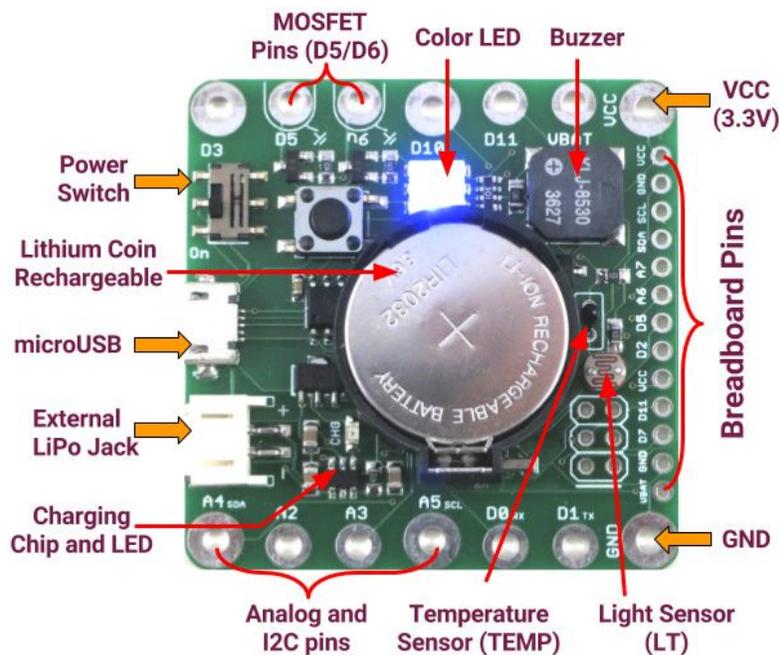


SquareWear 2.4 User Manual

(May 29, 2017)

SquareWear 2.4 is an open-source, wearable and Arduino-compatible microcontroller board. This version measures 1.7"x1.7" in size, and has built-in LIR2032 rechargeable Lithium coin battery. It has a number of integrated components (see below). It is designed to be sewable: you can stitch conductive threads through the large pin pads, solder a wire directly onto the pads, or solder snaps onto the pads to allow quick attachment or detachment from textile and fabric. Best of all, it's based on Arduino, so you can make use of numerous available Arduino libraries to help build your project! SquareWear 2.4 is perfect for wearable electronic projects as well as general-purpose microcontroller projects. It's also a great little board for learning Arduino programming.

1. Hardware Interface:



2. Features and Built-in Components:

- ATmega328 running at 8MHz, compatible with Arduino Pro/Pro Mini 8MHz or Lilypad w/ ATmega328
- 3.3V 250mA linear regulator.
- Built-in Lithium rechargeable coin battery (LIR2032), with an additional external LiPo battery jack.
- Built-in Lithium battery charging chip and indicator LED; can charge either the built-in coin battery or an external LiPo battery.
- Built-in CH340G USB-serial chip.
- Built-in microUSB port, for uploading Arduino program, charging battery, and serial communication.
- Temperature sensor, light sensor, color LED, buzzer, push-button, power switch.
- Seven digital pins (0, 1, 3, 5, 6, 10, 11) and four analog pins (A2, A3, A4, A5, among which A4 and A5 are also I2C pins) are mapped out onto large pin pads suitable for sewing and soldering.
- Six of the mapped out pins are extra large to fit sew-on snaps. A pin for directly accessing battery voltage is also mapped out (VBAT).
- Two digital pins (5 and 6) are internally wired to MOSFETs to support high-current load (220mA).
- Breadboard friendly pins mapped out on the right-hand side, with additional digital and analog pins.

3. Power Options (**IMPORTANT! PLEASE READ!**)

- SquareWear has built-in 45mAh rechargeable Lithium coin battery (LIR2032). Every time you plug in the USB cable it charges the battery automatically. **Do NOT use it with non-rechargeable batteries** such as CR2032.
- You can also use an external LiPo battery. If you do, please remove the built-in coin battery.
- The build-in Lithium charging chip is set to charge at 35mA. This will fully charge the coin battery in about 1-2 hour. The time to fully charge an external LiPo varies depending on the battery capacity. The green indicator LED will turn off when battery is fully charged.
- SquareWear has a built-in LDO providing regulated 3.3V (up to 250mA) from battery. When battery voltage drops below 2.7V, the microcontroller will stop running. In this case, you should plug in a USB cable and charge the battery for at least 15 minutes before using it again.
- SquareWear has a VBAT (battery) pin, which allows direct access to the battery voltage. If your project requires high power, you can use this pin to provide high current. Keep battery plugged in at all times. Certain functionality, such as buzzer, may not work properly if battery is removed.

4. Pin Names and Functions (compatible with Arduino)

- **Digital I/O Pins:**

- **D0 / D1:** also serial RX/TX pins
- **D3 / D5 / D6 / D10 / D11:** supports hardware PWM*. Among them D5 and D6 are MOSFET pins**.

*** PWM (Pulse Width Modulation)**

*Also referred to as analog output, provides adjustable level of voltage. You can use PWM to control the brightness of the LED, the speed of a motor etc. All PWM pins can function as standard digital I/O pins, but additionally you can use Arduino's **analogWrite** function to set analog voltage levels.*

**** MOSFET pins**

D5, D6 support hardware PWM, and in addition they are internally wired to MOSFETs that serve as 'Power Sinks'. This means setting the pins to logic high will connect them to GND, and setting them low will disconnect them from GND. Therefore, in order to use MOSFET pins, such as for controlling an LED, a motor, a muscle wire etc, you need to connect the positive lead of the device to VCC or VBAT, and negative lead to one MOSFET pin. By setting the pin high or low, you can control the device.

