Simple Circuit Removes Sync or has Negative Going Sync Tip

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As the digital world encroaches into analog territory, signal conditioning circuits are required to prepare analog signals for digital processing. The standard composite video signal is an analog signal and generally AC-coupled in video systems to prevent circulating DC currents. The following circuits demonstrate a method of conditioning a composite video signal for an analog to digital converter by clipping of the sync tip. CMOS ADCs may have a parasitic latch-up problem when subjected to negative input voltage levels. The sync is often clipped off applying just the video information to the full resolution of the ADC. The basic circuit consists of two main sections, a DC-restore amplifier and a clamping amplifier.

We used the ISL4089 and EL4581 as a simple solution to this application. The EL4581 pin 1 (Composite Sync) is normally used for the ISL4089 hold input for sync tip clamping as shown in Figure 1. The single supply ISL4089 REF has a 10mV offset to hold the sync tip at 10mV so the output will never go to 0V and lose feedback.

The video signal first goes to a sync separator, the EL4581 pin 2 (composite video in) and at the same time to a DC-restore amplifier, pin 2 of the ISL4089. The EL4581 pin 1 (composite sync out) outputs a CMOS logic low signal into hold control input of the ISL4089 during the sync tip section of the video signal. When the hold control input is low, the servo loop in the DC-restore amplifier forces its output to the reference level on REF (pin 3). Thus, you can set the clamp level to any positive level by simply biasing REF (pin 3) to the desired level (Refer to Figure 1).

For sync tip clipping, the back porch must be at a known level and the IRE standard defines this level to be ground. A key point to note is, the sync tip may not be at a defined level and the entire video signal amplitude may vary due to gain differences at the source. Thus, using the composite sync output as the input to hold the DC-restore amplifier may clamp the back porch at an incorrect level.

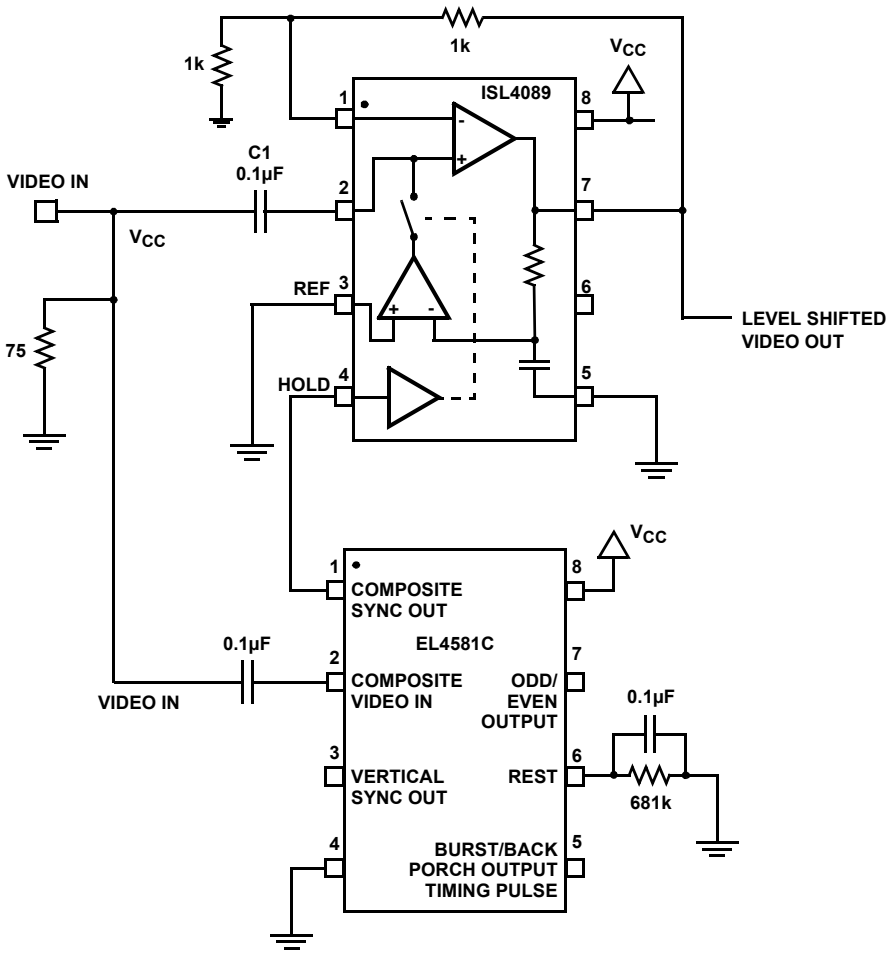

FIGURE 1.

