



# DIY BARE MINIMUM ARDUINO MEGA 2560

By FuzzyStudio (/member/FuzzyStudio/) in Technology (/technology/) &gt; Arduino (/technology/arduino/)

46,008

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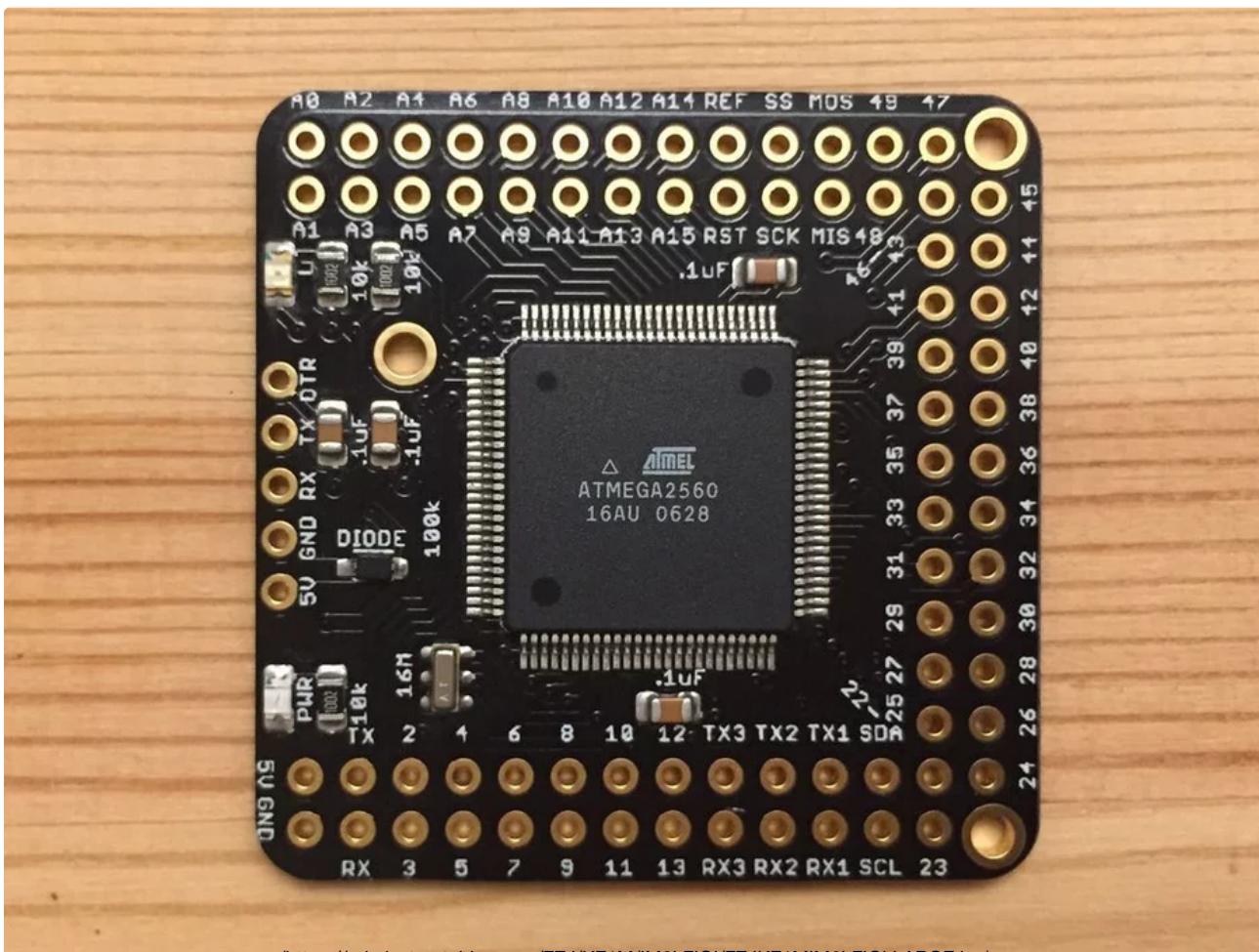
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## Intro: DIY Bare Minimum Arduino Mega 2560

[2017 Update] Eagle files please click [here](https://github.com/FuzzyStudio/Fuzzy-Naked-Mega) (<https://github.com/FuzzyStudio/Fuzzy-Naked-Mega>).

The objective of this project is to create a version of Arduino Mega 2560 board that has lower component count and smaller board size.

Personally to be used for robotics projects that require Atmega2560's 256 KB flash and digital/analog pins, where the size, weight, and USB port location of the original design is not ideal.

## References:

- Mr. Nick Gammon's [How to make an Arduino-compatible minimal board](http://www.gammon.com.au/breadboard) (<http://www.gammon.com.au/breadboard>),
- TSJWang's [DIY Arduino Mega 2560 or 1280](https://www.instructables.com/id/DIY-Arduino-Mega-2560-or-1280/) (<https://www.instructables.com/id/DIY-Arduino-Mega-2560/>)

Electronics/PCB knowledge provided by:

- [Adafruit Industries](https://www.adafruit.com/) (<https://www.adafruit.com/>),
- [SparkFun Electronics](https://www.sparkfun.com/) (<https://www.sparkfun.com/>).

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## Step 1: Prototype

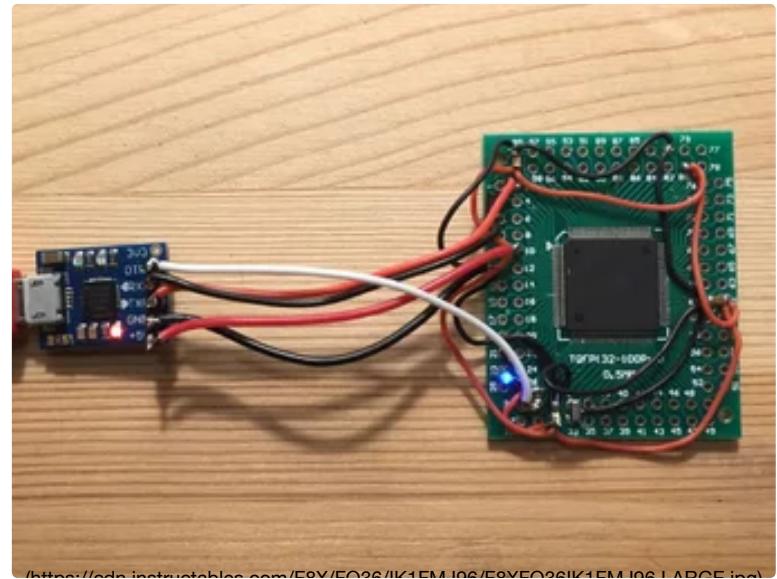
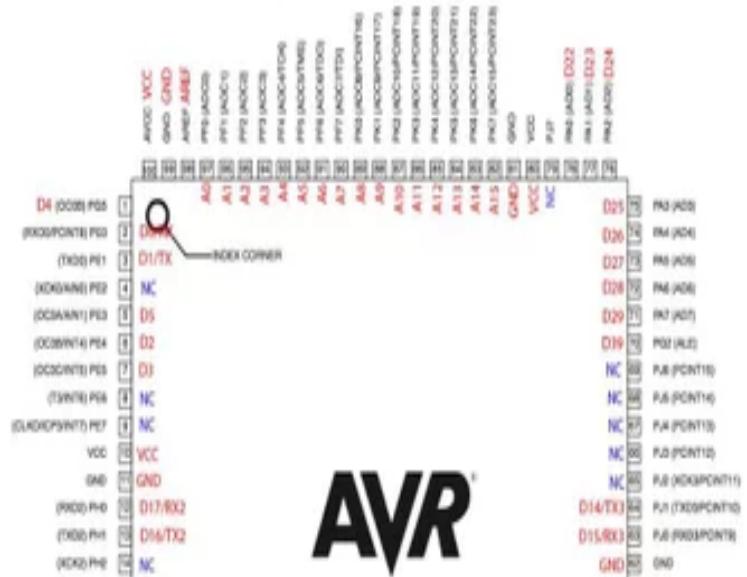




