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DEVELOPMENT OF HIGH DUTY PULSE POWER SUPPLY FOR S-BAND KLYSTRON

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Abstract

As industrial equipments , we have developed the line-type pulse modulator for S-Band klystron with 700pps maximum repetition rate and 205kW average electric power loss. And then PFN charging period is about 500uS , charging peak current is 50A and average current is 16A. Especially,we describes an issue on the design and test results in this paper.

Introduction

This paper describes the outline and test results of Klystron Pulse Modulator which we have developed as S-Band rf power supply of the industrial equipments in order to operate steadily with high duty (see Table 1).

Table 1
Parameter of power supply

Klystron beam voltage [kV]	140
Klystron beam current [A]	108
Gun voltage [kV]	150 CONSTANT
Gun current [A]	0.7 CONSTANT
Pulse width [uS] flat top	14
-3dB	19.2
Pulse stability and flatness [%]	±0.7
Pulse rise time [uS]	2.5
Pulse repetition [ppS]	60-700

Composition

Fig.1 shows the block diagram of klystron modulator and Fig.2 indicate the Klystron mount. And then Photo.4 shows the thyratron unit.

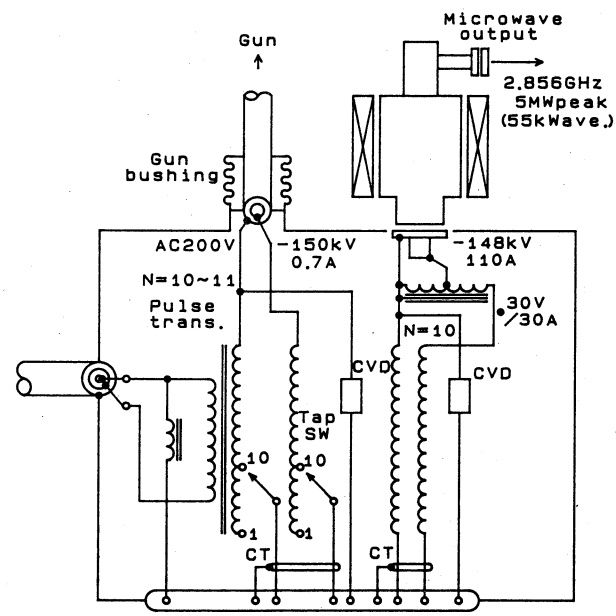


Fig.2 Klystron mount

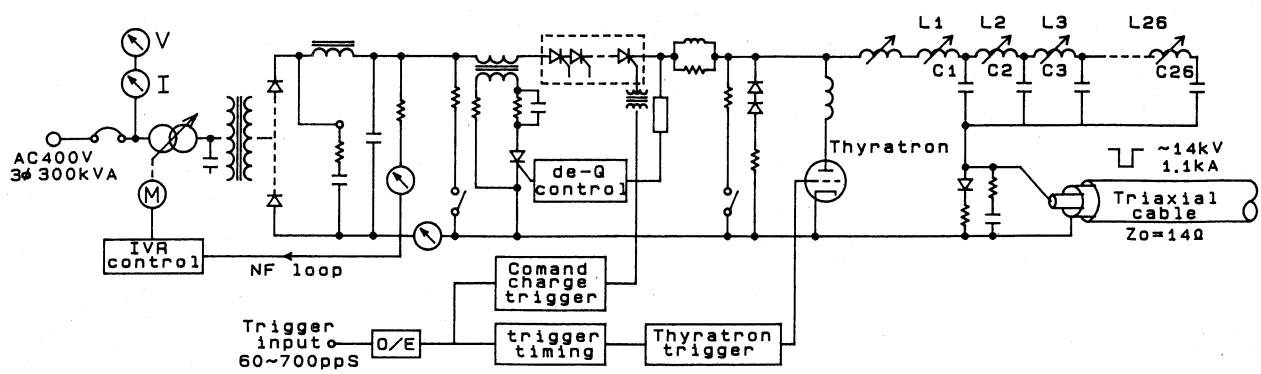


Fig.1 Block diagram of this klystron modulator

Design point

1. Selection of switching device:

Thyratron is used in general for the switch of high voltage and high current . As to the thyratron as satisfying to Table 2 , we have chose the big tube, CX-1720MN which has a effective result after discussion with EEV(Maker of thyratron).

