

Electronics 1 Assignment

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Submission date: 27-Jan-2022 09:49PM (UTC+0000)

Submission ID: 170447383

File name: 34166_Ryan_Joshua_Stapleton_Electronics_1_Assignment_394634_1741904480.docx (1.04M)

Word count: 2191

Character count: 12456

2021

'Smart' Rear Bike Light Assignment

ASSIGNMENT 1
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Introduction

This document will outline my findings when given the task to design a 'Smart' rear bike light.

This document will cover the basic research undertaken with existing products on the market. It will also cover more in-depth research such as components which suit the needs of the circuit and ensuring that components are not being overpaid for. Included is also some research on flashing lights vs still lights, and why flashing lights are preferred when it comes to attracting and grabbing attention.

It will also showcase the various stage taken to design the circuit, from a block diagram to the actual circuit designed using Fritzing, with the option for the circuit to be put into production. Included is also a cost list of the approximate cost of the components required for the circuitry if it was to be constructed.

Background Research

Similar Products Currently on the Market

The first stage is to see what is currently out there on the market. The obvious places to look are websites such as amazon, and bike retail stores who will likely stock such cycling equipment.

The main thing to look for is the datasheet, which will outline details such as how it's powered, the brightness, some of the features included etc.

ENFITNIX USB Rechargeable Smart Bike Tail Light Cubelite II [1]

This is the first example of what is currently on the market. This small/compact light is packed full of features. Key features include:

- USB Rechargeable battery (400mAH Internal battery)
- 30 Lumen COB LEDs
- IPX5 rating water protection
- Day mode/night mode
- Automatic mode to detect movement, when stationary, light turns off to save power



OLIGHT RN 180 Smart Bike Tail Light 180 Lumens Break Sensing Rear Light [2]

Another example from amazon, although this one has slightly different features. Key features on this light include:

- USB Rechargeable battery (800mAH)
- 180 Lumen COB LEDs
- Low power mode
- 'Smart' battery level indicator
- Motion sensor



Lezyne Strip Drive Pro 300 Lumen Rear Bike Light, Black [3]

Key features of this light include:

- 300 Lumens
- USB Rechargeable
- IPX7 Rating

This is a rather basic light, that doesn't come with many features.



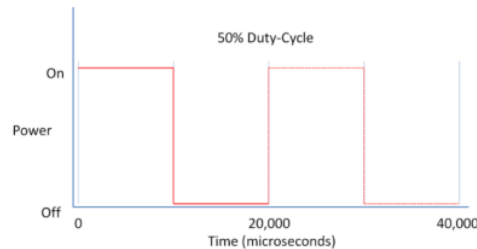
Core Technology Research

Various components are required for the circuit to become functional. This includes components such as PICs, LEDs (CREE/COB), Switches, Capacitors, resistors etc. Therefore, all these components need to be researched to ensure the correct components are being used.

PWM Theory

PWM can be used to modulate the brightness of the LEDs used within the circuit. This will allow the 'blinking' state of the lights.

[4]To modulate the brightness of the LEDs, the power sent to the LED can be controlled, for example, with a potentiometer. The basic principle is the more power delivered to the LED, the brighter the LED will be. The issue we come across is that microcontrollers only have two power states, 'on' or 'off', as they are digital. This is where the PWM comes into it. PWM allows us to simulate varying power levels, which can be achieved by oscillating the output from the microcontroller.



For example, over a short period of time, if the LED is turned on for 50% and off for 50% of the time, the total light output over this time will be half of that if the LED was 'on' for 100% of that time. Therefore, the LED will appear half as bright over this time. The important factor is the duration, as if the light is turned on and off too slowly, then the viewer will see the flashing of the LED, and not a constant light output.

Duty Cycle

The duty cycle equates to the total amount of time a pulse is 'on' over the duration of a given cycle. The cycle is usually measured in Hertz, which gives the number of cycles per second. Therefore, for 50Hz, we get 50 cycles per second, which equates to a cycle every 0.02 seconds.

