A Practical Approach of Designing Infrared Controlled Thermometer

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Abstract- **Infrared Controlled thermometer is a non-contact temperature measurement device. The main focus of the project is to develop hardware specified design to support the infrared environment; where at the receiver end we shall be able to find the ambient temperature of that particular place. In this project the infrared ray projected from the transmitter activates the phototransistor. The signal derived from the phototransistor is amplified and decoded. This processed signal puts the relay ON. The output from the relay makes the temperature sensor operational which gives an output in form of DC voltage which is equivalent to the ambient temperature in degree Celsius. The transmitter can operate within a range of 2-6 meters.**

Keywords: **Amplification, Infrared, Signal, Thermometer, Wavelength.**

I. INTRODUCTION

Infrared (IR) radiation is electromagnetic radiation of a wavelength longer than that of visible light, but shorter than that of microwaves. The name means "below red" (from the Latin infra, "below"), red being the color of visible light with the longest wavelength. Infrared radiation has wavelengths between about 750 nm and 1 mm, spanning five orders of magnitude. Humans at normal body temperature can radiate at a wavelength of 10 microns.

An infrared thermometer is a non-contact temperature measurement device. Infrared Thermometers detect the infrared energy emitted by all materials -- at temperatures above absolute zero, (0°Kelvin) -- and converts the energy factor into a temperature reading. The most basic design consists of a lens to focus the infrared (IR) energy on to a detector, which converts the energy to an electrical signal that can be displayed in units of temperature after being compensated for ambient temperature variation. This configuration facilitates temperature measurement from a distance without contact with the object to be measured. As such, the infrared thermometer is useful for measuring temperature under circumstances where thermocouples or other probe type sensors cannot be used or do not produce accurate data for a variety of reasons. Some typical circumstances are where the object to be measured is moving; where the object is surrounded by an EM field, as in induction heating; where the object is contained in a vacuum or other controlled atmosphere; or in applications where a fast response is required.

II. RELATED WORK

In this project the infrared ray projected from the transmitter activates the phototransistor. The signal derived from the phototransistor is amplified and decoded. This processed signal puts the relay ON. More precisely the block structure of Infrared Controlled Thermometer is given below:

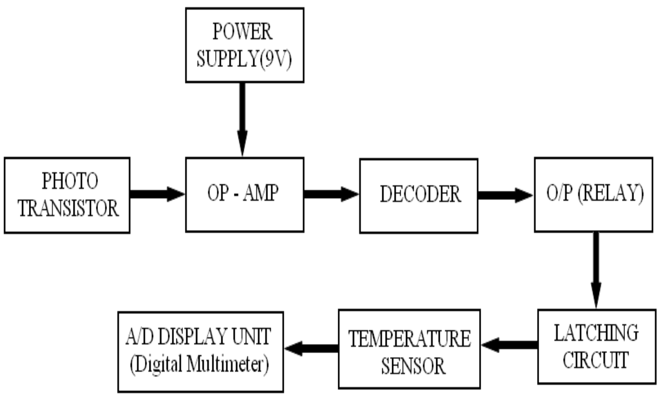

Figure: 1 Block structure of Infrared Controlled Thermometer

The output from the relay makes the temperature sensor operational which gives an output in form of DC voltage which is equivalent to the ambient temperature in degree Celsius. The transmitter can operate within a range of 2-6 meters.

A. POWER SUPPLY

From the block diagram we can see that at first a DC circuit has been designed which can supply operating range of 9V-12V power supply. 9 V power Supply is directly fetched to operational amplifier which is primary part of the receptor circuit. The power supply mainly used to make the receptor circuit ON. The Circuit diagram of power supply can be viewed as below:

