Switching Inverters for the LCD Backlighting

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Abstract
Various types of switching inverters such as a full-bridge, a half-bridge, a push-pull, and a multi-vibrator, are introduced for multi-lamps backlighting with EEFLs and CCFLs. Synchronizing the phase between voltage and current waves, a high luminance and a high efficiency have been achieved.

1. Introduction
Various types of switching inverters are fabricated to be efficient in driving multi-lamps of external electrode fluorescent lamps(EEFLs) and cold cathode fluorescent lamps(CCFLs). Operation method of synchronizing current and voltage is introduced for a high brightness and efficiency.

In this report, the circuits and the waveforms are investigated in the respect of the influences on the lamp operations.

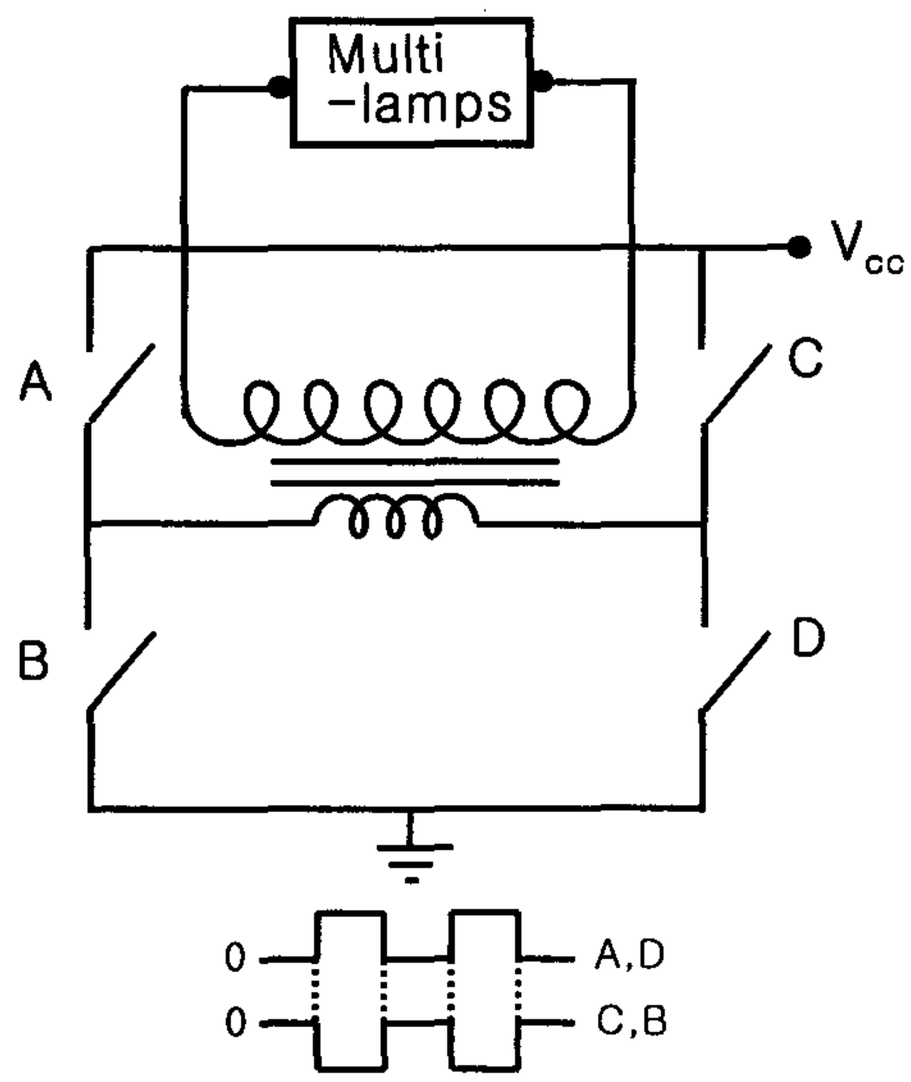
2. Switching Inverters
A DC-AC inverter generates a high voltage AC signal required to drive the fluorescent lamps, EEFLs and CCFLs. Conventionally CCFL lamp is operated by LC-resonace inverter of a sinusoidal oscillation for high voltage output. However, the high voltage of square wave to drive multi-EEFLs and CCFLs is more efficient since the lighting characteristics depend strongly on the waveforms of a rise/fall time , a voltage sustaining time , the frequency and the duty.

