PEAK LED SOLUTIONS

QUESTIONS AND ANSWERS

LED flashlights are a relatively new concept and are very different from incandescent lamp flashlights. There is also a recent proliferation of products from various companies. Some are very good, and some are not so good. We would like to answer some questions posed to us as why Peak LED Solutions products are the worlds best.

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1. WHO IS PEAK?

Peak LED Solutions is a woman owned company, with a combined 60 years of experience in design, engineering, and manufacturing of aero-space / commercial mechanical components and electronic assemblies. Peak is well qualified to produce the exception in LED flashlights.

Mechanically manufactured components are machined on modern CNC turning and machining centers. Production assembly of the electronic components are referenced to International Standards Organization 9001-2000 certified compliance. Other quality and process controls include ANSI/ASQC-Q9001, IPC-A-610 class 1, 2, and 3 as required, and IPC/EIA J-STD-001 C – ESD. *Quality and reliability are our standards in manufacturing.*

Because of our extensive aero-space background, we meticulously design and completely test our LED flashlights to ensure that you get a reliable and quality product. The entire Peak product line of LED flashlights are designed, manufactured and assembled in Phoenix, Arizona USA.

Peak utilizes State of the Art electronics in its designs. As a result, a single electronic design can be used in different power level applications. Our goal was to develop reliable base-line designs, which have substantial current drive capability. In-turn, development and manufacturing costs are reduced which reflect in the development of new product designs.

2. WHAT ARE 'SNOW' WHITE LEDs?

Peak uses a special 5 mm diameter LED that has a truer natural white light output than the average LED used by most other LED flashlight manufacturers. The average LED has a very distinct blue tint to the output. The premium LED that Peak uses has an output closer to the natural output of the Sun of 5300 degrees Kelvin. Most other white 5 mm LEDs have a 6700 degree Kelvin output or higher. In side-by-side comparisons with Peak LED flashlights and the competition, their white LED color has been described as <u>angry blue</u>. Only Peak 'Snow' white LEDs reproduce colors close to the CIE international standard. The reproduction of true colors is an exclusive advantage that Peak LED flashlights have in medical applications and in the electronics industry.

3. WHY NOT USE 5 mm AND 8 mm MULTIPLE DIE LEDs?

The 8 mm diameter white LED is comprised of four dice in a single housing. The light output is rated a 16,000 MCD, (Mili-Candela), at 100 mA input current. The 5 mm four die LED is rated at 15 Lumens at 150 mA input current. When we tested the 5 mm LED the output was 68,000 MCD. The temperature of the LED was so hot that it was impossible to hold onto. The maximum current that we would recommend would be 100 mA to prevent the destruction of the LED due to excessive heat.

The premium 'Snow' white LED that Peak uses has a nominal output of 20,000 MCD at 20 mA of input current. Our Standard Power drive current is 24 mA for an output of 24,000 MCD. When we over-drive the LED at 35 mA, High Power the output is 30,000 MCD and when driven at 50 mA, Ultra Power the output is 40,000 MCD. Several of the Peak LED flashlights use multiple LEDs for increased light output. The three LED Peak Matterhorn in High Power has a nominal output of 90,000 MCD.

4. WHAT ARE OVERDRIVEN LEDs?

The most popular method of producing more light output from a single LED is to drive the LED with more current than recommended by the manufacturers' maximum limits, as specified from their data sheets. All LED manufacturers of 5 mm diameter LEDs rate their output in MCD at a specified voltage and input current. LED life is also rated at that drive current and at a specified die junction temperature.

As input current is increased, (over-driven), light output is also increased, but as die junction temperature increases LED life decreases. In most 5 mm LED flashlights this is not a real problem. A single color LED, (red as an example), has a typical life of about 100,000 hours to 40 % of initial light output, at a standard operating condition of 20 mA input current. A white LED is completely different.