Table 2
Parameter for operating switching device

		Max.rating
PFN charging voltage [KV]	33	50
PFN peak current [A]	1080	5000
PFN average current [A]	14.4	25
Recovery time [uS]	———	25

2. Use of command charging system

One of specifications in thyratron , there is problem of recovery time . In order to recover thyratron , it should be kept over 25uS at condition of Anode voltage below 100V after stopping thyratron. Therefore, thyristor is used for the switch in order to turn on or turn off the charging voltage . Thyratron surely was recovered by trigger timing as Fig.3.

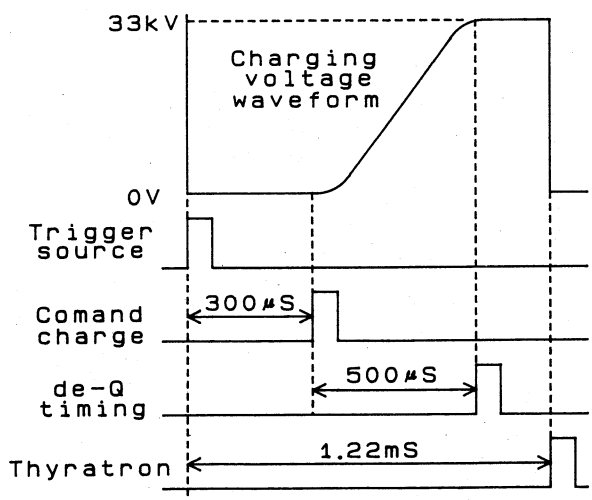


Fig.3 Block diagram of trigger timing

3. Selection of SCR thyristor for hold off of command charging system

The SCR thyristor is required to satisfy Table 3 , and so there are two important an issue . One is the research for the SCR break down voltage (3-1) . The other is the SCR gate trigger system (3-2).

Table 3
Parameter of thyristor

PFN charging voltage [KV]		33
PFN charging		
Peak current	[A]	50
RMS current	[A]	30
Average current	[A]	16

3-1. Research for the SCR break down voltage

In case of high speed thyristor , the peak repetitious opposite voltage is about 2500V at the maximum,if required as Table 3,it is better to use in series /30pcs according to the device of dilating break down voltage, and then we use 6pcs per 1 stack , ie using 5 stack. And also using high speed thyristor(turn off time <40uS) was adopted in order to keep the precision of charging voltage.

3-2. SCR gate trigger system

It is required to put the reliable gate trigger in order to operate surely all of SCR/30pcs at the same time without failure , and then it is operate by the insulated pulse transformer which is able to endure 40kV . Fig.4 shows the configuration of the insulated pulse transformer for SCR gate trigger unit.

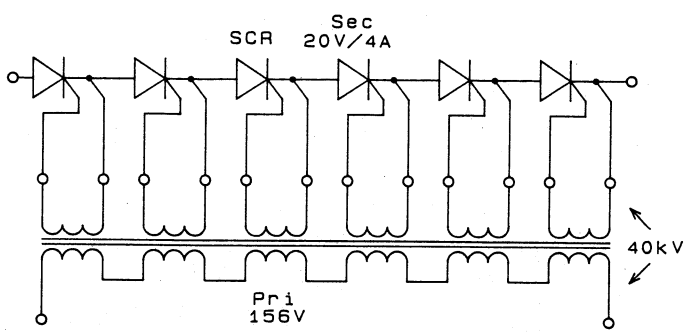


Fig.4 Configuration of the insulated pulse transformer for SCR gate trigger unit

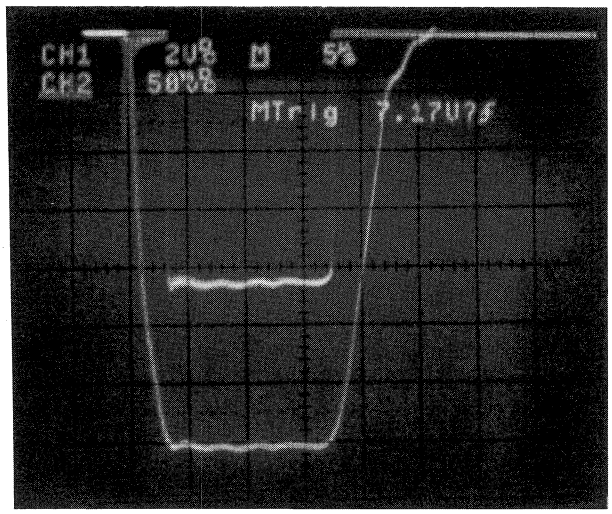
4. Treatment for noise

With regard to noise treatment , we bind the sheet copper (width 365mm , thickness 0.1mm)to bottom of enclosure and between enclosure and klystron . Then we have succeeded to operate surely this equipment without any trouble .

