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National Research Council of Canada, Radio and Electrical Engineering Division

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RADIO AND ELECTRICAL ENGINEERING DIVISION

CLASSIFIED PROGRESS REPORT NO. 2

(JULY - SEPTEMBER 1955)

OTTAWA

OCTOBER 1955

FOREWORD

This Classified Progress Report is intended to present a convenient quarterly summary of some of the classified aspects of the research and development program of this Division, for the information of the Services in Canada, the U.K., and the U.S.A., and of laboratories and other organizations in these countries which are engaged in work similar to ours and which have been supplying us with reciprocal information. Unclassified material, whether or not it is of Service interest, appears in our open publications and will not be covered here. The format of this report is such that the account of each project may be separated from the whole without loss of security grading. It is thought that this feature may be appreciated by some agencies, such as the Project Co-ordinating Center of the Department of National Defence, where they may prefer to file the individual sheets according to their own systems. It also permits us to issue the separate sheets to persons who may have an interest in certain selected projects but who do not require the remainder of the report.

A list of classified reports issued by the Division each quarter is included. There is no automatic distribution for these reports — the circulation list for each is determined by the nature and interest of the work described. Requests for copies of these reports, to be directed to the Document Control Office of this Division, will be given every consideration, subject to the security regulations. Recipients of these documents should note that Canadian approval is required for the release to other persons, organizations or governments of any classified information (including this Classified Progress Report) which may be issued by this Division.

CONTENTS

COUNTER MORTAR RADAR (AN/MPQ-501)

Reference: Army. DND Project B22-38-50-01

Period under review: July-September, 1955

PURPOSE OF EQUIPMENT

The primary role of this radar is the detection and location of mortars to ranges of at least 7000 meters. A parabolic extrapolation through two points, located on the bomb trajectory, is made by means of a computer. The mortar location is given as a map grid reference and contour. Range and bearing to the mortar are indicated also. Secondary roles include location of airburst, fall of shot, vehicles, and personnel.

GENERAL DESCRIPTION

The radar is built around an AFV603 armored personnel carrier in order to achieve a high degree of mobility and protection. The antenna, transmitter, and generator assemblies are mounted on the outside, while display and control equipment and part of the receiver are inside the body of the vehicle. No cabling or external stabilization of the vehicle is necessary on site; consequently the equipment may go into, or out of action with minimum delay.

STATUS

During 1953 and 1954 field trials were held, following which a contract for a prototype was let. NRC personnel have been actively associated with the engineers engaged in the production design. In addition, development on several items has continued at NRC. This is reported below.

Scanner

During the period under review CAL engineers have made considerable progress with the cast, toothless, Foster scanner design. On completion of the preliminary drawings, a meeting of NRC, Aluminum Company, and CAL engineers was held. Numerous points relating to design and casting techniques were discussed and clarified but it was generally agreed that no great difficulties would be encountered.

Receiver

A laboratory receiver using a hybrid mixer was assembled. This receiver, which has a bandwidth of 3.8 Mc/s, is being used for measurement of the overall

noise factors obtainable with reversed crystal pairs.

Computer

The computer is being packaged in four main assemblies following much the same distribution of functions as in the NRC model. The philosophy of design is that all gears operate in a dust-proof enclosure with removable sub-assemblies for the servo components.

The K Correction Servo, by means of which parabolic extrapolation is obtained, was redesigned completely and simplified considerably by using square-law potentiometers instead of linear types, since the former are now more readily available. Also, the time interval range has been increased from six to ten seconds.

Of the additional features which were requested by the user subsequent to the trials, the present design includes the following features: polar coordinates of weapon location, difference coordinates for correction of artillery fire on ground bursts, and improvement of angle-of-sight indication for combined visual and radar location of air bursts.

Automatic levelling was applied to the NRC model using sensitive mercury switches and a variable speed motor. Levelling accuracy of about two minutes of arc was obtained, but the time lag in the mercury bubble limited levelling speed to about two or three degrees per minute. Consideration is being given to use of a two-speed system.

