

Lab 6 Post Lab Report
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A) Objectives (Requirements document from the Lab for which you selected to layout the PCB)

1. Overview

1.1. Objectives: *Why are we doing this project? What is the purpose?*

The objectives of this project are to design, build and test an alarm clock. Educationally, students are learning how to design and test modular software and how to perform switch/keypad input in the background.

1.2. Process: *How will the project be developed?*

The project will be developed using the TM4C123 board. The system will be built on a solderless breadboard and run on the usual USB power. The system will use external buttons, LEDs, and a speaker. There will be 4 hardware/software modules: button input, time management, LCD graphics, and sound/LED output. Each module will be designed and tested independently. After each module is tested, the system will be built and tested.

1.3. Roles and Responsibilities: *Who will do what? Who are the clients?*

EE445L students are the engineers and the TA is the client. David and I will split the hardware/software modules for parallel coding, and then come together to build the hardware and debug the system.

1.4. Interactions with Existing Systems: *How will it fit in?*

The system will use the TM4C123 board, a ST7735 color LCD, a solderless breadboard, and be powered using the USB cable.

1.5. Terminology: *Define terms used in the document.*

power budget - allocation of power available for consumption by the system

device driver - collection of software routines that perform I/O functions

critical section - occasions within a software module where if an interrupt were to occur, an error could result

latency - response time of the computer to external events

time jitter - deviation from periodicity

modular programming - the process of sub-dividing a computer program into separate sub-programs

1.6. Security: *How will intellectual property be managed?*

The system may include software from Tivaware and from the book. No software written for this project may be transmitted, viewed, or communicated with any other EE445L student past, present, or future (other than the lab partner of course). It is the responsibility of the team to keep its EE445L lab solutions secure.

2. Function Description

2.1. Functionality: *What will the system do precisely?*

The clock will perform the following functions:

- 1) It will display hours and minutes in both graphical and digital forms on the LCD. The graphical output will include the 12 numbers around a circle, the hour hand, and the minute hand. The numerical output will be easy to read.*
- 2) It will allow the operator to set the current time using buttons.*

- 3) *It will allow the operator to set the alarm time, including enabling/disabling alarms, using buttons.*
- 4) *It will make a sound at the alarm time.*
- 5) *It will allow the operator to stop or snooze the sound.*
- 6) *It will allow the operator to start and stop a stopwatch.*
- 7) *An LED heartbeat will signify when the system is running.*

2.2. *Scope: List the phases and what will be delivered in each phase.*

Phase 1 is the preparation; phase 2 is the demonstration; and phase 3 is the lab report. Details can be found in the lab manual.

2.3. *Prototypes: How will intermediate progress be demonstrated?*

A prototype system running on the TM4C123 board, ST7735 color LCD, and solderless breadboard will be demonstrated. Progress will be judged by the preparation, demonstration and lab report.

2.4. *Performance: Define the measures and describe how they will be determined.*

The system will be judged by three qualitative measures. First, the software modules must be easy to understand and well-organized. Second, the clock display should be beautiful and effective in telling time. Third, the operation of setting the time and alarm should be simple and intuitive. The system should not have critical sections. All shared global variables must be identified with documentation that a critical section does not exist. Backward jumps in the ISR should be avoided if possible. The interrupt service routine used to maintain time must complete in as short a time as possible. This means all LCD I/O occurs in the main program. The average current on the +5V power will be measured with and without the alarm sounding.

2.5. *Usability: Describe the interfaces. Be quantitative if possible.*

There will be four button inputs; mode, increase, decrease, and confirm. The mode button can be used to switch between modes. The modes available will allow users to 1) set the time, 2) set the alarm and activate the alarm, 3) display the current time, and 4) run a stopwatch. The user will be able to set the alarm and time by hours and minutes. The buttons will be debounced. After approximately 30 seconds of inactivity, the display will return to displaying the current time.

The LCD display will show the time using a graphical display typical of a standard analog wall clock, as well as a digital clock display. The current mode (CLOCK, SET TIME, ALARM, STOPWATCH) will also be displayed at the top of the LCD. When the alarm goes off, a sound will be produced, and can be muted in 2 ways. The user can turn off the alarm by pressing one of the buttons, or the user can snooze the alarm for a set number of minutes by pressing a different button. If snoozed, the alarm will ring again after the snooze time passes. The alarm will be loud enough to hear from 3 feet away.

