Milestone 1 - Communicating with Will Byers

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1 Design Overview

Our main design goal was inspired by a scene on a Netflix TV show called Stranger Things. The idea is to create a serial communication between RGB LEDs. Each LED will have a nodes and by using Universal Asynchronous Receiver-Transmitter (UART) communication Protocol each RGB will be addressable by using the nodes. Over the UART RX line each node will receive a string of hex values. The 3 least significant bytes then will be transformed into duty cycles.

In our design, we have implemented a hardware Pulse-width modulation(PWM). We have chosen MSP430F5529 micro-controller since the timer A0 of the board has 5 capture/compare registers(CCR). Timer A0's TA0.0 - TA0.3 have been used to store the duty cycles of the respective LEDs. Once our node receives the string of hex values through the UART RX line, it takes away the 3 least significant bytes and transmit the rest of the value through the TX line of the UART.

1.1 Design Features

These are the design features of our implementation:

- Hardware Pulse-width Modulation
- Universal Asynchronous Receiver-Transmitter Protocol
- Implemented on MSP430F5529
- Used Timer A0's 4 out of 5 capture/compare registers(CCR)
- Receives string of Hex value through UART RX line
- Takes off the 3 least significant Bytes
- Transmit the rest of the HEX value through UART TX line

1.2 Featured Applications

- UART Communication Protocol
- MSP430F5529
- Hardware Pulse Width Modulation(PWM)

1.3 Design Resources

Implementation File:
`https://github.com/RU09342-F18/milestone-1-createanewteam/blob/master/MSP430F5529LP_Milestone_1/main.c`

1.4 Block Diagram

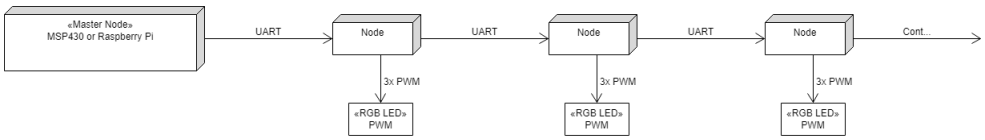

Figure 1: Overall Architecture

1.5 Board Image

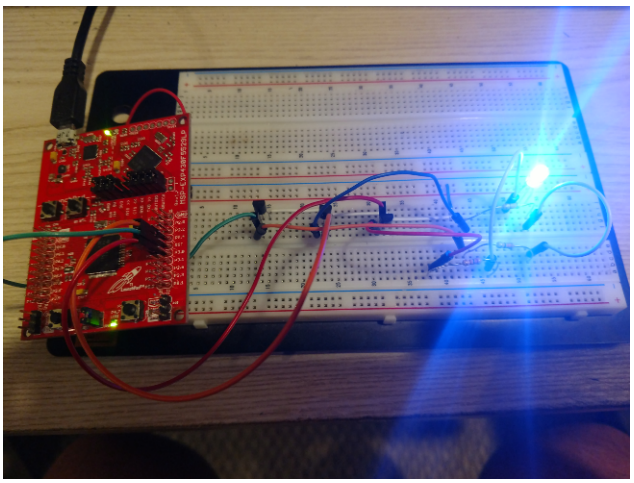

Figure 2: Board Image

2 Key System Specifications

You can organize these as a table. This is meant to talk about the specifications which your system is capable of performing. I highly recommend looking up a LaTeXtable generator online.

PARAMETER	SPECIFICATIONS	DETAILS
Red LED V_F	2 V	The Forward voltage of the Red LED is 2 V.
Green LED V_F	2.2 V	The Forward voltage of the Red LED is 2.2 V
Blue LED V_F	3.3 V	The Forward voltage of the Red LED is 3.3 V

3 System Description

3.1 Detailed Block Diagram

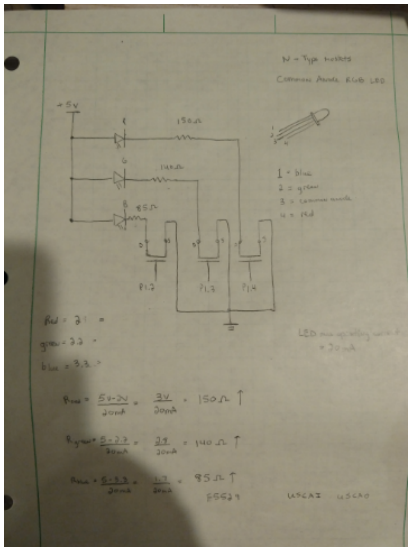

Figure 3: Detailed Block Diagram

3.2 Highlighted Devices

- MSP430F5529: Our project uses the timers in this micro-controller for pulse width modulation purposes.

