

# ELEX 7660: Digital System Design

## Composite Video Encoder with SPI Interface

Matthew Knight, Cole Harkness

2017-04-13

# Contents

<b>Introduction</b>	<b>3</b>
<b>Background</b>	<b>3</b>
The Composite Video Signal . . . . .	3
. . . . .	3
. . . . .	3
<b>Objectives</b>	<b>3</b>
Main Objective . . . . .	3
Secondary Objectives . . . . .	3
Framerate Control . . . . .	3
Sound Synthesizer . . . . .	4
Open MSP430 Synthesis . . . . .	4
Colour . . . . .	4
Hardware . . . . .	4
<b>Implementation</b>	<b>4</b>
8-bit DAC Hardware . . . . .	5
Composite Driver . . . . .	5
Timing Control . . . . .	5
Line Buffer . . . . .	5
Colour Modulation . . . . .	5
SPI Module . . . . .	5
RAM Interface . . . . .	5
<b>Results</b>	<b>5</b>
<b>Conclusion</b>	<b>5</b>
<b>Appendix</b>	<b>6</b>
Module Listings . . . . .	6
Colour Module Listings . . . . .	6

# Introduction

In the simplest of terms, our project is making video driver for composite video. But what differentiates us from other video drivers is that we plan on implementing a majority hardware solution. When this project was first brought up, we knew whatever project we choice had to meet our own personal requirements. It had to be challenging, useful, and have a hardware and software component. Although this already exists in the market they can be over priced. We plan on trying to make the same product for cheaper.

## Background

### The Composite Video Signal

Originally video was broadcast in black and white, only requiring one channel. In terms of driving the television itself, one needs only change DC voltage in the active video region of the signal to change luminosity levels.

Once colour televisions became a reality, video needed to be broadcast in colour as well. In order to also be backwards compatible with black and white televisions still in common use, colour was added to the video signal by adding an amplitude and phase modulated sinusoid. This allowed for only requiring one additional radio band for broadcast, keeping the now "composite" signal on a single wire, and black and white televisions would discard the colour components by passing the signal through a low-pass filter.

## Objectives

### Main Objective

The main objective of this project is to generate a black and white composite video signal that will drive a Cathode Ray Tube (CRT) television. To accomplish this, we will develop a video card with a serial interface that can generate a composite video signal. We will be able to achieve a resolution of 240 x 320 pixels on the screen.

Figure 1: System Overview

### Secondary Objectives

#### Framerate Control

The framerate for a CRT is roughly 30Hz while the shutter rate for most video cameras is 24Hz. When filming a CRT screen, slightly more than one frame will be displayed in the time that the image is captured on the camera, this results in a sweeping, white bar that will appear on the television when viewing the film. This is undesirable.

Many prosumer and professional cameras have an output signal called HSYNC. This signal will be used to trigger the composite video encoder so that only one frame is written to the television during one shutter period. In theory this will

remove any erroneous artifacts that would normally be seen in the video.

## **Sound Synthesizer**

Adding to the SPI interface, we could add commands that trigger pre-generated sound "bites" which would play in conjunction with pong. These sounds could either be programmed to the encoder through SPI, and saved into RAM or hardcoded into ROM. A DAC would then be needed to drive a speaker. Sound information and playing would be modeled after some standard, possibly something like WAV.

## **Open MSP430 Synthesis**

On Opencores.com an open source IP of the MSP430 core can be downloaded for synthesis in an FPGA. To cut back on the hardware used in the project, we can put this core on our FPGA and program pong onto it. This also adds some complexity as the ADC on the evaluation board would need to be interfaced to the system.

## **Colour**

The colour component of a composite signal is transmitted through the phase and angle modulation of a 3.58MHz carrier. In order to generate this signal we would need to employ a parallel DAC instead of our cheap, lopsided, but inexpensive resistor divider DAC. Another project within our class is to create a Nintendo Entertainment System on an FPGA, and so we will base our colour output on the NES.

## **Hardware**

To be able to complete this project we will need more hardware than what we currently have. We have a MSP430 microcontroller, the FPGA board, and a mini black and white TV. We need an 8-bit parallel, single channel DAC. We will use the AD9748 from Analog Devices Inc. which can be ordered from Digikey, and we will also need a breakout board for the 32-QFN package which can also be picked up from Digikey. Any hardware we may need, such as parts for filtering will be provided by us.

## **Implementation**

Figure 2: Module Diagram

**8-bit DAC Hardware**

**Composite Driver**

**Timing Control**

**Line Buffer**

**Colour Modulation**

**SPI Module**

**RAM Interface**

**Results**

**Conclusion**

## **Appendix**

### **Module Listings**

#### **Colour Module Listings**