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NATIONAL RESEARCH COUNCIL OF CANADA  
RADIO AND ELECTRICAL ENGINEERING DIVISION

CLASSIFIED PROGRESS REPORT NO. 12  
(JANUARY - MARCH 1958)

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APRIL 1958

NRC # 35417

## 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 United Kingdom, and the United States, 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 Coordinating Centre 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 security regulations. Recipients of these documents should note that Canadian approval is required for release to other persons, organizations, or governments of any classified information (including this Classified Progress Report) which may be issued by this Division.

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## CONFIDENTIAL

### COUNTER MORTAR RADAR (AN/MPQ-501)

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

Period under review: January - March 1958

### 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 designed for mounting on an AFV 603 armored personnel carrier in order to achieve a high degree of mobility, reliability, and protection for operators and equipment. The antenna, transmitter, and generator assemblies are mounted outside, while the display and control equipment 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 and manpower.

### STATUS OF PROTOTYPE

Following DAD Acceptance Trials at Camp Borden and Ottawa, the equipment was transported to Camp Shilo, Manitoba, in December 1957 for Users Trials. These are still underway. Results indicate that an improvement in accuracy is being achieved since the operators have now become familiar with the equipment, and that the accuracy and range requirements will be met.

Following a recent assessment, RCEME states that, from the maintenance standpoint, "electrically the set has been performing quite reliably and very well, but mechanically some minor items have been giving difficulties which only require minor corrections on a production equipment".

### ASSESSMENT OF SCANNER AND RECEIVER

A visit was made to Camp Shilo, Manitoba, to measure the rise time of the receiver and the VSWR of the scanner, and to make general observations on the performance of the receiving system. In addition, a pair of logarithmic IF amplifiers built by NRC was checked in the radar set in preparation for evaluation trials on this type of amplifier, and found to operate satisfactorily.

It was found that the "A" video amplifier rise time was 0.25 to 0.3  $\mu$ sec, and that the "B" video amplifier rise time was approximately 0.17  $\mu$ sec. These excessive rise times make precise range calibration of the equipment difficult. The stages of the amplifier causing this pulse distortion have been isolated and correction of this condition has been discussed with the manufacturer.

The bandwidth of the IF amplifiers was checked, and although slightly less than the design figure of 7 mc/s, receiver rise time does not seem to be impaired by this reduction.

The measured VSWR of the scanner is considerably higher than values measured immediately following assembly. Also, there are peaks in the VSWR at the "cross over" positions of the scanner, where the radiation is switched from the lower to the upper beam. The increase in VSWR was found to be due to an accumulation of metallic particles inside the scanner, which were drawn into the interior while wear was occurring to the scanner drive system. (This wear resulted in premature failure of several mechanical components recently, and was the result of a loose set screw on the drive pulley.) The mechanical parts have been replaced and the scanner is now back in operation.

Radar performance was checked, using the NRC Ku-band Radar Test Set, and found to be satisfactory.

Any deficiencies of importance, noted during the visit, are receiving active consideration by NRC and the manufacturer. Correction can be made without difficulty in the production equipment.

#### DEVELOPMENT AT NRC

##### Polarizer

A polarizer was designed to provide the option of circular polarization. Pattern and reflection measurements on a curved test section of the polarizer have been made. On the basis of information obtained therefrom, minor changes were made in the design parameters for the full-size prototype, which is now in an advanced stage of construction, and will be tested on the McGill-NRC scanner in the near future.

##### Storage Tube Display

A storage tube display was built and is under test prior to applying radar signals to it. It is intended that this unit be "patched in" to the radar to make an assessment of its usefulness in simplifying the operation of the equipment.

Computer

The computer is being considered with a view to increasing its accuracy further. The extrapolation equations which approximate the assumed "straight-line" and "parabolic" trajectories of a bomb have been checked on a digital computer to determine the effect of the approximations which were made in their derivations. The "parabolic" extrapolation in azimuth has been found to be satisfactory, nearly all cases having less than 10 meters error. In range, at high angles of sight, some deviation from true parabolic extrapolation is evident, but this can be corrected by a simple gear ratio substitution within the computer.

