Detecting the Absences of Video with HSYNC Present

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Introduction

Security and professional video systems use remote video cameras that output just black screen while there is no activity in front of the camera. When activity is detected, these systems need to automatically switch over to the camera with activity.

Problem

How do you detect the start of active video on a NTSC/PAL composite video signal when the camera is already sending a black or blue screen with no active video present? Detecting H_{SYNC} or V_{SYNC} for the presence of active video will not work. In this application, during non-active video, the video feed still supplies H_{SYNC} and V_{SYNC} but the active video field is black.

TV transmitters, up-link satellites and commercial video cameras can take advantage of this design. However, two subtle issues should be considered when working with broadcast video. Broadcasters will typically combine the composite sync and the active video just before transmission and need to ensure the video channel is working. They need to detect the point in the video broadcast where video is lost and be notified immediately of the failure. A second issue you need to be aware of is that broadcast TV will insert a blank field just before and just after the inserted advertisement. The design must be able to allow for this without indicating a loss of active video.

Solution

Design a system which will detect active video above "blank" and generate a logic level indicating active video presence for the entire field.

This Technical Brief is a guide to assist in designing such a circuit to fit the designer's objectives and not as an all-inclusive design. We also make the assumption the designer is familiar with standard video design.

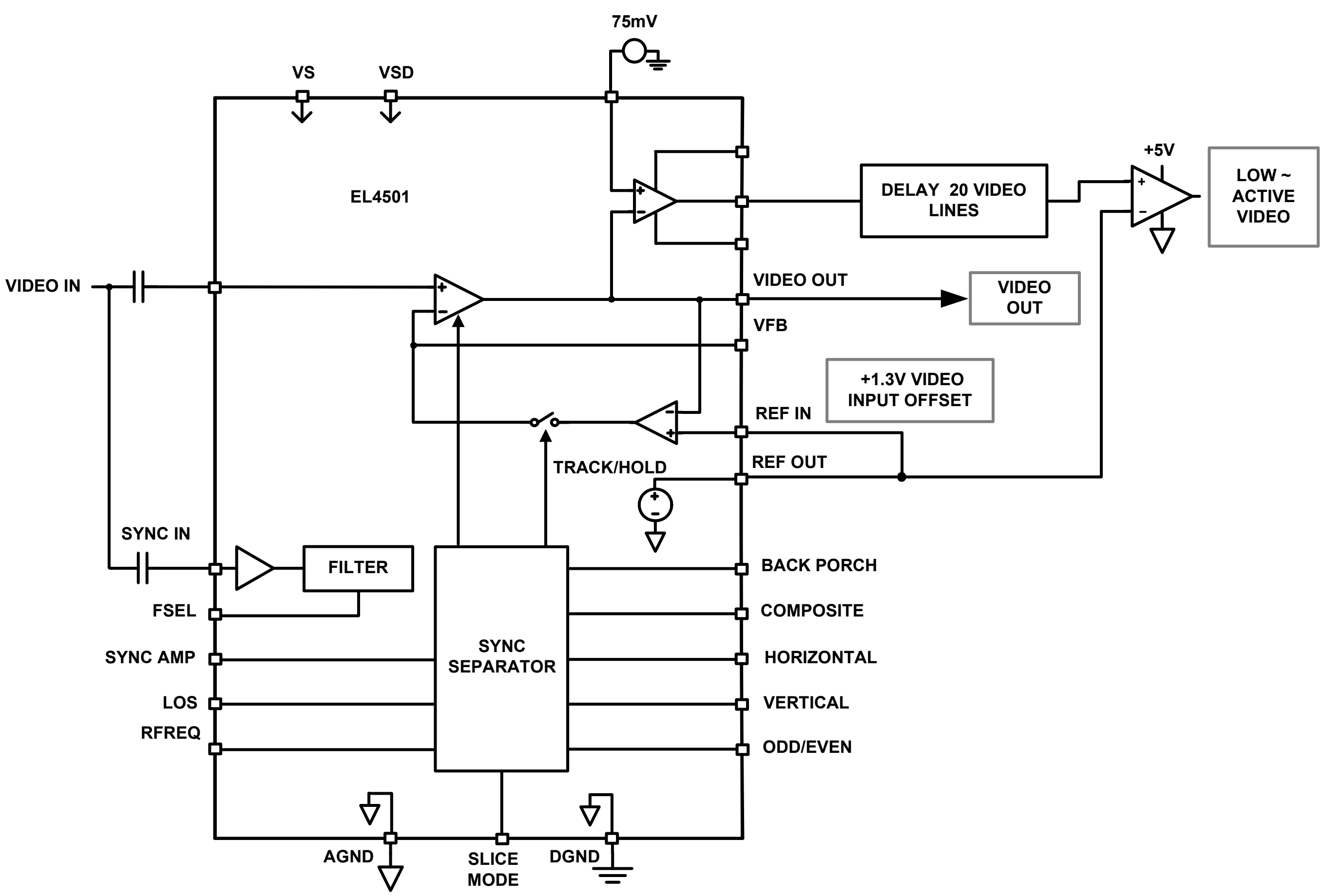

FIGURE 1. BLOCK DIAGRAM

Design Outline

1. Compensate for un-terminated and double-terminated video feeds
2. Monitor the video for active content and generate a logic level when detected
3. Operate from a single 5V supply
4. Blue vs Black screen detect

Component Selection Design Requirements

1. **Level shifter** – shift the negative H_{SYNC} tip levels above ground
2. **Video buffer** – reduce the input impedances' influence on the active video detector
3. **Level detector** – detect the active video field and signal active video presence
4. **Delay timer** – set the active video detect window

