ATTENDANCE FREE PARKING COUNTER USING MICROPROCESSOR AND MAGNETIC SENSOR (HARDWARE)

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This report is submitted in partial fulfillment of the requirements for the award of Bachelor of Electronic Engineering (Telecommunication Electronics) With Honours

Faculty of Electronics and Computer Engineering
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BORANG PENGESAHAN STATUS LAPORAN
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To my dear supervisor
Miss Nurmala Irdawaty Bt Hassan

To my beloved parent
Mr. Md Fazeli Johari & Mrs. Hasnah Sagir

To my brother
Md Fariz Saiful Reza Md Fazeli

And

Fellow friends

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ABSTRACT

This project contains the study of producing a prototype for attendance free parking counter using microprocessor and sensor. The objective is to count a car entering and leaving a parking lot and the amount of available parking space. The study includes on how magnetic field is behaved and how to manipulate the behavior of magnetic field to function as a magnetic field sensor. In addition, the study on the effect of magnetic earth to the magnetic field sensor is also considered into account. Next, the research also contains the mechanism of how the counter will be trigged by magnetic field sensor. The mechanisms which are containing comparator and amplifier are elaborated in this report. Furthermore, the study of assimilation of two magnetic field sensors in single hardware to detect the entering car and leaving car at a parking lot is being elaborated too. Then the way of visualization of output is also elaborated.

ABSTRAK

Projek ini merangkumi kajian untuk membina sebuah sistem mekanisma tempat meletakkan kereta percuma dengan menggunakan mikroprosessor dan sensor. Objektif projek ini ialah untuk mengira kehadiran kereta masuk dan keluar serta jumlah petak meletakkan kereta yang masih kosong dalam sesebuah tempat meletakkan kereta. Ianya merangkumi tentang sifat medan magnet dan cara untuk memanfaatkan sifat medan magnet ini untuk menjadikannya sebagai sensor medan magnet. Kajian tentang kaitan antara medan magnet bumi dan sensor medan magnet ini juga telah dijalankan. Kemudian, ianya juga termasuk mekanisma bagaimana cara sensor medan magnet ini boleh meggerakkan pembilang. Mekanisma penguat dan pembanding juga dijelaskan dalam projek ini. Dalam projek ini, kajian tentang penggunaan dua sensor medan magnet dalam satu litar untuk mengesan kehadiran kereta masuk dan keluar di tempat meletakkan kereta juga dirancang. Kemudian, cara keluaran visual juga dirancang.

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LIST OF ABBREVIATION

AC	-	Attenuated Current
AMR	-	Anisotropic Magneto-Resistive
DC	-	Direct Current
DIP	-	Dual In-line Packaged
GMR	-	Giant Magneto-Resistive
IC	-	Integrated Circuit
JPJ	-	Road Transport Department
LCD	-	Liquid Crystal Display
LED	-	Light Emitting Diode
PCB	-	Printed Circuit Board
PIC	-	Programmable Integrated Circuit
SOIC	-	Small Outline Integrated Circuit
UV	-	Ultra Violet

LIST OF APPENDICES

CHAPTER I

INTRODUCTION

Chapter One focuses on project background, project objectives, problem statements, scope of work, methodology and organization of thesis.

1.1 Project Background

Nowadays there are many new models and type of car produced widely. Almost each family has their own car. The number of their cars depends on family members and their purpose. Based on Road Transport Department (JPJ) portal, there are more than 10 million vehicles registered. By having a car, life is easier especially for working, shopping or hangout without waiting for bus or another public transport.

Parking is the act of stopping a vehicle which it will be left unoccupied for more than a brief time. Huge amount of car needs more parking lots. Parking is an essential component of the transportation system. When vehicle reach the destination, they should find a place to park the vehicle. Parking resources consist of private and public parking garages, lots, and curbside parking. It is very important to locate a space for parking because the vehicle are driven everywhere. Hence, it should stop at everywhere also. It is impossible to have private parking lot at all places for ordinary people. If the particular place is not busy or less vehicle, then the finding of parking lots should be easy. However, if the particular place is busy and has a lot of vehicles, then it will be a hard task to find parking space. Consequently, a driver has to compete with other drivers for a parking space or it is already full, then they should wait for empty parking space.

The attraction of urban development and the increased use of cars have lead to park issues and concerns at many places. Parking problems arise from the moment before visitors enter the perking lot until after they leave the parking lot. These parking problems ranges from user behavior, space utilization, variable and peak demand, engineering design and planning, pricing and parking charges, revenue collection, traffic management, security and safety to environmental and regulatory issues.

Problem occurs when a driver enters a parking lot but no space available. However, it can be frustrated experience if another parking lot also is full at the same time. It is an advantage for a driver to find a parking space knowing the number of available parking space at the parking lot. For drivers who drive to the parking lot those they never been before, it is impossible to predict the available parking lot. They may drive for an hour without getting anything but instead, they have to pay more for fuel consumed on top of that, they are just wasting their valuable time there.

Some parking lot use ticket system to counter the amount of available space. To obtain a ticket, drivers have to pay. Alternatively, some conventional parking counters use barrier gate or weight (bump) to count But the main problems of this method is high cost of weight installation because the road surface need to dug up. In addition, the vehicle have to decelerate to cross the bump or stop before barrier gate.

1.2 Project Objective

This part discusses deeply about the project, problem statement, scope of work, briefly explained about the system operation (methodology) that has been done in this project and organization of thesis.

