International Journal of Latest Engineering and Management Research (IJLEMR)
ISSN: 2455-4847
www.ijlemr.com Volume 1 Issue 3 ǁ April 2016 ǁ PP.01-04

Design and implement customized CMOS driver for ILED colour tunable display using FPGA

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ABSTRACT *:* *Inorganic LEDS have attractions over conventional liquid crystal technology and original LEDS(OLEDS) such as high efficiency and brightness, reliability and stability, capability under harsh temperature conditions. But, the main problem with organic LED`sis to design a simplified driver which can be controlled with a single signal instead of 3 digital data segments(RGB). We have to design a CMOS drivers for producing emitting different colours with various spectrums of high efficiency. Here we are using a variable resistor as a single signal to beread by our controlling system (FPGA). The variable resistor is connected to analog to digital converter (ADC) and that converted data is sent to FPGA kit for data analysis. The analysed data is a gain transferred to digital to analog converter (DAC).This converted signal is fed to a tri color LED to produce RBG spectrums. By this,we can able to produce different colors in the same LED with high efficiency and intensity using a single signal*

KEYWORDS - *colortunability , microdisplay , visible light communications (VLC**),** Micro Light Emitting Diodes,Colour Controlled display*

I. INTRODUCTION

Inorganic LEDS have more attractions than conventional liquid crystal technology and organic LEDS.Inorganic LED's has high efficiency, brightness, reliability and the capability under harsh temperature conditions compared with LEDs and OLEDs.These LEDs are fabricated from the semi-epilayer usually emits the light at a single colour determined by the specific quantum well structure.So, inorganic LEDs are less used in flat panel screens for television, computer and mobile devices.On the mechanical packaging the separated LED devices for emitting different colours(R, G, B) from a multicolour unit (Pixel). The integration of monochromatic LEDs with different colour converters such as organic polymer blends and semiconductor Nano-crystals are observed for attaining this. There have been several reports on differential growth methods to achieve colour tunability of inorganic LEDs and their potential in multicolour display with different spectrums using InGaN structure. To implement the micro display system, we have to fabricate a dedicated micro pixel LED array from this InGaN structure, interface it to a CMOS driver array, and show direct display performance and colour tuning under the CMOS control board integrated with a field-programmable gate array(FPGA) configuration.

II. DEVICE DESIGN AND FABRICATION

The LED wafer used for the micro display fabricationwas grown on a sapphire by the process of metal organic chemical vapour deposition. The low-indium-content blue QWs function as an electron reservoir and pre strain-relaxation layer for improving the radiative substrate efficiency, the micro LED device used for the micro display demonstration was fabricated by using a similar process to that previously reported. The light is extracted through the polished sapphire substrate of the device. It shows the current voltage and corresponding optical power versus driving current curves of a typical display segments such as LED pixel, driven by CMOS under dc conditions at room temperature.

The CMOS driver chip, which consists of an individually controllable driver cells on a center-to-center pitch. It contains a bump bonded onto a corresponding CMOS driver cell, which contains of a bonding pad and dedicated logic circuit. Each bonded CMOS driver functions as a high-speed switch to control the output of each LED pixel according to the state of input trigger signal. The input trigger signals for each CMOS driver cell, this micro display system is capable of delivering dynamic images. The FPGA unit allows the micro LED array to deliver video images by distributing input signals for CMOS drivers according to the computer instructions programmed by hardware description language and also powers the whole micro display system using the power supplied from a computer USB port

III. Experimental Details and Results

A significant blueshift of the emission wavelength of the main QWs is observed as the injection current is increased. Both the screening of the quantum-confined stark effect in polar QWs and the band-filling effect can

