NEW HORIZON COLLEGE OF ENGINEERING

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"BREADBOARD VIDEO CARD"

A MINI PROJECT REPORT

Submitted by

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CERTIFICATE

Certified that the mini project work entitled **"BREADBOARD VIDEO CARD"** carried out by **MANISHA PREM(1NH18EC067), MELITA ROSE G (1NH18EC071), SANSKRUT GARUD (1NH18EC101), SURAJ SURESH (1NH18EC110)** bonafide students of Electronics and Communication Department , New Horizon College of Engineering, Bangalore. The mini project report has been approved as it satisfies the academic requirements in respect of mini project work prescribed for the said degree.

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ABSTRACT

Video cards, also being referred to as graphic cards are expansion cards that handle the data we are visually able to see on screens. They are components attached with the motherboard of the computer and is responsible for displaying images on screens (monitor, TV, projector). The better your graphics card the better, and smoother an image can be produced. This is naturally very important for gamers and video editors.These graphics cards are responsible for sending an image to the monitor and this is done by the conversion of data into those signals that the monitors will understand

There are types of graphics card such as integrated graphics card and discrete graphics card. Integrated graphics card are those that are built onto the motherboard and no add-in cards are used, but these models cannot be easily upgraded. Discrete graphics cards are those add-in cards that have been installed onto the motherboard as extra components. In this type, modification of the system can take place by upgradation of the graphics card.

This project focuses on building a video card with the usage of breadboards, hence the name **Breadboard video card**.

The main aim behind this is to demonstrate and understand the working of a video card (graphics card) and build a basic one on breadboards that displays an image on a VGA monitor. The circuit makes use of various components such as breadboards, logic chips, crystal oscillator, EEPROM, etc to build the video card. This project mainly demonstrates how VGA signals work and focuses on building a card that gives us correct timing of sync signals that the monitor recognizes and to finally display an image which is stored in the EEPROM used.

The applications of this component are in every computer, laptop devices being used, gaming, general purpose computing and much more.

ACKNOWLEDGEMENT

The satisfaction that accompany the successful completion of any task would be, but impossible without the mention of the people who made it possible, whose constant guidance and encouragement helped us succeed.

We thank **Dr. Mohan Manghnani**, Chairman of **New Horizon Educational Institution**, for providing necessary infrastructure and creating good environment.

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Finally, a note of thanks to the teaching and non-teaching staff of electronics and communication department for their co-operation extended to us, who helped us directly or indirectly in this successful completion of mini project.

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CHAPTER 01

INTRODUCTION

This project focuses on the building of a breadboard video card. Video cards , also known as graphics card in general are those expansion cards that handle the data we are able to visually on screens. These cards are hardware components that produce the images that appear on the monitor. They render images to the monitor by the conversion of data into signals that the monitor would understand. The better the graphics card, smoother and better is the quality of the image that is obtained, this factor is important for gamers and video editors.

Fig 1(a) : Picture of Graphic card

These are available in two primary types: integrate graphics card and discrete graphics card. Discrete cards are those add-on components that can be installed onto the motherboard. Upgrading the graphics card can modify the systems,in the case of discrete cards. Integrate cards are those that are built onto the motherboard where no addon components are used. These cards are found on most standard computers and laptops but cannot be easily upgraded.

Fig 1(b): Manufacturers of discrete graphics card

There are two main manufacturers of discrete graphics cards, AMD and Nvidia - Some users have allegiances to a particular brand but each will do the same job.AMD also produce some integrated graphics option as well as the current market leader - Intel.

The basic goal of this mini project is to build a basic videocard on breadboards and demonstrate the working of it, the process of how VGA signals work and building a circuit that provides the correct timing of sync signals so that a monitor recognizes the signal and displays an image stored on an EEPROM. The final purpose is to be able to display some sort of an image on the monitor.

The hardware and the software required to build this project and they have been implemented to get the proper output has been discussed in this report.

Our video card will be able to output an image with a width of 100 pixels and a height of 75 pixels at 60 frames per second to the monitor using a VGA interface. It can produce 64 different colours for each pixel.

CHAPTER 02

LITERATURE SURVEY

Title of paper	**Author and year of publication**	**Outcome**	**Limitation**
Graphic card analysis and design concepts	Sheng Huang (2015)	Analysis of the graphics card being the basic and important part of a computer and the tasks handled by it that reflects its efficiency.	Video card design on breadboard not recommended for high voltage and current applications.
Understanding EEPROM Programming	Michael Lu Prescott Siao (2004)	Implementation and understanding of EEPROM configuration and programming to store image data.	Different voltages are required for erasing, reading and writing the data.
Build A VGA monitor controller	Article by Enoch Hwang (2005)	Clear description of the five main signals that controls a VGA monitor. The generation of the sync signals and their working has been understood	Obtaining Complex images of higher resolution is difficult

Tab 2.1: literature survey

CHAPTER 03

PROPOSED METHODOLOGY

Graphics cards are widely used today in every computer , laptop devices, gaming, general purpose computing and much more. Back then ,there were large number of companies that made graphics cards but now the industry is mainly dominated by NVIDIA and AMD. The first ever graphics card to be made was released by IBM in the 1980's and later modifications were made. The information about the texts or images used by the computer is sent from the CPU to the graphics card which creates pixels on the computer screen .

The graphics card built in this project has been done on a breadboard by primarily making use of TTL logic chips and EEPROM circuitry. The block diagram shown below depicts the method being used to build the graphics card.

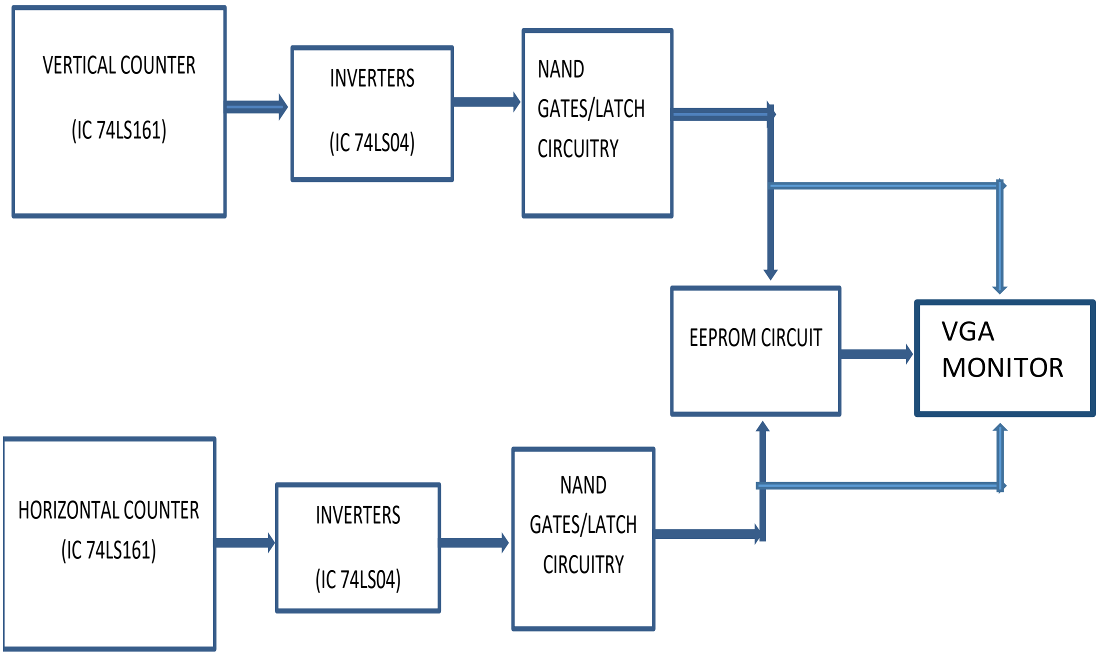


Fig 3(a) : Basic Block diagram

- The first part of the circuit is formed by the horizontal counter by using three 74LS161 counter ICs. This is followed by the vertical counter built using three 74LS161 counter ICs.
- Inverter IC 74LS04 ICs are also used to get the inverted outputs of the horizontal and vertical counter outputs.
- This is followed by NAND gate circuitry which receives inputs from the counter's output and inverter's outputs and accordingly counts the number of pixels

generated to detect the visible area, front porch, sync pulse ,back porch and then the whole line, both horizontally and vertically.

