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Modified optical OR and AND gates

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Abstract. This paper deals with optical OR and AND gate, using unijunction transistor (UJT), light emitting diode (LED), and photo-resistor (LDR). Effort is made to extend the development of the gates using UJT, LDR, and LED to work at 1.8 V_{dc} instead of 3 V_{dc}. The power dissipation is approximately 2 mW. These optical gates find application in the field of instrumentation, optical logic isolators, and fiber optics systems where intrinsic safety is of prime importance rather than speed of operation.

Keywords: bistability, intrinsic safety, low speed.

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1. Introduction

In the last few years attempts[1-4] have been made towards study and development of fundamental optical gates. Recently, great interest is being taken in developing various optical systems[6] that provide bistability, because of their practical application in the field of fiber optics and other instrumentation system.

The most recent development[5] is OR, AND, NOT, NAND, and NOR gates using photoresistor and light emitting diode working at 3 V_{dc}. In this paper, effort is made to extend the development of these gates using UJT, LED, and LDR to work at 1.8 V_{dc}. These gates are intrinsically safe and can be used for monitoring of data in hazardous environments such as petroleum industry, chemical industry, fertilizer industry, and underground coalmines [6].

The UJT used is 2N2646. The LDR dark resistance is 150 MΩ, and no-dark resistance is 10 KΩ, Logic 1 and Logic 0 are represented by LED on and LED off.

2. Optical NOT

Fig. 1 shows the circuit diagram of optical NOT with input having optical power OP_i. The photoresistor LDR is connected in series to UJT emitter and the power supply $+V_{dc}$ to the base B_2 through a pair of resistances R_{21} and R_{22}. The pair is selected as to provide required voltage/current to the UJT and LED. The approximate values of R_{21}, R_{22}, R_{11}, and R are taken as 100 Ω, 510 Ω, 4.6 KΩ, and 10 Ω with $+V_{dc}$ equal to 1.8 V_{dc}. Optical output OP_0 of NOT occurs only when the input OP_i is low, thus satisfying the condition, $OP_0 = OP_i$.

2. Optical OR

Fig. 2 shows the circuit diagram of optical OR with input having optical power OP_{i1} and OP_{i2}. The LDR_1 and LDR_2 are connected in parallel to the UJT_1 emitter and the power supply $+V_{dc}$ to the base B_2 through a pair of resistances R_{21} and R_{22}. The pair is selected to provide required voltage /current to the UJT's and LED's. The approximate values of R_{21}, R_{22}, R_{11}, and R are taken as 100 Ω, 510 Ω, 4.6 KΩ, and, 10 Ω with $+V_{dc}$ equal to +1.8 V_{dc}. Optical output OP_0 of OR will not occur when both the inputs OP_{i1} and OP_{i2} are low. Thus, satisfied is the condition $OP_0 = (OP_{i1} + OP_{i2})$.

4. Optical AND

Fig. 3 shows the circuit diagram of optical AND with input having optical power OP_{i1} and OP_{i2}. The LDR_1 and LDR_2 are connected in series to the UJT_1 emitter and the power supply $+V_{dc}$ to the base B_2 through a pair

