Design of Start Voltage Waveform for Driving Flat Fluorescent Lamp (FFL) LCD Backlight

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Abstract

Flat fluorescent lamp(FFL) is used as a light source for LCD TV backlight and is composed of many discharge channels but each channel may not be turned on simultatneouly especially at cold temperature. The simultaneous start of each lamp channels of FFL was accomplished by driving FFL with specially designed voltage and currnet waveforms without sacrificing the inverter efficency.

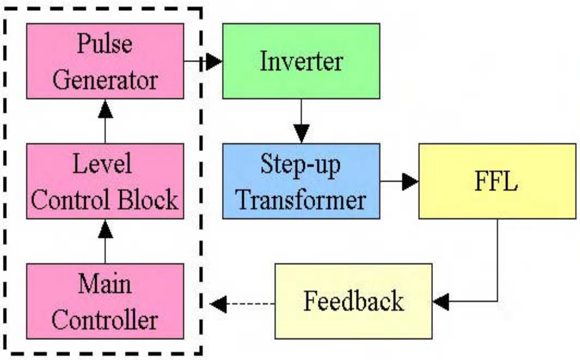
1. Introduction

Recently, FFLs have been studied for the application of backlight for LCD TV. FFL is composed of multi-channel lamps arrayed in parallel in one lamp body. The driving method for FFL is the same as that of the external electrode fluorescent lamp (EEFL). FFL is realized in one body and operated by using wall charges. Pulse waveform is used for driving FFL and the driving condition depends on the initial condition of FFL.[1][2][3]

CCFL, EEFL and FFL use mercury so that the condition is different at warm and cold start and there is a possibility of inhomogeneous lamp start between lamps or channels. Especially, it is difficult to start-up the lamp under low ambient temperature, because it is not enough to vaporized mercury. Therefore, it is necessary to find different driving method to improve the mercury lamp start characteristics. In this paper, improvement of mercury lamp start characteristics were studied and demonstrated without sacrificing the inverter efficiency.

2. Block diagram of Inverter

It is necessary for the start voltage and current of the inverter to be high enough to start FFL with safety. It is shown that Fig.1 is a block diagram of inverter. Inverter consists of three blocks, level control block (LCB), switching inverter and high voltage step-up transformer. LCB has three components. Main controller generates signals including inverter on/off, and control signals. LCB is like a buffer to control a current feedback level.

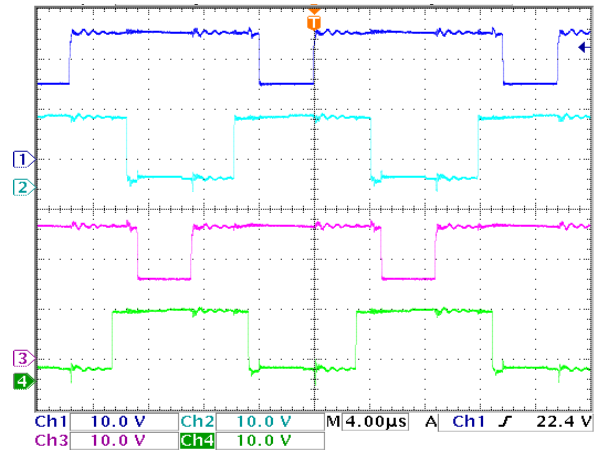


<Fig. 1. Block diagram of inverter>

Main controller decides FFL’s start voltage, current and time, and it controls a LCB to generate a signal for cold or warm start of FFL. It is important to control LCB because FFL is blinking if LCB is unstable.

Full bridge topology is more suitable for driving FFL, because FFL is one body one lamp structure and needs high power consumption. Full bridge topology is stable under wide voltage variation.

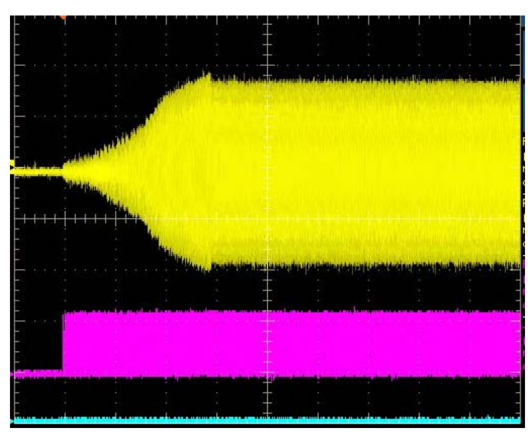
Full bridge has four switches. The pulse waveform from four switches are shown in Fig. 2.



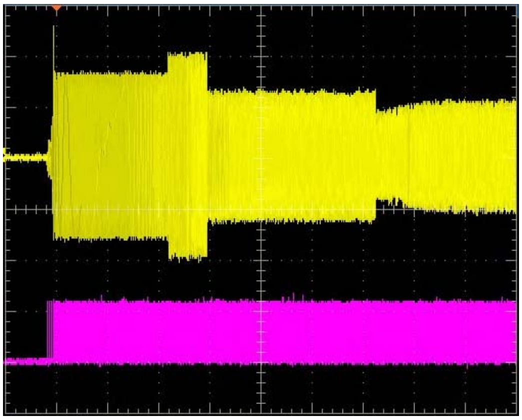
<Fig.2. Waveforms from full-bridge switching gates >

3. Driving of FFL

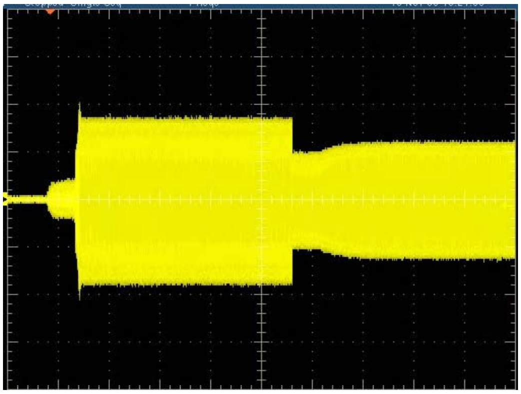
Samples of starting current waveforms of FFL are shown in Fig.3, Fig.4, and Fig.5. Fig. 3 shows the soft-start current waveform for FFL. Fig.4, Fig.5 show the various current levels and striking current with time.



