About Optical Isolation

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What is Optical Isolation and When Do You Need It.

You have probably noticed that optical isolation is a popular feature on datacom products. But what is optical isolation? And why is this feature in demand? This article will present a brief overview of optical isolation and identify some "flags" to alert you that the solution you're recommending ought to incorporate it.

Some Background In 1887, Gustav Hertz discovered that particular surfaces liberated electrons when influenced by light. Subsequent work by Max Planck and Albert Einstein in the early 1900s established that bundles of light energy, called "photons", could transfer their energy to free electrons and liberate them from metal surfaces in a mathematically predictable way. The application of this "photoelectric phenomenon" to the field of semiconductors is the basis for optical isolation.

The Basic Theory Optical isolation has two basic elements: a light source (usually a light emitting diode) and a photo-sensitive detector. These two elements are positioned facing one another and inserted in an electrical circuit to form an optocoupler. The key property of an optocoupler is that there is an insulating gap between the light source and the detector. No current passes through this gap, only the desired light waves representing data. Thus the two sides of the circuit are effectively "isolated" from one another. Primary Application In data communications, the primary application for optical isolation is in a point-to-point data circuit that covers a distance of several hundred feet or more. Because the connected devices are presumably on different power circuits, a ground potential difference likely exists between them. When such a condition exists, the voltage of "ground" can be different, sometimes by several hundred volts.

Where a ground potential difference exists, a phenomenon called ground looping can occur. In this phenomenon, current will flow along the data line in an effort to equalize the ground potential between the connected devices. Ground looping can, at the very least, severely garble communications--if not damage hardware!

Optical isolation solves the problem of ground looping by effectively lifting the connection between the data line and "ground" at either end of the line. If an optically coupled connection exists at each end, the data traffic "floats" above the volatility of ground potential differences.

Optical Isolation vs. Transformer Isolation A common belief is that optical isolation is superior to transformer isolation in every case. Theoretically this is true, because optical isolation provides a "true" physical barrier, whereas transformer isolation is a coupling designed to merely "absorb" unwanted frequencies. However, in practice optical isolation is a less efficient transmitter of energy than transformer isolation--an important consideration when signal strength is an issue. Therefore transformer isolation is sometimes the best choice for very long-distance applications. And optical isolation also becomes a prohibitively expensive solution at higher data rates. So in the real world, transformer isolation still has its place.

Optical Isolation vs. Surge Protection Another common belief is that optical isolation takes the place of surge protection. After all, if optical isolation provides a barrier against ground loops, won't it provide a barrier against transients as well? This belief fails to account for the fundamental difference between ground loops and transients.

Ground loops tend to be of long duration and relatively low voltage. Transients, on the other hand, tend to be of short duration and very high voltage. Consequently, the amount of current instantly presented by a transient must be directed safely to ground. An optocoupler will be destroyed by a high voltage transient exceeding its rating. True, the transient will not get past the barrier, and components on the other side of the optocoupler will be spared. But components on the side receiving the "hit" (usually the analog line side) can be damaged. In any case, the unit will no longer pass data.

What's needed, therefore, is surge protection (such as the Silicon Avalanche Diodes used by Patton) placed ahead of the optocoupler--right where the line enters from the outside world. Surge protectors respond instantly and shunt relatively large amounts of current quickly to chassis ground. This dangerous current is not permitted to roam around and damage components (including the optocoupler). Then the optocoupler can do its job of providing a constant barrier to low voltage ground loops.

Conclusion:
Ideally this article has "illuminated" the feature of optical isolation enough to give you added confidence when recommending Patton short range modems or interface converters. And hopefully it has proven to be a worthy companion to this week's release of the Patton Model 590 RS-232 opto-isolator. Maybe you know several customers who could use a Model 590.

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