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MATH'S NOTES

WHAT'S NEW AND HOW TO USE IT

Balanced Video

A couple of months ago, we discussed the implementation, characteristics, and benefits of both the balanced and unbalanced configurations for audio. We discussed how a balanced scheme rejects common-mode noise while preserving desired signal fidelity, and we even gave a couple of circuit examples to show how to implement inputs and outputs. This month we would like to expand on that topic but in the area of video, since the use of balanced transmission techniques for conventional baseband closed-circuit TV video offer some interesting and unique opportunities for the experimenter.

The most common and familiar method for connecting video signals is with coaxial cable. Using coax provides some degree of shielding from outside noise sources and is relatively inexpensive. Coax does suffer from one problem, however: You need the coax! When you have to route a video signal throughout a building or even from one room to another, the job of routing the coaxial cable can be a real headache, especially if you want a permanent, neat installation. On some occasions, it may even be impractical to run coax.

This was the case in my home, where we wanted to install a small CCTV camera to monitor the front door, but had no way to route the coax through the brick veneer walls that constitute the front of the house. We did have the push-button leads from the doorbell, however, which happened to be located in just the right place. Research into how to use these leads resulted in a neat solution which we will divulge in a moment.

There is a technique in use today with some CCTV installations that employs a simple twisted pair of wires, such as telephone-grade cable, for the transmission of video. This technique operates by first converting the normally unbalanced video signal into a balanced differential signal. This is easily done with a readily available transformer. The balanced signal is then applied to the twisted pair of copper conductors. At the receiving end another transformer converts the differential signal back into a single-ended one. Fig. 1 shows this arrangement.

The transformer must have enough bandwidth to pass the 4–5 MHz baseband video signal, to operate into and from 75 ohms, and to handle the 1 volt pp signal level. Fortunately, such transformers do exist and are commonly used to transport digital signals in various computer-oriented local-area networks. They are called 'baluns" in this marketplace. Baluns are fairly inexpensive and are stocked by most of the larger computer accessory dealers. The connectors on these devices are usually BNC on the unbalanced end and RJ-11 type connectors on the balanced end. Obviously, they are designed to work with telephone cable, and installation is simply "plug and play," as they say. Inexpensive (under $10) baluns can often transport video signals hundreds or even thousands of feet, depending on the quality of the twisted pair and the actual transformers used. This is a real experimenters project, however, so results can be anything from spectacular to miserable. When longer distances are involved, the high-frequency degradation of the twisted pair comes into play and must be compensated for.

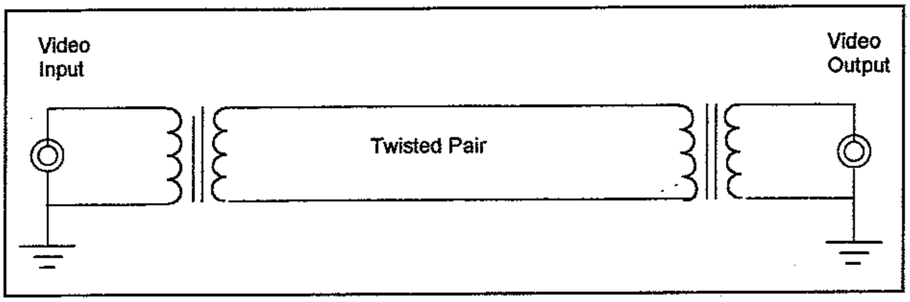

Fig. 1– Balanced video transmission using a twisted pair.

When longer distances must be covered, compensation is accomplished by a cable equalizer circuit which is in reality just a variable high-pass filter. Since the loss of any cable increases as the frequency increases, a simple circuit such as shown in fig. 2, which increases its gain as a function of frequency, will do nicely as such an equalizer. If the cable loss is properly matched to the filter gain, the result is a flat response. Those of you who are familiar with commercial FM broadcasting will be aware of the same technique, at audio, where the signal is first pre-emphasized at the transmitter and then de-emphasized at the receiver.