2.6. *Safety: Explain any safety requirements and how they will be measured.*

The alarm sound will be VERY quiet in order to respect other people in the room during testing. Connecting or disconnecting wires on the protoboard while power is applied may damage the board.

3. *Deliverables*

3.1. *Reports: How will the system be described?*

A lab report described below is due by the due date listed in the syllabus. This report includes the final requirements document.

3.2. Audits: How will the clients evaluate progress?

The preparation is due at the beginning of the lab period on the date listed in the syllabus.

3.3. Outcomes: What are the deliverables? How do we know when it is done?

There are three deliverables: preparation, demonstration, and report.


B) Hardware Design

One page description of the battery (printout from the web) (Preparation 2)

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PowerCoreの使用方法
Utilisation de votre PowerCore
Utilizza il tuo PowerCore
Usar tu PowerCore
使用你的PowerCore
استخدم اقدرتك

- Check the power level**
Überprüfen des Energiestands
確認電圧を確認
Afficher le niveau d'énergie
Visualiza la carga residual
Controla el nivel de batería
查看剩余电量
مستوى سعة البطارية

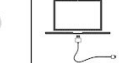


Charge your phone or tablet

Ihre Handy oder Tablet laden
お手持の携帯電話やタブレットを充電
Rechargez votre téléphone ou tablette
Carga tu celular o tablet
Caricar tu móvil o tabletta
给你的手机或平板电脑充电
الحن الجاد الخاصك أو اللبقة الحاسبك




- No Lightning cable included.**
IM lightningning cable lightningning...
本品店には、ライトニングUSBケーブル付属していません。
Cable Lightning non inclus.
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No se incluye cable Lightning.
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PowerCore wieder aufladen
PowerCore本体の充電
Rechargez votre PowerCore
Recarga tu PowerCore
Recargar tu PowerCore
給PowerCore充電
اعد شحن اقدرتك بالاسلاك الخاصة بها



Welcome Guide


PowerCore 5000

Bedienungshandlung | 取扱説明書 | Guide d'utilisation
Guía d'Uso | Manual de Instrucciones
使用说明书 | مبادئ التوجيه



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ANKER
POWER YOUR MODEL LIFE

To give you PowerCore the fastest, safest recharge, use an Anker® USB charger.

Um Ihren PowerCore mit der schnellsten und sichersten Ladezeit zu versorgen, verwenden Sie ein Anker® USB Ladegerät.

PowerCore本体を最適な安全に充電するために、Anker製のUSB充電器をおすすめいたします。


Utilisez un chargeur USB Anker® afin de garantir une recharge sûre et rapide de votre PowerCore.

Per caricare il tuo PowerCore nel modo più rapido e sicuro, utilizza un caricatore USB Anker®.

Para cargar su PowerCore de manera rápida y segura, use un cargador USB Anker®.

为了给你PowerCore最快的充电速度，建议使用Anker® USB充电器。

لنأمن لك اقدرتك بالأسرع والأمان، استخدم اقدرتك بشارج USB من أنكر.



Specifications

製品仕様	Capacity	5000 mAh / 18.5 Wh
Input	5 V ~ 2 A	
Output	5 V ~ 2 A	
Size	108 × 33 × 13 mm 4.3 × 1.3 × 1.3 in	
Weight	134 g / 4.7 oz	

Attention

Achtung | 注意 | Attention
تنبيهات | Atención | 注意

- To preserve battery lifespan, use and recharge at least once every 4 months**
Bitte verwenden und laden Sie den Akku mindestens alle 4 Monate um die Lebensdauer zu erhalten.
请及时使用和充电以保持电池的寿命。少なくとも4ヶ月に一度使用および充電してください。
Pour préserver la durée de vie de la batterie, utilisez et rechargez-la au moins une fois tous les 4 mois.
Per preservare la vita della batteria, utilizzare e ricaricarsi almeno una volta ogni 4 mesi.
Para preservar la vida útil de la batería, use y recargue al menos una vez cada 4 meses.
為了保持電池壽命，請至少每4個月使用及充電一次。
لنأمن لك عمر البطارية، استخدم وارجعها للشحن مرة واحدة على الأقل كل أربعة أشهر.
- Use original or certified cables**
Verwenden Sie originale oder zertifizierte Kabel.
原裝正品或經認證之傳輸線為最佳選擇。
Utilization avec des câbles originaux ou certifiés.
Utilizzare i cavi originali o certificati.
Usar cables originales u/o certificados.
使用原廠或經認證之傳輸線。
استخدم الكابلات الأصلية أو المعتمدة.
- Do not expose to liquids**
Sobren la exposición a líquidos no debe utilizarse.
液体に曝露しないでください。
Ne pas exposer à des liquides.
Non esporre con liquidi.
Evitar contacto con líquidos.
請勿與液體接觸。
لا تعرضه للسوائل.
- Do not disassemble**
Niemals den Gesäht auseinandernehmen.
請勿拆解。
Ne jamais dissocier.
Never disassemble!
Nunca desarmes.
請勿拆解。
لا تقسمه.

