

Digital Speedometer

Project By Group 8

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Presentation Outline

- ◆ ELDEN – Physics and Mathematical Concepts
- ◆ TOM - Hardware Concepts
- ◆ SAM – Software Concepts

PURPOSE

- ◆ The purpose of this project is to implement a speedometer that can be used in an automobile
- ◆ The program which calculates and displays MPH can be used for any device that has a rotational part and by conversion turn this RPM into MPH
- ◆ Our purpose is for automobile uses

INTRODUCTION

- ◆ Our project implements the way a speedometer works in automobiles
- ◆ We have a multi-speed motor that controls the rotational speed of a magnetic wheel
- ◆ Magnetic wheel has 4 north poles and 4 south poles being alternated
- ◆ Using a hall effect sensor we can count the number of revolutions

INTRODUCTION CONT.

- ◆ Convert rotational to linear speeds
- ◆ This value is then displayed on an LCD display
- ◆ Driver can know how fast they are going

DESIGN ALTERNATIVES CONSIDERED

- ◆ Hall effect sensor or Opto-electronic sensor
- ◆ Problem not used for automobiles
- ◆ For our application for an automobile we used a hall effect sensor

DESIGN ALTERNATIVES CONSIDERED CONT.

- ◆ Electric motor in order for us to power and rotate the wheel
- ◆ How could we change the speed of the motor
 - Change resistance to regulate input voltage?
 - Change voltage itself to the motor?
- ◆ 120V AC to 18V AC converter with a switch and a full wave rectifier circuit

DESIGN ALTERNATIVES CONSIDERED CONT.

- ◆ Next step was to find a motor that we could control by varying the voltage
- ◆ Considered a stepper motor
 - not used for this type of application
- ◆ Continuous speed controlled motor
- ◆ Connected the pulley of the motor to the axle of the wheel

DETAILED THEORY OF OPERATIONS

- ◆ Motor powered by a 120V AC converter to 18V AC with a full wave rectifier circuit
- ◆ Connect a belt from the motor pulley to the axle of the magnetic wheel
- ◆ Wheel consists of 4 north pole and 4 south pole magnets
- ◆ Wheel is then placed next to the haul effect sensor
- ◆ Wheel rotates due to the motor, it will alternate pulses of 1's and 0's

DETAILED THEORY OF OPERATIONS CONT.

- ◆ Physics Point of View
- ◆ The digital speedometer needs to display the linear speed value of the rotational speed of the wheel
- ◆ In an automobile there are plenty of parts that are rotating RPM to MPH

DETAILED THEORY OF OPERATIONS CONT.

- ◆ 1st STEP - count the number of pulses we have in a 1/2 second = frequency
- ◆ Equation for conversion is $V_{lin} = V_{rot}(\omega R)$ where $\omega = 2\pi f$, and R is the radius of the wheel or rotating body
- ◆ Since 1 revolution has 4 pulses - Take the frequency divide it by 4 to get the number of revolutions
- ◆ Then the circumference of the wheel is multiplied by the number of revolutions, which is the length that passes in that one time period

DETAILED THEORY OF OPERATIONS CONT.

