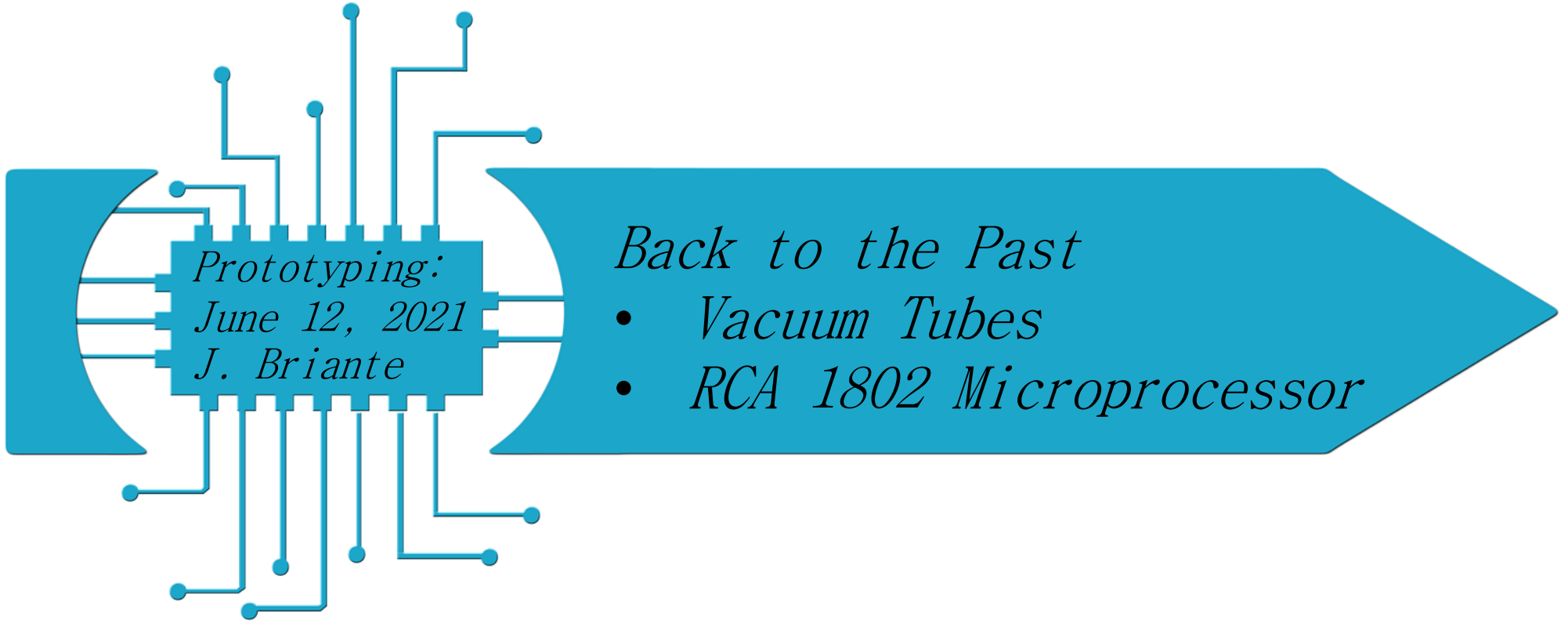
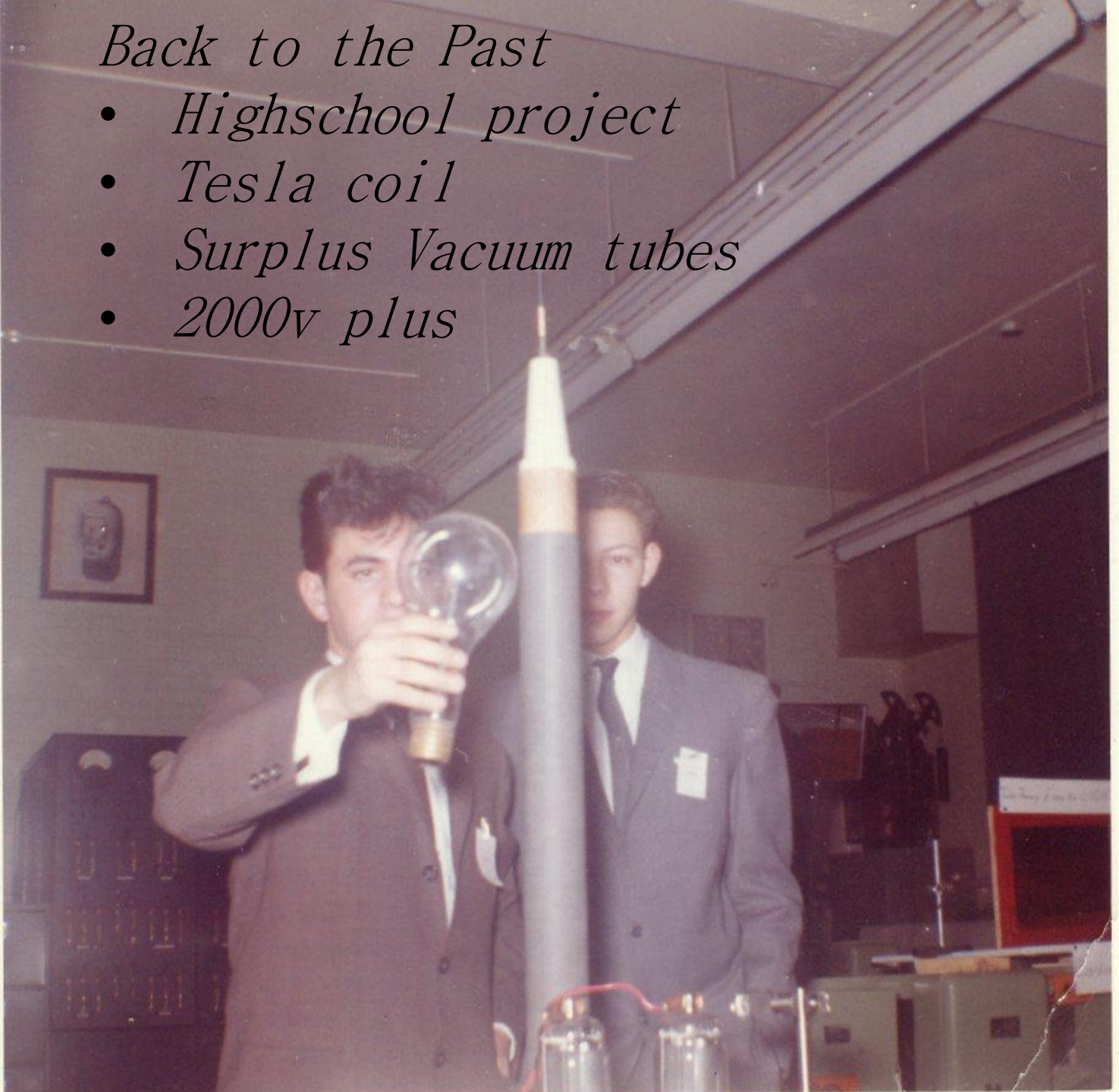


Nothing lasts forever but at least we got these memories.

J. Cole



Back to the Past

- *Highschool project*
- *Tesla coil*
- *Surplus Vacuum tubes*
- *2000v plus*

My first radio ham transmitter

- *Bendix transmitter (military surplus)*
- *Used in Lancaster bomber/tanks*
- *Donated to museum*

Mewer Kenwood radio ham transceiver

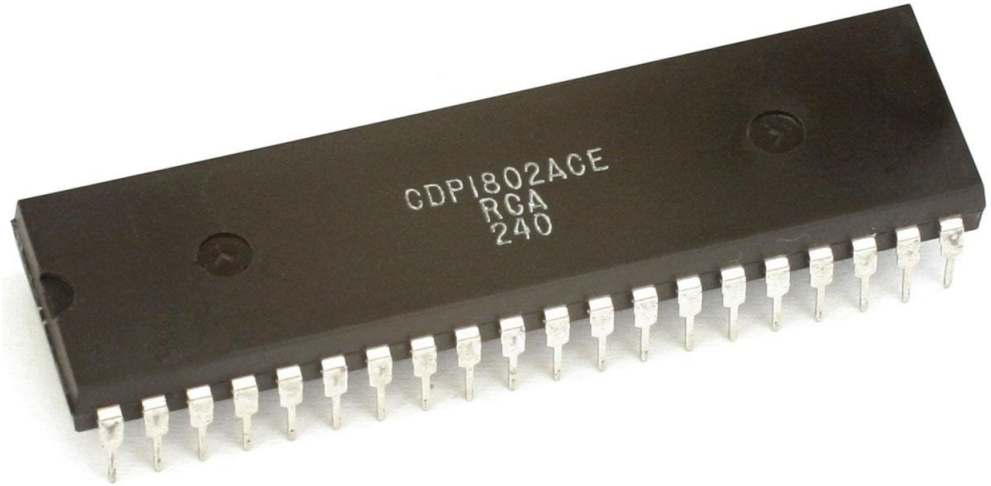
- *Antenna tuner below*
- *J. briante: WE7QLQC*

RCA 1802 Microcontroller: How it all started

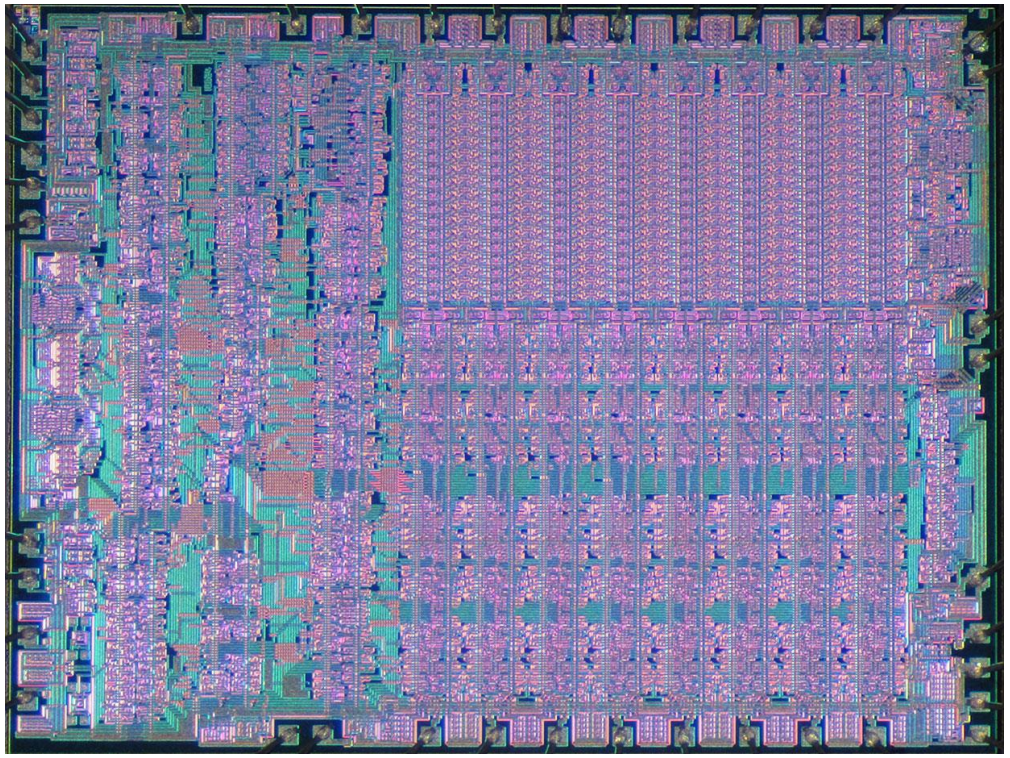
- *Was asked to join a team let by a UofW prof who was developing new sensors for smoke detectors and their integration into a modern fire alarm and control panels using the 1802*
- *My role was purely hardware: Inter connecting the many Ics necessary to make a working control system using the 1802, e.g. decoding memory space for ram, rom, i/o, etc.*
- *Programming the 1802 was the role of a fellow programmer*
- *Inner workings of the 1802 and its opcodes led to programming*

Chip Hall of Fame: RCA CDP 1802

Despite bad management, the first CMOS microprocessor went all the way to Jupiter

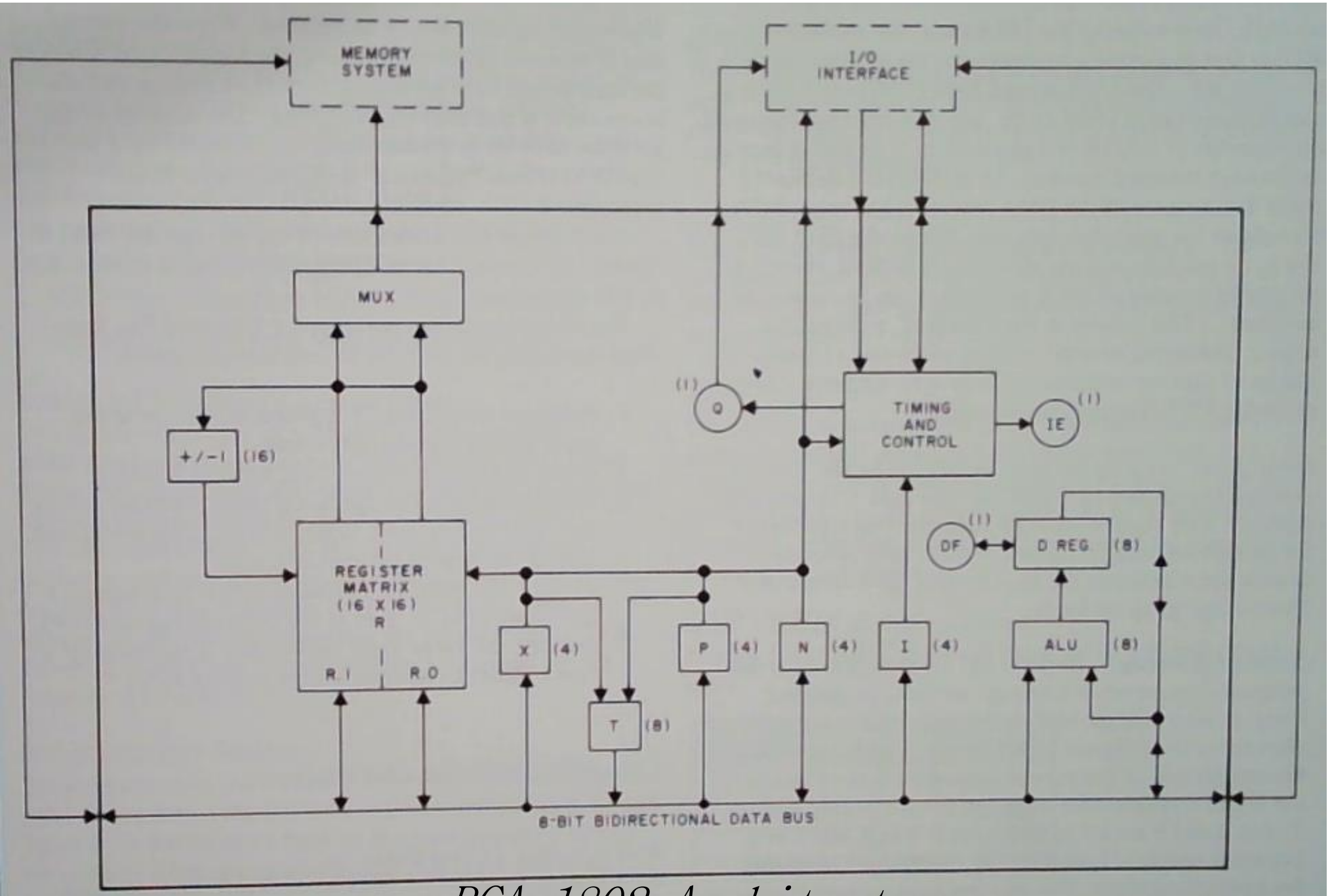


Another aspect of the 1802 made it popular among aerospace designers. It was available in a version resistant to radiation [PDF], making it ideal for the harsh environment of space. Six 1802s were used as the brains of the Galileo probe, which launched in 1989 (a year before Weisbecker passed away) and orbited Jupiter between 1995 and 2003.



