

electronic assignment

by Nicholas Regan

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Title:

Design of a Smart Rear Bicycle Light

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Declaration

The work of this assignment which has been completed under the supervision of:

Gareth Jones

I declare that this assignment is the product of my own work and has not been submitted for any other degree etc.

Signed:..........

Date:.....20.5.20.....

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Introduction

This assignment will cover the research, design and basic operation of a smart rear bicycle light. This will involve theories on embedding a computer to an LED rear bicycle lamp. It will include background research on microcontrollers and their components, advantages or disadvantages and suitability. Types of LED lighting, will be researched, LED drivers and the theory of pulse width modulation.

The assignment will conclude with a design of an appropriate design and circuit.

Background Research

A smart bicycle light is a LED light module with built in sensors and ability to communicate with an app, usually on a smartphone. The sensors will sense how light it is, the speed the cyclist is travelling. The light intensity will change according to the need. It will flash to enable other road users to notice them faster. Also it is considered safer now to have bicycle lights on in the daylight for the same reason. LED lighting is perfect for a bicycle light as it shines brightly and has a wide side visibility, but does not dazzle oncoming traffic. See Appendix 1 for further information and an examples of smart bicycle lights and their features.

When a computer is used to control a device and therefore attached to it, is it known as 'embedding'. Dean explains this term in a related university lecture: "Embedding, adding a computer to monitor and control a de vice." (1 slide 8). This is the method used in smart home devices and the Internet of Things. It is now a very popular and common place in every home. Most smart home devices also work by sensors.

There are advantages in embedding a computer in a device. The device this assignment is covering is an LED rear bicycle light. Embedding a computer will improve the performance and the energy efficiency, therefore extending the battery life/usb recharging. This is important for a bicycle light for safety purposes. The brightness will be constant even though the battery voltage falls. (1 slide 11). Dean also adds further advantages of being able to have the device automatically switched off after a fixed time and adjustment of the brightness. (1 slide 15). These advantages also occur in smart home devices, as the computer can be programmed to switch devices on or off at certain times to save energy and power. A good example of this is thermostatically controlled heating and sensors detecting temperature and presence of people in the house.

The main items of equipment needed in the task for this assignment would be a computer, battery switch, LED light with battery, resistor and a capacitor. A method must be included to prevent the current being too high and therefore damaging the LED light. Dr.. Dean in his lecture suggests a switch mode driver

can limit the current by switching on and off quickly to average out power use. (1. Slide 11). This is similar to pulse width modulation technique, (PWM). See page 14 of this assignment.

There is a choice of computer types that could be used, but the most popular and suitable would be a microcontroller. There are several reasons that make a microcontroller preferable: For example the fact that they are low to medium cost to purchase and are easy to upgrade and fix bugs. They are small in size for what they can achieve and lightweight as well. Despite of their size the power they produce is moderate. These reasons are supported by Dean (1 slide 9).

What is a Microcontroller?

According to Roshni, a microcontroller is “a combination of processor memory and peripherals in a single chip” (2). It is in fact a mini computer but without a keyboard or monitor. Schertz points out that technology has progressed so extensively over the years so that this small computer, “a small computer on a single board” performs the same work as a processor in a desktop PC did a few years ago, which was much larger. (3 p573).

According to Wikipedia.org, microcontrollers were first invented in 1959, however according to other sources the first successful model was in 1971 by different technicians. (More information on the history and progression can be found in Ref 4). It has improved over the years and now appears in many household appliances such as microwaves, televisions and VCR's, security systems and toys such as robots. Sinclair and Duncan explain that application wise, they could be divided into three types

Stand alone: interact with people but nothing else, e.g. thermometers, pedometers, calculators.

Interact with people and environment, have remote controls, e.g. media players, mobile phones, alarm sensors.

Devices that perform an automated (pre programmed) function when triggered, e.g. car washes, wheel balancing machines, CD/DVD players.

Schertz confirm that there are now thousands of microcontrollers produced with "different designs and features to suit different applications". (3 p807). There are a variety of sizes ranging from 4bit to 32 bit depending on their use requirement.

According to Schertz, the Microchip PIC's are most popular as they are simple to programme, cheap and lots of development software available. (3. p399). Also, an unknown author, writing in an internet tutorial states they are popular as they are "low in cost, easy to use "very popular with hobbyists and industry". (6). Also, in Roshni's opinion: they are the "smallest microcontroller in the world" but they are capable of more than a normal microcontroller, "PIC microcontrollers hold the ability of faster execution of programs than microcontrollers." Roshni adds another two advantages, the serial interfacing is easy and the power consumption is low. (2).

Wikipedia.org in their definition of PIC microcontrollers list further advantages: "wide availability, large user base, extensive collection of application notes, free development tools, serial programming and reprogrammable flash memory capability." (7). There are not a great deal of disadvantages, Roshni mentions two: the fact that it only holds a single accumulator and the the fact that is has a less number of instructions increases the length of the programme (2).

These common and popular PIC microcontrollers were manufactured by Microchip Technology Corporation based in Arizona USA, in 1989 with 8 bits, (2). However they were first developed by General Instrument Microelectronics Division in 1975. (8). PIC stands for 'Peripheral Interface Controller' but more recently this was changed and the initials now stand for 'Programmable Intelligent Computer.' They are based on the Havard Computing architecture and in this type, the code and data are placed in separate registers. This increases throughput of the input and output, (I/O), (8).

PIC microcontrollers are capable of carrying out a large number of operations at a faster rate. According to Roshni there are two reasons for this: firstly that they have 100bytes of ROM to store the programme, (2). Secondly because PIC

microcontrollers have RISC architecture (reduced instruction set computer). This enables it to work faster as it only has 35 instructions to deal with. (2).

Schertz explains that the programme is firstly written on a host PC and downloaded via parallel or serial port of the PC, to the microcontroller. (3 p791).

Architecturally there are three groups of size: (listed in 6).

Baseline Architecture: These are 8 bit and include the 'PIC10F' range of models. Suitable for battery embedded gadgets. This size would be suitable for this project.

Mid Range Architecture Include 'PIC12F' and 'PIC16F' range.

High Performance Architecture 16 bit programme, with 18-100 pins. Include analogue to digital converters. This would include the 'PIC18F' model.

Components of PIC Microcontrollers:

PIC is basically a data RAM with 100bytes of ROM for storing a programme. I/O ports, one timer with 8 pins on a single chip. (2).

Components:

The CPU central processing Unit which contains ALU, CU and MU. The ALU performs arithmetic logic. The CU controls I/O devices connected that are connected to the system. The MU memory unit stores instructions and data before and after they are processed. (2).

Schertz describes the CPU as "the brains of microcontroller", (3 p574) and "the thinking element" (3 p791). It carries out instructions given to it by a programme. As well as arithmetic functions, it can move data from one part of the memory to another. It can receive data from the outside world. (3 p574). Because of the RISC architecture, it can only hold 35 instructions. This will enable it to take less time as less number and shorter length of instructions only. This also makes debugging easier. (2).

Memory: There are two types of memory:

1. Programme or code memory, holds set of instructions to be performed. This is ROM. The ROM only allows the programme to be stored once. The EEPROM (electrically erasable programmable read only memory) allows the code to be written multiple times on the ROM. (2).

Schertz explains that the EEPROM is a memory that holds the programme that runs on a microcontroller. Once data is stored in EEPROM, it cannot be changed by a programme running on CPU. Information can be sent to EEPROM from a desktop PC via USB port. Software on a desktop can create programme, then send it to microcontroller via the USB port. (3 p p791). This is carried out by the Serial Port Adaptors which provide "serial communication between the microcontroller and PC". (3 p791). There are two types of adaptor,

UART Universal Asynchronous Receiver Transmitter

USART Universal Synchronous/Asynchronous Receiver Transmitter.

Also there is flash memory in the PIC microcontroller which can be erased as many times as needed. According to Wikipedia.org, flash memory was added in 2002 and is now included on all models of PIC microcontrollers. (7).

2. Data memory: stores data in it. It is the RAM (random access memory). The PIC microcontroller holds 368 bytes of RAM. The data is stored temporarily in two registers:

General Purpose Register where general mathematical functions are carried out and stored in another. No special functions are done here.

Special Purpose Register known as SFR. Special functions, (hence SFR) are performed here and are pre-set when the PIC is being manufactured.