The extrapolation accuracy is being studied for the case of a projectile whose trajectory deviated from a parabola because of air resistance.



ACQUISITION RADAR MODIFICATIONS (AN/MPS-501B)

Reference: Army. No DND project number.

Period under review: January - March 1958

One AN/MPS-504 radar, provided by the Canadian Army, is being prepared for the "Burnt Cork" trials against airborne carcinotron jammers this summer. It is expected that the following items will be available for evaluation during the trial:

a) Tunable pre-selection cavity.

Laboratory test results have been described in NRC Report ERB-425 and in earlier issues of the Progress Report.

b) Modified horn and feed assembly.

This modification has reduced second-order beams to less than -26 db.

c) Dicke-Fix Receiver.

An improved anti-jamming receiver is being fitted. Details are included in this report under "Anti-Jamming Measures against Carcinotrons" (page 5).

d) Logarithmic Receiver.

A wide-range (80-db) logarithmic receiver has been constructed and will be fitted.

e) Video Enhancer and Integrator.

A photoelectric video processing accessory known as a "video enhancer" has been shown to provide 3 to 4 db improvement in signal visibility. This will be fitted together with a video integrator, which has yielded a further 3-db improvement in laboratory tests. Progress on the integrator is reported separately under "Anti-Jamming Measures against Carcinotrons".

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ANTI-JAMMING MEASURES AGAINST CARCINOTRONS

Reference: Army. DND Project B22-38-20-23

Period under review: January - March 1958

PREPARATION FOR OPERATION "BURNT CORK"

Video Integrator

A video integrator of conventional design, using a 2500- $\mu$ sec quartz delay line was constructed and is ready for test. Special attention was given to maintenance of gain stability and to freedom from hum-pickup. Both of these requirements may be more easily met if the heater supply for all tubes within the integrator loop is stabilized direct current. A transistor regulator has therefore been included.

In the original design, transistor video amplifiers were used for low-level stages, but they have been abandoned for the present because of the temperature dependence of the gain of such amplifiers. It is felt that they have no real advantage over tube amplifiers, if the latter are designed for low hum-level, in equipment which must, of necessity, employ many vacuum tubes in other positions.

Dicke-Fix Receiver

A synchronously tuned Dicke-Fix Receiver was built for this trial. Special attention was given in this unit to flexibility, in that it may be switched in or out as an alternative to a logarithmic receiver or a linear receiver, and the limit level may be readily adjusted. For these reasons the preamplifier has multiple low impedance output feeds, and more than the normal gain has been incorporated in each unit in order to allow pre-limit and post-limit gains to be "traded".

### IMPROVEMENTS TO GROUND RADARS

Reference: Navy, Army, RCAF. DND Project D48-38-03-27

Period under review: January - March 1958

#### DICKE-FIX RECEIVER

This item is covered in the section "Anti-Jamming Measures Against Carcinotrons" (page 5).

#### LOGARITHMIC RECEIVER

Further trials with the NRC model were carried out by the RCAF, but no report has been received from them. Canadian Arsenals Limited are building units based on NRC's model for trials with Army and Navy radars.

#### ANTENNA PATTERN RECEIVER

In recent WSEG trials in the United States, NRC's antenna pattern receiver [see NRC Report ERB-458 (Restricted)] was used with an AN/FPS-20 radar to measure the strength and azimuth of jamming strobes. With the use of it, very little trouble is encountered in determining the true azimuth ( $\pm 5^\circ$ ) of a single aircraft with four fast-sweep L-band jammers. At the same time, absolute jamming strength at the output of the radar antenna could be measured easily with an accuracy of about  $\pm 5$  db. It is hoped that copies of the films obtained with the use of this receiver will be made available to NRC for further analysis.

Canadian Arsenals Limited are building units based on NRC's model for trials by the three Services.

#### PRF JITTER UNIT

The NRC unit has been modified for trials with the AN/CPS-6B radar.

#### AZIMUTH TIME RECORDER

The first of the Canadian Arsenals Limited models was rushed to completion in time for the WSEG trials. It was apparent from the preliminary trials that several modifications, from both the electronic and human engineering aspects, would be required to make it suitable for operational use.