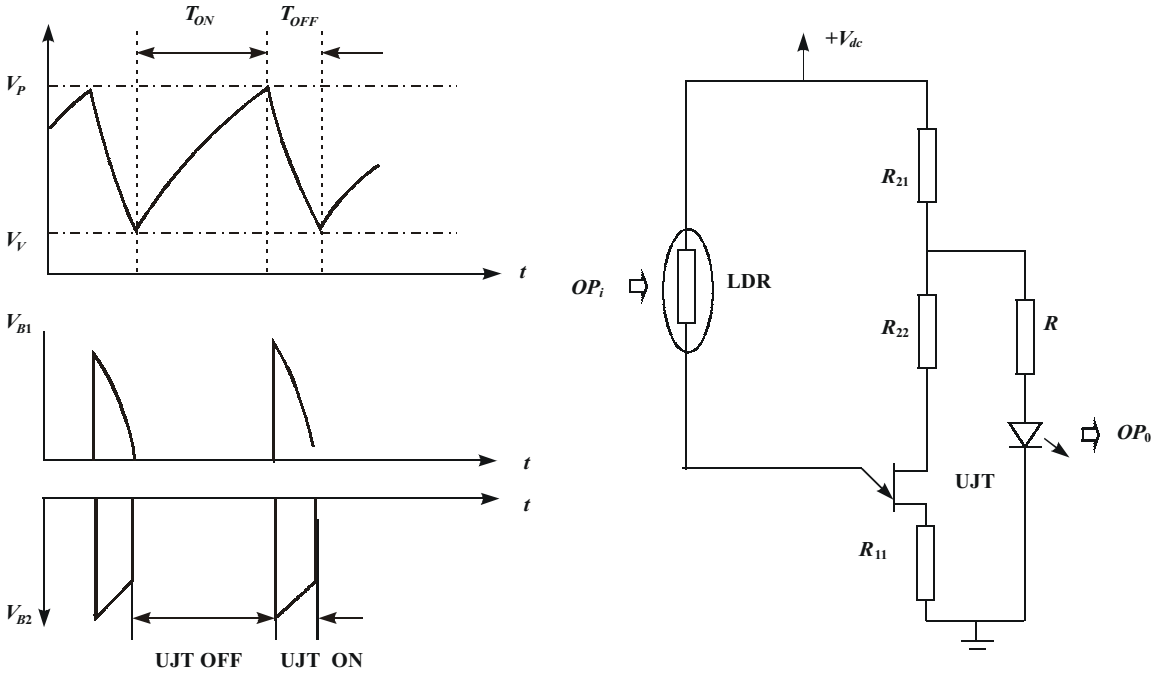
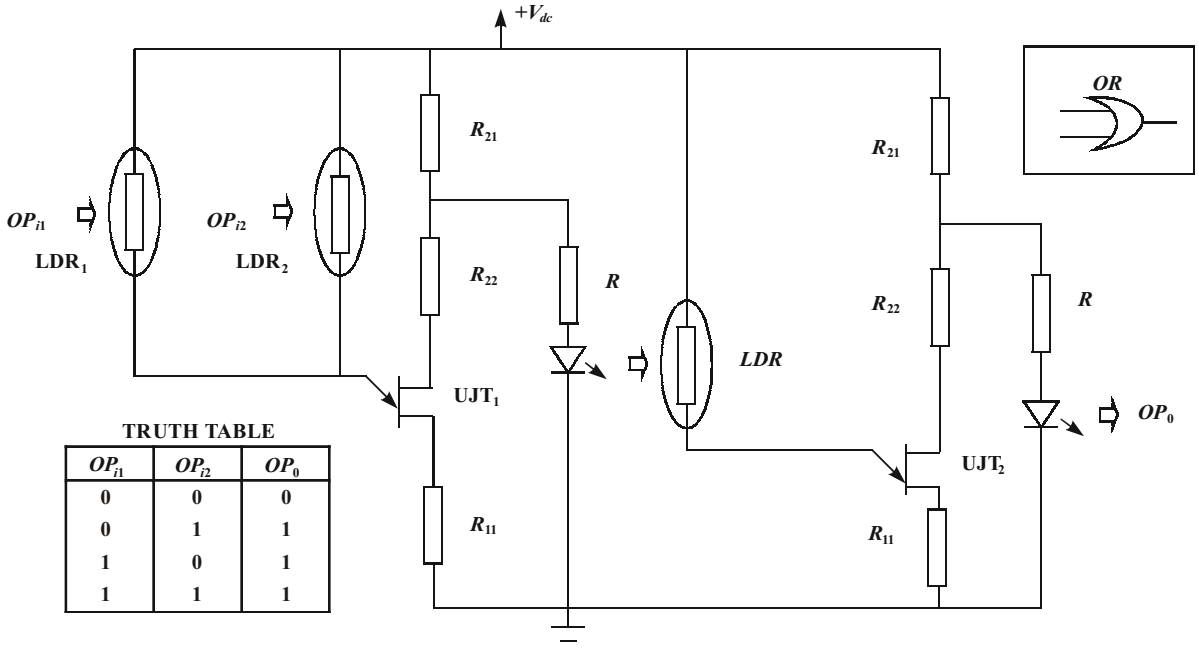


Fig. 1. Optical NOT



TRUTH TABLE

OP_{i1}	OP_{i2}	OP_0
0	0	0
0	1	1
1	0	1
1	1	1

Fig. 2. Optical OR

of resistances R_{21} and R_{22}. The pair is selected to provide required voltage /current to the UJT's and LED's. The approximate values of R_{21}, R_{22}, R_{11} and R are taken as 100 Ω, 510 Ω, 4.6 KΩ, and 10 Ω with $+V_{dc}$ equal to +1.8 V_{dc}. Optical output OP_0 of AND will occur only when both the inputs OP_{i1} and OP_{i2} are high, thus satisfying the condition $OP_0 = (OP_{i1} \cdot OP_{i2})$.

