23 March 1936

NRL Report No. R-1250
BuEng. Prob. No. R5-10

NAVY DEPARTMENT

BUREAU OF ENGINEERING

FR-1250

Report

on

Test of Models RAA and RAB Receiving Equipments. R.F. and I.F. Amplifier and Detector Circuits of Models RAA-RAB. (Supplementing Reports No. R-1028 and R-1030.)

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D.C.

Number of Pages: Text - 10 Tables - 5 Plates - 50

Authorization: BuEng. ltr. S67/46/L5(12-22-W8) of 26 Dec. 1933.

Date of Test: Intermittently from April 1934 to January 1936.

Prepared by: W.B. Burgess, Radio Engineer. S.A. Greenleaf, Asst. Radio Engineer.

Reviewed by: T. McL. Davis, Radio Engineer, Chief of Section.

A. Hoyt Taylor, Principal Physicist, Superintendent, Radio Division.

Approved by: H.M. Cooley, Captain, USN, Director.

Distribution:
BuEng. (10)

ejj

TABLE OF CONTENTS

APPENDICES

APPENDICES (Continued)

AUTHORIZATION FOR TEST

1. The tests herein reported were authorized by reference (a). Other additional references pertinent to the tests are listed as references (b) to (g).

Reference: (a) BuEng. ltr. S67/46/L5(12-22-W8) of 26 December 1933.
(b) Memo on conference relative to BuEng. Prob. R5-7 dated 30 March 1934.
(c) NRL Report No. R-1027.
(d) NRL Report No. R-1028.
(e) NRL Report No. R-1030.
(f) NRL Report No. R-1063.
(g) NRL Report No. R-1042.

OBJECT OF TEST

2. This problem covers exhaustive tests and examination of the Model RAA-RAB receiving equipments, and this report covers the additional work determined upon at a conference in the Bureau of Engineering on 29 March 1934, as described in reference (b).

ABSTRACT OF TEST

3. The following tests were made to supplement the tests previously reported in references (c), (d), (e) and (f):

(a) Determine the time constant under key-click conditions (duplex operation) in first oscillator detector combination of the Model RAB equipment.

(b) Investigate the detector and oscillator plate current, oscillator frequency instability, and detector bias, resulting from various overload conditions.

(c) Investigate frequency drift, Model RAB, at 8000 kcs., also high and low L/C ratios.

(d) Complete sensitivity and selectivity measurements in bands B-1, B-2, C-1, C-2, D-1, and D-2 of the Model RAB.

(e) Make a complete investigation of receiver response to frequencies other than the fundamental, with relatively high input, Models RAA and RAB.

(f) Obtain second detector sensitivity for the Model RAB.

(g) Investigate to determine the effect of using a 300-ohm resistor in place of a reactive dummy antenna combination on pre-selector characteristics in both Models RAA-RAB. Determine the best average dummy antenna capacitance for use with the compensating condensers supplied in these receivers.

(h) Make pre-selector measurements for Model RAA equipment in loose coupling positions.

(i) Make comparative selectivity curves by three methods. First use a modulated input and the total audio output. Second, use a wave analyzer for the measurement of signal output. Third, use increments in second detector plate current as an indicator of standant output.

(j) Determine individual stage gains, Model RAB.

Band B-1 - 2460, 3128, 3956 kilocycles.
B-2 - 3956, 5010, 6320 kilocycles.
C-1 - 6320, 8000, 10130 kilocycles.
C-2 - 10130, 12830, 16190 kilocycles.

(k) Determine microvolts on any grid with 1 microvolt antenna input, Model RAB.

Band A-1 - 1000, 1244, 1544 kilocycles.
A-2 - 1560, 1950, 2460 kilocycles.
B-1 - 2460, 3128, 3956 kilocycles.
B-2 - 3956, 5010, 6320 kilocycles.
C-1 - 6320, 8000, 10130 kilocycles.
C-2 - 10130, 12830, 16190 kilocycles.

(l) Measure selectivity, Model RAA, at 100 kilocycles and sensitivity, all bands, after complete realignment.

Conclusions

(a) From the exhaustive tests and examination of the Model RAA and RAB equipments, certain performance characteristics have been observed which are pointed out for the Bureau's information.

(b) In the Model RAB, with inputs exceeding 0.5 volt on the grids of either the first or second detector, instability of the first and second oscillators is noted, which effect increases in proportion to the voltage applied. In the first oscillator a frequency change is noted. Prior to the change from type 38064 to type 56 tubes, spurious oscillations occurred causing the detector tube to become more or less regenerative, producing in effect a super-regenerative first detector. Since the change to type 56 tubes, spurious oscillations do not occur with selected tubes of this type.

(c) In the case of the second oscillator, in addition to a considerable frequency change, oscillations are stopped over a range above and below the normal setting of the tuning vernier, the breadth of this range varying with the voltage input to the second detector grid. In both cases, the instability appears to result from an increase in damping of the oscillator tuned circuit with increased signal levels. An increase in signal level apparently decreases the plate-cathode resistance of the detector, and since this is coupled to the oscillator, a progressive increase in damping results.

(d) In the Model RAA, measurements of pre-selector circuit selectivity indicate no appreciable effect on selectivity when changing from "close" to "loose" coupling positions. It was noted that "loose" coupling produces an attenuation of the signal of the order of five to one, and also an increase in the input impedance of the receiver. However, the instruction book only recommends the use of "loose" coupling in the case of parallel operation of receivers. No appreciable change is noted on pre-selector characteristics in changing from a 300-ohm resistor to a reactive dummy antenna in the input circuit.

(e) The measurement of selectivity of the Model RAA by three methods gives practically identical results, indicating that the use of any one of the methods will give a true representation of the selectivity of the receiver.

(f) The frequency drift of the Model RAB is, according to frequency, from .02 to .003 per cent during the first forty minutes of operation from a cold start, after which the frequency levels off with comparatively little change. This appears to be due to the stabilization of voltages from the power pack after operation for this length of time.

(g) A complete realignment of all circuits of the Model RAA shows considerable improvement in sensitivity and selectivity, indicating the desirability of realignment from time to time during service use.

(h) The input impedance of the Model RAB varies from 200 to 1200 ohms, with an average of 600 ohms for the entire frequency range of the receiver.

(i) The input impedance of the Model RAA varies from 150 ohms to 210,000 ohms with "close" coupling, and from 2000 to 360,000 ohms for "loose" coupling.

(j) Receiver responses appear at harmonics of 60 cycles, as shown on the tests where the receiver is tuned to 10 kilocycles. These responses are not serious with a wave form no worse than that at this Laboratory.

Recommendations

(a) That the condition reported wherein the strong signal on the first detector reacts on the oscillator circuit to pull the latter into phase or stop oscillations, be avoided in future equipments. This can probably be accomplished by the use of a proper adaptation of the electron coupling principle.

(b) That in order to assure maximum efficiency from the Models RAA and RAB receivers, the annual report on radio material be made to include a report on the sensitivity of these receivers after realignment in accordance with the instructions furnished with each equipment.

MATERIAL UNDER TEST

4. Model RAA-1 receiving equipment, Serial No. 8, consisted of the following units:

1 - CRV 46034 radio frequency tuner.
1 - CRV 50022 intermediate and audio frequency amplifier.
1 - CRV 20016 power unit.

Model RAB receiving equipment, Serial No. 74, consisted of the following units:

1 - CRV 4552 radio frequency tuner.
1 - CRV 4553 intermediate and audio frequency amplifier.
1 - CRV 4554 power unit.

Model RAB-1 receiving equipment, Serial No. 30, consisted of the following units:

1 - CRV 46035 radio frequency tuner.
1 - CRV 50023 intermediate and audio frequency amplifier.
1 - CRV 20016 power unit.

These equipments were manufactured by the RCA Victor Company, Camden, New Jersey.

METHOD OF TEST

5. Time constants were determined by the use of a cathode ray oscillograph. Impacts from a linear sweep circuit were applied to the input of the receiver at a frequency which was synchronized with the sweep frequency used for the output images. The time of recovery from the impacts to normal receiver output could then be calculated from the length of the image over which the impact voltage persisted, as compared to the full length image of one cycle of the sweep frequency. A Radio Research CR tube, calibrated in volts per centimeter, was used to measure the impact voltage.

6. The stability of the first detector-oscillator combination was tested as follows. In order that the respective plate currents of these tubes might be observed separately, it was found desirable to remove the two radio frequency amplifier tubes, as their screen grids are supplied from the regulated 90 volt plate supply of the oscillator, and their plates from the 200 volt lead supplying the detector plate. This eliminated circuit changes likely to upset performance and permitted the insertion of meters at the cable terminals without materially affecting the operating voltages of the remaining tubes. The output of a Model LC-1 standard signal generator was amplified by a specially built amplifier, and applied to the first detector grid, using a vacuum tube voltmeter (0.5 to 15 volts) for direct measurement. This input was applied through capacitance, with the grid leak, as provided in the design. (This tube has a normal cathode self-bias potential of 4.1 volts.) The frequency chosen was 16,190 kilocycles (receiver tuning) + 0.84%, a point at which abnormal effects had been noted in routine measurements. A wire was introduced into the first

oscillator tube compartment just enough to couple the oscillator to a second Model RAB receiver, tuned for a beat note on the oscillator's frequency of about 19,580 kilocycles in order to observe frequency changes in the oscillator.

7. Input was progressively increased and decreased, noting the change in oscillator frequency, detector and oscillator plate currents.

8. Frequency drift was measured by resonating the receiver with a harmonic of the 100 kilocycle crystal output of the Model LD-2X heterodyne calibrator, and noting the output frequency drift with a General Radio Interpolation Oscillator, Type 617A, Serial No. 37.

9. Sensitivity and selectivity measurements and determination of stage gains were completed in accordance with the procedure followed in reference (e).

10. Investigation of receiver response to frequencies other than the fundamental, with a relatively high receiver input was made by applying the output of a standard signal generator, through a laboratory constructed amplifier to the input terminals, and varying the input frequency, the input voltage being measured with a vacuum tube voltmeter.

11. Second detector sensitivity of the Model RAB was obtained by applying a CW input from a standard signal generator, to the grid of the second detector tube, at the four different intermediate frequencies, and measuring the output voltage across the primary of the audio transformer, which is coupled to the plate circuit of the second detector tube.

12. Input impedances of both Models RAA-1 and RAB-1 were measured by applying a constant signal to the receiver input, noting the output voltage, then inserting resistance in series with the input sufficient to reduce the output voltage by one-half. The inserted resistance would then be the equivalent of the input impedance at the particular frequency of measurement.

13. Selectivity of the pre-selector circuit of the Model RAA-1 was measured by applying a CW input from a standard signal generator to the receiver input terminals. In the plate circuit of the first detector, the primary of the first intermediate frequency transformer was disconnected and replaced by a Samson choke. The high potential side of this choke was coupled through a one-half mfd. condenser, and 5000 ohms resistance to the antenna input terminal of a Model RAJ, Type CBY 46046 receiver. This receiver was used simply to amplify the output carrier frequency component in the first detector plate circuit, and was re-resonated each time the input signal was moved away from the frequency of resonance of the Model RAA. The gain of the amplifying receiver was held to the same level, and a standard output used as in other selectivity measurements.

14. Determination of microvolts on any grid with one microvolt antenna input was made by calculation from the curves showing individual stage gains.

DATA RECORDED DURING TEST

15. Complete data were recorded for each test conducted and are contained in tables 1 to 5, inclusive, and plates 1 to 50, inclusive, appended hereto.

PROBABLE ERRORS IN RESULTS

16. In estimating the overall accuracy of the results obtained, consideration is given to the manufacturer's rating of the probable errors in the instruments used, and where test circuits are involved, to the probable extent of inaccuracies, which might develop in the methods used.

Time constants	± 10%
Frequency drift	3 parts in 10^6
Sensitivity	± 20%
Selectivity	± 20%
Image response	± 10%
Second detector sensitivity	± 10%
Input impedance	± 10%
Pre-selector measurements	± 25%
Individual stage gains	± 20%

RESULTS OF TEST

17. Figure 1 on Plate 1 shows the radio frequency signal output at the terminals of the last intermediate frequency transformer, together with the impact signal, the total image representing 1/5750 seconds, or one cycle of the sweep frequency. The impacts are shown to persist approximately 1/24,000 second.

18. Figure 2 shows the same with an increased signal output and a 6000 cycle sweep.

19. Figure 3 shows the impact voltage only, without signal, with a 6000 cycle sweep.

20. Figure 4 shows impact only, and Figure 5 shows the signal and the impact signal at the "broad" audio output terminals, with a 60 cycle sweep, showing the impact to persist approximately 1/240 second.

21. Figure 6 shows impact only, and Figure 7 shows the signal and the impact signal at the "sharp" audio output terminals, with a 60 cycle sweep, showing the impact to persist approximately 1/90 second.

22. It was found during stage gain tests that when off resonance radio frequency inputs to the first detector were progressively increased, that receiver output noise suddenly increased from a low value to a considerably higher one. That is, a very small increment of input, under the right conditions, might give a noise increase of about one hundred fold. It was known from previous tests (see paragraph 6.14 of reference (e)) that the first oscillator frequency was affected by signal level.

23. When the second RAB receiver (#2) was tuned to beat the oscillator frequency of the test model (#74), it was found that when a strong input produced the excessive noise already noted, the clear beat note gave way to noise in the monitoring receiver, and that if the latter were tuned, as many as 38 successive beats could be observed at regular intervals of about 6.7 kilocycles. Such a condition could have been caused by the presence in the oscillator of two frequencies, 19,580 kilocycles (approximately) and 6.7 kilocycles, the latter producing successive side band frequencies either side of the former, which corresponded to the progressively weakening harmonics of the 6.7 kilocycles oscillation, which was probably of the relaxation type and rich in harmonics.

24. On the stage gain run at 16,190 kilocycles, top frequency of Band C-2, it was found at +0.84% from resonance that at necessary input for test, the first detector oscillator combination behaves abnormally, the oscillator plate current dropping and the mode of oscillation changing to a fundamental of similar frequency plus some 38 side bands at regular intervals of 6.7 kilocycles, tapering off in intensity away from fundamental. Under these conditions, output noise jumped from below 0.1 milliwatts to 270-300 milliwatts, probably because of multiple heterodyning frequencies operating on receiver noise which might also be described as a super-regenerative detector condition. Less than half a volt at the input causes this effect.

25. This is probably the first detector overload previously reported, but manifested differently and investigated more completely. The first oscillator may be pulled toward signal frequency some 500 cycles before giving up. As signal input is decreased, the behavior does not follow the reverse track. Plates 2 and 3 are appended to show how plate currents of detector and oscillator, detector total grid bias, oscillator frequency and receiver output noise vary with input signal direct to the first detector grid. (It was necessary to cut out the first two tubes to eliminate their overload effects and measure only the two desired.)

26. Uncertainty remains as to the cause of the oscillator frequency change. It may be due to coupled effects from the detector circuit, or unsatisfactory voltage regulation in power pack, and is known to tie in with line voltage. If the line voltage be increased, the spurious oscillations may be produced without input signal at these frequencies. They were not found at lower frequencies. Too tight feedback coupling or excessive oscillator grid bias can produce such effects.

27. The time of recovery is variable up to appreciable fractions of a second at times. The failure to return over the same curve on removal of signal suggests oscillation hysteresis, which often introduces serious time constants. It may be tied in with the appreciable time constants of the power pack voltage divider.

28. A study of Plates 2 and 3 will show that when the signal voltage as delivered to the first detector grid reaches 3 volts, an

abrupt reduction in plate current in both the detector and the first oscillator occurs and simultaneously the receiver output noise rises to a very high level. It is assumed that this is the result of the development of a spurious oscillation which acts as a quenching voltage on the detector, this tube being made more or less regenerative by the relatively high amplitude signal swing, thus producing in effect a super-regenerative first detector. As the high input signal changes, the first oscillator frequency and the spurious quenching frequency bears no useful relation to the intermediate frequency, the receiver no longer functions, and may be said to be blocked.

29. This test was made with a Model RAB receiver equipped with type 38064 tubes for oscillators. Since changing to type 56 oscillator tubes, spurious oscillations do not occur with such of the type 56 tubes as are considered good.

30. The frequency drift of the Model RAB is shown at 8000 kilocycles, and also for high and low L/C ratios in the same band, on Plate 4.

31. Sensitivity for all bands is shown on Plate 5.

32. Selectivity for Bands B-1, B-2, C-1, C-2, D-1 and D-2 to complete the measurements reported in reference (e), is shown on Plates 6, 7, 8, 9, 10 and 11.

33. Receiver response, with relatively high inputs, is shown when resonated for one frequency in each band. This is shown **for** the Model RAA-1 in Tables 1 and 2, and for the Model RAB in Table 3.

34. Second detector sensitivity for the Model RAB, plotted to show the gain for various inputs to the detector grid, is shown on Plate 12. It will be noted by reference to this plate that with inputs exceeding one-half volt the gain rapidly decreases. In taking these measurements, it was found that in order to maintain a one thousand cycle beat note with the second oscillator (this being the audio frequency used to measure the detector output, with the wave analyzer) it became necessary to retune the second oscillator when inputs to the detector grid were increased above 0.5 volt.

35. The second oscillator stability, with high inputs to the detector grid, was then investigated, with the results as shown on Plate 13.

36. With increased inputs above 0.5 volt and without retuning the second oscillator, by means of the vernier on the receiver panel, oscillations would stop. By rotating the oscillator tuning vernier in either direction, oscillations were resumed but with decreased detector gain. The required range over which the oscillator tuning vernier was varied to start oscillations was increased as the inputs to the detector grid were increased.

37. It appears that the coupling between the oscillator and the detector cathode circuit is sufficient that with a strong signal the

oscillator pulls into signal voltage phase or even to oscillator extinction. This coupling appears, however, to be about optimum for best signal noise ratios at voltage below 0.5.

38. In practical operation, the condition of oscillator pulling as described above may lead to erroneous interpretation of frequency as taken from a receiver dial, unless proper attenuation of the signal to be checked for frequency is made prior to the second detector tube. The service should be warned that in checking transmitted frequencies the signal voltage being measured should be attenuated to the extent that the receiver output is not over a very few milliwatts.

39. In the Model RAB-1 receiver used for this test, both first and second oscillator tubes had been changed to type 56.

40. Pre-selector circuit selectivity, with inputs through both a standard dummy antenna and a 300-ohm resistor, and for both close coupling and loose coupling conditions, is shown on Plates 14, 15, 16 and 17. It will be noted that there is no appreciable effect on the selectivity measurements in changing to any one of the above mentioned conditions, there being, however, an attenuation of the signal due to loose coupling of approximately five to one. The input impedance for the Model RAA is shown in Table 4, and for the Model RAB in Table 5. It will be observed that the input impedance for the Model RAA is several times greater for the "loose" than for the "close" coupled condition.

41. Measurements of selectivity of the Model RAA-1 receiver at 1000 kilocycles were made by three methods: First, using a modulated input and using the total audio output, designated as method (a); second, using a wave analyzer for the measurement of signal output, designated as method (b); third, using increments in second detector plate current as an indicator of standard output, designated as method (c). The results of measurements by these three methods are shown on Plate 18. The results from the three methods were practically identical.

42. Individual stage gains, Model RAB, supplementing the information given in reference (e), are shown as follows:

Band	Frequency (kcs.)	Plate
B-1	2460	19
	3128	20
	3956	21
B-2	3956	22
	5010	23
	6320	24
C-1	6320	25
	8000	26
	10130	27
C-2	10130	28
	12830	29
	16190	30

Microvolts on any grid with one microvolt antenna input, Model RAB, are shown as follows:

Band	Frequency (kcs.)	Plate
A-1	1000	31
	1244	32
	1544	33
A-2	1560	34
	1950	35
	2460	36
B-1	2460	37
	3128	38
	3956	39
B-2	3956	40
	5010	41
	6320	42
C-1	6320	43
	8000	44
	10130	45
C-2	10130	46
	12830	47
	16190	48

43. Selectivity at 100 kilocycles and sensitivity in all bands for the Model RAA-1 is shown after complete realignment, on Plates 49 and 50. During the progress of tests, variable contact was noted in the audio "broad-sharp" DPDT switch, and replacement was made. Examination of the switch replaced showed considerable wear of the metal contacts, indicating insufficient durability to withstand service use.

CONCLUSIONS

44. From the exhaustive tests and examination of the Model RAA and RAB equipments, certain performance characteristics have been observed which are pointed out for the Bureau's information.

45. In the Model RAB, with inputs exceeding 0.5 volt on the grids of either the first or second detector, instability of the first and second oscillators is noted, which effect increases in proportion to the voltage applied. In the first oscillator a frequency change is noted. Prior to the change from type 38064 to type 56 tubes, spurious oscillations occurred causing the detector tube to become more or less regenerative, producing in effect a super-regenerative first detector. Since the change to type 56 tubes, spurious oscillations do not occur with selected tubes of this type.

46. In the case of the second oscillator, in addition to a considerable frequency change, oscillations are stopped over a range above and below the normal setting of the tuning vernier, the breadth of this range varying with the voltage input to the second detector grid. In both cases, the instability appears to result from an increase in damping of the oscillator tuned circuit with increased signal levels. An increase in signal level apparently decreases the plate-cathode resistance of the detector, and since this is coupled to the oscillator a progressive increase in damping results.

47. In the Model RAA, measurements of pre-selector circuit selectivity indicate no appreciable effect on selectivity when changing from "close" to "loose" coupling positions. It was noted that "loose" coupling produces an attenuation of the signal of the order of five to one, and also an increase in the input impedance of the receiver. However, the instruction book only recommends the use of "loose" coupling in the case of parallel operation of receivers. No appreciable change is noted on pre-selector characteristics in changing from a 300-ohm resistor to a reactive dummy antenna in the input circuit.

48. The measurement of selectivity of the Model RAA by three methods gives practically identical results, indicating that the use of any one of the methods will give a true representation of the selectivity of the receiver.

49. The frequency drift of the Model RAB is, according to frequency, from .02 to .003% during the first forty minutes of operation from a cold start, after which the frequency levels off with comparatively little change. This appears to be due to the stabilization of voltages from the power pack after operation for this length of time.

50. A complete realignment of all circuits of the Model RAA shows considerable improvement in sensitivity and selectivity, indicating the desirability of realignment from time to time during service use.

51. The input impedance of the Model RAB varies from 200 to 1200 ohms, with an average of 600 ohms for the entire frequency range of the receiver.

52. The input impedance of the Model RAA varies from 150 ohms to 210,000 ohms with "close" coupling, and from 2000 to 360,000 ohms for "loose" coupling.

53. Receiver responses appear at harmonics of 60 cycles, as shown on the tests where the receiver is tuned to 10 kilocycles. These responses are not serious with a wave form no worse than that at this Laboratory.

TABLE 2

MODEL RAA

High Input Receiver Response

Receiver Resonated at 25 kcs. (Intermediate 20 kcs.)

Optimum Gain - Input 2 volts - CW

Frequency giving 1000 cycle beat (kcs.)	Output (MW) Broad	Output (MW) Sharp	Remarks
20.07	290.0	200.0	I.F.
65.3	2.0	0.55	Primary image.
Receiver Resonated at 63 kcs. (Int. 37.8 kcs.)			
37.8	300.0		0.5 volt input.
Receiver Resonated at 158 kcs. (Int. 95.5 kcs.)			
95.5	300.0		0.5 volt input.
Receiver Resonated at 400 kcs. (Int. 238 kcs.)			
238.0	375.0		0.5 volt input.

TABLE 3

Receiver Response.

Model RAB Receiver No. 74 Resonated at

2000 kcs. (Intermediate Frequency 600 kcs.) Optimum Gain.

Frequency (kcs.)	Volts Input	Output MW	Remarks
3225	10.0	5.0	Primary image.
Receiver Resonated at 4000 kcs. (Int. 1450 kcs.)			
1448	13.0	5.0	Int. frequency.
5450	10.0	No response.	Primary image.
Receiver Resonated at 8000 kcs. (Int. 3250 kcs.)			
14460	0.5	Weak response.	Primary image (not measurable with output meter).
Receiver Resonated at 20,000 kcs. (Int. 7200 kcs.)			
7137	0.183	5.0	Int. frequency.

TABLE 4

Input Impedance.

Model RAA-1 - Serial 8.

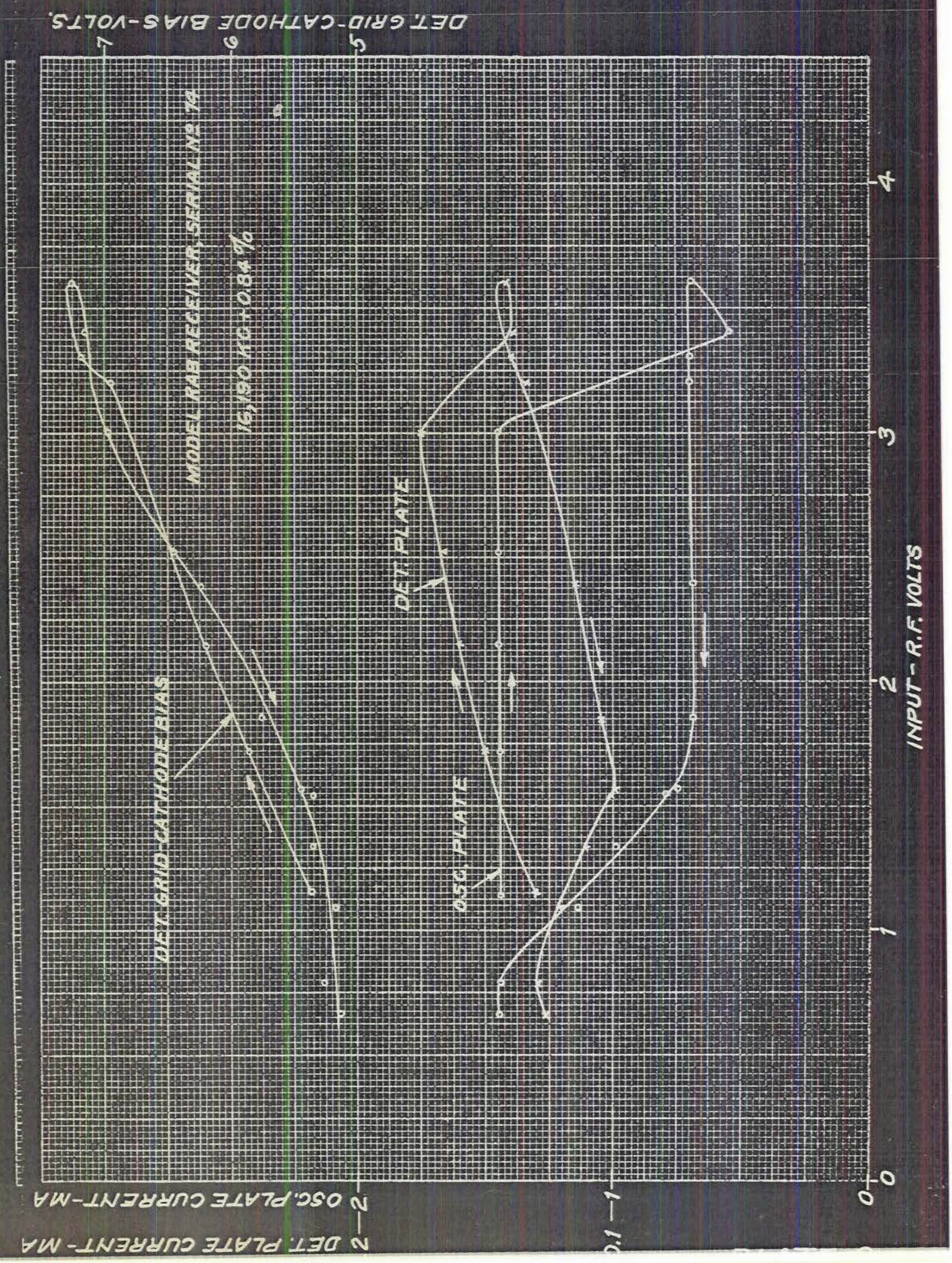
Frequency (Kcs.)	Ohms Z-Close Coupling	Ohms Z-Loose Coupling
13	40,000	360,000
19	26,000	215,000
25	15,000	160,000
25	210,000	250,000
28	100,000	200,000
30	65,000	180,000
46	26,000	120,000
63	12,500	66,000
63	9,400	78,000
100	2,200	40,000
158	600	18,000
158	9,100	33,000
250	1,600	20,000
400	430	10,100
400	2,000	12,000
700	300	5,200
1000	150	2,000