Display

A study of available information on the effect of acceleration voltage on persistence of the P2 and P7 phosphors indicates that a higher voltage than presently being provided in the CAL design may be required in order to achieve usable persistence on the display tube. Discussions have not yet reached the agreement stage.

Rack Design and Placement

A rack layout was agreed upon after numerous tentative designs and considerable detailed discussion. The rack will be placed on the port side of the vehicle, as against the starboard side used in the NRC model, in order to improve access to the vehicle and to simplify maintenance of the hydraulic system.

Test Equipment

Consideration was given to test equipment requirements, and after comparison of various types of equipment a small commercially available oscilloscope of a military

type was found to be suitable. The R.F. test equipment which appears most suitable provides for performance monitoring and detailed measurements of receiver and transmitter parameters in a single instrument.

AREA MOVING TARGET IDENTIFICATION

Reference: Army, RCAF. No project number.

Period under review: July-September, 1955

The purpose of this investigation is to determine the performance to be expected from an Area MTI system when added to a radar set such as the AN/MPS-501B.

The basic equipment is the original laboratory model developed by the U.S. Army Signal Corps and the Radio Corporation of America. This equipment has been modified as follows:

1) Both the heater and high-voltage power supplies for the storage tubes have been replaced by stabilized units.

2) The range-gating and range-sweep chassis has been removed and a more stable phantastron-type sweep generator has been substituted.

3) An I.F. strip of more conservative design, with adequate gain stability, has replaced the 30 Mc/s signal separation amplifier.

At the request of Canadian Arsenals Limited a visit was made at the end of August, 1955, to the RCA Victor Laboratories in Montreal, where a pre-production prototype of the latest model Area MTI Kit was nearly complete.

All of the modifications suggested and tried in the present program of investigation have been incorporated in this model, with the exception of the stabilization of the power supply for the heater of the storage tube. In addition, the scope of the equipment has been extended by the use of three storage tubes, each of which is gated to store and subtract information derived from 120° of azimuth.

In view of the Company's plans to test this version of the Area MTI Kit with a radar set in the near future it was decided to suspend our own investigation until the RCA trials have been completed.

REMOTE RADAR DISPLAY

Reference: Army, RCAF. No project number.

Period under review: July-September, 1955

The remote display system was developed to provide a compact equipment capable of relaying a PPI picture from a radar site to any convenient location by means of a coaxial cable or a wide-bandwidth radio-frequency communication link. The radar display must be reproduced without appreciable loss of quality or accuracy.

Experimental equipment has been built and tested both in the laboratory and in the field. Pulse-time modulation is employed to transmit azimuth information during the time between range sweeps. A 400-cps resolver, mechanically coupled to the antenna, controls the position of the sine and cosine information pulses. Various methods of separating the information pulses from the video signal are being tried to determine which method is most reliable.

An attempt was made to modify a CSRDE type 30-5-A microwave relay system for use between the Metcalfe Road Field Station and the Radio and Electrical Engineering building, a distance of seven miles. The wide-band signal-to-noise ratio of this equipment proved unsatisfactory.

The remote display system is now in use at the Metcalfe Road Field Station in connection with several flight trials. The demodulator is connected to the A.A. No. 4 Mk. 6 radar by a 1000-foot length of RG-58/U coaxial cable. The single demodulator controls two 12-inch indicators. Control of video gain, limit level, intensity, and display range is provided on each indicator. A high-speed oscilloscope is used to give type-A presentation.

This arrangement provides a good opportunity to experiment with the equipment under actual working conditions.

LOW-ANGLE DETECTION

Reference: Army, RCAF. No project number.

Period under review: July-September, 1955

The modified AN/MPQ-501 transmitter with the adapted A.A. No. 4 Mk. 6 receiver and display are now operating on the roof deck of the Radio and Electrical Engineering building. Further operation of the set has not been possible because of other projects requiring the personnel and some of the equipment. A storage tube and auxiliary equipment is being assembled, and plans are underway to obtain a television-type display to be used in conjunction with the storage apparatus.

Inquiries to France and England reveal that similar work is in progress there but suitable storage tubes are still only in the laboratory stage and hence unavailable.

