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Book of Abstracts

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PB4

Compensation of the capacitance effects produced by a HPDLC cell on a voltage amplifier

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1. Abstract

Holographic polymer-dispersed liquid crystal (HPDLC) [1] is a composite electro-optic material, able to exhibit holographic volume regime and whose refraction index can be varied by the application of an electric field. This electrical tunability combined with volume regime offer the possibility of many interesting photonics applications such as in diffraction optics, reflection display, and in optical interfaces and interconnects [2-4].

In principle H-PDLC cells need high voltage AC signals, typically 1 kHz bipolar waveforms, to be tuned, therefore a high voltage amplifier in combination with a waveform generator is necessary. In this work we provide evidence of limitations in the voltage range applied with our voltage amplifier due to the capacitance of the HPDLC cell. The theoretical modelling, done using OrCAD-PSpice® software confirms the experimental results. Finally we show how this limitation can be overcome.

2. Experimental and results

In our experiment, a high-voltage amplifier (Newtons 4th Ltd., Model: LPA400) is used in combination with an arbitrary function generator (Tektronix, Model: AFG3022B) to generate the AC signal to be applied to the HPDLC cell. We consider a bipolar 1 kHz signal, which is very usual in the literature. Digital multimeters are used to measure the root mean square (rms) value of the intensity delivered by the amplifier and the applied voltage. The applied voltage is also monitored with a digital oscilloscope (Tektronix, Model: TDS1012B). The HPDLC cells used have a square shape with lateral dimension ranging from 2 to 5 cm, and a cell gap of about 15 μm. Different compositions such as in Ref. [5] have been tested.

We have found that typically the high voltage amplifier when connected to the ITO electrodes in the HPDLC cell automatically switches off with applied voltages as low as ±30 Volts. This is far lower than ±400 Volts, which is the maximum value deliverable by the LPA400 amplifier. Actually, values of 20 Volts/μm are normally necessary to switch the HPDLC cell. In a first step we substituted the HPDLC by discreet electrical components, trying to obtain the same values for the rms intensity and rms voltage measured with the multimeters, and the same temporal waveform measured with the digital oscilloscope. We obtained that the HPDLC cell is equivalent to a resistance with a value about 50 kΩ in parallel with a capacitor of about 10 nF. These values have been introduced in the OrCAD-PSpice® software (electrical modelling software) to calculate the applied voltage and the total intensity provided by the amplifier. In Fig. 1 we plot the intensity profile calculated for 30 V applied. The intensity reaches values about 60 mA, whereas in the specifications the maximum AC output current enabled by the amplifier is 50 mA rms. High values activate a protective circuitry in the amplifier so that it does not get damaged. Using OrCAD-PSpice® software we have calculated the modifications to be introduced to be able to provide a value of about 400 V rms to the HPDLC cell without reaching high values of intensity. As a result we have obtained that a suitable combination is a resistance of about 5kΩ in series with an inductor of 0.4 H and in series with the HPDLC. This has been experimentally implemented with success, being able to apply more than 400 V rms to the HPDLC cell.

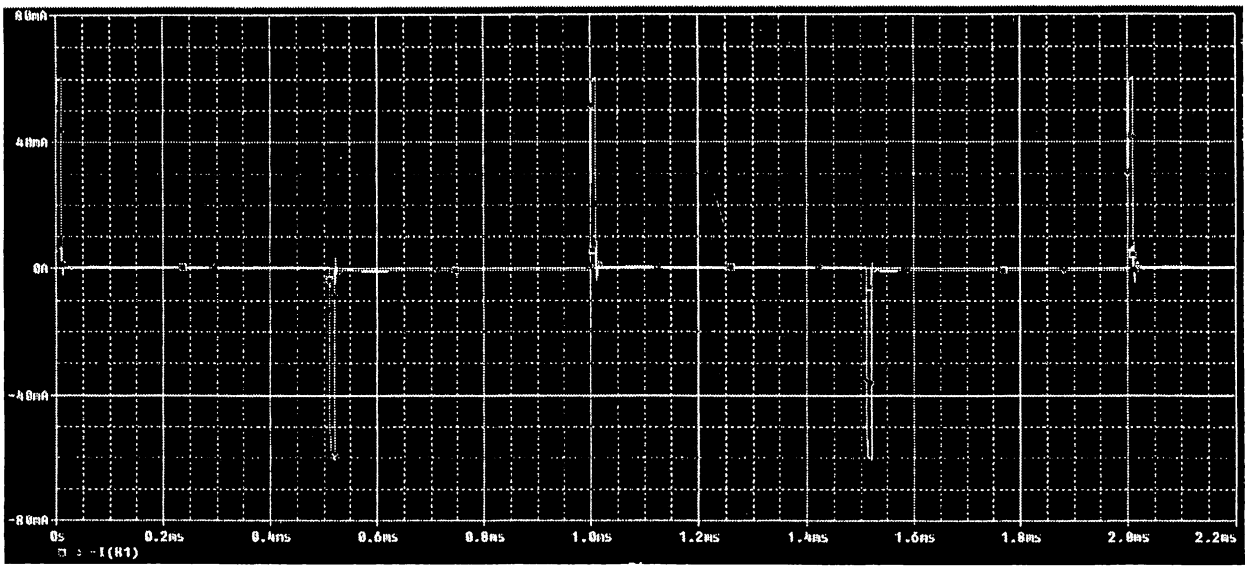

Fig. 1. Electro-optical response for the HPDLC.

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