Investigation of Optoelectronic Circuits

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Abstract - **This paper presents an optoelectronic circuit which a non-linear transistor load synthesizes the operation of an inductor, with excellent suppression of DC and low-frequency light. The DC characteristics at different voltage bias are simulated. The AC and noise behavior are analyzed too.**

Keywords – **optoelectronic circuits, photodiode, electronic gyrator, simulation**

I. Introduction

The analysis of the circuit photoreceiver efficiency at different input impacts is from the basic significance for the optoelectrical devices design. There are no specialized CAD simulators in the engineer practice to describe the operating characteristics of the optical devices not only like the electronic circuits, but at the physics impacts too. The possibilities of the standard simulator PSpice must be expanded in order to obtain electrooptical characteristics and parameters.

The circuits with nonlinear transformation of the optical signal are of the big interest because the stage gain is varied at the different frequencies and the same time the electronic components are minimized.

The paper presents an optoelectronic circuit which non-linear transistors load synthesizes the operation of an inductor, with excellent suppression of DC and low-frequency light.

II. Circuit Description

The circuit shown on figure 1 is an electronic gyrator, which uses a capacitor and gain stage to synthesize a large value inductor. It will provide at DC a low-impedance path for photocurrent, giving a low otput voltage. At a precise high frequency the circuit will exhibit high impedance, allowing the full load resistir sensitivity to be obtained.

RC-circuit and transistor amplifiers are the active load for the photodiode. Let note a large DC photocurrent I_p flowing through the photodiode and load resistor and then into thr transistor base capacitor C_L. As the capacitor charges positivly, the transistor is turning on, because it will become forward biased. This shorts out the load ressitor, limiting the output voltage.

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The high-frequency photocurrents at the transistor base are routed to ground through the capacitor, stopping the transistor and allowing the high-value load resistor to be fully utilized. The transition between low- and high-frequency behavior occurs when R_L and C_L have the same impedance.

The circuit study is implemented at the following components values: R = 1.5kΩ, R_L = 330kΩ, C_L = 33nF. The *Vc* source models the input light power. The low-frequency impedance is about 1kΩ, rising to 250kΩ at 50 kHz using these values.

The output signal must be taken to a high-impedance buffer such as a voltage follower. Negative output voltages can be achieved by using PNP transistor and negative voltage bias.

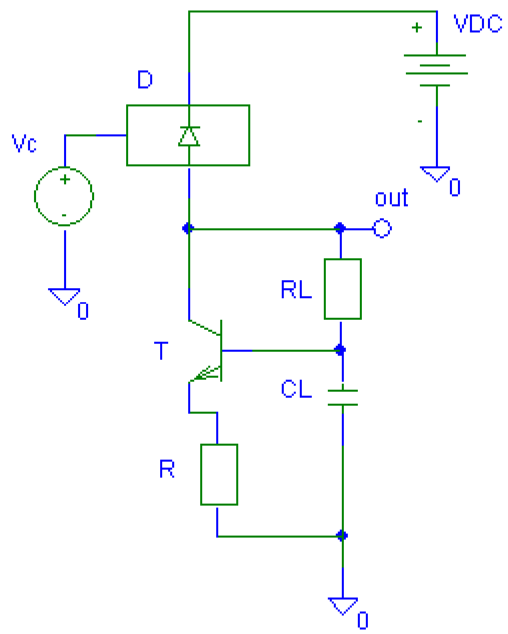

Fig.1

III. Simulation Results

The DC analysis is accomplished at input light power about 0 to 4mW as a voltage input *Vc*. Figure 2 shows the relation of the photocurrent vs the input power at the different voltage bias V_{DC} = 2V; 3V; 4V; 5V. The dynamic range is expanded with the augmentation of the voltage bias.

Figure 3 presents the photocurrent at 10 kHz optical signal with 1mV DC offset and 0.03mV amplitude. The distortions of the current are occurred.

