UNIVERSITI TEKNIKAL MALAYSIA MELAKA (UTeM)

LINEAR MOTION BASED SENSING TECHNIQUES

Thesis submitted in accordance with the partial requirements of the
Universiti Teknikal Malaysia Melaka for the
Bachelor of Manufacturing Engineering (Hons)(Robotics and Automation)

By

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DECLARATION

I hereby, declared this project entitled "**Linear Motion Based Sensing Technique**" is the results of my own research except as cited in references

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Date : May 2008

APPROVAL

This report submitted to the Senate of UTeM and has been accepted as partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Robotics and Automation). The member of the supervisory committee is as follow:

…….

Project Supervisor

May 2008

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DEDICATION

This project and all the works that I have done were dedicated especially to my lovely mother that never stop from giving me advice and make me realize that I can do this project as long I don't give up. I also dedicate this work to my father who support me mentally and financially until the end of my project.

ABSTRACT

In this report, there are explanations on how the sensor can be used to detect a linear motion, thus produce an output (electrical signal) that can be used for many applications whether in the manufacturing industries or daily works. But in this study, the application was focused on the linear motion of a milling machine.

The system for this study should have the capabilities to control the output or in other words have a multiple output. The main idea of this project was when the linear motion becomes faster; the output will be high, and when the linear motion becomes slower or stop, the output would stop. The systems generally have three major parts or sections where the parts were sensing system, processing system, and output system. Sensing system would have sensor to detect the motion, processing system have devices that can vary and stabilizes the output, while the output system have a motor where the motor speed depends on the output of second part. Sensing system must have a very good accuracy in order to give an accurate output. The elements that should have in processing system were good reliability and flexibility while in the output system, the element was high response.

There were many factors need to be considered in designing the system for this project's title such as the resistance, voltage, current (AC/DC) stability, input, output, environment, etc. However, after made some research, the project finally have finished and the objectives have been achieved where the output completely depending on the velocity of the motion as an input.

ABSTRAK

Di dalam laporan ini, terdapat penerangan bagaimana ‘sensor’ digunakan sebagai alat untuk mengesan pergerakan linear, seterusnya membentuk satu aplikasi yang boleh digunakan dalam industri pembuatan atau dalam aplikasi seharian. Di dalam laporan ini, aplikasi dari tajuk ini difokuskan untuk mengesan pergerakan linear mesin ‘milling’.

Sistem untuk projek ini berupaya untuk mengawal hasilnya (dalam bentuk volt) atau dengan erti lain, boleh mengeluarkan keputusan yang pelbagai. Idea utama projek ini ialah apabila kelajuan pergerakan linear bertambah, maka volt yang keluar juga akan bertambah, manakala apabila kelajuan pergerakan linear tersebut berkurangan atau berhenti, maka volt yang terhasil adalah kosong. Secara umum, sistem ini mengandungi tiga bahagian dimana bahagian pertama ialah sistem pengesan, kedua ialah sistem pemprosesan dan ketiga ialah sistem keluaran.

Terdapat banyak factor yang perlu diambilkira dalam membentuk sistem ini, antaranya ialah rintangan, kestabilan arus (AC/DC), input, output, dan persekitaran. Bagaimanapun, setelah membuat kajian, akhirnya projek ini berjaya disiapkan dan semua objektif telah berjaya dicapai dimana output bergantung sepenuhnya kepada kelajuan pergerakan.

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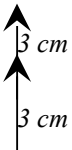


LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

E&E	-	Electric and Electronic
IR	-	Infrared Sensor
DC	-	Direct Current
AC	-	Alternate Current
LVDT	-	Linear Variable Differential Transducer
LVT	-	Linear variable Transducer

CONTENT

CHAPTER 1
INTRODUCTION

1.1 Introduction

Sensors are devices that detect the activity happen around it (environment). A sensor is a type of transducer. Direct-indicating sensors, for example, a mercury thermometer, are human-readable. Other sensors must be paired with an indicator or display, for instance a thermocouple. Most sensors are electrical or electronic, although other types exist. Sensors are used in everyday life. Applications include automobiles, machines, aerospace, medicine, industry and robotics. Technological progress allows more and more sensors to be manufactured on the microscopic scale as microsensors. In most cases a microsensor reaches a significantly higher speed and sensitivity compared with microscopic approaches

1.2 Background of Problem

There are many machines used linear motion as their movement to operate. From this linear motion, we have made something or produced an output so that the motion will not be wasted. So the idea was to make used of the linear motion and produced some applications from it.