The white LED is made from a blue LED that has a mixture of phosphors applied over the die. The phosphor coating over time deteriorates similar to that of a florescent lamp. The epoxy envelope incasing the metal parts of the LED is also subject to heat deterioration. The higher the input current applied to the LED over the recommended specifications, the shorter the expected life of the white LED will be.

5. WHAT IS THE LIFE OF A WHITE 5 mm LED?

When driven at a standard input of 20 mA, the average life expectancy of a typical white 5 mm LED to 40 % of initial light output is 10,000 hours. The Peak Standard drive current is 24 mA for a life of about 8,000 hours. When driven to 35 mA input current, (High Power), the life is then about 3,500 hours and at 50 mA input current, (Ultra Power), less than 1,000 hours. Even higher currents can result in life expectancy to several hundred hours or less.

Many LED flashlight competitors advertise 100,000 hours of white LED life on the packaging of their 5 mm LED flashlights. Unfortunately there is no requirement in the flashlight industry for truth in advertising. The die itself may last 100,000 hours, but the white light output will not.

6. WHAT 5 mm LED POWER LEVEL IS MOST POPULAR?

The last three years of production of Peak LED flashlights using the 5 mm LED has resulted in the following percentage of requested power output levels. Standard output 5 %. High Power output 43 %. Ultra Power output 62 %. Most customers would rather have more light output than worry about LED life or battery run time. The typical LED flashlight usage is about 5 minutes per day or less. That would be 30½ hours per year. Some users may only change a battery once a year. For that usage rate the Ultra Power output level is of minor concern as to LED life. If used for more than 15 minutes a day then the High Power output level is the better choice. For more extensive on-time, we recommend the new Baltic or Pacific lines of Peak LED Solutions flashlights. The Baltic and Pacific use the larger high performance LEDs that have been designed with proper thermal management capacity to remove heat from the die junction area.

7. WHY USE MULTIPLE LED HEAD ASSEMBLIES?

The 5 mm diameter LED by design is limited to the amount of current that it can effectively handle. Because of the inability of the design to remove heat from the die junction area, (thermal management), light output per LED is also limited. To increase the light output we have incorporated a multiple LED design option for the 5 mm heads. The Peak 3 LED High Power head outputs more than double the MCD of a single overdriven 5 mm LED competitive flashlight, (90,000 MCD vs. 43,000 MCD), and has both a longer battery run time and LED life.

8. WHY DOES ONE FLASHLIGHT APPEAR BRIGHTER?

No two LED flashlights are the same. Most of the difference in output is due to the manufacturing process of the LED. When the LED goes through the various steps in being made, variables in tolerance occur. The completed LEDs are then tested as to color tint, voltage, and light output. The test takes about 25 milliseconds for each LED; the tested LED is then sorted into separate bins. A single manufactured run of LEDs may have as many as 20 different bins of color, voltage and output power. Typical power output bins may have as much as a 30 % variation per bin.

The output ranking from one manufacturer of LEDs divides a particular LED into three Luminous Intensity bins. Bin T; 11,000 to 15,500 MCD. Bin U; 15,500 to 22,000 MCD. Bin V; 22,000 to 31,000 MCD. They then state that, (Luminous Intensity Measurement allowance is plus or minus 10 % per bin). Then they indicate that, (One delivery will include up to two consecutive color ranks and three luminous intensity ranks of the product). The quantity-ratio of the ranks is decided by them.

That is why two identical LED flashlights appear to have different power outputs and color tint. The premium hand-picked Snow white LEDs that Peak uses are very consistent as to both color tint and power output.

9. ARE ADVERTISED NUMBERS ACCURATE?

When a number is stated in an advertisement or a paper such as this one, a stated number may be one of four types of numbers. The first is a precise number that directly relates to a known fact. The second is the average number of an entire group of items. The third is a mean statistical average of a small random sample of items from an entire production run. The fourth is a nominal number that represents a target within multiple ongoing production runs of the same item.

