

# Abstract

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## **Performance Optimization of Apodized FBG-Based Temperature Sensors in Single and Quasi-Distributed DWDM Systems with New and Different Apodization Profiles**

In this work, different FBG temperature sensors are designed and evaluated with various apodization profiles. Evaluation is done under a wide range of controlling design parameters like sensor length and refractive index modulation amplitude, targeting a remarkable temperature sensing performance. New judgment techniques are introduced such as apodization window roll-off rate, asymptotic sidelobe (SL) decay level, number of SLs, and average SL level (SLav). Evaluation techniques like reflectivity, Full width at Half Maximum (FWHM), and Sidelobe Suppression Ratio (SLSR) are also used. A "New" apodization function is proposed, which achieves better performance like asymptotic decay of 18.4 dB/nm, high SLSR of 60 dB, high channel isolation of 57.9 dB, and narrow FWHM less than 0.15 nm. For a single accurate temperature sensor measurement in extensive noisy environment, optimum results are obtained by the Nuttall apodization profile and the new apodization function, which have remarkable SLSR. For a quasi-distributed FBG temperature sensor the Barthann and the new apodization profiles obtain optimum results. Barthann achieves a high asymptotic decay of 40 dB/nm, a narrow FWHM (less than 25 GHz), a very low SLav of 45.3 dB, high isolation of 44.6 dB, and a high SLSR of 35 dB. The new apodization function achieves narrow FWHM of 0.177 nm, very low SL of 60.1, very low SLav of 63.6 dB, and very high SLSR of 57.7 dB. A study is performed on including an unapodized sensor among apodized sensors in a quasi-distributed sensing system. Finally, an isolation examination is performed on all the discussed apodizations and a linear relation between temperature and the Bragg wavelength shift is observed experimentally and matched with the simulated results.