SOUND-RANGING COMPUTER

Reference: Army. No project number.

Period under review: July-September, 1955

DIGITAL

The general requirements of a digital computer which could be used to solve the sound-ranging problem have been discussed very briefly in report ERB-365. Because of the wide range of numbers involved in the solution of the problem and the simplicity of the external operations required, it appears that a floating-point computer is necessary. The inclusion of floating-point operations in the computer would increase the time required to solve the problem and would also increase the complexity of the computer slightly. However, the increase in time is negligible in the case of the sound-ranging problem, since high speed is not a requirement. Also, the inclusion of floating-point operations results in an increase in accuracy over a fixed-point computer of the same word length. A logical design of an arithmetic unit which will perform the floating-point operations has been completed.

ANALOG

An analog solution of this problem is being investigated. A method of solution has been evolved and a breadboard model has been set up. The method uses simultaneous nulling of four bridge networks to produce optimum overall null using an appropriate distribution of bridge error signals. At present, manual operation with oscilloscope indication is being used, while the necessary mechanisms for automatic operation are being designed. It is probable that there will be a stability problem in an automatic system. Output will be in grid coordinates with polar coordinates available, if desired.

INSTANTANEOUS MICROWAVE DIRECTION FINDER AN/UPD-501

Reference: Navy, RCAF. DND Project A12-44-10-03

Period under review: July-September, 1955

The purpose of this equipment is to detect a pulsed radar transmission instantaneously and indicate the bearing in an unambiguous manner. It consists of a four-channel crystal video receiver with signals displayed on a cathode-ray tube as a radial line, from which bearings may be read.

As the indicator and power supplies are now in production, most of the effort during the period under review has been put into development of satisfactory antennas and detector crystal mounts.

A contract has been let for the production of an antenna with horizontal polarization in the 2300-5500 megacycle, and 7000-10,500 megacycle bands. The design of an interim antenna with vertical polarization in these bands has been completed. A vertically polarized antenna is being designed to operate in the 5500-10,500 megacycle band. A vertically polarized antenna to operate from 1000 to 2300 megacycles, using dipoles, has been designed and tested. Radiation patterns of the horizontally polarized antenna for this band are not satisfactory, as yet.

A coaxial crystal mount has been designed with a low standing-wave ratio over a frequency range of 1000 to 5500 megacycles. The good impedance match over a wide frequency range will make it very useful when operating with radio-frequency filters. The sensitivity of this crystal mount is 2 or 3 db less than that of the best commercial mounts at some frequencies. A report is being written on this crystal mount.

Several types of crystals have been tested for equality, and tracking of sensitivities over the two bands, 2300 to 5500, and 5500 to 10,500 megacycles. Tests to date indicate that the Philco type-263 germanium crystal is best, both in sensitivity and in equality of characteristics throughout the bands. This is particularly true from 9000 to 10,500 megacycles where wide variations exist from one crystal to another in the type-1N23B crystal.

A suitable switching arrangement was obtained for selecting antennas and at the same time operating the attenuators and switches that protect the crystals from burnout from close-by radars. The system may be interlocked with the ship's or plane's radar.

A test signal generator was re-designed, making it more stable, and less affected by supply voltage fluctuations. This unit produces video pulses with switching facilities for testing the AN/UPD-501 video amplifiers and display. It also generates an X-band radio-frequency pulsed signal for checking the overall performance of the DF equipment. A specification has been written so that it may be produced in industry.

A d-c filament supply was made for use with the video amplifiers and mixer circuits when installed on an aircraft using engine-driven alternators with supply frequencies up to 1000 cycles per second. This was found to be necessary as signals at frequencies above 400 cps were coupled into the channels through the filaments. Components are now undergoing qualification approval at CAMESA.

Evaluations of the AN/UPD-501 equipment from the operational point of view have been performed by the Anti-Submarine Warfare Operational Research Team, Department of National Defence, and are described in their Memoranda No. 2, 12, 22 and 23.

