OPTICALLY CONTROLLED MULTIFUNCTION OSCILLATORS

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There is need not only for simple conversion of different illuminations in electrical signals in the practice. Thus the production of a signal (voltage, frequency or make-to-space ratio), which is proportional to the difference between two illuminances, is needed in many cases.

Keywords: Optically Controlled, Oscillator, Frequency

1. OPTICALLY CONTROLLED OSCILLATORS

There are many circuits, which convert illumination in electrical signal, for instance circuits for illuminance – voltage (current) conversion. Optically controlled oscillators with one photodetector had been created as their output frequency is proportional to the illumination. The circuit, shown on figure 1, is an optically controlled differential multipurpose oscillator with two photodetectors, which converts the illumination in frequency, voltage and also converts the difference between illuminances in make-to-space ratio.

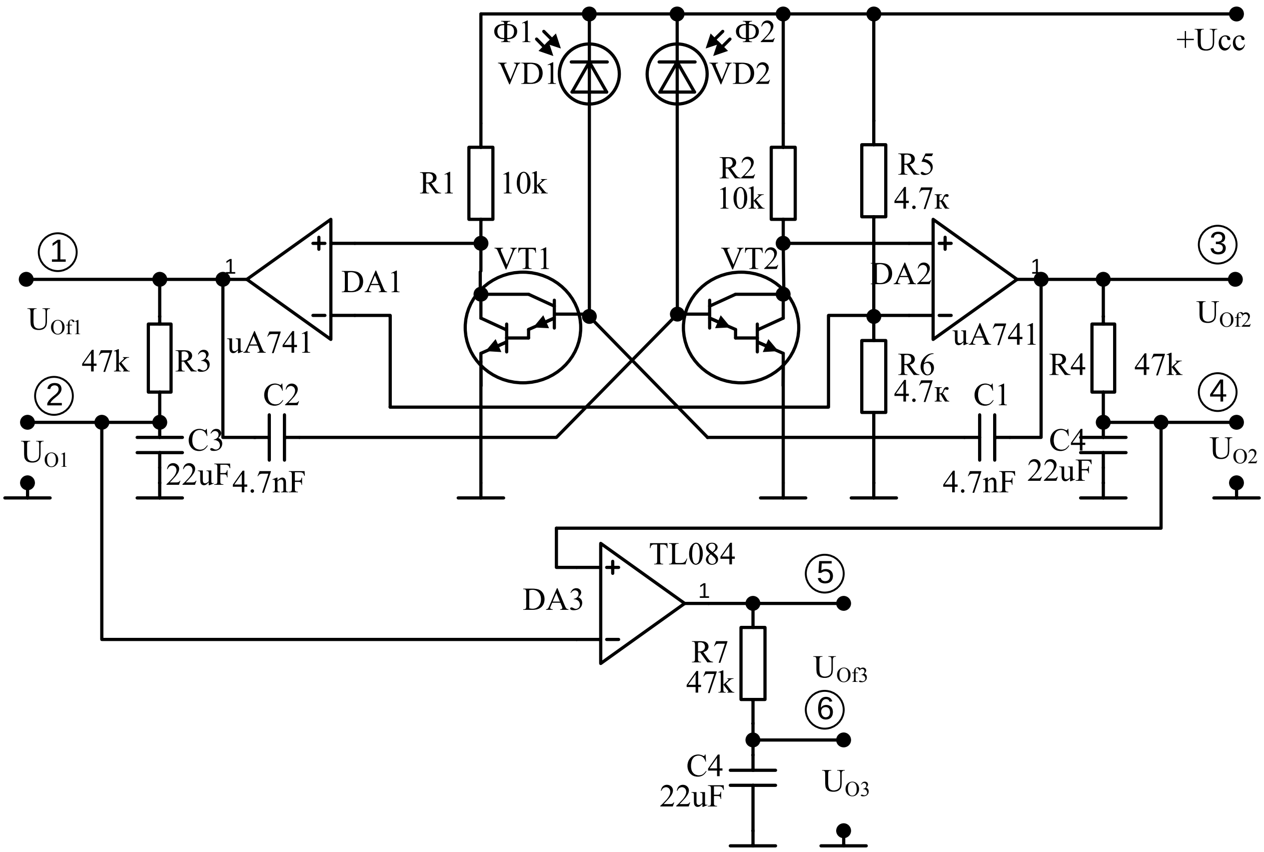


Fig.1

The action principle of the circuits is based on the fact that the change in the illumination leads on the change in charge and discharge periods of the two capacitances that are connected in the time specifying branches of the circuit, which determine the oscillator frequency. The differential photodiode SFH 221 S is used as photodetector. The two photodiodes VD1 and VD2 are connected in the base circuits of the Darlington transistors VT1 and VT2. The transistor signals are then amplified by the operational amplifiers DA1 and DA2. The resulting signal is passed through the third operational amplifier DA3. Integrating groups are connected to the output of each amplifier, thus the output voltage is proportional to the difference between the illumination of the photodiodes.

