ELECTRO-OPTICAL DEVICE PARAMETERS MODELING

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This paper presents electro-optical device parameters modeling for OrCad Pspice simulator. Electro-optical parameters of photodiodes, LEDs and laser diodes like total output power, spectral sensitivity, optical power vs. current are modeled using ABM method. The modeled relations are fitted using MATLAB which is resulting in good accuracy. The models are implemented in the OrCad PSpice simulator as subcircuits.

Keywords: photodiodes, LEDs, laser diodes, Spice, MATLAB

1. INTRODUCTION

The applications of LED and laser diodes are rapidly increasing. They are used in diverse applications from complex electro-optical measurements, optical communications systems and consumer electronics to material processing tools. This is the motivation for creating PSpice models of for LEDs and laser diodes, as well as photodetector counterparts for applications that use them.

The designers need models describing accurate electrical characteristics, as well as optical parameters.

2. MODEL DESCRIPTION

LEDs are used to convert input electrical current to optical power. Their applications are as indicators (visible light) and to transmit optical power. Common wavelengths manufactured are 660nm (red), 850nm, and 940nm (infrared). An LED is characterized by its peak wavelength, output power, forward current and reverse capacitance and leakage characteristics. The LED can use a diode to model the diode impedance, and a controlled voltage source to fit the power output vs. forward current curve.

Photodiodes are used to convert input optical power to electrical current. They typically come with peak wavelengths of 800nm and 940nm (infrared), and are also available for laser diodes. A photodiode is typically characterized by its peak wavelength, sensitivity, dark (leakage) current, output power, and its forward current and capacitance characteristics. The diode model can be created using the forward current, reverse breakdown, dark current (reverse leakage), and capacitance curves on the datasheet. Then, use the ABM method, the spectral sensitivity (A/W) vs. forward current can be modeled.

Laser diodes can be used for applications such as bar code readers, and often contain a monitor diode in the same package.

The electro-optical devices models use a diode to model current and capacitance characteristics, impedance and other parameters. The controlled current sources are used to model the optical power vs. monitor current curve for LEDs or the spectral sensitivity vs. forward current for photodiodes or the optical power vs. laser diode current.

3. PARAMETERS EXTRACTION AND MODEL IMPLEMENTATION

A LED model is presented more detailed in this paper.

The diode model consists of the parameters listed in Tab.1, which is extracted from datasheet:

IS [A]	saturation current
N [-]	emission coefficient
RS [Ω]	parasitic resistance
CJO [F]	zero-bias p-n capacitance
M [-]	p-n grading coefficient
VJ [V]	*p-n* potential
ISR [A]	recombination current parameter
BV [V]	reverse breakdown knee voltage
IBV [A]	reverse breakdown knee current
TT [s]	transit time

Tab.1

To achieve an accurate description of the optical relations described above, it is necessary to develop a high precision analytical model that exhibit nonlinear variation of the electro-optical parameters vs. current. The graphs from datasheet are digitizing using an appropriate program like GetData. Then the data set imports in MATLAB and using Curve Fitting Toolbox the appropriate equation is determined.

The GVALUE type current controlled source is used to realize the fitting curve.

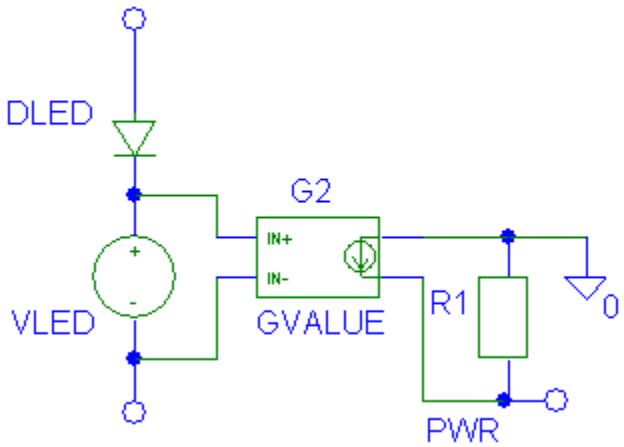

Fig.1. A LED diode model

The models are implemented in the OrCad Pspice simulator like subcircuits. The subcircuits have three pins: anode, cathode and power as voltage output in Watts.

