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A Hybrid Topological Design of Led Driver for Automotive Applications

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Abstract: ***Light-emitting diodes (LEDs) have long been utilized as the default component for signaling and interior lighting applications in automotive industry. The response rate of an LED as compared to a traditional incandescent bulb is ten times faster. The ease of maintenance and controllability feature of LEDs also makes them a natural choice for intelligent lighting system. This lighting can be adjusted based on the sensor inputs of a vehicle with ease. The multi lighting capabilities of a LED driver provides options that can address multiple applications with the same LEDs. A constant current is required for uniform LED lighting. Owing to the high reliability on LEDs for an array of applications in the automotive sector, additional circuitry for over voltage protection, under voltage protection, reverse polarity risk, over current protection, over temperature protection and short circuit protection needs to incorporated. The proposed design provides a improvement of 5% over the state of the art existing topology for over voltage protection.***

Keywords: Light Emitting Diodes (LED), LED driver, transients

I. INTRODUCTION

As the advancements in strong state lighting evolved, LEDs are being structured in the outside applications also. Albeit utilized fundamentally in focus high-mount stop lights (CHMSL) and back mix lights, LEDs keep on making progress for most car inside and outside lights. The broad appropriation of strong state light sources occurs as a direct result of engaging properties like prolonged lifetime, smaller size, lesser power consumption and higher efficiency. Car manufacturers need to address the issue of potential decrease in vitality utilization just as the space reserve funds acknowledged by littler lighting fixtures.

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The styling capability of LEDs likewise is an extraordinary benefit for purchasers, which empowers increasingly appealing and particular structures. Customers likewise benefit from wellbeing parts of utilizing strong state flag lighting. For instance, quicker turn-on of the stop lights can lessen the danger of backside impacts. Furthermore, maybe the most convincing explanation behind utilizing LEDs is their normal unwavering quality and lifetime.

These are benefits producers and customers can both acknowledge, as they will possibly significantly diminish swap and upkeep costs for car lighting. Outside LED lighting has been progressively prevalent on trucks and transports on account of the minimized size and stun opposition of strong state lights. These favorable circumstances of the LED lighting fixtures rearrange consistence with different security guidelines. The outside applications incorporate tail lights, stoplights, marker lights and identification (ID) lights. For instance, the National Highway Transportation Safety Administration (NHTSA) has issued another consistence that truck trailers 80-in. wide or over must have ID lights mounted over the back entryway regardless of whether the space accessible is just 1-in. high. Driven restricted rail lights give the main arrangement handy in such least space applications. Albeit strong state forward lighting isn't normal soon, a large portion of the significant vehicle makers have tried different things with LED headlights in their idea models. One such model by Hyundai Motor Corp. has the majority of its flag and lighting gadgets, including headlights, utilizing high-splendor LEDs from OSRAM Optoelectronics fueled by LED driver arrangements from Super tex Inc. Be that as it may, creation models having LED headlamps are not expected to land until 2007. Up to that point, the forward lighting utilizations of LEDs will keep on being restricted to daytime running lights (DRLs), which are basically flag lights showing a vehicle is being used.

The pattern of utilizing LEDs in forward-lighting applications is essentially determined by their styling potential. In any case, producers are investigating the hood-opening space reserve funds from utilizing LED headlamps, just as the decrease of the front over-hang, which is fundamentally directed by the headlamp development. Dashboard lighting is the most widely recognized inside use of high-brilliance LEDs. About each European vehicle is furnished with LED backdrop illuminations in the instrument board. Driven backdrop illumination improves styling and makes the instrument boards progressively lucid and agreeable for drivers.

Other inside uses of LEDs incorporate guide and perusing lights, entryway ledge lights and feeling lighting. Driven based arch lights are ending up progressively appealing for their smaller size, uniform light and low warmth. Because of the electrical properties of high-brilliance LEDs, they can't be fueled specifically from the car battery voltage.

