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NAVY DEPARTMENT - OFFICE OF RESEARCH AND INVENTION

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AIRBORNE RADIO DIVISION - ENGINEERING TEST SECTION

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AIRBORNE RADIO - RESULTS OF ENGINEERING PERFORMANCE TESTS ON MODEL AN/ARC-12 VHF COMMUNICATIONS EQUIPMENT

Final Report
By

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Numbered Pages------- 33
Plates-------------- 77
Tables-------------- 6
Distribution-------- 8

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ABSTRACT

The model AN/ARC-12(XN-1) equipment is a VHF radio communication receiving and transmitting equipment intended for operation in the frequency range 225 to 350 megacycles. Two prototype units, serial numbers 1 and 4, were submitted by the Bell Telephone Laboratory of New York for the purpose of conducting engineering analysis for compliance with refs. (a) and (b), and for technical evaluation as to suitability for use in Naval Aircraft as requested in ref. (c). All parts of the problem directive have been complied with and the results are herein reported.

The results of measurements show that the equipment does not meet all the requirements of refs. (a) and (b). Although it possesses several excellent and desirable features, it is not considered suitable for use in Naval Aircraft, chiefly because of low transmitter power output and excessive incidental frequency modulation of the transmitter carrier. While correction of the items mentioned above involves a major modification, it is recommended that the Bureau direct such to be done.

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TABLE OF CONTENTS

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15. Another very desirable feature of the RT-58/ARC-12 is that all channel tuning is done with a single control knob on the front panel. An indicator, calibrated in frequency, makes channel tuning especially easy. This adjustment requires the use of an auxiliary test meter, type TS-80/U. Spring-loaded cables are used for mechanical tuning connections between sub-assemblies. The proper crystal is selected from a turret driven by the auto-tune motor.

16. The front panel is protected by a dust cover held by four "Dzus" fasteners. Removal of this cover makes available the channel tuning knob as well as the main channel crystal oven, test jacks, test meter switch, receiver sensitivity adjustment (screwdriver with locking nut), squelch disabling switch and a secondary power switch (See Plates 1 and 2). For further details of mechanical construction see ref. (d).

EXTERNAL DIMENSIONS

17. The external dimensions of the RT-58/ARC-12(XN-1) serial #4 were found to be 21-5/8 inches in height, and 10-5/8 inches in width (from outside of one handle to the outside of the other handle). The overall length was found to be 1/8 inch longer than that allowed by paragraph E-4a(1) of reference (a) when measured from the outside of one handle to the outside of the other. The measured height was within specifications. The unit was capable of being mounted in mounting rack type MT-230A/ARC and meets all other requirements of reference (a)paragraph E-4a(1).

WEIGHT

18. The weight of the RT-58/ARC-12(XN-1) serial #4, as received from Bell Telephone Laboratory with a Redmond dynamotor model 5014 serial #15, was 48.5 pounds, one half pound in excess of specifications. Redmond model 5014 dynamotor weighed 1.25 pounds less that a DY-9/ARC-1 dynamotor (5.25 lbs. vs. 6.5 lbs.). Therefore, if the ARC-12 were equipped with a DY-9/ARC-1 dynamotor it would weigh 49.75 pounds. This would be 1.75 pounds in excess of the specified limit in paragraph E-4a (2) of reference (a).

RESULTS OF TESTS

SENSITIVITY

19. Sensitivity measurements of the RT-58/ARC-12(XN-1) receiver were made by means of a Ferris type 48-A signal generator (serial #14). The signal generator output meter was calibrated by the Measurements Section of the Laboratory prior to making any sensitivity measurements. The RT-58/ARC-12 was coupled to the low-impedance output tap of the signal generator through a 5-foot length of type RG-8/U coaxial cable and a 50 ohm series resistor (See Plate 14, figure (a)). Three methods of measuring the sensitivity were used: (1) the resultant output and noise at maximum sensitivity were recorded when a 5 microvolt signal was supplied to the antenna; (2), the signal input for 50 milliwatts output was measured with the sensitivity control adjusted for a 6 db ratio of signal plus noise to noise; (3), the Signal input for 100 milliwatts output was measured at 6db signal plus noise to noise ratio above.

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25. The variation in audio signal and noise output for changes in primary supply voltage is shown in Plates 20 and 21 for channels 5 and G.C. respectively. These data were obtained with a constant 5 microvolt input signal 30% modulated with 1000 c.p.s. and with the receiver controls set for maximum sensitivity and maximum audio gain. On channel 5, the audio signal output increased from 20.0 to 27.3 db above one milliwatt and the noise from 8.5 to 16.3 db above one milliwatt when the voltage was increased from 22 to 32 volts.

26. A temperature change from -30°C to +50°C had little effect upon the sensitivity of the ARC-12 receiver. On channel 1, the sensitivity for 50 milliwatts output was 2.4 microvolts at -30°C, 2.5 microvolts at +10°C and 2.0 microvolts at +50°C. The sensitivity of channel 5 was 1.8 microvolts for the three temperatures mentioned above, and on channel 9 it was 4.1, 2.25 and 3.25 microvolts respectively. Connections to the ARC-12 from the signal generator were made as in figure 14a, but with a 10-foot length of coaxial cable substituted for the 5-foot length.

27. The audio output for a constant 5 microvolt input signal varied as shown in plate 22 when the ambient temperature was changed from -30°C to +50°C. This method was found to be more accurate than above because it eliminated any signal generator reset errors.

28. The ARC-12 was arranged in a non-operating condition and subjected to an ambient atmospheric condition of +50°C, 95% relative humidity, and sea level pressure for a period of 48 hours. At the end of this period and following a 20-minute receiver warm-up, the sensitivities for 50 and 100 milliwatt output of channels 1, 5, 9, and G.C. were measured. These measurements showed that the noise level of the ARC-12 had decreased, and that with the sensitivity control set at maximum, the resultant signal plus noise to noise ratio was greater than 6 db, being well within the 12 db variation from STANDARD conditions required by paragraph E-7b of reference (a). Channel 5 showed the greatest variation due to humidity. The sensitivity for 100 milliwatts output changed from a dry reading (at +50°C) of 1.45 microvolts to the wet reading (+ 50°C, 95% R.H.) of 3.4 microvolts, or 7 db. However, the signal plus noise ratio for the wet reading was 10.7 db, at maximum sensitivity control setting. Reference is made to Table 2 for additional information.

AVC CHARACTERISTICS

29. The AVC characteristics were determined for channels 1,5,9, and the monitoring Guard Channel. The first requirement of paragraph E-7c of reference (a) states that the audio output shall be between 450 and 600 milliwatts with a one millivolt signal modulated 30% at 1000 cycles. Three of the channels tested (5, 9, and GC t/r) were found to be within the limits specified as shown by Plates 23, 24, and 25. However, with the above specified signal input fed through five feet of 50-ohm coaxial cable to the ARC-12, channel one output

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was 262 milliwatts, or 2.4 db below the minimum specified (See Plate 26). Under the same conditions of signal input, the Guard Channel output was 330 milliwatts or 1.3 db below the minimum specified (See Plate 27). The audio noise output was also measured on the subject channels and this information is plotted on plates 24, 26, 27, 29, and 30.

30. Paragraphs E-7c of reference (a) states that when the input signal, 30% modulated at 1000 cycles, is fed thru five feet of 50-ohm coaxial cable and varied from 10 microvolts to 100,000 microvolts, the audio output power shall not vary more than 2 db with reference to that output obtained with a one millivolt signal. The maximum output from the "Lo" tap of the Ferris model 48-A signal generator operating into a matched load was between 4,900 and 2,000 microvolts, depending on the output frequency. Due to this output limitation, the above requirement in reference (a) was determined only for channel 9.

31. In order to attain to a degree an output of 100,000 microvolts, as required by paragraph E-7c of reference (a), the ARC-12 was connected to the "HI" output tap of the Ferris model 48-A signal generator. (See Plate 14(b)). The mismatch caused by connecting 50 ohms across the 33 ohm source resistance produced standing waves on the connecting cable. The absolute value of the microvolt output was subject to error; but, since the signal generator frequency setting remained constant, the relative decibel levels between any two R.F. meter readings have significance. Five feet of 50-ohm coaxial cable was inserted between the "HI" output of the signal generator and the antenna input of the ARC-12. With this method of signal input and the resultant mismatch the audio output power of the receiver on channel 9 was 350 milliwatts with an input signal of 10 microvolts, and 1000 milliwatts with an input signal of 100,000 microvolts, or a difference in power output of 4.6 db. The audio output power obtained with an input signal of one millivolt was 760 milliwatts, which is 3.5 db above the audio power output with a 10 microvolt input signal and 1.1 db below the audio power output with a 100,000 microvolt input signal (See Plate 24) .

32. However, when the AVC characteristics obtained with a matched output condition for the signal generator (connected as shown in Plate 14(a)) are extrapolated to a signal level of 100,000 microvolts, the audio output power level is 500 milliwatts, which is less than 2 db above the 470 milliwatt output obtained with a one millivolt input signal. With an input of 10 microvolts under the same conditions, the audio power output was 300 milliwatts or one db below the output obtained with an input signal of one millivolt (See Plate 24).

33. The audio power output obtained with an input signal of 10 microvolts was compared with the output obtained with a one millivolt input signal on channels 1, 5, GC t/r and the monitoring Guard Channel, as well as for channel 9 as mentioned above (See Plates 23, 24,25,26, and 27). Of the five channels tested only channels 5 and 9 showed less than a 2 db difference between the audio power output obtained

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with input signals of 10 microvolts and one millivolt, while at the same time exhibiting an audio output of 500 milliwatts (-10% +20%) with the one millivolt signal applied. For the audio noise output on these channels see Plates 24,26,28,29,3 and 30.

34. Paragraph E-7c of reference (a) also prescribes that the receiver shall be protected against blocking for input signal levels up to 2 volts. Again due to the limitations of existing test equipments, a signal of 2 volts in this frequency range could not be obtained. However, the AVC charcteristics of the i f strip were taken by inserting a standard modulated signal from the Ferris model 16-C signal generator into J 712, the input from Guard Channel r-f amplifier unit to the i-f strip, while P712 and P6733 were disconnected. The AVC characteristics of the i-f strip thus obtained indicated that the i-f strip would not block with an input signal up to one volt (See Plate 31). Since AVC is applied to two stages of the r-f amplifiers as well as the i-f strip and in consideration of the above measurements, it is not likely that the receiver would block with input signal levels up to 2 volts.

35. The effect on the AVC characteristics of channel 9 by the addition of a Navy Model *R-4A/ARR-2 receiver connected through 2-feet of 50-ohm coaxial cable to the "AUX" connector was studied. Measurements were made with the sensitivity control of the ARC-12 set at maximum and later at the one-half position (See Plates 32 and 33). With a one millivolt input, the audio power output was still within the limits specified in paragraph E-7c of reference (a). The audio power output with a 10 microvolt input signal was 2 db below that obtained with a one millivolt input signal, therefore, the addition of the ARR-2 equipment did not appreciably affect the AVC characteristics of the ARC-12 for input signals above 10 microvolts. However, for inputs below 10 microvolts, the effect was primarly that of increasing the receiver noise level although the audio power output was reduced by amounts up to 1.5 db (See Plate 32). When the ARC-12 sensitivity control was reduced to the one-half position, the effect of the ARR-2 on the AVC characteristics of the ARC-12 was more pronounced for signal inputs below 7 microvolts. For example with a 5 microvolt input signal, the addition of the ARR-2 reduced the audio power output by 3.8 db (See Plate 33).