The main advantage of MOSFET pins is that they can drive a high current (up to 220mA), so your LEDs will look very bright, your speaker will sound loud, etc. Some devices, such as motor, heat wire, muscle wire, require high current to work. In contrast, Arduino's Digital pins can only drive about 40mA current. You can combine the two MOSFET pins together to drive twice as much current.

- **Analog Input Pins:**

- **A2** (also digital D16)
- **A3** (also digital D17)
- **A4** (also digital D18 and I2C SDA pin)
- **A5** (also digital D19 and I2C SCL pin)

Analog pins are typically used to read analog signals, such as sensor values. They can also function as digital I/O pins.

- **Internally Assigned Pins** (**not available for general-purpose use**):
 - **D4**: push-button
 - **D8 / D12 / D13**: red / green / blue channel of the RGB LED
 - **D9**: buzzer (set this pin LOW if not using buzzer).
 - **A0**: light sensor (LT)
 - **A1**: temperature sensor (TEMP)
- **Breadboard Pins** (**below are additional pins that have not been covered above**):
 - **D2 / D7**: digital I/O pins (these two do not support hardware PWM but can use software PWM)
 - **A6 / A7**: analog input pins (these two are analog-only and cannot be used as digital pins)

Breadboard pins are useful if you want to use SquareWear for breadboard experiments. In addition, the ordering of these pins is carefully designed for easy plug-in of external components. The image on the right shows an example of plugging in MPU6050 gyro/accelerometer, as well as a Bluetooth transceiver. The breadboard pins directly match the pin ordering on these external components.



- **Sewing and Touch Sensing**:

SquareWear has large pin pads, allowing you to stitch conductive threads through them and attach the board to textile or fabric. You can also solder wires directly to the pin pads, or solder sew-on snaps to allow quick attachment to / detachment from textile. The large pins are also suitable for touch sensing. Please refer to the touch sensing demos in SquareWear software library. It generally helps increase the touch sensitivity by: 1) moistening fingers; 2) holding the VCC or GND pins.

5. Programming SquareWear 2.4:

1. **Arduino Installation**: go to arduino.cc, download and install Arduino.
2. **Driver Installation**: (*driver is only required for Windows XP, or Windows 7 64-bit, or Mac OSX*)
 - Windows driver: <http://raysfiles.com/drivers/ch341ser.exe>
 - Mac OSX driver: http://raysfiles.com/drivers/ch341ser_mac.zip
3. **Arduino Library**: SquareWear 2.3 library provide several starter demos. Installing the library is optional but is a recommended starting point (note: SquareWear 2.3 and 2.4 are almost the same, except 2.4 has built-in lithium coin battery whereas 2.3 does not have built-in battery):
 - **Download the library**: <http://raysfiles.com/sqrwear/SquareWear23.zip>
Unzip it to the libraries folder in your Arduino installation folder (e.g. arduino-1.0.6/libraries)
 - **Workshop tutorial materials**: <http://raysfiles.com/workshops/SWworkshop.zip>
The tutorial materials are good for a 2-3 hour workshop at high-school or college level.
4. **Upload a Program**: run Arduino, then in **Tools -> Boards**, select **Arduino Pro Mini 3.3V 8MHz w/ ATmega328** (or **Lilypad w/ ATmega328**) and in **Tools -> Serial Port**, select the available serial port (similar to standard Arduino), then click on Upload to upload a program to SquareWear. To try any library example, go to **File -> Examples -> SquareWear23**, and select any example there.

Using Arduino Libraries:

Since version 1.0.5, Arduino allows you to install libraries directly in the Arduino IDE (**Sketch -> Included Libraries -> Manage Libraries**). Some of the libraries files included in SquareWear23 folder may be outdated (e.g. SoftPWM library). If you receive an error message when compiling any demo program, you can install the latest version of the corresponding library directly in the Arduino IDE and try again.

Using Hardware Interrupts:

Hardware interrupt pins are very useful for low-power applications when you need to wake up Arduino from deep sleep, or other applications such as frequency counting. SquareWear 2.4 has two hardware interrupt pins:

- **D3**: also known as INT1. This pin is mapped out at the upper-left corner of the circuit board.
- **D2**: also known as INT0. This pin is mapped out at the breadboard pinout area.

Serial Communication:

SquareWear 2.4 has built-in CH340G USB-serial chip, which allows serial communication. You can use the standard Arduino Serial functions, such as `Serial.begin`, `Serial.print`, `Serial.println`, for printing information to the serial monitor, for debugging, and for receiving user input from the serial monitor etc.

Using Neopixel (WS2812/WS2813) LED Strips or Matrix:

The SquareWear23 library has pre-installed Adafruit's **Neopixel** library. You can use it to interface with Neopixel (aka 2812/2813) LED strips/matrix. The SquareWear examples include several demos under the LED matrix category. These demo programs assume the LED strip/matrix is connected to: VCC (red wire), GND (black wire), and pin D10 (white wire). If the LED strip or matrix contains a large number of LEDs, we recommend using the VBAT (battery voltage) pin instead of VCC, to provide high current.

