A Review on Design and Implementation of FPGA Based VGA Monitor and PS2 Keyboard Interface Technique

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Abstract: This project gives the detailed study about the designing of VGA (Video Graphic Array) Controller and PS-2 keyboard controller, by using combination of three bit input data to Control eight different colors to display text on the screen by using PS2 keyboard as database online for the input. Three color signal collectively referred as R (red), G (green) and B (blue) signal. The VGA monitor screen uses a resolution of 640 by 480 by mode to display colors. The project is developed by using Xilinx ISE 14.7 software and Spartan-3E-500 FPGA board to develop the project into a complete module. The timing diagram must be appropriate, in order to get VGA monitor controller displays properly. The design will be written by using Verilog coding style ensure the VGA controller and PS-2 controller work properly. The behavioral simulation was done by using Xilinx ISE Tool software to verify the working of the design. The Spartan 3E-500 starter Kit board was chosen to implement the design.

1. Introduction

As the performance of the monitors has increased, the demand for high-speed VGA controllers, which can provide high resolutions, has also increased. The purpose of this project is to display the monitor with the help of a single chip, like an FPGA working as VGA controller. Since, a single FPGA is used, the power consumption as well as the hardware requirements is less and the efficiency is more. The Spartan 3E-500 Field- Programmable Gate Array family gives users high performance, abundant logic resources, and a rich feature set, all at an exceptionally low price. This project aims at displaying a character on the monitor, which can be read. The size and the location of the characters can be controlled by using the Verilog hardware design language. The character can be displayed on the monitor only by the application of proper timing signals to the H-sync, V-sync, red, green and blue signal inputs to the monitor. As a rule, we saw that any declaration at release board is not appealing such as content static. Besides, many papers are utilized to make a declaration at the notice board which is wastage. To experience this issue, Video Graphics Array (VGA) are utilized as a part of this framework to show any content, picture and figure to the screen to make declaration at notice board, for example, screen or Television which is more appealing, for example, content would move be able to with different development. Moreover, this VGA will decrease the use of paper which are utilized at the Bulletin load up. The VGA are utilized as a part of this framework since it has a top notch determination video standard and the capacity to transmit a sharp point by point picture. This VGA is executed in Xilinx Spartan-3E FPGA starter unit board. By utilizing this board, we can undoubtedly plan an advanced framework which depends on FPGA which to acknowledge controller. As we can get the characters show freed of, VGA is ordinarily utilized as a part of PC screens as a standard mechanical show interface. This standard has characterized numerous parameters of VGA, for example, invigorating rates, synchronization flag timing, flag extremity and RGB signals electrical level. The reason that VGA is called Video Graphics Array is screen shows an edge of picture information at last is an exhibit which is made out of M line and N push pixel spot. MxN is determined to the show determination. VGA Controller and PS-2 Console Controller is a strategy used to make VGA show interface. The development of VGA show framework by this strategy is little, low power misfortune, dependable and can be connected to many events.

2. VGA Controller

VGA (video graphics array) is a video display standard protocol which is used in almost all the display devices such as CRTs (cathode ray tubes) and LCDs (liquid crystal display). It gives a simple procedure to interlink a system with a screen for
displaying characters or text. VGA has been broadly used as it is standard display in many displaying devices. In displaying the result of the process in real time, there is more and more requirement, as the fast development of embedded system, especially in making high speed character processors. When people present something, display is used. More attention is created when characters or texts at display catch as compared to verbal voice when people presents their presentation. When people presents such type of presentation, some device is required to control the screen. Red, green, and blue are three signals – that transmits color related information to a VGA screen. An electron gun is controlled by these three color signals each drive that transmits electrons which paint one primary color at a point on the display. Analog signal levels between 0 (completely dark) and 0.7 V (maximum brightness) on these control lines tell the VGA display what increases the intensity of these three basic or primary colors to combine them all in order to generate the color of a dot (or pixel) on the display. A simple two-bit digital-to-analog converter is used in order to the one of four levels by two digital outputs. The four probable levels on each analog input are mixed by the display system in order to generate a pixel with one of 64 different colors. Therefore the six digital control lines makes it possible to select from a set of 64 colors.