The voltage and the frequency dependence from different photodiode illuminations are experimentally obtained as this characteristic can be used in certain applications or when precise measurements are been carried out. To obtain the dependence characteristic, a photometer is used in the test, as the device outputs are connected to the digital voltmeter and digital frequency-meter or the oscilloscope. The dependence is shown on figure 3. The developed oscillator can provide very wide range of frequency change as the photodiode has linear characteristic $I_{ph} = f(E)$ and the photocurrent changes in wide diapason.

Multipurpose optically controlled oscillator, accordingly to the illumination of the photodiodes, can generate symmetrical orthogonal pulses when the illuminances are equal or nonsymmetrical – different illuminations. The difference between the photodiode illuminances can be determined by the different duration of the pulses from Output 1 and Output 3 of the oscillator. The pulse duration from output 5 can be used when questioning very small differences in the photodiode illuminances, since the pulse signal from operational amplifier DA3 is proportional to much smaller differences in the illumination.

The intensity of light fluxes Φ1 and Φ2 can change up to 10000 times, which means that the multiplicity of the oscillator frequency change is approximately 10000 times. If the photodiodes VD1 and VD2 are equally illuminated, the voltage that is half of the supply voltage (+6 V), will occur on the outputs 2, 4 and 6. These outputs will have different voltages only when there is illumination deference between photodiodes. The voltage from output 6 can have much higher value in comparison with the voltages from outputs 2 and 4.

The oscillator period and frequency reckoning

$$T = 0.7C1.R_{ph1}(\Phi 1) + 0.7C2.R_{ph2}(\Phi 2) \tag{1}$$

When the oscillator works in symmetrical mode:

$R_{ph1}=R_{ph2}=R_{ph}$, C1=C2=C, Ucc=12V

$$T = 1.4CR_{ph}(\Phi) \tag{2}$$

$$f = \frac{1}{T} = \frac{1}{1{,}4CR_{ph}(\Phi)} \tag{3}$$

When R_{ph}=50kΩ, C=4.7nF, then:

$$T = 1.4.4.7.10^{-9}.50.10^{3} = 329\mu s\text{, E=1000 lx} \tag{4}$$

When R_{ph}=500MΩ, C=4.7nF

$T = 1.4.4.7.10^{-9}.500.10^{6} = 3.29s$, E=0 lx (5)

The time coefficient of the integrating circuit R3 – C3 is:

