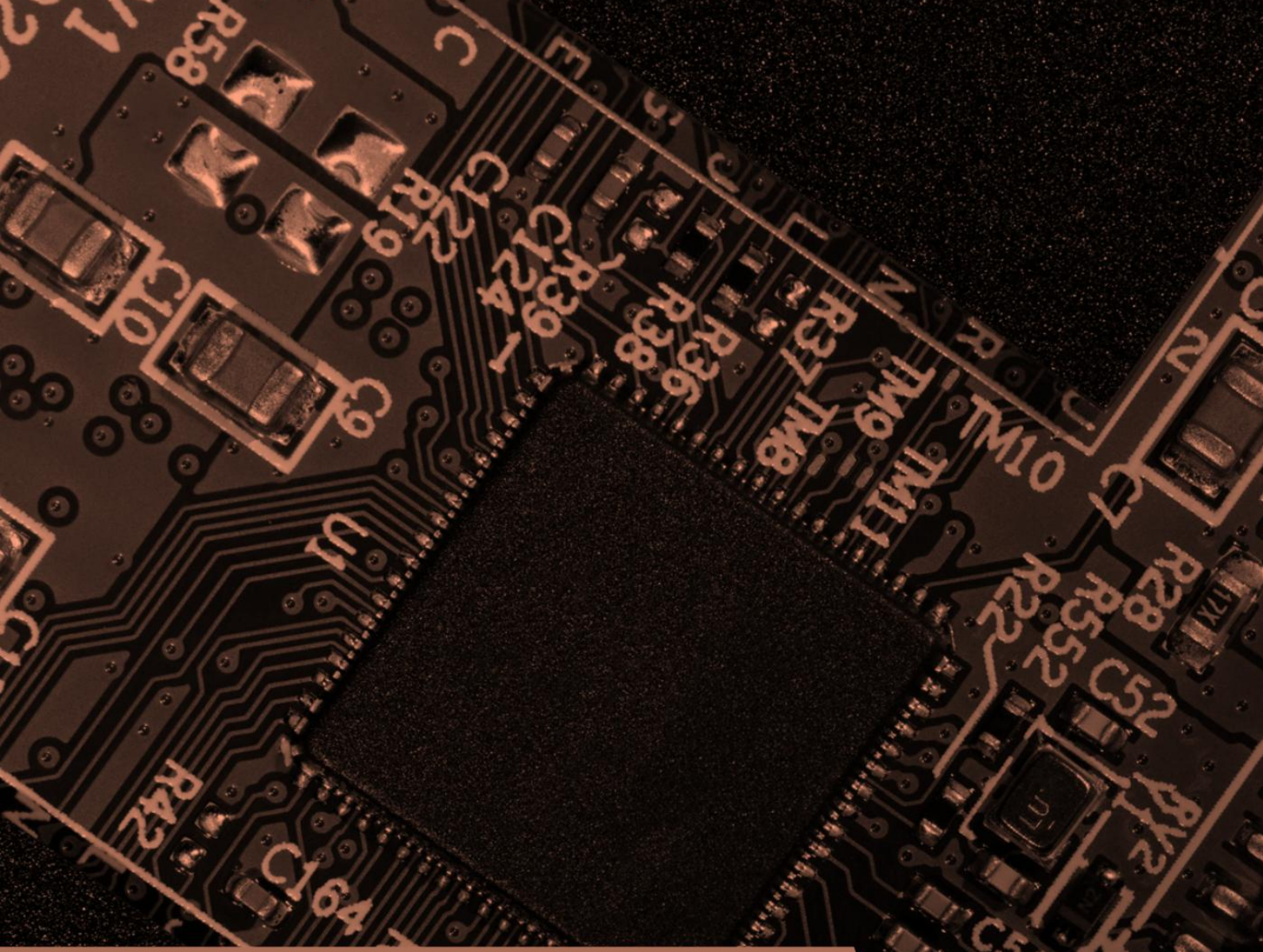

PCB-WATCH
INSTRUCTIONS

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Introduction

This is a guide on how to make a 40mm watch in an analog style that features a cyber-inspired electronics design, highlighting its PCB, microcontroller, and high-tech LED display. This project is inspired by the Lumidial Project [1]. It focuses primarily on hardware interfacing, along side there is an opportunity to learn about PCB design if desired.