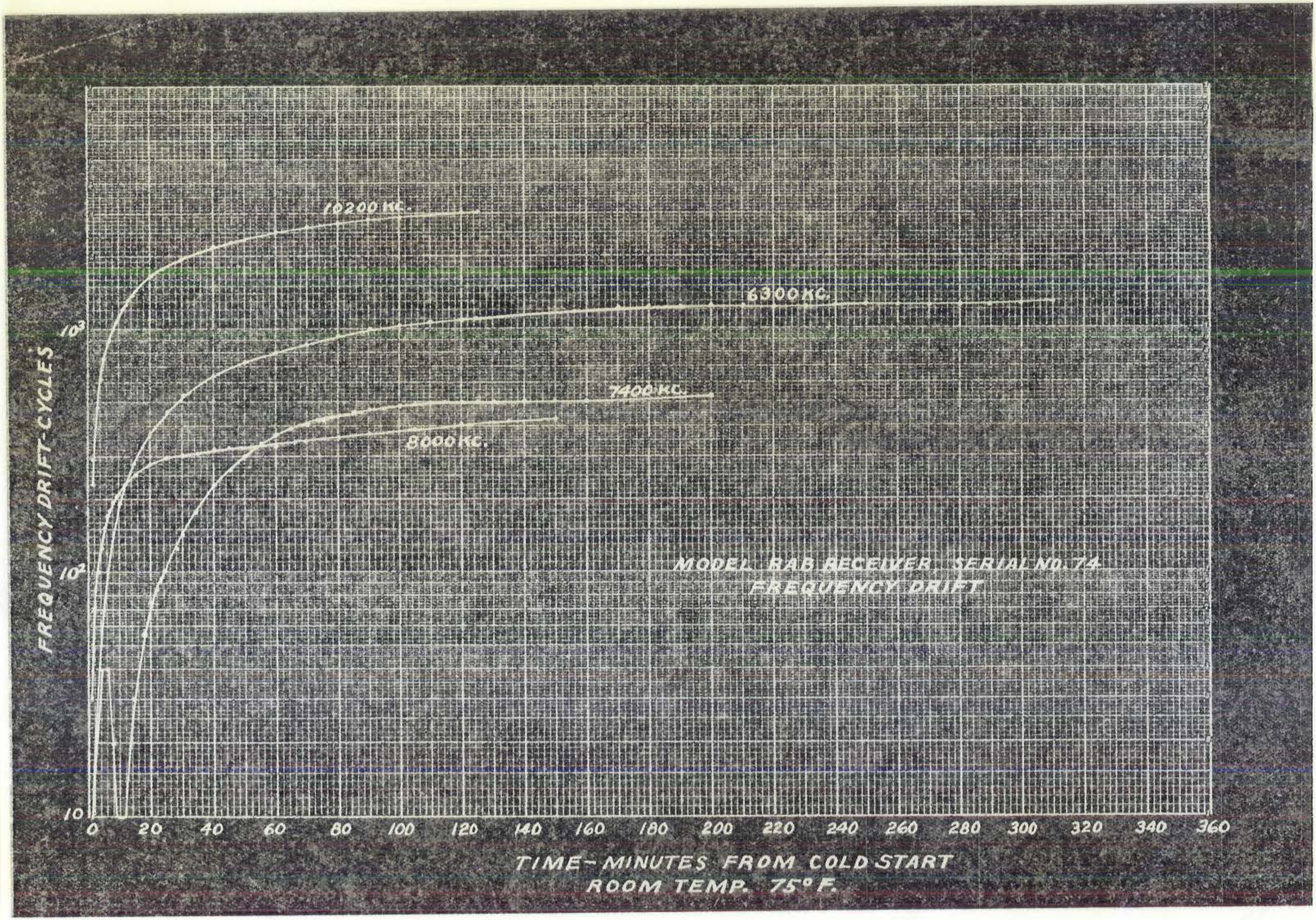
TABLE 5

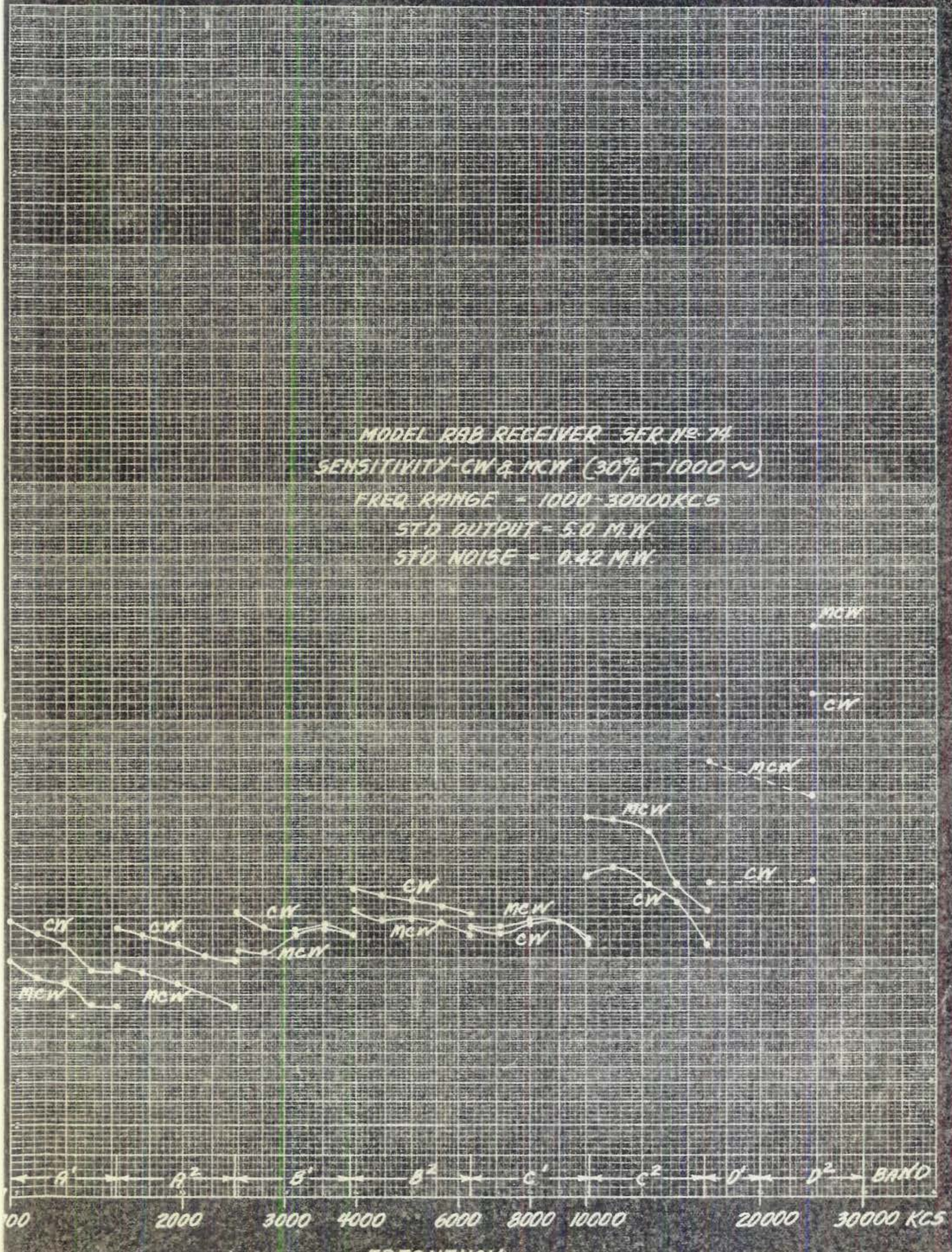
Input Impedance

Model RAB-1 - Serial 30.

Frequency (Kcs.)	Z - Ohms
1000	1200
1250	700
1544	450
1544	1200
1950	600
2470	400
2470	600
3150	600
3956	500
3956	600
5200	600
6320	600
6320	700
8000	950
10130	1200
10130	450
13000	450
16190	400
16190	300
20000	200
24510	300
24510	300
27000	600
30000	600


DET. GRID-CATHODE BIAS-VOLTS.
7
6
5
MODEL RAB RECEIVER, SERIAL No 79
16,190 KC ± 0.84 %
DET. GRID-CATHODE BIAS
DET. PLATE
OSC. PLATE
INPUT - R.F. VOLTS
0
1
2
3
4
OSC. PLATE CURRENT-MA
DET. PLATE CURRENT-MA


10200 KC.
6300 KC.
7400 KC.
8000 KC.
MODEL RAB RECEIVER SERIAL NO. 74
FREQUENCY DRIFT
FREQUENCY DRIFT-CYCLES
10³
10²
10
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360
TIME-MINUTES FROM COLD START
ROOM TEMP. 75° F.


MODEL RAB RECEIVER SER. Nº 74
SENSITIVITY-CW & MCW (30% - 1000 ~)
FREQ. RANGE = 1000-30000 KCS
STD OUTPUT = 5.0 M.W.
STD NOISE = 0.42 M.W.
MCW
CW
A¹
A²
B¹
B²
C¹
C²
D¹
D²
BAND
2000
3000
4000
6000
8000
10000
20000
30000 KCS
FREQUENCY

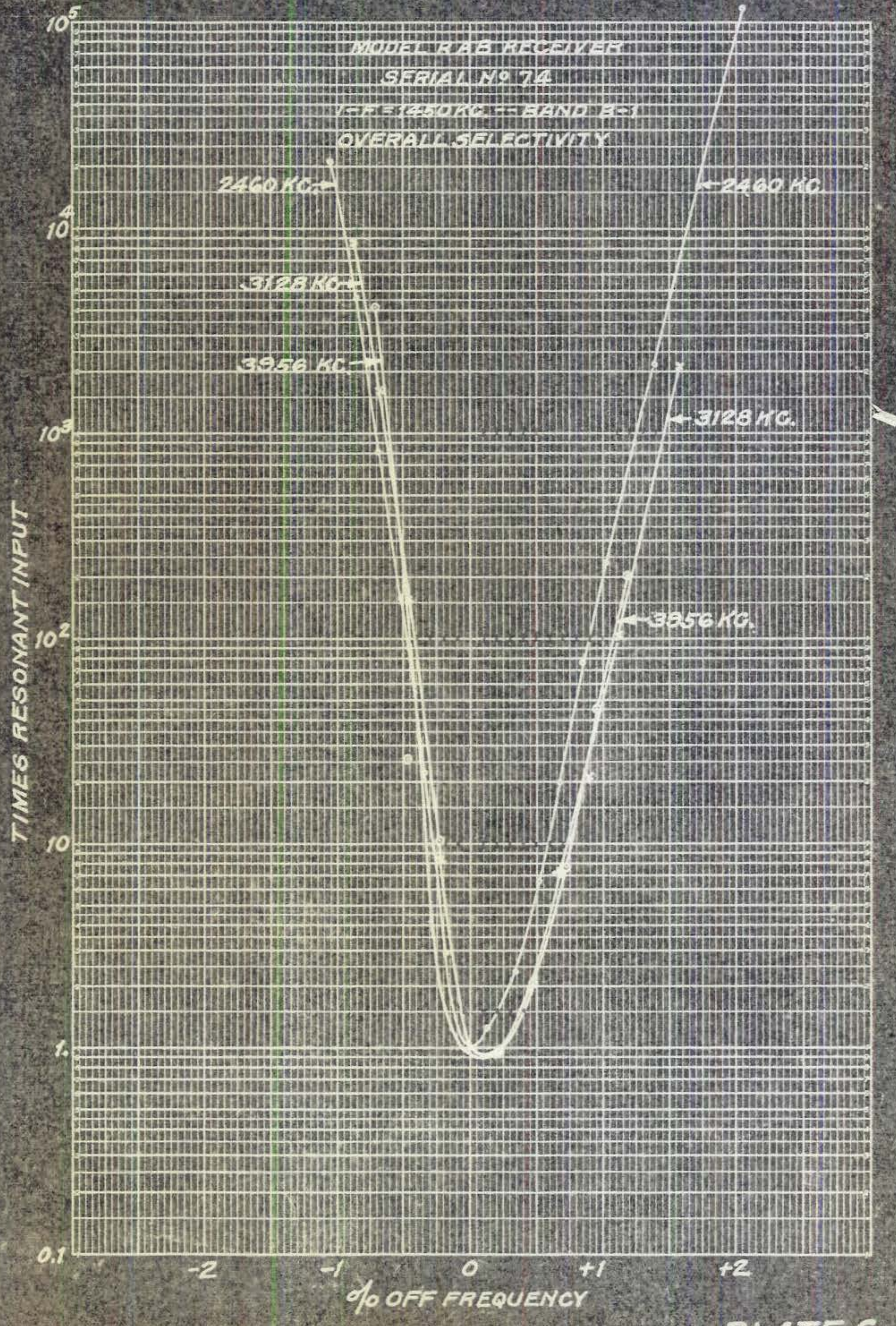
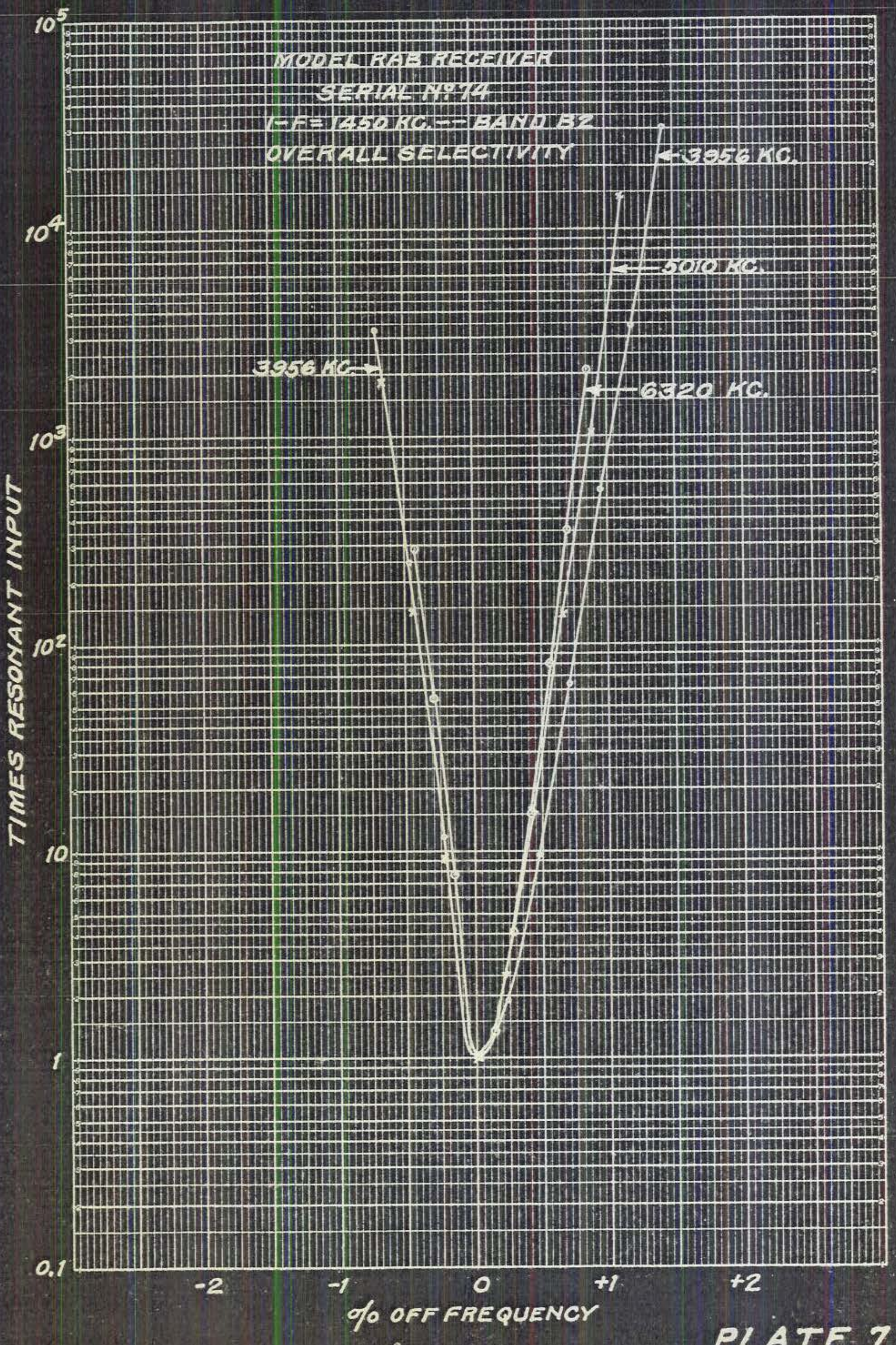

MODEL RAB RECEIVER
SERIAL Nº 74
I-F =1450 KC -- BAND B-1
OVERALL SELECTIVITY
2460 KC.
3128 KC.
3956 KC.
2460 KC.
3128 KC.
3956 KC.
TIMES RESONANT INPUT
10^5
10^4
10^3
10^2
10
1.
0.1
-2
-1
0
+1
+2
% OFF FREQUENCY

PLATE 6



MODEL RAB RECEIVER
SERIAL Nº 74
I-F = 1450 KC. --- BAND B2
OVERALL SELECTIVITY
3956 KC.
5010 KC.
6320 KC.
3956 KC.
TIMES RESONANT INPUT
10^5
10^4
10^3
10^2
10
1
0.1
-2
-1
0
+1
+2
% OFF FREQUENCY

PLATE 7

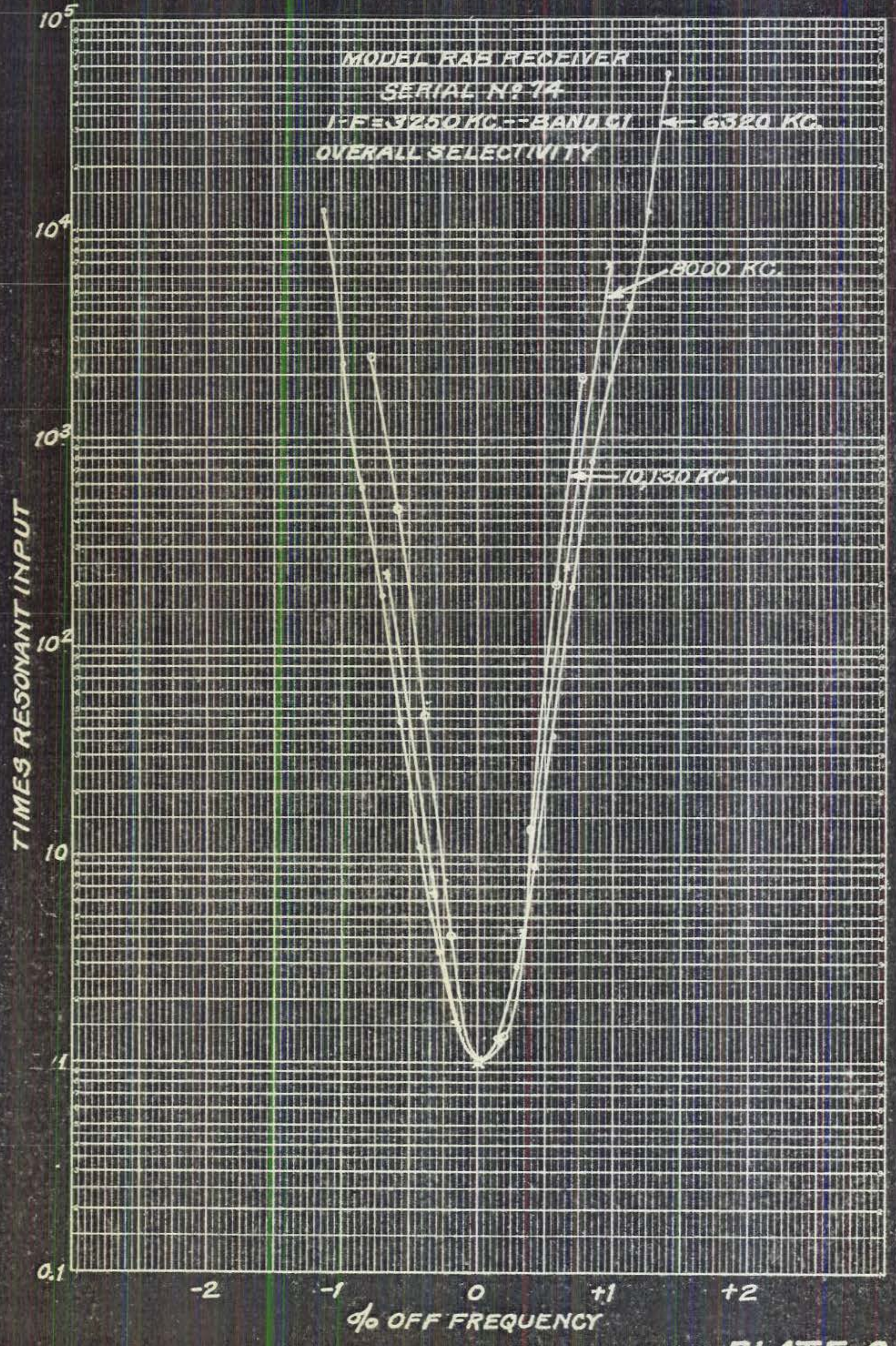
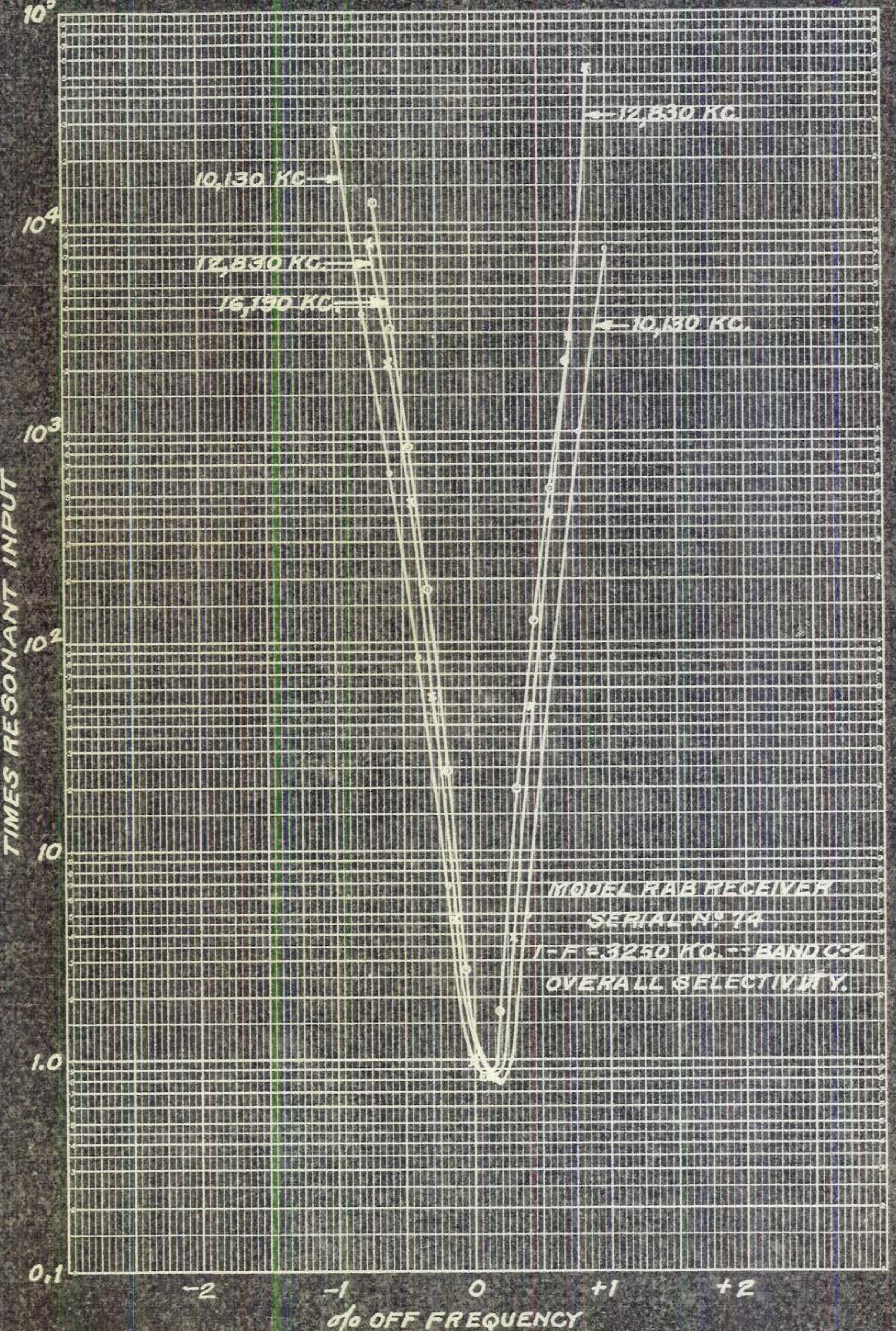
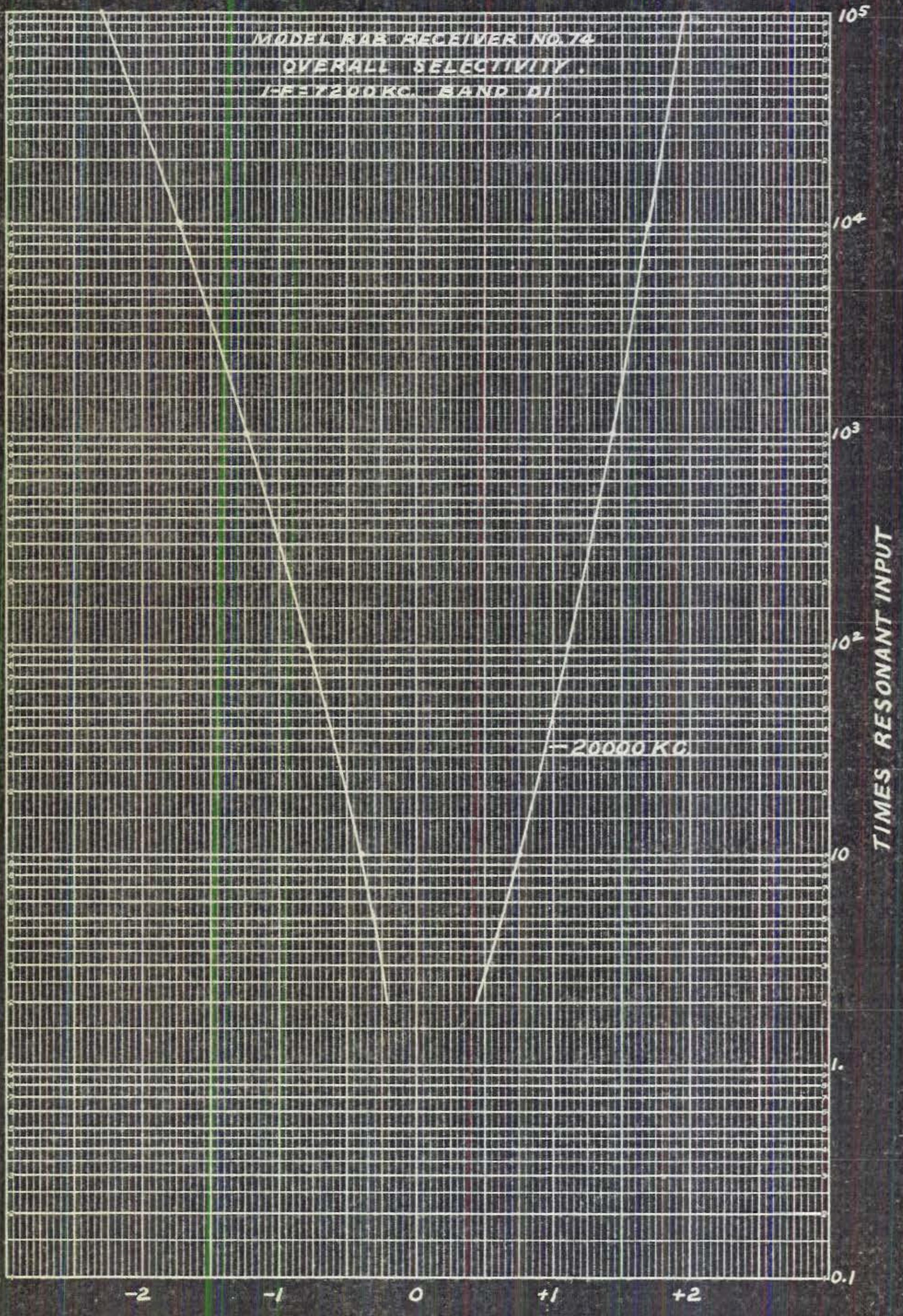

MODEL RAB RECEIVER
SERIAL No 14
I-F=3250 KC.--BAND C1
OVERALL SELECTIVITY
6320 KC.
8000 KC.
10,130 KC.
10^5
10^4
10^3
10^2
10
1
0.1
TIMES RESONANT INPUT
-2
-1
0
+1
+2
% OFF FREQUENCY

PLATE 8



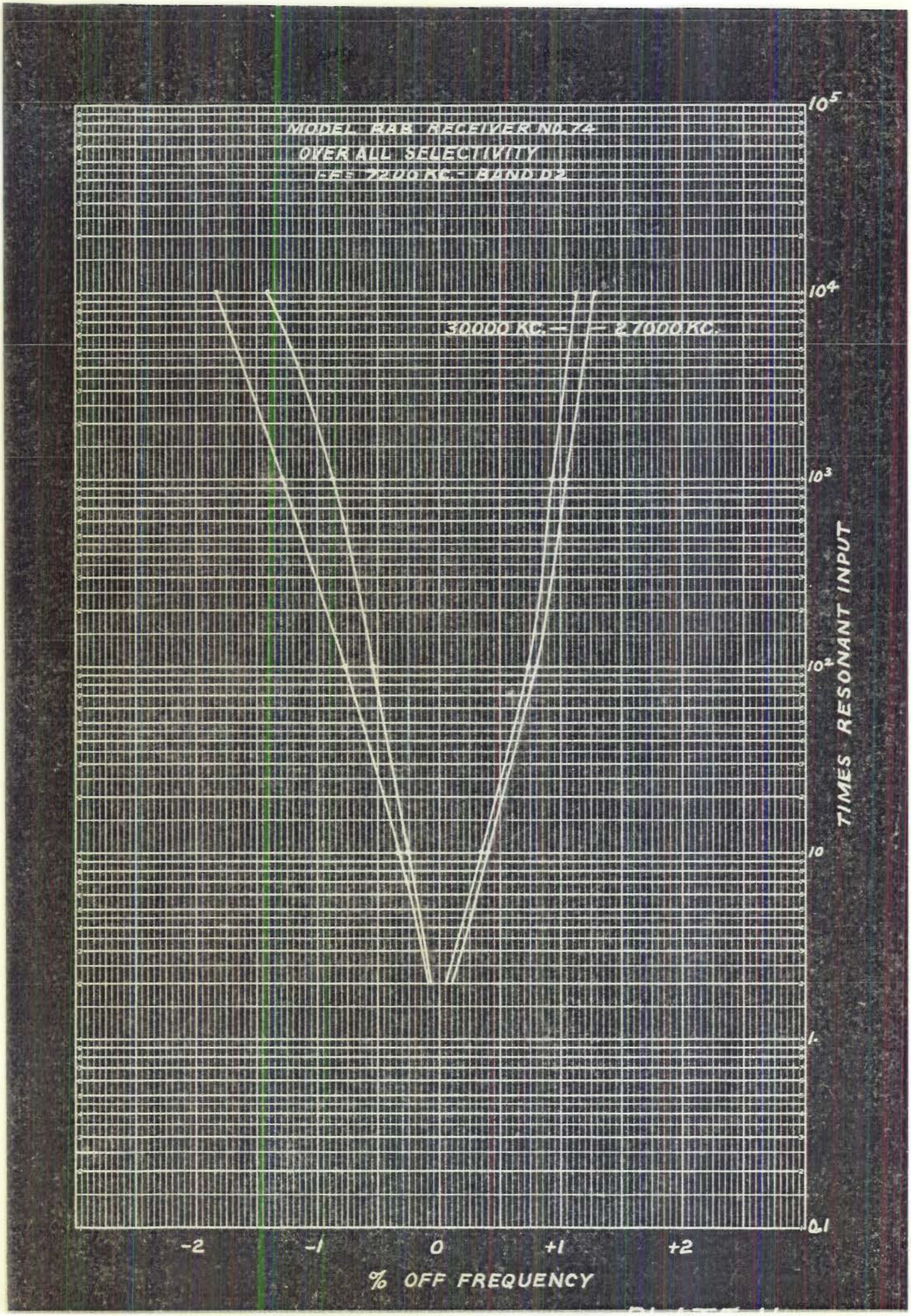
10^5
10^4
10^3
10^2
10
1.0
0.1
TIMES RESONANT INPUT
-2
-1
0
+1
+2
% OFF FREQUENCY
12,830 KC.
10,130 KC.
12,830 KC.
16,190 KC.
10,130 KC.
MODEL RAB RECEIVER
SERIAL Nº 74
I-F = 3250 KC. -- BAND C-2
OVERALL SELECTIVITY.

