THE NATIONAL INSTITUTE OF ENGINEERING

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Analog CMOS IC Lab Project [EC3L01] – III Semester

Report on

LIGHT SENSOR CIRCUIT USING MOSFET AND LDR

under the guidance of

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ABSTRACT

The light sensor is a passive device that converts the “light energy” whether visible or in the infra-red part of the spectrum into an electrical signal output. Light sensors are more commonly known as “Photoelectric Devices” or “Photo Sensors” because they convert light energy (photons) into electricity (electrons). In this Light Sensor Circuit we are using LDR to vary the gate voltage of the MOSFET which in turn varies the drain current flowing through the LED connected in series with the drain terminal.

CONTENTS

INTRODUCTION

In this light sensor circuit we are using LDR to vary the gate voltage of the n-MOSFET. A light dependent resistor works on the principle of photoconductivity. Photoconductivity is an optical phenomenon in which the materials conductivity is increased when light is absorbed by the material. LDR's are light dependent devices whose resistance is decreased when light falls on them and that is increased in the dark. When a light dependent resistor is kept in the dark, its resistance is very high. This resistance is called as dark resistance.

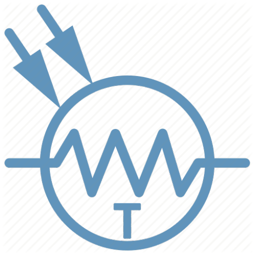

Fig.1 **LDR symbol**

The MOSFET(Metal-Oxide-Semiconductor Field-Effect Transistor) used here is IRFZ44N. The IRFZ44N is a n-channel MOSFET with a high drain current of 49A and low R_{DS} value of 17.5 mΩ. It also has a low threshold voltage of 4V at which the MOSFET will start conducting. We have built a voltage divider circuit in which the gate voltage is given by $VG = VDD * (R2)/(R1/R2)$.

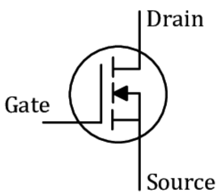

Fig.2 **n-MOSFET symbol**

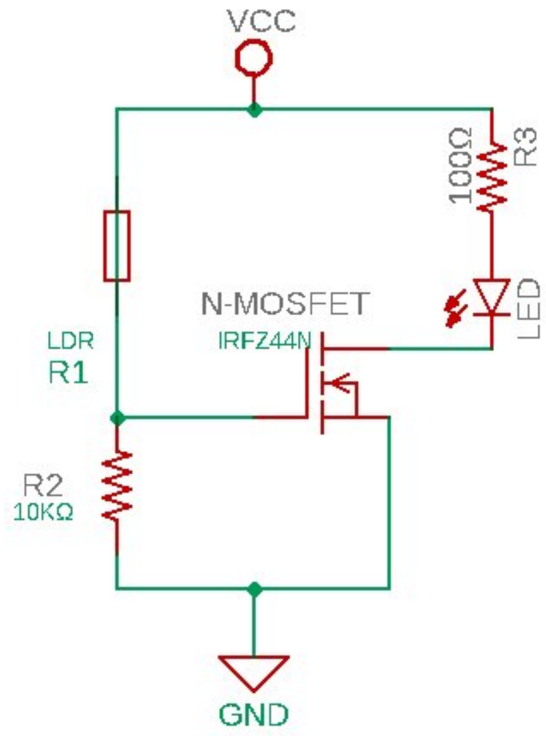

Fig.3 **LIGHT SENSOR SCHEMATIC**

A voltage divider circuit is a simple circuit which turns a large voltage into a smaller one. Using just two series resistors and an input voltage, we can create an output voltage that is a fraction of the input. The LDR is used as R1 resistor and the R2 resistance value is fixed. The supply voltage gets divided between the two resistors which appears as the gate voltage. The LDR is used to vary the input voltage into the gate, as the light intensity falling on the LDR increases, the resistance decreases causing the voltage across the gate terminal to increase. The voltage divider formula is $VG = (VDD * R2)/(R1 + R2)$ where V_{DD} is the voltage of the supply and R1 is the resistance value of LDR. The supply voltage given here is 5V. The resistance value of R2 is 10KΩ.

