FIBER OPTIC VERSES COPPER BASED CLASS A SERVICE

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Examples of Class A circuits, as defined in IEEE-487, would be pilot-wire protective relaying, transferred tripping, audio tone protective relaying, and critical supervisory circuits (SCADA) that are used for remote control and or monitoring of regional and or nation wide power grids. Copper cable based CLASS A service performance demands an extra amount of design and circuit coordination between the power and telephone companies. In addition to providing a High Voltage Protection (HVP) interface that can withstand very high GPR levels they must also be engineered to withstand high induced voltages.

You can't talk about induced voltages and Class A service without understanding the basic relationship of voice frequency noise on telecommunication circuits; summed up in the following equation:

Circuit Balance = Noise to ground (induction) – Noise metallic (circuit noise)

or

$$N_M = N_G - \text{Balance}$$

N_M, Noise metallic (circuit noise) becomes a problem when it exceeds 30dB.

N_G, Noise to ground (induction) becomes a problem when it exceeds 90dB.

Balance, refers to either the serving copper cable and or the equipment terminated on either end of a cable facility. Balance greater or equal to 60dB is an industry standard.

Using this direct relationship, if you have a circuit configuration with an overall balance of 60dB, with 90dB of induction, the circuit noise would be a marginal 30dB (30 = 90 – 60). Increase the induction by 20dB to 110dB and the circuit noise becomes an unacceptable 50 dB (50 = 110 – 60). **Power induction into copper cables in on or around a power substation, during fault conditions, routinely exceed 200dB!** With the same circuit balance of 60dB, the power induction far exceed the transmission levels of the circuit, and therefore make them inoperable during power fault conditions.

Some manufactures, who produce copper based HVP systems, have attempted to alleviate this problem by producing terminating transformers with an 80dB balance. With an 80dB balance the circuit noise would be reduced by an additional 20dB. Not much help with a 200dB plus induction level! In addition they also produce Mutual Drainage Reactors (MDR's) that are placed at the opposite end of the cable induction at the serving central office. MDR's are a 100 year old technology first used in long distance open wire lines.

Voice frequency copper based Class A circuits require MDR's at the serving central office to drain off these induced voltages at a remote location. They are also required on the drop side of a copper based HVP interface if the circuit extends across the substation grid to a secondary location. The center tap of an MDR is referenced to the local ground where it is installed and must be wired in their "shorted" configuration without gas tube protectors anywhere on the circuit. When configured this way, DC sealing current, as well as any additional DC function, cannot be placed on the Class A circuit! Sealing current is universally used to keep copper based data circuits operational over extended periods of time. These "dry" Class A circuits have always been prone to intermittent failures and have been avoided like a plague by the power industry due to their unpredictability. This unpredictability is a direct contradiction to the IEEE-487 Class A definition:

> **NON-INTERRUPTIBLE service performance (must function before, during, and after the power fault condition). The non-tolerable service interruptions include both loss of DEPENDABILITY (failure to deliver a valid trip signal) and loss of SECURITY (delivery of a false trip or control signal).**

Returning to the previous equation, with the knowledge that fiber optic systems are immune to power induction, when ($\mathbf{N_G}$) is removed the circuit noise ($\mathbf{N_M}$) will always be at or below 0 dBrn (10^{-12} watts) regardless of the overall circuit balance ($\mathbf{N_M = N_G}$ **- Balance**). If there is a power induction issue when RLH fiber optic systems are being placed at the end of an existing telco copper cable, Class A service can be provided by extending the fiber cable beyond the power exposure area. Doing so meets the IEEE-487 definition of Class A service.

If any circuit, including Class A service, extends across a substation grid to a secondary location it will always be considered to be exposed to high levels of induction. IEEE-487 is based on the requirements of copper based facilities. It recommends that if a copper cable is placed on a power substation grid between two or more locations the cable must be placed in a metallic pipe along with a minimum of a 2/0 AWG copper grounding cable. These additional current carrying conductors must also be grounded at both ends of the communication cable run. The metal pipe and grounding wire are required to reduce, but not eliminate, induction and attempt to equalize voltage differences that occur on grids during GPR conditions. This is a very expensive configuration and is rarely followed. Again, Fiber optic systems are immune to power induction and do not need these additional measures to provide noise free circuits in harsh power induction environments.

Summation: For the above reasons the power industry has pulled a vast majority of their Class A, and other critical circuits, off copper facilities and placed them on fiber optic systems. Fiber optic systems are immune to power induction and therefore have become the engineering first choice for critical circuits of all types, including Class A, over the past 25-30 years! Fiber offers the highest level of noise and maintenance free service for critical Class A circuits. **In effect, all circuits on RLH Fiber Optic Link systems are, by the IEEE-487 definition, Class A.**

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