- SR latches (using IC 7400) are built on both the horizontal and vertical counters . The latch in the horizontal counter gives us the HSYNC (horizontal sync) signal. The latch in the vertical counter gives us the VSYNC (vertical sync) signal.

- These HSync and VSync circuits are connected to an EEPROM which drives a simple resistor DAC (digital-to-analog converter). The five main signals HSYNC ,VSYNC,Red , Blue,Green are sent through a VGA connector to the monitor which receives these signals. The monitor recognises these signals and the image stored onto the eeprom is displayed by the monitor.

The graphics card initially makes a frame image using straight lines . Then fills the remaining pixels and adds colour, texture ,shading and the lighting of the image . Getting the timings of the horizontal and vertical counter right means a circuit to count pixels, and inject the front porch, sync pulse, and back porch at the end of each horizontal and vertical lines.

This project will demonstrate the exact functioning of the graphics card ,the process of the timing signals and pixel generation so that the monitor recognizes it and displays an image

GENERAL PICTURE OF THE PROJECT

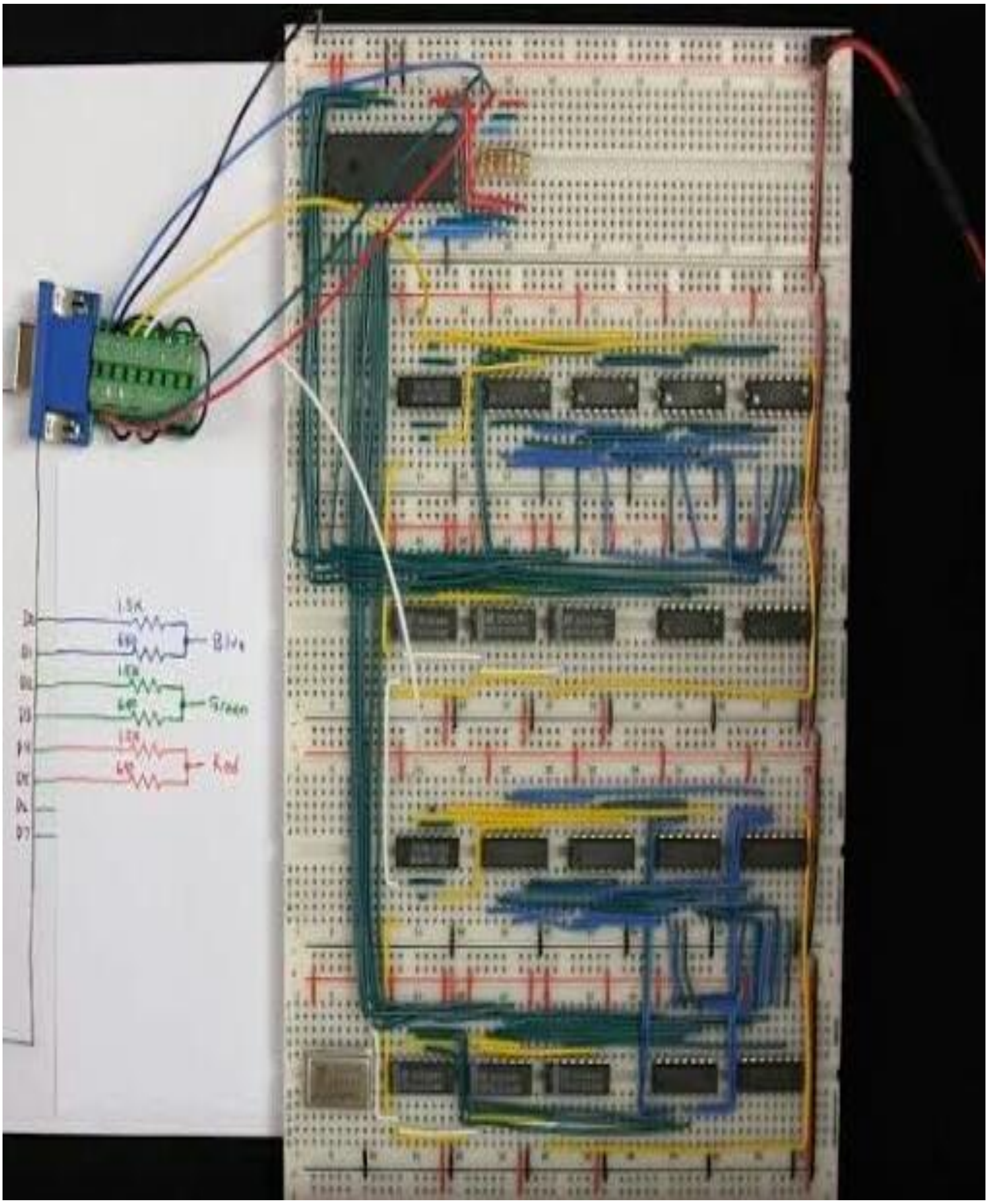


Fig 3(b): Picture of the Project

CHAPTER 04

PROJECT DESCRIPTION

Our video card is built using an EEPROM (for RGB signals) along with a few important circuits like: a clock, counters, NAND logic and SR latches (for the sync signals) to display an image onto a monitor.

The main objective of this project is to help us easily understand and demonstrate others, how the VGA interface works and essentially how multiple signals in a video card work together in order to display an image.

Well, to begin with, we researched on VGA and found out that out of 15 pins there are only 6 important ones that we actually need to care about. They are: pins 1, 2, 3, 5, 13 and 14 (Red, Green, Blue, Ground, Horizontal sync and Vertical sync). The remaining pins are individual grounds and signals used for the monitor to communicate back to the video card which can all be ignored for our objective.

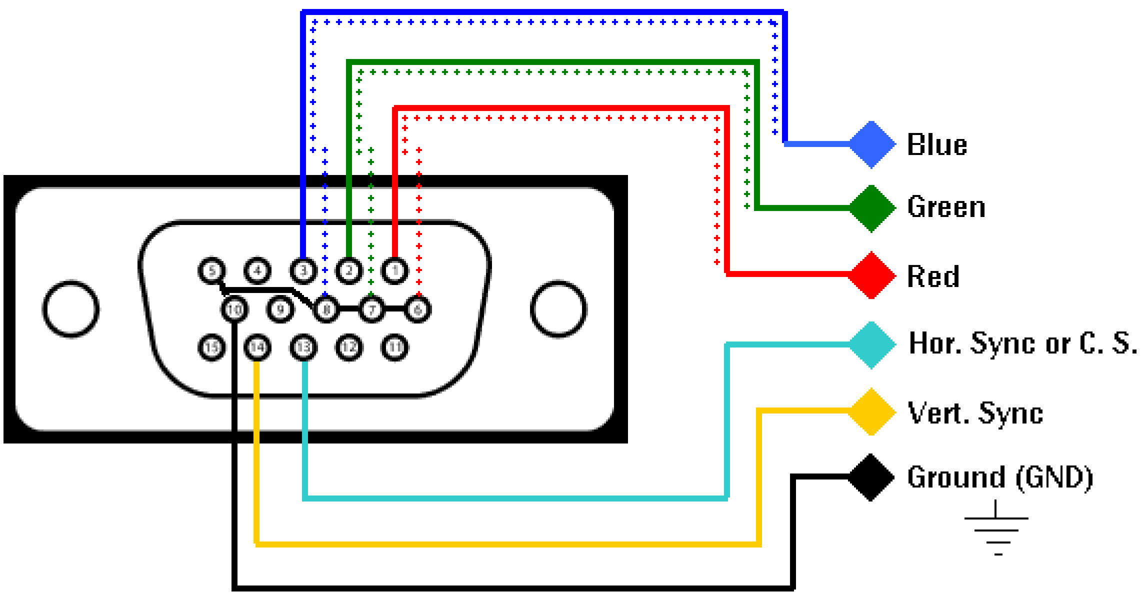


Fig 4(a): Details of VGA connector

Specification of our video card and how the VGA interface works?

There are many modes (resolutions and refresh rates) that the VGA interface supports. For convenience and simplicity of calculations, we chose the 800x600 at 60Hz mode and scaled it down to 100x75 at 60Hz. We had to scaled down the resolution because

- To operate at the 800x600 mode we require a 40MHz clock but most LS TTL (Transistor Transistor Logic) is only rated up to about 20MHz for most chips (and that's pushing it to its limits).