Keeping the IC count to a minimum, we selected the EL4501 to fill the roles of level shifter, video buffer and basic interface to the incoming video feed. The delay timer is a combination of the EL4501 and the EL8100. The EL8100 also doubles as the logic signal indicator of active video. As an added advantage, the EL4501 also has a LOS (Loss of Sync) output that goes high if there is no video sync signal and has a video amp output that can direct drive a video cable.

Complete Design

Compensation for Different Terminations

Video feeds can be un-terminated or double-terminated, both having an impact on the H_{SYNC} tip negative level. Since we are limited to a single supply 5V, we need to take into account the impact of the termination and adjust for negative H_{SYNC} tip levels (Refer to Figure 2, NTSC Standard Video Wave Form).

The key to this overall design is using the single supply EL4501 and it's internal V_{REF} = 1.3V to offset the incoming video. Doing so will allow the EL4501 to support a negative incoming H_{SYNC} tip (-40IRE or approximately -300mV) by adding +1.3V offset on the back porch. Now the EL4501 will support an un-terminated video feed which will have a 2x H_{SYNC} tip and it will also accommodate a double-terminated video cable with a 0.5x H_{SYNC} tip. We set the gain of the video input buffer to 2x to recover the losses from a back-terminated output video feed.

The un-terminated video sync tip will be approximately -600mV times an amp gain of 2 and will output a sync tip of approximately -1.2V. The +1.3V offset raises the -1.2V sync tip to +0.1V above ground for the sync tip. More on the actual circuitry can be found in “Termination and detecting reference level” on page 3.

Monitor for Active Video

Reviewing the NTSC/PAL standards, you will find that not all lines will contain active video and some of the lines are reserved for functions other than active video. The filter needs to be designed to not trigger on these non-video functions even though this small amount of data on the lines might be detected as active video. If we delay the detection for about the first 20 lines in the vertical interval, the detector will be monitoring the correct active video lines. Also, TV stations normally have 1 field that is black before and after advertisements so the filter may need to have enough delay to not detect approximately 20ms black level video (one field).

The video black level is 7.5IRE or approximately 54mV for NTSC. Thus, the video detector will have to be set to some value above 54mV.

