DESIGN AND CONSTRUCTION

OF A VGA TO TELEVISION CONVERTER

HARDWARE AND SOFTWARE INTERFACE, FOR CONVERSION OF

COMPUTER VIDEO TO TELEVISION VIDEO GRAPHICS

BY

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SEPTEMBER 2003

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A PROJECT SUBMITTED TO THE DEPARTMENT OF

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CERTIFICATION

This is to certify that the project titled design and construction of a VGA to TV converter was carried out by Olayemi Shola under the supervision of Engr. Paul Attah and submitted to the Department of Electrical/Computer Engineering, School of Engineering and Engineering Technology of the Federal University of Technology Minna in partial fulfillment of the requirement for the award of a Bachelor (B ENG.) degree in Electrical and Computer Engineering.

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.....
External Examiner

.....
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DEDICATION

This project is dedicated to **ALMIGHTY GOD,** my parent and siblings and to my dearest one who is to come.

AKNOWLEDGEMENT

All praise and adoration goes to the King of Kings, the one who leads and sustains me. I ascribe all the glory, majesty and worship for His help during the course of this project and my stay in the university. Thank you Lord!

I appreciate my parents, Mr. and Mrs. P.O. LAWAL for their love and understanding, for believing in me and making funds available for me. God bless you.

My appreciation goes to my supervisor, thank you for your time, advice and for believing in me.

Special thanks to the Adebayos, the Aarons, Chapel choir members, Emmanuel Okoronkwo, Yinka Oladejo, Bayo Asorose, Goke Odie, Adi Terngu, Blessing Adagbasa, Ebenezer, Tosin, Yinka Ojo, Tunde Togun, Chidon, Seun and a host of others.

ABSTRACT

This project comprises of a software driver that conditions a video microcontroller to work in consonance with an external hardware, which is designed to convert computer video graphics for display on TV. It therefore provides, a larger field of view, for computer gamers, screen presentations and video viewing.

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CHAPTER ONE

GENERAL INTRODUCTION

1.1 INTRODUCTION

The monitor has come a long way in its use to display computer graphics; it basically constitutes the **VDU** (Visual Display Unit) of the PC (Personal Computer), so that one cannot think about the PC or using it, without the monitor being involved in visually presenting feedback to the user. In this sense, the monitor reduces the communication gap that would have existed, between the PC and its User (user friendly). There is no sense imagining a computer system without VDU, in-fact it is crazy to imagine the Internet without a VDU (with all other system unit in place), the interactive spice of the Internet will be lost.

The TV (Television) has for decades, been in the forefront, championing the home multimedia system. The TV is certainly one of the most influential forces of our time; information (signals) can be transmitted (at different frequencies within the range, receptive by the TV) from different stations, with all signals received by TV sets, at several kilometers from the transmission station, ranging from a few kilometers to thousands of kilometers (satellite TV). In our time a government that has no control over its media is no government; companies have excelled because of their intelligent use of television advertising, knowing that the average Nigerian spends between two and five hours a day glued to "the tube"!

The PC is taking the center stage, in home multimedia system (modern home theater system), taking the traditional role of the TV, and going the extra mile by using the same

display unit to view both computer and normal broadcast video. Modern technology allows the use of PC (with right hardware + software), to view TV programs and edit video material. DVD movies can also be viewed on the PC, with PC connected to a TV or video projector, to get a larger picture, than what the monitor gives.

The idea of integrating the TV with the computer brings a new touch to computer use. TVs can be found almost everywhere, using the Central Processing Unit (with a small video converter unit) and a TV, makes for convenience, relative portability and transferability of desktop systems.

A good computer – TV integrated system will save the cost of buying a monitor.

There are several ways to get VGA graphics to the television screen, they include:

TV with VGA input, (VGA) Graphics card with TV output and VGA to TV converters e.g. scan converter

1.2 LITERATURE REVIEW

The first graphics cards, introduced in August of 1981 by IBM, were monochrome cards designated as Monochrome Display Adapters (MDAs). The displays that used these cards were typically text-only, with green or white text on a black background. Color for IBM-compatible computers appeared on the scene with the 4-color Hercules Graphics Card (HGC), followed by the 8-color Color Graphics Adapter (CGA) and 16-color Enhanced Graphics Adapter (EGA). When IBM introduced the Video Graphics Array (VGA) in 1987, a new graphics standard came into being. A VGA display could support up to 256 colors at resolutions up to 720x400 pixels.

Graphics cards adhere to industry standards so that a variety of cards can be chosen for a PC. Even though any card bought today will offer higher colors and resolution than the basic VGA specification, VGA mode is the de facto standard for graphics and is the minimum on all cards. In addition to VGA, a graphics card must be able to connect to the computer.