PRESELECTION CAVITIES

A new cavity with spring finger contacts was constructed. Tuning was more stable than with earlier models not so equipped. The information was passed to Canadian Arsenals Limited who are producing models for the Services.

AUTOMATIC STROBE TRIANGULATION DISPLAY (ASTRID)

Reference: RCAF and Project "Napkin". No project number.

Period under review: January - March 1958

This project is concerned with the problem of rapidly determining the position of a number of jammer-equipped aircraft when bearing information alone is obtainable from the strobes generated by radars in the presence of jamming. Conventional triangulation techniques involve plotting simultaneous bearings from at least two sites to determine the intersections of the bearing lines. However, with only two reporting sites and more than one jammer, the resulting plot is ambiguous since "n" bearing lines from each of two sites will, in general, result in  $n^2$  intersections. Bearings from a third site can help to distinguish the "n" true intersections from the  $n(n-1)$  false or ghost intersections, since in general, only true intersections will then be formed by the intersections of three bearing lines. To present such a plot automatically, a 12-inch long-persistence cathode-ray tube is used with circuitry such that the strobe pictures from three radar sites can be presented essentially simultaneously on the one display, with the centers of the three rotating scans disposed on the tube to represent the three radar sites. This is accomplished with a fixed coil display by switching the azimuth and signal strength information electronically from the three sites at a switching rate of 400 cps.

To assess the systems without resorting to field trials, a jammer simulator was built, which can simulate the jamming strobes which would result from three ground radars in the presence of a number of ECM-equipped aircraft. The jammers are simulated by moving spots of light projected from below onto a frosted glass screen by small projectors, each separately motor-driven to turn slowly about a horizontal axis. The three radar simulators are mounted on a clear glass shelf above the frosted glass, and consist of a photomultiplier tube behind a narrow slit cut in a disk.

During the period under review, detailed planning was started for a field test system as contrasted to the simulator previously built. Probably the most important factor requiring study is the extent to which a group of people can cooperate effectively to carry out the "de-ghosting" process. Two displays are proposed, with horizontal CRT faces and room for at least four persons around each display. One display group may be operative and the other a spare, or one may be a master and the other a slave, or both may be operated independently in competition to seek different possible de-ghosted solutions. All three arrangements will be tried out in an RCAF Air Defence Command sector during the summer. In the third method one display group may operate in real time, the other in fast time by tape recording all the data and playing back at increased speed.



Each operator's position will be provided with a joystick type of control which can be used to place the intersection of two artificial strobes over a true or false intersection of interest. These strobes can be repeated as required on the second display or on an Intercept Controller's display of the AN/UPA-35 type. At one position on each display, the joystick control can be replaced, if necessary, by two synchros to facilitate the transfer of strobes to certain types of controller's displays.

The equipment needed to transmit strobe information from one radar station to another is under construction, as are the displays and controls, deflection amplifiers, and the switching circuitry.

CONFIDENTIAL

FLIGHT PLAN CORRELATION EQUIPMENT

Reference: RCAF. DND Project C98-39-30-02

Period under review: January - March 1958

The experimental model was set up at the Metcalfe Road Field Station, operating with radar information supplied from the AA No. 4 Mk. 6 radar, and was demonstrated to those interested. The use of magnetic cores for character selection code storage is being studied.

REMOTE RADAR DISPLAY

Reference: Army, RCAF. No DND project number.

Period under review: January - March 1958

No further work was done on this project. A preliminary report is about to be published.

LOW ANGLE DETECTION

Reference : Army, RCAF. No DND project number.

Period under review: January - March 1958

The new indicator is about half completed: a 1000-cycle supply to operate the antenna bearing synchro has been finished.

An improved magnetron has been received and tested with very apparent improvement in radar performance.

Patent applications on the voltage-doubling circuit, and on the detector circuit are progressing.

SOUND-RANGING COMPUTER

Reference: Army. No DND project number.

