

## Video over twisted-pair (CAT5)

Whether its at grocery stores, malls, schools, sports arenas, or transportation terminals, video displays are starting to appear everywhere in all types of applications. Advertisements, local news, announcements, and even weather reports are now being brought to the public eye via LCD screens and plasmas TVs. This change is due to an evolving AV world. It is now simple and cost effective to transmit and distribute video signals with audio at distances up to 1000-ft. away over simple and inexpensive Twisted-pair cabling.

Traditional AV transmission and distribution relied on sending the signals over expensive and ridged coaxial cable. Costly and difficult to run and conceal, coaxial signal distribution never became a mainstream solution. Teq AV/IT's Twisted-pair Transmitters / Receivers offer a better alternative which beats coaxial solutions in terms of cost, simplicity, and performance.

### The benefits of using twisted-pair to transmit video

Using Teq AV/IT's Twisted-pair transmitters / receivers, high resolution video signals can be transmitted up to 1000-ft. using twisted-pair cabling. The UTP or CAT5 cable used with Twisted-pair transmitters and receivers goes for about a nickel a foot and can be purchased just about anywhere. Traditional coaxial cable can cost up to 40 times that of twisted-pair cabling. Crimping or soldering BNC connectors and making all the connections can be labor-intensive and unpredictable. On the other hand, twisted-pair cabling is much easier to terminate precisely and organize.



Twisted-pair cable, commonly known as CAT5 cable, is globally the most popular connection standard. Twisted-pair is widely accepted for the following reasons:

- Cost-effectiveness
- Ease of installation
- Versatility
- Modularity
- Small size cable runs
- Light Weight
- Use of existing network infrastructure
- Optimal use of technology
- Ready for the future
- Mainstream installation vs. proprietary

### The Anatomy of signal transmission over Twisted-pair cable

Analog video signals consist of up to three major components:

- Video (color, composite, or separate like RGB, or YUV)
- Sync (timing information for vertical and horizontal transitions)
- DDC (communication between display and source)

Video and Sync signals are always part of any analog signal. For composite video signals, video (color) and sync may be combined into a single component while for s-video they are split into two separate components. For component video signals the video and sync are present in three separate components. For computer video the video

and sync is present mostly in five individual components (RGBHV) or in a combined form of RGsB or RGSB to consolidate for cable cost reduction.

Analog video signals are typically transmitted over coaxial cable with 75 ohm impedance. The sync signal with different impedance is transmitted over the same 75 ohm coaxial cable or a standard wire. The Twisted-pair (UTP or STP) consists of two wires with 100 ohm impedance twisted together at uniform intervals. The majority of twisted-pair cable is used for data transmission in computer networking and commonly known as CAT5, CAT5e, or CAT6.

Use of twisted-pair cable to transmit analog video signals imposes several challenges like impedance mismatch, signal loss, and timing disparity. To transmit analog video signals over Twisted-pair cable requires conversion at the source and recovering at the display.

There are two ways to transmit the signal: passive (baluns) or active (transmitter / receiver pair). Baluns have distance and quality limitations and are typically used for low resolution signals. Active transmitter / receiver pairs are used for high resolution and high quality video signal transmission.

### Video Signals over Twisted-Pair cable

In the basic setup, a twisted-pair transmitter encodes an RGB signal for transmission over twisted-pair cabling. Located at the other end of the twisted-pair cabling is a twisted-pair receiver which decodes the signals back to RGB for the display.