Whereas ROM holds the programme, RAM stores data the microcontroller is working on, like a 'note book'. Schertz explains: "RAM stores the temporary data needed during programme execution". (3 p792). There can be an area in RAM for storage of certain calculations. There is a small memory in a microcontroller. In Schertz's opinion it is a challenge to programme a

microcontroller for this reason, as it is difficult getting the programme to run with the small amount of memory available. (3).

Clock, (Oscillator)

Clock: provides timing pulses. "Control the pacing of the programme instructions as they executed one at a time by the CPU". (3 p574) There are a few million ticks a second. (In comparison on a PC there are a few billion ticks a second).

Some microcontrollers can choose an internal RC or an external RC and one or more speeds of a crystal oscillator. Sinclair and Dunton point out it is important to choose correctly. The factory default is an internal RC oscillator as it has the advantage of making extra I/O pins available, External oscillator will use I/O pins. (5 p401).

Sinclair and Dunton list other PIC additions:

Watchdog timers. These will reset the processor if it appears to have crashed. Can be internal peripheral or external chip. (5 p404).

Sleep, is a low power mode and stop clock until it is woken... a button pressed for example. Remote TV controller. (5 p405)

Counter Timer. A counter has a parallel load facility. The counter is an up counter, but the parallel load facility allows it to used in applications that require a down counter. (5 p410).

Pulse Width Modulator is a "A more complex counter peripheral". It is a counter with an "additional comparator and a data latch and output flipflop". (5 p411). See page 14 of this assignment for more detail on Pulse Width Modulation.

I/O Ports

The number of ports will depend on the PIC model. The number of ports is usually 5 in most PIC's. The I/O pins enable microcontroller to communicate with outside world. For example to "light sensors, speakers, LED's or other logic circuits" (3 p793). The input and output pins are shared.

Bus

The Bus communicates between different units. PIC has two buses, the data bus, between the memory and I/O port and the address bus which holds the address of the location to/from where data is loaded.

Interrupts

Mass states "Interrupts are very powerful tools built into almost every microcontroller" (8) It is not required in all applications, but makes programming more efficient and allow microcontroller to complete tasks more slowly than would be required if interrupts were not available. (5 p419).

See Appendix 3 for further information and an example of interrupts.

LED Lighting

LED light bulbs were first manufactured in 1962 by N. Holonyak and Dr R. Hall at General Electric Company, using GaAs semiconductor laser technology. (9). The actual first LED in 1961 was red in colour, but was not actually visible to the human eye. Holonyak improved this in 1962 to make it visible. This led on to major improvements and developments over the years to the present time.

The letters 'LED' stands for 'light emitting diode'. The diode is a p-n junction diode "which emits light energy when adequate voltage is given." (10). At the time of Holonyak's and Hall's discovery it was described as "visible light emitters based upon minority carrier injection and radioactive combination of excess carriers." (9).

LED lighting is used for many applications and is suitable both indoors and outdoors. It has many advantages according to Microchip in an online article on LED's:

"Best overall efficiency: 25-50% less energy than a fluorescent light, longest life 50,000 hours, has no 'warm up', no radiated heat, and good outdoors or indoors". (11). Helman, in an internet report on the manufacturing company Cree, states that whereas an incandescent light bulb would last 2 years, an

equivalent LED bulb would last 20 years and only use 10% of the electricity an equivalent incandescent bulb would use. (12).

An unknown author in an online tutorial on LED interfacing state that LED's are "irreplaceable" as they have so many advantages and can be used for so many applications. They are reliable have low power use and are now obtainable in many colours of light bulb. (10).

Cree is a multi billion American based company who played a major part in the progress and development of LED lighting. In 1989 Cree developed a blue LED. By 1993 white LEDs were used for street and industrial lighting, using far less power and therefore helping the environment. (12). By the millennium LED lighting was manufactured for domestic use, mainly by Cree. For example in 2008 ceiling fixture lights appeared on the market. However it was not until 2013 that Cree released LED light bulbs (40W and 60W equivalent). (13)

Soon after 1994, scientists at Cree used an array of light emitting diodes and redesigned the structure in the middle of the bulb called the 'filament tower'. 10-20 varying colours were used and these individual light sources "overlapped to create an omni directional glow". (12). Cree's design was an array of LED's on an aluminium substrate which became known as Cree's 'surface mounted devices', (Cree's SMD's). By 2007 a design of LEDs more suitable for the domestic house called 'downlights' came on the market that could be used in homes as opposed to industry. (12). Because LED lights lasted so long they could be fitted into furniture and fixtures as they were guaranteed to last as long as the furniture. (12).

Cree's SMD's are diodes permanently fixed to a printed circuit board, (PCB). According to James and Granath they can have more contacts than previous designs. "It can have more than two contacts and up to three diodes on a single chip, each with its own circuit with its own anode and cathode." (14). This means it can have two, four, or six contacts in a chip. The SMD can include red green and blue colours, which will enable any colour of the spectrum to be produced. Multiple channels are needed for this that the SMD's have. This makes the SMD very versatile. (14).

Another recent, approximately 2010, design of LED product, is the 'Chip on Board' (COB). Rice, from Silicon Lightworks explains this is a "mounting of a bare LED chip in direct contact with a substrate such as silicon carbide or sapphire, to produce LED arrays." (15). Matrix Visual Solutions, a major LED lighting supplier explain further: Chip on boards involve "embedding LED directly within the PCB, fully sealed, protected with a resin layer." (16). As well as protecting, the resin also acts as a lens. They state that the main advantage is the increased viewing angle, brighter lumen, less power use and longer lifetime. However they point out there are disadvantages. For example, no colour, as mentioned earlier. Also, since the LED's are all sealed, if one LED becomes faulty, then it cannot be individually replaced. The entire module would have to be replaced. (16).

Rice agrees that COB LED's are brighter than the previous designs and consume less power. He states that "the output is of a higher quality compared to the older LED technologies". (15). When using the term older technologies he is referring to SMD's and Dual in Line Packages, (DIPs) both manufactured by Cree. Rice states also that there are many advantages of the COB. There is a improved lumen density, as there is a higher packing density of the LED array. Therefore there is "greater uniformity, consumes less energy and is smaller." (15). There is one circuit and two contacts for the whole chip. It does not matter how many diodes there are. See Figure 1 below:

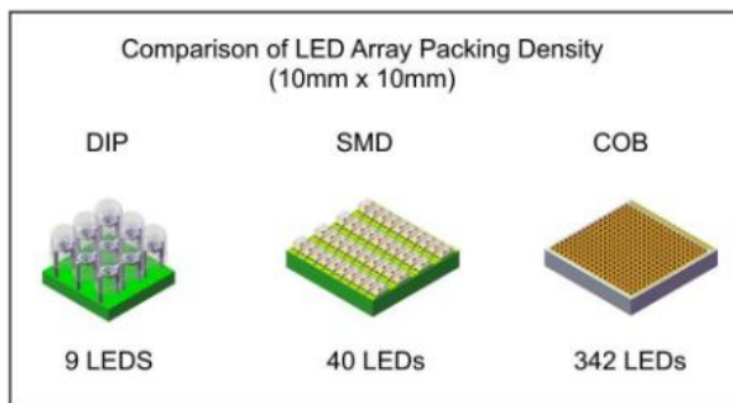


Figure 1: Comparison of LED Packing Density

The Cree SMD LED and COB LED are the two most popular choices on the market. Both have advantages but the COB cannot have colour changing effects due to only having one circuit. (14).

Sunper, an unbiased lighting supplier explain that there is little to choose between the two. The SMD is larger and has a wider PCB area than the COB. "This is because it has many discrete units on the PCB plate. This results in a more uniform luminance." (17). The COB is more integrated in its design. Another advantage of the SMD is because of its larger area it can dissipate the heat which is generated when the lights are in use, more easily. (17). The SMD's are more versatile according to James and Granath. In their opinion the COB would be better choice as a bicycle or torch light rather than other uses, due to the ultra brightness it can output and its smaller size. (14).

SeeSense, a bicycle light supplier consider that both Cree's SMD and COB LED's would be very suitable for a bicycle light as the light is ultra bright, it is small, weighs little and uses less power so battery or usb recharging will last longer. (18). They have a choice of models using both types and a mix of the two. Both types are favoured with many advantages. See Appendix 4 for further details.

LED lighting is very useful for torches which can have options for flashing and different levels of brightness and colours. For example a hiking torch would require a setting for emergency flashing, using less power for a long life battery and bright visible light. Torches and bicycle lights would all need to be waterproof. LED has all of these attributes. It has not been possible to ascertain in the technical data on commercial torches as to whether they use SMD or COB LED design, but one would presume it depends on the model and size. See Appendix 5 for example.