Figure 1 represents schematic circuits for various types of switching inverters.

A full-bridge circuit in Figure 1(a): The circuits or IC chips are designed for bi-directional current controls of inductive loads, for examples the motors or pulse transformers . Switching logics control the switches A and D are at ON state while C and B at OFF, then the current is flowed to any direction of the coil load.

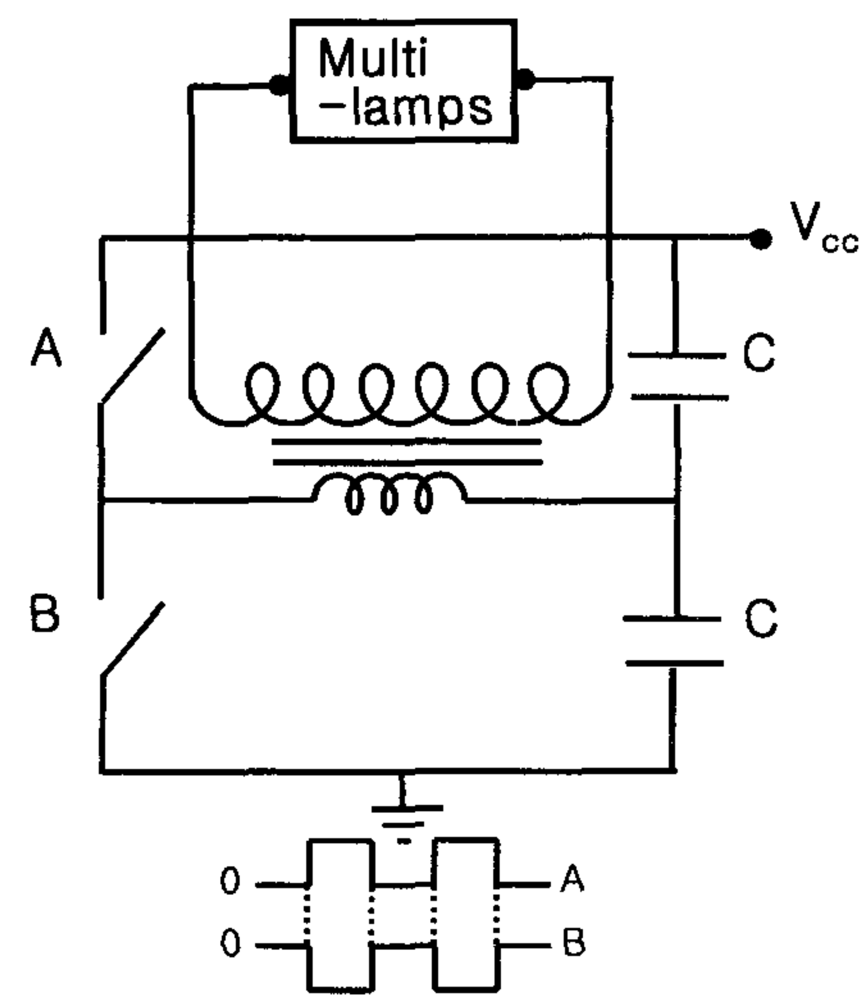
When switches C and B are ON state, the current flow is vice. Selecting source and sink switching pair works in a fast currents on inductive load, the current flows in forward and backward with fast rise and fall ti