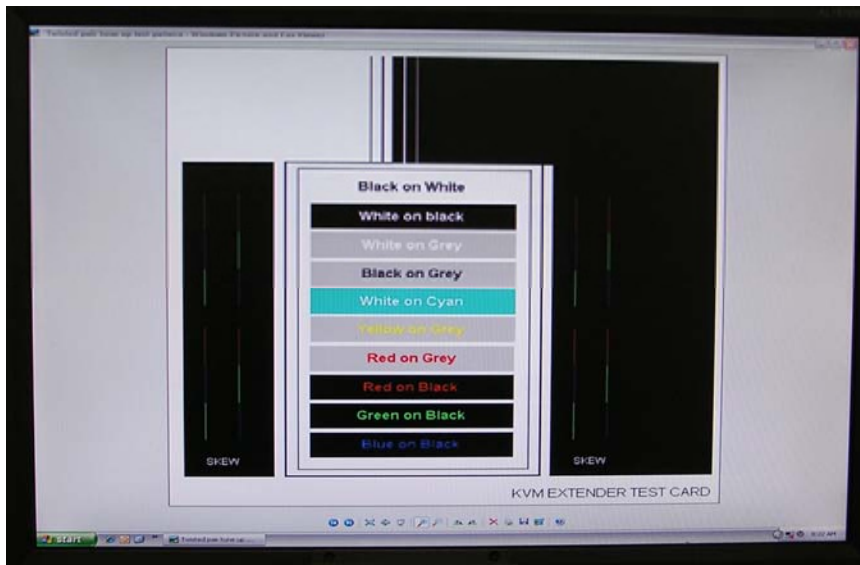
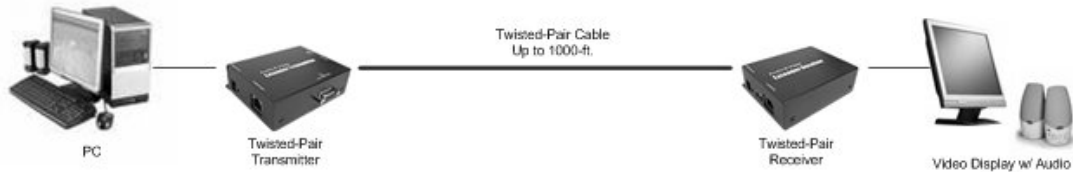


Figure 1. Original video image (WXGA @ 60Hz) over 3-ft. VGA cable (direct connection to source).



Figure 2. Video image (WXGA @ 60Hz) transmitted over 1000-ft. UTP (CAT5e) cable through Twisted-pair interface.

No gain  
No equalization  
No skew

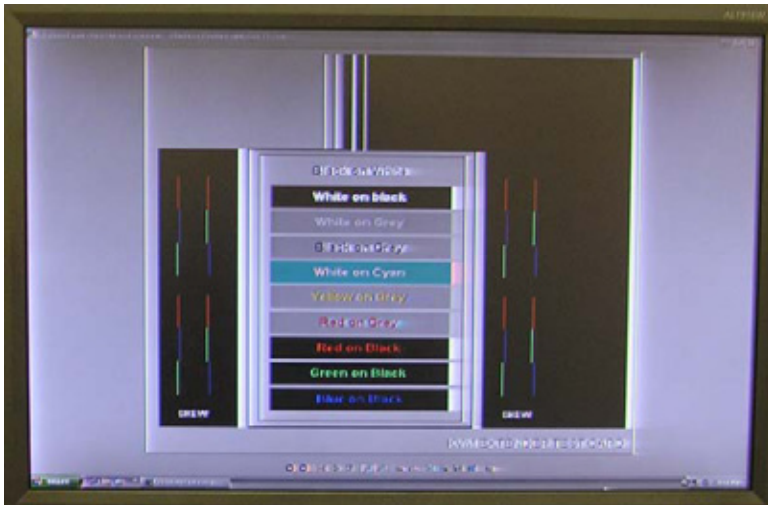


Figure 3. Video image (WXGA @ 60Hz) transmitted over 1000-ft. UTP (CAT5e) cable through Twisted-pair interface.

With equalization  
No gain  
No skew

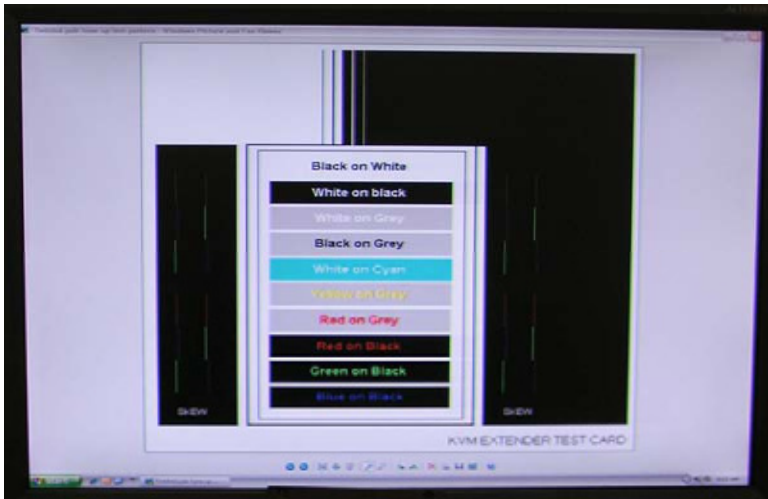


Figure 4. Video image (WXGA @ 60Hz) transmitted over 1000-ft. UTP (CAT5e) cable through Twisted-pair interface.