This project is designed to help drivers to find most available perking space. This project can monitor the number of available space exactly which can give a choice for driver to park. This project also can avoid finding available parking space problems. This project is developed with the following objectives:

a) To built a counting system using microprocessor for counting the number of available space in a parking lot.

b) To design a counter that will decrease the number if the car entering a parking lot and increase if the cars exit from the parking lot.

c) To design a circuit that can detect the car at entrance and exit parking lot.

d) To combine software and hardware in one system.

1.3 Problem Statements

Each trip use car to go anywhere will end up with finding the best place to park the car. Problems in parking facilities always occur because of increasing the number of a car especially at high population area. At peak hour, it is difficult to find empty parking space. Entering a parking lot is not necessarily ensured that there has an empty space to park. Drivers must take time to find available space in parking lot and this situation getting worst when involving multi-storey parking.

Conventional parking lot mostly use barrier gate which actually slowing down the traffic into the parking lot and at the same time will cause a long queue. Large parking spaces make it difficult for driver to determine which area is available, because there have no indicator to give direction for the driver. For installation conventional parking system, the road surface must be dig; the cost of installation process is high.

When design the hardware, the problems is some component is not suitable between coding in PIC and hardware. To analyze the problems needs more time and cost. A lot of error occurs when software part combine to hardware part.

1.4 Scope of Work

The main function of this project is to count the number of available space in parking lot. This project is purposely for a free parking system. This project will produce a prototype. This project can apply either in indoor or outdoor parking lot. The parking lot only for vehicle in this class:

i. Class 1 = Vehicle two axle, three or four tire except taxi.
ii. Class 4 = Taxi.

This main project is divided into two parts, there is hardware and software. The software part using microprocessor will program the up/down counter involving PIC programming using C language and burned in PIC. There have two inputs either will count up or count down. One output as a display to drivers knows the number of available space in parking lot. The hardware part divided into five parts. There is entrance sensor circuit, exit sensor circuit, PIC, display and power supply. This project is using Anisotropic Magneto-Resistive (AMR) sensor to detect the vehicles and Liquid Crystal Display (LCD) as display to show the available space to drivers.

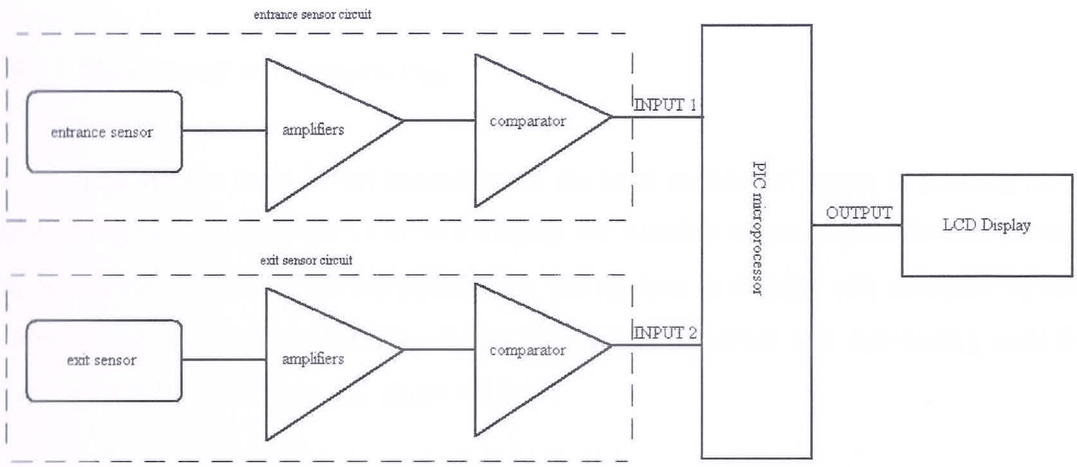

Figure 1.1 Overall circuit of this project

This sensor must only detect a car without detect human or animal pass through it. The sensor in this project are using magnetic field sensor combined with instrument amplifier will gain the signal from sensor and the comparator function is to set sensitivity of the sensor. When signal came at Input 1 in PIC, the counter will count down the value which had set in PIC. If input 2 got the signal, the counter will count up.

The output of this circuit is a display to give the information to drivers using LCD display. LCD displays the number of available space from the number of total parking space to zero. Number zero on this LCD display is represent ‘FULL’ display mean there have on available space in that parking lot. This entire project is using power supply and voltage regulator to function.

The voltage divider and sensor circuit is design using Protues 6 professional and transferred to Printed Circuit Board (PCB). Then proceed with PCB fabrication which is the etching drill and soldering process. PIC and LCD circuit design in strip board. Testing and troubleshooting process was repeated to ensure all parts are functional and connect to each other.

1.5 Short Brief on Methodology

The system must be set according to the total number of space in parking lot. If the parking lot is empty the LCD will display the number of total space in that parking lot. When the first car enters the parking lot, the number in display will decrease by one. Following by the next car entering the parking lot, the number will decreasing until the parking lot full the display will show 'FULL'.

The number will increase if the cars exit from parking lot that inform the driver that there have available parking space in that parking lot.

In PSM I, the project start with literature review on magnetic sensor device and family of Honeywell magnetic sensor refer on Honeywell's datasheet written by Michael J. Caruso and Lucky S. Withanawasam also refer to the internet, books, supervisors, lecture notes and so on understands whole process in this project.

All the components are determined and start finding either buy or apply from the university.

In PSM II, the sensor and power divider circuit was design and schematic generated by using Protues. This PCB layout was printed negative and mask on the PCB using UV Light. After that PBC was dissolve in PCB developer and after rinse that PCB dissolve in ferric chloride to remove unwanted copper and for last stage wipe the PCB with PCB cleaner. All the etching process was doing manually.