They require specific power converters conveying steady current yield. The huge assortment of LED fixtures utilized in cars calls for different kinds of LED driver topologies. These power converters must be in consistence with various industry specifications. This article will address material power-converter topologies valuable for driving LEDs. The accentuation will be on LED driver resistance to directed electrical unsettling influences that exist in autos

II. AUTOMOBILE TRANSIENT CONDITIONS

Under typical activity of the vehicle, voltage at the supply lines runs between 9 V and 16 V (12-V framework), or between 18 V and 32 V (24-V framework). Be that as it may, a considerably more extensive scope of voltages of both positive and negative extremity may show up along the supply lines because of led electrical homeless people. Electrical unsettling influences produced by separating inductive burdens, abrupt power cutoff in the primary circuit or switch ricocheting are regularly alluded to as inductive exchanging. Separating an inductive component causes a high rearranged overvoltage on its terminals. Positive high-voltage homeless people happen at the supply lines after the start key cuts the battery-supply circuit. For this situation, the start circuit keeps on discharging unsettling influences until the motor quits pivoting. Exchanging the power provided by electric engines going about as generators (the cooling fan, for instance) likewise creates overvoltage spikes. Their plentifulness is expanded by the nonappearance of separating, which would regularly be completed by the battery. Albeit inductive exchanging unsettling influences can create high voltages up to 600 V of both positive and negative extremity, the most noteworthy vitality accessible from these drifters more often than not does not surpass 2.3 J per one heartbeat.

In this way, LED lighting gadgets can be shielded from the inductive exchanging homeless people by insignificant cinching of the supply voltage at an adequate dimension. A considerably more forceful electrical unsettling influence happens when the vehicle battery is all of a sudden separated while being charged by the alternator. Amid such a heap dump condition, the voltage on the alternator terminals increments quickly. The length of this aggravation relies upon the time steady of the generator excitation circuit and can be up to a few hundred milliseconds. Arrangement obstruction of the alternator circuit is just a small amount of 1 ohm. In this way, the vitality accessible from the heap dump transient can reach as high as 50 J. Positive over voltages of up to 87 V (12-V framework) or 174 V (24-V framework) can show up along the supply lines. This kind of transient can be deadly for the LED lighting gadgets. Most current alternators are furnished with an uncommon concentrated clipping circuit, which normally braces the heap dump transient voltage beneath a 40-V level. Different car principles give to some degree diverse definitions of a heap dump test. A commonplace wave shape is appeared in Fig. 2.

The spotted line assigns the midway clipped burden dump beat. In any case, some inside or outside lighting fixtures might be planned as retort for inheritance gadgets. These fixtures may require assurance from unsuppressed burden dump homeless people. Quick information drifters can introduce a difficult issue for LED lighting gadgets because of low powerful impedance of the LEDs themselves. The driver hardware must give extremely quick info supply dismissal to shield the LED gadgets from high pinnacle flows that could be conceivably damaging. Both the power topology and the control plan of the LED drivers must be cautiously chosen so as to guarantee dependable activity of the LED lighting gadgets.

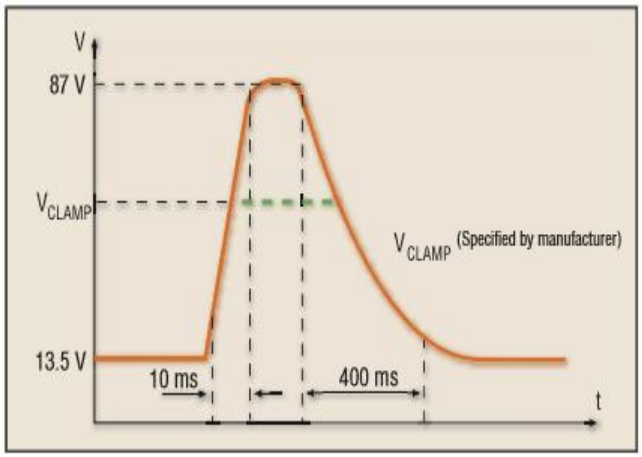

Fig. 1. Typical load-dump test wave shape (12V system).

