Atmega328P Standalone

Table of Contents

Description

Atmega328 standalone means that you use the Atmega328 IC on a project without using an Arduino board.

Arduino Uno is basically a breakout board for Atmega328 µC for making the use of the µC beginner friendly.

The benefits of Atmega328 standalone are that you can make your project compact because the Atmega and the necessary components are in total smaller than the Arduino Uno board.

In advance Atmega standalone will help you reduce the power consumption of your project because you are not using extra components like leds.Also you can a have a working µC with less components.

Components for Standalone Atmega328

1x Atmega328P IC

1x 16MHz Crystal

2x 22pF Capacitors

1x Button

1x Arduino Board with the Atmega chip on it to burn the bootloader

1x Arduino Board without the Atmega ic or a ftdi board to program the chip.

If you use a ftdi board you would need also a 0.1uF capacitor

1x Breadboard or prototype board (for building your own “Arduino” board)

Not necessary parts (for making your own board with regulated 5v power supply)

Pin headers (female or male)

1 x 100uF Capacitor

1 x 10uF Capacitor

1 x 1N4001 Diode

1 x L7805 Voltage Regulator

Bootloader

First and foremost you need to burn the Arduino bootloader to your atmega so you can program it using Arduino IDE.If you have removed your atmega from an working Arduino board the atmega already have the Arduino bootloader.If your atmega is new or for someotherreason the bootloader is not there you can burn the bootloader easily using an Arduino as in system program(ISP).

Without burning the bootloader you cannot upload code to your Atmega using Arduino IDE you will need a programmer to upload your code.

If you want to check if you have bootloader onto your chip you can try to upload code to it.If your chip does not have a bootloader you will get error while uploading.

Steps to burn Arduino Bootloader using an Arduino board

1 To start you need to open Arduino IDE and select the correct board and serial port from tools menu.

2 Next you should upload ArduinoISP sketch on a working Arduino from Arduino IDE's examples

3 Then you need to wire the µC and the Arduino Board

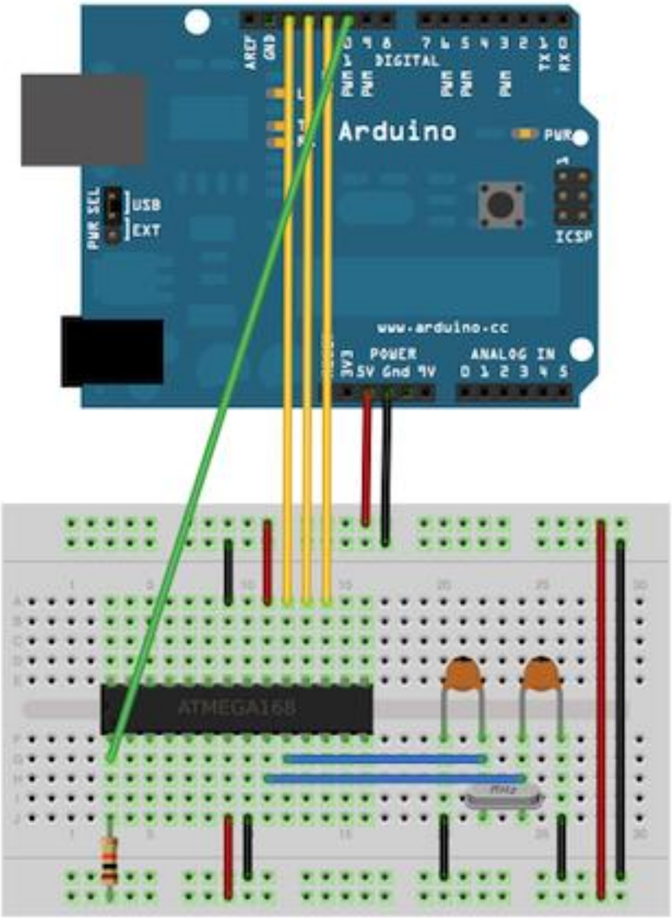
Arduino pins 13,12,13 to the equivalent pins on atmega and Arduino pin 10 to atmega's reset pin.Also you need to wire 5V and GND.