SHORE-BASED HIGH-FREQUENCY DIRECTION FINDER (AN/GRD-501)

Reference: Navy. DND Project A14-38-10-10

Period under review: July-September, 1955

This equipment is a narrow bandwidth direction finder which is intended to provide all the facilities required for direction finding on conventional types of communication signals in the HF band. In addition it is intended that it shall provide bearing information on messages of duration as short as 0.1 second.

As a result of an agreement to standardize, two models have been produced by the contractor, one for the United Kingdom and one for Canada. The UK model has been sent to ASRE to undergo trials and to serve as a basis for production.

The other model is being used to complete tests on the antenna, and to provide preliminary performance specifications for Canadian production. Both models are incomplete as far as the recording equipment and antenna are concerned. Final modification of the NRC experimental recorder is now underway, after which drawings will be submitted to the contractor. The NRC experimental antenna is complete except for some details of the sense-finding circuits, and two antennas are under construction by the contractor.

Guidance is being given to the contractor who is preparing to construct two final prototypes of the receiver and antenna.

SHIPBORNE HIGH-FREQUENCY DIRECTION FINDER

Reference: Navy. DND Project A12-38-20-19

Period under review: July-September, 1955.

The purpose of this equipment will be to intercept and provide bearings on short-duration ground wave signals, transmitted at random times and on frequencies random within predictable bands. These bands are wide enough to contain a vast number of interfering signals, and the main problem is one of identifying and separating the wanted signal.

To assess the seriousness of the interference problem and to gain experience in wide-band techniques, a twin-channel receiver is being built which will permit direct evaluation of the effectiveness of instantaneous twin-channel display for this purpose.

MAGNETIC SIGNATURES OF ALUMINUM MINESWEEPERS

Reference: Navy. DND Project A20-05-60-02

Period under review: July-September, 1955

This project was undertaken in cooperation with the Canadian Navy to determine the magnetic fields of rolling ships and to evaluate methods of reducing the magnitude of these fields. The two principal components making up the total signature of a rolling aluminum ship are: the magnetic field of eddy-currents and the magnetic field caused by "tilt" effect. The eddy-current field is due to currents which occur as a result of emf's induced in closed framework loops as they oscillate in the earth's field. "Tilt" effect is the field caused by mismatch between the field of the static degaussing coils and the field of the iron parts (mainly engines and generators) as the ship is tilted out of a level position. The magnitude of the tilt component is in general much smaller than that of the eddy-current component in the class of aluminum ships under study. It is approximately in phase with the roll angle of the ship, whereas the eddy-current component is approximately in phase with the roll velocity of the ship.

The development of a method of reducing the magnitude of the ship's field has been directed mainly towards compensating the eddy-current field by a degaussing process. This process consists in passing currents through compensating coils within the ship which are in anti-phase to the eddy-currents in the ship's framework. This system can also achieve some degree of "tilt" compensation if the amplitude and phase of the compensating currents are suitably adjusted.

Trials have been conducted to test the relative performances of two compensating systems. The first of these systems employs a detector consisting of two monitoring coils, one of which is mounted with axis vertical and the other with axis horizontal athwartship. During rolling, these coils produce voltages which are proportional to the emf's induced in the vertical and horizontal frames of the ship. The second system uses a detector which monitors the currents in the aluminum ship members. The outputs from these detectors are fed through phase-shifting networks and amplifiers, which in turn feed currents through vertical and horizontal degaussing coils in the ship.

During the period under review these two systems were installed on the Canadian minesweeper HMCS "Comox", and extensive rolling trials were carried out over a sensitive field-measuring range. Measurements were also made of the uncompensated field of the ship. The data obtained during these trials are now being analyzed.

In order to obtain more information about the "tilt" effect a second minesweeper,

having a wooden hull without internal aluminum framework, was rolled over the same range. The British Navy had suggested that the tilt effect is not exactly in phase with the roll angle. Analysis of the data from the wooden minesweeper trials is now nearing completion and the results appear to confirm that there is a phase difference between tilt effect and roll angle.

Since the completion of the "Comox" trials a representative of the Division has witnessed similar trials being carried out by the British Navy at Portsmouth, England.