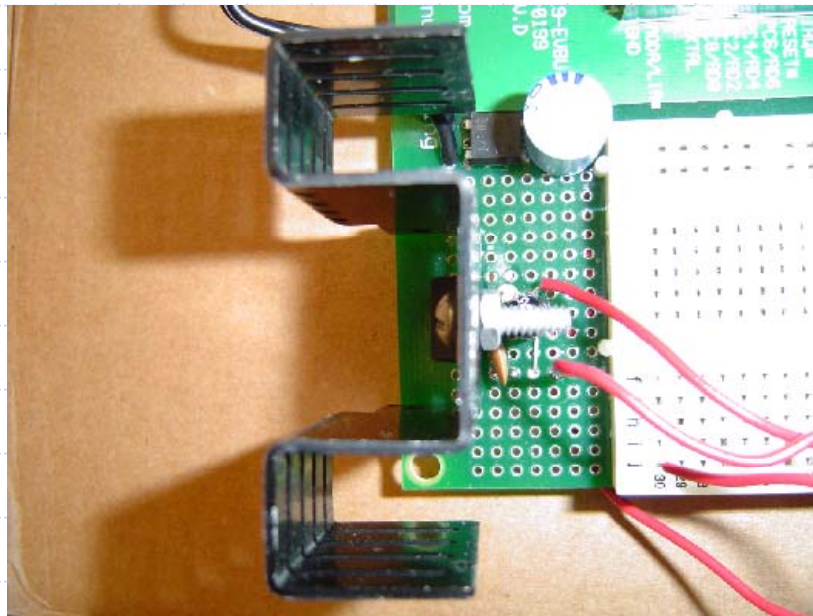
- ◆ $V_{rot} = \text{Length/time} = \# \text{ rev} * (\text{circumference} / t) = \# \text{ rev} * (\text{circumference} / 0.5 \text{ sec}) = \# \text{ rev} * (2 * \text{circumference})$
- ◆ linear speed to rotational speed found by $V_{lin} = V_{rot} * (\omega * R), \text{ or } 2\pi f * R$
- ◆ Then this speed is not yet MPH, it will be in/0.5sec
- ◆ Conversion of in/sec is converted to MPH and this value is then displayed on the LCD display
- ◆ Each 1/2 second the 68HC11 will do this conversion and display the speed on the LCD display

Parts Used

- ◆ Motorola M68HC11 EVBU board
- ◆ LM117 Voltage Regulator
- ◆ 18V AC Power Supply
- ◆ Hall Effect Sensor
- ◆ Rectifier Chip
- ◆ Ring Magnet
- ◆ 12V DC motor

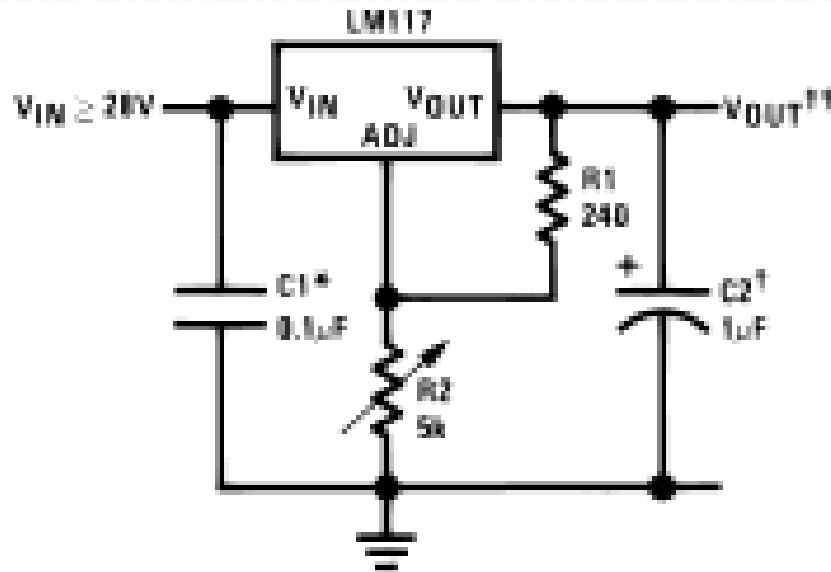
The Rectifier

- ◆ This IC is used to convert AC to DC voltage.
- ◆ Our input is 18V AC, this IC converts the voltage to about 26V DC.



Voltage Regulation Circuit

This circuit uses a Potentiometer to regulate Voltage



Hall Effect Sensor

- ◆ This sensor is used to detect magnetic north and south.

