Development of Multi-Channel IF System for ECE Radiometer on KSTAR Tokamak

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Plasma experiments on KSTAR are scheduled to start up this year (2008). We have developed an electron cyclotron emission (ECE) radiometer to measure the radial electron temperature profiles in KSTAR experiments.

Figure 1 shows a block diagram of the ECE radiometer system. The ECE from plasma is introduced to a diagnostics port via two reflecting mirrors, and received by an oversize circular waveguide. The ECE traveling in the waveguide over 30 m is fed to a multiplexer which can divide the signal into two signals with respective frequency range from 110 to 162 GHz and from 164 to196 GHz. Each signal is received by a conical horn independently, and fed to a pre-down conversion box. We name the ECE radiometer system as "T-band" and "G-band system" whose name corresponds to handling frequency band of the system. The system is completely independent from each other. In the pre-down conversion box of T-band (G-band) system, the signal is converted to the signal with frequency up to 26.5 GHz (16 GHz) by using band-pass filters, mixers, LOs, and amplifiers. Total conversion gain of the pre-down conversion box is about 37dB. These outputs from the box are then fed to a 2nd down conversion module for the purpose of further down conversion. Signals with frequency of 1-26.5 GHz at the input port are converted to the signals with frequency up to 9.5 GHz, and fed to the output ports of IFOUT1-4, respectively. Then a detector module resolves the signal by the band-pass filter bank with center frequencies from 2 to 9 GHz by 1 GHz step, and detects amplitude of the resolved signal by the video detectors. The detected signal is digitized after a video amplifier stage. Figure 2(a-d) shows evaluation results measured after the video amplifier outputs by connecting the same set of the detector and the video amplifier module to the different output port (IFOUT1-4) of the 2nd down conversion module, respectively.

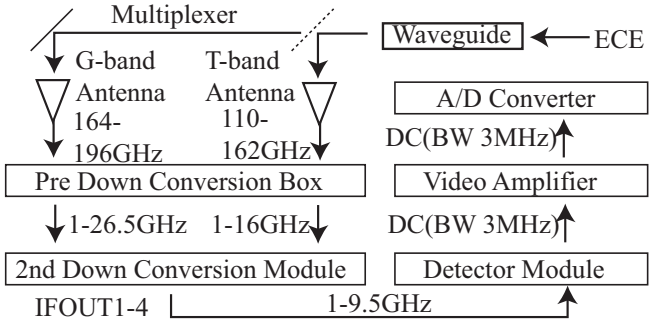

Fig. 1 Block diagram of the ECE radiometer system

In this evaluation, input power at the input port of the 2nd down conversion module is fixed at -15dBm, and frequency is swept from 1 to 27GHz. The signal increase is confirmed within corresponding center frequency and bandwidth of the band-pass filter. The base line around 0.1V agrees with amplified result of the tangential signal sensitivity (TSS) of the video detector. In the certain outputs such as 12 GHz and 18 GHz channels, spurious response can be recognized. For example of 12 GHz channel, signal increment around 16 GHz is considered as a spurious signal. This problem is caused from the mixer characteristics that conversion loss of the harmonics is comparable to that of the fundamental. This problem has been overcome by employing proper frequency range of the band-pass filter in the 2nd down conversion module. Unnecessary frequency components are cut off by the rejection-band of the band-pass filters. We confirmed that sufficient attenuation of the signal was achieved within the unnecessary frequency range in the 2nd down conversion module. AC noise voltage measured at each video amplifier output ranges from 8 to 12 mV with frequency up to 10MHz. This AC noise level corresponds to minimum measurable temperature of 50eV from the brief estimation. A low-pass filter may decrease amplitude of the AC noise level, however, excessive low cutoff frequency deteriorates time response of the measurement.

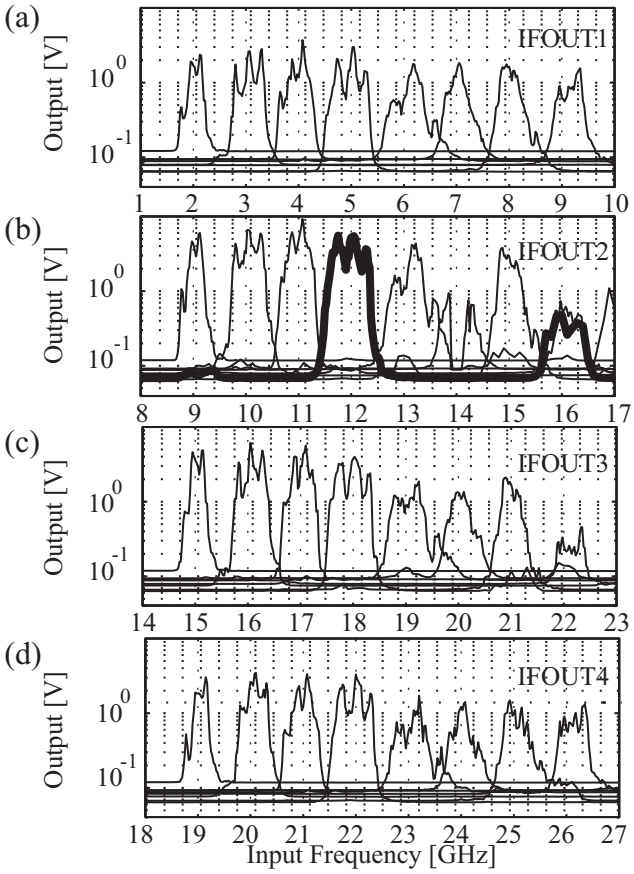

Fig. 2 Video output characteristics measured at each detector module output channel