1KW S-BAND RF SOLID STATE AMPLIFIER FOR BEPC LINAC MICROWAVE DRIVER SYSTEM

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Abstract

This paper presents the development of a 1KW S-Band RF Solid State Amplifier (SSA) for BEPC Linac Klystron. 1KW peak power with a pulse width of 2—10μsec under low voltage operation is achieved by combining 8 160W high power Solid State Amplifier using a low-loss (0.2dB) radial combiner. Other key performance parameters are: RF phase drift during pulse ≤±0.6 degree, RF rise time/fall time is 88nS/40nS,RF pulse flatness is 0.7%, and RF power stability is 0.1dB.

1 INTRODUCTION

In BEPC Linac, a microwave driving signal of 1KW peak power, 4μsec pulse width supplies the first klystron. Part of output power of the first klystron drive other 15 Klystron amplifiers. Old RF driver system which uses TWT amplifiers has some defects, for example unsteady, high failure rate, short life time and not very well performance. To overcome the limitations, we development new RF driver -- 1KW S-Band RF Solid State Amplifier instead of old type.

Compared SSA and TWT amplifier, SSA has many obvious advantages which make it an ideal equipment for BEPC Linac Microwave Driver System. First, SSA has high performance and high reliability. Performance parameters were critical measured and mentioned above in the abstract section. Second, SSA has low voltage operation for safety and high efficiency, and long life time is estimated. Final, SSA has many features for maintainability and availability have been obtained as follows: Front panel input/output RF power display & adjustment, Front panel pulse width control, Fault monitoring display panel, Power supply excess current & voltage protection function.

2 DESIGN

A block diagram of the 1KW S-band RF SSA is shown in Figure 1. The overall gain is more than 50dB which is achieved by three stages of amplification. The outputs of the first and second stage amplifier are 3W and 20W, respectively. The output stage consists of 2 580W amplifiers module which are combined.