There are many complications in making the project to work, and most of them came from the first and second system, that was sensing system and processing system. For the sensing system, it took a lot of time to find a suitable sensor where almost all electrical shop and internet websites have been explored, just to find the right sensor.

For the processing system, it required a system that can controlled the speed of motor which depends on the output of sensor. There are many ways have been thought to settle this problem such as using inverter, pendulum or even electronic circuit clock and relays. But it seems that the most reliable device to be used in this part is by using the Integrated Circuit (IC) circuit in the control system part.

The control system circuit consist of 3 ICs, resistors, capacitors, diodes, transistors and chips like LM 2940 voltage regulators, LM 2917N, LM 3914N. LM 3914N is used to control the dim of the LEDs use in the project while LM 2940 is used as voltage regulators that will fixed the output to 8V even the input voltage vary from 8 to 14 volts. For the LM 2917N, it is used to charge pump the input pulse that come from the detector and turn it into voltage output.

1.3 Objective

The objectives of this project are like below:

- Detect the linear motion speed
- Control the motor speed (output) depends on the linear motion speed.
- The voltage output will vary same as the linear motion speed.
- When the linear motion speed is high, the output also must be high.

The main objective of this report was to make an output that came from linear motion of an object or surface. The voltage output would be higher when the velocity increases and would became lower when the linear motion's velocity decreases. From the linear motion, we could control the motor speed depend on how fast the motion was. Graph below shows the voltage output versus velocity of linear motion.

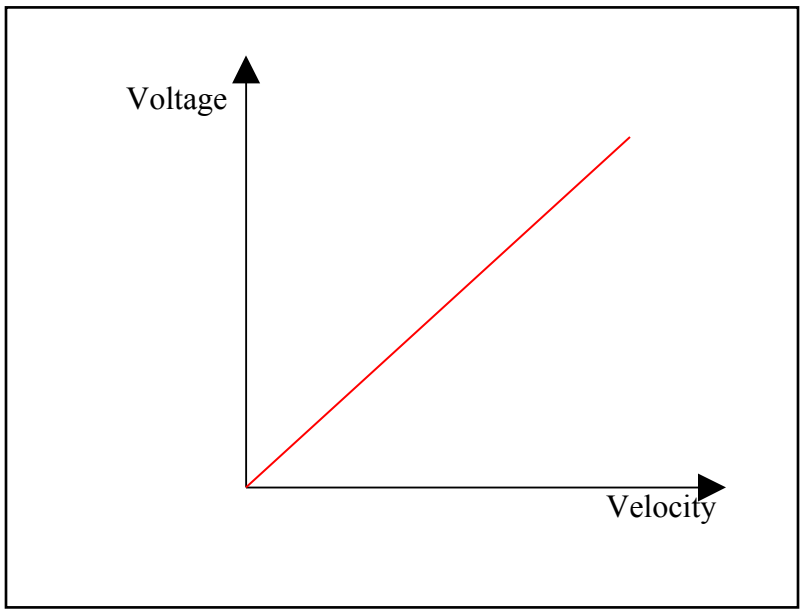


Figure 1.1: Graph Voltage vs Velocity

1.4 Scope

In this project, the final goal was to build a system that could detect the linear motion. Although the task sounded like simple, it's actually consumed a lot of hard work and time in applying the knowledge in both electrical and mechanical. The circuit for controlling the motor speed was manually constructed using the skills gained in electric and electrical (E&E) subject. The sensor used to detect the linear motion was hard to find because the sensor need to be reliable and could coped with the environment. After much research, the method used was by using three IC circuits in the control system part while for the detection, the infrared sensor was used.