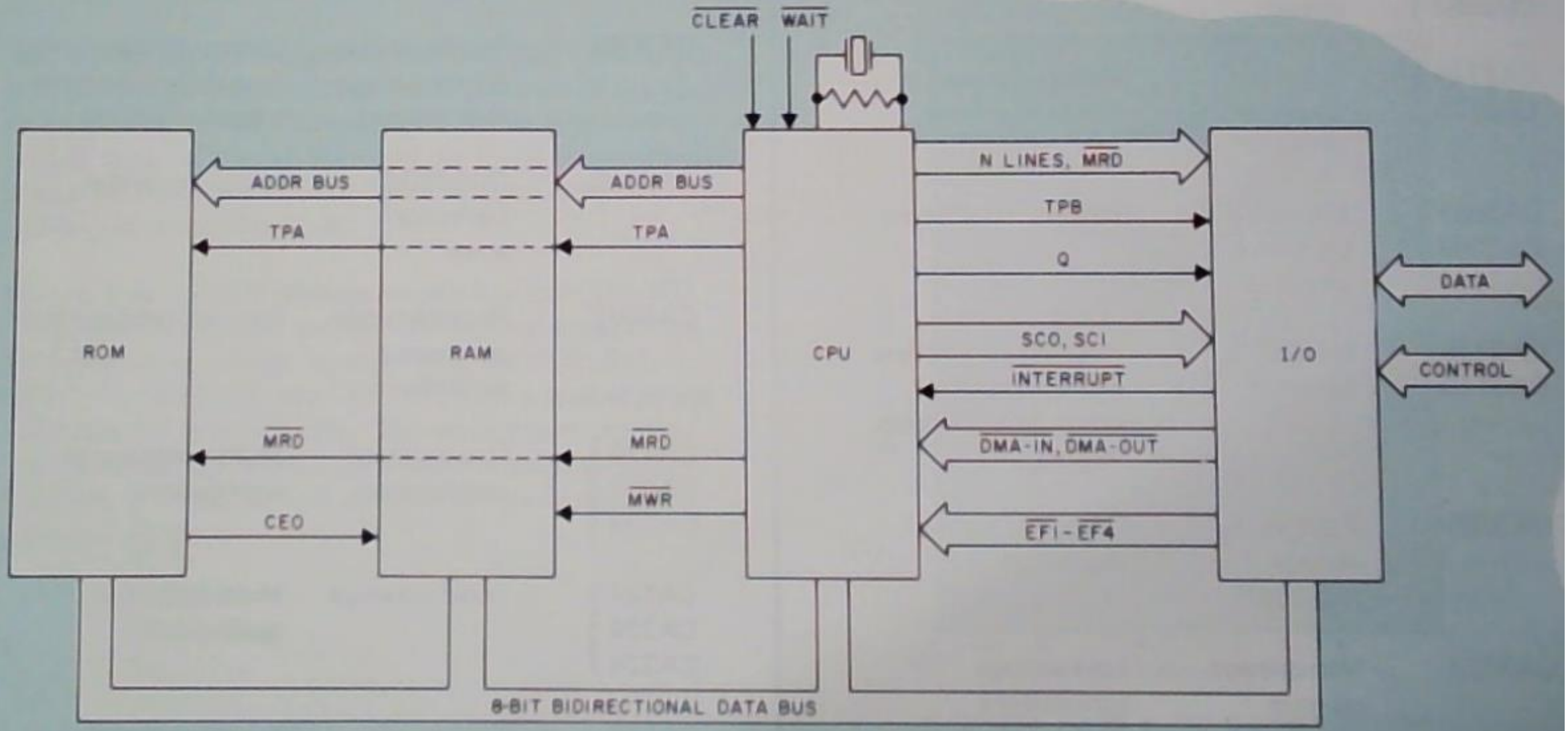
1972, RCA 1802 with 5,000 transistors

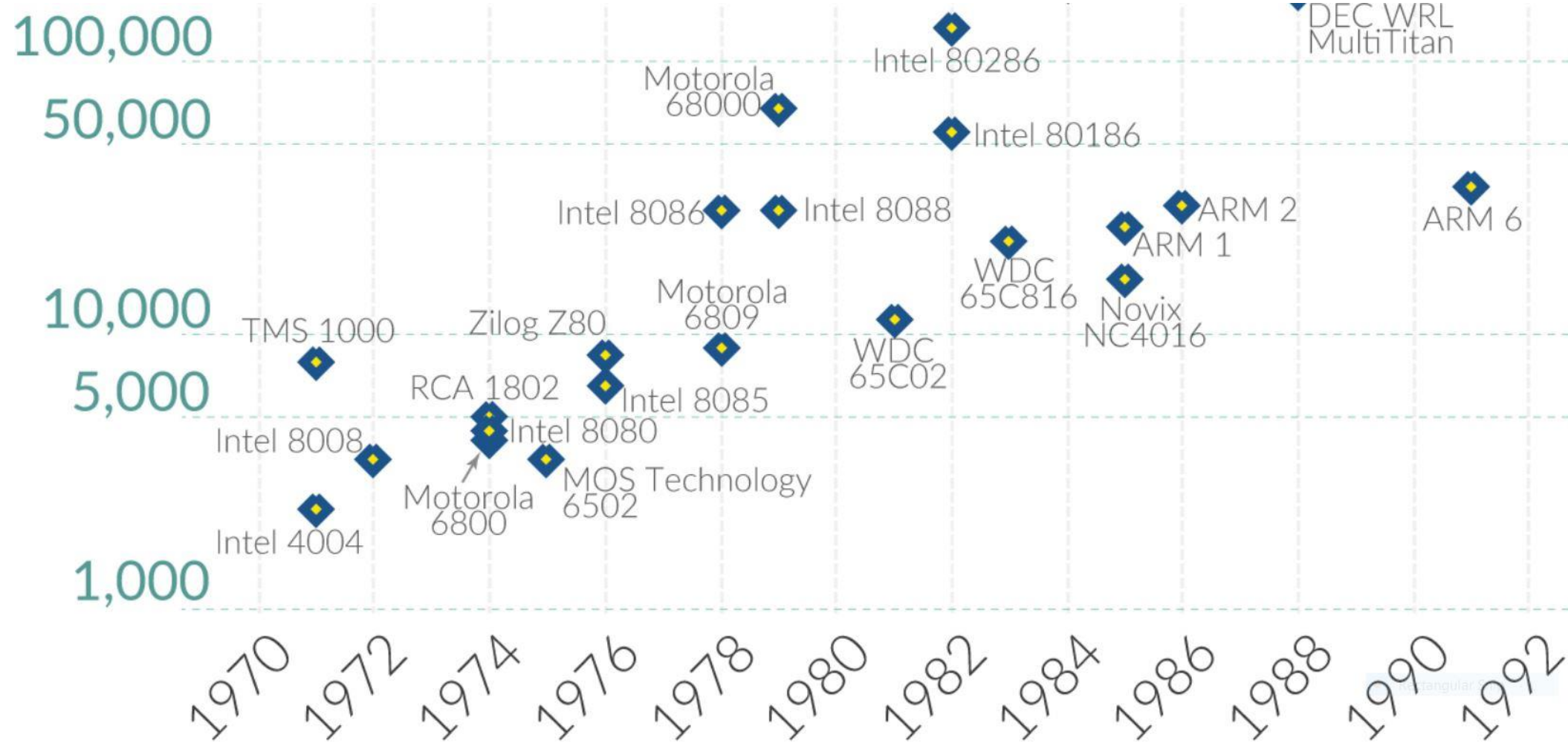
(Wikipedia)



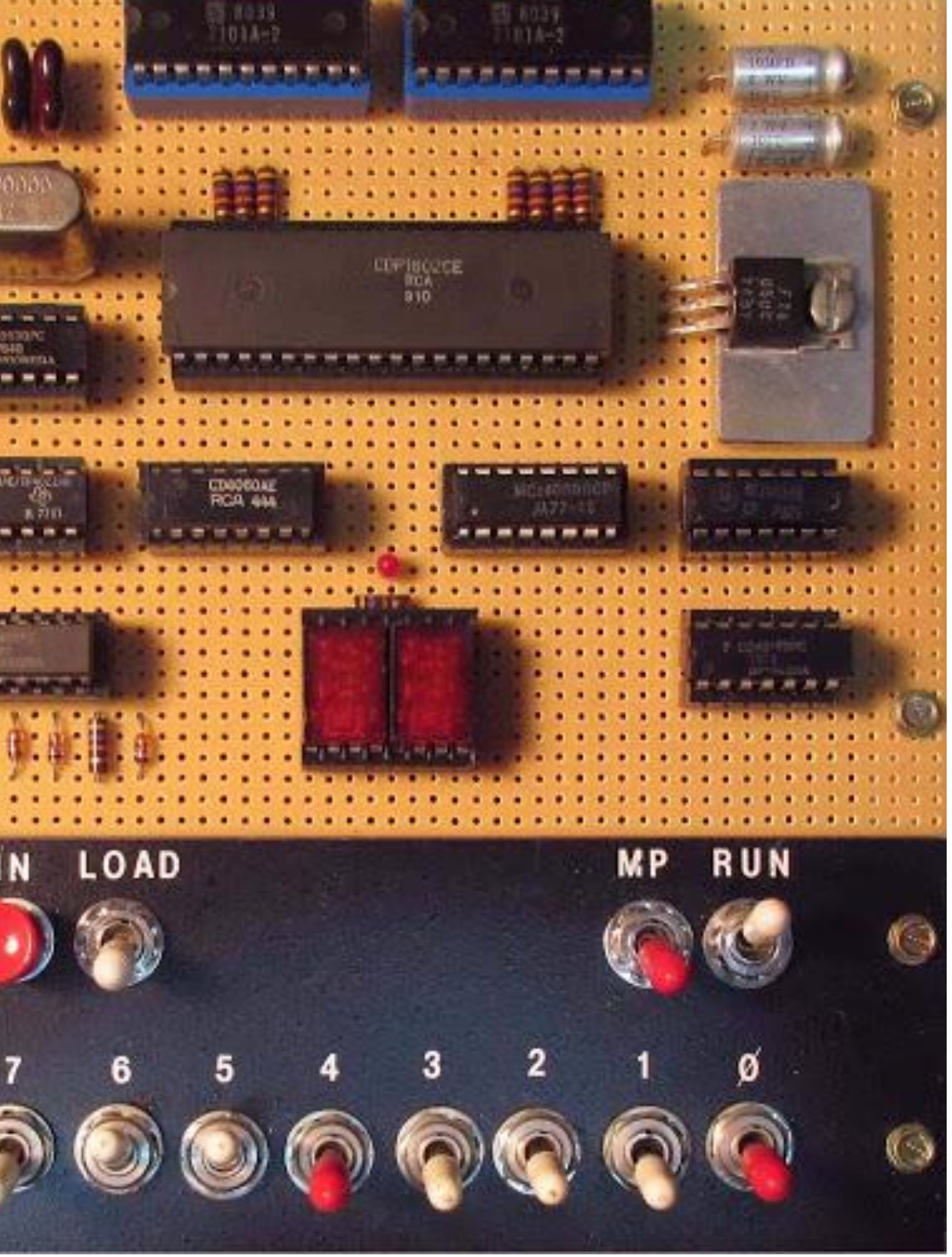
RCA 1802 Architecture

Typical CDP1802 microprocessor system





Microprocessor/controllers - Comparison by Date and Number of Transistors - Wikipedia

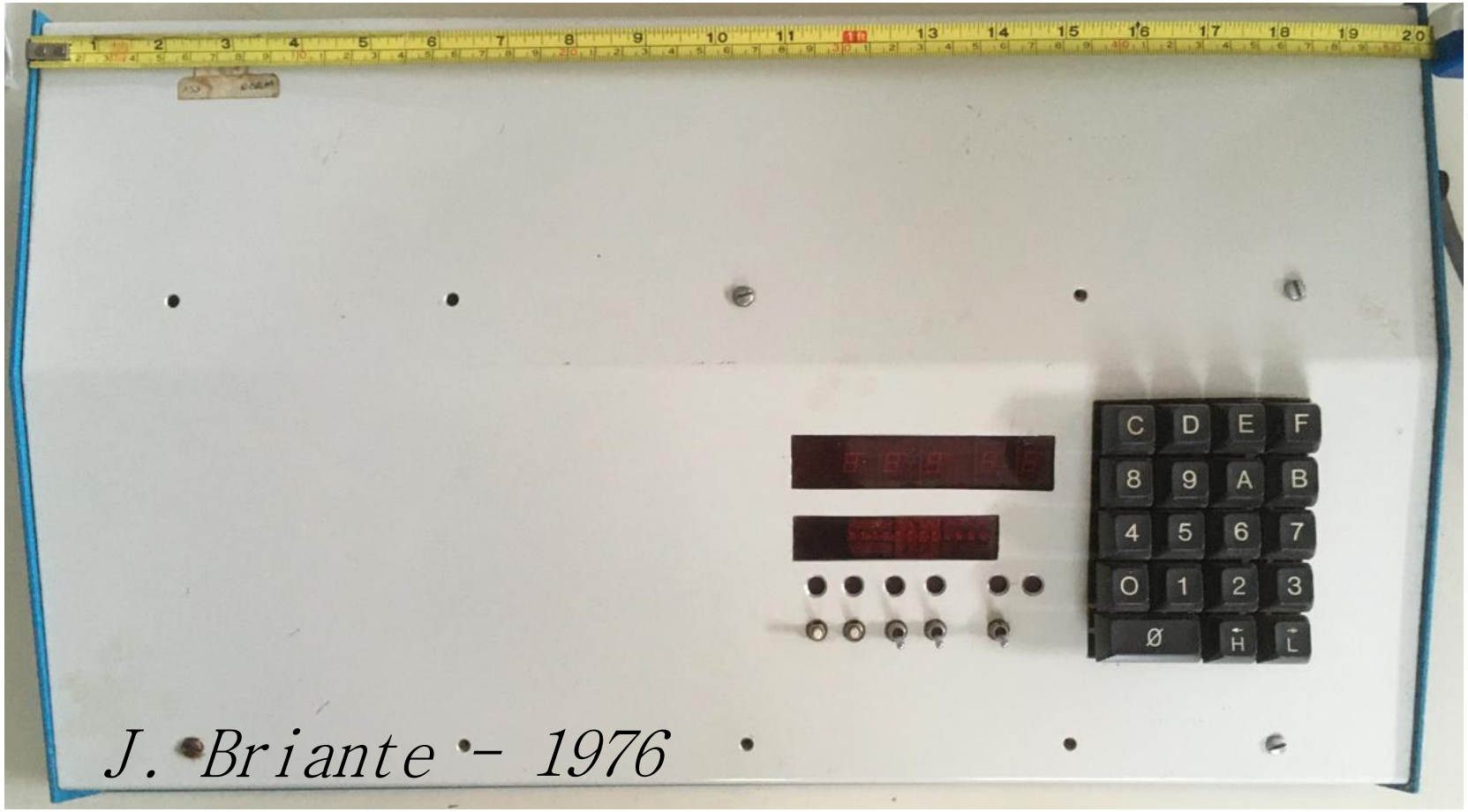


Early 1802 Cosmac Elf

- *Opcodes set by switches*
- *Opcodes manually loaded*
- *No ROM*
- *RAM <256 bytes uses also as ROM via a MP switch*
- *RAM memory write protected switch*

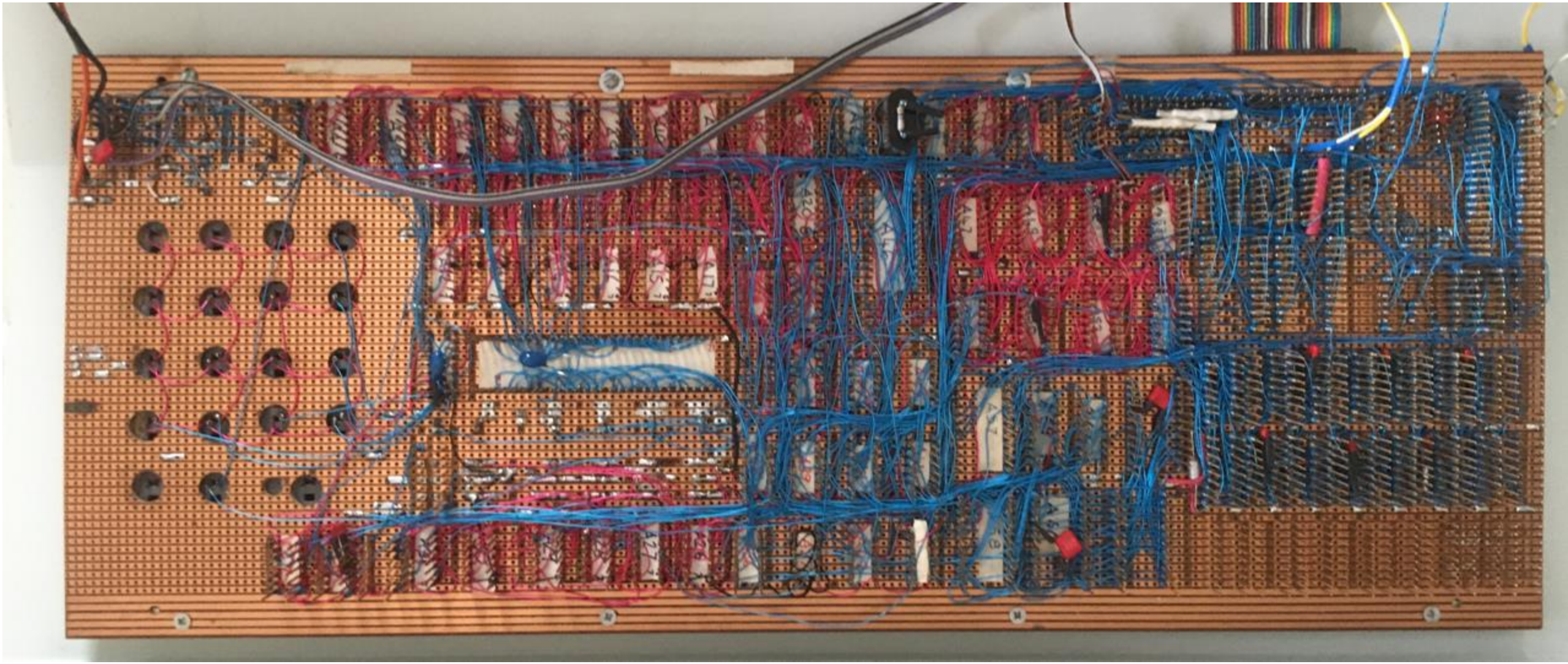
Improved 1802 Cosmac Elf

- *Opcodes set by keypad*
- *Alphanumeric display*

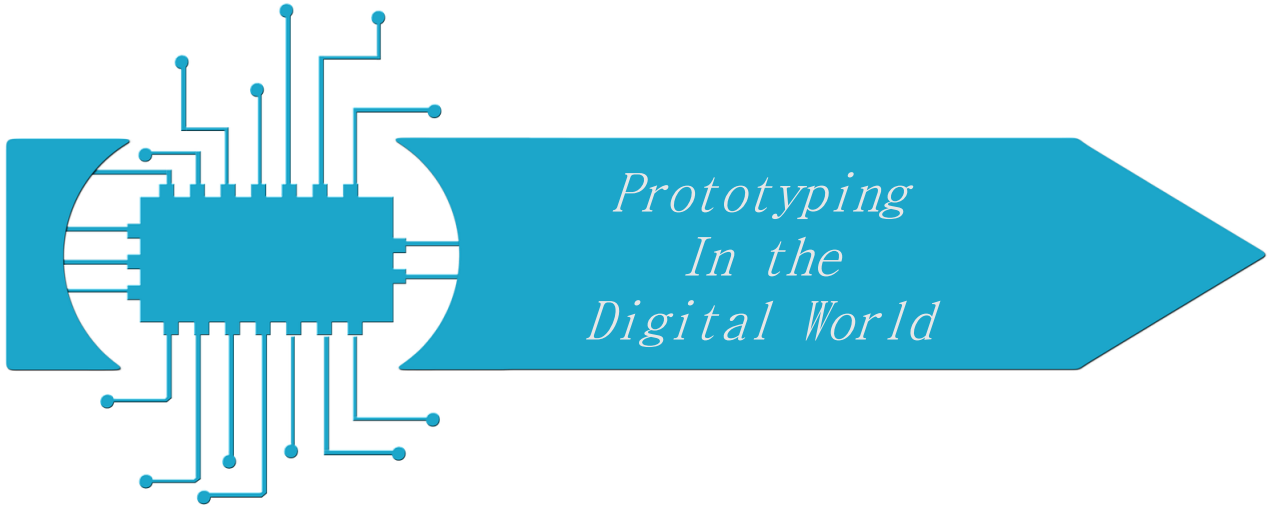


Complete 1802 Dev System

- *Printer & RS232 Ports*
- *EEProm programmer*
- *Audio cassette data storage*



1802 Dev System wiring



Prototyping takes on different meaning based purpose

Proof-of-concept prototype:

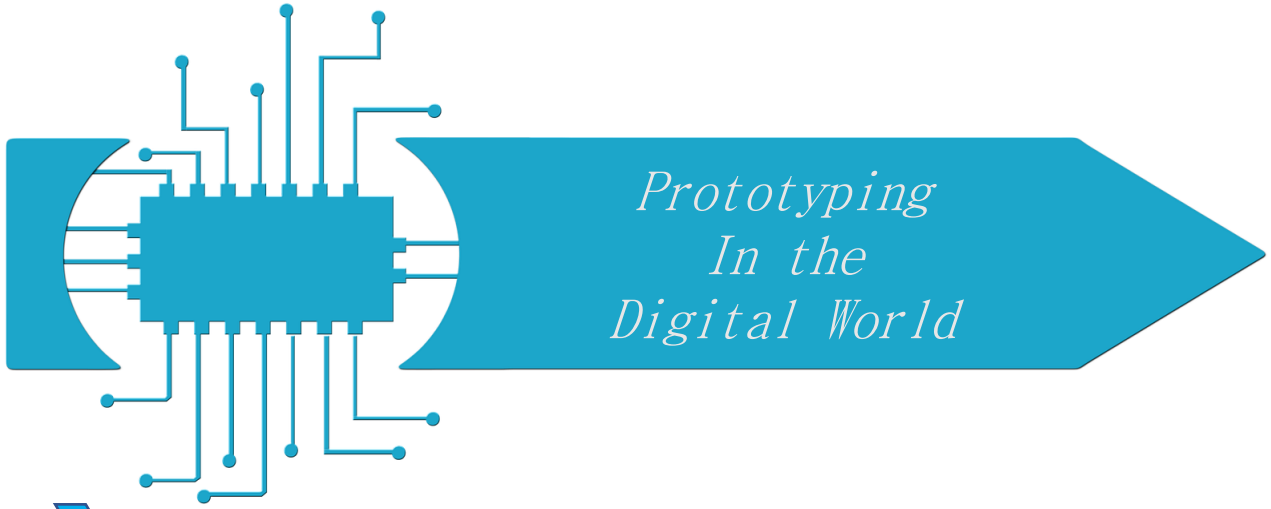
- *to validate certain aspect of a design*