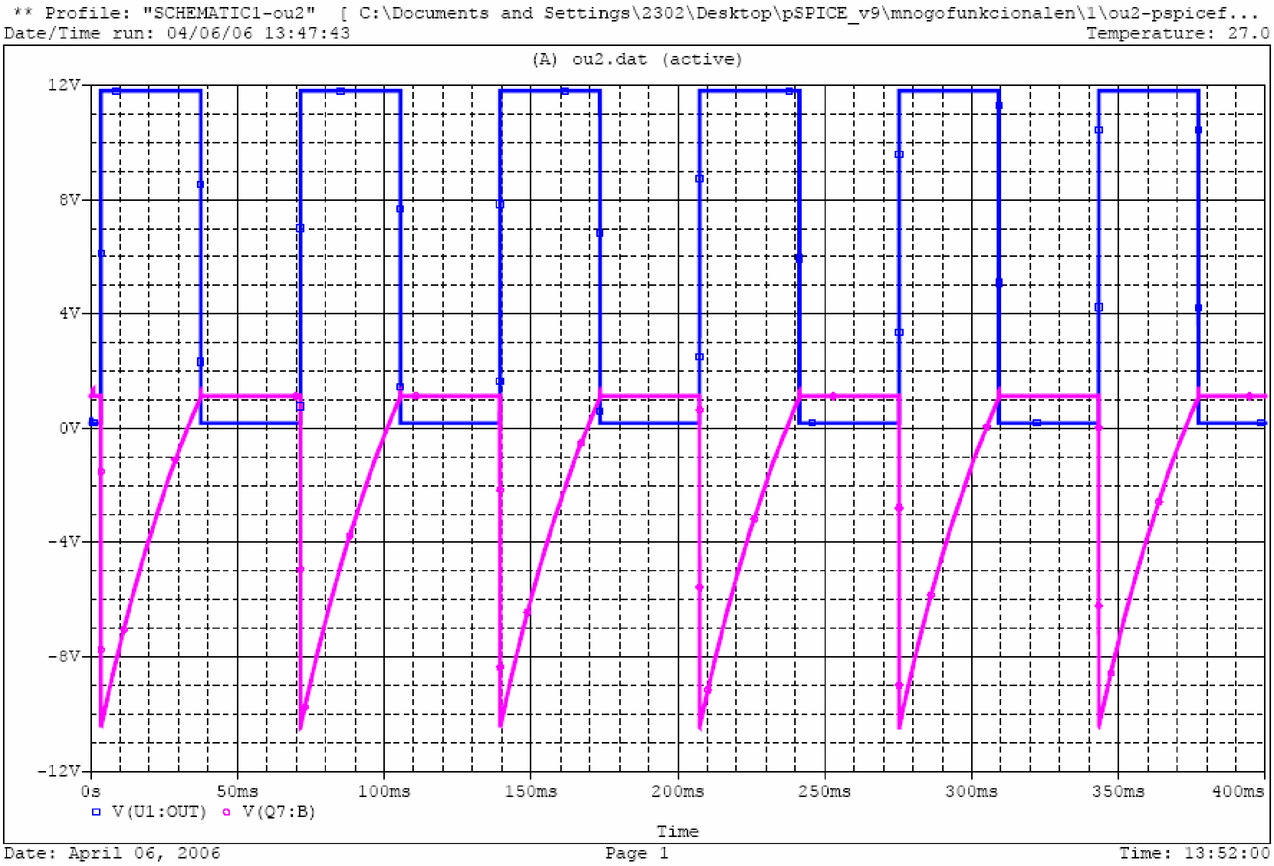


Fig.2

E, lx	3	10	30	100	300	1000	3000	
I_{ph}, μA	0.1	0.22	0.7	2.2	7	22	70	
T, ms-mes.	790	359	113	36	11	3.59	1.13	
f, Hz-calc.	1.27	2.79	8.87	27.9	88.7	279	887	
T, ms-mes.	818	371	117	36.9	11.6	3.71	1.18	
f, Hz-mes.	1.22	2.70	8.55	27.1	86.2	270	847	
Error, ε*	ε≈3.54%							

