Illuminance to Frequency Converter also Used for Conversion of the Ratio between Two Illuminances into a Number of Pulses

Tsanko Karadzhov[1], Ivelina Balabanova[2]

Abstract –**A circuit for conversion of illuminance to frequency and the ratio between two illuminances into a number of pulses has been developed. A simulation of the circuit performance has been carried out by means of PSPICE software and the transfer function of the converter taken by way experimentation.**

Keywords **– Illuminance, Frequency, Converter.**

I. INTRODUCTION

Optical to electric signal converters are integral parts of analogue or digital devices for measuring illuminance or light flux and they have a wide range of application in optoelectronics. This necessitates the design and development of such converters as well as the improvement of their parameters and functional capacity.

[1]Tsanko Karadzhov Technical University of Gabrovo, 4 H. Dimitar, 5300 Gabrovo, Bulgaria, E-mail: karadjov_st@abv.bg
[2]Ivelina Balabanova Technical University of Gabrovo, 4 H. Dimitar, 5300 Gabrovo, Bulgaria, E-mail: ivstoeva@yahoo.com

II. CONVERTER DESIGN

The 555 integrated timer is a specialized integrated circuit designed to generate square pulses of particular duration and frequency of repetition. One of the most frequently used operation modes with this timer is its involvement as astable multivibrator. If some of the components in the mastercircuit are replaced by optoelectronic components,then at the timer output it is possible to obtain pulses whose parameters are optically controlled. Figure 1 shows the design of illuminance to frequency converter also used for conversion of the ratio between two illuminances into a number of pulses.

Three timers type 555 have been used and photo diodes BPX 61 (product of SIEMENS) have been used as photo sensitive components. The photo diodes are included in the master circuit of the first timer – DD1. It controls the other two timers and determines the period throughout which the second and third timer will generate pulses with T=30.2μs and f = 33.11 kHz. The timer's period is approximately defined by means of the following expressions:

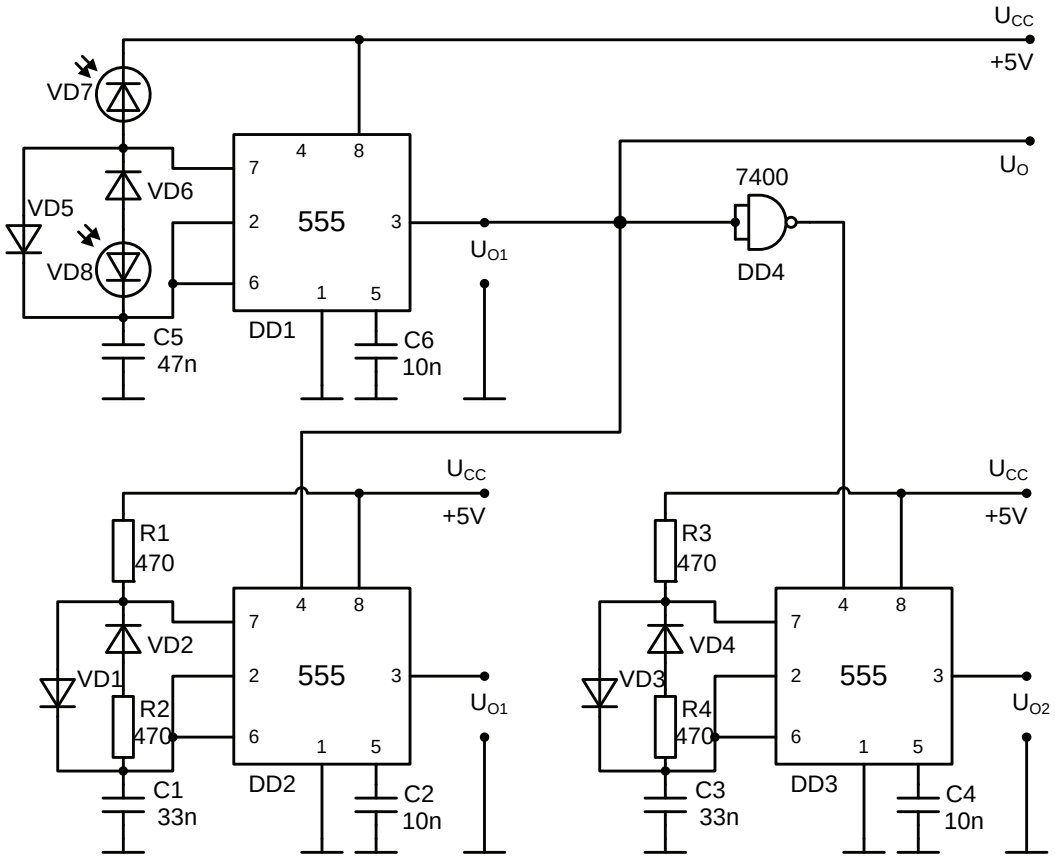

Fig.1 Converter design

Timer 2:

$$T \approx 0{,}7.C_1.(R_1 + R_2) \quad (1)$$

Timer 3:

$$T \approx 0{,}7.C_3.(R_3 + R_4) \quad (2)$$

Timer 1:

$$T \approx 0{,}7.C_5.(R_{VD7}(\Phi_1) + R_{VD8}(\Phi_2)) \quad (3)$$

Time diagrams of the circuit performance are shown on fig.2, fig.3 and fig.4 with different illuminance ratio of the two photo diodes.