AC characteristic of the photocurrent is shown on figure 4. The maximum of the current is at 3.5 kHz. This frequency can be changed using R_L, C_L and R values.

Figure 5 presents the output noise characteristic. The frequency of the noise maximum is the same like the photocurrent maximum.

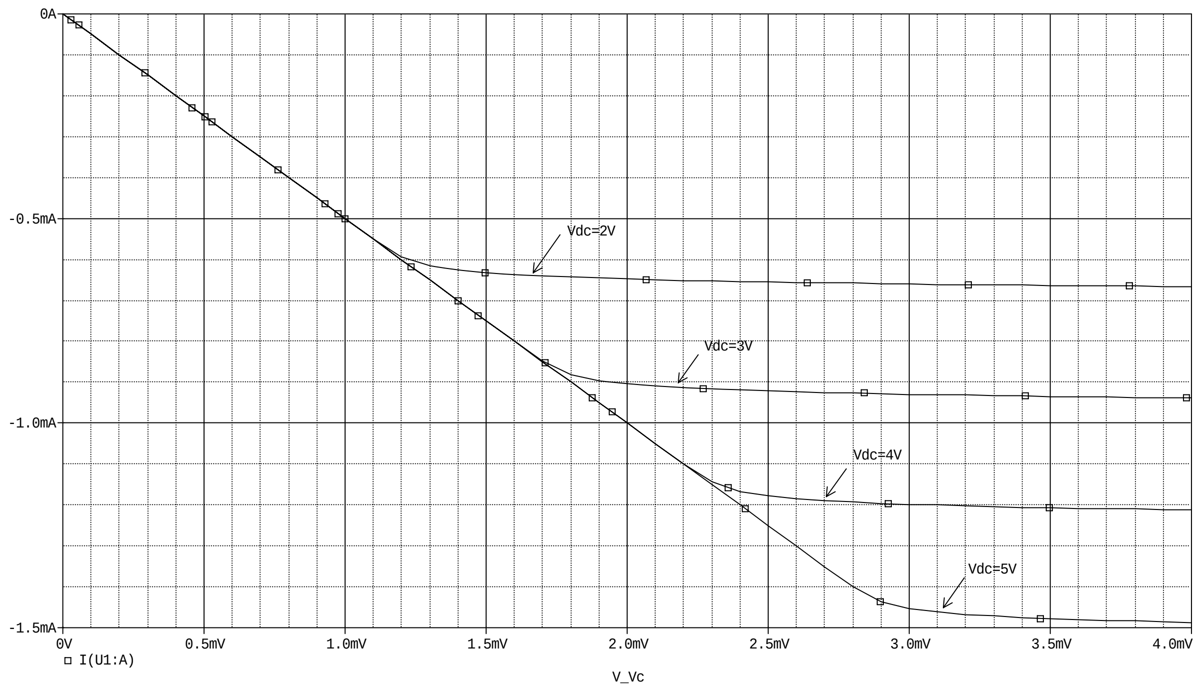

