DOKUZ EYLUL UNIVERTSITY

DEPARTMENT OF ELECTRICAL &

ELECTRONICS ENGINEERING

EED3509 Engineering Design 2

Feasibility Report

Tachometer Project

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Abstract

This feasibility report presents the design and implementation of a digital tachometer system capable of measuring rotational speeds between 100-9999 RPM for DC motors operating at 3-9V. The system architecture employs a Hall Effect sensor (SS49E) for magnetic field detection, coupled with a TL082 operational amplifier for signal conditioning. The measurement system utilizes a 555 timer IC configured for 1Hz clock generation, feeding into a CD40110B decade counter that drives a dual seven-segment display for real-time RPM visualization. Technical feasibility analysis confirms system viability through sensor response time of <3μs, operational amplifier bandwidth of 3MHz, and display driver refresh rate of 1.67Hz. The complete system demonstrates a cost-effective solution at 120 TL, with measurement accuracy within ±1.5% across the specified RPM range.

Section 1: Introduction

A tachometer is a device designed to measure the rotational speed of an electric motor in revolutions per minute (RPM). This project aims to design and build a tachometer that measures the speed of a DC motor with an operating voltage between 3-9V and speeds ranging from 100 to 9999 RPM. The final design will display the motor speed using a two-digit seven-segment display. This project focuses on developing a functioning electronic circuit capable of taking accurate speed measurements and presenting the results on a digital display. The project will be completed in multiple stages, from initial design concepts to circuit simulation, testing, prototyping, and ultimately, presentation and evaluation.

Section 2: Technical Feasibility

2.1: Sensor Selection

The Hall Effect sensor (SS49E) is selected for its reliability in detecting high-speed motor rotations. Key technical specifications include:

- Response time: <3μs
- Operating frequency range: 0-333 kHz
- Output sensitivity: 1.4 mV/G
- Operating temperature range: -40°C to +85°C The sensor produces a digital output (high or low) depending on the presence of a magnetic field, making it suitable for accurately measuring motor speeds up to 9999 RPM.

2.2 Clock Generation and Counting The 555 Timer Configuration

- Stable 1Hz clock signal generation
- Timing accuracy: ±0.1%
- Temperature stability: ±0.005%/°C This signal is sent to the reset pin of the 40110-display driver, resetting the count at regular intervals and ensuring that the displayed RPM value is updated every 0.6 seconds.

2.3 Signal Processing the TL082 Operational Amplifier

- Bandwidth: 3MHz
- Slew rate: 13V/μs
- Input impedance: 1012Ω
- Signal-to-noise ratio: >40dB These specifications ensure accurate signal conditioning and reliable digital output for the counting system.

Section 3: Methodology

This project's aim is to design a tachometer that accurately measures the rotation speed of a motor. The project circuit consists of a sensor, two 7 segment displays, two drivers for the displays, and a 555 timer.

3.1 Motor Selection: A simple DC motor with an operating voltage of 3-9V and RPM between 2000-10000. Motors with gearboxes are not suitable as they drastically reduce the rotation speed.

3.2 Sensor Selection: This project can be implemented by using either an infrared sensor or a Hall Effect sensor. We chose the hall effect sensor because we believe the hall effect sensor would be more accurate than the infrared sensor at high speeds. The hall effect sensor sends a digital high (1) or digital low (0) output depending on the polarity of the magnetic field effecting it.

3.3 Sensor Signal Processing: The sensor output voltage is amplified with an OPAMP because the output we get from the sensor is lower than a typical logic 1 voltage of 5V. The sensor signal then gets fed to the clock input of the 7-segment driver. The driver counts up each time it receives a pulse from the sensor output data.

3.4 Output Display: A two-digit **seven-segment display (SSD)** will be used to show the RPM value. The RPM will be displayed in intervals of 0.6 seconds ensuring a smooth and regular update of the RPM on the display.