PLATE 9



MODEL RAB RECEIVER NO. 74
OVERALL SELECTIVITY.
I-F = 7200 KC. BAND D1
20000 KC.
10^5
10^4
10^3
10^2
10
1.
0.1
TIMES RESONANT INPUT
-2
-1
0
+1
+2
% OFF FREQUENCY

PLATE 10



MODEL RAB RECEIVER NO. 74
OVER ALL SELECTIVITY
-F= 7200 KC - BAND D2
30000 KC.
27000 KC.
10^5
10^4
10^3
10^2
10
1.
0.1
TIMES RESONANT INPUT
-2
-1
0
+1
+2
% OFF FREQUENCY

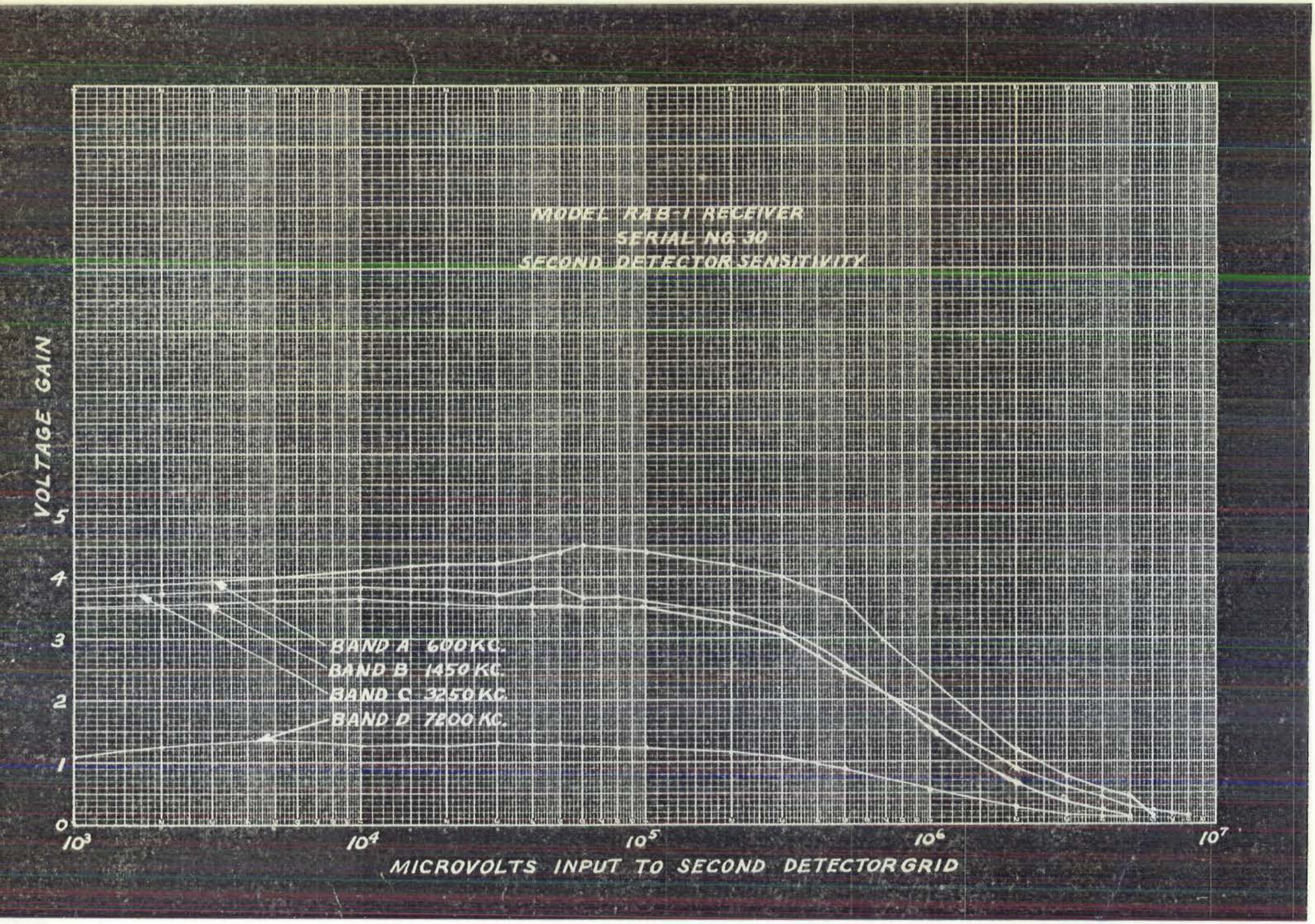
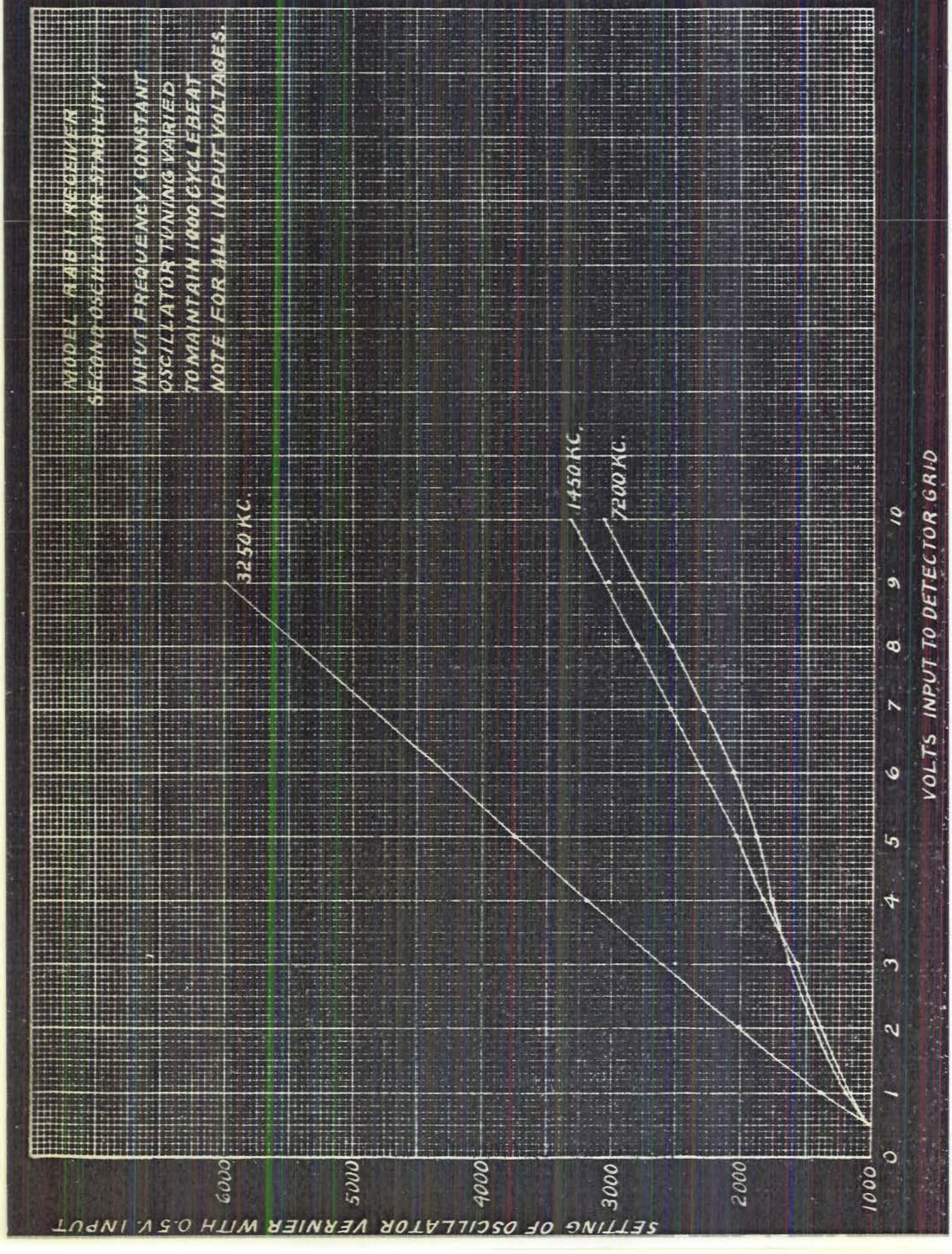

MODEL RAB-1 RECEIVER
SERIAL NO. 30
SECOND DETECTOR SENSITIVITY
VOLTAGE GAIN
0
1
2
3
4
5
BAND A 600 KC.
BAND B 1450 KC.
BAND C 3250 KC.
BAND D 7200 KC.
10³
10⁴
10⁵
10⁶
10⁷
MICROVOLTS INPUT TO SECOND DETECTOR GRID

PLATE 12

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE



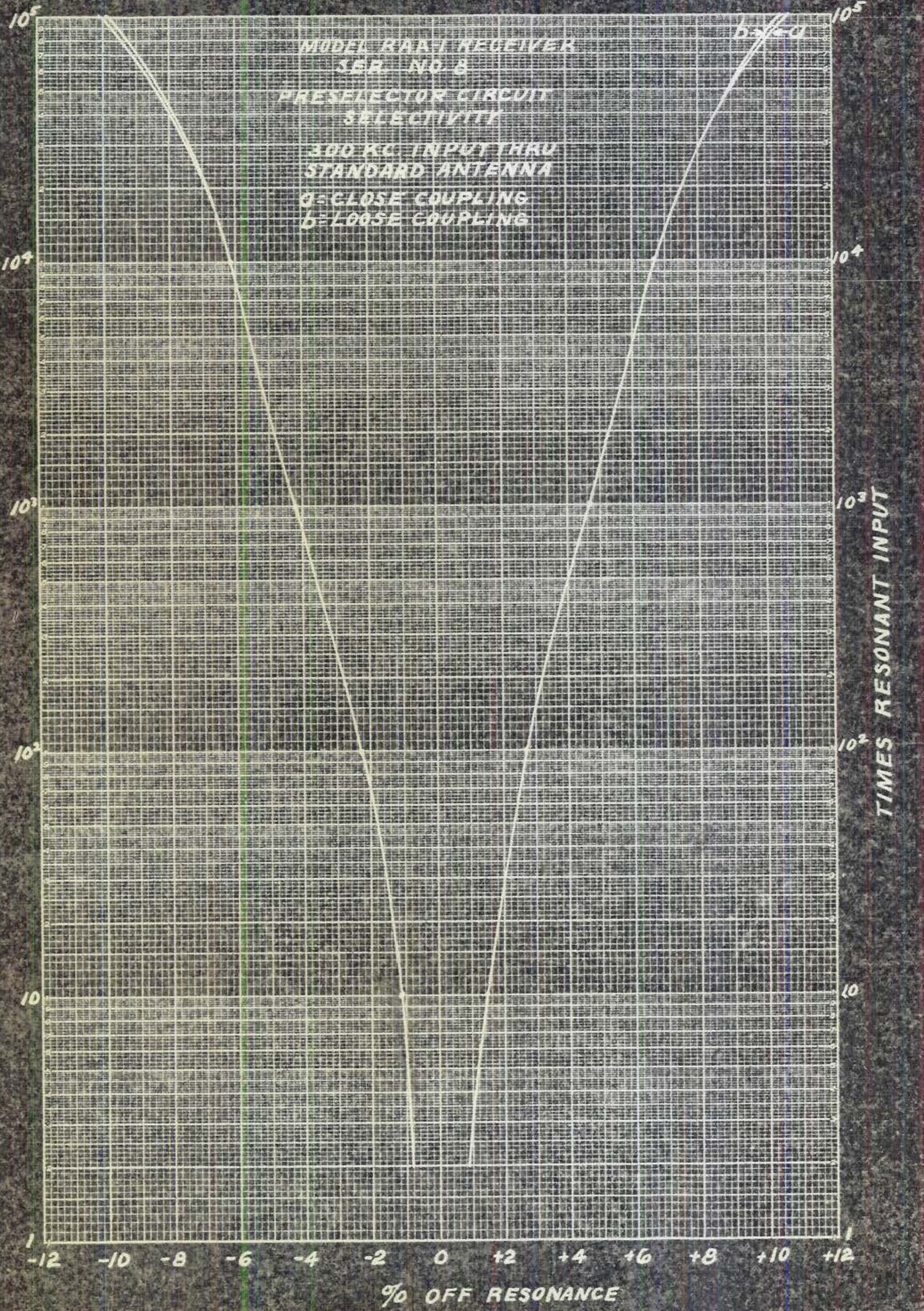

MODEL RAA-1 RECEIVER
SER. NO. 8
PRESELECTOR CIRCUIT
SELECTIVITY
300 KC INPUT THRU
STANDARD ANTENNA
a=CLOSE COUPLING
b=LOOSE COUPLING
10^5
10^4
10^3
10^2
10
1
-12
-10
-8
-6
-4
-2
0
+2
+4
+6
+8
+10
+12
% OFF RESONANCE
TIMES RESONANT INPUT

PLATE 14

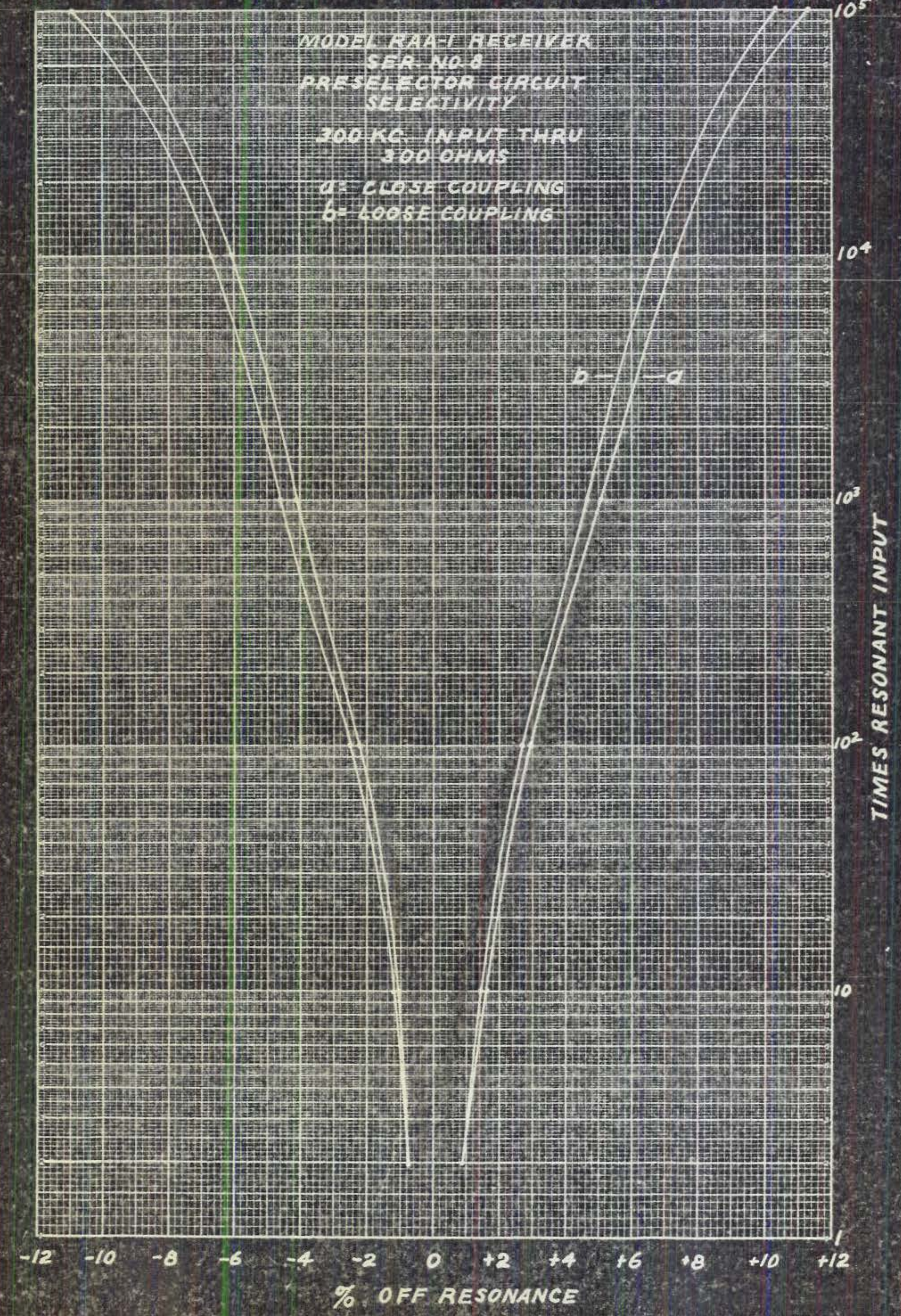

MODEL RAA-1 RECEIVER
SER. NO. 8
PRESELECTOR CIRCUIT
SELECTIVITY
300 KC. INPUT THRU
300 OHMS
a= CLOSE COUPLING
b= LOOSE COUPLING
b
a
10^5
10^4
10^3
10^2
10
1
TIMES RESONANT INPUT
-12
-10
-8
-6
-4
-2
0
+2
+4
+6
+8
+10
+12
% OFF RESONANCE

PLATE 15

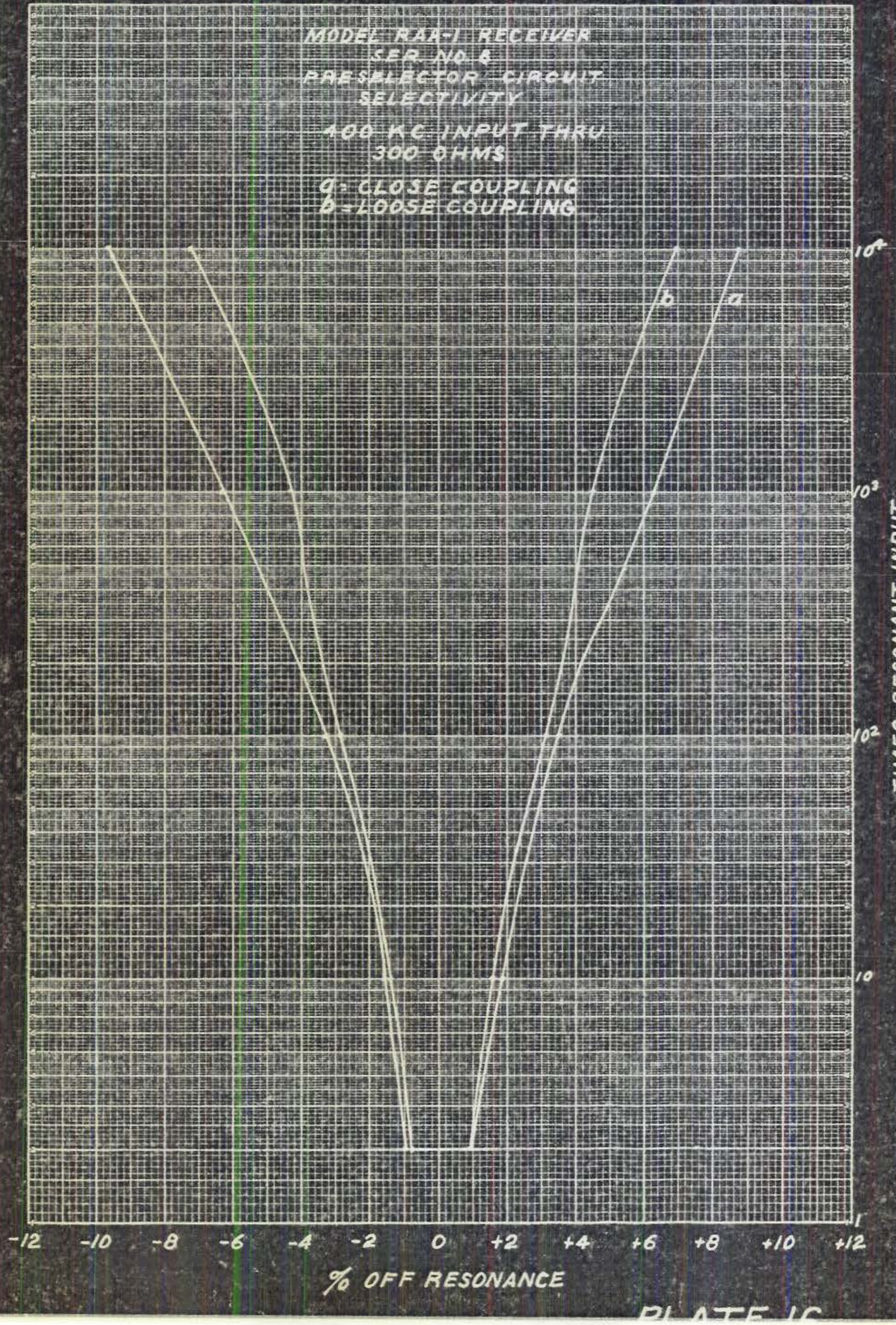

MODEL RAA-1 RECEIVER
SER. NO. 6
PRESELECTOR CIRCUIT
SELECTIVITY
400 KC INPUT THRU
300 OHMS
a = CLOSE COUPLING
b = LOOSE COUPLING
b
a
10⁴
10³
10²
10
1
TIMES RESONANT INPUT
-12 -10 -8 -6 -4 -2 0 +2 +4 +6 +8 +10 +12
% OFF RESONANCE