The power dissipation is approximately 2 mW, which is well below intrinsic safe region of highly flammable gases. Fig. 4 shows the experimental curve for LDR resistance against the output voltage.

These circuits though not fast, but finds useful in hazardous environment, where speed is not important. Some of the applications are monitoring system[7] of CH_4 and CO_2 in underground coalmine, ethylene and acetylene

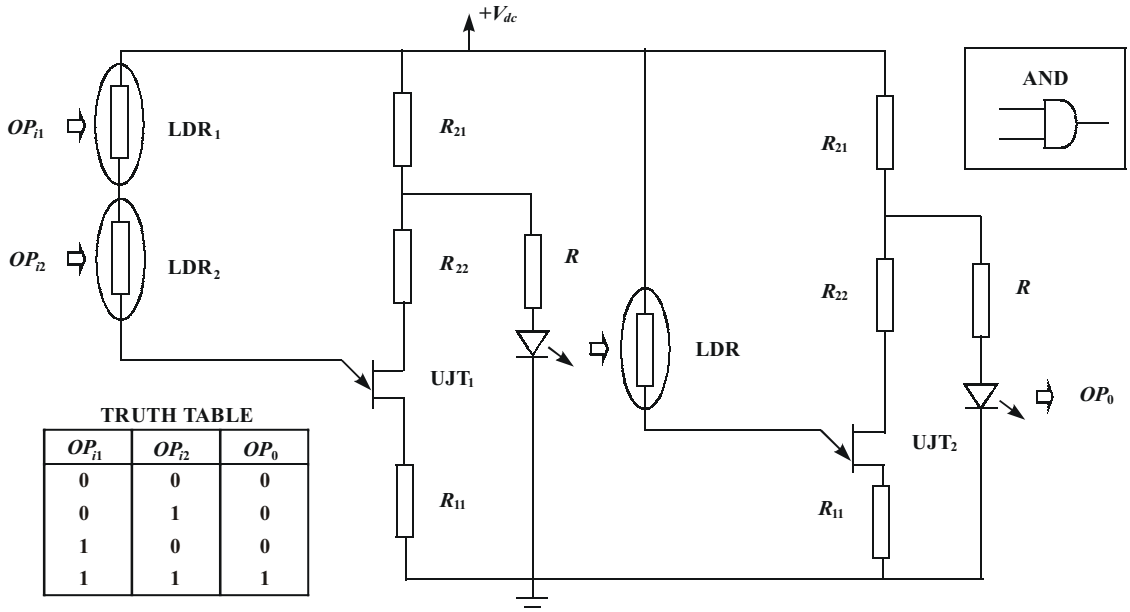


Fig. 3. Optical AND

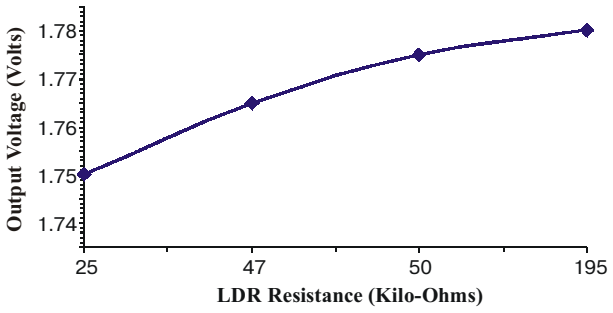


Fig. 4. Output voltage vs LDR resistance

monitoring system in petrochemical industry, monitoring of different hydrocarbons, and gases like NO_X, SO_2 and CS_2 in chemical, pharmaceutical cosmetic, and fertilizer industry[1, 6].

5. Conclusions

Optical OR and AND were realized successfully using UJT, LED, and LDR working at 1.8 Volts. Fiber optic systems and other areas mentioned above can employ these optical gates for their intrinsic safety, because of low power dissipation. These are incapable as elements in integrated structure. Other gates, multiplexers, and demultiplexers can be established similarly.

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