Cable Lore

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GROUNDING OF POWER CABLE SHIELDS

The purpose of the shielding system on a power cable is to provide a fixed, known path to ground for the cable charging current. To perform that function the shield must be grounded.

If there is an insulating jacket over the shield and if, because of an accident or corrosion, the shield ground connection is broken, the voltage between that shield and ground can approach the conductor to ground voltage that is on the insulated conductor.

Obviously the threat to human life and physical hazards to a 'floating' shield must be avoided. This is one good reason for multi-point shield ground. The decision to ground the shield at a single or multiple points depends on the overall electrical system. The following information is intended as a tool to help a user to decide which grounding scheme is most suitable for the particular application.

I. Single Point Grounding

The current in the conductor induces a voltage along the shield. The amount of induced voltage depends on many factors, including cable geometry, cable spacing, conductor current, and frequency. Some systems are designed with a particular maximum value of shield voltage in mind. Values are selected for safety and sometimes to reduce the possibility of corrosion due to AC electrolysis. As the distance increases from the grounded point, so does the voltage of the shield (Fig. 1). Equations for calculating shield voltages may be found in the Underground Systems Reference Book[1] and other references.

During abnormal conditions such as current surges or fault conditions in either cable or equipment, the voltage between the shield and ground can be much higher. The abnormally high voltage can result in related equipment problems.

[1]Edison Electric Institute, *Underground Systems Reference Handbook,* Edison Electric Institute, 1957.

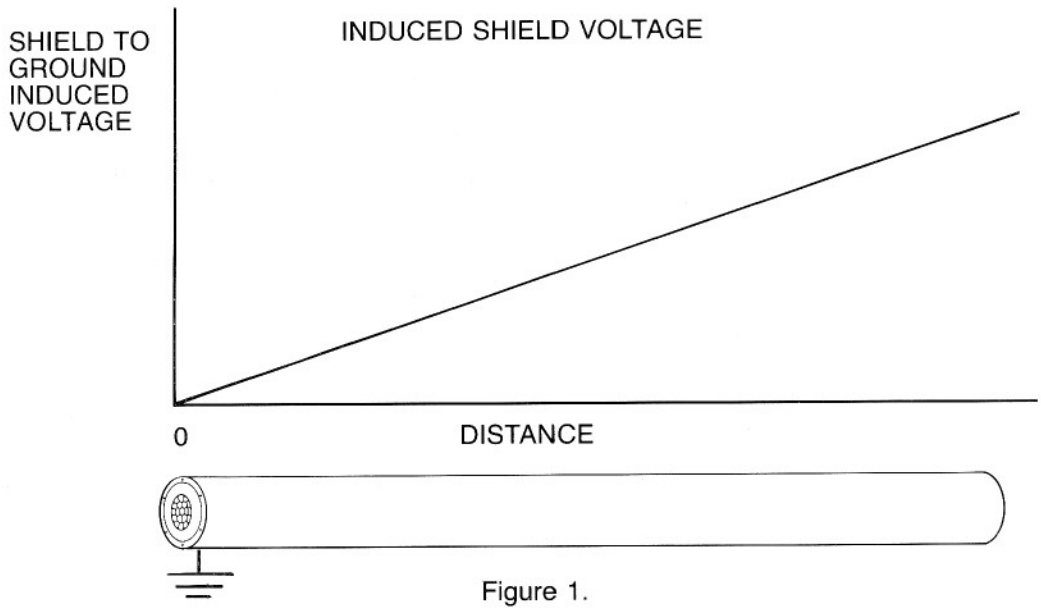

Figure 1.

II. Multiple Point Grounding

When the cable shields are bonded and grounded at multiple points, the shield to ground voltages are essentially eliminated. However, the longitudinal voltage induced along the shield by the conductor current causes a current to flow in the shield which results in additional cable heating known as shield losses. (Fig. 2)

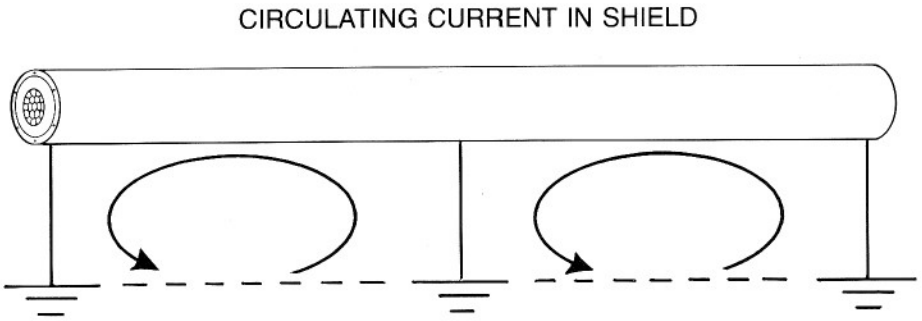

Figure 2.