Unless there is an understanding or a statement as to what a particular type of number is, all numbers should be regarded as being nominal and not exact. As an example the U bin is 15,500 to 22,000 MCD plus or minus 10%; or actually from 14,850 to 22,650 MCD. The precise numbers are 14,850 MCD and 22,650 MCD. The average number is 18,750 MCD. The mean statistical average could be anywhere within 14,850 and 22,650 MCD, and that number will change each time a different production run is manufactured. An advertised representative nominal number of the U bin could be 20,000 MCD.

10. ARE REVIEWER TEST RESULTS ACCURATE?

When a flashlight reviewer makes a test on a flashlight it is normally on only one flashlight of that type and brand. The reported output is therefore from a single source and not of a range or an average of many. The sample may be a picked best or a random selection. When comparing one each of several closely related flashlights of different brands; the results can only be speculative and not that of a precise actual number. That particular sampling may not be representative of the difference between many flashlight brands. Typically a difference of 10 to 20 % of output power is not noticeable during normal operating conditions.

Peak uses only hand-picked quality LEDs in the manufacture of its LED flashlights. This cost a little more but the output consistency of Peak lights are unequaled. With some other competitors it is a lottery as to color tint and power output within the same flashlight production run.

11. WHAT ARE LUMENS?

Lumens is a measurement of <u>total</u> light output power from a source. Special equipment is required for the measurement and it is normally done under laboratory conditions. The output of Lumens from a light source does not change when the beam pattern changes. If a measured output of 45 Lumens from an LED is spread over 140 degrees, at a 30 degree spread, it will still measure 45 Lumens. Even if the angle of spread has been changed to 10 degrees, it will still be 45 Lumens. The output in Lumens of the LED remains constant regardless of the output angle.

12. WHAT IS A CANDELA?

Candela or candlepower or foot-candles are the same thing. This is a measurement of <u>maximum intensity</u> of light at a single point twelve inches distant from the light source. A test sample LED measured at a 45 Lumens output and with a 30 degree beam pattern will give a maximum Candela reading of 79. Using the same 45 Lumen output and a 20 degree beam pattern, the maximum Candela reading was 217. When a 10 degree beam pattern is used the measured Candela became 790. The 30 degree pattern will be more of a flood and the 10 degree sample will be more of a spot beam. Lux is a measurement of maximum intensity at one meter from the source of light. Candela is the measurement at twelve inches.

13. CAN LUMENS BE COMPAIRED TO CANDELAS?

There is no mathematical conversion between the two methods of measurement. The higher the Lumens the more light is being produced by the LED source. The higher the Candela reading, the farther away an object will be illuminated. One Candela is equal to 1,000 MCD.

Peak chooses to measure its flashlights in Candela so that anyone with an inexpensive light-meter may verify the Candela output. Many other manufacturers will state the output of their high performance LED flashlight in Lumens. Most often they will state that they use, (as an example), a 45 Lumen LED in their flashlight. This Lumen output number can typically come from the data sheet of the LED manufacturer. Recently another company tested an imported competitors LED flashlight and verified as to output in Lumens by a well known laboratory. The measured Lumens of that sample were 29 Lumens less than advertised. The actual output in Lumens of that flashlight may or may not have been measured by the flashlight manufacturer. An advertised output in Lumens may not take into account the efficiency of the reflector / lens assembly, electronics or battery or quality of the LED. A stated output in Lumens is very expensive for the consumer to verify, nor does an accurate measurement in Lumens indicate how far away an object may be illuminated. Accurate measurements of both Lumens and Candela are important.

14. WHAT IS A HIGH PERFORMANCE LED?

The 5 mm LED design is decades old and the typical input current is a standard of 20 mA. The light output at that time was from 4 MCD to 60 MCD. As an indicator light, a higher output was not required. In the last few years the LED manufacturers have been able to increase the output so that it is now possible to use them in flashlights. The 5 mm LED has just about reached a maximum practical limit in MCD output.