Materials

Main materials

- Li-Po Battery 3.7V 150mAh with built-in protection circuit Rechargable (TinyTronics)
- TP4056 USB-C Li-ion charger 1A with Li-ion protection circuit (TinyTronics)
- Watch strap (personal preference)
- Watch case 40mm x 11,5mm (The PCB is 39.6mm for this case you need to sand it down: AliExpress 39mm (Tip: this case also has an issue, the back panel is glass meaning its harder to make a hole for the charging port.)
- Stranded wires length 20cm (for charger)
- Pogo-pin connector 2pin male female AliExpress

Tools

- Pogo Pin Probe Clip - 6 Pins (TinyTronics)
- F-F Jumper Wires: 6pcs (Preferably the same colors as your clip)
- Arduino Uno
- Arduino IDE
- Soldering iron, solder & flux
- Multimeter

PCB components

The custom PCB for this project can be ordered pre-assembled or as a blank PCB. For simplicity, it is recommended to order a pre-assembled PCB, for this refer to CustomPCB.

However, if you prefer to self-assemble, the following components are required:

- Microcontroller: ATmega328P (TQFP-32 package)
- Real-Time Clock (RTC): DS3231MZ+ (SMD package)
- Red SMD LEDs: 60 pcs (0603 package)
- Blue SMD LEDs: 12 pcs (0603 package)
- SMD Tactile Switch: 1 pc (3 × 2.5 mm package)
- Crystal Oscillator: 16 MHz (SMD package)

- Load Capacitors for Crystal: 20 pF, 2 pcs (0603 package)
- Current-Limiting Resistors: 470 Ω (0603 package)
- Pull-up / General Resistors: 4.7 kΩ, 3 pcs (0603 package)
- Decoupling Capacitor: 100 nF (0.1 µF), 1 pc (0603 package)
- Bulk Capacitor: 10 µF, 1 pc (0805 package)
- Filter Capacitor: 1 µF, 1 pc (0603 package)

Custom PCB

First things first, the main component is the PCB. As previously mentioned, the PCB can be ordered pre-assembled, this is also the approach the tutorial focusses on.

In the given zip file there are 4 different files,

1. Gerber file
2. Bom file
3. Pick & Place file
4. PADS

For those who wish to edit the PCB design or add a custom silkscreen, the design can be modified using Easyeda by importing the PADS file.

To order the PCB you will need the remaining files (Gerber, Bom and P&P) , or through the Easyeda page click File → Export → Gerber → Order PCB.

When ordering you will be greeted with alot of options, choose your colour as you wish etc but make sure to have the following settings:

PCB Specification:

- Surface Finish: Leadfree HASL

PCB Assembly settings (not needed if you self assemble) :

- PCBA Type: Standard
- Assembly side: Both Sides

Components list:

- Project has unselected parts: Click on do not place.

Programming

Once you have the PCB, it is time to make it into an actual functioning watch!

Physical Set up

To program the ATmega328 on the PCB, six programming pads are provided. A 6-pin test clip can be attached to these pads, after which the clip's cables must be connected to an Arduino.

You will need six female-to-female jumper wires for this step. It is recommended to use jumper wires that match the colours of the test clip leads to minimize confusion during wiring.

When using the TinyTronics test clip listed in the materials, the relevant wire colors are:

Red, Brown,Black,White,Gray,Purple

If you are using a test clip with different wire colors, the specific colors listed above do not apply; refer instead to the pin mapping provided in the programming table.

PCB	Arduino	Function	Cable number + (colour)
MISO	D12	Master In Slave Out	1. Red
MOSI	D11	Master Out Slave In	2. Brown
SCK	D13	Serial Clock	3. Black
RST	D10	Reset	4. White
GND	GND	Ground	5. Gray
VCC	5V	Power (5V)	6. Purple

Arduino IDE Set up

To successfully upload code to the ATMega328 the Arduino IDE needs the correct settings and the Arduino needs to act as a programmer.

Prepare the Arduino as an ISP

1. Open **Arduino IDE**
2. Connect your Arduino to your PC
3. Go to File → Examples → 11.ArduinoISP → ArduinoISP
4. Select the correct **Board** and **Port** for your Arduino
5. Upload this sketch to your Arduino

After this, your Arduino acts as a programmer.