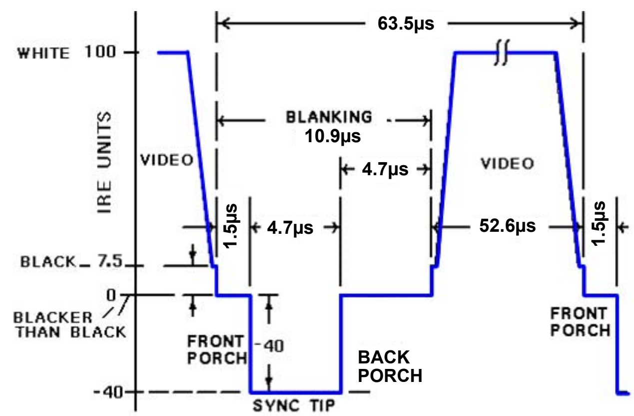

FIGURE 2. NTSC STANDARD VIDEO WAVEFORM

We selected about 80mV for the active video detect level. This gives us about 25mV of noise margin over the typical black level. To set this level on the EL4501, we use the Data Slicer comparator reference input (DS REF) to fix the threshold by simply adding a resistor divider from VCC to VREF as shown in Figure 3.

The 30kΩ resistor and the 680Ω resistor will set DS REF to about 80mV with respect to the BACK PORCH. The comparator will now detect levels about 26mV above Black and thus detect active video. You can also use this technique to monitor for non-blue screens by setting the threshold above the blue level.

Note: For standard and double cable termination, use 680Ω. For the remainder of this tech brief, we will assume standard cable termination and will use the 680Ω resistor

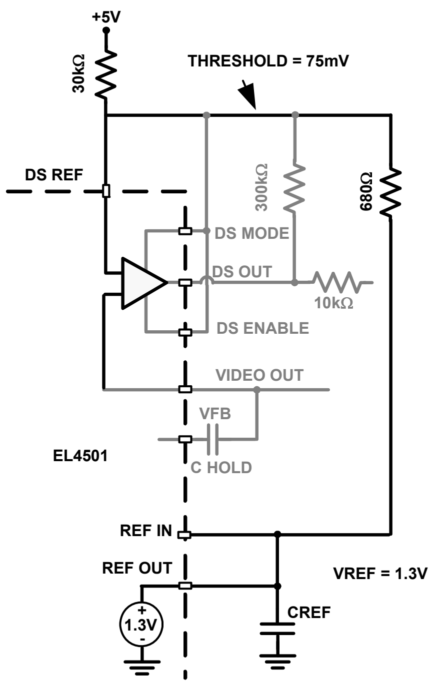

FIGURE 3. BLACK LEVEL THRESHOLD

HYSTERESIS FOR SLOW RAMP EDGES

We want to ensure the detection circuitry is not responding to noise during a slow edge. We need to design-in some level of hysteresis to help prevent false triggering.

The video detector senses the output level of a filter with slow edges. The series 10kΩ output resistor and 0.33µF capacitor to ground controls how fast the DS output transits to ground. If some of the blanking lines contain digital data, such as TTY, the 10kΩ resistor will slow the response and reject this digital data and noise. We need to insure a smooth transition through the DS comparator's transition point. This can be accomplished by adding about 6.8mV offset to the DS comparator output. Adding a 300kΩ resistor feedback to the DS REF input pin will help prevent jitter from occurring at the DS OUT due to slow changing video transitions through the DS comparator's switching point.

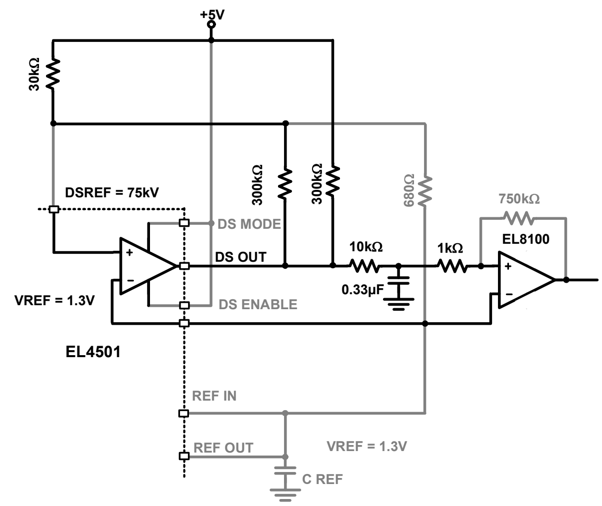

FIGURE 4. HYSTERESIS

The EL8100 is a fast recovery amp (see Figure 4) and can be used as a comparator to detect the level of the DS output filter, the series 10kΩ resistor and 0.33µF capacitor to ground. The filter will have slow rise and fall edges so hysteresis is needed. We add about 10mV offset to DS OUT by adding a 300kΩ resistor feedback to the DS REF pin. The EL8100 has a 750kΩ resistor from the output to the non-inverting input to generate the needed hysteresis. The EL8100 may be set up to give the reversed logic output by reversing the inputs to the 1.3V VREF and filter output. The 1kΩ resistor in series between the non-inverting input and DS OUT allows for hysteresis.

