비디오 출력 테스트

Testing Video Output

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***Abstract*—Increasing numbers of CMOS image sensors have encoded analog video output, IP750 (Teradyne Automatic Test Equipment called as ATE) provides solutions for capturing standard television signals on the system.**

I. Introduction

Motivation of this paper is from Increasing numbers of CMOS image sensors have encoded analog video (NTSC /PAL) output. So this paper provides solutions for capturing standard television signals on the IP750 test system,

The following figure1 shows the video display example of NTSC which has 480 * 720 resolution

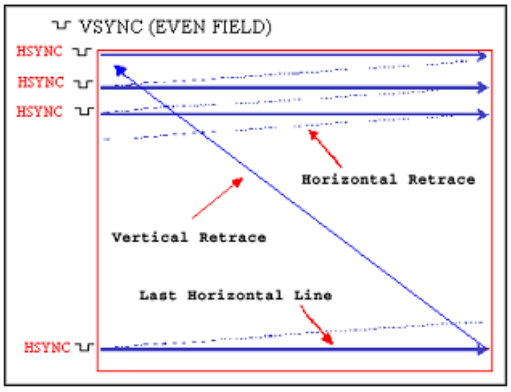


Fig.1 Video display example

This video signal has 3 kinds of components, the 1st thing is the luma signal which is commonly called as luminance, this contains the intensity (brightness or darkness) information of the video image. And the 2nd thing is the chroma signal contains the color information of the video image like blue and red, green. The last thing is the synchronization signal and this signal controls the scanning of the signal on a display such as the TV screen.

The following figures show the components of a video signal with different types. The figure 2 is the monochrome composite video signal with luma steps from white to black. And figure 3 shows the color information signal for a color bar line including the color burst. Also the figure 4 shows the color composite video signal for a color bar line including the monochrome and color information.

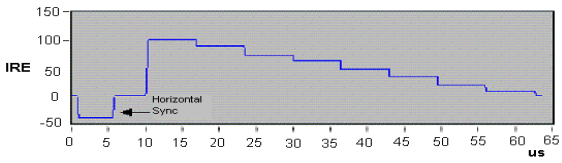


Fig.2 Monochrome composite video signal

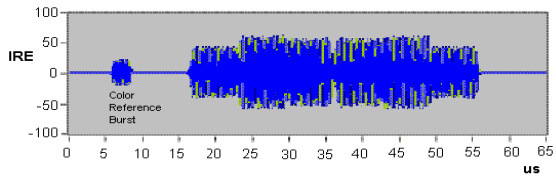


Fig.3 Color information signal

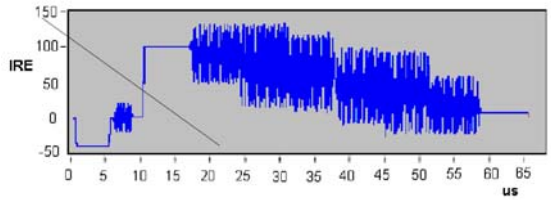


Fig.4 Color composite video signal

II. Method for Capturing

To get the captured image data from the video output, there are two approaches, the first one is to use the method of an analog capture. And 2nd one is to use the method of a digital capture.

In case of an Analog capture method, captures raw waveform with ICUA instrument (image capture unit analog) in IP750 system. And Digital capture method use ICUD (image capture unit digital) in IP750 system for capturing digital image. For analog capture, synchronizing to the device output is very important and for digital capture, digitizing and decoding the device output is important to implement this method. .And the figure 5 is the IP750 system overview.

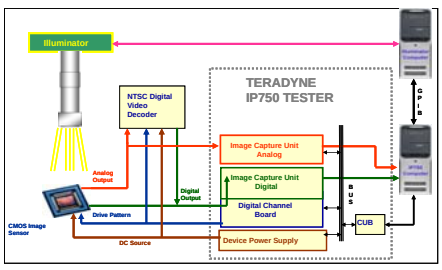


Fig.5 System Overview

i. Analog Capture Method

During Analog Capture, measurements for following items are required for the future analysis.