- Breadboards cannot be used to build circuits that operate at such high frequencies, 40MHz is well above what is considered achievable on a breadboard (due to parasitic capacitance problems).

- The setup time for the AT28C256 is 150ns, and at 40MHz the pixel timing is going to be 25ns so the EEPROMs would never keep up unless you come up with some incredibly complicated interleaving scheme or use some high speed addressable RAMs instead of EEPROMs.

Conversion from 800x600 to 100x75

- Now that we are done understanding why we had to convert to 100x75 mode, let us see how we did it.

- The pixel frequency in 800x600 mode is 40MHz, for the above discussed reasons and convenience we went with a 10MHz crystal oscillator as the clock. This meant that the number of horizontal pixels had to be divided by 4 in order to maintain the same timing.

Tab 4.1: General Timing

Screen refresh rate	60 Hz
Vertical refresh	37.878787878 kHz
Pixel freq.	10.0 MHz

Tab 4.2: Horizontal timing (line)

Scanline part	Time [µs]	Pixels in 40MHz	Pixels in 10MHz
Visible area	20	800	200
Front porch	1	40	10
Sync pulse	3.2	128	32
Back porch	2.2	88	22
Whole line	26.4	1056	264

Tab 4.3: Vertical timing (frame)

Scanline part	Time [ms]	Lines
Visible area	15.84	600
Front porch	0.0264	1
Sync pulse	0.1056	4
Back porch	0.6072	23
Whole line	16.5792	628

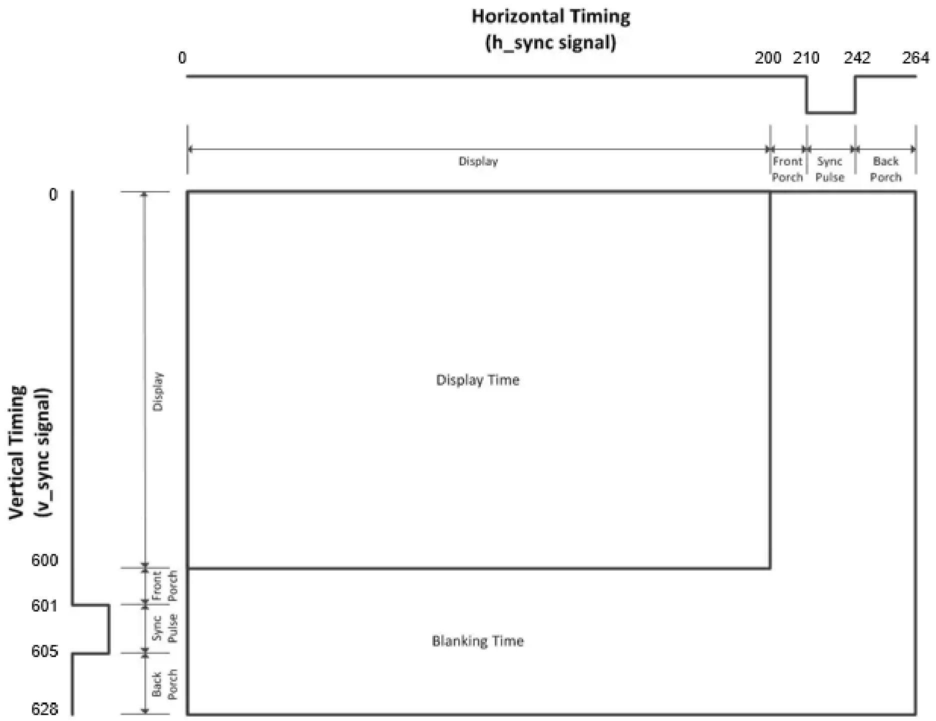


Fig 4(b):Timing Waveforms

Our project can be broadly classified into 2 major blocks and a few smaller blocks:

1. **Synchronous Counters (using IC 74161)**
    - **9-bit Horizontal Counter**
    - **10-bit Vertical Counter**
2. **EEPROM Circuit (CSI AT28C256)**

Additional Circuitry:

- **Clock module**
- **EEPROM Programmer**
- **VGA connector**
- **Power supply**

Synchronous Counters

Horizontal Counter:

We needed a 9 bit counter that could count from 0-264 to generate a single horizontal line. The circuit first has to count out 200 pixels (0-200), send a blanking interval (200-210), then set the sync low (210-242), and finally another blanking interval (242-264) before rolling down to the next line.

This needs to be done 37878 times every second (at a frequency of 37.878KHz). To do this we used three 74LS161 ICs, it is a 4-Bit Binary Synchronous Counter. Cascading three of these ICs meant it could count up to 12 bits (4096) but all we wanted was to count up to 264. So, each time the counter reaches 264, we reset it.

Working:

The three ICs are cascaded by giving them the same clock and connecting the carry out (pin 15) of one IC to the carry in (pin 10) of the next IC and so on. This way the three 4-bit ICs can now function together and act as a single 12 bit counter. To count till 264 we require only 9 bits since 264 is less than 512 (2^9=512). The remaining 3 bits are left unused.

Now, to detect when the counter reaches 200, 210, 242 and 264, a combinational logic circuit is built using NOT gates also called as inverters (IC 7404) and four 8-input NAND gates(IC 7430). The signal from the fourth NAND gate that detects 264 is used to reset the counter. It is also used as clock for the Vertical Counter. The outputs of these NAND gates are given to cross coupled 2-input NAND circuit called an SR Latch or a basic NAND latch to produce the blanking interval and the horizontal sync signal.

An SR latch is the simplest type of flip-flop. It has two inputs (Set and Reset) and two outputs (Q and $\overline{Q}$). The first latch is in set state till the counter counts up to 200, this gives us the display interval. Similarly, in the second latch when the counter reaches 210 it resets the latch and then sets it back high when the counter reaches 242.

The blanking interval is nothing but the inverted output of the first latch which can easily be obtained from the $\overline{Q}$ output. This is how the display interval, blanking interval and the horizontal sync signal are generated from the counter.

