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Transforming Coherent Telecom Receivers into Current Sensors

Lightning-induced damage poses a major threat to infrastructure, particularly in power and telecommunications networks. Accurate current measurements are essential for designing protective systems and assessing damage. While traditional sensors such as shunt resistors and Rogowski coils offer high accuracy, they must be installed at the strike point, making them unsuitable for wide-area deployment. Remote sensing approaches can scale across many installations; however, current estimates derived from measured fields and empirical models limit their accuracy. Achieving the precision of local measurements through remote means remains an open challenge. This research explores a novel method for distributed lightning current measurement using deployed fibre telecom infrastructure.

Lightning-induced magnetic fields cause polarisation changes in the light transmitted through optical fibre via the Faraday effect. By monitoring these changes, both fast and slow current measurements can be made. In contrast, many existing lightning current measurement techniques struggle to detect slow changes due to their reliance on measuring the time derivative of the current or field. Coherent optical receivers in telecom systems already track polarisation changes to compensate for environmental effects that alter the transmitted optical signal. This raises an important question: can polarisation information from these receivers be repurposed for lightning current sensing?

This study investigates the feasibility of using polarisation data from coherent receivers for current measurement. We experimentally compare this approach with a standard fibre optic current sensor, assessing its ability to measure fast- and slow-changing currents. Performance is evaluated in terms of linearity, resolution, sensitivity, and noise immunity, laying the groundwork for scalable lightning current measurement using deployed optical networks.

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