<table>
<thead>
<tr>
<th>VGA-RED</th>
<th>VGA-GREEN</th>
<th>VGA-BLUE</th>
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<td>WHITE</td>
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In the VGA standard, each line in the 640*480 VGA video, 40 cycles of the pixel clock are needed for the back porch, 8 cycles are required for the blank left border of the screen, then comes the 640 cycles for the actual pixels of the video, followed by 8 cycles for the blank right border, 8 cycles for the back porch, and at last 96 cycles are needed in which the horizontal sync signal is active. For one line of 640*480 video a total of 800 cycles of the pixel clock is needed.
3. PS2 Keyboard Interface
This details a PS/2 keyboard interface component for use in CPLDs and FPGAs. The component receives data transactions from a PS/2 keyboard and provides the keyboard make and break codes to user logic over a parallel interface.
The figure conceptually illustrates the PS/2 keyboard interface component’s architecture. The clock and data signals from the keyboard are first synchronized and then debounced. The resultant internal PS/2 data signal is then serially loaded into a shift register on falling edges of the PS/2 clock. An idle counter determines when the transaction is finished, defined by the PS/2 clock remaining at a high logic level for more than 55us, i.e. longer than half of the worst-case PS/2 clock period. Combinational error checking logic verifies the start bit, stop bit, and parity bit with the data. When the PS/2 port is idle and the data is valid, the component outputs the received PS/2 code and sets the new code flag high to indicate that a new code is available on the bus. The code remains available on the bus until another code is received. The new code flag remains high until another PS/2 transaction begins i.e. when a low PS/2 clock signal clears the idle counter.

4. Literature Review


In the designed VGA control system, the use of FPGA to build this system, which can display characters or information. This design can be used in most FPGA devices regardless of the model. Experimental results show processing algorithms programmed by Verilog HDL can make design flexible and programming conveniently. The controller will be used for image processing research. VGA controller can be made easily without making the circuit manually; just to write a codes based on its logic flows, then simulate it, synthesize it with net list, and finally burn it onto FPGA. It is very much beneficial as this VGA controller requires fresh data to change to another design display. Thus, FPGA-based VGA controller can be a better choice as it is easy to be designed.

(Khan Huma Aftab, Monawuer Alam, 2014) “Design of VGA controller for LCD using FPGA”

In this, interfacing of VGA port present on FPGA board to form the characters from ASCII text characters. Displaying characters on VGA controller is a difficult task. The generation of character from a circuit that took the character from ROM to facilitate the display of text characters on a screen. To display characters on VGA display, arrangement of the 640*480 display area into “tiles” where each tile represents a character location. The size of every character is 16*8(height & Width). Each of the 640*480 pixels in the display are associated with one of the 80*30 character locations. VGA is an important output section for displaying the results. This whole process could be further move for interfacing the keyboard (PS2/USB) for many interesting real world implementation to a complete gaming device.

(Kavyashree S, 2015) "Design and implementation of UART using Verilog”

UART basically forms the serial data from the parallel data and establishes serial communication. Many processors require UART for external interfacing. The micro blaze processor is used to control the interfacing between the UART and the FPGA board. This minimizes external routing problems and cost as FPGA has large number of logic gates that are not used. FPGA can be a better solution for reconfiguration of the system hardware modification.

(Radi H.R Caleb W.W.K et al, 2012)"Design and implementation of VGA controller on FPGA”

In this paper, Field-Programmable Gate Array (FPGA) is great discovery to be used in designing a VGA Controller. VGA controller interfacing protocol can be easily designed by using the Verilog HDL language; just to write a behavioral model based on logics, then simulate it with test benches, synthesize it with net list, and finally burn it onto FPGA. It is very beneficial as this VGA Controller requires fresh data to change to another display design. Thus, FPGA-based VGA controller is be a better choice as it is easy to be designed and used.

