ISSN : 0973 - 8355

www.ijmmsa.com

IJMMSA

INTERNATIONAL JOURNAL OF
MATHEMATICAL, MODELLING, SIMULATIONS AND APPLICATIONS

E-MAIL
editor.ijmmsa@gmail.com
editor@ijmmsa.com

IJMMSA INTERNATIONAL JOURNAL OF MATHEMATICAL, MODELLING, SIMULATIONS AND APPLICATIONS

ISSN 0973-8355www.ijmmsa.com

Vol 9,Issuse 2.April 2021

Galvanic Isolation Based Three Phase Converter for HB-LED

1B.PRATHAP,2K.JITHENDRAGOWD

Abstract:-Because of their many advantages over traditional lighting solutions, high brightness light emitting diodes (HB-LEDs) are becoming more and more commonplace in illumination products across the board. As another example, primary three-phase power is supplied to a range of commercial and industrial establishments all over the world at varying voltages, such as 347V in Canada, 480V in the United States, and 230V across Europe except in the United Kingdom (240V). Hence, the question arises as to why LEDs are not employed in three-phase grids if the three phase grid is accessible. Single-phase universal input voltage supplies are the norm for HB-LED drivers (100 to 277V). The high voltages in some areas necessitate the use of a step-down autotransformer and access to neutral in order to use these HB-LED drivers in three-phase setups. These step-down autotransformers have an electrical efficiency of less than 95 percent, which significantly affects the overall efficiency of the entire system. By penalizing Total Harmonic Distortion (THD) or requiring a high output voltage, most converters based on a single switch have a high power factor (PF). For a high PF and low THD, it is possible to utilize a multi-cell loss-free resistor three-phase driver (LFR).

IINTRODUCTION

Because of their many advantages over traditional lighting solutions, high brightness light emitting diodes (HB-LEDs) are becoming more and more commonplace in illumination products across the board. As another example, primary three-phase power is supplied to a range of commercial and industrial establishments all over the world at varying voltages, such as 347V in Canada, 480V in the United States, and 230V across Europe except in the United Kingdom (240V). As a result, the question arises as to why, in the event that a three-phase grid is available, no specific solution for LEDs is used. Single-phase universal input voltage supplies are the norm for HB-LED drivers (100 to 277V).The high voltages in some areas necessitate the use of a step-down autotransformer and access to neutral in order to use these HB-LED drivers in three-phase installations [1]. It is less expensive to utilize these step-down autotransformers than

1PGScholar,Dept.ofElectricalPowerSystem(EPS),JawaharlalNehruTechnologicalUniversity,Anantapuramu,AP.

2 Assistant Professor, Dept. of Electrical and Electronics Engineering (EEE), Jawaharlal NehruTechnologicalUniversity,Anantapuramu,AP.

efficiency substantially due to their electrical efficiency not being more than 95 percent in a best case scenario.. The increased size of the power supply [2] is an additional consideration. Thus, the need for a compact solution created specifically for this use. [3] synthesizes a number of studies on AC/DC three-phase power systems in preceding research. By penalizing Total Harmonic Distortion (THD) or requiring a high output voltage, most converters based on a single switch have a high power factor (PF). For a high PF and low THD, it is possible to utilize a multi-cell loss-free resistor three-phase driver (LFR). More components and maybe a higher price tag go into these drivers, making them more difficult to regulate, but they offer a better trade-off between output voltage and total harmonic distortion (THD). DC/DC converters such as DCM flybacks [4] [5], Cùk [6] and SEPIC [7] are employed as LFR cells in the literature. Using this multi-cell technology is proposed in this stu