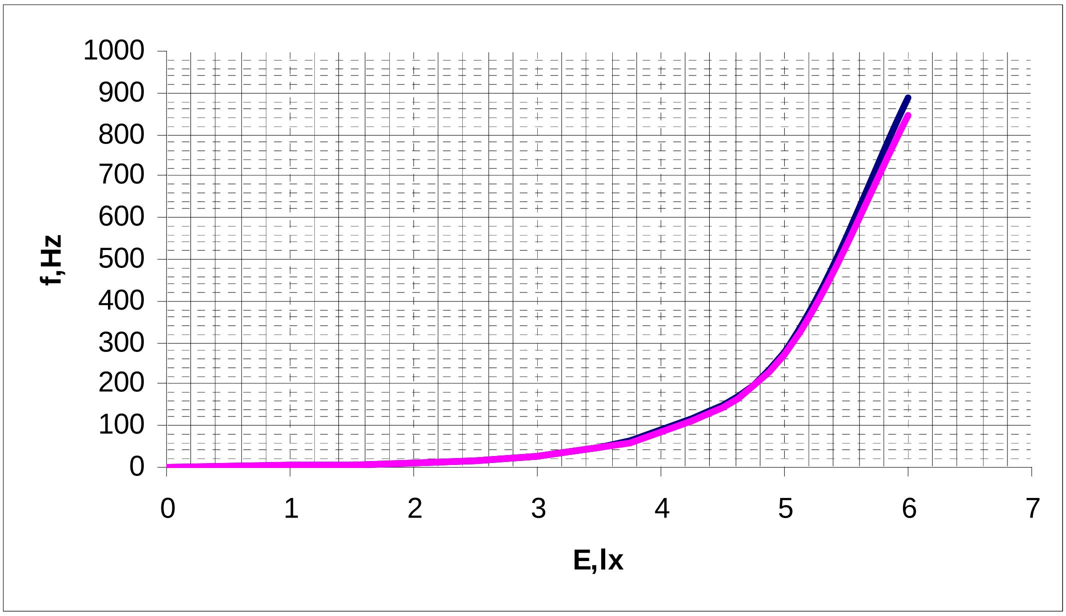
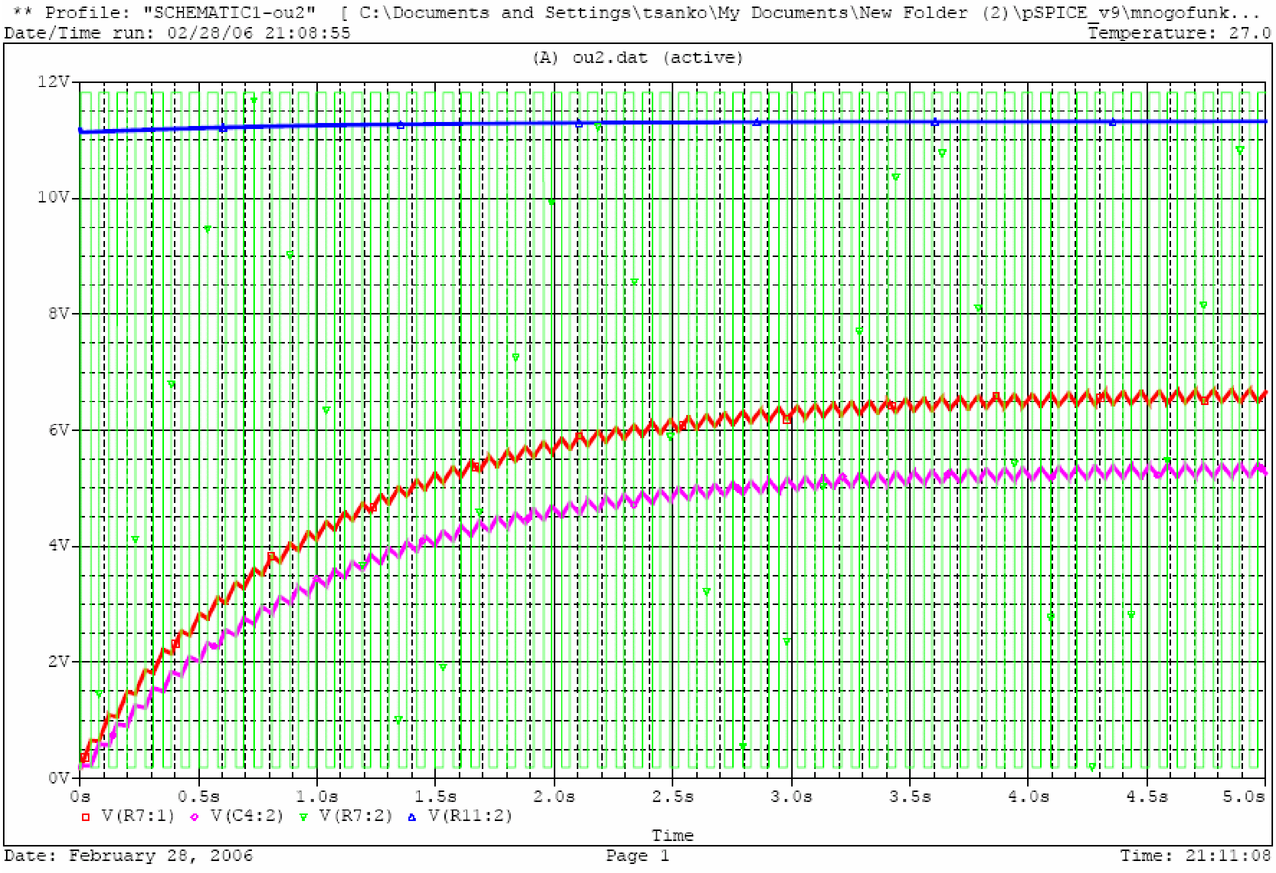

1000
900
800
700
600
500
400
300
200
100
0
f,Hz
0
1
2
3
4
5
6
7
E,lx

Fig.3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Date/Time run: 02/28/06 21:08:55
Temperature: 27.0
(A) ou2.dat (active)
12V
10V
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4.0s
4.5s
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V(R7:1) V(C4:2) V(R7:2) V(R11:2)
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Fig.4