Period under review: January - March 1958

The sound-ranging problem has been programmed for the E101 computer, using the simultaneous equations method. Meteorological corrections are applied using an effective wind and temperature. Various methods of applying the wind and temperature corrections are being studied.



INSTANTANEOUS MICROWAVE DIRECTION FINDER (AN/UPD-501)

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

Period under review: January - March 1958

The purpose of this equipment is to detect a pulsed radar transmission instantaneously and to indicate the bearing in an unambiguous manner. It consists of a four-channel crystal video receiver, with the signal displayed as a radial line on a cathode-ray tube. The angle of the line, with respect to a reference, represents the bearing of the signal.

SPIRAL ANTENNA

An experimental direction-finding antenna which will operate in the 500 to 1000 mc/s band was designed and built. This antenna consists of eight spiral elements, having circular polarization, equally spaced on a 10-inch-diameter cylinder. It will be tested for bearing errors in both vertical and horizontal planes of polarization. As the frequency response of this antenna is very wide, bandpass filters will be required to eliminate unwanted signals lying outside the frequency band.

PROTOTYPE ANTENNA

Three prototype antennas were received from Cossor (Canada) Ltd. Electrical performance measurements are being carried out and modifications made to bring them within specifications. On completion of these tests they will be transferred to Inspection Services, DND, for environmental testing.

TEST EQUIPMENT

A test antenna coupler for the frequency band 1.0 to 2.35 Kmc/s was designed and a satisfactory experimental model built. A test coupler for the frequency band 11.0 to 20.0 Kmc/s has been designed. A weatherproof cover which has a low reflection coefficient at these frequencies is being sought.

A developmental model of the portable klystron test oscillator UPM-501 was fabricated. Extensive measurements were made on the unit to determine such factors as power output level and stability with varying line voltage, undesired RF leakage, and performance of the attenuator and monitor at several frequencies from 1.2 Kmc/s to 7.5 Kmc/s.

A stripline attenuator was developed for use with the test set. The performance of the unit is satisfactory from 1.4 Kmc/s to 7.0 Kmc/s, although the increase of attenuation with frequency is greater than desired. This means

that the attenuator cannot be calibrated unless the frequency is known.

#### CRYSTAL TYPES

Comparative measurements were made of tangential sensitivity and VSWR of several types of crystals used as low level video detectors. The tangential sensitivity of types MA423A, 1N23E, and MA408B is 3 db higher than that of type 1N23B, the type commonly used in UPD-501. The sensitivity of type MA423A is 0.5 db better than that of types 1N23E and MA408B.

With the Mark V crystal mount, the VSWR of the type MA423A crystal is lower than that of type 1N23B from 2.3 Kmc/s to 11.0 Kmc/s; the VSWR of the type 1N23E is only slightly lower than that of the 1N23B from 2.3 Kmc/s to 4.0 Kmc/s.

#### POWER SUPPLIES

Two 60-cycle power supplies for the AN/APR-9 receiver were completed. Wiring diagrams of these supplies were drawn and blueprinted so that copies will be available.

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

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

Period under review: January - March 1958

A complete calibration of the installation at the Naval Test Site was carried out with the aid of RCN personnel. Some of the results have been analyzed on a small computer, but the bulk of the data is awaiting analysis on the new computer at Toronto. A report is being drafted which will attempt to show a method of deriving from calibration data corrections for observations made on the direction finder. A start has been made on the design of a harmonic generator to be used in the field as a test oscillator for calibrating the Direction Finder.

A report on the design of the antenna coupling circuits for GRD-501 is being drafted.

SHIPBORNE HIGH-FREQUENCY DIRECTION FINDER

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

Period under review: January - March 1958

This project was rather inactive during the period under review because of the temporary diversion of effort to the shipborne short-signal intercept receiver (DND Project No. A17-38-20-24). Nevertheless, much of the work done on the intercept receiver has a direct bearing on the direction finder and this project may not be delayed as much as might be expected.

Some design work was done on the broadband RF amplifiers, and a rack cabinet has been selected for containing the equipment.