HB-LED driver using a converter A three-phase converter with unity PF indicates that neither the input nor the output power is pulsing. As well as eliminating the electrolytic capacitor, non-pulsating power improves the quality of light in commercial and industrial situations. The IEC 1000-3-2 [8-10] rule will be taken into consideration when designing this driver. Class A equipment because of the three-phase nature of the device, but Class C because of the fact that it is also a piece of lighting equipment. In order to meet the more stringent requirements of Class C, the HB-LED driver will be modified in this project. In the subject of three-phase dimmable lighting, in this example for fluorescent bulbs, there has been some prior research [11]. For HB-LED illumination, however, this has never been done. In this paper, a small and dimmable HB-LED driver based on LFR cells is proposed. To wrap things up, we'll go through our findings and discuss our plans for the future. To summarize, the electrolytic capacitor can be eliminated from the converter lifespan by using three-phase AC/DC converters instead of single-phase ones. If a 3-wire line is available, rather than a 2-wire line, it is necessary to use it to connect the LED driver.

IILEDDRIVER

Three single-phase AC-DC converters, each one handling a phase, are linked to the three-phase power grid using a star, see Fig. 3.3, or delta connection, with their outputs connected in parallel. The neutral wire is not required in these three-phase power supply. For this reason, the three phase power supply's AC-DC converters all act like resistors at the input, resulting in high quality current at each phase's input.

As shown in Fig. 1, the HB-LED driver has an LFR in every one of its cells. Cells' input ports are referred to as VIN+ and VIN-, while their output ports are referred to as VOUT+ and VOUT- in this diagram, respectively. Flyback converters in Discontinuous Conduction Mode (DCM) will be used to test the validity of this work's concept. These cells are shown in Figure 1 and have ports that match those in Figure 1. However, as previously established, any dc-dc converter capable of operating as an LFR can be employed as an LFR cell. However, other LFR cells will be able to do so as well.achievebetterefficiencythantheflybackbasedone.AshasbeenstatedaflybackworkinginDCMsuppliesafixedamountofcurrenttotheload, which in thiscase are HB-LED. The LFRvalue of a DCM flyback converter, which is thebasiccellof theproposedthreephaseHB-LEDdriver.

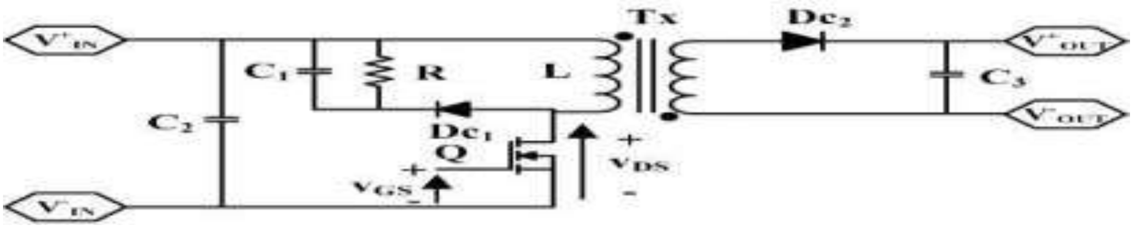


Fig:3.5LFR flyback cell schematic illustration

In order to ensure that each flyback acts as a resistor at its input, the DCM mode with a set duty cycle can be used to force the flybacks to work. As a result, each phase will require a sinusoidal current with high PF and low THD. Following this, the LFR cells will be regarded as ideal resistors and the output as an ideal power source in Fig. 3.6, where each phase's power is represented by the number of revolutions per second (RPS). Not taking into consideration possible flyback component tolerances, the resistor values will be deemed equal (Rcell). Half of the diodes need to be conducting for the HB-LED driver to require a theoretical sinusoidal current.