Figure 1-1. TQFP-pinout ATmega640/1280/2560



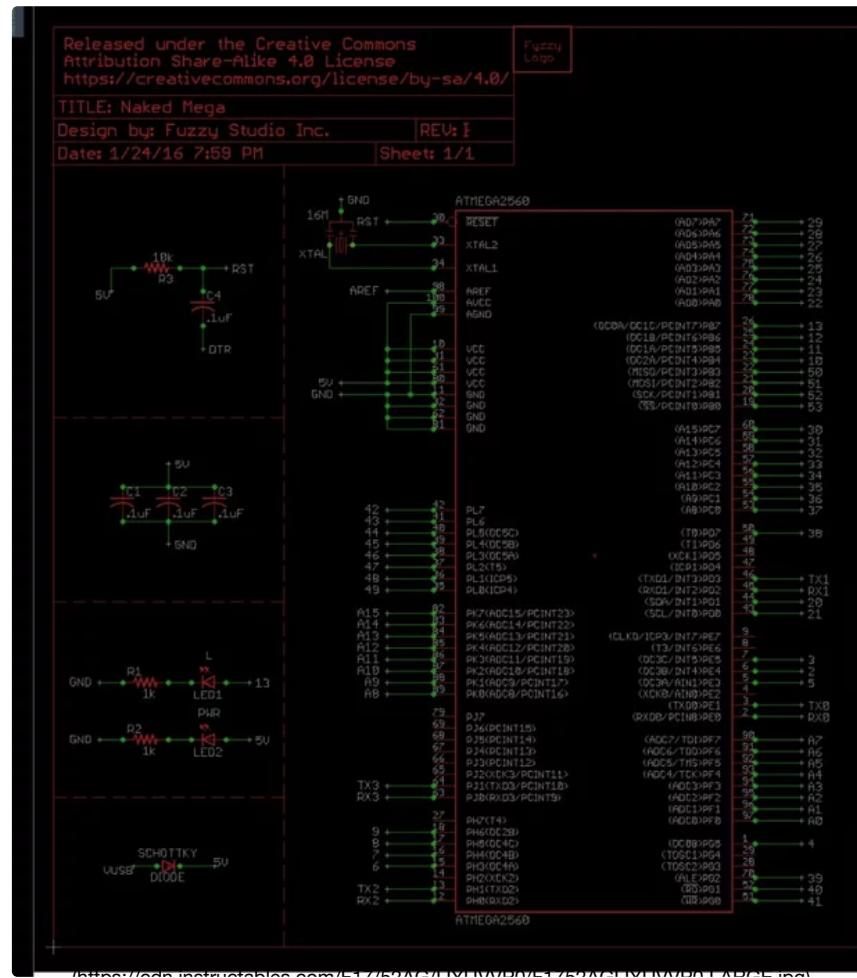
A prototype board was made as proof of concept, the components, placements, and connections are:

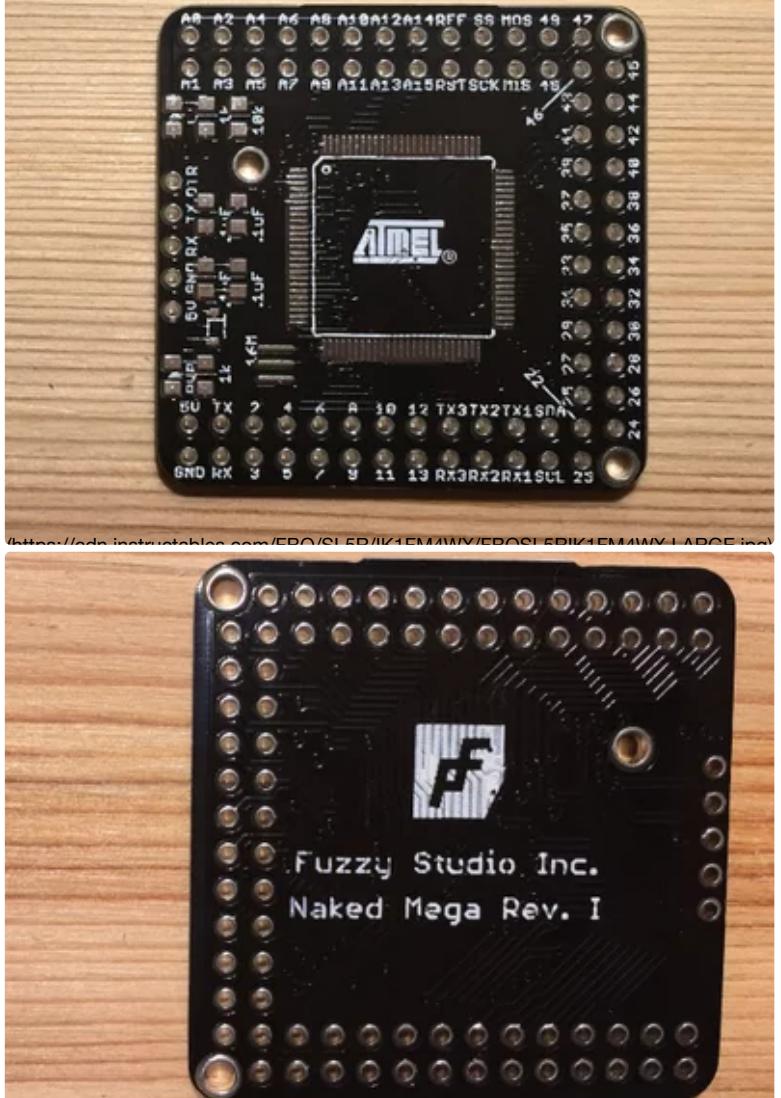
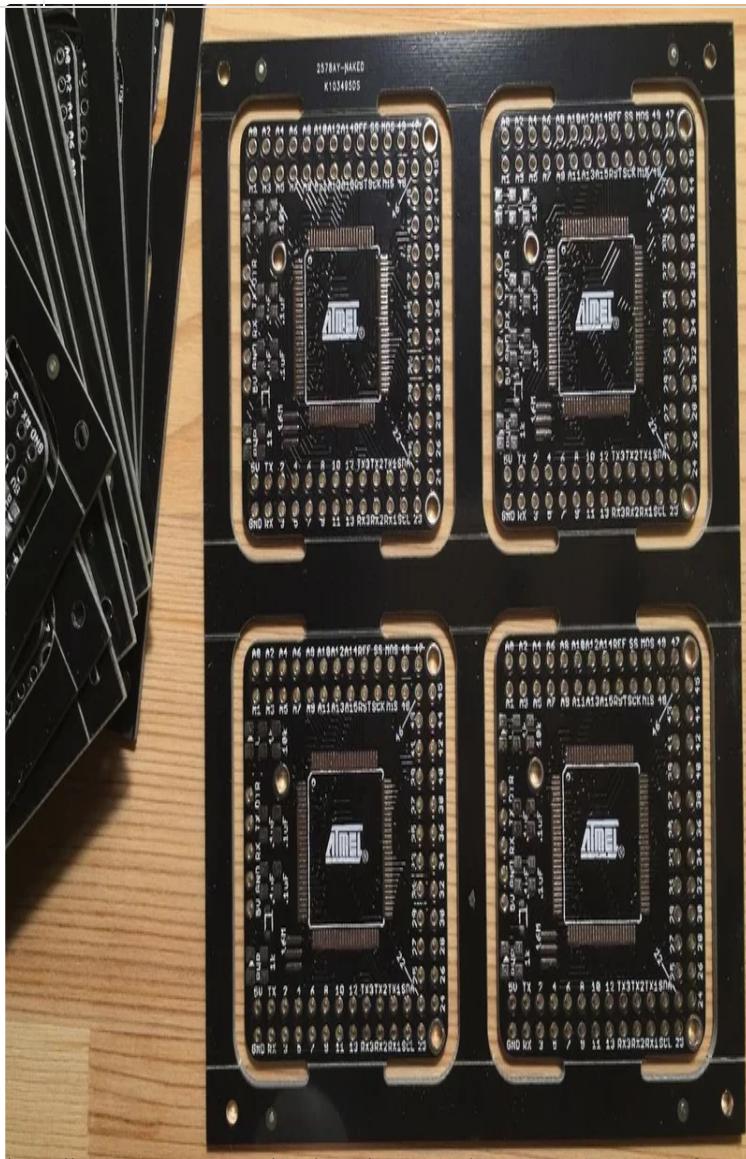
- ATmega2560 chip from an Arduino Mega2560 clone (functional chip and bootloader) removed with a hot-air gun, soldered on to a TQFP100 breakout PCB.
- Connect all VCC/AVCC (chip pins 10, 31, 61, 80, 100) together and GND (chip pins 11, 32, 62, 81, 99) together.
- 0.1uF bypass capacitor x 3, connected in parallel to 3 of the VCC/AVCC and GND pairs (chip pins {31,32}, {61,62}, {99,100}).
- 10k pull-up resistor x 1 connected between RESET (chip pin 30) and VCC/AVCC.
- LED x 1 and 1k current limiting resistor x 1 connected between D/13 (chip pin 26) and GND, this is same as the Arduino Mega "L" LED, to be used as indicator to test prototype.
- 16MHz ceramic resonator connected between chip pins 33 and 34, with resonator's ground pin connected to chip's GND.
- CP2102 USB to UART TTL Module (one that has a DTR pin), with the connections:
  - 0.1uF capacitor x 1 between module's DTR pin and RESET (chip pin 30).
  - Module's RX to D1/TX (chip pin 3).
  - Module's TX to D0/RX (chip pin 2).
  - Module's 5V to chip's VCC/AVCC.
  - Module's GND to chip's GND.