Successful etching PCB has been drilled to insert all the components. The entire component was soldering step by step on the PCB.

PIC and LCD circuit was constructed on strip board. The hole for component was marked first to avoid mistake then soldering the component on the strip board.

Completed soldered circuit was tested before assemble in the casing. The circuit was tested again with complete casing.

1.6 Organisation of Thesis

This thesis contains five chapters. Chapter One is all about the introduction which contains project background, project significances, project objective, problems statement, scope of work, system operation and organisation of thesis, it is more about over view of the project. Chapter Two explains about literature review regarding to the project. Chapter Three is about methodology and approach taken and a closer look on how the project actualized and the last one is Chapter Four is discussion and data analysis of this project and chapter Five is conclusion and suggestion of this project

CHAPTER II

LITERATURE REVIEW

This chapter reviews some references from previous project, journal, article, books and data sheet. All these information was collected from the different sources such as library, internet, product manual and etc. the useful data will be discussed on the chapter.

2.1 Logic Circuit

This project involves logic device to operate as a counter.

2.1.1 Latch

A latch is a type of bistable logic device or multivibrator. An active-HIGH input S-R (SET-RESET) latch is formed with two cross-coupled NOR gates, as shown in Figure 2.1; an active-LOW input S'-R' latched is formed with two cross-coupled NAND gates, as shown in Figure 2.2. Notice that the output of each gate is connected to an input of the opposite gate. This produces the regenerative feedback that is characteristic of all latches and flip-flop. [1]

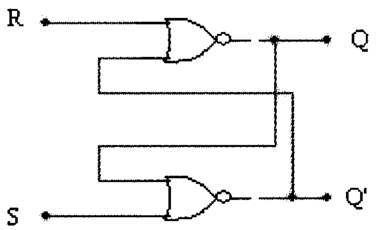

Figure 2.1 Active HIGH input S-R latch

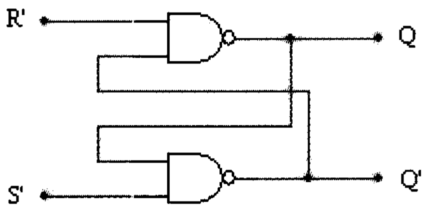

Figure 2.2 Active LOW input S'-R' latch

Table 2.1 Truth table for an active-HIGH input S-R latch.

INPUT		**OUTPUT**		**COMMENS**
S	**R**	**Q**	**Q'**	
0	0	INVALID	INVALID	Invalid Condition
0	1	0	1	Latch RESET
1	0	1	0	Latch SET
1	1	NO CHANGE	NO CHANGE	No Change,

A gated latched required an enable input. An enable input have same function as switch to active or deactivate the latch.

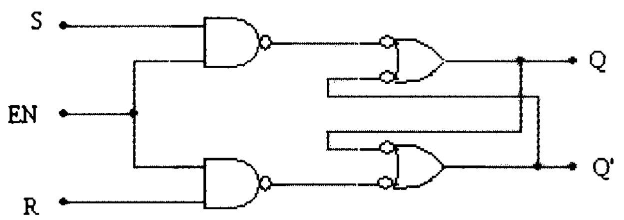

Figure 2.3 Gated S-R latch logic diagram

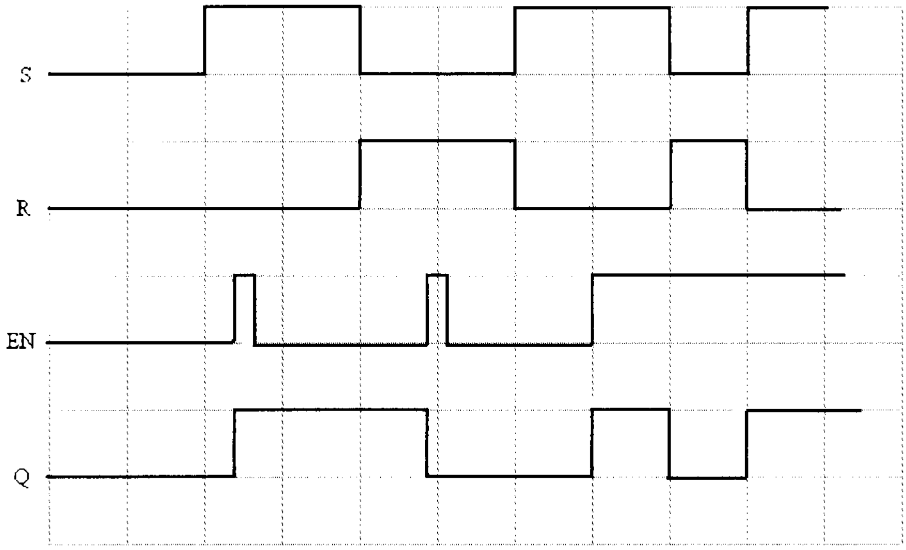

Figure 2.4 Example of timing diagram S-R latch

2.1.2 Flip-Flop

Flip-flop is synchronous bistable device. The J-K flip-flop is versatile and is a widely used type of flip-flop. The functional of the J-K flip-flop is identical to that of the S-R flip-flop in the SET, RESET, and no-change condition of operation. The difference is that the J-K flip-flop has no invalid state as does the S-R flip-flop.

