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TECHNICAL REPORT ON IMPROVED VERSION OF 97MHz, 200 WATTS RF AMPLIFIER

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ABSTRACT

We are reporting the latest version of 97MHz, 200 watts version of RF amplifier designed and developed at NSC for powering LINAC resonators. The assembly and test procedures, schematic diagrams, PCB layout, bill of materials, SMPS specifications and test plots are attached in this report. This report supersedes Ref: NSC/TR/BPA/97/157.

FEATURES:

1. Dual amplifiers in a single 3U 19" cabinet for compactness
2. Single SMPS module as DC source for easy maintenance
3. Reproducible Low cost RF power sensor * and
4. Commercial Aluminium Extrusion as heat sink for easy machining, low cost, less complicated water cooling copper tube pipe bonding.

The earlier versions of this amplifiers were made using bulky conventional regulated power supply with series pass transistor bank not having over voltage and over current protections except for SLOW TURN-ON. The usual problems encountered in this amplifiers were related to regulated supply and causing severe reliability problems like OVER VOLTAGE at the output of the supply. Since, the modular SMPS units upto 1500w rating are now available in the local market, we have adopted SMPS for powering this unit.

Since the Aluminium heatsink of required size were not readily available for this purpose, the copper flat was machined and used as heatsink in earlier versions. The preparation of heatsink using copper flat is not easy, due to its softness. Whereas, the cheaper Aluminium heatsink extrusions of required size are now available in the local market.

The low cost and easily reproducible VHF power sensor using directional coupling technique with good isolation characteristics is adopted for indicating forward and reflected powers on the front panel. This includes, analog meters with custom scaling for convenient measurement. The test set-up for the gain, spectrum analysis and phase characteristics along with the plots for individual amplifiers is shown here.

* see separate technical report

PRINCIPLE OF OPERATIONS

POWER AMPLIFIER:

The power amplifier is designed to output minimum of 200 watts (+53dBm) at 97 MHz across 50 ohm load with an input power of 0 dBm. The desired power level is achieved using three stages power amplification.

PRE-DRIVER:

The CATV amplifier module CA2832C (+28V, 500mA) is used as wideband pre-driver. It is capable of outputting 1.6 watts, 0-200MHz, with 35 dB gain. The overall amplifier is having high gain, a attenuator pad of 17dB is added at the input of this pre-driver.

DRIVER AMPLIFIER:

A Push pull power amplifier (+15dB) using power MOSFET MRF 151G working as a power driver amplifier in class AB configuration. The idling current flow in each transistor is set to 0.5A each. Since, these devices are having very high gain at low frequencies, they tend to oscillate at low frequencies and get destroyed. A RC negative feedback network is connected between drain and gate leads for stable operation. The input and output impedences are matched with semirigid transmission line transformers with suitable impedance ratios. The gate to gate isolation is provided using powdered iron cores in the input transformers.

POWER AMPLIFIER:

The power amplifier section consists of two identical amplifiers, similar to driver amplifier circuit. The input power to these amplifiers are fed by splitting the power using SAGE WIRE-LINE power splitter (97MHz). The output power from these amplifiers are combined in a high power SAGE WIRE-LINE combiner (97 MHz). The isolated port of power splitter and combiner are terminated with heatsink mounted terminators.

The input and output impedences of amplifiers are matched with transmission line transformers using semi-rigid coaxial cable of suitable characteristic impedences. The trimming capacitors at the output of each amplifiers are added to match the amplfier output impedences and to maximize the power at the output.

The detail schematic diagram is attached along with assembly and test procedures. The test set up schematic is attached along with test plots. The gain distribution of the overall amplfier is shown in a attached sheet.

REFERENCES:

1. MOTOROLA RF DATA BOOK VOL I & II
2. RADIO FREQUENCY TRANSISTOR, PRINCIPLE AND PRACTICAL APPLICATIONS, by NORM DYE, HELGE GRANBERG.
M/s.MOTOROLA INC.,
3. DESIGNERS GUIDE TO WIRELINE AND WIREPAC, SAGE LABORATORIES Inc. 28/1/99

SPECIFICATIONS:

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| 1. | FREQUENCY OF OPERATION | : | 97MHz (BW 10MHz) |
| 2. | OUTPUT POWER | : | 200 WATTS min (+53dBm) |
| 3. | INPUT POWER | : | -3dBm (200 WATTS) |
| 4. | NUMBER OF CHANNELS | : | TWO |
| 5. | CONFIGURATION | : | CLASS AB |
| 6. | EFFICIENCY | : | BETTER THAN 60 % |
| 7. | HARMONIC CONTENTS | : | BETTER THAN 30dB down |
| 8. | DC SUPPLY | : | +30 VOLTS/ 30A (SMPS 3U) |
| 9. | PROTECTION (DEG) | : | OVER TEMPERATURE (50 OVER VOLTAGE, SHORT CIRCUIT |
| 10. | VSWR | : | WITHSTAND OPEN CIRCUIT 200 WATTS |
| 11. | SIZE | : | 19" X 5.25" X 18" (3U) |
| 12. | COOLING | : | WATER (25DEG) 2-4LT/MIN FORCED AIR COOLED |
| 13. | CONNECTORS | : | BNC (INPUT) N (OUTPUT) |
| 14. | POWER MEASUREMENT SENSOR RANGE | : : : | DIRECTIONAL COUPLER TYPE 0-250 WATTS ANALOG SCALE INDEPENDENT FORWARD AND REFLECTED POWER MEASUREMENTS |
| 15. | MAXIMUM INPUT POWER | : | 0 dBm |
| 16. | PHASE ROLLOVER | : | WITHIN 15 DEG. ACROSS SPECIFIED POWER LEVEL |