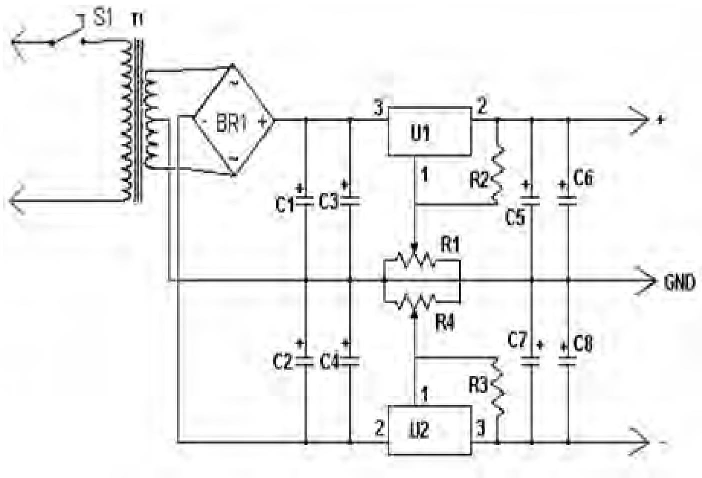

Figure: 2 Circuit Diagram of 12V DC variable dual power supply

B. LATCHING CIRCUIT

Now the relay gets ON when the infrared radiation is projected but it gets OFF as soon as the infrared projection is withdrawn thus making the toggling of any future application impossible.

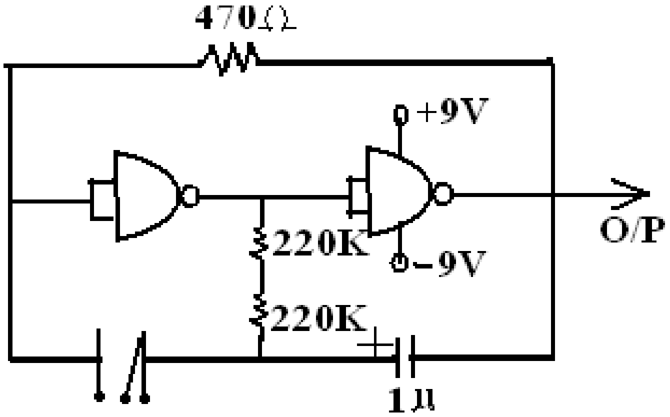

Figure: 3 Latching Circuit

So in order to toggle the circuit for future use a latching circuit consisting of NAND gates is put into use. Thus the latching circuit works as a flip-flop. So when the relay is ON the latching circuit continues to be in the ON state unless and until the relay gets OFF. In the OFF state of the relay the latching circuit stays OFF.

The output signal from Pin 4 of IC 4011 is supplied to the enable pins 5 and 6 of IC 4016. As IC 4016 is a switching IC, the signal from Pin 5 activates the switches 3 and 4 of IC 4016 thus putting the green LED on. This indicates a continuous current supply to the temperature sensor.

Another part of the output from the IC 4011 is directed to the enable pin 6 that actually activates the switches 8 and 9 making the temperature sensor operational.

C. RECEIVER CIRCUIT

The circuit works in two states. It is in the ON state in the presence of infrared radiation and switches to the OFF state when the projection of infrared radiation is withdrawn.

OFF State-Current from terminal A flows through resistor R1 and is triggered by capacitor C1 before making its way to the inverting pole (pin2) of the Op-Amp.

The IC-741 is being used here as an inverting operational amplifier. So in this case:

- Pin 3 is grounded.
- Pin 4 is supplied with -9V.

- Pin 7 is supplied with +9V.
- A negative feedback from Pin 6 is sent back to Pin 2.

Final output,

V_O From Pin 6 = - (R3/R2)V_i.

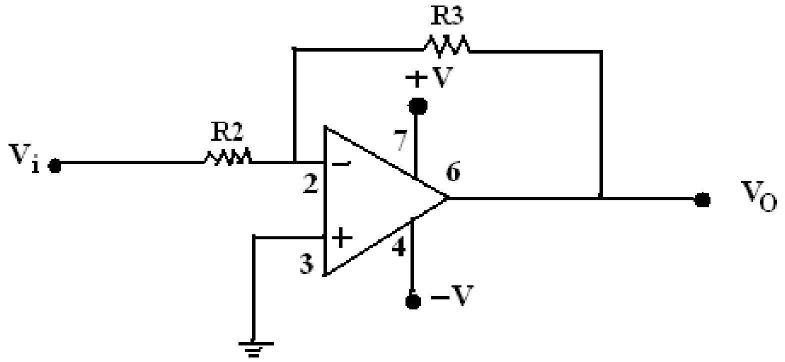

Figure: 4 Inverting Amplifier

As V_i is high, the output V_O which is also in the high state energizes the tone decoder LM 567. Now the output (Pin 8) which is connected to the potential difference between the input and the output terminals of the relay is zero.

ON State-Due to the presence of infrared radiation, a positive pulse is projected on the base of the NPN photo-transistor which in turn allows the flow of current from the collector to the emitter. As a result of which V_i and V_O is low. As the output of the tone decoder also turns out to be low due to a low input it puts the relay on under a potential difference of 9V.