Table 2.2 Truth table for a positive edge-trigged J-K flip-flop

INPUT			OUTPUT		COMMENTS
J	K	CLK	Q	Q'	
0	0	↑	Q_0	Q'_0	No change
0	1	↑	0	1	RESET
1	0	↑	1	0	SET
1	1	↑	Q_0	Q'_0	Toggle

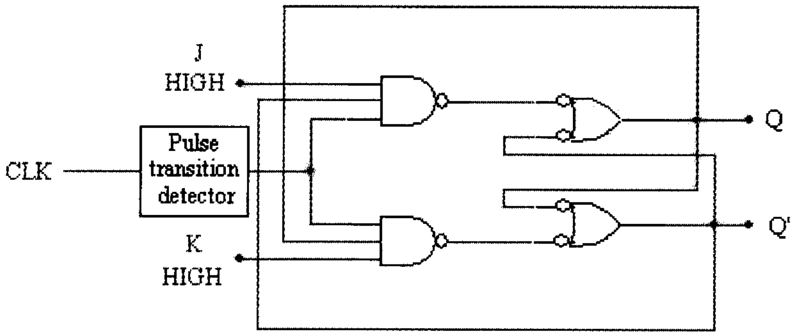

Figure 2.5 Transition illustrating the toggle operation when J=1 and K=1

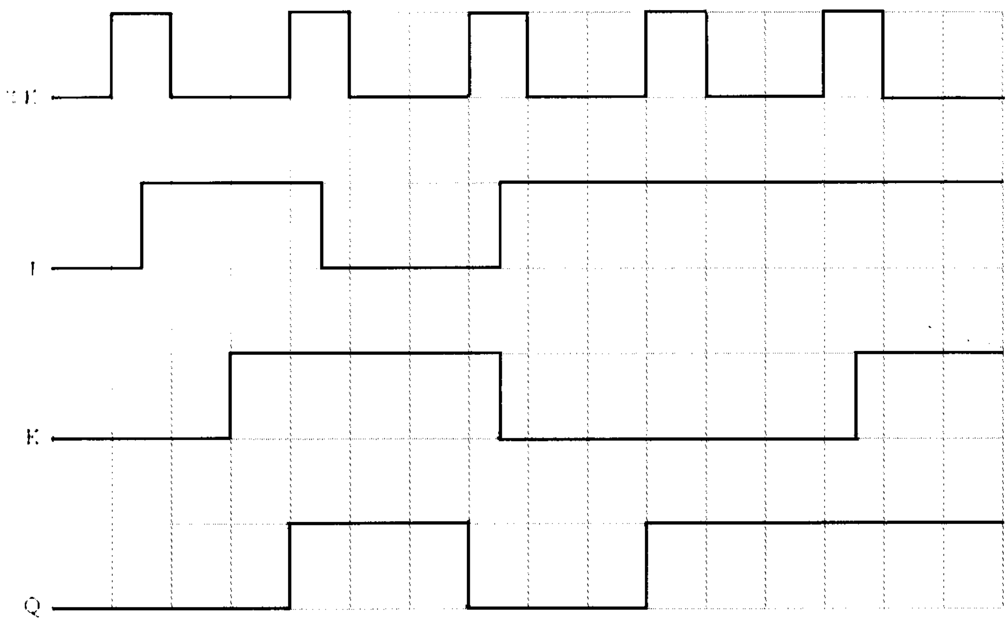

Figure 2.6 Example of timing diagram J-K flip-flop

Most integrated circuit flip-flop also have asynchronous input. These are input that affect the state of the flip-flop independent of the clock. They are normally labeled present (PRE) and clear (CLR). An active level on the preset input will set the flip-flop and an active level on the clear input will reset it. [1]

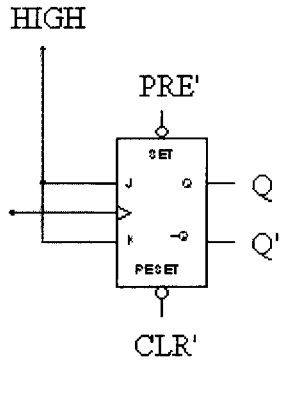

Figure 2.7 Block diagram of J-K flip-flop with preset and clear

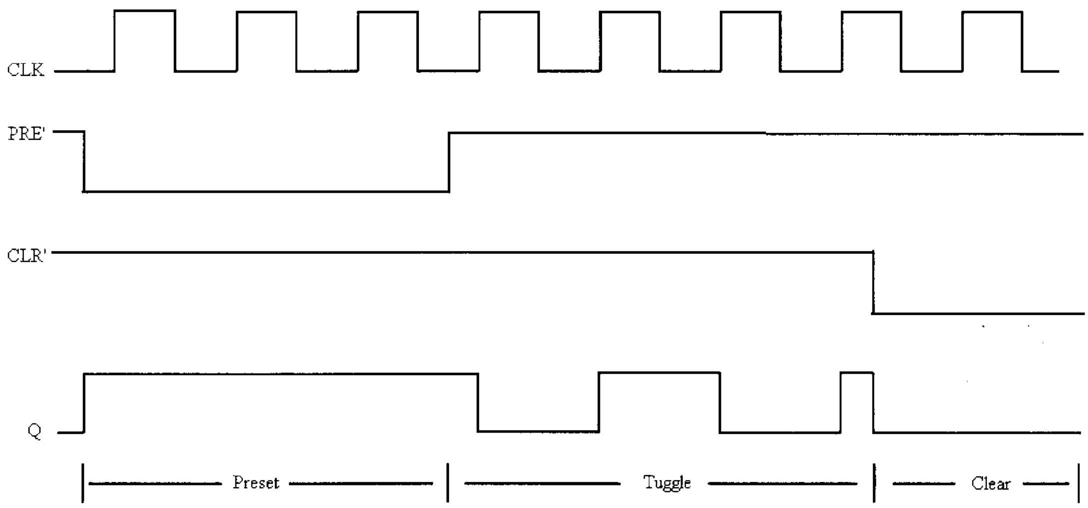

Figure 2.8 Timing diagram of J-K flip-flop with preset and clear

2.1.3 Counter

The basic of the counter is flip-flop. There are several types of flip-flop combined to design a counter. The number of flip-flop used and the way in which they are connected determined the number of state and also the specific sequence of state that the counter goes through during each complete cycle.

