KEYBOARD CONTROLLER VGA CONTROLLER ONLINE

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In the name of Allah swt the Beneficient,the Merciful…

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ABSTRACT

This project describes about the design of VGA (Video Graphic Array) Controller and PS-2 keyboard controller using combination of three bit input data to control eight differences colours to display text at monitor by using keyboard as database online for the input. Three colour signal referred to collectively as R (red), G (green) and B (blue) signal. The VGA monitor using resolution of 640 by 480 by mode to display colours. The project constructed by using Xilinx ISE 10.1 software and Xilinx Spartan-3E board to develop the project into a complete module. The project using the Finite State Machine (FSM) technique to generate HDL coding based on the VGA timing diagram specification. To get VGA monitor controller properly, the timing diagram must be correctly. The design will be written using VHDL (VHSIC Hardware Description Language) coding style based on FSM to ensure the VGA controller and PS-2 controller work properly. The behavioral simulation was done by using Xilinx ISE Tool software to verify the functionality of the design. The Spartan 3E starter Kit board was chosen to implement the design.

ABSTRAK

Projek ini menerangkan tentang mereka bentuk pengawal VGA (Susunan Grafik Video) dan pengawal PS/2 papan kekunci dengan menggunakan gabungan tiga bit data input untuk mengawal lapan perbezaan warna untuk memaparkan teks di monitor dengan menggunakan papan kekunci sebagai talian pangkalan data untuk sistem input. Tiga isyarat warna kolektif merujuk kepada R (merah), G (hijau) dan B (biru) isyarat. Monitor VGA dengan resolusi mode 640 x 480 digunakan untuk memaparkan warna. Projek ini dibuat dengan menggunakan perisian Xilinx ISE 10.1 dan papan Xilinx Spartan-3E untuk membangunkan projek ini menjadi modul yang lengkap. Projek ini menggunakan teknik mesin keadaan terhad (FSM) untuk menghasilkan bahasa keterangan peranti keras (HDL) kod berdasarkan pada spesifikasi VGA diagram waktu. Untuk mendapatkan pengawal monitor VGA dengan betul, diagram waktu harus benar. Reka bentuk ini akan ditulis dengan menggunakan gaya kod VHSIC bahasa keterangan peranti keras (VHDL) berdasarkan FSM untuk memastikan pengawal VGA dan pengawal PS/2 berfungsi dengan betul. Simulasi perilaku dilakukan dengan menggunakan perisian Xilinx ISE untuk mengesahkan fungsi reka bentuk. Papan Spartan 3E starter Kit dipilih untuk melaksanakan reka bentuk ini.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF ABBREVIATIONS

VGA	-	Video Graphic Array
FPGA	-	Field-Programmable Logic Array
VHDL	-	VHSIC Hardware Descriptions Language
VHSIC	-	Very-High-Speed Integrated Circuit
HDL	-	Hardware Description Language
ASIC	-	Application-Specific Integrated Circuit
CLB	-	Configurable Logic Blocks
PLD	-	Programmable Logic Device
RTL	-	Register Transfer Level
DCM	-	Digital Clock Manager

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1 Introduction

The term VGA stands for Video Graphic Array. This VGA is a graphics display systems for PCs developed by IBM. VGA has become one of the factor standards for PCs. In graphics, generally the resolution is either 640 by 480 within 16 colours or 320 by 200 within 256 colours. While this resolution has been superseded in the personal computer market, it is becoming a popular resolution on mobile devices. Figure 1.0 shows overview of VGA port connection to a monitor.