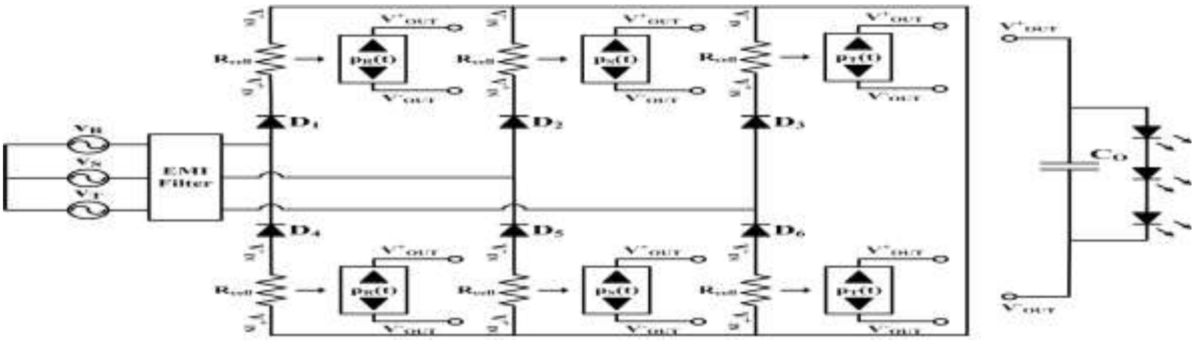


Fig:1SimplifieddiagramoftheproposedthreephaseHB-LEDdriver

When the phase voltage is positive, the higher diodes in each phase (D1, D2, and D3) will conduct, whereas the bottom diodes (D4, D5, and D6) will conduct during the phase voltage's negative half line cycle. With the exception of vT, all three phases have their own diodes dedicated to them, with the exception of Vs (D1 and D4) which have two diodes dedicated to it. Thus, three distinct diodes are used.

going to be conducting every π/3 of ωt, dependingonthephasevoltages(vR,vS,vT),asitis summarizedinFig. 2.

Thisisanadvantageoftheproposedtopology when compared with the Delco topologywhere a voltage drop equal to six rectifier diodes is experienced by the line currents. However, the proposed architecture necessitates twice as many converters. Phase S's upper diode, D2, is one such example. According to Fig. 2, it will be active from t1 to t4 of phase S, which corresponds to the positive half line cycle of phase S. At this point, two more diodes are in operation, as well. Due to their role in reversing the other two phases R and T, they do not have the same exact conduction time ([t1, t4]) as D2. As a result, when phase T changes from positive to negative, D3 becomes D6 and D4 becomes D1, respectively.

