With the variety of local objects, reflections of a probing signal get to the radar receiver. They interfere these objects and do not allow the identification of their position in space.

The results of the experiments show that the use one quadrature registration scheme of the received signal does not permit to separate the picture of cardiac activity from the reciprocal motion of the chest, whose amplitude exceeds the amplitude of the heartbeat.

The article suggests an analytical method of restoration of the motion trajectory of an object according to two quadratures of the phase receiver, which works in a variety of local objects.

The combination of two quadratures of the phase receiver of the radar with their previous differentiation and subsequent arctangent-demodulation provides an actual trajectory of the object motion, necessary for further analysis of the frequency and nature of this movement

Keywords: *radar, bioradiolocation, breathing, heartbeat*

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LED PCB THERMAL SIMULATION USING FLOEFD

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В статті представлені результати створення корпусів світлодіодів (LED) високої потужності на основі друкованої плати та подвійного шару склотекстоліту FR4. Перш за все, створюється деталізована модель корпусу LED на підкладці. Потім модель оптимізується з урахуванням виду, кількості та розташування теплових міжшарових з'єднань, ширини теплових каналів та розсіювання потужності LED

Ключові слова: світлодіод, оптимізація, керування температурними режимами, друкована плата

В статье представлены результаты создания корпусов светодиодов (LED) высокой мощности на основе печатной платы и двойного слоя стеклотекстолита FR4. Прежде всего, создается детализированная модель корпуса LED на подложке. Затем модель оптимизируется с учетом вида, количества и расположения тепловых межслойных соединений, ширины тепловых каналов и рассеиваемой мощности LED

Ключевые слова: светодиод, оптимизация, управление температурными режимами, печатная плата

1. Introduction

Heat dissipation of the light source and the dependence of its parameters on the ambient temperature, the energy balance of the source, optical and heat transfer characteristics of the materials are used in the evaluation and calculation of the thermal mode of the light source [3]. The article presents the results from thermal simulations of power LED's mounted on PCB. Simulations were performed using the method CFD (computational fluid dynamics) via the software Mentor Graphics FLOEFD. Simulation experiments were conducted to optimize the distribution of heat in terms of type, number and location of the vias, width of the conductive paths and dissipated power of the LEDs.

2. Computational simulations using FLOEFD

Since FloEFD is based on solving the time-dependent equations of Navier-Stokes problems in steady state are solved by stationary approach. For quicker acquisition of the stationary solution a method of local computational steps in time is used. Multigrid method is used to accelerate convergence of the solution and to suppress oscillations. In order to optimize the time of termination of the calculation and to determine more accurately the physical parameters of interest, that oscillate in iterations. Physical parameters of interest could be determined as calculation purposes. Prior to starting creating a model and a FloEFD project, it is necessary to choose the geometrical and physical characteristics of the engineering problem which most significantly affect the solution to this problem. If the model has already been created when designing the object, i.e. it is fully adequate to the object, then the solution of engineering problems using FloEFD, may be required to simplify the model or add auxiliary parts of the model. Proper use of these two activities can be crucial for obtaining reliable and accurate solution. As soon as the main part of a FloEFD project, that is unlikely to change is build, the next step is to choose a strategy to solve the engineering problem using FloEFD, i.e, obtaining reliable and accurate solution to a problem. The strategy for solving engineering problems includes the following important steps:

• Settings for solving geometric characteristics of the model and to obtain the required accuracy of the solution
• Monitoring of the calculation
• Review and analysis of the obtained solution
• Assessment of the reliability and adequacy of the solution obtained.

3. Thermal computational simulations of LED PCB

Thermal mode is determined by the heat intensity of the structure, which is characterized by specific power p per unit area S.

$$p=\frac{P}{S}, \tag{1}$$

where P is the total power of the light sources into the light body and S is the total area of heat dissipation assembly. Basic initial data to solve the problem of thermal management is the temperature of the LEDs and exactly the p-n-junction (active area) of the LED crystal and ambient temperature. It is known that the junction temperature, and the current affect the lifetime of LEDs (LED's working resources).

