
Hardware Design Considerations for a Wireless LED Based Display Design

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ABSTRACT

LED's are a better way to illuminate any kind of sign. Advances in processor or design, display technology and lithium batteries have LED to a new generation of powerful, compact and cost efficient. One of the applications of LED's is scoreboards. A scoreboard is a board for publicly displaying the score in a game played between two teams. Most levels of the sport use at least one scoreboard for keeping score, measuring time and displaying statistics. In these, digits are often composed of large dot-matrix or seven segment displays made of incandescent bulbs or light emitting diodes. An official or neutral person will operate the scoreboard using a control panel i.e., IR Remote control. The main objective of this project to display LED's values which are transmitted wireless by using MSP430 microcontroller device. The MSP430 device is selected to interface between the IR communication module and the display module. This application report is only for displaying numerals on the scoreboard but the same concept can be applied to display alphabets. A scoreboard that is used as an inside display for inside sporting events is selected for this project.

Keywords: MSP430F5529 microcontroller, IR remote, TSOP Decoder, SMD LED module.

INTRODUCTION

SMD LED's used in the scoreboard are quite small since it has no leads or surrounding packaging that comes with a standard LED. Two main factors determine whether a display can be used inside or outside. The first factor is weather durability and secondly, outside displays use different LEDs than inside displays. This means it's best handled, not by a human, but by automated assembly equipment. For instance, here I am using for indoor display screens. SMD LEDs work well because you can arrange a large number of diodes in tight groups of red, blue and green, generating a large variety of colors. This LED gives high brightness while it has lower power consumption than of a normal LED light tubes (e.g. dip or cluster led) and traditional light bulbs. The purpose of this project is to provide generic information by displaying numerical on the scoreboard which is transmitted wirelessly with the help of IR Remote module by using MSP430F5529 microcontroller. RC5 is an encoding standard used in infrared remote control signal transmission. The TSOP 1738 decoder is a member of IR remote control receiver series, supporting all major transmission codes.

OBJECTIVE

The main objective of this project is to display LED's values which are transmitted wireless by using MSP430 microcontroller device. The recommended design provides information regarding LED display which is specifically designed for either inside or outside use. The MSP430 device is selected to interface between the IR communication module and the display module.

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Objectives of this paper is understanding MSP430 controller and all specifications like power requirements I/O ports availability, IR Remote control module for communication purpose, SMD LED and Embedded C code development is in CCS4 IDE. Finally understanding the interfacing of IR remote control module and display module is done with MSP430F5529 controller.

The rest of this paper is written as follows. In section III, operation principle is introduced. Section IV originates the hardware implementation for SMD led display. Section V clarifies about firmware implementation. Section VI explains about working procedure and results. Future scope and conclusion are presented in section VII.

OPERATING PRINCIPLE

In this project, the IR remote control module is used to operate consumer electronic devices. The hardware design consideration for a wireless SMD LED based display design consists of two modules: IR transmitter section and IR receiver section.

A. Infrared Remote Control

High performance infrared remote control systems are perfect for industrial and home based applications where accidental operations are undesirable. It increases operator safety and productivity. The scoreboard is controlled by IR remote, even when if there is no witness for the players, they still can add their scores by the remote control without going up to the board as other regular scoreboards.

B. Infrared

Infrared(IR) is invisible radiant energy, electromagnetic radiation with longer wavelengths than those of visible light, extending from the normal red edge of the visible spectrum at 950 nm. The main technology used in LED remote controls is infrared (IR) light. There must be a line of sight between the transmitter (light source) and the receiver (light detector).which is invisible to the human eye. The human eye can see in the visible light portion of the spectrum chart as shown in below fig.1

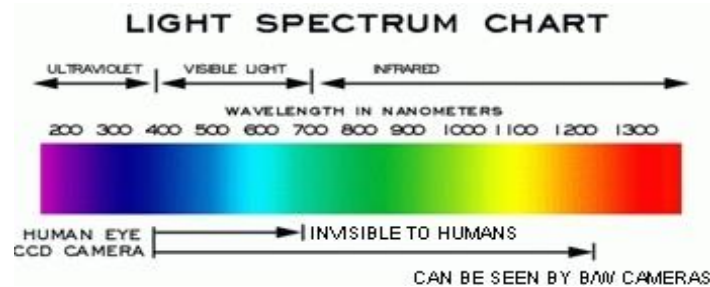


Figure2. Light Spectrum chart

Take a TV remote and press a button while pointing it at camera for a simple demonstration of how a camera can see IR as shown in fig.2

