Embedded Computer Design

(DISEÑO DE COMPUTADORES EMPOTRADOS)

Course 2017/18

Getting Started with Arduino

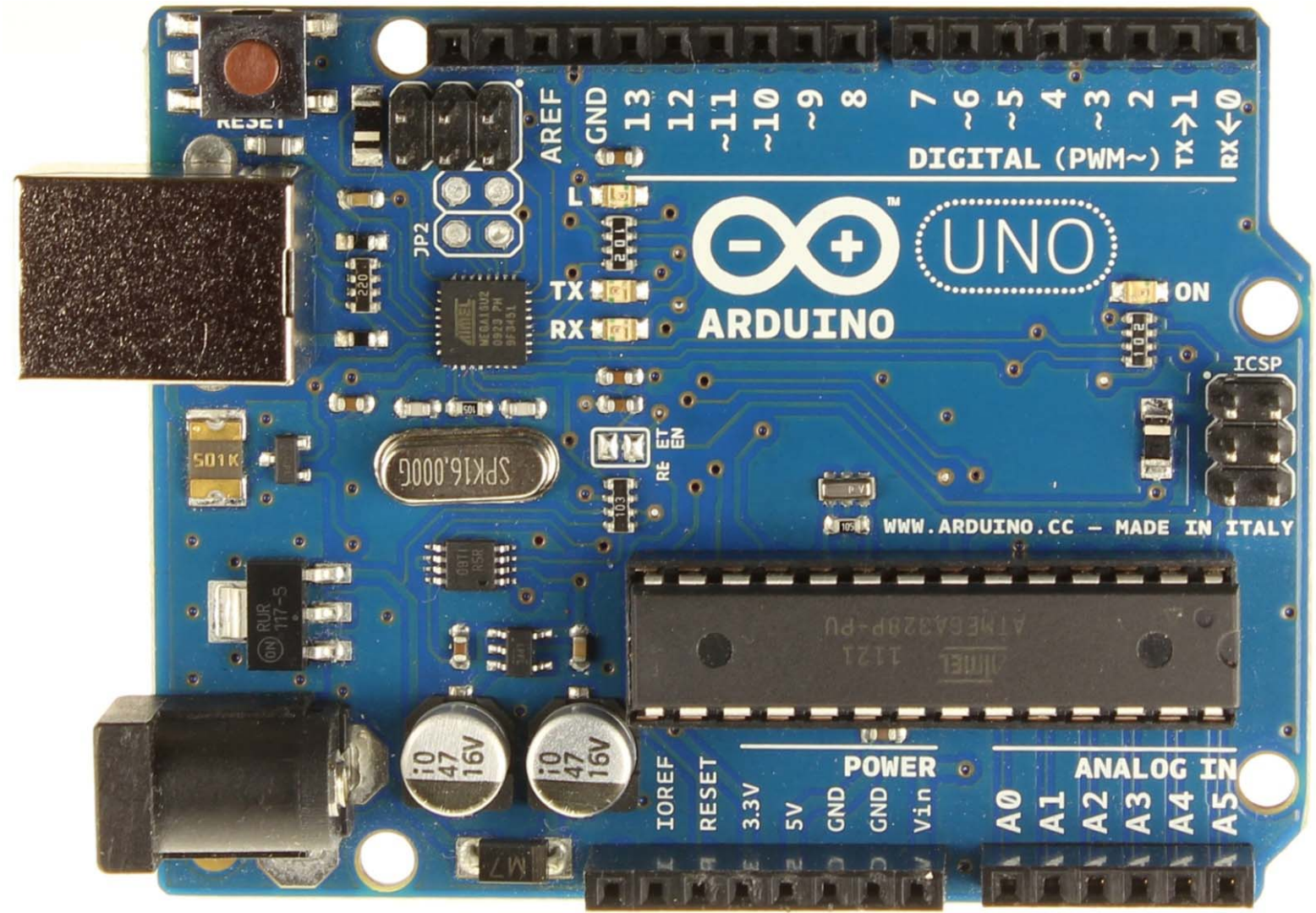
Professors:

- Arturo Morgado Estévez
- Mirian Cifredo Chacón

Computer Engineering Degree

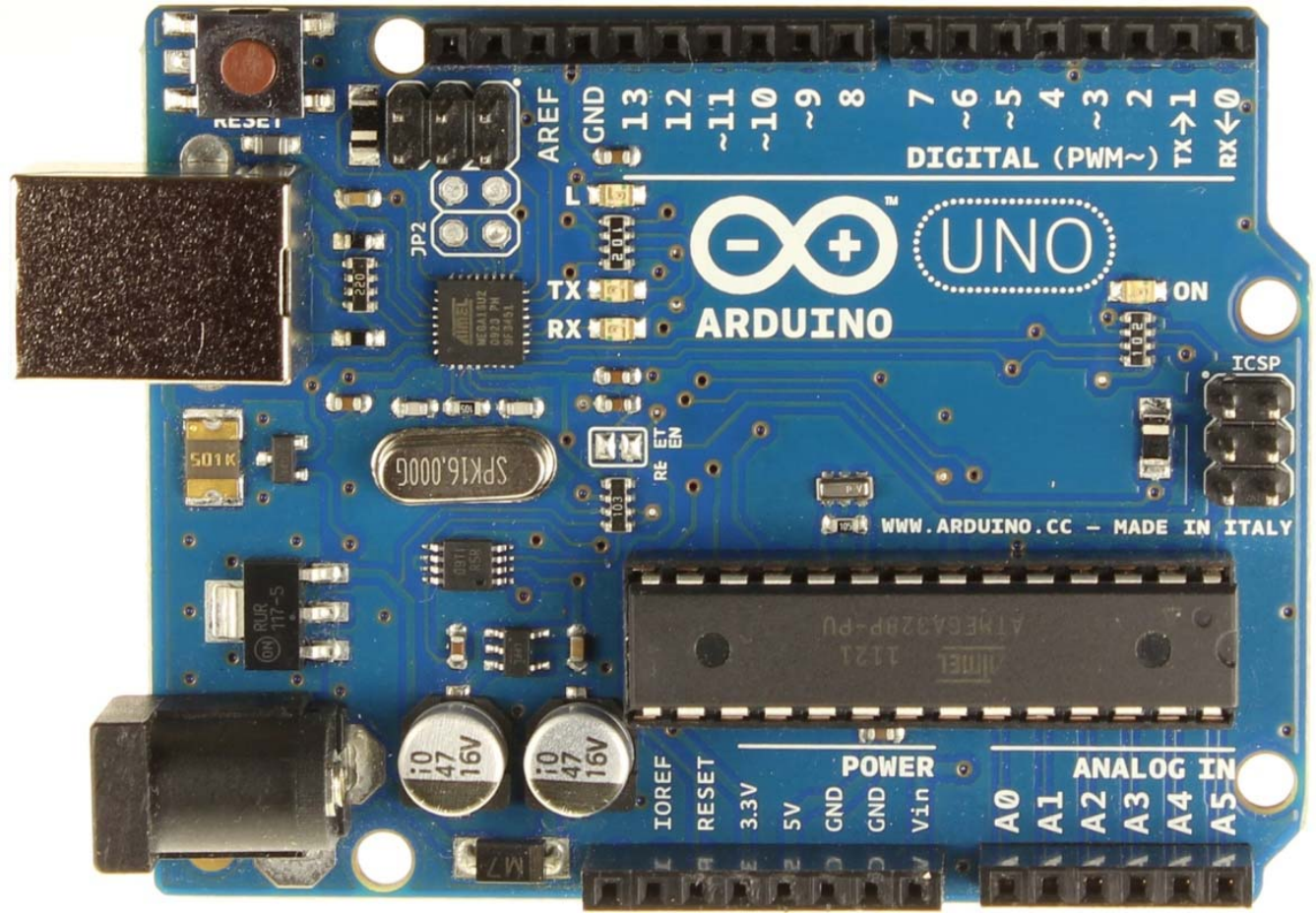
Getting Started with Arduino

- The website of Arduino.
  - http://www.arduino.cc/



Getting Started with Arduino

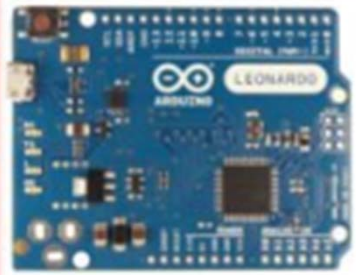
- Arduino Board.
  - Arduino is an **open-source prototyping platform** based on easy-to-use hardware and software.



Getting Started with Arduino

- Arduino Board. Products.
  https://www.arduino.cc/en/Main/Products


Arduino Uno


Arduino Leonardo


Arduino WiFi Shield


Arduino Mega 2560


Arduino LilyPad


Arduino Ethernet Shield


Arduino Mega ADK


Arduino Fio


Arduino Wireless SD Shield

Getting Started with Arduino

- Arduino Board. Products.

