

§5. Developments of Multi-channel Microwave Reflectometer System

Tokuzawa, T., Kawahata, K.

In order to measure the multi-point fluctuation phenomena using microwave reflectometer, we have been developing the new multi-channel system. Recently, we have tested two types of new technique. One is a frequency-modulated system and another is a comb generator system.

The frequency modulation technique generates the multiple sidebands on a carrier wave. When an oscillating voltage is combined with a dc voltage to tune a voltage controlled oscillator (VCO), the resultant frequency component of the VCO is given by

$$\omega(t) = \omega_0 + \Omega_m \cos(\omega_m t), \quad (1)$$

where ω_0 is the center frequency, ω_m is the modulated frequency, and Ω_m is the modulating envelope at ω_0 . We investigated the frequency components of output signal. In Fig. 1, the controlled voltage to VCO (Spinnaker VC1218B1) is combined with dc voltage and modulator output voltage by using the bias-T which has a high frequency responsibility. Figure 2 shows the example of

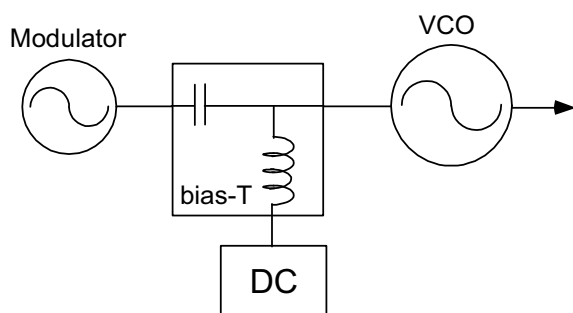


Fig. 1. Schematic of FM test set

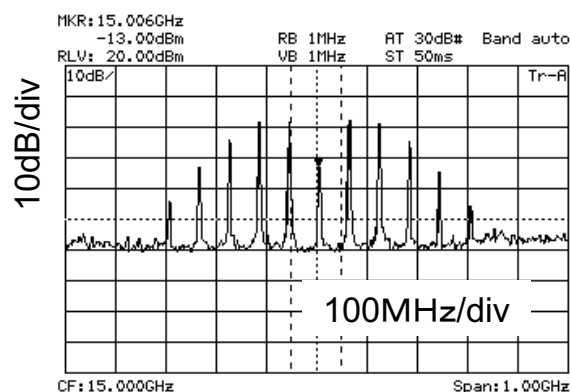


Fig. 2. Example of frequency spectrum of VCO output. $f_0=15$ GHz, $f_m=60$ MHz.

the test which the center frequency is 15 GHz and the modulation frequency is 60 MHz. About ten frequency peaks can be observed. Difference of each peak is equal to the modulation frequency of 60 MHz. In addition, when this output is multiplied, we can get wider frequency components with same frequency difference. The output frequency is quite sensitive to the input voltage and the stabilization is important.

Low phase noise comb generator which is based on monolithic Non-Linear-Transmission-Line (NLTL) circuit technology has been developed, recently. The comb generator can output an array of many frequencies and the frequency range is quite broadband. We have tested the frequency characteristics of the comb generator (PSPL 7102). The output of comb generator can be controlled by the modulator signal shown in Fig. 3. Figure 4 shows the example of the output frequency components. Broadband and many frequency combs can be observed. Each frequency is separated and the difference is the same as the modulation frequency of 410 MHz in this test. The obtained comb is quite clean and stable. When we use the multiplier, the additional frequency components can be also obtained.

Currently, both frequency array systems need a power amplifier for the LHD plasma measurements. We make a plan of total reflectometer system using this technique and will install the new system in near future.

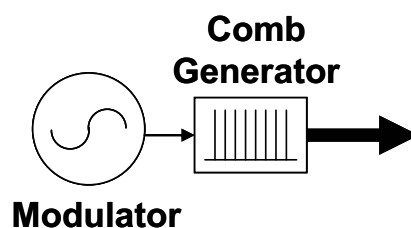


Fig. 3. Schematic of Comb generator test set

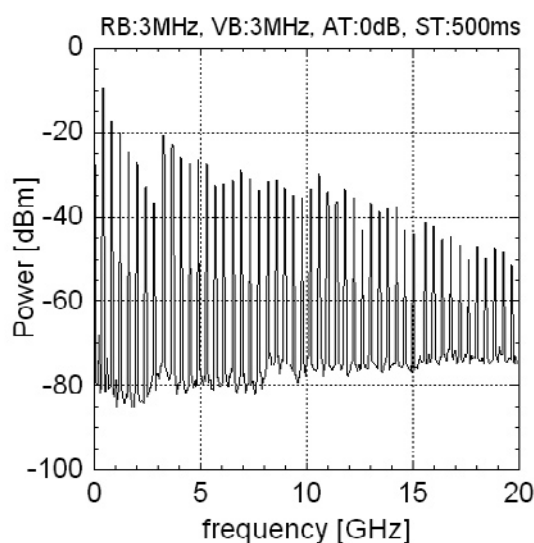


Fig. 4. Example of frequency spectrum of comb generator output. $f_m=410$ MHz.