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Illumination Saving Energy Sources on Light-Emitting Diodes For Agriculture

The up-to-date application of super bright white light-emitting diodes (LED) allows to create new light sources consuming less power and having longer expiration date (up to 50-100 thousand hours) enabling to control a wide range of light brightness and provide a wide emission of spectrum in comparison with fluorescent lamps and incandescent lamps. Luminous efficiency of single high power light-emitting diode is 30-50 lm / W (in some instances up to 80-100 lm / W), color rendering index is over 80. High price, degradation (radiation power of light decreases after 30-50% of deterioration) and the problem of heat emission of high-powered light-emitting diode (1-10 W) are the factors preventing active use of these light sources [1].

Light-emitting diode light sources are contributed by the governments of many countries vigorously to introduce energy-saving technologies in illumination engineering since LED light sources have the highest light efficiency. In addition, the price on super bright light-emitting diodes is being reduced due to the competition between manufacturers.

However, possessing the highest conversion efficiency of electrical energy into light among artificial sources of LED light sources existing nowadays contribute much to introduce into energy-saving technologies in light engineering. Moreover, the advantage is that steady decrease is being observed in the cost of high-brightness light-emitting diodes due to the competition of global manufacturers.

At present simple power supplies with ballast capacitor are used in most house light-emitting diode lamps. But they have such disadvantages as inrush current in the course of their switching on, a narrow interval of the voltage that corresponds to the limits for the current through the LEDs and also there is a possibility of damage of power supplies when cliffs appear in electric circuit when the power supplies are under the load. All these disadvantages lead to premature failure of the lamps. That means that such decision circuitry can not provide effective long-term operation of light-emitting diode light sources with predictable expiration date of 50-100 thousand hours [2]. That’s why the purpose of the article is to examine development of technically simple and cheap power supply for lamps with low-powered (5mm and 10mm) white light-emitting diodes (0,01-0,08 W) as the most common (about 90% super bright light-emitting diodes being produced in the world) enabling to regulate luminous flux.

All of the above mentioned disadvantages that are related to the power supply units with the ballast capacitor aren’t being in buck voltage regulators that have high efficiency (up to 90%). However, the problems arise in buck regulator scheme

selection, and these problems, in its turn, are connected with a large number of components being used discretely and with the difficulties in the course of developing and producing effective protection and control schemes.

Therefore, the choice was made on a company STMicroelectronics chip VIPer22A after choosing a large number of chips for switching power supplies (SPS) representing a high-voltage MOSFET-transistor with control and protection scheme in one housing. SPS on-chip VIPer22A have a minimum number of additional electronic components. Besides, the company provides special automated computer programs to calculate the parameters of the power supply enabling to get the output of ready scheme and the list of items, thus ensuring high repeatability. The SPS based on VIPer22A can get a power output of approximately 20 watts being acceptable for low-power light-emitting diode lamps.

The program Non-Isolated VIPer Design Software v.2.3 was used for the designing the converter [2]. It allows to obtain SPS to supply 30-10mm white super bright light-emitting diodes with the following parameters: supply voltage range is 88...264 V, the output voltage is 33 V, load current is up to 100 mA, switching regulator efficiency is 80%.

The light-emitting diode brightness control based on pulse-width modulation (PWM) was added to designed SPS. The PWM controller is made on the basis of cheap and widespread timer NE555 (domestic counterpart - КР1006ВИ1) [2]. The LED brightness change is performed at the expense of the used resistor. 10mm white super bright light-emitting diodes are being used in the lamp prototype with radiation angle of 15°. They have weak color rendering but these lamps can be used in emergency, regular and general (in hallways, utility rooms, etc.) light devices; general light devices are used in places with no high requirements to color rendering.

The prototype of LED lamp with designed power supply has been proposed in the article. The use of LED of diffused light in lamps (radiation angle of 55-65°) enables to get lamps with uniform curve light.

The cost of elements of the power supply in a complete set will make up approximately 30 UAH.

In conclusion it should be mentioned that designed power supply provides a range of operations at wide range of supply voltage. It has a high efficiency, low price, simple design and assembly, high reliability, and it can be used to create low-power light-emitting diode lamps enabling to regulate the brightness of light-emitting diodes for further use in agriculture.

References:

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