Receiver for the Microwave Reflectometer

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Phase measurements are widely used in many plasma diagnostics because of the high S/N ratio and the high accuracy. Since it is difficult to directly measure the phase of electromagnetic waves, they are mixed with another electromagnetic wave (local source) and the frequency is down-converted to an appropriate frequency. Then the phases of down-converted signals (IF signals) are measured. This type of method is called heterodyne detection.

A heterodyne receiver with the IF frequency of about 1GHz (Fig.1) has been designed and constructed for the microwave reflectometer in the JIPP TII-U tokamak. Although it is constructed for the reflectometer, it can be used for other diagnostics, so far as the IF frequency is in the same range.

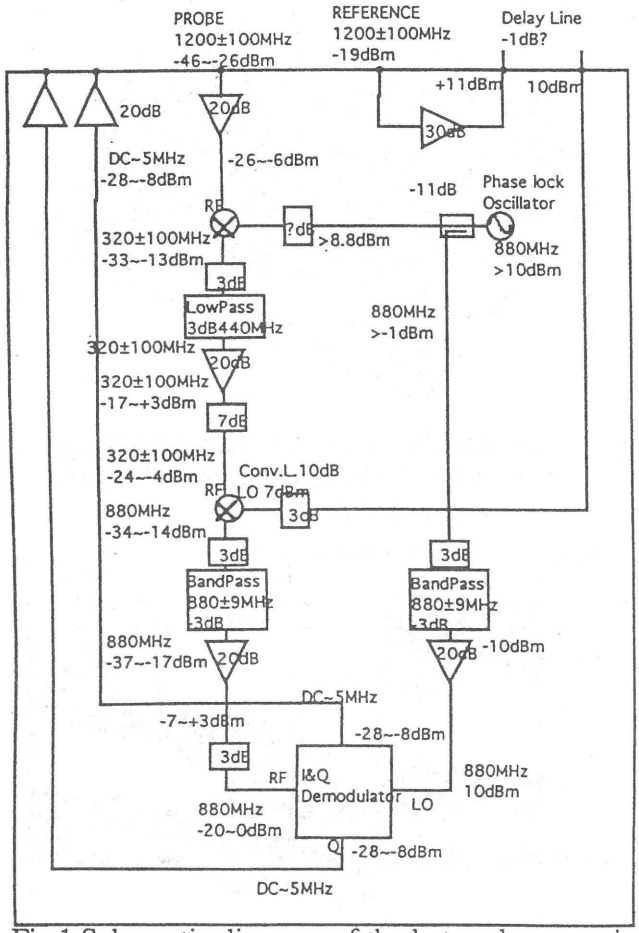

Fig.1 Schematic diagram of the heterodyne receiver

The IF frequency fluctuates because the relative frequency fluctuation of microwave sources. In order to compensate the fluctuation, the IF signal is mixed twice. Without a plasma, the resultant (880MHz). This method of compensating is a standard technique in heterodyne measurements [1]. With the plasma, the IF signal includes phase information along the path of microwaves in the plasma. The quadrature mixer at the final stage of the receiver yields sin/cos outputs. The phase and power are calculated from these two signals. The performance of the receiver can be checked by the Lissajous's figure of the two outputs (Fig.2). Ideally , the trace is a circle. Deviation from a circle (ellipticity and rotation angle of the long axis) is small. While the radius of the circle is almost constant when the phase variation is smaller than about 5MHz, the deviation becomes large at lower frequency (~1MHz). The radius of the circle is proportional to the square of the IF power over the range of -75~-30 dBm, and begins to saturate at higher power (Fig.3). This heterodyne receiver is going to be install into the reflectometer in JIPP TII-U.

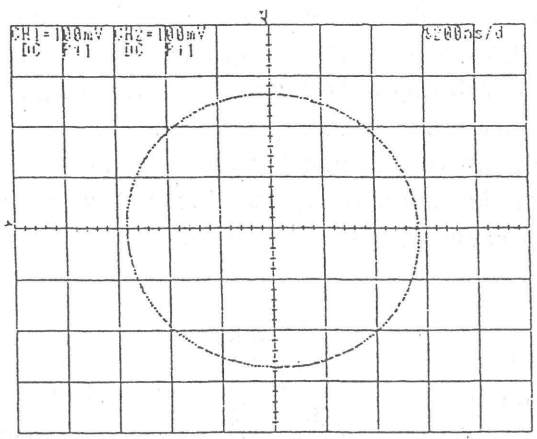

Fig.2 Lissajous's figure of the two outputs when the IF signals have 1MHz different frequency.

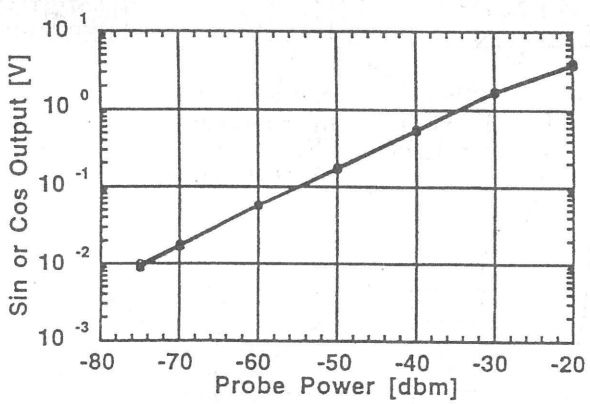

Fig.3 Output of the receiver as a function of input IF power.

References

1)E.g. Done, J.L., Rev. Sci. Instrum. 51 (1980), 317. Hartfuss, H.J., et al., Rev. Sci. Instrum. 65 (1994), 2284.