Customer Service

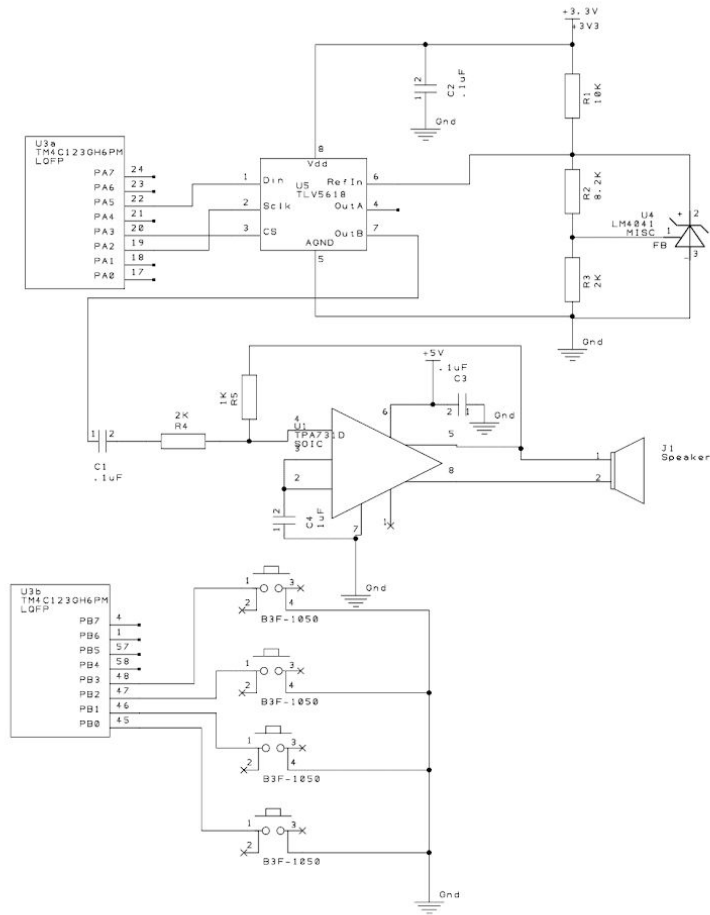
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18-month limited warranty
18-Monats-Garantie / Garantie de 18 mois
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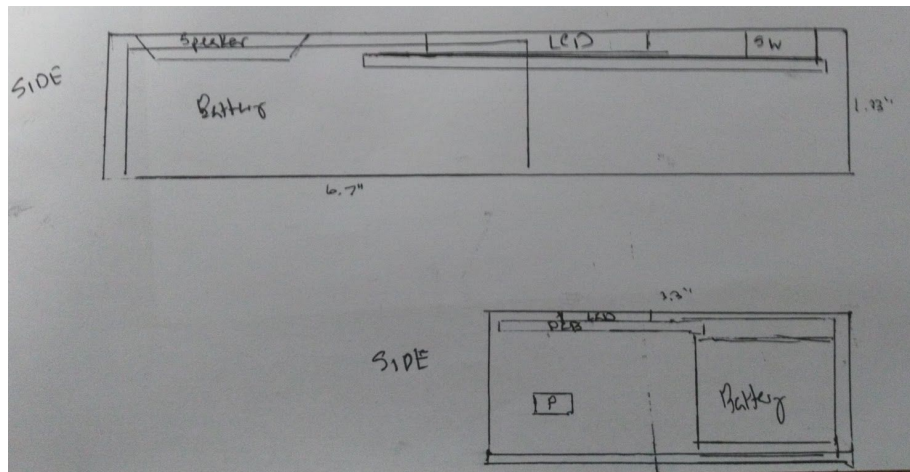
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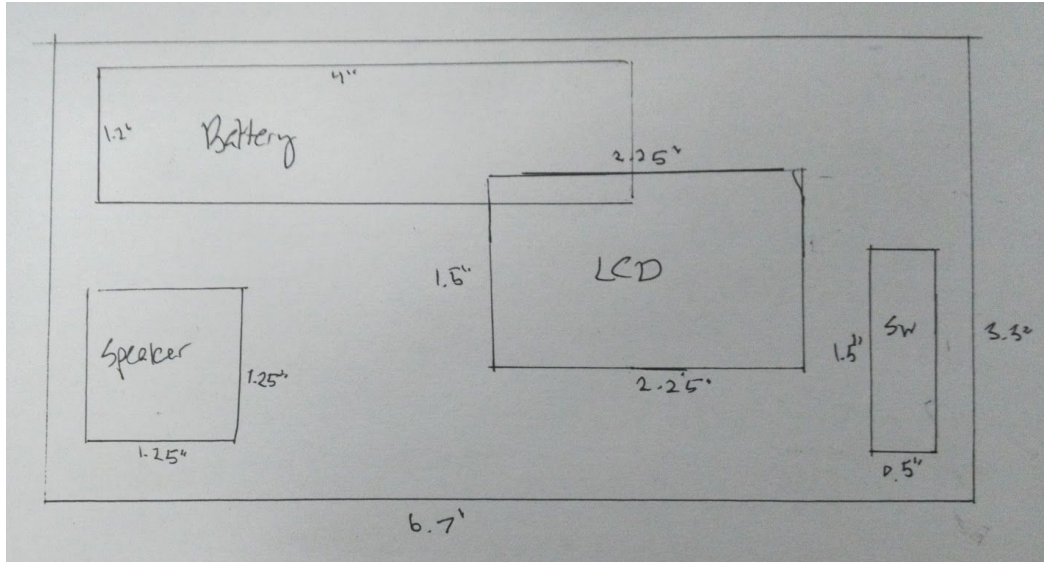
support@anker.com
 1-800-988-7373 Mon-Fri 9:00-5:00 PST (US)
 01-455-7823 | Mon-Fri 9:00-17:00 JST (JP)
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 040-0550-026 | Mon-Fri 9:00-17:30 PRT