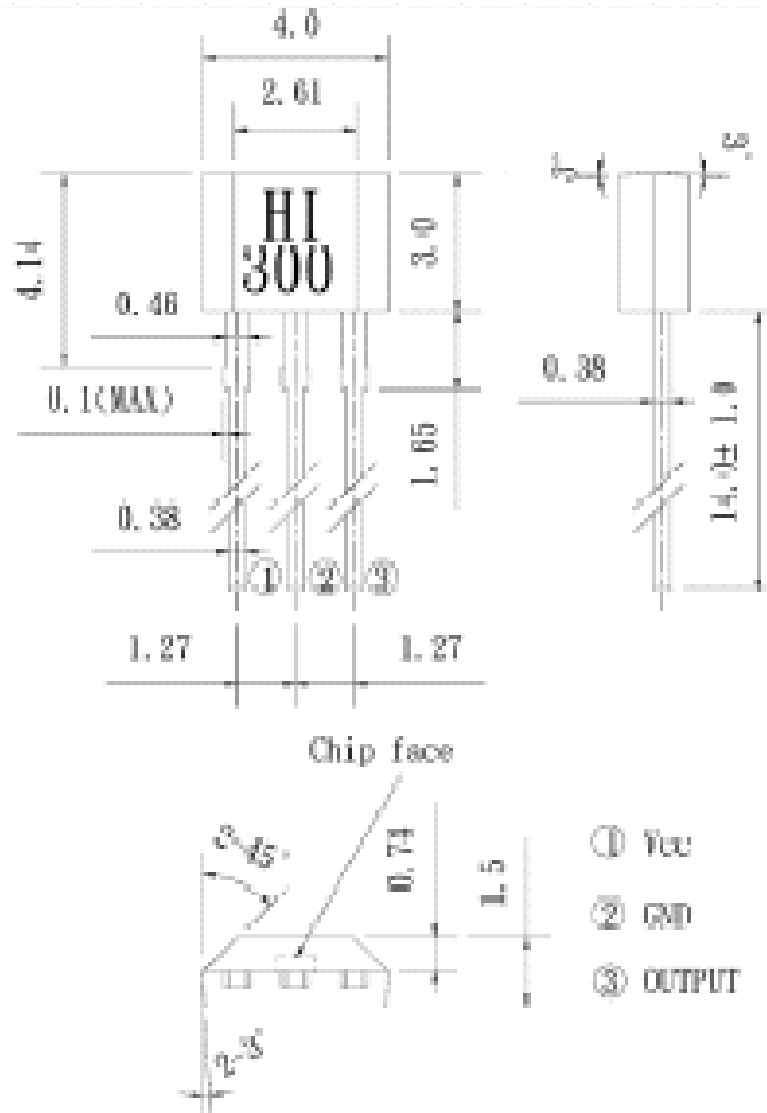
ELECTICAL CHARACTERISTICS:

($T_a=25^\circ\text{C}$)