TERMINATION AND DETECTING REFERENCE LEVEL

The incoming video may come from a cable source with standard, double or no termination. This will cause the H_{SYNC} tip to change from 286mV to double or reduce to 2/3. The back porch is always at 0V, so it is the most stable reference point. The back porch pulse is from the sync separator to the DC restore to set the back porch to 1.3V. The 1.3V allows the sync double level of 572mV times an amplifier gain of 2 to have a 1.14V H_{SYNC} tip and 160mV above ground so not to induce clipping. The black level can be 54mV x 2 for no termination and x 2 for amp gain to give 216mV. The video from the amp output is internally connected to the Data Slicer (DS) inverting input. The data slice detector can have the DS Ref set to approximately 250mV. If the EL4501 amp gain is 1, the DS REF can be approximately 145mV. Figure 5 is for an amplifier gain of 1.

Video Detect

The Data Slicer (DS) inverts the video. The output will be high (open drain) with no video. If data is present in the vertical blanking intervals, then the DS output will go low and the filter input resistor value can be set to be fast enough to detect the data or slow enough to reject the data. When the filter is set to be slow, it will take longer to detect video. The large pull-up resistor (300kΩ) on the filter prevents dark video pictures from generating false outputs.

Non-Active Video Delay Time

We need to design the input filter into the EL8100 to be slow enough to delay any detection for a number of non-active video lines. 1.3ms is the time necessary to wait for 20 video lines added to the 1 field time of 16.6ms (the advertisement black field), for a total of 18ms or more. When video is not present (no active video luminance above 75mV) the DS output is open drain. Since the DS OUT becomes an open drain, you can conclude the charge path is basically the sum of two paths; 300kΩ from 5V and the parallel 310kΩ from the approximately 2V node. We can make this simplification because the current through the 30kΩ and 680Ω resistors is large as compared to the current through the 300kΩ from 5V supply rail. Thus, the node at the junction of 30kΩ and 680Ω can be viewed as approximately 2V supply regardless of the charge on the capacitor. Also, the EL8100 trip point is at 1.3V or about 1 RC time constant for the 2V charge path. So, the total current to charge the 0.33µF capacitor to 1.3V is essentially 22µA.

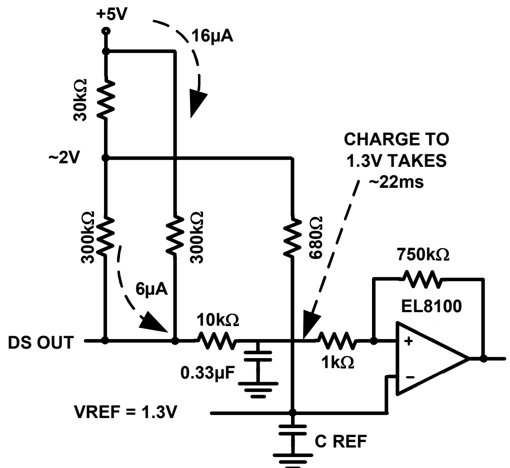

FIGURE 5. NON-VIDEO DELAY CIRCUITRY

A first order approximation of the delay time can be determined from I = C(dv/dt). So the time it takes to charge to 1.3V is about 22ms or the delay time. If video is present, then DS OUT would be at ground, not allowing the RC network to charge. Thus, the output of the EL8100 would be low for active video. This 22ms delay is one field (16.6ms) plus 1.3ms into the second field to ensure we are looking at an active video field and also ignore the black field before and after an advertisement.

We have added a simple video switch (ISL43110 switch) to isolate any loading of the video on the next stage when no active video is present.