One page description of the box (like Figure 6.2, Preparation 3)



Two mechanical drawings (Procedure 9)

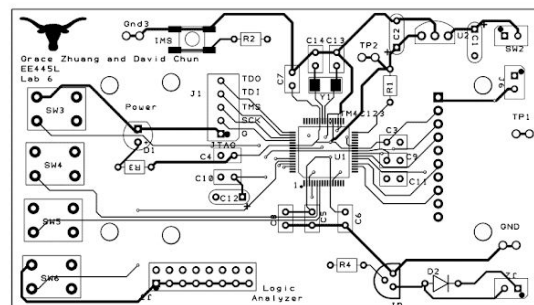
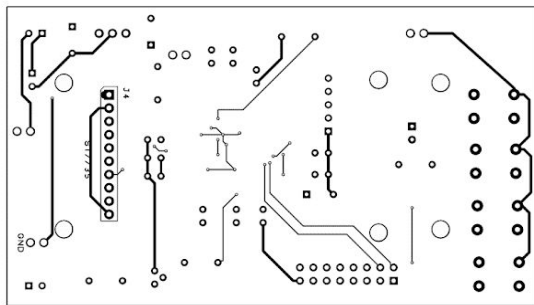




Final circuit diagram of the embedded system, SCH file

Attached in .zip folder

Cardboard mockup of the PCB layout (with top copper/silk on top and bottom copper/silk on bottom)



