PRECISE VIDEO MEASUREMENT OVER TWISTED PAIR

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In the past, measuring video picture quality of CCTV signals being transmitted over UTP (unshielded twisted pair) wires has been very difficult. Without some way to measure actual video transmission results, there is no way to objectively evaluate system performance, especially in terms of picture definition and the relative performance of the various types of equipment available to implement UTP video transmission.

Video signal loss at low frequencies can be measured with an Oscilloscope that has been calibrated to measure voltage accurately, and then only on coaxial cable systems. However, measuring picture definition using an Oscilloscope, even on coaxial transmission systems requires either a color camera or a video waveform test generator.

STANDARDS:

It is helpful to be aware of the standards for video waveforms and the parameters that are used in professional video measurement to measure them.

First of all, all professional video measurement is made in terms of I.R.E. UNITS. The I.R.E. UNIT gets its name from the INSTITUTE of RADIO ENGINEERS that developed the standard "I.R.E. UNIT" for video measurement used in the United States, Canada and elsewhere. The sync pulse is 40 I.R.E. units, the peak picture amplitude is 100 I.R.E. units and so a standard one volt black and white peak-to-peak video signal is 140 I.R.E units (40 + 100 = 140).

Color video adds a 40 I.R.E. 3.58MHz Colorburst signal on to the Back-Porch (just after the sync pulse), as well as the picture itself and when transmitting 100% saturated colors, causes the picture amplitude to increase from 100 I.R.E. units to 120 I.R.E. units. This in turn makes a saturated color (maximum color brightness) picture content to be 120 I.R.E. units, which when added to the 40 I.R.E. of sync, causes the total video signal to be 40 + 120 = 160 I.R.E. units. Since 140 I.R.E. units does equal 1 Volt peak-to-peak, then a 160 I.R.E. picture signal would equal 160/140 = 1.143 Volts. Since a sync pulse on a 1 Volt peak-to-peak signal is 40 I.R.E. units and peak-to-peak video is 140 I.R.E. units, the sync pulse voltage is 40/140 Volts = .2857 Volts, a not very easily measured quantity, thus the use of more easily managed I.R.E. units. Note that both color signals and black and white signals will measure 100 I.R.E. units because the 3.58 MHz color information is filtered out in the I.R.E. measurement device. Note that an ordinary Oscilloscope has no such filter and will read much higher picture amplitude than any I.R.E. reading meter.

The important bit of information here is that color pictures have a maximum peak-to-peak output of 1.143 Volts peak-to-peak instead of 1 Volt peak-to-peak. When combined with the nominal "hot" output of many CCTV cameras of 1.3 Volts peak-to-peak, then is can be seen that actual peak-to-peak voltages of CCTV cameras can reach 1.3 X 1.143 = 1.149 Volts. This can

considerably exceed the maximum input permissible on Digital Transmission systems and some corrective action must be applied prior to entering any digital transmission system.

AVAILABLE VIDEO DEVICES:

As has been noted above, a normal Oscilloscope (without an I.R.E. filter) cannot accurately measure color video signals. External I.R.E. filter adapters are available to convert normal Oscilloscopes for measuring color picture amplitude. In any case, and unbalanced input Oscilloscope cannot be used on balanced UTP transmission systems.

There is also the portable, battery operated and hand held CM-2 Camera Master, which with the CM-1 UTP adapter can measure sync pulse, picture amplitude, overall composite sync and picture, focus and color burst amplitude in I.R.E. units, in both 75 Ohm unbalanced cable (coax) and in 105 Ohm balanced UTP (Unshielded Twisted Pair).

COAX VS UTP:

Note that the peak-to-peak voltage standard is the same on coax or UTP cable and that measurements in I.R.E. units will read the same amplitude on the CM-2 Camera Master reading a 75 Ohm unbalanced signal as reading a 105 Ohm balanced UTP signal with the CM-1 UTP adapter.

UTP CABLE SIGNAL MEASUREMENT:

Where a color camera or color video Test Generator is available as a signal source, an accurate measurement of the transmission performance of a coaxial or a UTP cable can be made using the CM-2 Camera Master and the CM-1 UTP adapter.

First measure Sync amplitude and Color Burst amplitude at the color camera with CM-2 (no adaptor). Record these results for further reference. Next, connect the "sender" or UTP converter to the color camera and connect the balanced output of the "sender" to the balanced input of the CM-1 UTP adapter (while it is in place attached to the CM-2 Camera Master). MAKE SURE THAT SENDER AND CM-1 UTP ARE CORRECTLY PAIRED (+to +, and - to -).

Read the Sync amplitude and Colorburst amplitude. Be sure that the adapter switch is on "terminated" and read the Sync amplitude and Colorburst amplitude. Compare the measurements with the previous ones at the 75 Ohm coax side. There should be very little loss (reduction in measurement). Any reduction in measurement will only add to the loss created by the twisted pair cable (see table for TWISTED PAIR LOSS). Note that "passive" senders will have some small loss if not defective, but may contribute substantial loss (particularly at Colorburst) if defective.

Now connect the UTP cable to the "Sender" and move the CM-1 UTP adapter and CM-2 Camera Master to the far end of the Twisted Pair. Insure that the wire connected to the + input of the CM-1 UTP adaptor is also the same wire that is attached the + output of the "Sender". A reversal will result in incorrect reading. Again read and record the Sync and Colorburst amplitude. Compare these readings with the first set of readings and look up the cable loss in the TWISTED PAIR LOSS table.

Now remove the CM-1 UTP adaptor from the CM-1, connect the UTP cable to the

Balanced-to-unbalanced converter (possibly a "sender" hooked up in reverse) and measure and record the Sync and Colorburst again. Compare video and Colorburst loss overall. This is the quality performance of the system.

Note that the CM-2 and CM-1 UTP adapter can be used at any intermediate "punch blocks" in the UTP cable system to help to locate shorts or opens in the cable pairs. At intermediate locations always switch OFF the built-in termination and be sure that both ends of the cable are connected to senders and are properly terminated.

The TWISTED PAIR LOSS table will help in evaluating trouble conditions and assessing whether active equalizers are necessary to provide a quality system. Contact me at FM SYSTEMS at 800-235-6960 for help in using or interpreting measurement results that you obtain.

When cable loss or Colorburst loss is excessive, consider using active senders with appropriate cable pre-equalization or active "Receivers" with built-in high frequency equalization with appropriate pre and post equalizers it is possible to completely compensate UTP cables of 4000' or longer and ever longer with minor cable loss.

TWISTED PAIR LOSS TABLE

CABLE LENGTH IN FEET	SYNC PULSE	LUMA WHITE	COLOR BURST
0	40	100	40
50	39	99	37
100	39	98	35
200	39	98	34
300	38	97	32
400	38	97	31
500	37	96	29
600	37	96	27
700	36	95	25
800	35	93	23
900	35	92	22
1000	34	92	20
1100	34	91	19
1200	34	91	18
1300	33	90	17
1400	33	90	16
1500	32	89	15
1600	32	89	14
1700	32	89	13
1800	31	88	12
1900	31	87	11
2000	30	87	10