AD NUMBER

ADC954499

CLASSIFICATION CHANGES

TO: **unclassified**

FROM: **confidential**

LIMITATION CHANGES

TO:

Approved for public release, distribution unlimited

FROM:

Controlling DoD Organization... Naval Research Laboratory, Washington, DC 20375.

AUTHORITY

NRL ltr, 23 Jan 2004; NRL ltr, 23 Jan 2004

NAVAL RESEARCH LABORATORY REPORT

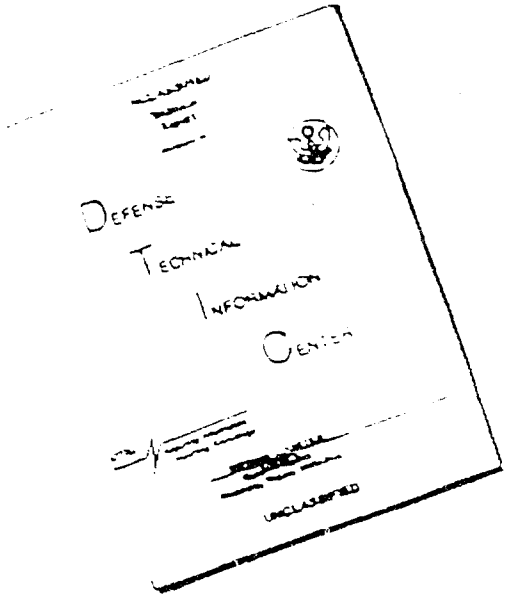
THE EFFECTIVENESS OF THE AN/APQ-2 "RUG" JAMMING TRANSMITTER USING MODIFICATION KIT MX527/APQ-2 FOR FREQUENCY MODULATION

By K. M. Watson

- Report R-2839 -

NAVAL RESEARCH LABORATORY
WASHINGTON 20, D. C.

DISCLAIMER NOTICE



THIS DOCUMENT IS BEST QUALITY AVAILABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

COPY NO. 29

Navy Department - Office of Research and Inventions

NAVAL RESEARCH LABORATORY
Washington, D.C.

* * *

SHIP-SHORE RADIO DIVISION - SEARCH RADAR SECTION

15 May 1946

THE EFFECTIVENESS OF THE AN/APQ-2 "RUG" JAMMING TRANSMITTER USING MODIFICATION KIT MX527/APQ-2 FOR FREQUENCY MODULATION (C)

By K. M. Watson

- Report R-2879 -

V 41431
CONFIDENTIAL

* * *

Approved by:

R. C. Guthrie - Head, Search Radar Section

L. A. Gebhard - Superintendent, Ship-Shore Radio Division

Commodore H. A. Schade, USN
Director, Naval Research Laboratory

Preliminary Pages . . .	a-c
Numbered Pages	8
Plates	3
Distribution List . . .	d

NRL Problem S1182

ABSTRACT

The purpose of the AN/APQ-2 ("Rug") transmitter modification kit MX527/APQ-2 is to sweep the "Rug" center frequency from 5 to 20 Mc at a low rate. It was hoped that the jamming bandwidth of the "Rug" would be considerably increased with no decrease in its effectiveness at any one frequency. The results given in this report indicate that the jamming effectiveness is decreased by sweeping the transmitter output to such an extent that the use of the swept signal is not justified.

TABLE OF CONTENTS

INTRODUCTION

1. The purpose of the AN/APQ-2 modification kit MX527/APQ-2 was to sweep the jammer center frequency back and forth over a range of 10 to 20 Mc at a rate of a few cycles per second. Several preliminary modification kits were received by this laboratory to be tested. Further tests than those reported here were considered inadvisable in view of the termination of the war. Work on this problem was conducted under the authorization of NRL Problem S1182T-0, in accordance with references 1 and 2.

2. Investigations were undertaken to determine whether: (1) the increase in the jamming spectrum width might not make the AN/APQ-2 effective as a barrage jammer, (2) the setting-on-frequency problems might not be simplified due to the wide frequency distribution of jamming power, and (3) an increase in actual jamming effectiveness at any spot in the jammed channel might not result due to the random displacement of the indicator base line as the jamming carrier is swept back and forth through the receiver pass-band. In addition, tests were conducted to determine the optimum combination of sweep excursion width and sweep excursion rate for maximum jamming effectiveness against a radar system of specified bandwidth. The effectiveness of the swept AN/APQ-2 in all cases was referred to that of the same jammer unswept.