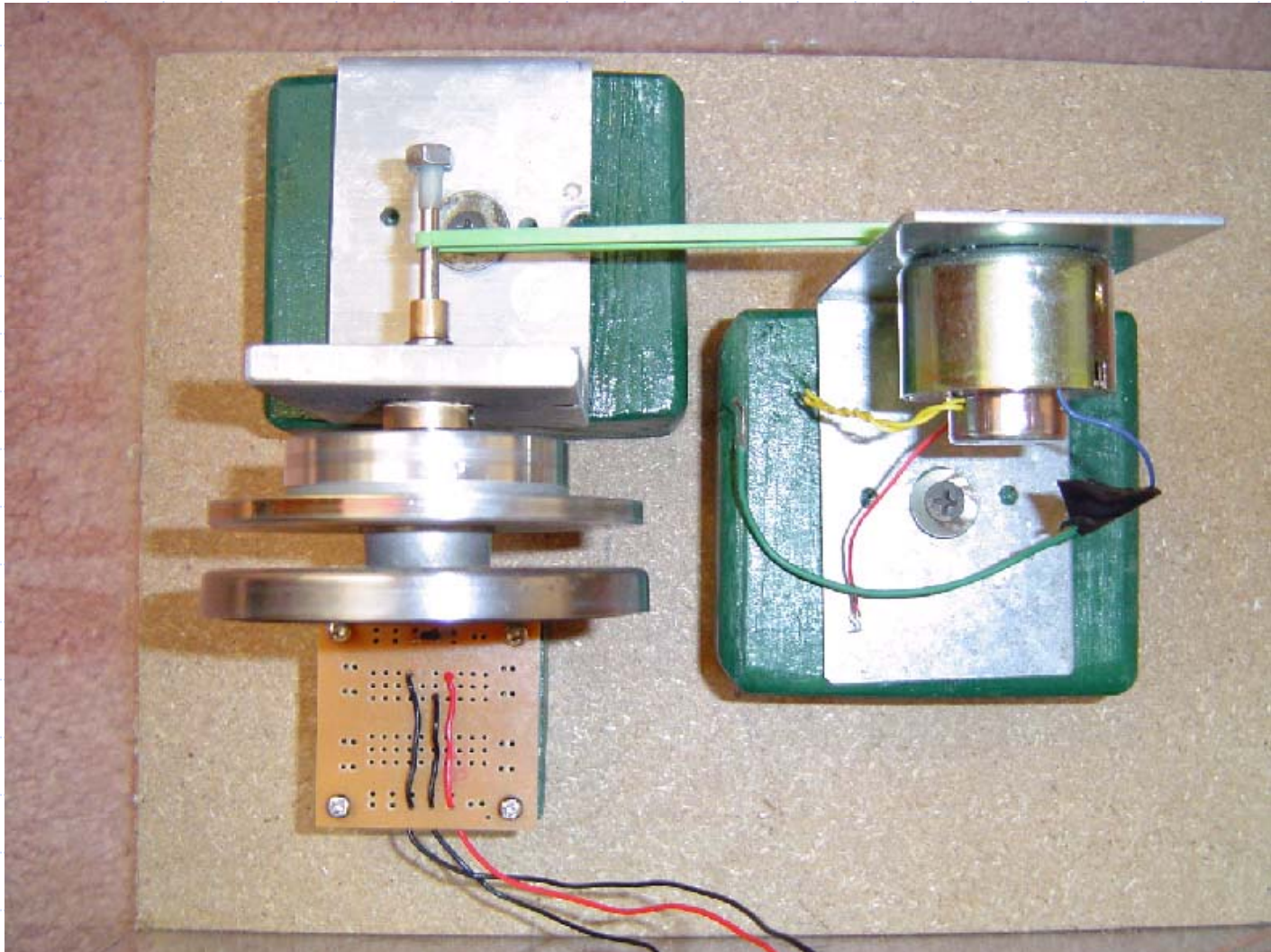
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	CONDITION
Supply Voltage	V_{CC}	3	-	20	V	Operating
Output Saturation Voltage	V_{SAT}	-	-	0.2	V	$I_{OUT}=5\text{mA}, B > B_{OP}$
Supply Current	I_{CC}	-	3.5	6	mA	Operating
Output Leakage Current	I_{LEAK}	-	0.5	2	μA	$V_{OUT}=20\text{V}, B > B_{RP}$
Output Rise Time	t_r	-	0.4	-	μS	$V_{CC}=12\text{V}, R_L=4.7\text{k}\Omega,$
Output Rise Time	t_f	-	0.4	-	μS	$C_L=20\text{pF}$