Working prototype:

- *one that has most or all aspects of a final product*

Functional prototype:

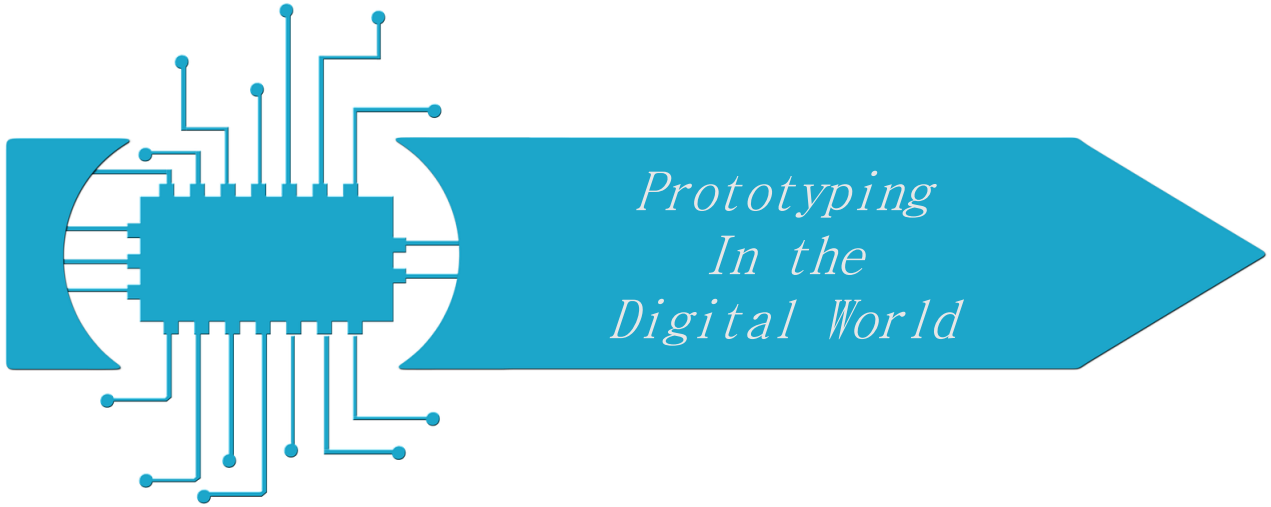
- *working prototype with physical appearance of final product*



- *Prototyping is not a new concept*

- *Prototyping in our recent history*
  - *Using vacuum tubes*
  - *Transistor*
  - *Integrated circuits*
  - *Microcontroller/ Dev boards*
  - *Next stage ??*

- *What has changed historically?*
  - *Tools required to prototype*
  - *What segment of the populating is able to prototype*



- *Vacuum tubes*
  .Very little remains
  . Not completely dead

- *Integrated circuits (ttl and cmos logic)*
  - *Dip packages are obsolete*
  - *The more useful cmos logic has resurfaced as SMD*

- *Microcontrollers IC*
  - *Shrink packages are making prototyping difficult*
  - *Require SMD to DIP converter PCB*

- *Some prototyping tools from the past are still useful*

- *Analog Circuits*
  - *More difficult to create or analyze*
  - *Deal with continuous variables not binary o or 1*
  - *Temperature causes many problems such as*
  - *Change in values, drift, offset, frequency dependency, etc.*

- *Simulation*
  - *ti- TINA*
  - *ti- Pspice*

- *Test Equipment*
  - *Function Generator*
  - *Oscilloscope*
  - *Other*

Recent Trends

- Active and passive component packages have migrated to SDD
- Component footprints have reduced in size

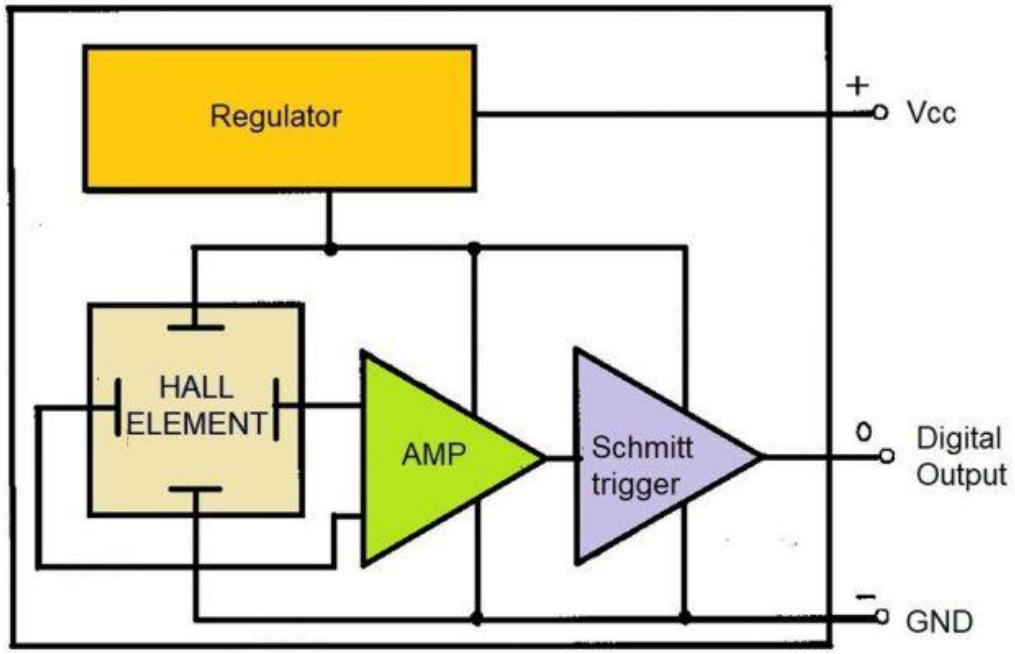
Op-amps

- Operate on lower voltages as low as ±1v
- Power consumption down to milliwatts
- Available with zero drift
- Improved bandwidth

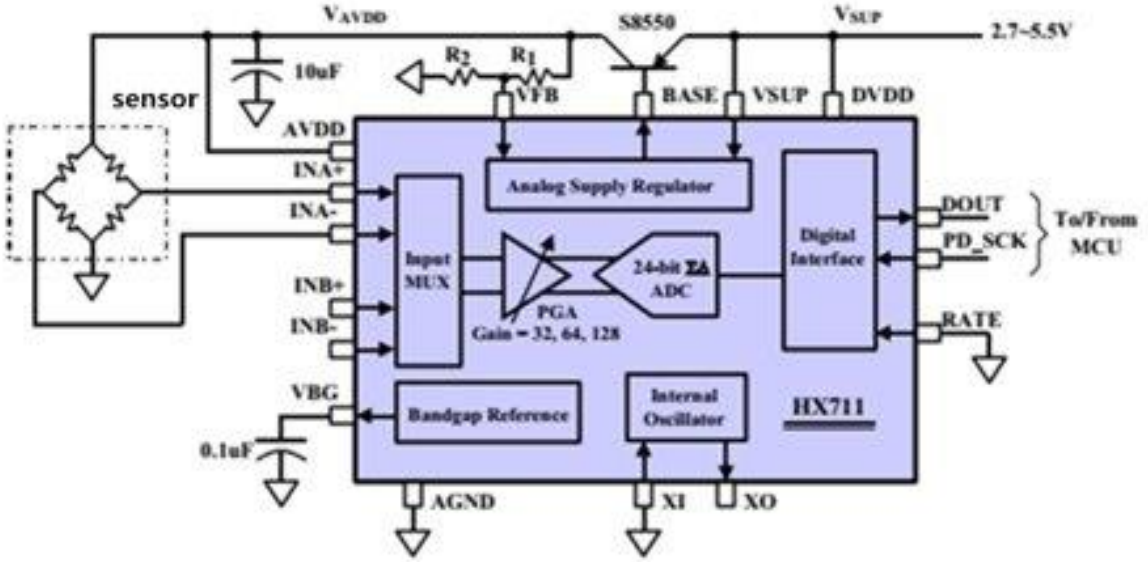
Analog Blocks to Digital

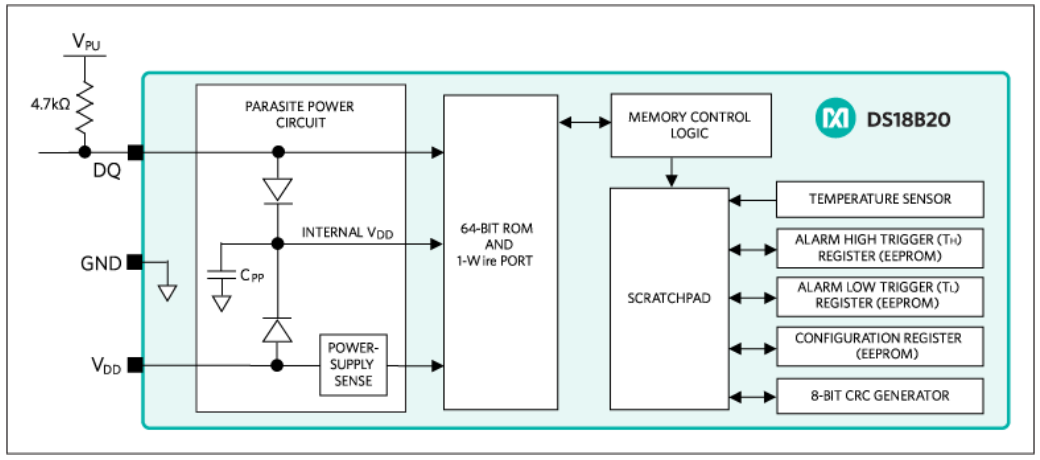
- A/D converters
- Specific to sensor type e.g. HX711
- Imbedded in Sensors, e.g. Digital Hall effect sensors, ds18b20

Digital Hall effect sensor

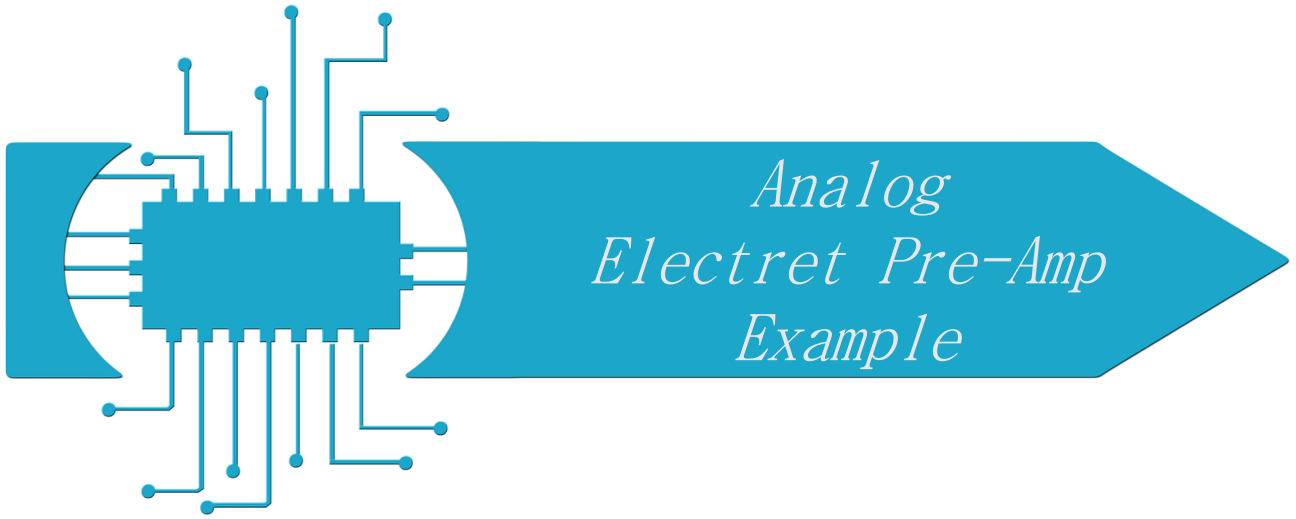


HX711 Internal Block Diagram



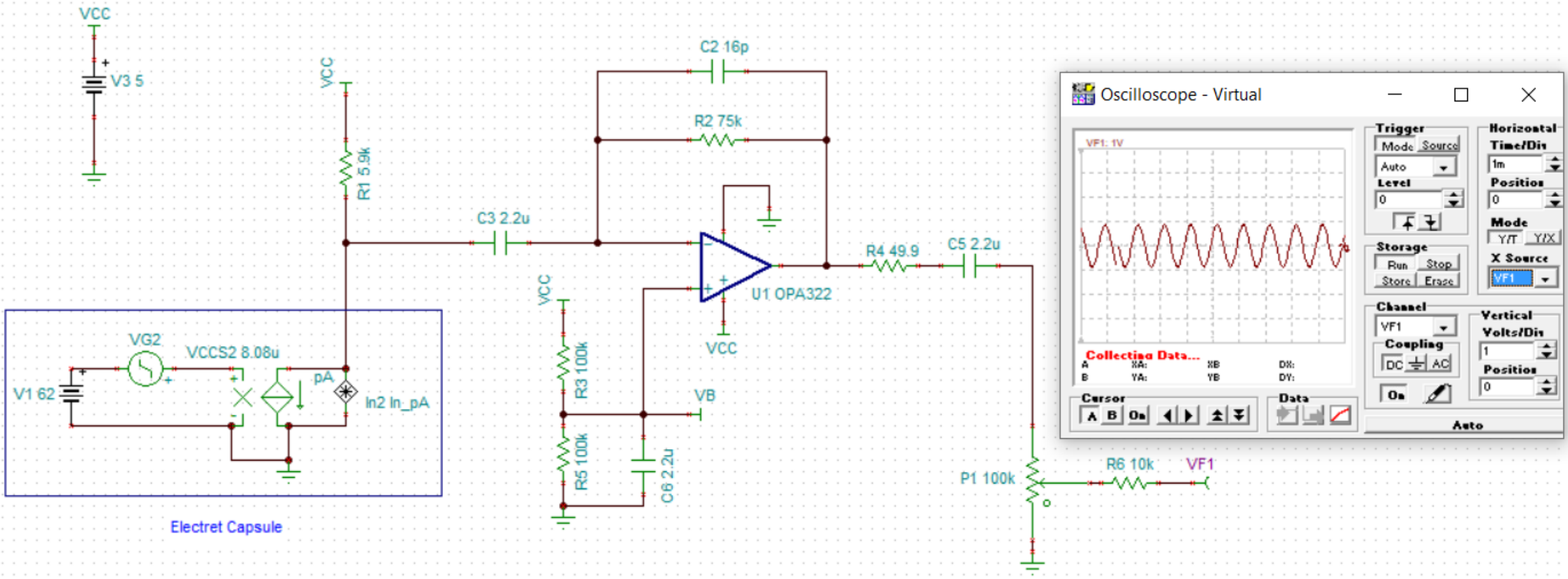


Analog to digital blocks makes prototyping possible for all



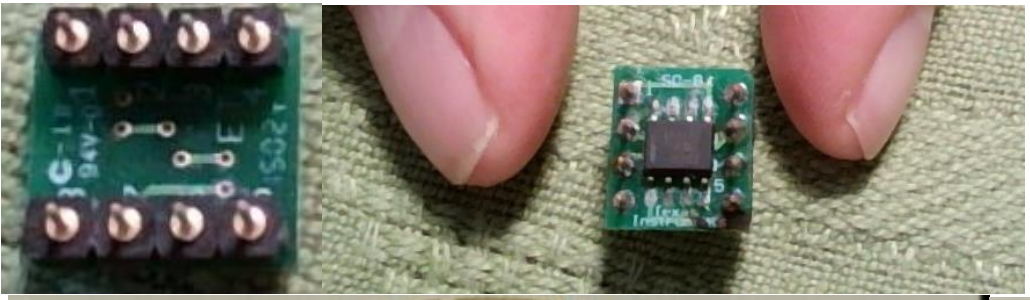
Stages

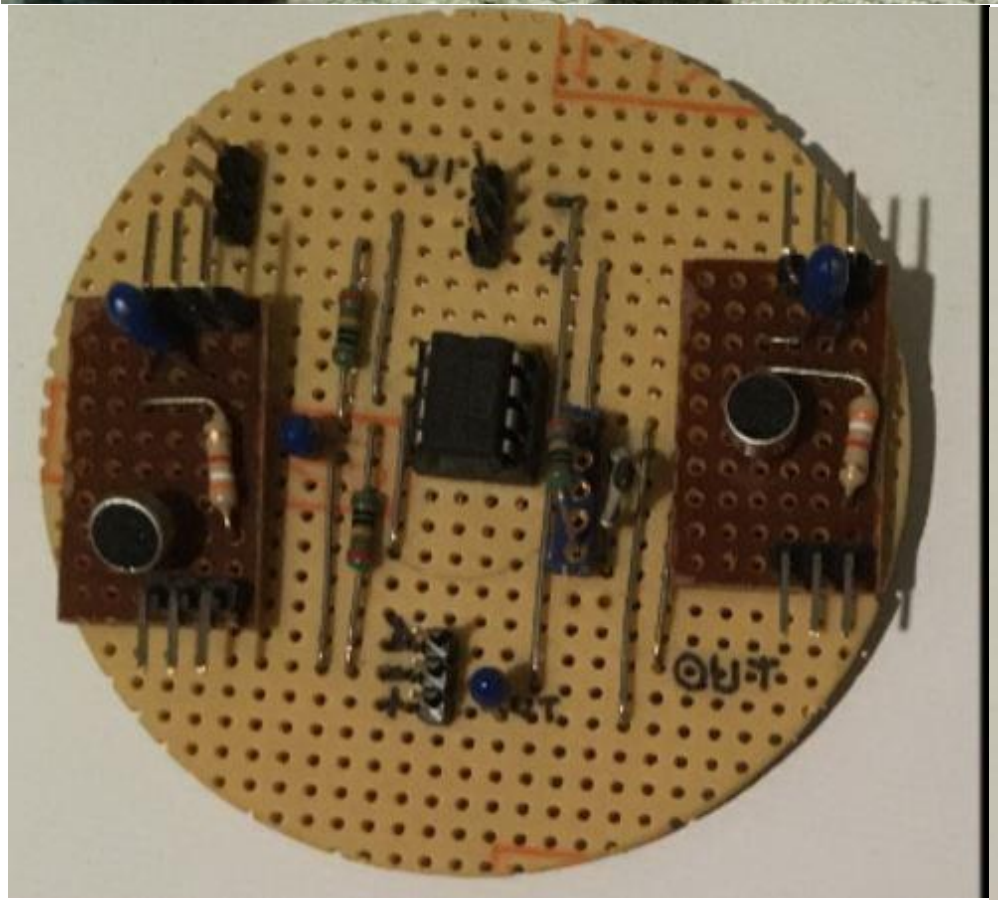
- Simulation using ti-TINA √
- Prototype
- Testing
- Verification
- PCB Design
- PCB Manufacture
- Testing
- Verification