C-119 AIRCRAFT ANTENNA STUDY

Reference: RCAF. DND Project C37-55-40-09

Period under review: July-September, 1955

Radiation patterns of all the HF, VHF, and UHF antennas on the C-119 aircraft are being investigated to determine whether or not improved antenna performance may be achieved by minor modifications of antenna configuration or location. To date the studies have been made on the antennas associated with the following equipment: AN/APN-12; AN/ARC-27; AN/ARN-14; AN/ARN-18; and AN/ARC-3. In no case could significant improvement be realized without major modifications.

VHF ANTENNA FOR THE CF-100, MARK IV

Reference: RCAF. Avro Aircraft Order No. RL-7793

Period under review: July-September, 1955

An order has been accepted from Avro Aircraft to study means of improving air-to-ground communication on the CF-100 Mark IV aircraft. Pattern studies have shown that excellent coverage can be expected from an external antenna mounted on the underside of the fuselage near the trailing edge of the wings. Preliminary design of an antenna for this location has been completed, and some impedance measurements have been made. As a result Avro is constructing a prototype antenna for final matching and testing.

ANTENNA INVESTIGATIONS FOR "VELVET GLOVE" MISSILE

Reference: DRB. DND Project D46-55-40-14

Period under review: July-September, 1955

Development and testing of the front guidance antenna for the "Velvet Glove" missile referred to in the previous issue of this report have been completed.

In the period under review the program on the telemetering antenna, also referred to in the previous report, has been successfully completed. Pattern studies showed a notch-type antenna cut in the body of the missile at the rear to be quite satisfactory. Such an antenna has been designed and fitted to a full-scale missile body, and impedance measurements show a very good match to 50-ohm line. At the request of CARDE, some thought is being given to a suitable test procedure for factory-tuning these antennas.

HIGH RESOLUTION IFF ANTENNA FOR AN/FPS-3

Reference: RCAF-S1950-100-IFF DRW

Period under review: July-September, 1955

It was reported previously that a high resolution experimental IFF antenna had been designed and constructed for use in conjunction with the AN/FPS-3 radar. This antenna consisted of two 30-foot non-resonant slotted-waveguide arrays, each array performing the single function of transmitting or receiving.

Flight trials of the antenna were carried out on June 21 and 22, 1955, at RCAF Station Foymount. The antenna has been returned to our laboratories and further measurements will be conducted contingent upon the results of these trials. No results have been received from AFHQ to date.

MODEL ANTENNA STUDIES FOR HMCS "BONAVENTURE"

Reference: Navy. DND Project A12-55-40-16

Period under review: July-September, 1955

Antenna studies for the aircraft carrier HMCS "Bonaventure" can be divided conveniently into two separate programs:

a) VHF/UHF model antenna studies,

b) HF model antenna studies.

Radiation pattern measurements of the various VHF/UHF antennas have been carried out on a 1/6 - scale model of the mast and rigging of the "Bonaventure" with the objective of obtaining the most effective all-round coverage. These measurements have been completed and copies of the various patterns forwarded to Naval Technical Services, NDHQ, Ottawa. A similar antenna study is continuing for the DE-205 destroyer escort.

For the HF studies, construction of the 200-foot by 70-foot pattern range is continuing. It was reported previously that an experimental investigation on a scale-model of the final pattern range was conducted for the purpose of obtaining design data and information. The results of this work can be found in Report ERA-287 (Unclassified). Drawings of the "Bonaventure" were received from NDHQ, and working drawings of a 1/48 - scale model are being prepared.

AN/FPS-502

Reference: RCAF. DND Project B22-38-10-09

Period under review: July-September, 1955

SECOND-ORDER BEAMS OF ANTENNA

The AN/FPS-502 radar, when put into service, was found to have a double picture on the PPI screen on very strong permanent echoes. The second "paint" of the permanent echoes lagged the first by about 30 to 35 degrees. Subsequent investigation proved that they were due to "second-order beams" from the slotted waveguide feeding the parabolic reflector in the antenna system.

A complete antenna assembly was obtained from the manufacturer and mounted on a turntable. Provision was made to tilt the complete assembly in order to locate and measure the second-order beams. The size of the second-order beam was found to be 1 percent, 14.5 percent, and 13 percent, at 2700, 2800, and 2900 Mc/s, respectively.

