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RGB Color Skew In Video Over UTP Systems

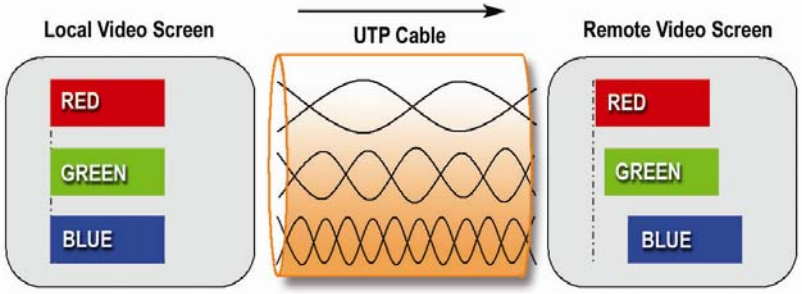
UTP and STP cables including Cat-5/-5e/-6 are constructed using four twisted pairs. In all standard cables the twist rate (number of twists per inch) is different among the various pairs inside the cable. This is an intentional design feature of these cables since they were originally developed for LAN applications. The twist ratio difference cuts down on the crosstalk in bi-directional data communication. Due to the low cost, availability, and ease of termination, these cables are now being used in high-resolution video extension and many manufacturers, including Hall Research Technologies (HRT), offer a wide array of products that can use UTP cables for this purpose.

Regardless of the manufacturer, virtually all RGB or RGBHV (e.g. PC's VGA) video over UTP systems transmit each color component over its own dedicated twisted pair, therefore three pairs are used for the transmission of color. The fourth pair can be used for other purposes such as phantom power, audio, data, serial port, keyboard/mouse, etc.

This diagram shows only three of the four pairs used in RGB over UTP extension, and it clearly depicts the misalignment that occurs at the remote end due to the twisting rate (which makes the overall lengths of each pair different).

Spec 568B.2 lists a 45-nanosecond maximum delay skew for Cat-5, -5e and –6 at 100 meters. This means that if you initiated a pulse on one end of the cable simultaneously on each of the four pairs, on the other side this pulse will not arrive at the same time on the different pairs. The time difference between the appearance of the first and last pulse could be as much 45 nanoseconds. How much skew can you expect in terms of pixels on the screen? Here are pixel times for typical resolutions used today:

1024x768 @ 60 Hz 1 pixel=15.3 nsec
1280x1024 @ 60 Hz 1 pixel= 9.3 nsec



Lets assume that the average Cat-6 cable has 25 ns/328 feet (or 100 meters), this means that without skew correction, there would be color separation of one pixel at a length of 122 feet of Cat-6 cable. For watching a video or looking at a PowerPoint presentation with big fonts, this would not be a problem. But for displaying small text, it would drive the viewer crazy—and 122 feet is relatively short for video over Cat-5 solutions since suppliers boast 300 feet to 800 feet or more. That's why it is advisable to use low-skew UTP cables for video. But if this is not possible, and the end-user is dissatisfied with the results, a product like Hall Research's SKU-RGB might come in handy. One advantage of the SKU-RGB is that it has standard VGA input and output connectors. This makes it independent of the method used by different manufacturers to embed the VGA signal in the UTP cable.

It is common to confuse skew correction with high-frequency compensation. Some of the lowest cost baluns and devices have no compensation or adjustment at all. Most do have a means to boost the gain of high-frequency components of the signal to make up for the losses which occur in long cables. This is often referred to as "peaking." However, the vast majority of devices on the market have no adjustment for skew, which is entirely a different mechanism, and those that do are pricy.

It is worth noting that RGB color skew is not unique to UTP setups and can in fact be a problem in video extension when standard multi-coaxial video cables are utilized as well. These cables (such as VGA extension cables) use three separate coax lines for the RGB, the arrival times at the remote end depends on the propagation speeds in each line. Small variations in geometry or the coax foam insulation's properties can cause one color component to travel slower than others, which would necessitate skew correction if one desires the clearest image possible.

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