

Overcoming Signal Skew Differences In Cat-5 Cable

by Patrick Long

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Coaxial cabling has typically been used to move analog video signals from one place to another, but to reduce cost, many applications are now moving to Cat-5 cables. The cost of 300 m of coaxial cable is about \$240 compared to \$20 for the same length of Cat-5. Video, with a pixel clock rate of up to about 100 MHz, can be transmitted over lengths of 200 - 300 m of Cat-5 using appropriate techniques, but there are many technical hurdles to overcome when adopting Cat-5. One of the tougher challenges has been to overcome the signal skew differences between the four twisted pairs that form the cable. Since it was designed for transmitting data, the pairs that make up the Cat-5 cable are twisted at a different rate to prevent crosstalk, meaning the electrical length of each twisted pair is different.

For GBR video signals this is a significant issue with the three signals arriving at slightly different times at the receiver, resulting in skew. Cable specifications average skew of Cat-5 at 20 ns/100 m which creates an unacceptable image on any monitor.

There are solutions to this challenge: ideally an analog delay line, which should be elegant and cost-effective in a small package. Instead of banks of op amps or folded traces eating up board space, designers require a single device. One example is Intersil's EL9115, a triple analog delay line that allows three channels to be independently delayed in 2 ns steps up to 62 ns so the three signals can be precisely aligned at the receiver.

Figs. 1, 2 and 3 show images from video that has been transmitted over 300 m of Cat-5 with the video card set at 1280 x 1024 at 75 Hz, corresponding to a greater than 98 MHz pixel clock. Fig. 1 is video transmitted without any equalization; Fig. 2 shows video that has been equalized for signal attenuation by differential receiver/equalizers (in this case using the EL9110.)

Note the test pattern comprised of red, green and blue lines on the lower left side. This shows that signal skew is still present while Fig. 3 shows the same video routed through the EL9115 with 44 ns delay on the green channel and 18 ns on the red completely removing the skew.

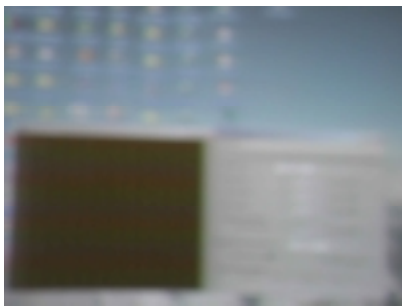


Fig. 1: Video Display After 300 m of Cat-5 Cable

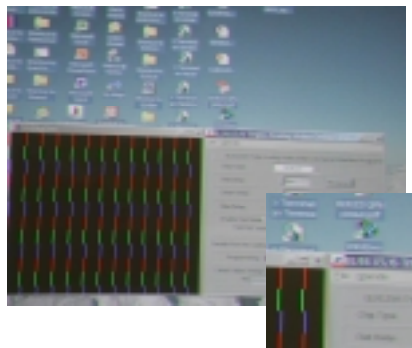


Fig. 2: Same Setup After Equalization

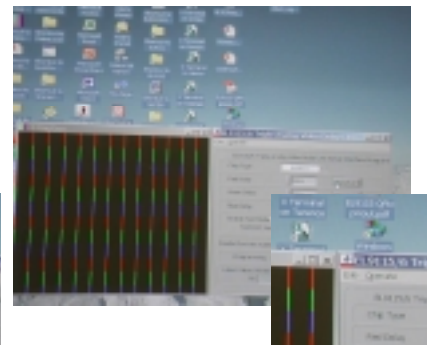


Fig. 3: Same Setup After De-Skewing

The EL9115 uses ± 5 V rails and has a serial interface to control the delay of each channel.

Additional features were added to set up an auto de-skewing system. Three pins are provided that allow a feedback loop to be created with the user's processor or microcontroller.

During normal operation these pins output pulses of current for a duration corresponding to:

- DELAYR pulse = Red out (A) with respect to Green out (B)
- DELAYG pulse = Green out with respect to Blue out
- DELAYB pulse = Blue out with respect to Red out

Averaging the current gives a direct measure of the delay between the signals. When A precedes B (Fig. 4) the pulse is $+50\ \mu\text{A}$ and the output voltage increases. If B precedes A the pulse is $-50\ \mu\text{A}$.

The A and B signals are derived from the input by comparing the video signal with a slicing level set by an on-board DAC (programmed through the serial interface). This enables the delay to be measured either from the rising edges of signals encoded on top of the video or from a dedicated set-up signal. The outputs can be used to set the correct delays for the signals received.

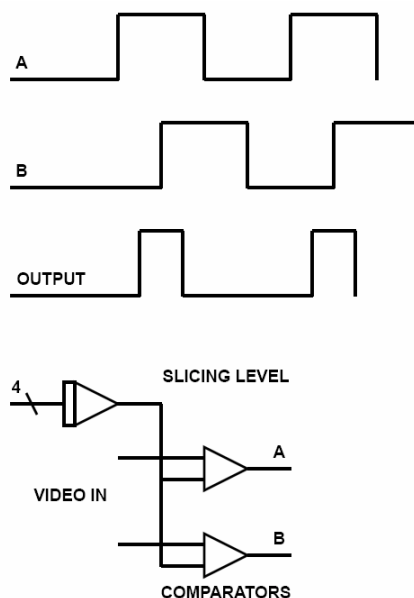


Fig. 4: Pulse Output and Slicing

The part uses proprietary architecture to provide $\pm 2\%$ channel-to-channel gain matching and $\pm 10\%$ delay accuracy.

About The Author

Patrick Long is marketing manager for video products at Intersil and prior to joining Intersil, he held key positions in the high-speed data converter and mixed-signal video groups at Texas Instruments.