When embedding with a PIC microcontroller the LED lamp brightness is determined by forward current. An online tutorial article written by Keim for "All About Circuits" explain that current is the quantity that determines the brightness. (19). To make adjustments to the brightness the current would need to be controlled. (see page 12 of this assignment).

The LED is sensitive to the current applied. Microchip explain that “LED output is a direct function of the current flow- too little current and the light will remain dim, too much current and the lifetime will be shortened.” (11). As it is dangerous for the LED is the current is too much, methods must be applied to limit the current. Otherwise it could overheat and cause damage to the LED. LED drivers have the ability to control current.

LED Drivers

An LED driver is a device that takes the electrical power from the supply and converts it to a form that the LED can use. The domestic supply is AC and a LED light (SMD's or COB's) can only accept DC, so it needs to be converted.

Keim, writing for the website All About Circuits advises that although the current needs to be maximum, to keep safe, (not damage the LED as this will happen if the current is exceeded), a 'constant current drive' is needed. (19).

Davis explains that in some LED modules the current is already regulated by simple resistors or a constant current driver within the LED module. (20).

However the constant current driver can be in an external component depending on the LED type.

Chonowski explains that most LED's run on low voltage direct current electricity. However, a typical supply from an outlet would be high voltage with alternating current. A constant current driver within the LED driver is required to change this high voltage alternating current into a low voltage direct current that an LED will accept. (21). In other words it changes the voltage across the LED to keep it stable and constant. Davis states that “LED's do not use current limiting resistors as a constant current driver offers more control.” (20).

Chonowski adds that LED's “are constant current devices with a forward voltage drop. This means that the voltage supply must exceed that drop in order to allow the current to flow.” (21). Also, by controlling the current the intensity and brightness can also be controlled. Day, writing for Texas Instruments states

that “brightness is proportioned to their forward current.” (22). Therefore it is essential for the current to be able to be controlled.

Santa Cruz agrees that LED lights “require a driver to provide and properly deliver the required output.” (23) However, there are two types of drivers, constant voltage and constant current. Both of these drivers supply power but deliver it in a different way. The constant current driver, as discussed, varies the voltage along the circuit which results in constant current to the LED bulb. This is for LED’s that require a fixed output in amps. Some LED’s require constant voltage. The constant voltage driver will deliver this regardless of the current load. For example, in LED signage, the load will alter so a constant voltage driver would be used. (23).

It is important to choose the correct version of driver otherwise the LED light could overheat and be damaged. It will depend on the type of LED light as to which driver will be suitable. All manufactured LEDs will state their specification, that is one output current rating and a range of voltages depending on the wattage of the light.

Day, states that LED drivers need “direct control of current, PWM dimming. And overvoltage protection.” (22). He states that there are two methods of controlling the current. First is to use the LED V-I curve, add a voltage and use a ballast resister. The change in the forward voltage causes a change in the current. However, an 11% change in forward voltage causes a 30% in forward current. Also, “the voltage drop and power dissipation across the ballast resister waste power and reduce battery life.” (22). See Figure 1:

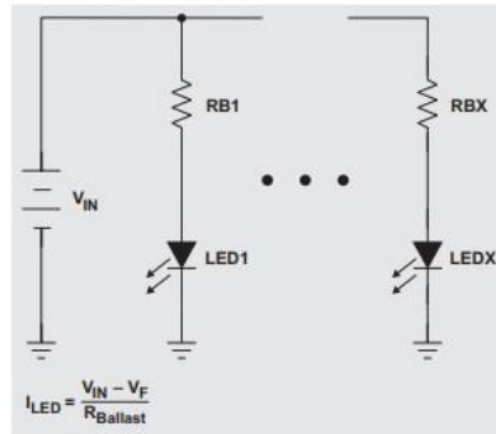


Figure 2 : Voltage Source with Ballast Resister

In Day's opinion the constant current driver option is preferable as it does not change the current. The voltage of the power supply and value of the current sense resistor control the current. See Figure 2.

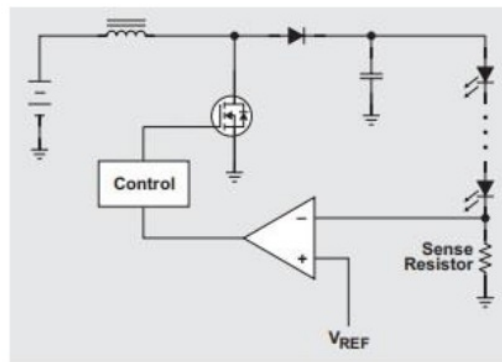


Figure 3: Constant Current Source for driving LED's.

Day also mentions over voltage protection. This can be done by use of a zener diode (breakdown diode) and a current sense resistor, but Day recommends to monitor the output and shut down supply when over voltage occurs. This second method will help save power. (22).

See Appendix 6 for examples of LED Drivers.

Pulse Width Modulation

Pulse width modulation is known as PWM. It is a 'process' where analogue signals are converted to digital signals. So 5V would become '1' (digital) and 0V would become '0' (digital). PWM is the same as 'switch mode controlling'.

An unknown author writing in an online article for Evaldate website on PWM explains that PWM is "a series of pulses and non pulses 1 or 0 respectively". (24). It is usually used to control a device such as the speed of an engine for example.

The pulse, (1) is when the signal is 'high', 'on' or 'on time', The non-pulse (0) means the signal will be 'low', or 'off'. The signal can only be high or low, (on or off) at one time. Dee explains PWM can "change the proportion of time the signal is high compared to when it is low over a consistent time interval", (25) as it varies the ratio of high time to low time.

Wikipedia.org define PWM as "a method of reducing the average power delivered by an electrical signal, by effectively chopping it up into discrete parts." (26). The voltage is controlled by turning the switch of the supply on and off very quickly.

This is put into detail by explaining that PWM encodes a signal into periodic pulses of equal amplitude but varying width. The width of a pulse at a given point is proportional to the amplitude of the message signal at the time. Large volume =wide pulse. Small volume=narrow pulse. (24).

Dee explains that the amount of 'on time' is called a duty cycle. The duty cycle is measured in a % of the time the signal is on a high over a the period of time it takes to complete one cycle. The time it takes to complete the cycle is known as the 'frequency'. (25). See figure of duty cycle below.

50% duty cycle



75% duty cycle



25% duty cycle



50%, 75%, and 25% Duty Cycle Examples

100% duty cycle would be the same as setting the voltage to 5 Volts (high). 0% duty cycle would be the same as grounding the signal.

Figure 4 Examples of Duty Cycles

PICs can have an integral PWM included or a peripheral PWM attached to set up the PWM. This will save using up space in the PIC but like any peripheral that is not integral, this will use up an I/O port which is a disadvantage.

The unknown author from Evalidate's website states that PWM is a "good way of dimming an LED", (24), but the frequency of the square wave does need to be high to get proper effect. In the case of For example 20% duty cycle at 1Hz will look like turning on and off but 20% duty cycle at 100Hz will look dimmer.

Another method of dimming an LED is by control of the current. By reducing the current the light intensity will dim and by increasing it the light will become brighter. This is known as 'analogue dimming' or 'constant current reduction'.

Santa Cruz confirms that "LED light output is proportional to it's current supply and LEDs are rated to operate within a certain current range." (23)

Dean adds “ LED brightness is proportional to its current”. (1 slide 10) He explains that the LED current depends on applied voltage, but not proportional. The exact current curve varies with each LED as it depends on the manufacturer. Also the current curve changes depending on temperature. For example, 2.9V may produce 100mA when cold and 200mA when hot. (1 slide 10).

Most LED drivers also have an inbuilt dimming facility. See Appendix 6 for examples of LED Drivers.

System Diagram

The most suitable microcontroller for this project design is a PIC16F877A for many reasons. It is “low cost and easy to handle.” (27). It is a popular choice that can be programmed with multiple software programmes. Most importantly, It has all the features needed to programme this design.

The microcontroller will have a push button and power supply as an input. The push button will be used to trigger through light modes and the power supply will be a rechargeable battery which will have a USB port to enable it to charge. It will also have a PWM module to control the LED's and it will use an accelerometer to switch the light on.