(a) Full-bridge Circuit



<Switching Control Logic>

(b) Half-bridge Circuit



<Switching Control Logic>

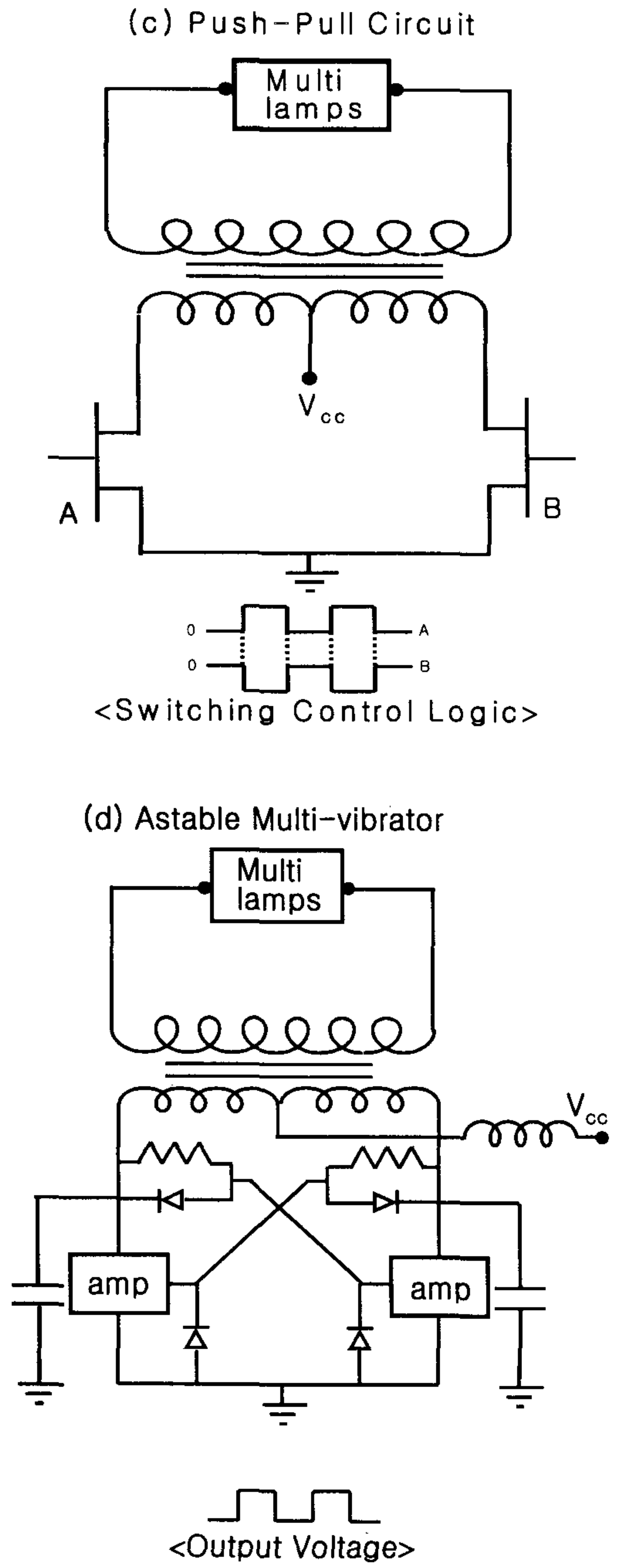


Figure 1. Schematic circuits for various types of switching inverters (a) full-bridge, (b) half-bridge, (c) push-pull, (d) multi-vibrator.