3. The kit was designed to be installed in the field. It consisted of a small butterfly-type variable condenser driven by a 24-volt d-c motor, two sets of loading coils, two short flexible straps for shorting these loading coils, and two output pick-up loops. Plate 1 shows a photograph of the kit installed. When installed, the butterfly-condenser is connected in shunt with the plate lines at the high impedance ends and during rotation causes an excursion of the center frequency over a fixed band. The width of this band depends on both the central frequency about which the jammer is sweeping and on the number of plates in the rotating condenser. At a central frequency of 220 Mc, the excursion width can be adjusted in steps between the limits of 3 and 20 Mc while at 350 Mc the width is adjustable between 10 and 20 Mc. The central frequency, in turn, can be set anywhere between 150 and 350 Mc by making use of various combinations of loading coils and shorting straps. The rate of excursion is controllable over a range of 6 to 16 sweeps per second by adjustment of a rheostat in the armature of the 24-volt drive motor.

METHOD OF MEASURING EFFECTIVENESS

4. The tests were conducted in the laboratory using a simulated radar system for the jammed "victim". The jammer was operated into a water-cooled load and a variable attenuator-probe was used in the transmission line to pick off a small amount of its output energy for introduction into the simulated radar system. An artificial echo signal to be jammed was supplied from a pulsed signal generator and fed to the receiver input circuit through a decoupling network. Then, in the presence of jamming the echoes were decreased in strength until just visible on a type "A" indicator. The output of the pulsed generator in db was then recorded

and used as a measure of jamming effectiveness. The signal generator reading for a given test was taken both with the "Rug" operating normally (not swept), and with the MX527/APQ-2 attachment in operation (sweeping). The measure of effectiveness given in the tables of data which follow the text is the difference in reading from the swept and unswept condition - i.e., the data gives the relative jamming effectiveness for these conditions. The details of the measuring technique are more fully described in reference (3).

RESULTS

5. Various combinations of sweep excursions and sweep frequencies were tried and each compared with the "Rug" unswept.

6. Tabulated values of the jammer r-f power output are given in Table 1. At both ends of the frequency range the power dropped down for large excursions of the frequency sweep. Typical power spectra are shown in Plate 3.

7. The effectiveness was then measured for various sweep excursions, sweep rates, and receiver bandwidths. The results of these measurements are tabulated for a center frequency of 210 Mc in Tables 2, 3, and 4. For other center frequencies similar comparisons were made and are shown in Table 5. For each set of conditions, the readings are corrected to give "db relative to the effectiveness when the 'Rug' is operated unswept". For narrow sweep excursion and wide-band receivers, it appears that the jamming effectiveness is a little greater for the swept case than for the non-sweeping case. This seems to be due to the breaking up of the clipping level of the noise, as a result of sweeping the jamming signal into and out of the receiver pass-band. However, for very wide excursions (20 Mc), the minimum detectable signal using the "swept Rug" was found to be only a little greater than that for the receiver in the absence of jamming - - i.e., the jamming was almost totally ineffective. The effect of receiver bandwidth (except for clipping effects - - see reference 3) seems to be that the decrease in effectiveness due to the sweeping of the transmitter is less for wider bandwidth, since for such a receiver the signal is within the i-f pass-band a greater portion of the time.

8. A typical set of curves for the power-output spectra are shown in Plate 3. These are given for no sweep, minimum excursion, and maximum excursion at a center frequency of about 140 Mc.

RECOMMENDATIONS

9. With large sweep excursions, the "Rug" appears to be worthless for the purpose of obscuring an echo. It could conceivably have some nuisance value, however. For smaller excursions, the advantage of broadening the output spectrum is largely lost. It thus becomes questionable as to whether the added complication entailed by the use of the frequency sweeping device is worthwhile. It is suggested, however, that this problem could be studied further.

