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411-138 December 26, 1944

SENSITIVITY OF THE AN/APR-5A IN WAVEGUIDE, 3 TO 10 CM

RADIO RESEARCH LABORATORY
HARVARD UNIVERSITY

NATIONAL DEFENSE RESEARCH COMMITTEE
DIVISION OF RADIO COORDINATION (15)

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OEMsr-411
Project RP-107
RRL R-1000

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411-138

ABSTRACT

The sensitivity (r-f power necessary to produce an audio signal power equal to the noise power) of the AN/APR-5A receiver in waveguide ranges from 10^{-10} watts at 10 cm to 10^{-7} watts at 3 cm. The sensitivity of the receiver is about the same for each of the oscillator harmonics.

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A. INTRODUCTION.

The need having arisen for a microwave search receiver at frequencies above 6000 megacycles, the most expedient solution seemed to be the operation of the AN/APR-5A receiver in waveguide at frequencies above those for which it was originally designed; i.e., 3000-6000 Mc. For this use information about the absolute sensitivity of the receiver was necessary over the proposed range of 3 to 10 cm. The absolute sensitivity is defined as the receiver r-f input power that produces an audio signal power equal to the noise power. Since the receiver operates on harmonics of the local oscillator, the sensitivity of the receiver is partially determined by the relative power of these. This report presents the results of measurements of the absolute sensitivity of the AN/APR-5A for each of the possible harmonics over the 3 to 10 cm. range.

B. METHOD OF MEASUREMENT.

The test oscillators were 100% square-wave modulated and worked into dissipative "padding" cable which was always between the oscillator and the coaxial-line-to-wave-guide transformer. R-f power measurements were made by matching into a thermistor for maximum power measured on a Radiation Laboratory TBN-3EV thermistor bridge. The coaxial-line-to-wave-guide transformer was matched so that power reflected from the receiver mixer would not be reflected back by the transformer. This was done to simulate an antenna matched to space.

For each harmonic response the receiver was tuned for maximum audio output with all gain controls on maximum. The audio output power was determined by the current through a constant 670-ohm load as measured on a sensitive thermocouple and galvanometer.

The r-f power into the receiver was taken as the power measured on the thermistor bridge attenuated by known amounts. The attenuation was introduced by fixed lengths of RG-21/AU cable whose attenuation as a function of frequency is reliably known over the entire range (see report 411-123). The r-f power input to the receiver was adjusted so that the audio signal power was equal to the noise power.

C. RESULTS.

The results of the measurements are presented in tabular form in Table I and graphically in Fig. I. Measurements were made on one of the production models of the receiver and should be fairly representative of the receivers generally.

D. DISCUSSION OF THE RESULTS.

The variations in the sensitivity shown in Fig. I for the several harmonics are much greater than the probable error in the input r-f power. This error is of the order of 3 db maximum at 3 cm and 1.5 db maximum at 10 cm.

Possible causes for these variations are: (1) change in sensitivity with crystal current (2) changes in relative oscillator harmonic output with tuning (3) variation of noise power level with tuning.

A comparison of the AN/APR-5A waveguide mixer with a small X-band waveguide mixer of similar type at 3.26 cm wavelength showed the smaller mixer to be 20.8 db better for the 8th harmonic and 18.3 db better for the 4th harmonic. This improvement was probably due to the fact that the small mixer was used with 3 cm width guide while the larger mixer used 5 cm guide, the latter allowing propagation of the TE_{03} mode. The existence of the TE_{03} mode was verified from standing-wave patterns in the line. The length of waveguide between the coax-to-waveguide coupler and the mixer crystal determines the position of the crystal in the TE_{03} standing-wave pattern. Thus the receiver sensitivity will vary with this length. To overcome this difficulty, a wave-guide "line stretcher" was used to obtain maximum and minimum sensitivities. The arithmetic mean of these values was recorded.

Fig. I shows that the sensitivity of the receiver at a particular frequency is not greatly different for any of the harmonics of the local oscillator out to the 9th.