#### After the driver for CP2102

(<https://www.silabs.com/products/mcu/Pages/USBtoUARTBridgeVCPDrivers.aspx>), was installed, a few sample Arduino sketches such as "Blink" and "Fade" were uploaded to make sure the chip was still functioning before designing the board in Eagle PCB.

## Step 2: EAGLE PCB: Revision I



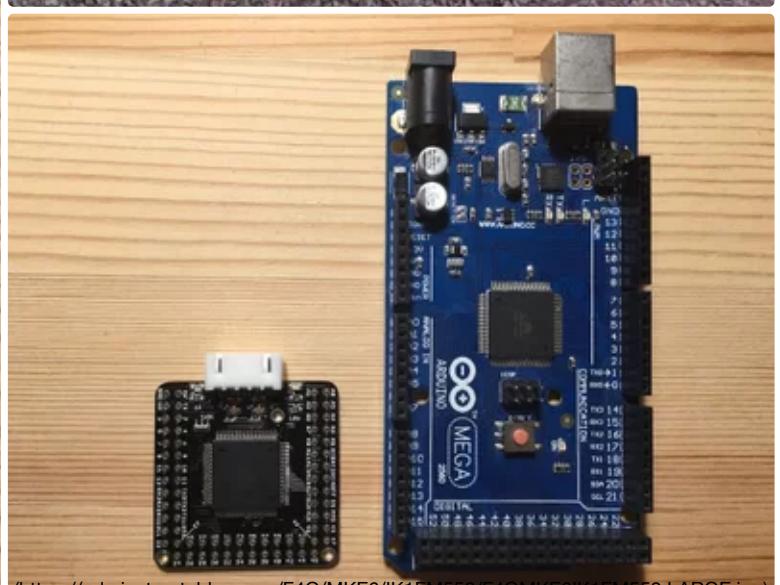
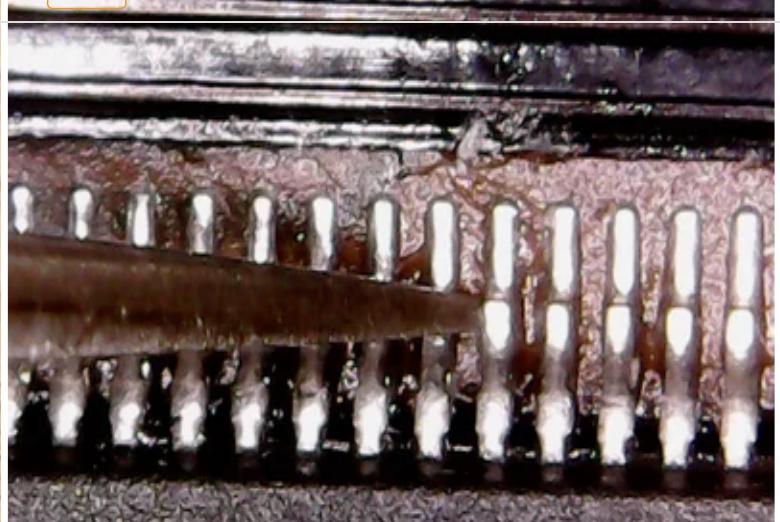
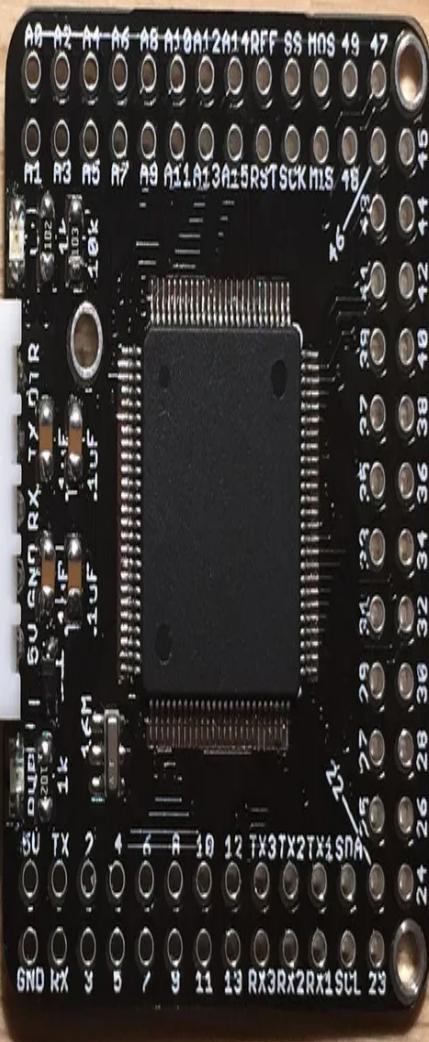


PCB's were made by a manufacture found on China's [www.taobao.com](http://www.taobao.com) (<http://www.taobao.com/>); the cost for 4-layer PCB was 300RMB (45USD) excluding shipping for 10 pieces of 10cm x 10cm board (total of 48 "Naked Mega" produced, with panelizing and extras boards giving by the manufacture), production time was 6 days.

The leaded HASL process was selected for surface finish, this finish is not very flat, thus silkscreen (text and logo...etc.) wasn't pretty; next revision will probably try Electroless Nickel Immersion Gold (ENIG) as the surface finish, cost would be 400RMB (60USD) for the same order.

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## Step 4: Solder Components: Revision I



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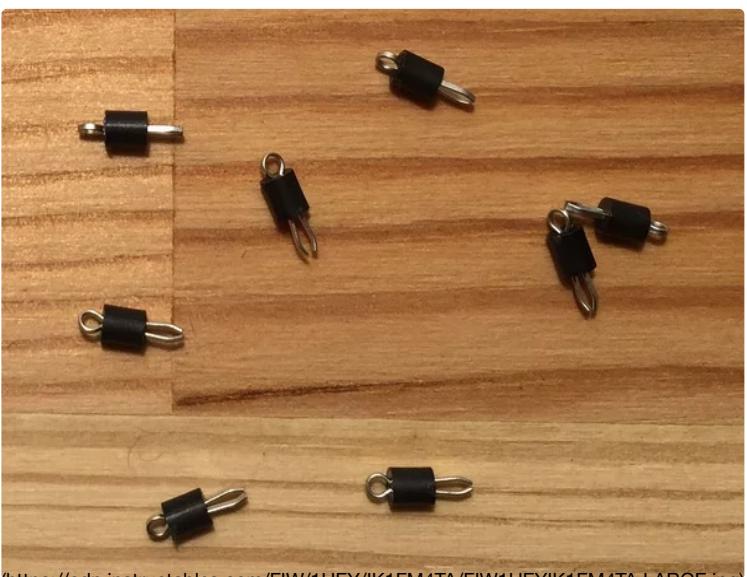
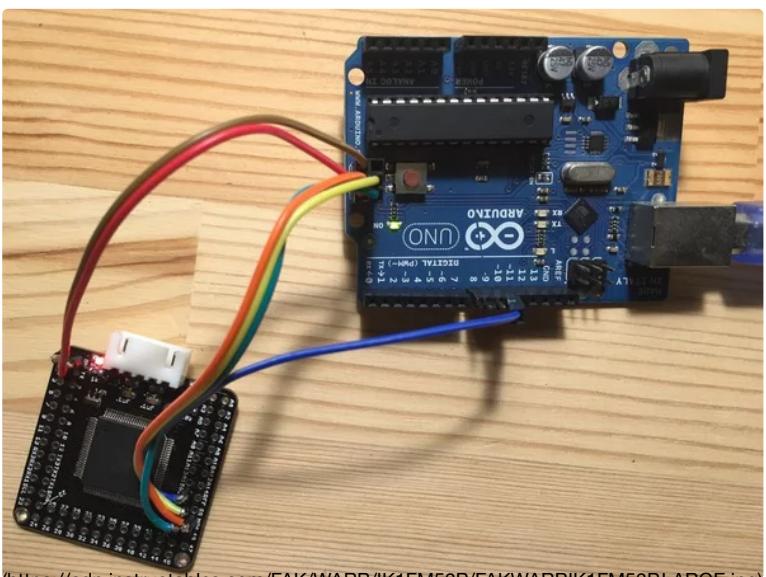
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## Step 5: Upload Bootloader