This circuit is built such that when light level increases the LED glows. The LDR and R2 resistor can be swapped around so that when light intensity decreases the gate voltage increases which will increase the drain current.

RESULT AND ANALYSIS

In n-MOSFET, the drain current flows from source to drain only when the gate to source voltage(V_{GS}) is greater than Threshold voltage(V_T). The calculated V_T of IRFZ44N is 3.6V. This means gate voltage must be greater than 3.6V for the drain current to flow through the LED. The condition where $V_{GS} > V_T$ is known as saturation region. If $V_{GS} < V_T$ then it is known as cut-off region. The LED glows only when MOSFET is in Saturation region.

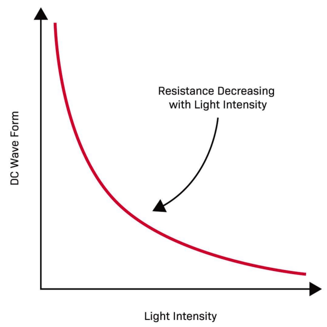

Fig.4 **Variation of LDR resistance with intensity of light.**

When the flashlight is brought near the LDR, its resistance value becomes 1.2KΩ and the gate to source voltage becomes 4.46V. Since V_{GS} is greater than V_T, the MOSFET goes into saturation region. Therefore the drain current flows through the LED, making it glow. The LED becomes dimmer as we take the flashlight away from LDR. When there is no light falling on the LDR, its resistance becomes 30KΩ and V_{GS} becomes 1.25V . Here V_{GS} is less than V_T indicating that MOSFET is in cut-off state and no current flows through the LED. The LED becomes brighter as we take the flashlight nearer to the LDR.

Table 1 Comparison V(GS) and R(LDR)

INTENSITY OF LIGHT	RESISTANCE OF LDR	GATE-SOURCE VOLTAGE
HIGH	1200 Ω	4.46 V
LOW	30 KΩ	1.25 V

Under room conditions, the drain current of MOSFET varies with LDR resistance as shown in Fig.5. The blue curve indicates drain current and red curve indicates LDR resistance.

Between the time interval 659 to 830 the LDR resistance is high so the drain current is low. And in the time interval 830 to 880 the LDR resistance is low which makes drain current high.