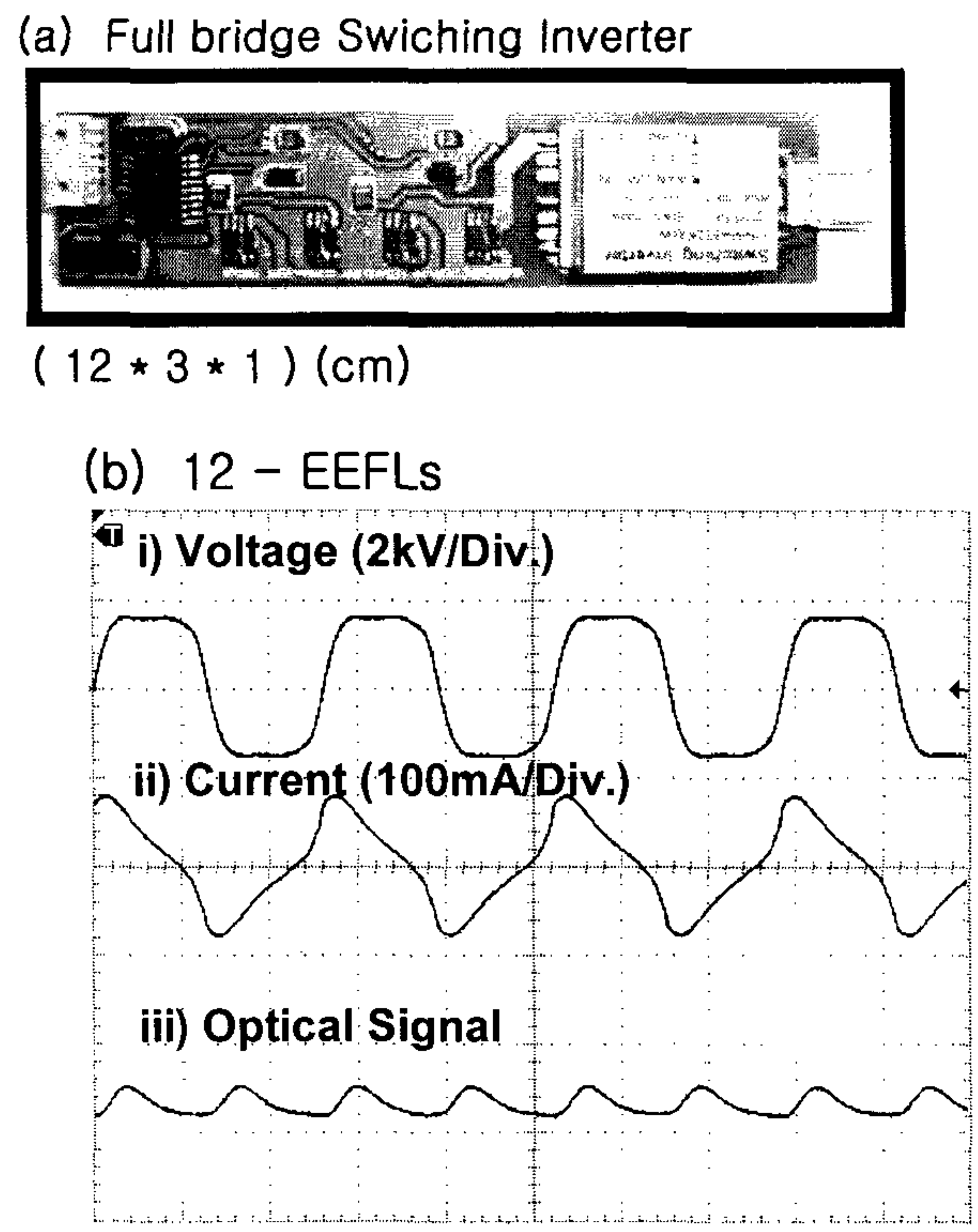
A half-bridge with the capacitor in Figure 1(b): It can be operated as a full-bridge which is for bi-directional current control of inductive loads. When the switching logic control A→ON and B→OFF , current flows through the inductive load to be charged on capacitor . At A→OFF and B→ON states, this works the current works as to be discharged from the capacitor to reverse direction.

A push-full circuit in Figure 1(c): Center tapped transformer is used with switching elements, FET or transistor. This is a simple circuit configuration of self-oscillation or for forced oscillation, but poor rise/fall time of square wave output. For self-oscillation, the frequency is depended on capacitances of EEFL or CCFL lamp(s).

A multi-vibrator in Figure 1(d): Astable multi-vibrator can be used as a switching inverter for square wave voltage generation as a fluorescent lamp power sources. Poor rise/fall time characteristics it has, because of inductive loads at collector or source of active power elements. Very simple circuits for oscillation of inverter and the operating oscillations are depend on load capacitances. The more number of arrayed lamps, the lower frequency operated.

3. Oscilloscope Signals.

Figure 2 shows a full-bridge type switching inverter(a), and oscilloscope signals of driving backlight panels of 12-EEFLs(b) and 12-CCFLs(c) with the frequency of 40 kHz. The voltage waveforms are represented nice shapes of a trapezoid with fast rising and falling times about 2 us. The peak voltage is Vp=1.6 kV for EEFLs in Figure 2(b), while the peak voltage is Vp=1.2 kV for CCFLs in Figure 2(c).