In the last decade, a lot has been done in order to display computer video graphics on TV. Significant contributions have been made by men like Tomi Engdahl (http://www.hut.fi/misc/electonics/circuitsvga2tv/index.html), Paulo Sérgio Coelho (http://pwp.netcabo.pt/pscoelho/vgatv_pane.html), and a host of others, who decided to explore the idea of displaying VGA graphics on TV, by using easily available materials and technology, thereby yielding to a much less expensive product than those paraded by manufacturers (commercial scan converters).

Tomi Engdahl worked on both converting from:

1. R G B + HSYNC + VSYNC (from VGA card, with refresh rate compatible to PAL or NTSC standards) to Composite video and S-video (Y/C) (through his circuit).
2. R G B + HSYNC + VSYNC (from VGA card, with refresh rate compatible to PAL or NTSC standards) to R G B + composite video. (i.e. VGA to SCART TV converter)

Paulo Sérgio Coelho chose to go the composite way, with circuitry similar in principle to the one done by Tomi Engdahl as stated in 1 above.

SCART TV's give room for reception of RGB and composite video, thereby making for easier compatibility with the output from the VGA card, in contrast with TV's with RF input, which affords for further processing of the VGA signal to make it receptive for display on TV. Though what is seen on the every day broadcast TV is composite video, TV's with SCART interface gives better picture quality.

Currently there are three basic techniques used for the conversion today, each with its own advantage and disadvantage. Depending on the (area of) application, careful consideration is to be given to the features needed in the application, with proper selection of product type that matches the need in question.

Four VGA to TV conversion techniques

1. One TV scan line memory buffer

Application fields where this technique is used: Most inexpensive small external VGA to TV converters, VGA chipsets with built-in TV output.

2. Many scan line converters with scaling

Application fields where this technique is used: PC video cards with built-in TV output capabilities (for example ATI PC2TV series of cards, 3D cards with TV output)

3. Full frame converters

Application fields where this technique is used: Professional converters used in many AV installations, professional broadcast quality VGA to TV converters and inside LCD projectors.

4. Make VGA to send out TV frequency signals

This technique (similar in principle to the technique 1, without a memory buffer) has been used in the cheapest VGA to TV gaming adapters like ADS Technology Game Zapper (not manufactured anymore) and Boffin Multimedia VIP 50. The product consists of VGA to TV adapter box and the drivers. The drivers set the VGA card to generate signals at normal TV frequencies.

The advantage of this design is that the electronics is cheap and the products can be made cheap. This technique was used in this project.

Application fields where this technique is used: Cheap game TV converters, commercial TV non-VGA video output cards, and special applications.

1.3 PROJECT OBJECTIVE AND MOTIVATION

The design and construction of the VGA to TV converter, was made to achieve various objectives including:

1. Application of the knowledge acquired in my course of study in the department of Electrical and Computer Engineering.
2. Display of computer video graphics on television using the most cost effective means
3. Exposure into the world of interfacing and system programming.
4. Experience in design and construction of electrical circuits.
5. Development of Research and reporting skill

1.4 PROJECT OUTLINE

This thesis comprises of four chapters. It outlines the design procedures and techniques involved in the design and construction of the VGA to TV converter.

Chapter one provides a general introduction of the project, it gives an insight into the project. The chapter also introduces the VGA to TV converter and gives literature review and the objectives the project is aimed at achieving.

Chapter two deals with system design and analysis. It gives information about the operating principles of the VGA to TV converter and the units that it consists of.

Chapter three describes the steps in construction. It also contains testing, results, their discussions and the limitations of the project.

Chapter four contains the conclusion obtained and then it gives appropriate recommendation.

CHAPTER TWO

SYSTEM ANALYSIS AND DESIGN

2.0 PREAMBLE

This project consists of two principal parts namely: Hardware and software (driver). They together constitute the VGA to TV converter. The converter in principle is expected to do the following:

Match VGA horizontal/vertical sync frequency to TV sync frequency.

Match VGA display frame rate (60 or 70Hz) to TV frame rate (50 or 60 Hz).

Convert non-interlaced VGA picture to interlace format for TV.

Convert VGA picture signals to RGB + Sync, PAL/NTSC composite video.

Synchronization signals.

Synchronization is needed for proper alignment of images on the screen.

In most video formats, there are two types of sync signals, the horizontal and vertical sync. The horizontal (line) sync in a composite video is a short, negatively going pulse at the beginning of each scan line of the monitor. Basically it tells the monitor to prepare for a new line of data. Horizontal sync lies in the unseen (blanking) area of the signal. There are an equal number of line sync pulses and video lines.

The vertical sync is a negatively going set of pulses at the beginning of each video field. It tells the monitor to be prepared for a new field of data (50 fields/sec in PAL).

