Digital Kitchen Timer

Developer Guide

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System Overview

This digital kitchen timer is a simple, single-purpose appliance designed for reliability and ease of use. The timer features an intuitive control scheme, allowing almost anyone to immediately understand how to operate it. A bright OLED display provides simple yet complete feedback as to the status of the system, and a piezoelectric buzzer audibly alerts the user when a timer alarm goes off. Additionally, the device features a high capacity rechargeable li-ion battery. The battery is easily replaceable by the user, so the device can continue to function long after the first rechargeable battery wears out. A rugged enclosure protects the device from physical damage to further ensure the longevity of the system.

Electrical Specifications

Min supply voltage	3.3V
Max supply voltage	7V
Max supply current	2.0A
Nominal supply current	2.0A
Temperature Range	0-45℃

Notes:

1. The maximum and nominal supply current are the same, as a plugged in system spends a majority of time charging the battery in constant-current mode at exactly 2.00A.
2. The temperature range is limited by the li-ion battery cell.

User Guide

Turning on the device

To turn on the timer, press and hold the power button in the lower left-hand corner of the front panel for two seconds. The display will briefly show a boot screen, after which the device is ready to use. Alternatively, the timer automatically turns on when first attached to an external power source.

Turning off the device

To turn off the timer, press and hold the power button in the lower right-hand corner of the front panel for five seconds. The timer will shut off. Alternatively, the timer may be allowed to shut off on its own with the automatic shut-off function. When there is no timer running and the device receives no user input for 30 seconds, it will shut itself off.

Setting the desired time

To set the time for the timer, rotate the black knob in the middle of the front panel. Time can be adjusted in increments of fifteen seconds, up to a maximum time of fifteen minutes. The display will show the currently selected time, along with a message indicating the device is in time select mode. When selecting four minutes or ten minutes, the device will provide messages indicating that an egg cooked for that amount of time will be soft boiled or hard boiled respectively. Upon customer request, firmware with alternate increment and maximum time settings may be provided.

Starting the timer

To start the timer, press the red button in the middle of the front panel. The timer will count down, updating the remaining time on the screen once every second. When the timer reaches zero, an alarm will sound in order to alert the user that the timer is done counting. At this point, the timer can once again be set to a new value and restarted.

Stopping the timer

To stop a running timer, press the red button in the middle of the front panel.

Charging the device

To charge the device, attach a Micro USB cable to the port on the bottom of the enclosure and plug the other end into a compliant USB power supply. The device will immediately turn on and display a lightning bolt indicator in the upper right corner of the screen, indicating that the battery is charging. While charging, the device will not fully shut itself off after the automatic shutoff timeout. Instead of turning off, it will display a large lightning bolt icon across the entire screen. When the lightning bolt disappears, the device is done charging.

Adjusting display brightness

While the device is on, press the button in the lower right-hand corner of the device to change the brightness. Pressing the button will cause the device to cycle between three different brightness levels (low, med, and high), displaying the current brightness level on the screen. Once the brightness has been changed, the display will go back to its previous state after three seconds. Brightness can be adjusted at any point, even while a timer is running.