(c) 12 - CCFLs

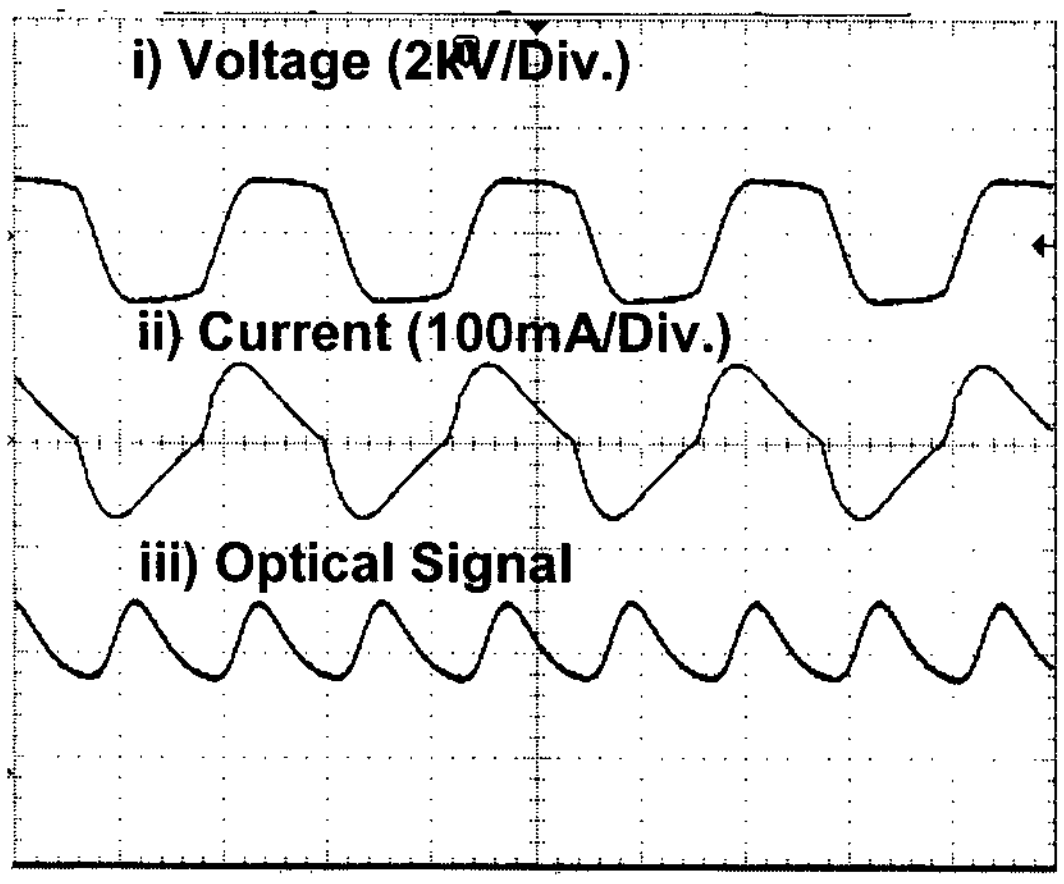
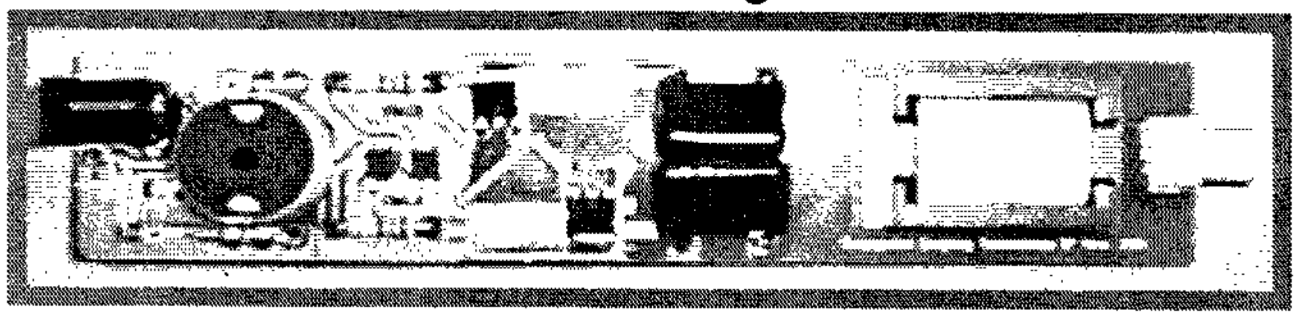


Figure 2. Full bridge type switching inverter and oscilloscope signals of backlights for EEFLs(b) and CCFLs(c).