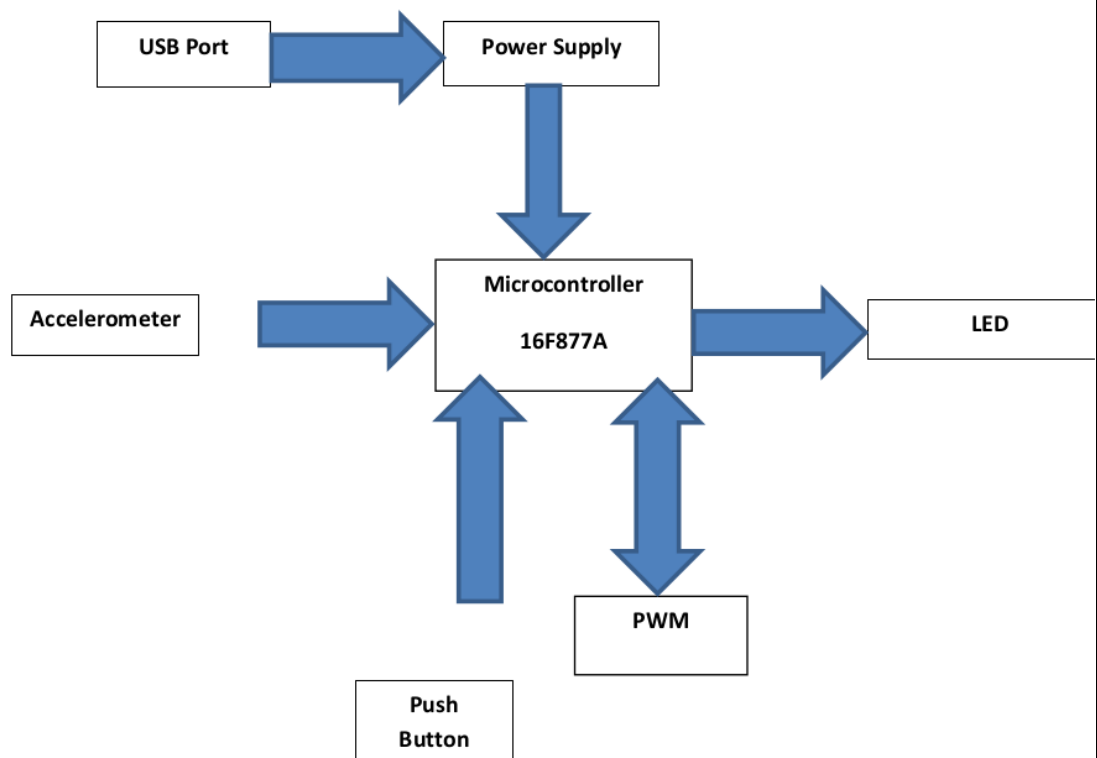


Figure 5: System Design

Flowchart and Circuit

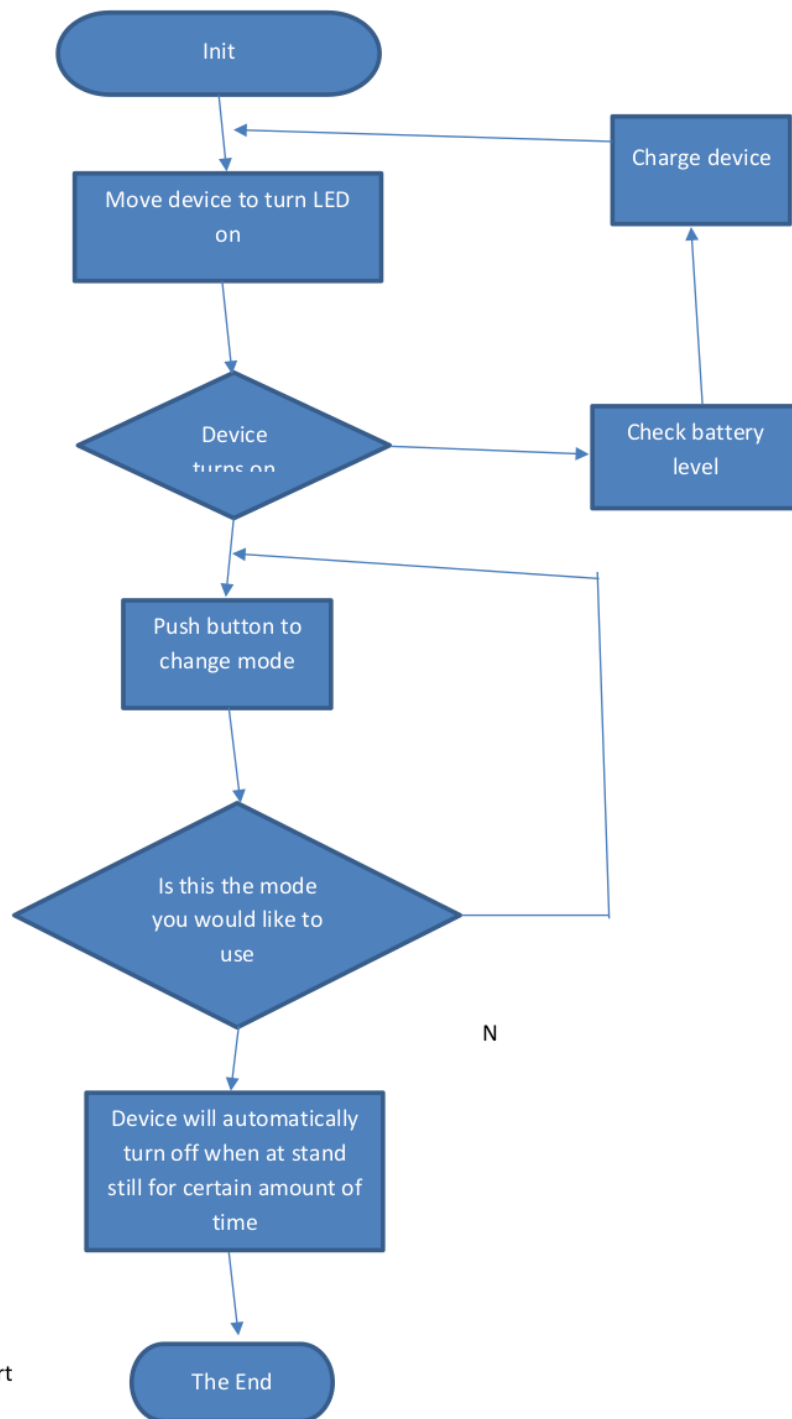


Figure 6: Flowchart

As shown in the flowchart diagram above, the device will turn on when motion is detected. This will be carried out using an accelerometer to detect the motion. Once the device is turned up, the user will be able to check the battery level and if this is low the device can then be charged. If the device is charged a push button can be used to change light modes which are constant, dimmer and flash. The device will automatically turn off when there is no motion for a certain period of time.

The figure below is the circuit designed for a bicycle light. The author of this assignment has used a 9V battery and a 7805 voltage regulator to power the PIC.

As can be seen, instead of using an accelerometer, a quadruple bilateral analogue switch was used with a potentiometer. When the device moves the potentiometer will slide and when the voltage goes below or above 50 this will turn the LED from the RB1 output. When the device has no movement for a certain amount of time the device will turn on.

This design also uses the PWM module twice for dimming and flash. A MOSFET transistor is used to control the amount of current to the LED and the inductor is used to store the current when the transistor turns off which is when the digital value is 0.

Three LED's have been used along with a resistor used for current sensing. This is used to create voltage a drop. The PIC16f877a's internal ADC will convert the voltage drop into a digital value.

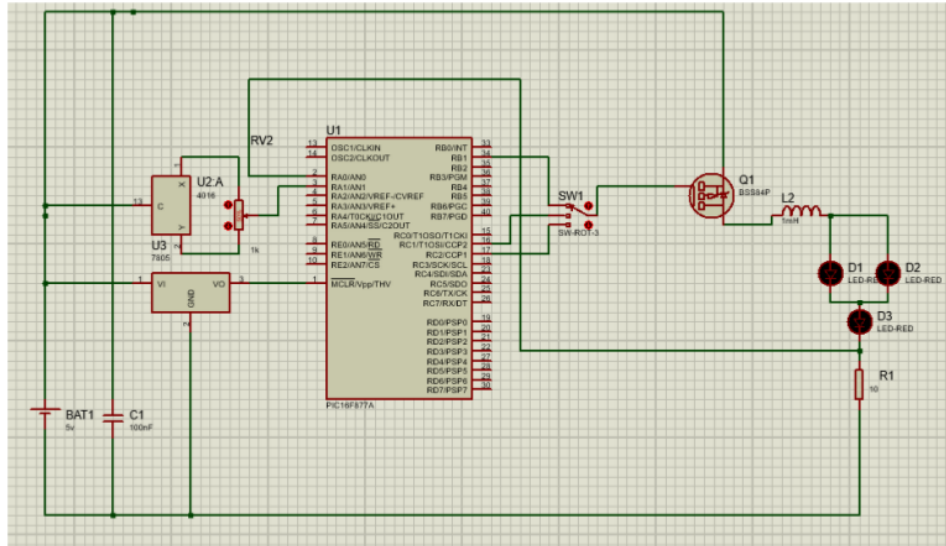


Figure 7: Circuit

Conclusion

In conclusion the Author of this assignment felt like the design was satisfactory but as there was no programming of the PIC it was not able to be confirmed whether it worked or not.. This was an issue that would needed to be resolved in the future but more research would be needed. Also to improve on the circuit the Author would prefer to use a push button instead of a rotary switch. Apart from that the Author feels that the right component choices were made however more research could be done into choosing the right values. Smart home devices are now used in every home and have many advantages. A smart bicycle light is more efficient in it's ease of control, use of less power and therefore longer battery or usb charge life, and brighter light.