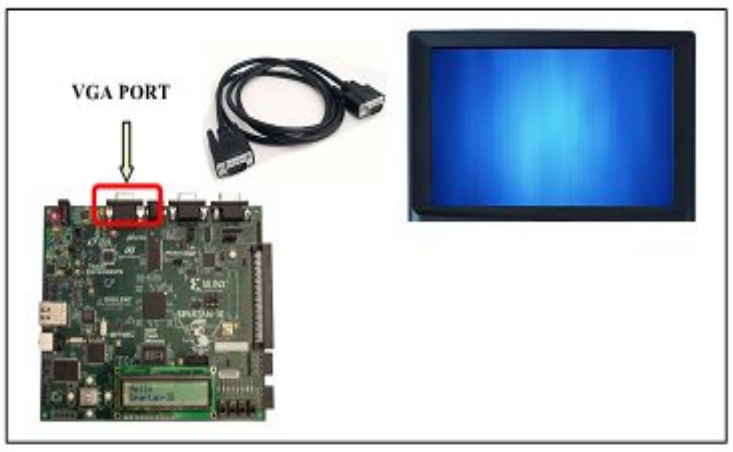

Figure 1.0: VGA port connection to a monitor

A keyboard is an input device, which uses an arrangement buttons or key to act as mechanical levers or electronic switch. The PS/2 keyboard was originally an extension of the AT devices which is developed by IBM. It supported a few additional host-to-keyboard commands and featured a smaller connector. All communication between the host and the keyboard uses an IBM protocol.

This project describes about the design of VGA Controller and Keyboard Controller using combination of three bit input data to control eight differences color to display text at monitor by using keyboard as database online for the input.

1.2 Problem Statement

Usually, we saw that any announcement at bulletin board is not attractive such as text static. Furthermore, many papers are used to make an announcement at the bulletin board which is wastage occurs. To encounter this problem, Video Graphics Array (VGA) are used in this system to display any text, image and figure to the screen to make announcement at bulletin board such as monitor or Television which is more attractive such as text can move with various movement. Besides, this VGA is reduce the paper are used at the Bulletin board and also saving time to make any announcement. This VGA are used in this system because it has a high definition resolution video standard and the ability to transmit a sharp detailed image.

This VGA is implemented in Xilinx Spartan-3E FPGA starter kit board. By using this board, we can easily design a digital system which is based on FPGA which to realize real time of display. Controlling VGA through FPGA, we can make use of tiny and flexibility chip which is advantage of FPGA and work out these weaknesses such as inflexibility of processor and too much space-taking. As we can get the characters display rid of.

VGA is commonly used in computer monitors as a standard industrial display interface. This standard has defined many parameters of VGA, such as display resolution, refreshing rates, synchronization signal timing, signal polarity and RGB signals electrical level. The reason that VGA is called Video Graphics Array is monitor displays a frame of image data finally is an array which is composed of M line and N row pixel spot. M×N is set on the display resolution. VGA Controller and PS-2 Keyboard Controller is a method used to make VGA display interface. The construction of VGA display system by this method is small, low power loss, reliable and can be applied to many occasions.

1.3 Objectives

The objectives of project are to:

i. Design a VGA Controller using VHDL code with Xilinx ISE Tool software.
ii. Design a PS-2 Keyboard controller using VHDL code with Xilinx ISE Tool software.
iii. Implement the two controllers such that a VGA Controller and a PS/2 keyboard can be interfaced on the Xilinx Spartan-3E FPGA starter kit board.
iv. Display at the monitor.

1.4 Scope of Project

The scopes of this project are:

i. Three bit input data to control eight difference color display at monitor.
ii. The VGA signal timing using the resolution 640 by 480 pixels with the 25MHz pixel clock and 60Hz to display at monitor.
iii. Database online using PS/2 keyboard for the input.

1.5 Thesis Organization

This thesis consists of five chapters. The first chapter is introduction of the project, problem statement, project objective and scope of project.

Chapter 2 presents the related references that have been studied and used in the implementation of this project. The controller used is also introduced in this chapter.

Chapter 3 would elaborate more about the project methodology which clearly explained about how this project is planned and organized in order to complete this project.

Chapter 4 presents the result for the system designed and discussion of overall result.

In the final chapter which is chapter 5, the project research is summarized and the recommendation for future works is presented.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter describes and gives information about VGA controller, ps/2 keyboard controller, FPGA and VHDL that are related to this project. All the information is studied from three main sources which is journal, books and internet. This information will be the guideline for this research.