1.5 Purpose of Project

This project can be said was a new invention although the sensor was already exists. The application and the system were new and can be extended. It could utilize the unused energy that was the kinematics energy came from linear motion. From the motion, an output could be produced and another application could be done.

1.6 Conclusion

The project's title was linear motion based sensing techniques and in this project, there were three major parts, which were sensing system, processing system (the control system part), and output system. The system was simple but was able to control the speed of motor and also reliable.

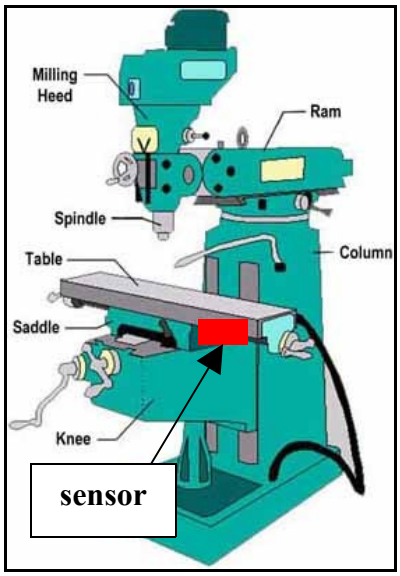
CHAPTER 2
LITERATURE REVIEW

2.1 INTRODUCTION

The rapid development of sensor for example now with computer compatible output signal has been remarkable since sensor being first introduced somewhere in 1970s. The sensor technologies mostly were used in the industry sector where the usage of sensors expends tremendously but nowadays there has been new applications and market sector where new sensor technologies can be applied. This made the demand for sensor increase for years by years.

For linear motion based on sensing techniques, there were sensors nowadays that can be used to measure it but the use of sensors in this section still have a lot of potential to be improved. The linear motions detection also has the capabilities to be applied in many applications such as in industries and in the daily lives. There were so many examples of linear motion in this world such as a moving car with the ground, milling machines, surface grinder, and lathe machine. In this report, the application was focused in applying the system with milling machine. Milling machine table moves horizontally and there was the place where the sensor would be placed to detect the linear motion.

Figure 2.1: Sensor Position at Milling Machine



2.2 How the System Works

As being stated in the abstract section, there were three major parts that consist in this report system, that are sensing system, processing system, and output system. Each of the section plays important role to make the system works and accomplished the objectives of this report.