PWM Resolution

The higher the PWM resolution results in more levels of brightness which can be displayed. For higher resolutions, finer timing from the microcontroller is required. The faster the microcontroller, the smaller the durations that it can time. One other limiting factor of obtaining higher resolutions is the execution of the code, as the microcontroller will not only need to time the 'interrupt' to cause the pulse generation but will also need to run code to control the output of the LED. This is just to create the pulse generation for the PWM, the microcontroller will also need to contain code to monitor other aspects of the system at the same time.

'Flashing' Light Research

[5] Studies show that flashing lights appear brighter compared to still lights. As these lights appear brighter, they grab the attention of people faster, which is good for cyclists as they will be identified faster by motorists. However, the problem with flashing lights over still lights is that it's harder to identify the speed and distance as to which the light is moving. Therefore, if a cyclist has a flashing light, although they will be spotted quicker, it'll be harder for the motorist to determine how far away they are, and at what speed they are moving.

LEDs

Vishay VLMR334BACB-GS08, VLMR334 Red CoB LED [6]

Attribute	Value
Luminous Intensity	4500 mcd
Optical Source Diameter	2.4mm
Series	VLMR334
LED Colours	Red
Forward Voltage	2.8 V
Forward Current	50mA
Dimensions	3 x 2.8 x 1.75mm
Automotive Standard	AEC-Q101

This LED found on RS components is an ideal candidate for the circuit of our rear bike light. This is due to the operating voltage being 2.8V, and our battery being able to supply 3.7V. It is also the required colour of output that I need for the bike light. Also, the LED only requires 50mA to operate.

ICs

Various PICs and ICs could be used in the circuit design of the smart rear bike light. For example, ICs will be needed for charging the batteries through a USB port. There will also need to be a central PIC

that contains software to carry out various functions of the bike light. For example, different light modes etc.

MAX1555 IC [7]

"The MAX1555 charge a single-cell lithium-ion (Li+) battery from both USB and AC adapter sources. They operate with no external FETs or diodes and accept operating input voltages up to 7V. On-chip thermal limiting simplifies PC board layout and allows optimum charging rate without the thermal limits imposed by worst-

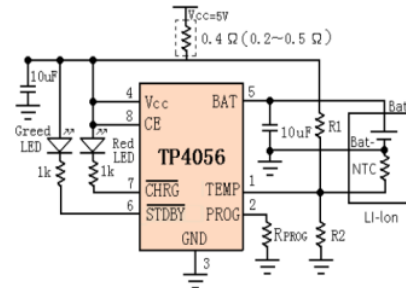
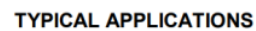


case battery and input voltage. When the MAX1555 thermal limits are reached, the chargers do not shut down, but progressively reduce charging current. The MAX1555 instead features a CHG output to indicate charging status. With USB connected, but without DC power, charge current is set to 100mA (max). This allows charging from both powered and unpowered USB hubs with no port communication required. When DC power is connected, charging current is set at 280mA."

TP4056 IC

“Integrated Circuit TP4056 is 1A Standalone Linear Li-Ion Battery Charger with Thermal Regulation and two LED Indication in case SOIC-8/SO-8/SOP-8.

The TP4056 is a complete constant-current/constant-voltage linear charger for single cell lithium-ion (Li-Ion) batteries. Its SMD package and little external components make the TP4056 ideally suited for portable applications.” [8]



Positive

- “Linear Charger – no additional interference like switching power supplies
- Small Space – SMD package
- Simple Design – low count external components
- Adjustable charging current – programmed externally with a single resistor”

Negative

- “Maximum input voltage is only 8 V
- Maximum charging current is only 1 A
- Not available in DIP-8 package (i.e. standard THT case)
- Output charging voltage is fixed 4.2 V (no other choice for different types of batteries – LiFe etc.)” [8]

LiPo USB Charger [9]

This premade small circuit could also be used in the circuit for the smart rear bike light. This would allow the battery to be charged via a USB port, or barrel port, which allows for compatibility with various inputs for the user.

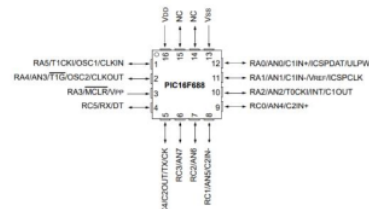


"The board joins a charging circuit, status LED, selectable weld jumper for 500mA or 100mA charging current, outer LED impression, USB input, two pre-introduced JST connectors for SYS OUT and BATT IN, and (back by famous interest) a barrel jack connector."