REFERENCES

1. BuShips ltr to NRL, C-A22.1(920-Db), C-920-7447, dated 19 July 1945, requesting assignment of Problem S1182.

2. NRL ltr to BuShips, C-S67-5/RCM (701), Ser. C-701-2965/45, dated 26 July 1945, assigning Problem S1182T-C, Priority A-2.

3. NRL Secret Report R-2498, dated 18 July 1945: The Dependence of the Effectiveness of Clipped Noise Jamming On the Radar Receiver Bandwidth.

TABLE I

Power Output of Swept AN/APQ-2 Jammer at Various Frequencies

Center Frequency (Mc)	Total Sweep Excursion (Mc)	Po(watts)	Condenser coupled to plate line by
158	0	7	4 turn loading coils.
158	5	7	
158	18	3	
200	0	14	1¼ turn coils
200	10	13	
200	19	12	
255	0	12	1½ turn coils
255	10	17	
350	0	15	straps
350	22	9	

TABLE II

Effectiveness of Swept AN/APQ-2 Transmitter Relative To Normal AN/APQ-2 Transmitter

Total Frequency Excursion - 4 Mc
Center Frequency - 210 Mc
Power Output - 7 Mc

Sweep Rate (cps approx)	Receiver Bandwidth (Mc)	Effectiveness (db)
5	1.5	+ 1
10	1.5	+ 3
20	1.5	+ 4
5	.5	- 7
10	.5	- 4
20	.5	- 4
5	.2	- 17
10	.2	- 13
20	.2	- 11

TABLE III

Effectiveness of Swept AN/APQ-2 Relative To Normal AN/APQ-2 Transmitter

Total Frequency Excursion - 10 Mc
Center Frequency - 210 Mc
Power Output - 7 Watts

Sweep Rate (cps approx)	Receiver Bandwidth (Mc)	Effectiveness (db)
5	1.5	- 12
10	1.5	- 11
20	1.5	- 11
5	.5	- 19
10	.5	- 16
20	.5	- 16
5	.2	- 30
10	.2	- 27
20	.2	- 28

TABLE IV

Effectiveness of Swept AN/APQ-2 Transmitter Relative to Normal AN/APQ-2 Transmitter