lead to this blueshift. The blueshift of the spectra is mainly caused by the band filling effect, since the Piezo-electric field is almost completely screened in the high-current-density regime. when increasing the injection current from 0.1mA to 80mA then the main emission peak wavelength of the micro LED shifts from 600nm-550nm and saturates at 550nm.Where the micro LED is from the main QW's, it is more dominant to the blue QW's, which is probably due to long hole-migration distance between the blue QW's and the p-GaN layer.
The co-ordinate curve according to the injection current is dependent on normalized EL spectra. This CIE curve shifts from the red region to the green region with increasing the injection current, indicating a distinct and direct colour change of the light emitted by the micro LED. Three micro LED images with different colours, corresponding to the three CIE coordinates are observed.A current dependent spectral shift is generally undesirable for applications where a constant emission is required. However, utilizing this characteristic of the LEDs, it is feasible to demonstrate a colour tunable or multicolour micro display system based on a has many advantages such as the elimination of using inorganic/organic colour converters and LED die`s emitting at other colours, thereby reducing the production cost and enabling a more compact design. Knowing that the apparent average brightness of each pixel under pulsed operation can be tuned by changing the duty cycle, specifically designed active CMOS driver electronics have been used to drive the LED array. To control the state of LED using an external source, the trigger signal should be first adjusted to reach the logic threshold of the CMOS electronics and then sent to the CMOS chip to modulate the CMOS drivers directly. The trigger signal used here is a square wave with a peak-to-peak voltage of 5V and a period of 20 ms (frequency of 50 Hz).
Its duty cycle is adjustable and using this pulse width modulation to normalize the power of LED pixels emitting at different colours does not influence the capability of the micro display to deliver animated images. The change of colour caused by the small redshift is not noticeable by the human eye and is thus not a real problem for the micro display. This is very important for the multicolour demonstration when the LED is operated at different colours with comparable brightness. The reason for that changing in brightness of the LED without changing its colour significantly is due to the short turn-on and turn-off time of the LED. The peak current remains basically the same when the LED is turned on regardless of the duty cycle, In the duty-cycle-dependent EL measurement, the LED device was drivenat long enough time to reach stable EL emission at each duty cycle, and we repeated this measurement three times. Each measurement took about one hour, and we did not observe any obvious redshift at higher duty cycle in each measurement. There are two possible reasons to explain why the redshift is very small for our devices approximately identical average output power for each pattern was achieved by driving the LED array with different duty cycles.
The red pixel is in dc operation at 0.5 mA with an output power of 0.93W, Due to the power normalization along with the small pixel size used, the absolute power from individual LED pixels is relatively low here compared with commercial illumination LEDs. According to our reliability test for a similar LED device, its pixel does not show any obvious degradation of power output. Apart from being useful for multicolour displays, further measurement shows that the CMOS controlledLED pixels have high modulation bandwidth, indicating that they can also be used for optical data transmission or Visible Light Communication (VLC). The idea is to utilize this CMOS-controlled smart display to deliver programmable animated images for the purpose of display and, at the same time, modulate one pixel or several of them for the purpose of data communications. Such a smart display system could show dynamic images to the human eye but have additional information encoded in them, which can be received by a detector to set up an optical-communication link at increasing modulation frequency, the colour changes slightly, which is attributed to a reduction in the effective voltage applied to the LEDs due to the frequency response characteristics of the CMOS or micro LED pixels. This change in colour during modulation could be mitigated in a future CMOS design by implementing a small-signal modulation scheme. The optical signal from the modulated pixel was incident on a high-speed silicon photo detector, and the electrical output from this detector was sent to a 25-dB amplifier before returning to the BERT.

Overcoming techniques:

The integration of monochromatic LEDs with different colour converters such as organic blends and semiconductor Nano crystals had been observed.

Disadvantages:

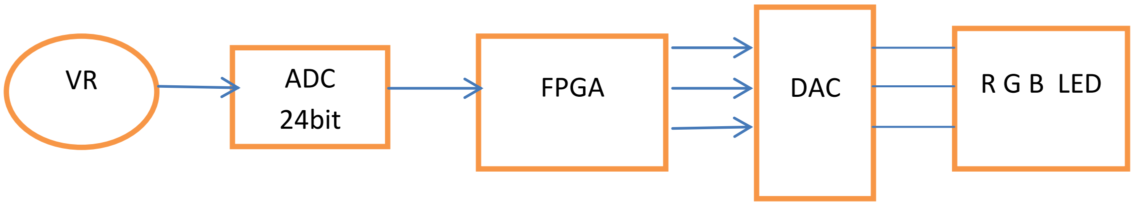
In the previous system all the three led`s have separate inputs to glow as based on their required colour.There should be of having separate FPGA board and converters.

Suggested Solution:

To simplify the complexity with above mentioned techniques,we proposea method to achieve colour tunability of inorganic LED`s and their potential in multi-colour display. When integrated with CMOS electronics &CMOS driving board with FPGA configuration, the display is completely controllable.

