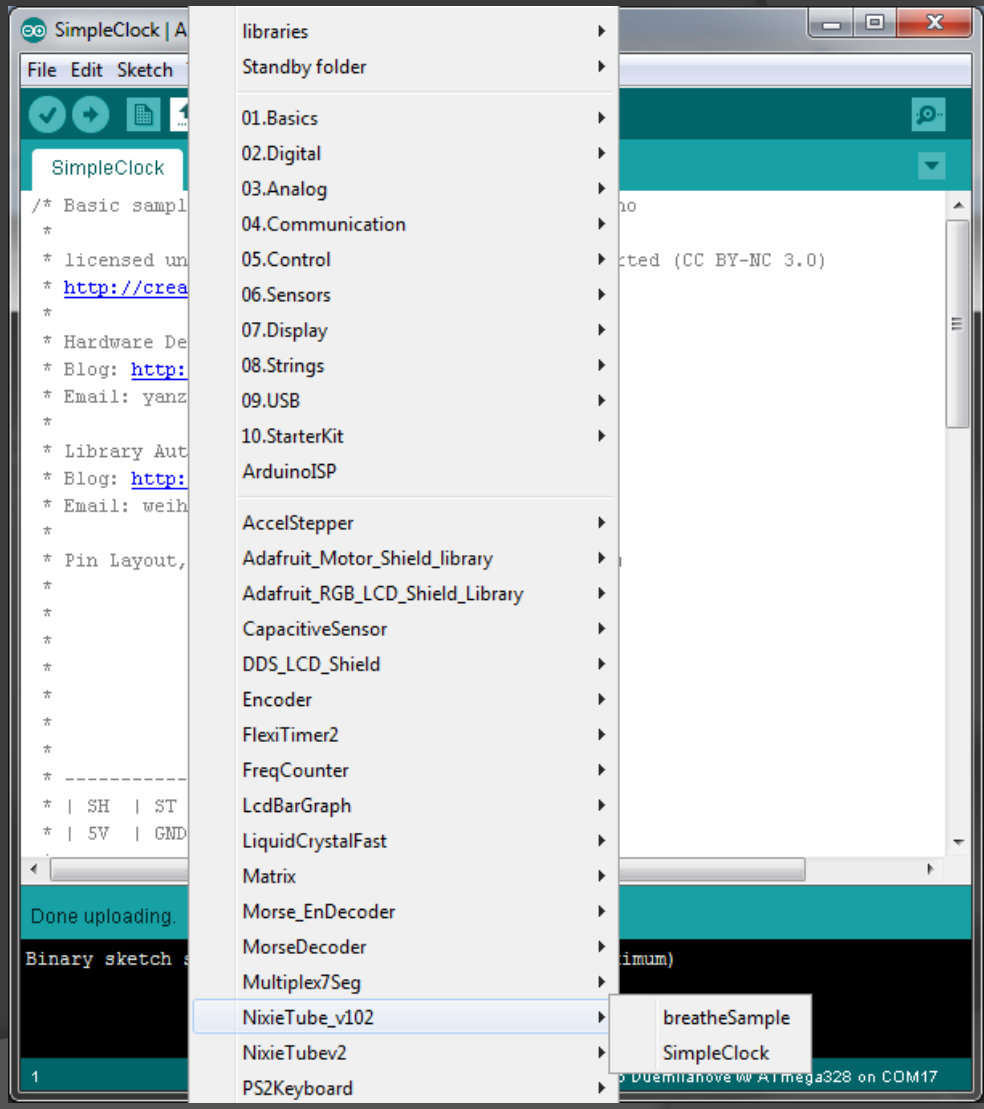


“Blink” sketch

- Flashes the onboard LED every second

Libraries

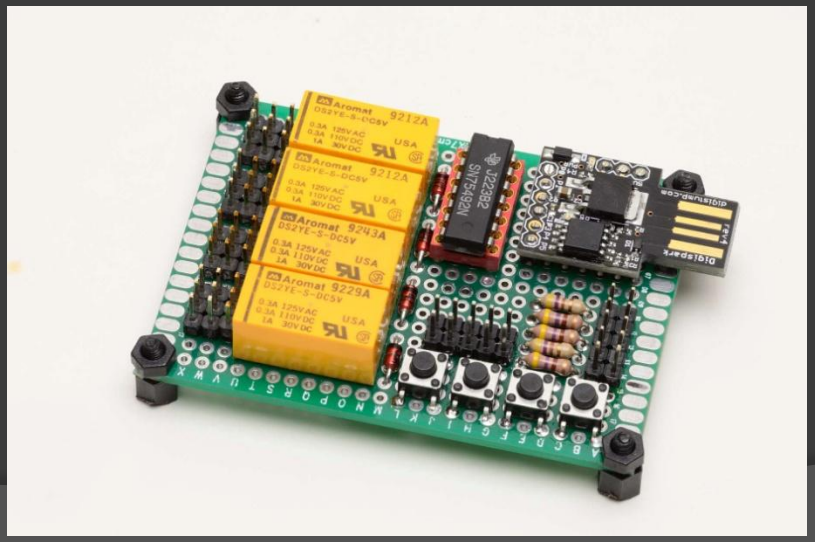
- Many already bundled
- Many more available
- Open Source = FREE
- Provide canned functionality



SHAMELESS PLUG ….