Arduino Ethernet

Arduino Pro

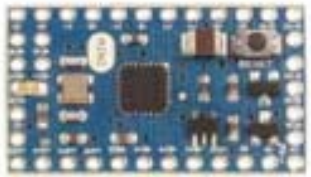
Arduino Wireless Proto Shield

Arduino BT

Arduino Nano

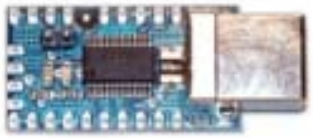
Arduino Motor Shield

USB/Serial Light Adapter

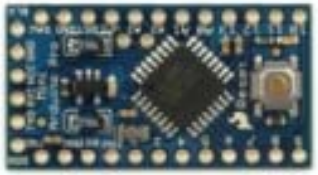


Arduino Mini

Arduino Proto Shield



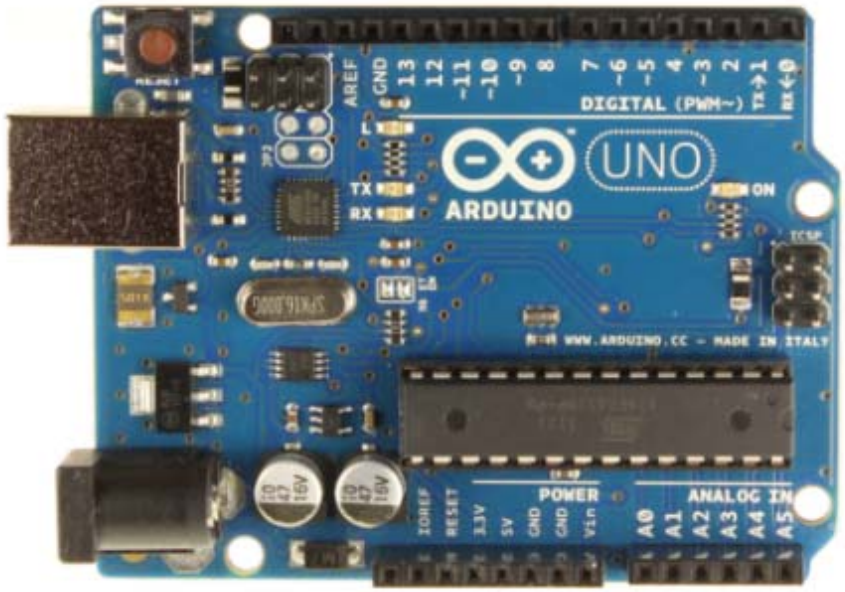
Mini USB/Serial Adapter



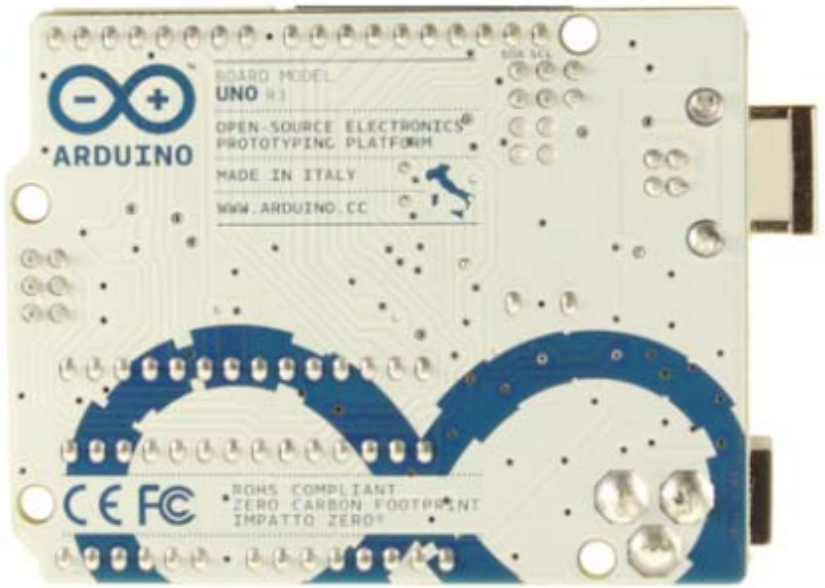
Arduino Pro Mini

Getting Started with Arduino

- Arduino Board.
  - Arduino UNO.



Arduino Uno R3 Front

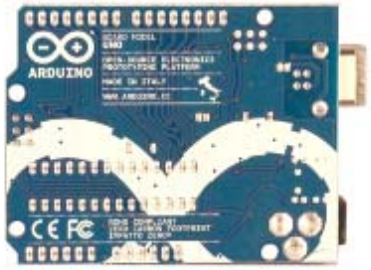


Arduino Uno R3 Back

Arduino Uno R2 Front

Arduino Uno SMD

Arduino Uno Front



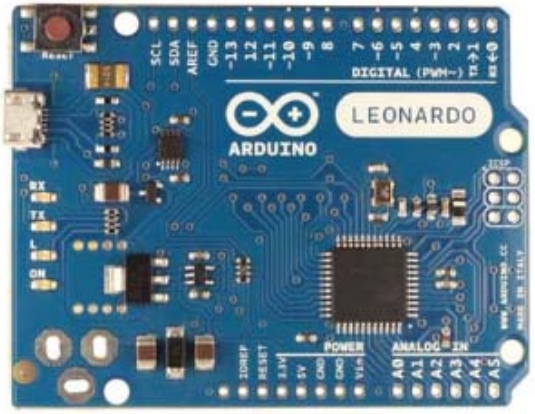
Arduino Uno Back

Getting Started with Arduino

- Arduino Board.
  - Arduino Leonardo.

Arduino Leonardo Front with headers

Arduino Leonardo Rear

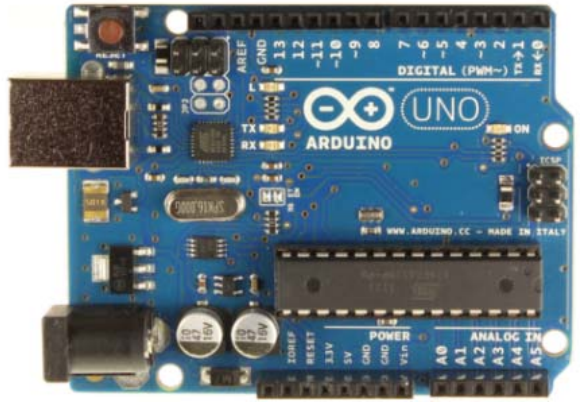


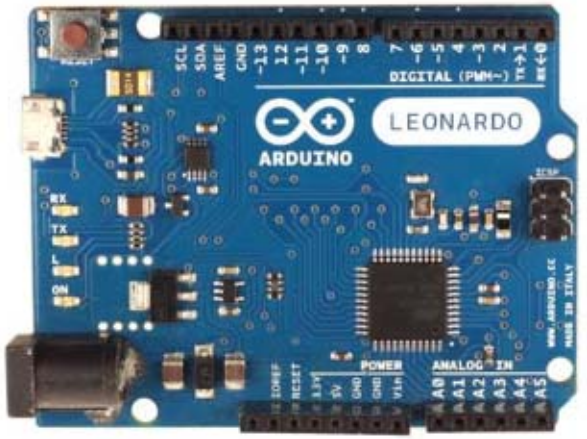
Arduino Leonardo Front without headers

Getting Started with Arduino

- Arduino Board.
  - Arduino UNO and Arduino Leonardo Technical specs.