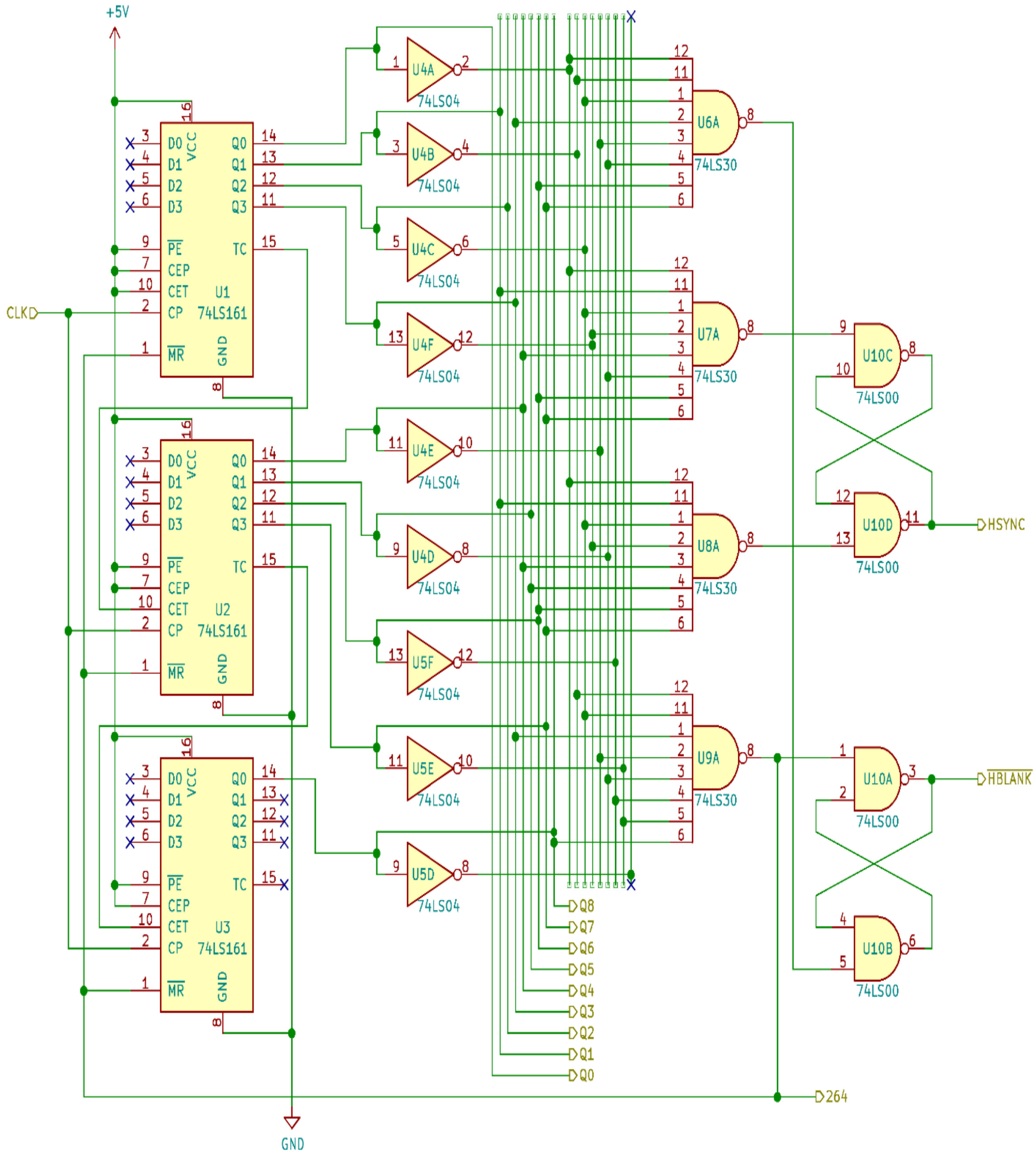


Fig 4(c) : Schematics of the horizontal counter

Vertical Counter:

For the vertical counter we needed a 10 bit counter that could count from 0-624 to generate a frame. The circuit first has to count out 200 pixels (0-600), send a blanking interval (600-601), then set the sync low (601-605), and finally another blanking interval (605-628) in order to complete a single frame. This needs to be done 60 times per second (60Hz or 60fps). To do this we again used three 74LS161 ICs. In this case, we wanted to count up to 628. So, each time the counter reaches 628, we reset it.

<u>**Working**</u>:

Just as we did for the horizontal counter, the three ICs are cascaded by giving them the same clock and connecting the carry out (pin 15) of one IC to the carry in (pin 10) of the next IC and so on. This way the three 4-bit ICs can now function together and act as a single 12 bit counter. To count till 628 we require only 10 bits since 628 is less than 1024 (2^{10}=1024). The remaining 2 bits are left unused.

Now, to detect when the counter reaches 600, 601, 605 and 628, a combinational logic circuit is built using inverters (IC 7404) and four 8-input NAND gates(IC 7430). The signal from the fourth NAND gate that detects 628 is used to reset the counter.

The outputs of these NAND gates are given to cross coupled 2-input NAND circuits called an SR Latch or a basic NAND latch to produce the blanking interval and the horizontal sync signal.

An SR latch is the simplest type of flip-flop. It has two inputs (Set and Reset) and two outputs (Q and $\overline{Q}$). The first latch is in set state till the counter counts up to 200, this gives us the display interval. Similarly, in the second latch when the counter reaches 210 it resets the latch and then sets it back high when the counter reaches 242.

The blanking interval is nothing but the inverted output of the first latch which can easily be obtained from the $\overline{Q}$ output. This is how the display interval, blanking interval and the horizontal sync signal are generated from the counter.

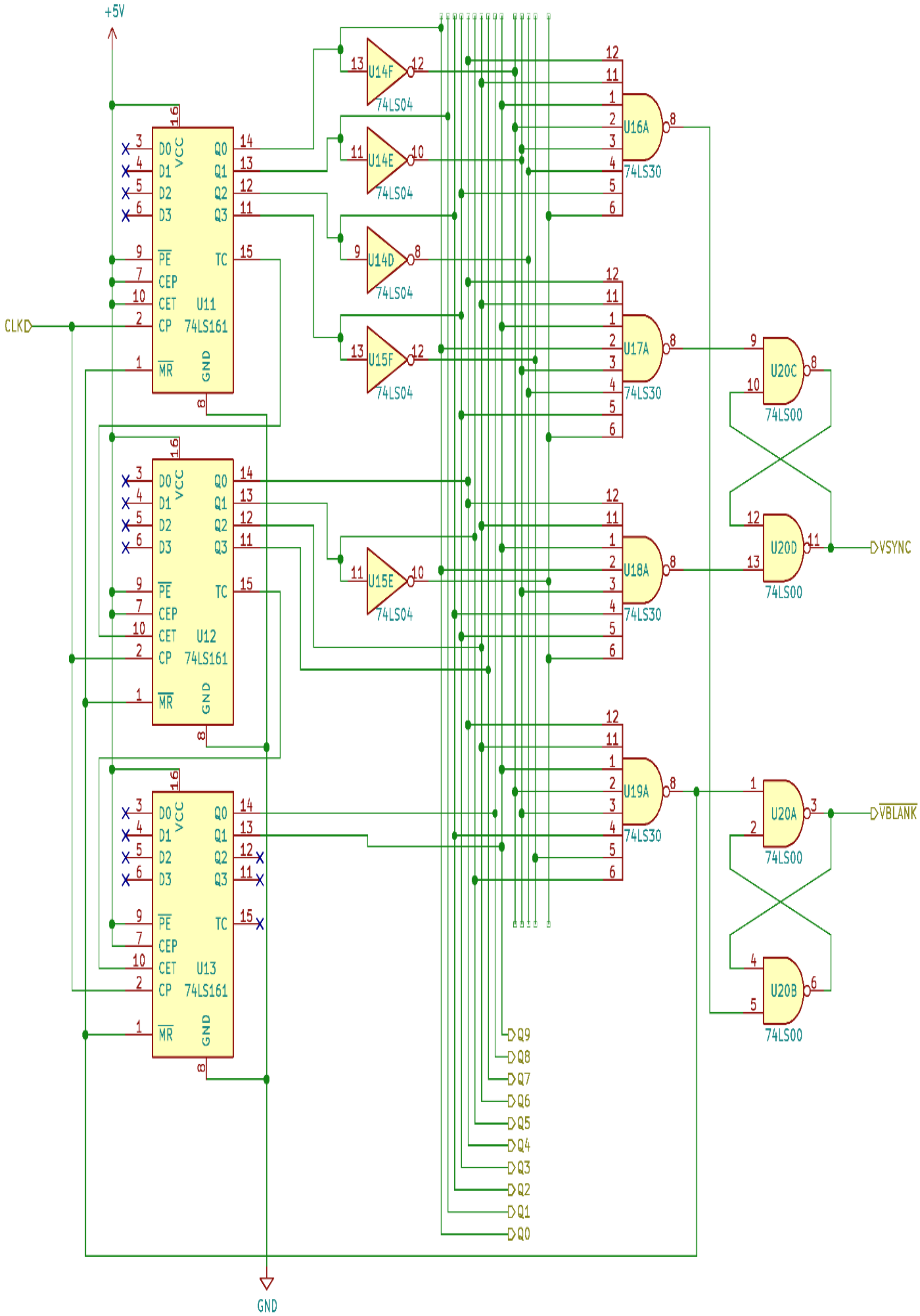


Fig 4(d): Schematics of the vertical counter

EEPROM circuit

Why we used an EEPROM?

By connecting the horizontal and vertical sync signals to a monitor, we observed that the monitor was able to detect the correct mode and turned on from standby but there was nothing being displayed on the screen

This is because in order to display something, the monitor requires colour data input from its RGB pins. We could display coloured stripes by giving signals between 0 and 0.7 to its RGB data lines, but what we really wanted to do is display a complex picture.

In order to do this, the pixel data of the image needs to be stored in some memory somewhere. Normally in a computer the data for whatever is on the screen is stored in a part of the RAM and the software accordingly changes its value to display different images. We used an EEPROM to store the pixel data of an image and output that to the RGB lines of the monitor.

<u>Working:</u>

The EEPROM that we used is the AT28C256. It has 32KB of memory and all this memory is accessed using 15 address lines. The address line inputs to the EEPROM is given from the Horizontal and Vertical Counters since it gives the X and Y coordinates telling it which part of the display the video card is displaying. An image is stored in the EEPROM by extracting the colour(RGB) data of the image using a software called VIM using Python and programming it using an EEPROM programmer.

The EEPROM is made sure to be enabled only during the display interval and turned off during the blanking interval by connecting the output enable to the ANDed output of both the horizontal and vertical blanking signals.