SHIPBORNE SHORT-SIGNAL INTERCEPT RECEIVER

Reference: Navy. DND Project A17-38-20-24

Period under review: January - March 1958

This is a short term project aimed at producing two receivers capable of indicating the presence of a large-amplitude short-duration signal occurring within a one-megacycle bandwidth. To deliver this equipment in the shortest possible time use is being made of available equipment and of circuit techniques which have reached an advanced stage of development in the shipborne high-frequency direction finder (DND Project A12-38-20-19). NRC Report ERB-453 was issued in January describing the arrangement for this receiver.

Commercial power supplies and two Racal receivers have been received, the display circuitry for one receiver (including a regulated RF power supply) has been constructed and operates satisfactorily, and adaptor units have been built to make the broadband output of the Racal receivers available. Cabinets are being modified to hold the equipment and the broadband IF amplifiers are nearing completion. It is expected that the equipment will be ready for delivering to the Navy before the next quarterly Progress Report is written.



IMPROVEMENT OF HF DF TECHNIQUES

Reference: DND Project A14-38-10-24

Period under review: January - March 1958

Over a period of about six weeks, check-bearing data on known fixed stations was accumulated in an effort to assess the performance of the GRD-501 equipment. Exceptionally low standard deviations of error have been shown by analysis of this data; it remains to be shown how much this reduction from the normal expected error was due to the operator who took the readings, and how much was due to the equipment.

Equipment for synchronously gating the direction finder so as to receive specific echoes forward- or back-scattered from a pulse transmitter was built and tested. The purpose of the experiment is to take advantage of certain transmissions of this type from laboratories of the Defence Research Board, which may afford some information on propagation during auroral disturbances. Also a number of pulse transmitters being operated for the International Geophysical Year may provide comparable data.

A paper entitled "Some Recording Techniques for High Frequency Direction Finding" has been accepted for publication in "Electronic and Radio Engineer".

MAGNETIC SIGNATURES OF ALUMINUM MINESWEEPERS

Reference: Navy. DND Projects A20-05-60-02 and A12-05-60-04

Period under review: January - March 1958

During the month of March, an extensive series of trials were carried out on the minesweeper HMCS "Cowichan" to complete a study of magnetic fields which was begun earlier. Investigations were made of the following:

- 1) The static ferromagnetic field of the ship and the degree of compensation of this by the degaussing system.
- 2) The dynamic field due to a combination of eddy currents and "tilt" effect. A "tilt" corrector, which was installed on the ship, was tested during this trial.
- 3) The static "tilt" field of the ship and the compensation of this by the "tilt" corrector.
- 4) The pulse field arising from the system consisting of the impulse generator, the impulse controller, and the cables connecting the impulse generator to the minesweeping loop.
- 5) The field of a magnetic clutch which was an integral part of the 400-cycle power supply.
- 6) The field of the minesweeping cable winch when operating under full load.
- 7) The field of the cathodic protection system.

A large number of magnetic field recordings were made during these trials. These are now being analyzed.

DYNAMIC CHARACTERISTICS OF THE INDUCED FIELD  
IN FERROMAGNETIC BODIES

Reference: Navy. DND Project A17-05-60-07

Period under review: January - March 1958

Ferromagnetic degaussing systems are usually designed to compensate a ship's magnetic field in the even-keel position only. During rolling and pitching, a mismatch occurs between the degaussing field and the ship's field. This gives rise to a time-varying field sometimes called "tilt" field. The objectives of the project on "tilt" fields are to study the frequency characteristics of this effect and to determine the required dynamic system which will compensate this field correctly.

In the Canadian minesweepers under investigation by the National Research Council there are a number of ferromagnetic parts which can be considered as short cylinders. Previous experimental studies have been made of short cylinders magnetized in the direction normal to the axis. This work has now been extended by measuring the field of the same cylinders when magnetized along the axis, as well as determining the degaussing field for this case.

A report (ERA-332) has been written on this work.

TELEMETRY ANTENNA FOR CARDE TEST VEHICLE

No DND project number .