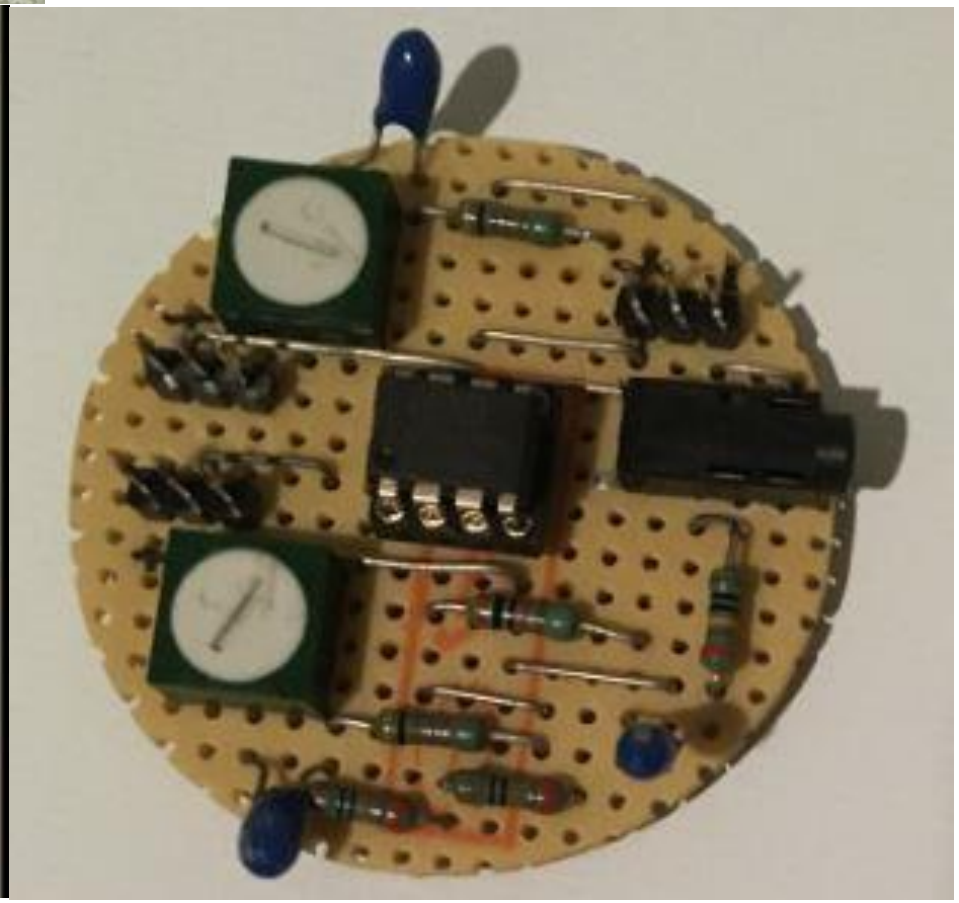


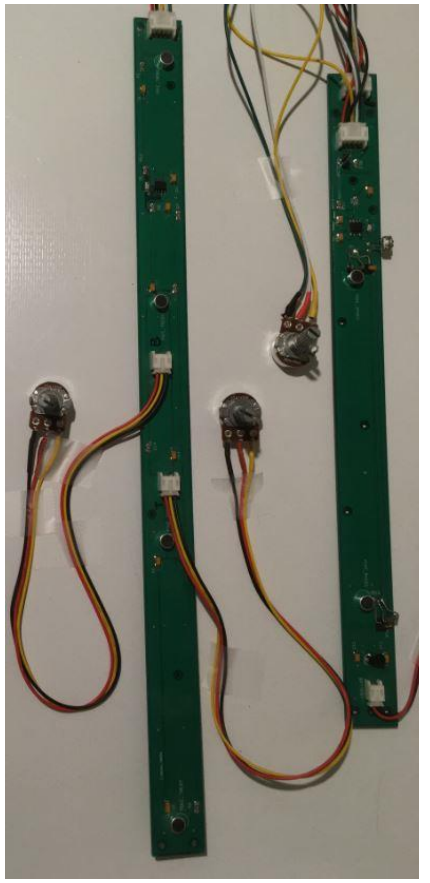
Texas Instruments TINA (Interactive Network Analysis)

- *Spice based Simulation*



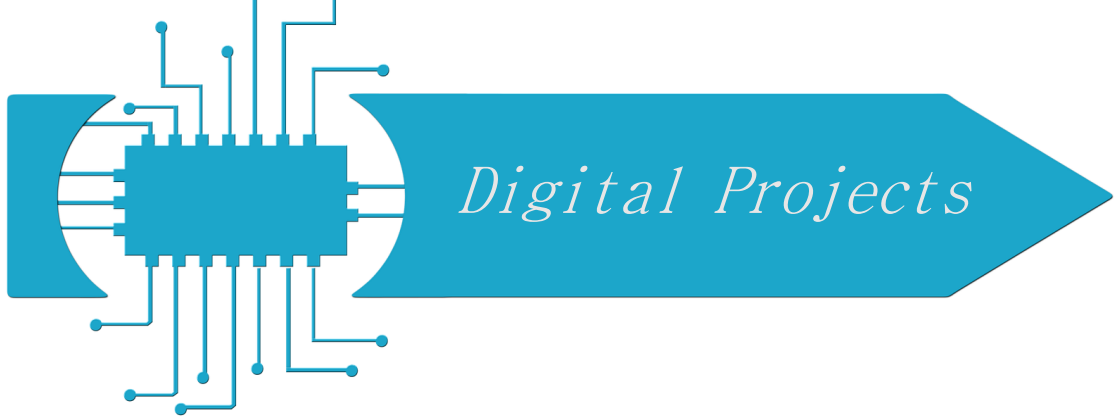






Accordion Pre-Amp Prototypes

Final



Project Components

- Dev Boards-Plus
- Microcontrollers-Plus

Programming Environment

- Dev Boards based

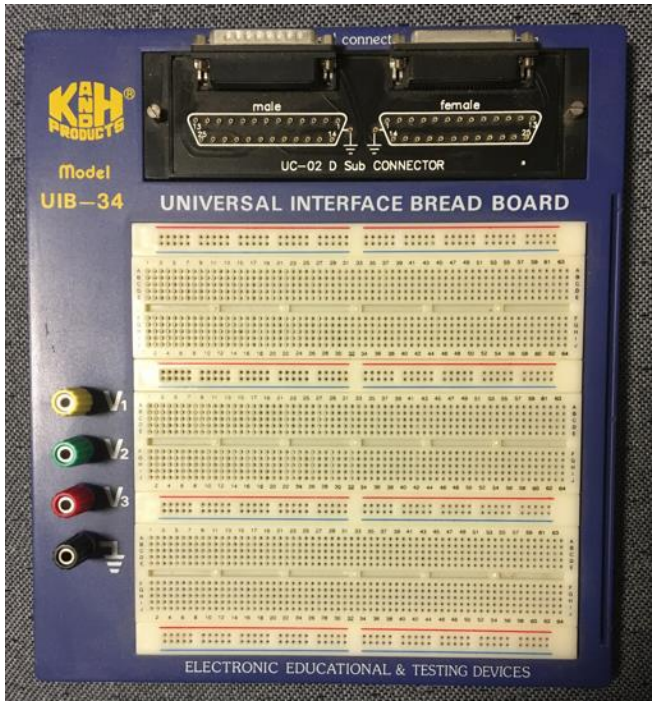
Additional Software

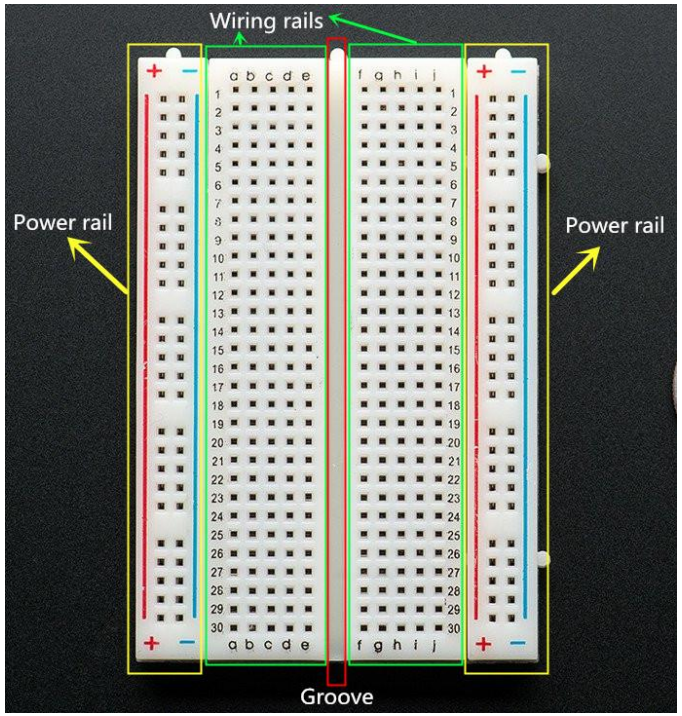
- Terminal Communication
- Eagle - PCB, Schematics