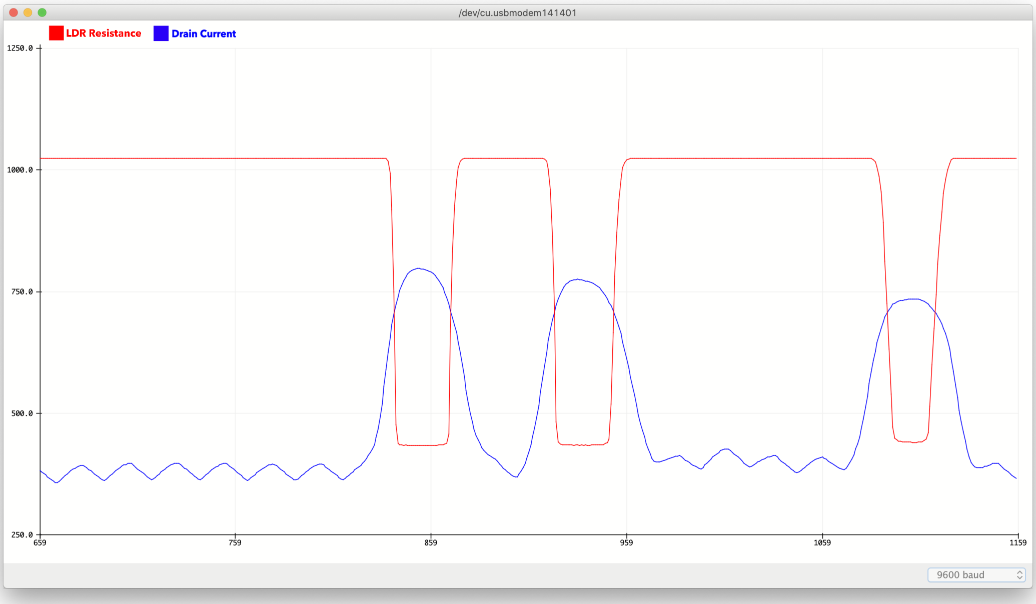

Fig.5 **Variation of I_D and R_{LDR}**

Fig.6 shows the variation of drain current with LDR resistance. When the resistance is low drain current becomes 10.65mA. As the intensity of light decreases the RLDR increases and drain current decrease gradually to zero.

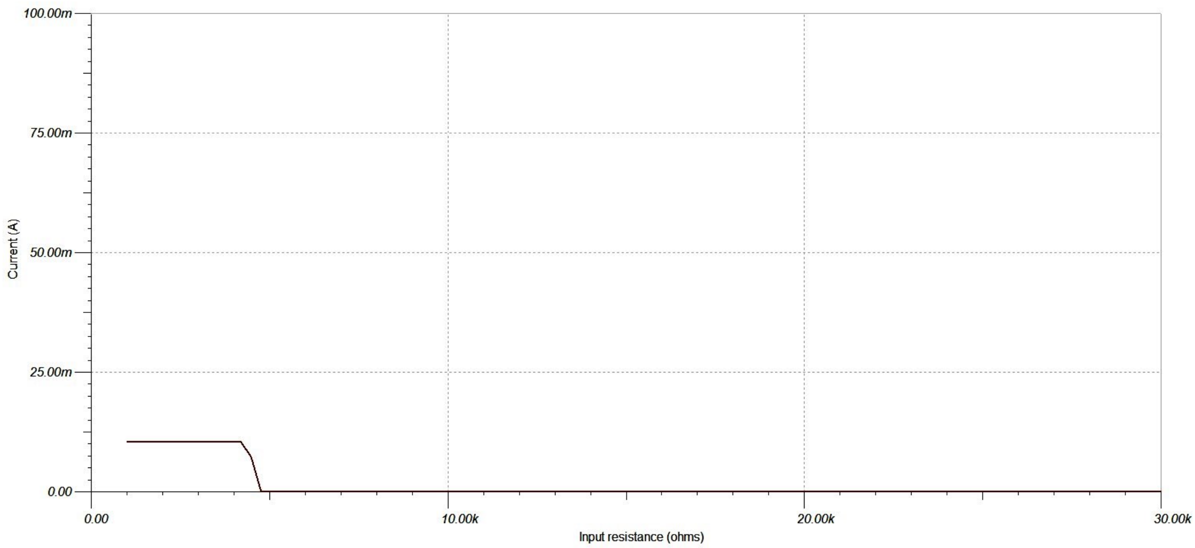

Fig.6 **Drain Current** vs **LDR Resistance**

CONCLUSION

The light sensor circuit implemented here is based upon voltage divider circuit of the MOSFET. In this circuit we can see how the gate voltage depends upon the series resistors used and how the drain current varies with gate voltage. The drain current is dependent on gate voltage only. So the MOSFET is known as voltage controlled device. The light sensor circuit with some modification can be used in alarm systems, street light controller, automatic contrast and brightness control in television receivers.