In recent years a new design has been introduced with the ability to remove the heat buildup from the die junction area of the LED. Through the proper application of heat sinking and thermal management engineering, a very large increase of input current is now possible with a corresponding increase in light output. The average 5 mm LED can tolerate one-eighth of a watt of power. The new high performance LEDs are rated at one watt, three watts, five watts, and as much as 100 watts of power. These LEDS are also known as high flux LEDs. The latest high flux LEDs are now as efficient as florescent tubes in Lumen output per watt of electrical energy input.

15. DO LEDs PRODUCE HEAT?

Yes, although LEDs are very efficient at converting a very high percentage of electricity into light emitting photons, the problem is getting those photons out of the die junction area where they are created. On average only about 15 % of the photons get out, the rest is reabsorbed inside the die and converted into heat. This heat must be removed, if retained within the die, the efficiency of the LED light output decreases and could even result in premature LED failure.

16. WHY DO LED FLASHLIGHTS GET HOT?

Quality High Performance LED flashlights do get hot. The heat generated within the die junction area must be removed. This is referred to as thermal management engineering.

- **Power dissipated by the LED**
- **Thermal path between the LED junction and ambient conditions**
- **Ambient temperature of the LED's immediate surroundings**

The outside cases of some inexpensive high performance LED flashlights remain cool. This is due to a lack of proper thermal management engineering. The majority of LED failures are temperature-dependent. Elevated junction temperatures cause light output reduction and accelerated die degradation. A low cost LED flashlight may not be a good overall value. Murphy's Law applies to when needed most, the required reliability of a poor quality LED flashlight may not be there.

17. HOW MUCH LIGHT OUTPUT DO I NEED?

This depends on the intended purpose and use of the flashlight. Output, size, and battery run time are three very important considerations in the choice of a particular LED flashlight. Is the light going to be used in tight close quarters or to see something at a distance? For most close usage from six inches to 30 feet an output of 35 to 150 Candelas is sufficient. From 30 feet to about 120 feet an output up to 700 Candela is required. Out to 300 feet there is a need of 1700 Candela or more. Older eyes require higher LED light outputs as does close fine detail inspection. More is usually better. Higher outputs generate more heat and shorter battery life.

18. WHY USE A SINGLE BATTERY?

A single battery flashlight is by definition a small pocket carry flashlight. This type is perfect for Every Day Carry. Once you start to EDC with a high performance LED flashlight, the average user is amazed at how handy it becomes and how often they use it. Most of the Peak LED single battery pocket flashlights outperform the old style 2 D battery flashlights for both light output and run time.

If your high performance LED flashlight is not with you and left at home in a drawer because it is too big, what good is it?

19. WHY USE MULTIPLE BATTERIES?

Sometimes there is a requirement for a higher light output or a longer run time is required than what a single battery can provide. Peak LED Solutions manufactures several multiple battery options. These optional battery compartments can replace the single battery case that normally comes with the Peak LED flashlight. This allows the owner to customize the flashlight without having to have separate flashlights for different uses.

20. WHAT IS A MODULAR LED FLASHLIGHT?

Only Peak LED flashlights are modular in design so that a single flashlight may be tailored by the user to a particular requirement.

There are different body styles that can be interchanged with the same power head. The Baltic Sea power head by Peak, as an example, can be fitted with up to nine different battery compartments. Some are single battery and others use two batteries. Some battery compartments have been designed to replace the removable key ring adapter with an optional momentary tail switch. Others are more compact and shorter in overall length. The Baltic Sea may also use three different sizes of batteries. Additional battery compartments with an optional water tight cap can be used to store spare batteries or anything else that you may want to fit inside. The Baltic Sea may also be ordered with 5 different light output power levels. You may choose from the XRT, (eXtra Run Time), to the Super Ultra for maximum light output.

Some other LED flashlight manufacturers may offer three different case color options; Peak offers up to five different metal case options.

Others may have only one power output level, Peak offers up to five. With Peak you may choose between many case styles and battery types. Others offer only one of each. With Peak you may custom build the exact LED flashlight that you need at non-custom prices.