Finally, the output of the EEPROM is given to the monitor using a resistor ladder that acts a voltage divider to convert the binary signals into analog voltages between 0V and 0.7V to display a total of 64 colours.

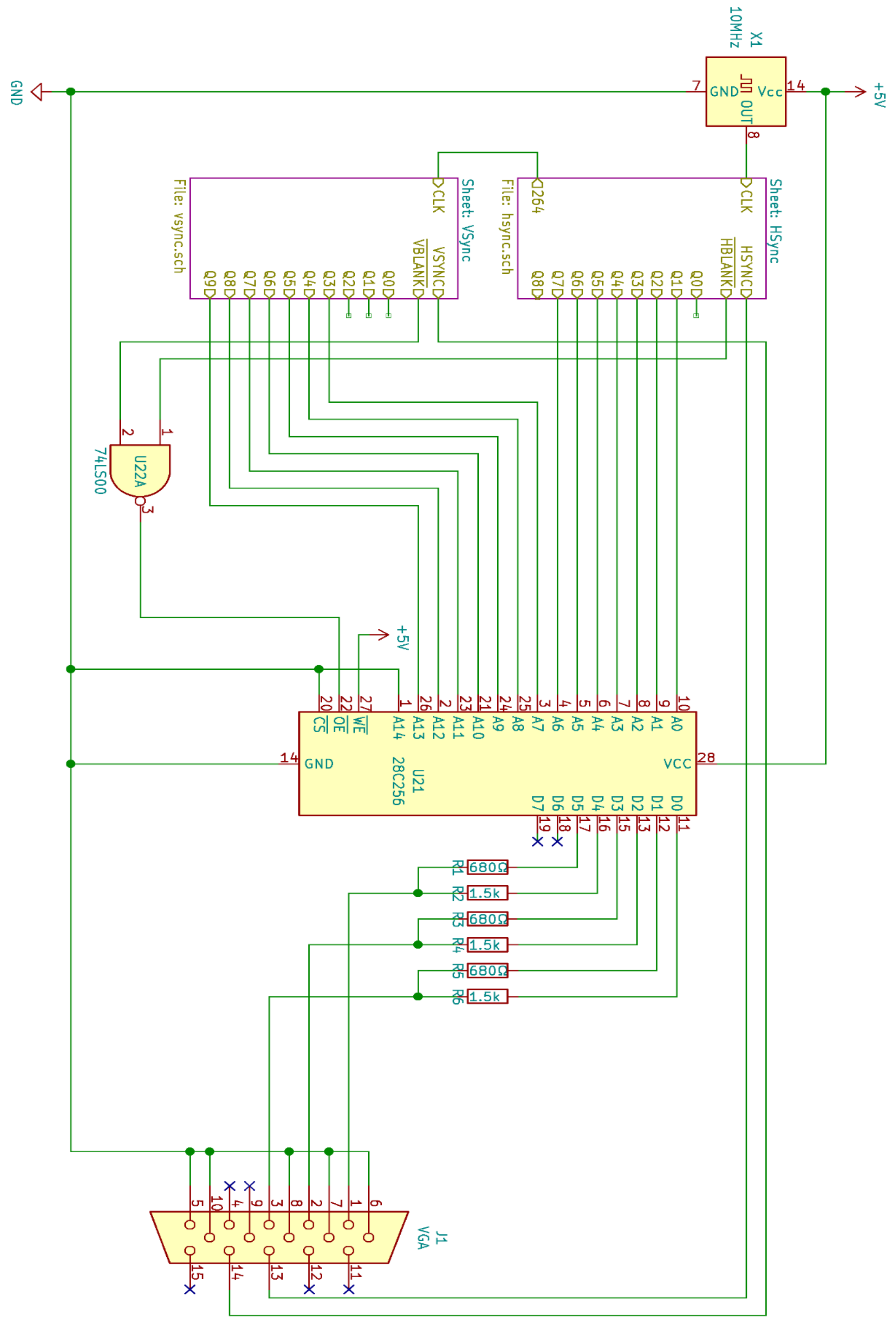


Fig 4(e): Final Schematics(eeprom circuitry)

Additional Circuitry and Components used:

- To power everything, any regulated 5V source can be used. We used a power bank.
- All these signals generated are connected to the monitor using a 15 pin high density D-SUB (D shaped subminiature) female connector.
- The EEPROM is programmed using an Arduino as the programmer.
- The 10MHz clock is provided by a full can crystal oscillator module.

CHAPTER 05

HARDWARE AND SOFTWARE REQUIREMENTS

The hardware requirements for the project are as follows:

- **Breadboard**
- **10 MHz Crystal Oscillator**
- **74LS00(Quad NAND Gate)**
- **74LS04(Hex inverter)**
- **74LS40(8-Input NAND Gate)**
- **74LS161(4-Bit Synchronous Binary Counter)**
- **AT28C256-15 EEPROM**
- **VGA Connector**
- **VGA Monitor**
- **Arduino Nano**
- **IC 7495 (Shift Register)**
- **USB Cable**
- **Resistors(680 ohm, 1.5K ohm)**

1) BREADBOARD:

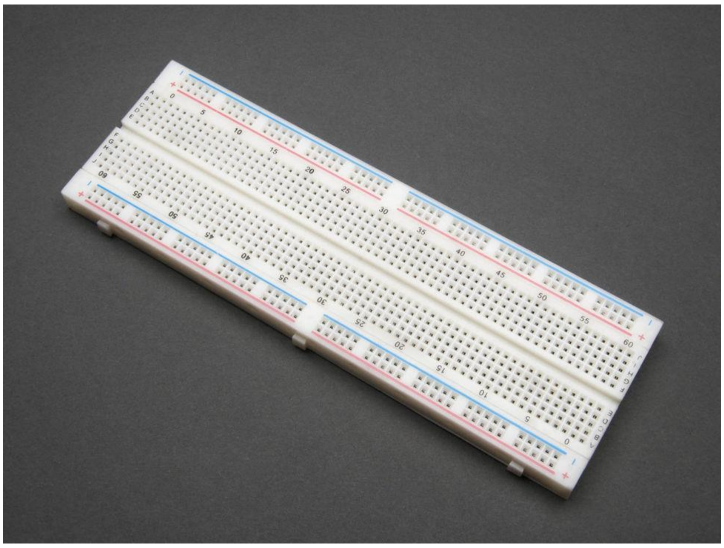


Fig 5(a) : Picture of breadboard

The breadboard represented in fig is a base used for constructing circuits on the base.

This breadboard that the picture depicts is a solderless breadboard also called as the terminal array board.These are the boards that are required for the prototyping of various electronic systems ranging from analog to digital circuits and also complete CPU. These are made white plastic, solderless material.

Since it is a board that does not require soldering (solderless) it is a reusable board and it becomes much easy to use for circuit design,for the creation of temporary prototypes and for the purpose of experimenting. On usage of other boards like stripboard, pcb with similar prototyping, the boards cannot be used for experimenting as it is not reusable. And this is one of the reasons why these solderless boards are popular amongst the students i n usages pertaining to circuits and technological constructions. In this project, breadboard serves as a base to house the various equipments used such as resistors, 555 ic, capacitors.

2) 10MHz CRYSTAL OSCILLATOR:

The picture is that of a 10 MHz full can crystal oscillator which is one kind of the many available oscillators; this works with the frequency of 10MHz.

These electronic oscillators create electric signals of some specific frequency which is capable of providing clock signals that are stable in nature,used in digital integrated circuits. This has four pins: Vcc, ground, enable , clock output.

Fig 5(b): 10 MHz crystal oscillator

In general,it is observed that these crystal oscillators are used to generate clock pulses that are essential for the synchronization of various internal operations. These crystal oscillators basically work on the principle of piezoelectricity and resonance , wherein the application of an alternating voltage across the crystal surfaces of the oscillator results in it vibrating at its natural frequency. It is observed that these are the vibrations that inturn get converted into oscillations.