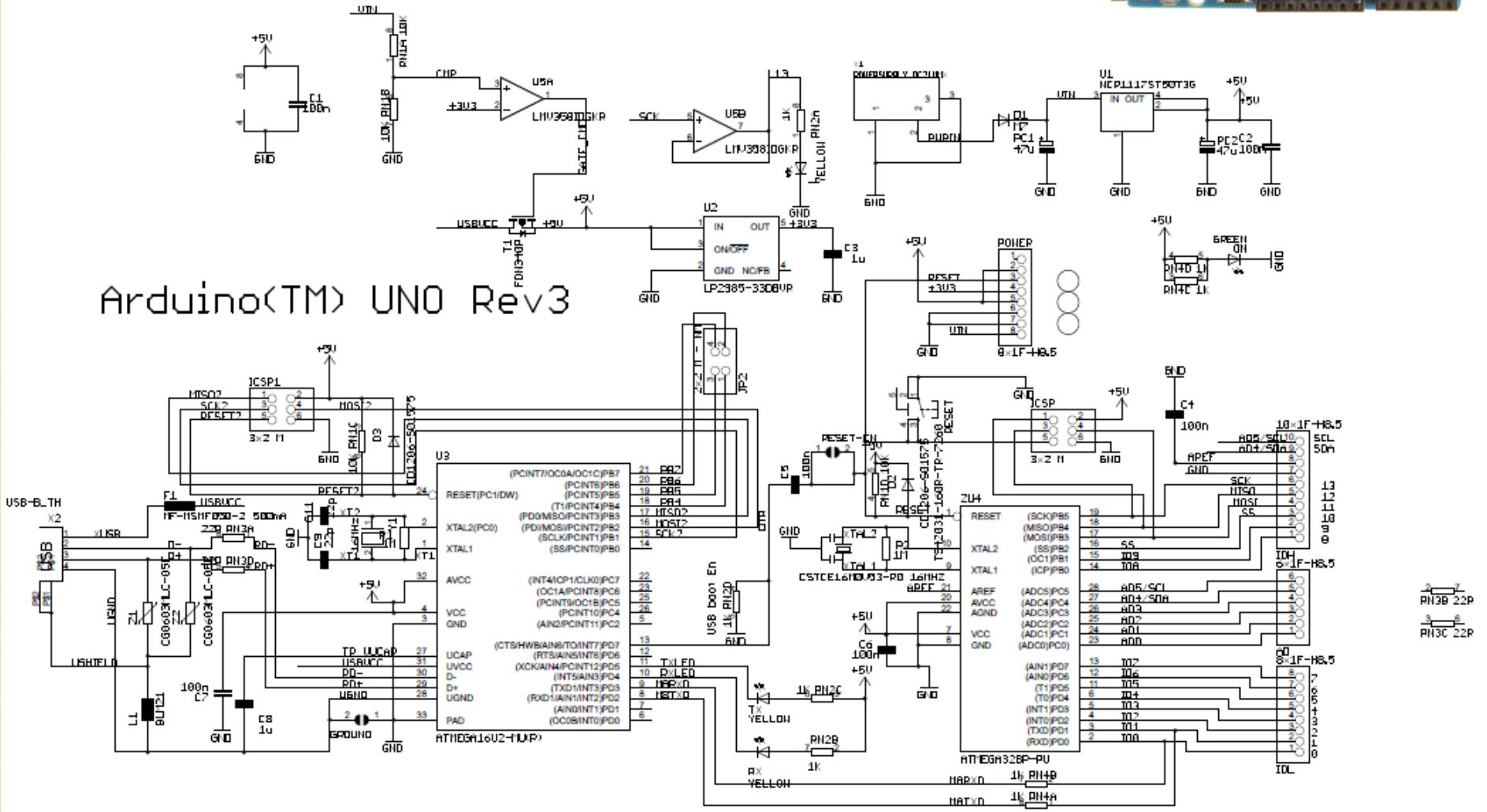
	Arduino Uno	Arduino Leonardo
Microcontroller	ATmega328	ATmega32u4
Operating Voltage	5V	5V
Input Voltage (recommended)	7-12V	7-12V
Input Voltage (limits)	6-20V	6-20V
Digital I/O Pins	14	20
PWM Channels	6	7
Analog Input Pins	6	12
DC Current per I/O Pin	40 mA	40 mA
DC Current for 3.3V Pin	50 mA	50 mA
Flash Memory	32 KB (ATmega328) of which 0.5 KB used by bootloader	32 KB (ATmega32u4) of which 4 KB used by bootloader
SRAM	2 KB (ATmega328)	2.5 KB (ATmega32u4)
EEPROM	1 KB (ATmega328)	1 KB (ATmega32u4)
Clock Speed	16 MHz	16 MHz





Getting Started with Arduino

- Arduino Board.
  - Arduino UNO Schematic.



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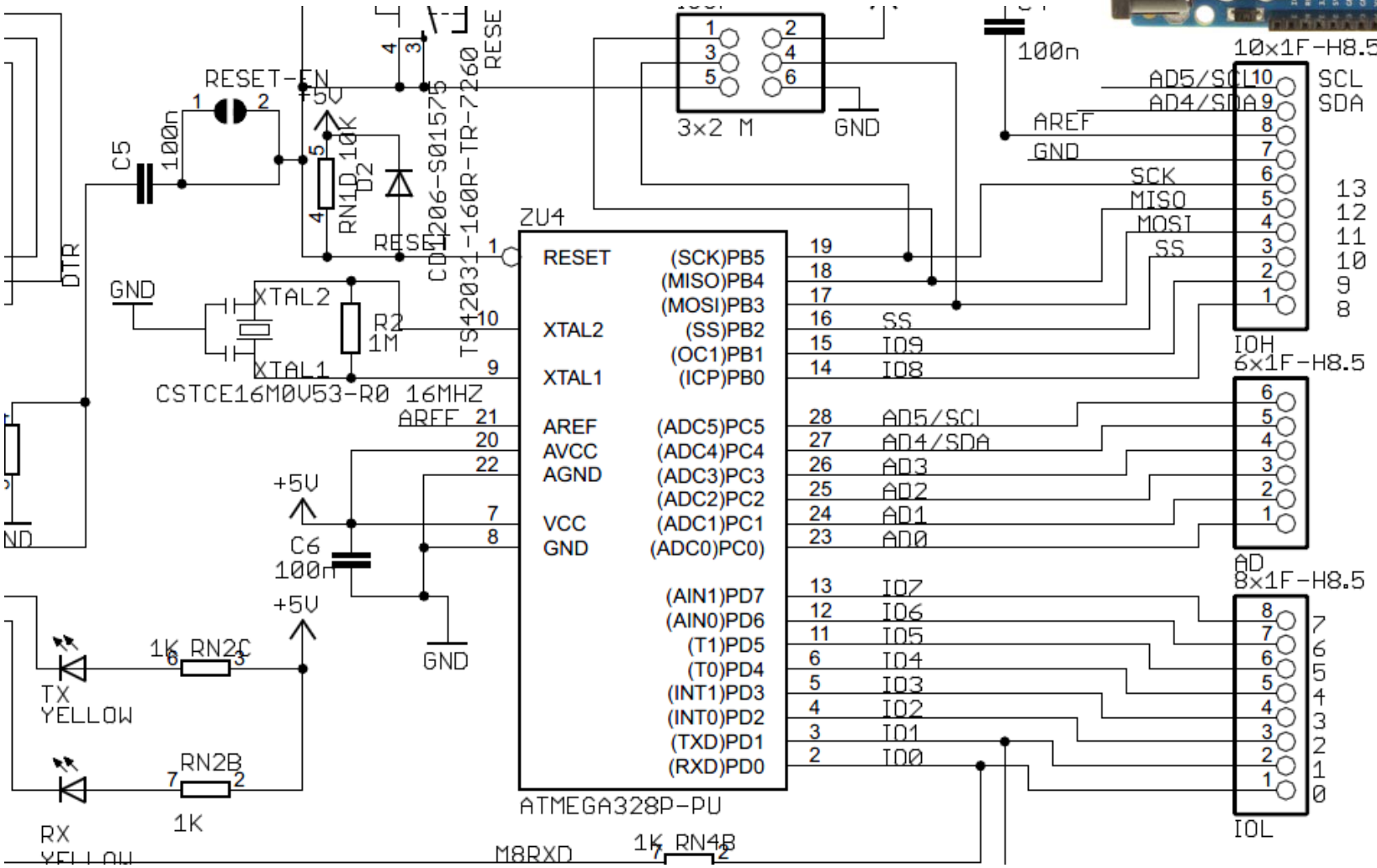