Bill of Materials			September 3, 2017		"not free" means you have to buy it			"free sample" means you have to order it			
EE445L Fall 2017			EE445L pays for the PCB		"Cabinet means in one of the six black cabinets in professor's office (bring a print out of your SCH)"			"McDermott" means ask McDermott, quantity and style will vary (bring a print out of your SCH circuit)			
Qty Not Estimated Current			"Box means in box in your McDermott's office (bring a print out of your SCH circuit)"								
Qty	Not	Estimated	Current	Type	Description	Manufacturer	Mfg. P/N	Distributor	P/N	Unit	Cost
1				ASM	32-ohm speaker			AlIElectronics	SK-230		\$0.50
1				ASM	Black case, 7.5" by 4.3" by 2.2"	Hammond	1591ESBK	Mouser	546-1591ES-BK		\$5.18
4				CAP	Ceramic, Z5U, -20/+80%, 0.1 μ F			Digikey	399-4151-ND		\$0.05
3				CAP	Ceramic, Z5U, -20/+80%, 0.01 μ F			Digikey	399-4148-ND		\$0.40
2				CAP	Ceramic COG, 10%, 10 pF	Murata 50V 5%	RDE5C1H100J0P1H03B	Digikey	490-8629-ND		\$0.31
1				CAP-Tant	Tantalum, 16V, 20% 2.2 μ F	AVX Corporation	TAP225M016CCS	Mouser	581-TAP225M016CCS		\$0.29
2				CAP-Tant	Tantalum, 16V, 10% 4.7 μ F			Jameco	94035		\$0.22
2				CAP-Tant	Tantalum, 20V, 10%, 1 μ F			Digikey	478-1833-ND		\$0.32
1				CON	2-pin header			AlIElectronics	SBH-2		\$0.10
4	18mA			CON	Test point, black	Keystone Electronics	5001	Digikey	36-5001K-ND		\$0.23
1				CON	Logic Analyzer connector	FCI	68021-208HLF	Digikey	609-3344-ND		\$0.27
1				CON	ITAG 1 by 5 male header						\$0.29
1	8 mA			CPU	TM4C123GH6PM 64-pin LQFP	TI	TM4C123GH6PMI	Mouser	595-TM4C123GH6PMI		\$11.55
1	8mA			CRYST	NX5032GA-16.000000	NDK	NX5032GA-16.000000	Digikey	644-1037-I-ND		\$0.51
1	50uA			DIODE	1N914 diode	Fairchild	1N914	Digikey	1N914B-ND		\$0.05
1	100mA			IC	LP2950 3.3V regulator, 100 mA TO-92	TI	LP2950-33LPRE3	Digikey	296-31455-I-ND		\$0.19
1	1mA			LCD	18-bit color 128*160 1.8" TFT LCD disp	Sitronix	ST17735R	Adafruit	358		\$19.96
1				LED	Red 1.6V 1mA 5mm diffused	Avago Technologies	HLMF-D150	Digikey	516-1323-ND		\$0.29
1				RES	Carbon 1/6W, 5%, 470	Yageo	CFR-12JB-470R	Digikey	470EBK-ND		\$0.02
2				RES	Carbon 1/6W, 5%, 10K	Yageo	CFR-12JB-10K	Digikey	10KEBK-ND		\$0.02
1				RES	Carbon 1/6W, 5%, 1M	Yageo	CFR-12JB-1M0	Digikey	1.0MEBK-ND		\$0.02
1	10mA			SW	Tactile Switch, surface mount	C&K Components	KSC353JLFG	Mouser	611-KSC353JLFG		\$0.86
4				SW	B3F tactile push button switch	Omron Electronics	B3F-1052	Digikey	SW405-ND		\$0.17
1				SW	On/off power switch			BGMicro	SWT1010		\$0.85
1	10mA			TRAN	PN2222 NPN transistor	Fairchild Semiconductor	PN2222	Digikey	PN2222BU-ND		\$0.13
1				CON	Micro USB Type B, surface mount	Hirose Connector	ZX62D-B-5PA8(30)	Mouser	798-ZX62D-B-5PA830		\$0.47
TOTAL		209mA									

Explain how you chose the battery (Preparation 2)

At 209mA max current draw, the 5000mAh battery will last 24hrs (23.9hrs) which we believe is acceptable for a rechargeable clock. If we used a larger 20000mAh battery, we could run our lab for 3.98 days.

E) Analysis and Discussion (1/2 page maximum)

Test Buttons: No software needed

- Connect a scope to test point V1 corresponding to SW 1 to ensure switch 1 operates correctly
- Connect a scope to test point V2 corresponding to SW 2 to ensure switch 2 operates correctly
- Connect a scope to test point V3 corresponding to SW 2 to ensure switch 3 operates correctly
- Connect a scope to test point V4 corresponding to SW 2 to ensure switch 4 operates correctly

Testing Software: Run TM4C software clock as normal

Testing Software: Verify the clock outputs the correct hour and minute mark

- Connect a scope to test point V6 for PF1 corresponding to the interrupt trigger for incrementing the time displayed
 - Verify PF1 properly increments at 60 second intervals

Testing Software: Set alarm on running TM4C software clock

- Connect a scope to test point V6 and V7 corresponding to the LED snooze outputs to verify the visual snooze properly executes
- Connect a scope to test point V8 for PF2 corresponding to the interrupt trigger for alarm length, both time to alarm and snooze alarm
- Connect a scope to test point V5 corresponding to the output of the DAC to verify the alarm sounds matches the sound waveform