2.2 VGA Controller

Video Graphics Array (VGA) is mostly used for computer monitors, with a high-definition resolution video standard. It has the ability the ability to transmit a sharp detailed image. VGA uses separate wires to transmit the three color component signals, vertical and horizontal synchronization signals. Red, green and blue are three signals that send color information to VGA monitor. There are four main components in VGA controller which are VGA interface signals, VGA interface definition, VGA control signal, VGA timing Control and VGA monitor.

2.2.1 VGA Interface Signals

There are two types VGA interface signals to display which is data signal, and the other one is control signal. Data signal have three part which is Red, Green and Blue and for control signal have two part which is Horizontal Synchronization and Vertical Synchronization. There are different frequencies of the horizontal synchronization signal and vertical synchronization signal for the changeable output resolution. Here is a table to imply the range of frequencies corresponding to these common resolutions.[1] They are just shown in Table 2.1.

Table 2.1: List of Frequencies Corresponding to Resolutions.

Resolution	Horizontal Synchronization(Hz)	Vertical Synchronization(Hz)	Pixel Clock (MHz)
640×480	31.496	59.940	25.175
800×600	48.077	72.188	50.000
800×600	48.875	75.000	49.500
1024×768	48.363	60.004	65.000
1024×768	56.476	70.049	75.000

In VGA control based on FPGA, we only need to consider these five signals which are horizontal synchronization signal, vertical synchronization signal, red data signal, green data signal and blue data signal. As the five signals can be sent to VGA interface from FPGA, we can make the control of VGA.[1]

2.2.2 VGA Interface Definition

VGA interface sends corresponding display signals to display through DB-15 linker which is directly connected to Monitor or LCD by monitor cable. There are 15 pinholes which are asymmetrically divided into 3 lines, and there are 5 on each line.[1] Here is Figure 2.1 showing how these pinholes are arranged.

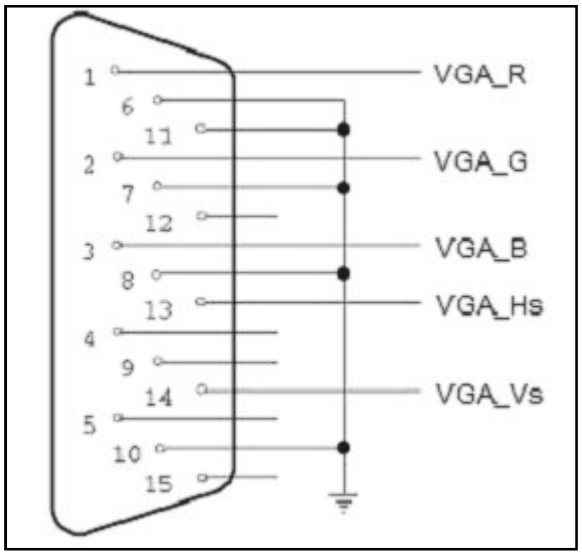

Figure 2.1: VGA display port

2.2.3 VGA Color Signal

In this system, FPGA drives 5 VGA signals directly using series resistance. Every color signal is linked to a resistance serially, and a bit of color signals are made up of VGA_R, VGA_G and VGA_B. While, VGA_Hs and VGA_Vs drive level use standard LVTTL or LVCMOS3 I/O. Finally, there will be 8 kinds of color according to which level are VGA_R, VGA_GR, and VGA_BL.[1][2] They are just shown in Table 2.2.

Table 2.2: 3-Bit Display Color Codes.

VGA_R	VGA_G	VGA_B	Resulting Color
0	0	0	Black
0	0	1	Blue
0	1	0	Green
0	1	1	Cyan
1	0	0	Red
1	0	1	Pink
1	1	0	Yellow
1	1	1	White

2.2.4 VGA Timing Control

Timing of VGA signals are ruled by VESA. Here is a short introduction about how FPGA drive the VGA display with 640×480@60Hz. In the standard of VGA industry, the output frequency of pixel is 25.175MHz, and the frequencies of horizontal scan and vertical scan are 31.496 KHz and 59.940 Hz. If display receives this standard frequency, then the resolution will be 640×480, and refresh rate is 60Hz.[2] Figure 2.2 and Figure 2.3 show us the timing of VGA's Horizontal timing and Vertical timing.