(Anderson Pereira Correia, Carlos Humberto Llanos et al, 2010) “A control design approach for controlling an autonomous vehicle with FPGAs”

A fully advanced car control system was designed by using FPGA-embedded processor. The designed car motion system consists the steering wheel, clutch, gear brake and throttle subsystems. To achieve the controller’s implementation, specific commands are required. These commands can be used to the control program running inside the embedded microcontroller. That is, the commands are really specific functions that are implemented in C language and makes the designing of the automation strategies of the car. This approach allows to use the commands in order to follow a particular trajectory, that is important for automatic parking maneuvering issues and to handle the hands-free driving issues. The implemented controller gives monitoring facilities for the
different status variables. The main part of this work is that it implements the whole automation of a normal car, even with a mechanical gear. The results of this work can be easily applied in the case of people with disabilities. Additionally, a RS-232 based serial communication protocol was designed and tested to allow the user to send the commands to the controller (by typing in a keyboard). The same protocol makes the controller sends predefined data packages to the LabVIEW environment in order to update the current status of the virtual car in real time.

(J Viejo, A. Millan et al) “Efficient design and implementation on FPGA of a micro blaze peripheral for processing direct electrical networks measurements”

A sophisticated signal processor for direct electrical measurements has been successfully designed and implemented on a Xilinx Spartan3E-500 FPGA. The DSP takes the form of a standard peripheral so that it can be managed by a system processor implemented in the same FPGA like the Micro Blaze provided by Xilinx. The device also monitors eight analog input signals and calculate offset, root mean square and real and reactive powers from the inputs in each and every single cycle.


A well designed VGA is used in many embedded systems video surveillance systems, ATM machines, video players, or video conferencing. This system gives a simple method to interlink a system with a monitor for showing characters. Depending on the requirements of these applications, many systems does not require a high display quality. FGPA are used to control the VGA controller with minimum cost and high flexibility. Industrial production machines of today must be highly flexible in order to fulfill all unplanned demands. FGPA are especially suited to complete these requirements. FGPA provides a compacted size and low power consumption solution. For study, research and experimentation, the new technology of FGPA made VGA controller design much suitable. In this paper, the Altera’s FPGA is used for the hardware circuit. The top-down programming methodology took the integrated tools. When the protocol is designed, compiled, simulated, and layout and timing simulation has been done and then each module can be downloaded into FPGA. This method decreases the size of the circuit board and increases reliability of system and design flexibility. As a result, it can decrease the system cost.


The objective of this paper is to print characters by giving the interfaces to connect a VGA port for graphical output and a PS/2 port for keyboard input. In this synthesisization of the system is to be done on the FPGA board and should has strength of executing a program to display characters which takes input from the PS2 keyboard and prints the results on a VGA screen. This paper is developed under the environment of Xilinx ISE. This all is done with the help of Xilinx software, VHDL IP core and MICROBLAZE processor, the characters inputted by PS2 keyboard, and will be displayed on the VGA monitor. Based on Spartan 3E-500 Starter Board Hardware Architecture, Software Development mainly has of two parts: one is that PS2 keyboard scan code receiving and processing program, the other one is program used to display on VGA screen. The Xilinx under MICROBLAZE processor is used to define embedded processor to make applications with peripheral devices using FPGA. Some files are written depending upon the peripheral configuration and specifications those are MHS, MPD, MSS and UCF to develop the interface between peripherals and initialization. After the peripheral is imported, applicant can use the peripherals in the design with the help of XPS flow process. The software application can be written in a “C or C++” to control I/O peripherals through serial communication then the complete embedded processor system for user application will be completed and verified by generating and downloading the bit file into actual hardware.