4 Select Arduino Duemilanove or Nano w/ ATmega328" from the Tools > Board menu.

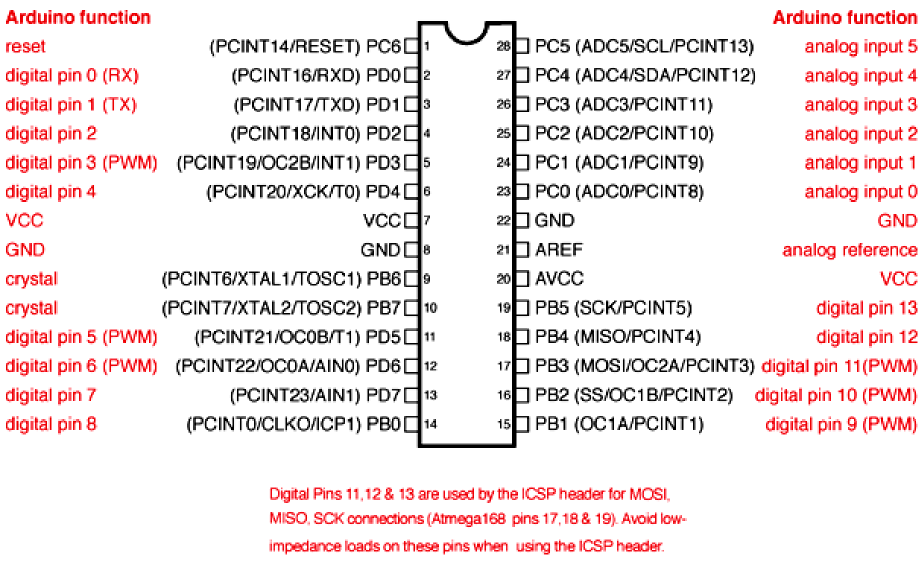
5 Select "Arduino as ISP" from Tools > Programmer

6 Then burn bootloader from tools menu.

After that, you can remove the wires from pins 10,11,12,13.



Connections for burning the bootloader to Atmega chip.Photo from official arduino website.



Arduino function					Arduino function
reset	(PCINT14/RESET) PC6	1	28	PC5 (ADC5/SCL/PCINT13)	analog input 5
digital pin 0 (RX)	(PCINT16/RXD) PD0	2	27	PC4 (ADC4/SDA/PCINT12)	analog input 4
digital pin 1 (TX)	(PCINT17/TXD) PD1	3	26	PC3 (ADC3/PCINT11)	analog input 3
digital pin 2	(PCINT18/INT0) PD2	4	25	PC2 (ADC2/PCINT10)	analog input 2
digital pin 3 (PWM)	(PCINT19/OC2B/INT1) PD3	5	24	PC1 (ADC1/PCINT9)	analog input 1
digital pin 4	(PCINT20/XCK/T0) PD4	6	23	PC0 (ADC0/PCINT8)	analog input 0
VCC	VCC	7	22	GND	GND
GND	GND	8	21	AREF	analog reference
crystal	(PCINT6/XTAL1/TOSC1) PB6	9	20	AVCC	VCC
crystal	(PCINT7/XTAL2/TOSC2) PB7	10	19	PB5 (SCK/PCINT5)	digital pin 13
digital pin 5 (PWM)	(PCINT21/OC0B/T1) PD5	11	18	PB4 (MISO/PCINT4)	digital pin 12
digital pin 6 (PWM)	(PCINT22/OC0A/AIN0) PD6	12	17	PB3 (MOSI/OC2A/PCINT3)	digital pin 11(PWM)
digital pin 7	(PCINT23/AIN1) PD7	13	16	PB2 (SS/OC1B/PCINT2)	digital pin 10 (PWM)
digital pin 8	(PCINT0/CLKO/ICP1) PB0	14	15	PB1 (OC1A/PCINT1)	digital pin 9 (PWM)

Digital Pins 11,12 & 13 are used by the ICSP header for MOSI, MISO, SCK connections (Atmega168 pins 17,18 & 19). Avoid low-impedance loads on these pins when using the ICSP header.

