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RTC based Countdown Timer for Exam

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Abstract: *This project implements a Real-Time Clock (RTC)-based countdown timer specifically designed for exams. The system is built using an Atmega328 microcontroller, a DS1307 RTC module, an I2C-based LCD display, and a MAX7219-based 7-segment LED display. The countdown timer allows users to set the exam duration using a potentiometer and initiate the countdown with a push button.*

The system continuously displays the real-time clock and date on the LCD while also showing the countdown timer on the MAX7219 7-segment display. A buzzer provides audio feedback at key moments such as countdown initiation, completion, and time adjustments. The system includes an interactive date and time-setting mechanism controlled via tactile push buttons.

For power, the system utilizes a 12-0-12 step-down transformer, a center-tap rectifier with 1N4007 diodes, and voltage regulation via a 7805 regulator with capacitors for stability. The setup ensures reliable operation with an uninterrupted power supply.

Keywords: RTC module , ATMEGA328, control panel

I. INTRODUCTION

Time management plays a crucial role in academic environments, particularly during examinations where students must complete their tasks within a fixed duration. To assist in effective time tracking, an RTC-based countdown timer is designed to provide a reliable and accurate timekeeping solution. This project utilizes an Atmega328 microcontroller, a DS1307 Real-Time Clock (RTC) module, an I2C-based LCD display, and a MAX7219-based 7-segment LED display to create a persistent and user-friendly countdown timer.

Traditional countdown timers often reset upon power failure, making them unreliable for critical applications like exams. The integration of an RTC module ensures that the countdown timer retains accurate timekeeping even after power loss. The system allows users to set a countdown duration using a potentiometer, displays the remaining time on an LED display, and provides audio alerts using a buzzer when the timer starts, reaches critical points, or ends.

This project is powered by a 12-0-12 step-down transformer with a center-tap rectifier and a 7805 voltage regulator, ensuring a stable and uninterrupted power supply. The combination of visual (LED, LCD) and audio (buzzer) feedback ensures high visibility and ease of use, making it an ideal solution for exam halls, classrooms, and study environments.

By integrating real-time clock functionality, user-friendly controls, and a reliable power system, this project enhances time management, efficiency, and accuracy in exam settings, ensuring a seamless and stress-free experience for students and examiners alike.

II. LITRETURER REVIEW

1. Introduction to Real-Time Clocks (RTC) in Embedded Systems

Real-Time Clock (RTC) modules, such as the DS1307, are widely used in embedded systems to keep track of time independently of the main microcontroller. Studies have shown that RTCs provide accurate timekeeping due to their battery backup functionality, ensuring time is maintained even when the system is powered off. Research in time-sensitive applications, such as attendance systems and scheduling devices, highlights the importance of RTCs in automation and precision timing.

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2. Existing Countdown Timer Solutions

Various countdown timers are available in the market, including digital clocks, mobile applications, and microcontroller-based solutions. However, most generic timers lack integration with an RTC module, meaning they reset when powered off. Studies on RTC-integrated countdown timers, especially in academic environments, indicate that having a persistent time reference enhances reliability, preventing accidental resets and ensuring consistency in exams and tests.

3. Use of Atmega328 in Embedded Applications

The Atmega328 microcontroller is a popular choice for timer-based applications due to its low power consumption, easy programmability, and compatibility with peripherals such as I2C LCD displays and MAX7219-based LED matrices. Research comparing PIC, ARM, and AVR microcontrollers suggests that AVR-based solutions (like Atmega328) provide a good balance between cost and performance, making them ideal for educational and low-cost embedded projects

4. Display Technologies for Timers

Two types of displays are used in this project:

I2C-based LCD display: Used for real-time clock and date display. Studies show that I2C communication reduces the number of GPIO pins required, making it suitable for microcontroller applications with limited I/O.

MAX7219-based 7-segment LED display: Used for countdown visualization. Research on 7-segment displays for timer applications suggests that LED-based countdowns provide higher visibility in exam halls compared to LCDs, especially in low-light conditions.

III. WORKING

The power supply unit provides a stable 5V DC for the microcontroller and other components.

- Step-down Transformer (230V to 12V AC) – Converts high voltage AC to lower voltage AC.
- Center-tap Rectifier (1N4007 Diodes) – Converts AC to pulsating DC.
- Filter Capacitor (1000µF) – Smooths the DC output, reducing voltage ripples.
- Voltage Regulator (7805) – Regulates the voltage to 5V DC for circuit operation.
- Another 1000µF capacitor is added after the regulator to eliminate the loading effect and ensure stability.