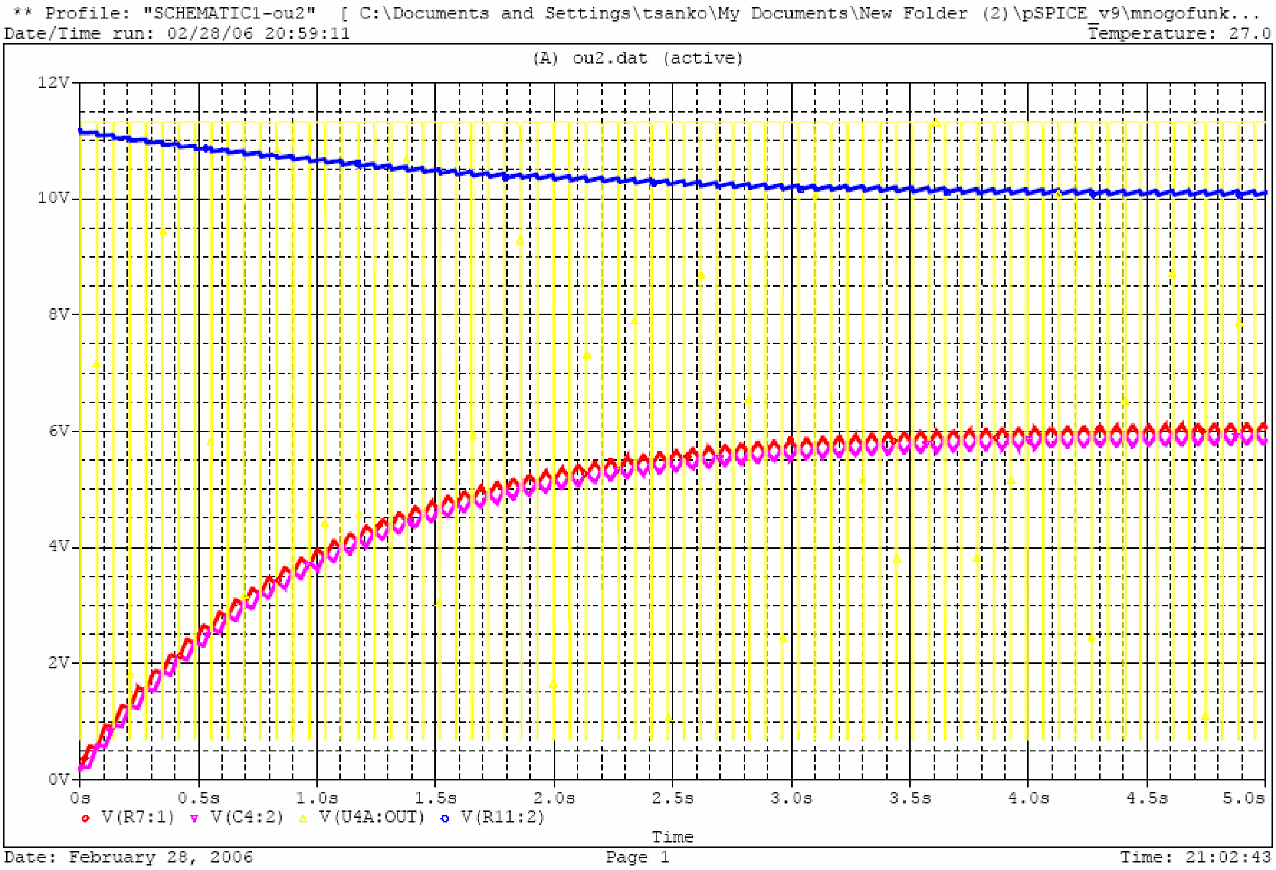

Fig.5

$\tau \approx R3.C3 = 0.7.100.10^{3}.10.10^{-6} = 1s$

The outputs 5 and 6 can respond to very small illumination differences between the photodiodes VD1 and VD2, thus the oscillator can be applied in precise positioning systems. The circuit output time charts, obtained via computer modeling, are shown on figures 2, 4 and 5.

2. CONCLUSIONS

The multifunction oscillator can be also applied in the construction of photometers (luxmeters) for measuring illumination or difference between two illuminances. The circuit can be as well adopted in the systems for couple pairing of photodiodes with the most similar parameters, which diodes then can be used in the construction of differential or coordinate-dependent photodetectors.

3. REFERENCES

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