Many manufacturers grant such dependencies for their LEDs. This article discusses an approach for optimized thermal design of the topology of PCB for LED modules. For substrate FR4 material is selected to lower the cost of the LED module.

In Fig. 1a, 1b and 1c are shown cross-section and topology of the selected for simulation structure.

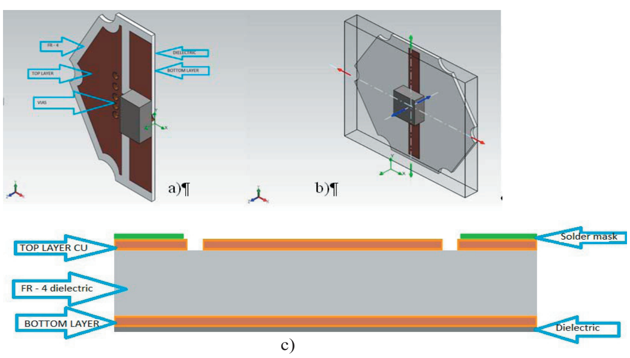

Fig. 1. Construction of PCB LED module

Optimizing thermal mode is performed in respect of thermal vias in the substrate, width of the thermal paths, dissipated power from the LED. The substrate is coated from the both sides with copper layers 70 um thick. The thickness of the FR-4 is respectively 1588 um , width of the contact pad is 3,3 mm and 20 mm.

In Fig. 2 and 3 are shown results of the simulations for samples with widths of the conductive paths of 3,3 mm and 20mm and without thermal vias.

Simulations are performed with different power dissipated from the LEDs. The displayed results of 3D simulation of Fig. 2a and 3a refer to the 1 W dissipation power, fig. 2b and 3b refer to 5 W, respectively.

The maximum temperature gradient for both widths of the paths at 1W dissipated power LED is 2^0C, while at 5W dissipated power is 7^0C.

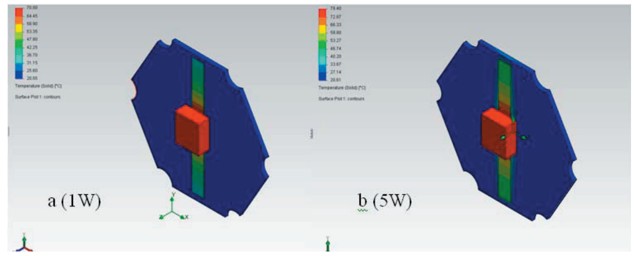

Fig. 2. 3D thermal simulations of LED module with path's width 3,3 mm for different dissipated power

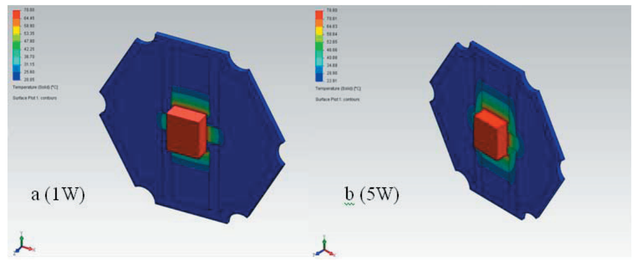

Fig. 3. 3D thermal simulation of LED module with path's width 20 mm for different power dissipated

Thermal simulations were conducted to evaluate the thermal mode with and without vias for different dissipated power. Fig. 4 shows the results for the two cases of heat dissipation without vias.

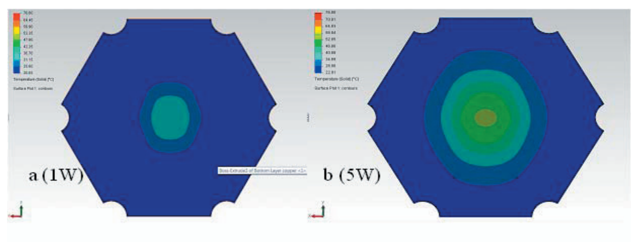

Fig. 4. 3D simulations of LED module without vias

The maximum temperature in the middle for the region underneath the chip on the back side of the substrate at 1 W power dissipation of the LEDs is 38^0C and 56^0C at 5 W, respectively.

For fivefold increase in power dissipation the maximum temperature underneath the LED chip on the back side of the board increases by approximately 65%.