(Punj Pokharel, Binod Bhatta, Anand D. Darji) “Optimized Drivers for PS/2 and VGA using HDL”

The use of FPGA is popularly increasing as it has feasible prototyping, low cost and high speed. Input/output interfacing is inevitable for any system. So important signals for VGA and PS/2 interface are generated using HDL. The design is synthesized and implemented in Xilinx Virtex-II Pro. The mapped signals in FPGA Board are optimized decrease available resource utilization. The whole design is implemented in hardware with a VGA monitor and a PS/2 keyboard.
5. Results

5.1 Interfacing between PS2 Keyboard and the FPGA Board

Two counters are utilized inside this module: counter and down counter. Down counter is accustomed to bring the recurrence 250 times when trigger is activated. Count reading tallies up if not a full bundle of 11 bits is gotten yet. The PS2 interfacing module gets the data and checks the bits. If the trigger is activated, at that point check if the PS2_CLK changed its state. If the state changed and if the clock is on falling edge do add up the data that was right now gotten to the previous bits, mark down that one more piece was gotten. If 11 bits were gotten, trigger out another flag, telling that it completed the process of perusing. Check the equality bit if they got data is correct. If 11 bits were not gotten check in the event that it took more than 4000 times for counter reading to number up after it got the past piece and reset everything in the event that it took more. Else skirt this. Another little module extricates the data: Wait for the trigger, which checks if the full pack of 11 bits was received. If there was a blunder in the got bundle, dispose of everything. However remove the DATA bits if the data was correct.

5.2 Interfacing between VGA controller and the FPGA board

In this we interface a VGA port accessible on FPGA board to produce the character(s) from ASCII text characters. To show message on video controller is an essential capacity. The Character generation circuitry is designed that took the character from ROM to display the characters on a screen. To show message VGA screen, we sorted out the 640x480 show region into "tiles" where each tile is linked to a character area. In this venture, the text dimension of each character is 16x8 (tallness and Width). This textual style will show 80 content characters in each line. Mapped onto a 640x480 show (i.e., 640 pixels isolated by 8 segments for every character) and 30 lines (480/16). Each of the 640x480 pixels are related with one of the 80x30 character areas.

6. Scope and Expandability

The work on “Design and implementation of FPGA based Word Editor” is a small step for the development of application specific projects. It gives the idea and the logic hidden behind the high speed cards and computer games accessible in the market. It gives the fundamental thought for the advancement of top notch computer games, for example, "ATARI" and "NINTENDO" computer games, which give genuine nature on TV screens. This venture can be extended to give more determination, shading mixes and more information alternatives. Scientists are attempting to grow significantly more dependable and speedier VGA controllers. Examinations have been done on the planning and number of entryways yet it is being attempted to incorporate significantly more parameters for ideal outcomes like region limitation. With the progressing innovative time, we have attempted to get light the little strategies and bases on which our quicker and littler frameworks and chips are being produced.

7. Conclusion

In this project interfacing of VGA port available on FPGA board to generate the character(s) from ASCII text characters which are given as input through the PS2 keyboard, a different set of protocol has been designed for interfacing the PS2 keyboard with the FPGA board. To display characters on video controller is an important function, to transfer the characters from the FPGA board to the VGA controller screen UART protocol has been designed. The Character generation circuit that took the character from ROM to facilitate the display of text characters on a screen. To display characters on my VGA display, organization of 640*480 display area into tiles where each tile represents a character location. In this project, the font size of each character is 16*8 (height & Width). This font will display 80 text characters in each line. Mapped onto a 640*480 display (i.e., 640 pixels divided by 8 columns per character) and 30 lines (480/16). Each of the 640*480 pixels in the display are associated with one of the 80*30 character locations. VGA is an important output section for displaying the results. This can be move beyond for interfacing for more interesting real world implementation to a complete gaming device.

8. References


