F I N A L R E P O R T

on

D.S.S. Contract OSU4-0090.

"THE DEVELOPMENT and APPLICATION OF A FREQUENCY MODULATION SYSTEM FOR IONOSPHERIC SOUNDING USING PARTIAL Reflections"

Industry Canada
Library - Queen

Atmospheric Dynamics Group

Institute of Space & Atmospheric Studies

IC

LKC
P
91
.C654
G73
1975

University of Saskatchewan
Saskatoon, Saskatchewan

F I N A L R E P O R T

on

D.S.S. Contract OSU4-0090.

"THE DEVELOPMENT and APPLICATION OF A FREQUENCY MODULATION SYSTEM FOR IONOSPHERIC SOUNDING USING PARTIAL Reflections"

Industry Canada
Library - Queen
AOUT AUG 14 2012
Industrie Canada
Bibliothèque - Queen

between

Department of Communications
Communications Research Centre
Shirley Bay, Ottawa

and

University of Saskatchewan
Saskatoon, Sask.

COMMUNICATIONS CANADA
CRC
OCT 22 1984
LIBRARY – BIBLIOTHÈQUE

Report prepared by:

J. B. Gregory

J.B. Gregory,
Professor of Physics

Date: 27 March, 1975

P
91
C654
G13
1975

DD 4610375
DL 4610439

INDEX

COMMUNICATIONS CANADA
CRC
OCT 22 1984
LIBRARY – BIBLIOTHÈQUE

I. Introduction

1.1 Scope

This report covers work done on the development of an F.M. sounding system during 1974-75 fiscal year. A further report will be issued on completion of the total project, and may be anticipated within one year.

1.2 Application considerations

Some comments on the probable future of F.M. partial reflection sounding systems are desirable at this point, especially in respect to their use in the M.F. and lower H.F. bands. As was stated in the Contract Proposal (8 April, 1974), a reason for the attempted development of an F.M. system was the congestion which exists in the frequency spectrum around 2-5 MHz. Implicit in this comment was the belief that an F.M. transmission, which occupies a given frequency interval, Δf, for a time $\Delta t = \Delta f / \frac{df}{dt}$, would cause less interference than a pulse system, for which harmonics of the repetition rate, f_R, are present throughout a working band of width $\approx 2/\tau$, when τ is pulse length. However, information has been received (personal communication, Dr. W.J. Wright) that the subjective reaction of listeners who hear F.M. transmissions may be one of greater annoyance at the F.M. system than at the pulse system. This opinion may offer an explanation of the prohibition against transmissions by the F.M. system developed by the group at Max-Planck Institute for Aeronomy, DFR.

In respect to interference by pulse systems, it has been found that reaction of users of voice communication equipment is not serious provided the repetition rate is sub-audible, e.g. <5 Hz. A similar requirement may have to be applied to the sweep rate used for F.M. sounding, and tests of this point will be undertaken.

This possible limitation on F.M. transmissions will require to be kept in mind in respect to applications of the system. However, the ability of such a system to discriminate against received interference is not impaired.

II. Development of System

2.1 Elements of system

The system is conceived as comprising the following sections:

(a) Transmitting and receiving arrays

(b) Linear power amplifier

(c) Driver for (b)

(d) Control logic, including sweep generator

(e) Receiver

(f) Recording system

(g) Analysis procedures

These will be described in turn. In brief, progress has been made on all sections, except the receiver.

2.2 Transmitting and receiving arrays

The system will utilize an existing 16 dipole (4 × 4) array at Park Site for transmission on 2219 KHz.

The 4 × 4 array is currently in use for pulse transmissions: some improvements are under way in respect to the feeder system.

A 2 × 1 dipole receiving array is also available.

2.3 Linear power amplifier

A linear power amplifier of new broad-band solid state design has been built. This device is based on new TRW transistors and on ferrite-bead transformers. Nominal output power is 300W. Input power is supplied at 28V D.C.

Preliminary tests have shown that the device has adequate performance in the range 1.5 to 14 MHz, within which F.M. soundings are likely to be restricted. Power gain is ≈30 and efficiency is ≈40%, as expected. However, in the present design, the performance above 14 MHz starts to deteriorate. Further work on this amplifier is well warranted. Both thermal and R.F. performance can be improved.

A satisfactory mains-powered supply, at 0-50 volts, 0-25A, has been obtained and mounted to feed the linear power amplifier.

2.4 Driver and control logic

For reasons which will appear, these two sections are integrated.

The problem of generating an F.M. sweep of adequate linearity appeared to be important, at the outset of this work. As noted (Contract Proposal, p. 16), an inexpensive solution would be attempted, in the knowledge that a more expensive solution was available. In fact, the cost of frequency synthesisers has been decreasing in the past year. An interim solution, after some initial trials, has been the use of a medium cost frequency-sweep generator, (Type F34, Interstate Electronics Corporation) which appears to be marginally adequate for initial tests.

Since simple sweep generators may show some drift of the limits of frequency sweep, provision has been made in the control logic for checking the value of the limits, and inhibiting further amplification of the sweep, e.g. by the driver section, should the limits not be maintained. The frequency limits are in fact monitored.

In the current design, a sweep duration of 0.4 secs, over a band of 100 kHz, is established; and may be varied. The repetition rate is 2 sec^{-1}. The sweep is amplified in the driver unit to a power level of ≈10W.

Transmission is interrupted to permit reception, and the interruption rate is required to be not less than twice the highest beat frequency $f_b = (2R/c)(df/dt)$, where R is range. This function is also performed in the logic unit, at a rate of 1 KHz.

2.5 Receiver

Investigation of the requirements of a receiver, particularly in respect to distortion, has commenced. No construction has been done to date on this section.

2.6 Recording system

For initial tests, simple analogue recording of the (beat) frequency output of the receiver is proposed. A commercial Butterworth filter has been purchased to define the audio bandwidth. A commercial tape recorder has also been purchased.

2.7 Analysis

Each sweep of the beat frequency output will be analysed to determine the frequency components. This is possible by means of the Fast Fourier Transform. A subroutine for this purpose has been obtained, and has been incorporated in a program for a PDP-8 computer now available in the Institute of Space and Atmospheric Studies. To aid in loading this program, a high-speed paper tape reader has been purchased.

Further programming will be required to collate the results of the FFT analysis. This is expected not to present difficulties.

2.8 Summary

The foregoing work suggests that there are good prospects

of realizing the transmitting portion of an F.M. sounder, at relatively low cost. In terms of a program of development, the completion of a transmitter must precede the development of a receiver, in order that the latter can be adequately tested.

III. Personnel

Development of the system has been carried out by the following persons: Dr. D.G. Stephenson (Control Logic and overall supervision); Dr. J.B. Gregory (Linear Power Amplifier); Mr. O. Van Dongen (mechanical and electronic construction).

IV. Financial

The Business Office, University of Saskatchewan, has submitted claims for expenditure under the contract. At the end of the financial year and contract period (31 March 1975) it is expected that expenditure will be approximately $150.00 less than the contract amount of $9997.00.

LKC
P91 .C654 G73 1975
The development and
application of a frequency
modulation system for
ionospheric sounding using
partial reflections

of a

P
91
C654
G73
1975

DATE DUE
DATE DE RETOUR

LOWE-MARTIN No. 1137

CRC LIBRARY/BIBLIOTHEQUE CRC
P91.C654 G73 1975
Gregory, J. B.
INDUSTRY CANADA / INDUSTRIE CANADA
208119