Atmega's equivalent pins to Arduino's

Programming the Atmega

1st Way:

The simplest of all

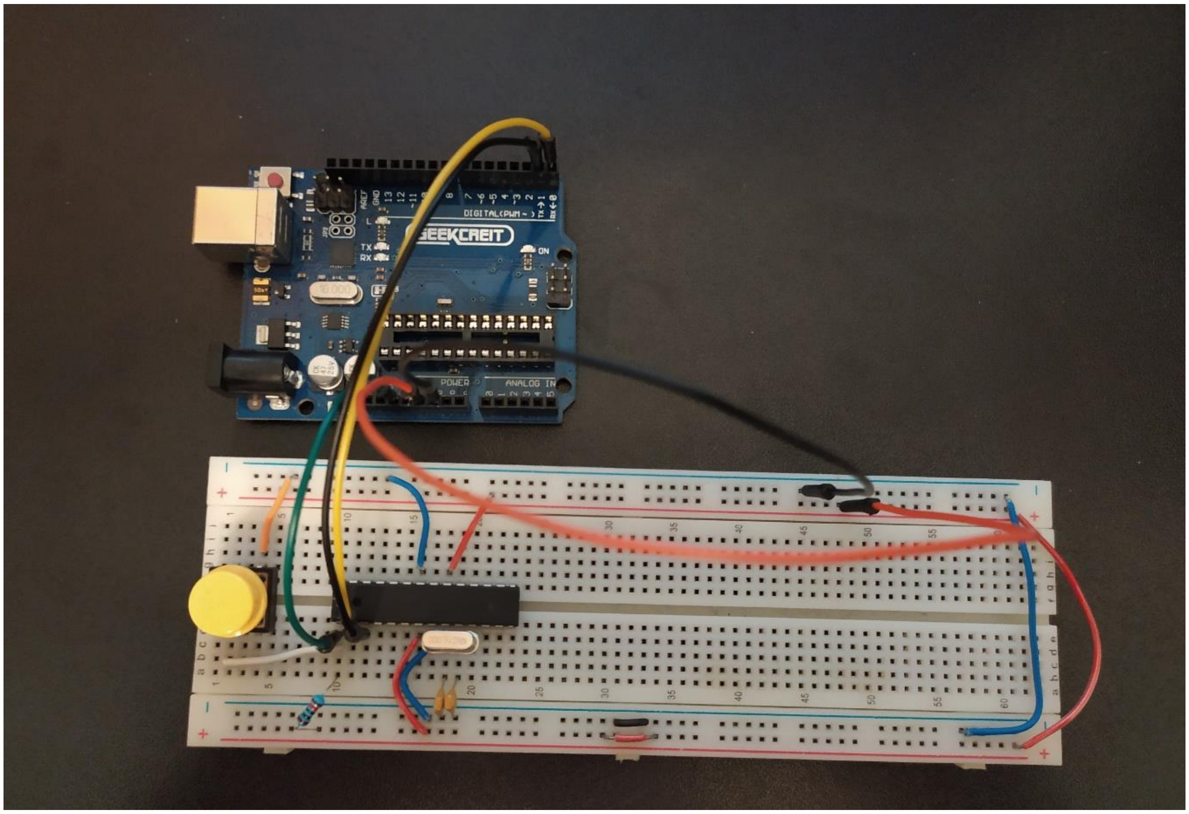
Put your Atmega chip back to an arduino board.

