A.11: Development of 1.3 GHz solid state RF power source for testing SCRF cavities in RRCAT Vertical Test Stand (VTS)

After the fabrication of the SCRF cavities, the cavities are required to be tested for checking their endurance at high field gradient. This is done in the Vertical Test Stand where the cavities are fed with RF in cryogenic environment. 1.3 GHz SCRF cavities require ~250 W of CW power to achieve gradient in excess of 35 MV/m. Keeping in view the maximum field gradient to be achieved in the cavities and the margins for other losses, a 1.3 GHz, 500 W CW solid state power amplifier system has been designed and developed indigenously. The amplifier consists of a water cooled high power stage driven by an air-cooled 50 W amplifier. The high power stage is realised with two dual 250 W LDMOS transistors @1.3 GHz where the output power is combined using two stage quadrature combiners. The quadrature combiners have been developed using thick 2.2 dielectric constant microwave low loss laminates. Table A.1.1 shows the measured performance of the combiners. The complete amplifier assembled in its rack with power supplies, and control and protection systems is shown in the Fig. A.11.1. The two stage 4:1 quadrature power combiner is shown on bottom side of the power amplifier box inside.

Table A.11.1 : Measured performance of 4:1 Hybrid power combiner

Parameter	Value
Isolation	30 dB (min)
Amplitude Imbalance	±0.2 dB
Phase Imbalance	±5°
Insertion loss	0.25 dB

The input matching network is fabricated on 4.5 dielectric constant low loss microwave substrate whereas the output matching network is fabricated with 2.2 dielectric constant low loss microwave substrates. Amplifier was tuned to obtain the desired bandwidth of 1270 MHz - 1310 MHz and efficiency of around 50%. The amplifier has been tested up to 600 W pulsed output power and 430 W CW power @1.3 GHz. The power is sufficient enough for characterization of a 5 cell Nb SCRF cavity. The amplifier response was obtained by using a LabVIEW based data acquisition and control system, which has been developed for automatic characterization of the amplifier characteristics. As per our design the output of the power is easily achievable over 500 W CW with increased cooling. Fig. A.11.2 shows the output power versus input power response of the amplifier @1.3 GHz. Fig. A.11.3 shows the CW frequency response of the amplifier. Fig. A.11.4 shows output power up to 600 W in pulsed mode.

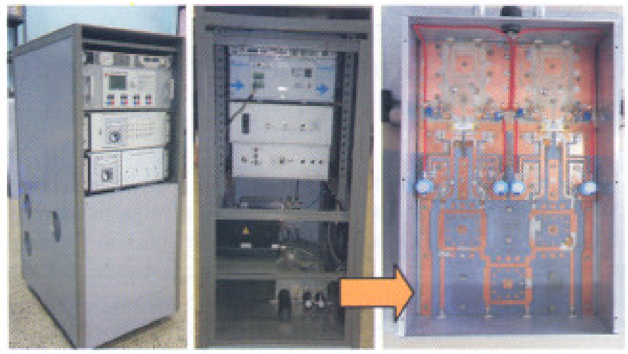

Fig A.11.1: High Power RF source for VTS. Photo from left shows the front view of complete chassis, the rear view with high power amplifier on bottom side and the inside view of the amplifier with power divider on top side and combiner on bottom side of the box.

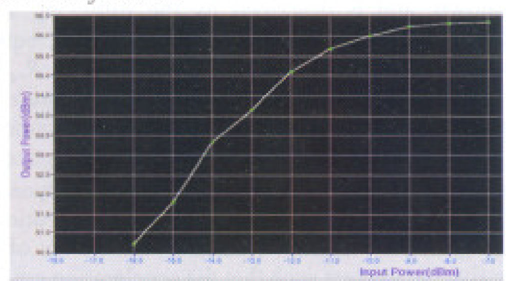

Fig. A.11.2 : Output Power vs Input Power curve for amplifier @ 1.3 GHz in CW mode.

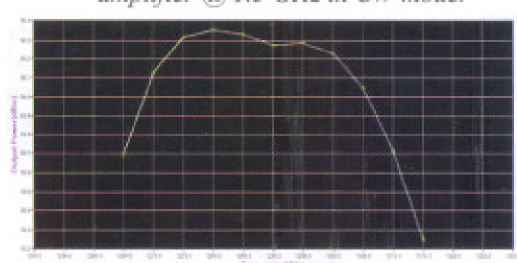

Fig. A.11.3: Output Power vs frequency curve for amplifier in CW mode.

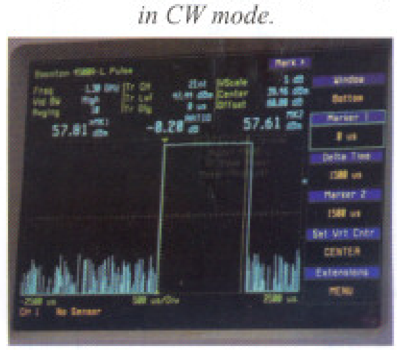

Fig. A.11.4 : Output Power @600 W peak pulsed mode.

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