

Charge-Dissipative Electrical Cables

Lossy dielectric layers and grounding conductors drain spurious charges to ground.

Goddard Space Flight Center, Greenbelt, Maryland

Electrical cables that dissipate spurious static electric charges, in addition to performing their main functions of conducting signals, have been developed. These cables are intended for use in trapped-ion or ionizing-radiation environments, in which electric charges tend to accumulate within, and on the surfaces of, dielectric layers of cables. If the charging rate exceeds the dissipation rate, charges can accumulate in excessive amounts, giving rise to high-current discharges that can damage electronic circuitry and/or systems connected to it.

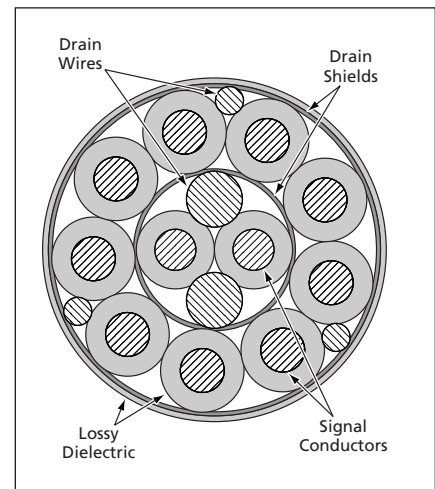
The basic idea of design and operation of charge-dissipative electrical cables is to drain spurious charges to ground by use of lossy (slightly electrically conductive) dielectric layers, possibly in conjunction with drain wires and/or drain shields (see figure). In typical cases, the drain wires and/or drain shields could be electrically grounded via the connector assemblies at the ends of the cables, in any of the conventional techniques for grounding signal conductors and signal shields. In some cases, signal shields could double as drain shields.

To be suitable for use in a charge-dissipating cable, a dielectric material must be inherently lossy throughout its bulk, and not, say, an insulating polymer with a conductive surface film or containing embedded conductive particles. Conductive surface films can be rendered inef-

fective by flaking off or cracking, especially when cables are bent. Embedded particles can act as defect sites that initiate arcing within dielectric layers.

The concept of lossiness can be quantified: Dielectric materials can be broadly categorized, as either “excellent” or “lossy” according to their volume electrical resistivity (ρ) values. Excellent insulators may be roughly categorized as having ρ of the order of $10^{16}\Omega\cdot\text{m}$, while lossy or dissipative insulators may be categorized as having ρ of the order of $10^9\Omega\cdot\text{m}$.

In designing for a specific application, one must choose the lossy dielectric material and the configuration of grounding conductors to be capable of dissipating a sufficient proportion of static charge within an acceptably short time. For a typical cable that handles signals of sufficiently low frequencies (having wavelengths much greater than the length of the cable), the effective charge-dissipating admittance or conductance must be much less than the nominal signal admittance or signal conductance of the circuits connected with the cable, so as not to adversely affect the transmission of signals. For a typical cable that handles signals of sufficiently high frequencies (having wavelengths comparable to or less than the length of the cable), the effective charge-dissipating admittance or conductance must be taken into account as part of the overall signal-propagation cable imped-



This Cross Section illustrates one of many possible charge-dissipating designs for a cable containing 11 signal conductors.

ance, and the signal attenuation caused by loss in the dielectric must be acceptably low. These requirements could be difficult to satisfy if a cable is too long and, hence, imposes either a limit on the allowable length of the cable or else a requirement to pay closer attention to interactions between the charge-dissipation and signal-propagation aspects of the cable design.

This work was done by John R. Kolasinski and Edward J. Wollack of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-14648-1

Deep-Sea Video Cameras Without Pressure Housings

Camera units could be made smaller, lighter, and less expensive.

NASA's Jet Propulsion Laboratory, Pasadena, California

Underwater video cameras of a proposed type (and, optionally, their light sources) would not be housed in pressure vessels. Conventional underwater cameras and their light sources are housed in pods that keep the contents dry and maintain interior pressures of about 1 atmosphere ($\approx 0.1\text{ MPa}$). Pods strong enough to withstand the pressures at great ocean depths are bulky, heavy, and expensive. Elimination of the pods would make it possible to build camera/light-source units that would be significantly smaller, lighter, and less ex-

pensive. The depth ratings of the proposed camera/light source units would be essentially unlimited because the strengths of their housings would no longer be an issue.

A camera according to the proposal would contain an active-pixel image sensor and readout circuits, all in the form of a single silicon-based complementary metal oxide/semiconductor (CMOS) integrated-circuit chip. As long as none of the circuitry and none of the electrical leads were exposed to seawater, which is electrically conductive, silicon inte-

grated-circuit chips could withstand the hydrostatic pressure of even the deepest ocean. The pressure would change the semiconductor band gap by only a slight amount — not enough to degrade imaging performance significantly.

Electrical contact with seawater would be prevented by potting the integrated-circuit chip in a transparent plastic case. The electrical leads for supplying power to the chip and extracting the video signal would also be potted, though not necessarily in the same transparent plastic. The hydrostatic pressure would tend