PLATE 1C

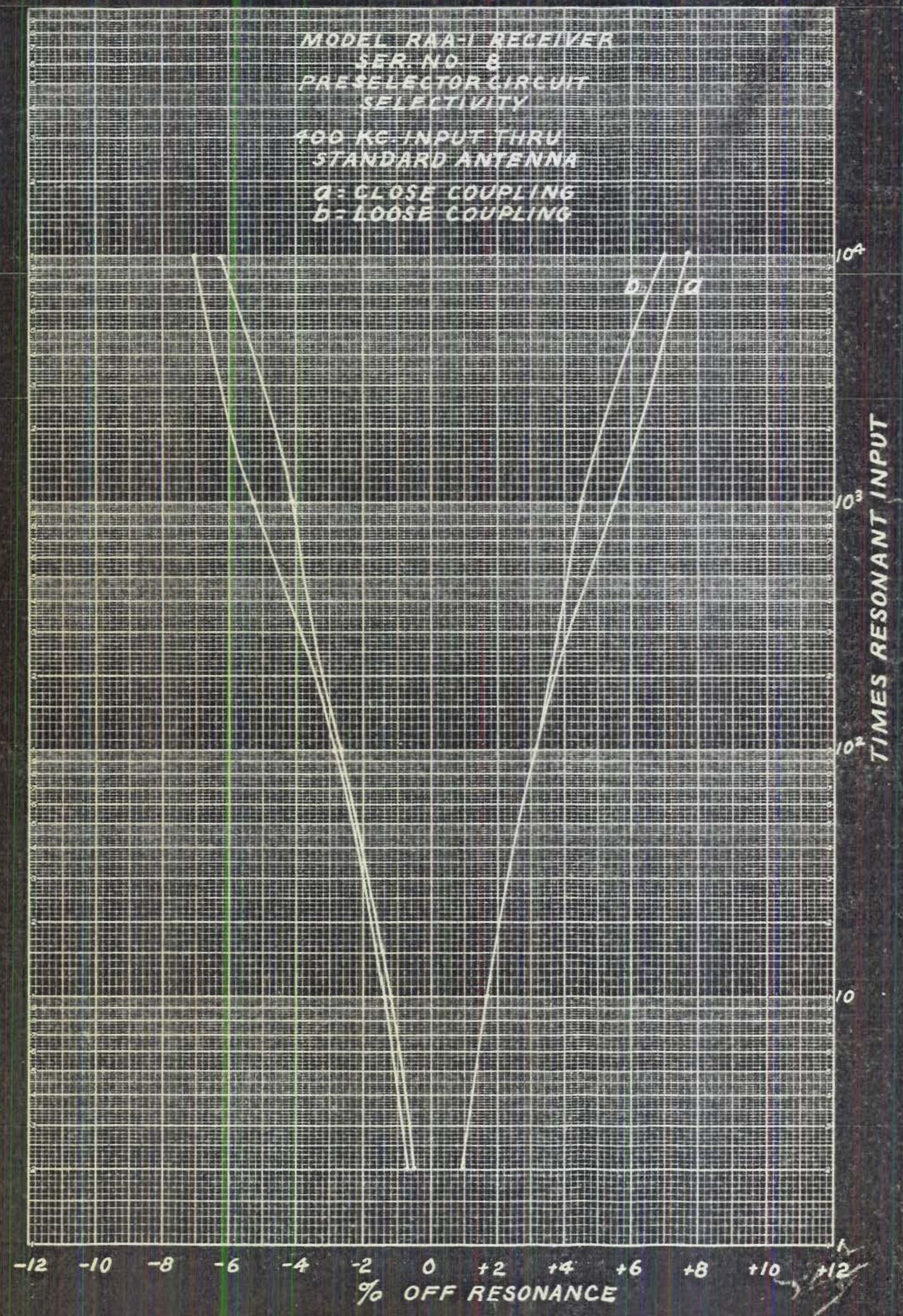
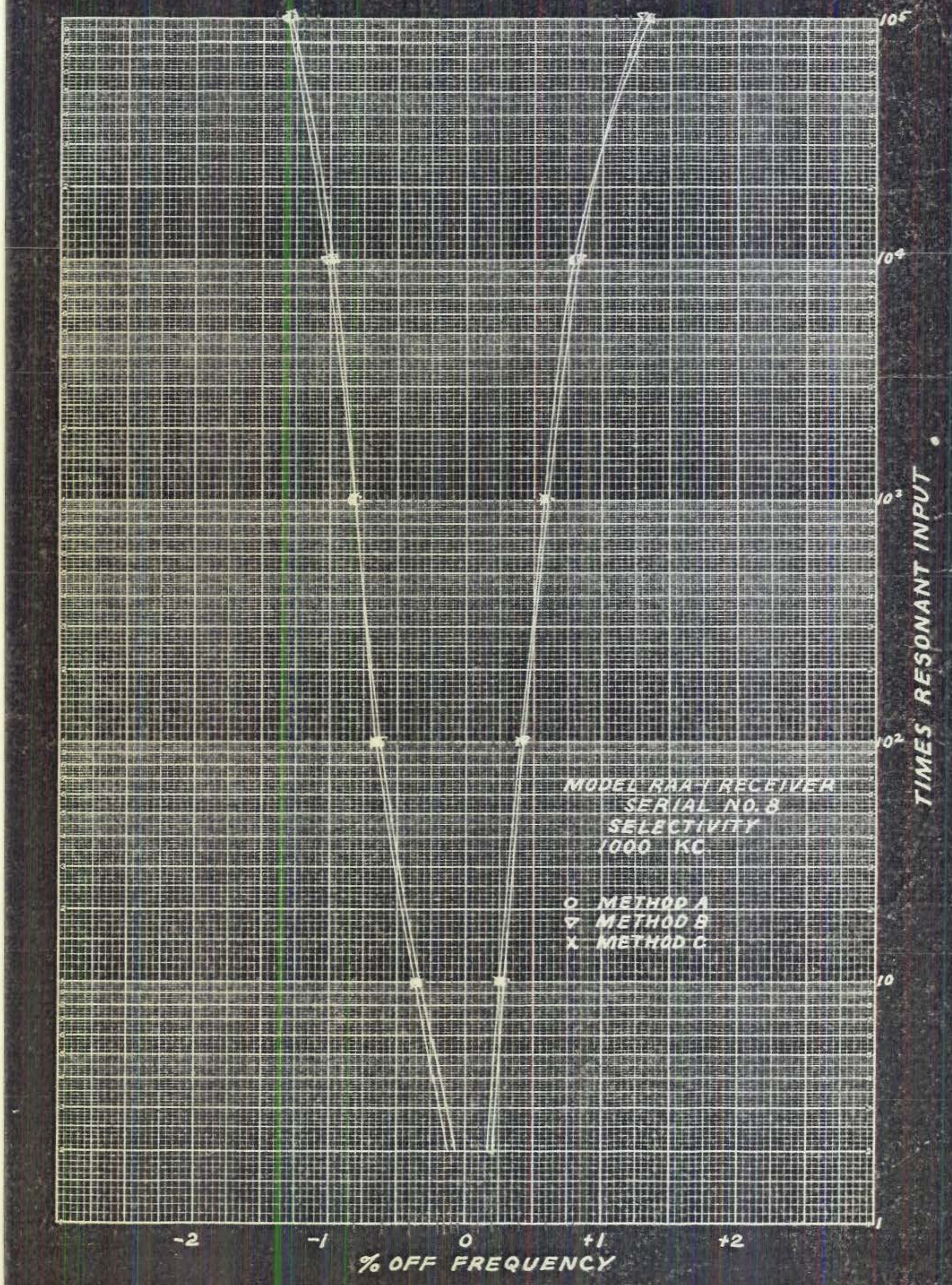
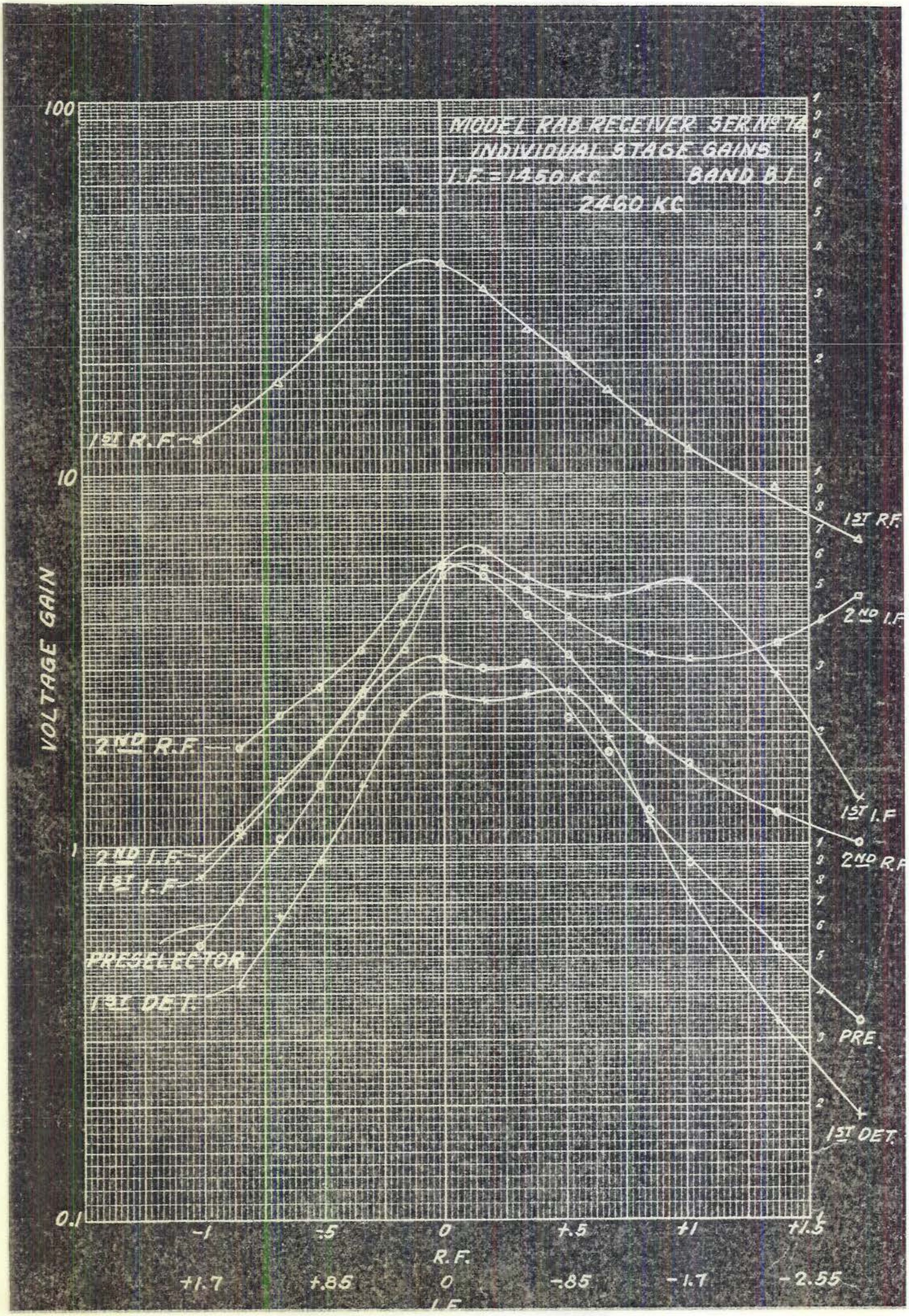
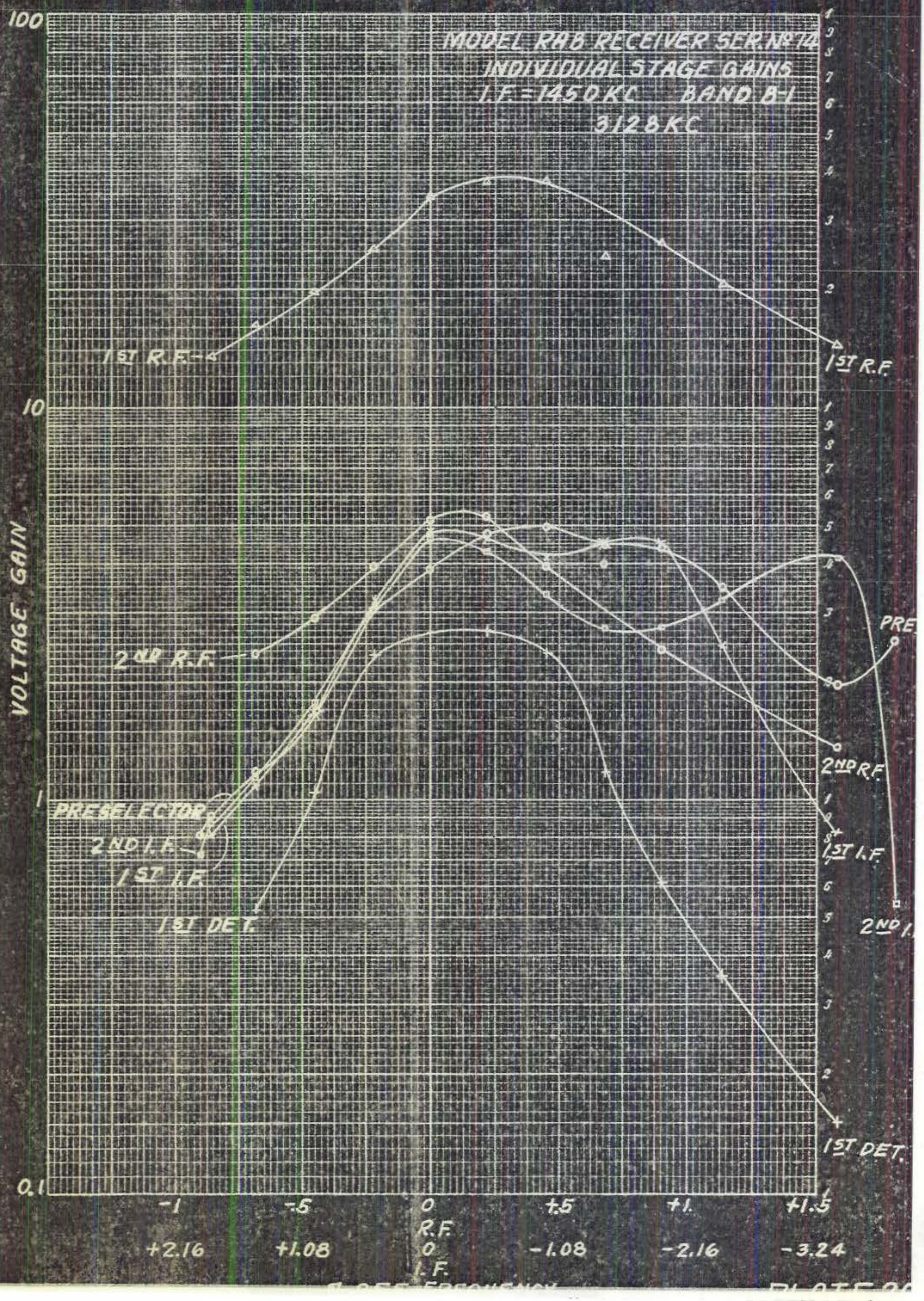

MODEL RAA-1 RECEIVER
SER. NO. 8
PRESELECTOR CIRCUIT
SELECTIVITY
400 KC. INPUT THRU
STANDARD ANTENNA
a = CLOSE COUPLING
b = LOOSE COUPLING
b
a
10^4
10^3
10^2
10
1
TIMES RESONANT INPUT
-12
-10
-8
-6
-4
-2
0
+2
+4
+6
+8
+10
+12
% OFF RESONANCE

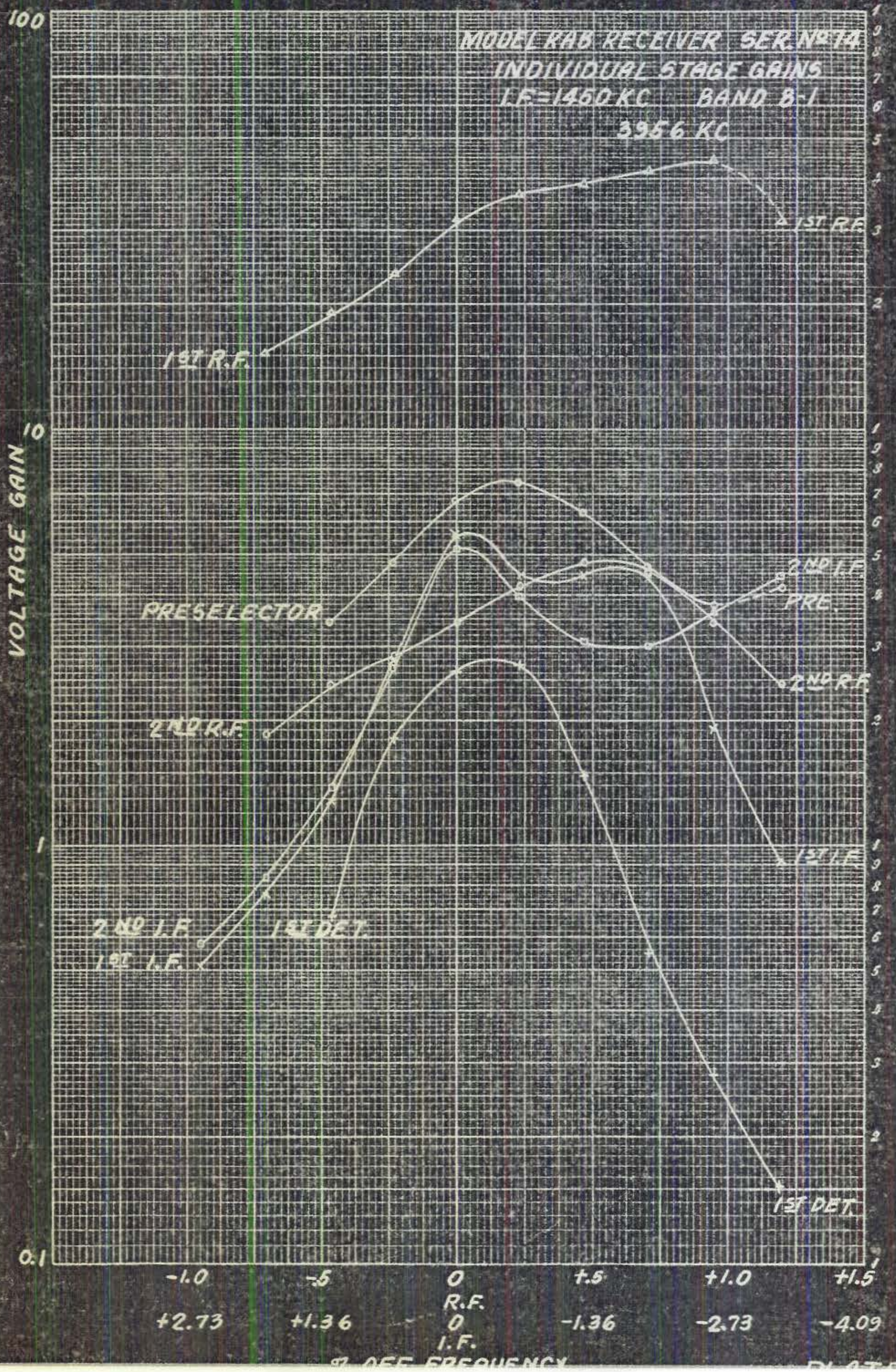
PLATE 17


MODEL RAA-1 RECEIVER
SERIAL NO. 8
SELECTIVITY
1000 KC.
O METHOD A
▽ METHOD B
X METHOD C
TIMES RESONANT INPUT
% OFF FREQUENCY
10^5
10^4
10^3
10^2
10
1
-2
-1
0
+1
+2



MODEL RAB RECEIVER SER. No. 14
INDIVIDUAL STAGE GAINS
I.F. = 1450 KC
BAND B 1
2460 KC
VOLTAGE GAIN
100
10
1
0.1
1ST R.F.
2ND I.F.
2ND R.F.
1ST I.F.
PRESELECTOR
1ST DET.
PRE.
-1
-.5
0
+.5
+1
+1.5
R.F.
+1.7
+.85
0
-.85
-1.7
-2.55
I.F.


MODEL RAB RECEIVER SER. № 14
INDIVIDUAL STAGE GAINS
I.F. = 1450 KC BAND B-1
3128 KC
VOLTAGE GAIN
100
10
1
0.1
1ST R.F.
2ND R.F.
PRESELECTOR
2ND I.F.
1ST I.F.
1ST DET.
-1
-.5
0
+.5
+1.
+1.5
R.F.
+2.16
+1.08
0
-1.08
-2.16
-3.24
I.F.



MODEL RAB RECEIVER SER. № 14
INDIVIDUAL STAGE GAINS
I.F.=1460 KC BAND B-1
3956 KC
VOLTAGE GAIN
100
10
1
0.1
1ST R.F.
PRESELECTOR
PRE.
2ND R.F.
2ND I.F.
1ST I.F.
1ST DET.
-1.0
-.5
0
+.5
+1.0
+1.5
R.F.
+2.73
+1.36
0
-1.36
-2.73
-4.09
I.F.

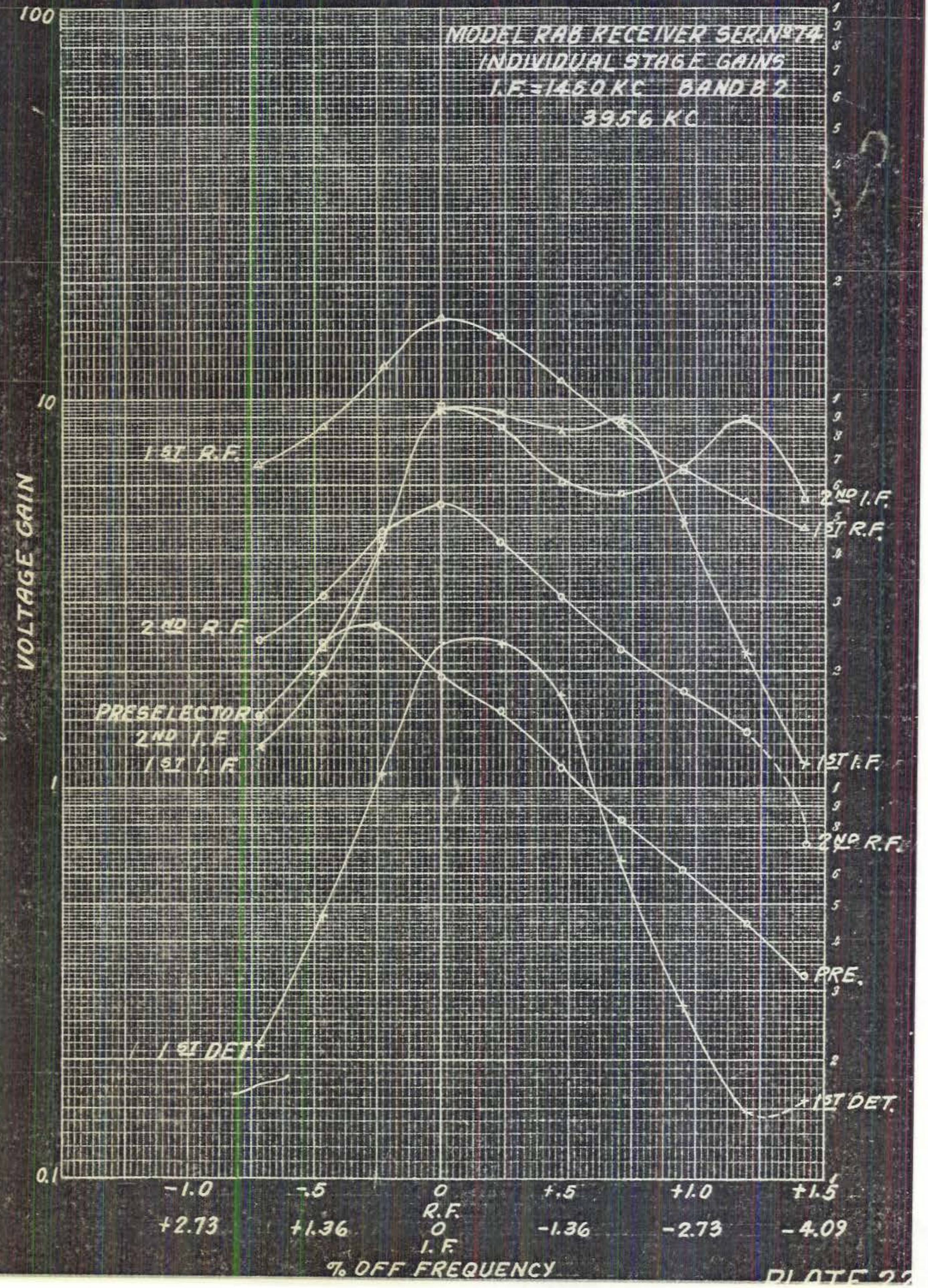
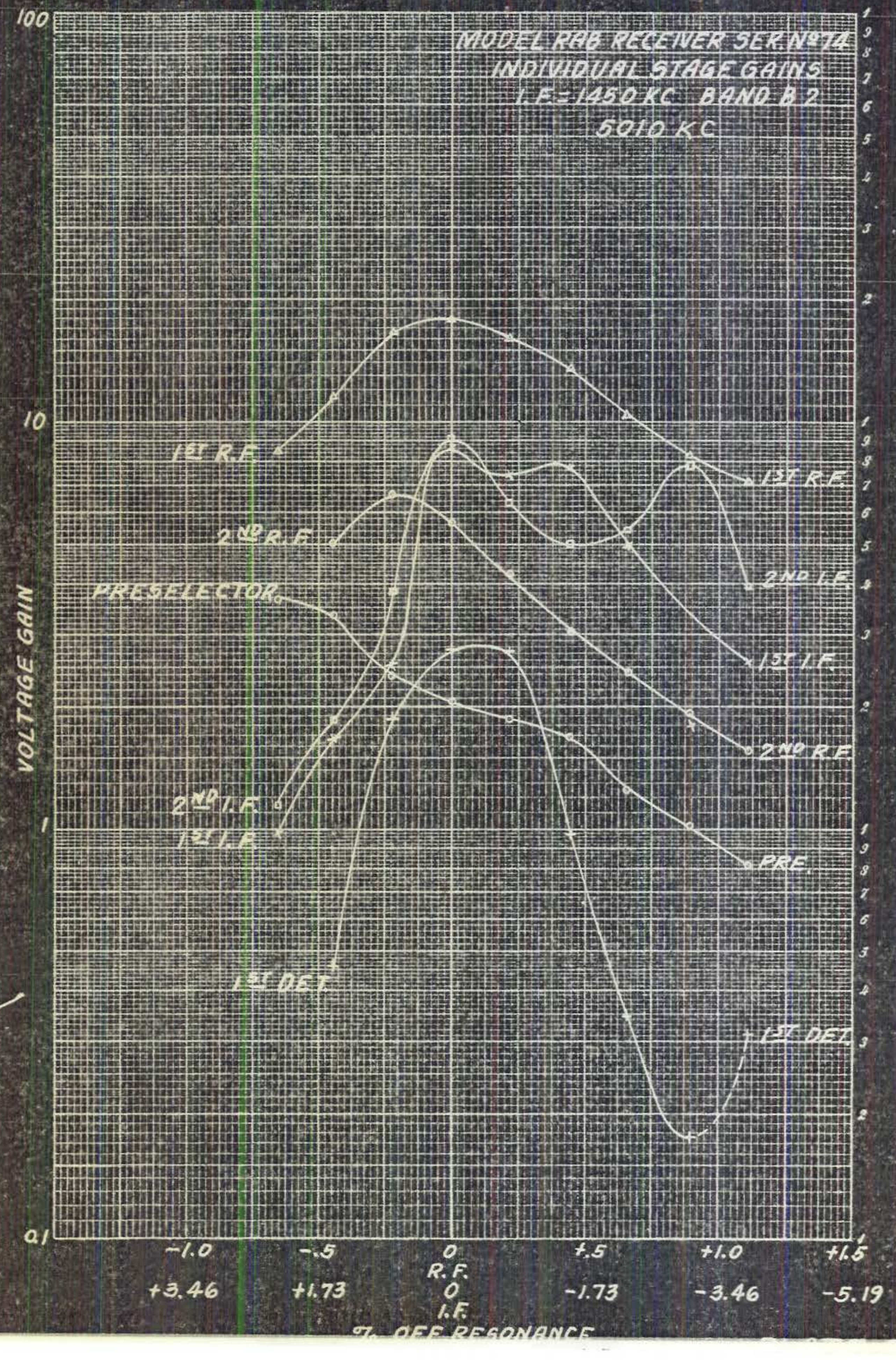

MODEL RAB RECEIVER SER. Nº 74
INDIVIDUAL STAGE GAINS
I.F. = 1460 KC BAND B2
3956 KC
VOLTAGE GAIN
100
10
1
0.1
1ST R.F.
2ND R.F.
PRESELECTOR
2ND I.F.
1ST I.F.
1ST DET.
2ND I.F.
1ST R.F.
1ST I.F.
2ND R.F.
PRE.
1ST DET.
-1.0
-.5
0
+.5
+1.0
+1.5
R.F.
+2.73
+1.36
0
-1.36
-2.73
-4.09
I.F.
% OFF FREQUENCY

PLATE 22



MODEL RAB RECEIVER SER. Nº 74
INDIVIDUAL STAGE GAINS
I.F.=1450 KC BAND B 2
5010 KC
VOLTAGE GAIN
100
10
1
0.1
1ST R.F.
2ND R.F.
PRESELECTOR
2ND I.F.
1ST I.F.
1ST DET.
2ND I.F.
PRE.
-1.0
-.5
0
+.5
+1.0
+1.5
R.F.
+3.46
+1.73
0
-1.73
-3.46
-5.19
I.F.
% OFF RESONANCE

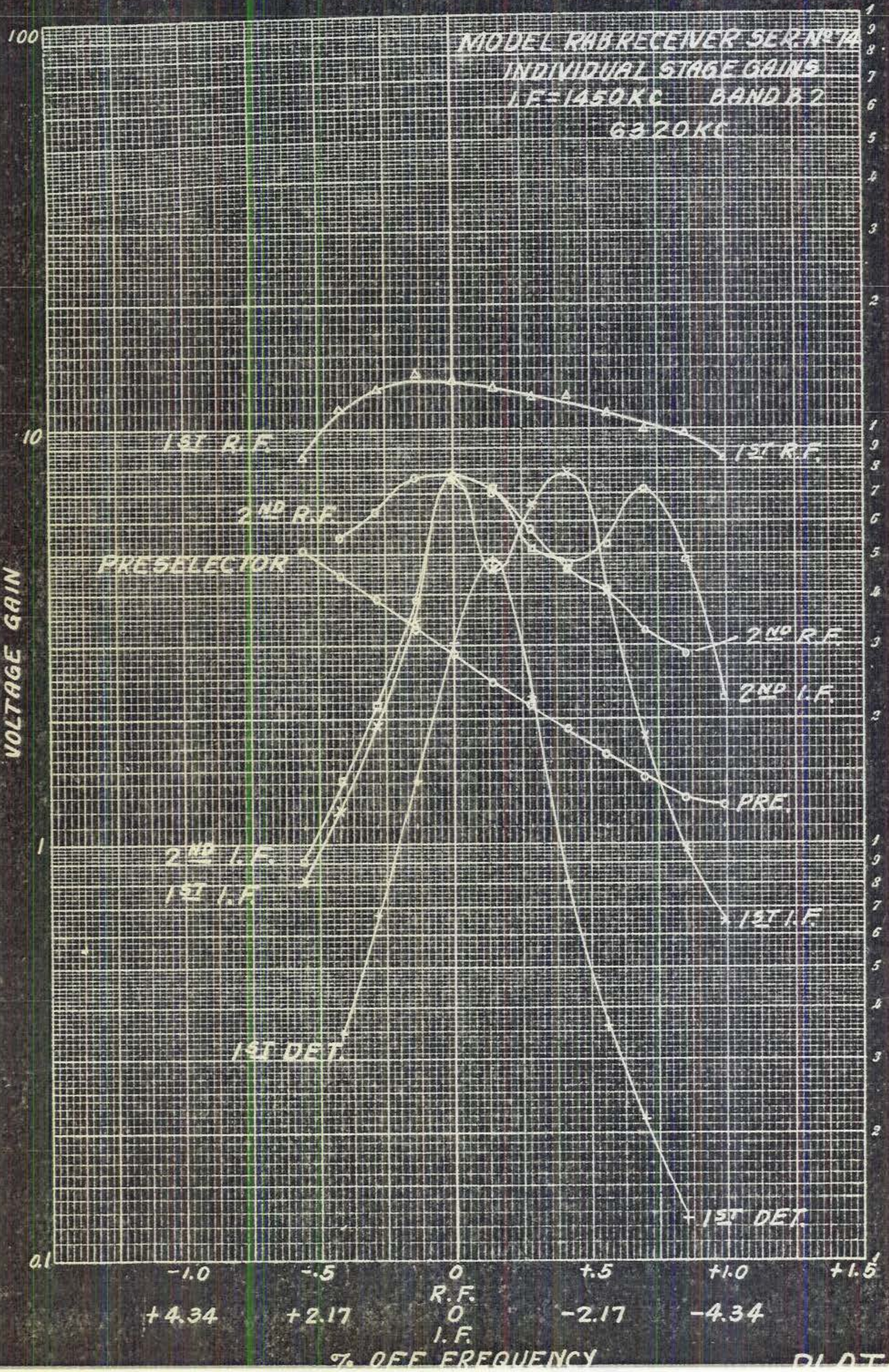

MODEL RAB RECEIVER SER. Nº 14
INDIVIDUAL STAGE GAINS
I.F.=1450KC BAND B 2
6320KC
VOLTAGE GAIN
1ST R.F.
2ND R.F.
PRESELECTOR
2ND I.F.
PRE.
1ST I.F.
1ST DET.
R.F.
I.F.
% OFF FREQUENCY