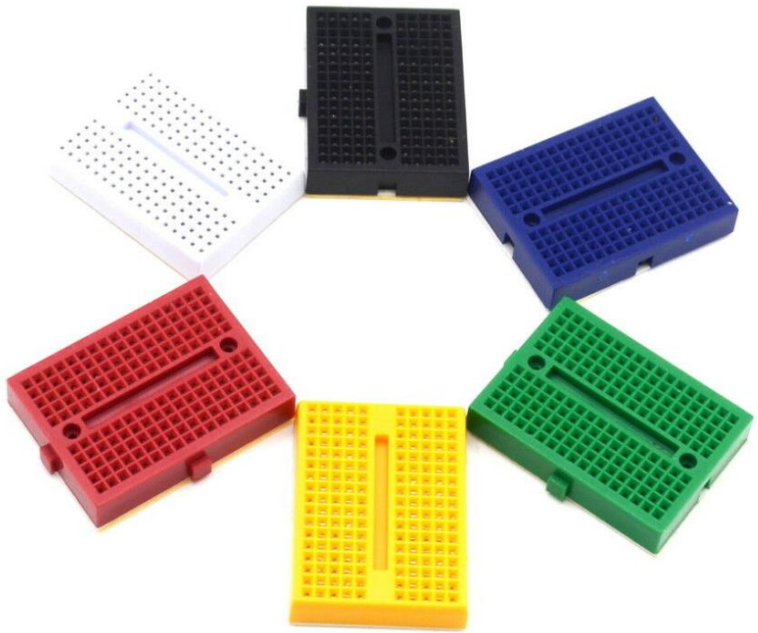
Additional Hardware

- In-Circuit emulators
- Oscilloscope

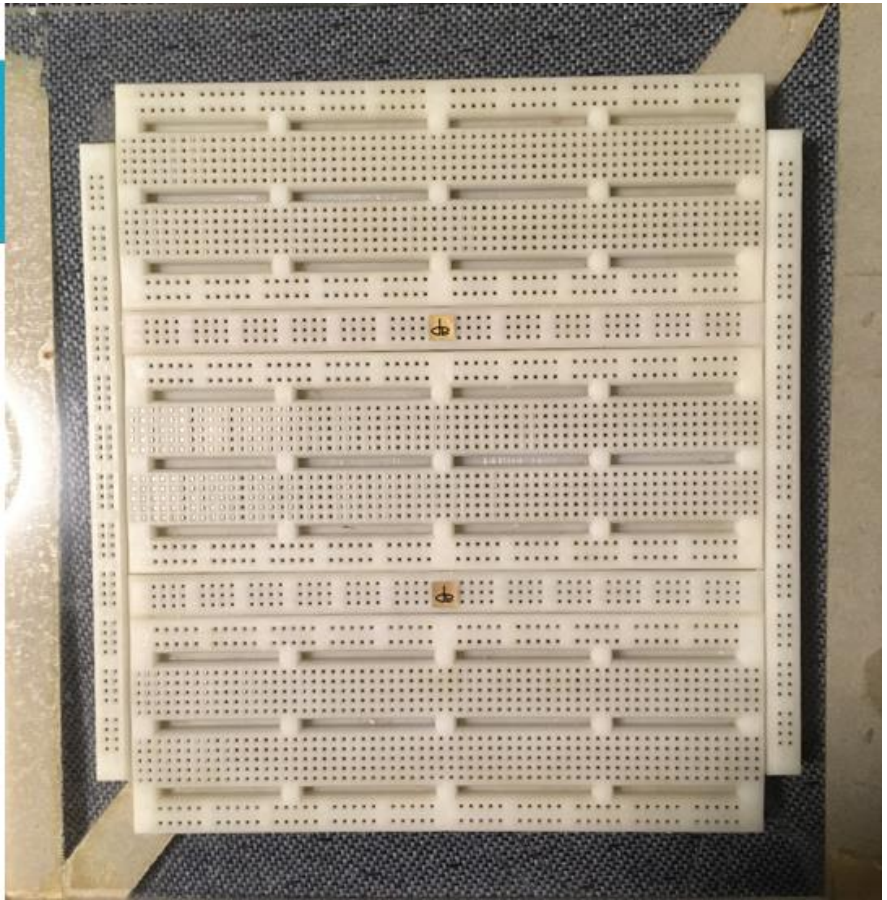
Breadboards

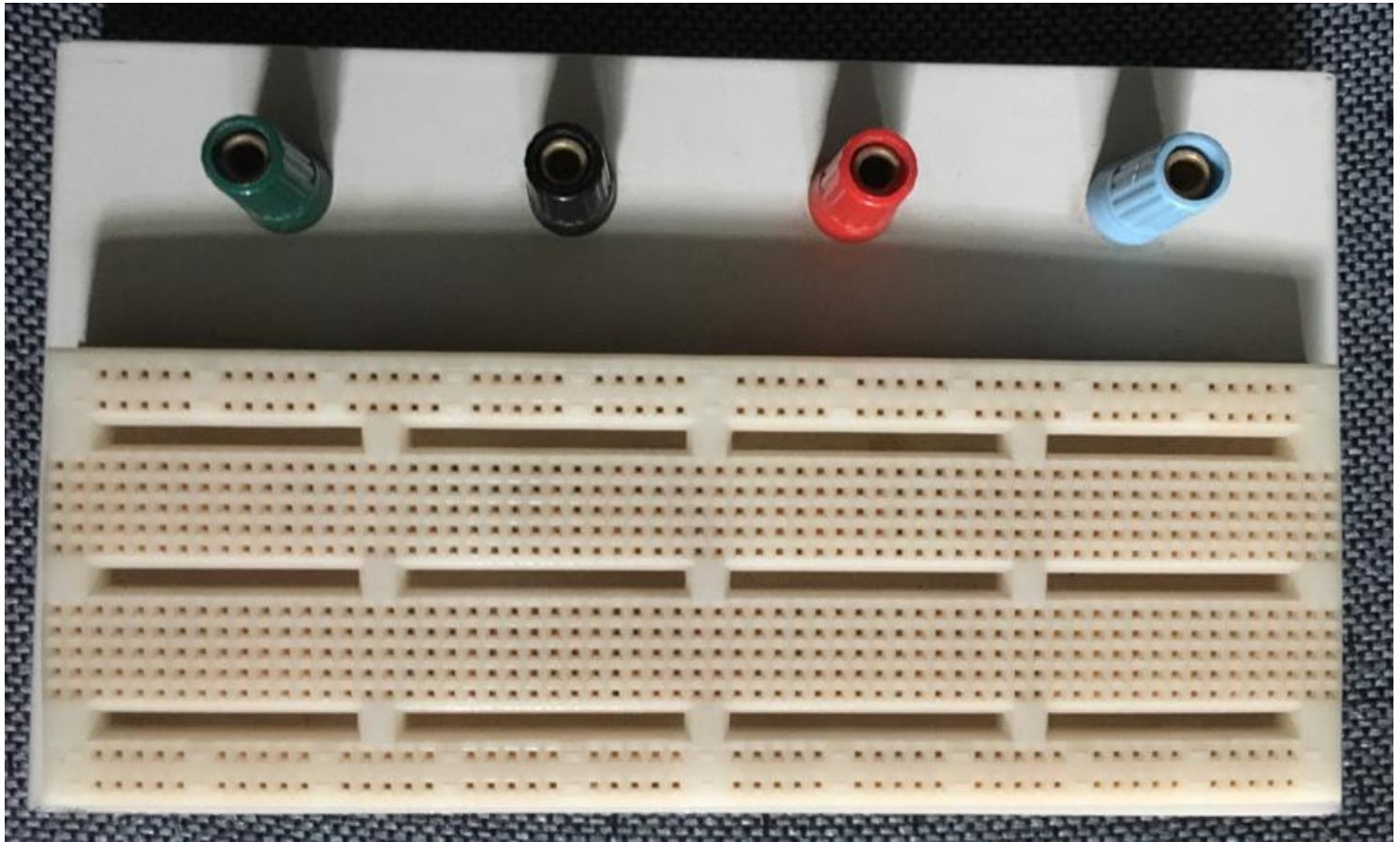




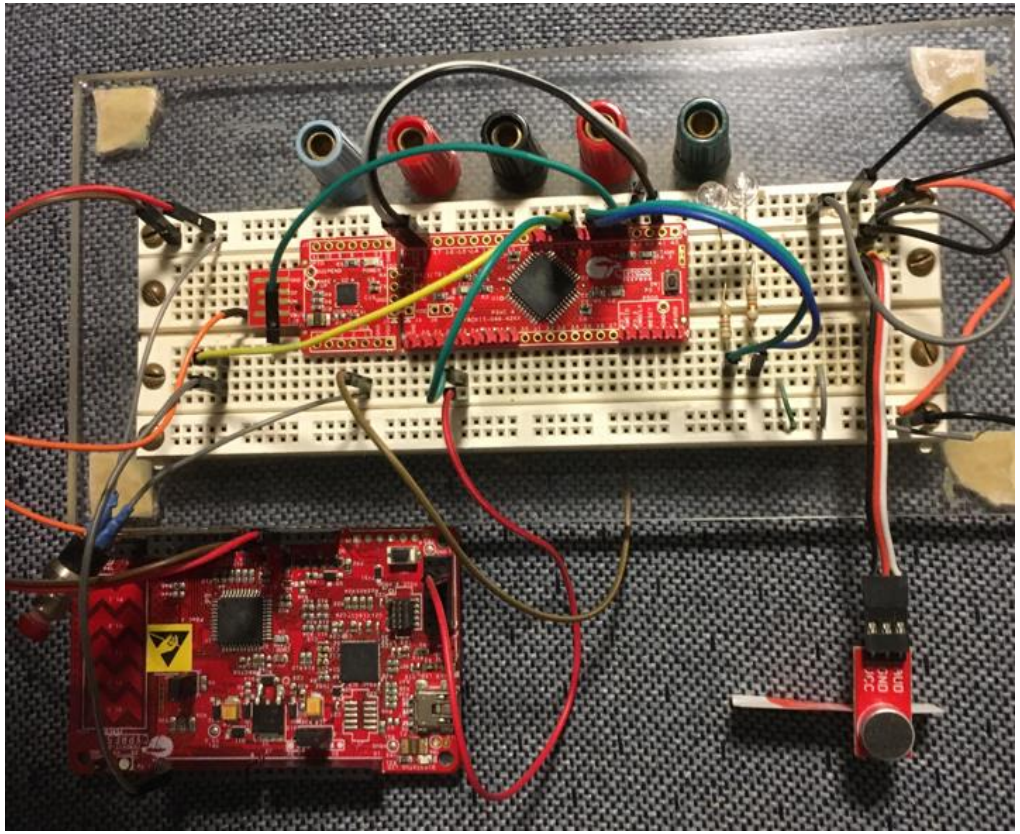


Breadboards
Home Made

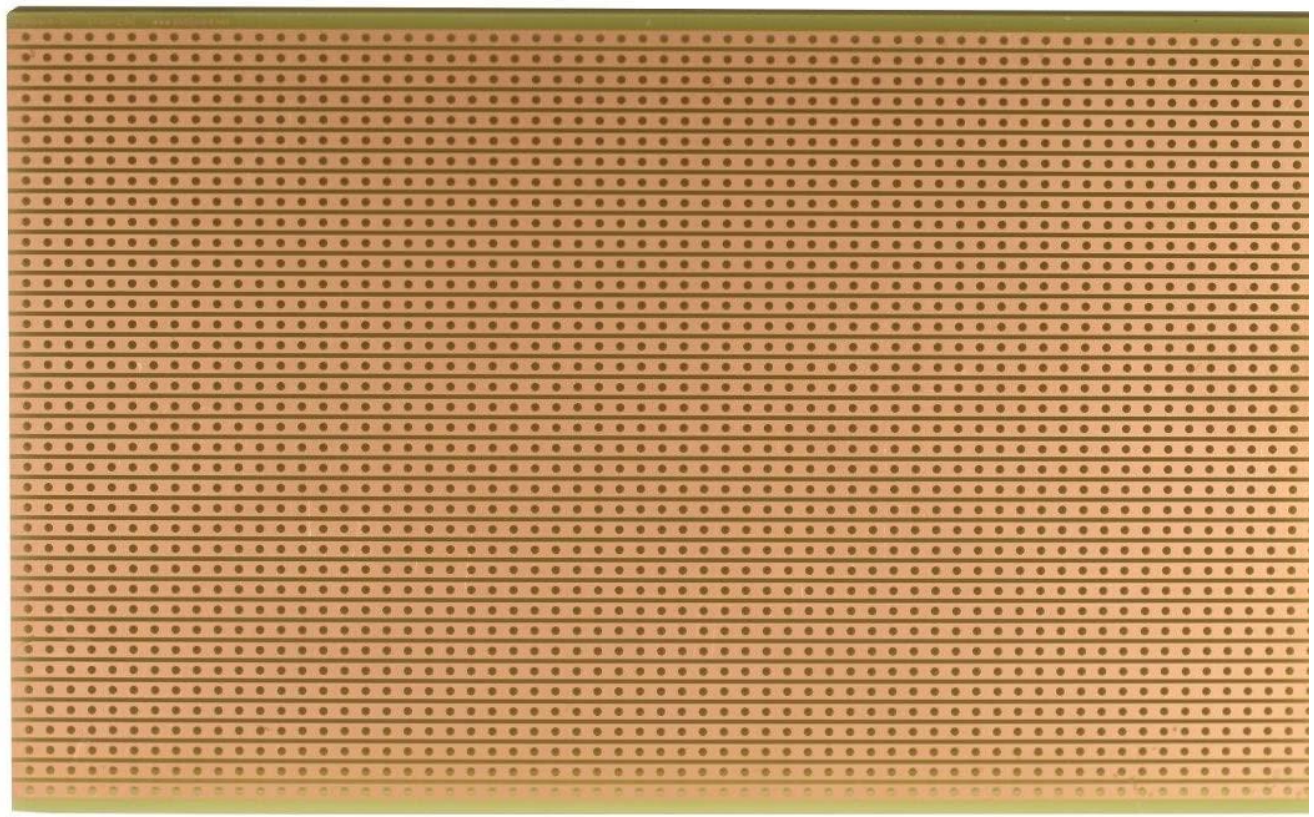


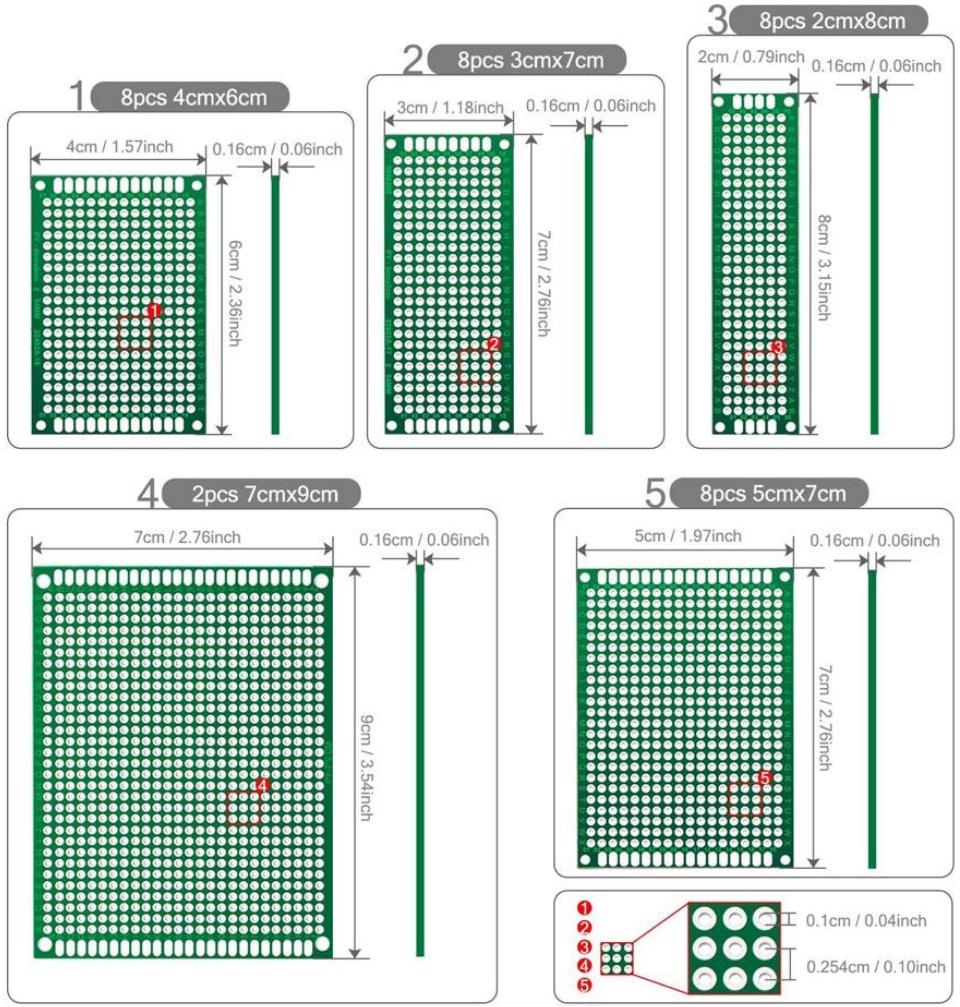


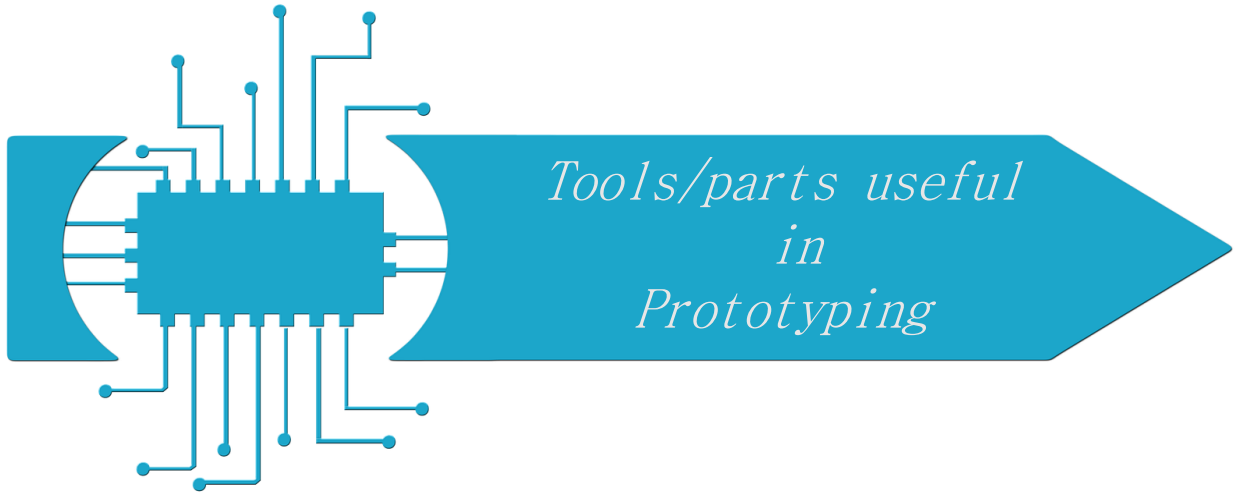
Breadboard
Jumpers, Precut wire



Prototype PCB







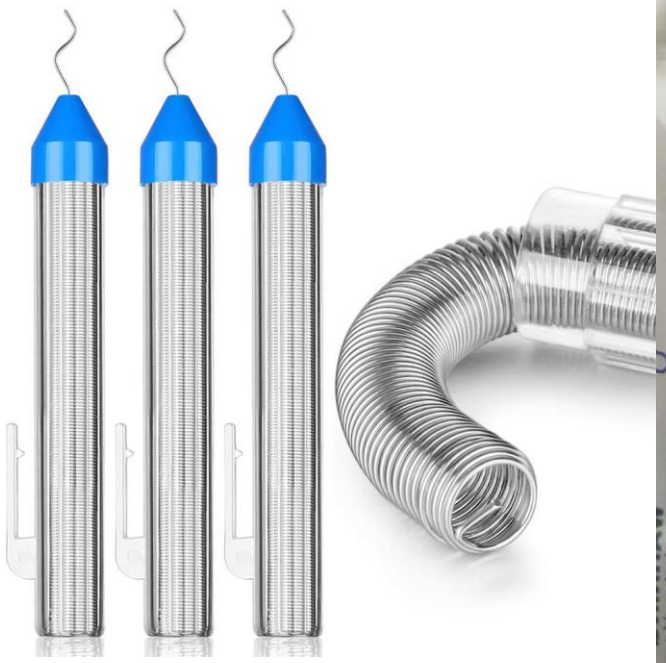
Tools & Components

- Wire wrapping, wire & gun
- Soldering, temperature control
- Headers
- Connectors
- DC power supply, USB, Battery
- Examples

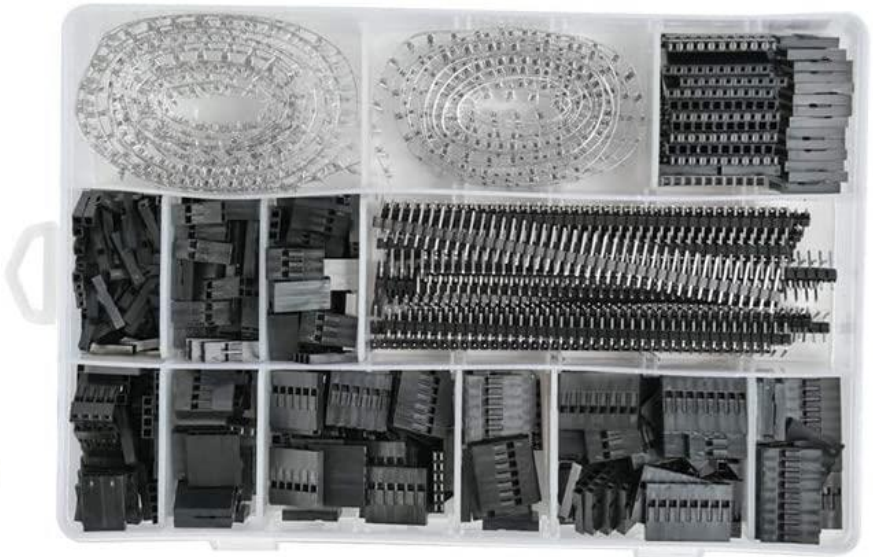
Breadboards
Wire Wrapping
Tools

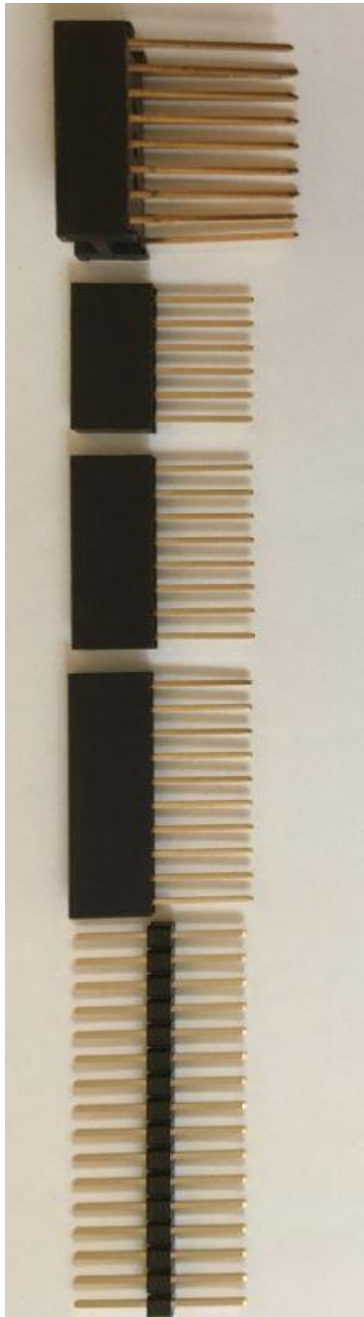
3 in 1 function, it can wrap, strip and unwrap the wire, practical to use.