Getting Started with Arduino

- Arduino Board.
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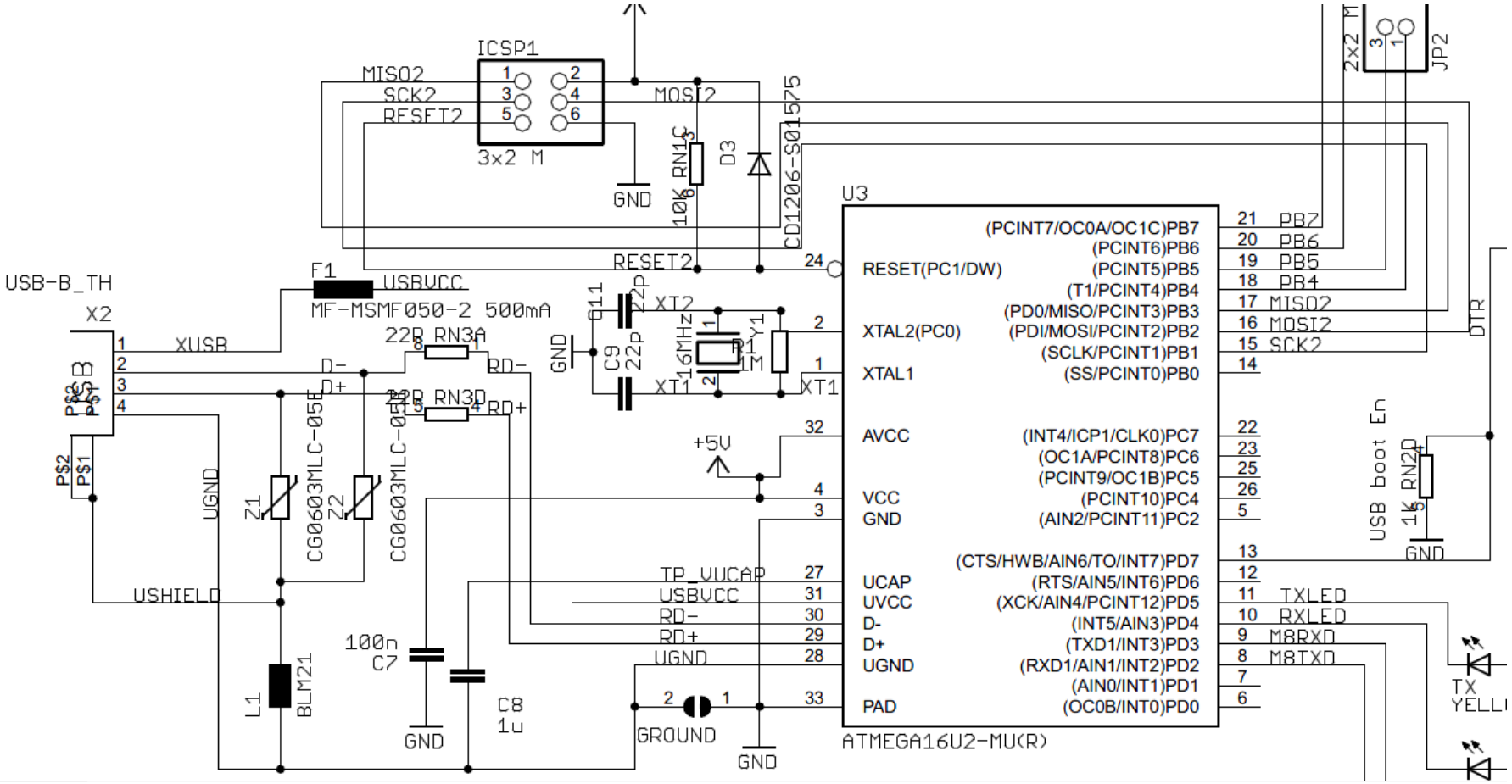

Getting Started with Arduino

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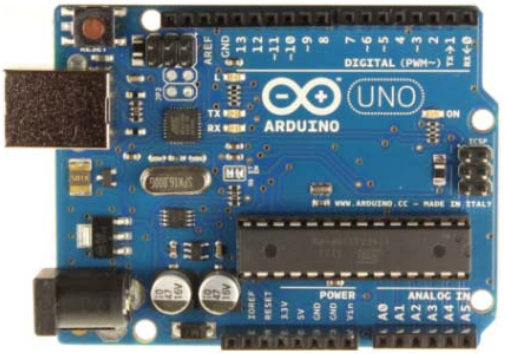
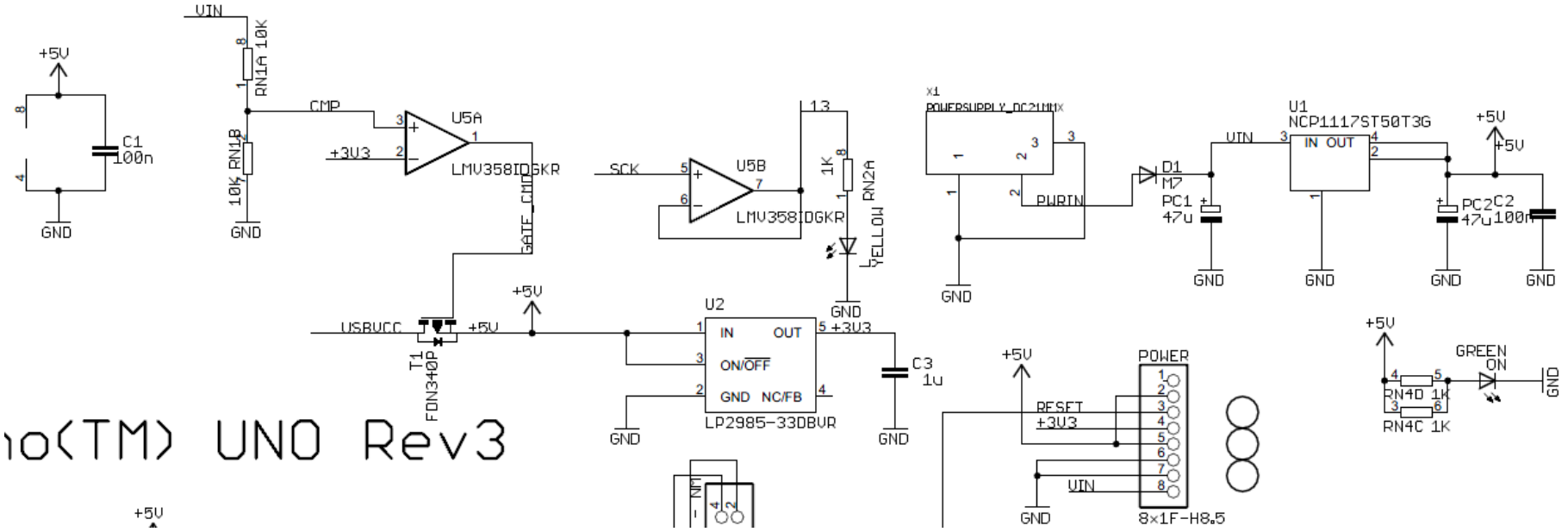
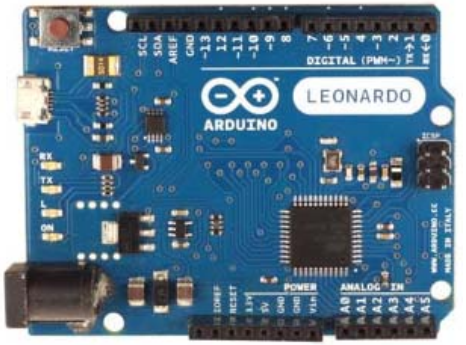
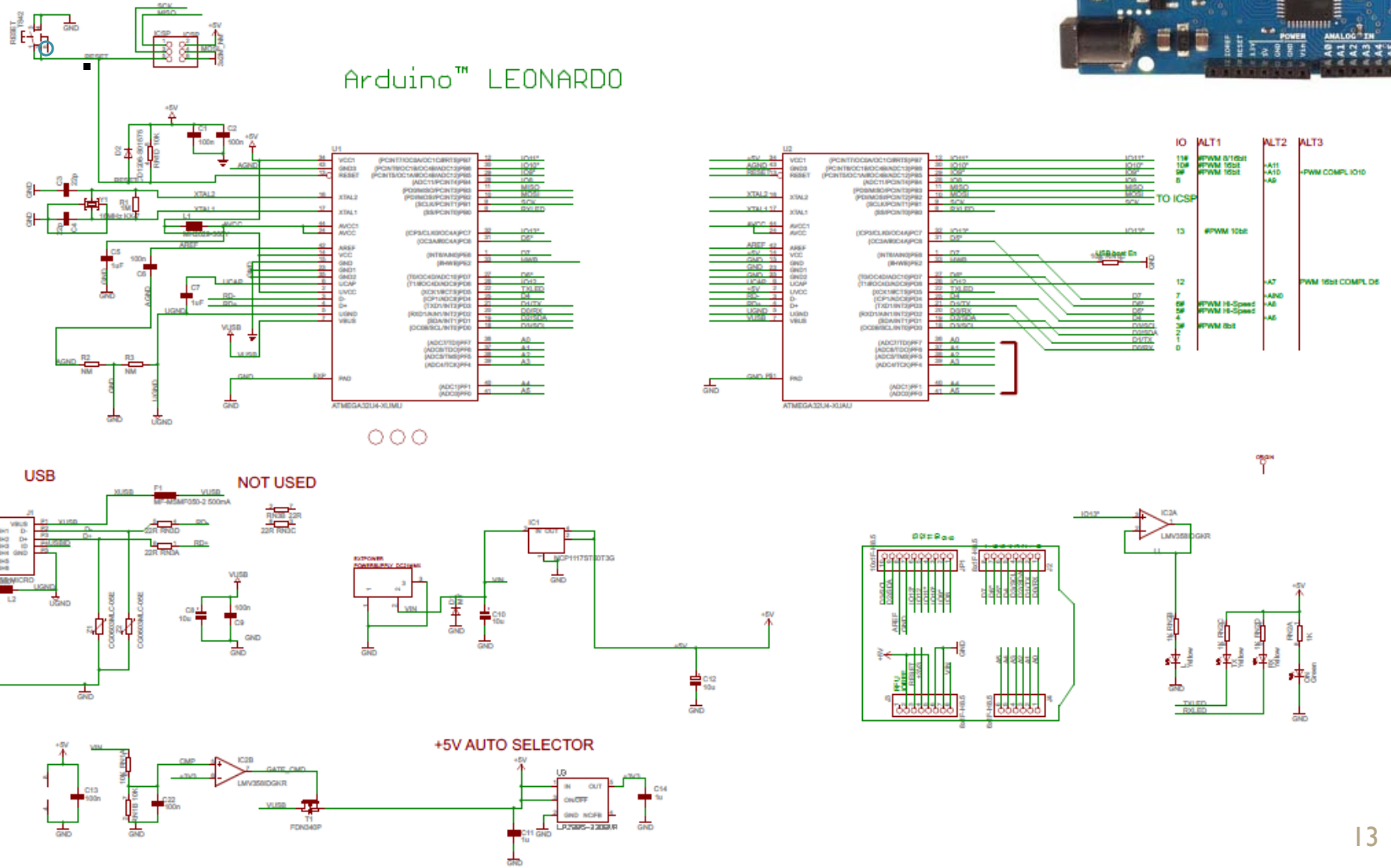