PLATE 2

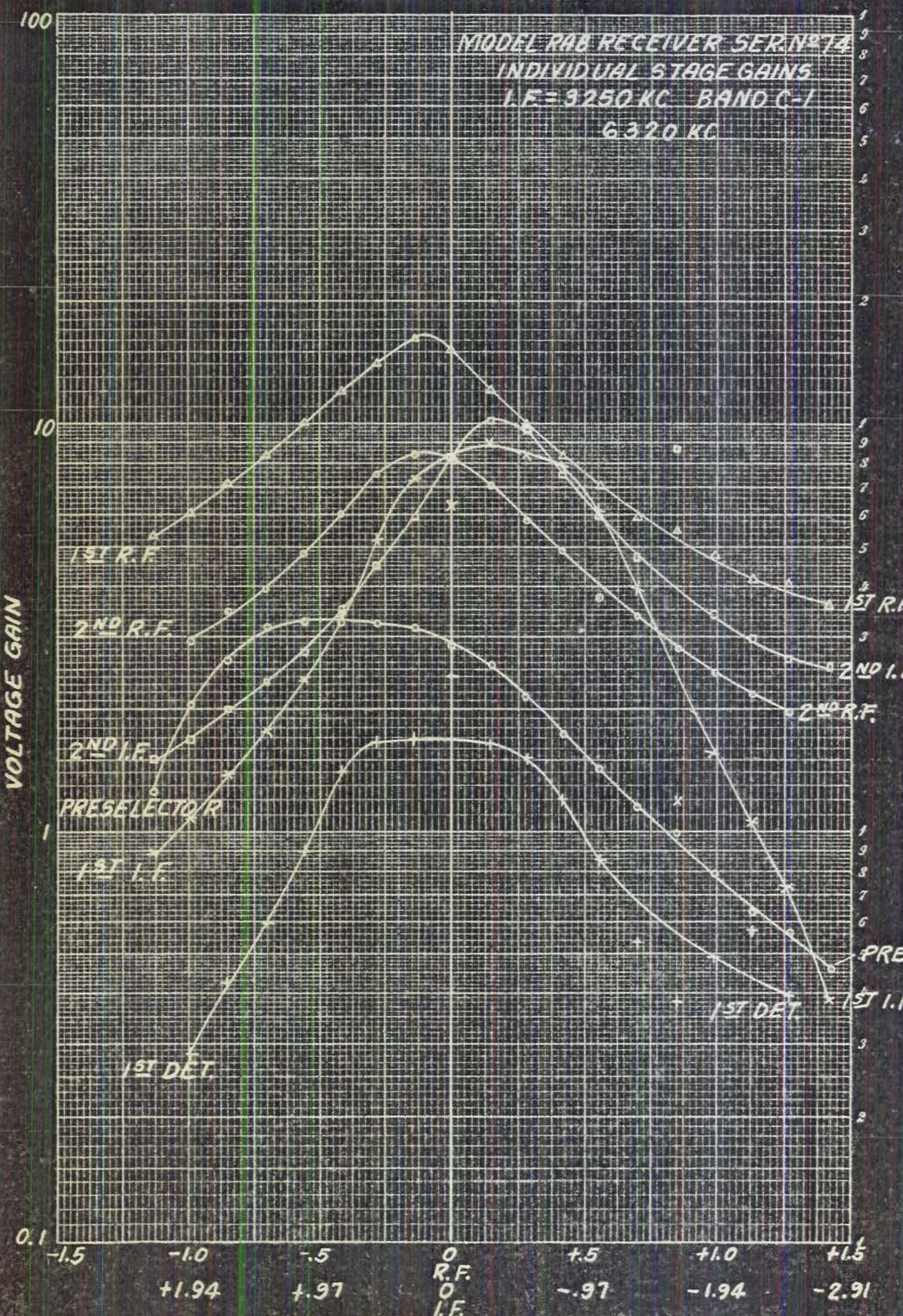
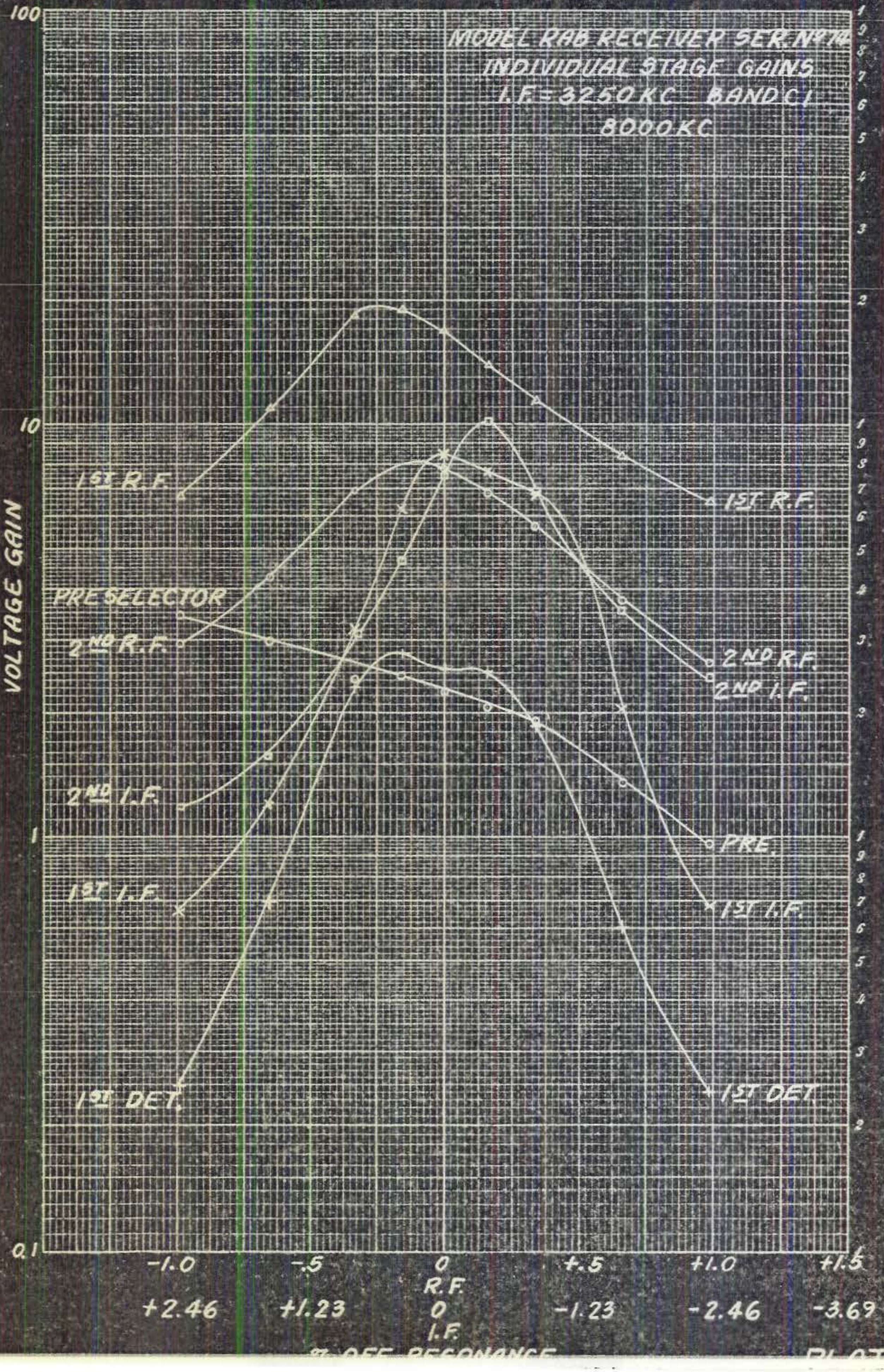

MODEL RAB RECEIVER SER. Nº 74
INDIVIDUAL STAGE GAINS
I.F. = 3250 KC BAND C-1
6320 KC
VOLTAGE GAIN
100
10
1
0.1
1ST R.F.
2ND R.F.
2ND I.F.
PRESELECTOR
1ST I.F.
1ST DET.
PRE.
-1.5
-1.0
-.5
0
+.5
+1.0
+1.5
R.F.
+1.94
+.97
0
-.97
-1.94
-2.91
I.F.
% OFF RESONANCE

PLATE 25


MODEL RAB RECEIVER SER. Nº 14
INDIVIDUAL STAGE GAINS
I.F. = 3250 KC BAND C1
8000 KC
VOLTAGE GAIN
100
10
1
0.1
1ST R.F.
PRESELECTOR
2ND R.F.
2ND I.F.
1ST I.F.
1ST DET.
1ST R.F.
2ND R.F.
2ND I.F.
PRE.
1ST I.F.
1ST DET.
-1.0
-.5
0
+.5
+1.0
+1.5
R.F.
+2.46
+1.23
0
-1.23
-2.46
-3.69
I.F.

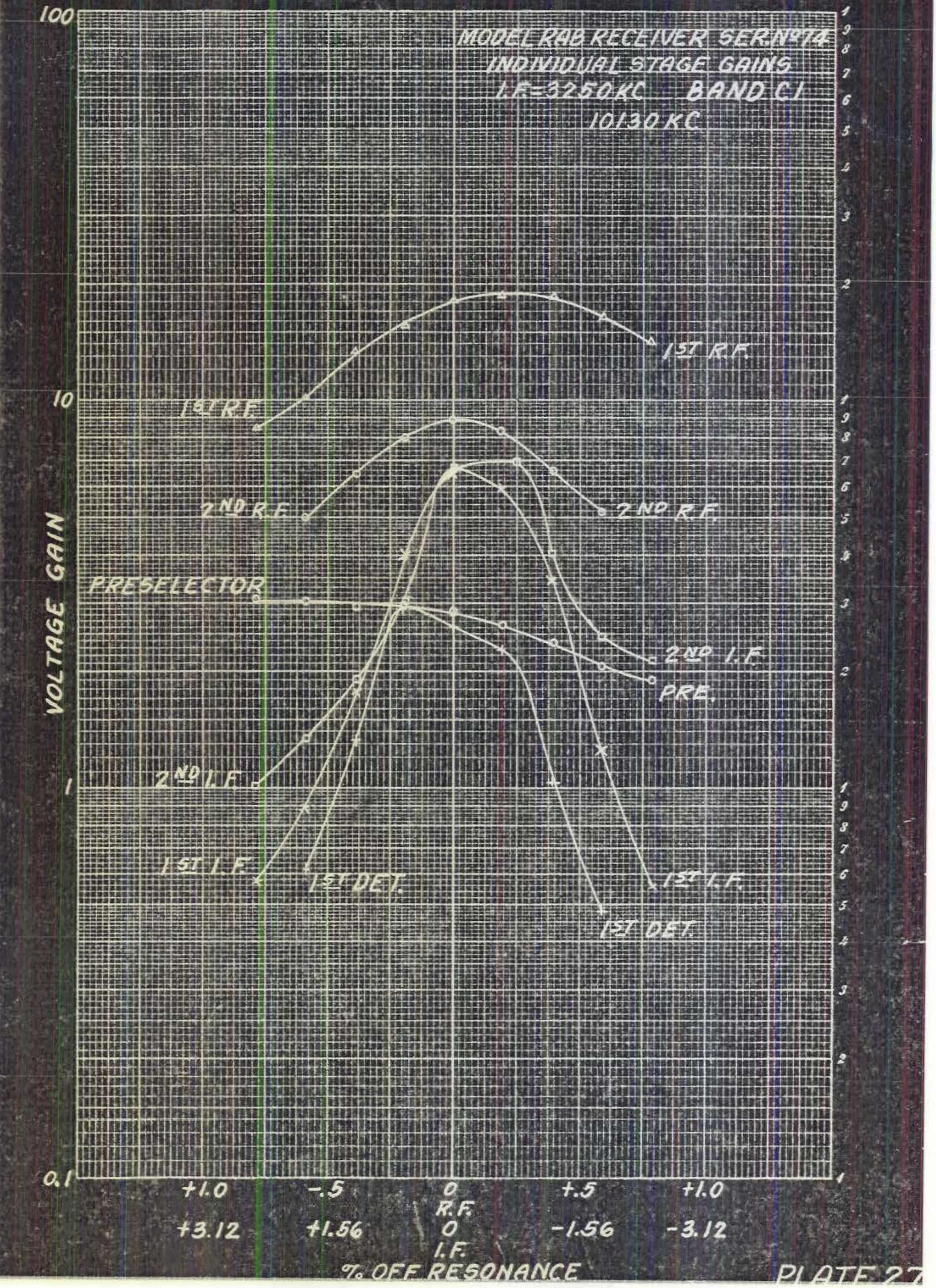
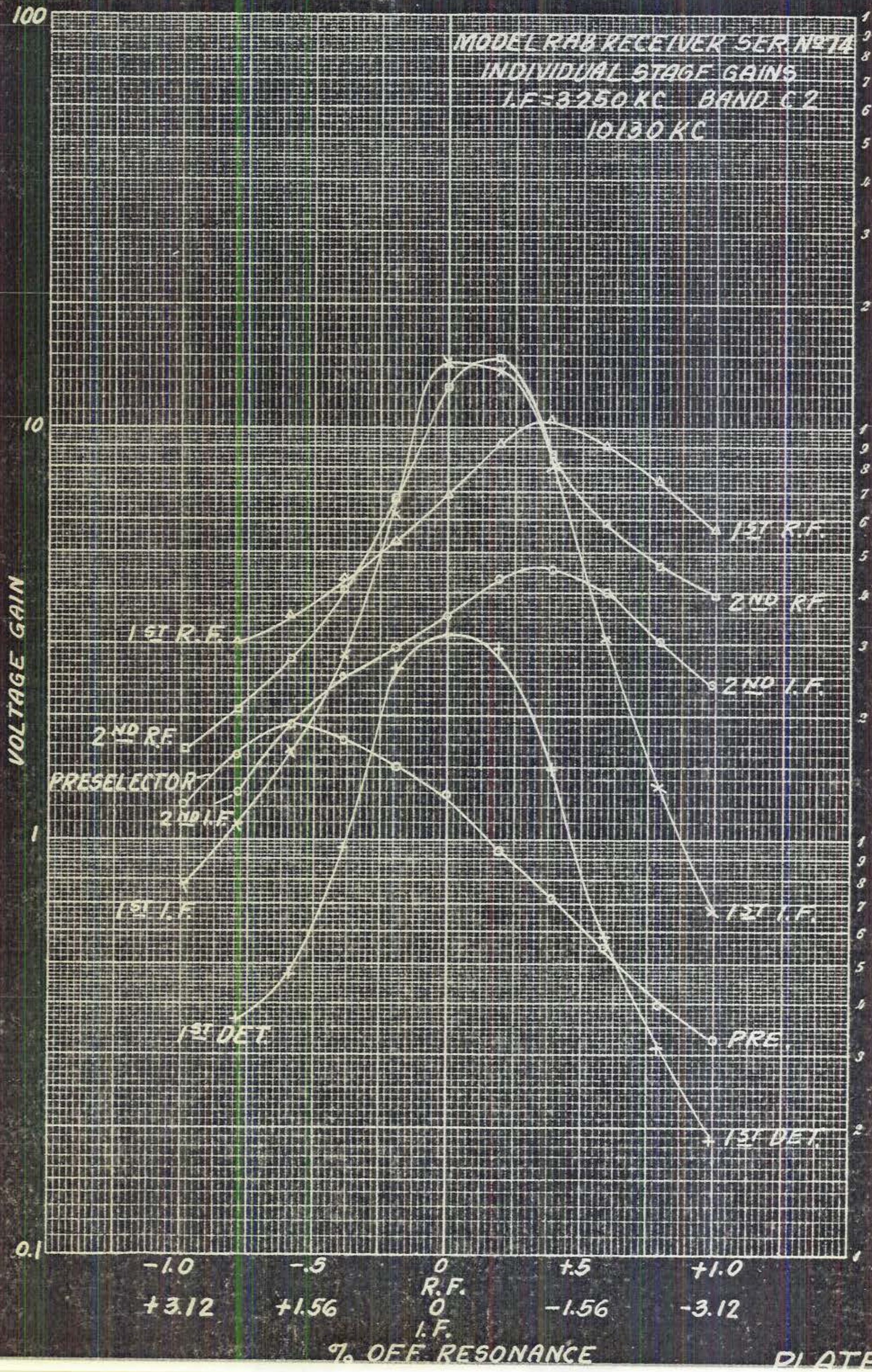

MODEL RAB RECEIVER SER. Nº 74
INDIVIDUAL STAGE GAINS
I.F.=3250 KC BAND C.I
10130 KC
VOLTAGE GAIN
100
10
1
0.1
1ST R.F.
2ND R.F.
PRESELECTOR
2ND I.F.
1ST I.F.
1ST DET.
PRE.
+1.0
-.5
0
+.5
+1.0
R.F.
+3.12
+1.56
0
-1.56
-3.12
I.F.
% OFF RESONANCE

PLATE 27



MODEL RAB RECEIVER SER. No 14
INDIVIDUAL STAGE GAINS
I.F.=3250 KC BAND C2
10130 KC
VOLTAGE GAIN
100
10
1
0.1
1ST R.F.
2ND R.F.
2ND I.F.
1ST I.F.
PRE
1ST DET.
PRESELECTOR
-1.0
-.5
0
+.5
+1.0
R.F.
+3.12
+1.56
0
-1.56
-3.12
I.F.
% OFF RESONANCE

PLATE 28

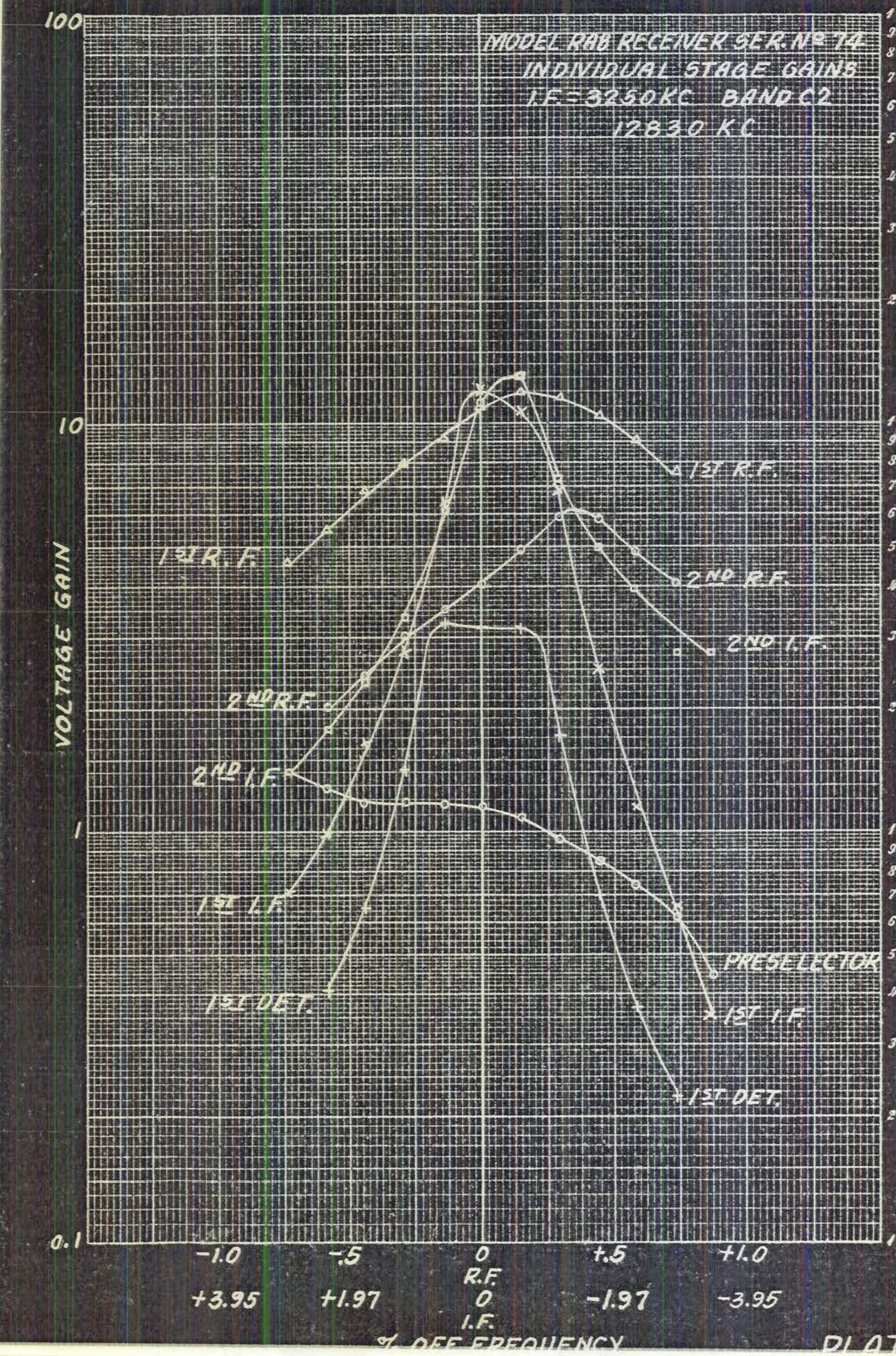
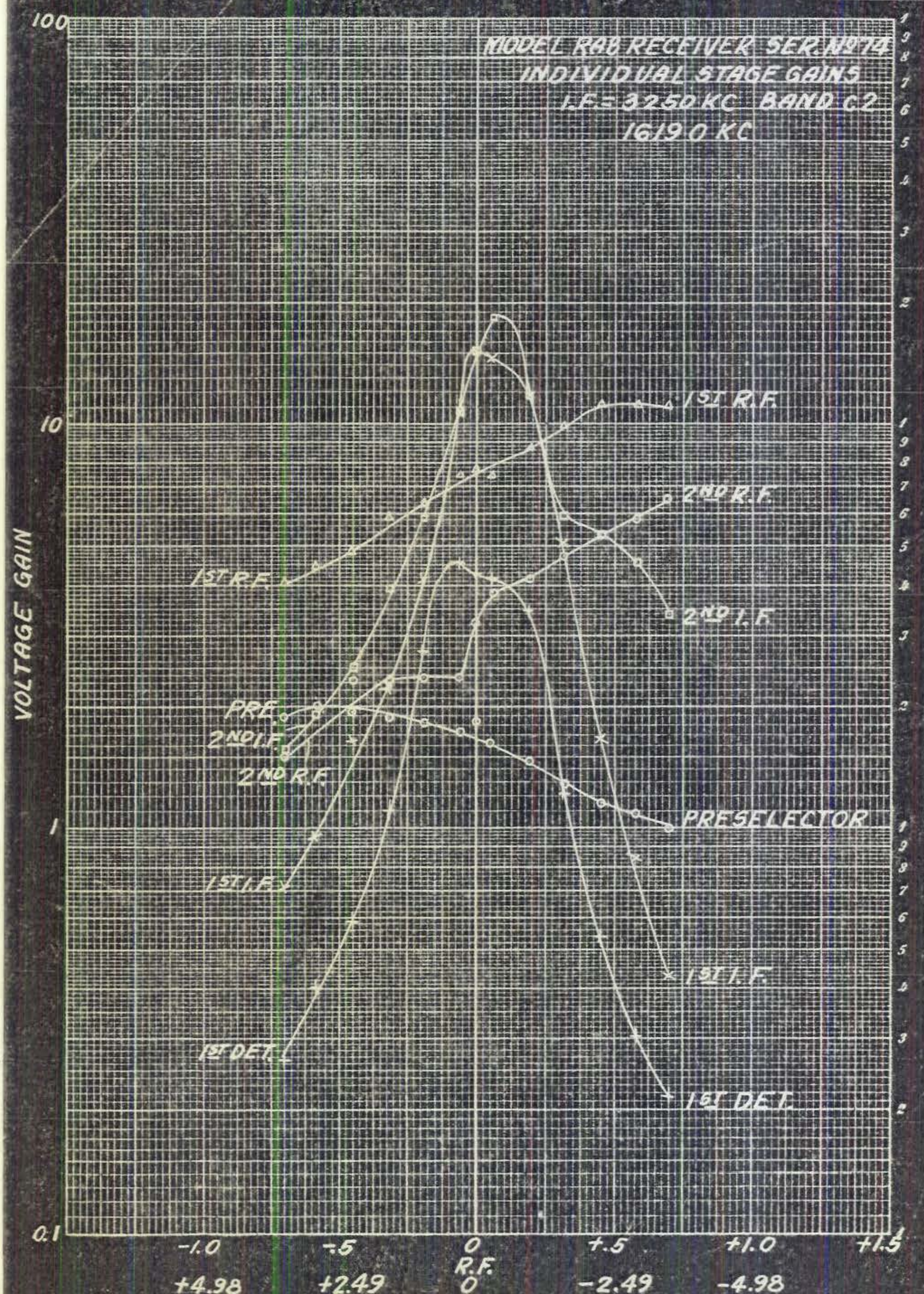
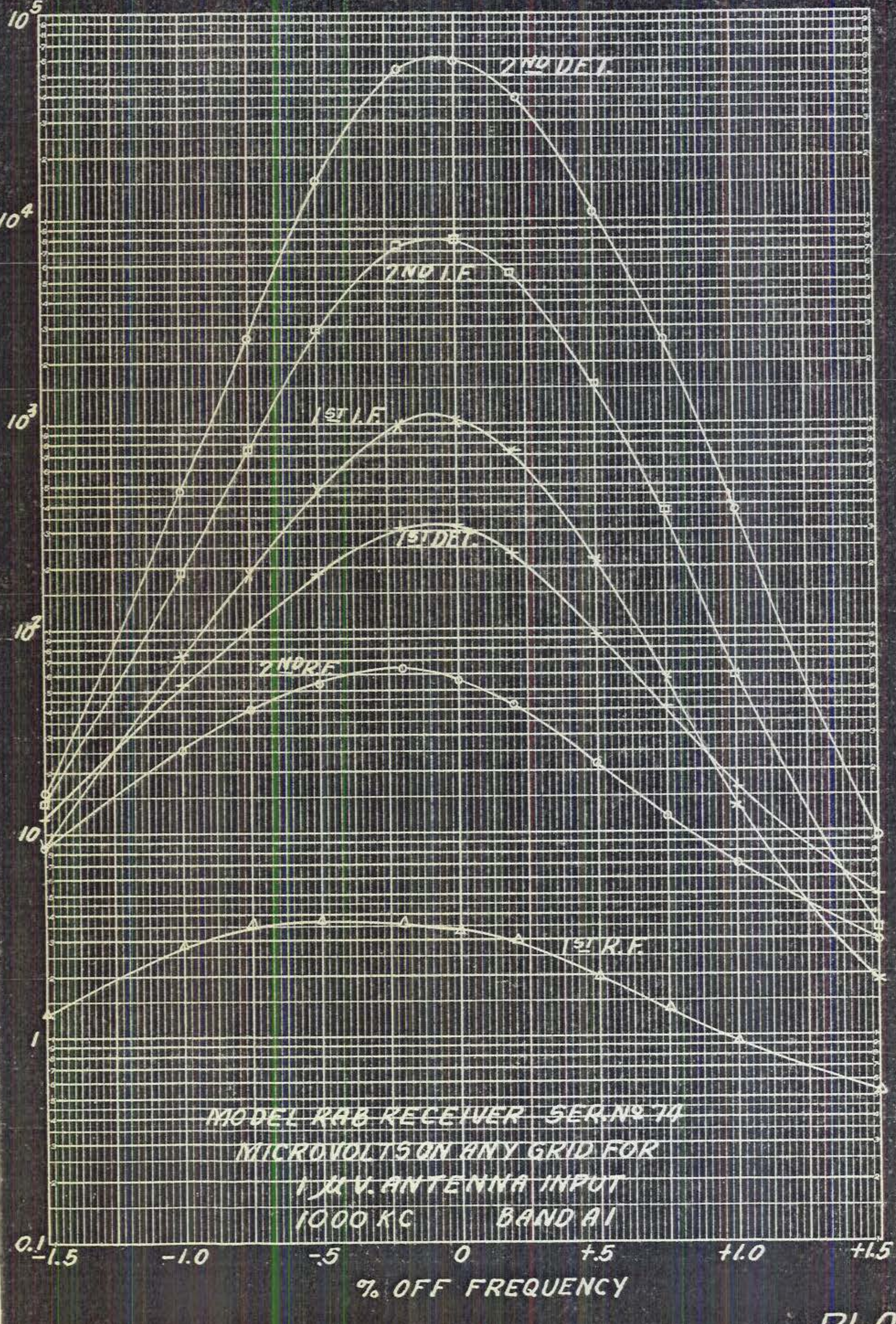

MODEL RAB RECEIVER SER. № 74
INDIVIDUAL STAGE GAINS
I.F. = 3250 KC BAND C2
12830 KC
VOLTAGE GAIN
100
10
1
0.1
1ST R.F.
2ND R.F.
2ND I.F.
1ST I.F.
1ST DET.
PRESELECTOR
-1.0
-.5
0
+.5
+1.0
R.F.
+3.95
+1.97
0
-1.97
-3.95
I.F.
% OFF FREQUENCY

PLATE 29



MODEL RAB RECEIVER SER. Nº 74
INDIVIDUAL STAGE GAINS
I.F.=3250 KC BAND C2
16190 KC
VOLTAGE GAIN
100
10
1
0.1
1ST R.F.
2ND R.F.
2ND I.F.
PRESELECTOR
1ST I.F.
1ST DET.
PRE.
-1.0
-.5
0
+.5
+1.0
+1.5
+4.98
+2.49
R.F.
O
I.F.
-2.49
-4.98
% OFF FREQUENCY