Total Sweep Excursion - 20 Mc
Center Frequency - 210 Mc
Power Output - 7 Watts

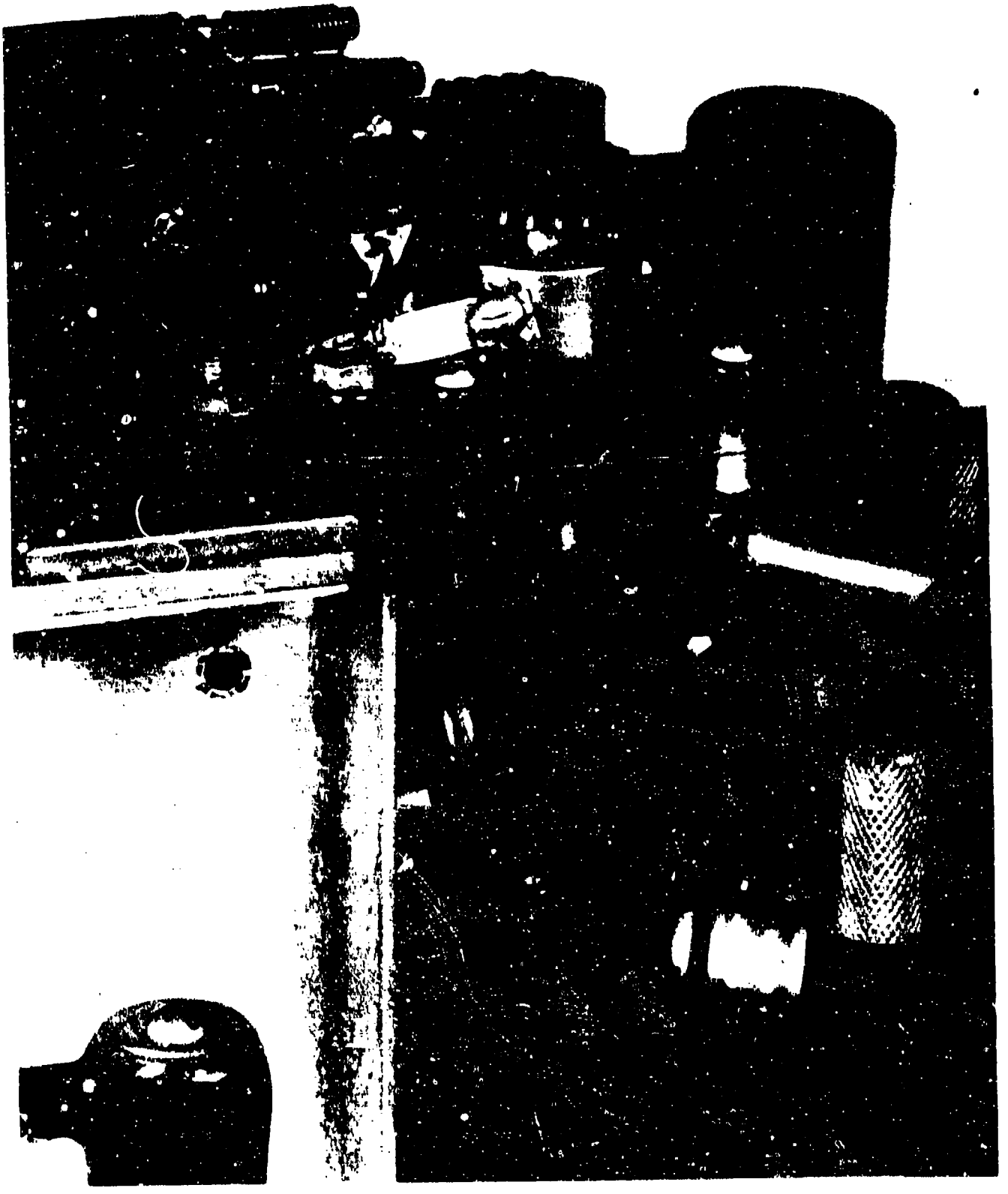
Sweep Rate (cps approx)	Receiver Bandwidth (Mc)	Effectiveness (db)	Min. Det. Signal of Rec.
5	1.5	- 25	- 39 db
10	1.5	- 19	- 39 db
20	1.5	- 29	- 39 db
5	.5	- 33	- 41 db
10	.5	- 30	- 41 db
20	.5	- 35	- 41 db
5	.2	- 41	- 48 db
10	.2	- 40	- 48 db
20	.2	- 43	- 48 db

TABLE V

Effectiveness of Swept AN/APQ-2 Transmitter Relative to Normal AN/APQ-2 at Various Frequencies

(Operated against RDO Receiver)

Center Frequency (Mc)	Sweep Excursion (Mc)	Sweep Speed (cps)	Effectiveness (db)
350	20	16	- 24
350	20	5	- 15
350	10	16	- 10
350	10	5	- 9
204	20	16	- 10
204	20	5	- 5
204	3	16	- 3
204	3	5	0
146	20	16	- 11
146	20	5	- 5
146	3	16	- 1
146	3	5	0