SELECTIVITY

36. Overall selectivity measurements are not included in this report as facilities were not available for accurate measurements. However, since the overall selectivity is influenced primarily by the i f amplifier, a measurement of i-f selectivity was made with a Ferris type 16C signal generator. The results of this test are shown on Plate 34.

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The zero kc. line of Plate 34 is at 15.100 Mc of the signal generator calibration but the dashed vertical line is the approximate axis of symmetry. Specifications, Ref. (a), require that the overall selectivity curve fall within limits as indicated by the dotted lines on Plate 34. The bandwidths at 6,20,40,and 60 db are 155 kc, 230 kc, 325 kc, and 420 kc respectively. Specifications require that bandwidths be less than 220 kc for the 20 db point and less than 285 kc for the 40 db point. The i-f characteristic curve is not within the overall specification at these points, but it is considered to be satisfactory. The flat portion of approximately 50 kc at 0 db is considered a desirable characteristic.

IMAGE REJECTION

37. The image rejection on channel 9 of the ARC-12 receiver was not within the specifications of Ref. (a), paragraph E-7e, being 56.6 db where requirements called for at least 60 db. On all other channels image rejection was satisfactory. Table 3 contains the values of the image rejection for all channels.

I-F. REJECTION

38. Measured i-f rejection ratios are listed on Table 3 for channels 4, 9, and the Guard Channel. These ratios are in excess of 90 db as required in paragraph E-7f of reference (a) and are considered satisfactory.

REGENERATION

39. Regeneration in the receiver was not encountered when operating the ARC-12 equipment at a primary supply in excess of 29.15 volts. Paragraph E-7g of Ref. (a) states that the tubes used for this test be in the upper 25 percent of the JAN specification limits. Such tubes were not available, and tests for regeneration were conducted with the tubes installed by the manufacturer.

PEAK NOISE LIMITER

40. Operation of the peak noise limiter is shown by photographs of the receiver output wave shape as it appeared on the screen of a Dumont type 224A oscillograph. The receiver output had a 300-ohm resistive load, and the oscillograph was connected across this load. In each figure of Plates 35 to 39, the input conditions to the ARC-12 are recorded below the photograph of the output wave. Two signal generators, the Ferris type 48-A and the Line Materials Model E were used to supply a sine wave and a pulse input to the ARC-12 simultaneously. The type 48-A generator was 30% sine wave modulated by 1000 c.p.s. and the model E generator was modulated with a pulse repetition rate of 1000 p.p.s. Both modulating signals were synchronized from a common audio signal. The pulse width was monitored with a servoscope.

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41. The photographs of noise limiter operation indicated that in general, the peak noise limiter reduced the output peaks caused by a pulsed input, but not to the extent that the output due to pulsed input ceased to be objectionable. It may be seen that in some cases the entire wave shape of the output was changed by the pulsed input (See figures 2 and 10 of plates 35 and 37 respectively).

42. Paragraph E-7h of reference (a) does not specify the type of noise which should be clipped by the peak noise limiter. The operation of this circuit is dependent upon the pulse width and repetition rate. It is therefore necessary to specify the type of noise which should be limited by this circuit in order to evaluate the peak-noise limiter operation.

43. Because of the output limitations of the Ferris type 48-A signal generator , it was not possible to obtain sufficient signal to produce a receiver audio output of three watts as specified in Paragraph E-7i (1)a of Ref. (a). Plate 40 shows the receiver audio output at the maximum signal attainable from this generator. However, the sidetone output during transmitter tests reached a level of 3.15 watts, which indicated the output capability of the audio circuit to be greater than three watts (See Plate 55).

44. Sidetone distortion during transmission was in excess of 30% and did not remain at a constant value. This distortion was attributed chiefly to the narrow band discriminator of the AFC circuit and only partially due to the receiver audio circuits.

OVERALL FIDELITY

45. The receiver overall fidelity was measured by impressing a constant one millivolt, 30% modulated signal at the antenna connector, with the squelch disabled and the sensitivity control set at maximum. The audio power output was then recorded as the modulationg frequency was varied from 100 to 10,000 c.p.s. Paragraph E-7i(1)b of Ref. (a) states that the audio response shall not vary more than ± 3 db relative to the response at 1000 cycles for modulation frequencies from 300 to 4000 cycles per second.

46. On channel 1, the output with 300 c.p.s. modulation was 1.3 db below that obtained with 1000 c.p.s. modulation. With a modulating frequency of 4000 c.p.s. the output was down 1.6 db from that obtained with 1000 c.p.s. modulation (See Plate 41).

47. On channel 9, the audio power output varied from 2 to 3.1 db below the output obtained with a 1000 c.p.s. modulated signal as the modulating frequency was varied from 300 to 4000 c.p.s. (See Plate 42).

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48. The receiver distortion was measured for the above audio modulation test conditions on channels 1 and 9 and the results are contained on Plates 43 and 44. The distortion was found to be less than 15 percent for all audio frequencies between 300 and 4000 c.p.s.

49. The dynamotor ripple frequency was present in the receiver audio output and contributed to the receiver audio distortion. Separate measurements of this ripple voltage were not made.

R-F GAIN CONTROL CHARACTERISTICS

50. The operation of the r-f gain control is shown by the AVC chanracteristic curves which were measured at r-f gain control settings of maximum, 3/4, 1/2, 1/4 and minimum (See Plates 23, 25, and 27). ParagraphsE-7j of Ref. (a) requires that the gain control be capable of varying the receiver overall gain not less than 20 db nor more than 40 db. Plate 25 shows that the ARC-12 receiver on channel GC t/r complied with the above requirement only for inputs between 3 and 5.5 microvolts. The variation in gain between inputs of 3 and 5.5 microvolts was 20 db as the sensitivity control setting was changed from maximum to minimum. Channel 5 (See Plate 23) had less than 20 db variation in overall gain for all inputs above 2 microvolts. On the Guard Channel, the control was less than 20 db for all inputs above 18 microvolts (See Plate 27).

51. Since the r-f gain control is used primarly for the adjustment of squelch operation, it is desirable to have the specified range of control at the lower input levels. Paragraph E-7j, Ref(a), does not state the input levels at which the above measurement should be conducted.

52. Plate 45 shows the input in microvolts on channel GC-t/r required to operate the squelch at any setting of the sensitivity control. The receiver noise level operated the squelch when the control was set at 0.7 of maximum or above. At a control setting of 1/2, a signal (30% modulated with 1000 c.p.s.) in excess of 3 microvolts was required to operate the squelch. At the same control setting a 5 microvolt signal, similarly modulated, produced an output of 200 milliwatts. An input change of one db effected a change in output greater than 10 db. This complies with the requirements(Ref. (a), paragraph E-7j),for squelch operation.

R-F POWER OUTPUT

53. The transmitter r-f power output was measured on all channels by the bolometer method, the circuit of which is shown on Plates 46 and 47. In principle, the bolometer bulb is used as the unknown element in a Wheatstone Bridge circuit. The bridge circuit is balanced and the d-c power dissipated in the bolometer element is determined with no r-f present. R-f is them introduced through the slotted line to the bolometer element and stub tuning adjustments made on the line to get maximum unbalance of the Wheatstone bridge. The d-c power to the bolometer element is then reduced until the bridge is again balanced. The difference between the two d-c power readings is then the r-f power introduced through the slotted line. This bolmmeter method of measuring r-f power was checked with a 50-ohm calorimeter system and the two results agreed within 5%. Since the bolometer was

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much faster and easier to adjust, it was used almost exclusively for the r-f power output measurements of the ARC-12.

54. The C.W. power to a 50-ohm resistive load was found to vary from 2.55 watts on channel 1 to 4.7 watts on channel 4 (See Plate 48). When the slotted line tuning stub was adjusted for maximum power output at each frequency, the r-f power output was increased on all channels. C.W. power output for optimum load conditions varied from 3.75 watts on channel 9 to 5.3 watts on channels 2, 3, and 4 (See Plate 48). Paragraph E-7k of reference (a) states that under STANDARD conditions the transmitter shall be capable of delivering not less than 6 watts of radio frequency carrier energy.

55. The transmitter r-f power output under optimum load was measured on channels 2, 5, and 9 while the primary supply voltage was varied from 22 to 32 volts (See Plate 49). Paragraph E-7k of Ref. (a) states that under SERVICE conditions (26.5 volts primary supply $\pm$ 10%) the power output shall be at least 4 watts. With a primary supply of 23.85 volts, the power output was 2.95 watts on channel 2, 2.25 watts on channel 5, and 1.15 watts on channel 9 (See Plate 49). All of these power measurements were made after the transmitter had 20 minutes or more continuous transmission.

56. Data were taken on the effect of System warm-up time on the transmitter power output. Plate 50 shows the power output versus transmitter locked-key time after the equipment had only a one minute warm-up period. Plate 51 presents the data obtained under the same conditions after the equipment had a warm up period of 20 minutes. In both cases the power output is very low for approximately the first minute of transmission, and it is pointed out that the normal service operation period probably would not exceed one minute.

57. The transmitter power output was measured on channel 1 at ambient temperature of $-30^{\circ}C$, $+10^{\circ}C$ and $+50^{\circ}C$. for the first 20 minutes of continuous transmission. After one minute of transmission and system warm-up, the lowest power output was 1.5 watts at $+10^{\circ}C$ (See Plate 50). When the equipment had operated in the receive position for 20 minutes, and after one minute of transmission, the power output was 1.6 watts at $-30^{\circ}C$ (See Plate 51). After twenty minutes of continuous transmission, regardless of the warm-up time before keying the transmitter, the lowest power output was observed to be 4 watts at $+50^{\circ}C$. The maximum power output was 5.2 watts at $-30^{\circ}C$ (See Plates 50 and 51). Transmitter power output and test meter measurements versus transmitter locked-key time are shown on Plate 52 for further information.

58. The transmitter power output of the ARC-12 serial #1 did not change with warm-up time as above. The r-f power reached maximum value at the instant it was keyed and remained constant for a 20 minute locked-key period.

59. A test of transmitter C.W. power output versus continuous transmission time was conducted after the ARC-12, serial #4, had 48 hours stabilization time in an ambient atmospheric condition of 95% relative humidity at $+50^{\circ}C$. Humidity conditions did not effect the r-f power output.

MODULATION CHARACTERISITICS

60. Percent modulation measurements were made from an oscillographic presentation of the modulated envelppe of the transmitter. A special receiver, having a bandwidth of 200 Kc at the 3 db points, was constructed to convert the ARC-12 signal and amplify it at an intermediate frequency of 12 megacycles to an output level sufficient for ample deflection of a Dumont model 224A oscillograph when employing direct plate connection. An output calibration of this receiver was made to assure no overloading during use; and the input signal to this receiver was always adjusted for linear operation.