Picture of the Schematic for the Hall Sensor



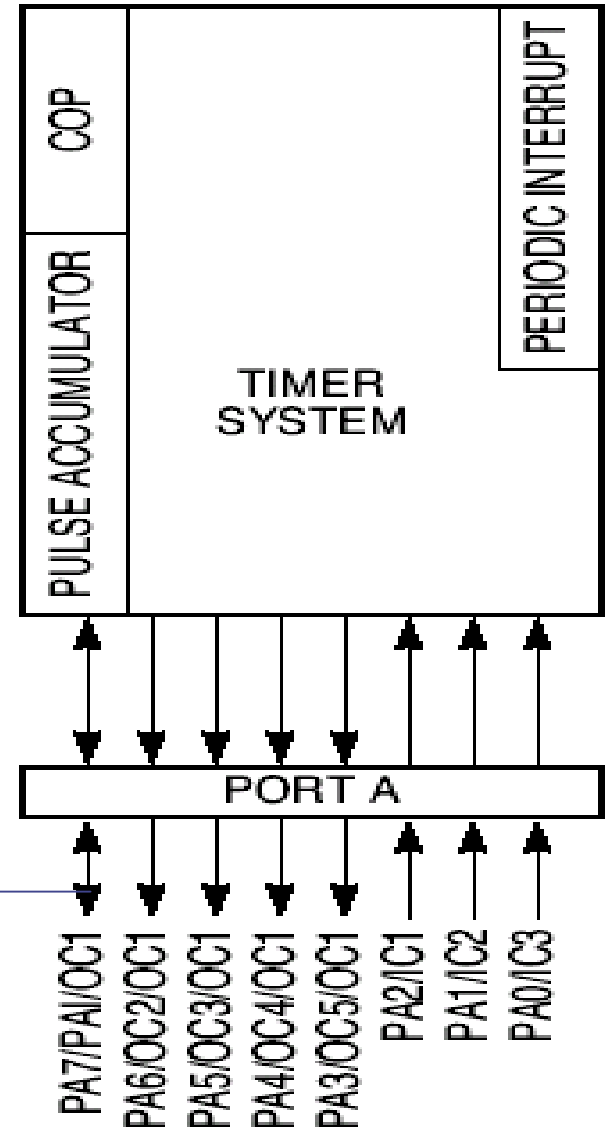
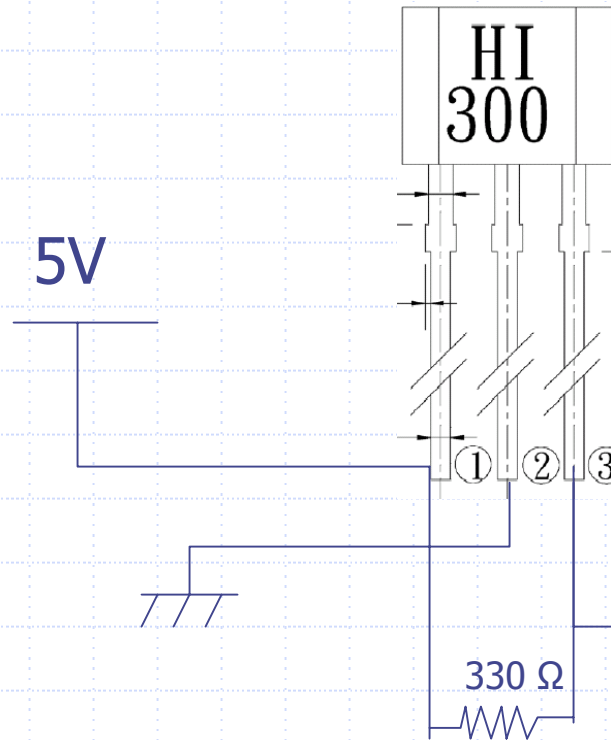
Motor and Wheel Setup



Motor and Wheel Setup



Pin level Drawings



Main Theory of Speedometer

The Principle behind the speedometer

1. Use Pulse Accumulator to Capture any number of pulses during a fix interval
2. Once the interval is over, convert those pulses in to RPM and MPH.
3. Use software to convert the numbers from Hex to Decimal
4. Display those numbers