Figures

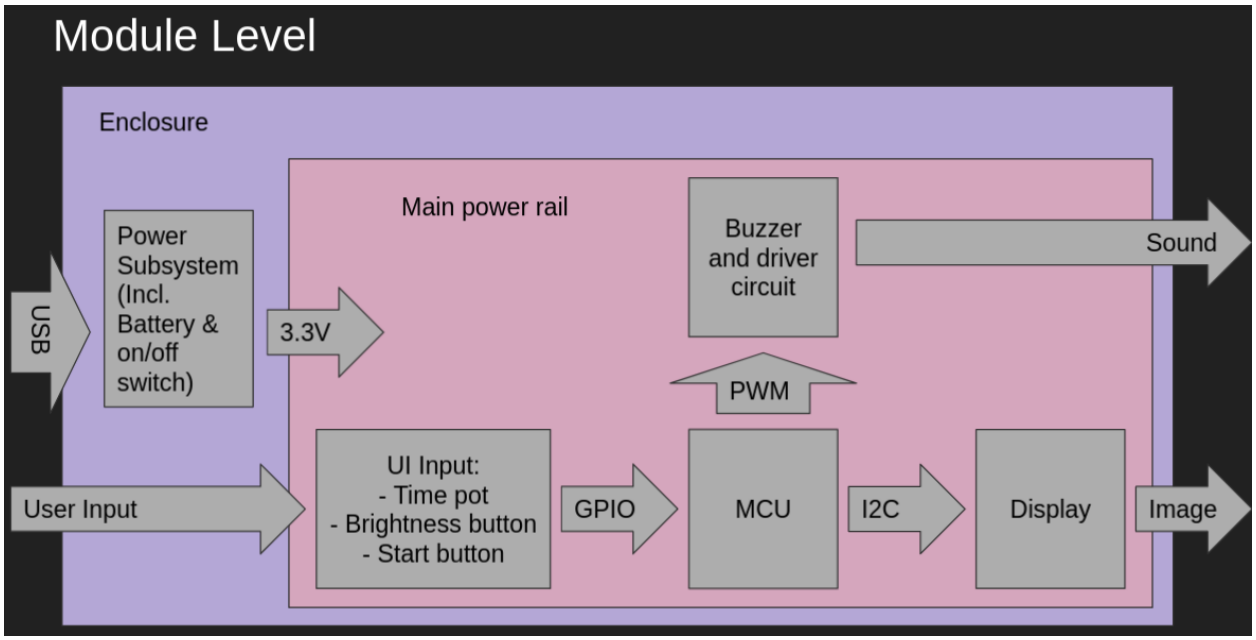

Figure 1: Block Diagram

Figure 1 is a block diagram of the hardware. The design centers around an STM32 microcontroller, which controls all aspects of the timer's function. The microcontroller connects to various peripherals such as I2C and PWM. The power subsystem handles charging the battery, selecting a power source, and converting DC voltages. The latest PCB revision establishes communication between the microcontroller and the power subsystem, allowing for features such as automatic power off and an on-screen charging indicator.