Getting Started with Arduino

- Arduino Board.
  - Arduino Leonardo Schematic.





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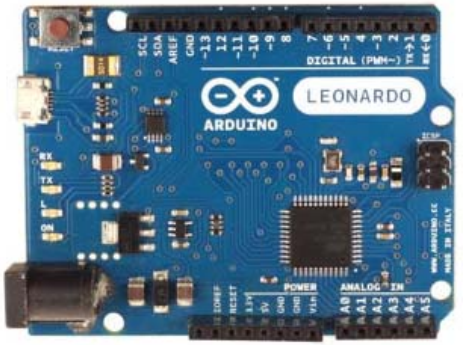

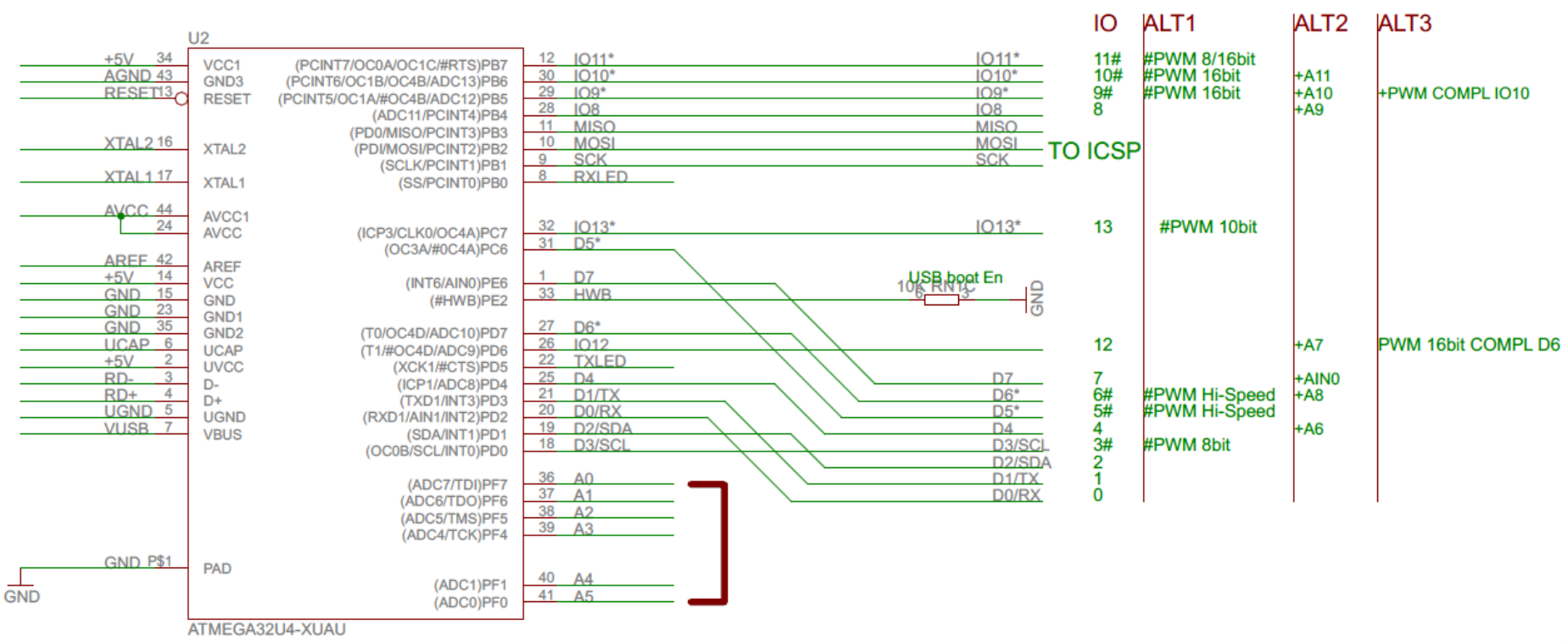

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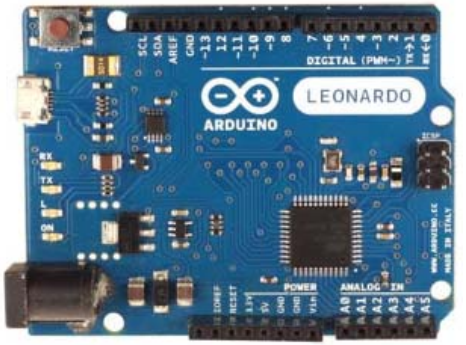