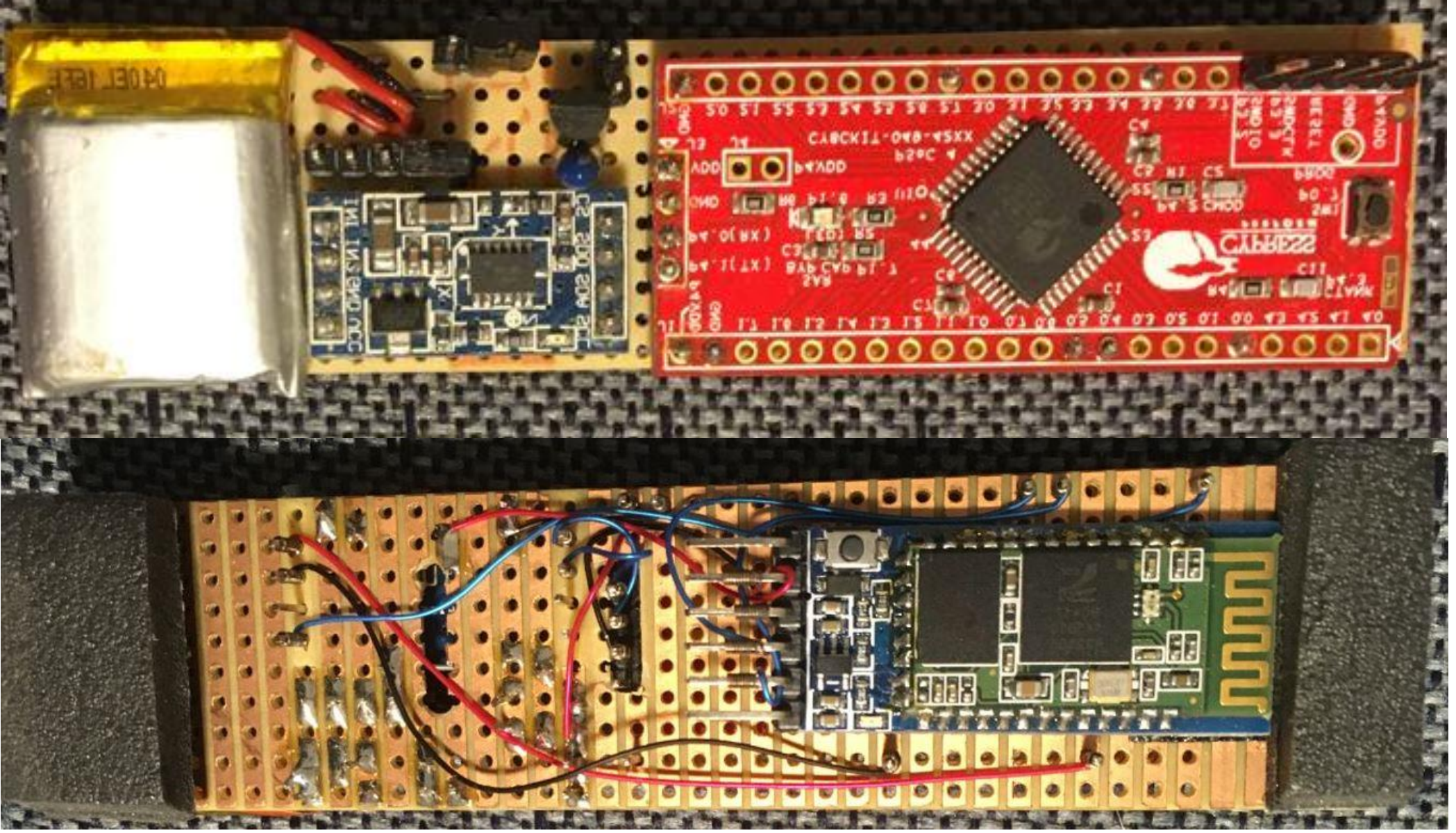
PCB Boards Soldering Tools



PCB Board Connectors, Headers

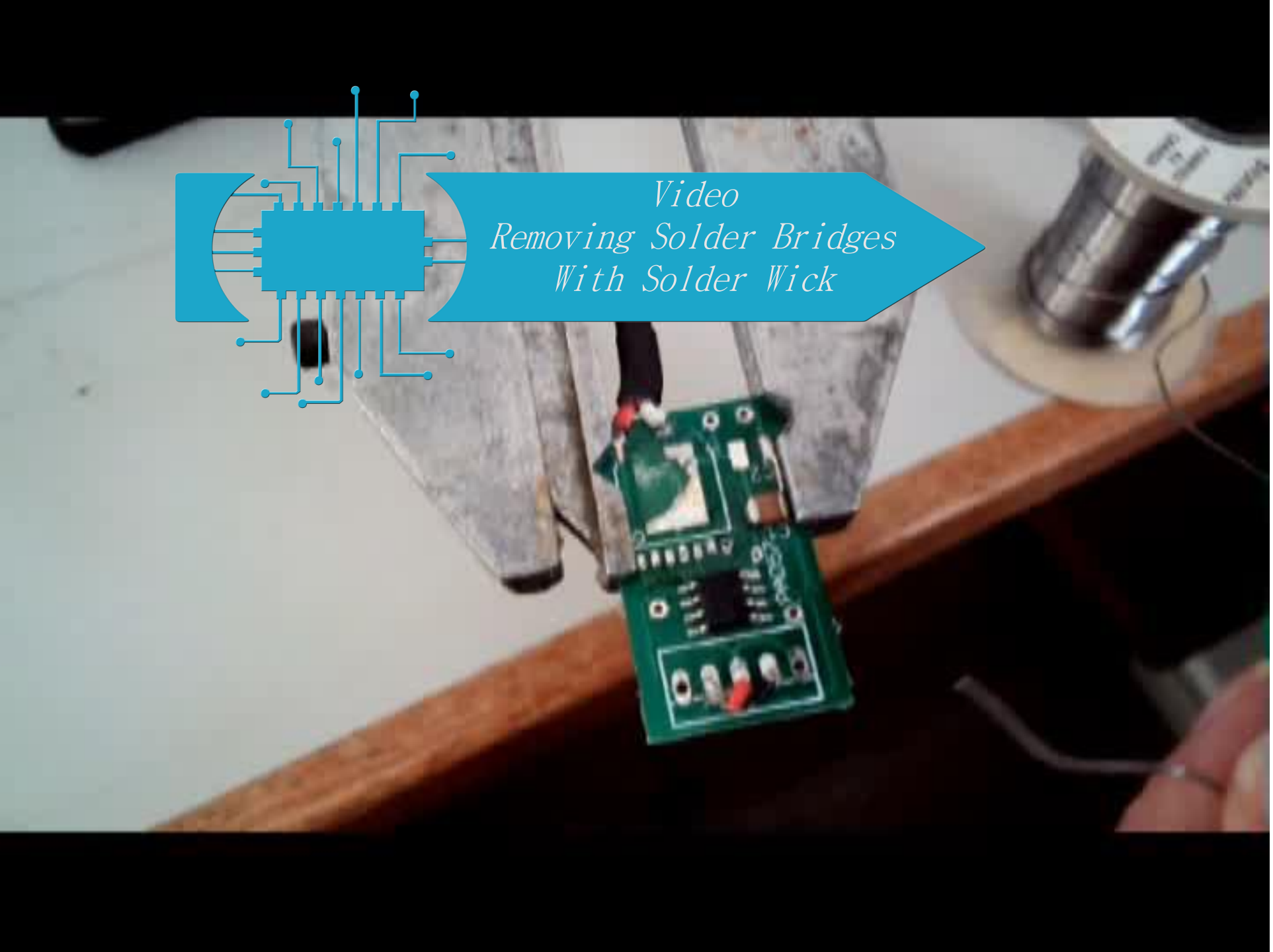


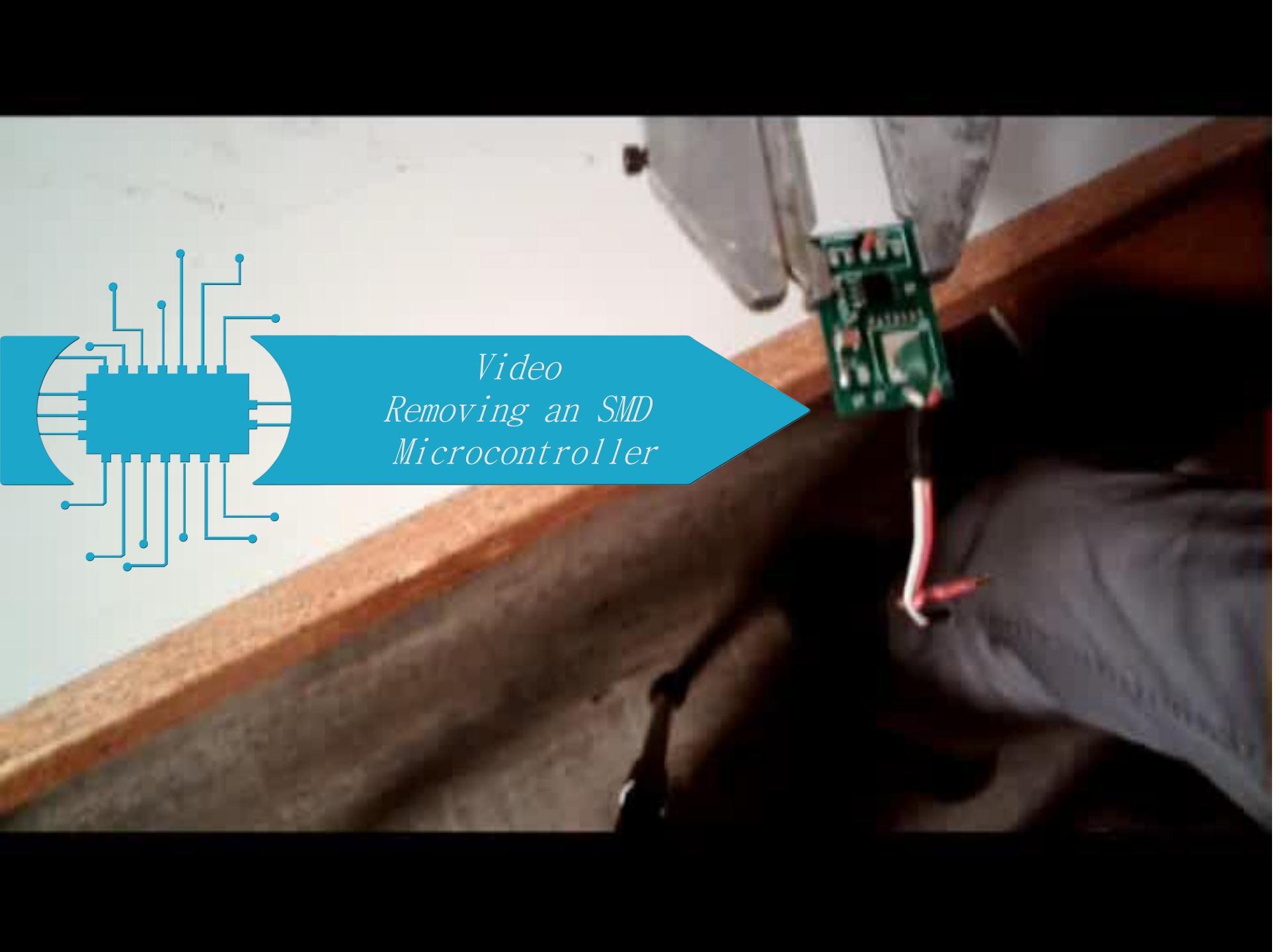


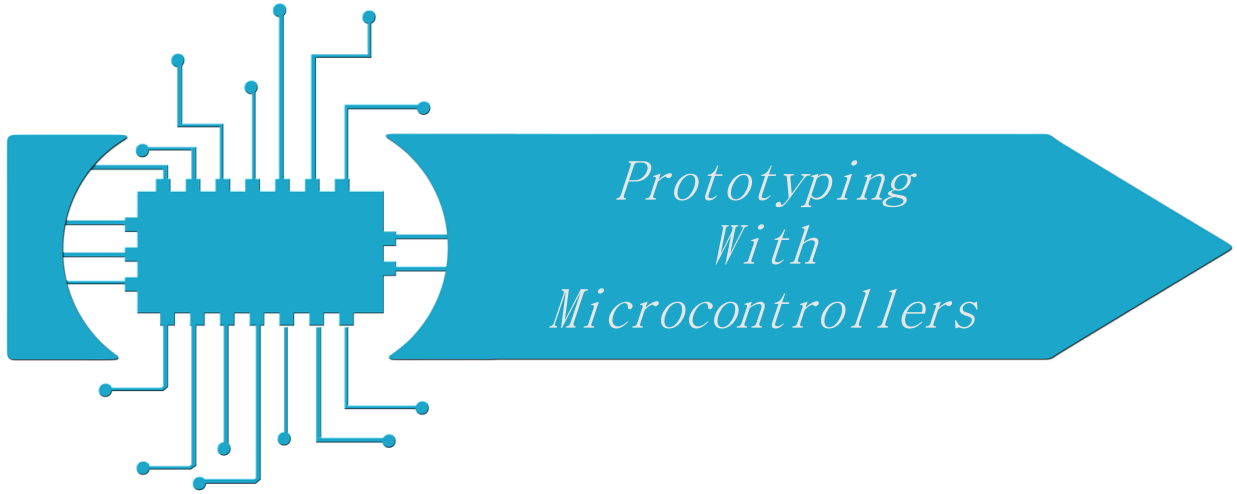


Prototypes using wire wrap


Rework Hot Gun
GJ-8018LCD
TEMPERATURE-CONTROLLER
COOLING DOWN
30" AFTER USE
O.C
PASSED
HEATER
AIR
Used for removal/soldering of SMD devices


Video
Removing Solder Bridges
With Solder Wick


Video
Removing an SMD
Microcontroller

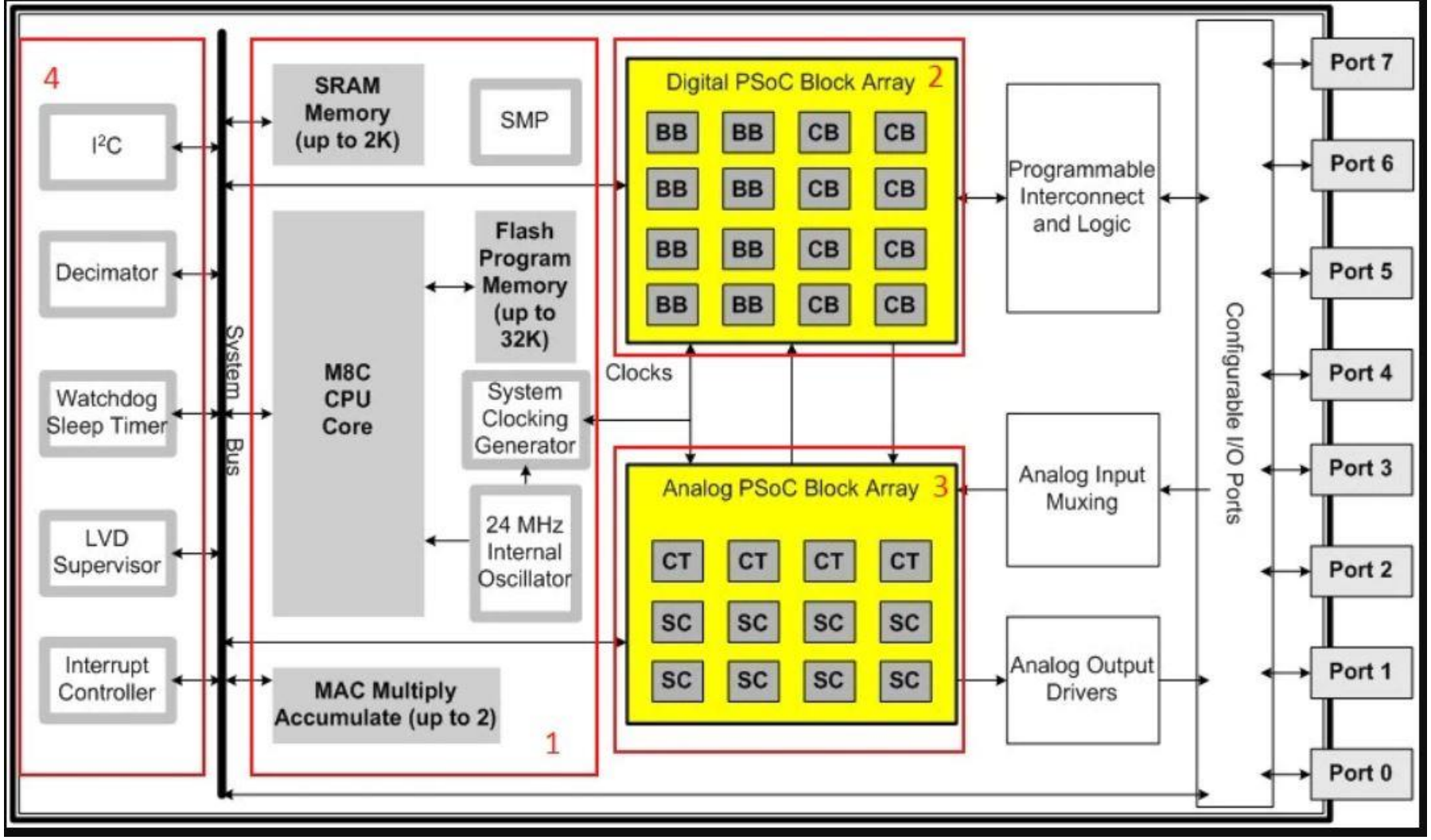


Microchip

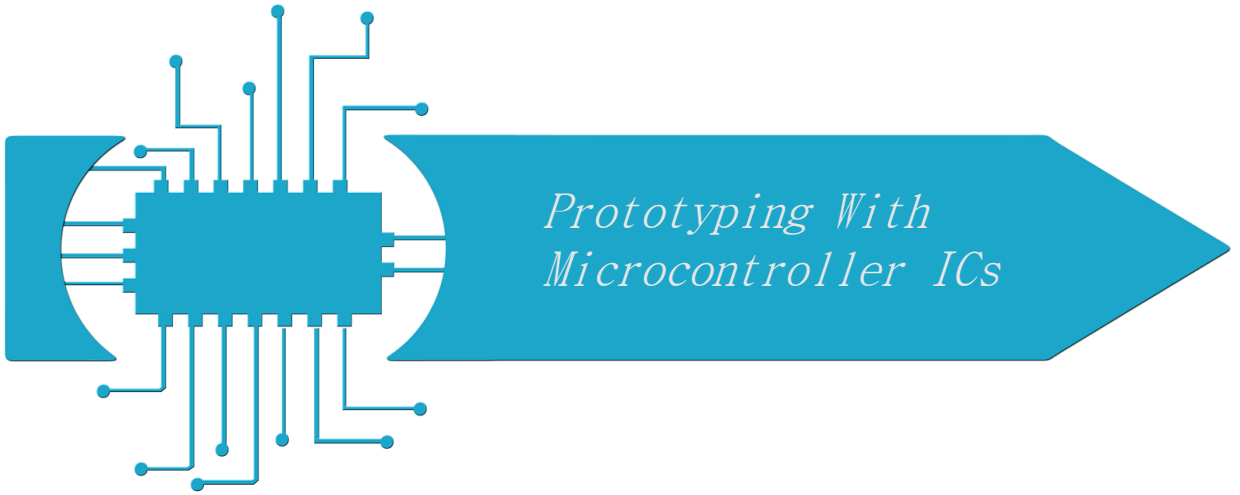
PRODUCT	STATUS	5K PRICING	PROGRAM MEMORY SIZE (KB)	
ATtiny102	In Production	$0.43	1	**ATTINY102-SSNR $0.96**
ATtiny104	In Production	$0.47	1	
ATmega324PA	In Production	$2.91	32	
ATmega324PB	In Production	$1.30	32	

Cypress Microcontrollers-five different families of devices, each based around a different microcontroller core:

- PSoC 1 — CY8C2xxxx series — M8C core. Family of 12 with 106 devices
- PSoC 3 — CY8C3xxxx series — 8051 core.
- PSoC 4 — CY8C4xxxx series — ARM Cortex-M0 core. Family of 2 with 23 devices.
- PSoC 5/5LP — CY8C5xxxx series — ARM Cortex-M3 core. Family of 4 with 16 devices
- PSoC 6 — CY8C6xxxx series — ARM Cortex-M4 core with an added ARM Cortex-M0+ core
- Family of 4 with 14 devices.



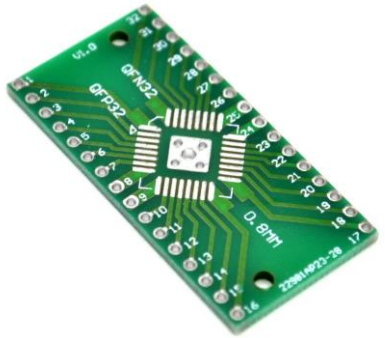
Cypress PSoC 1 Architecture with Digital and Analog Block
Analog: ADC, amplifiers, muxes, comparators, DAC
Digital: functions (too many to list), logic(25),registers



Why Prototype With Microcontroller ICs ?