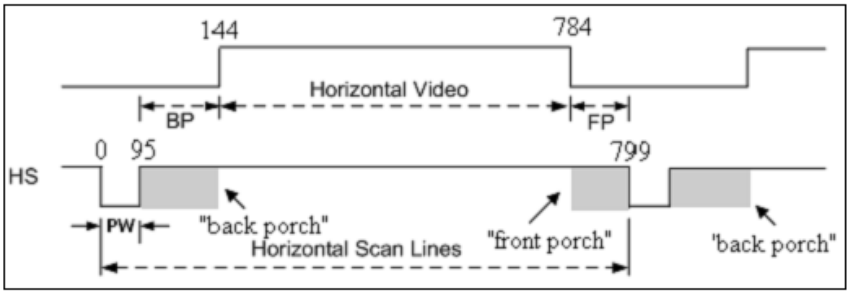

Figure 2.2: Horizontal Timing

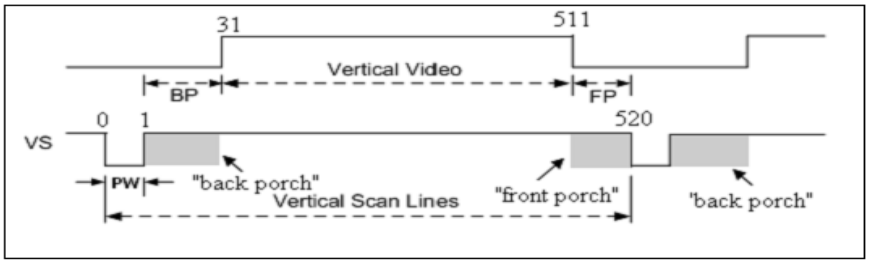

Figure 2.3: Vertical Timing

2.2.5 VGA Monitor

From Figure 2.4 below, it shows the VGA monitor with 640 columns by 480 rows. This VGA monitor is based on 25MHz clock. A single dot of colour on a video monitor does not impact much information. A horizontal line of pixels carries a bit more information. However, a frame composed of multiple lines can present an image on the monitor screen. A frame of VGA video typically has 480 lines and each line usually contains 640 pixels.[1]

Within the displays, current waveforms pass through the coils to produce magnetic fields, which deflect electrons beam to transverse the display in a raster pattern. The electrons move horizontally from left to the right and vertically from top to bottom across the screen as shown in Figure 2.4.[3] The scan starts from row 0, column 0 at the top left corner and moves to the right until it reaches the last column in the row. When the scan reaches the end of the row, it continues at the beginning of the next row. When the scan reaches the last pixel at the bottom right corner of the screen, it goes back to the top left corner of the screen, and repeats the scanning process again. The information only would be display when the electron is forward directions from left to the right and from top to the bottom, but when the electrons return back to the left of the top edge of the screen, the information would not be display.