<Fig.3. Start-up lamp current waveform>

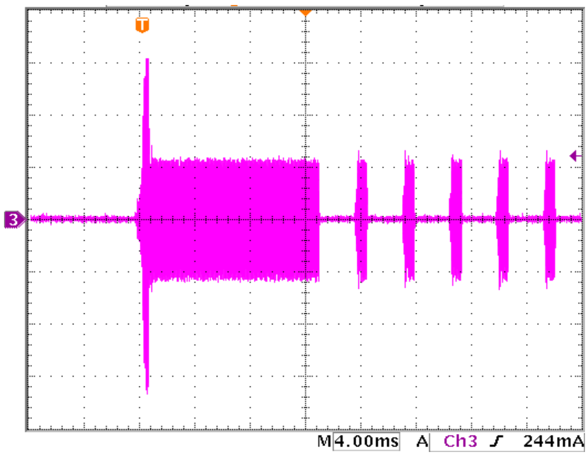


<Fig.4. Start-up lamp current waveform>

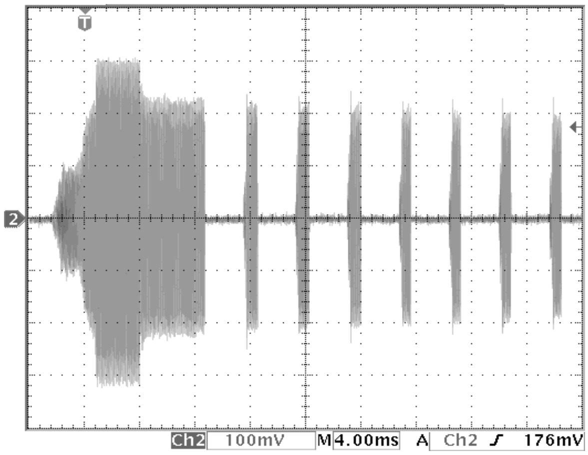


<Fig.5. Start-up lamp current waveform>

Lamp current and start time are easily controlled. It is possible to use a conventional pulse width modulation (PWM) to control a lamp current, but PWM method has a serious problems such as blinking. Fig.4 show a sample lamp current waveform that has four-step current levels, start time and linear increase of lamp current. At cold start, LCB help FFL to start-up FFL entirely light up at low dimming ratio.



<Fig.6. Conventional low level dimming start-up lamp current waveform>

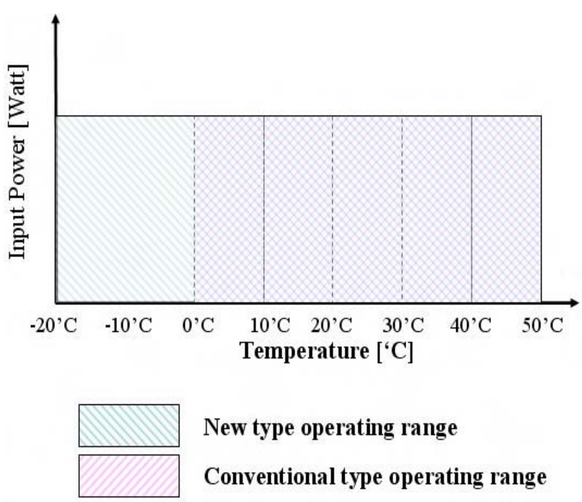


<Fig.7. New low level dimming start-up lamp current waveform>

4. Results and Discussion

LCB designed and fabricated was tested. It was shown that LCB can be used to increase the temperature range for the start and operation of FFL. Usually, the conventional starting method is used to operate FFL only from 0°C to normal ambient temperature range. It is necessary to increase step-up transformer's turn ratio to operate FFL below 0°C. But the luminous efficiency will decrease as the turn ratio increases.

With LCB method, it is not necessary to increase step-up transformer turn ratio. Therefore, there will not be any decrease of luminous efficiency even if the FFL operates below 0°C. It is shown that FFL start characteristics and operating temperature range improve by using LCB as shown in Fig. 8.



<Fig.8. FFL's operating temperature range>

5. Conclusion

The full operation of FFL under any circumstance is required for LCD TV application of FFL. The adjustment of inverter voltage and current waveform for cold start was successfully realized without any sacrifice of inverter efficiency by using LCB. Fig. 9 shows LCD TV with FFL backlight driven by inverter with LCB.

<Fig.9. LCD TV with FFL backlight >

6. References

[1] Y.S. Kim, el al., SID Symposium Digest 37, Poster.78, 2006

[2] H.S. Kim, el al., SID Symposium Digest 32, pp. 687-689, 2001

[3] Namok Kwon, "Self-discharge Synchronizing for High luminance and high efficiency in LCD backlight," Kwang Woon University, 2003