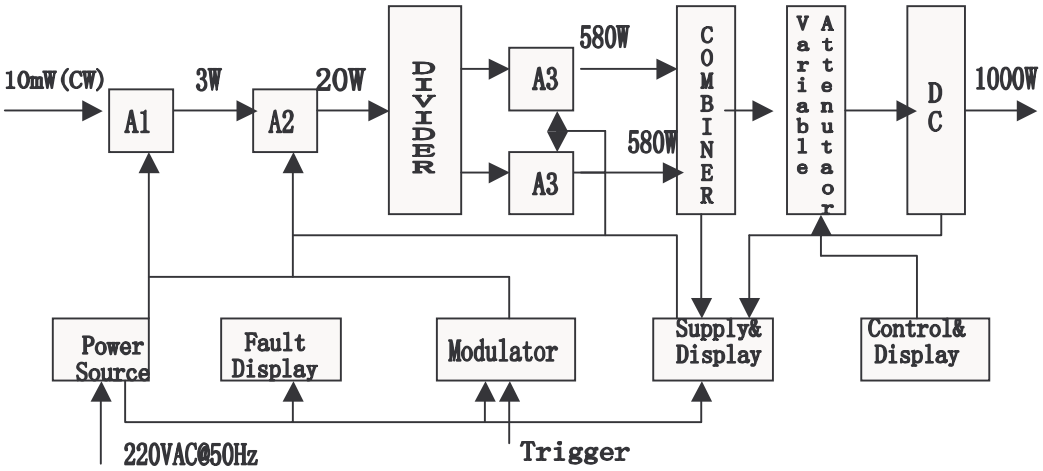

Fig. 1 Block Diagram 1KW Solid State Amplifier

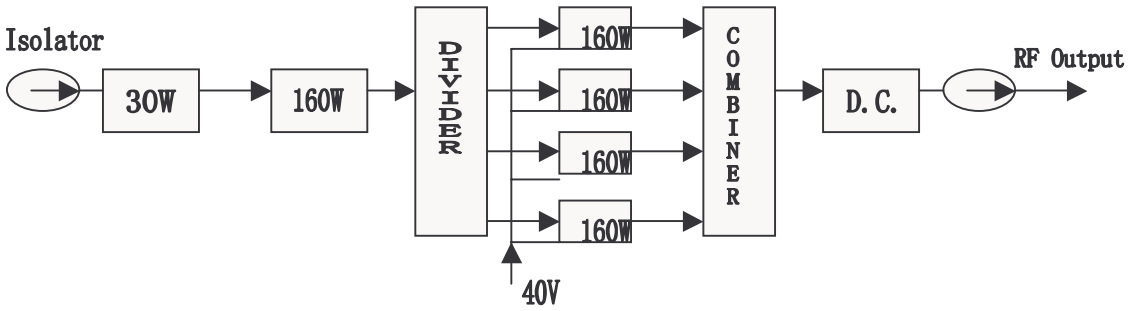

Fig. 2 Block Diagram of 580W High Power Amplifier

The heart of the SSA is the 580W amplifier module. Its block diagram is shown in Figure 2. The architecture for the 580W amplifier consists of three stages of amplification that amplifiers a 4W input signal to a 580W output signal. The first stage is 30W power transistor. The second stage transistor is an 160W device followed by a third stage of four paralleled 160W transistors as seen in figure 2. A four way power divider/combiner consisting of 2 levels of two branchline micro-strip couplers is used to excite and collect power from the four parallel output stage transistors.

A photograph of the 580W amplifier module is shown in Figure 3. It consists of a low cost network that is fabricated in a high dielectric constant, low loss microstrip package. It contains input and output isolators that along with the divider/combiner allow for "hot replacement" of amplifier.

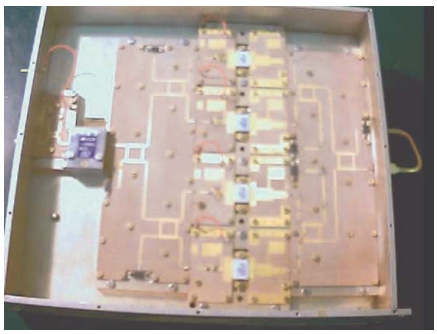

Figure 3: Photograph of 580W High Power Amplifier

2:1 Power divider/combiner is a center fed, radial microstrip structure that yields very low loss, low VSWR, and excellent phase and amplitude balance. The insertion loss for both the divider and combiner was measured at <0.3dB, amplitude and phase variation were 0.1dB and 5° respectively. VSWR was < 1.3.

3 EXPERIMENTAL RESULTS

A photograph of outline of the 1KW SSA is shown in figure 4. Performance parameters were critical measured. The ideal measuring result is obtained and detail presented in table 1. A Copy of pulse waveform of the 1KW SSA output power is shown in figure 5.

Figure 4: Photograph of The SSA View

Table 1: Designed and Measured parameters of 1KW Solid State Amplifier

Parameters	Unit	Designed	Measured
Frequency	MHz	2856	2856
Bandwidth	MHz	± 2.5	2853--2868
PulseWidth	μSEC	2.0 to 10	2.0 to 10
PPS		1 to 100	1 to 100
Trigger	1μsec	±5V	±5V
Power In	Watts	0.5	0.006--0.01
Power Out	Watts	1000	1030
RF Gain	dB	≥34	≥50
Phase Drift	Deg max.	< 1	0.6
Rise/Fall Time	μSEC	<0.1/0.1	0.088/0.04
RF Pulse Flatness	maximum	0.5%	0.69%
RF Power Stability	dB	± 0.2	±0.1dB

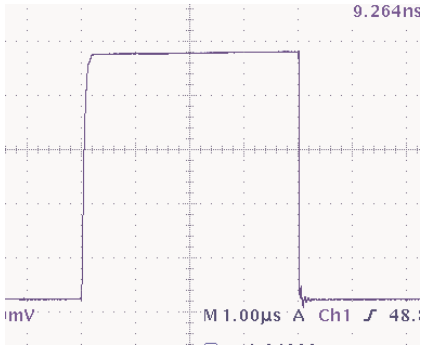

Figure 5: Output Waveform of the 1KW SSA Pulse Power

4 CONCLUSIONS

The Design, development and performance of a 1KW S-Band Solid-State Amplifier has been presented. This equipment achieves high reliability, enhanced performance which are required for BEPC Linac microwave driver system, and upgrades of existing system using TWT amplifier. This equipment serves BEPC Linac from April of this year on, its operating stats is good, and no problem occurred.

REFERENCES

[1] MICHAEL HANCZOR and MAHESH KUMAR “12KW S-BAND SOLID STATE TRANSMITTER FOR MODERN RADAR SYSTEMS”,1993 IEEE