Sync signals are integral composition of composite video signals. Composite video signal include; sync information (Horizontal & Vertical), luminance information and chrominance (color) information.

2.1 HARDWARE

Hardware design is concerned with designing an effective circuit that would be able to convert computer video graphics to television video graphics. After having designed the converter using the block diagram (see figure 2.0.1), a hardware circuit performing such operation can be easily developed. Thus the VGA to TV converter schematic (fig 2.1.5) shows the components used and how they were connected.

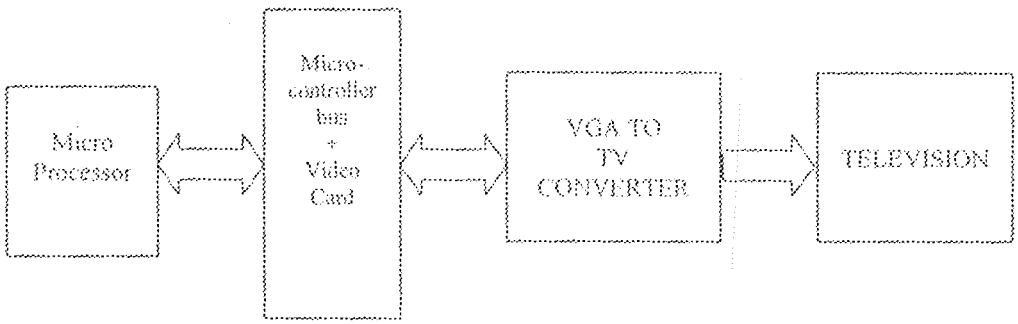

Figure 2.0.1: Block Diagram of VGA to TV Converter System

2.1.1 VGA Card

The VGA card's primary role is to make computer graphics signal available to the monitor for display, using the DB 15 cable connector. The VGA card has memory that holds the colour of every pixel 1 bit in length. It communicates with the computer, which sends pixel signals to alter its memory, through an appropriate interface bus on board (e.g. Industry Standard Architecture (ISA) or Peripheral Component Interconnect (PCI) slot). The graphics card then generates signals for the monitor. The card must generate color signals that drive the cathode ray tube (CRT) electron beam, as well as synchronization signals for horizontal and vertical sync. The VGA card sends signals to

the monitor for each pixel on each line, and then sends a horizontal sync pulse; it does this repeatedly for all 480 lines, and then sends a vertical sync pulse.

Computers usually operate in a Non-interlaced mode, i.e. an image is made of one frame and the image is swept out line by line. If the screen is refreshing at 60 frames per second, it means that the graphics card scans the entire memory array 1 bit at a time and does this 60 times per second.

The basic function of the video card in this project is to feed the VGA to TV converter with Red, Blue, Green and Sync (Horizontal & Vertical Sync) signals, through a connector called DB 15 shown in the figure below. Pin 1, 2, 3, 6, 7, 8, 10, 13 and 14 were connected to constitute the converter's input.

The standard VGA sends out separate sync signals to the monitor. It provides line (HSYNC – Horizontal Synchronization) frequency of about 31 KHz at a frame frequency of 60 – 70 Hz and a VSYNC (refresh) rate of 60 Hz (configurable).

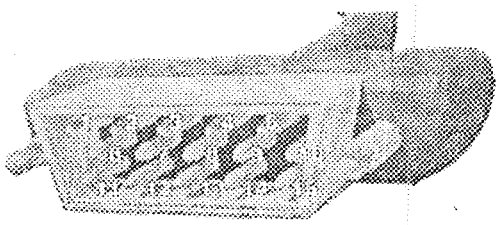

Figure 2.1.1 DB 15 video (VGA) connector

Table 2.11: DB 15 Pin labels and their functions

1: Red out	6: Red return (ground)	11: Monitor ID 0 in
2: Green out	7: Green return (ground)	12: Monitor ID 1 in
3: Blue out	8: Blue return (ground)	13: Horizontal Sync out
4: Unused	9: (circuit +5V)	14: Vertical Sync
5: (Circuit) Ground	10: Sync return (ground)	15: Monitor ID 3 in

Resolution in graphics card, describes the computer desktop, using resolutions (i.e. the number of pixels) expressed as a horizontal by vertical figure. Standard VGA resolution is 640 x 480 pixels. The commonest SVGA resolutions are 800 x 600 and 1024 x 768 pixels. Refresh rate, or vertical frequency, measured in Hertz (Hz), represents the number of frames displayed, on the screen per second. If this number is few, the eye will notice the inervals in between, and a flickering display perceive. The world-wide accepted refresh rate for a flicker-free display is 70Hz and above (preferably 75 Hz or more).