Get the correct Board

Add MiniCore to Arduino IDE

1. Open Arduino IDE → File → Preferences
2. In the “Additional Boards Manager URLs” field, add this URL:

https://mcudude.github.io/MiniCore/package_MCUdude_MiniCore_index.json

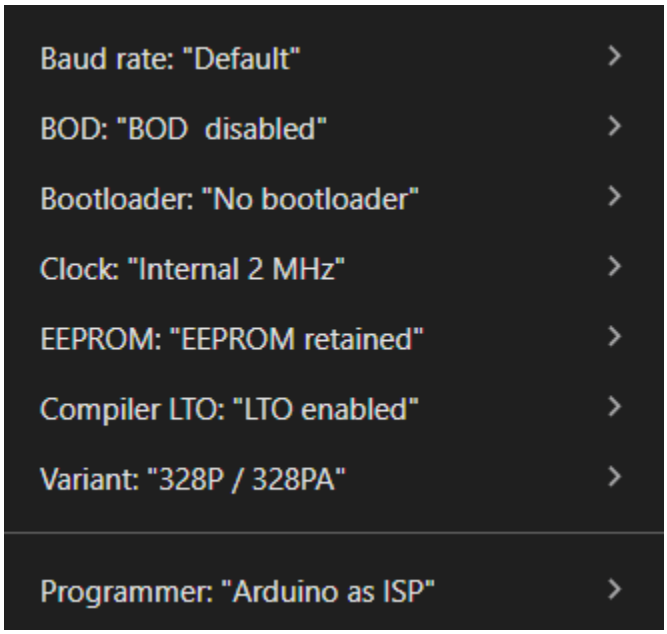
3. Click OK

Install MiniCore via Boards Manager

1. Go to Tools → Board → Boards Manager…
2. Search for MiniCore
3. Click Install for the package by MCUdude

Select the ATmega328P Board

1. Go to Tools → Board → ATmega328 (MiniCore section)
2. Configure options:



Library to install

- DS3231M

Code

Once the setup has been completed, code can be uploaded. Feel free to customize to preference.

For ready to upload working code you can find it in my GitHub: GitHub PCB_Watch it contains the following features:

LED Matrix Display

- Uses a 9x8 (anodes x cathodes) matrix to display hours, minutes, and seconds.
- Shows time in 12-hour format for hours, 60 for minutes/seconds.
- Blinking in edit mode for easier adjustment.

Button Control

- Short press (<0.5s) in edit mode: increments current value.
- Medium press (0.5s) in normal mode: toggles LEDs on/off.
- Long press (2s): cycles through edit modes — Hour → Minute → Second → None.
- Extra long press (8s) in normal mode: toggles DST on/off.

Edit Mode

- Entered via 2-second button press.
- Visual feedback: blinking LEDs indicate which value is being edited.
- Adjust hours, minutes, and seconds individually.

Power Optimization

- Disables unused peripherals (ADC, USART0, Timer1/2, SPI) to reduce power consumption.

Power

To finish off its time to give it life by powering it and thus being ready to be placed in its case.

Battery

To begin, it is essential that the battery includes a protection circuit to ensure safety and long-term reliability. This protection circuit disconnects the battery in critical situations such as over-discharge, short circuits, overheating, and other fault conditions.

This step is straightforward. Start by stripping a small section of insulation from both the red and black battery wires, then apply flux to the exposed conductors.

Heat the B− pad on the PCB with the soldering iron and apply solder. Attach the black wire to the B− pad and allow the joint to cool.

Next, repeat the process for the positive connection. Heat the B+ pad, apply solder, and solder the red wire to the B+ pad on the PCB.

If the connections are correct, the watch should power on. If it does not, use a multimeter to troubleshoot the connections and verify polarity and continuity.

Charger

The final finishing touch is assembling the charger. This step is slightly more complex, as it involves magnetic components, which can make soldering a bit tricky.

Because the pogo pins are magnetic, the soldering iron tip may be pulled toward them, which can unintentionally heat the surrounding plastic. Take extra care during this step, as excessive heat can cause the spring-loaded pins to sink into the plastic housing, making them difficult to repair.

Once the wires are attached, start by connecting the side with the spring-loaded pins, as shown in Figure 1. Solder one wire to the B− pad and the other to the B+ pad on the charging module.

Figure 1 Pogo pins (left: charging module, right: PCB)

Next, click the two connectors together and carefully verify the polarity. When attaching the other end to the PCB, ensure that B− corresponds to C− on the PCB. Solder the wire to the C− pad. Repeat the process for the positive side, making sure B+ corresponds to C+, and solder the wire to the C+ pad on the PCB.

Verify the connections and continuity with a multimeter, and you should be all set!

References

[1] Taifur, “LumiDial: a 72-LED Analog Wristwatch Powered by ATmega328,” [Online]. Available: https://www.instructables.com/LumiDial-a-72-LED-Analog-Wristwatch-Powered-by-ATm/.