Application Note Template

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1 Design Overview

This project involved creating a node in an individually addressable RGB LED strip. The node consisted of an MSP430G2553 on a development board with an RGB LED attached to it. The node performed communications with previous and subsequent nodes over a custom UART protocol. The brightness and color of the RGB LED was controlled by PWM outputs from the MSP430.

1.1 Design Features

These are the design features:

- Control brightness and color of the LED via PWM outputs from the MCU
- Receive and send commands from the previous and to the next node over a custom UART protocol

1.2 Featured Applications

These are the featured applications:

- RGB LED strip with any number of individually addressable LEDs
- Basic display using a array of RGB LEDs (Frame rate will greatly depend on the number of nodes used)

1.3 Design Resources

Here is a link to the code created for the project: `https://github.com/Intro-To-Embedded-Systems-milestone-1-smootz6`

1.4 Block Diagram

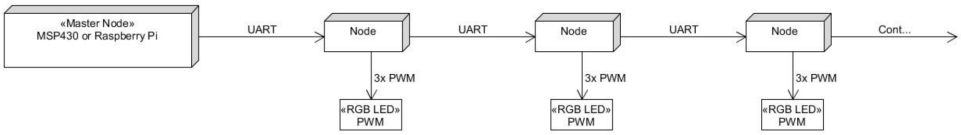

Figure 1: Block diagram of several nodes connected together

2 Key System Specifications

These are the system specifications:

- Control brightness and color of the LED via PWM outputs from the MCU
- Receive and send commands from the previous and to the next node over a custom UART protocol

3 System Description

This system is a node that can be used in an individually addressable RGB LED strip. The node consists of an MSP430G2553 on a development board with an RGB LED attached to it. The node performs communications with previous and subsequent nodes over a custom UART protocol. The brightness and color of the RGB LED can be controlled by PWM outputs from the MSP430.

3.1 Detailed Block Diagram

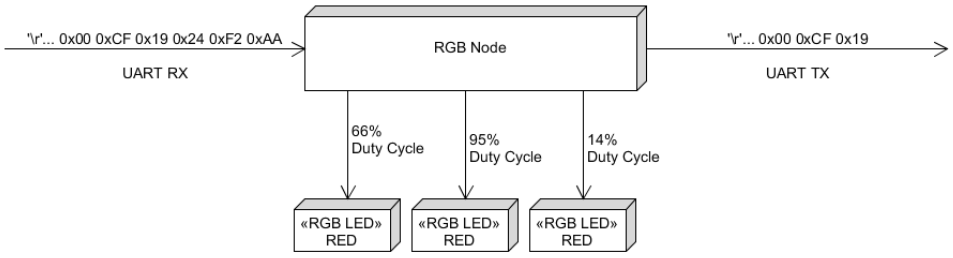

Figure 2: Detailed block diagram of an RGB node

3.2 Highlighted Devices

These are the highlighted devices:

- MSP430G2553
- RGB LED

3.3 MSP430G2553

The MSP430G2553 is the micro-controller at the center of the node. It handles receiving, processing and transmitting messages over UART, as well as generating the PWM signals for the RGB LED based on those UART messages.

3.4 RGB LED

Controlling this RGB LED is the entire purpose of the system. It has 4 pins, one anode for each of the colors that can be controlled via PWM from the MCU, and a common cathode.

4 SYSTEM DESIGN THEORY

There are 2 major design requirements for this system, UART communication, and PWM generation.

4.1 UART Communication

UART is used for communication between the nodes to indicate what color and intensity each LED should be.
A message contains the following:

- A length byte to indicate the length of the message
- Many sets of 3 bytes, with each set indicating the R, G, and B values of one LED
- An end of message byte

For one node to parse a message, the following set of actions is performed:

- The length byte is read, and that length minus 3 is transmitted
- The 1st set of 3 bytes are read, and the R, G, and B values of the node's LED are set
- The remaining bytes are transmitted as they are received.

