Ground Isolation in Video Transmission

In coax video transmission systems the shield of the coax cable is usually connected to ground. It may very well turn out that a voltage difference at the power line frequency may exist between the ground at the transmitting location and the ground at the receiving end. The 60 Hz current through the shield is then likely to cause serious interference with the video transmission as the resulting voltage drop will add on directly to the video signal.

Power systems are grounded for a number of reasons: To provide a low impedance path for lightning strikes, to create a common reference point for different power sources, and as a safety measure in case of equipment failures. Machinery and instrumentation are usually grounded so as not present a hazard to anyone making physical contact with it.

Normally, no current should flow in a grounding connection. However, there is a variety of conditions that may cause current to flow in ground loops which have enough resistance to cause substantial voltage differences between ground points.

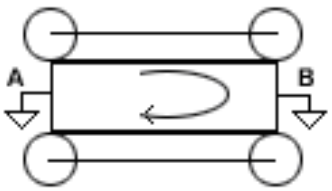

Figure 1. Ground Loop Current Due to Magnetic Field

A simple illustration is shown in Figure 1 where two coax cables run between points A and B. The grounded shields of the two cables constitute a loop which may be exposed to a 60 Hz magnetic field. The resulting loop current flow will set up a potential difference between A and B which will add on to video signals being transmitted.

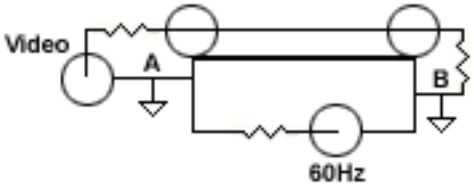

Figure 2. Equivalent Circuit

The equivalent circuit of a video coax transmission line and associated ground loop circuit is shown in Figure 2.

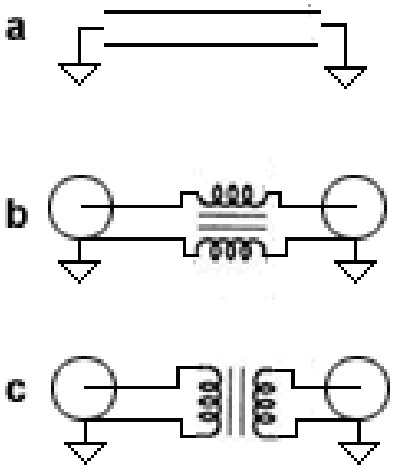

Figure 3. Anti-Loop Current Measures

GROUND ISOLATION TECHNIQUES

The effect of ground loop currents may be minimized by any one of three techniques, illustrated in Figure 3. In 3a, the coax cable is replaced by a balanced line. In 3b, the windings of a transformer are connected in series with the two line conductors. In 3c, they are placed in shunt, breaking the ground connection.

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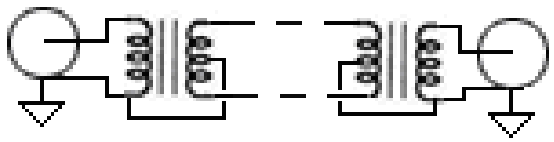

Figure 4. Balanced Transmission Circuits

BALANCED LINE

Balanced lines are a favorite medium in signal transmission because of minimal radiation and inherent immunity from interference without expensive shielding.

Interfering signals are “common mode,” i.e. voltages between the electrical midpoint of the balanced line conductors and ground. A 60 Hz voltage between the two midpoints at the ends of a balanced line is thus a common mode signal.

In Figure. 4, a UTP (unshielded twisted pair) balanced line has replaced the coax cable between a single-ended (one side grounded) source and a single-ended termination. The unbalanced to balanced conversion is performed by a two-winding transformer connected as shown in Figure. 4.

Although the transformers in Fig. 4 break the ground connection, ground is reintroduced by grounding the center-taps of the balanced windings. This is necessary to assure that the midpoint of the balanced line is at ground. It also provides lightning protection.

HUMBUCKERS

The inline transformer in Fig. 3b is variously known as a “humbucker” or “common mode filter” or “common mode choke.”

Since the signal current is equal and opposite in the two windings of the transformer, it creates zero net flux and is, therefore, essentially transparent to the video signal. Ideally, the humbucker does not play a role in the video transmission process over the entire frequency range down to dc. Its function is to come into play when the vector sum of the currents in the two legs of the transmission circuit is unequal to zero, in which case it tries to suppress all but the signal current.

If the cable shield had zero resistance, the entire ground loop voltage would be across the lower winding which would then induce an equal voltage in the upper winding. The net 60 Hz video loop voltage would then be zero. In practice, humbuckers provide 40 to 50 dB isolation.

There is also a limitation on the maximum 60 Hz signal that may be accommodated due to core saturation. It is of the order of 2 to 3 Vrms.

HUMSTOPPERS

The shunt transformer circuit is shown Fig. 3c. The North Hills designation for this device is “Humstopper.” It has the advantage of providing more than 120 dB of isolation and will accommodate 60Hz voltages up to 500 Vrms. It also has highly linear differential gain and phase characteristics.

Unlike the humbucker, the Humstopper is a crucial element in the video transmission process. As a magnetic device it cannot transmit dc and its low frequency limit is between 10 to 20 Hz. It, therefore, requires a video feed which includes a dc blocking capacitor. This is usually the case, but for the rare cases where it is not, North Hills has models available with built-in blocking capacitors.

There are Humstoppers for various video signal formats, such as NTSC, PAL et al. in single and multi-unit assemblies.

Please don’t hesitate to contact us to discuss your particular applications and needs.

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