The additional heating caused by shield losses may require a derating of the cable ampacity. The amount of derating depends on many factors, including cable size, cable separation, and frequency. The shield resistance is a major factor affecting the shield losses. Figure 3 shows the relationship between the shield loss and shield resistance.[2]

[2]Insulated Cable Engineers Association, *Ampacities Including Effect of Shield Losses for Single Conductor Solid Dielectric Power Cable P-53-426,* New York: Insulated Cable Engineers Association; National Electrical Manufacturers Association, 1976.

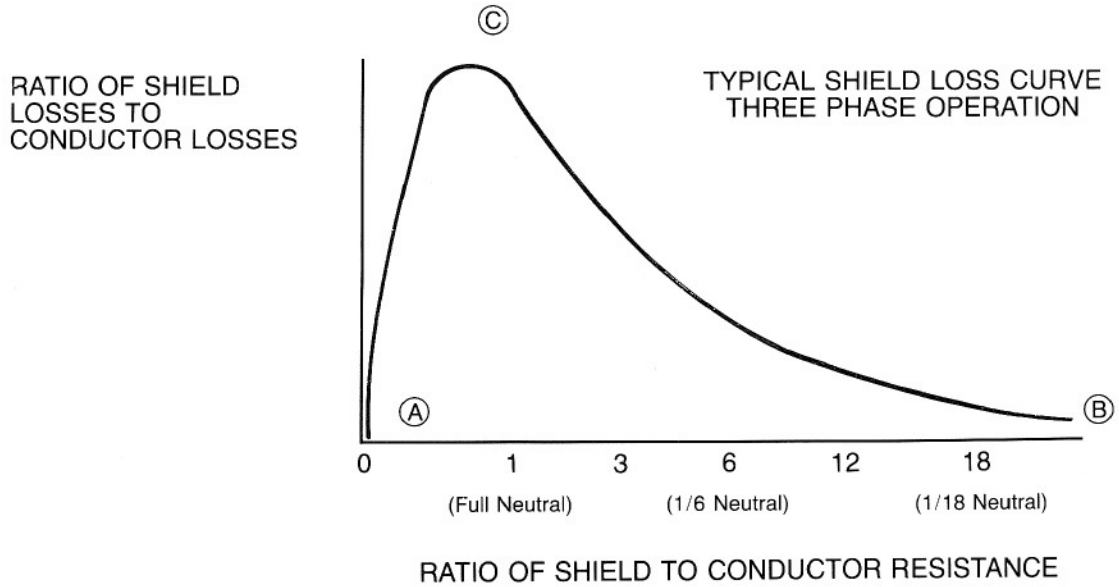

Figure 3.

A —Low shield resistance; the shield current meets little opposition and results in low shield losses. A shield resistance this low is rarely used in practice.

B —High shield resistance; the shield current is almost 'choked off', resulting in low shield losses.

C —In this area, the shield resistance and shield current combination result in the greatest shield losses.

Several schemes have been devised for multiple point bonding which reduce the shield current losses while providing reduced shield voltage. Many of these schemes are not practical, and others are mainly used on high voltage cable systems (69 kV and above) where shield losses are a major factor. For most medium voltage systems, either single or multiple point bonding and grounding is used.

UNISHIELD and MULTIPLE POINT GROUND — AN IMPORTANT NOTE —

UniShield has a semiconducting jacket which provides electrical contact between individual cables that are touching or between any conducting material in contact with the cable. In general, UniShield cable will operate with the shields *grounded at multiple points.* Examples would include direct burial, multiple cables in a conduit, or metallic cable tray.

For large cables with low shield resistance near the peak of Fig. 3, the heat generated in the shield can be almost twice the heat generated in the conductor. However, UniShield and Uniblend cables operate near area 'B' of Fig. 3, with much lower shield losses because of the high shield resistance. For instance, with 3 UniShield or Uniblend cables in a duct, the ampacity difference between single and multiple point grounding is about one to two percent. For spaced UniShield or Uniblend cables, the difference can be 10% or higher. Again, remember that UniShield cables will be operating essentially as multiple point grounded because of the semiconducting jacket material.

III. Fault current capability of a shield is related to the shield resistance. If more metal is used in the shield to increase fault current capability, the resistance decreases and the shield losses may increase. Alternately, fault current capability can be gained by using a separate conductor for return current without the penalty of additional shield losses. Therefore, UniShield and Uniblend cables can be used which offer lower shield losses, with additional fault current capability provided by the separate conductor.

SUMMARY

The decision to single or multiple point ground the cable shield is a trade-off between induced shield voltage and circulating shield current. Multipoint grounding does provide redundant ground connections and reduces the possibility of a floating shield. The reduction in ampacity for multiple point grounding is minimal for three UniShield or Uniblend cables in a duct.

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