21. WHICH BATTERY SHOULD I USE?

There are different sizes of batteries and different chemistries within most of a standard battery size. Primary batteries can be used only once and then discarded. Secondary batteries are rechargeable and if treated with care can be recharged 500 times or more. Secondary batteries have less watt density than primary batteries of the same size, and therefore less overall run time.

The smaller the size the less run time given a similar light output. The larger the battery means a larger overall flashlight bulk and possibly a higher light output capability. Chemistry makeup changes the characteristics of the output run time. Internal mechanical design determines current output capacity.

Batteries are rated as to voltage output and current capacity in mAh, (mili-amperes per hour). When both are multiplied together the result is a capacity in watts. This is also sometimes referred to as watt density or watt density per unit weight.

Carbon Zinc batteries have the lowest watt density and should not be considered for high power LED flashlights. Alkaline batteries are the least expensive per watt density and can give the longest run times. The problem with alkaline batteries is under high current draws, the internal resistance of the battery increases rapidly and reduces the rated mAh capacity of the battery. This increase of internal resistance also lowers the output voltage of the battery and that lowers the conversion efficiency of the electronics, decreasing both light output and run time. Alkaline battery development has reached about 90/95 % of theoretical capacity. Alkaline batteries are a good choice for medium output low cost daily usage.

Primary CR type Lithium batteries have very low internal resistance due to their internal construction and maintain a steady high drain output until the chemistry is used up. This type of battery also has very good shelf life of 10 years or more to 90 % of original capacity, and can tolerate both high and low temperature conditions. CR type Lithium batteries are best used in high power output LED flashlights and for emergency response or short intermediate less than 5 minutes per day usage. They are the most expensive per watt density. Lithium batteries are at about 65 % of theoretical capacity.

Secondary rechargeable batteries are very good for high output, high drain applications under long constant flashlight on times. They have typically one-half the current density of Lithium batteries and need to be recharged often even if they are not used. NiMH or Li-Ion rechargeable batteries have the lowest cost per hour of run time. These are the best battery type for more than 15 minutes of daily usage. Li-Ion batteries are evolving with different chemistries and internal construction. 5 Minute recharge rates and very high output capacities will soon add a brand new level of performance to the high output LED flashlights.

22. WHY ARE ELECTRONICS NEEDED?

An LED requires a minimum amount of Voltage to produce maximum light. This is referred to as the voltage drop across the LED. The incoming voltage supply to the LED must be same or higher than the required voltage drop to realize the maximum output of light from the LED. The voltage needed is different for different types of LEDs. As an example a 5 mm white LED requires an average of 3.7 volts of electricity. A single alkaline battery can provide only 1.5 volts of electricity. An electronic circuit is therefore required to convert the lower voltage from the battery to the higher voltage demanded by the LED. The most common circuit for this operation is known as a boost circuit. The boost circuit output is then used to regulate the amount of current flowing through the LED. The higher the current flow the more light is produced by the LED.

When the voltage supply is higher than required by the LED, a Buck circuit is used to control the amount of current flowing through the LED. Too high of a current can overdrive the LED and cause premature failure.

Boost or Buck circuits are only two of at least a dozen or more types of electronic circuits that can be used in powering an LED flashlight.

23. WHY DO SOME FLASHLIGHTS RUN LONGER?

Some LED flashlights with the same Candela light output and using the same battery will run longer than others. This is due the quality of the electronic circuit used to power the LED. A high quality circuit will have a better efficiency percentage with less energy loss to heat. Peak only uses the best and most efficient circuits available. The cost of the integrated circuit by itself that Peak incorporates in its designs typically exceeds the total cost of our competitor's entire electronics.

24. WHAT IS THE DIFFERENCE BETWEEN CASE MATERIALS?

Peak LED Solutions only manufactures high quality metal flashlights. We offer four different case metal options. A hard, type III anodized coated aircraft grade aluminum for light weight. Solid brass, (optional Gold plate), for appearance and the feel of quality lost to a world filled with cheap plastic. Stainless steel offers ease of maintenance and long lasting value. And limited runs of Titanium that is not only a highly desirable space-age metal, it also has lasting durability and half the weight of stainless steel.