PIC16F886 Microcontroller [10]

Looking at the datasheet for this PIC, it has 4Kb of program memory, which should be enough for the program required to operate the system. It also has various pins which can be wired to do a variety of things, which can be seen from the datasheet.

16-pin QFN



I/O	Pin	Analog	Comparators	Timers	EUSART	Interrupt	Pull-up	Basic
RA0	13	AN0/ULPWU	C1IN+	—	—	IOC	Y	ICSPDAT
RA1	12	AN1	C1IN-	—	—	IOC	Y	VREF/ICSPCLK
RA2	11	AN2	C1OUT	T0CKI	—	IOC/INT	Y	—
RA3	4	—	—	—	—	IOC	Y ⁽¹⁾	MCLR/Vpp
RA4	3	AN3	—	T1G	—	IOC	Y	OSC2/CLKOUT
RA5	2	—	—	T1CKI	—	IOC	Y	OSC1/CLKIN
RC0	10	AN4	C2IN+	—	—	—	—	—
RC1	9	AN5	C2IN-	—	—	—	—	—
RC2	8	AN6	—	—	—	—	—	—
RC3	7	AN7	—	—	—	—	—	—
RC4	6	—	C2OUT	—	TX/CK	—	—	—
RC5	5	—	—	—	RX/DT	—	—	—
—	1	—	—	—	—	—	—	VDD
—	14	—	—	—	—	—	—	VSS

Lithium Ion Batteries

3.7V 3500mah 18650 Lithium-ion Battery [11]

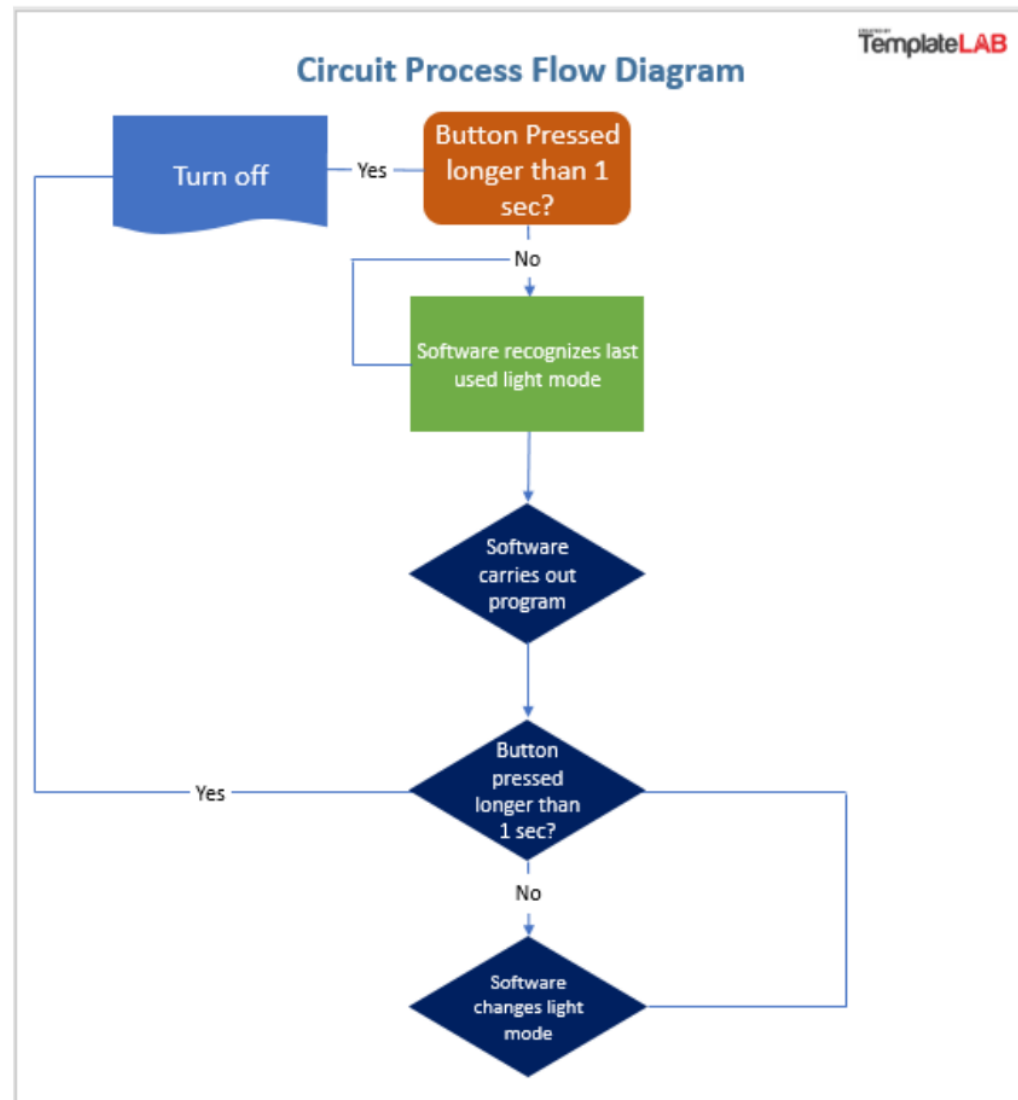
- Nominal Voltage: 3.6V
- Nominal Capacity: 3500 mAh
- Minimum Discharge Voltage: 3V
- Maximum Discharge current: 1C
- Charging Voltage: 4.2V (maximum)
- Charging current: 0.5C
- Charging Time: 3 hours (approx)
- Charging Method: CC and CV
- Cell Weight: 48g (approx)
- Cell Dimension: 18.4mm (dia) and 65mm (height)



