ACCELERATOR PROGRAM

A.1 Solid state RF amplifier development

Solid-state RF amplifiers are finding increasing use in accelerator field as driver amplifiers. These amplifiers are also used to drive the super conducting cavity structures. Indus-2 RF system employs four modules of 64KW Klystron tube based power amplifiers. Four numbers of solid-state amplifiers operating at 505MHz have been developed to drive the klystron power amplifiers. Each of these solid-state amplifiers is capable of providing 10 Watt of RF power with a gain of 40dB. Additional four amplifiers have been developed as auxiliary amplifier for compensating line loss in RF system. Each amplifier consists of cascaded stages of 166C MOSFETs. Matching circuit of each stage encompasses transmission line transformer and micro strip line based network. Distributed negative feedback is employed to make amplifier stable for full range of VSWR. For reducing downtime, hot swappable redundant configuration has been used. For safety and precaution like over voltage, thermal overload etc. bias circuit has been designed using bias regulator. Hot swapping, gain control, transfer of amplifier status over serial bus and other supervisory functions are executed by an FPGA based card.

Fig. L.1.1 RF amplifier

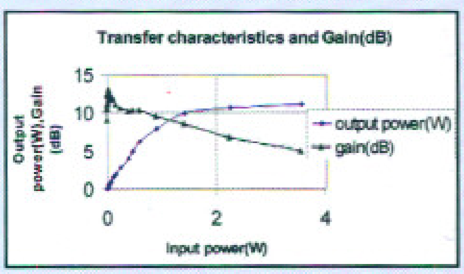

Fig.L.1.2 Gain and out put power curve

Complete amplifier has been housed in 19" form factor EMI/EMC sub rack (fig.L.1.1). Measured transfer characteristics for gain and power is shown in the fig. L.1.2.

Development of SSA at 350 and 700MHz for use in Proton Accelerators has been taken up. Prototype amplifiers and combiners operating at these frequencies have been developed.

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A.2 Test set-up for measurement of conducted EMI

The high-frequency switching power conversion systems are known to be more efficient, lightweight and compact than their line frequency and linear counterparts. However, the former generates electromagnetic interference (EMI). The EMI, operates in two forms, radiated and conducted, and may disturb the normal functioning of other equipments in the vicinity. The conducted noise is usually several orders of magnitude higher than the radiated noise in the free space. The conducted noise, categorized as differential and common mode noise, is reduced by EMI filters. The metal cabinets normally reduce the radiated noise.

With increasing use of high-frequency switching power converters for accelerator and laser systems, it is imperative to limit the electromagnetic pollution to facilitate system integration. A set-up for the measurement of conducted EMI has been developed. The following normative documents containing provisions of concerned international standards are followed:

1. CISPR 11: 1997, Industrial, Scientific and Medical (ISM) radio frequency equipment – Electromagnetic disturbance characteristics – Limits and methods of measurements.
2. CISPR 16-1: 1997, Specifications for radio disturbance and immunity measuring apparatus and methods, Part – 1: Radio disturbance and immunity measuring apparatus.
3. CISPR 16-2: 1996, Specifications for radio disturbance and immunity measuring apparatus and methods, Part – 2: Methods of measurement of disturbance and immunity.

Fig.A.2.1 shows the photograph of the test set-up. The equipment under test (EUT), is placed on a 12 X 8 feet, 1.6mm thick ground plane fabricated with aluminum sheets on wooden insulating supports of height 10cm. The conducted noise is measured in terms of mains disturbance voltage across a 50Ω termination impedance of an artificial mains network (AMN) or line impedance stabilization network (LISN) through which the AC mains power to EUT is provided.