Period under review: January - March 1958

At the request of CARDE, Valcartier, Que., a program has been under way to develop a telemetry antenna system for a new propulsion test vehicle. CARDE requirements call for an antenna system near the nose of the vehicle, in proximity to the telemetry equipment, since it is not feasible to run coaxial cable from the nose to an antenna system located near the tail, because of the heat generated by the rocket motor. The geometry of the vehicle launching tower further dictates that external projections occur in line with the three control fins. Pattern studies at  $\frac{1}{13}$ -scale have shown satisfactory performance using three unipole antennas inclined at  $45^\circ$  to the vehicle center-line, and spaced  $120^\circ$  around its circumference. Two of these are excited in push-pull, and the third operates as a parasitic element.

Six prototype antennas have been constructed by CARDE. One set of three was made in the form of tapered cylindrical unipoles, and have been satisfactorily matched over a limited band of frequencies. The second set are of aerofoil cross section to increase the impedance bandwidth and to reduce the aerodynamic drag. These antennas have not yet been tested.

ANTENNA FOR AIRBORNE EARLY WARNING

Reference: USAF. No DND project number

Period under review: January - March 1958

In co-operation with Division IV, Lincoln Laboratory, a combination radar-IFF antenna has been developed for use with an experimental airborne early-warning system. The antenna consists of two  $52\frac{1}{4}$ " focal length pillboxes stacked one above the other, having a horizontal aperture of 16 feet. The radar portion operates with horizontal polarization in the frequency range 650-700 mc/s, and the IFF portion, with vertical polarization, in the frequency range 990-1130 mc/s.

The prototype antenna, the Mark IIA, was delivered to Lincoln Laboratory in December 1957 and underwent successful flight tests in January 1958. In the period under review a scale-model study was carried out to determine the airborne radiation patterns when the antenna is mounted on a WV-2 aircraft. Development and testing of the prototype and scale-model antennas are described in NRC Report ERB-464, "An Antenna for Airborne Early Warning" (Confidential).

In the period under review, a second antenna, the Mark IIB, has been designed and nearly completed. This antenna does not include an IFF section, but provides dual-channel operation at the radar frequency. A conducting vane divides the "cheese" reflector and feed system into two parts which can be excited either in, or out of phase, through independent coaxial inputs. The antenna pattern for the in-phase or "sum" channel is almost identical with that obtained with the Mark IIA antenna, while the out-of-phase or "difference" channel produces a split beam. In operation, transmission takes place through the "sum" channel, while reception takes place through both channels. Radiation patterns have been checked on a full-scale mock-up of the antenna and it is expected that the project will be completed in April.



MODEL ANTENNA STUDIES FOR HMCS "ST. LAURENT"

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

Period under review: January - March 1958

A basic investigation is being continued on broadband HF antenna systems for HMCS "St. Laurent". Two methods of exciting the main mast of the destroyer to operate as an HF antenna in the frequency range 2 to 5 mc/s are being investigated. Model impedance measurements have been conducted on a notch configuration and the results indicate that this method of excitation is basically narrow-band. A second method which appears more promising, is a folded monopole configuration where the mast serves as the grounded element. Impedance measurements are currently being carried out on a 1/6-scale model of the main mast.

X-BAND WAVEGUIDE SWITCH FOR THE ROYAL CANADIAN NAVY

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

Period under review: January - March 1958

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

Construction and performance of the switch was reported in NRC Report ERB-452, which includes photographs of the PPI display during switching.

JAMMING STUDIES

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

Period under review: January - March 1958

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

The study is concerned with both the properties, capabilities, and limitations of the more promising generators of jamming signals and the manner in which such signals affect various systems, so that the feasibility of jamming can be predicted. Knowledge of what may be expected in the way of jamming by a hostile force, and the susceptibility of our defences to such jamming is necessary in defence system planning.

Investigation of the effects of FM-by-noise jamming of radar receivers was continued. A study of the advantages and limitations of the "Local Oscillator Off" fix was completed. A summary of the results in the form of a technical memorandum was produced for the Working Group of "Project Napkin", and a more detailed report has been prepared for publication.