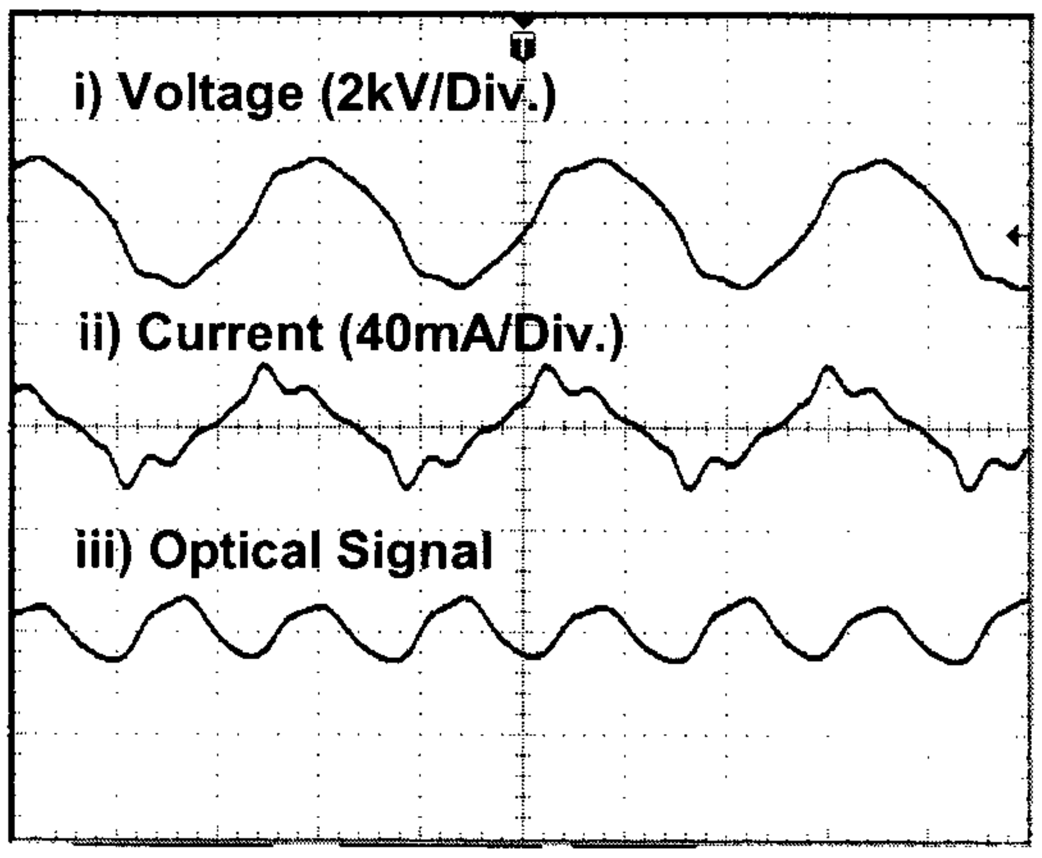
Figure 3 shows a multi-vibrator switching inverter(a), and oscilloscope signals of driving backlight panels of 12-EEFLs(b) and 12-CCFLs(c). The voltage waveforms are represented slow rising and falling times about 5 us. The peak voltage is Vp=1.6 kV and the frequency is 36 kHz for EEFLs in Figure 2(b), while the peak voltage is Vp=1.2 kV and the frequency is 32 kHz for CCFLs in Figure 2(c).