61. The modulation characteristics of the ARC-12, serial #4, transmitter are shown in Plates 53 and 54. Plate 53 indicates the percent modulation versus dummy microphone open circuit potentials at standard atmospheric conditions with a modulating frequency of 1000 c.p.s. The modulation envelope changed from a sine wave to a double-peaked wave when the modulation was suddenly raised from low percentage to a high percentage. Excessive incidental F.M. which resulted from high percentage amplitude modulation caused this wave shape. Occasionally a sine wave envelope could be attained at the higher modulation levels when the modulating voltage was increased very slowly from zero to that required for the higher modulation level. Input values, determined by this method are shown on Plate 53. Channel #5 required an open circuit dummy microphone voltage of 1.62 volts for 95 percent modulation at sea level.

62. The ARC-12 was placed in an altitude chamber and the modulator output voltage measured at inputs from 0 to 1.8 volts from the dummy microphone at altitudes of 0; 15,000; 22,000; 30,000; and 40,000 feet. The effect of altitude upon the modulator gain is shown in Plate 54. From Plate 53 it may be determined that 1.62 volts r.m.s. are required for 95% modulation of channel #5 at sea level as shown. On Plate 54, this input voltage corresponds to a modulator r.m.s. output voltage of 176 volts. In order to maintain the same modulator output voltage, the dummy microphone voltage required a reduction of 0.27 volts or 1.44 db at 15,000 feet, 0.42 volts or 2.6 db at 22,000 feet, and 0.575 volts or 3.8 db at 30,000 feet altitude. Specifications, Ref. (a) paragraphs E-71(1) require an increased gain of 5 db at 15,000 feet, 10 db at 22,000 feet, and 15 db at 30,000 ft.

63. During the modulation tests and after considerable data were taken, a supersonic frequency was observed as a modulation component of the transmitted signal. This reached a sustained level of 5 percent modulation during one test of channel 9. A reduction of the AFC gain by a representative of The Bell Telephone Laboratory eliminated the supersonic component. All the modulation data presented are for the latter condition.

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FIDELITY

64. The transmitter fidelity was measured by two methods to determine compliance with ref. (a) paragraph E-71(2). In the first method, Plate 55, the dummy microphone input necessary to produce 100% modulation was recorded in decibels at audio frequencies between 300 and 5000 c.p.s. The zero db level was established at the input required for 100% modulation with 1000 c.p.s. The response at 300 c.p.s. was 7.7 db below that at 1000 c.p.s.; at 3500 c.p.s. the response was 0.35 db above the 1000 c.p.s. response, and at 5000 c.p.s. the response was 8.4 db below the 1000 c.p.s. value. Specifications, Ref. (a) paragraph E-71(2) require that the response at 300 and 3500 c.p.s. be no greater than the 1000 c.p.s. value nor less than 3 db below it. Plate 56 shows the resulting distorition of the transmitter output for the above conditions. The distortion was less than 15% for frequencies between 400 and 3500 c.p.s. that for 300 c.p.s. was 24% which exceeds the 15% specifications of Ref. (a), paragraph E-71(2).

65. The second method of transmitter fidelity measurement was made with constant dummy microphone volatage and the percent modulation recorded for audio frequencies between 100 and 10,000 c.p.s. (See Plate 57). With the response at 1000 c.p.s. used as the zero db reference level, the response at 100 c.p.s. was found to be more than 30 db below the reference level, and those at 300, 2000, 3500, 4000, and 6500 c.p.s, were found to be -9.0 db, +0.5 db, 2.0 db, 4.0 db, and 13.0 db respectively. This performance exceeds specifications, Ref. (a), paragraph E-71(2), at 300, 2000, 4000 and 6500 c.p.s. as shown in Plate 56.

66. The microphone energizing current was 46 milliamperes with an 82 ohm dummy microphone and with the equipment operating from a 26.5 volt d.c. supply. Paragraph E-71(3) of Ref. (a) specifies that this current shall be between 45 and 55 milliamperes. (See Plate 58).

67. With a short-circuit between the ring and sleeve of the microphone (simulating a shorted microphone) the microphone energizing current increased to 54 milliamperes. This current is not considered excessive (See Plate 58).

CARRIER SHIFT

68. The oscillograph presentation of the transmitter modulation envelope appeared as a double peaked wave when the ARC-12 was 95% modulated with 1000 c.p.s. The special modulation receiver, described in Paragraph 60 of this report was used to produce the oscillograph presentation, and the incidental F.M. of the ARC-12, (due to amplitude modulation) was the cause of this distorted wave pattern. Hence, a conventional carrier shift indicator, when used in conjunction with the modulation receiver, showed a false reading. A test of transmitter output power, first unmodulated, then 95% modulated with 1000 c.p.s.,

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showed that the modulated power output increased by a factor of 1.425 over the unmodulated power output. Since the load resistance was constant, the power change was accompanied by an r.m.s. current change equal to the square root of 1.425, which is an increase of 1.19 and in compliance with Paragraph E-71(4) of Ref. (a).

SPURIOUS RADIATIONS

69. The ARC-12 was equipped with an Army V.H.F. stub antenna, designed to cover from 210 to 380 Mc. (S.W.R. less than 1.5 to 1) which was centered in a 42 x 42 inch ground plane. Spurious radiations from this antenna and the ARC-12 case were measured by the use of specially calibrated receivers provided with probe antennas. No attempt was made to separate the spurious case radiation from that radiated by the antenna.

70. A Hallicrafter type SX-28 receiver calibrated by the use of a Ferris Type 16C and a Ferris Type 40A signal generator, was used to detect spurious radiation in the frequency range 0.55 Mc. to 40 Mc. A loop about three inches in diameter with 10 turns of hook-up wire was used for the receiver pick-up probe. A Navy type RDO receiver calibrated against a Ferris Type 48-A and a Ferris Type 40-A signal generator was used to detect similar radiation in the frequency range 40 Mc to 1000 Mc. The pick-up device used with the RDO receiver was an electrostatically shielded probe conforming to the requirements of Aeronautical Standard Drawing AN-3065.

71. Paragraph E-7n of reference (a) states that the magnitude of any radiated signal on other than the carrier frequency shall be 50 db or more below the carrier level. Spurious radiations from the subject equipment were found throughout the frequency range of 0.55 Mc. to 1000 Mc. Since it was difficult to separate the ARC-12 spurious radiations from those inherent in the test receivers used for these measurements, measurements were only taken at the fundamental frequencies of the individual circuits in the ARC-12. These circuit frequencies are as follows:

(a) Narrow band discriminator circuit----------0.57 Mc.
(b) Narrow band discriminator Xtal Osc.--------14.53 Mc.
(c) Intermediate Frequency--------------------15.1 Mc.
(d) Main Channel Xtal Osc.---------Depending upon Channel Xtal.
(e) Main Channel Harmonic Amplifier-----------Four times (d)
(f) Main Channel Doubler circuit------------- Eight times(d).
(g) Main Channel Fundamental-----------Eight times (d) +15.1 Mc.
(h) Guard Channel Xtal Osc.---Depending upon guard channel Xtal.
(i) Guard Channel Harmonic Amplifier----------Four times (h)
(j) Guard Channel Doubler circuit-------------Eight times (h)
(k) Guard Channel Fundamental----Eight times (h) +15.1 Mc.

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72. Spurious radiation measurements were made for transmitting conditions on Channels 1, 5 and 9. The results of these measurements are shown on table 4 and are tabulated both in microvolts and in db below the carrier level. The strongest spurious radiation measured was 16,000 microvolts at 215.5 Mc. on Channel 1, and was 41 db below the carrier level. This was the Main Channel, Doubler circuit, frequency for channel 1. The spurious radiation of the Main Channel crystal oscillator (Channel 9) was 7700 microvolts, but was only 29 db below the carrier level.

COUPLING FACTOR

73. Coupling factor tests were conducted for signal input to the primary power leads and to the audio output jack of the remote jack box, C-44/ARC-1(XN-1). Plate 59 is a block diagram of component units used for this test, and all of these units were grounded to a copper ground plane. The point at which the signal was injected into either the power line or the audio leads was determined by sliding the coupling to a position of maximum test receiver output. The results of these tests are listed in Tables 5 and 6 for power line and audio injection respectively. The power line coupling factor exceeded the 0.0001 specification (Ref. (a), paragraph E-7n) on channels 3,4,6,7,8, and 9, with 0.00068 for channel 7 (289.8 Mc) being the greatest deviation from the specified maximum. In addition, channels 7 and 9 had excessive audio coupling factors of 0.00048 and 0.00075 respectively. All other channels were found to be within specifications.

FREQUENCY STABILITY

74. Frequency drift versus temperature measurements were conducted for channels 1,5,9, and G.C. over a temperature range of -30°C to +50°C in accordance with Paragraph E-7o of Ref. (a). The results of these measurements are shown on Plates 60 to 65 for both transmitter and receiver oscillators and on Plate 66 for the Guard Channel receiver oscillator. All measurements were made at the final frequency following multiplication and not at the crystal frequencies. The frequency measuring equipment utilized a 5 Mc. harmonic spectrum where one of the harmonics of 5 Mc was mixed with the ARC-12 frequency to produce a beat note between 0 and 5 Mc. This beat note was fed to the input of a TRF receiver where it was mixed with the receiver C.W. oscillator at the detector to produce an audio signal output. The drift of this audio signal was measured by conventional methods. During these measurements, the receiver C.W. oscillator was checked against a 100 kc. crystal oscillator, and both the 100 kc. and 5 Mc. oscillators were continuously checked against the 5 Mc. standard signal transmitted by the Bureau of Standards, WWV.

[redacted]

75. The frequency drift of the receiver oscillator had a cycling effect caused by the temperature control of the main channel crystal oven. The cycling effect of the receiver oscillator frequency drift (Plate 60) was closely followed by the drift of the transmitter output frequency (Plate 61). The zero time reference of the data shown in Plate 59 is the instant the receiver was turned on. In Plates 61, 63, and 65, the zero time refers to the instant the transmitter was keyed, following a minute receiver warm-up. The stabilization time of the temperature chamber prior to measurements was 1-1/2 hours. A curve showing frequency drift versus temperature for any specific warm-up time would be misleading, due to the frequency cycling characteristic. Hence, the data are presented as frequency drift versus warm-up time at several temperatures.

76. The frequency drift of the receiver oscillator, channel 1, during the 20 minute warm-up period was from -7kc at 1/2 minute when operating at -30°C to +15Kc. at 8-1/4 minute when operating at 0°C or a total drift of 22 Kc. (0.01021%). (See Plate 60.). However, after the crystal oven reached its operating temperature the frequency drifted between the limits +0.5 Kc and + 13.0 Kc., a drift of 12.5 Kc or 0.0058% with respect to the final oscillator frequency of 215.5 Mc. The transmitter frequency drift was the same number of cycles, but with respect to the output frequency of 230.6 Mc. it was 0.00542%. The percent frequency drift of channel 5 was less than that of channel 1, but it was below the assigned frequency instead of above. (See Plates 62 and 63). On channel 9, the transmitter frequency cycled through the assigned frequency as indicated in Plates 64 and 65. The percent drift is again well within specifications Paragraph E-7o of Ref. (a). It is apparent that the shapes of the cycling curves are not the same on any two of the channels tested. This could result from slightly different compensation in the receiver crystal oscillator circuit.