D. TRANSMITTER CIRCUIT

The design of transmitter circuit is based on the concept of “Darlington Pair.” In electronics, the **Sziklai pair** (also known as a "compound transistor") is a configuration of two bipolar transistors, similar to a Darlington pair. In contrast to the Darlington arrangement, the Sziklai pair has one NPN and one PNP transistor. Hence, it is sometimes called the "complementary Darlington". Current gain is similar to that of a Darlington pair, being the product of the gains of the two transistors. The configuration is named for its inventor George C. Sziklai.

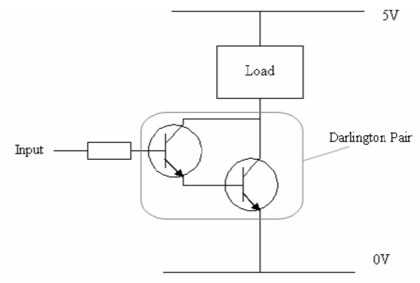

Figure: 5 Darlington Pair Circuit

A Darlington Pair is two transistors that act as a single transistor but with a much higher gain. The circuit diagram of transmitter circuit is given below:

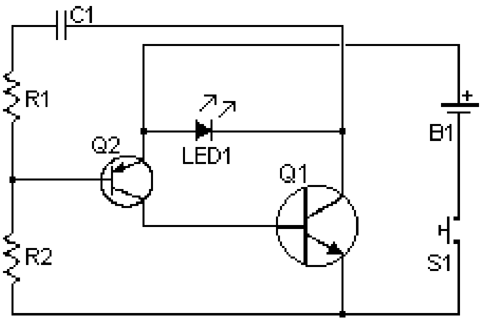

Figure: 6 Transmitter Circuit

One advantage over the Darlington pair is that the base turn-on voltage is only about 0.6V (compared to about 1.2V). Like the Darlington, it can saturate only to 0.6V, which is a drawback for high-power stages.

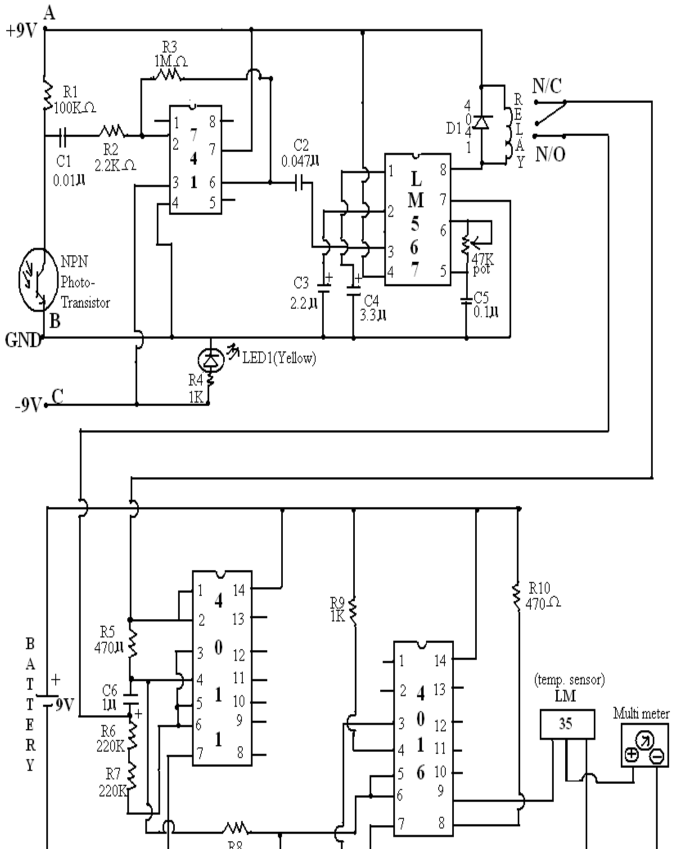

Figure: 7 Circuit Structures of Receptor and Temperature Sensing Block

III. RESULT AND CONCLUSION

The most basic design consist of a lens to focus the infrared (IR) energy on to a detector which converts an energy to an electrical signal that can be displayed in units of temperature after being compensated for ambient temperature variation. This configuration facilitates temperature measurement from a distance without contact with the object to be measured. [4]

With the help of infrared transmitter and receiver we can almost get an idea about the temperature of a particular place by operating the temperature sensor from a particular distance depending upon the range of the transmitter. As such, the infrared thermometer is useful for measuring temperature under circumstances where thermocouple or other probe type sensors cannot be used or do not produce accurate data for a variety of reasons.

