

**Embedded Systems Course**

**Traffic Light Controller**

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**Introduction**

The traffic light controller is a vital component of modern traffic management systems. It regulates the flow of traffic at intersections, ensuring smooth and safe movement of vehicles. In this report, we present a traffic light controller designed using the PIC16F877A microcontroller from Microchip Technology.

**Microcontroller Selection**

The selection of the appropriate microcontroller is a crucial step in developing a reliable and efficient traffic light controller. After careful consideration of various factors, the PIC16F877A was chosen as the optimal microcontroller for this project. Its 8-bit architecture, robust feature set, ample flash program memory (14KB), and 368 bytes of SRAM make it well-suited for handling the complex logic required in traffic control applications.

**System Overview**

The traffic light controller developed in this project operates on a well-defined traffic light sequence that includes three primary states: Red, Yellow, and Green. The controller effectively manages the timings for each state, ensuring seamless traffic flow and adherence to traffic regulations.

**Hardware Design**

The hardware design of the traffic light controller comprises a carefully selected set of components to facilitate efficient traffic light operation and reliable performance. Key components include the following:

1. A circuit board with many wires

   Description automatically generated**PIC16F877A microcontroller:** Serving as the core processing unit, it coordinates the traffic light timings and state transitions.
2. A diagram of a circuit

   Description automatically generated**LED modules:** These modules, incorporating high-intensity LEDs for Red, Yellow, and Green lights in both directions, clearly indicate the current state of each traffic light.
3. **Current-limiting resistors:** These resistors are placed in series with each LED to ensure that the LED operates within its safe current range and to protect against excessive current flow.
4. **Push buttons:** Manual override functionality is incorporated through push-buttons, enabling traffic light state control during exceptional situations or maintenance.

A screen shot of a video game

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1. A diagram of a circuit

   Description automatically generated**Crystal oscillator:** A precise crystal oscillator is integrated to ensure accurate timing and synchronization of traffic light states.
2. A diagram of a circuit

   Description automatically generated**Power supply and decoupling capacitors:** A stable power supply and appropriate decoupling capacitors are used to ensure reliable and glitch-free operation of the microcontroller and associated components.
3. **7-Segments Common Anode, 7447 ICs and PNP transistors:** These displays play a crucial role in displaying countdown timers, providing real-time information to pedestrians and drivers about the time remaining for a particular light state. 7447 ICs provide a way to accept BCD as input and converts it into corresponding seven segment code.

A diagram of a circuit board

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**Software Design**

The software implementation of the traffic light controller is a critical aspect that governs the sequencing and timing of traffic light states and the management of the countdown timers displayed on the 7-segment displays. Developed in the C programming language and compiled using the mikroC PRO for PIC, the software incorporates an array of sophisticated functionalities, ensuring precise control and synchronization of the traffic light sequence and countdown timers. The core components of the software implementation include:

**Initialization:** The software initializes the PIC16F877A microcontroller, configures the I/O pins for the LED modules, 7-segment displays, and push buttons, and sets up timers and interrupts to facilitate accurate timing.

**Main Event Loop:** At the heart of the software lies the main control loop, a designed algorithm that efficiently manages the traffic light timings and state transitions. This includes the following key states:

* **Green State:** During this state, the traffic light controller illuminates the Green LED for the main road, while keeping the lights on the other direction's traffic signal in the Red state, allowing vehicles on the main road to proceed. The 7-segment display simultaneously shows the countdown timer for the Green state.
* **Yellow State:** The traffic light controller smoothly transitions from the Green state to the Yellow state, providing a cautionary signal to alert drivers of an impending change in the traffic light. The 7-segment display indicates the countdown timer for the Yellow state.
* **Red State:** In the Red state, the traffic light controller illuminates the Red LED for the main road, while keeping the lights on the other direction's traffic signal in the Green state. This facilitates safe crossings for pedestrians and vehicles on the secondary road. The 7-segment display displays the countdown timer for the Red state.

**Manual Override:** The software implements a comprehensive mechanism to monitor the state of push buttons, allowing for manual override control. In exceptional circumstances or during maintenance activities, this feature enables traffic light state alterations to ensure smooth traffic management.

**Conclusion**

The traffic light controller, based on the PIC16F877A microcontroller, stands as a robust and efficient solution for traffic management at intersections. Its intelligent coordination of traffic light sequences, smooth state transitions, and real-time countdown timer displays on 7-segment displays contribute to enhanced safety and improved traffic flow for both vehicles and pedestrians. The selection of the PIC16F877A microcontroller showcases its prowess in traffic control applications, offering a blend of advanced features, ease of programming, and cost-effectiveness.

Overall, the PIC16F877A-based traffic light controller exemplifies the power and flexibility of microcontrollers in addressing complex real-world challenges, making road intersections safer, and contributing to the seamless flow of traffic in cities and communities.