2.1.2 Monitor

The video adapter in PC sends signals from its image memory at a fixed rate (usually configurable), through the DAC (digital to analog converter) circuit, to the monitor connector on the graphics card. The DAC, converts numeric pixel color values to voltage levels for red, green and blue, they are sent to the monitor, through its cable. The computer therefore communicates, with the monitor via a video Interface, called the video card.

Most monitors today, use the traditional CRT (Cathode Ray Tube), which works on the same scientific principle as a television set. The vacuum – tube produces an image, when an electron beam strikes the phosphorescent surface inside the monitor.

The term, "sync signal", will be seen often in this project. Sync signal, also known as sync pulses, are negative-going timing pulses in video signals, used by video-processing or display devices, to synchronize the horizontal and vertical portions of the display (i.e. resolution). All computer monitors require sync signals, which determine the resolution of the display. PC VGA card sends out separate sync signals and beams, which the PC monitor is designed to accept.

2.1.3 The Television

TV Video (NTSC, PAL) operates in an interlaced mode, i.e. an image is made of 2 fields (1 frame) and the image is swept out in odd and even fields. A frame is one complete scan of a picture, in NTSC it consists of 525 horizontal scan lines, for PAL it is 625 lines. In interlaced scanning systems (TV), a field is half of a frame; thus, two fields make a frame. In PAL/SECAM for example, the Video has a line (HSYNC) frequency of 15.625 KHz, a field frequency (VSYNC, refresh rate) of 50 Hz and a Frame Frequency of 25 Hz. In NTSC systems those values are 15.750 KHz, 60 Hz and 30 Hz respectively.

The television used in this project was one that has as a SCART input receptor (female SCART) interface to receive the converter's output signal for display on its screen.

A SCART interfaced TV was used because of compatibility, quality and convenience reasons. VGA card picture components; RED, GREEN and BLUE are already at the correct voltage level (0.7Vpp) and have correct impedance (75 ohm) for direct connection to corresponding inputs (SCART) in the TV as stated earlier.

SCART TV was used for quality reasons, because it gives better picture quality as compared to normal broadcast TV since direct RGB connections are made between VGA card and TV because usually there are no bandwidth limitations in RGB signals like in composite video, so the picture signal can be much sharper than those of TV broadcasts and have extremely good colors.

2.1.4 Monitor Vs TV

Monitors, as we all know, have similarities as well as dissimilarities, both in structure and operation with TVs. They are both used for reception of video signals, information, they both use the same technique, to display picture on the CRT and they have the same physical structure. But yet still they operate at different scan rates.

It can be seen that the VGA connector, fig 2.1.1 has three separate lines for the Red, Green and Blue color signals, and two lines for horizontal and vertical sync signals. In a normal television, all of these signals are combined into a single composite video signal. The separation of the signals is one reason why a computer monitor can have so many more pixels than a TV set. With the forgoing, it follows that many Computer images can't directly be displayed (on TV) or recorded on video mediums, due to these differences. To display them, it is needed first to convert the computer signal into video format, compatible with the video device (TV in this case), using a suitable scan converter.

Scan converter is a general term, basically used for products that convert the horizontal and vertical scan rates, in order to make the Computer and Video devices compatible with each other. Manufacturers specifically describe a Scan Converter as a device that enables Computer (Workstations, PC, MAC) images, to be displayed on a standard Video Monitor and TV set, or for recording Computer images on videotape.

Scan Conversion arose from the incompatibility, between standards used in computer and video environments. The table 2.1.4 below clearly indicates that a lot of conversion is to be involved, in order to display VGA graphics on TV screen, since naturally the computer graphics (VGA) and normal broadcast television (NTSC, PAL or SECAM standard), are very incompatible with each other.

Table 2.14: Comparison between the Television and the Computer Monitor

COMPUTER MONITOR	TELEVISION
The picture signal sent out by PC graphics cards (VGA, Super VGA) is analogue RGB signal with separated sync signals	Normal video signals watched on TV screen are generally in composite video or RF (antenna)
The picture resolutions for computer is typically from 640x480 and well above 1024x768	For broadcast television it is nominally 525 or 625 lines in Y direction in signal, somewhat less visible resolution. X direction is not absolutely defined, (usually effective X resolution is between 300-600 pixels)
Computer uses non-interlaced video format	The picture format used in broadcast TV interlaces
Original VGA used around 31 KHz HSYNC rate (line frequency) and 60-70 Hz frame rate. Nowadays typical values are HSYNC=30-65 kHz and VSYNC (refresh rate) 60 - 75Hz	The picture format sync rates are different. The HSYNC rate of TV is 15.625 KHz (for PAL/SECAM standards) or 15.750 KHz for NTSC standard). The VSYNC rate is 50 Hz (PAL/SECAM) or 60 Hz (NTSC). The frame rate is 25 Hz (PAL/SECAM) or 30 Hz (NTSC)

2.1.5 SCART

The SCART (Syndicat des Constructeurs d'Appareils Radiorécepteurs et Téléviseurs) is a twenty one pin connector plug developed by the European community and found on the back of most European televisions and video players. The connector is also known as Peritel connector or Euro connector.