Upload the code and the remove it and put it back on your breadboard or your project.

2nd Way:

Using the Arduino’s USB-to-serial convertor (FTDI chip)

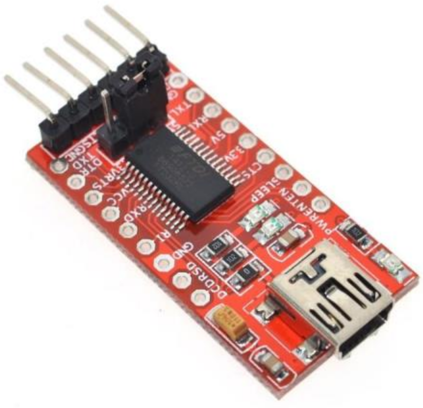
First you remove the µC from the arduino board then you connect Arduino’s board RX,TX and Reset pins to the corresponding pins on the Atmega and you upload your code as you do on an Arduino.



Programming my Atmega on breadboard using Arduino board.

3rd Way:

Using and external FTDI like the one below.Mine has not arrive yet so I will let this part for later.

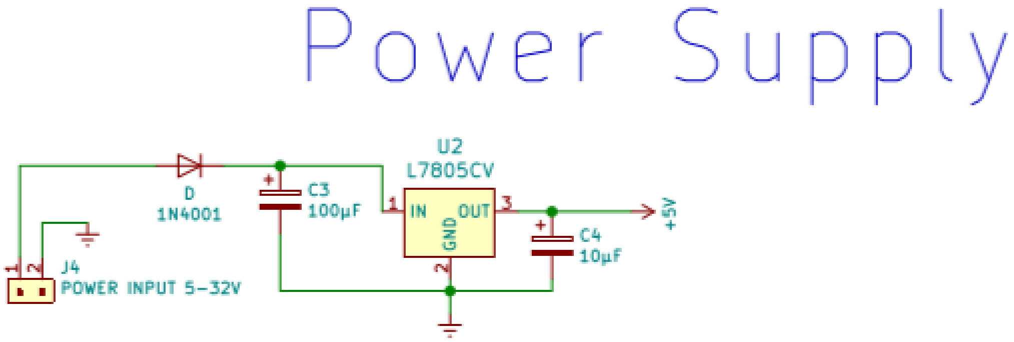


Atmega Minimal Configuration

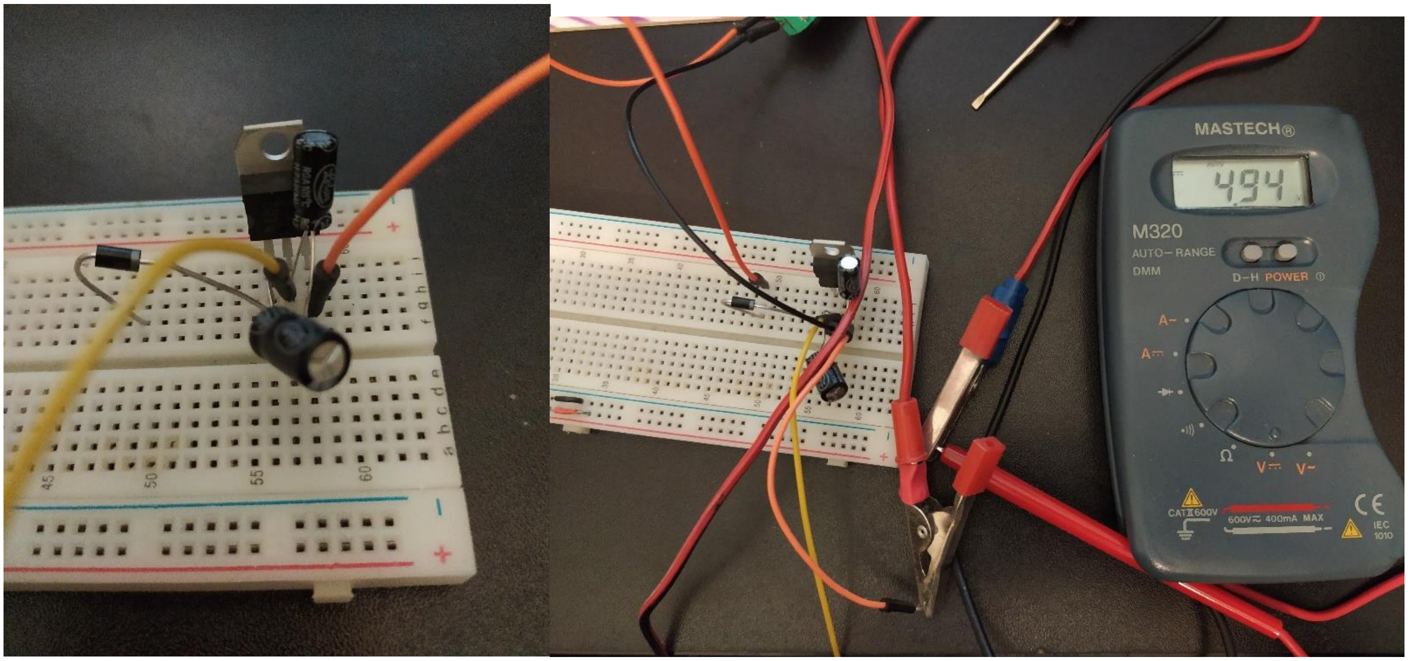