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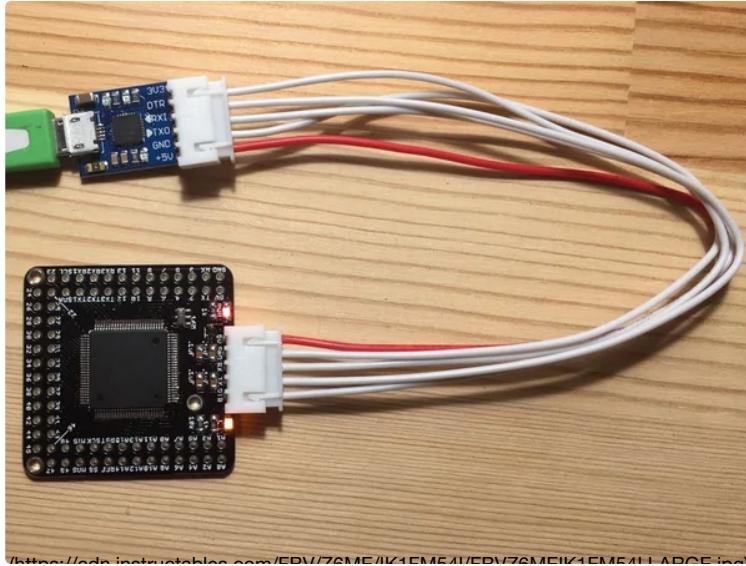
<https://www.instructables.com/EIW/1UEV/W1EM5TA/EIW1UEV/W1EM5TA/LARGE.html>

- Arduino UNO SS (D10) -> Naked Mega Reset/RST pin.
- Arduino UNO MOSI (D11) -> Naked Mega MOSI (D51).
- Arduino UNO MISO (D12) -> Naked Mega MISO (D50).
- Arduino UNO SCK (D13) -> Naked Mega SCK (D52).
- Arduino UNO VCC/5V -> Naked Mega 5V.
- Arduino UNO GND -> Naked Mega GND.

Downloaded Mr. Nick Gammon's [Atmega\\_Board\\_Programmer](#) ([https://github.com/nickgammon/arduino\\_sketches](https://github.com/nickgammon/arduino_sketches)), and upload bootlaoder to chip using Serial Monitor of Arduino IDE according to [instructions](#) (<http://www.gammon.com.au/bootloader>).

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## Step 6: Upload Sketch



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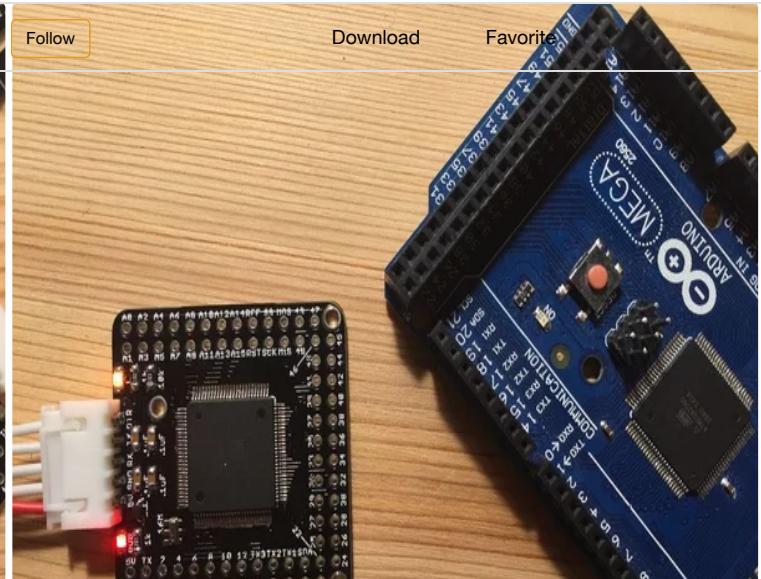
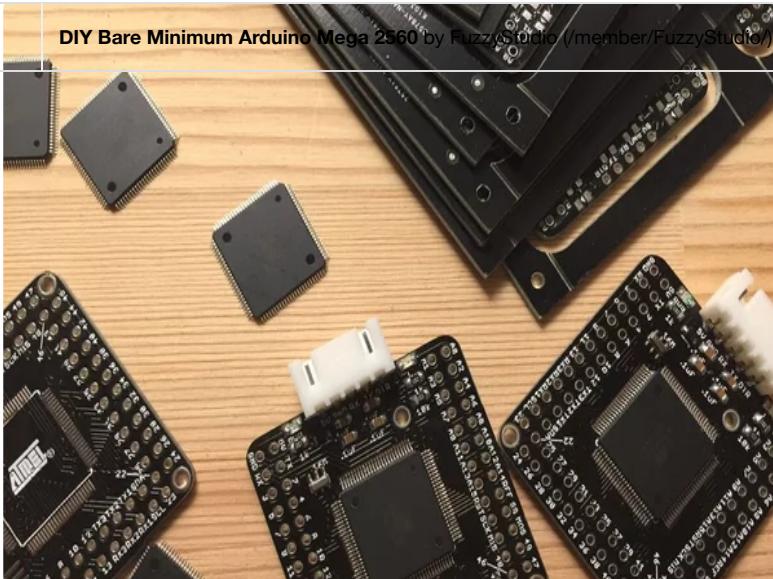
<https://cdn.instructables.com/FU/LIE/LIS/K1EME4/FU/LIE/LIS/K1EME4.LARGE.jpg>

If the [driver](#)

(<https://www.silabs.com/products/mcu/Pages/USBtoUARTBridgeVCPDrivers.aspx>), for CP2102 was installed, when connected the Naked Mega can be programmed like an original Arduino Mega 2560.

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## Step 7: Cost Breakdown



### Cost Breakdown:

- PCB: \$45.6 for 40, \$1.14 for 1.
- ATmega2560: \$6-10 for 1 (price fluctuates greatly)
- 0.1uF 0805 SMD Capacitor: \$0.012 for 4\*.
- 1k 0805 SMD Resistor: \$0.003 for 2\*.
- 10k 0805 SMD Resistor: \$0.0015 for 1\*.
- LED 0805 SMD: \$0.1 for 2.
- 16MHz Ceramic Resonator \$0.08 for 1.
- 1N5819 SOD-323 Diode: \$0.0074 for 1\*.

\*SMD components purchased in strips containing 100 pieces.

**\*\*Cost per board only if all 40 PCB's were used to make functional Naked Mega due to the fixed cost of PCB production.**

\*\*\*Total shipping, taxes and fees was approximately 10(USD) for the above listed orders.

\*\*\*\*\*Cost for a pair of 5-pin 2.54 XH connectors plus wires was 0.18(USD).

A small batch was made and can be purchased on [Tindie](https://www.tindie.com/products/FuzzyStudio/bare-minimum-arduino-mega-2560/) (<https://www.tindie.com/products/FuzzyStudio/bare-minimum-arduino-mega-2560/>).