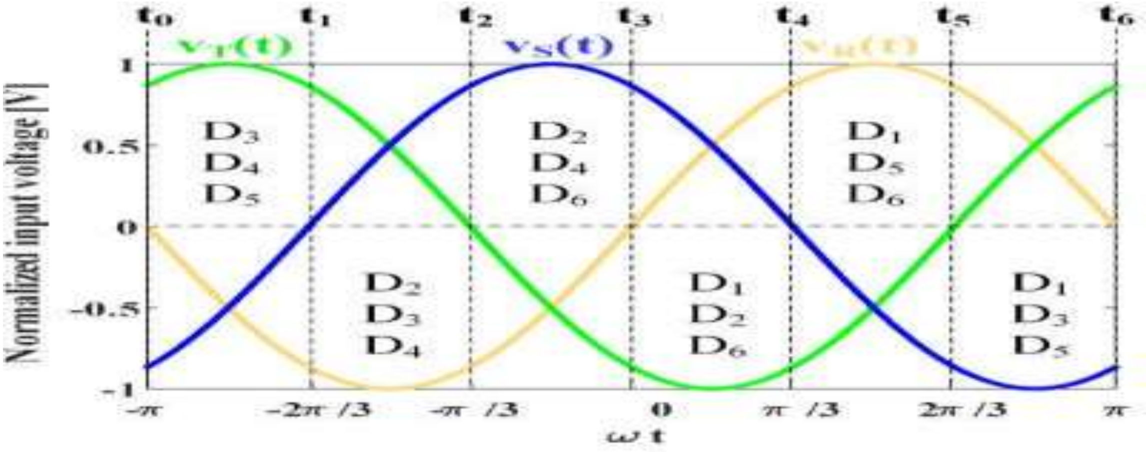


Fig:2Theoreticalconductionofthediodesdependingonthephasevoltages

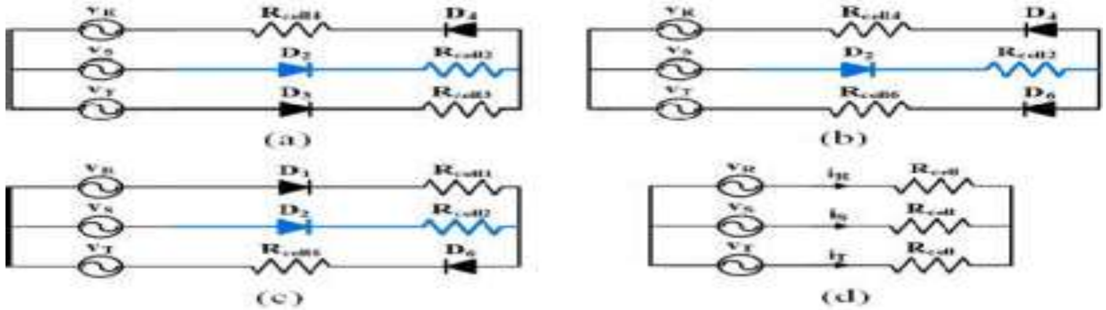


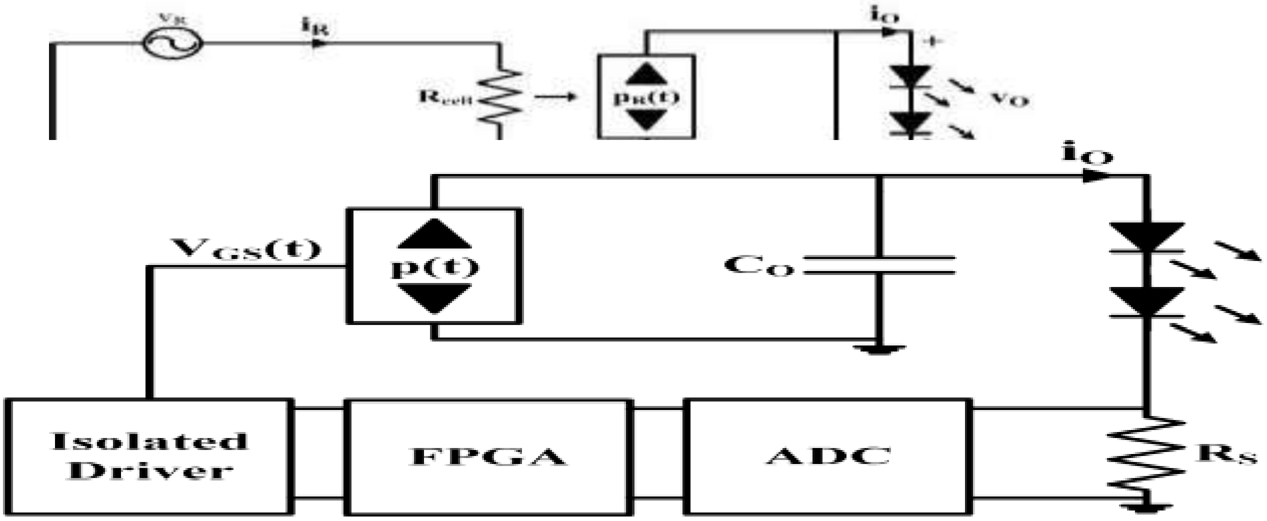
Fig:3.8(a) During [t1] and [t2] (b) During [t2, t3], the conductance As of [t3] and [t4], (c) (d) Driver's job style simplified

For each diode, the driver can be broken down into three steps. Figure 3 shows an example of a diode D2 going through these three stages. The diode D2 conducts from t1 to t4 and the diodes D1, D3, D4 and D6 are the diodes that alternate between R and T phase voltages. The results of the D2 analysis are applicable to all of the other diodes. As a result, the HB-LED driver is comparable to a star connection if the entire line length is taken into account, as illustrated in Fig. 3. (d).IIICONTROLSTRATEGIES

In most situations where a specific voltage or current level must be maintained, closed loop functioning is required. HB-LED drivers are no exception, given that temperature fluctuations or ageing might affect the load. A particular voltage/current level must be maintained to ensure not only high light quality, but to minimize negative effects on humans in commercial and industrial settings. Schematically, three power supply can be linked in parallel to the same load in order to operate the HB-LED driver. The parallelization of power sources has been the subject of numerous earlier literary works.