With gain  
With equalization  
No skew

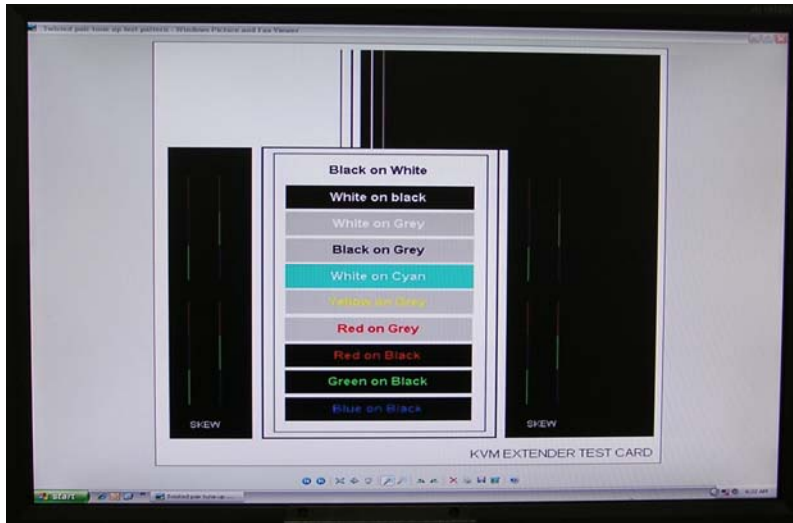


Figure 5. Video image (WXGA @ 60Hz) transmitted over 1000-ft. UTP (CAT5e) cable through Twisted-pair interface.

With gain  
With equalization  
With skew

## Effects

Let us look at the impact of cable dynamics on video image quality. All transmission line cable, including coaxial and twisted-pair, introduce signal distortion and loss to original signals. The types of losses introduced to signals sent through a transmission line include the following:

- Resistance
- Skin effect
- Dielectric effect
- Interference effect

Each of these effects impacts the quality of the video signal in a different way and only gets worse with increased cable length.

## Solution

Adding an equalizing filter can reverse these effects introduced to the signal by the cable. Digitally controlled multiple variable filters are used to tune the image and compensate for any cable distance up to 1000-ft. Unlike the competition, Teq AV/IT filters:

- Do not require multiple adjustments
- Give a single and definite result
- Have no need to tune at both ends

Tuning at both ends simultaneously can be difficult and inconvenient if the distance between the source and display is sizeable.

The approach used by Teq AV/IT Twisted-pair products for cable length compensation is intended to simplify the entire process. The adjustment, which takes place only at the receiver end, is accomplished by turning a control dial while viewing test pattern. No adjustment is made at the transmitter end. This approach is the easiest, fastest, and most understandable way to optimize the image.

Teq AV/IT technology preserves video rise times to provide constant bandwidth throughout the product's distance adjustment range. Video image clarity directly relates to video rise time. Video rise time is the measure of time it takes for the system to transition from white to black and black to white. With poor rise times, image distortion called aperture distortion leaves horizontal smear in the image.

By providing this constant bandwidth, the Teq AV/IT Twisted-pair products are capable of displaying a high resolution image over any distance 1000-ft or less. No need to read or listen to a resolution vs. distance table. The maximum resolution at specified distance is fixed 1000-ft @ UXGA or 800-ft @ WUXGA.

## Sync Signal Transmission

Sync is important for image quality. With a poor sync signal received from twisted-pair product, one can see the following problems:

- Display equipment does not lock into sync signal (blue screen)
- Noise on the edges of the image
- Horizontal position of the image is misaligned

Through the use of PLA circuits and A to D converters, the sync signal integrity is maintained. At the receiver the received sync signal is synchronized with the incoming sync video signal. The final sync signals are delivered to the display in the format and quality like that of the source providing a clean and raster geometry.

## Compensating for Skew

Most UTP (CAT5) cables are designed for networking applications where cross talk must be minimized for reliable operation. To minimize this cross talk, the cable manufacturers twist each of the pairs at different rates to decrease the magnitude of the signal coupling between them.

Pairs in the UTP are twisted at different rates to reduce cross talk, which also introduces signal skew. The tighter the pair of wires is twisted, the greater the length of wire needed to cover a particular distance. Meaning the most loosely twisted-pair in a given UTP jacket is electronically shorter than the most tightly twisted-pair. The signals on the tightly twisted-pair will arrive after the signal carried by the loosely twisted pair. The difference in signal arrival time results in the appearance of color smearing on the edges in the image. The greater the transmission distance, the more skew, meaning Red, Green, Blue colors are far more separated.