77. The frequency drift of channels 1 and 5 versus warm-up time did not change after the ARC-12 had been subjected to 95% relative humidity at +50°C for a period of 48 hours. The drift versus warm-up time for observed data at +50°C with less than 50% relative humidity and for observations after the 48 hour humidity test are shown on Plates 67 and 68 for the above channels. It is evident from these plates that humidity had no appreciable effect upon the oscillator frequency.

SIDETONE

78. The sidetone audio output power was measured on channels 2,5, and 9, as the percent modulation of the transmitter was varied from 0 to 100%. These measurements were made with a modulating frequency of 1000 cycles per second. Paragraph E-7p of Ref. (a) stipulates that the minimum sidetone power output from the receiver shall be 700 milliwatts when the transmitter carrier is modulated 30% at 1000 c.p.s. When the transmitter carrier was so modulated, the sidetone power output from the receiver was 1850 milliwatts on channel 2, 2400 milliwatts on channel 5, and 45 milliwatts on channel 9 (See Plate 69). It was observed while making these measurements that intermittent grounds between the top cover plate and the chassis of the ARC-12 caused wide deviations in the receiver output during transmission. This partially explains the low audio output measured on channel 9. In addition, the stray coupling between the transmitter and receiver, as well as transmitter power output, varied with frequency.

 [redacted]

79. Reference (a) also states that, if practicable, the modulation signals delivered to the receiver output as sidetone while transmitting be obtained by rectifying a small portion of the carrier output rather than from the modulator directly. In essence the ARC-12 was in compliance with this requirement since the main channel receiver was operated with reduced R.F. gain during transmission.

SIDETONE FIDELITY

80. Measurements were made of the sidetone fidelity on channel 2 with a constant 1000 c.p.s. input signal of 1.91 volts connected to the 82 ohm dummy microphone circuit (See Plate 70). This was the voltage required to obtain 100% modulation of the carrier at 1000 cycles per second. With a modulating frequency of 300 cycles, the audio output was -3.3 db relative to the response at 1000 c.p.s. With a modulating frequency of 4000 cycles, the audio output was -2 db relative to the response at 1000 c.p.s. (See Plate 71). The specifications, Ref. (a) do not cover sidetone fidelity, but the results obtained are in keeping with the receiver and transmitter fidelity requirements specified.

NOISE OUTPUT

81. Vibration tests of the ARC-12 equipment were conducted as required by paragraph E-7q of Ref. (a). The mechanical procedure and vibration characteristics of model RT-58/ARC-12 (XN-1) serial #4 when installed on model MT-230A/ARC mount are included in Appendix 1, prepared by the Shock and Vibration Division of the Laboratory. No electrical or mechanical failures were encountered during the vibration tests, although excessive excursion was experienced during resonance conditions at the higher vibration frequencies. It was observed that the noise modulation of the transmitter output slightly exceeded the specified maximum modulation (5%) at several vibration frequencies. This excessive modulation was observed in both horizontal and vertical vibration. On channel number 2 the noise modulation frequently reached a value of 6.5% for vibration in both vertical and horizontal planes. The audio output level of the receiver for 2 or 5 microvolts unmodulated r-f input did not exceed the equivalent of that obtained with a similar r-f input signal modulated 5% at 1000 c.p.s.

INPUT POWER

82. Paragraph E-7r of Ref. (a) states that the power input requirements of the complete equipment shall not exceed 20 amperes during transmission or reception, nor more than 25 amperes during operation of the channel selecting mechanism. The current drain of the subject equipment from a primary supply of 29.15 volts (maximum specified in paragraph D-4(b) of Ref. (b)) was 11.05 amperes in the transmit position without autotuning and 12 with the latter

[redacted]

in operation. Seven and six tenths amperes was the current drain from the same source for the receiver and heater circuits (See Plate 72).

CHANNEL CHANGING CYCLE TIME

83. The channel changing cycle time of the autotune mechanism was found to be within the 6 second limit of paragraphs E-7s, Ref. (a) only under STANDARD conditions. At room temperature, this time was 3.6 seconds with a primary supply of 26.5 volts, (See Plate 73). At -30°C the time was 4.9 seconds with the same primary supply. After three, 48 hours humidity tests, the autotune no longer functioned properly, because the mechanism would stop somewhere between channels and it was necessary to operate the power switch to produce a surge voltage which would cause the autotune to complete its cycle. No investigation was made to determine the source of trouble, but it was possibly due to inadequate lubrication.

84. The ARC-12 equipment has no provision for disabling the audio circuit during the autotune cycle as evidenced by the noise level present.

85. The autotune of ARC-12, serial #1, was permanently damaged by changing the channel while the locking control was unlocked. Investigation of this unit revealed a sheared engaging pin between arm O-501 and the arm of relay K502.

ANTENNA CIRCUITS

86. In order to meet the requirements of paragraphs E-3b and E-6b (5) of Ref. (a), the ARC-12 was supplied with an antenna coupling unit (See Plate 12). Since no radiation measurements were made at the Laboratory, this coupling unit was not involved in any of the measurements presented in this report.

87. The equipment provides no indication of relative antenna current or voltage as preferred in paragraph E-7t of Ref. (a).

FREQUENCY MODULATION

88. Paragraph E-7u of Ref. (a) states that the incidental frequency modulation of the transmitter output shall not exceed three kilocycles peak deviation when the transmitter is 80% modulated with 1000 c.p.s., and that the peak deviation shall not exceed one Kc. with no modulating voltage.

89. During initial measurements it was found that the automatic frequency control motor hunted when the continuous tone modulation level of the transmitter exceeded 60% . Replacement of the type 9002 tube (which proved gaseous on the tube tester) in the modulator

[redacted]

unit increased the level to which the modulation could be raised without experiencing motor hunting, and a level of 100% modulation could be obtained. The frequency modulation during a-f-c motor hunting exceeded 150 kilocycles total excursion. Hunting continued throughout the transmission period with sufficient percentage modulation, and occasionally, the a-f-c motor would hunt when operating the microphone push-to-talk button and with no modulation.

90. A supersonic amplitude-modulation of the transmitter output signal was produced by operating the transmitter microphone switch. A representative of the Bell Telephone Laboratory traced the cause to oscillation in the feedback circuits of the automatic frequency control system. This instability caused a sustained modulation of 10% in some instances. The a-f-c gain was subsequently reduced and the supersonic oscillation ceased. The Peak deviation of the incidental frequency modulation was however increased by reduction of the a-f-c gain. The inherent phase shift in the a-f-c feedback circuit limited the amount of usable gain to a value below that necessary to counteract severe frequency modulation. Hence, the incidental frequency modulation could not be eliminated or reduced to specification limits. All measurements herein reported were made with the a-f-c gain set just below the point where supersonic oscillation was obtained.

91. When the ARC-12 was voice-modulated with a Navy type RS-38-A microphone so that the modulation percentage did not reach 100%, the frequency modulation was approximately 10 kc. peak deviation or 20 kc. total excursion. When the transmitter was voice modulated at such a level that peaks occasionally reach 100% modulation, the peak deviation was approximately 20 Kc. When the transmitter was overmodulated, the peak deviation occasionally exceeded 50 Kc., or 100 Kc. total excursion. The above measurements were made with a Navy type RBW-3 panoramic receiver which had an input frequency of 5.3 megacycles. The ARC-12 output frequency was mixed with a stable oscillator to produce a 5.3 megacycle difference frequency required for this receiver. The sweep range of the panoramic receiver calibrated with an external signal was expanded on the indicator tube as necessary to provide sufficient spread of the side frequencies.

92. Under continuous tone modulation conditions, the peak deviation was found to build up to values in excess of 100 Kc as observed with the panoramic receiver. At 100% modulation the a-f-c motor hunted and continued to hunt until the modulation level was decreased to approximately 60%. As the modulation was gradually increased, a point was reached where a spurious oscillation appeared on the transmitter output carrier envelope. This spurious oscillation appeared simultaneously on the panoramic receiver screen as an increase in side frequency components which extended more than 150 Kc. from the carrier frequency. These

[redacted]

side frequencies were not symmetrically related to the carrier frequency. With 1000 c.p.s. modulating frequency and at modulation percentages which caused neither the a-f-c motor to hunt nor spurious oscillations, the magnitudes of observed peak frequency deviations are shown on Plate 74.

93. A static test of transmitter frequency change versus plate voltage of the type 832A power amplifier tube was conducted to compare the measured frequency change with the above dynamic test. A d.c. voltage was applied from an external source to the power amplifier through terminals #11 and #16 of the power control unit terminal strip. The return lead which connected terminal #11 to the dynamotor was opened, the type 6V6 modulator tubes were removed, and the a-f-c motor switch set in the "off" position for this test. The results are shown on Plate 75. The plate voltage of the type 832A tubes was 290 volts with no modulating signal. With modulation applied, this voltage is increased and decreased by the value of the peak modulating voltage during each cycle of the modulating frequency. The transmitter output frequency change resulting from a plate voltage change (from dip to peak values) is approximately equal to the total frequency excursion of the transmitter for the percent modulation corresponding to the plate voltage variation. For example, a 50% modulation would provide a peak plate voltage of 435 volts and a minimum of 145 volts. From Plate 75 this would cause a frequency difference of 22 Kc. for ARC-12 serial # 1. The dynamic curve shown on Plate 74 shows approximately the same result.

AUDIO VOLUME CONTROL

94. Measurements of audio volume control characteristics were made with the ARC-12 installed in an AN/ARC-1 harness. This harness consisted of a mounting rack MT-230A/ARC, a remote control unit C-45/ARC-1, a junction box J-21/ARC-1(XN-1), two jack boxes C-44/ARC-1(XN-1) and the associated cabling. The audio volume control measurements were made with a 5 microvolt signal supplied to the antenna connector of the ARC-12 by a Ferris model 48-A signal generator modulated 30% at 1000 c.p.s. and a General Radio type 583A output power meter, adjusted for a 300 ohm load, connected to the audio jack in the two jack boxes. The audio power output was then recorded for different fixed settings of the audio volume control on one jack box while the audio volume control of the other jack box was varied. The interaction between the volume controls of the two jack boxes was found to be excessive as shown on Plates 76 and 77. For example: the output obtained from jack box serial No. 25, when its volume control was set at 3/4 maximum, was changed 16 db as the volume control on jack box serial No. 26 was varied from minimum to maximum (See Plate 77).

[redacted]

95. The following additional observations were made during these tests.

(a) The main channel oven door was sealed shut by high temperature and humidity conditions.
(b) The RT-58/ARC-12(XN-1) serial No. 4 did not show signs of corrosion due to high humidity. However, jack box C-44/ARC-1 (XN-1) corroded around the headset jack during the humidity test.
(c) Inspection of the subject equipment after the vibration test showed that no mechanical failures were incurred as a result of the vibration tests.
(d) The audio output and test meter jacks on the ARC-12 front panel are identical and, though properly labeled, permit interchanging the test meter and headphones.
(e) The top cover plate of the ARC-12 was warped and did not insure a good ground connection throughout the length of the cover.