Test results

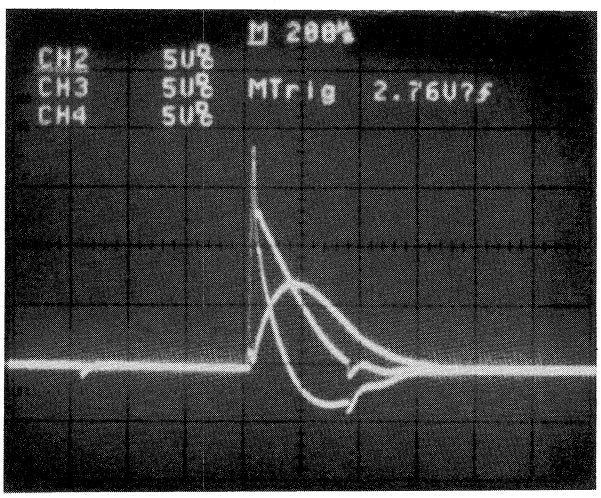
Picture 1 through 3 shows the wave form at each position for this line-type pulse modulator , and then these wave form have indicated really steady operation without disturbance due to noise.

Photo.1
Up rf output power 5.5MWpeak
Down Klystron beam voltage 140kVpeak



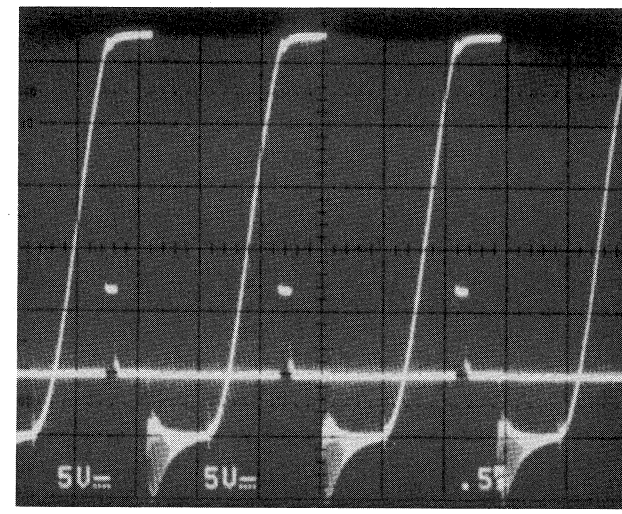
Up 50mV/div 5uS/div
Down 20kV/div 5uS/div

Photo.2
Up de-Q R current 300Apeak
Middle de-Q current 800Apeak
down de-Q C current 800Apeak



Up/Middle/Down 200A/div 200uS/div

Photo.3
Up Charging voltage 33kV
Down de-Q timing of trigger



Up 5kV/div 500uS/div
Down 5V/div 500uS/div

Conclusion

We have succeeded to develop the pulse power supply at the first achievement in the world which has gained pulse width 14uS and the pulse repetition 700pps.

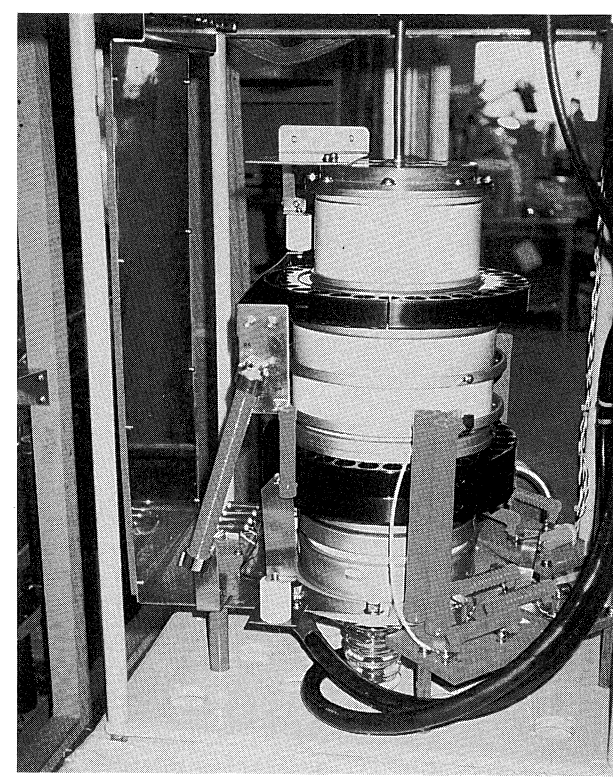


Photo.4 Thyratron unit for forced oil cooling