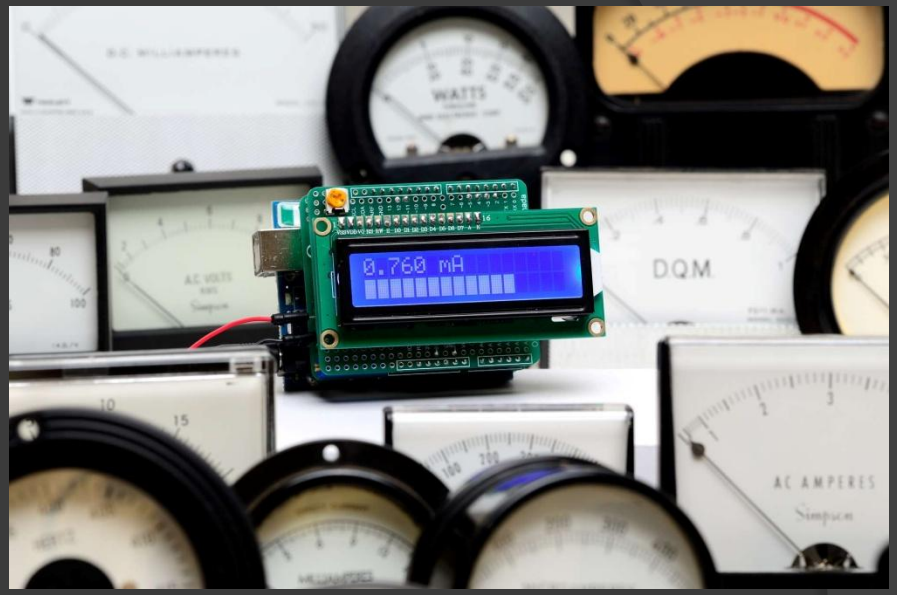
Applications

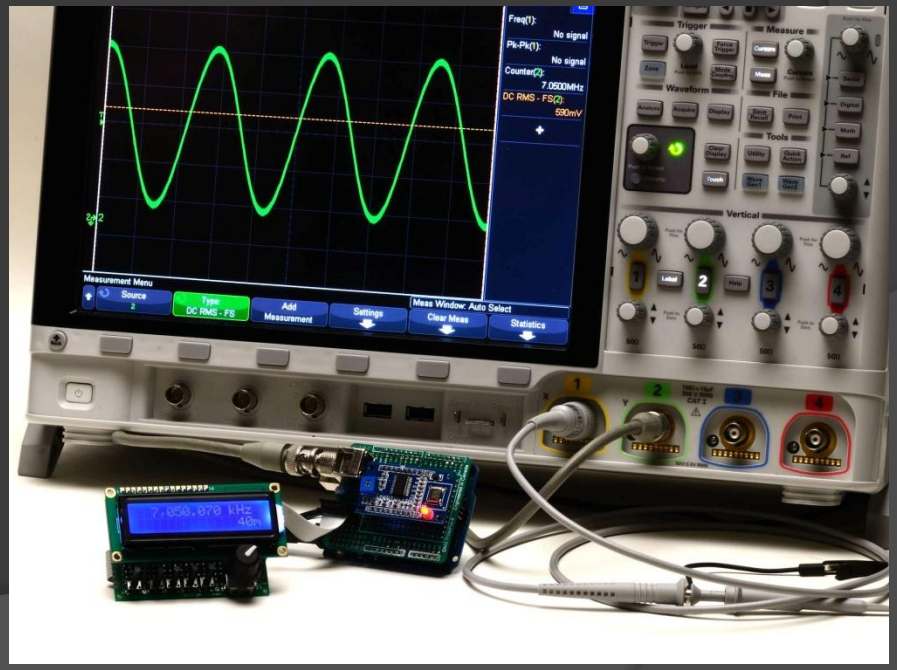
- VHF/UHF Sequencer
  - Four relays
  - Sequential turn on / turn off
  - Adjustable time delays and order
  - Selectable outputs: NC/NO ground, +5 VDC and AUX
  - Uses Digispark



Applications

- Digital Panel Meter
  - 0-1 mA
  - Analog bar graph
  - Easy scaling
- DDS VFO
  - HF Ham Bands
  - Analog Devices 9850
  - Spurious down 45 dB+





Applications

- Morse decoder
  - Up to 45 wpm
  - Audio input
  - Text display

- Frequency Display
  - Measure up to 24 MHz
  - Supports multiple schemes
    - Single / Dual / Triple
    - Calculate display freq

Resources

- arduino.cc
- makershed.com
- adafruit.com
- sparkfun.com
- pololu.com
- dfrobot.com
- seeedstudio.com
- linksprite.cn
- digistump.com

- atmel.com
- digilent.com
- netduino.com

- github.com

What will *YOU* make?