In Europe RGB interface is very common in TVs that have SCART A/V connector in them. Typically all TVs with SCART connector have RGB input capability and there are only quite few exceptions to this rule.

RGB needs at least three high quality cables (75 ohm coaxial cables), four if the separate sync signal is used, which is quite common. In some high end applications (such as workstations and PC VGA monitors) five wires are used, with separate horizontal and vertical drive signals in place of the sync line.

RGB is mostly used in computer systems, but it is also used in some TV production systems (RGB component cameras) and in home AV systems The PC VGA monitor is also becoming more and more popular in video production systems, because such displays are used by many computerized video editing sysiems.

In this project the SCART connector was used at the TV input end being a suitable means of making video signal output from the converter available for reception by the television

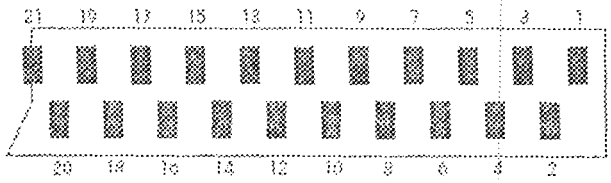

Figure 2.1.2: SCART Male connector front view

Table 2.1.6: SCART pin labels and their function

Output Connector		**Input Connector**	
1	Audio right out	2	Audio right in
3	Audio left (or mono) out	6	Audio left (or mono) in
4	Audio return	4	Audio return
7	Blue out	7	Blue in
5	Blue return	5	Blue return
11	Green out	11	Green in
9	Green return	9	Green return
15	Red out	15	Red in
13	Red return	13	Red return
16	RGB status out	16	RGB status in
14	RGB status return	14	RGB status return
19	Sync (composite video) out	20	Sync (composite video) in
17	Sync return	18	Sync return
21	Shield	21	Shield

2.1.6 VGA TO TV CONVERTER

The circuit for VGA to SCART connection is as shown in figure 2.1.5. The sync signal conversion is done by the electronics in the circuit. It is basically a circuit which takes VGA signals (via a DB 15 whose pins were wired to the converter) and converts it to RGB + composite sync signal which can be fed to TV SCART (female) input, through a standard SCART interconnection cable.

VGA card picture components RED, GREEN and BLUE are already at the correct voltage level (0.7Vpp) and correct impedance (75 ohm) for direct connection to corresponding inputs (SCART) in the TV. Since RGB signal is a direct feed from VGA to the TV picture driving electronics. What needs to be done is to combine separate horizontal and vertical sync signal from VGA card (available at pin 13 and 14 respectively) to one composite sync signal, which is fed to TV video in pin, in SCART connector (pin 20). However for this converter, since a SCART interconnection cable is used to connect the converter to TV, the composite sync signal out from the circuit is connected to SCART pin 19 instead of 20 because standard SCART RGB cable crosses all audio and video lines so that what is input in one end is connected to the output on another end. See table 2.1.5. The circuit sends correct level signal to the TV RGB input enabling the control pin in the SCART connector (pin 16), in readiness to RGB signals.

In summary the converter circuit acts as sync signal converter i.e. combining horizontal and vertical sync signals to form composite sync signals.

N.B. The components used in designing the converter circuit were chosen based on their availability and effectiveness in achieving the desired result.

2.2 SOFTWARE (DRIVER) DESIGN

The purpose of the software (driver) is to set the VGA card to generate signals at normal TV frequencies. The driver program replaces some VGA BIOS routines with its own code to make VGA card to use frequencies suitable to PAL TV set. The program is designed to be used only with the circuit connected to TV.

The VGA to TV driver is a small (less than 2 kilobytes) DOS TSR program which enables VGA card to be connected to ordinary NTSC or PAL TV with the VGA to TV converter designed earlier.

The software driver used in this project is a shareware downloaded from the internet. It has the ability to switch between NTSC and PAL modes. The program was written in assembly language (8086), it compiles and links well with Turbo Assembler 2.0 (an Intel based assembler) and Turbo Link 3.01 respectively, and therefore it was successfully assembled and compiled.

2.2.1 VGA to TV driver Architecture

The DOS drivers for using VGA to TV drivers have to change VGA register to make VGA card to send sync frequencies that are compatible with normal TV. For changing of those frequencies, the following thing needs to be done:

Set suitable clock frequency by reprogramming Sequencer registers.