An up/down counter is one that is capable of progressing in either direction through a certain sequence. An up/down counter, have any specified sequence of state. In general, most up/down counter can be reserved at any point in their sequence. Figure 2.9 shown a basic implementation of a 3-bit up/down binary counter using the logic equation just developed for the J and K input of each flip-flop. Notice that the UP/DOWN' control input is HIGH for UP and LOW for DOWN. [1]

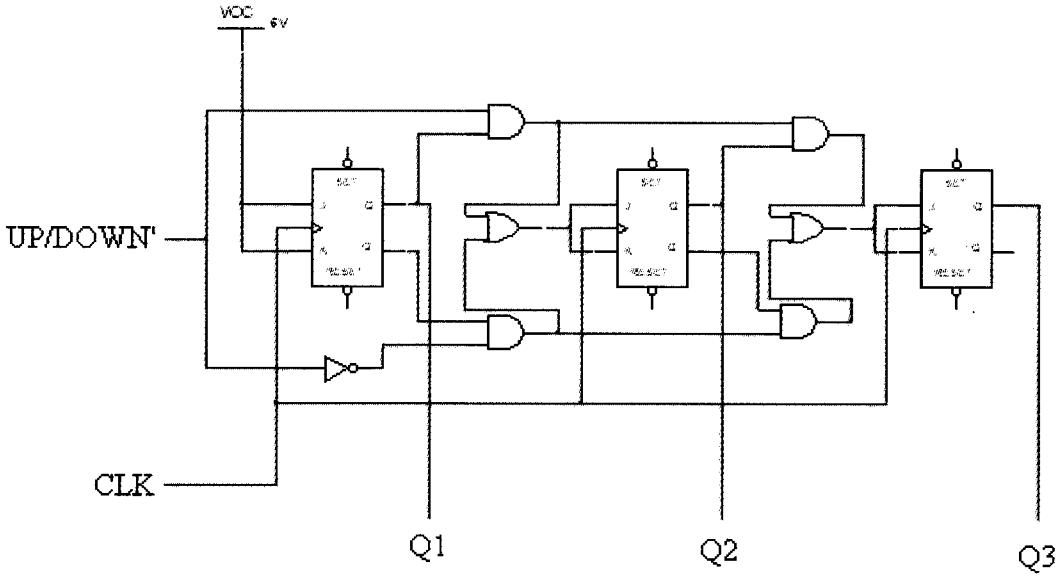

Figure 2.9 Basic 3-bit up/down synchronous counter

2.2 Circuit Device

2.2.1 Differential Amplifier

Differential amplifier circuit has two separate inputs and two separate outputs, and that the emitters are connected together.

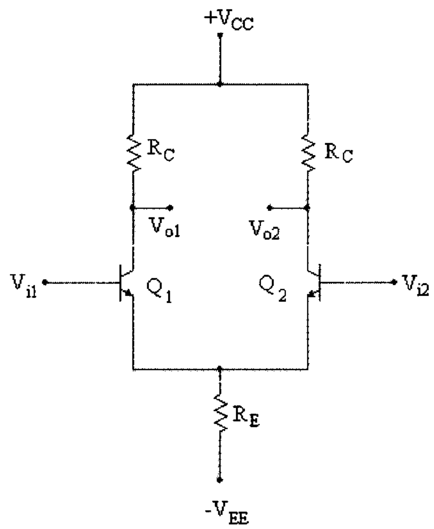

Figure 2.10 Basic differential amplifier circuit

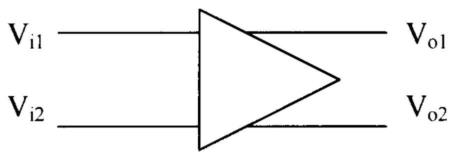

Figure 2.11 Basic differential amplifier symbol

In single-ended operation, single input signals are applied. However, due to the common-emitter connection, the input signal operates both transistors, resulting in output from both collectors.

In double ended operation, two input signal are applied, the difference of the input resulting in output from both collectors due to the difference of the signal applied to both input.

In common mode operation, the common input signal results in opposite signal at each collector, these signal canceling, so that the resulting output signal is zero.

The main feature of the differential amplifier is the very large gains when opposite signals are applied to the input as compared to the very small gain resulting from common input. The ratio of this difference gain to the common gain is called common-mode rejection. [2]

2.2.2 Op-Amp

An operational amplifier is a very high gain amplifier having very high input impedance and low output impedance. The basic circuit is made using a difference amplifier having two inputs and at least one output. [2]