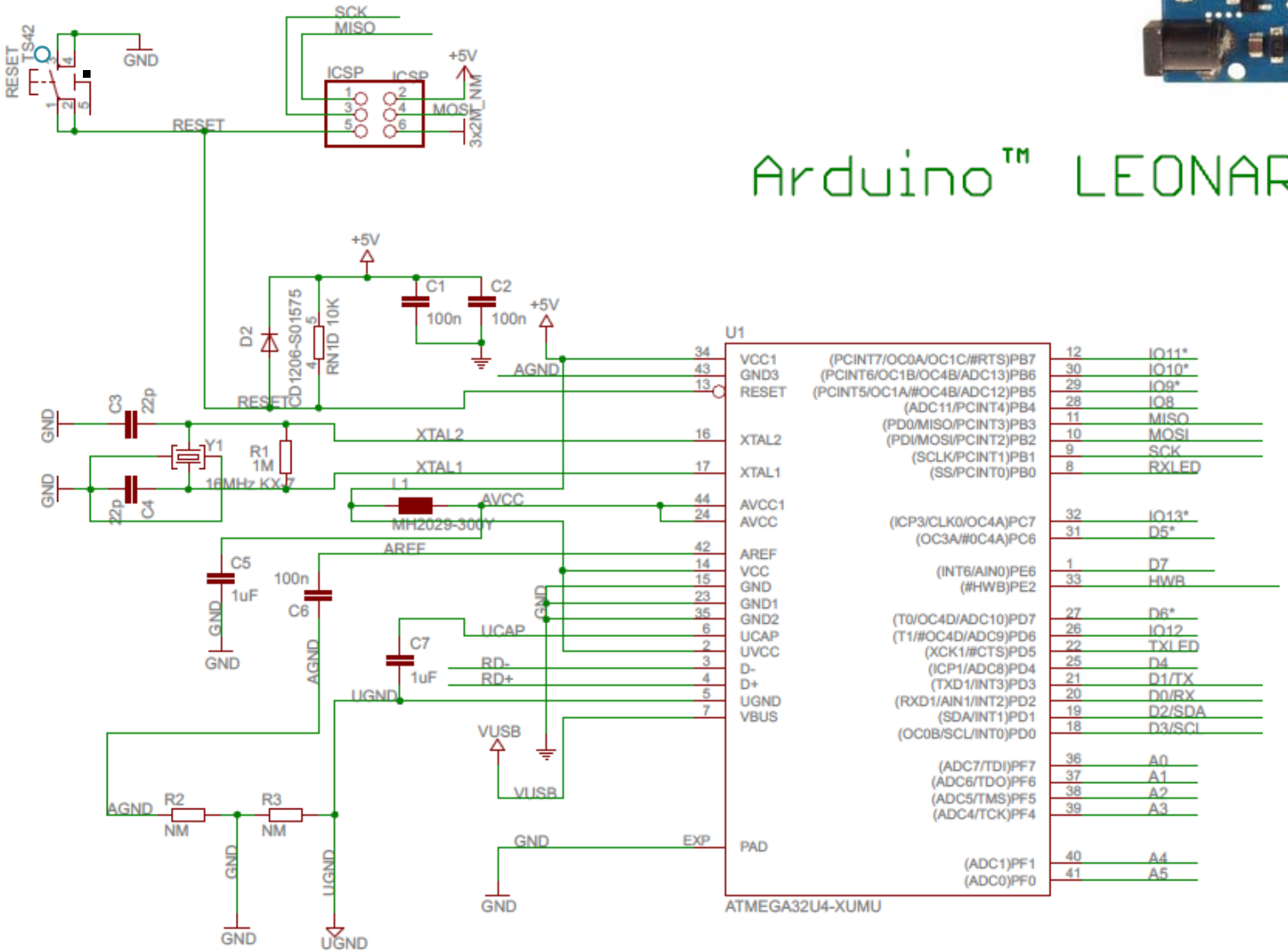

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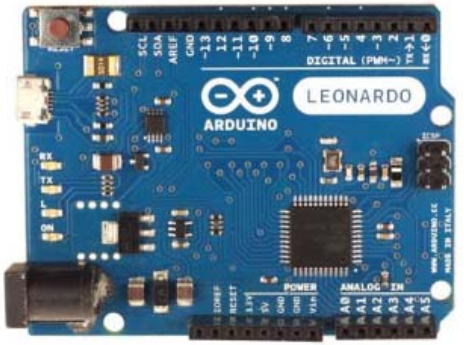

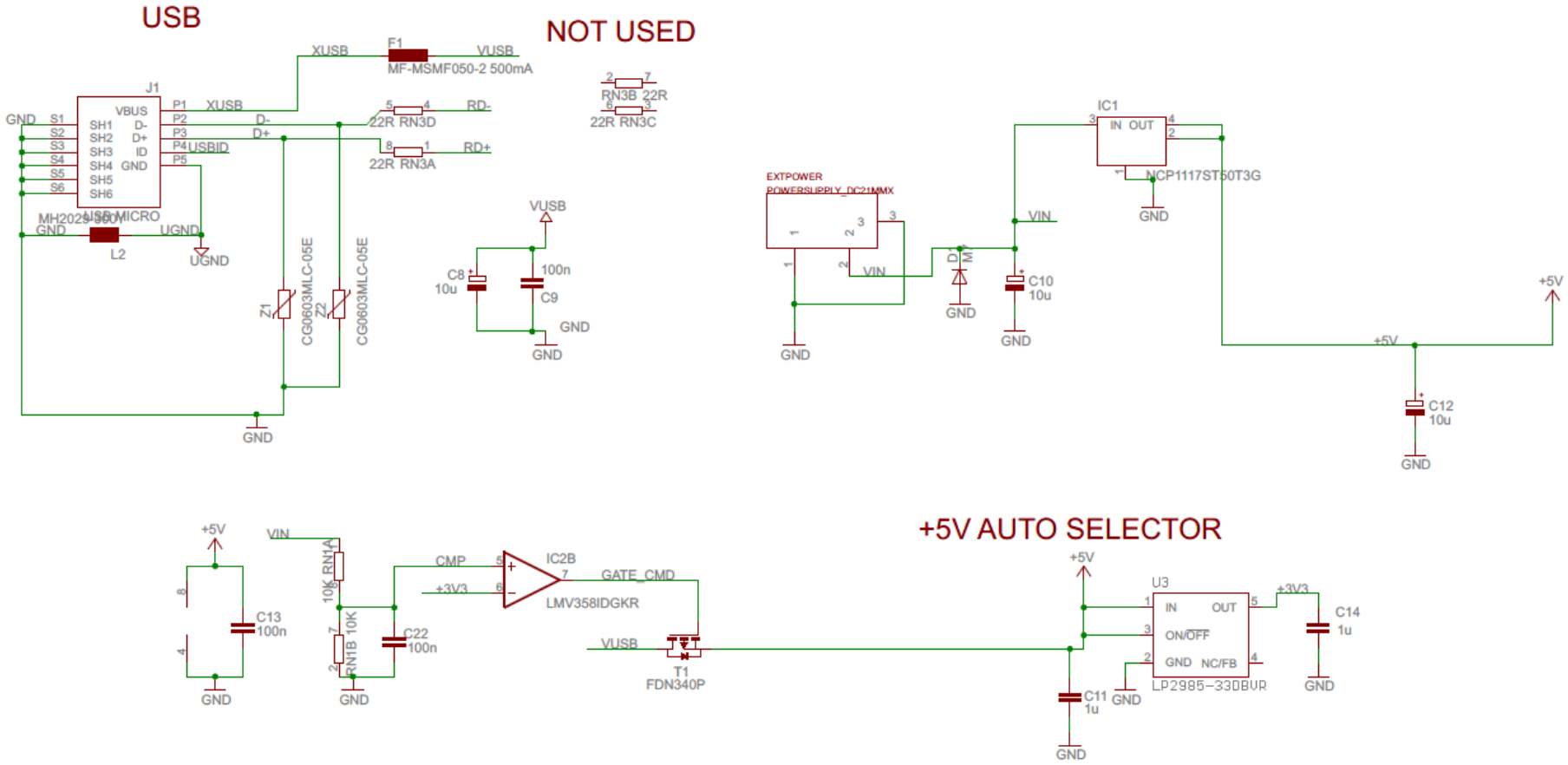

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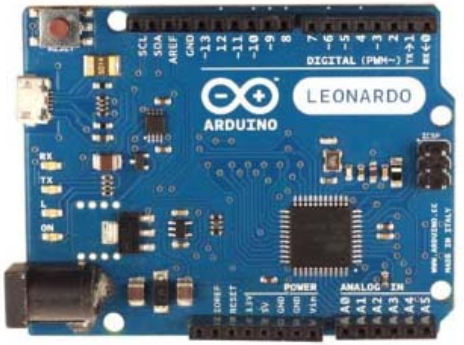
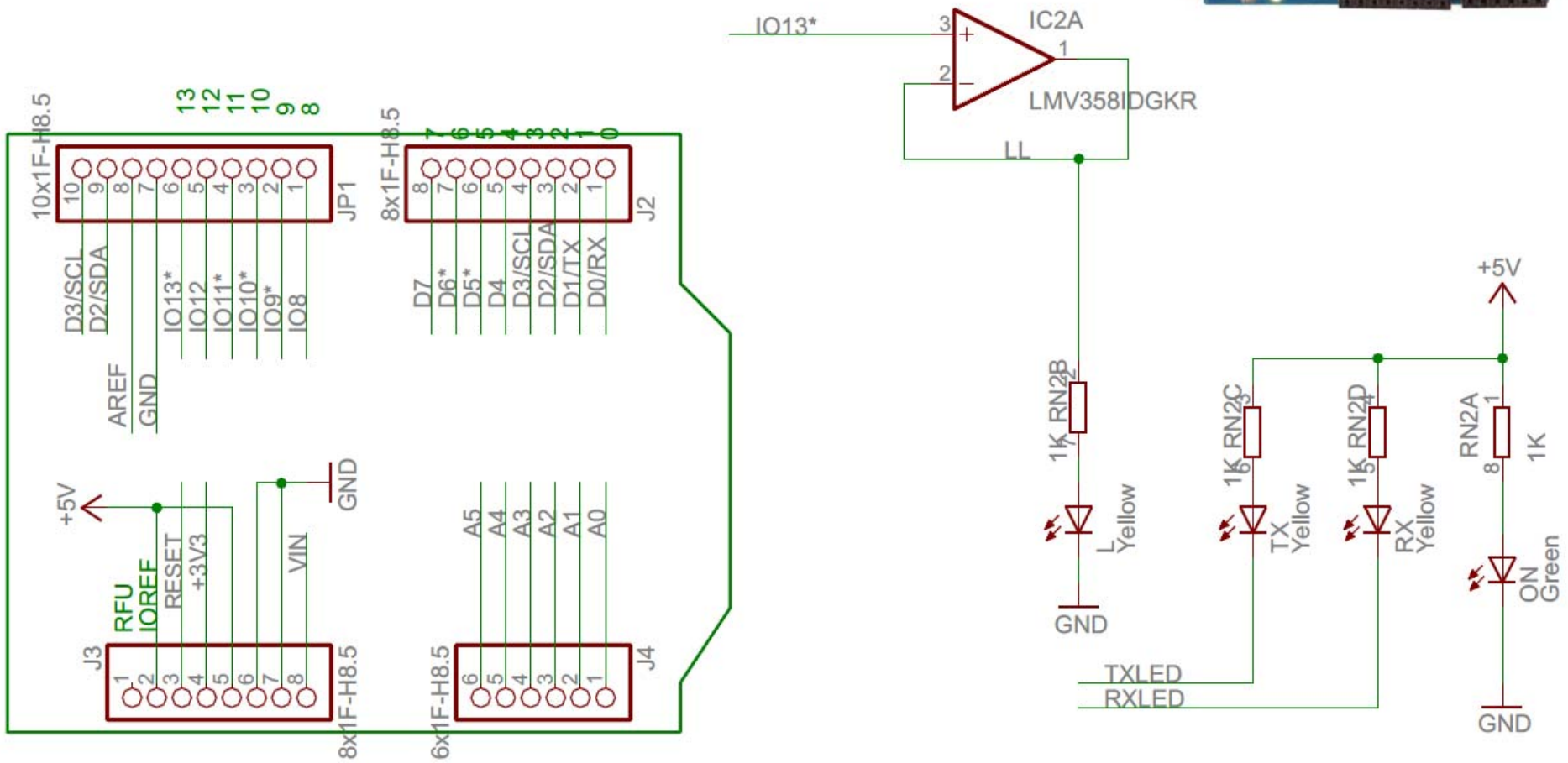
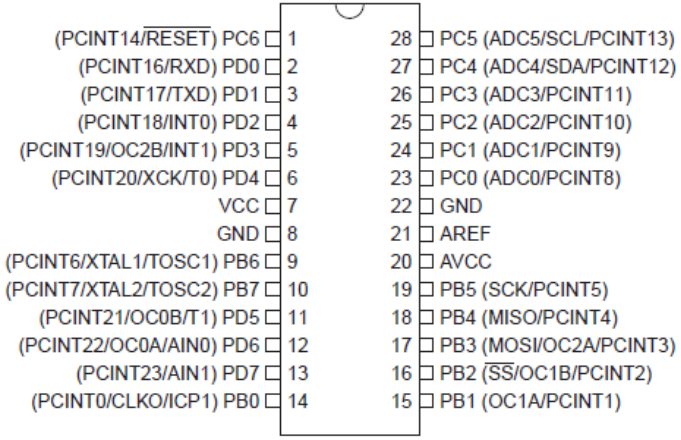




