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R.F. Predriver Gain and Power Measurements

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Introduction

Recently it became apparent that the RF system predrivers were not delivering ample driving power for the power amplifiers. The first inkling of this came when it was found that the AGC would run into the clamp when operating on one predriver but not the other. As beam intensities increased further, both units were running into the clamp level as noted by obvious departures of the gap voltage sum signal, from the AGC program. Finally, the first stage plate currents were running 30% higher than their original value for rated output, while plate currents of the succeeding stages only flickered.

This note discusses the results of a brief exploratory study to make gain and power measurements, and in turn, troubleshoot and restore both predrivers to their original designed operating state.

Initial Measurements

The outputs of both predrivers were connected to water cooled coaxial load resistors. The inputs were driven at 2.0 volts peak to peak RF at 4.5 MHZ. The AGC voltage was increased until maximum output power was obtained. The measured maximum output powers were 6.7 kw for predriver no. 1 and 2.5 kw for predriver no. 2. They were originally designed for a rated power output of 30 kw.

Troubleshooting

A graphic description of troubleshooting details is not important, but a list of problems and adjustments required by either or both predrivers, to recover a major part of their original capabilities is as follows:

1. Increase input drive signal level.
2. Increase output stage filament voltage.
3. Return quiescent values to normal settings.
4. Correct unbalances in pushpull circuitry.
5. Replace badly mismatched pairs of tubes.

Upon completion of the above, immediate improvements were noted. The output signal levels at the dummy loads were more closely balanced. The cathode currents of pushpull pairs were nearly identical. Finally, the cathode currents of the first stages were reduced to about half of values that they have been running in recent months.

The proper quiescent cathode currents and typical values at the 15 kw level are tabulated below.

Quiescent cathode currents

1st Stage	50 to 60 ma. for two tubes
2nd Stage	100 ma. per tube
3rd Stage	0.8 ampere per tube
4th Stage	2.0 amperes per tube

Cathode currents at the 15 kw level*

1st Stage	100 to 110 ma for two tubes
2nd Stage	110 to 120 ma per tube
3rd Stage	1.1 to 1.2 amperes per tube
4th Stage	2.0 to 2.1 amperes per tube

*Input drive voltage 3.0 volts peak to peak. Outputs terminated by 50 ohm dummy loads.

Output Power and Voltage Gain Measurements

The output power of both predrivers was measured by dummy load calorimeter measurements and also computed from output voltage measurements. There were variations between the two methods, as high as 20 percent. Considering the age of the high voltage scope probes used, there was more confidence in the calorimeter method.

The following is a tabulation of power output and voltage gain for both predrivers.

Freq.	PDR no.1		PDR no.2	
(MHZ)	P out (kw)	V gain (db)	P out (kw)	V gain (db)
2.5	15.2	55.8	17.2	55.6
2.7	14.2	56.1	16.5	54.5
2.9	13.9	55.8	17.9	54.5
3.1	13.9	55.4	16.2	54.9
3.3	14.2	55.6	16.5	54.5
3.5	13.9	55.7	15.8	54.3
3.7	13.9	55.6	15.2	54.2
3.9	12.9	55.2	14.5	53.75
4.1	12.9	55.3	13.2	53.3
4.3	12.5	55.2	11.2	52.8
4.5	12.5	55.3	11.2	52.7

The predrivers were originally designed for 30 kw output into a pair of 50 ohm loads. Original test data, dating back to 1969, indicates that both units were tested at the 20 kw level from 1.4 to 4.5 MHZ. The above data shows that neither unit is able to deliver 20 kw at this time.

All bias levels and grid drive signals have been measured and are set at their design values. There have been no circuit modifications. Also, the loss of output power is common to both units and is not merely a malfunction. It can be concluded that the output tubes (which are new) have a lower transconductance than the originals.

Based on the nominal power gain of the high power output amplifiers and drivers (10 db), 12 kw output from the predrivers is sufficient for driving all the power amplifiers to their full 120 kw output.

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