IV. FIGURES AND TABLES

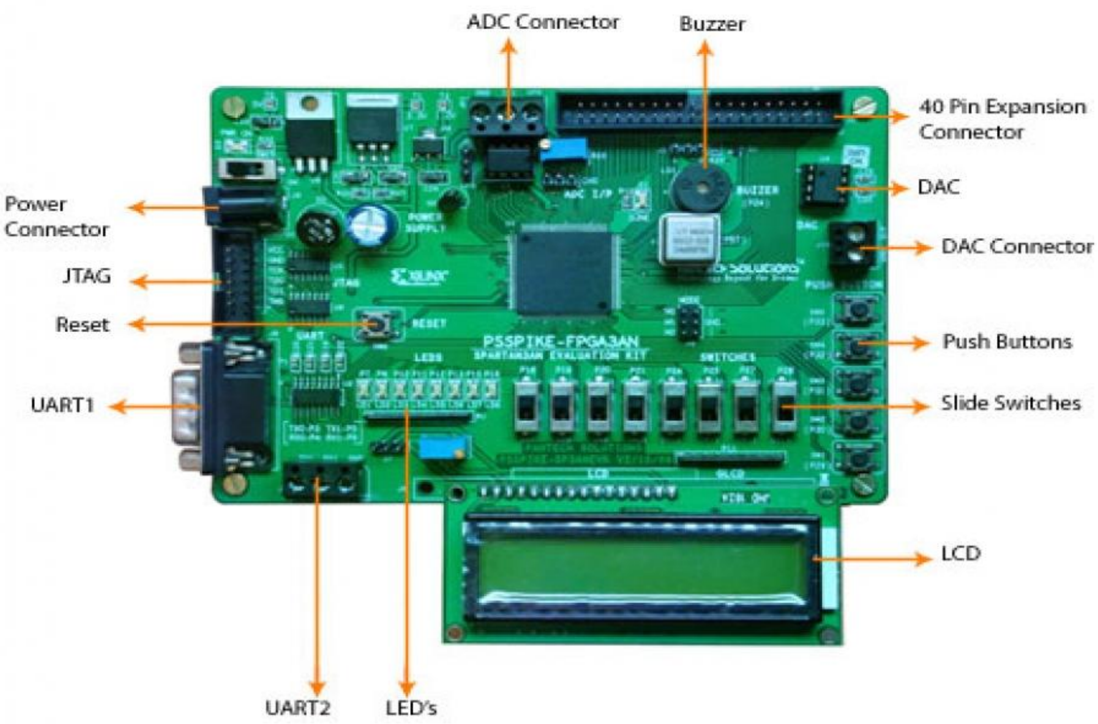
The development of colour tunable inorganic LED`s and developing a customized CMOS drivers with FPGA are equally important. So we are proposing to design a CMOS tricolour led driver with FPGA board.



The single channel input variable resistor gives the input to ADC(Analog to Digital converter) of 24bit,and this ADC gives the converted data to FPGA(field programmable gate array). As we know that FPGA is a board with Logic elements, which can be programmable as per required. This board contains some gate arrays as logic-1,0 which can code and decode the program as for our concern, after programming the data it will be sent to the DAC(Digital to Analog converter). The customized data form the DAC is connected to the tricolour LED. Based on the input given to the LED, a particular colour of the lighting will be observed. Showing that the FPGA kit has LCD display which shows the amount of the input had given to generate that particular colour. For example, if the variable resistor had tuned once there may be having the display of several numbers as per the led.

The LED is based on the single input which is given from the variable resistor in our proposed system. It provides an innovative method to overcome the limitations of using thin-film InGaN-based LED for multi-colour applications in the future.

SPARTAN3AN FPGA KIT:



V. CONCLUSION

The individual LED pixels from this CMOS-controlled system have high bandwidth modulation capacity, so that they can be used for high-speed VLC as well. Some of the methods for improving their efficiencies are:

1) Using them in commercial flat panel displays can be done by optimizing or re-designing the wafer structure to increase the colour-tuning range and the internal quantum efficiency of this material.
2) By investigating the modulation characteristics and relevant physical mechanisms of this high indium material.
3) Another method is by roughening LED top surface or integrating a photonic crystal structure on the LEDs to help enhance their light extraction efficiency and power output at different colours.

The work in this paper demonstrates a direct colour tunable GaN micro display for dual applications under CMOS control and, more importantly, provides an innovative method to overcome the limitations of using thin-film In GaN-based LED for multicolour applications in the future.

VI. Acknowledgement

To control the colour tuning of tricolour LED between different spectrums with a simple variable resistor with the help of a FPGA kit.

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