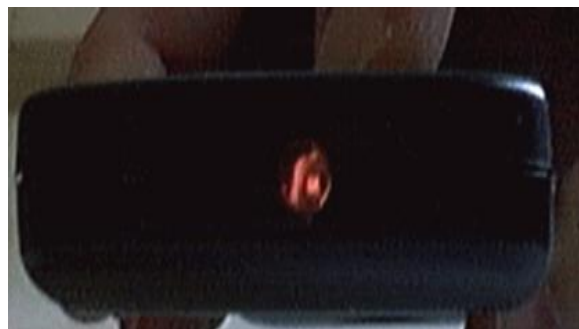


Figure2. Infrared Light

C. IR Modulation

The infrared light is emitted from an IR led controlled by the modulated signal from the transmitter’s MCU. Modulation can help the receiver distinguish the desired signals from all other infrared noise sources. The modulation is done by RC5 modulation protocol

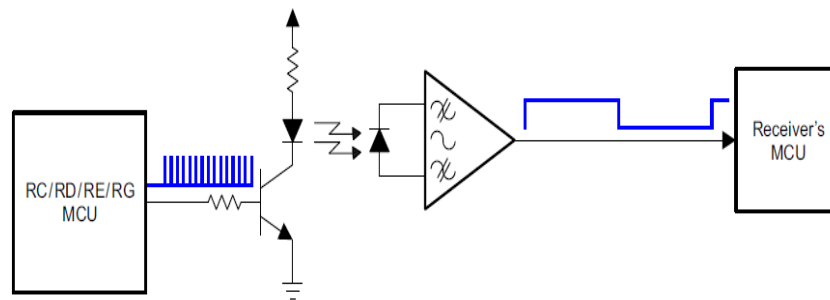


Figure3. Signal modulation

In fig.3, IR modulation is a technique that involves PWM an infrared led at certain 36 KHz frequency. The demodulated signal can be directly connected to the receiver’s MCU for decoding.

D. RC5 Protocol

A feature of bi-phase encoding (Manchester coding) is that the encoded signal will consists entirely of pulses signal high and signal low either a full duration. The encoder accepts data and control signals, encodes commands and outputs the commands to a suitable LED transmission circuit.

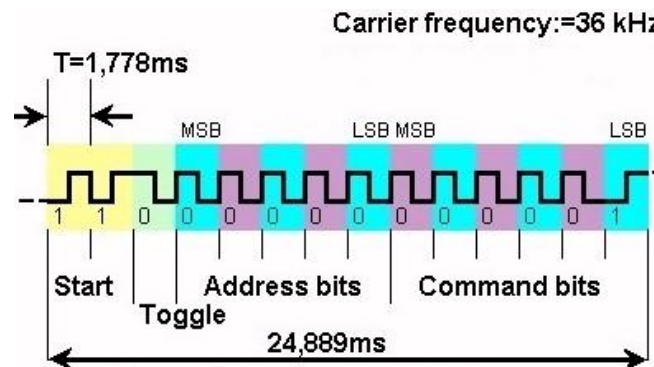


Figure4. RC5 Protocol

E. Communication

Wireless communication, as the term implies, allows information to be exchanged between two devices without the use of wire or cables. A wireless keypad sends information to the computer without the use of a keypad cable. Information is being transmitted and received using electromagnetic radiation. By controlling the spacing between the transmitted modulated signals, the waveform can be read by an input pin on a microcontroller and decoded as serial bit stream. The distance between the remote and the display is less than 20ft and the front of the sign are easily accessed. The message is changed infrequently and therefore storing all of the possible messages is not necessary.

HARDWARE IMPLEMENTATION

In this project, hardware design considerations for a wireless LED design consists of two modules. Firstly IR transmitter in which systems is trained by the individuals who will be using the system which consists of IR Remote.

