Harris Semiconductor

APP NOTE

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Harris Linear

Component Video Sync Formats (HFA1103)

Author: Chris Henningsen

Introduction

This application note will examine a variety of sync formats and a method for removing the sync pulse from component video signals (see Figure 1). The HFA1103 is a Video Op Amp with an open emitter NPN transistor output stage that is ideal for video signal amplification and sync stripping functions. This product was developed for video design engineers who need to remove sync from component RGB (red, green, blue) and monochrome RS-170 video data (see Figure 7). Recently the term RGB has been turned around and called GBR (green, blue, red) as video distribution systems normally put green on channel 1, blue on channel 2 and red on channel 3. This is consistent with the hook-up of the color difference standards.

TABLE 1. RGB STANDARDS SPECIFICATIONS (BROADCAST ENGINEERING 11/94)

	SMPTE/ EBU N10	NTSC (NO SETUP)	NTSC (SETUP)
Max	700mV	714mV	714mV
Min	0mV	0mV	54mV
Range	700mV	714mV	660mV
Sync	-300mV	-286mV	-286mV
Peak-To-Peak	1V	1V	1V

Table 1 lists standards specifications for SMPTE and NTSC video signals. All have $1V_{P-P}$ signals with sync signals ranging from -286mV to -300mV. A typical $1V_{P-P}$ video signal consists of up to +700mV of active video on top of a -300mV sync pulse. The application circuit shown in Figure 2 will strip off the sync pulse and transmit only the positive video data. See the Harris Application Note AN9514 titled “Video Amplifier with Sync Stripper and DC Restore” for additional details on this circuit. This circuit is useful in a variety of video processing applications such as; RGB video digitizing, RGB video distribution amplifiers for workstations and PC networks, and RGB monitor preamplifiers. When digitizing RGB video it is not necessary to digitize the sync pulse, so removing sync allows the full dynamic range of the A/D converter to be used on just the video data, resulting in a 30% increase in image resolution. In video distribution amplifiers, which are driving a number of video channels, it is undesirable to require separate switching channels for the sync signals. Sync is generally combined with the video signal, resulting in lower system costs by minimizing the total number of switching channels required. Certain applications, such as some RGB monitors, can't handle sync on the video signal and it must be stripped off, usually by a stage on the output of the distribution amplifier. Now that we know some of the applications where sync removal is important, let's look at why and where sync signals are used.

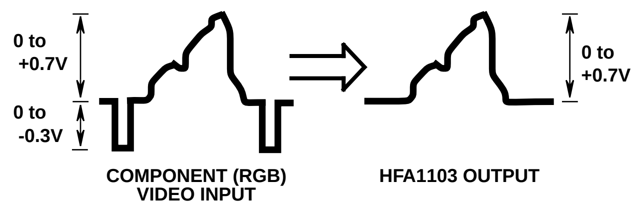

FIGURE 1. SYNC STRIPPER WAVEFORMS

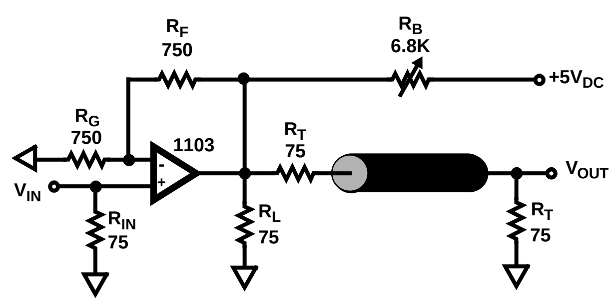

FIGURE 2. HFA1103 APPLICATION CIRCUIT VIDEO AMPLIFIER WITH SYNC STRIPPER

Transmitting two-dimensional moving pictures electronically requires the handling of a large amount of information and this is done by slicing the 2-D picture into horizontal strips of video and sending them sequentially. At the receiving end, or video monitor, the video information is recreated in scan lines on the display screen. This process continues until all of the scan lines needed for the picture are complete. Each complete picture refresh is called a frame, and typical frame refresh rates vary from 25 to 30 frames/s for broadcast video up to 72 frames/s in high performance video systems.

Sync signals are used to ensure that the scan lines are correctly placed on the display screen. A horizontal sync pulse is used to indicate the end of each scan line and signals the monitor to return to the left edge of the screen to begin the next scan line, below the one just completed. A vertical sync pulse is used to tell the monitor that the bottom of the picture has been reached, and that the next scan line will start at the top again. This is similar to a carriage return on a typewriter, where a scan line is equivalent to a single line of text and a frame of video is equivalent to a complete page of text (see Figure 3).