Low Cost Sync Clip

The ISL4089 can make use of the back porch output of the EL4581C to generate the hold timing, but the ISL4089 can have a slower recovery time than needed by some high end applications. Also, the REF input has a 10mV fixed offset which would place the back porch at 10mV above ground. This 10mV offset will leave 10mV of sync tip on the output. Below 100mV, the DC Restore linearity is somewhat reduced. One method of improving the linearity at these low levels is to simply DC couple the output load to ground, which will also clamp the output to ground. Thus, the ISL4089 makes a good low cost sync tip striper for removing Sync On Green (SOG) used in both consumer games and video products. Yet, a simple two-step solution will support both consumer video and high performance video requirements.

High Performance Sync Clip that Removes Offsets

The EL4581 back porch output is used to set the sample and hold window of the DC-restore amp. When the back porch output goes low, the video signal will be clamped to a fixed offset reference on REF (pin 3) of the ISL4089. The single supply clipping amplifier with an offset will remove the sync portion of the video signal.

By applying a positive offset voltage to REF input (pin 3) and using back porch output of the EL4581, pin 5, to drive the HOLD input (pin 4 of the EL4089), the back porch is now at the proper voltage to prevent the sync tip from being clipped at the output. EL4089 pin 4 going low, forces the necessary offset voltage to be placed across the sample and hold capacitor to create the proper input to output voltage shift. In the design example, C1, the AC-coupling capacitor doubles as a sample and hold capacitor. Photo 1 shows the analog video input and the sync separator back porch output waveforms.

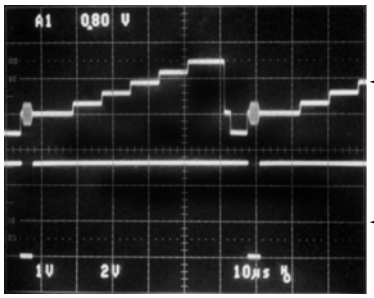

PHOTO 1. DC-RESTORE

Setting the Offset Voltage

First, you need to offset the REF input to the ISL4089, such that the output back porch of the ISL4089 will be about 0.8V above ground to retain sync tip.

Second, you will need to offset the sync stripper. Resistor offsetting of the ISL4089 will have a residual offset resulting in a 10mV sync tip. Yet, you can use an OpAmp to eliminate the offset and thus eliminate the residual sync tip. We use the EL8100 to remove both the 10mV offset and the addition 0.788V offset added at the input of the ISL4089.

More Details

First, adding the offset - A simple resistor voltage divider tied to pin 3 of the ISL4089 will offset the input by the desired 0.8V. Tie a 4.22kΩ resistor from the +5V supply in series to ground with an 806Ω resistor. Connect the junction to pin 3 of the ISL4089. This offsets the input by 0.8V and thus the output will have the sync tip offset by +0.8V.

The ISL4089 as stated before, has a +10mV built-in offset on REF (pin 3) allowing for single 5V operation and will need additional offset adjustment to compensate for the +10mV offset. The addition of a 43kΩ in parallel with the 806Ω will compensate for the 10mV input offset. The final offset applied to pin 3 will be 0.79V (0.800V- 0.01V). Note the ISL4089 has an extra 1.2V offset built in to the pin 2 video input for better linearity so if probed this will show an extra 1.2V offset. This does not effect the overall performance.

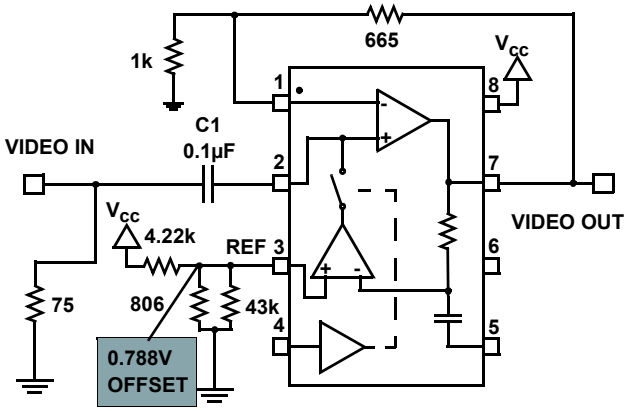

FIGURE 2.