Set CRT Controller timing register to make sync signals match TV standard.

The driver program as stated earlier, is a TSR (Terminate and Stay Resident) program which stays at the computer's memory when it is loaded, until it is restarted. The driver links to BIOS video services interrupt vector INT 10h.

The driver must change the function of the following services:

VGA screen mode change is handled in following way

- The driver calls the original mode setup routine in BIOS
- The driver modifies the necessary VGA registers to make VGA card to output at TV frequencies

VGA text mode font size changes

- The driver keeps the VGA fonts it needs to use, always active

This software driver approach works nicely with all DOS software that uses BIOS services to set up the standard VGA mode. This applies to most of the DOS games and even Windows 3.1 standard VGA driver. Sometimes the drivers fail to work with some exotic DOS extenders and memory manager programs.

Getting stable text display on TV involves the following things:

Setting the font size to 9x8 pixels and keeping the 25 text lines

Setting the pixel clock frequency to half speed

Adjust horizontal frequency using CRTC timing registers

Adjust vertical frequency using CRTC timing registers

Table 2.2.1: Driver supported VGA graphics modes:

Mode	Resolution	Comments
00H	40x25 text	Uses half of screen width
01H	40x25 color text	Uses half of screen width
02H	80x25 text	Uses 8x8 font
03H	80x25 color text	Uses 8x8 font
04H	320x200 graphics 4 colour	
05H	320x200 graphics 4	
06H	640x200 graphics 2	
0DH	320x200 graphics 16 color	
0EH	640x200 graphics 16 colour	
0FH	640x350 graphics 2	
10H	640x350 graphics 4 colour	
11H	640x350 graphics 16 color	
12H	640x480 graphics 16 colour	
13H	320x200 graphics 256 color	
95H	640x480 graphics 2560 color	Cirrus specific mode

Table 2.1.5: Truth Table for XOR gate

A	B	C
0	0	0
0	1	1
1	0	1
1	1	0

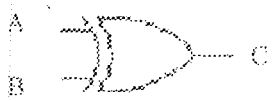

Figure 2.1.4: XOR GATE

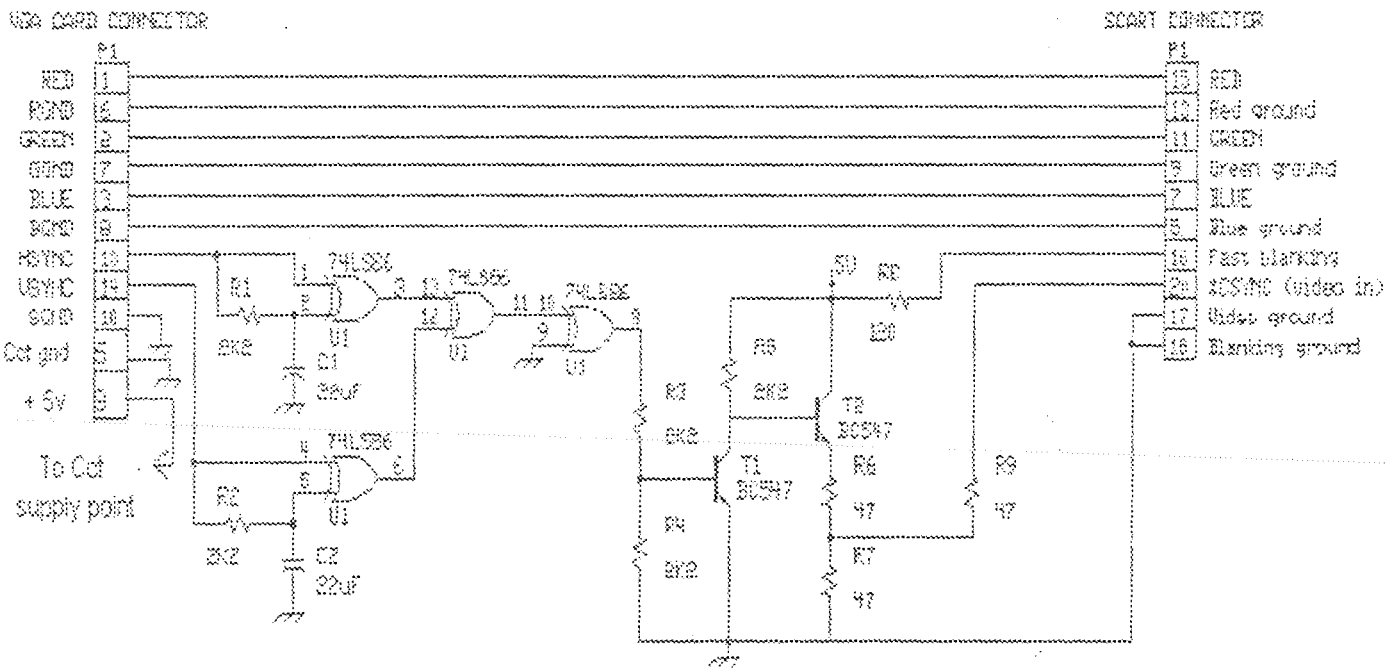

Figure 2.1.5 VGA to TV converter schematic

2.3 CIRCUIT ANALYSIS

Here is the description of schematic shown in fig. 2.1.5.