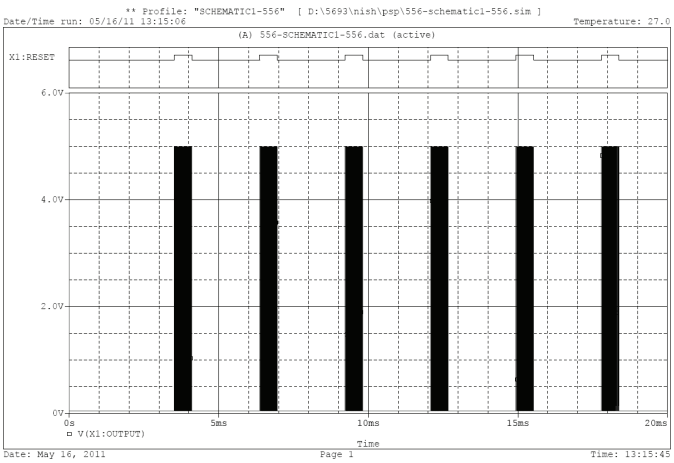

Fig. 2

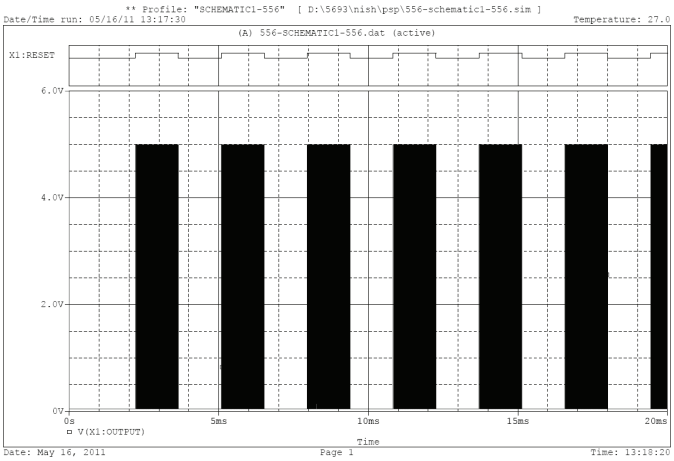

Fig. 3

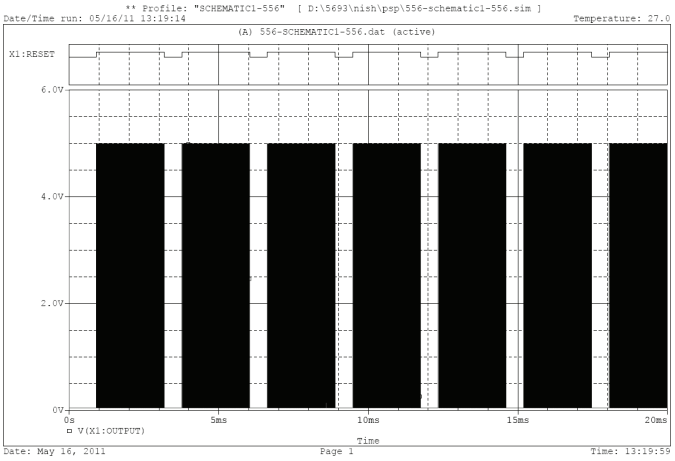

Fig. 4

Fig.5 shows the burst generated by timer 2.

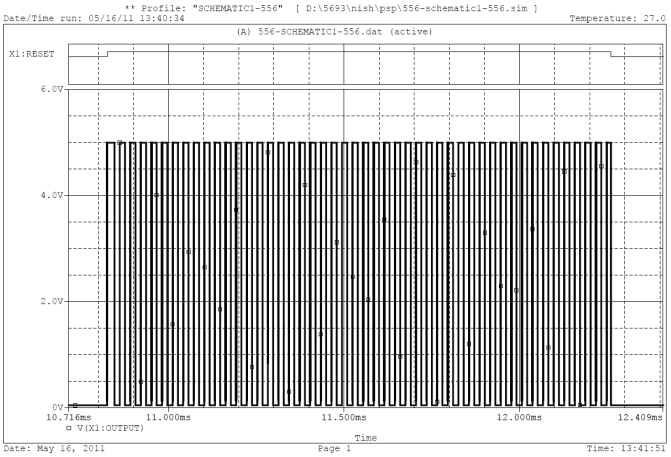

Fig. 5

Both charge and discharge of capacitor C5 occurs between voltage thresholds of the two comparators of the first timer ⅓ $U_{CC}$and ⅔U_{cc} by rule of the following laws.

