LED Watch

*User Manual*

## **Safety / Warning**

Keep the following in mind if planning to power and/or wear this device:

1. Battery must be inserted correctly. With the bottom of the board facing upwards, insert the battery with the positive side facing upwards. The negative side of the battery should be touching the board, the positive side touching the battery holder. ***Failure to insert the battery correctly will damage components!*** The lights will turn on if it is inserted correctly.
2. The watch has been coated to improve water and electrical resistance, however, it is not water-proof. Remove watch before showers, swimming, etc.

## **Usage / Battery Information**

The watch contains two buttons that control the watch’s functionality. They will be referred to as “top” and “bottom” button. The device can be powered using either a CR1216 (included) or CR1225 coin cell.

The battery life is highly dependent on how often the LEDs are on, the brightness of the LEDs, and the display mode. For a rough estimate, assume the CR1216 cell has an energy capacity of 25 mAh and the max current draw is 3.85 mA when the LEDs are on. With these values, the battery will last 6.5 hours if the LEDs are constantly on. When the LEDs are off, the watch enters a low power mode and consumes about 2 uA. If the LEDs are never on, the battery would last for well over a year. For this reason, it’s highly recommended to turn off automatic wake (see below).

### **Setting Time**

With the watch powered, press and hold the top button for three seconds. After three seconds, the current LED in the “hours” ring of LEDs will begin flashing. This signifies the currently set hour. To change the hour, press and/or hold the bottom button until the hour is set as desired.

Next, press the top button again and the “minutes” ring should begin flashing. Repeat as above, using the bottom button to change the set minute and the top button to continue

Lastly, the “seconds” ring of LEDs will flash. Set the desired time in seconds and finish setting the time by pressing the top button once more. The watch should return to showing time.

### **Changing Display Mode**

With the watch powered, the bottom button when pressed and not held will change the way the LEDs are lit to represent time. Mode 1 (default) and Mode 2 have automatic light detection and LED dimming. Mode 3 does not have this functionality.

### **Automatic Wake**

By default, the watch is programmed to automatically turn off the LEDs 10 seconds after the last user input to extend the battery life. It is also programmed to automatically wake or turn the LEDs on at the change of every minute. This can be changed to turn on the LEDs at every hour change, when the time is noon, when the time is midnight, or to disable automatic wake (highly recommended to extend battery life).

To change this setting, press and hold the bottom button for three seconds. An LED representing which setting is currently selected will be displayed:

1. LED at 12 o’clock on the hours ring lit, PM led off – Automatic wake at midnight
2. LED at 12 o’clock on the hours ring lit, PM led on – Automatic wake at noon
3. LED at 1 o’clock on the hours ring lit – Automatic wake at every hour change
4. LED representing 1 minute – Automatic wake at every minute change
5. All LEDs off – Automatic wake disabled

Use the bottom button to change which mode is selected. When desired mode is selected, use top button to save the change and return to displaying time.

### **Wake Timeout Configuration**

The watch will automatically turn off LEDs 10 seconds after user-input or an automatic wake event. The time before the LEDs turn off after one of these events can be adjusted. To do so, hold both the top and bottom buttons for three seconds. An LED in the “seconds” ring representing the current wake timeout will be lit. Use the top button to decrease the number of seconds before the watch goes back to sleep and the bottom button to increase the number of seconds.

## **Programming / Flashing New Firmware**

The firmware used for this watch is open-sourced and available from the following location: https://github.com/seanmharrington/LED\_Watch

The hardware is built around the MSP430FR5725 microcontroller. See family and device datasheet for information on the device and software registers if attempting to modify firmware. The firmware may be modified or extended to add new features as desired.

The programming interface is on the bottom right side of the board and uses TI’s Spy-bi-wire protocol. With the LEDs facing upwards, the pins from bottom left to top right go:

* Ground
* Test / TCLK
* Reset / TDO
* VCC (3v3)

The easiest method to reprogram is to use the built-in spy-by-wire programming interface on an MSP430 launchpad using jumpers from the launchpad to the corresponding programming pins on the watch’s PCB.

**There is no overvoltage protection in this design. Connecting any voltage over 3.3 volts will damage the components. See datasheets for more information about tolerances.**

The watch uses an external oscillator for accurate time keeping. The time can be precisely tuned within software using an oscilloscope or digital logic analyzer. The real-time clock module has not been calibrated on your device.