Traffic Light Control System - Project Documentation

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1. Project Overview

1.1 Introduction

The Traffic Light Control System is an embedded project implemented using the ATmega32 microcontroller.

It simulates a real-world traffic signal using LEDs, a seven-segment display for countdown, and an LCD

for displaying messages such as "GO", "Ready", and "STOP". Timer0 is used in CTC mode with interrupts

to manage timing accurately.

1.2 Goals

• Implement a traffic light cycle including green, yellow, and red phases.

• Display real-time countdown on a 7-segment display.

• Use LCD to show traffic messages.

• Utilize Timer0 interrupts to maintain precise time intervals.

1.3 Scope of Delivery

This document describes system architecture, hardware mapping, timing control logic,

LCD and 7-segment interfacing, and testing methodology.

2. System Architecture

The system uses a single ATmega32 microcontroller interfaced with LEDs, a 7-segment display,

and a 16x2 LCD.

Component | Connected To | Function

LEDs (Green, Yellow, Red) | PC0, PC1, PC2 | Indicate traffic phases

7-Segment Display | PORTA/PORTB | Show countdown of each phase

LCD 16x2 | PORTC + PB0/PB1/PB2 | Display system messages

Timer0 | Internal | Generate periodic interrupts

3. Hardware Implementation and Pin Assignment

3.1 LED Interface

• Green LED → PC0

• Yellow LED → PC1

• Red LED → PC2

3.2 Seven-Segment Display

• High nibble and low nibble used to show two-digit countdown.

• Controlled by PORTA and PORTB depending on wiring configurations.

3.3 LCD Interface

Data lines → PORTC (PC0–PC7)

Control lines:

RS → PB0

RW → PB1

EN → PB2

3.4 Timer0 Configuration

• Mode: CTC (Clear Timer on Compare Match)

• Prescaler: As configured for 1ms tick

• OCR0: Adjusted to generate 100 interrupts = 1 second

4. Software Design and Functional Flow

4.1 Initialization

• Initialize LCD, 7-segment, LEDs, and Timer0.

• Setup interrupt for Timer0.

4.2 Traffic Light Sequence

Green Phase:

• Turn on green LED

• Display "GO" on LCD

• Countdown from 30 to 0 on 7-segment display

Yellow Phase:

• Turn off green LED, turn on yellow LED

• Display "Ready"

• Countdown from 5 to 0

Red Phase:

• Turn off yellow LED, turn on red LED

• Display "STOP"

• Countdown from 20 to 0

4.3 Timer0 ISR

• A volatile counter increments every interrupt.

• When counter reaches 100, one second has passed.

• Countdown variable is decremented and 7-segment updated.

5. Use Case

The project can be used in:

• Embedded systems laboratory experiments

• Traffic light simulation demonstrations

• Educational environments to teach microcontroller timing and control

6. Testing & Validation Checklist

Test Case | Description | Expected Result

LED Functionality | Test each LED | Correct LED lights

7-segment countdown | Monitor 30,5,20 cycles | Correct decrementing

LCD messages | Check phase messages | Displays GO/Ready/STOP

Timer accuracy | Measure 1-second intervals | ISR increments correctly

7. Conclusion

This project demonstrates the integration of LEDs, timers, LCD modules, and 7-segment displays to create a fully functional traffic light simulation using ATmega32.