$$U_{C5} = \frac{1}{3}U_{CC} + \frac{2}{3}U_{CC}\left(1 - e^{\frac{-t}{R_{VD7}(\Phi_1)C_5}}\right) \quad (4)$$

$$U_{C5} = \frac{2}{3}U_{CC}\left(1 - e^{\frac{-t}{R_{VD8}(\Phi_1)C_5}}\right) \quad (5)$$

Table 1 and fig. 6 contain the results from the measurement and the transfer function of the converter plus the dependence of he output frequency from the illuminance of f=f(E)

TABLE I

E, lx	T, ms	f, Hz
100	27.0	37.04
200	13.7	72.99
300	9.25	108.1
400	6.99	143.1
500	5.63	177.6
600	4.71	212.3
700	4.06	246.3
800	3.56	280.9
900	3.18	314.5
1000	2.87	348.4
1100	2.61	383.1
1200	2.40	416.7
1300	2.22	450.4
1400	2.07	483.1
1500	1.93	518.1
1600	1.82	549.5
1700	1.71	584.8
1800	1.62	617.3
1900	1.53	653.6
2000	1.46	684.9

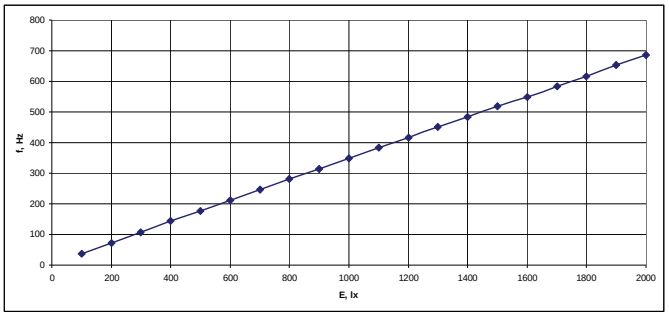

Fig. 6

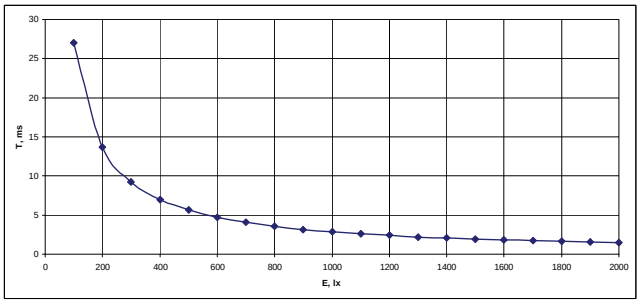

Fig. 7

Fig. 7 shows the dependence T=f(E).

Table II and fig.8 indicate the change in the pulse count(in percentage) within bursts at output U_{OI} depending on E1/E2

TABLE II

E1/E2, %	Брой импулси
10	10
20	20
30	29
40	38
50	48
60	57
70	66
80	75
90	84

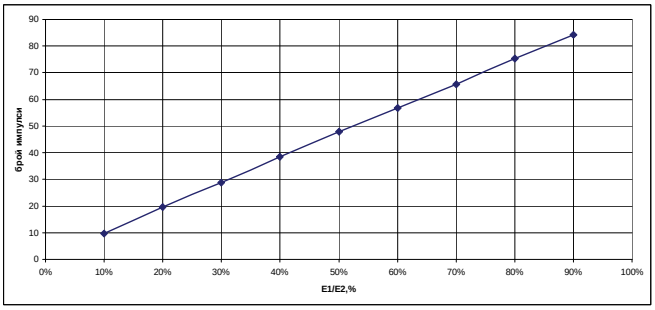

Fig. 8

The frequency of the pulses generated by timer 1 is much smaller than the pulse frequency of the other two timers. This determines the large number of pulses within a burst.

III. CONCLUSION

The newly developed multifunctional converter could be used in lux meters for measuring illuminance or the ratio between two illuminances. Output frequency and and pulse number could vary over a wide range. An advantage of the design is the linear transfer function which results from the linear dependence of the photo flux in the master circuit of timer 1 from illuminance.

REFERENCES

[1] Коев, Ц. К., Ръководство за лабораторни упражнения по Измервателни преобразуватели,ИК"Колонел", Габрово, 2002.

[2] Р. Трейстер, Радиолюбительские схемы на ИС типа 555, Мир, Москва, 1988