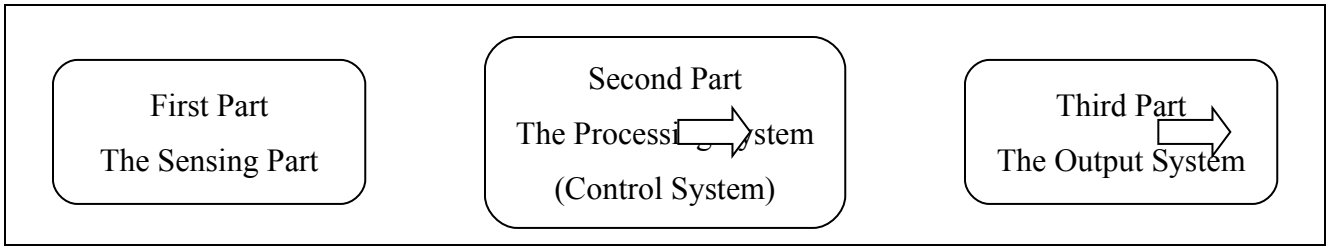


Figure 2.2: Parts in the System

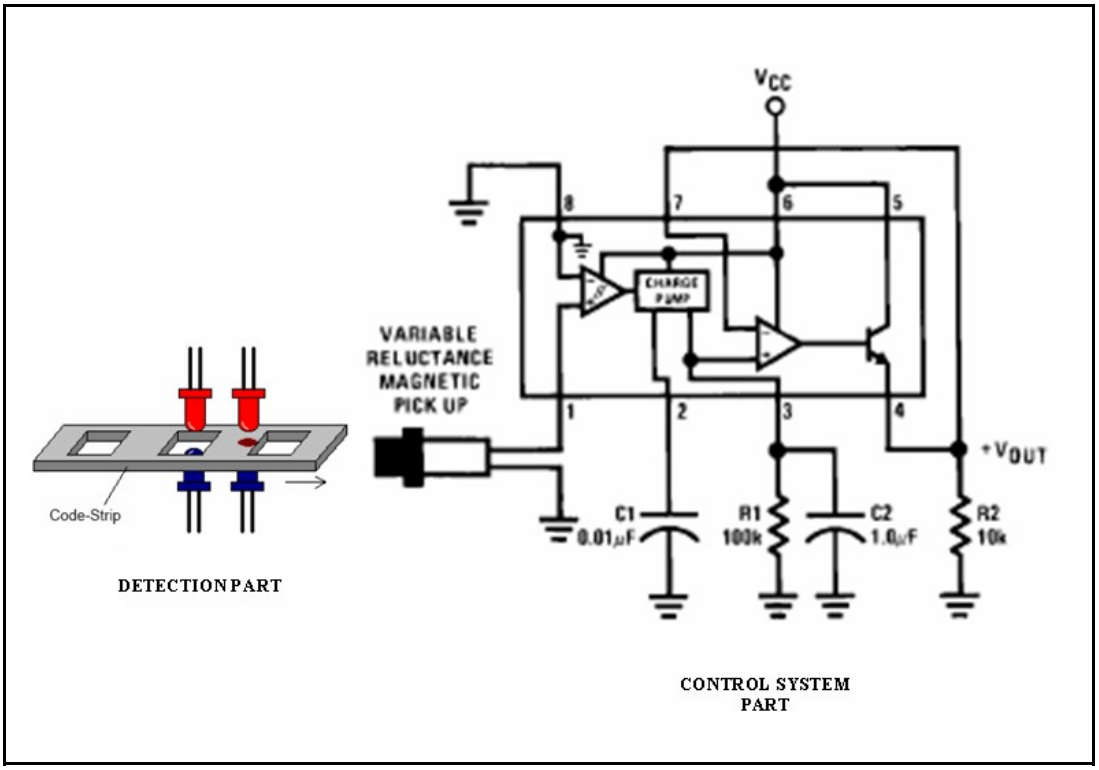


Figure 2.3: The System Circuit

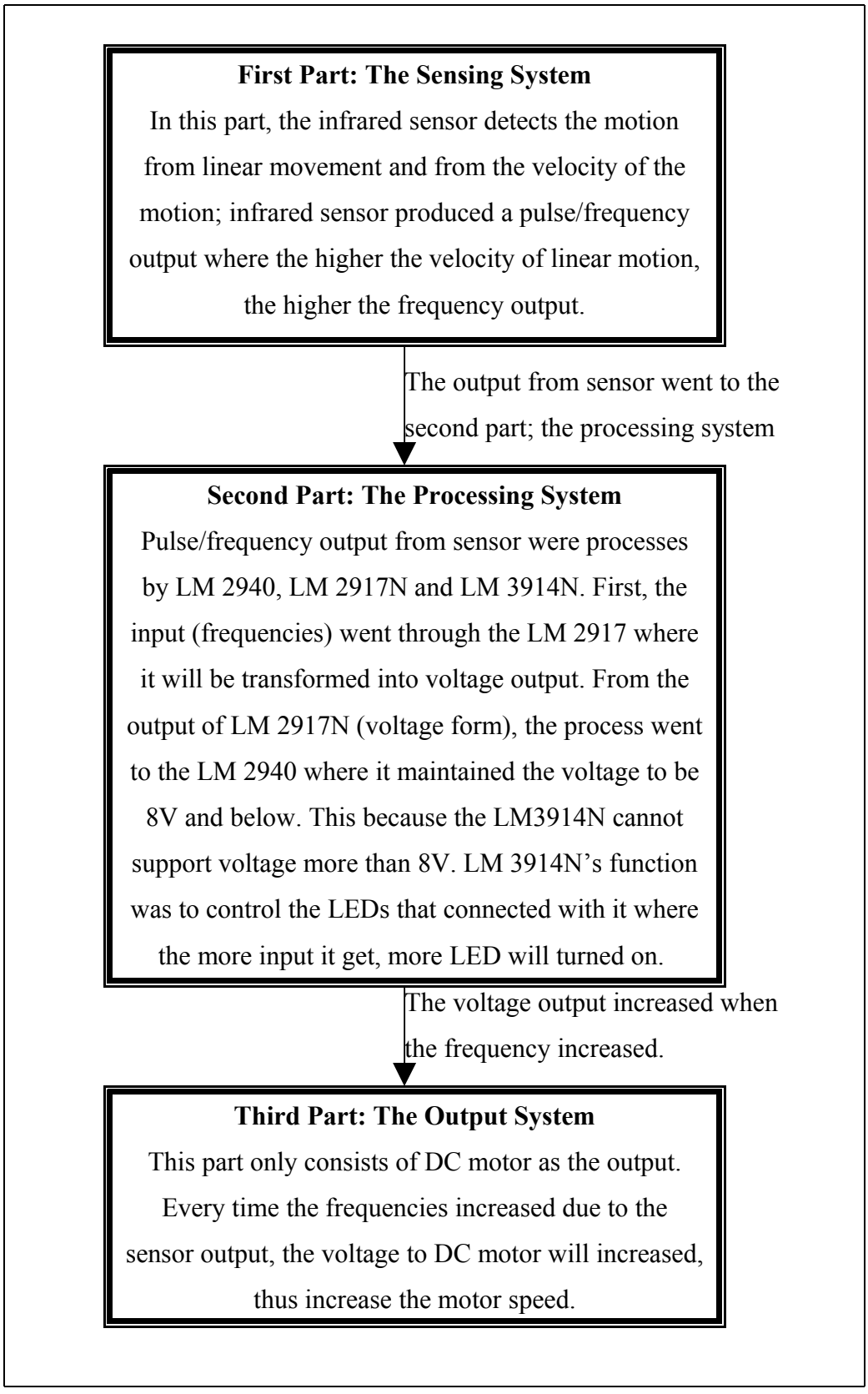


Figure 2.4: The Process Flow

2.2.1 First Part: The Sensing System

In this part, a sensor was used to detect the motion. The output for this sensor depending on the velocity of the linear motion where when the velocity is high, the output will also be high. The Infrared Sensor was used to detect and its output were in the form of frequencies or pulses where its output went through the control system part as an input for the part.

2.2.1(a) Infrared Sensor (IR)

Emissivity is a term used to quantify the energy-emitting characteristics of different materials and surfaces. IR sensors have adjustable emissivity settings, usually from 0.1 to 1.0, which allow accurate measurements. For the emitter, an LED will be used where it will be detected by the sensor.