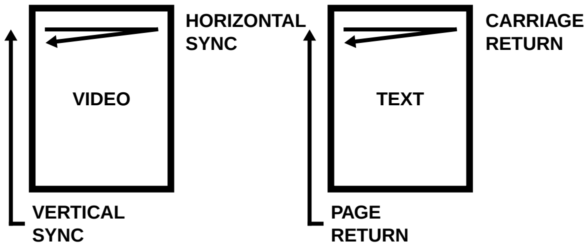

FIGURE 3. HORIZONTAL AND VERTICAL SYNC IS ANALOGOUS TO TEXT CARRIAGE RETURN AND END OF PAGE

The scan lines are formed by moving a spot of light, scanning left to right and top to bottom, in a pattern called a raster. As the spot traces out the raster pattern, it is modulated by the video signal to form the picture. Monochrome (black and white) systems require just one video signal, plus the horizontal (H) and vertical (V) sync pulses, for a total of three signals. Color computer systems require one signal each for red, green and blue, plus V and H sync pulses for a total of five signals. There are a variety of techniques used to reduce the number of wires needed to transmit these five signals.

Computer Systems

In computer systems the monitor is generally located close to the CPU and separate wires can be used for Red, Green, Blue and Horizontal and Vertical sync signals. It is common for monitors to be hooked up using a single connector housing the five separate wires. This approach is referred to as RGBHV. As the distance between the monitor and the computer increases, it is more convenient and less costly to use fewer wires. Combining both the horizontal and vertical sync into a single composite sync signal results in a four wire system, eliminating one wire. This approach is referred to as RGBS, where S is the composite sync signal. RGBS system monitors contain circuits to recreate the horizontal and vertical sync signals from the composite sync. Another wire can be eliminated by combining sync with a video channel. This is possible because sync pulses only occur between scan lines (horizontal sync) and between frames (vertical sync), when video signals are not present. Typically the composite sync is carried by the green channel and this 3-wire system is referred to as RGsB or SOG for sync-on-green. RGsB system monitors have circuits to identify composite sync from the RGsB video and to separate it into its horizontal and vertical sync components. In some cases sync is combined with all three color channels; red, green and blue, and is referred to as RsGsBs. We have now discussed how to transmit video using 5 wire RGBHV, 4 wire RGBS and 3 wire RGsB approaches (see Figure 4), with the major differences being the way in which the horizontal and vertical sync signals are handled. Using fewer wires is an obvious advantage in applications with long cable lengths between the computer and monitor. Many multisync monitors accept all three formats of RGB and sync, as they have circuits to adapt automatically to the type of RGB signal present. Other monitors are designed to work specifically with one of the RGB formats and the sync must be removed from green in RGsB or from all three channels in RsGsBs before driving the monitor. This is one of the primary applications for the HFA1103 video op amp with sync stripper.

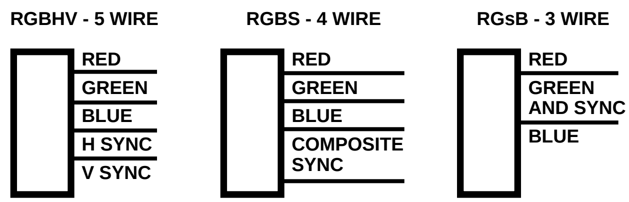

FIGURE 4. WIRES REQUIRED FOR RGBHV vs RGBS vs RGsB VIDEO

Now let's see if we can further reduce the number of wires by doing something with the way we transmit video. RGB video signals can be color space transformed into a separate black and white (monochrome) picture plus two additional pictures that describe the difference between the monochrome picture and the full color representation. The monochrome picture is called “luminance”, and is referred to as “Y”. The pair of color difference pictures are referred to as “U” and “V”. This YUV video signal can be color space transformed back into RGB, if needed. The advantage of the YUV signal is that it reduces the transmission and storage requirements in video transmission and distribution systems, as the total amount of video information is reduced. This is due to the fact that the human eye does not need as much color difference information as it does luminance information. Now the color difference information “U” and “V” can be combined into a single “chrominance” signal, referred to as “C”. We have now reduced the signal total to two wires. A new type of sync signal must be included so the video monitor can separate the two color difference signals again. This new sync information is called color burst, and is added to the chrominance, “C”, just after each horizontal sync pulse. The “Y” channel carries the composite sync information.

S-VHS videotape is the most popular YC format.