This battery is ideal for use in the rear bike light. The operating voltage is exactly what is required, along with the high capacitance of the battery, it can run for long periods of time.

Flow chart/Pseudo Code

Below is a flow chart of the basic operation of the circuit of the rear bike light.



Costings

Component	Cost	Quantity	Datasheet
PIC16F668	£2.50	1	[10]
WS2801	£7	1	[12]
LiPo USB Charger	£15.30	1	[7]
Lithium-Ion Battery	£5	1	[11]
TP4056 IC	£3	1	[8]
LEDs	£1.50	Varied	[6]
		Total Cost	≈£35

Conclusion

To conclude, I am fairly happy with the design of the 'smart' rear bike light with the limited knowledge I have on this subject. However, there are definitely improvements which could be made to this system.

For example, there are other features that could be implemented into this system to improve the system as a whole, such as accelerometers to detect movement. So, when the movement is detected, the light would begin its operation.

There could also be some sort of RADAR system included, such as the Garmin products, to alert the cyclist when there are cars close behind. Unfortunately, I do not have the technical knowledge to implement these features into my design.

There could also be improvements made to the efficiency of the circuit outlined, and also reduce the number of unnecessary components within my design. This could bring down the cost, and the size of fabricated product, and the casing required.

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Electronics 1 Assignment

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

Instructor

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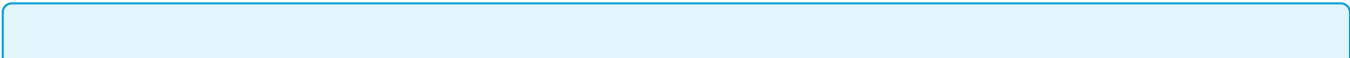
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ENGAGEMENT WITH LITERATURE

 A reasonable range of research sources used, however these are mainly components etc - only one looking at effectiveness of rear lights etc. **60**

KNOWLEDGE AND UNDERSTANDING

 Fair. Reasonable explanation of what things actually DO, but the over all solution is perhaps a little to basic to allow more to be written here. **60**

COGNITIVE AND INTELLECTUAL

 As above. Could have pushed the boundaries a lot more in terms of creativity. I mean - what exactly ARE the flash modes just as one example? **58**

PRACTICAL APPLICATION

 Circuit looks as if it might work ok. Its pasted in at too low a resolution for me to read hings like the pin designations though! And there is no block diagram. The flowchart is FAR too basic though. **50**

TRANSFERABLE SKILLS



The actual report presentation is good. well written with appropriate inclusion of diagrams etc.

65