Several types of horns were tried on the feed and it was found that a short length of parallel-plate region 1-3/4 inches wide at the waveguide slots suppressed the second-order beams to a size less than, or equal to the 2 percent noise level in the recording system.

The presence of the modified horn produced a change in the close-in side-lobe level, and a new slotted waveguide was constructed to alter the amplitude distribution along the array. When radiation patterns of this new array were taken it was found that the close-in side-lobes were below 9 percent, which was better than in the original antenna.

ACQUISITION RADAR MODIFICATIONS (AN/FPS-501B)

Reference: Army. DND Project.....

Period under review: July-September, 1955

ANTENNA MODIFICATIONS

A request has been received from the Canadian Army to redesign the slotted waveguide feed for the antenna of the AN/FPS-501B radar, in a manner similar to the redesign carried out on the antenna for the AN/FPS-502 radar (reference: DND Project B22-38-10-09, Restricted).

Since the antenna on the 501 is of the same type as that on the 502, it will also have second-order beams. These beams have given little or no trouble in the field so far, but it is felt that they should be removed in view of the importance of reducing a radar's susceptance to jamming. Steps are being taken to redesign the feed after the same manner as that followed for the 502.

WAVEGUIDE SWITCHES FOR THE ROYAL CANADIAN NAVY

Reference: Navy. DND Project A12-55-10-02

Period under review: July-September, 1955

The purpose of the project is to develop suitable fast-acting waveguide switches to allow switching of the full magnetron power of X-band radars from the antenna to a dissipative load.

A number of different mechanical designs were considered, but it is now felt that the requirements for switching time set forth in the specifications cannot easily be met by a mechanical switch.

The possibility of using a ferrite switch has been investigated. It appears now that some U.S. companies have or will soon have ferrite devices that will meet most of the specifications. Isolation between the two outputs of about 30 decibels appears feasible. This is considerably short of the requirements for good counter-countermeasure operation. Two or three switches may have to be used in cascade to meet the specifications as they stand. A single switch could probably be accommodated in the space allowed for by the specifications.

Further study of this problem and further correspondence with companies making ferrite devices is required.

CARCINOTRON STUDIES

Reference: DRB DND Project D48-44-20-01

Period under review: July-September, 1955

The aim of the project is to study the use of carcinotrons as devices for jamming, and to develop experimental jamming equipments.

Carcinotrons are microwave backward-wave oscillators having a very wide electronic tuning range, and output powers up to hundreds of watts. Because the tuning is accomplished electronically, the frequency can be varied at a very rapid rate. The device can be modulated in both frequency and amplitude by frequencies up to at least a few megacycles per second. Efficiencies of up to 30 percent are obtained in current tubes. The presence in a single tube of all these desirable properties permits the development of more effective microwave jammers than have been available previously.

If the best use is to be made of available sources of jamming signals, or if radar receivers with increased resistance to jamming are to be devised, a knowledge of the fundamental processes by which radar echoes are masked by various types of jamming signals in radar receivers is essential. To facilitate obtaining information, a test bench is being set up using low-power backward-wave oscillators. Such oscillators have been operated in both S-band and X-band using laboratory power supplies. A highly stabilized source of current for the solenoid of the X-band tube has been completed, and self-contained power supplies for the tubes are being developed. The essential units of the receiver section of an A.A. No. 4 Mk. 6 radar, on loan from the Canadian Army, have been assembled for use in the S-band studies. The S-band tube has been used in short range jamming of radar, and in the measurement of resonances in spaced choke flange waveguide coupling.

The construction and assembly of equipment required for bench operation of the type-CM710 carcinotron was completed, and both tubes have been operated without modulation over their specified frequency range at power levels up to about 250 watts. Performance has been found to be in agreement with the data supplied by the manufacturer. The expected frequency drift during warm-up and the ± 2 to 3 Mc/s variation in the output frequency due to a-c operation of the directly heated filament have been observed. During the next review period, data will be obtained on modulated operation and performance, and operation with a d-c filament supply.

