Seminar

Institute for Plasma Research

Title : Design and developmental aspect of high power ultra-wideband 3dB hybrid coupler for the ICRF heating in tokamak

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Time : 10.00 AM

Venue : Seminar Hall, IPR

Abstract:

The ICRH system of tokamak utilizes continuous wave rf power above 100kW and up to few MW at many frequencies in the range of 20 to 120MHz. The frequency depends upon geometry of the tokamak, desired plasma parameters and toroidal magnetic field at the centre of tokamak vessel. The ICRF generators are used to feed the rf power to the plasma with ICRH antennae. These should ideally be operated into matched load. The antennae load impedance not only depends on the antennae geometry but also on the boundary conditions of plasma which offers continuously variable mismatch. Due to the mismatched loading, significant amount of the rf power is reflected back and causes inconsistent performance or damage to the generator. The conventional matching systems operate on slower time scale and may fails to cope with the faster variation of plasma impedance. The 3dB hybrid coupler is used to provide the essential protection to the rf generator from the reflected power. The 3dB hybrid coupler can also be used as power combiner, divider and to protect the rf source by coupling of reflected power to the isolated port.

The 3dB hybrid coupler is a 4-port device in which input of rf power at port-1 is equally divided into the port-2 and port-3 with a phase difference of 90^0, whereas port-4 is remain isolated. In case, reflected powers due to mismatched load at port-2 and port-3 that are connected to antennae are equal in magnitude and phase, the total reflected power goes to port-4. Thus, rf generator is protected from reflected power. The high power hybrid couplers that are developed and presently available for these purposes are rated for narrow frequency band and does not cover full operational frequency range of the proposed ICRH experiments. Many 3dB hybrid couplers, at various discrete frequencies are required in the ICRF range. Therefore, hybrid coupler and the coupling mechanism need to be altered with change of operating frequency. The development of broadband 3dB hybrid coupler in the high power rating is not yet reported. Therefore, the need is felt and the author is motivated to intensify his research interest in this domain. The work has been completed in following steps:

1. A strip line based prototype 3dB tandem hybrid coupler of rating, 91.2±15MHz and 2.5 kW has been developed which creates the process for indigenous development at any frequency in the range of HF and VHF range.
2. Design of broadband multi-element coupled lines for high power handling capability is successfully completed.
3. A 200kW and 38-116MHz, ultra-wideband novel 3dB hybrid coupler is designed, developed, fabricated and tested for the desired performance.
4. Design and fabrication drawings of the 1.5MW ultra-wideband 3dB hybrid coupler for the ICRF heating in fusion grade reactor are completed.