Certain outside wellbeing signs might be relied upon to create light down to supply voltages of 6 V or 7 V, now and then for up to 2 minutes. These gadgets may incorporate tail and marker lights that can possibly make a back impact danger when not lit. This kind of voltage drop happens in the supply source when the starter circuit is initiated. Cold-temperature surrounding conditions irritate the supply voltage drop. The ordinary "cold wrenching" test wave shape is delineated in Fig. 3.

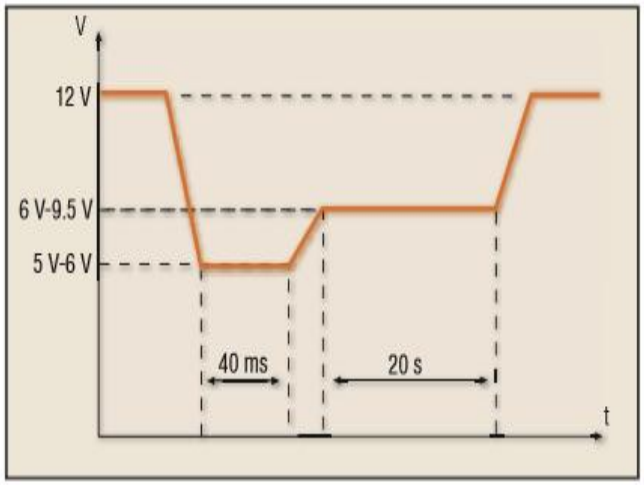

Fig. 2. Typical cranking-test wave shape with clamping level (12Vsystem).

Some car manufacturer's benchmarks are less express about the turning wave shape. Notwithstanding, there is a typical understanding that an ordinary working voltage condition dependably goes before the wrenching transient. Along these lines, the wellbeing signal gadgets are not required to most likely begin from the 7-V supply, as long as they don't douse at this low supply voltage.

It will be appeared in the content how this thought can streamline the LED driver plan. What's more, LED lighting gadgets are relied upon to endure nonstop use of +24 V/ - 12 V (12-V frameworks) or +48 V/ - 24 V (24-V frameworks) amid a jumper begin. Carports and crisis street administrations have been known to use 24-V hotspots for crisis begins, and there are even reports of 36 V being utilized for this reason. High voltages, for example, these are connected for as long as 5 minutes and some of the time with invert extremity.

III. REQUIREMENT OF LED DRIVER

The automotive LED driver devices are required to work from a wide info supply voltage run and to give invulnerability to include voltage. The driver setup incorporates security from overvoltage and under voltage condition and also incorporates info turn around extremity assurance.

IV. LED DRIVER TOPOLOGIES

One conventional minimal effort method for driving LEDs in car applications utilizes a resistor in arrangement with the LED gadget. In spite of the fact that this driving plan is basic and reasonable, it endures a few burdens. The LED current can change significantly over the battery voltage go even in ordinary activity of the vehicle, subsequently influencing the brilliance and decreasing the administration life of the lighting gadget. Moreover, security is required from car voltage homeless people and turn around extremity.

A. LINEAR REGULATOR

Direct ebb and flow controllers don't require input EMI filters and can yield modest LED driver arrangements. Be that as it may, both the resistor stabilizer and the direct controllers show low effectiveness. They may end up unrealistic for driving high-brilliance LED loads because of the over the top warmth scattering. In this way, exchanging power converters are required for driving many flag and lighting LED gadgets in autos. Besides driving the LEDs at a programmed current, these regulators can inherently protect them from a reverse-polarity surge and block voltage transients.

B. BUCK DC-DC REGULATOR

The inherent simplicity in design and low cost added with an ease of controlling the LED current makes a buck dc-dc regulator the most commonly used topology for automotive lighting devices. Fig. 3 shows a stoplight/taillight controller using a buck regulator. The HV9910 is a peak-current control PWM IC with an internal high-voltage regulator that powers the IC from an 8-V to 450-V supply voltage. The HV9910 control scheme provides high immunity to transients and surges on the input supply. The control IC allows for user selection between constant frequency and constant off-time modes of operation. The regulator of Fig. 3 is configured for the fixed tOFF mode, thereby permitting stable operation at duty cycles greater than 50% and reducing the effect of input voltage variation on the output LED current.