The circuit shown is a simple op-amp stage with a variable capacitor across the input resistor. As the input frequency increases, the capacitive reactance decreases, effectively shunting the 2.2K input resistor and raising the overall gain of the stage. By adjusting the variable capacitor, the "slope" of this gain characteristic can be modified as needed. Again,

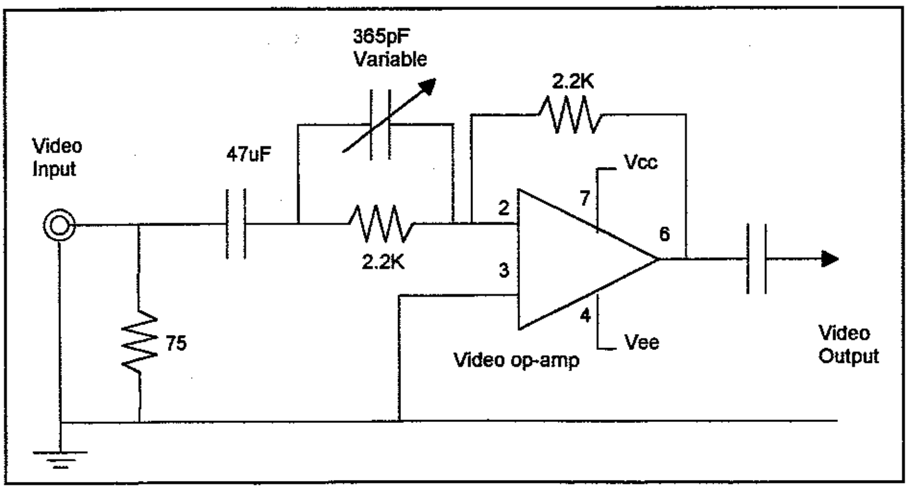

Fig. 2– Experimenter's video equalizer/filter.

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this is an experimenter's type circuit and probably will require a bit of "tweaking" to get acceptable results. The variable capacitor, by the way, will be familiar to AM broadcast-band experimenters, as it used to be quite commonplace, having been used in virtually all older AM broadcast-band receivers.

In the equalizer circuit, once the correct value is found by experimentation, it can always be replaced with a fixed ceramic capacitor of the proper value. By the way, this circuit can be used at the transmitting or receiving end, whichever gives better results. In commercial implementations of this technique, the video signal may be both pre-emphasized as well as de-emphasized. Bear in mind, however, that the circuit will not perfectly compensate for all cable losses. Phase changes, non-uniform cable characteristics, and a whole host of other factors that will affect the final results you obtain can come into play. The effort will be quite interesting, though, and certainly a lot of fun. Commercial systems using this scheme have transmitted good color video signals up to 10 miles through simple telephone cable, so keep in mind that it can be done.

Now to our final circuit. Fig. 3 shows how we configured the TV camera/doorbell system. Two center-tapped transformers were used for the video, while the low-voltage AC for the doorbell was applied between the balanced lines by means of the center tap and a third, common ground. We modified two commercial baluns by carefully unwinding them, adding the center tap, and rewinding. Everything was then held in place with a drop of nail polish.

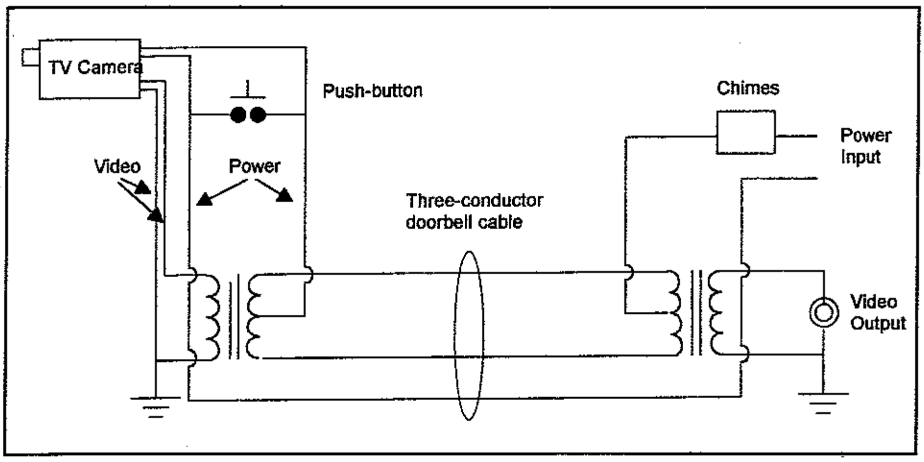

Fig. 3– Transmitting video over a twisted doorbell cable.

Although 60 Hz is present on the video conductors, it cancels itself (as far as the video is concerned) in the transformers due to the fact that the same phase of the sine wave is present on both conductors compared to the opposite phase for the video. The only problem with this setup is that the video is cut off when the push-button is activated.

The camera power (9–12 VDC) was obtained from a full-wave bridge and filter (not shown) which rectified the 16 volt AC from the doorbell transformer. Power required by the chip camera was low enough so that the doorbell chimes would not ring nor drop the AC by very much. The tiny camera was mounted in a small housing that also held the push-button, and the result was a compact front-door video monitor that did not require any coax over the 50 feet span to the monitor.

73, Irwin, WA2NDM