LED lighting is a perfect choice for a bicycle light as both the COB and SMD's are capable of outputting an ultra bright light with a wide side angle, without dazzling oncoming road users. LED's have a long lifetime and use less power.

The PIC 16f877a is the most suitable choice for this project of embedding and the LED interfacing as it has all the required features, it is low in cost and straightforward to use with readily available software.

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Taken from: C. Rice, Article Title: What Are “COB” LED’s and why do They Matter?, 10.12.17, found online at:
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Taken from . M. Day, Texas Instruments Corporation, Article Title: LED-driver considerations, found online at:
<http://www.ti.com/lit/an/slyt084/slyt084.pdf?&ts=1590137796537> accessed 2.5.20

Figure 3: Constant Current Source for Driving LED’s

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Taken from . M. Day, Texas Instruments Corporation, Article Title: LED-driver considerations, found online at:
<http://www.ti.com/lit/an/slyt084/slyt084.pdf?&ts=1590137796537> accessed 2.5.20

Figure 4: Examples of a Duty Cycle,

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Taken from J. Dee, Article Title: Pulse Width Modulation, updated 14.5.20, found online at: <https://learn.sparkfun.com/tutorials/pulse-width-modulation/all>, accessed 19.5.20

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Figure 6: Flowchart by Author of this Assignment

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Appendix 2	Example of a Commercial Bike Light
Appendix 3	Information on Interrupts
Appendix 4	Use of COB and SMD LED's in Bicycle Lights
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Appendix 1

Information on Intelligent Bike Lights

Taken from HOME / SEE.SENSE HUB

[PREVIOUS](#) / [NEXT](#)

April 05, 2018 3 min read

Bike lights have always been known as a useful yet simple piece of kit for helping us stay safe and seen on the roads. But now, with exciting and rapid advancements in technology, more and more of us are taking our road safety to a new level...

If you've been into cycling for a while, then you'll probably remember the first time you started browsing for some lights for your bike. Or, if you are indeed new to the sport then you will definitely be able to relate to how much more complex the experience might be than you originally thought! LEDs and lumens, steady lights or flashing, batteries or rechargeable? And where do we begin with mounting options and smart features? The process can sometimes be overwhelming - but we are here to help. Here's everything you need to know about smart and intelligent bike lights.

SO, WHY DOES A BIKE LIGHT NEED TO BE 'INTELLIGENT'?

THEY'RE BRIGHTER WHEN THEY NEED TO BE

One of the best things about intelligent bike lights is that they know when to flash more often and more brightly to keep you visible whenever you need to be most. By automatically adjusting their brightness, this means that they are using their battery power more efficiently - so they will flash for even longer.

BUT HOW ARE THEY INTELLIGENT?

So how does this actually work?

Sensors! See.Sense lights use built in sensors and components in the lights - (accelerometers, light & temperature sensors to name just a few). These work by monitoring road surfaces, the brightness of the surrounding light and also how fast (or slow) you are cycling.

The sensors make the lights react to the environment you are riding in at that time so that they shine brighter and faster to attract attention to you from drivers and other road users too. They will detect when you are cycling at roundabouts, road junctions and when you are filtering in traffic. The lights also react in response to approaching car headlights from behind you, and to any change in the light levels including when you cycle under trees or shadow. So all of this helps you stay more visible in these riskier situations.

THERE'S NO COMPROMISE

When shopping for bike lights, you will more than likely find that they are a compromise between brightness, run-time and size'. With our lights - there is no compromise. You are getting super brightness and a long runtime in a small and light piece of kit.

WHAT ABOUT DURING THE DAYTIME?

Daylight Visibility has been really important to us from the start. Being visible during daylight hours is just as important as being seen at night, especially when you are cycling through busy urban areas. Since 2011, all new cars in Europe are required to be fitted with daytime running lights because of the proven benefits. So why on earth shouldn't something as small as a bike not run daytime lights? Accidents can and do happen during the day, and daytime lights can offer some added visibility to all road users - vehicles and bicycles alike. That's why every light we've made since 2013 has been engineered for daylight visibility.

You can learn more about why we think it's time that all cyclists started using daytime running lights **here**.

THEY DO SO MUCH MORE THAN KEEP YOU VISIBLE

Now we can get onto the smart part... We all know that technology moves at a fast, fast pace, and with a smart bike light like See.Sense you can keep it up to date with regular firmware updates.

WHY WOULD I NEED TO CONNECT MY BIKE LIGHT TO MY PHONE?

Control your lights the way you like by connecting to our fun and intuitive companion app. You'll also avail of unique connected features including crash and theft alerts for peace of mind, and soon, you'll get personal stats based on your rides too.

THE BIG PICTURE FOR CYCLING

Cycling is one of the most sustainable modes of transport, yet it needs to be safer, more convenient and more enjoyable for everyone.

That's why we've developed technology that sits in a See.Sense light, or seamlessly integrates into bike share schemes, to create 'ride insights'.

These insights help cities, bike share operators and forward-thinking companies boost cycling safety, improve operations and reduce traffic congestion.

Taken from: <https://seesense.cc/blogs/hub/everything-you-need-to-know-about-smart-amp-intelligent-bike-lights>

Appendix 2

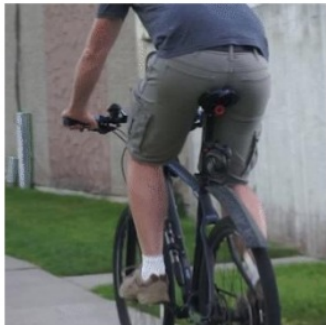
Example of a Commercial Bike Light

A NEW ERA OF BIKE LIGHTS!

We have re-thought the conventions of the standard bike light. Our goal? To provide riders the most advanced bike light on the market, which will improve their road safety, riding experience, and bicycle value. Best of all, our product is completely environmentally sustainable! Still don't believe us? Check out the numerous critically acclaimed reviews.

At the heart of the Xlite 100 is a unique patented system of gyroscopes and light sensors working to accurately adjust the light to your every move. Fully automated; the Xlite 100 will switch on under motion, flicker while you ride and dynamically brighten when you brake, and decelerate. The Xlite 100 will adjust under varying lighting conditions to save battery where required, and ensure visibility under high luminous intensity. It will also turn itself off after 60 secs when you stop!

Minimalist and sleek in design, the premium machined aluminium ensures quality, durability and IPx6 waterproofing. The Xlite 100 is extremely versatile, and can be securely mounted anywhere. With a large internal 400 mAh Li-ion battery the Xlite 100 will last an entire week (20+ hours) under a single charge.