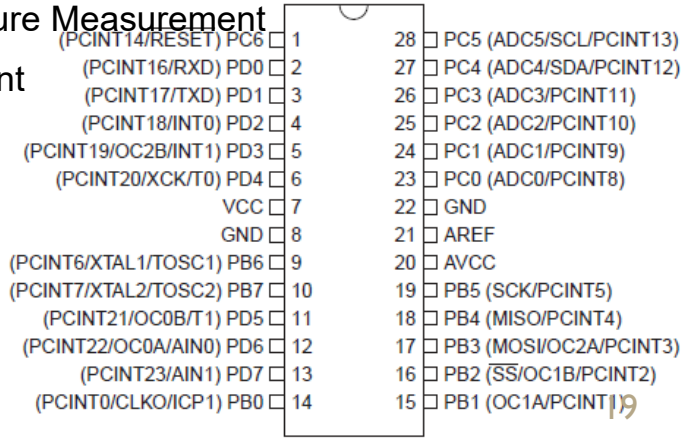
Getting Started with Arduino

- Arduino Board.
  - Arduino UNO. ATmega328P Microcontroller
    - http://www.atmel.com/Images/doc8271.pdf
- High Performance, Low Power AVR® 8-Bit Microcontroller
- Advanced RISC Architecture
  - 131 Powerful Instructions – Most Single Clock Cycle Execution
  - 32 x 8 General Purpose Working Registers
  - Fully Static Operation
  - Up to 20 MIPS Throughput at 20 MHz
  - On-chip 2-cycle Multiplier
- High Endurance Non-volatile Memory Segments
  - 4/8/16/32K Bytes of In-System Self-Programmable Flash program memory (ATmega48PA/88PA/168PA/328P)
  - 256/512/512/1K Bytes EEPROM (ATmega48PA/88PA/168PA/328P)
  - 512/1K/1K/2K Bytes Internal SRAM (ATmega48PA/88PA/168PA/328P)
  - Write/Erase Cycles: 10,000 Flash/100,000 EEPROM
  - Data retention: 20 years at 85°C/100 years at 25°C
  - Optional Boot Code Section with Independent Lock Bits In-System Programming by On-chip Boot Program True Read-While-Write Operation
  - Programming Lock for Software Security



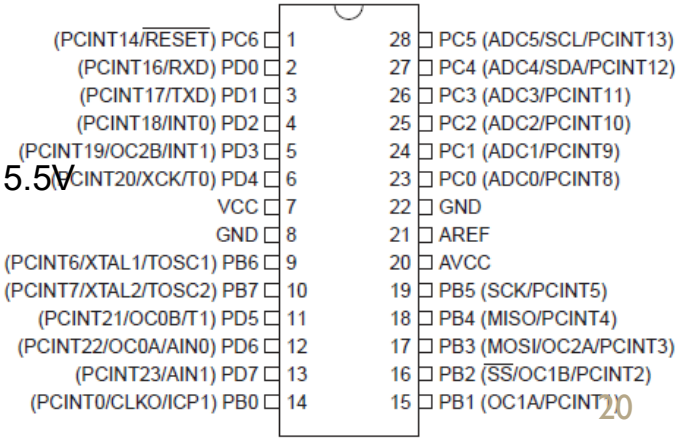
Getting Started with Arduino

- Arduino Board.
  - Arduino UNO. ATmega328P Microcontroller
    - http://www.atmel.com/Images/doc8271.pdf
- Atmel® QTouch® library support
  - Capacitive touch buttons, sliders and wheels
  - QTouch and QMatrix® acquisition
  - Up to 64 sense channels
- Peripheral Features
  - Two 8-bit Timer/Counters with Separate Prescaler and Compare Mode
  - One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode
  - Real Time Counter with Separate Oscillator
  - Six PWM Channels
  - 8-channel 10-bit ADC in TQFP and QFN/MLF package Temperature Measurement
  - 6-channel 10-bit ADC in PDIP Package Temperature Measurement
  - Programmable Serial USART
  - Master/Slave SPI Serial Interface
  - Byte-oriented 2-wire Serial Interface (Philips I2C compatible)
  - Programmable Watchdog Timer with Separate On-chip Oscillator
  - On-chip Analog Comparator
  - Interrupt and Wake-up on Pin Change



Getting Started with Arduino

- Arduino Board.
  - Arduino UNO. ATmega328P Microcontroller
    - http://www.atmel.com/Images/doc8271.pdf
- Special Microcontroller Features
  - Power-on Reset and Programmable Brown-out Detection
  - Internal Calibrated Oscillator
  - External and Internal Interrupt Sources
  - Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby, and Extended Standby
- I/O and Packages
  - 23 Programmable I/O Lines
  - 28-pin PDIP, 32-lead TQFP, 28-pad QFN/MLF and 32-pad QFN/MLF
- Operating Voltage:
  - 1.8 - 5.5V for ATmega48PA/88PA/168PA/328P
- Temperature Range:
  - -40ºC to 85ºC
- Speed Grade:
  - 0 - 4MHz@1.8 - 5.5V, 0 - 10MHz@2.7 - 5.5.V, 0 - 20MHz @ 4.5 - 5.5V
- Power Consumption at 1MHz, 1.8V, 25C
  - Active Mode: 0.2mA
  - Power-down Mode: 0.1µA
  - Power-save Mode: 0.75µA (Including 32kHz RTC)



Getting Started with Arduino

- Arduino Board.
  - Arduino Leonardo. uC ATmega32u4
    - http://www.atmel.com/Images/doc7766.pdf
- High Performance, Low Power AVR® 8-Bit Microcontroller
- Advanced RISC Architecture
  - 135 Powerful Instructions – Most Single Clock Cycle Execution
  - 32 x 8 General Purpose Working Registers
  - Fully Static Operation
  - Up to 16 MIPS Throughput at 16 MHz
  - On-Chip 2-cycle Multiplier
- Non-volatile Program and Data Memories
  - 16/32K Bytes of In-System Self-Programmable Flash (ATmega16U4/ATmega32U4)
  - 1.25/2.5K Bytes Internal SRAM (ATmega16U4/ATmega32U4)
  - 512Bytes/1K Bytes Internal EEPROM (ATmega16U4/ATmega32U4)
  - Write/Erase Cycles: 10,000 Flash/100,000 EEPROM
  - Data retention: 20 years at 85°C/ 100 years at 25°C(1)
  - Optional Boot Code Section with Independent Lock Bits In-System Programming by On-chip Boot Program True Read-While-Write Operation All supplied parts are preprogramed with a default USB bootloader
  - Programming Lock for Software Security

