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CENTER FOR SPACE RESEARCH

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

NASA SUNBLAZER GRANT NASr-249

Fifth Progress Report

July 1 to September 30, 1965

PR-5255-6

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

CENTER FOR SPACE RESEARCH

FIFTH QUARTERLY PROGRESS REPORT

For the Period

July 1 to September 30, 1965

on

NASA SUNBLAZER GRANT NASr-249

DSR Project 5255

To The

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Office of Grants and Research Contracts

Submitted by: J. V. Harrington
Principal Investigator

Introduction

During the current report period an optical rotation sensor and servo system has been tested and the RF electronics development has been primarily concerned with: 1. the redesign of the basic transmitter output power amplifier; 2. investigation of power dividing and combining circuits other than L section filters; 3. high power varactor tests; 4. packaging of the above circuits. Investigations also continue in antenna development.

1. Mechanical Design and Testing

The optical rotation sensor and servo system has been tested during this period. Major disturbing forces inherent in the system have been identified. A variable torque control modification was installed which enabled observation modes and operating techniques to be developed which produced dynamic results consistent with theory. There is a continuing effort to improve the stability of the system to provide a means of studying the effects of various libration damping devices.

Active preparations for vibration, shock, acceleration and thermal tests of the pre-prototype assembly are in progress, including the selection of test facilities, monitoring devices, the design and construction of special fixtures and machining of previously designed dummy electronics parts.

A tentative mechanical design of a series-stacked, phased dipole array has been achieved, and a search for a fabricating vendor is being made.

Acquisition of information and communications with authorities on space-stable thermal finishes is being organized to enhance the selection of the best available surface finishes for Sunblazer.

2. R.F. Electronics

The continuing program of high power transistor circuit evaluation has indicated a lower voltage transistor should be used in the next model of the Sunblazer transmitter. This unit (a type PT3611) is comparable in stability, performance and package configuration to the older higher voltage units. Typical 100 Mc device performance (at 25v collector supply voltage) is 60 watts RF power output and 75% collector efficiency at 5db gain. Since the output impedance of the power amplifier varies as the square of the collector voltage, a completely new amplifier design was developed along with the system of power combiners and dividers. The power divider that was realized is the lumped component equivalent of the microwave 3db hybrid. Typically this circuit performed satisfactorily over a 30% bandwidth with 20db isolation.

Another application of the hybrid circuit is in the area of high power VHF pulse compression. In this application, a hybrid is used as a directional coupler in the VHF analog of the travelling wave resonator. An experimental resonator was constructed, but high circuit losses limit its operation.

Because of the low impedances associated with the low voltage power amplifier, transmitter packaging has become more critical. This problem of realizing microminiature RF circuits depends on the availability of precise printed circuit inductors. As a partial solution to this problem a quantitative design procedure is being developed for the characterization of printed circuit RF components. This procedure will be of value not only for the power amplifier design but also in the crystal oscillator and frequency multiplier circuits used in the transmitter.

A ten-diode, frequency tripler circuit is being packaged using printed circuit techniques and miniature components. A breadboard version of this circuit using five frequency triplers, each with two diodes in parallel, was tested at the 800 watt level. Observed efficiency was 50% and higher power performance was limited by the available drive power. It is expected that this circuit will handle a kilowatt since each circuit was tested individually at the 200 watt level.

The basic transmitter crystal oscillator is being designed for maximum stability. The FET oscillator drive power is controlled by a feedback circuit. The temperature environment will be maintained by a thermal sensor and heater arrangement, which is incomplete at this time. A frequency measurement system, including a VLF standard has been put into operation in order to characterize the developmental oscillators.

3. Antenna Development

Several prototype spacecraft antennas are being investigated with respect to pattern and impedance matching. Modified electric and magnetic dipole configurations that are expected to yield several db of forward gain have been matched into 50 ohm cable. A foreshortened helix which uses the solar cell panel as a reflector is under study. Experimental models of these antennas have been constructed and pattern measurements will be taken during the next report interval.