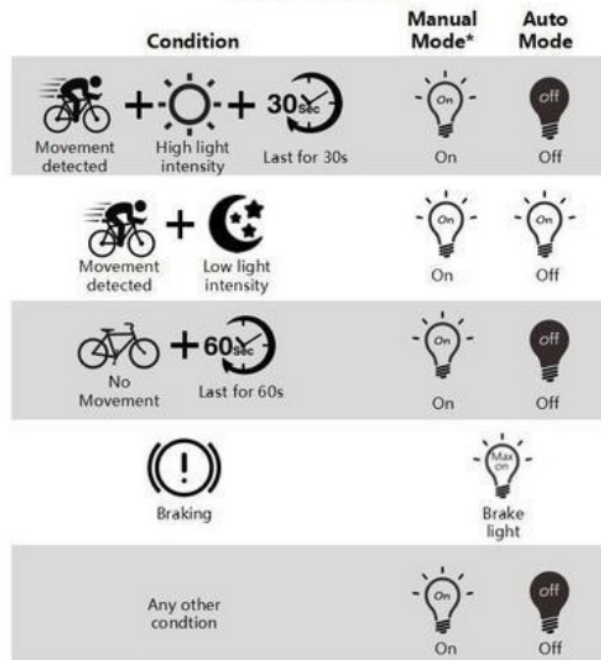


KEY FEATURES

- Premium CNC machined Aluminium Chassis
- patented system of gyroscopes and light sensors with Self-Adaptive Balancing Technology
- Manual & Auto Modes
- 20 Powerful Red COB LEDs + EnSca Lens rate at 100 Lumens
- High Luminous Intensity; Visible Up To 500m
- IPx6 Waterproof
- Automatic Shut Down after one minute of No Movement

- Automatic Shut Down after 30 sec exposed in a High Light Intensive Environment
- Large 400mAh Li-ion re-chargeable battery, with USB charging
- Up to 20-30 hours Runtime

Easy Control



Note : *Only the front bottom can turn off the light when operating under "Manual" mode

Taken from <https://smartbikelights.com/products/xlite100-bicycle-flashlight-bike-rear-light-auto-start-stop-brake-sensing-ipx6-waterproof-led-charging-cycling-taillight>

Accessed 12.5.20

Appendix 3

How an Interrupt Works

Microcontrollers have special hardware built into them to generate and handle interrupts. In the case of a timer-generated interrupt, the microcontroller generates an interrupt whenever a specific timer rolls over. Almost all microcontrollers have timers; timers are built-in register variables that are incremented every instruction cycle. Counting the instruction cycles is the same thing as counting the time. Certain instructions take more than one instruction cycle to run, but the instruction cycle time is constant. When a timer reaches its maximum value (255 for an eight-bit timer), it rolls over to a value of 0. If your timer interrupt is enabled, this rollover will generate an interrupt.

For eight-bit microcontrollers, timers that can generate interrupts are usually eight bits or 16 bits, sometimes with prescalers to extend their ranges. A prescaler allows you to get slower interrupt rates with an eight-bit timer, though with less precision. For instance, a prescaler value of 4 tells the microcontroller to increment the timer every fourth instruction cycle instead of every cycle, so that your interrupt frequency is a fourth as fast.

What exactly does it mean to generate an interrupt? To understand this, you need to know what is normally happening when a microcontroller is running. When you program a microcontroller, you place the assembly instructions of your code into sequential program memory addresses. In the simplest case, a microcontroller performs the instructions in its program memory in order. If it just performed the instruction at address location 123, then it will run the instruction at location 124 next.

However, when an interrupt is generated, the microcontroller jumps to a fixed interrupt address instead of going to the next instruction. This special address is sometimes called the interrupt vector and is often toward the beginning of the program memory. This location is where you put the start of your interrupt code. So, generating an interrupt really means making your microcontroller jump to a known address — the start of your interrupt routine.

When the interrupt has done its work, you want the microprocessor to go back to whatever it was doing just before the interrupt happened. There is a special return-from-interrupt instruction that does just this. It signals that the interrupt processing is over and that the microcontroller should go back to where it was prior to the interrupt.

One thing to keep in mind when using an interrupt is that you don't want to overwrite variables you were using in your main code. This is especially true of the accumulator or working register and any status flags. Some microcontrollers will store some of these important variables for you automatically and restore them at the end of the interrupt. If you are using a compiler, it will usually do this for you if the microcontroller doesn't, but — if you are writing assembly code directly — you will want to copy the value of the accumulator and any processor flag registers into temporary variables at the start of

your ISR and then copy those values back into the registers at the end of the ISR just before the return-from-interrupt instruction.

To recap, the whole process happens as follows: Your microprocessor is performing instructions in the main body of your code. As this is happening, the timer is incrementing. When the timer rolls over from its maximum value to 0, the microcontroller jumps to the interrupt vector address in its program memory. It runs through the instructions of your interrupt routine until it reaches the return-from-interrupt instruction. It then jumps back to wherever it was when the interrupt was generated and keeps running.

Different microcontrollers can also generate interrupts under other specific conditions. For instance, many microcontrollers have special external interrupt pins or pins that can generate interrupts when their state changes. These interrupts operate in much the same way, apart from their triggering. The interrupt service routines will have the same parts, except that they won't need to reset the timer. When you are using more than one source to generate interrupts, you will need to check which source generated each interrupt at the beginning of your interrupt routine.

AN EXAMPLE INTERRUPT — GENERATING PWM ON A PIC16F84

The interrupt service routine code shown below generates a PWM signal on pin 0 of PORTB with the duty cycle set by the variable `pwm_duty`. A value of 0 specifies 0% PWM and a value of 255 specifies 100% PWM. Intermediate values scale linearly. **Figure 2** shows what an oscilloscope trace looks like attached to the PWM pin with a `pwm_duty` value of 178. The `SWAPF` instruction is used to store the `STATUS` and `W` registers because it doesn't affect the `STATUS` flags that we are trying to save.

```
                ORG      0x04      ; Interrupt vector location<br />
int0:<br />      MOVWF      w_temp      ; Save the W register<br />
/>          SWAPF      STATUS,0<br />
/>          MOVWF      status_temp      ; Save the STATUS register

                BCF      INTCON,T0IF      ; Clear interrupt flag

                MOVLW     D'46'<br />      SUBWF      TMR0,1      ;
Subtract 46 from the timer

pwm0:<br />      INCF      pwm_phase,1      ; Increment the
phase<br />      MOVLW     D'255'<br />
/>      SUBWF      pwm_phase,0<br />
/>      BTFSS      STATUS,C      ; If phase >= 255, reset<br />
/>      GOTO       pwm1<br />      CLRF      pwm_phase      ;
Reset phase<br />      MOVF      pwm_duty,1      ; If it's the PWM
period start<br />      BTFSS      STATUS,Z      ; Check if duty
```

```

cycle is zero<br />          BSF      PORTB,0      ; If not zero,
start PWM pulse<br />          GOTO    pwmEnd<br /> pwm1:<br
/>          MOVF      pwm_duty,0<br
/>          SUBWF     pwm_phase,0      ; Subtract to compare<br
/>          BTFSC     STATUS,C<br
/>          BCF       PORTB,0      ; If phase >= duty, end PWM
pulse<br /> pwmEnd:<br />          <br
/>          SWAPF     status_temp,0<br
/>          MOVWF     STATUS      ; Restore the STATUS register<br
/>          SWAPF     w_temp,1<br
/>          SWAPF     w_temp,0      ; Restore the W register

          RETFIE      ; Return from the interrupt<br /> intEnd:

```

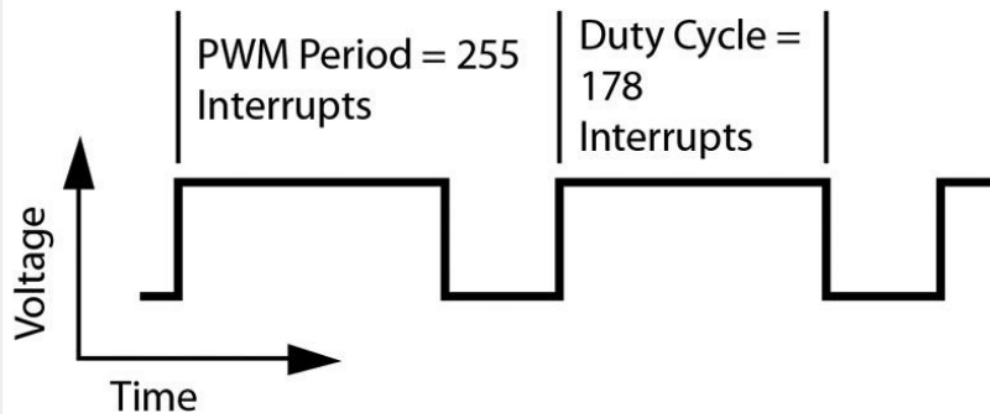


FIGURE 2. An oscilloscope trace of PWM generation using an interrupt with a 70% duty cycle.