If you do not have an 16MHz Crystal and the 22pF capacitors you can eliminate the external clock and use the internal 8MHz clock.

I will not cover this in the tutorial but you can read more at the official Arduino site https://www.arduino.cc/en/Tutorial/ArduinoToBreadboard

5V Power Supply for your own Atmega Board



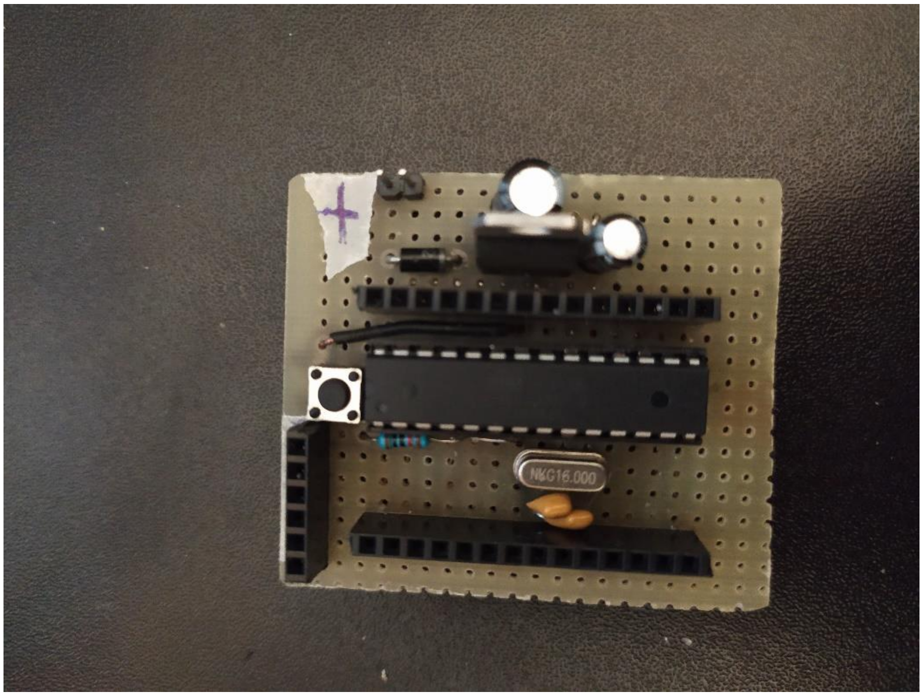
I am using a L7805 voltage regulator to drop the input voltage (5-32V) to 5V to power our board.I used two capacitors one at the input and one at the output to smooth the voltage at the output and make it stable (as the datasheet suggests).Also I used one 1N4001 diode for a basic reverse polarity protection.