A LED diode macromodel is shown in Fig.1.

4. SIMULATION RESULTS

A model for the MLED930 part from Motorola is developed to demonstrate the proposed technique.

Figure 2 shows P_o vs. I_F fitting using Curve Fitting MABLAB Toolbox. Exponential fit by the following function: $y = a.e^{bx} + c.e^{dx}$ is given the best accuracy. For this device the coefficients are listed in Table 2.

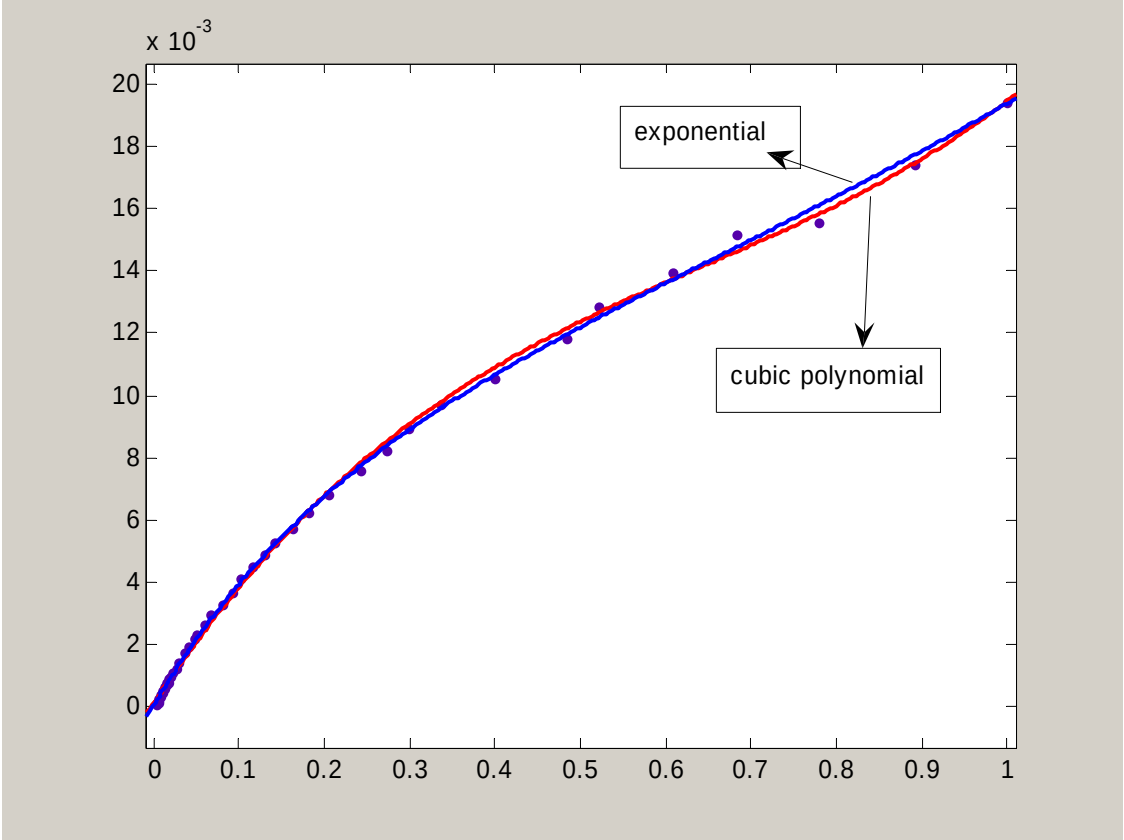

Fig.2.

coefficients	values
a	0.008875
b	0.7863
c	-0.008805
d	-4.444

Table 2.