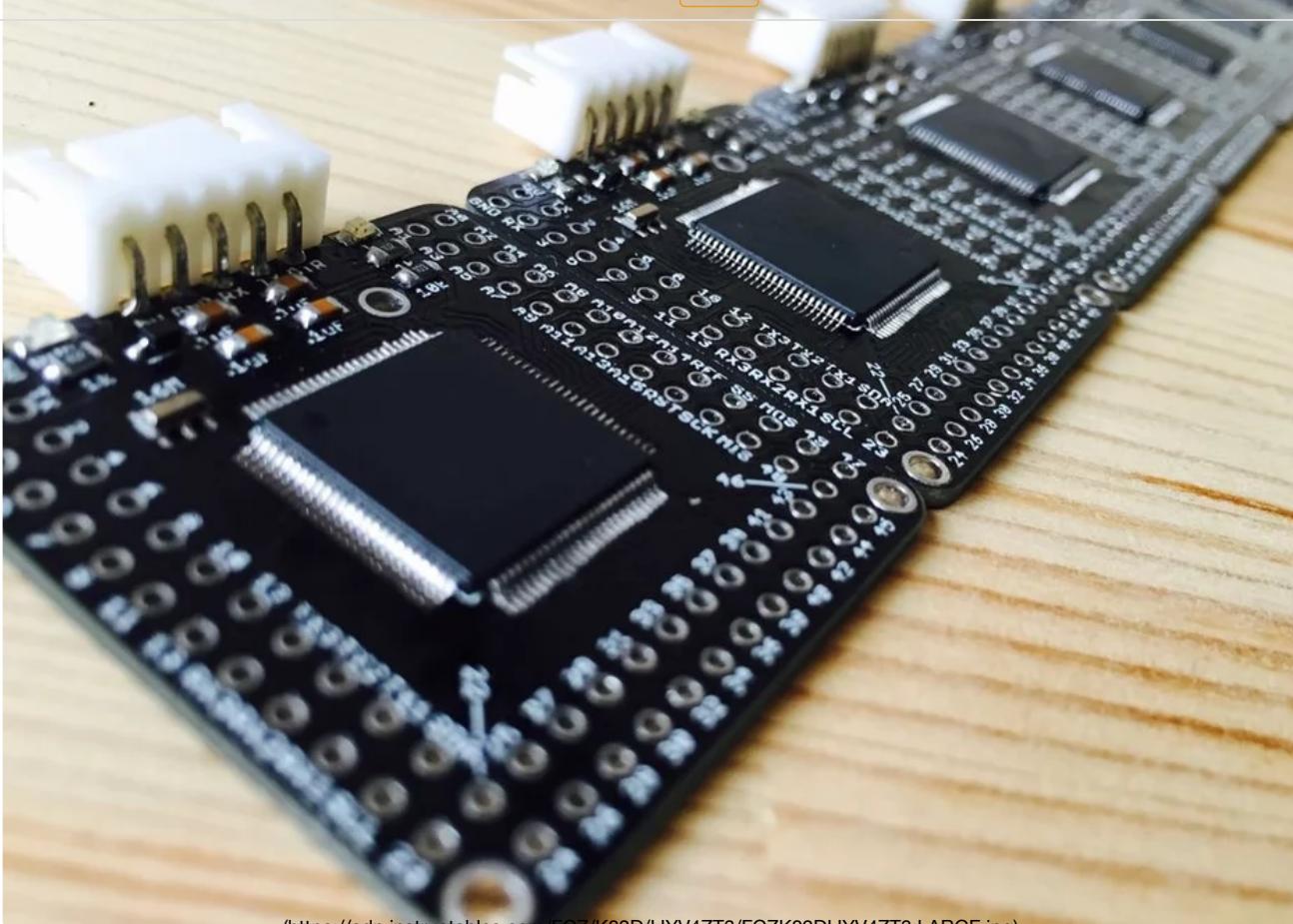
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## Step 8: Design Notes



(<https://cdn.instructables.com/EC7/K00D/LIV/ZT2/EC7K00DLIV/ZT2-LARGE.jpg>)

- To use the onboard AREF/REF pin, a 0.1uF capacitor must be connected between REF pin and GND.
- For safer operation, the external power source should have reverse current/polarity protection (e.g. Schottky diode on +5V).

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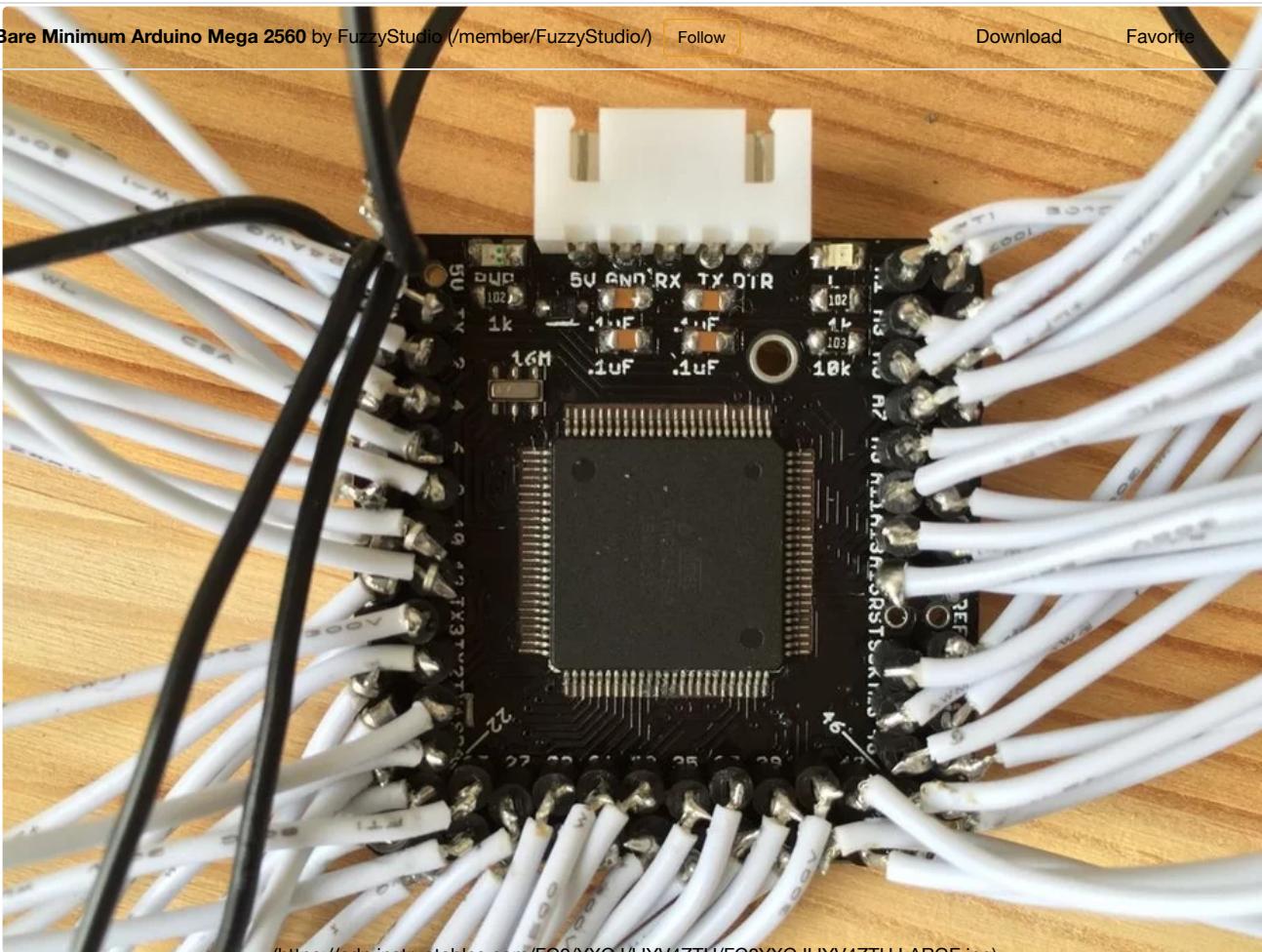
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## Step 9: Test