CONCLUSIONS

96. The model AN/ARC-12 (XN-1) equipment in its present form does not meet all the requirements of reference (a) and (b) and is not considered suitable for use in Naval aircraft, chiefly because of low transmitter power output and excessive incidental frequency modulation. However, the subject equipment does possess several highly desirable features which could be incorporated in future equipments, such as a single tuning control and plug in assemblies. The following conclusions are made on AN/ARC-12 performance which does not comply with specifications, references (a) and (b). In some individual cases the equipment performance which exceeds the limits of the specifications would not seriously inpair the operation of the system, but collectively all deficiencies contribute to make the AN/ARC-12 equipment unsuitable in its present form.

(a) The r-f power output was less than specified throughout the entire frequency range. On some channels the deviation from the required output, when operating into a 50 ohm load, was as great as 3.5 db(See paragraph 54).
(b) The incidental frequency modulation was excessive. This could be reduced by a redesign of the automatic frequency control circuits. However, with the ARC-12 an attempt to increase gain introduced an undesirable supersonic oscillation in the associated feedback circuit. (See Paragraph 90).
(c) The receiver sensitivity was decreased appreciably when the AN/ARR-2 equipment was coupled to the "AUX" antenna outlet. This effect was encountered over a large portion of the AN/ARC-12 frequency range (See paragraph 21).

[redacted]

(d) The autotune operation was unsatisfactory. Complete mechanical failure was experienced with autotune unit, serial number 7(installed in AN/ARC-12 (XN-1) serial #1) when it was operated in an unlocked condition. (See paragraph 85). Partial failure of the autotune unit in AN/ARC-12(XN-1) serial No. 4 was experienced following humidity tests. (See paragraph 83).

(e) The increase of modulator gain with decrease of ambient barometric pressure did not comply with specifications (See paragraph 62).

(f) The transmitter fidelity was not in accordance with specifications of reference (a), especially at audio frequencies below 500 c.p.s. (See paragraph 64).

(g) The transmitter total harmonic distortion was excessive (24%) at a modulating frequency of 300 c.p.s. (See paragraph 64).

(h) The vibration tests indicated excessive excursion of the equipment at the higher vibration frequencies. (See paragraph 87 and Appendix 1).

(i) The discussions of the following items not in compliance with specifications are covered in this report in the paragraphs indicated below:

Dimensions (Paragraph 17)
Weight (Paragraph 18)
AVC Characteristics (Paragraphs 29 to 36 inclusive)
Selectivity (Paragraph 36)
Image Rejection(Paragraph 37)
Receiver Overall Fidelity(Paragraph 47)
R.F. Gain Control (Paragraph 50)
Spurious Radiations (Paragraph 72)
Coupling Factor (Paragraph 73)
Sidetone Output Power (Paragraph 78)

97. No test was conducted on the antenna matching stub. However, the adjustment of this stub requires the use of a slotted-line and presents installation difficulties. A broad-band antenna, such as the Army v-h-f stub which covers the frequency range 210 to 380 megacycles with a standing wave ratio less than 1.5 to 1, provides electrical charateristics equal to that required of the matching stub and antenna combination, but eliminates many of the installation and alignment problems.

98. The mechanical design and form factor of AN/ARC-12 are, in general, very good and comply with D-1a of reference (b). However, inspection and tests disclosed the following:

(a) Poor grounding exists between the top cover plate and the case due to the inherent design.

(b) The crystal oven door was sealed closed by high temperature and humidity test conditions.

[redacted]

(c) The test meter jack and phone jack on the panel of the equipment are identical and will permit interchanging the test meter and phone cables. The latter could easily damage the test meter.

(d) Inclusion of patch cables with the sub-assembly type construction is highly desirable for service maintenance.

99. Excessive interaction exists between the audio volume controls when two type C-44/ARC-1 (XN-1) jack boxes are employed. Therefore, it is not desirable to use two of these jacksboxes simultaneously with an AN/ARC-12.

100. The specifications, reference (a), require clarificationsto establish definite standards of equipment operation for paragraphs E-7b, E-7g, E-7h and E-7t of sensitivity, regeneration, peak noise limiter and antenna circuits.

RECOMMENDATIONS

101. The development model RT-58/ARC-12(XN-1) v-h-f-communication equipment in its present form, as represented by serial numbers 1 and 4, is not recommended for use in Naval aircraft. Since the subject equipment possesses highly desirable features, it is recommended that the transmitter section be redesigned to provide increased r-f power output and decreased incidental frequency modulation to comply with the existing specifications, reference (a). In addition, the following recommendations are made:

(a) Provide suitable filtering of the receiver antenna circuits to prevent sensitivity loss in excess of 6.0 db. when the AN/ARR-2 is coupled to the "AUX" antenna connector.

(b) Improve the mechanical construction of the autotune mechanism. Provide means to prevent electrical and mechanical failures as a result of operating the autotune in an unlocked condition. Provide lubrication that is adequate under all SERVICE atmospheric conditions.

(c) Increase the range of the pressure operated modulator gain control.

(d) Improve the transmitter fidelity.

(e) Reduce the transmitter total harmonic distortion at low audio frequencies.

(f) Provide material on the crystal oven door to prevent the door from sealing closed after periods of high temperature and humidity.

(g) Mechanically secure the top cover plate to insure a more complete ground connection with the case. Construct the cover more rigidly to prevent changing of sidetone output power, by changes in stray coupling during transmission.

(h) Change test meter plug and jack to types not interchangeable with the phone plug. One possibility is the use of a three connector phone plug with the sleeves and ring used for

[redacted]

meter connections.

(i) It is recommended that a broad band antenna be used to replace the matching stub. On the basis of laboratory measurement, the Army broad band, v-h-f, stub antenna is suitable for this purpose.

(j) Improve the construction of the shock mount so as to provide better vibration characteristics.

[redacted]

REFERENCES

(a) BuShips Specification RE 13A 995A of 17 June 1944.

(b) BuShips Specification RE 13A 585B

(c) BuShips ltr. Sec. 913BH. Ser.07458 dated 23 June 1945-
Assigning Problem S-2087T-C.

(d) Instruction Book

(e) NRL ltr. report to the Bureau of Aeronautics -C-F42-1/
66(316:JTB) C-310-221/45(dge)dated 17 January 1946.

[redacted]

TABLE 1

RT-58/ARC-12
TUBES COMPLEMENT

Main Channel Oscillator	JAN-6AK5	V-561
" " Harmonic Amplifier	" -6AK5	V-562
" " Doubler	" -6AK5	V-563
" " 1st R.F. Amplifier	" -6AK5	V-671
" " 2nd R.F. Amplifier	" -6AK5	V-672
" " 3rd R.F. Amplifier	" -6AK5	V-673
" " Mixer	" -6AS6	V-674
Guard Channel Oscillator	" -6AK5	V-781
" " Harmonic Amplifier	" -6AK5	V-782
" " Doubler	" -6AK5	V-783
" " 1st R. F. Amplifier	" -6AK5	V-751
" " 2nd R. F. Amplifier	" -6AK5	V-752
" " 3rd R. F. Amplifier	" -6AK5	V-753
" " Mixer	" -6AS6	V-754
I.F. Amplifier I	" -6AK5	V-711
" " II	" -6AK5	V-712
" " III	" -6AK5	V-713
" " IV	" -6AK5	V-714
Detector and 1st Audio	" -6AQ6	V-843A-B
AVC control and Peak Noise Limiter	" -6AL5	V-842A-B
Phase Inverter	" -6AQ6	V-845
Audio Output	" -6AK6	V-846
Audio Output	" -6AK6	V-847
AVC Detector and Amplifier	" -6AQ6	V-841
Converter	" -6AS6	V-848
Wide band Amplifier Control and Squelch	" -6AQ6	V-844A-B
Narrow band Discriminator	" -6AL5	V-849
Wide band Amplifier(AFC unit)	" -6AK5	V-501
Wide band Discriminator (AFC unit)	" -6AL5	V-601
Electronic Control Amplifier I (AFC unit)	" -6AK5	V-503
Electronic Control Amplifier II(AFC unit)	" -6AK6	V-504
Electronic Control Amplifier II(AFC unit)	" -6AK6	V-505
Motor Control Amplifier I (AFC unit)	" -6AQ6	V-602
Motor Control Amplifier II(AFC unit)	" -6J6	V-603
Transmitter R.F. Oscillator	" -2C43	V-511
Transmitter R.F. Oscillator	" -2C43	V-512
Microphone Amplifier	" -9002	V-641
Modulator	" -6V6GT/G	V-642
Modulator	" -6V6GT/G	V-643
Transmitter Power Amplifier	" -832A	V-513

[redacted]

TABLE 2

SENSITIVITY

	Relative Humidity Less than 50%				Relative Humidity 95%			
Channel	μ Volts Input for 50 MW Output	Signal to Noise db for 50 MW Output	μ Volts Input for 100 MW Output	Signal to noise db for 100MW Output	μ Volts Input for 50 MW Output	Signal to Noise db for 50 MW Output	μ Volts Input for 100 MW Output	Signal to noise db for 100 MW Output
1	2.10	6	2.10	6	1.50	6.8	2.45	9.4
5	1.50	6	1.45	6	2.40	8.0	3.40	10.7
GC	5.90	6	5.95	6	4.75	8.0	6.00	10.0
9	3.10	6	3.25	6	3.25	6.5	6.05	11.0

Readings taken at+50°C;

Readings taken after 48 hours at+50°C and Relative Humidity of 95%. 20 minutes frequency drift allowed before check.