3) 74LS00(Quad NAND Gate):

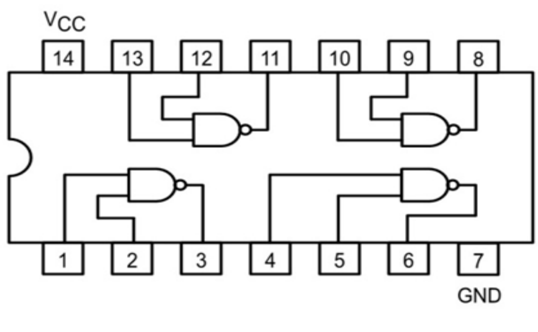


Fig 5(c): Pin Diagram of IC 7400

This IC that belongs to LS series are quad nand gates having two inputs per gate. The IC basically contains four independent gates wherein each of that gate performs the logic NAND operation. This is a 14 pin IC and each of the four gates present uses the input pins and one output pin , the remaining two pins are the ground and vcc pins. This is a widely used IC with its main feature being the fact that it can be used to design any type of logic gate as it is a universal gate.

4)74LS04 (INVERTER):

This 7404 ic belongs to the category of inverter chips(TTL chips) . This IC has six independent gates and each of it performs the logic invert function ,that is basically six NOT gates in it; hence it goes by the name Hex Inverter.

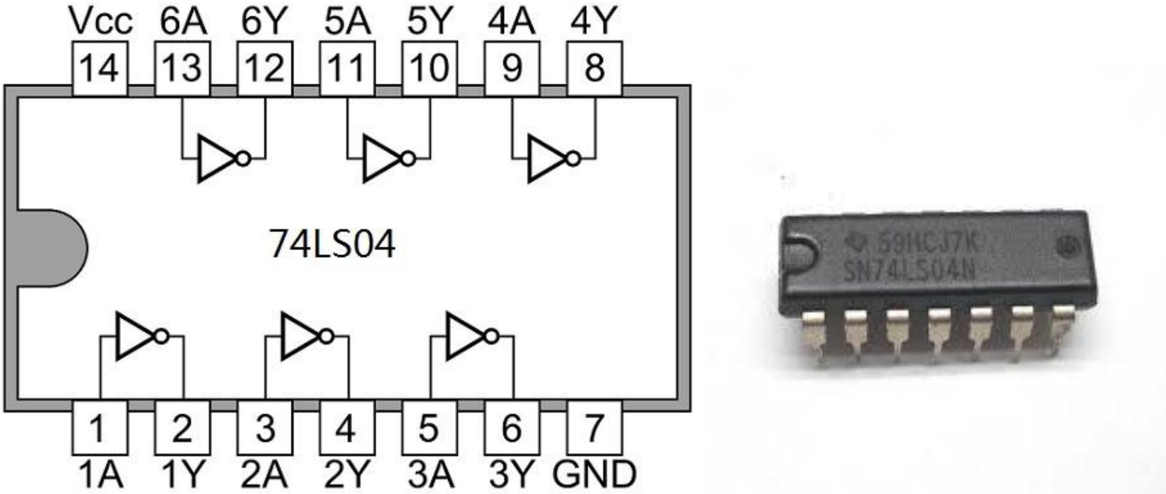


Fig 5(d): Pin Diagram of IC 7404

This is a 14 pin IC and each of the six pins present uses one input pin and one output pin, the remaining pins are the VCC and ground pins

5) 74LS40(8 Input NAND gate):

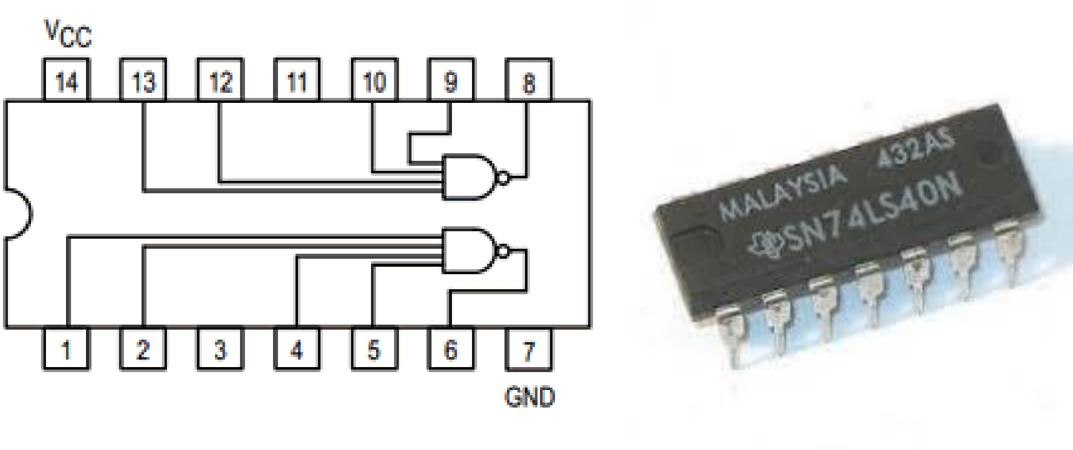


Fig 5(e): Pin Diagram of IC 7440

The 74LS40 IC belongs to the LS series and are 8 input NAND gates. The IC mainly contains two independent nand gates wherein each of the two gates has four input pins and one output pin, with the remaining pins being the VCC and the ground pins.

6)74LS161 (4 BIT SYNCHRONOUS BIN COUNTER):

These counters are 16 bit synchronous fully reprogrammable counters that can be set before hand(preset) to low and high levels as required. It contains and internal look ahead carry and is widely used in speed counting designs. The carry out of each block is decoded with the help of a NOR gate .

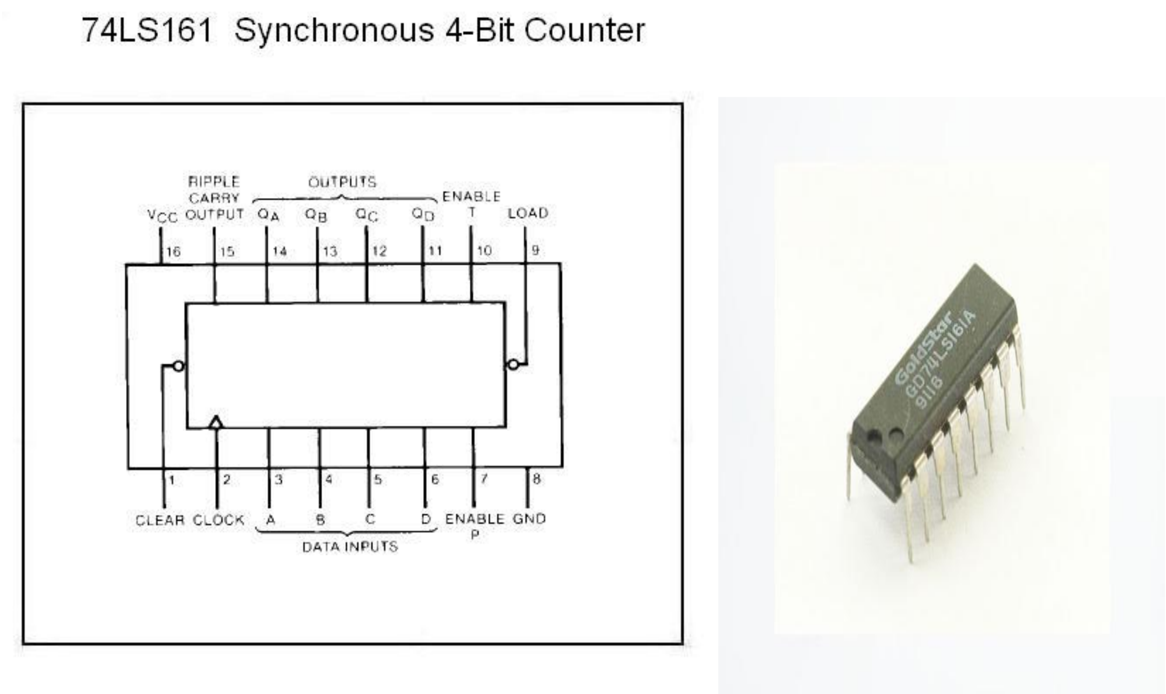


Fig 5(f): Pin Diagram of IC 74161

To provide synchronous operation all flip flops present in the counter are enabled to change outputs corresponding to each other according to the change in the internal functioning of the gates and the enable-count inputs.

The primary features of this counter includes its synchronously programmable factor, fast counting because of the internal look ahead carry, sunchronous counting on being enabled, n-bit cascading through the carry outpu, typical propagation time and frequency.