PLATE 30



10^5
10^4
10^3
10^2
10
1
0.1
2ND DET.
2ND I.F.
1ST I.F.
1ST DET.
2ND R.F.
1ST R.F.
MODEL RAB RECEIVER SER.No 74
MICROVOLTS ON ANY GRID FOR
1 μV. ANTENNA INPUT
1000 KC BAND A1
-1.5
-1.0
-.5
0
+.5
+1.0
+1.5
% OFF FREQUENCY

PLATE-31

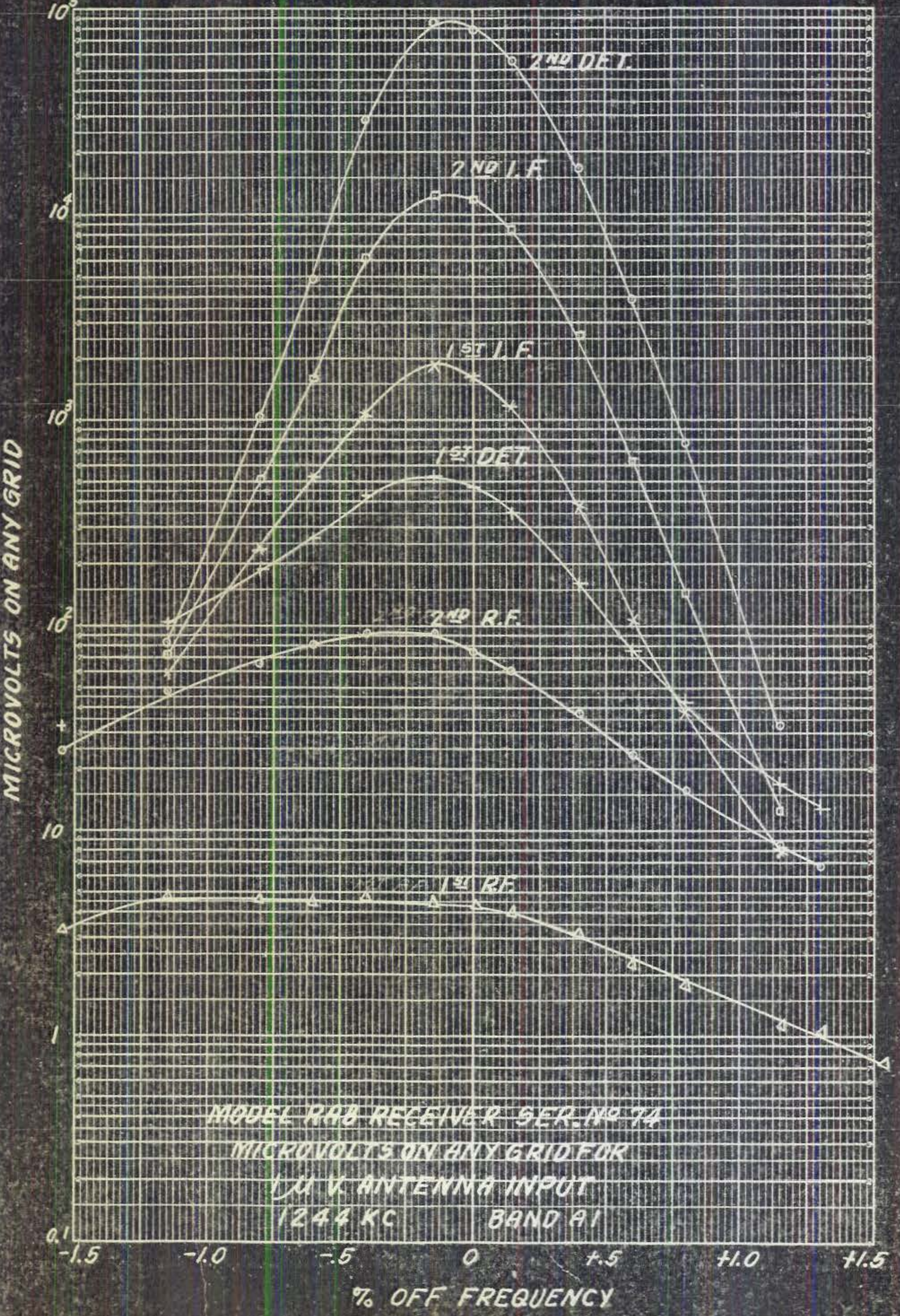
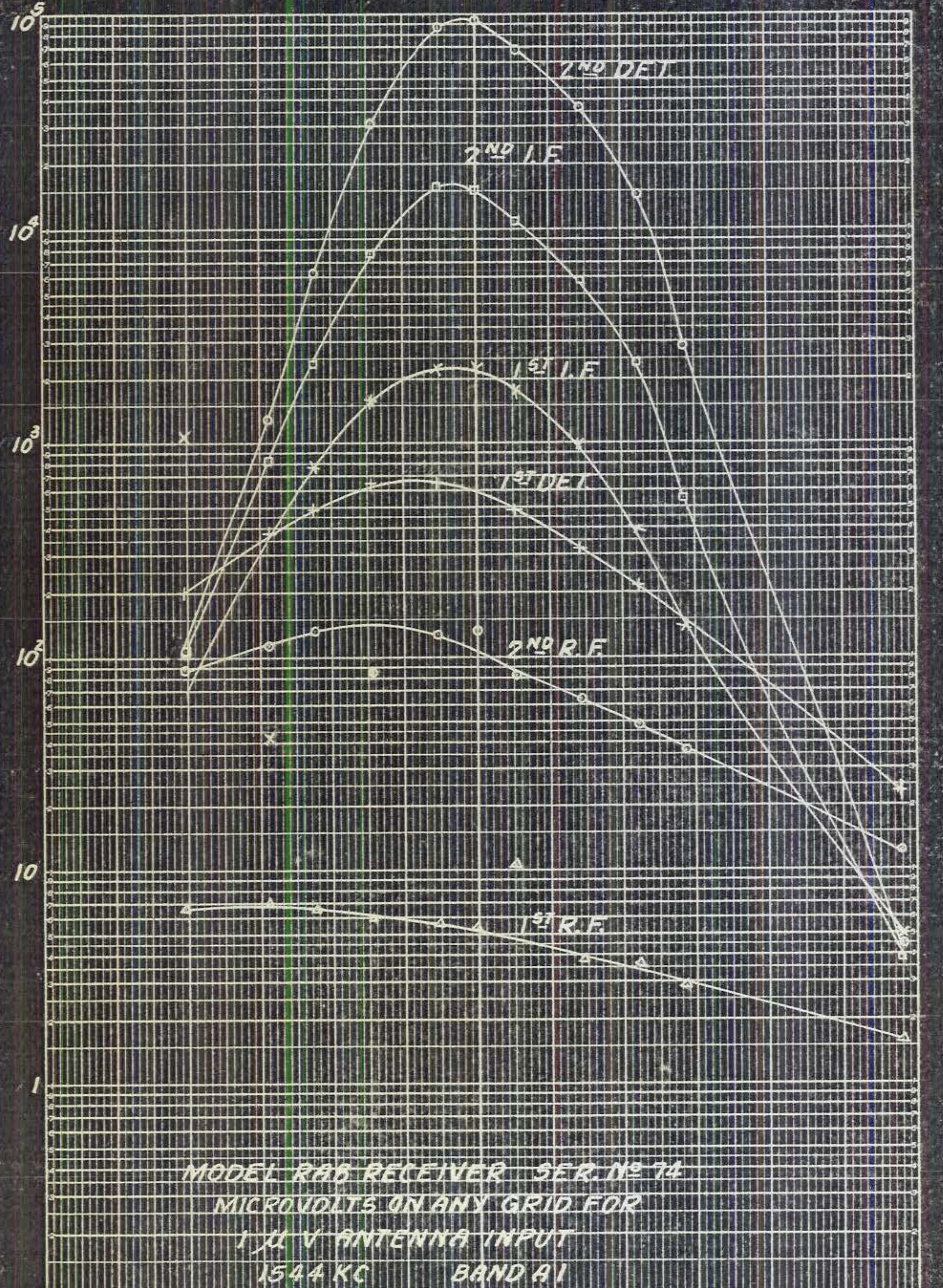
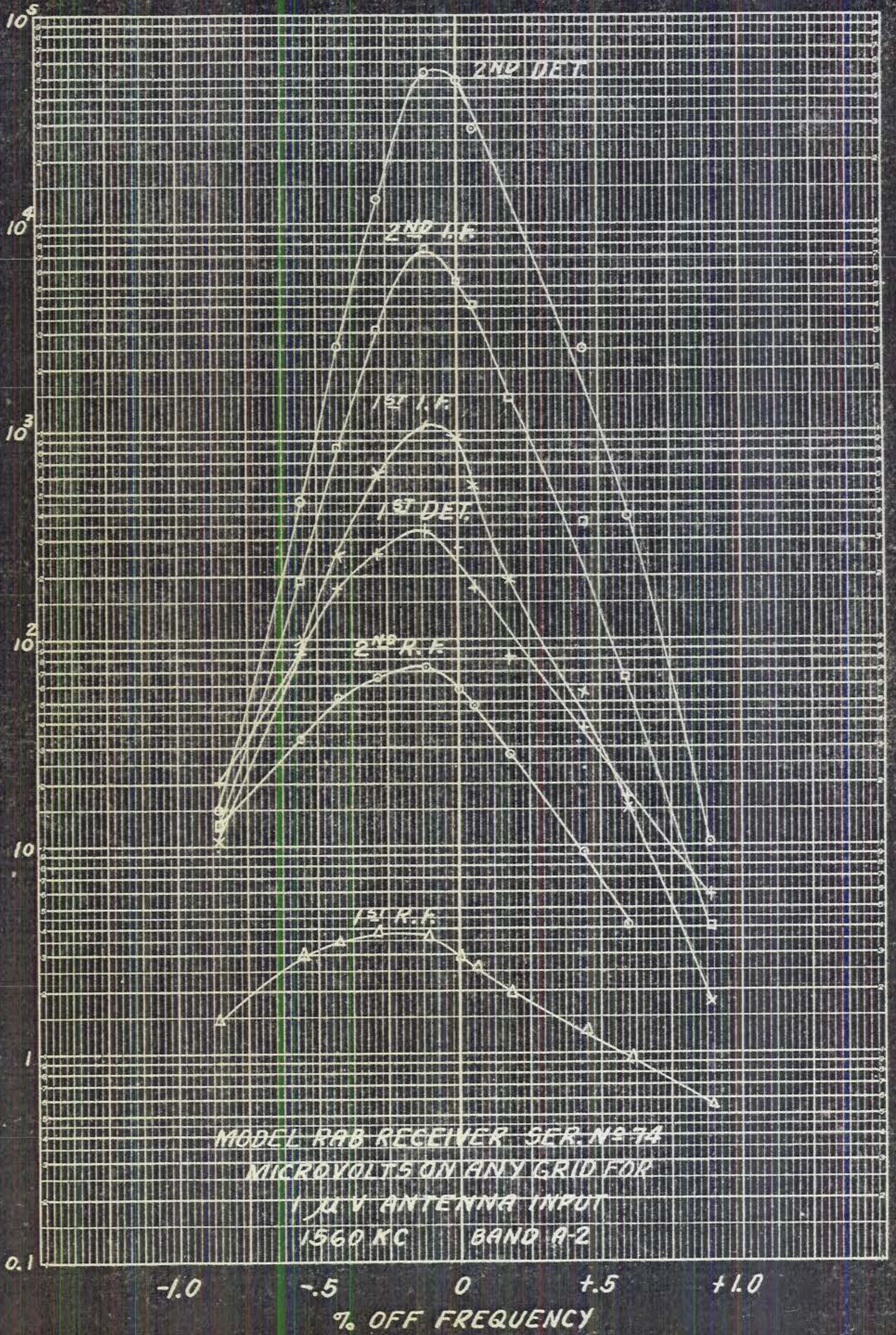
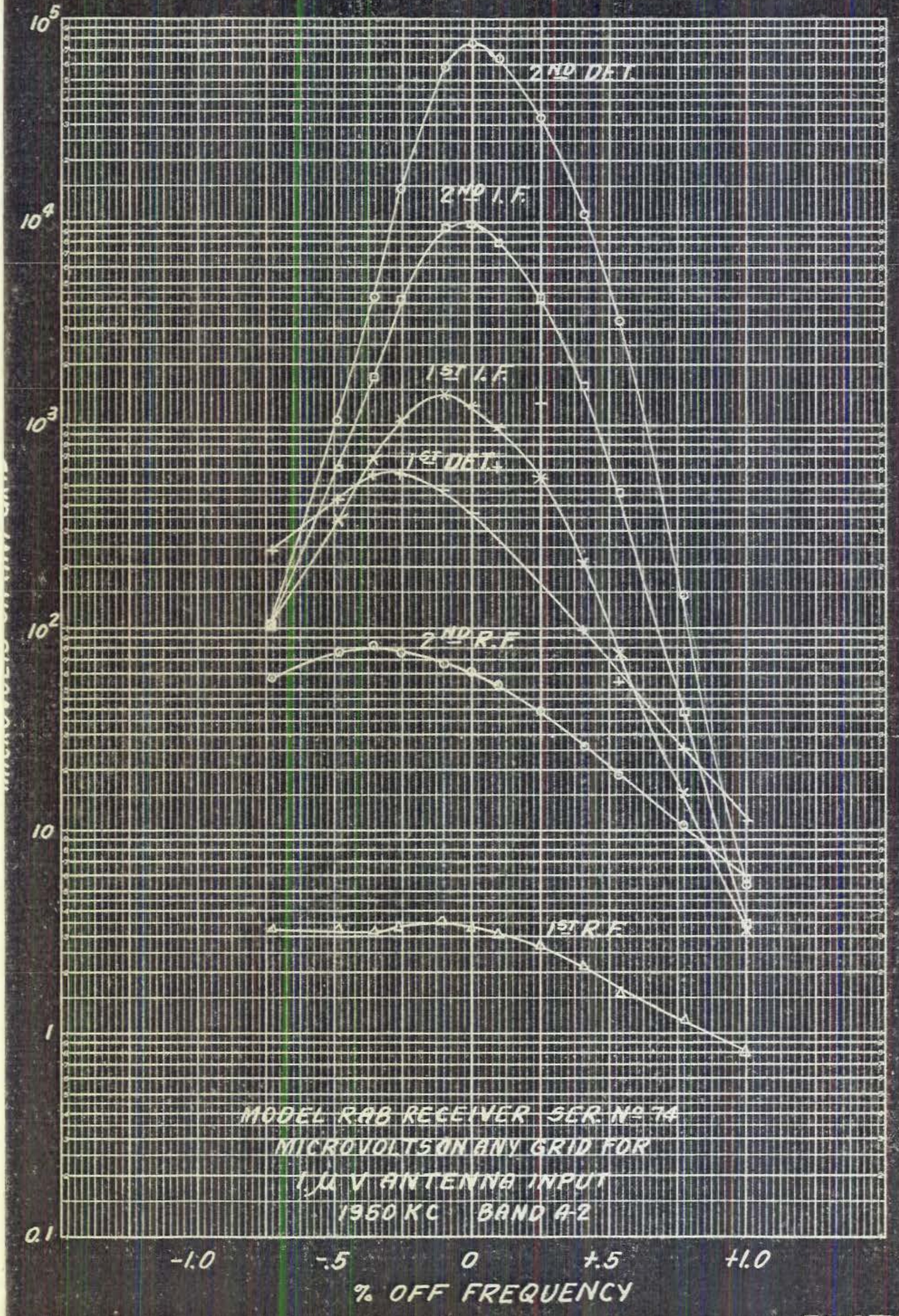

2ND DET.
2ND I.F.
1ST I.F.
1ST DET.
2ND R.F.
1ST R.F.
MICROVOLTS ON ANY GRID
% OFF FREQUENCY
MODEL RAB RECEIVER SER. No 74
MICROVOLTS ON ANY GRID FOR
1 μ V. ANTENNA INPUT
1244 KC BAND A1

PLATE 32



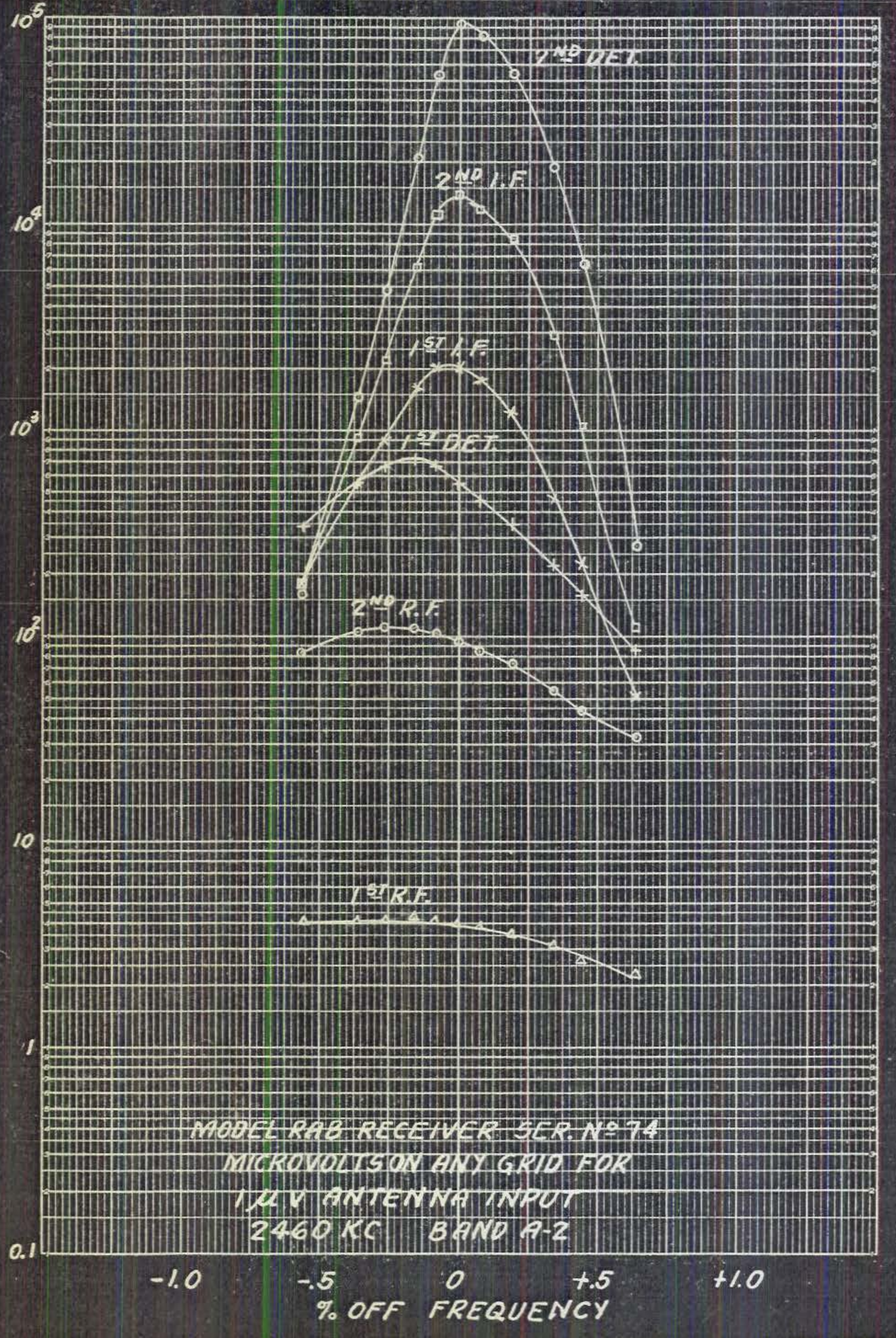
10^5
10^4
10^3
10^2
10
1
0.1
2ND DET
2ND I.F.
1ST I.F.
1ST DET
2ND R.F.
1ST R.F.
MODEL RAB RECEIVER SER. NO 74
MICROVOLTS ON ANY GRID FOR
1 μ V ANTENNA INPUT
1544 KC BAND A1
-1.0
-.5
0
+.5
+1.0
+1.5
% OFF FREQUENCY


2ND DET.
2ND I.F.
1ST I.F.
1ST DET.
2ND R.F.
1ST R.F.
10^5
10^4
10^3
10^2
10
1
0.1
MODEL RAB RECEIVER SER. № 74
MICROVOLTS ON ANY GRID FOR
1 μV ANTENNA INPUT
1560 KC BAND A-2
-1.0
-.5
0
+.5
+1.0
% OFF FREQUENCY



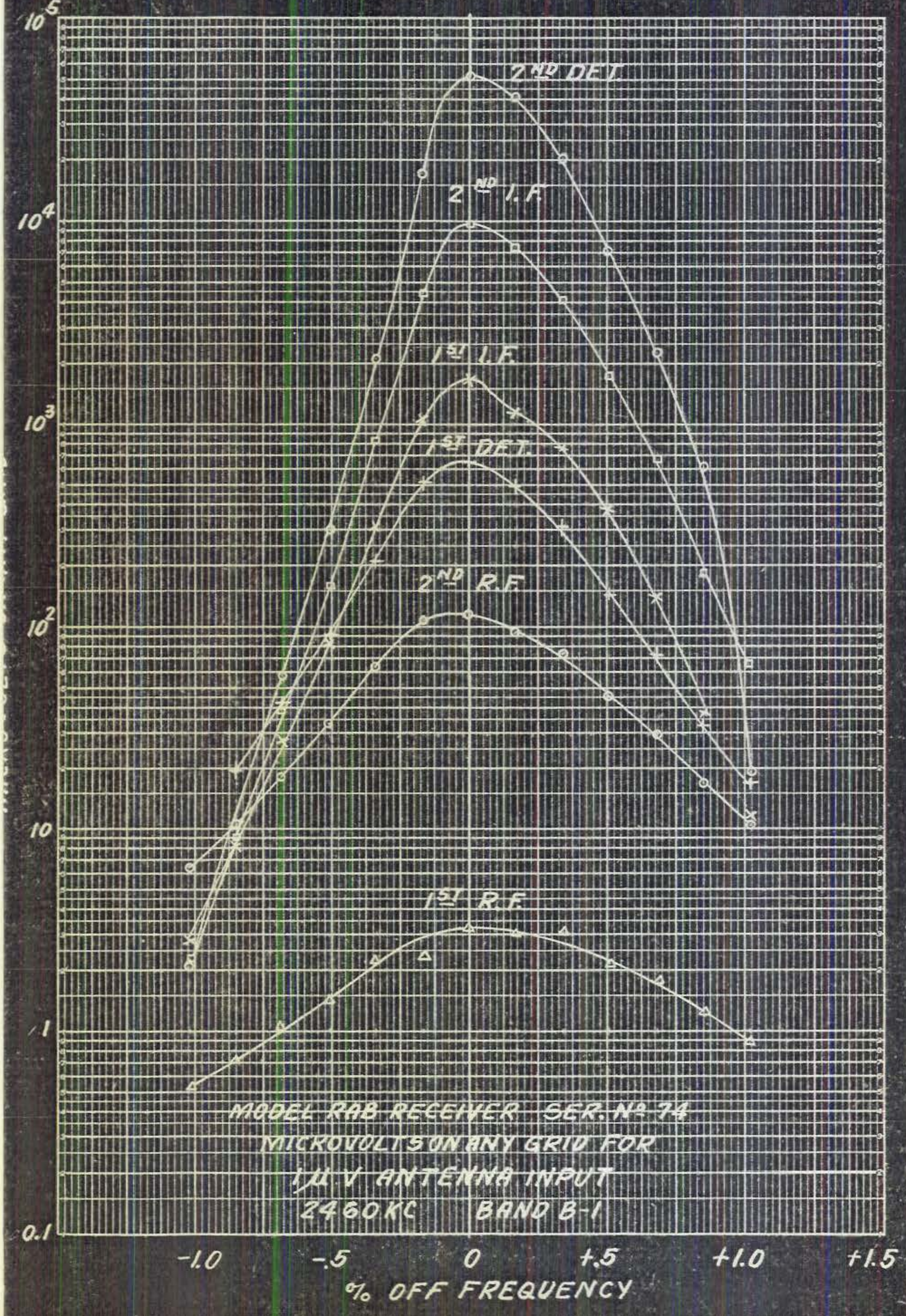
2ND DET.
2ND I.F.
1ST I.F.
1ST DET.
2ND R.F.
1ST R.F.
MODEL RAB RECEIVER SER. № 74
MICROVOLTS ON ANY GRID FOR
1 μ V ANTENNA INPUT
1950 KC BAND A-2
10⁵
10⁴
10³
10²
10
1
0.1
-1.0
-.5
0
+.5
+1.0
% OFF FREQUENCY

PLATE 35



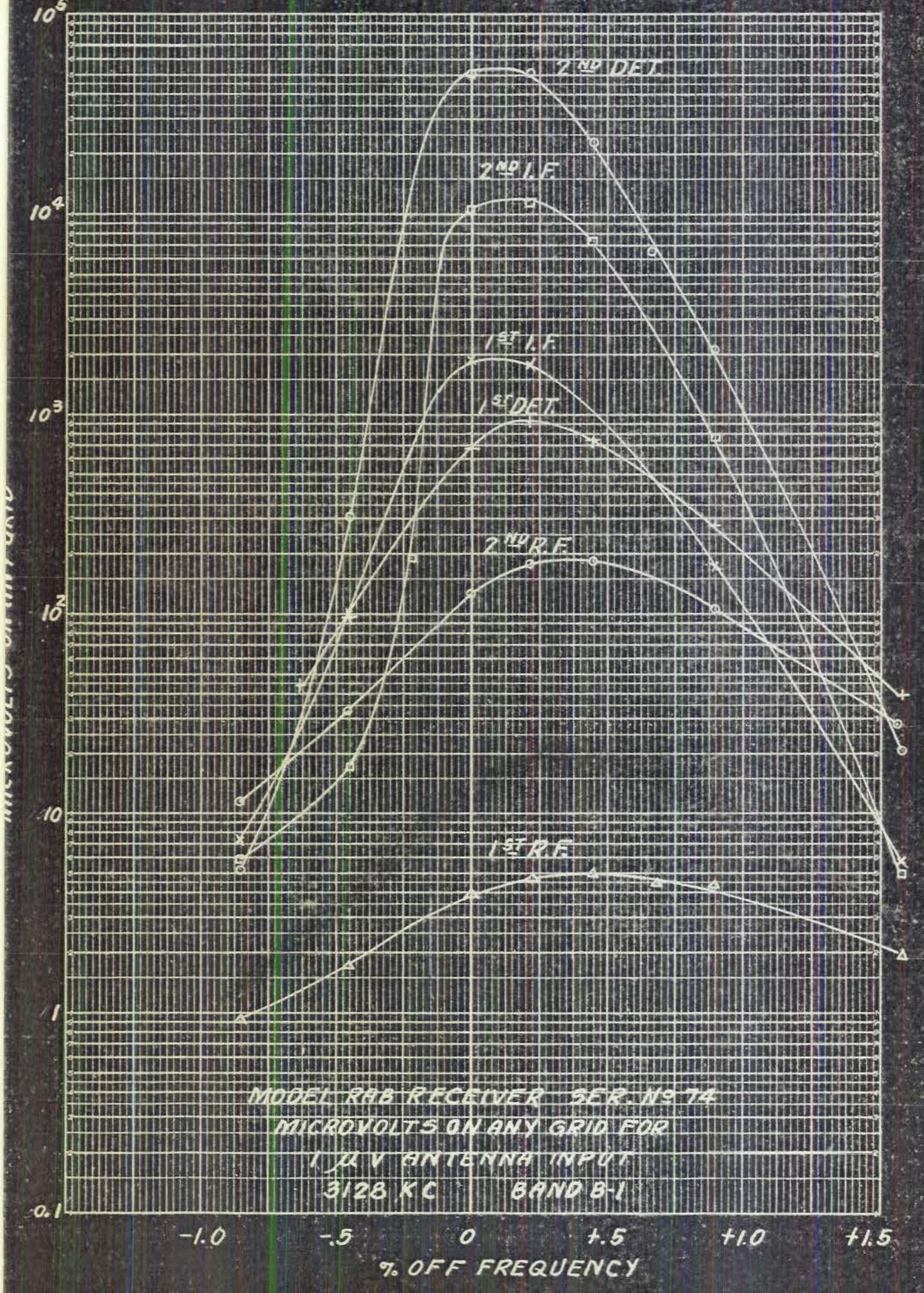
2ND DET.
2ND I.F.
1ST I.F.
1ST DET.
2ND R.F.
1ST R.F.
10^5
10^4
10^3
10^2
10
1
0.1
MODEL RAB RECEIVER SER. Nº 74
MICROVOLTS ON ANY GRID FOR
1 µV ANTENNA INPUT
2460 KC BAND A-2
-1.0
-.5
0
+.5
+1.0
% OFF FREQUENCY