3.3 Device/IC 1

The CPU in MSP430F5529 is characterized by the specific feature it incorporates such as calculated branching, table processing, and use of high-level language such as C. The CPU also has a Reduced Instruction Set architecture (RISC). Some of the components that are included in the CPU are a Program Counter(PC), Status Register(SR), Stack Pointer(SP). The address bus is a 20-bit bus and it also has a 16-bit data bus.

3.4 Device/IC 2

We have used the 5v output of the MSP420F5529 pin to drive the RGB LED. Since The forward voltage of the Red, Green and Blue Diodes in the LED is different, we have done the following calculation to come up with the right circuitry.

$$Red = \frac{5V - 2V}{20mA} = \frac{3V}{20mA} = 150\Omega \tag{1}$$

$$Green = \frac{5V - 2.8V}{20mA} = \frac{3V}{20mA} = 140\Omega \tag{2}$$

$$Blue = \frac{5V - 3.3V}{20mA} = \frac{1.7V}{20mA} = 85\Omega \tag{3}$$

4 SYSTEM DESIGN THEORY

The overall operation of this project is to use a UART communication protocol to serially connect different LEDs and be able to address each LED using a string of hex values. Each of the individual LEDs in the system will have a node that they can connect to. The major parts of the system are the timers that are used for pulse width modulation(PWM) and USCI UART mode. The string of HEX values will be received through the UART's RX line and after the 3 least significant byte are taken and used to control the PWM, the rest of the HEX values will be transmitted to the next node via TX line of the UART.

4.1 Design Requirement 1

In order to be able to use the hardware pulse width modulation by using the MSP430F5529, it was important to design the circuitry of the LEDs. we have calculated the resistance value that was needed to divide the 5V DC output from the launchpad. We have subtracted the Potential difference between the Power source and divided it with the current to find the Resistance value.

5 Getting Started/How to use the device

First of all the common anode LED needs to be connected to the 5V output of the microprocessor. Pin1.4 of MSP430F5529 drives the RED diode in the LED. A 150Ω resistor should be placed in between. Pin1.3 of MSP430F5529 drives the Green diode in the LED. A 140Ω resistor should be placed in between. Pin1.2 of MSP430F5529 drives the Blue diode in the LED. A 85Ω resistor should be placed in between.

The string of Hex Value should be fed into the RX pin of the Microprocessor and the TX line should be connected to the next node in the serial connection. That way the rest of the hex value can be transmitted to the next node in line.

5.1 Hierarchy Chart

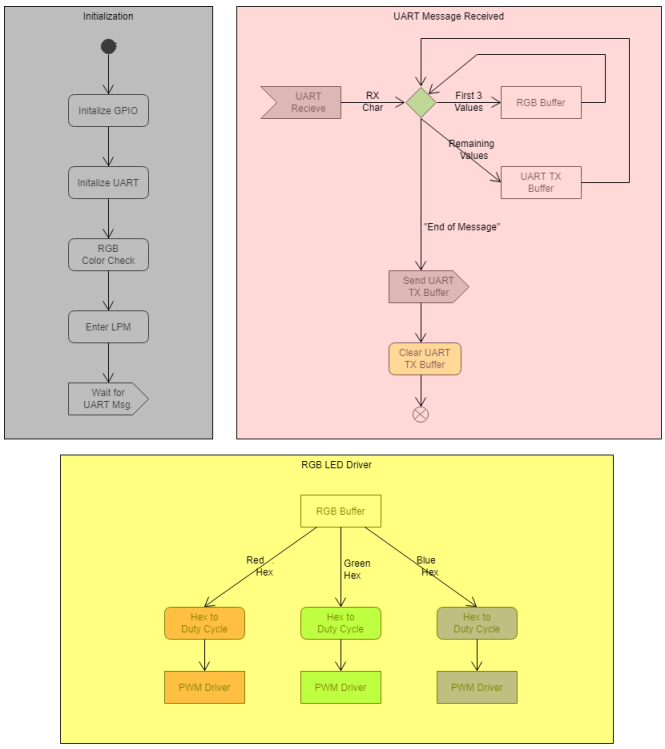

Figure 4: Flow Diagram