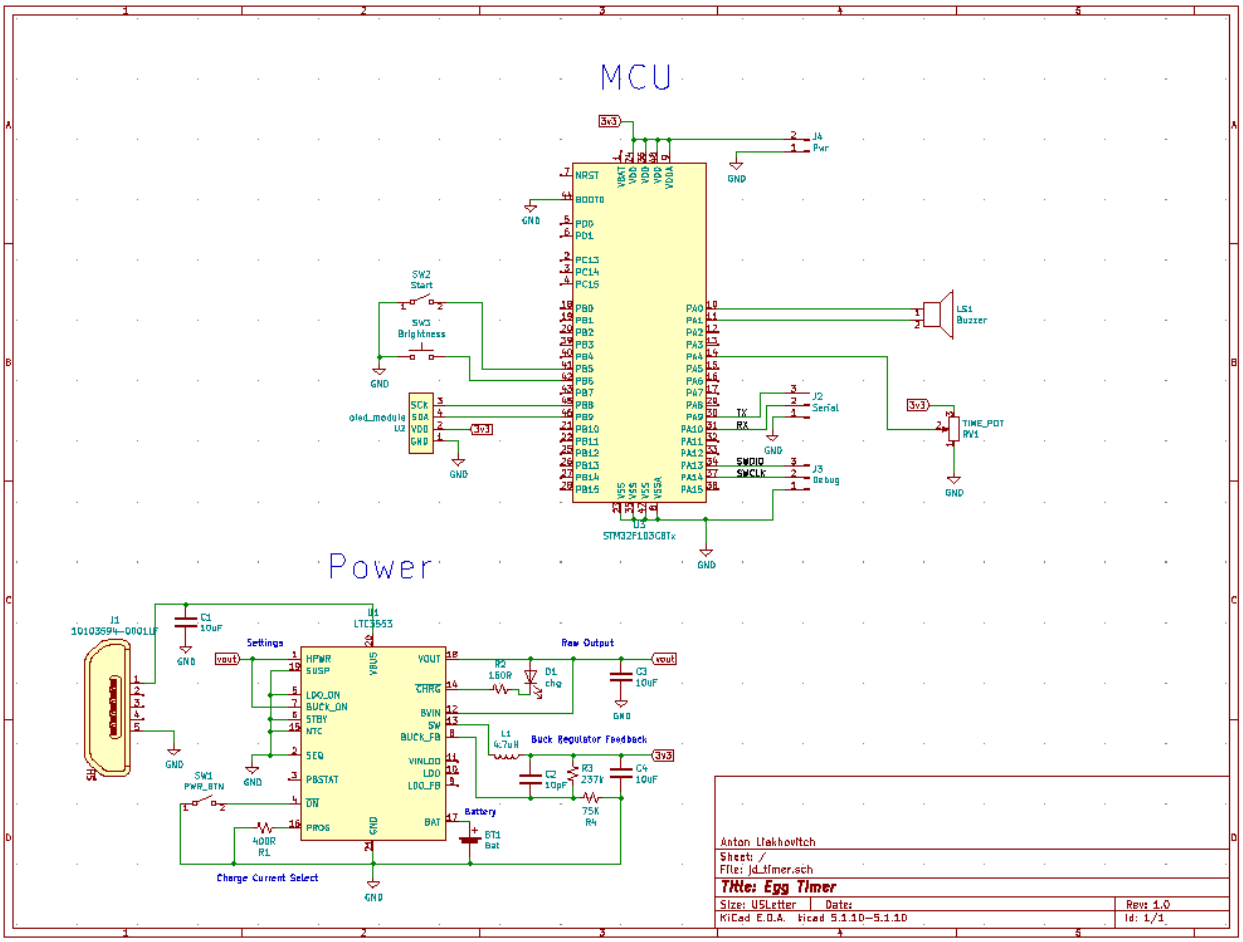

Figure 2: Schematic

Figure 2 is the electrical schematic of the system. Power and microcontroller subsystems are clearly labelled. The power subsystem is based off of an Analog Devices power management chip, which can fully control the charging and discharging of the battery cell with minimal part count. The MCU is a capable, cost-effective, and power-efficient STM32f103c8t6. This device includes onboard peripherals such as a clock generator and RTC, which are integral to the functioning of the timer but would have normally required additional components. The simple design with a low part count ensures that there are as few potential hardware failure points as possible.