Microcontroller (Atmega328) Connections

The Atmega328 microcontroller is the central processing unit that manages communication between the RTC module, LCD display, control panel, and GSM module.

- Power Supply: VCC (Pin 7) and GND (Pin 8) are connected to the 5V power source.
- Reset Circuit: A push button is connected to the RESET pin (Pin 1) along with a 10kΩ pull-up resistor to reset the system when pressed.

Oscillator Circuit:

- A 16 MHz crystal oscillator is connected between pins 9 and 10.
- Two 22pF capacitors are connected to stabilize the oscillator.

RTC Module (DS1307) Connections.

The RTC module (DS1307) provides real-time clock data and is interfaced with the microcontroller via the I²C communication protocol.

- VCC and GND of the RTC are connected to 5V and GND, respectively.
- SCL (Serial Clock Line) – Connected to A5 (Analog Pin 5) of Atmega328.
- SDA (Serial Data Line) – Connected to A4 (Analog Pin 4) of Atmega328.

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- A 3V coin-cell battery is used to maintain timekeeping even when the system is powered off.

LCD Display (16x2) Connections

The LCD display is used to show the current time, date, and system status. It operates in 4-bit mode, requiring six connections:

- RS (Register Select) – Connected to Pin 8 of Atmega328
- E (Enable) – Connected to Pin 9
- D4, D5, D6, D7 – Connected to Pins 10, 11, 12, and 13, respectively.
- VCC and GND – Connected to the 5V power supply.
- Contrast Pin (V0) – Connected to a 10kΩ potentiometer to adjust display contrast.

GSM Module (SIM800/SIM900) Connections

The GSM module is responsible for sending SMS notifications at scheduled times. It communicates with the microcontroller using serial communication (UART protocol).

- VCC and GND – Connected to 5V and GND.
- TX (Transmit) of GSM – Connected to Pin 6 (RX) of Atmega328 via SoftwareSerial.
- RX (Receive) of GSM – Connected to Pin 7 (TX) of Atmega328.
- A SIM card with an active network is inserted into the GSM module to enable SMS functionality.

Control Panel Connections

The control panel consists of four push buttons for adjusting time and settings. The buttons are connected as follows:

- Increase Button – Connected to Digital Pin 2
- OK/Select Button – Connected to Digital Pin 3
- Decrease Button – Connected to Digital Pin 4
- Clear Variable Button – Connected to Digital Pin 5
- Each button is pulled up using a 10kΩ resistor to ensure stable operation.

Buzzer (Notification Alert) Connections

A buzzer provides an audible alert when a message is sent or a button is pressed.

- BUZZ (Buzzer) – Connected to Analog Pin A3 of Atmega328.
- The buzzer is activated when an SMS is sent or a button is pressed.

IV. CONCLUTION

The RTC-based countdown timer is a reliable, accurate, and efficient solution for managing timed events, particularly in exam environments. By integrating the DS1307 RTC module, Atmega328 microcontroller, MAX7219 display driver, and I2C LCD, the system provides a precise and user-friendly interface for tracking and displaying time.

This project ensures uninterrupted timekeeping, even during power failures, and provides visual and audio alerts to help invigilators and students stay aware of the remaining time. The integration of push-button controls allows for easy time adjustments, making it an accessible and convenient solution.

The system is highly adaptable, with potential future enhancements such as wireless connectivity, remote monitoring, automated exam bell integration, and IoT-based control. These improvements can further expand its applications beyond educational institutions into industrial, medical, and commercial sectors.

V. APPLICATION

1. Examination Halls

- Used in schools, colleges, and universities to manage exam durations accurately.
- Ensures fair and equal time distribution for all students.

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- Provides visual and audio alerts, helping invigilators maintain exam schedules efficiently.

2. Competitive Exams & Test Centers

- Useful in entrance exams (JEE, NEET, SAT, GRE, etc.) and other timed tests.
- Prevents human errors in time tracking.
- Helps candidates stay aware of the remaining time, reducing anxiety.

3. Study Rooms and Libraries

- Can be used in self-study areas to help students manage study sessions effectively.
- Assists in maintaining focused study periods by setting a fixed time for revision or practice tests.