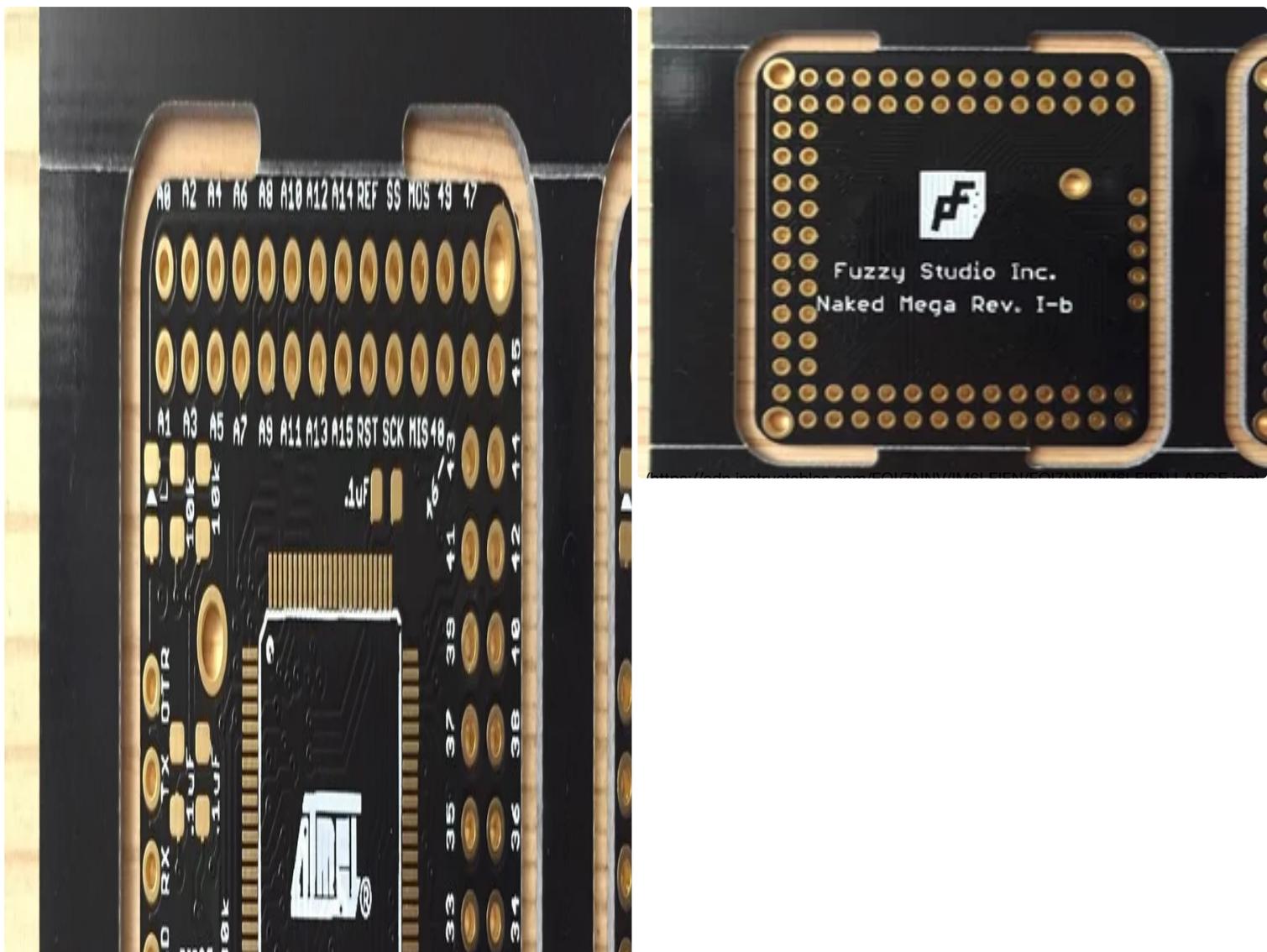
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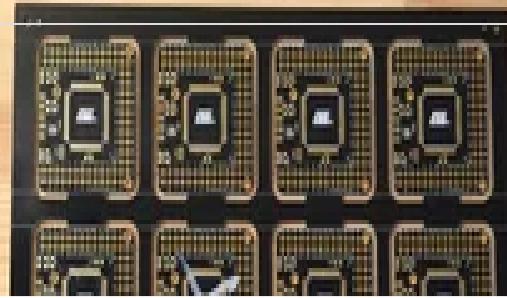
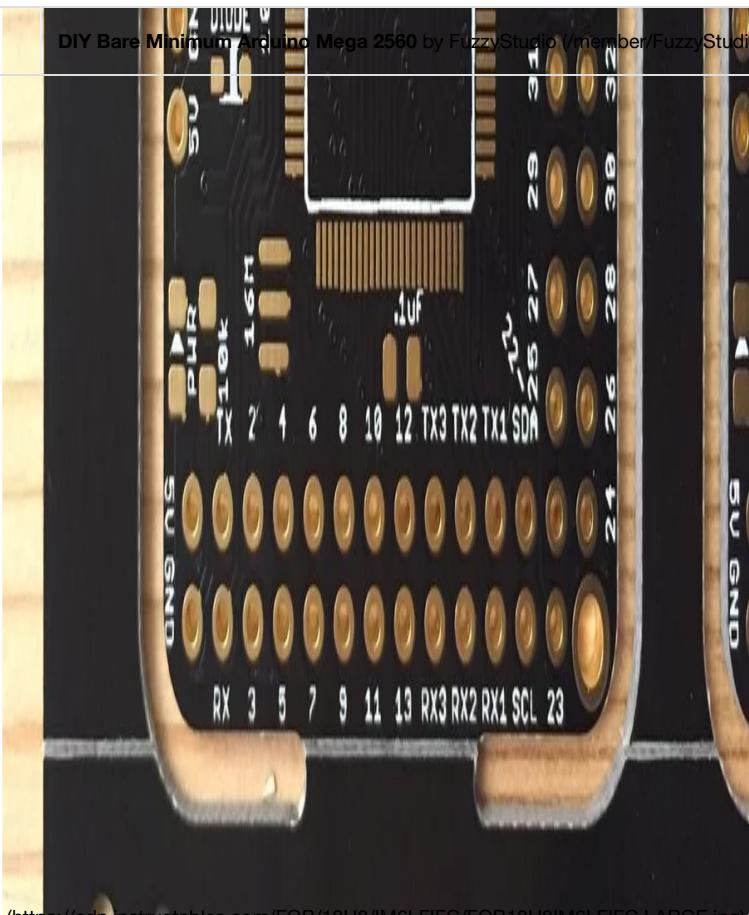
A simple test was done by connecting each of Naked Mega's 70 I/O pins (54 digital + 16 analog) directly to a LED's anode (+) with a 1k resistor in series, with all LED's cathode (-) connected to the board's GND.

The LED's are driven by the board directly, current draw for each LED is approximately 3mA, where the total current draw is around 210mA (3mA x 70); should be under the ATmega2560's max current output of 800mA according to [Arduino Pin Current Limitations](http://playground.arduino.cc/Main/ArduinoPinCurrentLimitations) (<http://playground.arduino.cc/Main/ArduinoPinCurrentLimitations>), as well as 500mA output for most USB ports.

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## Step 10: March 2016 Update: Revision I-b





Changes from previous version:

- Electroless Nickel Immersion Gold (ENIG) surface finish.
- Moved .01uF bypass capacitors closer to the microcontroller.