[redacted]

TABLE 3

RT58/ARC-12 (XN-1)

I.F. and Image Rejection

Channel	Image Freq. Mc.	50MW Res. Freq. Sensitivity μV.	Image Rejection db	I.F. Rejection db
1	200.4	2.5	92.1	
2	206.2	2.4	87.2	
3	220.4	2.8	71.1	
4	228.4	4.3	76.9	93.36
5	247.4	2.3	90.2	
6	252.9	1.9	74.4	
7	259.6	1.7	74.9	
8	274.0	1.8	82.8	
9	298.0	2.8	56.6	97.08
GC	250.0	4.5	86.0	92.96

[redacted]

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TABLE 4

Model AN/ARC-12(XN-1)
Serial #4
TRANSMITTER SPURIOUS RADIATIONS
SUPPLY VOLTAGE 26.5V

Circuit	Freq. Mc.	channel 1 µV.	channel 1 DB below Carrier	channel 5 µV.	channel 5 DB below Carrier	channel 9 µV.	channel 9 DB below Carrier
Narrow-band discriminator ckt.	0.57	4.3	112	30	101	9.3	89
Narrow band discriminator Xtal.Osc.	14.53	200	80	0.6		16	83
Intermediate Frequency	15.1	1.2K	63	190	85	3.9	
Main Channel Xtal. Osc.(Chan. 1)	26.9375	62.0	89				
" " " " (Chan. 5)	32.8375			4.6	118		
" " " " (Chan. 9)	39.1375					7.7K	29
Main Channel Harmonic Ampl.(CHan.1)	107.75	210	78				
" " " " (Chan.5)	313.1			325	81		
" " " " (Chan.9)	156.55						
Main Channel Doubler Ckt. (Chan. 1)	215.5	16K	41				
" " " " (Chan. 5)	262.7			5.5K	56		
" " " " (Chan. 9)	331.1					600	41.5
Main Channel Carrier (Chan. 1)	230.6	1,740K	0				
" " " (Chan. 5)	277.8			3520K	0		
" " " (Chan. 9)	328.2					266K	0
Guard Channel Xtal. Osc.	33.1375	5.5K	50	96	91	78	69
Guard Channel Harmonic Ampl.	132.55			325	81		
Guard Channel Doubler Ckt.	265.1	1.5K	61				
Guard Channel Carrier.	280.2						

TABLE 5

AUDIO COUPLING FACTOR
Maximum Sensitivity-Maximum Audio Gain
Input Signal 30% Modulated with 1000 cps

CHANNEL	μV Input to Audio Leads	μV Input to Ant.	Milliwatts Output	Coupling Factor
1	90K	1.9	100	0.000021
2	89K	2.5	100	0.000028
3	88K	2.1	100	0.000024
4	87K	2.25	100	0.000026
5	86K	3.5	200	2.00004
6	35K	2.25	200	0.00006
7	5K	2.4	200	0.00048
8	50K	3.20	200	0.00006
9	8K	6.00	200	0.00075
GC	90K	2.25	100	0.000025

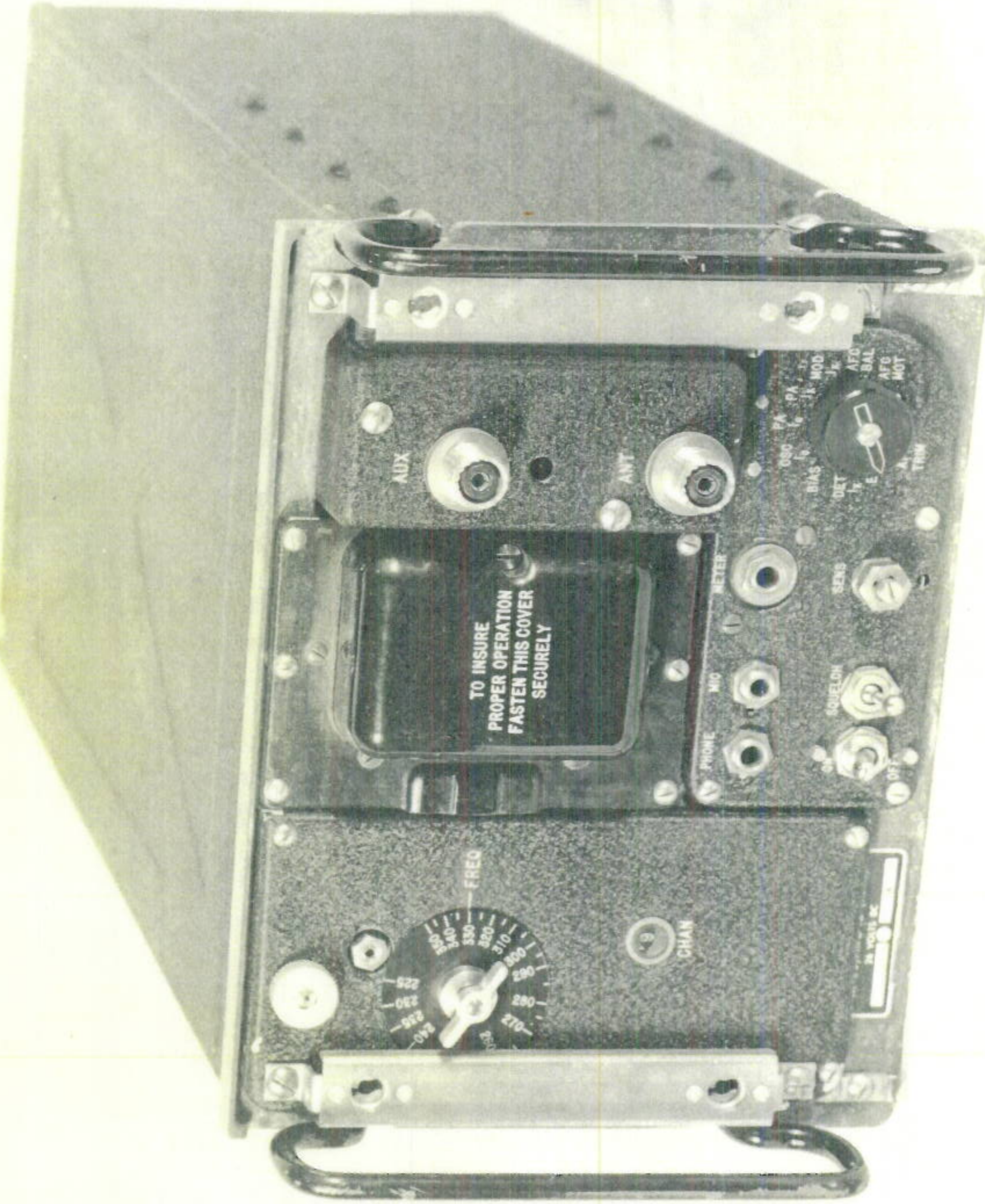
[redacted]

TABLE 6

POWER LINE COUPLING FACTOR
Input signal 30% Modulated with 1000 cps

Channel	µV Input to Power Line	µV Input to Ant.	Milliwatts Output	S+N/N Ratio	Coupling Factor
1	49K	2.5	50	4/1	0,000051
2	70K	2.4	"	"	0.000034
3	11K	2.8	"	"	0.00025
4	7K	4.3	"	"	0.00061
5	34K	2.3	"	"	0.000067
6	8,5K	1.9	"	"	0.00022
7	2.5K	1.7	"	"	0.00068
8	3.6K	1.8	"	"	0.00050
9	16.K	2.8	"	"	0.00018
GC-t/r	85K	2.4	"	"	0.000028
GC	> 85K	4.5	"	"	< 0.000053

[redacted]



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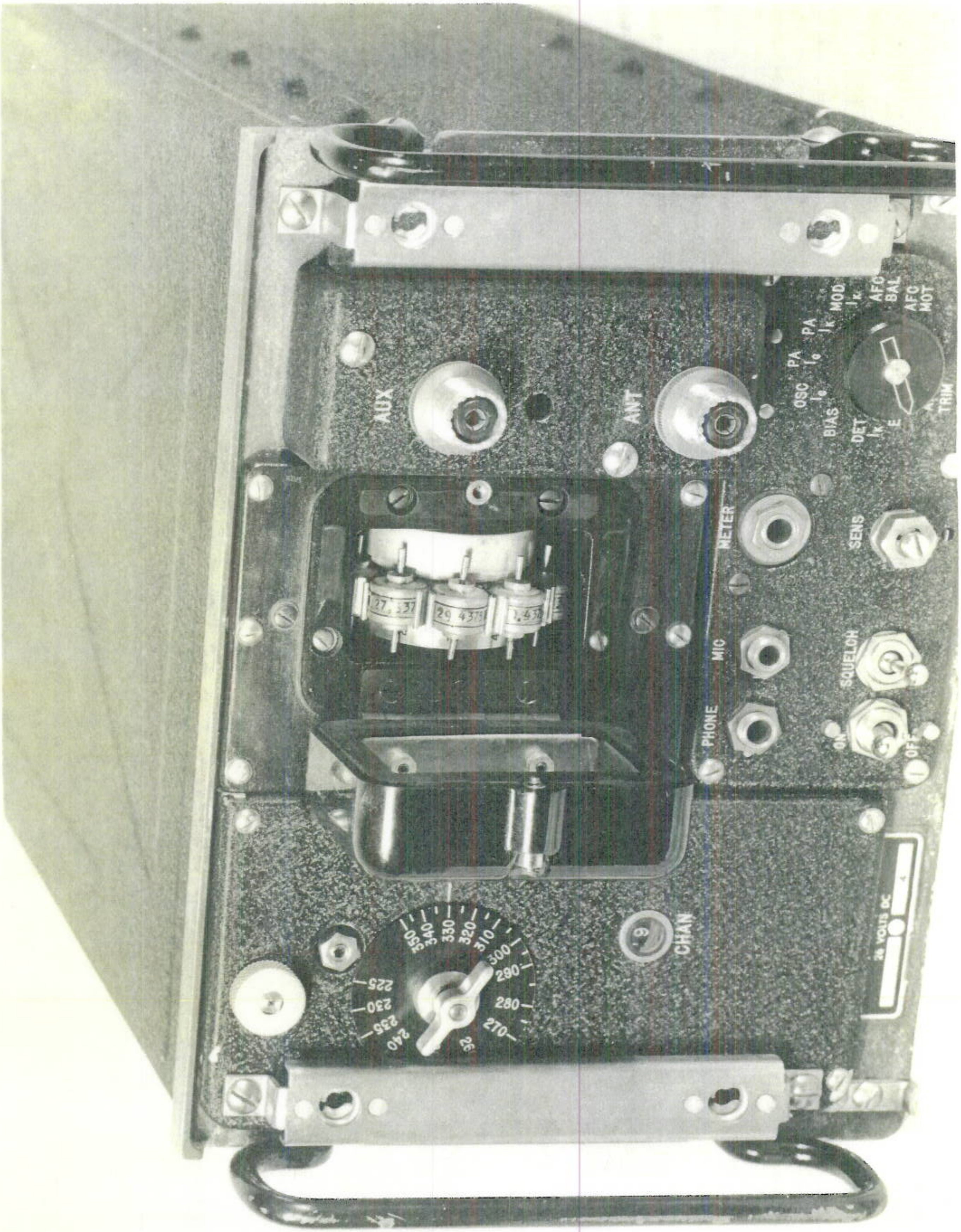
[redacted]