Jamming tests on the AN/SPG-48 radar were commenced. Measurements of the ratio of FM-by-noise jamming power to signal power required to unlock the range gate of the radar are to be followed by measurements of the maximum value of this ratio for which tracking can be initiated while in the search mode. Incidental to the jamming tests, it was possible to advise the RCN on the reduction in noise figure which could be obtained by the use of improved types of crystals in the radar mixer.

A cathode-ray tube — photocell method of conical-scan antenna-pattern simulation was investigated. Satisfactory signals for the control of a linear modulator were generated, but difficulty was experienced in obtaining such a device. Ferrite modulators have undesirable hysteresis effects, while TWT amplifier grid characteristics exhibit non-linear behaviour except over a narrow dynamic range. The added complexity of a feedback scheme may be required for satisfactory overall performance.

Regarding the 0.1 - 50 mc/s noise source described in the previous issue of the Progress Report, initial tests of the printed circuit model of the distributed amplifier stage showed sufficient promise that a three-stage amplifier using printed wiring is being constructed.

ANTENNA FOR X-7769 CARCINOTRON JAMMER

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

Period under review: January - March 1958

During the period under review an improved mounting arrangement was devised for the dielectric slab antenna. An X-band model incorporating the modification was built, and tests showed no substantial pattern changes. A full-scale dielectric slab antenna employing the improved mounting arrangement is under construction.

VULNERABILITY OF THE DOPPLER DETECTION SYSTEM TO COUNTERMEASURES

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

Period under review: January - March 1958

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 might be done to counter them.

Analysis of the results of the flight trial of the experimental, airborne, super-regenerative repeater-jammer was completed and the results were published. The flight trial revealed that when the jammer was modulated the frequency deviation was inadequate. Further work established that the required frequency deviation can be achieved with mechanical modulation of the oscillator cavity.

The VAD-161 tube, serial no. 3, received from Varian Associates was checked and used for some experimental work, but its usefulness is limited by the relatively high VSWR of the input and output transition.

Further investigation of the quasi-homodyne operation of the backward-wave amplifier tube type VAD-161 was centered on amplification of variations in collector current. These variations at a video rate, resulting from modulation of the electron beam, offer a possible alternative to a crystal diode detector at the output of the backward-wave amplifier.

Variations in collector current are very small, and consequently, the minimum detectable signal is some 10 db worse than with a crystal detector. However, by employing velocity-sorting detection, output can be increased and a minimum detectable signal equivalent to crystal detection of the backward-wave amplifier output can be achieved. The problem of optimizing the velocity-sorting detection over the wide range of d-c beam velocities inherent in broadband operation are undergoing further study. The present configuration of the collector is believed to be partly responsible for the low output.

INSTANTANEOUS MICROWAVE FREQUENCY INDICATOR

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

Period under review: January - March 1958

The purpose of this project is the development of a microwave instantaneous frequency-indicating device based on the principle of amplitude comparison of the video-detected outputs of a set of filters. A TWT amplifier is required to maintain sensitivity roughly equivalent to that of a crystal video receiver because of the losses involved in power division among the filters and padding between components, and because of lower antenna gain.

An S-band (2000-4000 mc/s) experimental system of 8 stripline filters with cascaded directional couplers for power division was assembled to determine the amount of error that might be expected. With ordinary components the error can be reduced to  $\pm 30$  mc/s on a direct-reading scale. Calibration will reduce this further. A system with 12 filters is under construction. The feasibility of direct calibration by a reference signal from a buzzer RF power source and a calibrated cavity has been checked over the frequency range 3000 to 4000 mc/s with an AN/UPM-46 test set. The power available from this source is marginal. An S-band and an X-band permanent-magnet-focussed TWT amplifier for use with this device has been procured.