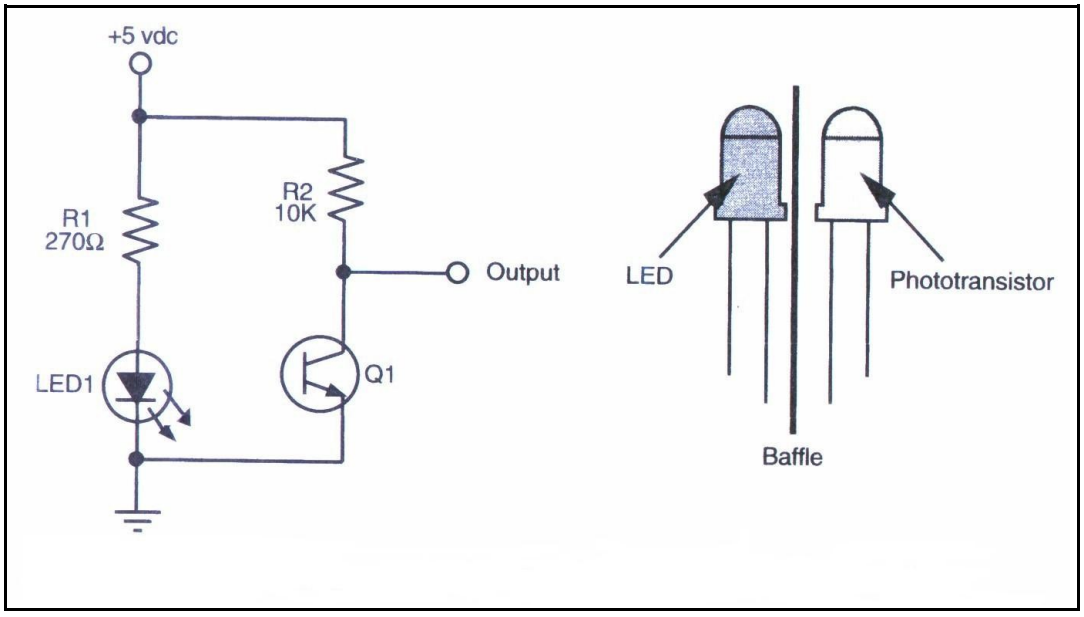


Figure 2.5: Basic design of IR sensor

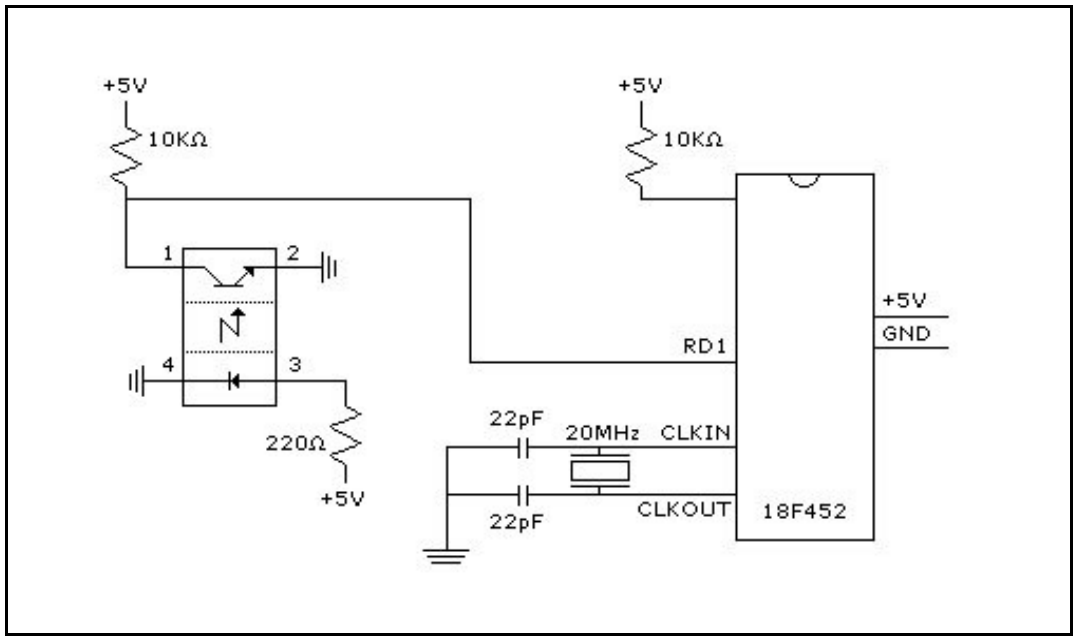


Figure 2.6: The Schematic Connection in IR Sensor

2.2.1(b) Sensor Features

- User-scalable 0/4-20 mA or 0-5 V output
- User-selectable 0/4-20 mA, 0-5 V, J or K thermocouple output

- Local user-interface for sensor programming
    - Optional laser sighting and high resolution optics
- Filed calibration software
- DataTemp MultiDrop Software compatibility
- Programmable relay outputs
    - Bi-directional RS485 communications supports networks of up to 32 sensors