Fig.2. Photocurrent vs the input power at the different voltage bias

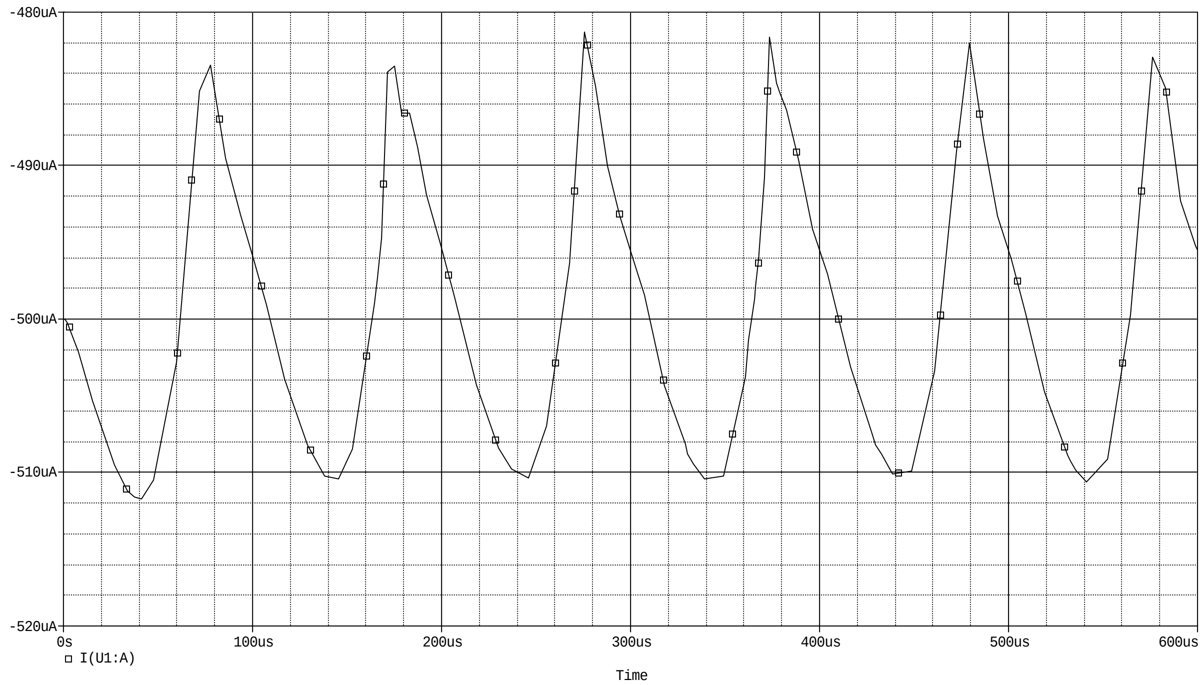

Fig.3 Simulated Photocurrent at 10 kHz optical signal and V_{DC}=5V

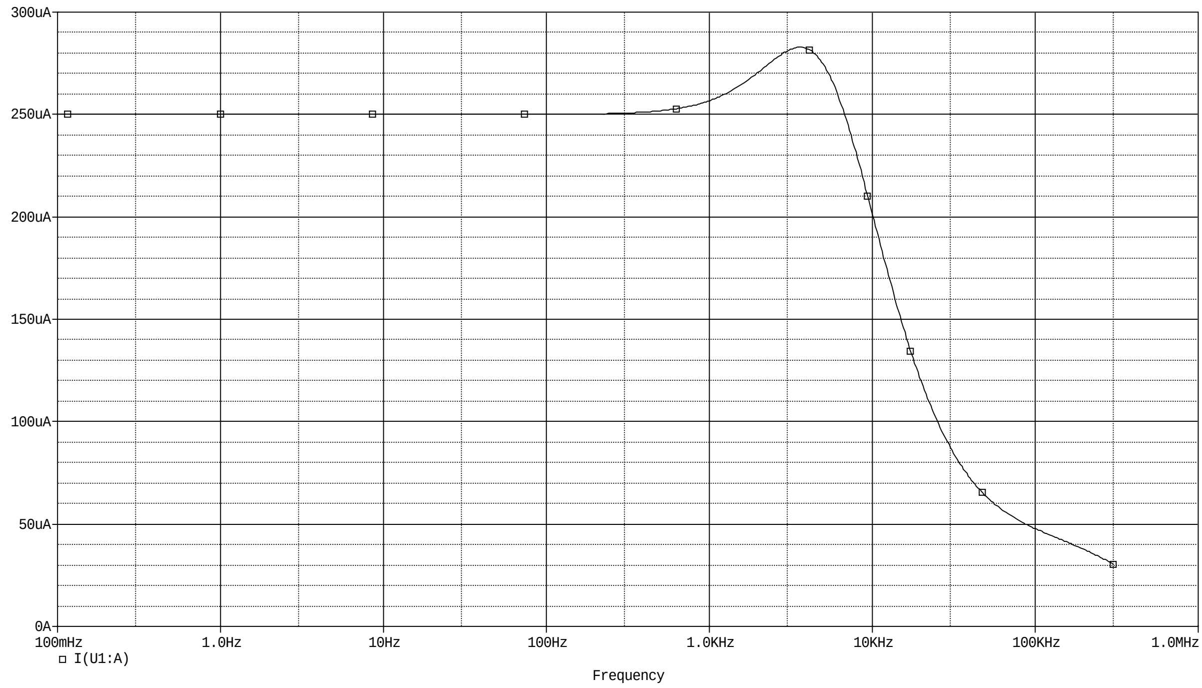

Fig.4 Simulated AC Characteristic of the Photocurrent

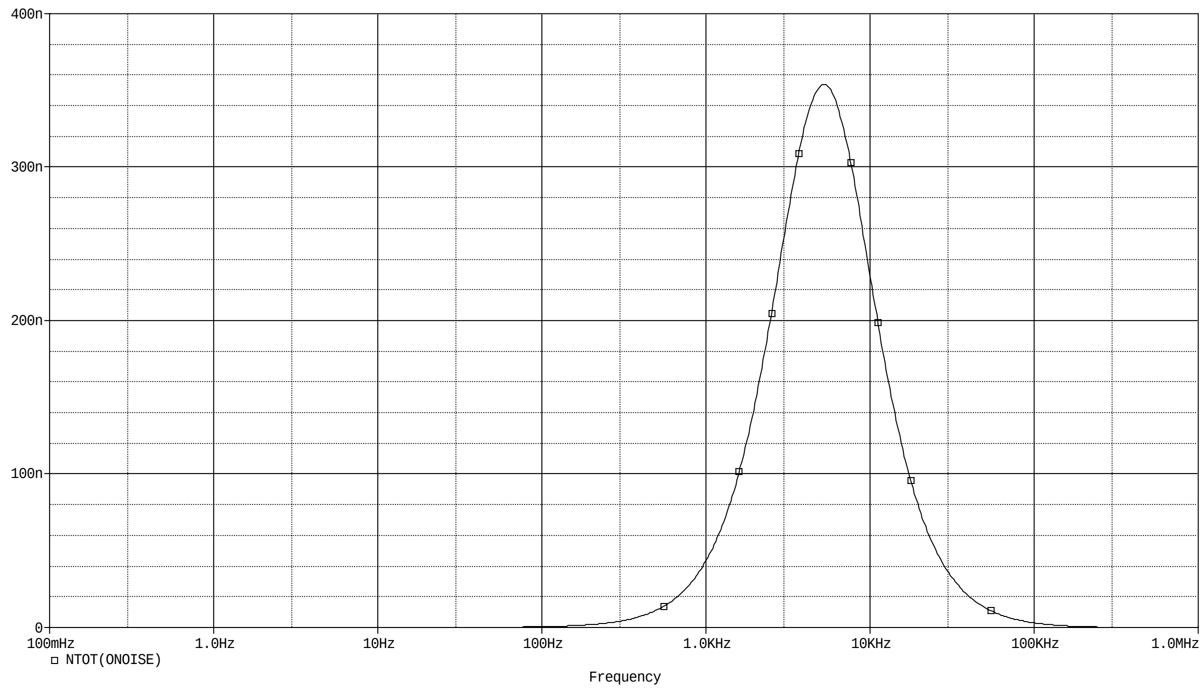

Fig.5 Output Noise Voltage

IV. CONCLUSION

A circuit, which nonlinear transistor load can synthesize the operation of an inductor, is presented. The good suppression of DC and low-frequency light is occurred. The DC- , AC- and noise characteristics are simulated.

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