Electrical and Thermal Analysis of an OLED Module

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Abstract

Electronics on flexible foils is an area of intensive research and development [1-4]. Such electronics applications may require a power source embedded in the flexible foil. Regularly DC-DC converters are used for this purpose because of their high efficiency [5]. A typical DC-DC converter topology requires an inductor. As the inductor needs to be implemented in the flexible foil, its design options are limited. An inductor for a DC-DC converter embedded in the substrate in an OLED tile (Figure 1) is analyzed in this paper [6]. The DC-DC converter places a number of requirements on the electrical characteristics of the inductor. An OLED tile is a lightning device and it has to conform to the required EMC standard CISPR 15 [7]. The OLED is made of the organic material that is extremely sensitive to thermal influences [8]. The inductor mounted on the OLED tile is analyzed from the standpoint of its electrical characteristics, electromagnetic compatibility and thermal performance. While evaluating the thermal performance of the OLED tile, the effects of the embedded DC-DC converter integrated circuit are taken in the account as well. COMSOL Multiphysics is used to model the OLED tile with the two-port inductor embedded in its substrate (Figure 1). The electromagnetic properties are analyzed by using the Electromagnetic Waves interface. The S-parameters, as well as the EM far field are evaluated in the model. The thermal profiling of the OLED tile is done by using the Heat Transfer Module. The results of the simulations show that the electrical characteristics (Figure 2) of the inductor fulfill the requirements of the DC-DC converter and that the far-field profile (Figure 3) conforms to the requirements of the EMC standard. The thermal profile (Figure 4) of the OLED tile shows that the temperature and its maximum difference across the OLED tile are too high. A heat spreader is thus needed. The dependence of the thermal profile with respect to the thickness of the heat spreader is investigated. The minimal value of the heat spreader thickness that fulfills the requirements on the operating temperature and the maximal temperature difference is determined. An OLED tile is analyzed in the context of its electrical, electromagnetic and thermal characteristics in this work. It is found that the electrical properties of the inductor meet the DC-DC converter requirements and that its radiated disturbance levels are lower than the required EMC limits. The thermal properties of the OLED tile can be improved by adding a heat spreader layer. The optimal thickness of the heat spreader is found to keep the maximum temperature difference across the OLED tile within the required range.

Reference

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Figures used in the abstract

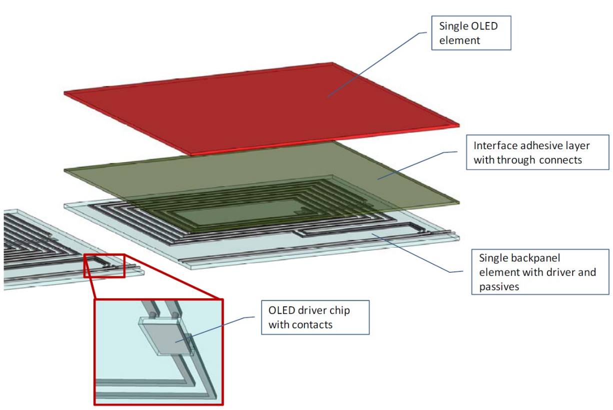

Figure 1: The 3D impression of the OLED module.

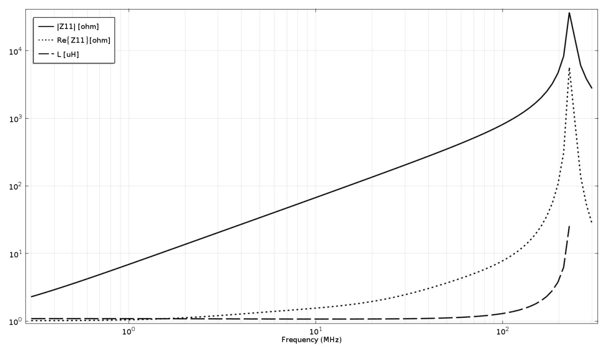

Figure 2: The frequency characteristic of the interport impedance.

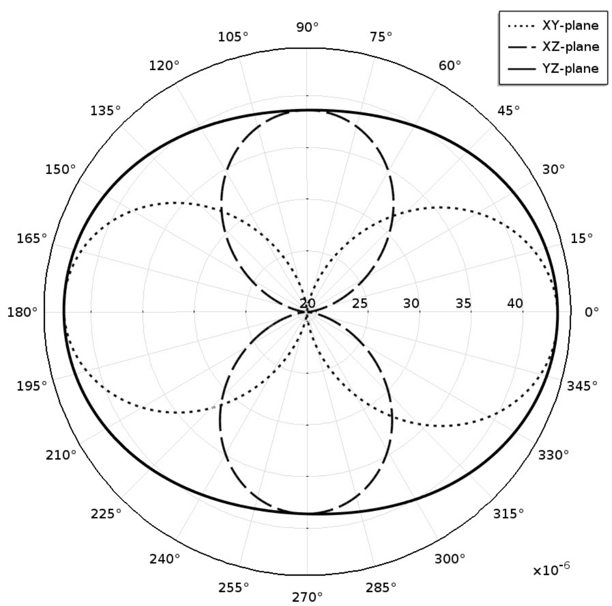

Figure 3: The cut planes of the far-field calculation.

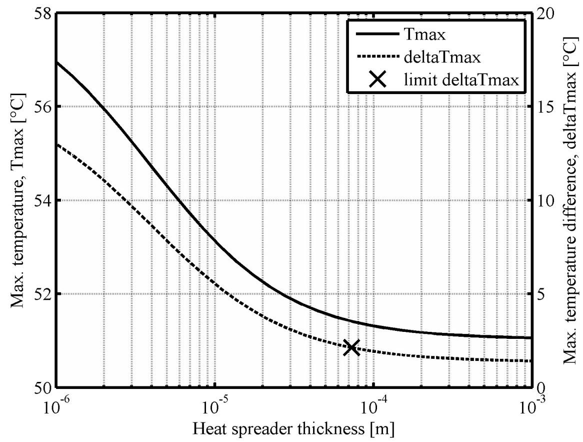

Figure 4: The dependence of the temperature and the maximal temperature difference with respect to the heat spreader thickness.