Setting Up the Pulse Accumulator

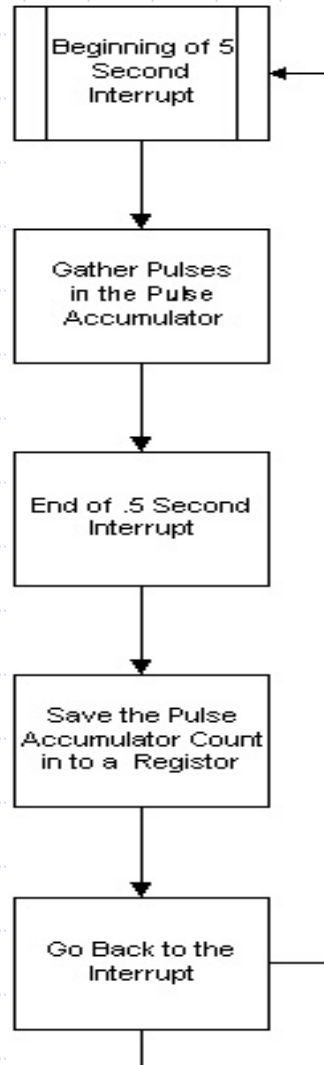
PACTL — Pulse Accumulator Control Register

\$1026

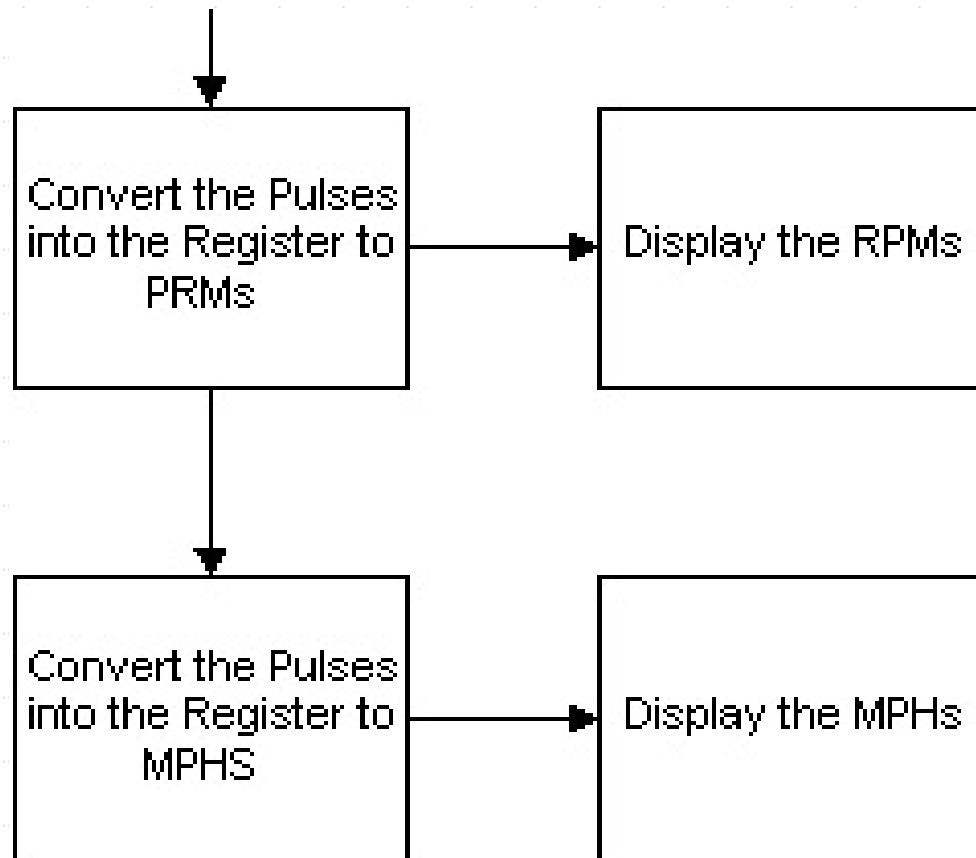
	BIT 7	6	5	4	3	2	1	BIT 0
	DDRA7	PAEN	PAMOD	PEDGE	0	0	RTR1	RTR0
RESET:	0	0	0	0	0	0	0	0

- We did not want the Microprocessor to be Interrupted every time we received a rising edge, so We did not program TMSK2 and TFLG2 to generate any interrupts.
- We just programmed the Control Register to capture rising edges, so we loaded \$50 into the PACTL.