Figure 3 shows the LED model waveform. V(PWR) is the LED power output in Watts (as a voltage).

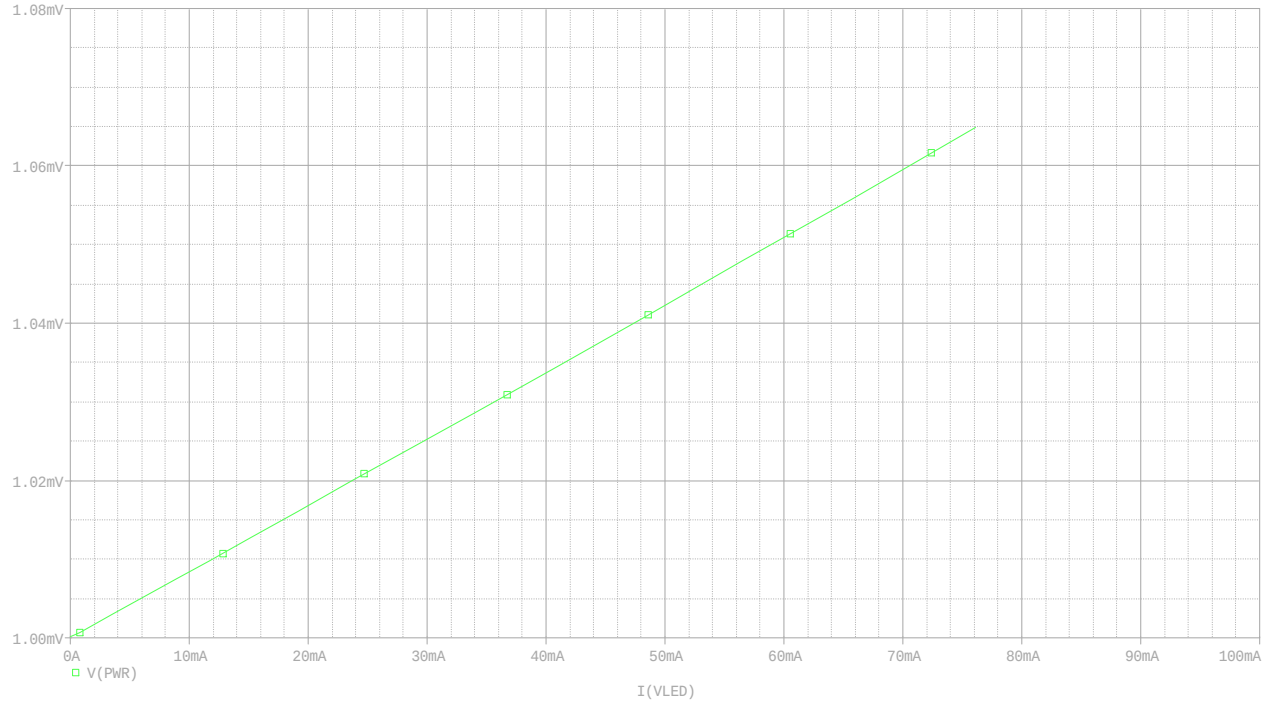

Fig.3. Output power vs forward current for the MLED930 model.

5. CONCLUSIONS

This paper presents electro-optical device parameters modeling for OrCad Pspice simulator. Electro-optical parameters of photodiodes, LEDs and laser diodes like total output power, spectral sensitivity, optical power vs. current are modeled using ABM method. The modeled relations are fitted using MATLAB which is resulting in good accuracy. The models are implemented in the OrCad PSpice simulator as subcircuits.

A LED macromodel is shown in the paper and the OrCAD simulation of the total output power vs. forward current are presented too. The good agreement between the simulation results and datasheet can be observed.

6. ACKNOWLEDGEMENT

This investigation has been supported by the Technical University of Sofia within the framework of the research project № 08014 НИ-3/2008.

7. REFERENCES

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