PLATE 36



10^5
10^4
10^3
10^2
10
1
0.1
2ND DET.
2ND I.F.
1ST I.F.
1ST DET.
2ND R.F.
1ST R.F.
MODEL RAB RECEIVER SER. No 74
MICROVOLTS ON ANY GRID FOR
1 µ V ANTENNA INPUT
2460 KC BAND B-1
-1.0
-.5
0
+.5
+1.0
+1.5
% OFF FREQUENCY

PLATE 37



2ND DET.
2ND I.F.
1ST I.F.
1ST DET.
2ND R.F.
1ST R.F.
10^5
10^4
10^3
10^2
10
1
0.1
MODEL RAB RECEIVER SER. No 74
MICROVOLTS ON ANY GRID FOR
1 μV ANTENNA INPUT
3128 KC BAND B-1
-1.0
-.5
0
+.5
+1.0
+1.5
% OFF FREQUENCY

PLATE 2

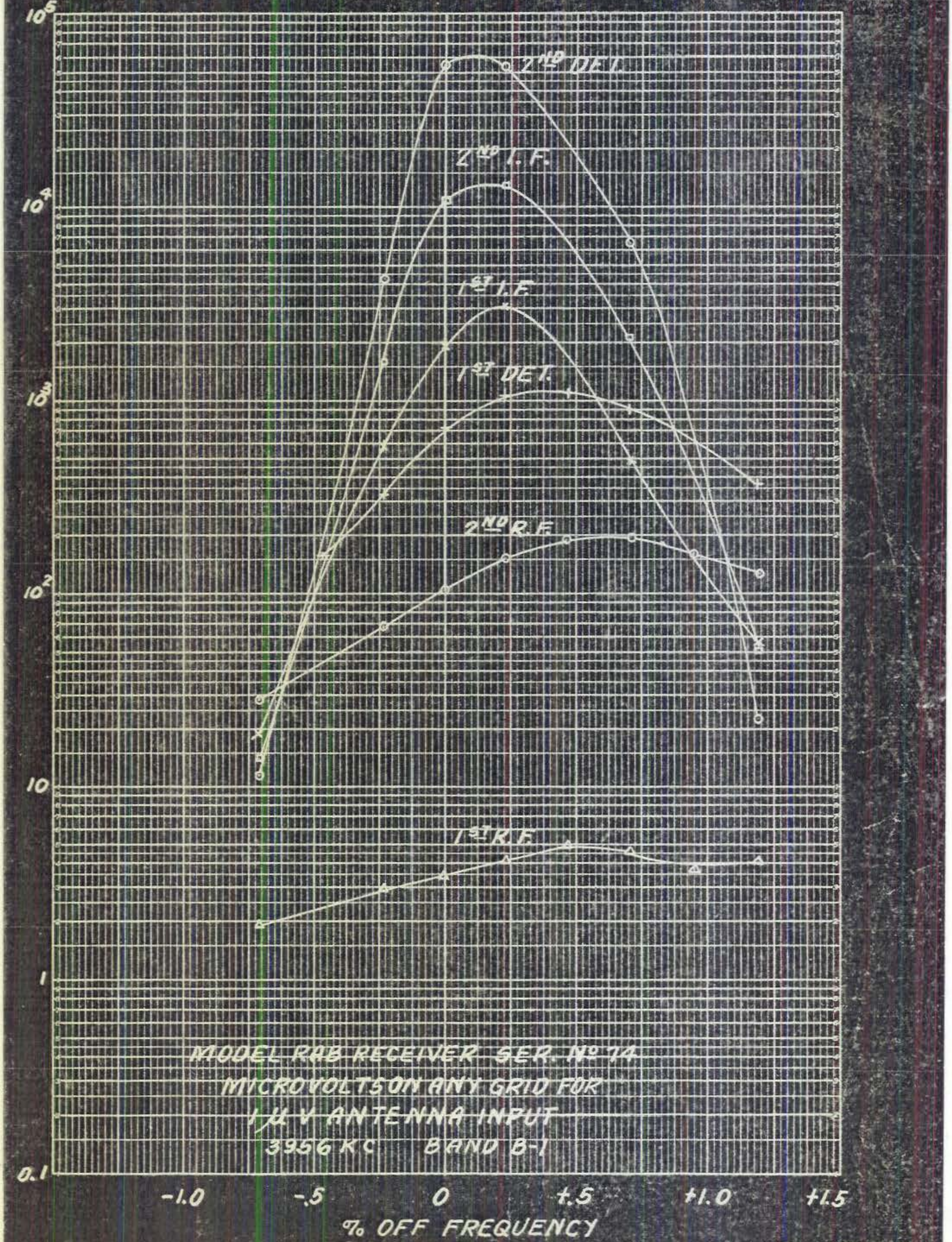
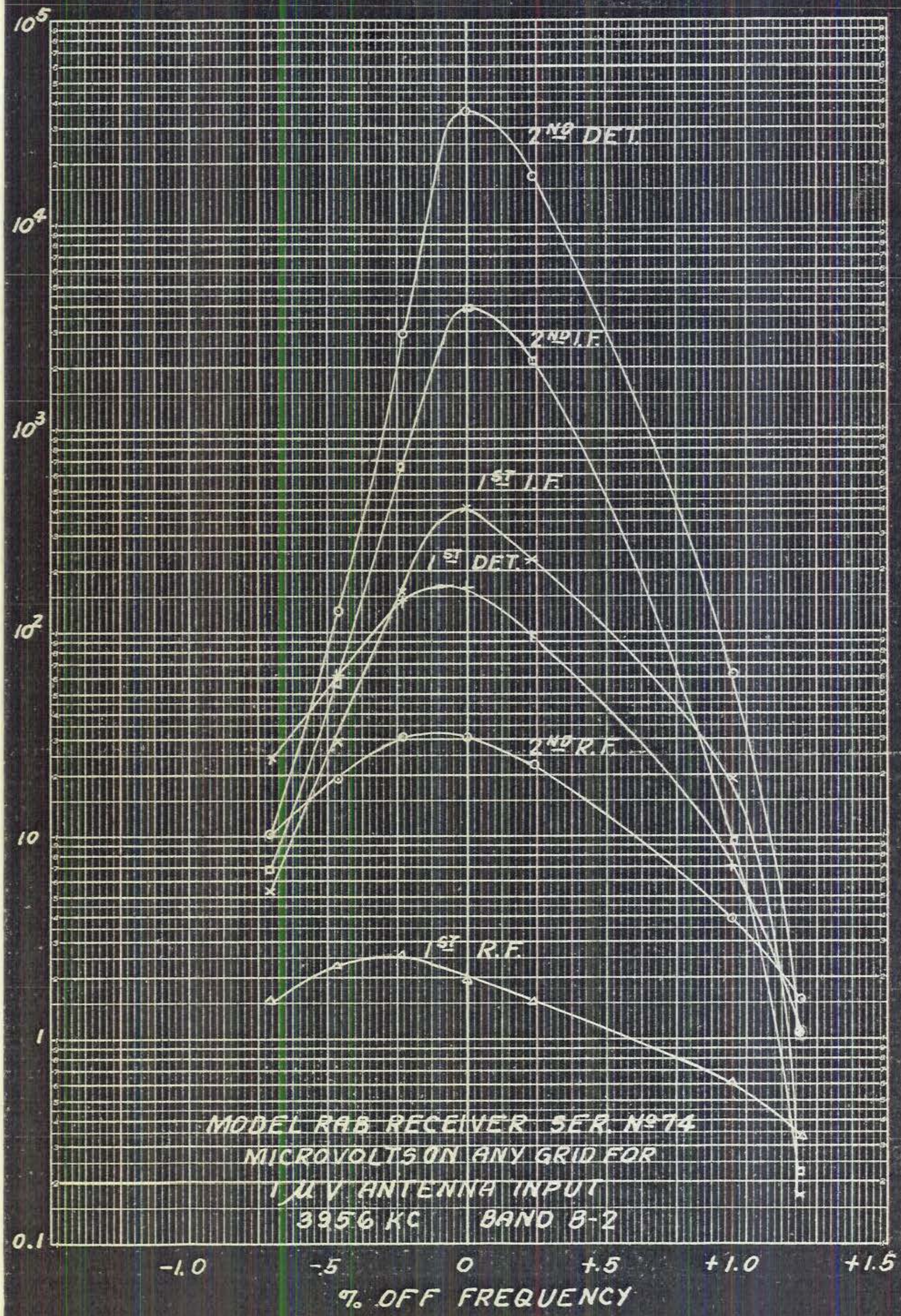
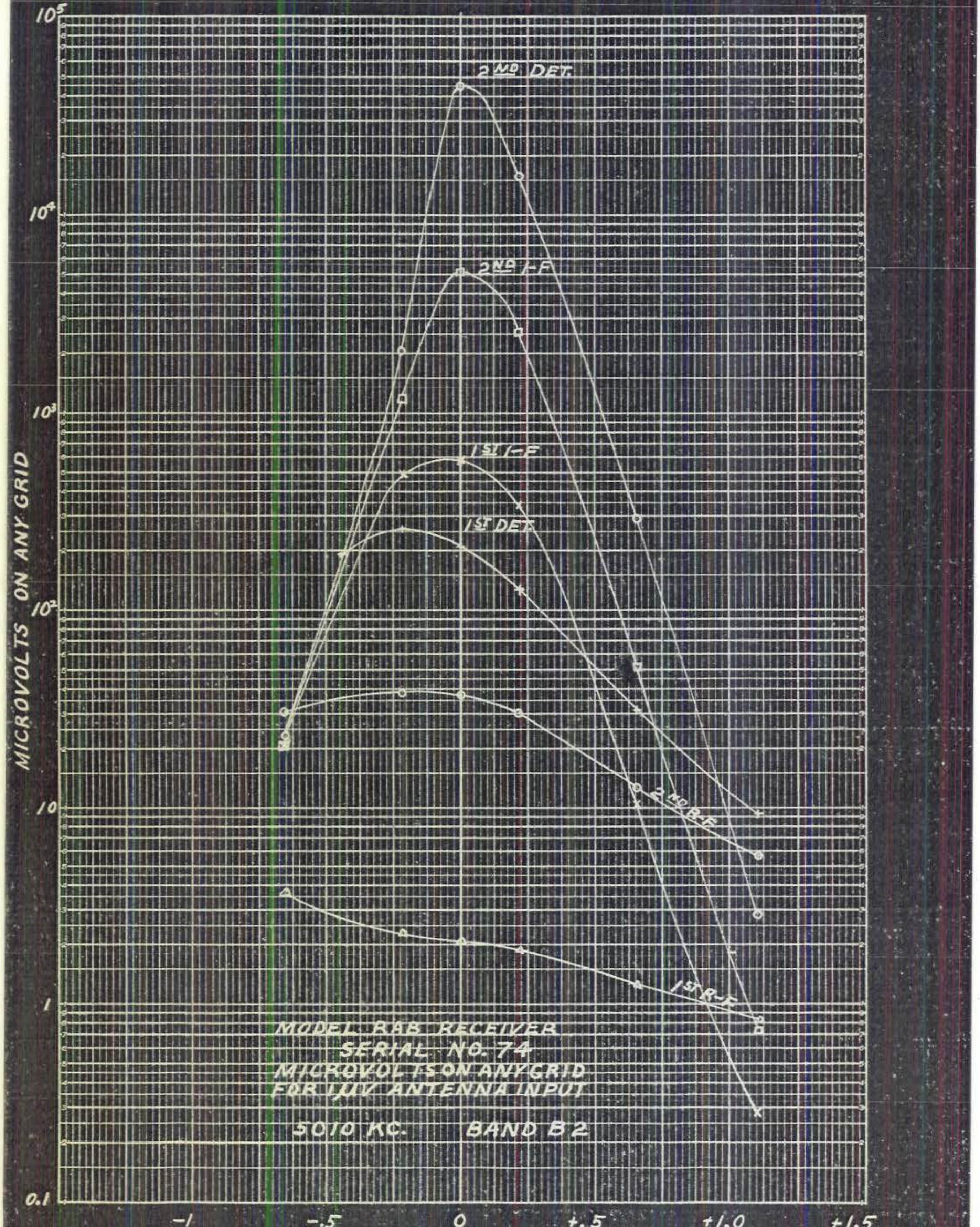

2ND DET.
2ND I.F.
1ST I.F.
1ST DET.
2ND R.F.
1ST R.F.
10^5
10^4
10^3
10^2
10
1
0.1
-1.0
-.5
0
+.5
+1.0
+1.5
% OFF FREQUENCY
MODEL RAB RECEIVER SER. No 14
MICROVOLTS ON ANY GRID FOR
1 µ V ANTENNA INPUT
3956 KC BAND B-1

PLATE 39



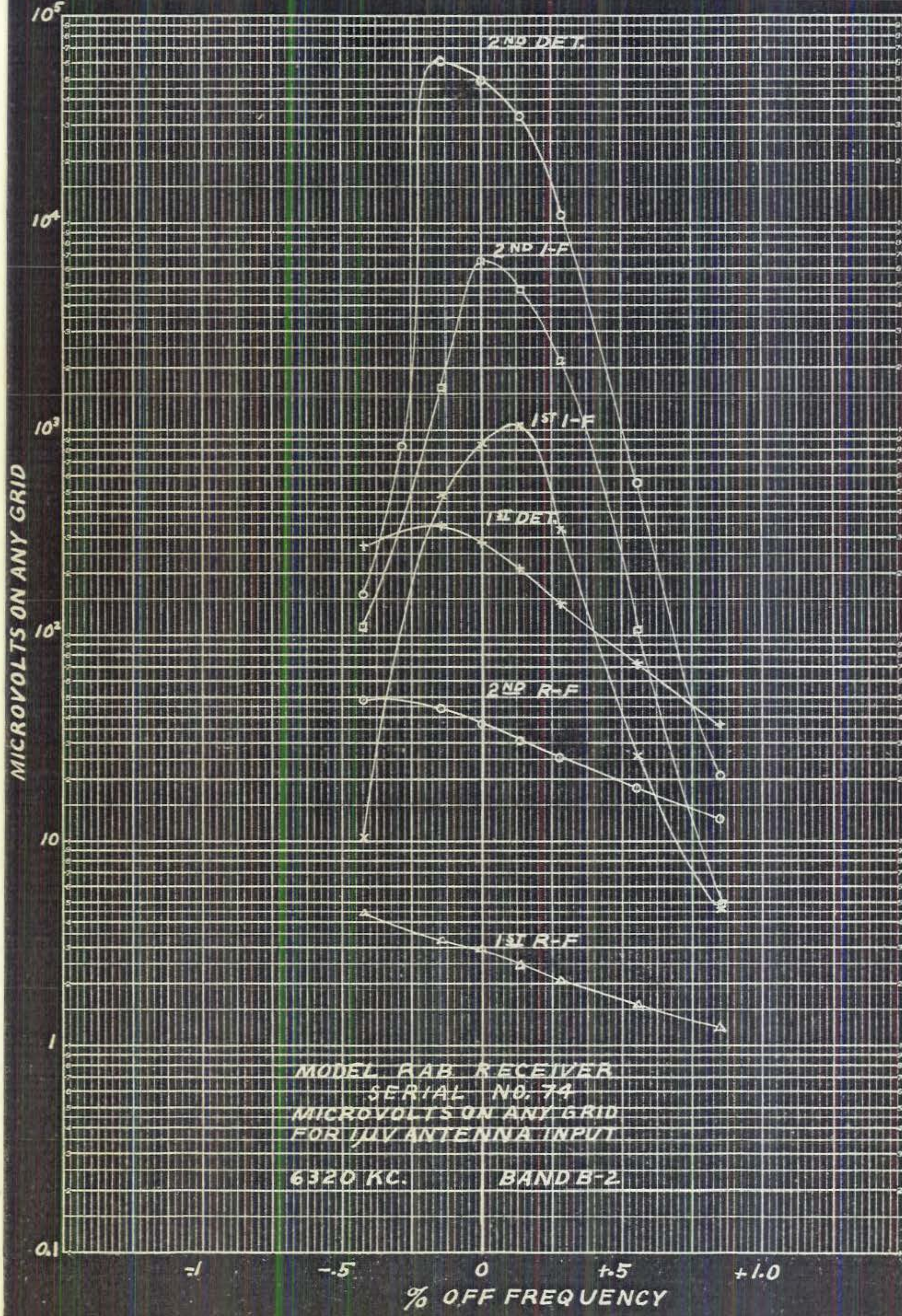
2ND DET.
2ND I.F.
1ST I.F.
1ST DET.
2ND R.F.
1ST R.F.
10^5
10^4
10^3
10^2
10
1
0.1
-1.0
-.5
0
+.5
+1.0
+1.5
% OFF FREQUENCY
MODEL RAB RECEIVER SER. No 74
MICROVOLTS ON ANY GRID FOR
1 μ V ANTENNA INPUT
3956 KC BAND B-2

PLATE 40



2ND DET.
2ND I-F
1ST I-F
1ST DET.
2ND R-F
1ST R-F
MODEL RAB RECEIVER
SERIAL NO. 74
MICROVOLTS ON ANY GRID
FOR 1μV ANTENNA INPUT
5010 KC. BAND B2
MICROVOLTS ON ANY GRID
% OFF FREQUENCY

PLATE 41



MICROVOLTS ON ANY GRID
% OFF FREQUENCY
2ND DET.
2ND I-F
1ST I-F
1ST DET.
2ND R-F
1ST R-F
MODEL RAB RECEIVER
SERIAL NO. 74
MICROVOLTS ON ANY GRID
FOR 1µV ANTENNA INPUT
6320 KC.
BAND B-2

PLATE 42

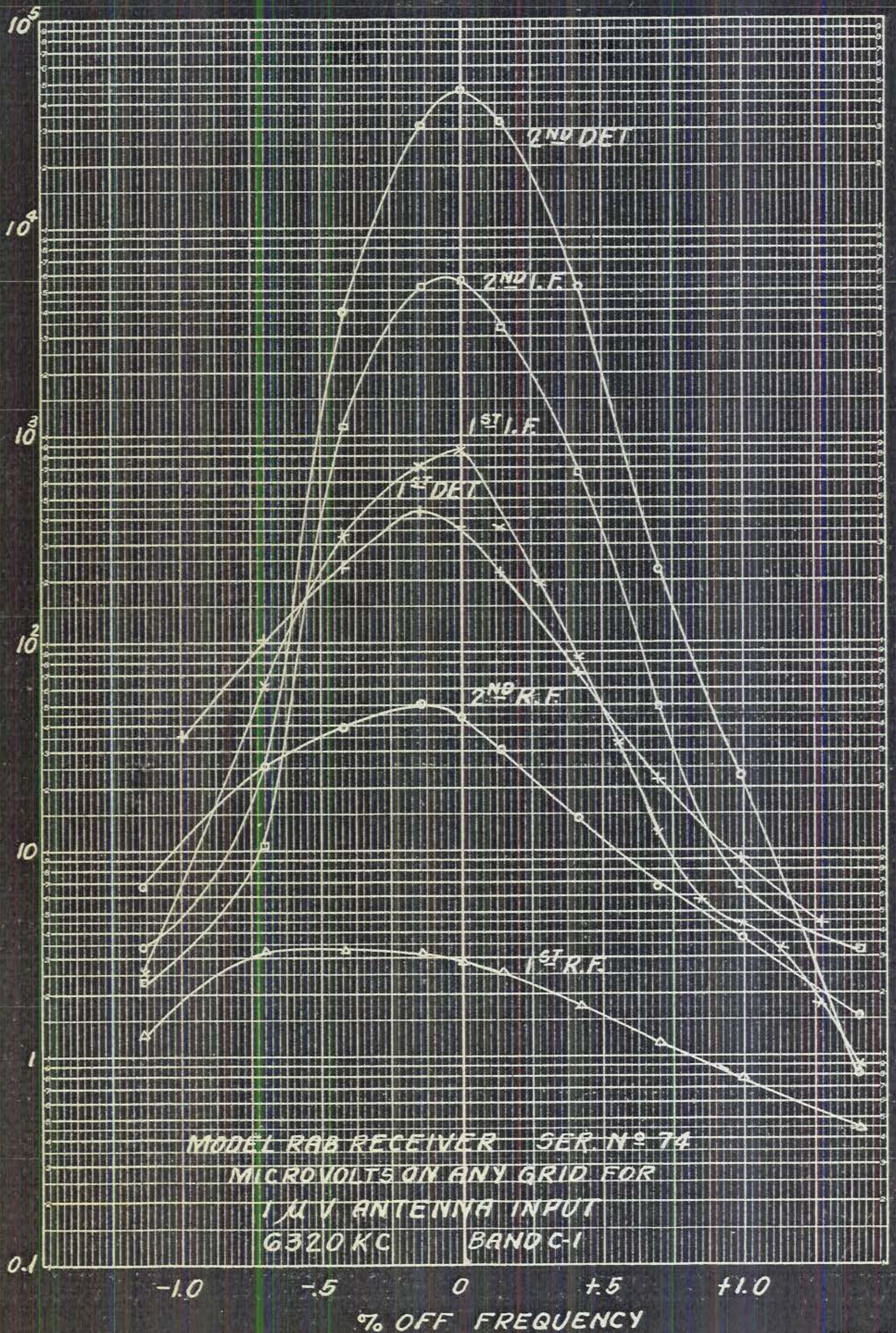

2ND DET
2ND I.F.
1ST I.F.
1ST DET
2ND R.F.
1ST R.F.
MODEL RAB RECEIVER SER. Nº 74
MICROVOLTS ON ANY GRID FOR
1 μV ANTENNA INPUT
6320 KC BAND C-1
% OFF FREQUENCY

PLATE 43

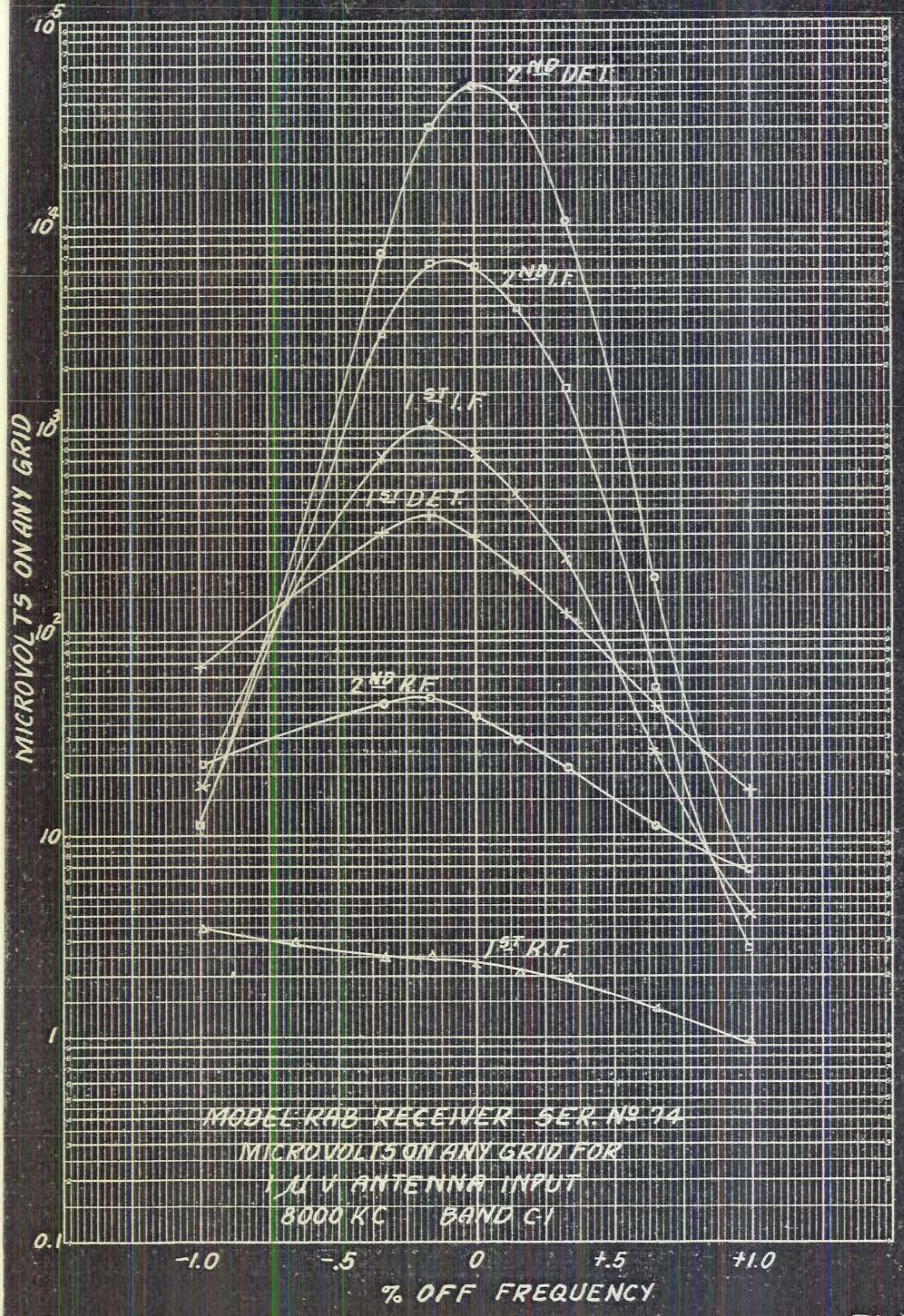
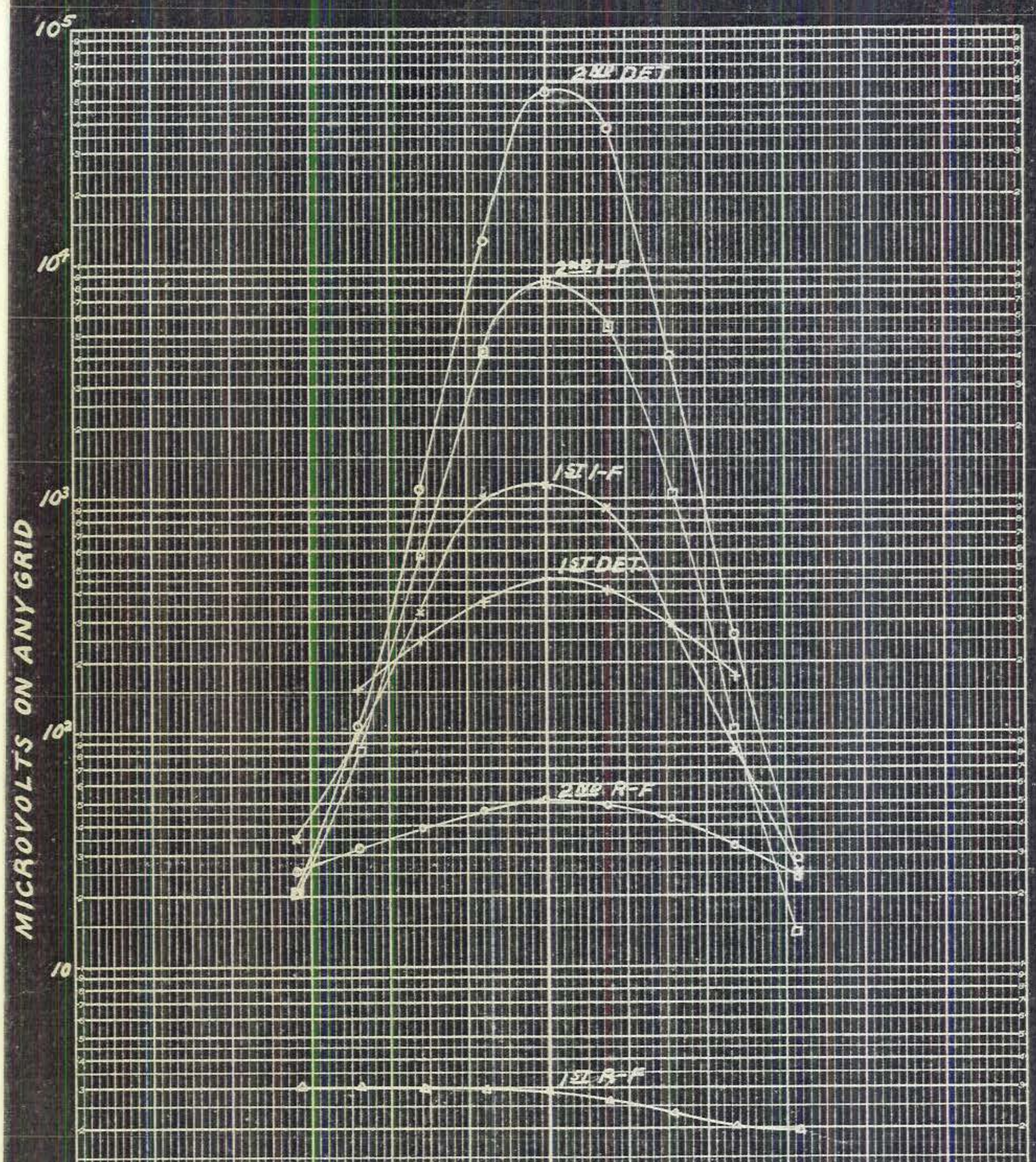
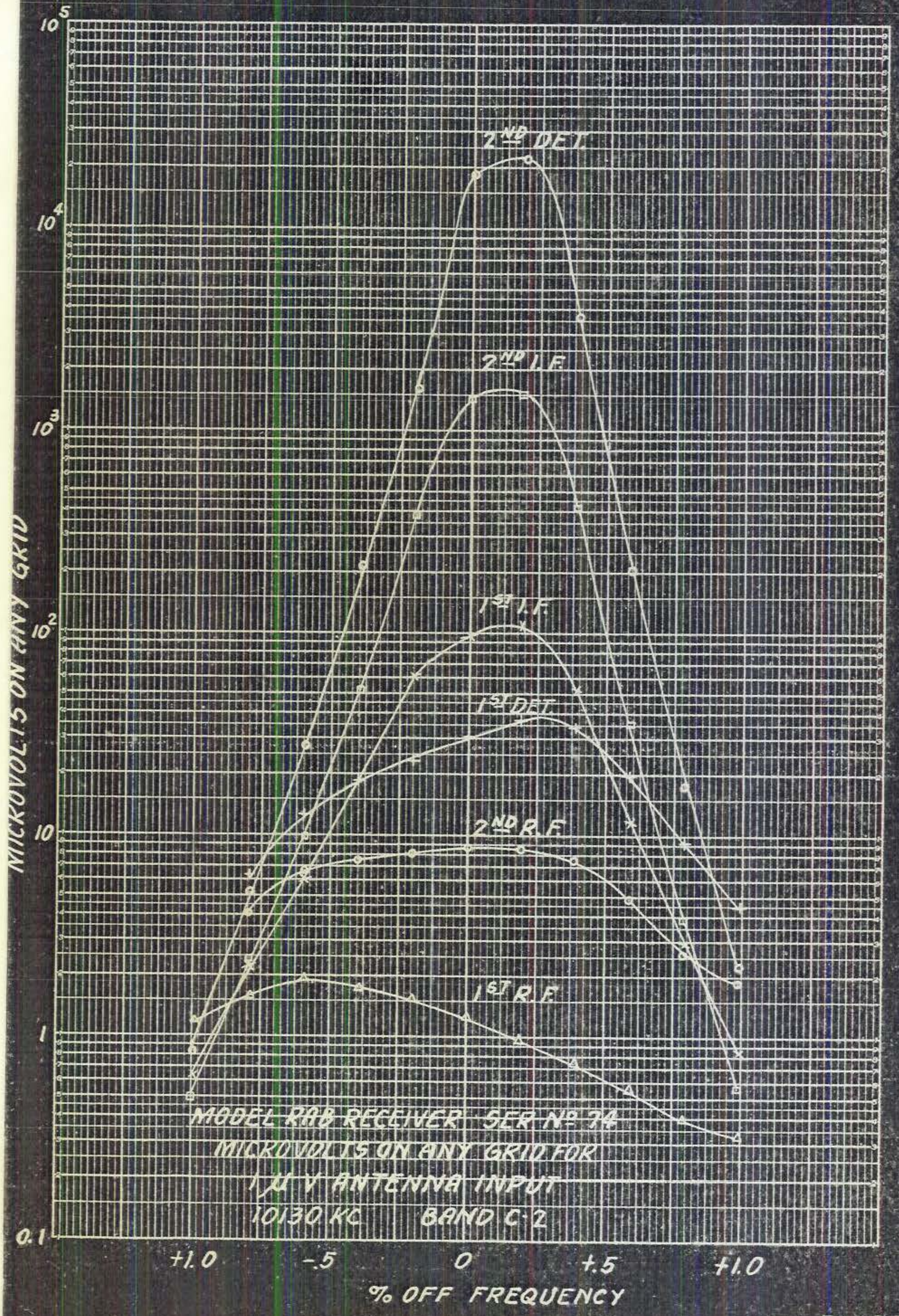