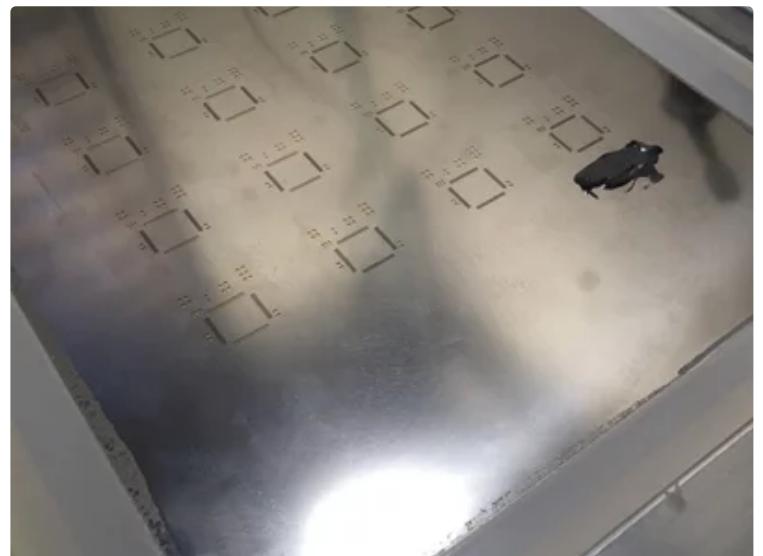
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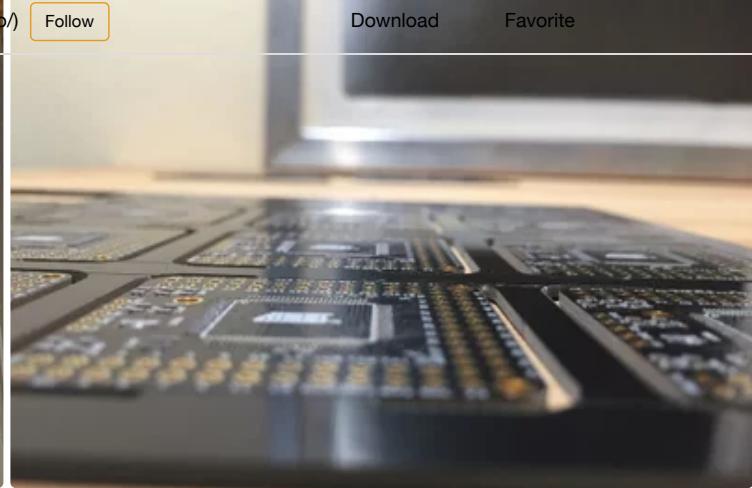
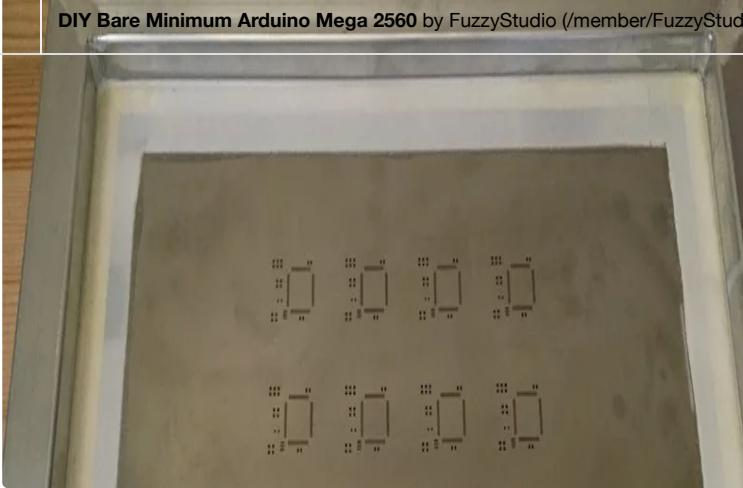
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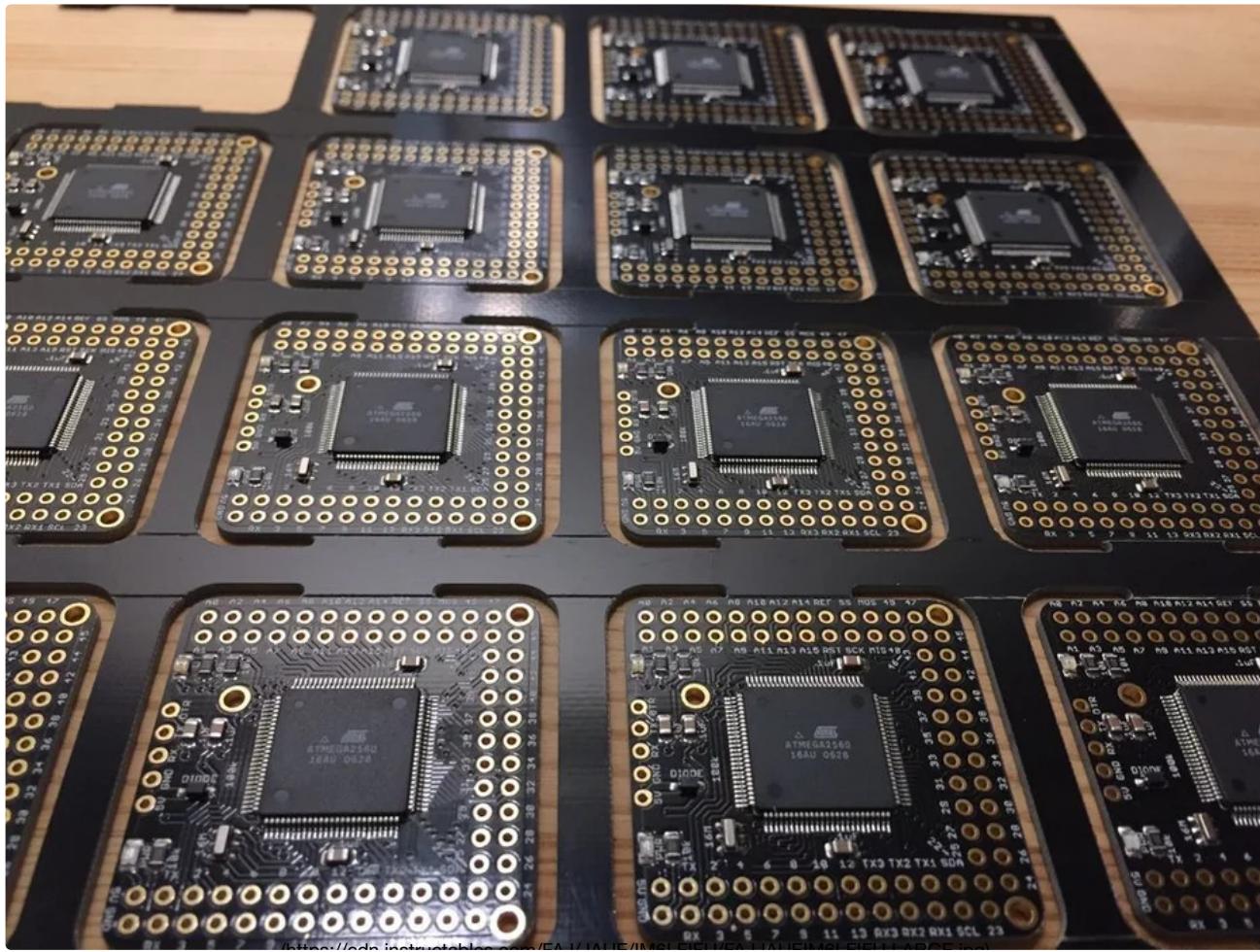
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## Step 11: Stencil for Solder Paste: Revision I-b

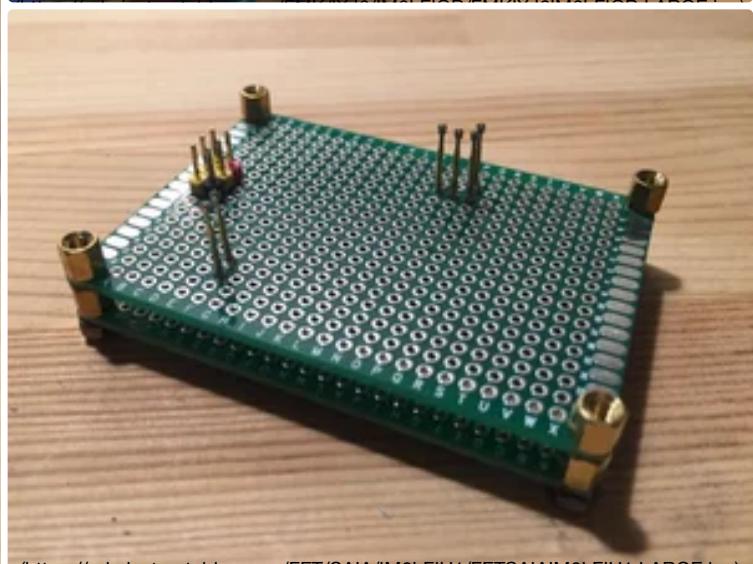
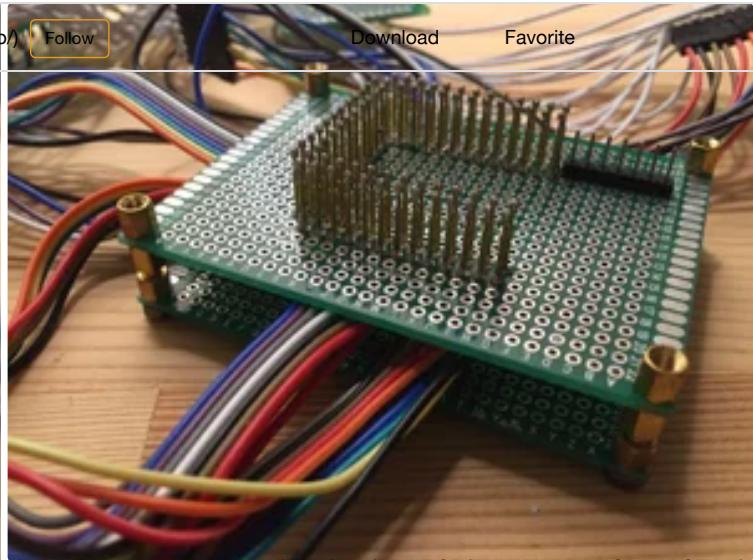
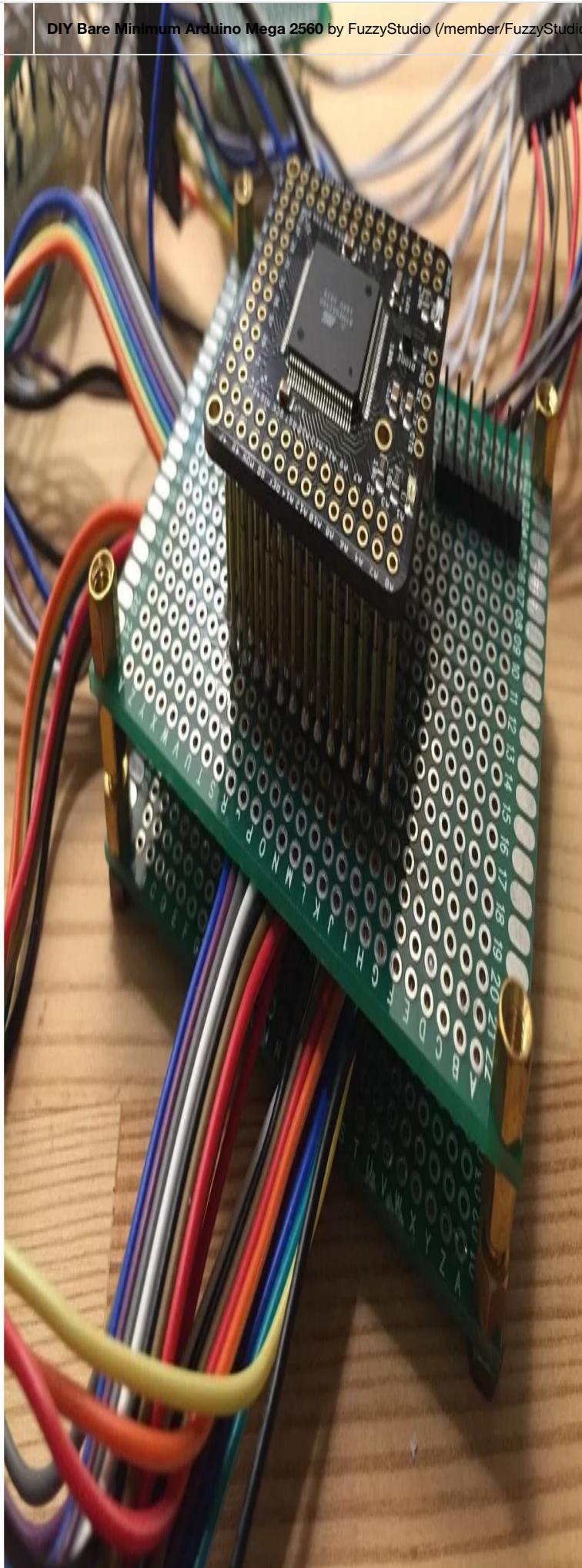