- Best choice for custom projects
- Pinout can match project requirements
- Reduce physical size
- Choice of current and voltage
- Project can spin other projects
- Leads to custom PCB project or new product

Prototyping with Microcontroller

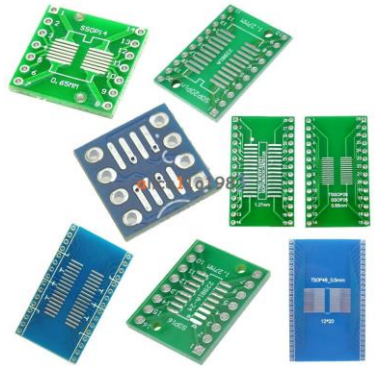


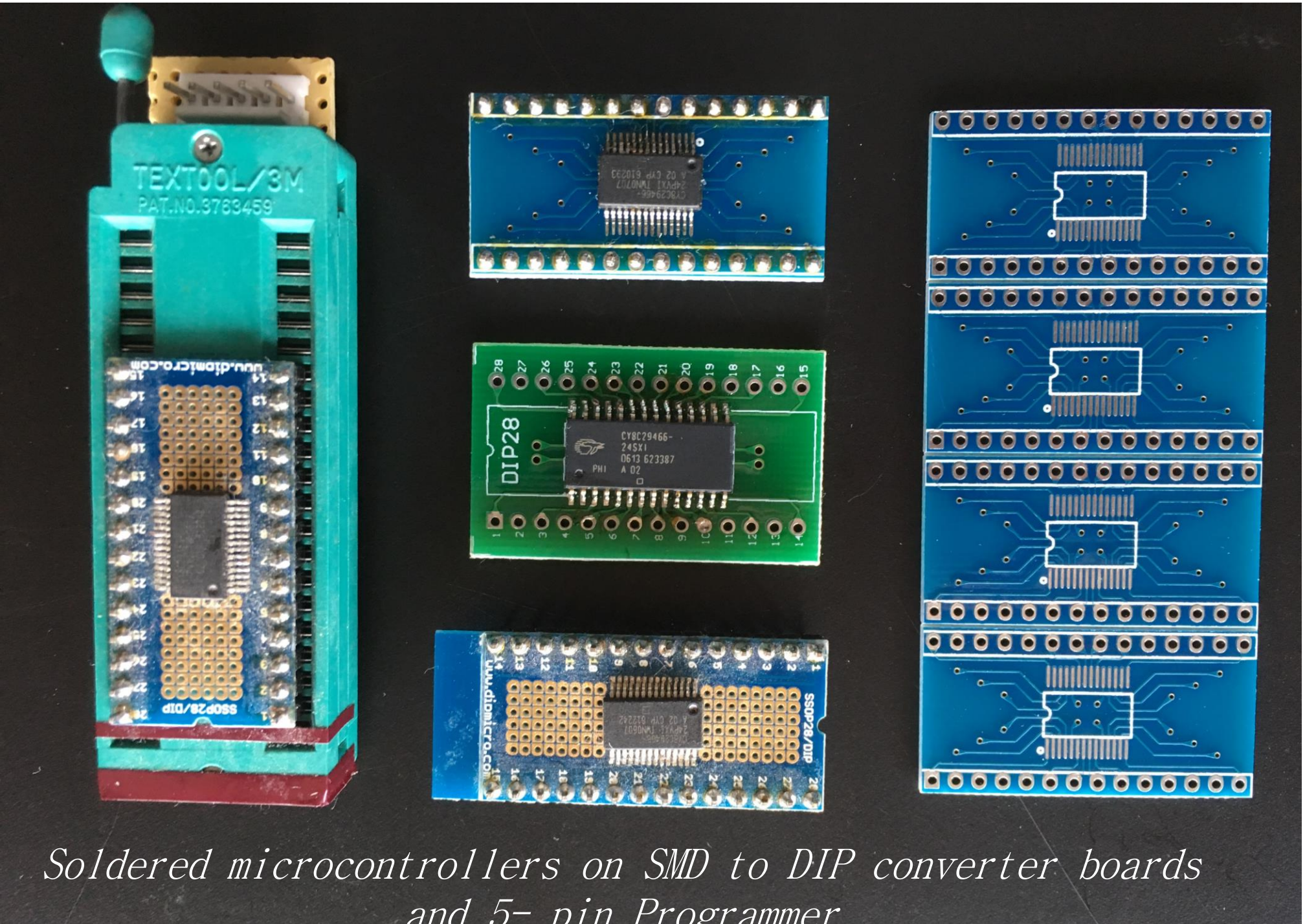
DIP Microcontrollers

- Solder/wire wrap Sockets
- Almost obsolete
- Expensive

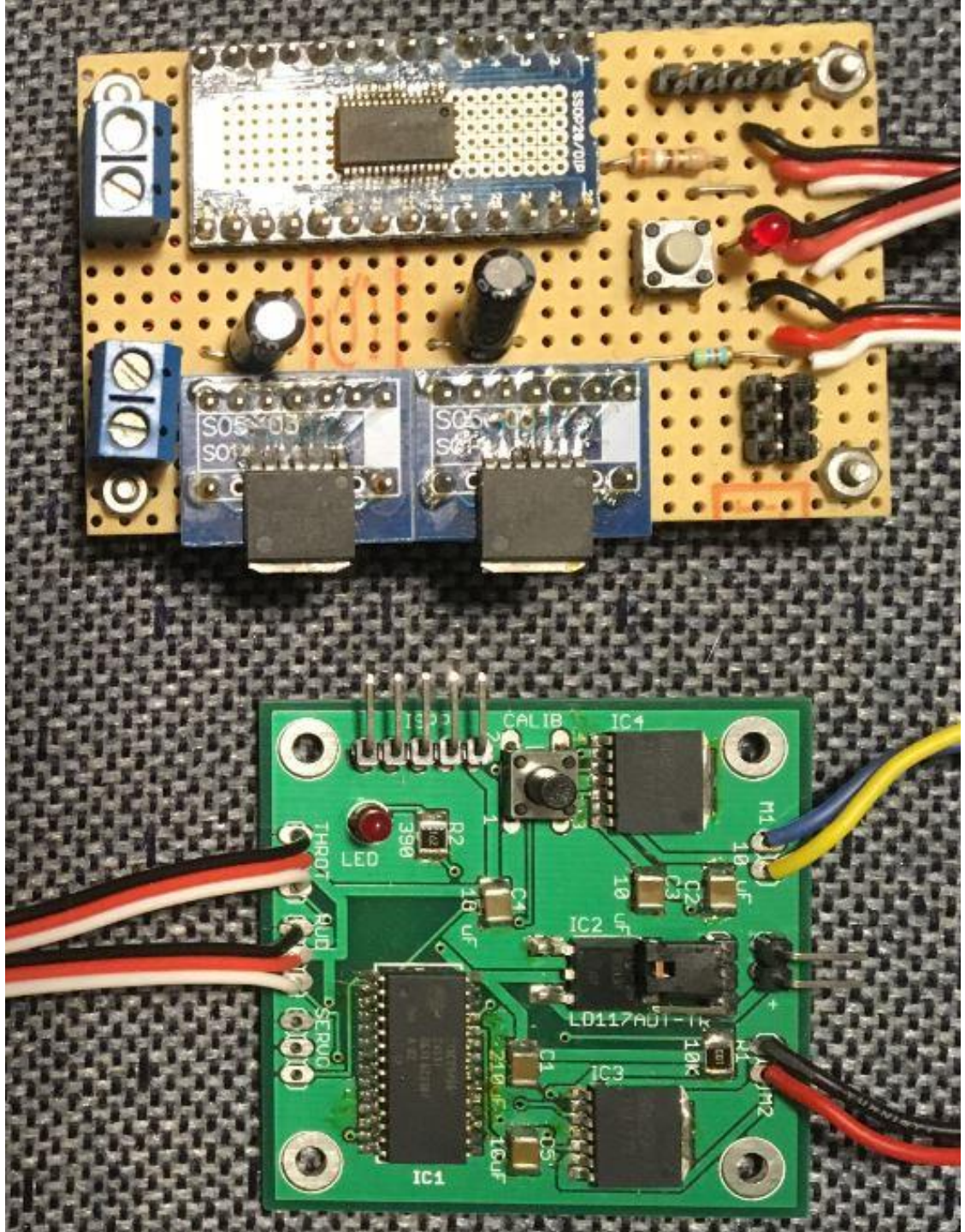
SMD Microcontrollers

- DIP Breakout Converter Boards
- Match Microcontroller Foot print
- SOP, SSOP, DFN



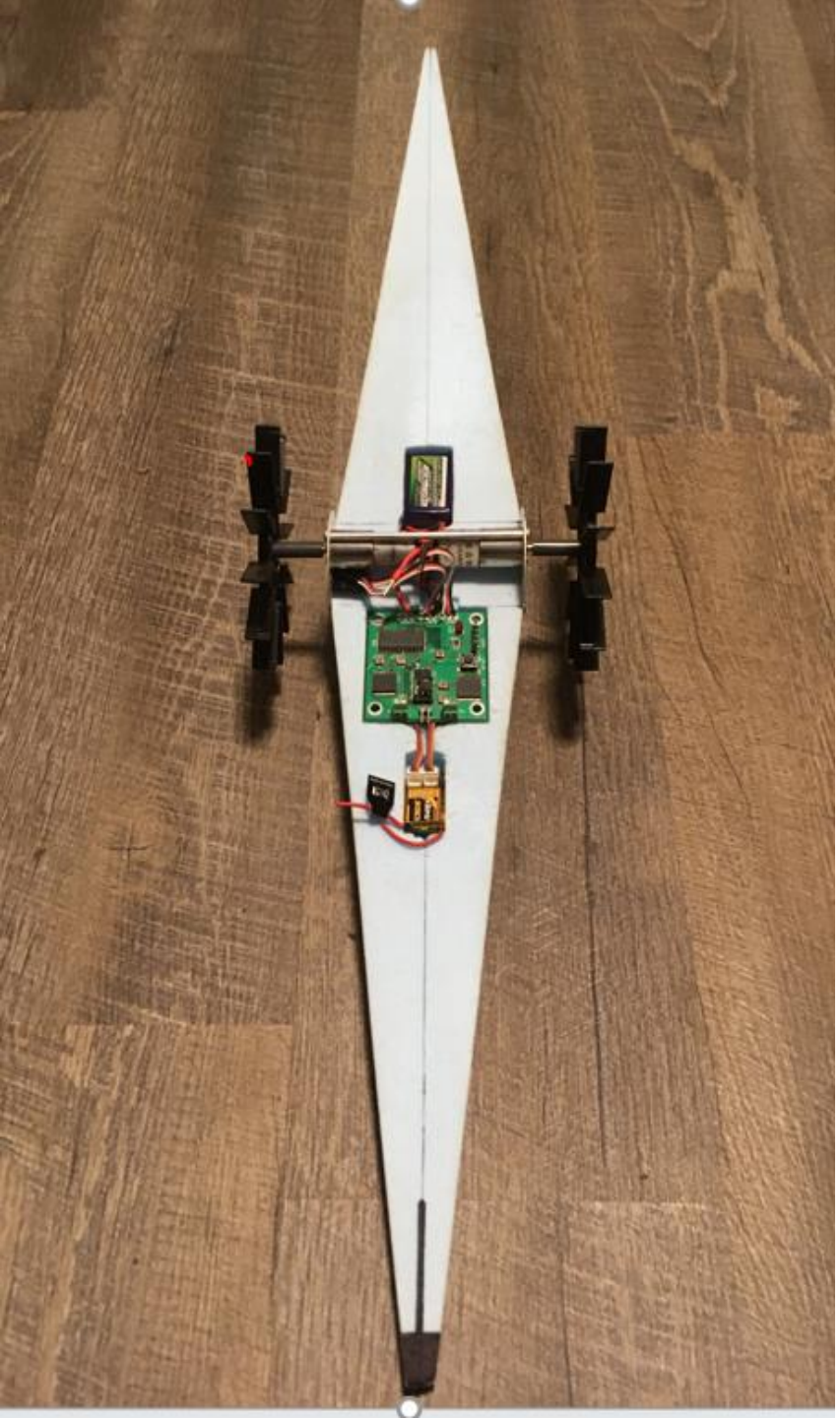


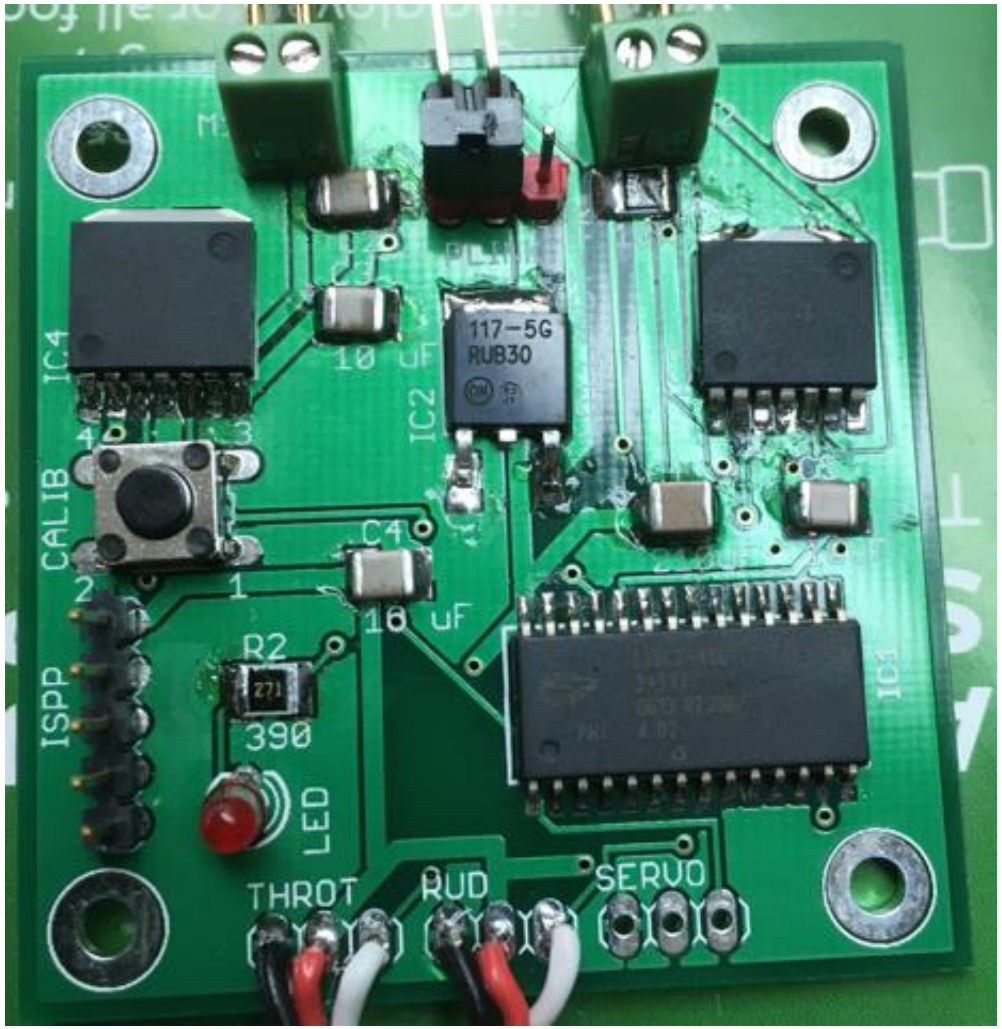
Soldered microcontrollers on SMD to DIP converter boards and 5- pin Programmer



Prototype and Final on PCB

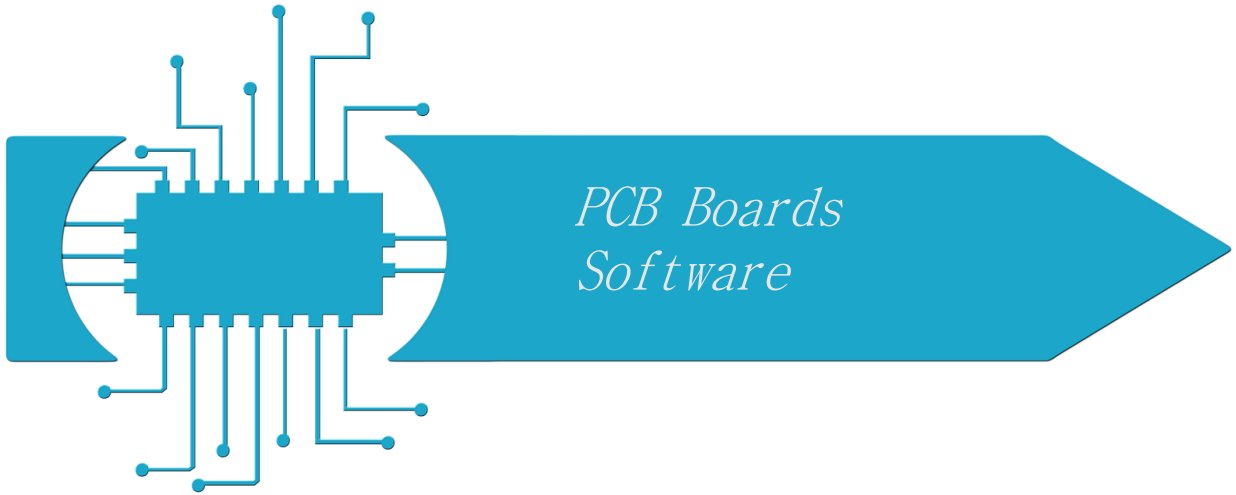
- *Two channel motor speed controller*



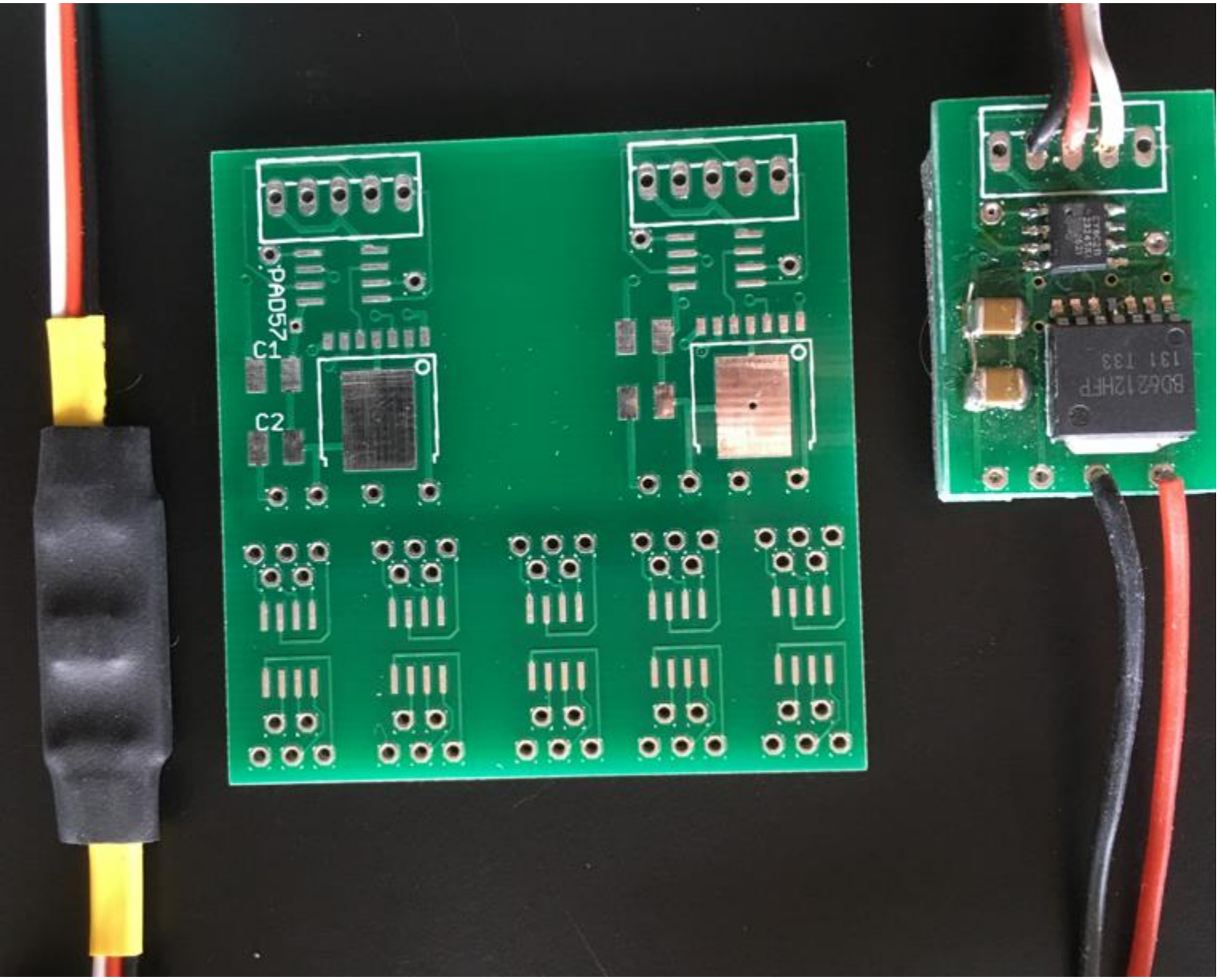


Two Channel RC DC Motor Controller Used on

- *experimental racing craft (right)*
- *Turns executed by slowing/stopping one paddle wheel*