Television Broadcast Systems

Television Broadcast Systems must take the five original signals (R, G, B, H, and V) and transmit them through a single transmitter. Here luminance “Y” and chrominance “C” are combined into a single video signal called composite video. Broadcast video systems are required to be compatible with monochrome and color receivers, and black and white receivers only need to process the Y portion of the signal. The broadcast standard in North and Central America, Korea, Taiwan and Japan is called NTSC and uses a 3.58MHz color subcarrier. Europe, Australia and the Middle East use PAL while France and Russia use SECAM, both 4.43MHz color subcarriers (Figures 5 and 6). Note that the application circuit for video sync stripping, shown in Figure 2, is not useful for composite video applications, as some of the color information (blue) resides below the black level (Figures 7 and 8) and would be lost by the sync stripping function.

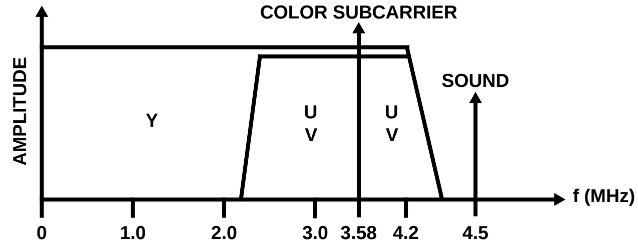

FIGURE 5. NTSC SYSTEM BANDWIDTH

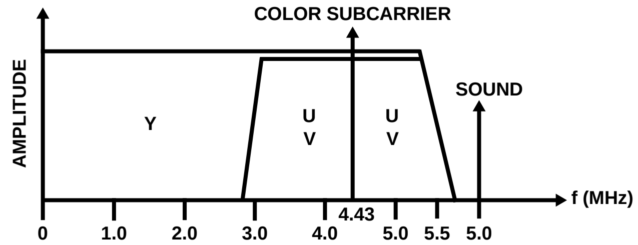

FIGURE 6. PAL SYSTEM BANDWIDTH

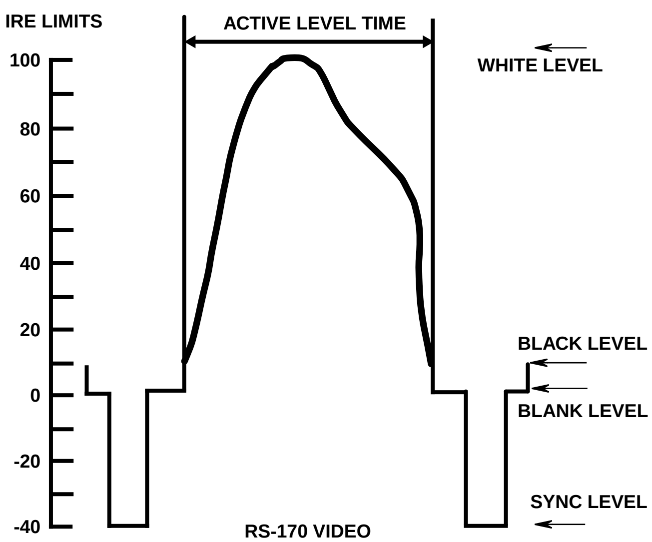

FIGURE 7. MONOCHROME VIDEO STANDARD

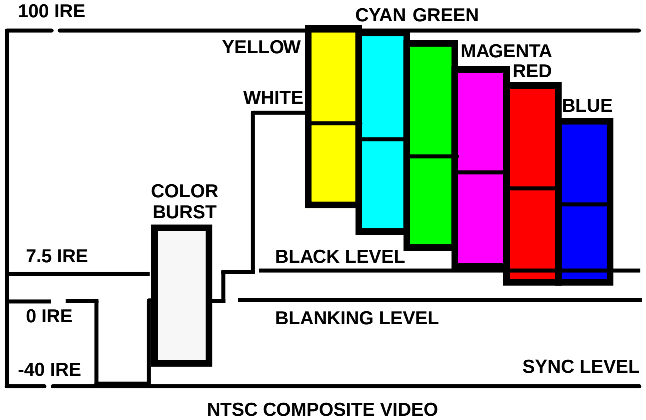

FIGURE 8. COMPOSITE VIDEO STANDARD

References

[1] Harris Semiconductor, High Speed Signal Processing Seminar, 1994 (Publication #BR-043A)

[2] Lies, Jeff and Henningsen, Chris, “Video Amplifier With Sync Stripper and DC Restore”, Harris Semiconductor Application Note AN9514 April 1995

[3] Epstein, Steve, Component Analog Video - So Many Standards, Broadcast Engineering, Nov. 1994

[4] Atwood Research Inc., Video Sync Formats, Application Note #3, 1994