Fig:4Three-phaseHB-LEDdriversimplifiedwithLFR

From these works a quick conclusion canbe extracted: the most optimal way to control thepower supplies (LFR cells), would be for each oneof them to have their own inputcurrent loop inorderforthemtodemandthesameamountofpower.However,inthecaseunderstudythatmeans the use of a current sensor for each cell,which leads to six current sensors. This solutionwouldincreasenotonlythepricebutthecomplexity ofthe control. It is important to notethat the tolerances of the components are going tohaveaneffectovertheLFRvalue(Rcell).Especially thetoleranceofLwhich isthemostcriticalcomponentinthissense.Thisvariationof



Because the power handled by each cell varies somewhat, the driver's output voltage and current will be affected by the Rcell from one cell to the next at a frequency of 100 Hz. Since the three-phase grid may have tolerance effects or imbalances, an independent current control for each cell would be ideal. However, because the difference between Rcell is so minor, using a more complicated control is not warranted. Because of this, the output current loop represented in Figure 5 will be employed. Fig. 5 shows a proposed current loop that uses a shunt resistor to measure the output current, as shown. An FPGA will digitally convert and process the measured voltage, which is proportionate to the current flowing through the HB-LEDs, in order to generate the digital pulse-width modulation (DPWM) sent to each cell's isolated driver. VGS (t) is the signal fed to each isolated driver, indicating that each cell's main switch is receiving the same signal. It is necessary to perform an equivalent study to the average small signal analysis described for single phase AC-DC converters in order to decide the compensator to be utilized in the HB-LED driver. Since the HB-LED driver's input power and the equation obtained from the circuit in Fig. 5 are known, that is where we begin our investigation.
Itisimportanttonotethattheimplementationhasbeendonebymeansofadigitalcontrol.Therefore, limitcyclingneedstobetakenintoaccountinthedesignofthecompensator, in this case by using the definitionsthatguaranteenonlimitcyclingperformanceinPFC.However,itispossibletoobtainsimilarresultswiththeuseofananalogcontrol.Thedesignerneedstokeepinmindthattheregulator

To ensure that no frequency component influences the control action, a crossover frequency of less than 300 Hz is required. Two non-idealities that were not taken into account in the theoretical analysis can cause these effects to show up in the outcome. Aside from that, it is important to note that the LFR cells have a wide range of component tolerances. Second, the quality of the input voltage can be affected by fluctuations during operation, resulting in the appearance of a 300 Hz component. Use of a true three-phase electrical grid connection. The lower crossover frequency reduces the system's bandwidth, resulting in a delayed reaction from the driver. HB-LEDs, on the other hand, are a fairly stable load, and their shorter response time isn't a concern. This is why a more expensive and complex control system has not been studied to decrease this effect. To ensure that the loop is closed, it is critical to remember that a driver might vary the duty cycle, which reduces system bandwidth, creating a slower response from the driver, which is why this is an important consideration. It is, however, a highly stable load and the slower response time is not a concern with HB-LEDs. This is why a more expensive and complex control system has not been studied to decrease this effect. Another crucial point to keep in mind when completing the loop is that the driver has the option to alter the duty cycle, which means that the Rcell value can be varied. Because Rcell fluctuates with time, it's possible that the PF and THD will be impacted by input current distortion. It is possible that the unity factor correction can be undermined if quick changes are allowed, resulting in a rise in voltage and current ripple. As previously stated, a low crossover frequency is all that is needed to address this issue. A flyback LFR converter's startup technique involves gradually increasing the duty cycle from 0% until it meets the specified output current requirement. The LFR values will drop when the duty cycle of the cell is increased, resulting in higher power for the HB-LEDs, which is how this method is carried out. The technique for starting up other LFR cells may be different.