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## Step 12: Place Components and Reflow Solder Paste - Revision I-b

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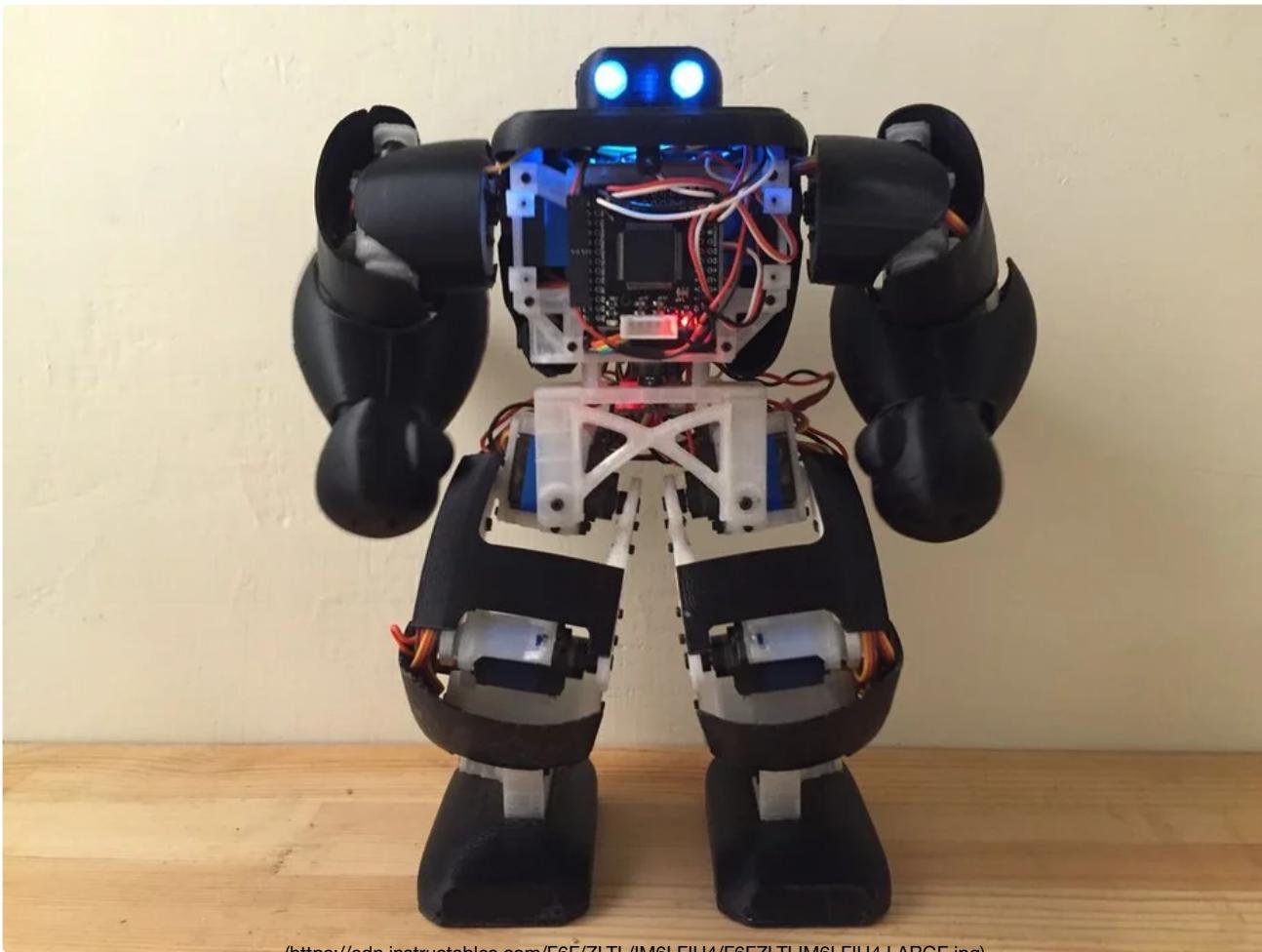
## Step 13: Testing: Revision I-b



Two testing boards were made with pogo pins (pin type P75-LM2/LM3), one to upload bootlaoder, another to test every pin of the board.

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## Step 14: Robot Made With Naked Mega



(<https://cdn.instructables.com/EEF/ZLTL/IM6LEI14/EEFZLTLIM6LEI14.LARGE.jpg>)

A batch of Naked Mega is available to be purchased on [Tindie](#) (<https://www.tindie.com/products/FuzzyStudio/bare-minimum-arduino-mega-2560/>).

Thank you for your support.

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(/member/MambaR/) MambaR (/member/MambaR/) Question 6 weeks ago

Answer

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I have a problem in that I need to connect both the USB connection and 5V power before my sketch will run on the mega. If I only connect the 5V to the mega then it does not run the sketch properly. But if I connect 5V power to both the Maga VCC input and connect this to the USB power input then it starts up properly. Is it ok to connect the 5V vcc supply to the USB power input?

(/member/Do\_Not\_Give\_Up/) Do\_Not\_Give\_Up (/member/Do\_Not\_Give\_Up/)  
Question 2 months ago on Introduction

Answer

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Do you offer a completed breakout board with all peripherals already assembled?

1 more answer ▾

(/member/offtherails2010/) offtherails2010 (/member/offtherails2010/) 3 months ago

Reply

▲ Upvote

absolutely BEAUTIFUL mini low-parts-count MEGA2560 !  
Well done and thanks for sharing the Eagle files for us lowly peasants to learn from !!  
VERY Nice work :)

1 reply ▾

(/member/Icefeet/) Icefeet (/member/Icefeet/) Question 2 months ago

Answer

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This might be a really simple question but i've never seen them before, what are those sort of through hole ring terminal connectors you used for testing? And where do you source them?

1 more answer ▾

(/member/GerardoG6/) GerardoG6 (/member/GerardoG6/) Question 4 months ago

Answer

▲ Upvote

Hello, I wonder if an FTDI could be used to program the MCU, or it is necessary to use the CP2102?, also, the bootloader could be the original from arduino?

(/member/madaeon/) madaeon (/member/madaeon/) 5 months ago

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(/member/SumitD3/) SumitD3 (/member/SumitD3/) 5 months ago on Step 1

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can you explain led blink sketch uploading process in details?

(/member/9600074747asma/) 9600074747asma (/member/9600074747asma/) Question 5 months ago

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(/member/t0mm0t/) t0mm0t (/member/t0mm0t/) 6 months ago

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you just did an awesome job with that. i was already super impressed and then i just saw the naked mega 3 on your tindie page. i can't believe that you've even found the space for a micro usb and all that. i would love to rebuild those as they would be perfect for a lot of my applications. any chance to get the eagle files for the naked mega 3? because on the linked github page there are unfortunately only the ones from rev 1-b.

i would be super thankful if you could share them.

cheers tom

1 reply ▾

(/member/edadalt/) edadalt (/member/edadalt/) 9 months ago

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can you give the link from the manufacturer you used in taobao?

2 replies ▾

(/member/alexandresr/) alexandresr (/member/alexandresr/) 10 months ago

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Eagle says that there's an error in line161, column25: Unexpected ' '... Any idea ?

2 replies ▾

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