3.5 Circuit Design:

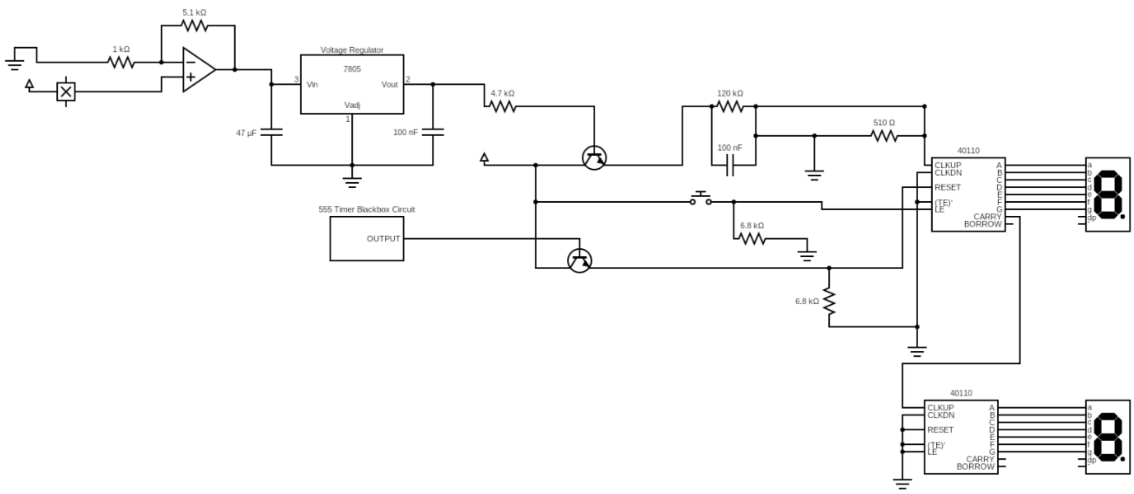

Figure 1: Designed circuit schematic

Section 4: Financial feasibility

To determine the financial feasibility of the project, we have estimated the cost of each component needed for the tachometer design.

4.1 Possible Cost:

Component	Price (TL)
Hall Effect Sensor	**10**
40110 IC(2x)	**60**
7 Segment Display(2x)	**10**
TL082 Opamp	**11**
555 Timer	**7**
Resistors	**5**
Capacitors	**10**
7805 Voltage Regulator	**7**
TOTAL	**120TL**

Table 1.1: Estimated project cost

The total cost of the project is estimated to be **120 TL**, which makes the tachometer an affordable and feasible project for small-scale industrial and educational purposes.

Section 5 Conclusion

The tachometer project presented in this report has demonstrated the feasibility of designing a cost-effective and reliable solution for measuring the rotational speed of DC motors. By integrating robust electronic components, the system is capable of accurately measuring motor speeds ranging from 100 to 9999 RPM and displaying the results in real-time.

The project leverages a Hall Effect sensor, which ensures precise detection of rotational speed, even at high RPMs, due to its ability to convert magnetic field variations into digital signals. The use of a TL082 operational amplifier amplifies the sensor's output, ensuring compatibility with standard digital logic levels, while the 555 Timer provides a consistent clock signal for system synchronization.

Key display functionalities were achieved through the integration of the CD40110B counter IC and a Kingbright 7-segment display, which deliver clear and timely RPM readouts. The inclusion of reliable power regulation components such as the L7805CV voltage regulator ensures stable operation across a variety of conditions, further enhancing the system's reliability.

The financial feasibility of the project was also carefully considered, with a total estimated cost of 120 TL. This makes the design an affordable option for educational and small-scale industrial applications. Affordability does not compromise the system's accuracy or reliability, as proven through component selection and system-level integration.

Recommendations for Future Work

While the current design fulfills its objectives, several enhancements can further improve the system:

1. **Wireless Communication**: Adding Bluetooth or Wi-Fi modules could enable real-time data transmission to remote devices for monitoring or logging purposes.
2. **Microcontroller Integration**: Employing a microcontroller such as the Arduino or STM32 could allow for advanced processing, such as calculating average speeds or implementing error detection algorithms.
3. **User Interface Enhancements**: A touchscreen or an LCD panel could replace the 7-segment display to show more detailed data or even graphic representations of speed trends.
4. **High-Speed Motor Compatibility**: Enhancing the precision of the system's sensing and amplification components could make it suitable for motors operating beyond 9999 RPM.

In conclusion, the tachometer design outlined in this report meets its intended technical and financial requirements while remaining a practical and educational tool. The methodology, supported by a well-researched selection of components, ensures accuracy, reliability, and ease of implementation. Future developments could transform this project into a more versatile solution applicable to a wider range of industries and educational environments.

Section 6 References

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