Car tail lights might be required to keep up certain light yields notwithstanding amid wrenching of the starter engine. Accessible supply voltage may move toward becoming insufficient for improving standard-level MOSFETs commonly having a greatest edge voltage (V_{th}(MAX)) of 4 V to 5 V. Then again, the heap dump conditions will manage the MOSFET channel voltage prerequisites, sometimes precluding the vast majority of the rationale level MOSFETs accessible in the business. Including a charge siphon circuit in the V_{IN} way of the HV9910 keeps up it in activity down to an info voltage of 5 V to 6 V.

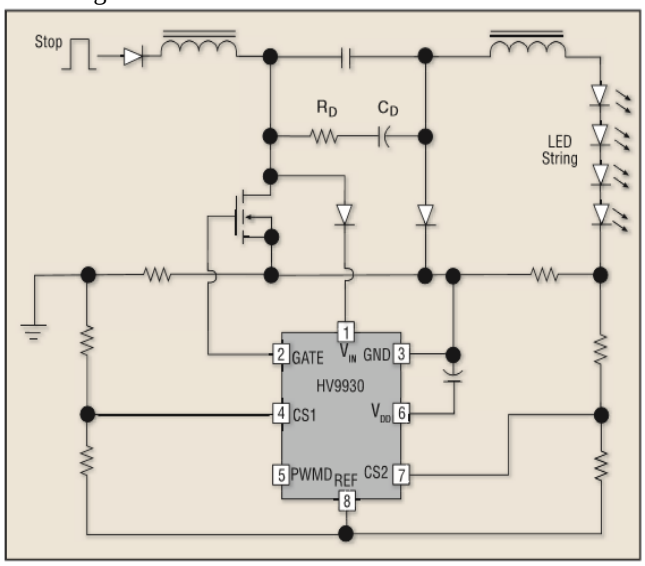

Fig. 3.Stoplight driver circuit driven from a boost-buck circuit.

When the HV9910 begins upon introductory utilization of the ostensible battery voltage, the charge siphon copies the supply voltage and applies it to the VIN stick. This voltage will keep the HV9910 running notwithstanding amid the virus turning transient. The LED driver offers several advantages for automotive applications as small size, more efficient and longer life.

V. RESULTS AND DISCUSSION

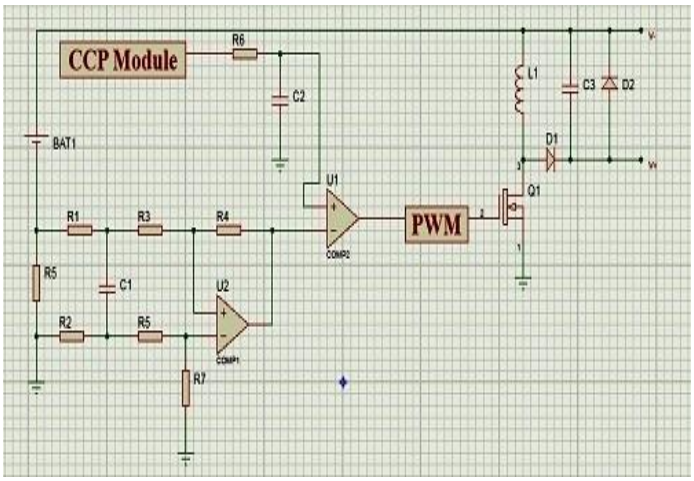

Fig. 4.Circuit Implementation

A simplified design of the driver for LED is shown in fig.4. The topology for the buck boost has been modified to include only the boost mode of operation. Here the output is referenced against the vehicle battery voltage as against the conventional ground reference. The modules CCP, PWM and comparator are internal modules of the PIC series microcontroller. The PIC16f877a has been chosen as the implementation platform.

The below figure 5 represents the plot of LED power vs the battery voltage.