25. WHAT IS A POWER PEN?

This is a commercial product that Peak has chosen to offer because of its great usefulness. It is a battery contact cleaner housed in a convent common pen sized applicator. A safe way to maximize the output of batteries in all battery powered devices and not only LED flashlights. Used on both the battery contacts and the negative and positive contact areas of the flashlight, we have observed an increase of up to 20 % light output in Candela using brand new batteries. Simple to use and non-destructive to either the battery or the flashlight, it cleans and helps to prevent future power robbing corrosion.

Use the Power Pen in all of your battery powered devices including battery operated power tools for maximum efficiency. Do not use with automotive lead acid batteries.

26. REFLECTOR vs. COLLIMATING LENS

5 mm LEDs have a built in reflector, high flux LEDs do not. The high flux or high performance LED has a typical output of light in a pattern that is a 360 degree cone with an angular spread of about 140 degrees. This very wide spread must be modified to become useful as a flashlight. A reflector is an open ended bowl shaped as a parabola with the LED placed at the focal point opposite from the open end. The reflector has been used with incandescent lamp flashlights for decades. Some reflectors have a dimpled surface or other type of built in surface features that blend the light output to hide distracting appearance artifacts from some light sources. This also results in less directed light and lowers the maximum Candela output.

The collimating lens used in LED flashlights is usually a solid clear plastic part designed to make light rays parallel. This has the same effect

as a parabolic reflector. A collimating lens must be used with some brands of high performance LEDs because the mechanical design of the LED does not allow the efficient use of the focal point of a reflector. Most collimating lens designs have a diameter to length ratio of about 1 to 1. This results in a less than efficient maximum Candela output even though the overall efficiency of the lens may be 90 %. When comparing a reflector side by side with a collimating lens, the reflector can have as much as 50 % higher Candela output with the same Lumen input. Only one LED flashlight manufacturer makes a correctly designed collimating lens, the problem is that the length is 3 times the diameter. This then becomes a very over long LED flashlight and no longer a flashlight that is small enough to be pocket-able.

Peak uses a smooth parabolic reflector that produces the maximum Candela output with a usable side spill of light.

27. PLASTIC LENS vs. GLASS LENS

The plastic lens that Peak chooses to protect the reflector and LED in our high performance flashlights is scratch resistant and almost unbreakable. Quality glass lenses can break and shatter when dropped which may damage the reflector or the irreplaceable LED. A glass lens with an anti-reflective coating will be a more efficient light transmission cover by several percentage points and will be more resistant to minor scratches. The light output difference can only be noticed by instrument measurement and only several minutes of run time can make up the difference in output.

Peak plastic lenses are replaceable and free. Send a self addressed stamped envelope and the model of the flashlight. And we will send out a replacement.

28. COST PER CANDELA OUTPUT

Peak LED Solutions sells only the highest quality LED flashlights Manufactured in Phoenix, Arizona USA. Our flashlights initially cost more than the imported lights of other brands. We only use the best, most expensive and reliable electronics in the manufacture and assembly of our lights. We do not cut corners or save pennies in our quest to bring to you the world's best LED flashlight, which you may rely on when other lights will fail. The efficiency of our electronics means that a Peak flashlight will still produce light when others are no longer able to. We design and build to last a lifetime.

There is no better value than a Peak LED Solutions flashlight.

29. WHAT IS THE PEAK CUSTOM SHOP?

This is a unique department to Peak that no other flashlight company offers. Within limits, any standard Peak LED flashlight can be modified to your requirements. We can also design and manufacture production runs of LED flashlights for special applications.

We take personal pride in manufacturing the best LED flashlights in the world. Please contact us at sales@peakledsolutions.net or 1-877-881-7325

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