7) AT28C256 EEPROM:

The AT28C256 has 256Kb/32Kb of memory in it. These data can be accessed by using those 16 address lines and data could be stored into the eeprom using the input/output pins. Apart from this , there are the supply voltage VCC, ground GND,write enable WE, output enable OE and chip enable CE pins present in the EEPROM. The chip will be enabled when active low is given to CE. The current through the chip has to be limited by the connection of current limiting resistors to the i/o lines. The OE should be grounded inorder to be able to read data in the chip by selecting the address location.

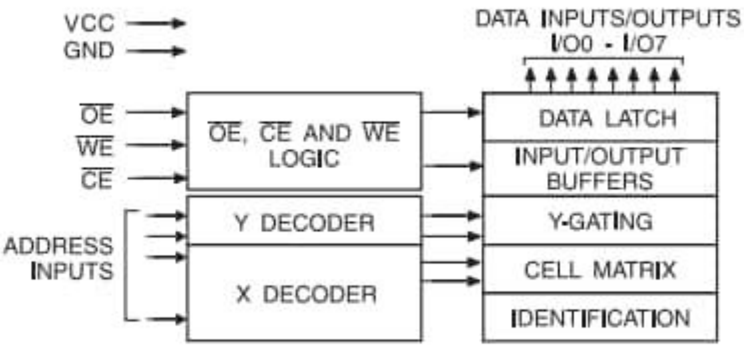


Fig 5(g): Block Diagram of AT28C256

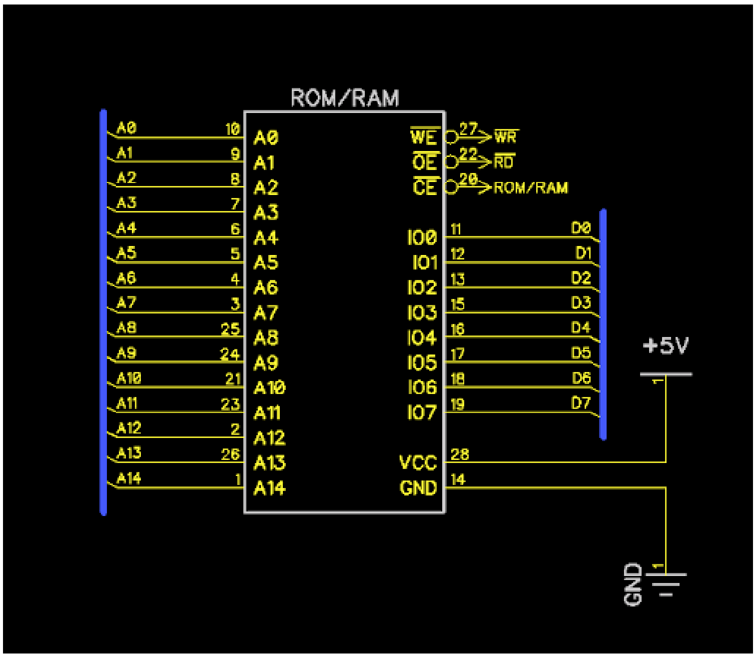


Fig 5(h): Pin Diagram of AT28C256

8) VGA CONNECTOR:

The Video Graphic Array connectors are 15 pin connectors that are arranged: 5 pins at the top, 5 pin in the middle , 5 at the bottom. These cables are used to carry analog components red, blue, green, horizontal sync(HSYNC) and vertical sync(VSYNC) video signals, and also the ground signals.

Fig 5(i): Picture of vga connector

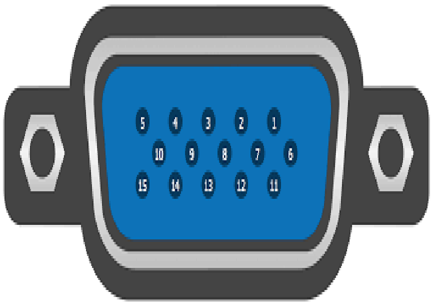


Fig 5(j) : Female D 15 VGA connector

These interfaces are said to function in a serial manner , meaning colour information for each of the pixel is being sent one after the other varying from all at once.

9) VGA MONITOR:

The video graphic array monitor is basically an analog display screen which accepts VGA signals sent through a VGA connector. Vga monitors are display interfaces or standard monitors being used in most PCs.

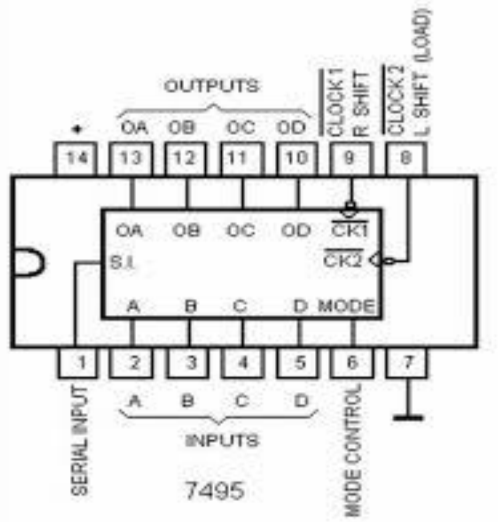
Fig 5(k): Picture of a VGA monitor

These monitors can be considered to be a grid of pixels wherein each pixel represents a picture element which can be set to a particular colour. These interfaces function serially ,that is, colour for each pixel is sent one after another , opposed to being sent all at once.

10) IC 7495 (SHIFT REGISTER):

This IC 7495 is a 14-pin IC that functions as a shift register. This IC has a combination of the basic AND and OR gates. These shift registers are a cascaded connection of flip flops wherein the output of one flip flop is being connected as the input to the other flip flop , in which position of bits is being shifted ,that is, data present at the inputs are shifted in and the array of bits at the output shifts out.

These shift registers can have both serial and parallel combination of the inputs and outputs. Depending on these , their configurations include : SIPO(serial input parallel output), PISO(parallel input serial output),etc. The PIPO is the fastest as the output is obtained on giving a single clock pulse.



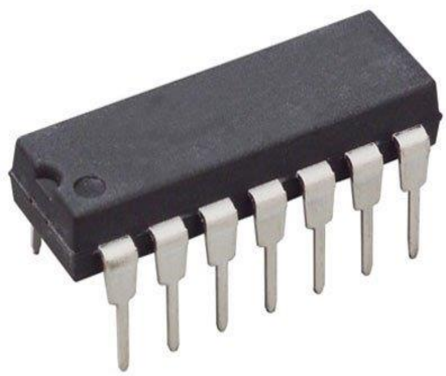


Fig 5(l) : Pin diagram of IC 7495

The primary applications of shift registers are parallel to serial data converters and vice versa, used as analog to digital converters at the transmitter section, digital to analog converters at the receiver section, sequence generators, etc.

12) USB CABLE:

Fig 5(m) : Picture of type-A cable

These cables refer to those highly functional connectors that help set up a connection between the laptop and any other devices that has a USB port. These cables are available in various types : USB TYPE A, USB TYPE B, USB TYPE C. These types are nothing but the length and the physical design of these cables. The one used here is the USB type A cable which is the standard rectangular and flat interface that is found on one end of every USB cable.

SOFTWARE REQUIREMENTS

The basic software requirements for this project are:

- Arduino IDE Version 1.8.1
- VIM
- Adobe Photoshop

1) Arduino IDE:

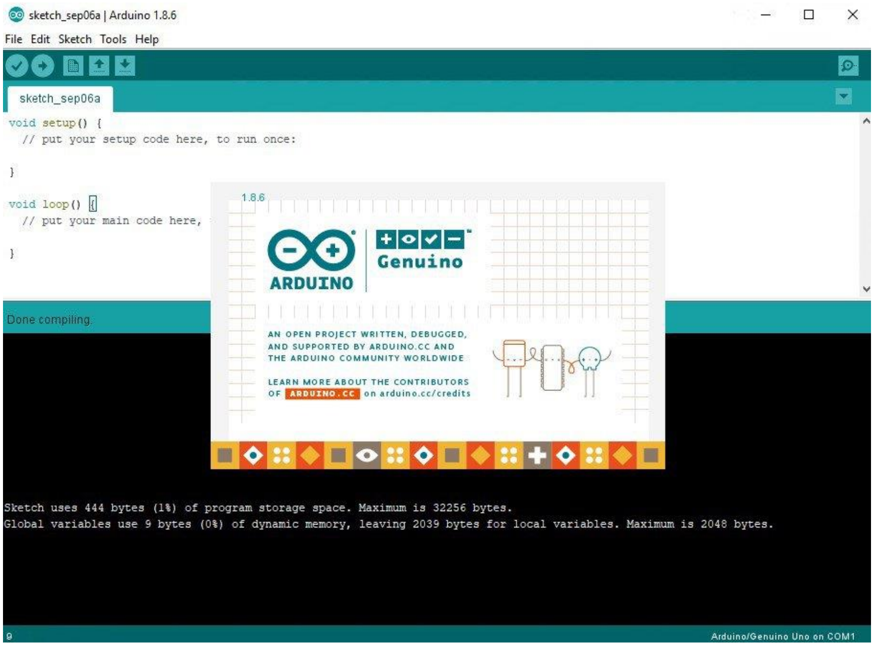


Fig 5(n): Arduino IDE

This Arduino (integrated development environment) , also referred to as the Arduino code package is an application program that provides a prototyping platform , thereby allowing users to develop interactive electronics objects. The Arduino IDE software that runs on Windows, Linux, Mac operating system makes it easier to write codes and execute and upload them to the boards. These Arduino boards are basically those development boards that enable makers to build devices, design and interact with other devices.