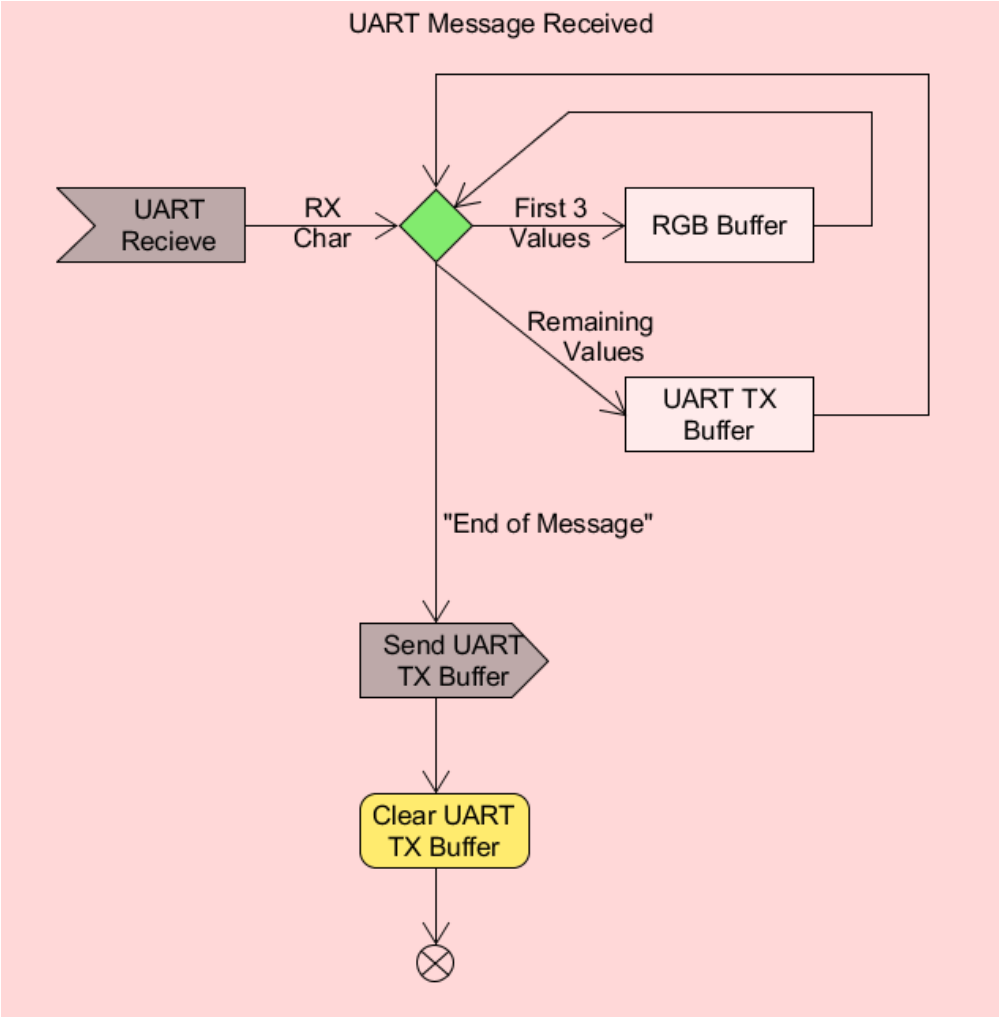

Figure 3: Block diagram showing required steps in processing the UART messages

4.2 PWM Generation

3 PWM signals need to be generated for driving each color of the RGB LED. These PWM signals are generated from the hardware PWM features in the timer modules in the MSP430. The duty cycles and periods of each PWM signal are controlled by modifying the CCR registers of the timers.

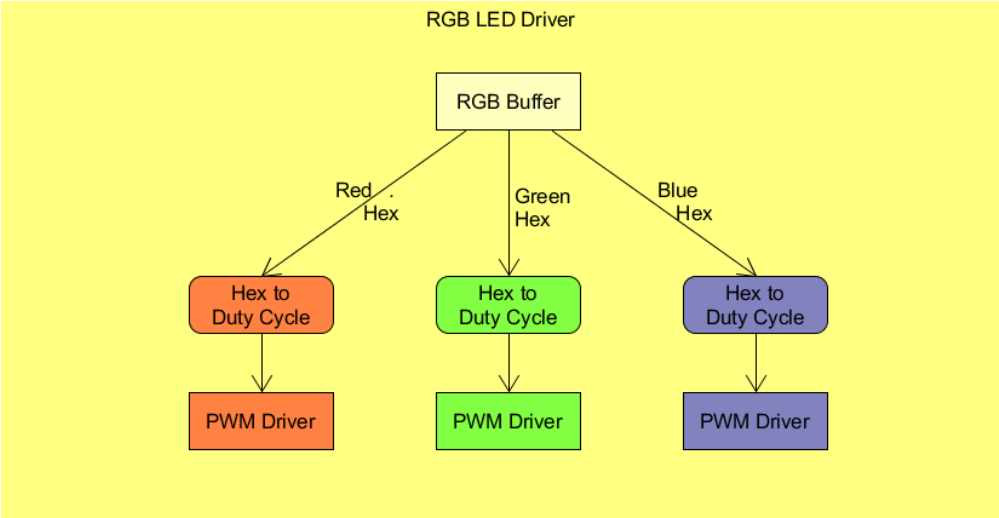

Figure 4: Block diagram showing required PWM signals

5 Getting Started/How to use the device

This devices communicates over UART at 9600 baud rate. Protocol used can be seen below in the figure below.

Byte Number	Contents	Example
Byte 0	Number of bytes (N) including this byte	0x50 (80 bytes)
Bytes 1-(N-2)	RGB colors for each node	0xFF (red) 0x00 (green) 0x88 (blue) ...
Byte N-1	End of Message Character	0x0D (carriage return)

Figure 5: Messaging Protocol

Simply hook up to the RX and TX pins on the dev board and start sending bytes!

6 Test Setup

To test the device, connect the board to the terminal of your choice and send a message. If you receive the correct response, and the LED changes to the correct color, it works!. Verify with other messages, and try to include as many edge cases as possible.