Fig. 5 shows the results of thermal simulations with different number of vias with a diameter of 0,7 mm at 1W and 5W dissipation power of LED's and width of the paths of 3,3 mm.

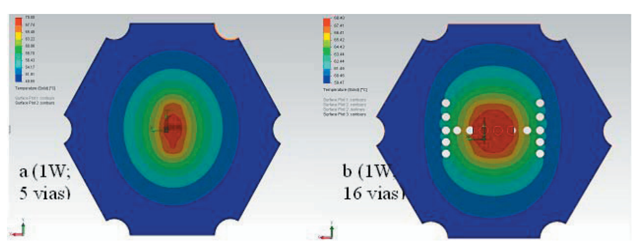

Fig. 5. 3D simulation of LED module with vias

For 16 vias arranged in the configuration shown in Fig. 5 for dissipated power 5 W, heat dissipation increases almost 2 times. As a result of the research, it appears that smaller openings in the range of 0,25 mm are a good solution, especially matrix arranged with a pitch 0,64 mm. The larger diameter of the vias and a larger number reduces the thermal resistance.

Thermal resistance is reduced by reducing the thickness of the FR4-dielectric, too.

Fig. 6 presents the profiles of the temperature distribution on vias for LED's dissipating power of 1 W and 5 W, respectively.

The zero point of the distance has been chosen as the center of the LED.

Experimental measurements are made with an infrared camera and shows that the errors of the simulations is not higher than 10% in the various models of the process of optimization.

4. Conclusion

Performed research shows that the use of CFD codes can be successfully used to simulate and optimize the design of the LED package-on-substrate. The results show that the models agree well with the actual measured value. A major advantage is saving time and money for the development of reliable design of LED modules.

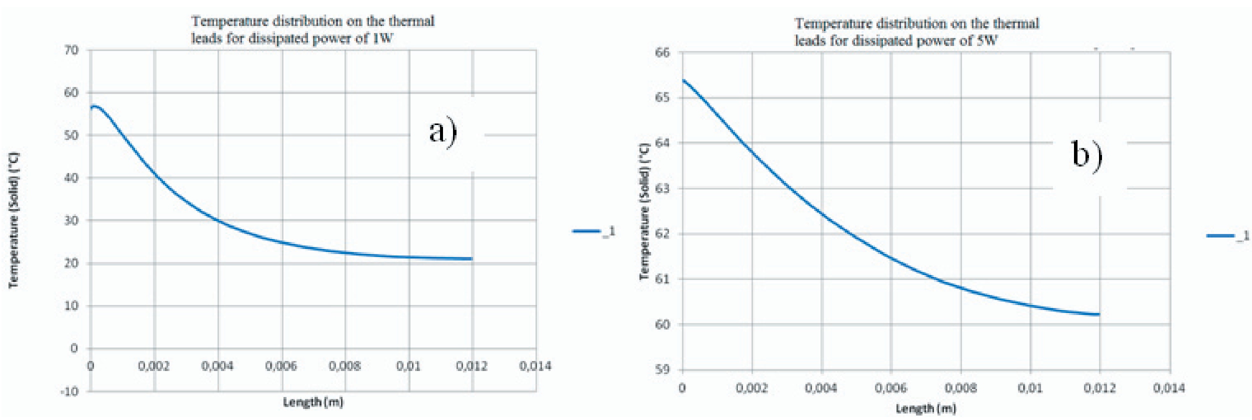

Fig. 6. Dependency of the temperature distribution from the center of the LED to the edges of the substrate

Referenses

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Abstract

This paper presents work done to create a high power light emitted diode (LED) package on a PCB and a double layer FR4. Firstly, a detailed model of an LED package-on-substrate is created. Then the model is optimized with respect to kind, number and location of the thermal vias, width of thermal paths and LED power dissipation. The method CFD (computational fluid dynamics) via the software Mentor Graphics FLOEFD is used as a tool to assist in the design of the power LED for the real application. The results show that the models agree well with the actual measured value. A major advantage is saving time and money for the development of reliable design of LED modules

Keywords: *LED, thermal simulation, optimization, thermal management, PCB*