This software contains the applications program for composing codes, a book support, a toolbar having the provision for basic capacities,a message region and also a progression of menus.

2)Adobe photoshop:

Fig 5(o) : Adobe photoshop software

Adobe Photoshop is a software that has been developed and published by the Adobe Inc. It has been designed to be used by the Mac and windows operating systems. This software application is extensively being used for editing of images and retouching of photos that are of use on windows and Mac operating systems. This platform also allows retouching for various images and video file formats; and also image manipulation.

This software tool offers the users the provision of creating, enhancing artworks,images and illustrations, simulation of real time arts,etc.

The elements of this application mainly includes:

- Manipulating image colour
- Quick access of photos through organization
- Cropping images ,adding writings or texts to images
- Removing people or objects present in an image
- Publishing and sending messages

3) VIM software

Fig 5(p): VIM software tool

Vim software is a text editor tool built to enable efficient text editing. This software is basically used in the project to extract the colour data for storing the the data in the EEPROM(that is, to extract the RGB values from the jpeg image). Since vim software is mainly a text editor tool, it is being used along with python inorder to extract this image data.

CHAPTER 06

RESULT AND DISCUSSION

- In this project, we learnt how VGA signals work and built a circuit that provides the correct timing of sync signals so that a monitor recognises the signal and displays an image stored on an EEPROM.

- The goal of this projects was to understand the basics of TTL chips, use the 74XX series of IC's to build a video card on breadboard and display some sort of image onto a monitor and we have achieved it.

- Our video card will be able to output an image with a width of 100 pixels and a height of 75 pixels at 60 frames per seconds to the monitor using a VGA interface.It can produce 64 different colours for each pixel.

- Each member of our group now has a very good understanding of how a video card works, how the VGA interface works, how to program an EEPROM,how to implement an idea onto a breadboard, measure timing of pulses using a DSO, us resistor ladders to convert 6 bit indexed RGB digital signal into analog and much more.

- Our basics on fundamental electronics has become stronger as we have implemented the concepts that we have learnt in class on to a breadboard and practically made it work which means we have fulfilled the objective of our project.

CHAPTER 07

CONCLUSION AND FUTURE SCOPE

CONCLUSION:

- The video card has been constructed using breadboards and logic chips.
- The entire project was quite cost effective and well within our budget. It cost us around ₹1500 for all the components. The typical current consumption and power dissipation of the project is around 400 mA and 2W respectively.
- Working of a graphics card has been understood thoroughly and demonstrated.
- The working and generation of timing signals and pulses that the VGA interface uses to connect to a monitor has been understood.
- EEPROM Programming that needs to be done to store an image and build a simple digital to analog converter that generates colour signals to successfully display an image has been understood and demonstrate.

FUTURE SCOPE:

Our future plans include, designing a PCB, improving the resolution, using addressable RAM instead of ROM and display more than one image.

- The problem involved with the improvement of the resolution is that higher clock speed is required but most LS TTL has only been rated up to around 20Mhz for most chips (and that's pushing it to its limits), and 40Mhz is well above what can be considered as achievable on a breadboard . And lastly , the setup time for the AT28C256 is 150ns, and at 40Mhz the pixel timing is going to be 25ns so the EEPROMs would never keep up unless we come up with some incredibly complicated interleaving scheme or use some high speed addressable RAMs instead of EEPROMs.
- We need to learn to use EDA softwares like KiCAD, EasyEDA,etc in order to be able to design this video card on a PCB

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APPENDIX

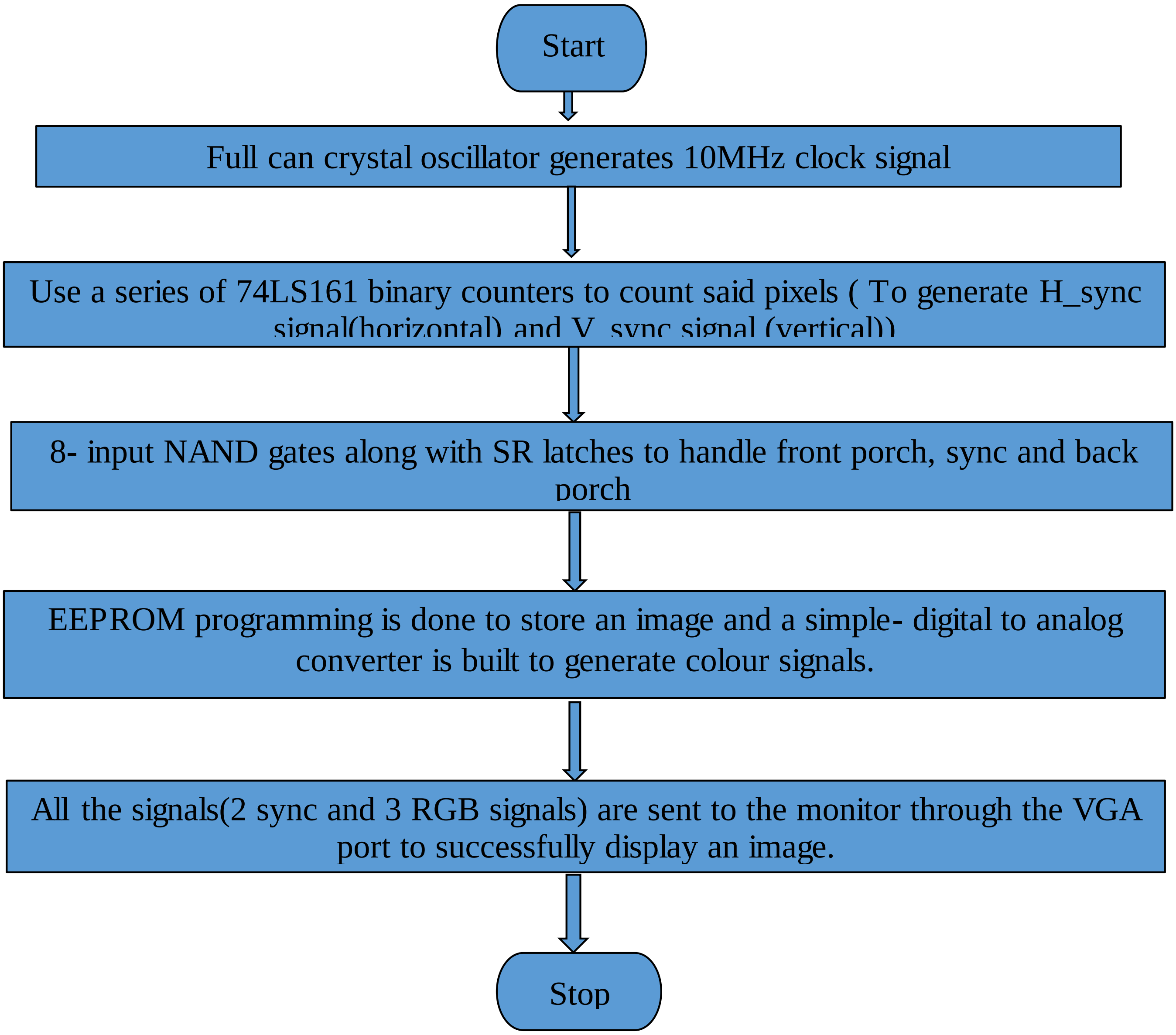

Fig A: Flowchart of the working