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December 20, 1944

TABLE I

FREQUENCY MC	HARMONIC OF OSCILLATOR	RF POWER FOR AUDIO P=NOISE P WATTS
9200	9th	1.4 x 10-6
	8th	2.0 x 10-7
	7th	1.7 x 10-7
	6th	2.6 x 10-7
	5th	9 x 10-8
	4th	2.5 x 10-7
8770	8th	2.5 x 10-7
	7th	2.4 x 10-8
	6th	3.3 x 10-9
	5th	1.9 x 10-8
	4th	1.6 x 10-8
7500	7th	1.3 x 10-7
	6th	8.6 x 10-9
	5th	5.6 x 10-9
	4th	2.0 x 10-9
	3rd	7.3 x 10-10
6500	6th	4.6 x 10-9
	5th	1.7 x 10-9
	4th	5.0 x 10-9
	3rd	2.0 x 10-9
5950	5th	3.0 x 10-8
	4th	8.4 x 10-10
	3rd	3.5 x 10-10
5450	5th	1.3 x 10-8
	4th	4.7 x 10-10
	3rd	8.4 x 10-10
	2nd	9.9 x 10-11
4830	4th	1.3 x 10-9
	3rd	9.3 x 10-10
	2nd	1.9 x 10-9
4020	3rd	5.5 x 10-10
	2nd	2.8 x 10-10
3540	3rd	1.3 x 10-10
	2nd	6.6 x 10-10
3240	3rd	2.2 x 10-10
	2nd	2.3 x 10-10

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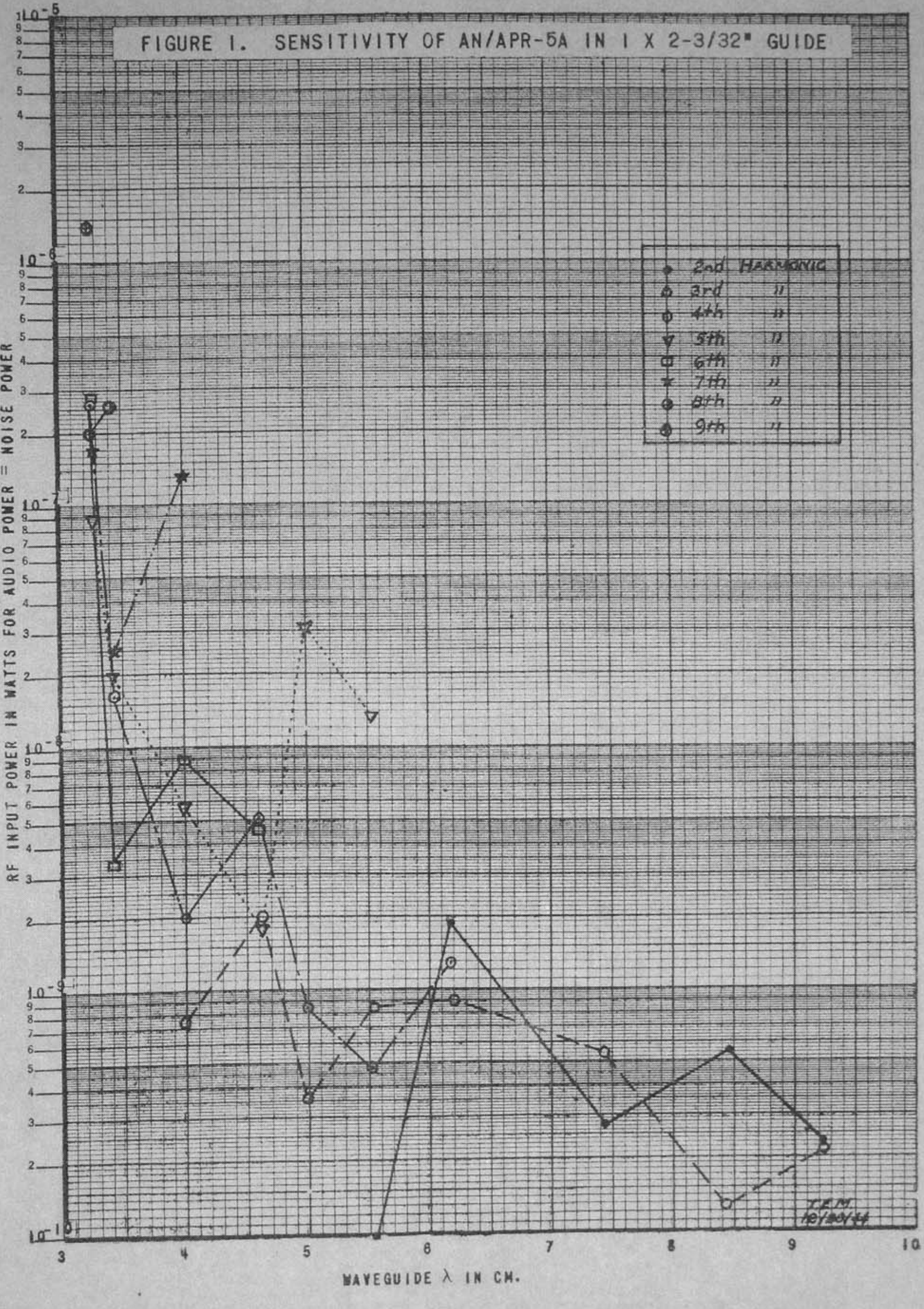

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