- Horizontal Frequency
- Vertical Frequency
- Sync rise time
- Horizontal Sync to color burst start
- Burst(sub carrier) frequency
- Sync to setup time

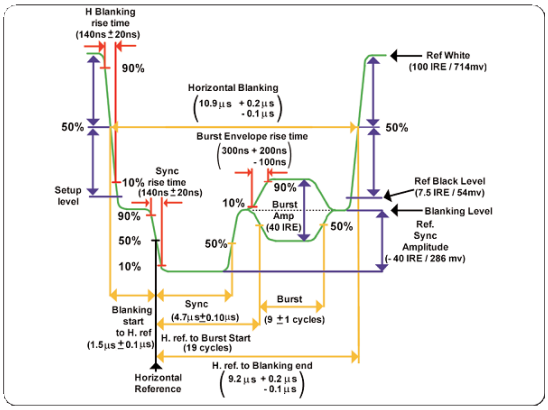


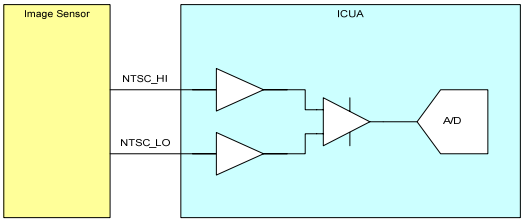
Fig.6 Required measurements

Standard sampling frequency of a video signal is 4 times of sub carrier frequency like the below figure.

Video Standard	Color Subcarrier F_{sc}	Sampling Frequency 4 x F_{sc}	Samples per line
NTSC	3.579 MHz	14.318180 MHz	910
PAL	4.443 MHz	17.734375 MHz	1135
SECAM	N/A	16.000000MHz	1024

Fig.7 Sampling Freq on each standard.

And ICUA instrument is capable of sampling at 50MHz which is one sample every 20ns and allows capturing with much better resolution than the minimum. So ICUA can capture signals containing the composite signal and a reference signal from the video output.



To get correct capture images, there are several things to solve first.

ISSUES	SOLUTION
Synchronization of ICUA and device	Capture more than 2 fields and use software sync
Small insertion loss because of the 50 ohm ICUA environment.	The loss is going to be 20%. Take this into account during the calculations.
Need a robust method to lock to HSync and VSync pulses.	Use a histogram based method to find the Sync and Blanking levels.

Fig.8 ICUA capture challenges

The figure 9 shows the video signal line sampled with the ICUA, and the figure 10 shows finding out the sync level and blanking level from the frequency domain.

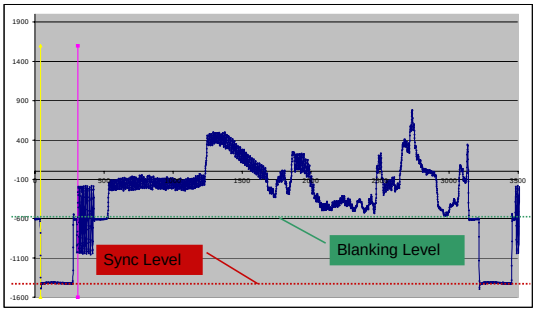


Fig.9 Video signal output in time domain

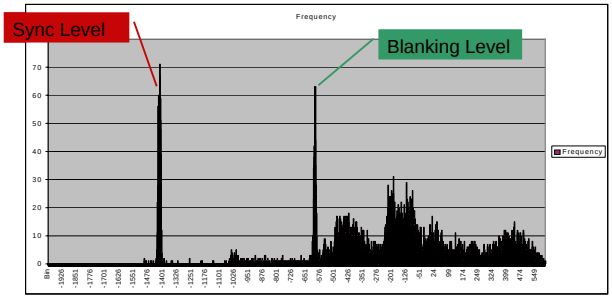


Fig.10 Video signal output in frequency domain

From the above result, Vsync and Hsync pulses can be found as following calculation.

Vsync Level Hi = Blanking Level + offset

Vsync Level Lo = Sync Level – Offset

Hsync Level = Sync Level + Offset.

And also the parameters can be calculated using the following figure 11 and the above results of Vsync and H sync.

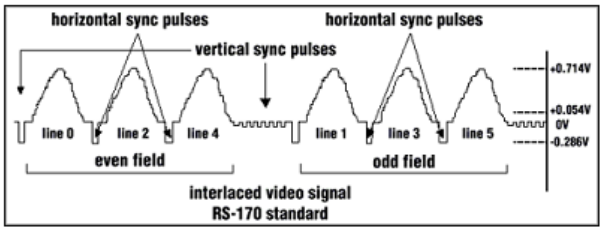


Fig.11 Interlaced video signal

The following table shows typical results from measurements.

Parameter	Result
Line Period	63.56 us
Line Freq	15.73 kHz
Vertical Period	0.01668 us
Vertical Freq	59.93 Hz
Rise Time	47.88 ns
Fall Time	46.67 us
HSync to Color Burst	5.38 us
Color Burst Freq	3.57 MHz
HSync to Setup Time	9.82 us

Fig.12 Typical Results

ii. Digital Capture Method

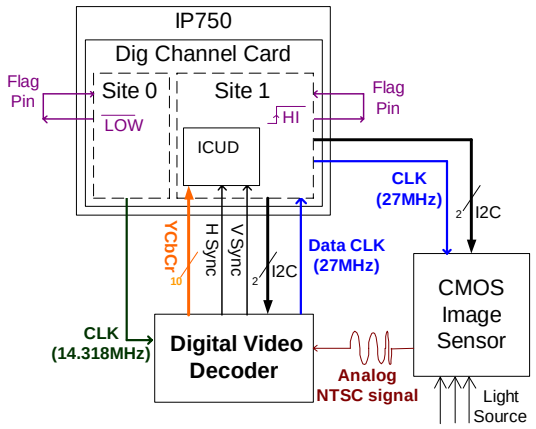


Fig.13 Overview of Digital Capture.