Second, offset the sync stripper output - You need to compensate for the output offset of the ISL4089 to set the back porch at ground at the EL8100 output. Using the feedback path, place an 806Ω resistor from EL8100 pin 6 (V_{OUT}) to pin 1 negative input and add a second resistor 4.22kΩ from pin 8 (V_{CC}) to pin 2. This will offset the sync stripper output down by 0.8V. Thus, the EL8100 will return the back porch to ground reference and strip off the sync tip.

The 4.22kΩ and 806Ω resistors should be 0.1% tolerance for offset cancellation to be only 1.6mV error max or they can be 1% with a max error of 16mV. By using the same type resistors for both offsetting networks, the ratio match of 1% resistors will be about 4 to 5 times better than 1%, so the error will typically be about 3mV to 4mV. The 43kΩ at 1% gives an error of 0.1mV plus 0.5mV for 5% supply change.

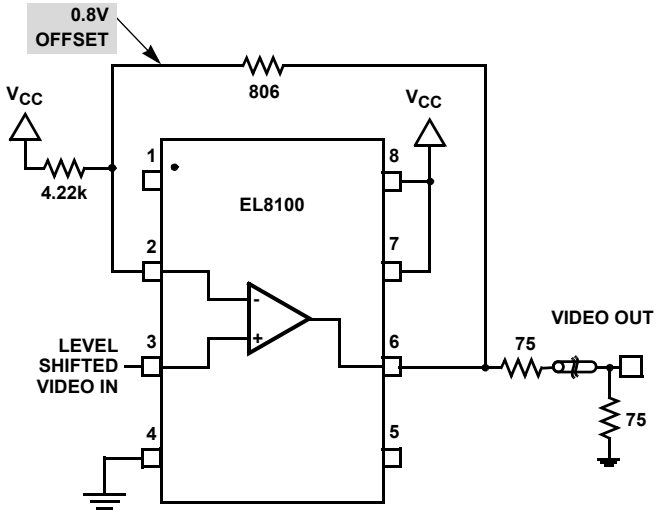

FIGURE 3.

This feedback circuit also changes the gain of the EL8100 to about A_V = 1.2. The overall circuit gain of the ISL4089 and ISL8100 must be a gain of 2 to recover from the double termination losses.

The EL8100 has a gain of 1.2. Thus, the ISL4089 will need a gain of 1.6 to give the overall circuit a gain of 2.0. The feedback circuit, to have a gain of 1.6, computes to be 625Ω in the feedback loop and 1kΩ to ground. The closest standard 1% resistor is 665Ω.

The EL8100 stage limits the negative excursion to the ground level. The input range of the EL8100 is 0V to 3.5V and output is 0V to 5V. Its fast 7ns of negative over-drive recovery makes it ideal for clamping applications (see Figure 5).

Photo 2 shows the incoming video signal whose back porch is clamped to the ground level and the amplifier output signal with negative going portion of the sync tip clipped off.

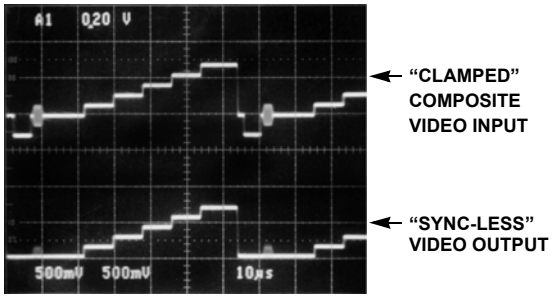

PHOTO 2. "SYNC-LESS" VIDEO SIGNAL

A gain of 1 is needed for some cases so the ISL4089 gain can be set to 1 by removing the 1k gain resistor and changing the feedback resistor to 0Ω. This will give an overall gain of 1.2. If the gain must be 1, then use an output divider on the EL8100 output of 200Ω series with 1kΩ to ground and their junction is the output.

DC-Restore with Back Porch at Ground and Minus Sync Tip

This circuit may be converted to provide video output with minus sync tip. Changing the clamp amp EL8100 to a dual supply, ±5V amp, such as the EL5160, will keep the back porch at ground with minus going sync tip (see Figure 4).