Teq AV/IT receivers are designed with onboard digital skew adjustment. Meaning no additional skew compensation module is needed to provide the display with synchronized video signal components, saving on equipment cost.

## Choosing the best twisted-pair cable

Another way to eliminate inter-pair signal skew is to use a low-skew UTP (CAT5) cable specifically designed for video applications. Teq AV/IT offers ultra-low skew UTP (CAT5) cable with either PVC or Plenum jacket.

For 500-ft. cable runs and above, a low-skew cable is ideal for best results. Although any inexpensive solid core twisted-pair (CAT5e) cable can be used. Regardless of which cable you select, proper gain, equalization, and skew adjustments are necessary to display the highest quality video. The shorter the run, the less cable quality becomes concern.

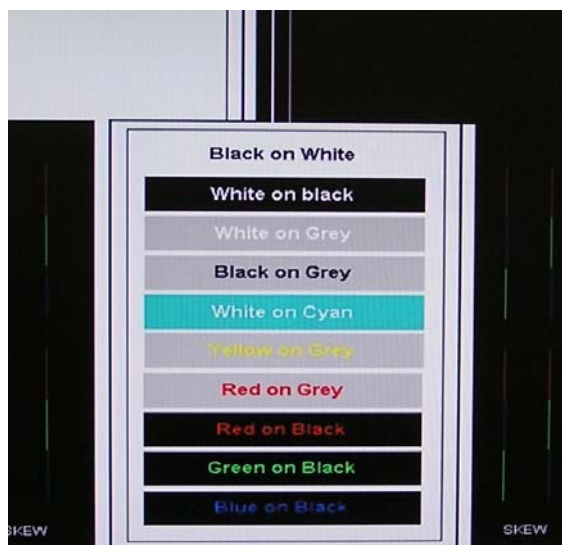


Figure 6. SXGA image over standard 1000-ft. CAT5e twisted-pair cable with skew adjustment.

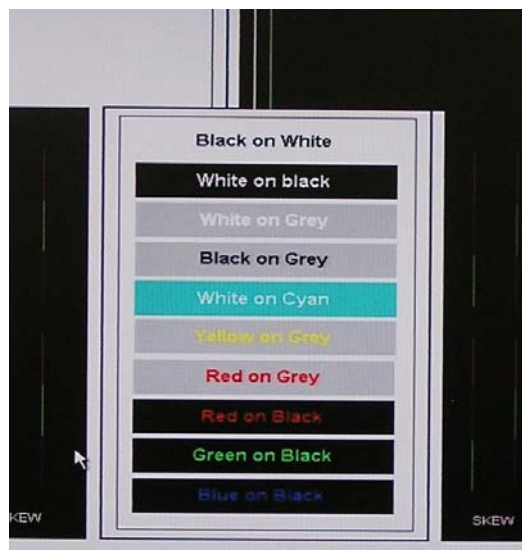


Figure 7. SXGA image over standard 1000-ft. CAT5e Low-Skew twisted-pair cable even without skew adjustment.

## **Mixing and matching twisted-pair transmitters and receivers**

Teq AV/IT has a complete line of twisted-pair transmitters and receivers. All of our twisted-pair equipment is fully compatible meaning; any combination of our transmitters and receivers can be mixed and matched to meet the needs any desired application.

## **Types of video signals that can be sent over twisted-pair cabling**

Analog video signals such as component or computer video can be sent over a single twisted-pair cable up to 1000-ft. using Teq AV/IT's Twisted-Pair Transmitters / Receivers along with a stereo audio signal.

## **What applications can the twisted-pair products used for?**

Our twisted-pair transmitters / receivers are ideal for digital signage, classrooms, courtrooms, boardrooms, government facilities, and houses of worship. Twisted-pair is quickly becoming the preferred video transmission solution for the reasons of cost, space, convenience, and even looks. In the rental and staging field, our twisted-pair solutions can be quickly installed for any last minute adjustments and challenges that might come up.

## **Summary**

Teq AV/IT Twisted-pair Transmitters / Receivers feature technology which results in:

- Easy installation and setup
- Sharp and clear video image
- Available test pattern to eliminate guess work during setup
- Easy adjustments, made at the receiver end only
- Compatibility with any component video or VGA (analog) display
- A 1000-ft, high resolution twisted-pair (CAT5) interface (point to point)
- Models with audio or RS-232 signal over a single twisted-pair (CAT5) cable
- A 2000-ft high resolution twisted-pair (CAT5) interface with use of repeater
- Several configurations available to meet different installation needs