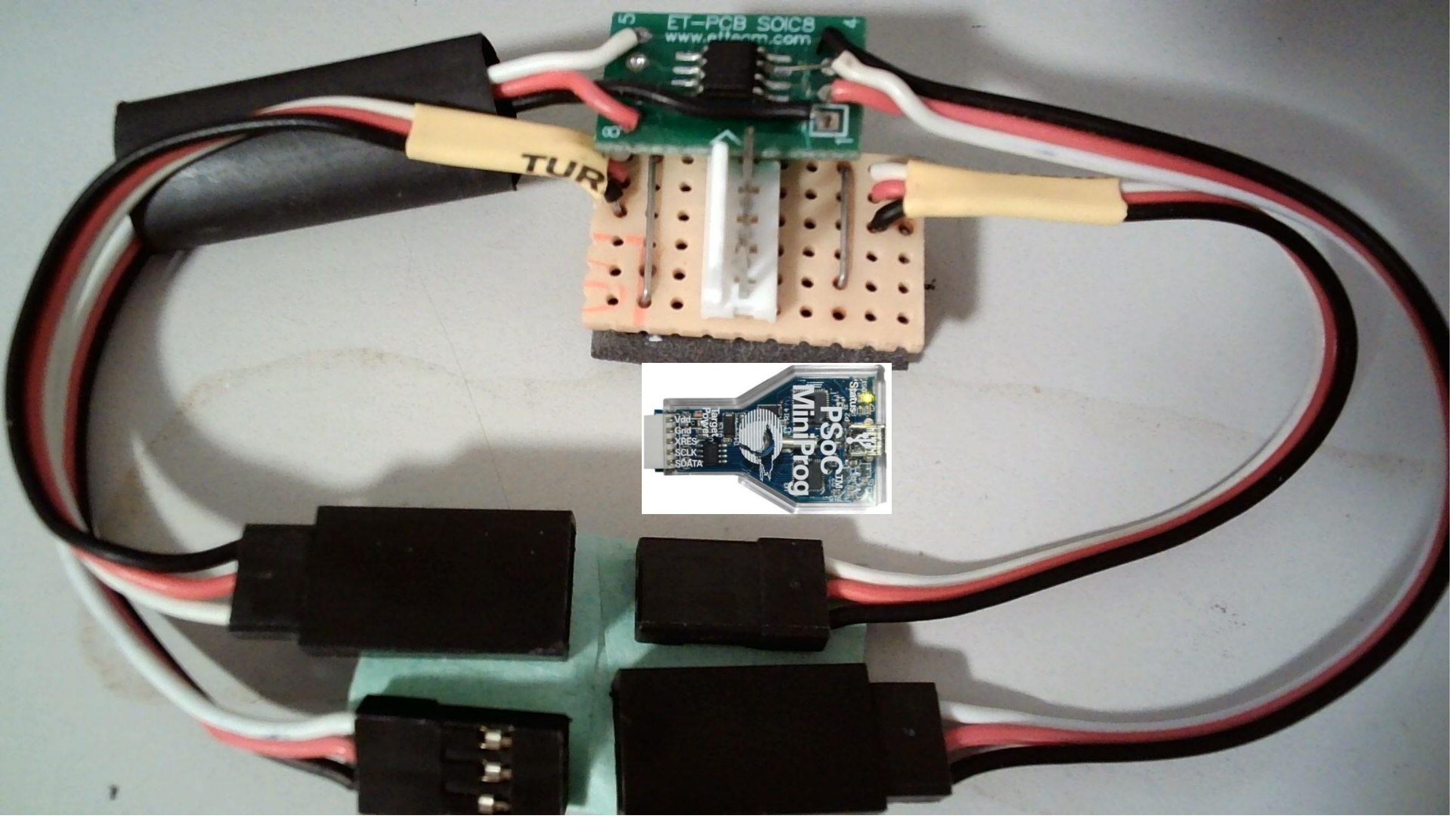


- *Eagle PCB Software*
  - *Free for board size 3.94 x 3.15*
  - *Larger boards licence required*
  - *Free Sparkfun library*
- *KiCAD PCB Software*
  - *Footprints for Digikey components*
  - *No auto router - added in near future?*



Eagle PCB x1

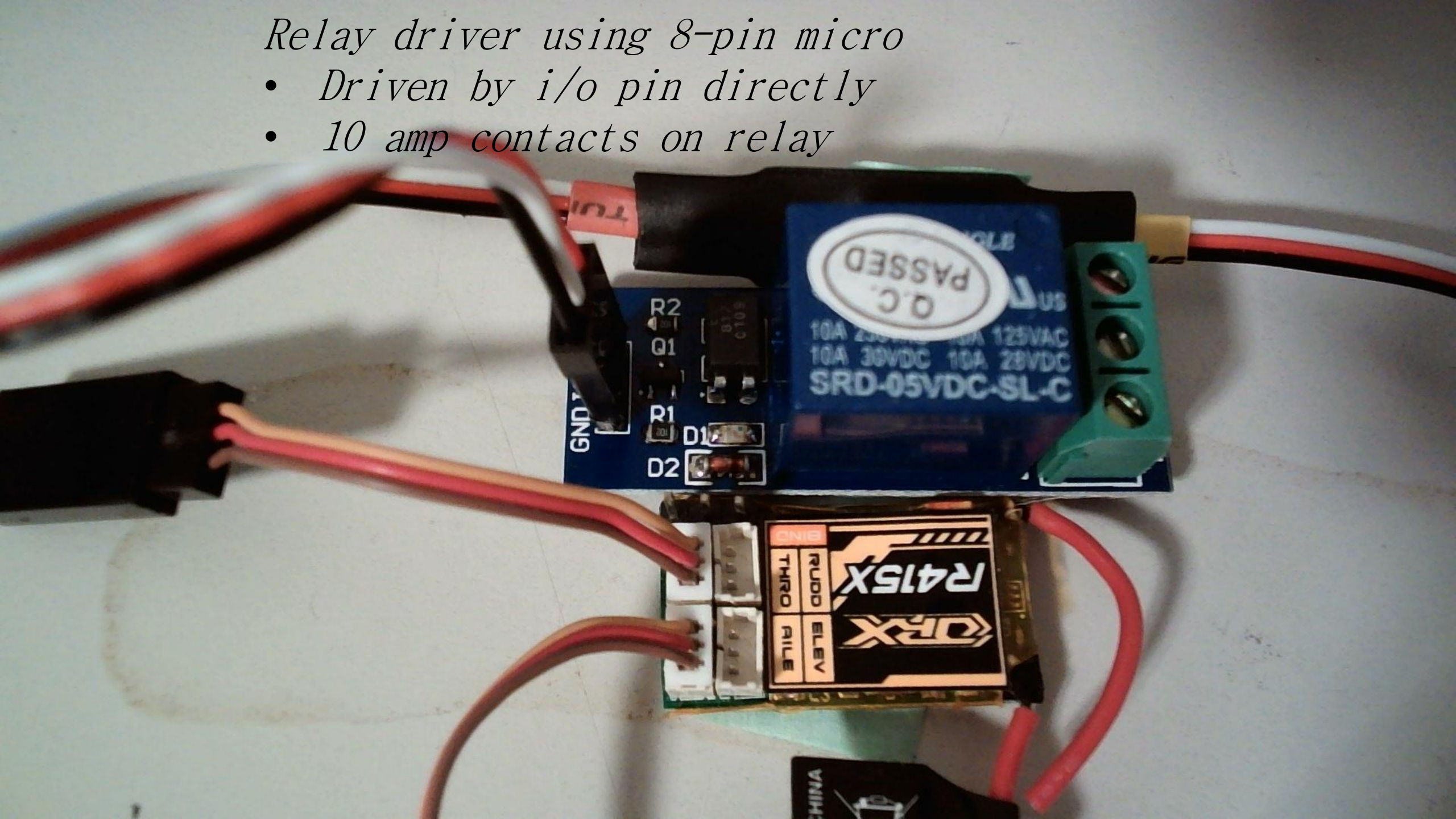
- *two layouts - seven boards*
- *X10 ⟶ 70 boards for $50*



Programmer for soic 8-pin microcontroller

Relay driver using 8-pin micro

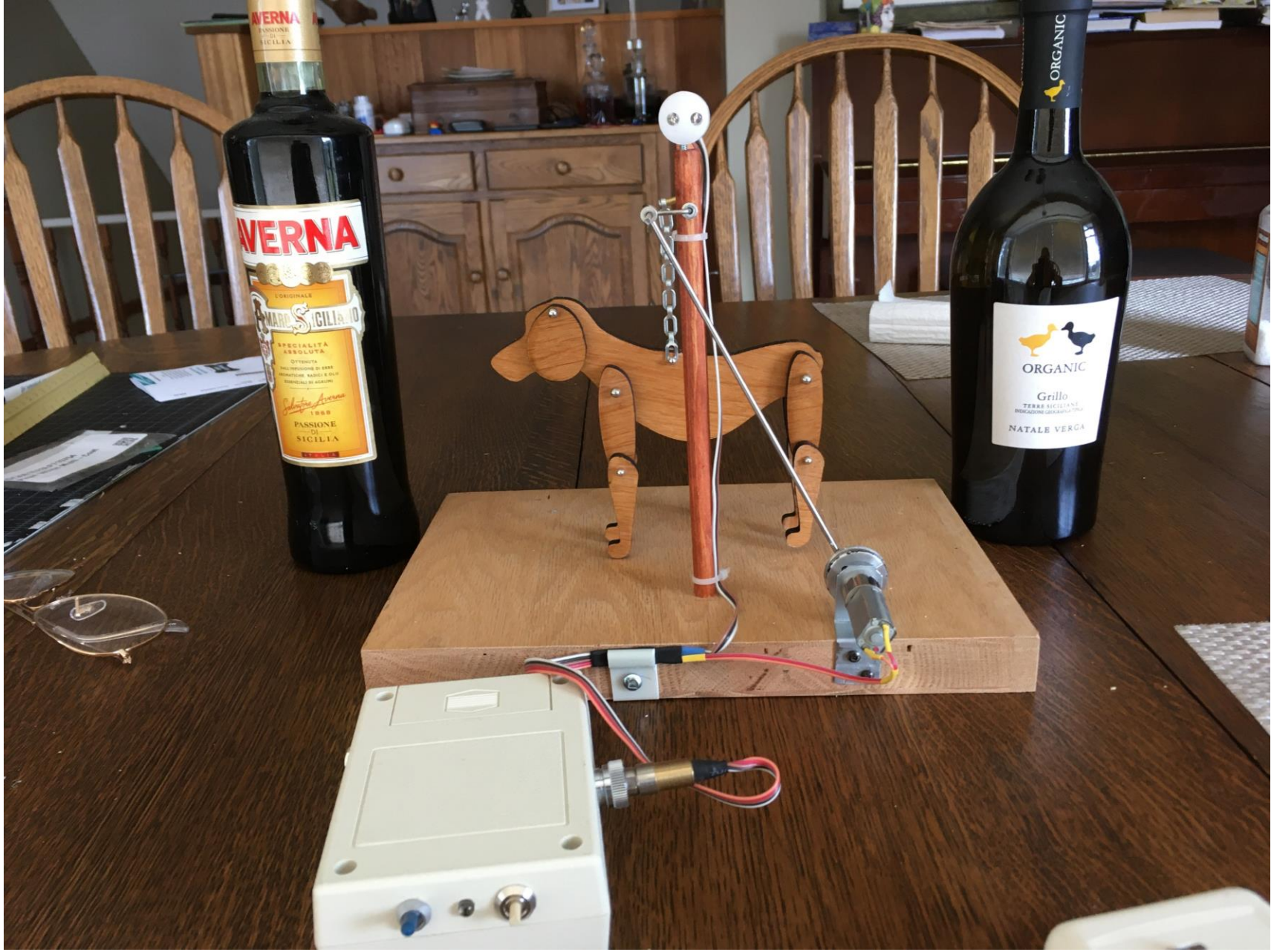
- *Driven by i/o pin directly*
- *10 amp contacts on relay*



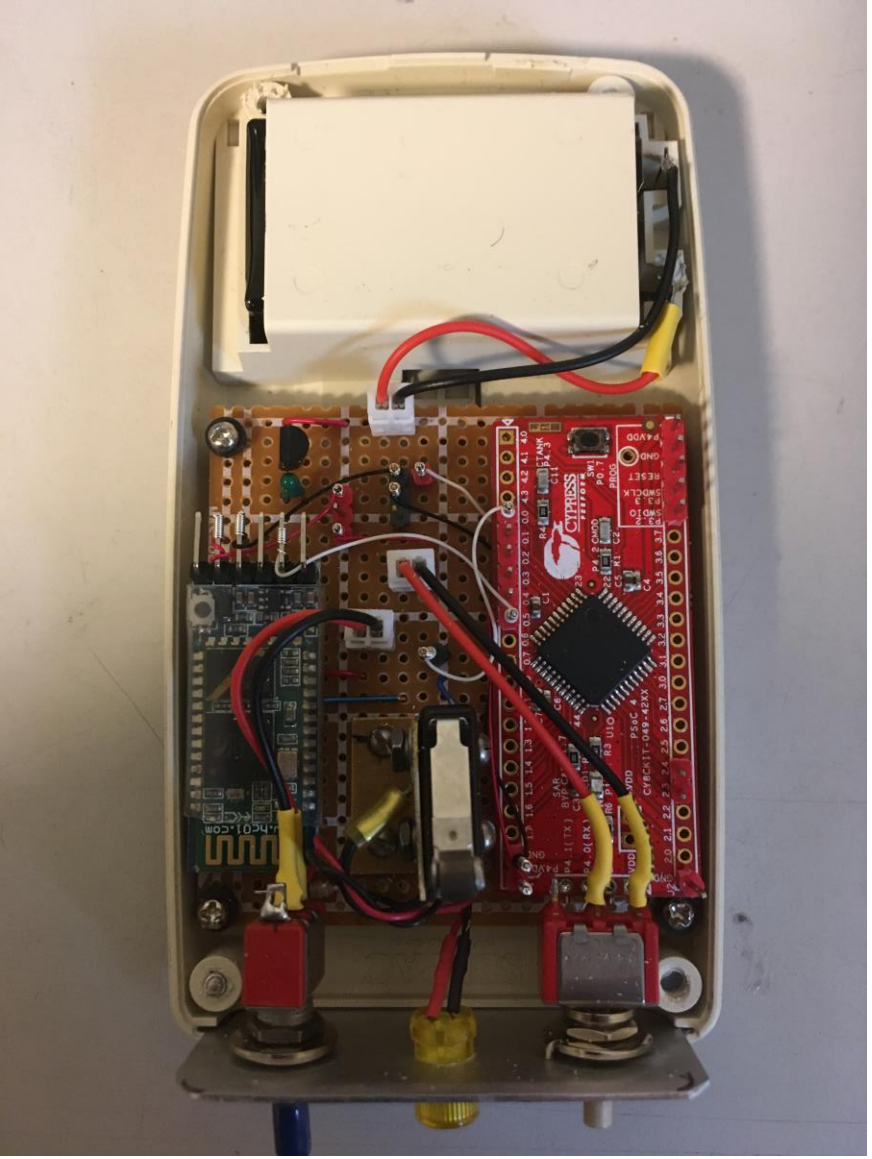
Video showing speed of a standard rc servo (2 ms)

Video reducing the speed of a rc servo

- *using 8-pin micro to reduce speed to 8 sec*

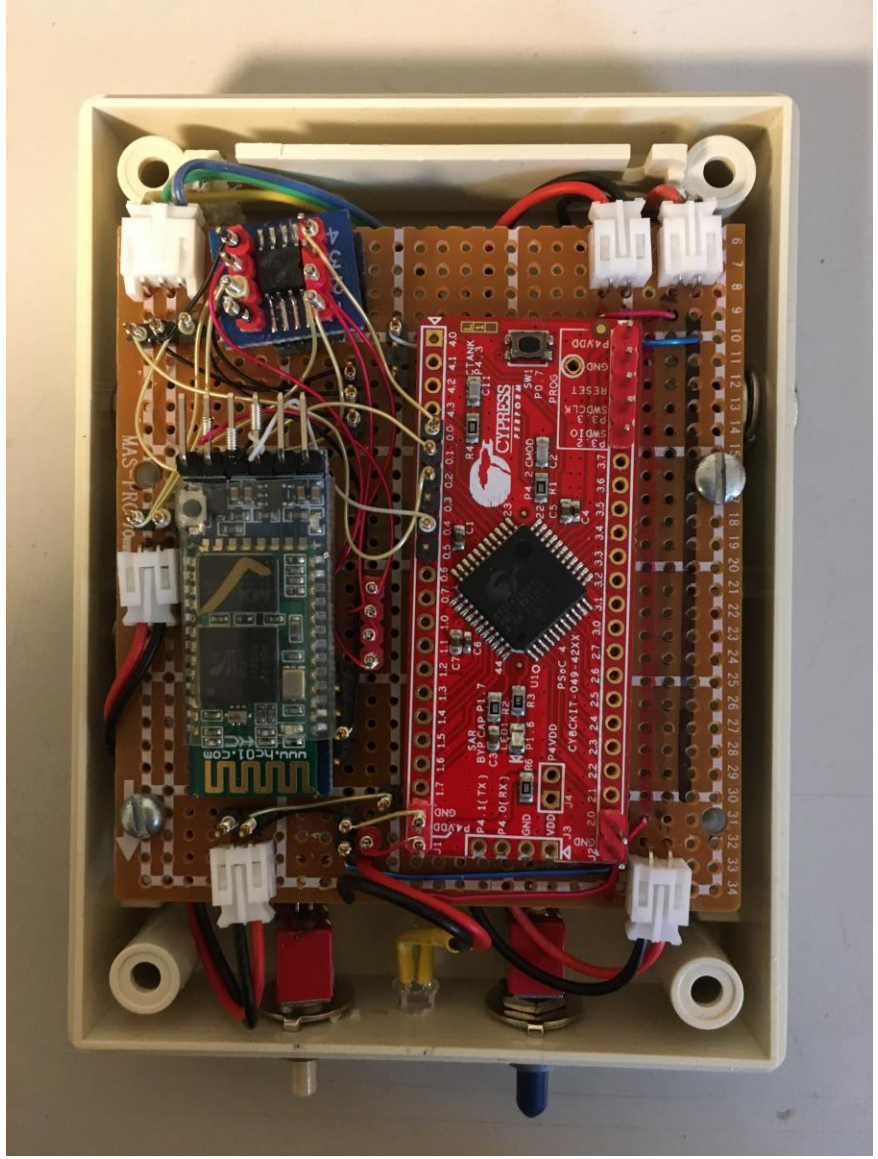


Articulated toy dog programmed to respond to a rhythm of 40 to 100 bps



Rhythm Unit (PSoC 4 microcontroller)

- *Beat set by switch/foot petal/mic*
- *Data linked to actuating unit via Bluetooth*



Actuating Unit: (PSoC 4 microcontroller)

- *Rhythm converted dc motor drive voltage*

Video of running dog

- *Blue/red LED indicators*
- *Flashing LEDs: error*

For Eileen

END