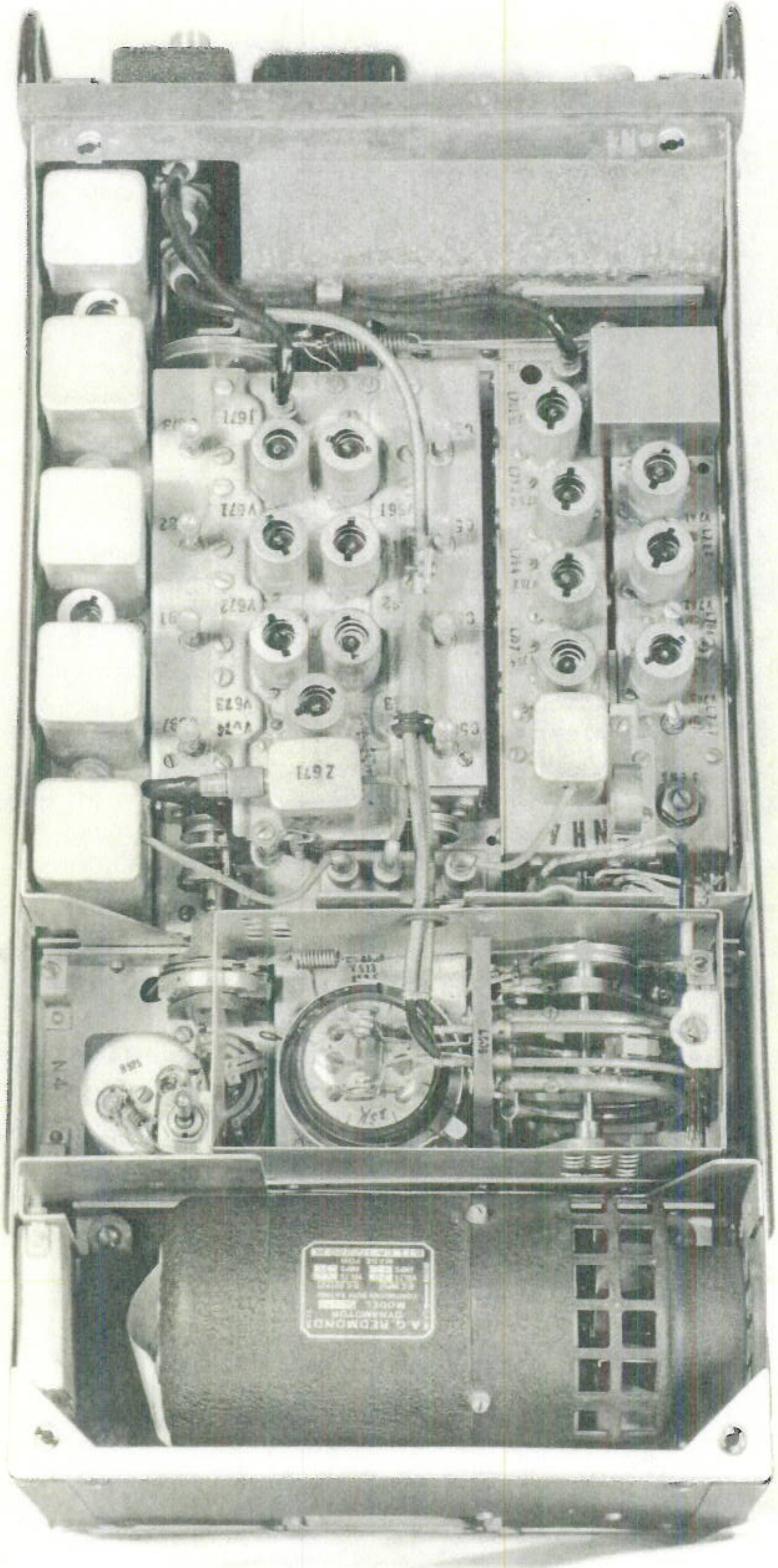
PLATE 2



CONFIDENTIAL

DECLASSIFIED

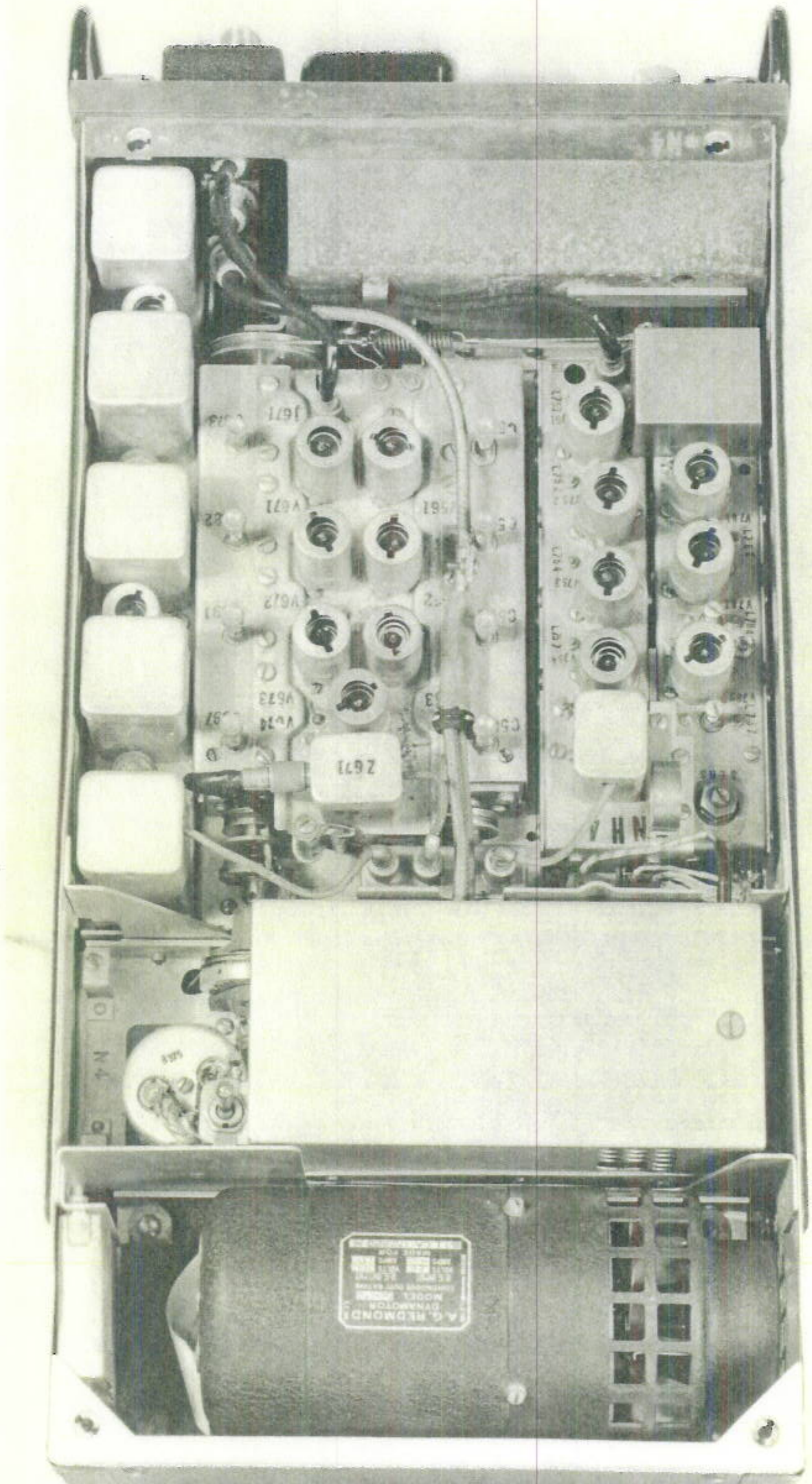
PLATE 3



[redacted]

DECLASSIFIED

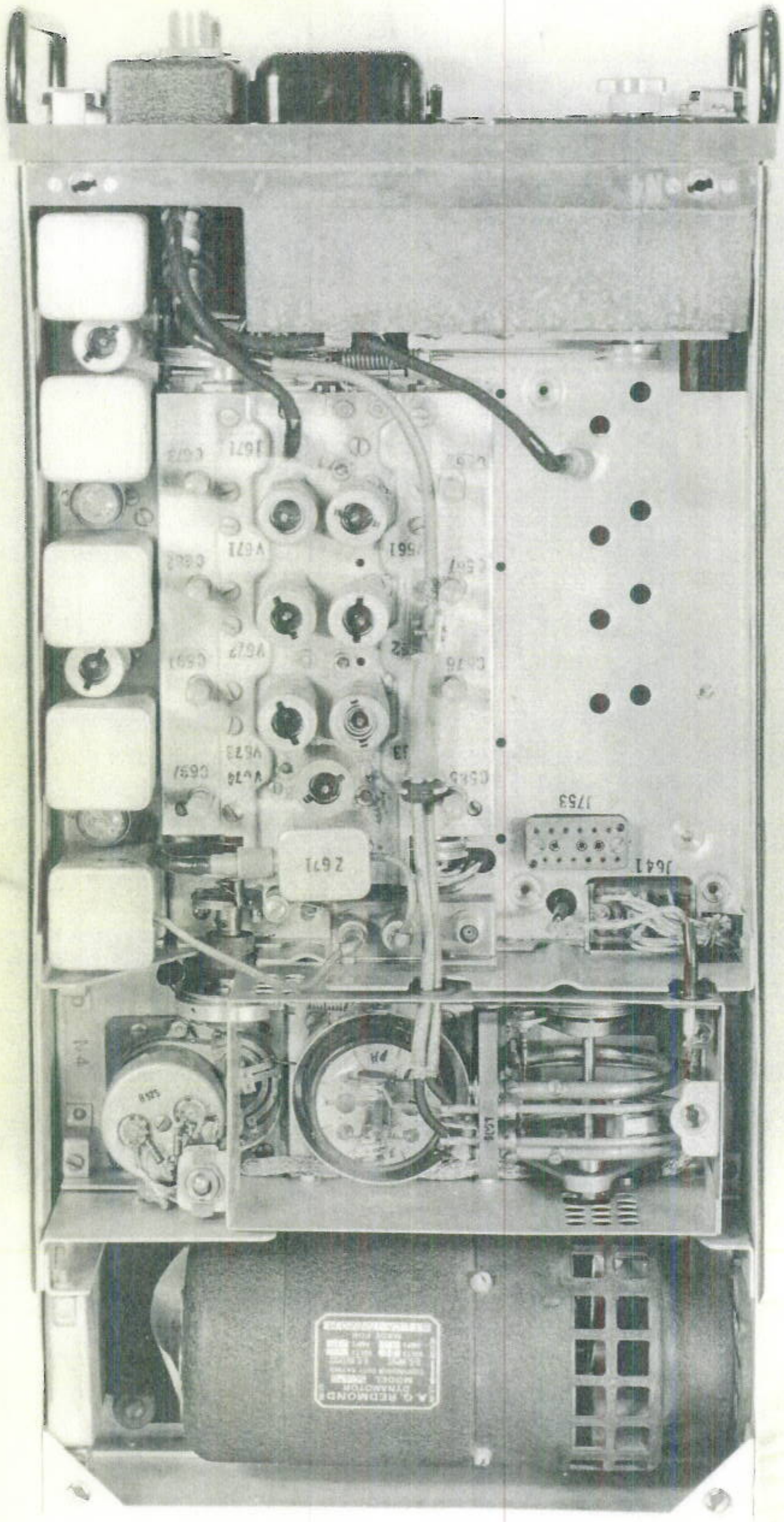
PLATE 4



DECLASSIFIED

[redacted]