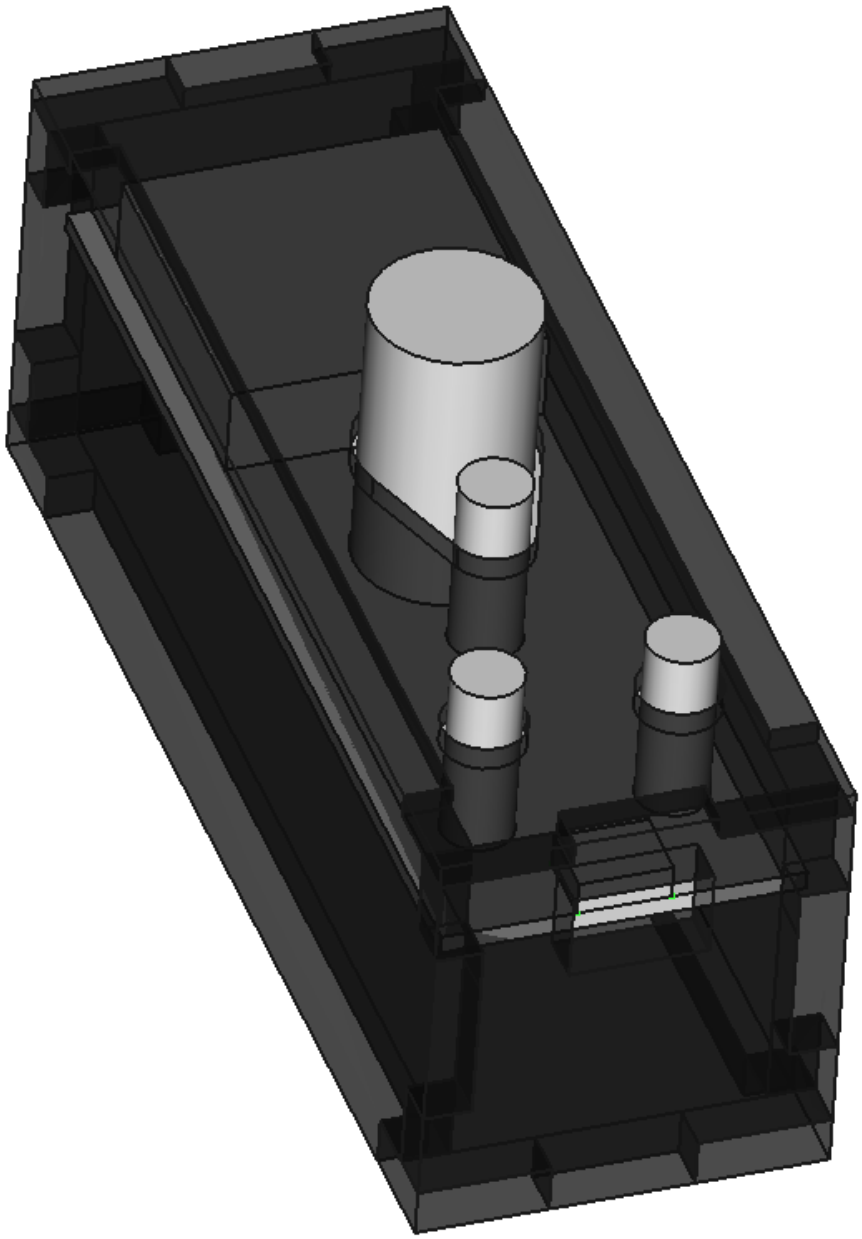

Figure 3: 3D Model

The 3D model demonstrates the rugged construction of the enclosure. All six parts are milled out of acrylic sheets and then press-fit together. Optionally, holes for 2mm screws can be drilled through the four corners on the front side. The enclosure is designed such that each hole would penetrate through four different parts, so that four screws can rigidly secure the entire structure. The left and right side panels include slots for the edges of the PCB, meaning that the entire device can also be assembled without any screws. Mounting the PCB in the middle of the structure makes it appear to 'float' inside the enclosure, increasing interest and aesthetic appeal.

PCB Information

The PCB is 30x90mm and serves as a base for all other components of the device. User interface components, pin headers, and the battery holder are through-hole parts. All other parts are surface-mount. The PMIC uses a QFN package while the microcontroller uses a QFP package. UI elements are arranged for user convenience, while the MCU and buzzer are located under the display module in order to save space. Supplemental information on PCB errata and nonstandard component installation can be found in the technical documentation document.