4. Laboratories and Research Facilities

- Useful in science and engineering labs where experiments require precise countdown timing.
- Helps researchers track reaction times, incubation periods, and other time-sensitive procedures.

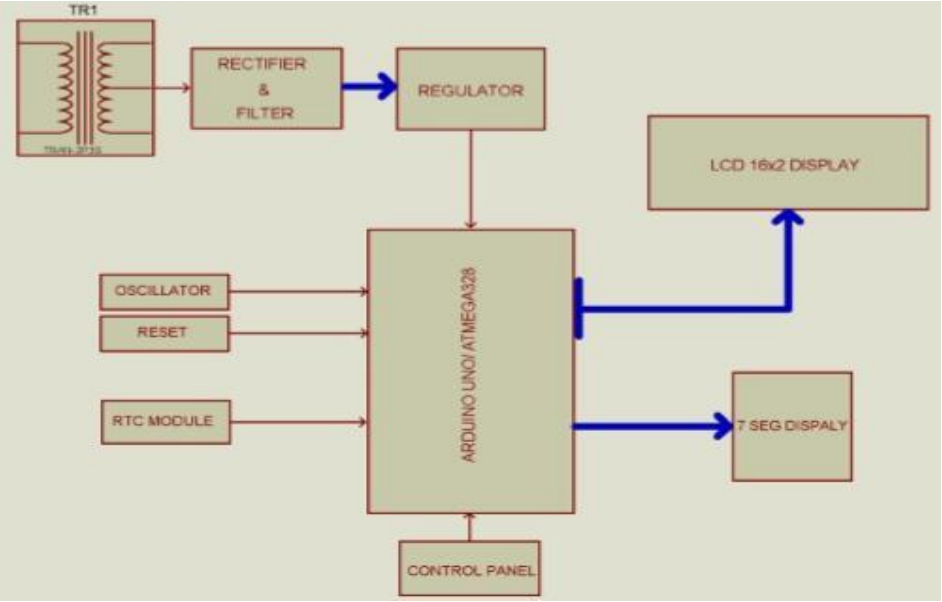
5. Sports and Fitness Centers

- Can be used in gymnasiums and training centers for timed workouts and sports practice.
- Ideal for interval training, countdown-based exercises, and competition timing.

VI. RESULT & DISCUSSION

The implementation of the RTC-based Countdown Timer for Exam Hall significant results, demonstrating the effectiveness and practicality of the system. This section discusses the outcomes of the project, evaluates the performance of the various components, and reflects on the implications of the findings.

BLOCK DIAGRAM



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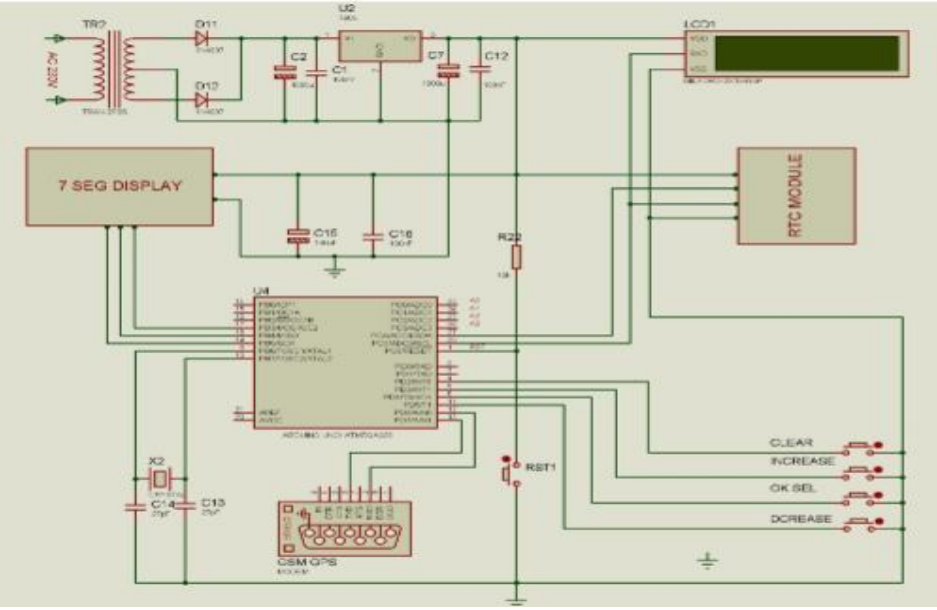
CIRCUIT DIAGRAM



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