The design and construction of various sub-units for the S-band sweeping receiver is continuing.

Assistance was given to the Defence Research Board and associated agencies in the planning and execution of Operation "Bracket" (flight trials of an experimental S-band carcinotron jammer developed in the United Kingdom by RAE). During the operation, opportunity was afforded to observe the effects on S-band radars when jammed with this equipment, and to discuss details of equipment and techniques with personnel from RAE.

GROUND-TO-AIR COMMUNICATIONS USING IFF

Reference: RCAF DND Project C37-28-01-05

Period under review: July-September, 1955

This system is proposed to provide an auxiliary ground-to-air communications link for Mark X IFF equipped aircraft. Laboratory tests have been completed on a system using pulse-frequency modulation, with a carrier consisting of double pulses spaced 11 microseconds at a mean PRF of 6000 pulse-pairs per second. A report (ERB-364) has been written describing the system, and the one-tube demodulator which is the only additional airborne equipment required. This report is under consideration at RCAF headquarters. Further work will depend on their decision concerning its suitability.

FLUTTAR WAVEFORMS

Reference: DRB, RCAF. DND Project D48-38-01-09

Period under review: July-September, 1955

The aim of this project is to discover useful properties and relationships of the waveforms generated by Fluttar systems.

The present source of waveforms is the library of tape recordings previously made in conjunction with an experimental Fluttar system. From time to time various electronic measuring, counting, and display devices have been tried.

The experimental results obtained with the recording frequency meter developed during the previous reporting period, have prompted a study of pertinent circuit properties. To start with, the impulse and step responses in the time domain and the amplitude and phase in the frequency domain were tabulated and plotted for a number of filter-like structures. Certain other parameters, such as noise power bandwidth, were also determined. It is expected that this data will provide an engineering basis for design.

VULNERABILITY OF DOPPLER DETECTION SYSTEM TO COUNTERMEASURES

Reference: DRB DND Project D48-44-01-01

Period under review: July-September, 1955

The purpose of this project is to study the Doppler Detection System with a view to determining what countermeasures might be used against it, how effective they might be, and what could be done to counter them. The project was begun in the previous quarter and remained mainly in the study and discussion stage in the period under review. Some field work was done with a repeater-jammer with doppler simulator which was built in our laboratory, and also with an APT/5 jammer. The trials of the repeater-jammer with doppler simulator have shown that the production, electronically, of a simulated crossing of a single Doppler Detection System line is, in principle, straightforward. However, the practical difficulties of operating this apparatus in the field, particularly against two parallel Doppler Detection System lines make it unsuitable as a countermeasure to the Doppler Detection System as conceived. Further work on these lines will be the investigation of a super-regenerative receiver-oscillator as a jammer. An APT/5 jammer placed about 10 feet above ground level approximately at the mid-point of the Ottawa-Arnprior experimental Doppler Detection Link with an antenna having about 10 decibels gain was completely ineffective as a jammer.

REPORTS ISSUED

The following reports relating to defence projects have been issued by the Radio and Electrical Engineering Division during the period under review:

Brahan, J.W. A Method of Reducing Sound Ranging Data Suitable for Use with a Computer (ERB-365) (SECRET)

The effects of wind and temperature on the accuracy of location by sound ranging are described. Errors in survey and meteorological data and in the interpretation of recorded sound data are also discussed. The method of obtaining locations by solving three simultaneous linear equations is reviewed, and the resultant probable errors in location have been calculated and are shown graphically. Also, the general requirements of a digital computer for solving the sound ranging problem are discussed briefly.

Kenney, J.R. Ground-to-Air Communication using Mark X IFF (ERB-364) (SECRET)

A system whereby emergency ground-to-air communications can be established with Mark X IFF equipped aircraft, with little or no interference to normal IFF operation, has been tested in the laboratory. Pulse-frequency modulation is used, with a carrier consisting of double pulses spaced 11 microseconds at a mean PRF of 6000 pulse-pairs per second. These pulses would be transmitted from a modified ground interrogation unit with a steerable antenna. In the aircraft, a decoder-demodulator circuit employing one tube envelope and weighing about two pounds, is connected to a video test receptacle on the IFF unit. No modification of this unit is necessary. Provision can be made to indicate automatically to the pilot that the system is in use. Suggestions for operational employment of the system are given, and it is recommended that flight tests be carried out.