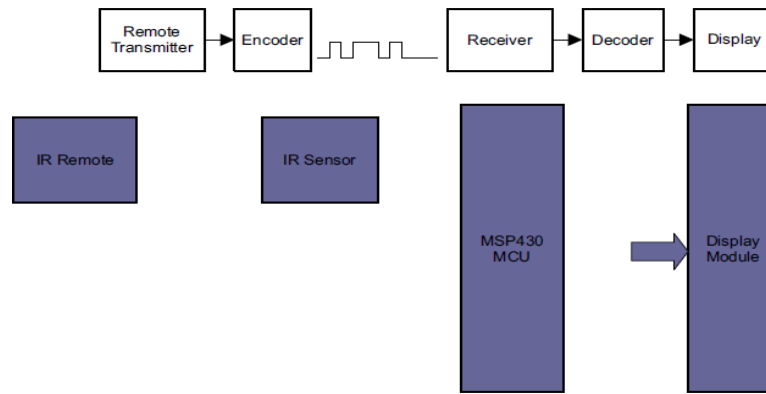


Figure5. Block Diagram

Secondly receiver section in which systems is trained to respond to a transmitter signal which consists of microcontroller, led scoreboard and making programming features possible and operate properly.

A. IR Transmitter

As we know remote control devices uses IR light. This is invisible light about 950nm wavelength. In order to exclude other sources, IR signal is modulated by some frequency and receiver has to be tuned for this frequency. Mostly remote controls transmits IR signal using 36 KHz frequency signals. Transmitting and coding is one part which can be done easily than receiving and decoding. When a key is pressed in remote control the processor wakes up to transmit the appropriate IR command otherwise it remain in low power sleep mode.

B. IR Receiver

The easiest way to receive the pulse sent from transmitter is to use an integrated IR receiver module like TSOP1738. This TSOP1738 receiver simply removes 36 KHz carrier signal and gives clean pulses that are used for device control. Members of TSOP17XX series are sensitive to different center frequencies of the IR spectrum. This can be used for remote controls burglar alarms etc.

C. MSP430F5529 Microcontroller

MSP430F5529 Micro controller series is an ultra-low power mixed signal microcontroller. This series are able to run up to 25 MHz, have up to 256 KB flash memory and up to 18 KB RAM. This flash based family features low active power consumption with up to 25 MIPS at 1.8V-3.6 V operation and fully integrated LDO with programmable regulated core supply voltage. The controller is the heart of the hardware circuit. The MSP430 microcontroller device is selected to interface between the IR communication module and the display module.

D. Light Emitting Diode

SMD LED stands for surface mount LED. It's a light emitting diode that is mounted onto and soldered onto a circuit board and used in indoor display screens.



Figure6. SMD LED

The above fig.6 is an SMD LED with seven segment technique. It works with low current operation, excellent numerical appearance and easy mounting on P.C. boards. Location of use; either inside or outside, viewing angle and time, communication method used and character or numerical size should be considered when selecting an LED scoreboard.

Different techniques can be used in this project for display scoreboards such as dot matrix, seven segment display, TLC5940 (16 channel) device or TLC5947 (24 channel) device. In this project I am using SMD LED with seven segment display. The LEDs are controlled by three SN74LS47N shift registers. This SN74LS47N is an open-collector outputs drive indicators directly and leading/trailing zero suppression.

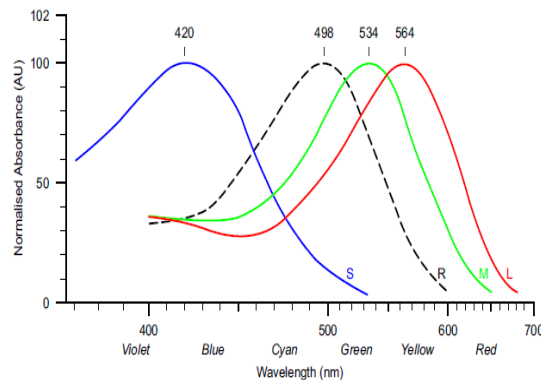


Figure7. Absorbency

A broad range of wavelengths of infrared light spectrum is at 750nm to 1mm is used in this project. The broadest range of visible LED light is red color. Because of the cones in the human retina, the red and yellow colors are best seen by the human eyes. The scoreboard in this application displays red numbers and is clearly visible at a minimum of 30ft.