The converter circuit consist mainly of two units the sync polarity processing/combining unit and inverter/amplifier unit.

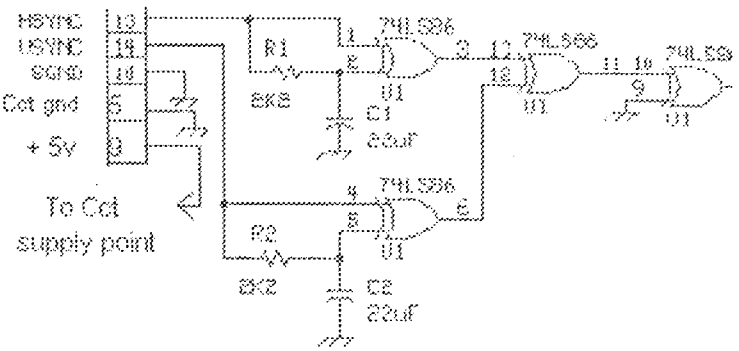

Figure 2.1.6 Sync Polarity/combining unit

The sync signal polarity processing/combining unit: The signal path is as follows. - R1 (2.2 K Ω, C1 (22 μF) and U1 (74LS86), the first XOR gate are pre-processing for HSYNC signal. The output of this circuit part is HSYNC signal that is at logic 1 when sync is active. The output sync is always this polarity no matter HSYNC input polarity. When sync is not active the capacitor discharges through R1, the output of the XOR gate is 0. The same follows for R2 (2.2 K Ω, C1 (22 μF) and U1 second XOR gate are pre-processing for VSYNC signal. The third UI XOR gate combines the processed HSYNC and VSYNC signals to composite sync signal. The sync is 1 when active, 0 when not active. The fourth UI XOR gate is just a buffer (there is option to reverse sync polarity that is needed in some modifications, the grounded input is connected to +5V).

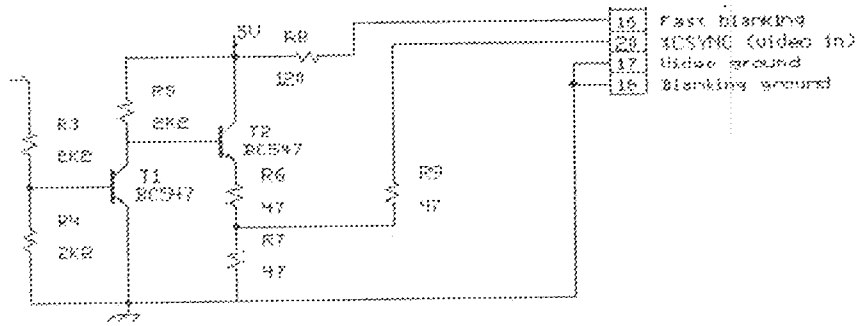

Figure 2.1.7 Sync Inverter/Amplifier unit

Amplifier unit: R3, R4, R5 (2.2 K Ω each) and T1 (BC 547) form an inverter that inverts composite sync polarity (to that which SCART needs, active low). Transistor T2 (BC 547) acts as a buffer to increase the current driving capacity of the inverter. Resistors R6, R7 and R9 (47 Ω each) form a potential divider that generates the suitable signal level for SCART (about 2V) and around 75 ohms impedance. Picture signals RED, GREEN and BLUE go directly to corresponding SCART connection. Resistor R8 (120 Ω) feeds control voltage for SCART "fast blanking" line that activates SCART input to take in RGB signal. R8 is here because +5V line directly to this pin is too much.

The 5V supply was tapped from the VGA card (Pin 9 & 5), with a switching option of using the converter with the VGA supply or a DC supply adaptor.

CHAPTER THREE

CONSTRUCTION AND TESTING

3.1 CONSTRUCTION

After completion of the design of the VGA to TV converter, all the components needed for the construction were bought and assembled together.

The construction started with the implementation of the design on a breadboard. This was done in units, proceeding from one unit to another after due testing.

The hardware units basically are: (a) Sync signal processing-combining unit.