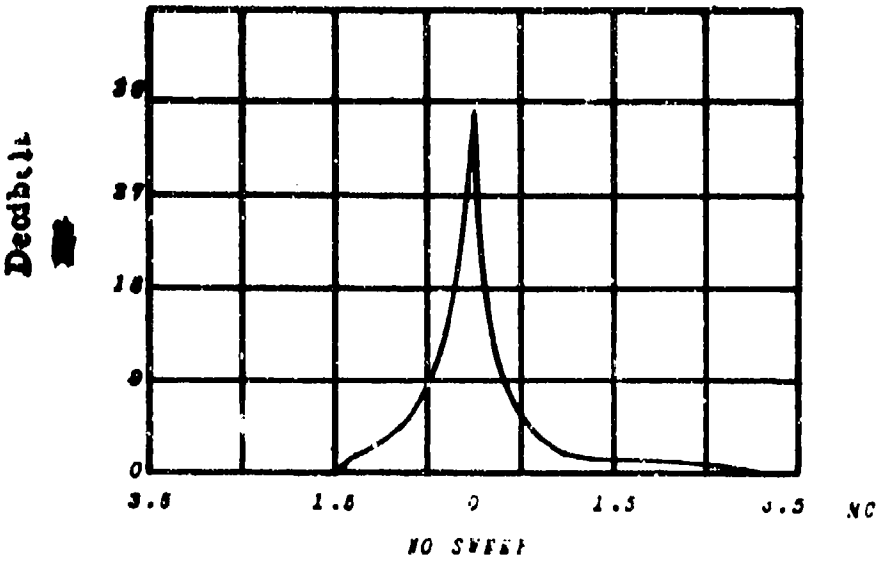


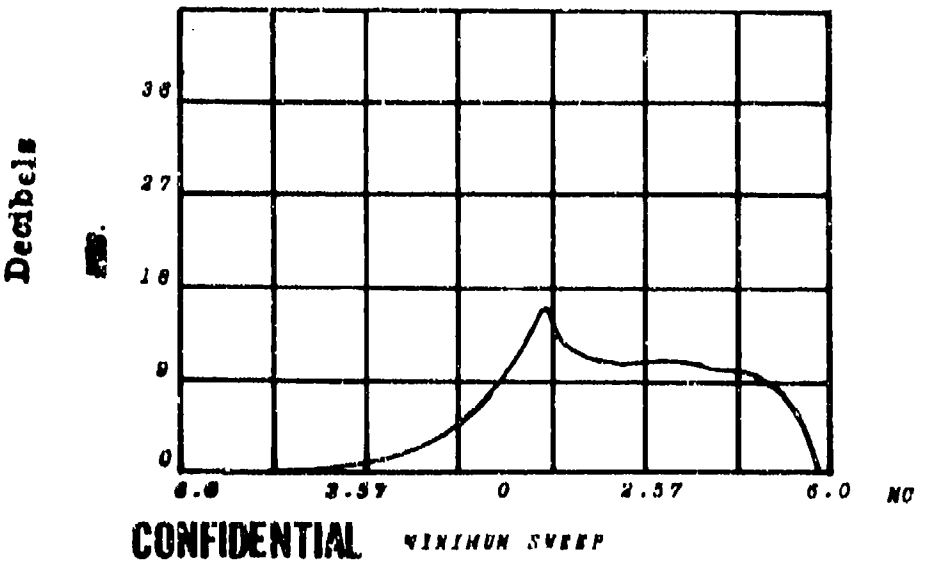
CONFIDENTIAL

PLATE I

CONFIDENTIAL

PLATE 2





CONFIDENTIAL

PLATE 3

DISTRIBUTION LIST

5 Chief, Bureau of Ships, Navy Department, Washington 25, D.C.

1. Office of Research and Inventions, Navy Department, Washington 25, D.C.

1. Commanding Officer, Radio Materiel School, Naval Research Laboratory, Washington, D.C.

6 Chief of Naval Operations, Navy Department, Washington 25, D.C. Attention: Code Op-413-B2

1 Chief of Naval Operations, Navy Department, Washington 25, D.C. Attention: Code Op-413-B3

1 Commanding General, Army Air Forces, Washington 25, D.C. Attention: Miss L. Diamond, Office of Air Communications Officer

1 Office of Chief Signal Officer SPSOI-4 Army Service Forces, Washington 25, D.C.

3 Navy Liaison Officer, Fort Monmouth, New Jersey

1 U. S. Naval Electronics Laboratory, San Diego, California

Naval Research Laboratory
Technical Library
Research Reports Section

DATE: January 23, 2004

FROM: **Mary Templeman**, Code 5596.3

TO: **Code 5300 Paul Hughes**

C: Tina Smallwood, Code 1221.1 tz 1/30/04

SUBJ: Review of NRL Report

Dear Sir/Madam:

Please review NRL Report 3665, 3968, 3682, 3617, 2713, 2827, and 2839 for:

- [x] Possible Distribution Statement
- [x] Possible Change in Classification

Thank you,

Mary Templeman
(202)767-3425
maryt@library.nrl.navy.mil

The subject report 5 (ALL) can be:

- [x] Changed to Distribution A (Unlimited)
- [ ] Changed to Classification Unclass
- [ ] Other:

Paul K Hughes II 1/23/2004
Signature Date