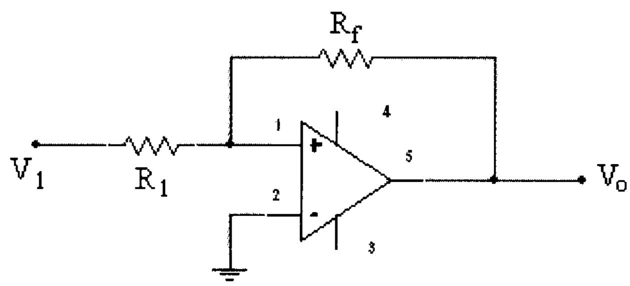

Figure 2.12 Op-amp connection

One of type of common op-amp circuit is the constant-gain multiplier which provides a precise gain or amplification. Non inverting constant-gain multiplier is provided by the circuit of Figure 2.12, with the gain given by

$$A = 1 + \frac{R_f}{R_1} \qquad (2.1)$$

2.2.3 Instrument Amplifier

A circuit provides an output based on the difference between two inputs shown in Figure 2.13. A potentiometer is provided to permit adjusting the scale factor of the circuit. Where three op-amps are used, a single –quad op-amp IC is all that is necessary. The output voltage can be shown to be [2]

$$V_0 = \left(1 + \frac{2R}{R_p}\right)(V_1 - V_2) = k(V_1 - V_2) \qquad (2.2)$$

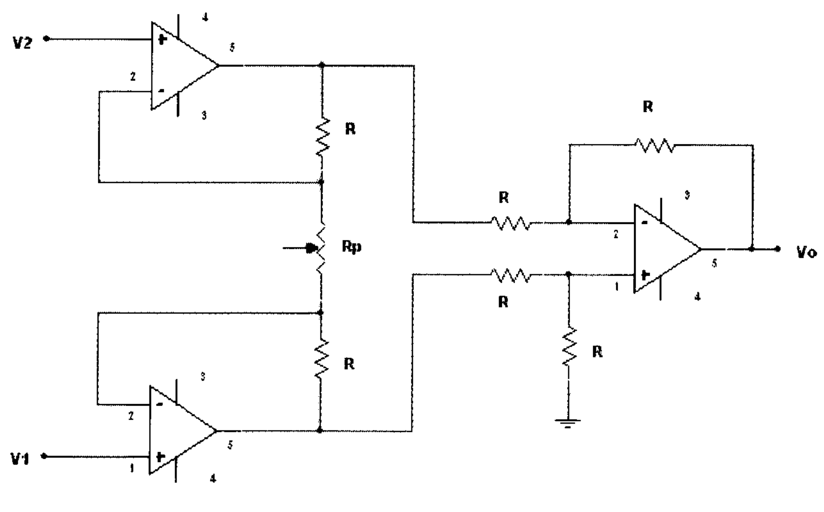

Figure 2.13 Instrument amplifier

2.2.4 AD263

The AD623 is an instrumentation amplifier based on a modified classic 3-op-amp approach, to assure single or dual supply operation even at common-mode voltages at the negative supply rail. Low voltage offsets, input and output, as well as absolute gain accuracy, and one external resistor to set the gain, make the AD623 one of the most versatile instrumentation amplifiers in its class.

The input signal is applied to PNP transistors acting as voltage buffers and providing a common-mode signal to the input amplifiers as Figure 2.14. An absolute value 50 kΩ resistor in each amplifier feedback assures gain programmability.

The differential output is:

$$V_0 = \left(1 + \frac{100k\Omega}{R_G}\right)V_c \qquad (2.3)$$

The differential voltage is then converted to a single-ended voltage using the output amplifier, which also rejects any common-mode signal at the output of the input amplifiers.

The amplifiers can swing to either supply rail, as well as have their common-mode range extended to below the negative supply rail, the range over which the AD623 can operate is further enhanced.

The output voltage at Pin 6 is measured with respect to the potential at Pin 5. The impedance of the reference pin is 100 kΩ; therefore, in applications requiring V/I conversion, a small resistor between Pin 5 and Pin 6 is all that is needed.