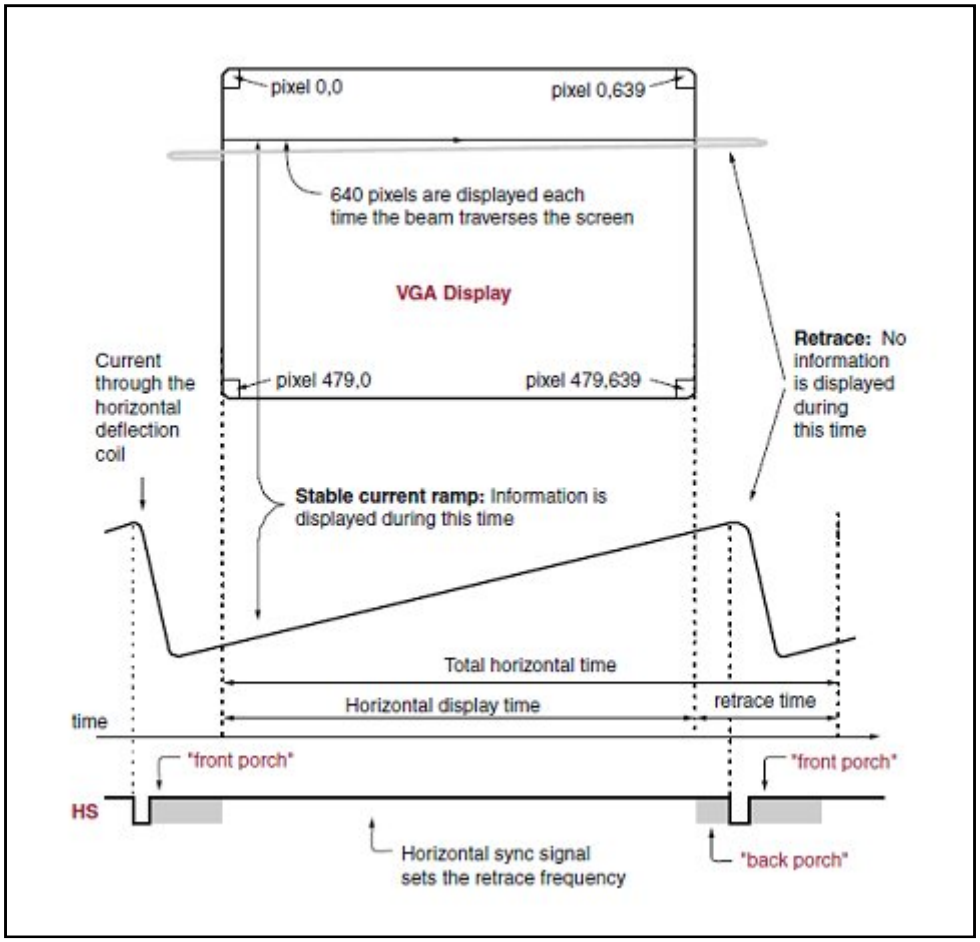

Figure 2.4: VGA Monitor

2.3 PS-2 Keyboard Controller

The original keyboard design had a single chip microprocessor. Nowadays, a customized controller chip is used. This keyboard controller chip control of all keyboard matrix scanning, key de-bouncing and communications with the computer, and has an internal buffer if the keystroke data cannot be sent immediately. The PC motherboard decodes the data received from the keyboard via the PS/2 port using interrupt IRQ1.[4]

This keyboards do not generate is ASCII values. Typical AT keyboard having more than 101 keys whereas a single byte could not store codes for all the individual keys, plus these keys along with shift, control, or alt,etc. Furthermore, for some functions there is no ASCII equivalent such as 'pageup', 'page down', 'insert', 'home' and

others. There are two different types of scan codes which is make codes and break codes.[4]

2.3.1 Make Code

A make code is deliver when a key is pressed or held down. Each key, including 'shift', 'control' and 'alt', sends a specific code when pressed. Cursor control keys, 'delete', 'page up', 'page down', 'ins', 'home' and 'end', send extended make codes. The make code is overtake by 'EO'h to show an extended code. The only exception is the 'pause' key that starts with a unique 'El'h byte.

2.3.2 Break Code

A break code is delivering when a key is released. The break code is the make code overtake by 'FO'h byte. For extended keys the break code has an 'EO'h overtake the 'FO'h and make code value. The only exception is the 'pause' key as it does not have a break code and does not auto-repeat when held down.

2.3.3 Scan Code

The set of make and break codes for each key possess a scan code set. There are three standard scan code which is sets numbered of 1, 2, and 3 stored in the keyboard controller. Scan code set 1 is keep for compatibility for older IBMXT computers. Scan set 3 is very equal to the set 2 but the extended codes are different. If, for example, you press 'shift' and 'A' then both keys will generate their own scan codes, the 'A' scan code value is not changed if a shift or control key is also pressed. Pressing the letter 'A' generates 'lC'h make code and when released the break code is 'FO'h, 'lC'h. The keyboard layout with codes is shown in Figure 2.5 and keyboard alpha numeric scan code in Figure 2.6.[4]