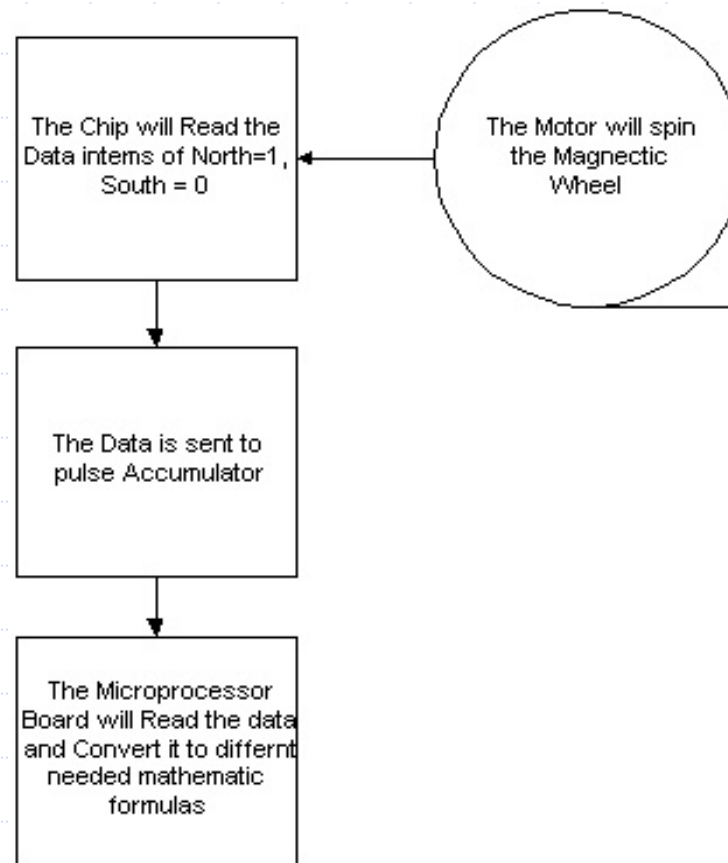
Software Schematic



Software Schematic



Interfacing Hardware and Software



Setting up the Pulse Acc. In Software

OC3SERV

```
LDD    TOC3,X
ADDD   #TWENTYFIVE_MS
STD    TOC3,X
INC    OC3_CNT
LDAA   #HALF_SEC
CMPA   OC3_CNT
BNE    OC3DONE
LDAB   PACNT,X
STAB   RPM1
LDAB   #0
BCLR   PACNT,X    $FF
CLR    OC3_CNT
OC3DONE
BCLR   TFLG1,X $DF
RTI
```

Pulse Accumulator Cont.

```
MAIN
SEI
LDX    #$1000
BSET   PACTL,X    $50
JSR    LCDSET
CLR    OC3_CNT
LDX    #REGBAS
LDD    TCNT,X
ADDD  #TWENTYFIVE_MS
STD    TOC3,X
BSET   TMSK1,X $20
BCLR   TFLG1,X $DF
CLI
```

TIMELINE

Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16	
Project Decision														
	Parts Needed and Ordered													
			Software											
			Hardware											
											Finishing Touches			
												Presentation		

Cost Analysis

Power Supply	\$15
Res., Caps. Etc.	\$15
Motor	\$5
Plexiglass, Wood etc.	\$15
Misc.	\$20
Micro Processor Board	\$100
=====	
Total	\$170

Patents and OSHA

- ◆ Pat No: 6,498,474 - Rotational velocity and direction sensing system
- ◆ Inventors: **Kelsey-Hayes Company** (Livonia, MI)
- ◆ Pat No: 6,414,481- Portable tester and calibration apparatus for a speed or position sensor
- ◆ Inventors: **Brunswick Corporation** (Lake Forest, IL)

Patents and OSHA Cont.

- ◆ OSHA regulations state that since this device used high voltage, the wires must not be exposed.
- ◆ The rotating wheel must also be protected and closed in a confined box.