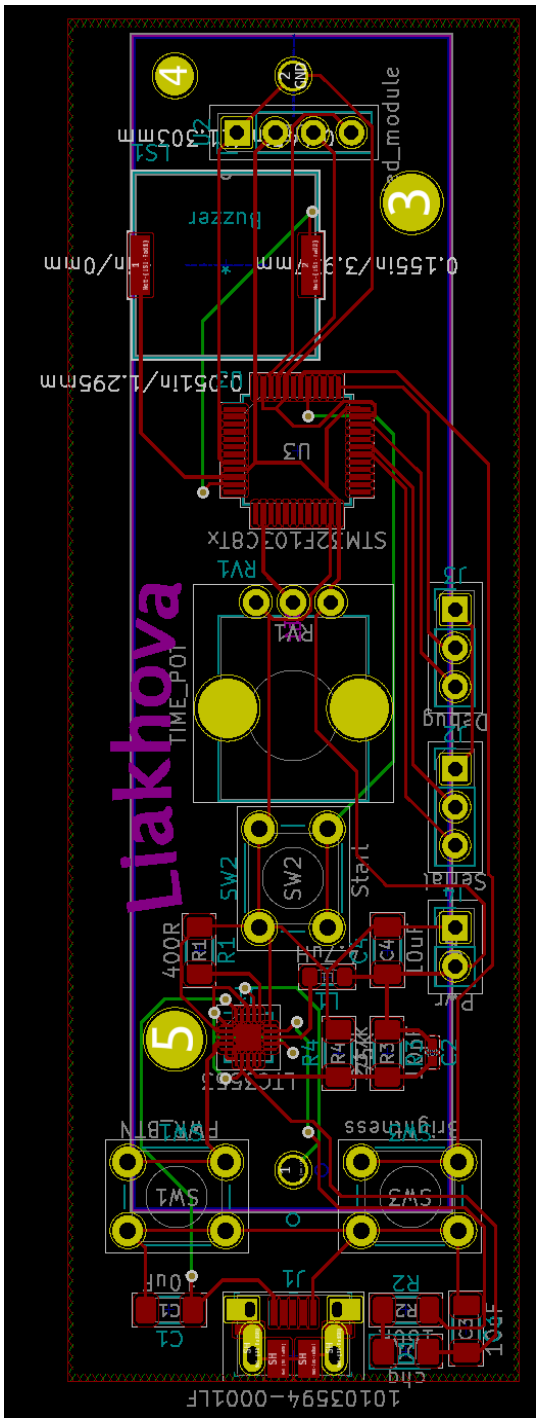

Figure 4: PCB layout

Part Information

Part Type	Manufacturer	Unit Price	Description
Stm32 Microcontroller	STMicroelectronics	5.95000	IC MCU 32BIT 64KB FLASH 48LQFP
Power Manager	Analog Devices Inc.	6.01000	IC USB POWER MANAGER 20UTQFN
USB plug	Amphenol ICC (FCI)	0.80000	CONN RCPT USB2.0 MICRO B SMD R/A
Battery	SparkFun Electronics	5.95000	BATTERY LITHIUM 3.7V 2.6AH
Resistor	Yageo	0.62000	RES SMD 400 OHM 0.1% 1/4W 1206
Led	Inolux	0.36000	LED RED CLEAR 1206 SMD
Resistor	Yageo	0.62000	RES SMD 160 OHM 0.1% 1/4W 1206
Inductor	Bourns Inc.	0.10000	FIXED IND 4.7UH 30MA 1 OHM SMD
Battery Holder	Keystone Electronics	3.14000	BATTERY HOLDER 18650 PC PIN
Buzzer	Murata Electronics	1.37000	AUDIO PIEZO TRANSDUCER 12.5V SMD
Potentiometer	Bourns Inc.	0.83000	POT 10K OHM 1/20W CARBON LINEAR
Resistor	Yageo	0.29000	RES SMD 237K OHM 0.5% 1/4W 1206
Resistor	Yageo	0.23000	RES SMD 75K OHM 0.5% 1/4W 1206
Capacitor	Samsung Electro-Mechanics	0.12900	CAP CER 10UF 6.3V X7R 1206
Capacitor	Yageo	0.10000	CAP CER 10PF 16V NPO 0402

Additional parts from personal stock (price unknown):

1. Button switches
2. Button caps
3. Potentiometer knob
4. Acrylic sheets
5. OLED module
6. Male headers