Taken from: P. Mass, Article Title: Confidently using Interrupts in your Microcontroller Project, found online at:
https://www.nutsvolts.com/magazine/article/confidently_using_interrupts_in_your_microcontroller_project

Appendix 4

Use of COB and SMD LED in Bicycle Lights

SeeSense ACE uses around 62 little COBs that work together to shine powerfully both in daylight and at night-time, to make you visible from over a mile away (125 lumens) and give you 200° of side visibility on your commute. With ACE, our design and tech team worked really hard to get this level of brightness and decent 10-hour runtime into such a tiny and neat package, absolutely ideal for all urban riding.



See.Sense ICON2 uses a combination of both COB and one single CREE LED (for both a focused and dispersed beam), to make you visible up to 3km away, and give you 270° of side visibility.

CREE - The best of the very best, CREE LEDs are like the Apple in the world of LEDs, or we like to think of it that way anyway. CREE's are super high-performing, energy-efficient LEDs which provide a crisp, but low-glare output. If you had an original ICON light, you will have seen that they used two twin CREE's which blasted out up to 250 lumens.

With ICON2, we have packed so much more brightness (and intelligence) into them, with a whopping 300-lumen output in the rear and 400 in the front to keep you seen. With the slightly bigger size, this means we can provide you with the

most brightness and runtime possible, making them the light for you if you ride longer distances on your weekends.



CAN YOU SEE ME NOW?

Lumen Talk - We've been talking a lot about lumens here, but basically, lumens are a measure of the total amount of visible light to the human eye.

Focused Or Dispersed? We've designed our lights using quality twin CREE LEDs and a fresnel lens to offer unique visibility during the day, even in direct sunlight. The lights give a dispersed output, rather than focused. This is to offer you over 270 degree side visibility to keep you visible, without dazzling other road users.

Solid Or Flashing? We recommend using flashing lights, to help attract attention sooner. When you have lights that flash brightly from both front and rear can help alert drivers sooner than a solid light, reducing risks out on the road.

DAYTIME VISIBILITY

What do you look for when buying a bike light? You might consider brightness and decent battery life as being important features, or you might want a light that offers good visibility in the dark. But what about being seen during the daytime?

It is a crucial aspect of cycling safety that many people tend to ignore when making their purchase. But when you consider that 80% of cycling accidents happen during the day, it's become evident that visibility during the day is now just as important as being seen in the dark.

Most accidents have been found to happen during the hours around dawn and dusk. This is partly due to rush-hour traffic, and also because of factors including changing ambient light conditions which can make it more difficult for motorists to spot cyclists.



Bright, visible bike lights using high-quality CREE or Chip-On-Board LEDs can help counter that problem by giving you more of a presence on your bike during the day. See.Sense was one of the first companies in the world to create daylight-visible bike lights. Lights that ensure you can see and be seen both day and night, no matter how bright the sun is. Unlike others, See.Sense lights are both light in weight and long in runtime.

A WORLD WHERE PEOPLE CYCLE MORE OFTEN?

We hope this explains our tech a little bit more and helps differentiate between ACE and ICON2. Improving cycle safety isn't just important for reducing fatalities, it can also encourage more people to take up cycling. And the more cyclists we have on the roads, the better cycling infrastructure can be developed to improve the overall cycling experience.

Taken from: Unknown Author, Article Title: COB and Cree Welcome to the World of LED's, 10.5.19, found online at <https://www.seesense.cc/blog/hub/cob-and-cree>, accessed 23.5.20

Appendix 5

Examples of LED Hiking Torches

jordtiernan

17TH MARCH 2020

What Are The Best Head Torches?

Here's are the features and aspects to consider when buying a head torch...

Brightness: The most obvious feature of a head torch. How many lumens (measurement of brightness) does the head torch in question emit? They're there to provide lighting in dark situations, after all. The brightness of a head torch will inevitably influence both the battery life and weight – as it takes more batteries to power a bright beam for long periods. Lumen ratings can be as low as 50 or reaching over 1000. Between 200-300 tends to signify a head torch that will balance brightness and battery life well.

Beam Width and Distance: The width and distance of the beam are a big factor. Many brands now have models that allow you to select between a wider (and less focused) beam, or a focused beam (but narrower). It's a great feature to be able to change the width and distance of the beam to suit different environments.

Reactive Lighting: Reactive lighting is a fairly modern addition to head torches. It essentially the ability to adjust the brightness of the torch's beam based on how light or dark the surroundings are – similar to that of your smartphone screen adjusting its brightness based on the surrounding light. Whilst it is of course battery-efficient to run your head torch on its lowest power settings, reactive lighting allows you to get the most out of the surroundings whilst using only the power that's required.

Battery Life: Burn time is obviously a big deal, particularly when you're going without power for multiple days, or you know that you'll need to consistently use the head torch on high power for long periods – night navigation comes to mind. Standard head torches on their highest output will only normally last maybe 2-3 hours, whereas on their lowest setting they might run for over 100 hours. We're

now starting to see some head torches that are able to offer up an impressive balance between high lumen output alongside impressive battery life.

Rechargeable or Replaceable Batteries: The choice between a rechargeable lithium-ion battery or AA or AAA batteries is something to consider. An alkaline powered head torch will go through a lot of batteries in its lifetime, and consequently, you'll be leaving behind a fairly hefty footprint on the environment. Integrated lithium ion batteries are an economical – and environmentally friendlier option. A single lithium-ion battery could avoid the use of up to 900 batteries from entering the landfill.

Don't write off head torches with replaceable batteries though, because there's always the option of using rechargeable AA or AAA batteries. It's worth checking out the GP Xplor PHR15 which not only uses rechargeable batteries but has an integrated USB port so you can plug in power up using a portable power bank.

Other Features: The weight of the head torch will be of particular interest for runners or fast-and-light hikers. Some people may also look for a red light mode which helps to preserve night vision and will stop you from winding up the entire refuge with your early-morning alpine start. Finally, other things to consider are the waterproof and dustproof ratings (measured IP and IPX ratings) and any easily accessible dimming modes – if you're using the head torch in winter, consider whether you'll be able to the modes while wearing gloves or with cold hands.

Black Diamond Spot 325

Price: £40

Weight: 86g

Lumen Range: 325-, 160- and 6-lumens.

[Black Diamond](#) are one of the go-to brands when considering a headtorch purchase, we've certainly been impressed with their offerings in recent years and the Spot 325 is no different.

The Spot collection was initially launched in 2017 with a 200-lumen model, it then got an update to 300 lumens in 2018 before seeing a complete overhaul for 2019, becoming

what we see here. This overhaul hasn't just involved an increase in power, they've also reduced the size of the entire unit, added a new mode selector, and updated the LED.

Power modes on this are able to be changed through the simple press of the main button on the top of the headtorch, whilst a smaller button located on the side allows for switching between the lens mode settings, including; dimming, strobe, red night-vision and lock modes.

With three AAA batteries the Spot 325 is able to offer 200 hours of power on the lowest (8 lumens) power mode and four hours of charge on the higher (325 lumens) mode. A feature we were big fans of on the Spot 325 was the IPX8 waterproof rating. This means that you'll be able to submerge it 1 metre underwater for up to 30 minutes and it'll keep powering on – not bad.

Full Specifications

PowerTap transitioning between full and dimmed power / low-profile design / three AAA batteries, included / brightness memory – turn the light on and off at a chosen brightness / full strength in proximity and distance modes / dimming / strobe / red night-vision / lock mode / IPX8 waterproof.

<https://www.amazon.co.uk/Xtreme-Emergency-Bright-Flashlight-Magnetized/dp/B00FQQRPDS>



Roll over image to zoom in



Xtreme Bright Emergency Auto Torch; Super Bright LED Flashlight
With Red Flashing Lights On Barrel, Powerful Magnetized Case
Attaches To Any Metal Surface. Much More Than A Basic Handheld
Flashlight!

by [Xtreme Bright](#)

[4.0 out of 5 stars](#) 362 ratings

Appendix 6

Examples of LED Drivers

NJW4617

Constant Current LED Driver with PWM Control

Data Sheet

 NJW4617 Data Sheet

Features

- Operating Voltage Range (2.5V to 40V)
- Recommended LED Drive Voltage ($V_{LED}=40V$ max.)
- LED Output Current ($I_{LED}=500mA$ max.)
- Output Current Accuracy ($\pm 2.0\%$)
- To 10 of White LED can be operated. (at LED $V_f=3.4V$)
- Current Consumption ($450\mu A$ typ.)
- With PWM Luminance Control / ON/OFF Control
- Internal Over Current Protection Circuit
- Internal Thermal Shutdown Circuit
- Package Outline (TO-252-5-L3)

General Description

The NJW4617 is a constant current LED with PWM control. 45V resisting constant current control and PWM control circuit can be offered with small package. It can achieve luminance control multiple white or blue and red LEDs. It can contribute to the reliability improvement of the system because it has an overcurrent protection and thermal shutdown circuit.