GROUND-TO-AIR COMMUNICATIONS USING IFF (CUFF)

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

Period under review: January - March 1958

This system was designed to provide an emergency ground-to-air communications link, using the receiver of the airborne transponder of the Mark X IFF system. A small decoder is the only additional airborne equipment, and normal interrogations can be carried on simultaneously with the use of a frequency-modulated pulse carrier for voice communication. An operational trial of this system was carried out in December 1957 from RCAF Station Foymount, Ontario, with some measure of success. The main difficulty was that of orienting the narrow-beam ground antenna. To help overcome this difficulty, an azimuth gating circuit has been built to aid in discerning the normal IFF reply when a continuous ring is being painted on the PPI from the interrogations from the steerable ground antenna. A circuit was also designed and a chassis built, which, together with a modified airborne transponder, can be used as a test set to check the airborne installations. Neither the test set nor the azimuth gating circuit has been tried in practice, since a decision has not yet been reached whether or not to proceed with further trials.

HIGH ALTITUDE MODIFICATIONS TO AN/APX-6 IFF TRANSPONDERS

Reference: RCAF. No project number.

Period under review: January - March 1958

Four AN/APX-6 IFF transponders which had been modified for use at an altitude of 50,000 feet were tested in flight trials at RCAF Station Foymount in December 1957. Results showed that these sets performed satisfactorily, though in some cases there appeared to be a small decrease in range. This completes the part of the project assigned to the National Research Council.

At present, several modified sets are being tested by the contractor (Canadian Aviation and Electronics Co., Ltd.) in order to determine any changes in the life expectancy of the circuit components affected by the modification.



CLASSIFIED REPORTS ISSUED

The following classified reports were issued by the Radio and Electrical Engineering Division during the period under review :

Burtnyk, N.                      I.F. Amplifiers and Gain Control for a Matched Twin-channel Receiver (ERB-431, Confidential)

Development of I.F. amplifiers and a gain control for a twin-channel receiver is discussed with particular reference to a specific design in AN/GRD-501 HF/DF equipment. Final choice of circuit design was rigidly governed by desired performance specifications as well as ease of maintenance.

Evans, G.                      Proposal for a Short-signal Intercept Receiver (ERB-453, Secret)

A requirement exists for the rapid development of a shipborne equipment capable of intercepting short-duration signals transmitted on frequencies in the band 1.5 to 30 mc/s. A proposal is made for a receiver built largely of existing equipment, or equipment for which the circuits are in an advanced stage of development, which would be capable of displaying a band of signals 1 mc/s wide, either directly, or on a panoramic display.

Hendry, A.,  
and  
Epp, C.A.                      A Fast-acting High-power X-band Waveguide Switch (ERB-452, Confidential)

A high-power X-band waveguide switch and associated control circuitry is described. Rapid operation and a high degree of isolation are obtained with the switch. PPI photographs illustrating use of the switch for radar illumination of preselected sectors are included.

Hunt, F.R.                      A Portable Receiver for Antenna Pattern Measurement (ERB-458, Restricted)

In the past the necessary additional equipment rendered radar antenna pattern measurement inexpe-

dient in the field. A solution was found in an antenna pattern receiver whose output is displayed on the usual PPI of the radar installation. The only additional equipment required is a c-w signal generator and a simple antenna, which are readily available on most Service radar sites. The receiver circuits, methods of use, and an illustration of the results obtainable are given in this report.

- Kenney, J.R.      Ground-to-air Communication Using Mark X IFF (A summary of progress to December 1957) (ERB-457, Secret)
- Morse, A.R.      A Study of Failures in Some 400-cycle 45-kw Alternators (Supplement to Report ERB-423) (ERB-446, Restricted)

This report describes an investigation of the manufacturing and assembling processes used by Kato Engineering, Mankato, Minnesota, during construction of 400-cycle generators. Tests made by the manufacturer on one of the Canadian Army's 400-cycle machines are also described. This machine, prior to testing, had shown signs of impending failure, similar to failures which had occurred on other identical machines. Finally, the discussions which took place between NRC, the Canadian Army, and Kato Engineering as a result of the foregoing are summarized, and the line of action decided upon is outlined.

The tests confirmed the original findings, that failures occur at phase-to-bus tie points, but the investigation could not determine the cause of failure.

It was agreed that the best line of action would be to re-wind all used machines as soon as possible, and to apply a special coat of varnish to unused machines before they were put into service.

- Wong, J.Y.      A High-resolution Slotted-waveguide IFF Antenna for the AN/FPS-3 Radar (ERB-456, Secret)

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