A.2: Deployment of 20 kW and 30 kW Solid State RF Amplifiers for Indus-2

Two of the four RF stations of Indus-2 Synchrotron Radiation Source are now running with solid state amplifiers having 20 kW and 30 kW of RF power capacity. These amplifiers were developed by Radio Frequency Systems Division (RFSD) and deployed for Indus-2 operation. With the support of these solid state RF amplifiers, Indus-2 operation has been enhanced and 100 mA of beam current at designed energy of 2.5 GeV has been achieved.

The solid state high power amplifiers offer many advantages like extreme modularity, high reliability, graceful degradation, no high voltage requirement, and low maintenance. Also increasing use of solid state amplifiers is continually contributing towards improvement in performance and reduction in cost. In view of the above, technology development programme was taken up by RFSD to build solid state amplifiers at 505.8 MHz for use in Indus-2 synchrotron radiation source. The solid state RF amplifiers capable of delivering 20 kW and 30 kW RF power have been designed, developed and successfully integrated with RF cavities of Indus-2. The scheme to build high power RF amplifiers involve development of 320 W basic RF amplifier modules employing MOSFET device and adding many such modules using appropriate combiners. Four numbers of high power amplifiers units capable of delivering 8 kW at 505.8 MHz have been realized by combining power from many basic amplifier modules. Two such units were combined to achieve 15 kW. The RF power from two numbers of 15 kW RF amplifiers was again combined using two way high power combiner to get 30 kW of RF power (Fig. A.2.1.). To get maximum combined output power, phase balancing of individual 8 kW unit was done using variable phase shifters. This resulted in reduced reflected power at amplifier modules, increased overall efficiency and will also improve the long term performance of the solid state amplifiers. In-house technology development of required RF components like high power amplifier modules, 2-way power dividers/combiners, 16-way power dividers/combiners, variable phase shifters, low and high power directional couplers, and RF dummy loads was carried out. This amplifier was integrated with RF cavity No. 3 of Indus-2.

Fig. A.2.1: 30kW Solid state amplifier

Further improvement in the design of basic RF power module was carried out to increase the output power to 400 W. Using these modules power from RF amplifies unit was enhanced to 10 kW. Combining power from two such units output power of 20 kW was obtained. This 20 kW amplifier was integrated with RF cavity No. 1 of Indus-2. With the addition of these 30 kW and 20 kW high power amplifiers and optimization of RF system operating parameters, beam energy could be increased up to 2.5 GeV at 100mA. These solid state RF amplifiers have been operated in round the clock shift mode. The experience gained in development and successful deployment of these amplifiers will be useful for the development of high power solid state amplifiers for Spallation neutron source (SNS) and accelerator driven systems (ADS).

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