Getting Started with Arduino

- Arduino Board.
  - Arduino Leonardo. uC ATmega32u4
    - http://www.atmel.com/Images/doc7766.pdf
- JTAG (IEEE std. 1149.1 compliant) Interface
  - Boundary-scan Capabilities According to the JTAG Standard
  - Extensive On-chip Debug Support
  - Programming of Flash, EEPROM, Fuses, and Lock Bits through the JTAG Interface
- USB 2.0 Full-speed/Low Speed Device Module with Interrupt on Transfer Completion
  - Complies fully with Universal Serial Bus Specification Rev 2.0
  - Supports data transfer rates up to 12 Mbit/s and 1.5 Mbit/s
  - Endpoint 0 for Control Transfers: up to 64-bytes
  - 6 Programmable Endpoints with IN or Out Directions and with Bulk, Interrupt or Isochronous Transfers
  - Configurable Endpoints size up to 256 bytes in double bank mode
  - Fully independent 832 bytes USB DPRAM for endpoint memory allocation
  - Suspend/Resume Interrupts
  - CPU Reset possible on USB Bus Reset detection
  - 48 MHz from PLL for Full-speed Bus Operation
  - USB Bus Connection/Disconnection on Microcontroller Request
  - Crystal-less operation for Low Speed mode

Getting Started with Arduino

- Arduino Board.
  - Arduino Leonardo. uC ATmega32u4
    - http://www.atmel.com/Images/doc7766.pdf
- Peripheral Features
  - On-chip PLL for USB and High Speed Timer: 32 up to 96 MHz operation
  - One 8-bit Timer/Counter with Separate Prescaler and Compare Mode
  - Two 16-bit Timer/Counter with Separate Prescaler, Compare- and Capture Mode
  - One 10-bit High-Speed Timer/Counter with PLL (64 MHz) and Compare Mode
  - Four 8-bit PWM Channels
  - Four PWM Channels with Programmable Resolution from 2 to 16 Bits
  - Six PWM Channels for High Speed Operation, with Programmable Resolution from 2 to 11 Bits
  - Output Compare Modulator
  - 12-channels, 10-bit ADC (features Differential Channels with Programmable Gain)
  - Programmable Serial USART with Hardware Flow Control
  - Master/Slave SPI Serial Interface
  - Byte Oriented 2-wire Serial Interface
  - Programmable Watchdog Timer with Separate On-chip Oscillator
  - On-chip Analog Comparator
  - Interrupt and Wake-up on Pin Change
  - On-chip Temperature Sensor

Getting Started with Arduino

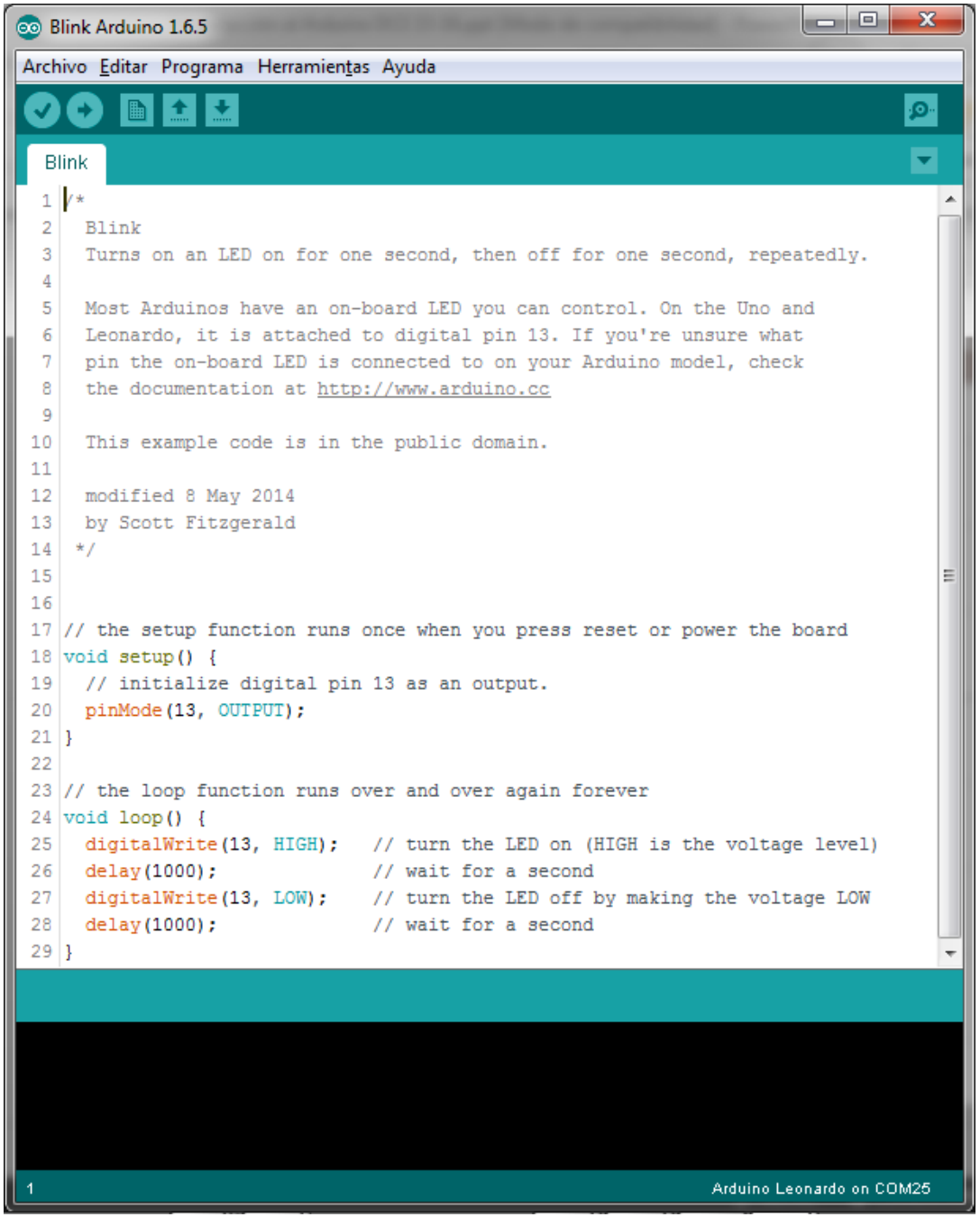
- Arduino Board.
  - Arduino Leonardo. uC ATmega32u4
    - http://www.atmel.com/Images/doc7766.pdf
- Special Microcontroller Features
  - Power-on Reset and Programmable Brown-out Detection
  - Internal 8 MHz Calibrated Oscillator
  - Internal clock prescaler & On-the-fly Clock Switching (Int RC / Ext Osc)
  - External and Internal Interrupt Sources
  - Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby, and Extended Standby
- I/O and Packages
  - All I/O combine CMOS outputs and LVTTL inputs
  - 26 Programmable I/O Lines
  - 44-lead TQFP Package, 10x10mm
  - 44-lead QFN Package, 7x7mm
- • Operating Voltages
  - 2.7 - 5.5V
- Operating temperature
  - Industrial (-40°C to +85°C)
- Maximum Frequency
  - 8 MHz at 2.7V - Industrial range
  - 16 MHz at 4.5V - Industrial range

Getting Started with Arduino

- Download the Arduino Software
  - http://arduino.cc/en/Main/Software

Getting Started with Arduino

- Arduino IDE



Getting Started with Arduino

- Videos
  - https://www.ted.com/talks/massimo_banzi_how_arduino_is_open_sourcing_imagination?language=es
  - https://vimeo.com/18539129
  - https://www.youtube.com/watch?v=21hPmFNYUNo
  - https://www.youtube.com/watch?v=QS2y-nc3uPI

- Others links
  - https://www.arduino.cc/en/Guide/Introduction
  - http://spectrum.ieee.org/geek-life/hands-on/the-making-of-arduino/0

Getting Started with Arduino

- Shopping. Arduino Leonardo
  - http://tienda.bricogeek.com/home/445-arduino-leonardo.html?gclid=COO7uq__q8gCFUsCwwod-lEEjg
  - https://www.cooking-hacks.com/arduino-leonardo-with-headers
  - http://www.electan.com/arduino-leonardo-p-3226.html?gmeltn=1&gclid=COavraKArMgCFSYUwwodW2EJPg
  - http://eud.dx.com/product/diy-eduino-leonardo-module-blue-black-844213956#.VhLHzPntmko
  - http://www.dx.com/es/p/diy-eduino-leonardo-module-blue-black-213956#.VhLIEvntmko
  - http://es.aliexpress.com/store/product/NEW-IEIK-Leonardo-R3-with-USB-Cable-Microcontroller-ATmega32u4-Can-Simulate-Keyboard-Mouse/1904367_32473639569.html?spm=2114.04020208.3.196.jTz0Ia&ws_ab_test=201556_7,201527_3_71_72_73_74_75,0_0

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Computer Engineering Degree