(a) Multi-Vibrator Swiching Inverter



(15 * 3 * 1) (cm)

(b) 12 - EEFLs



(c) 12 - CCFLs

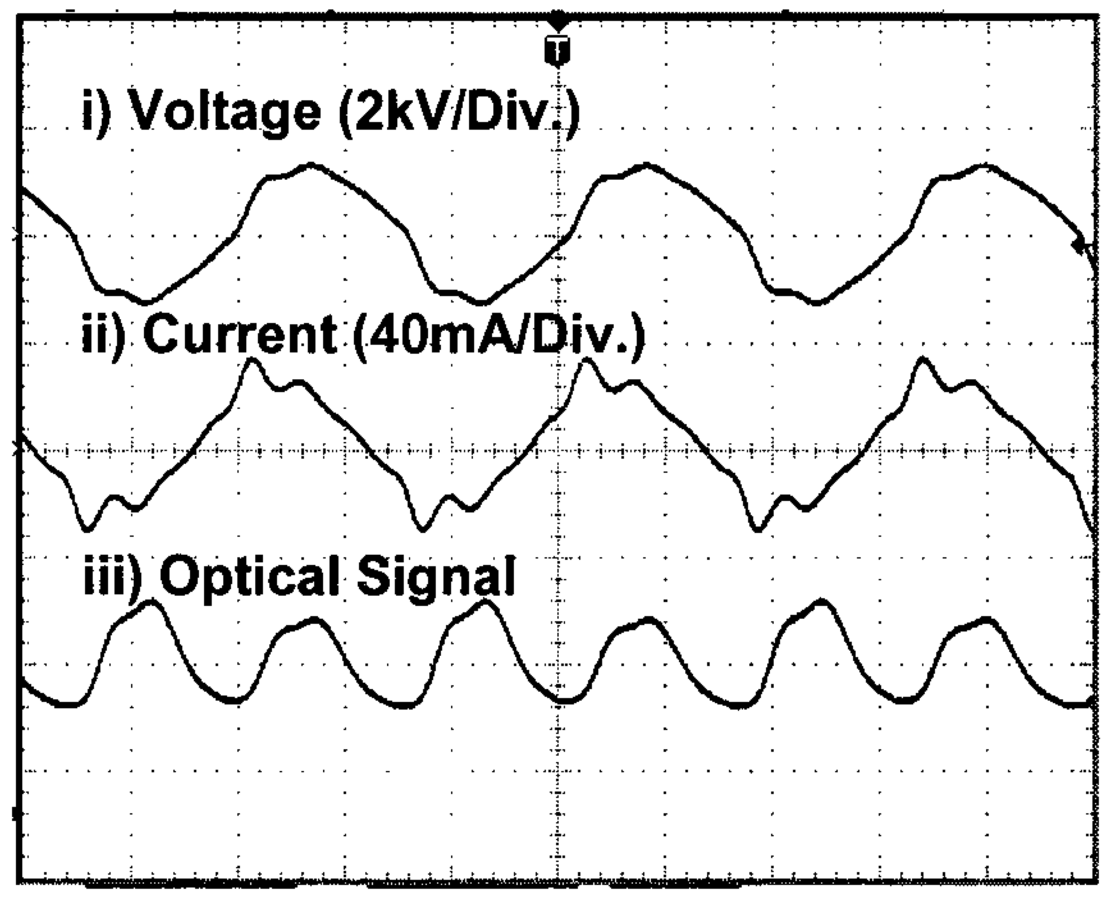


Figure 3. (a) multi-vibrator type switching inverter And Oscilloscope signals of 12-EEFLs(b) and CCFLs(a).

4. Phase Synchronizing between Voltage and Current

In a multi-vibrator switching inverter, the driving frequency is determined by self-resonance between load lamps and inverter. When backlights of multi-lamps are operated with a forced oscillation of switching inverters in Figures 1(a)-(c), the optimal driving frequency should be determined. For the purpose of a high efficiency, the method of a phase synchronizing between voltage and current waveforms should be considered with a self-discharge in lamps.

5. Conclusion

Various types of switching inverters are fabricated to investigate the generating waveforms. With a high speed on/off switching a nice shape of square wave are generated in a small size inverter about with an input voltage of DC 12 V and a power about 40 W for 12-lamps.

For the optimizing operations the driving frequency is determined by the method of phase synchronizing between voltage and current.

6. References

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