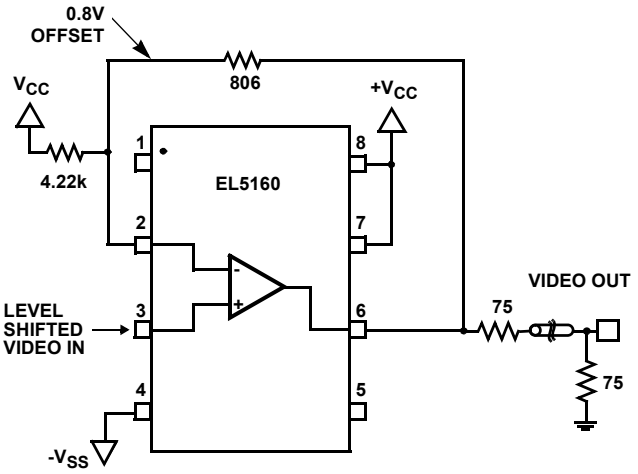

FIGURE 4. DC-RESTORE WITH NEGATIVE SYNC TIP OUTPUT

The Final Design:

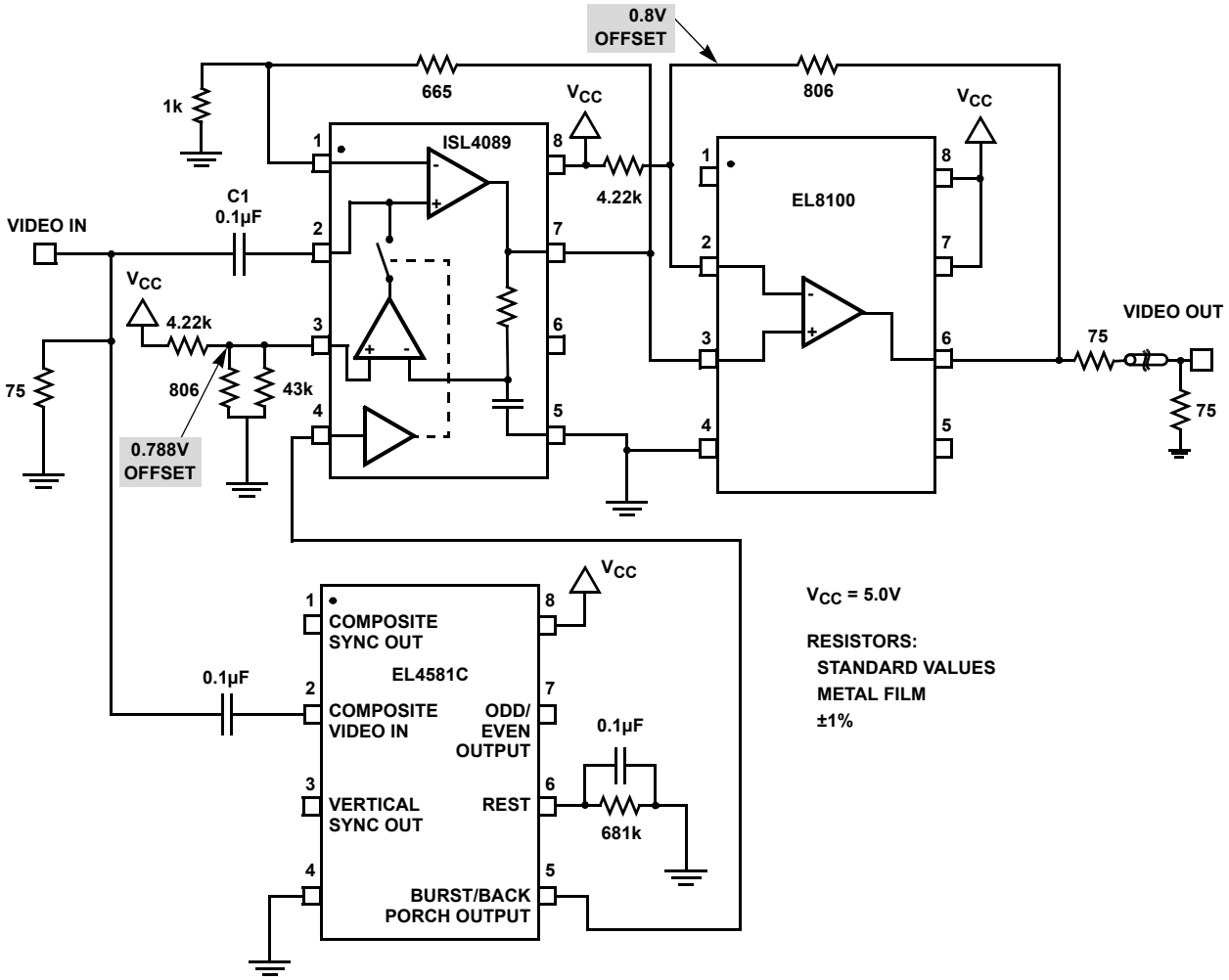

FIGURE 5.

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