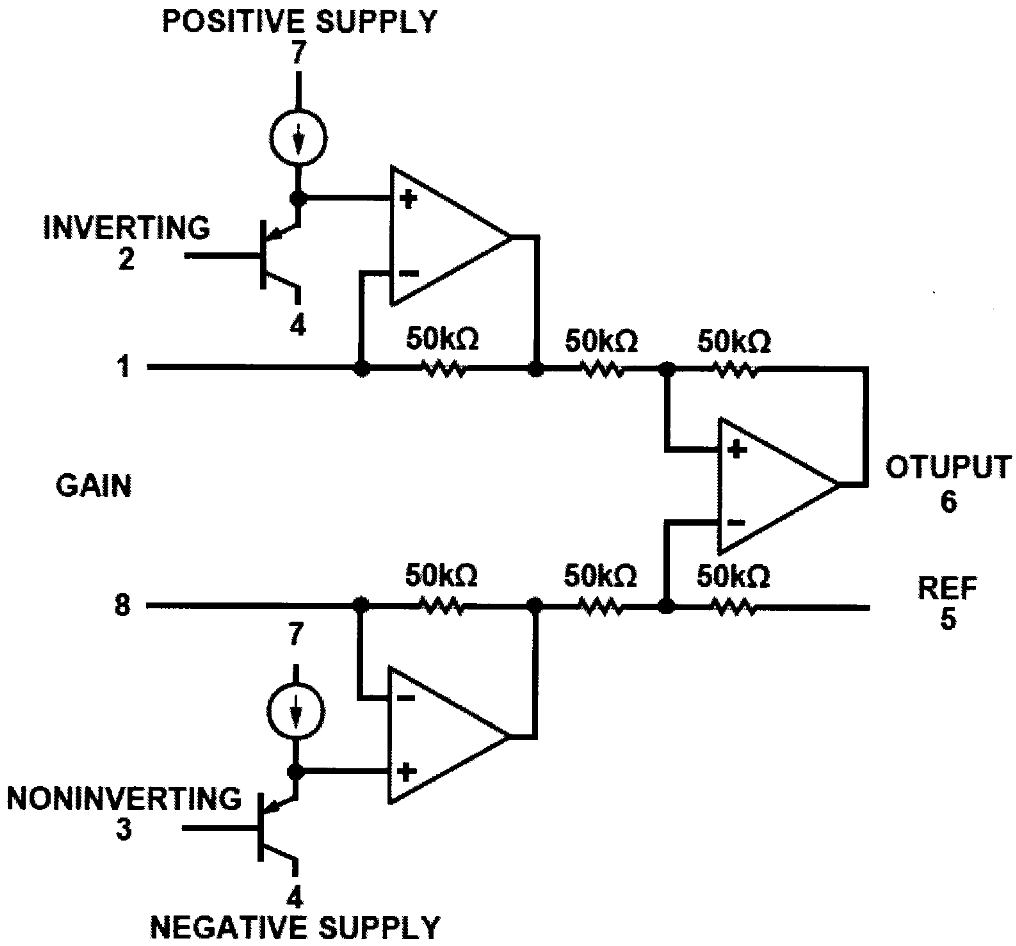

Figure 2.14 Simplified schematic AD263

Note that the bandwidth of the in-amp decreases as gain is increased. This occurs because the internal op-amps are the standard voltage feedback design. At unity gain, the output amplifier limits the bandwidth.

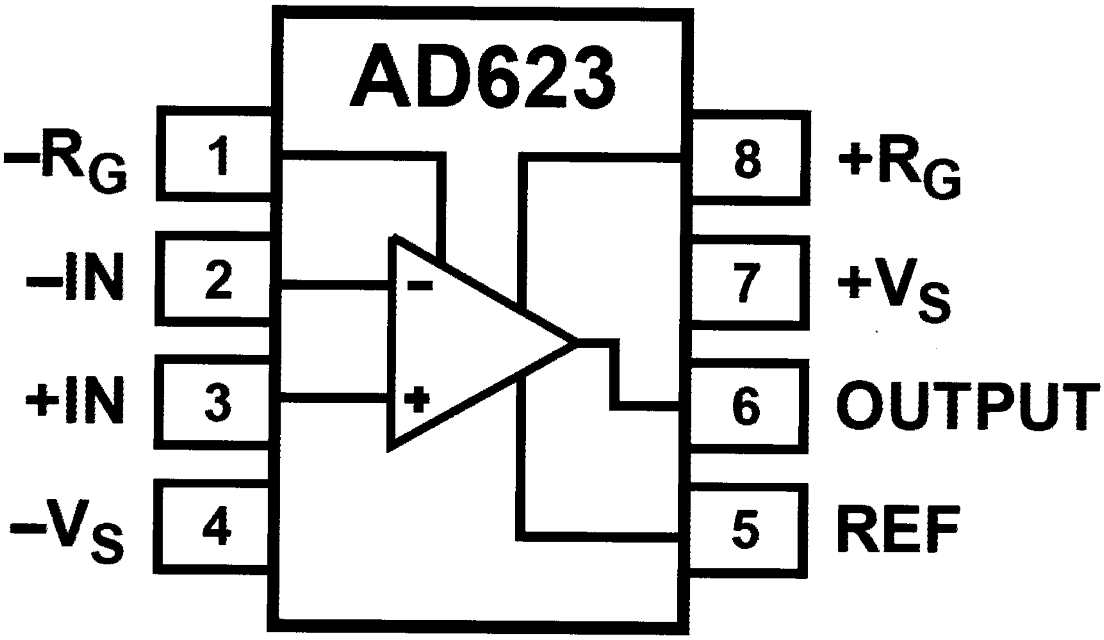

Figure 2.15 AD623 schematic diagram

2.2.5 Magnetic Field Sensor

Low field magnetic sensors come in two categories, magnetoresistive bridges, and coils. While coils can create magneto-inductive and flux-gate magnetic sensors, in general they tend to be larger in size, and required active oscillator circuits to determine the amount of magnetic flux influencing the coil(s). With magnetoresistive sensors, two types are available, called AMR and GMR. AMR or Anisotropic Magneto- Resistive sensors are directional sensors and provide only an amplitude response to magnetic fields in their sensitive axis. By combining AMR sensors into two or three axis configurations, a two or three dimensional measurement of the magnetic fields passing through the sensors is possible with excellent linearity.

GMR or Giant Magneto-Resistive sensors can also be used for low magnetic field sensing, but have a broad sensitivity to amplitudes with little directionality. For vehicle detection, GMR sensors must have a nearby magnetic bias field, from either a permanent magnet or DC driven solenoid to gain improved linearity. In the following discussions, we will confine discussion to AMR sensors for vehicle detection applications.

For AMR sensors, the sensor resistive elements are oriented as a resistive "wheatstone bridge" that varies resistance slightly as the magnetic field changes upon each element. The resistive elements are made of permalloy thin films and have around 1000 ohms of resistance, but each element is precision matched to within an ohm of each other when no magnetic fields are present. Figure 2.15 shows a typical AMR sensor Wheatstone bridge electrical diagram.