MICROVOLTS ON ANY GRID
10^5
10^4
10^3
10^2
10
1
0.1
2ND DET.
2ND I.F.
1ST I.F.
1ST DET.
2ND R.F.
1ST R.F.
MODEL RAB RECEIVER SER. No. 74
MICROVOLTS ON ANY GRID FOR
1 μ V ANTENNA INPUT
8000 KC BAND C-1
-1.0
-.5
0
+.5
+1.0
% OFF FREQUENCY

PLATE 44



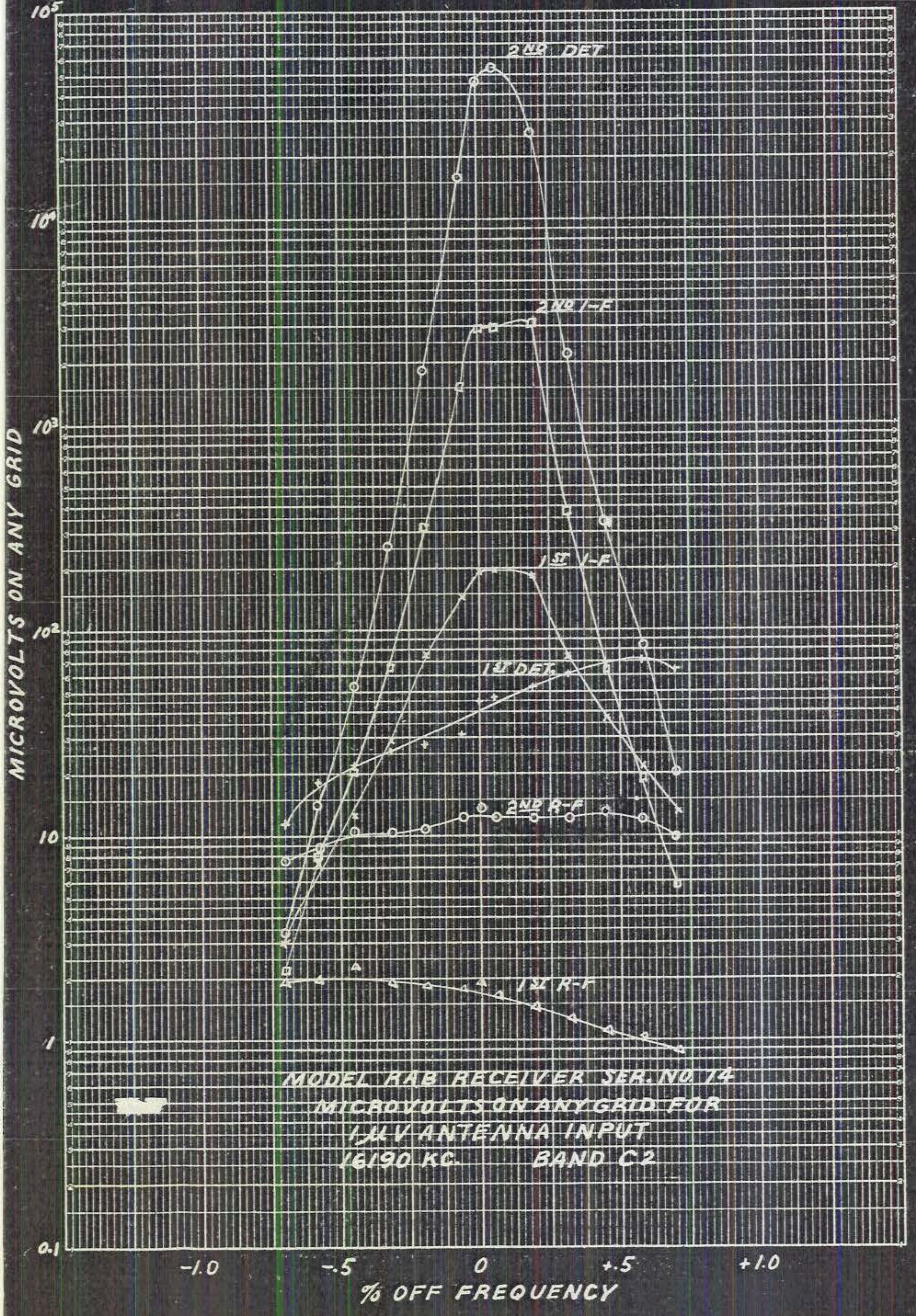
MICROVOLTS ON ANY GRID
% OFF FREQUENCY
10⁵
10⁴
10³
10²
10
1
0.1
-1.0
-.5
0
+.5
+1.0
2ND DET
2ND I-F
1ST I-F
1ST DET
2ND R-F
1ST R-F
MODEL RAB RECEIVER
SERIAL NO. 74 MICROVOLTS ON ANY GRID
FOR 1 UV ANTENNA INPUT
10130 KC. BAND C1

PLATE 45



2ND DET.
2ND I.F.
1ST I.F.
1ST DET.
2ND R.F.
1ST R.F.
MODEL RAB RECEIVER SER. No. 74
MICROVOLTS ON ANY GRID FOR
1 µ V ANTENNA INPUT
10130 KC BAND C-2
MICROVOLTS ON ANY GRID
10^5
10^4
10^3
10^2
10
1
0.1
+1.0
-.5
0
+.5
+1.0
% OFF FREQUENCY

PLATE 46



MICROVOLTS ON ANY GRID
% OFF FREQUENCY
2ND DET
2ND I-F
1ST I-F
1ST DET.
2ND R-F
1ST R-F
MODEL RAB RECEIVER SER. NO. 74
MICROVOLTS ON ANY GRID FOR
1 µV ANTENNA INPUT
16190 KC. BAND C2

PLATE 48

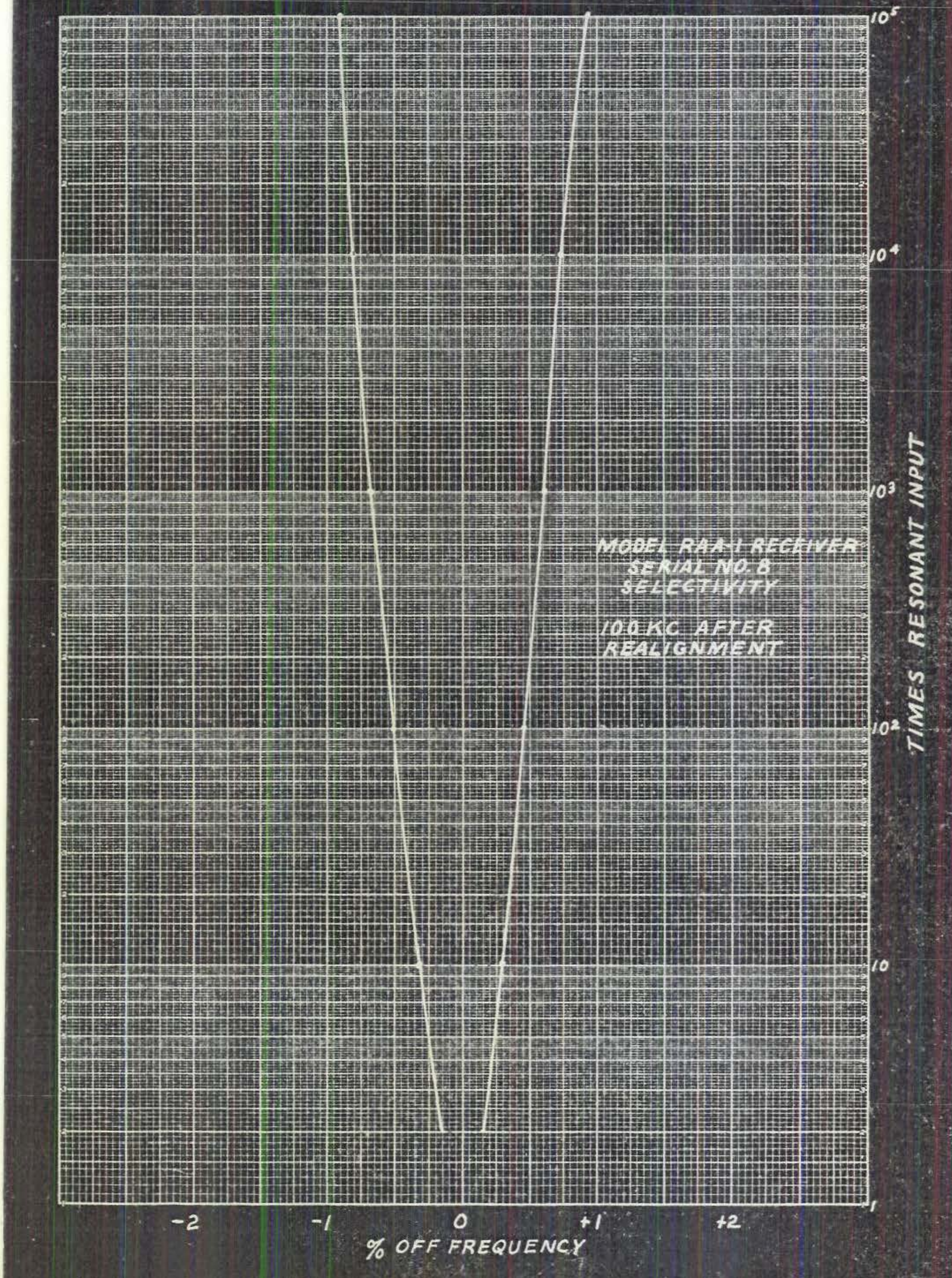

10^5
10^4
10^3
10^2
10
1
MODEL RAA-1 RECEIVER
SERIAL NO. 8
SELECTIVITY
100 KC AFTER
REALIGNMENT
TIMES RESONANT INPUT
-2
-1
0
+1
+2
% OFF FREQUENCY

PLATE 49

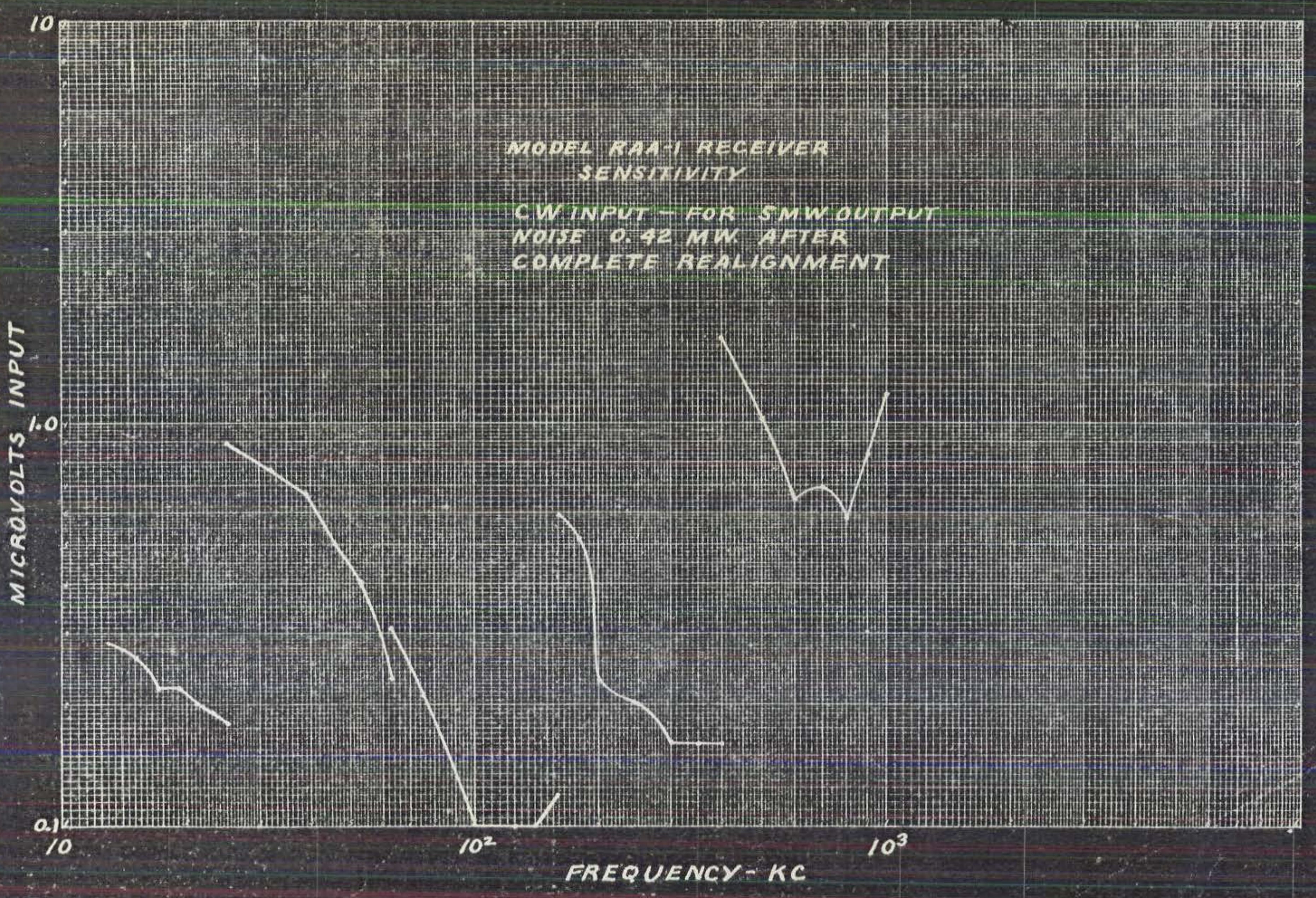
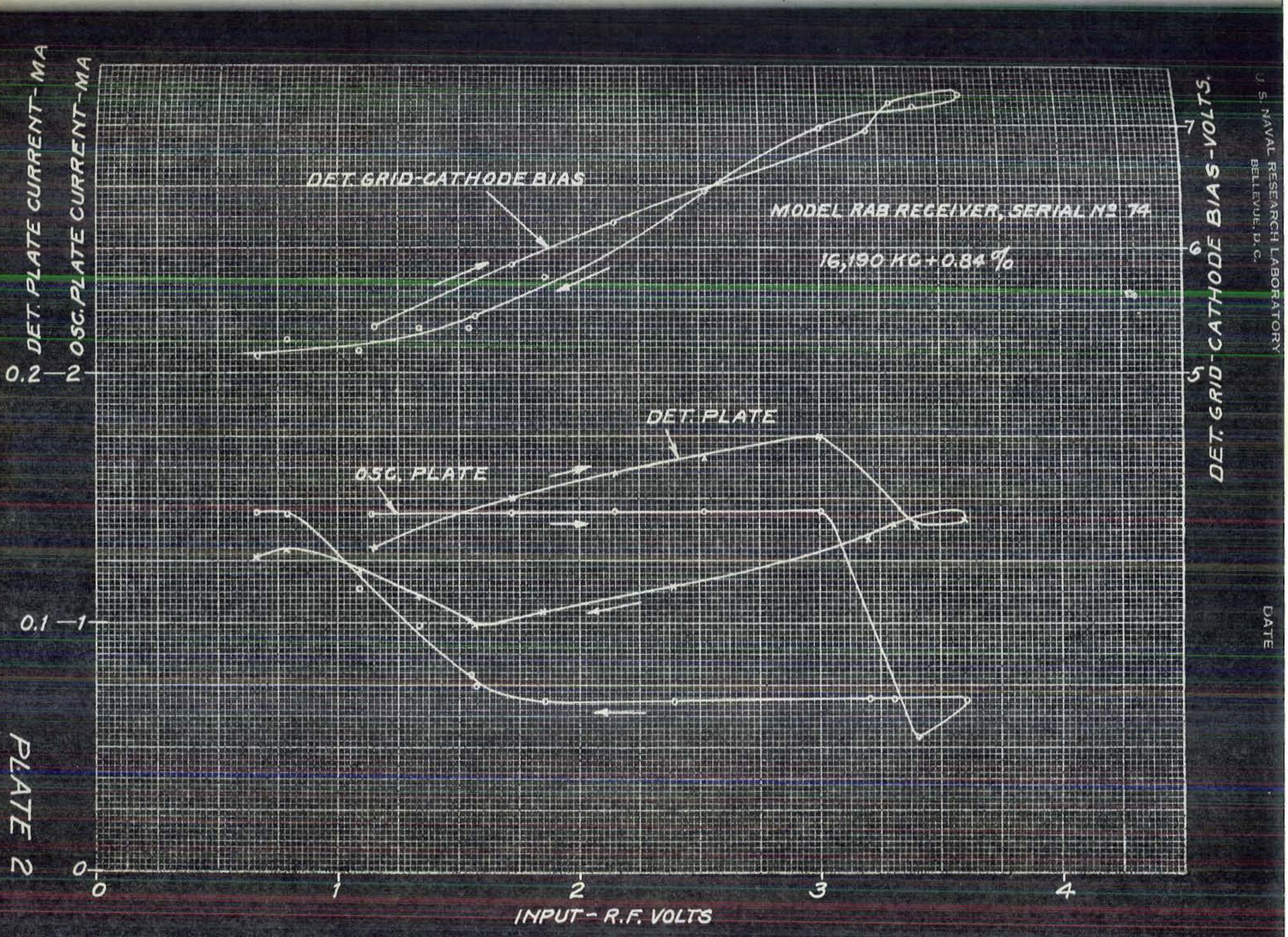

MODEL RAA-1 RECEIVER
SENSITIVITY
CW INPUT - FOR 5MW OUTPUT
NOISE 0.42 MW AFTER
COMPLETE REALIGNMENT
10
1.0
0.1
MICROVOLTS INPUT
10
10^2
10^3
FREQUENCY - KC

PLATE 50



U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.
DATE
MODEL RAB RECEIVER, SERIAL Nº 74
16,190 KC + 0.84 %
DET. GRID-CATHODE BIAS
DET. PLATE
OSC. PLATE
DET. PLATE CURRENT-MA
OSC. PLATE CURRENT-MA
DET. GRID-CATHODE BIAS-VOLTS.
INPUT - R.F. VOLTS
0
1
2
3
4
0.2 — 2
0.1 — 1
5
6
7

PLATE 2

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE

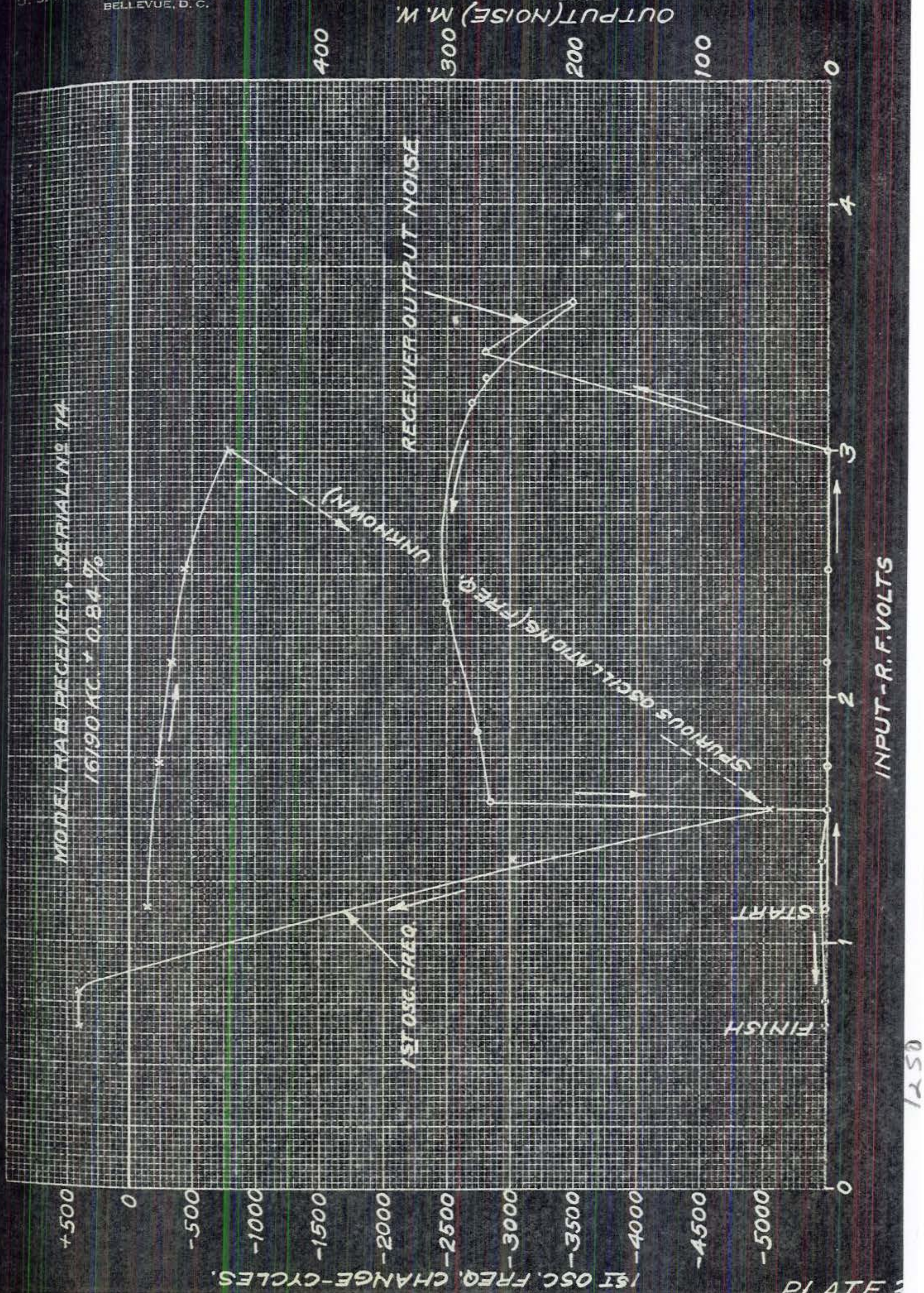


PLATE 3

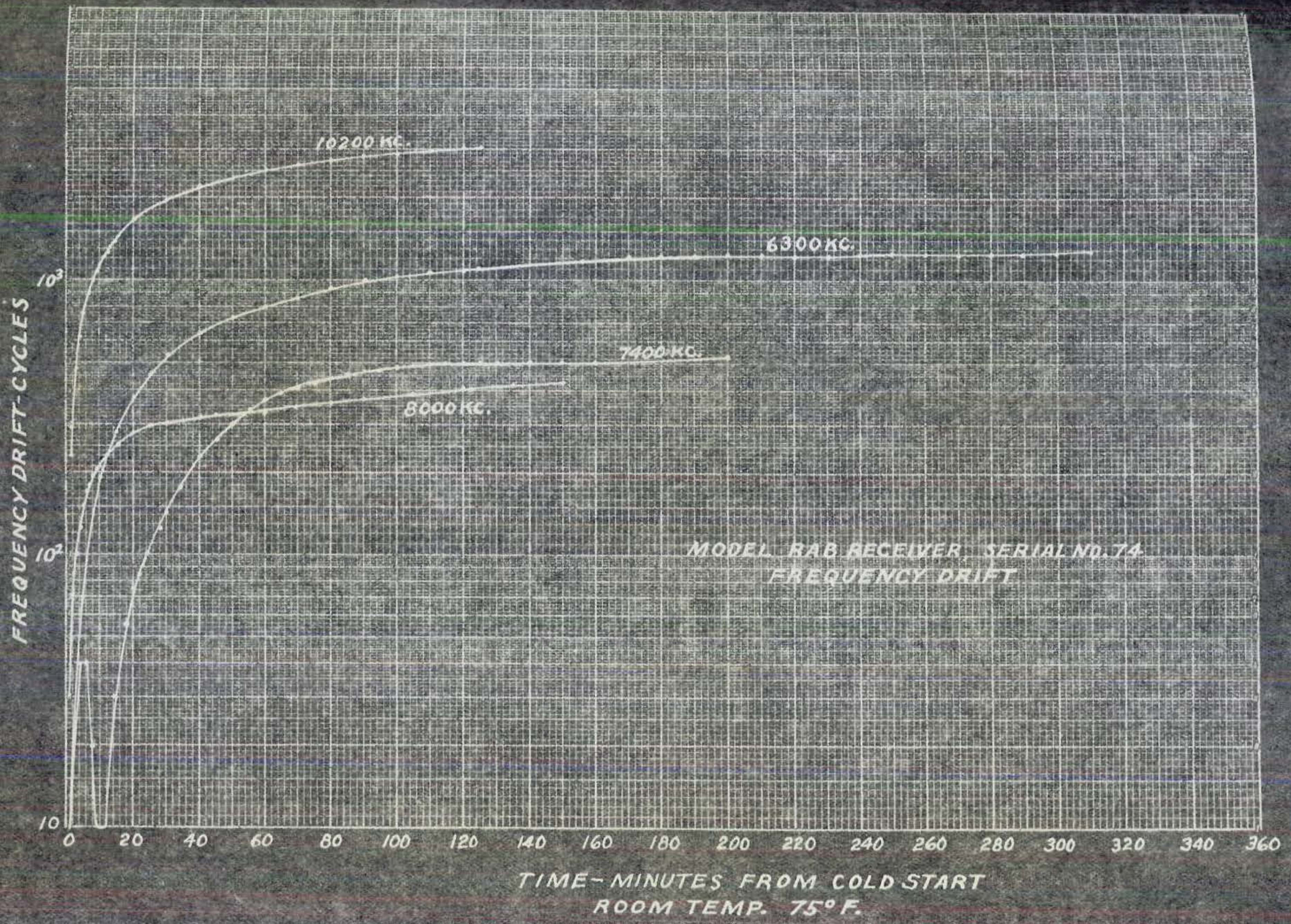

MODEL RAB RECEIVER SERIAL NO. 74
FREQUENCY DRIFT
10200 KC.
6300 KC.
7400 KC.
8000 KC.
FREQUENCY DRIFT-CYCLES
10^3
10^2
10
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
TIME-MINUTES FROM COLD START
ROOM TEMP. 75° F.

PLATE 4

1250