VCR/DVD BLUE SCREEN DETECT

The 680Ω or 1.5kΩ DS REF set resistors would be set to a value to sense blue screen the same as non-video. NTSC Blue luminance is 18.5IRE. By setting the threshold to 150mV (Blue luminance is 132mV), we added 18mV of noise margin. Thus, using a 1.5kΩ in place of the 680Ω resistor will set the threshold at 150mV. The circuit will now detect blue screen as non-video. Note: The blue detect level may not detect some dark video pictures as the average voltage level for the active video maybe too low.

TEST PERFORMACE

The results of testing the actual circuit were:

1. Loss of video to output high for no video was ~25ms
2. New video input to output low for video active was ~3ms

These agree with the design goals.

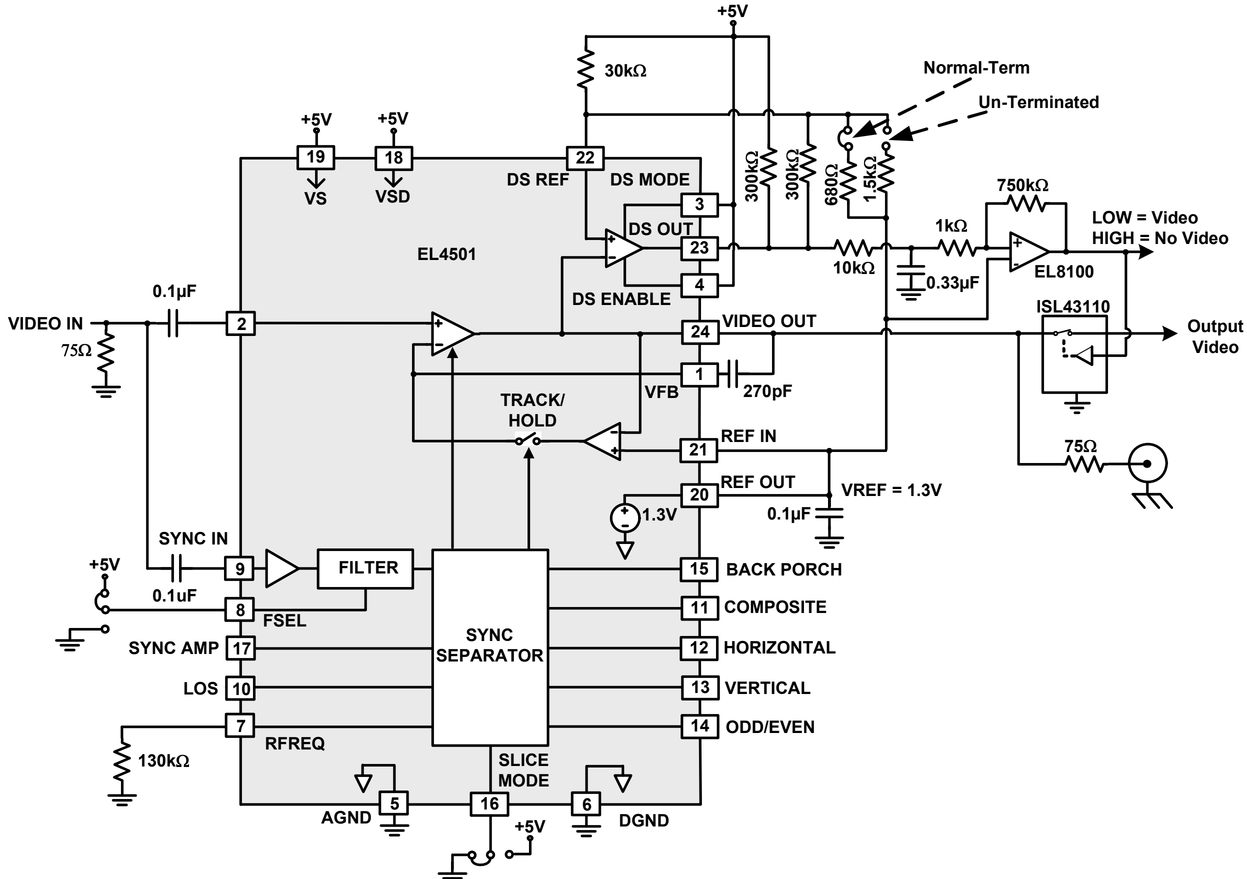

FIGURE 6. COMPLETE SYSTEM DIAGRAM

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