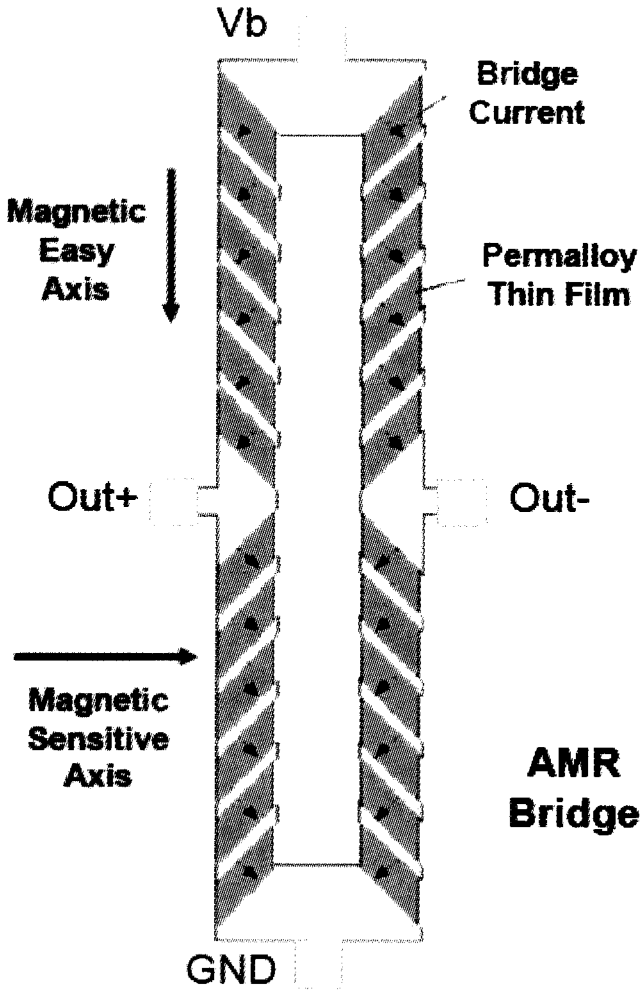

Figure 2.16 AMR sensor bridge

Each bridge has four resistive elements with opposite elements being identical. If the bridge receives a positive magnetic field or lines of magnetic flux in the sensitive axis, the Vb to Out+ and Out- to GND elements will slightly decrease in resistance while the other two elements will increase in resistance. The result will be that the voltage at Out+ increases above Vb/2 and the voltage at Out- decreases from Vb/2. If the bridge voltage, or Vb, equals 5 volts and the applied magnetic flux is 0.5 gauss, the nominal voltage at Out+ is 2.5012 volts and the nominal voltage at Out- is 2.4988 volts. [3]

The amount output voltage from the AMR sensor is measured from Out+ to Out- and is a function of the sensor sensitivity equation, or:

$$Out^{+} - Out^{-} = S \times Vb \times Bs \qquad (2.5)$$

With,

S = Sensitivity (nominally 1mV/V/gauss)

Vb = Bridge Supply Voltage in volts

Bs = Bridge Applied Magnetic Flux in gauss

2.2.6 HMC 1021S

HMC 1021S is a sensor with 8 small outline integrated circuit (SOIC) pin. This sensor is one axis sensor to detect a car.

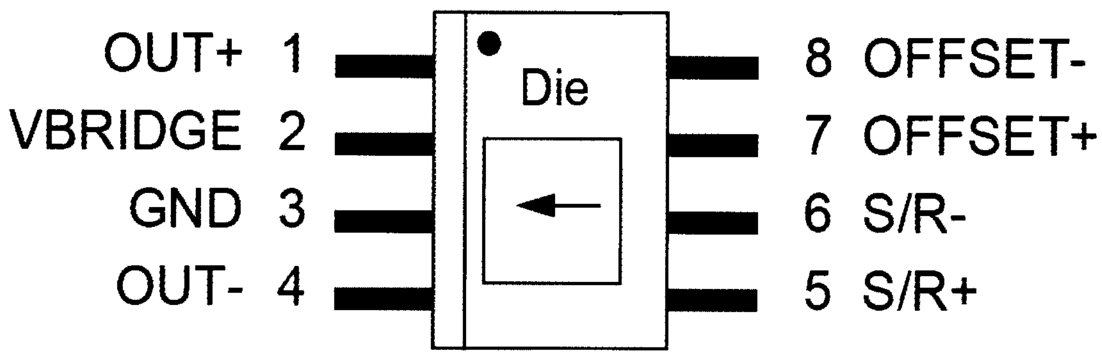

Figure 2.17 HMC1021S pin schematic

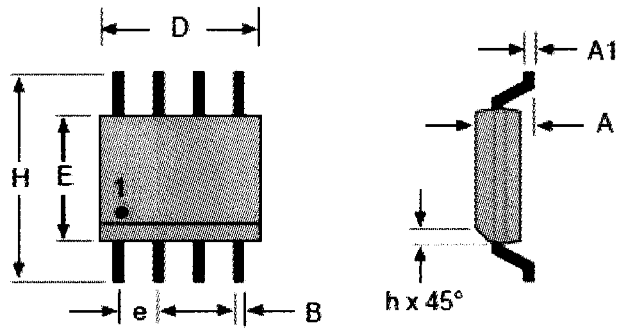

Figure 2.18 HMC1021S pin size

Table 2.3 HMC1021S pin size

Symbol	Millimeters Min	Millimeters Max	Inches Min	Inches Max
A	1.371	1.728	.054	.068
A1	0.101	0.249	.004	.010
B	0.355	0.483	.014	.019
D	4.800	4.979	.189	.196
E	3.810	3.988	.150	.157
e	1.270 ref		.050 ref	
H	5.816	6.198	.229	.244
h	0.381	0.762	.015	.030

2.2.7 Voltage Regulator

The linear IC voltage regulator is a device used to hold the output voltage from a dc power supply relatively constant over a wide range of line and load variations. Most commonly used IC voltage regulators are three-terminal devices.

There are four types of IC voltage regulators: fixed positive, fixed negative, adjustable, and dual tracking. The fixed-positive and fixed-negative IC voltage regulators are designed to provide specific output voltages. The adjustable regulator can