Wong, J.Y. Pattern and Gain Measurements on the AN/FPS-503 Antenna (ERB-366) (SECRET)

This report presents the results of pattern and gain

measurements performed on the McGill Fence (AN/FPS-503) Antenna. Radiation patterns in both the principal planes and in an elevated plane containing the maximum radiation are included for a band of frequencies from 470 to 500 Mc/s. An average of twelve degrees was obtained for the half-power beamwidth in the horizontal plane. Gain measurements yielded a power gain relative to an isotropic radiator of 16.8 db at 470 Mc/s, and 17.2 db at 495 Mc/s.

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39	Directorate of Physical Research
40	Directorate of Engineering Research
41	Operational Research Group
42-43	Project Coordination Centre
44-45	Defence Research Telecommunications Establishment
46	Canadian Armament Research and Development Establishment, Valcartier, Que.
47	Pacific Naval Laboratory
48	Defence Research Member, Canadian Joint Staff — London, England
49	Defence Research Member, Canadian Joint Staff — Washington, D.C.
50	Chairman, Electronic Research Panel
51	Director, Eaton Electronics Laboratory, McGill University
52	Chairman, Electronic Components Development Committee
53-60	Not assigned

Copy No.	Royal Canadian Navy
61	Director General of Naval Ordinance
62	Scientific Advisor to the Chief of Naval Staff
63	Director of Scientific Services
64	Director of Supplementary Radio Activities
65	Electrical Engineer-in-Chief
66	Naval Constructor-in-Chief
67	Director of Naval Communications
68-70	Not assigned
	Canadian Army
71	Scientific Advisor to the Chief of General Staff
72-78	Directorate of Armament Development
79	Directorate Royal Canadian Artillery
80	Directorate of Weapons and Development
81	Directorate of Electrical and Communications Development
82	Directorate Royal Canadian Corps of Signals
83	Deputy Quartermaster General — Development and Design
84	Canadian Army Signals Engineering Establishment
85-95	Not assigned
	Royal Canadian Air Force
96	Air Member for Technical Services
97	Scientific Advisor to the Chief of Air Staff
98	Chief of Plans and Intelligence
99	Chief of Air Operations
100	Chief of Telecommunications
101	Chief of Armament
102	Chief of Development
103-104	Air Materiel Command
105-106	Air Defence Command — St. Hubert, Que.
107	Directorate of Operational Requirements
108	Directorate of Armament Engineering
109-120	Not assigned
	UNITED KINGDOM
	Via Lt.-Col. P.W. Larsen, U.K. Ministry of Supply, Ottawa
121-126	Ministry of Supply
127-132	War Office

Copy No.	Via Lt.-Col. P.W. Larsen, U.K. Ministry of Supply, Ottawa (cont'd)
133-136	Air Ministry
137-140	Admiralty
141	BJSM — Washington
142	BJSM — Ottawa
143-148	Not assigned
	Via NRC Scientific Liaison Office, London
149	Radar Research Establishment
150	Royal Aircraft Establishment
151	Admiralty Signal and Radar Establishment
152	Services Electronic Research Laboratory
153	Signals Research and Development Establishment
154	Armament Research and Development Establishment
155-168	Not assigned
	UNITED STATES OF AMERICA
	Via the United States Embassy, Ottawa
169-172	Naval Attache
173-180	Army Attache
181-186	Air Attache
187	Signal Corps Engineering Laboratory
188	Board 4, Army Field Forces
189	Naval Research Laboratory
190	Naval Electronics Laboratory
191-192	Lincoln Laboratories
193	Rome Air Development Centre
194	Wright Air Development Centre
195	Air Force Cambridge Research Centre
196-207	Office of the Senior Standardization Representative, U.S. Army Directorate of Weapons Development, Army Headquarters, Ottawa.