(b) Sync signal converter-amplifier

Then permanent construction of the design was implemented a Veroboard.

Careful planning of the circuit layout was carried out to simplify wiring, minimize errors and make troubleshooting easy. Maximum management of the veroboard was also considered.

3.1.1 Construction of the SYNC Signal Processor-Combiner Unit

The 14 – pin IC socket that holds the 74LS86 (XOR gates), was first soldered on board. The two 2.2 KΩ resistors and two 22μF capacitors were connected. The continuities were broken where necessary. Then 5V was tapped from the VGA card to a line on the veroboard and then wired to the appropriate pins a DC adaptor was also used to supply 5V in the event that the VGA card has no supply terminal. The output of this unit is fed into the SYNC signal inverter-amplifier unit.

3.1.2 Construction of the SYNC Signal Inverter-Amplifier Unit

The 120 Ω, three 2.2 KΩ and 47Ω resistors and two npn (BC 547) were soldered to the board, and were adequately supplied from the 5V line on the veroboard.

3.1.3 Construction of the Hardware Interface

In order to identify the pins of the VGA card and the SCART, a digital multimeter was used to test for continuity. All the required pins of the VGA card were connected appropriately to the SYNC Signal Processor-Combiner Unit. The required pins of the female SCART connector were connected to the output of the SYNC Signal Inverter-Amplifier Unit.

3.2 TESTING AND TROUBLESHOOTING

Testing of the hardware circuit started from the beginning of the construction. Each of the circuit unit was tested, on completion, before moving to the next unit. The circuit was in each stage tested for continuity using a multimeter.

Before interfacing the VGA to TV converter hardware circuit unto the computer via the video card, the driver was tested. On that test the monitor lost sync, verifying that the driver was all right.

Testing of the converter was first carried out when it was on breadboard. The test was carried out without success until it was discovered that the video card used was incompatible with the converter. The compatibility problem was eliminated by using several other VGA cards (e.g. SiS 5597/5598 version 104).

3.3 OPERATING THE CONVERTER

The steps below are to be carried out in order to use the VGA to TV converter effectively.

- Load the VGA to TV driver to memory.
- Load this memory location in AUTOEXEC.BAT.
- Shut down the computer.
- Connect the converter to the video card and TV.
- Switch between VGA supply and DC adapter supply as the case may be.
- Boot the computer and be patient.

3.4 RESULTS

The VGA to TV converter designed and constructed was able to display computer graphics on an Euro SCART TV with relatively good quality.

3.5 DISCUSSION OF RESULTS

Graphics in DOS mode was excellent and all DOS programs that were tested worked fine. Graphics in windows was not as excellent. It was blurry but stable; the picture was not adequately centralized due to inability of the driver chosen to correct it. However certain better drivers are presently available to correct the problem.

3.6 LIMITATIONS

A limitation of this VGA to TV converter, apart from the blurry Windows picture, is the need to load software driver from a memory location each time this converter is to be used. The driver does not work with every VGA card. Another limitation of the converter is that it can only be used with European SCART TVs.

CHAPTER FOUR

CONCLUSION AND RECOMMENDATION

4.1 CONCLUSION

The objective of the project was achieved after having overcome various technical challenges in order to display of computer video graphics on television using the most cost effective means.

The construction and implementation of this project involved the application of knowledge acquired in the course of study. It opened the horizon into research, designing electronic circuits and understanding their components, giving an exposition into interfacing and system programming.

A keen look at this project will definitely reveal its great market potentials, especially with improvement to its driver software so that a larger variety of video cards and monitor can make use of the design.

4.2 RECOMMENDATION

For better graphics display on the TV screen, a better driver program should be used, (especially to display Windows programs clearly).

Further work should be done to display computer graphics on TVs other than European SCART televisions.

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APPENDIX

During the construction of the VGA to TV converter design, some electronic tools and equipment were used. These tools are briefly discussed in this section.

Soldering iron: A 30 watts rated soldering iron was used for this project bearing in mind that a higher wattage may damage electronic components.

Solder: Flux-core solder type was used for soldering all electronic component used.

Lead-sucker: Unneeded or bad soldering was corrected using the sucker.

Wire cutter: This was used to cut wires and trim off excess length of some electronic components after soldering.

Wires: Wires were used to link and integrate the circuit. Shielded wires were used to avoid interference.

Veroboard: This board was used to prototype the project design. The veroboard is pre-etched; therefore various electronic components were simply soldered in place, using wires to interconnect and a razor blade to break continuity of electronic links.

Digital multimeter: This was used to test for continuity of electronic links, to test zero logic, measure resistance, capacitance and voltage in various parts of the circuit. It was also used to check the contacts to ensure that bad connections are eliminated.