

Microcontroller based high power factor electronic ballast



The proposed topology is based on the integration of the buck and playback converters, the former providing power factor correction and the latter controlling lamp power. The lamp is supplied by a low-frequency square-waveform current, which is a convenient way to avoid acoustic resonances in high-intensity discharge lamps. Both converters operate in discontinuous conduction mode, thus allowing the use of only one high-frequency switch and simplifying the control.

The electronic ballast is digitally controlled by using a low-cost microelectronic . The microelectronic performs all the necessary tasks during starting, warming-up, and steady state, including closed-loop control of lamp current and protections. The closed-loop control takes into account the lamp dynamical impedance. Experimental results for a 35-W H lamp are presented, and the obtained overall efficiency is 90%. Index ? Electronic ballasts, metal () lamps, microelectronics. I.

Ballasts for high-intensity discharge (HID) lamps have attracted attention, compared to electromagnetic ballasts, because of their advantages: lighter weight, smaller size, higher efficiency, higher immunity to supply voltage changes, optimized performance, digital control and supervision, etc. The main drawback of using electronic ballasts to supply HID lamps is the risk of the acoustic resonances (Ares) rising [1]. Is the generation of standing pressure waves in the plasma, resulting in lighting arc fluctuation that can cause light flicker or even arc extinction [2], [3].

Recent literature has confirmed that the most reliable solution to avoid the problem of WAR is to supply the lamp with low-frequency square-waveform

() current and voltage, resulting in a constant instantaneous power, which avoids the AVR [4], [5]. This paper is focused on low-wattage metal () lamps, which are particularly sensitive to the effect of AVR. Therefore, the supply of these lamps must be performed with their complexity because conventional ballasts employ three power stages, resulting in an expensive circuitry, which are as follows: 1) power-factor-correction () stage; 2) lamp power control stage; and 3) inverter stage.

Therefore, many efforts are being made in order to integrate these stages which results in complex circuits presenting voltage or current stress in the shared switches. Moreover, the non easy lamp behavior also increases the complexity of the control circuit because these lamps have different operating phases, which can be classified as follows. 1) Lamp ? the lamp has very high impedance before ignition and a pulse of approximately 3 is necessary to start a cold lamp (for hot restarting, a pulse could be necessary). 2) Lamp ? the heating process takes from tens of seconds to minutes.

The lamp starts presenting a small impedance that increases as long as the lamp is warmed up. This stage must be as short as possible in order to avoid the detrimental effect of the glow current. 3) Steady ? after the lamp heating, the lamp reaches the steady state and some parameters (lamp power or current) must be controlled in a closed-loop way. Due to the complexity of the control circuit, the use of a microelectronic-based circuit provides several benefits over traditional analog control methods or commercially available . In addition, digitally controlled circuits have the advantages of high reliability and flexibility.

<https://assignbuster.com/microcontroller-based-high-power-factor-electronic-ballast/>

Noise immunity, resistance to environmental effects, possibility of changing the control scheme without modifying the hardware, and low cost are other attractive features of digital controllers. In the literature, there are some examples of microelectronic based electronic ballasts to supply HID lamps [18]. In [19]- [21], it was used to obtain electronic ballasts for automotive applications. Some applications of lamp dimming using microelectronics can be found in [22] and [23], and other applications. Manuscript received September 27, 2010; revised December 22, 2010; accepted January 19, 2011.

Date of publication February 14, 2011; date of current version November 1, 2011. This work was supported in part by the Spanish Government under Research Grant -61267, by the #o De Apportionment De Postal De Novel Superior, by the Consoles National De Discontentment Scientific e Techno¶OIC, and by the Pro-Public#sees Internationals/Pr¶-oratorio De P¶s-gradual#o Pipsqueaks/Universities Federal De Santa Maria. M. A. Dally Costa and A. L. Kristin are with the Universities Federal De Santa Maria, 97105-900 Santa Maria, Brazil (e-mail:Org;Fuss. BRB). J. M. Alonso ? leaver, J.

Garcia, and D. Socio Vaquero are with the Department of Electrical and Electronic Engineering, University of Video, 33203 Join, Spain (e-mail: sees;ate. Unmoving. sees). Color versions of one or more of the fugues in this paper are available online at <http://explorer.ieee.org>. Digital Object Identifier 10. 1109, Tale. 2011.

2114318 0278-0046/\$26. 00 2011 IEEE Fig. 1. Analyzed ballast. To keep the lamp power constant during its life are shown in [24]-[26]. Other examples <https://assignbuster.com/microcontroller-based-high-power-factor-electronic-ballast/>

can be seen in [27] to avoid Arc, in [28] to decrease the cost of the control circuit, and in [29] and [30] to ignite one or more lamps.

In [32] and [33], a constant power control is applied to the FPC stage, considering the lamp dynamical impedance, using a short-term current feedback loop and a long-term power feedback loop. However, in most of these papers, the lamp is considered as a pure resistance, and therefore, its dynamic behavior has not been considered in the design of the control circuit. It is well known that the lamp exhibits a dynamic response that can be characterized by its incremental impedance, which is defined as the ratio between the lamp voltage and current perturbations [31].

Neglecting the lamp dynamic response can lead to ballast malfunction, instabilities, or even breakdown. Therefore, in this paper, the lamp dynamic behavior is considered in the design of the digital compensator so that an adequate response of the complete closed-loop ballast is assured. Other contribution of the proposed work is the detailed operation of the microelectronic electronic ballast dealing with all operation takes of the lamp and providing the necessary protections for the circuit.

In this paper, Section II describes the ballast topology proposed in this paper, Section III defines the ballast operating stages and the requirements of the control circuit, Section IV presents the description of the control circuit, Section V shows the experimental results, and Section VI presents the conclusions of this paper.

Therefore, the circuit does not use a snubbed circuit. The magnetic

components were designed searching for the maximum efficiency (cooper <https://assignbuster.com/microcontroller-based-high-power-factor-electronic-ballast/>)

losses equal to core losses). VI. C INCLUSION This paper has presented a microelectronic-based control strategy implemented for a high-power-factor integrated electronic ballast for MM lamps. The power topology consisted of integrating buck and playback converters working in DC in order to provide the FPC and lamp supply, respectively. The microelectronic provided enough flexibility for the MM lamp start, warming up, steady state, and protections, which are rather complicated tasks.

The FISTICUFF microelectronic was employed in the control circuit. The lamp starting circuit was obtained by an SO-based circuit that only works when the lamp is turned off because, when the lamp is turned on, the circuit is naturally disabled due to the BUS decrease. In order to control the lamp in steady state, a digital PI controller was implemented by software, which keeps the lamp current constant during the lamp life. The proposed ballast presented high power factor.