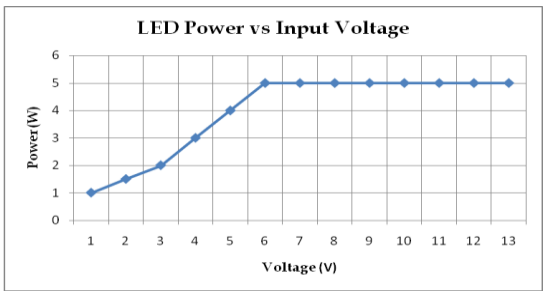

Fig. 5.LED Power vs Battery Voltage

It has been found to achieve the rated power of 5W for any input voltage combination of greater than 5V. The regulated output obtained can be supplied to run any rated LED in a automobile.

VI. CONCLUSION

Ongoing advances in the solid state lighting open new skylines in car applications. Phenomenal unwavering quality, roughness, wellbeing, high effectiveness, reduced size and extraordinary styling highlights of the LEDs bring critical focal points. Be that as it may, ideal answers for driving LEDs in the car condition are required. Insusceptibility to led transient discharges is one of the key necessities that must be tended to by architects. The correct decision of a power topology and a control conspire for the LED driver circuit ends up basic for meeting these prerequisites

REFERENCES

1. B. Sarath Kumar Reddy, P.V. Balasubramanyam, "A New Topology of Interleaved Boost Converter for Electric Vehicle Applications", International Journal of Recent Technology and Engineering (IJRTE), Vol. 8, Issue 2S8, 2019.
2. Road Vehicles—Electrical Disturbances from Conduction and Coupling. Part 2: Electrical Transient Conduction Along Supply Lines Only." ISO 7637-2, 2nd edition (2004)..
3. "Tests for Signal and Marking Devices Used on Vehicles 2032 mm or More in Overall Width." SAE J2139 (2001)..
4. "Electromagnetic Compatibility—Component Test Procedure. Part 42: Conducted Transient Emissions." SAE J1113-42 (2000)
5. Shubha Rao K, Veena S Chakravarthi, "High-Resolution DPWM for DC-DC Buck Converter using Sigma-Delta Modulation Techniques", International Journal of Recent Technology and Engineering (IJRTE), Vol. 8, Issue 2S8, 2019.
6. Greenland, Paul and Werner, Berns. "Powering Next-Generation Solid-State Lighting." Power Electronics Technology, May 2004, pp. 34-40.
7. Preethi Sontakki,A.D.Srinivasan, " SEPIC Topology Based High Voltage gain DC-DC Converter", International Journal of Recent Technology and Engineering (IJRTE), Vol. 8, Issue 1, 2019.
8. Tirumala, Rohit. "Constant Off Time, Buck-Based LED Drivers Using HV9910." Application Note AN-H50. Supertex Inc.
9. Swapnil S. Managule, Sanjay Dabhole, Sanjeev Gupta, "The Shunt Active Power Filter to Compensate Reactive Power and Harmonics with Optimized PI controller in a 3 Phase 3 Wire Distribution Network", International Journal of Innovative Technology and Exploring Engineering (IJITEE), Vol. 7, Issue 4, 2018.
10. H. J. Chiu and S. J. Cheng, "LED backlight driving system for large-scale LCD panels," IEEE Trans. Ind. Electron., vol. 54, no. 5, pp. 2751–2760, Oct. 2007.
11. L. Burgyan and F. Prinz, "High efficiency LED driver," U.S. Patent 6 690 146, Feb. 10, 2004.
12. Y. Q. Zhang and P. C. Sen, "A new soft-switching technique for buck, boost, and buck/boost converters," IEEE Trans. Ind. Appl., vol. 39, no. 6, pp. 1775–1782, Nov./Dec. 2003
13. T. Komine and M. Nakagawa, "Fundamental analysis for visible-light communication system using LED lights," IEEE Trans. Consum. Electron., vol. 50, no. 1, pp. 100–107, Feb. 2004.
14. J.Chen and C.Chang, "Analysis and design of SEPIC converter in boundary condition mode for universal-line power factor correction applications," in Proc. IEEE Power Electron. Spec. Conf.(PESC),2001,pp.742– 747.

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