FIRMWARE IMPLEMENTATION

The development environment used in this project is Code Composer Studio4 (CCS4). Code Composer Studio4 (CCS4) is an integrated development environment for TI’s DSPs, microcontrollers and application processors. Code Composer Studio includes a suite of tools used to develop and debug embedded applications, project build environment and many other features. The following are the steps for the firmware implementation

1. Open CCS and select a workspace directory.
2. Select project > Import Existing CCS/CCE Eclipse Project.
3. Browse to the extracted project directory.
4. Make sure the project is selected and click Finish.
5. Connect the MSP-EXP430F5529 Experimenter Board “eZ-FET” USB to the PC.

After the program is compiled and the build is complete a .hex file is generated in .exe folder in the project directory. Then the .hex is programmed to the MSP430 device.

WORKING PROCEDURE AND RESULT

A. Working Principle

The main objective of this project is to use Infrared frequency signal to control the SMD LED scoreboard display. IR remote control consists of keypad is used to send information to receiver side.

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The microcontroller device is selected between the IR remote and display module. The microcontroller receives the IR frequency signal from the receiver and it decodes and display information on the scoreboard display. All this process is controlled by MSP430F5529 microcontroller. The distance between the IR remote and display is 20ft.

B. Result

The implementation of “Hardware Design Considerations for a Wireless Based LED Display Design” is done successfully. Communication between peripheral modules and microcontroller is properly done.

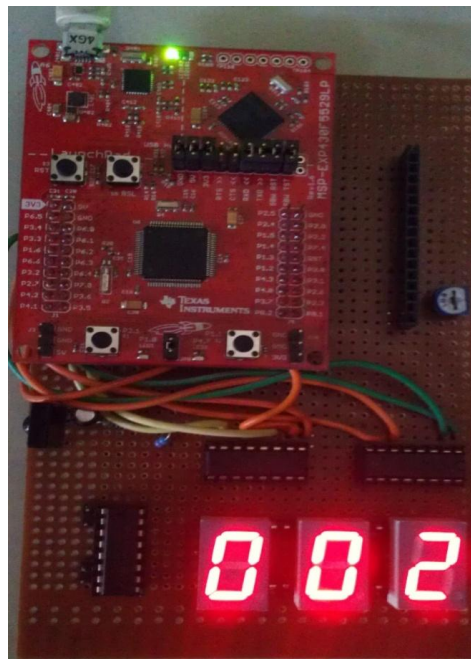


Figure8. Scoreboard before Increment

The above figure shows scoreboard before increment and the following figure shows scoreboard after increment.

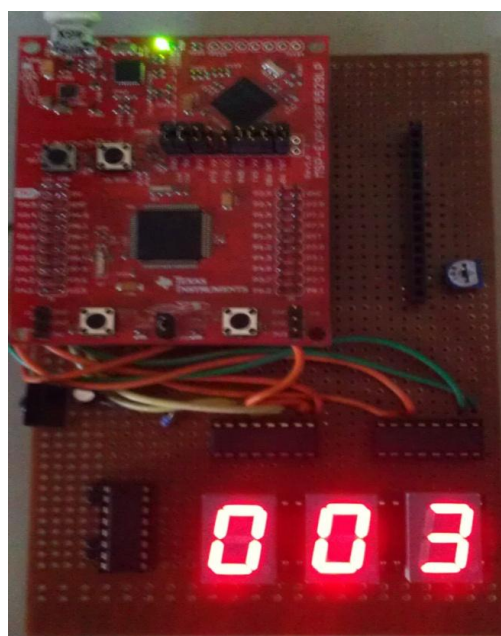


Figure9. Scoreboard after Increment

CONCLUSION AND FUTURE SCOPE

A. Conclusion

In the end, there's no question in the digital age for sport stadiums that brightness, high definition scoreboards are an integral part of a stadium. In sports, this is a win-win for everybody the owners get a better stadium and fans are ecstatic.

B. Future Scope

SMD LED technology has immense scope for improvement. The displays of the future will be stretchable, deformable into any shape, twistable and perhaps more importantly durable, efficient and cheap. This is the promise of a new approach for manufacturing inorganic light emitting devices.

C. Advantages

- Safe under all conditions of normal use and health.
- Compared to other LED's, the SMD LED's has long life span.
- Faster response times.

D. Applications

The applications of SMD LED's are:

- Aviation
- Automotive lighting applications
- Traffic signals
- Transmitting information from remote control units and in digital clocks.

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