BIBLIOGRAPHY

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[2] Light Sensor Circuit "https://www.instructables.com/id/Sensor-circuits-with-a-MOSFET/"

[3] IRFZ44N Datasheet "https://www.alldatasheet.com/datasheet-pdf/pdf/614121/NJSEMI/IRFZ44.html"

APPENDICES

Simulation nodal voltages and characteristic graphs can be found at "http://bit.ly/light_sensor_simulations"

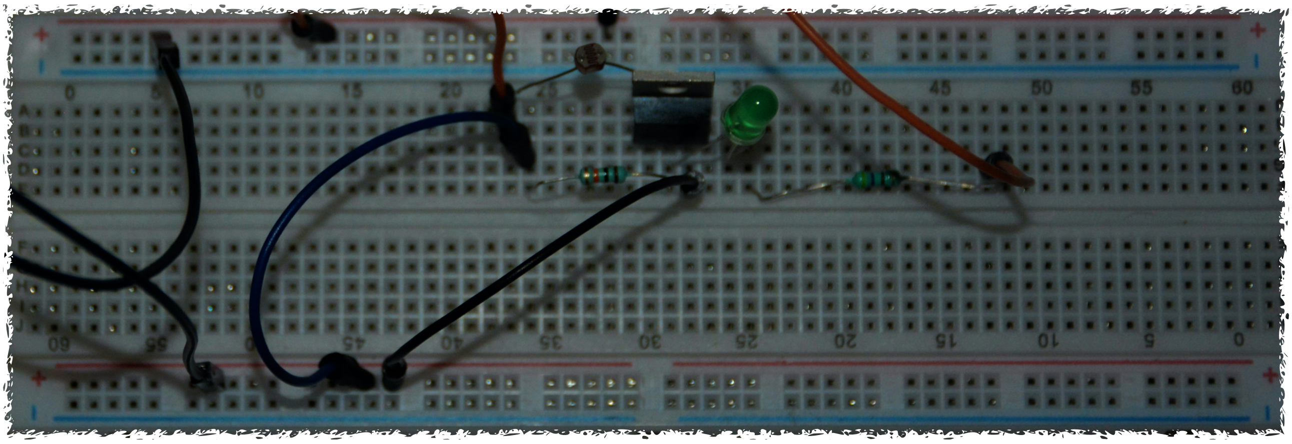

Fig.7 **Response of circuit for less intensity of light falling on LDR**

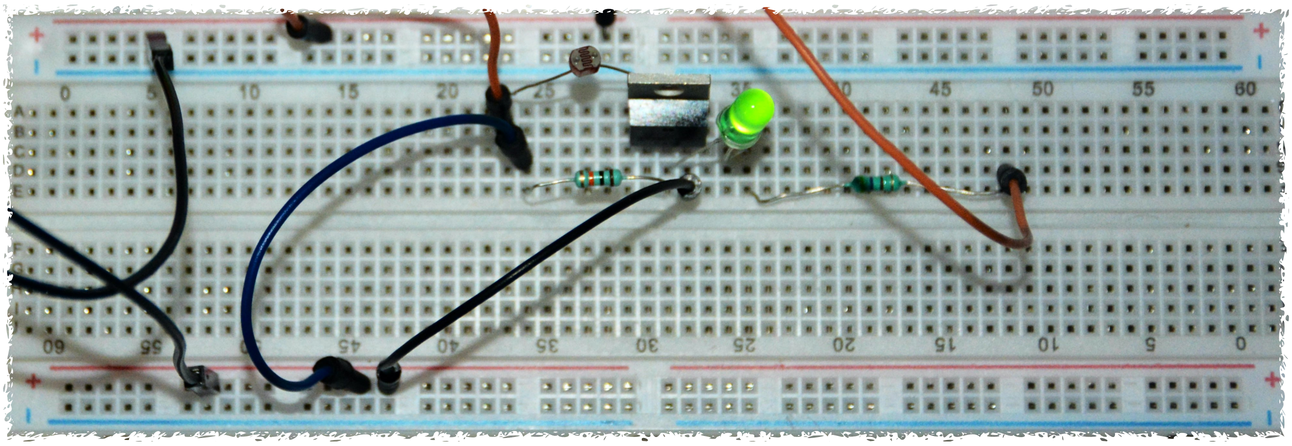

Fig.8 **Response of circuit for high intensity of light falling on LDR**