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4.1 A multiplexer-based Q-band multi-channel microwave Doppler backscattering reflectometer on the HL-2A tokamak

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Doppler backward scattering (DBS) reflectometer has proven to be a powerful technique to study the physics of L-H transition, plasma transport, GAM, and zonal flows though measurements of the perpendicular velocity of density fluctuations, and the radial electric field in plasmas. In this work, a Q-band 8-channel DBS reflectometer system based upon a low insertion loss multiplexer-based feedback loop microwave source, and quadrature demodulation have been designed, tested in the laboratory, installed and operated on the HL-2A tokamak. The SSB phase noise of the multiplexer -based feedback loop microwave source has a better SSB phase noise especially at high offset frequency (f > 100 kHz), compared with that of a typical commercial synthesizer. The 8 working frequency components of the new DBS reflectometer systems are 34 - 48 GHz with a frequency interval of 2 GHz, and the power variation of all frequency components is < 4 dB. They are developed to measure the localized intermediate wavenumber (k⊥ρ ˜ 1–2, k⊥ ˜ 2–10 cm−1) density fluctuations and the poloidal rotation velocity profile of turbulence. Details of the system design, laboratory tests, ray tracing estimation, and initial plasma results illustrate the capabilities of the multiplexer-based DBS reflectometers.

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