

A.8: Development of a compact 476 MHz, 1 kW solid state pulse power amplifier

PHPM Section has developed a 1 kW, 20 μ s solid state amplifier for sub-harmonic pre-buncher of CUTE FEL and IR FEL LINAC. The amplifier has been developed using high ruggedness, 50 V LDMOS transistor. Although the LDMOS transistor used here is meant for push-pull operation, the same has been used in single ended configuration with matching circuit developed on a thin (25 mils) high dielectric constant (9.7) laminate which has resulted in an extremely small amplifier module (10 cm x 8 cm) as shown in Fig A.8.1.

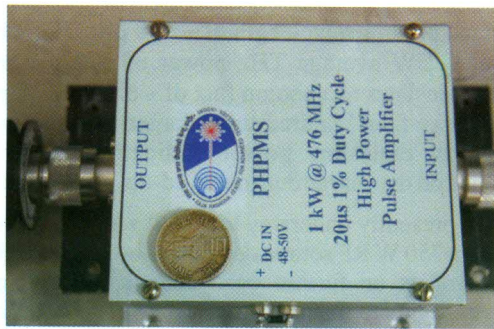


Fig A.8.1: 476 MHz, 1 kW compact amplifier with a ₹ 5 coin placed on top for size comparison.

The major specifications of the 1 kW amplifier module are listed below in Table A.8.1. The amplifier provides a saturated power of 1 kW and a P1dB power of 910 W while operating at 476 MHz, 50 V drain voltage and 100 mA bias current. The amplifier has been tested up to a maximum saturated power of 60.68 dBm (1170 W) with increase in drain voltage to 55 V, see Fig A.8.3.

Table A.8.1: Major specifications of the 1 kW solid state amplifier module

Specification	Value	Unit
P1dB @50V	59.5	dBm
	910	W
Psat @50V	60	dBm
	1000	W
P1dB @55V	60.17	dBm
	1040	W
Psat @55V	60.68	dBm
	1170	W
Gain	18	dB
Pulse Width	20	μ s
P.R.R.	500	Hz
Duty Cycle	1	%
Bandwidth (0.3 dB)	± 4	MHz

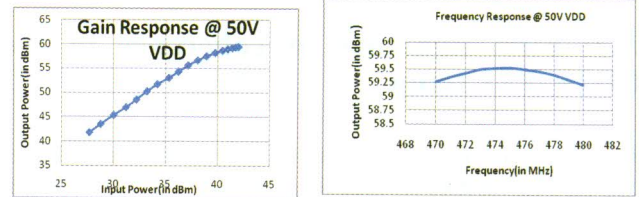


Fig A.8.2: Images shows gain and frequency response of amplifier while operating at P1dB @ 50 V

Since the power requirement for the LINAC is only 500 W and the LDMOS transistor used for development of amplifier has very high VSWR tolerance the amplifier can be operated without a circulator. The high power stage is driven by a commercially available low cost, high gain 20 W broadband amplifier. The two stage amplifier system provides a total gain in excess of 60 dB. A high isolation RF switch is used at the input of driver amplifier to provide pulse modulation allowing user to use a CW source for RF Input. The rise time/ fall time of the pulse has been observed to be less than 20 ns. The amplifier provides a 0.3 dB bandwidth of ± 4 MHz which is much higher than requirement of ± 850 kHz.

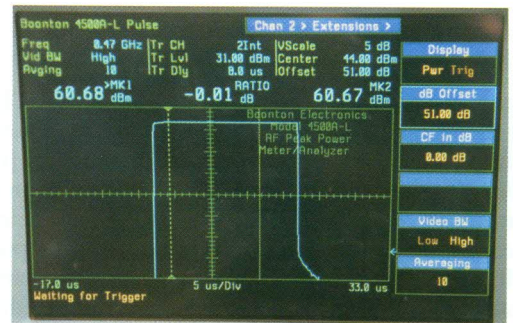


Fig A.8.3: Image shows the saturated output of amplifier operating at 20 μ s, 500Hz @55 V

The 1 kW amplifier along with its driver, RF switch and control system has been assembled in a 3U half 19 inch chassis see Fig A.8.4. The entire amplifier system was in house developed including the RF PCB which was fabricated using PCB prototyping machine.



Fig. A.8.4: 1 kW amplifier system assembled inside the half 19 inch 3U chassis.

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