SIMULATIONRESULTS

CONCLUSION

Here, we present and demonstrate an HB-LED driver with three phases. Class C IEC 1000-3-2 compliance and high PF and low THD are all provided by the HB-LED driver under investigation. The non-flickering behavior of the power factor correction system may be shown in the examination of various dimming modes, while the standard bulk capacitor is eliminated. When the capacitor in question is removed, the HB-LED driver's lifespan is substantially extended, making it an excellent choice for lighting primary three-phase grids.

FutureScope

When evaluated over the entire range of European three-phase voltage, the driver showed poorer efficiency at higher values, but was still a viable option when considering that THD and PF fluctuate roughly in this analysis. The lower the range, the better the driver performed. There is a downside in that the efficiency is too low while reaching full dimming, hence future research into alternative LFR topologies may be undertaken. It was then necessary to perform some transient loads on the voltage loop in order to verify that it worked properly. More study will be done in the future by examining various restrictions in this area.

REFERENCES

A Guide to Understanding 347V and 480V Lighting Installations, by G. Gray, e-Craftsmen.
Autotransformers for use in applications up to 375 watts, 480 to 277 V, GE lighting.
The IEEE Transactions on Industrial Electronics, Volume 51, Issue 3, pp. 641,660, June 2004, contains an extensive evaluation of three-phase better power quality AC-DC converters.

IEEE Proceedings -, vol.143, no.4, pp.233–240, August 1996, "Multiphase AC–DC conversion by means of loss-free resistive networks,".

[1] “Paper presented at APEC '16, the Applied Power Electronics Conference and Exposition, on "High Power Factor Modular Polyphase AC/DC converters based on Loss-Free Resistors," 2016.

[2] U. Kamnarn and V. Chunkag, "Analysis and Design of a Modular Three-Phase AC-to DC Converter Using CUK Rectifier Module with Nearly Unity Power Factor and Fast Dynamic Response," IEEE Transactions on Power Electronics, vol.24, no.8, pp.2000,2012, August 2009.

[3] Isolated three-phase high power factor rectifier based on the SEPIC converter operating in discontinuous conduction mode by Tibola, G. and Barbi, I., IEEE Transactions on Power Electronics, vol.28, no. 11, pp. 4962-4969 in November 2013.

[4] IEC 61000-3-2 Document, 2006: Draft of the Proposed CLC Common Modification

[5] IEC 61000-3-2/A2 Draft of the Proposed CLC Common Modification, 2010.ElectromagneticCompatibility(EMC)-Part3: Limits-Section 2: Limits for Harmonic CurrentEmissions (EquipmentInputcurrent< 16 AperPhase),IEC1000-3-2,1995.

[6] In the article "A Three-Phase Dimmable Lighting System Using a Bidirectional Energy-Efficient Power Electronic Transformer," Sabahi, Hosseini, Sharifian, and Goharrizi published in the IEEE Transactions on Power Electronics, the authors cite: "A Three-Phase Dimmable Lighting System Using a Bidirectional Energy-Efficient Power Electronic Transformer," IEEE Transactions on.
[7] [7] Design of a simple high-power-factor rectifier based on the flyback converter by R. Erickson, M. Madigan, and S. Singer, Applied Power Electronics Conference and Exposition, 1990. Proceedings of the Fifth Annual Meeting of the Asia-Pacific Economic Cooperation (APEC 90), 11-16 March 1990, vol., no., pp.792,801.
[8] pp.909-916 vol.2, 29 June-3 July 1992, Glaser J.S., Witulski A.F., "Application of a constant-output-power converter in multiple-module converter systems," PESC '92 Record., 23rd Annual IEEE, vol., no.

[9] theoretic classification of parallel connected DC–DC converters," in Circuits and Systems I: Regular Papers, IEEE Transactions on, vol 54, no 5, pp 1099-1108, May 2007.

[10] Classification of Parallel DC/DC Converters Part II: Comparative and Experimental Verifications
[14] 27-30 August 2007: Conference on, pp. 1014-1017, in.