Package Information

Part Number	Package Outline	Pins	Material Declaration (RoHS/Halogen)	Terminal Finish	Weight (mg) (Reference)	Reflow soldering	Flow soldering	Iron soldering	Packing Condition	MSL	Solder Foot Print
NJW4617 DL3	 TO-252-5-L3	5		Sn2Bi	301	Yes	Yes	Yes	Non dry pack	1	

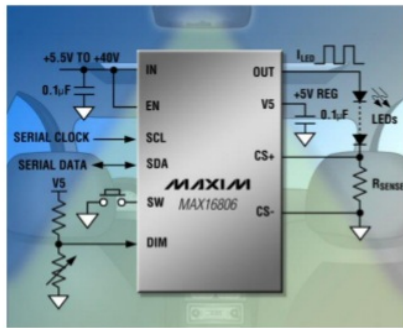
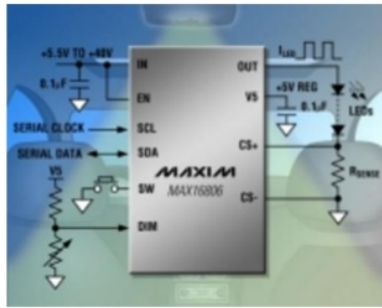
Sample & Buy

Part Number	Packages	Status	Packing Specification	Sample	Buy
NJW4617DL3	TO-252-5-L3	(Active)		Contact Us	Stock Check 

Taken from: <https://www.njr.com/semicon/products/NJW4617.html>

Maxim LED driver eliminates need for microcontroller or switch-mode converter

Sep 6th, 2006



Date Announced: 06 Sep 2006

SUNNYVALE, CA -- Maxim Integrated Products (NASDAQ: MXIM) introduces the MAX16806 EEPROM-programmable, 350mA, high-voltage (40V) linear, high-brightness LED driver.

This IC can be programmed through an I2C* interface to fold back the LED current if input voltage or LED temperature rises above the programmed threshold. Although a traditional architecture requires switch-mode converters to reduce power dissipation, the unique design of the MAX16806 LED driver manages total power dissipation in a lighting system, and thus eliminates the need for a switch-mode converter. Consequently, the MAX16806 reduces both cost and EMI concerns for powering high-brightness LEDs. The benefits of the Company's approach will be immediately

noticed in a broad range of lighting applications such as automotive interior and exterior lighting.

Switching from Incandescent Lamps to LEDs Poses a New Problem for Auto Makers

The automotive industry is replacing the existing incandescent lamps with white LEDs for dome and map lights. This change is done to create a technologically advanced image for the new cars. The LEDs need to work with the existing control module unit, and this poses a new problem for auto makers. The present theater dimming signal operates at very low frequency and causes the LEDs to blink noticeably during dimming. To eliminate this effect, the LED driver used to require a microcontroller to create a new PWM signal.

Unique LED Driver Design:

1) Eliminates the Need for External Controls

The novel architecture for the MAX16806 eliminates the need for a microcontroller's PWM signal, because an on-board 200Hz ramp generator allows analog control for PWM or theater dimming effect. The device's high-voltage (40V rated) DIM pin can also sync with up to a 2kHz external PWM signal. The fast turn-on/off times ensure a wide dimming range, while the wave-shaping circuitry minimizes EMI.

2) Reduces Production Costs

The MAX16806 was also designed to simplify production and reduce manufacturing cost. This LED driver uses one value of a current-sense resistor in conjunction with EEPROM-programmable current-sense reference to set the LED current for all LED bins.

3) Makes Them Versatile for Many Applications

LED brightness can be changed automatically, on-the-fly on this device, a feature that makes it especially versatile for demanding lighting applications that extend far beyond the automotive industry. Designers simply adjust the RGB LED current level dynamically through the I2C interface. This allows the creation of a wide range of colors for architectural or general lighting applications.

Integrated debounce circuitry supplies the necessary wetting current for a momentary switch. This feature makes the MAX16806 an ideal LED driver for automotive dome- or map-lighting applications. The device requires minimum external components to implement the LED driver circuit, making it a cost effective solution for many lighting applications.

The MAX16805, a companion product, has many of the same features as the MAX16806, but is offered for applications that do not need LED current thermal foldback or wetting current and debounce circuitry for a momentary switch.

Key Driver Specifications

The MAX16806 driver combines a low-voltage (204mV) current-sense reference with differential LED current sensing to provide load accuracy of $\pm 3.5\%$. This current accuracy allows consistent brightness for all light assemblies. The device's low-dropout pass element (0.5V typical) and current-sense reference minimize power dissipation. Output voltage is rated to 39V and allows the MAX16806 to drive multiple LEDs in series. The driver has overtemperature and short-circuit protection, important safeguards for lighting applications.

The MAX16806/MAX16805 are rated for operation over the automotive temperature range (-40 degrees Celsius to +125 degrees Celsius). They are available in a thermally enhanced, surface-mount, 5mm x 5mm, 20-pin TQFN lead-free package

rated at 2.67W power dissipation. Prices for the MAX16805 start at \$1.42 and \$1.49 for the MAX16806 (1000-up, FOB USA). For more information please visit: <http://www.maxim-ic.com/MAX16806info>

*Purchase of I2C components from Maxim Integrated Products, Inc., or one of its sublicensed Associate Companies, conveys a license under the Philips I2C Patent Rights to use these components in an I2C system, provided that the system conforms to the I2C Standard Specification defined by Philips.

A Data Sheet for this product is available on the web at <http://www.maxim-ic.com/MAX16806>

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Taken from www.maxim-ic.com/MAX1680 accessed 24.4.20

LED Drivers for Integrated Lighting

December 15, 2016 by [RECOM](#)

RECOM DC current (RACD04) and DC voltage (RACV04) LED drivers have been designed for cost-sensitive applications.

Safety extra low voltage or SELV terminals are ideal for supplying power to integrated LED lighting.

RECOM LED drivers can be built into furniture, hidden under shelving, or integrated into applications with extremely space available due to their compact design, including cable connections. The RACD04 series is aimed at LED spotlights, reading lamps and accent lighting, whereas the RACV04 series is ideal for LED strips, background and wall lighting, and furniture and cabinet illumination. Each 4W AC/DC LED power supply in IEC protection class II packed into a compact casing measuring 38 x 27 x 21 mm at a weight of just 40g. The RACD04 series has 350, 500 and 700 mA DC current terminals, whereas the RACV04 has 12 and 24V DC current terminals. The isolation voltage in either case is 3.5 kV AC/1 minute. These LED drivers are classified to IP65, and are therefore suitable for damp areas such as kitchens and bathrooms, or covered garden or outdoor facilities. The drivers provide complete protection against short circuit, overvoltage, overload and overheating, and are certified according to CE, DB, CSA and UL8750 standards and comply with the RoHS2.1 and ErP directives. Both series have a three-year guarantee. RECOM RACD04 and RACV04 are now available from the RECOM distribution network.

About RECOM

The RECOM group is a power supply manufacturer from Austria with over 45 years of experience in developing and manufacturing the latest converter technology in a power range from 0.25W to 960W.

Worldwide customers have access to the largest selection of DC/DC converters and AC/DC power supplies on the market plus a broad range of switching regulators and LED drivers, all of which comply with international safety standards and carry the latest certifications

Taken from : <https://eepower.com/new-industry-products/led-drivers-for-integrated-lighting>

Accessed 24.4.20

VVV

electronic assignment

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

Instructor

54/100

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GRADING FORM: GJ_2019

NICHOLAS REGAN

270

ENGAGEMENT WITH LITERATURE



Extremely wide range of research sources used.

75

KNOWLEDGE AND UNDERSTANDING



The wide range of background research information discussed has allowed a good mark in this section

65

COGNITIVE AND INTELLECTUAL

 Considering the extent of the research, very little 'joined up thinking' demonstrated in this section - little justification as to how the researched technologies have found their way into the end device etc.

40

PRACTICAL APPLICATION

 Very simple circuit. Basic things like flyback protection and smoothing capacitors missing. 5V coming IN to the regulator? How do you charge the battery? Its almost as if one person did the research, then another person attempted the rest of the assignment. Parts list and costing missing.

35

TRANSFERABLE SKILLS

 A number of spelling mistakes. The report could have benefited from more structure and formatting.

55