The Figure 13 shows the overview of digital capture method. And ICUD instrument in IP750 can be used for capturing the image data from the digital video decoder.
And in this case, the below decoder (Fig. 14) is used for converting analog NTSC signal to YCbCr which has the luma component and the blue and red chroma components. finally converted to Red, Green, Blue color by matrix multiplication.

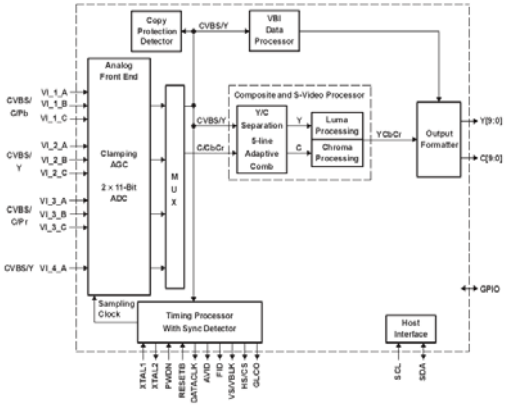


Fig.14 Digital Video Decoder

The Original NTSC output waveform is like the below figure 15.

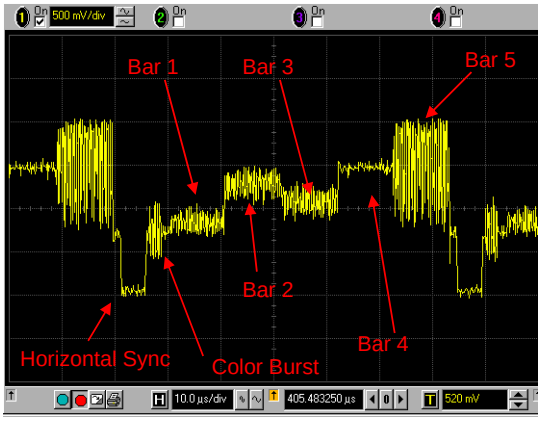


Fig.15 NTSC Waveform for color bar output

This output waveform shows 1 row of pixel data and a color bar test pattern for this test consists of five color bars. The following figure 16 shows the color bar raw output, The output type of YCbCr from digital video decoder is reconstructed as RGB color bar with using the below calculation.

$$\begin{pmatrix} 1 & 1.371 & 0 \\ 1 & 0.698 & -0.336 \\ 1 & 0 & 1.732 \end{pmatrix} \times \begin{pmatrix} Y \\ Cr-512 \\ Cb-512 \end{pmatrix} = \begin{pmatrix} R \\ G \\ B \end{pmatrix}$$

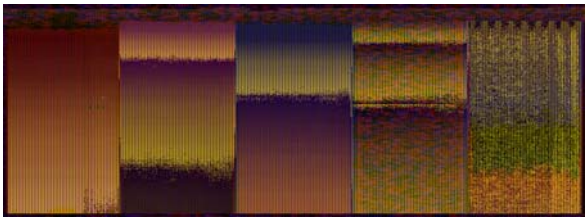


Fig.16 Color Bar Raw Output

The figure 17 shows the final RGB display image has the pixel size of 720 * 480.

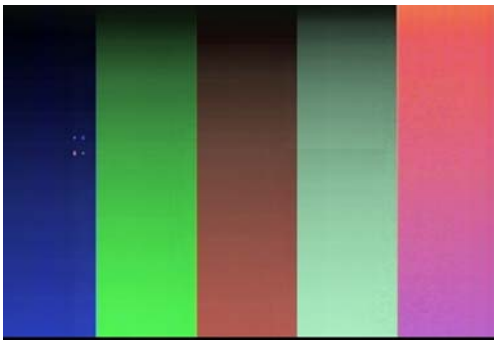


Fig.17 RGB color image

III. Conclusion

In this paper, we introduce how to capture the video output data using ICUD and ICUA instrument in IP750 test system. And also introduce analog video output data can be captured in the condition of original analog output or converted digital output. This capture method is supplied from the result of an experiment.

References

[1] "IP750 instrument manual"
[2] "Testing Video Output" TUG2006, by Colin Boyd & Guillermo Pidal.