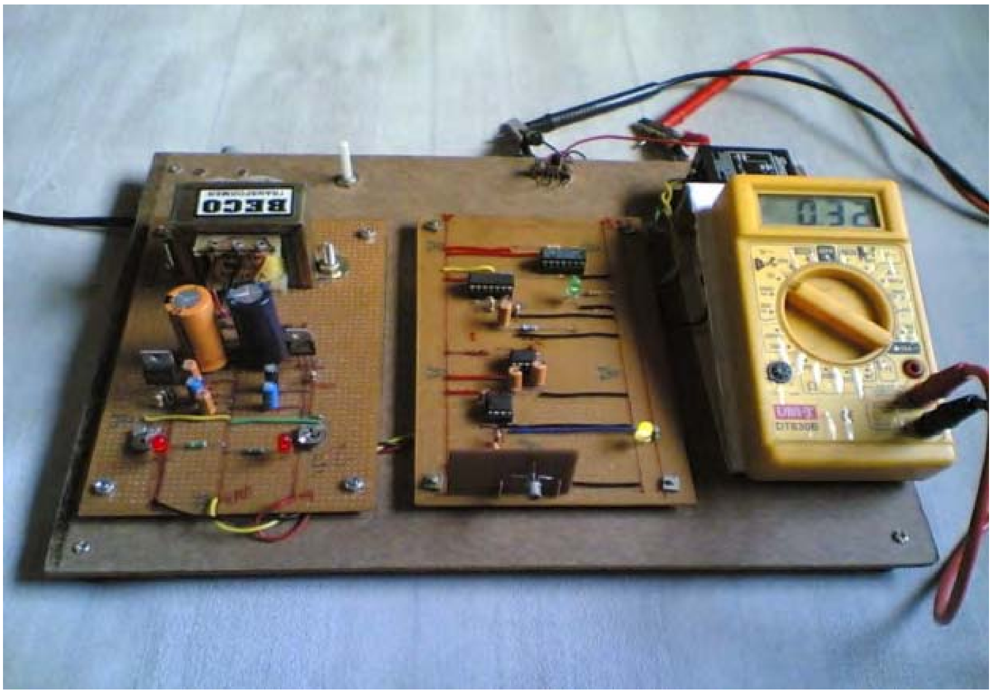

Figure: 8 Final Designed Receiver Circuit

Fig. No. - 8 shown above is the final hardware design of Infrared Controlled Thermometer. The transmitter can operate within a range of 2-6 meters. The output comes in form of DC voltage which is equivalent to the ambient temperature in degree Celsius. The reading in the Voltmeter, 0.32 specifies 32 degree Celsius. Every Circuit like transmitter, receiver and power supply works fine under desired circumstances.

IV. ACKNOWLEDGMENT

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V. REFERENCES

[1] "Thermographic analysis of the central office power plant-a tool for the maintenance engineer", Telecommunications Energy Conference, 1990. INTELEC '90., 12th International, McMenamin, D.P. Bell Atlantic Corp., Philadelphia, PA, USA **Page(s):** 487 – 489

[2] "Development of testers for indication of infraredradiation", Kolev, I.S.; Stoeva, I.S. Volume: 3, Digital Object Identifier: 10.1109/ISSE.2004.1490853, Publication Year: 2004 , Page(s): 448 - 450 vol.3

[3] "Development of a new infrared imaging system: aninfrared image superimposed on the visible image", Fujimasa, I.; Kuono, A.; Nakazawa, H. Engineering in Medicine and Biology Society, 1998. Proceedings of the 20th Annual International Conference of the IEEE Volume: 2, Publication Year: 1998 , Page(s): 950 - 952 vol.2

[4] Work cited from "www.omega.com/prodinfo/infraredthermometer.html"

VI. ABOUT THE AUTHOR

ANUJ SHAW received the B.Tech degree in Electronics & Instrumentation Engineering from West Bengal University of Technology, West Bengal, India in 2008, and the M.Tech degree in VLSI Design from SRM UNIVERSITY, Tamilnadu, India in 2012. He has published two research papers in International Journal. His research areas are in the field of ASIC design of Wireless System and in Low Power VLSI.

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