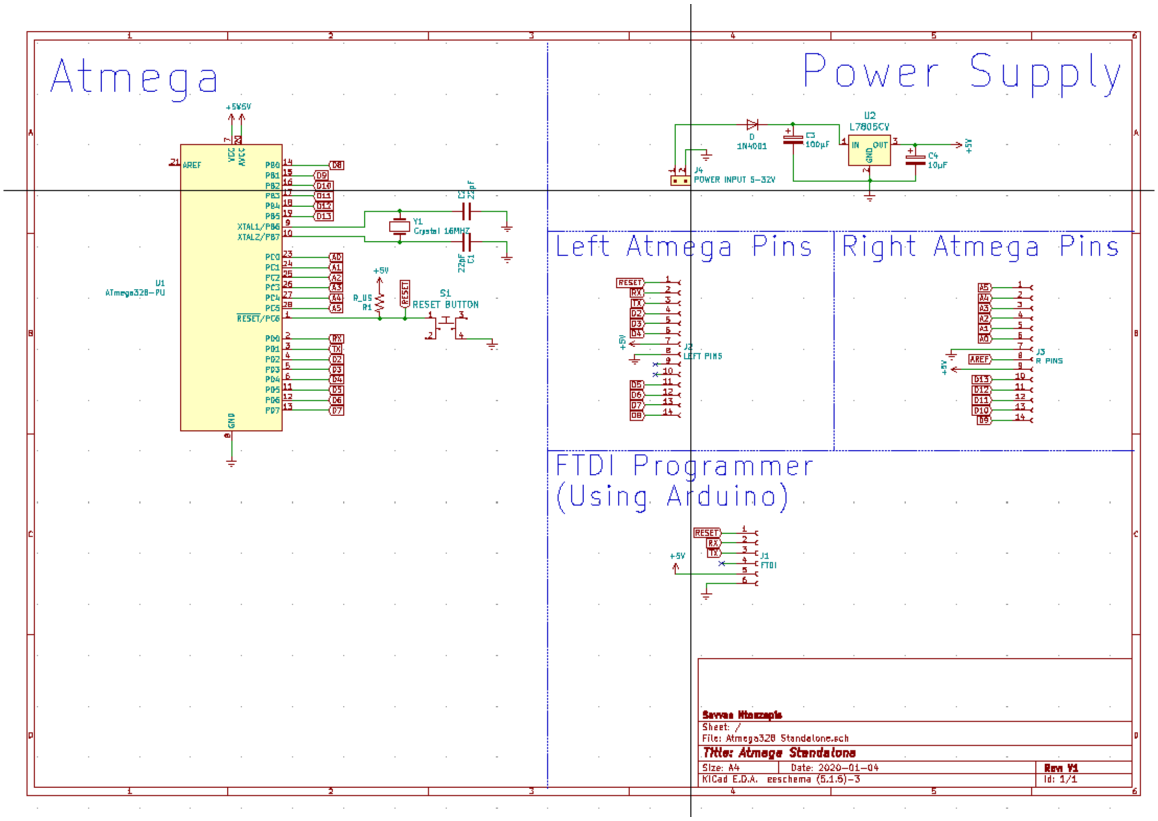


The circuit on a breadboard and the output measurement on a multimeter.

My Atmega328P board

My Atmega328P board and the complete schematic. You can also find the schematic at my gitlab





References

Arduino Web Site

https://www.arduino.cc/en/Tutorial/ArduinoToBreadboard

L7805 Datasheet

https://www.st.com/resource/en/datasheet/l78.pdf