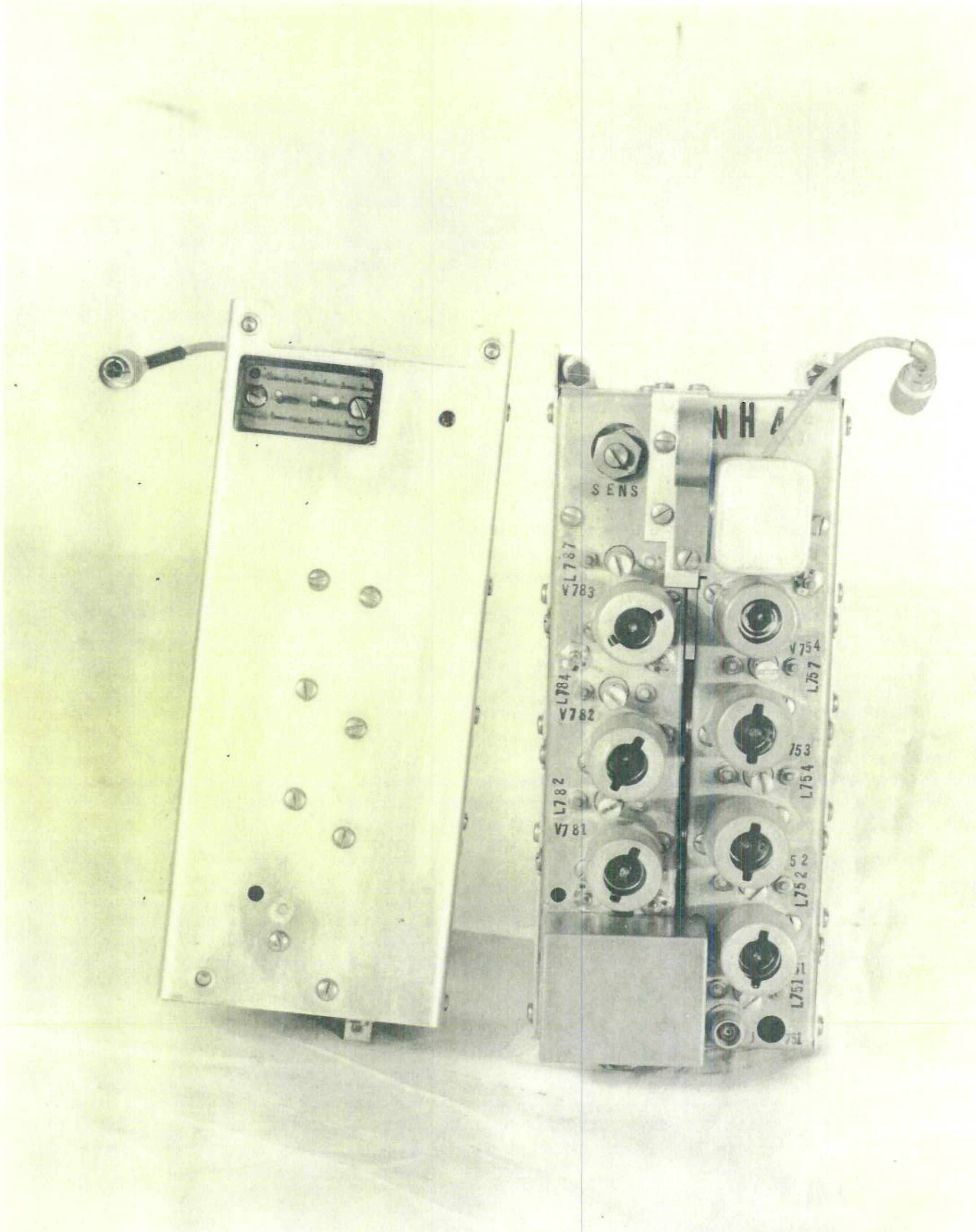
PLATE 5



DECLASSIFIED

[redacted]

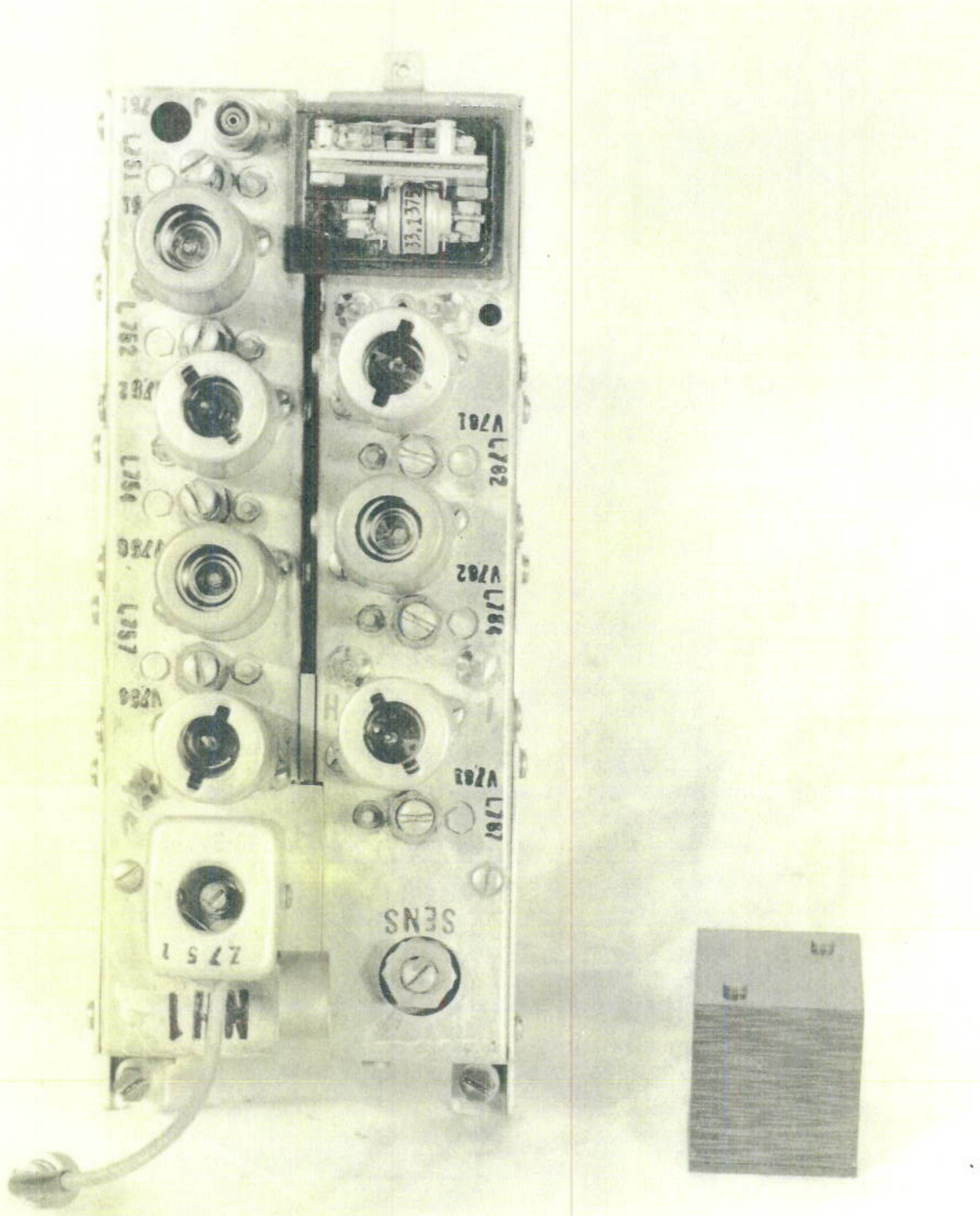
PLATE 6



[redacted]

DECLASSIFIED

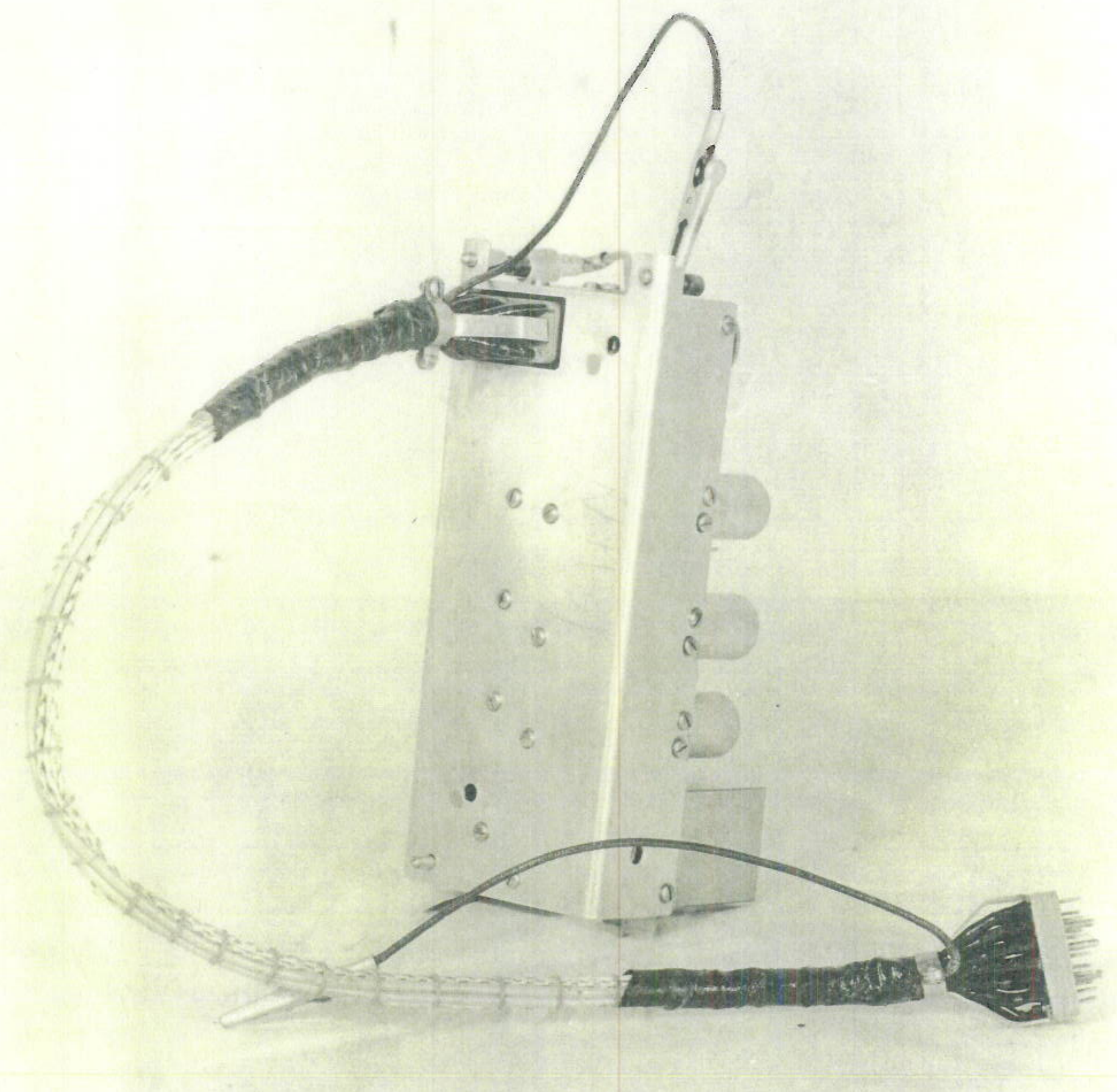
PLATE 7



DECLASSIFIED

[redacted]

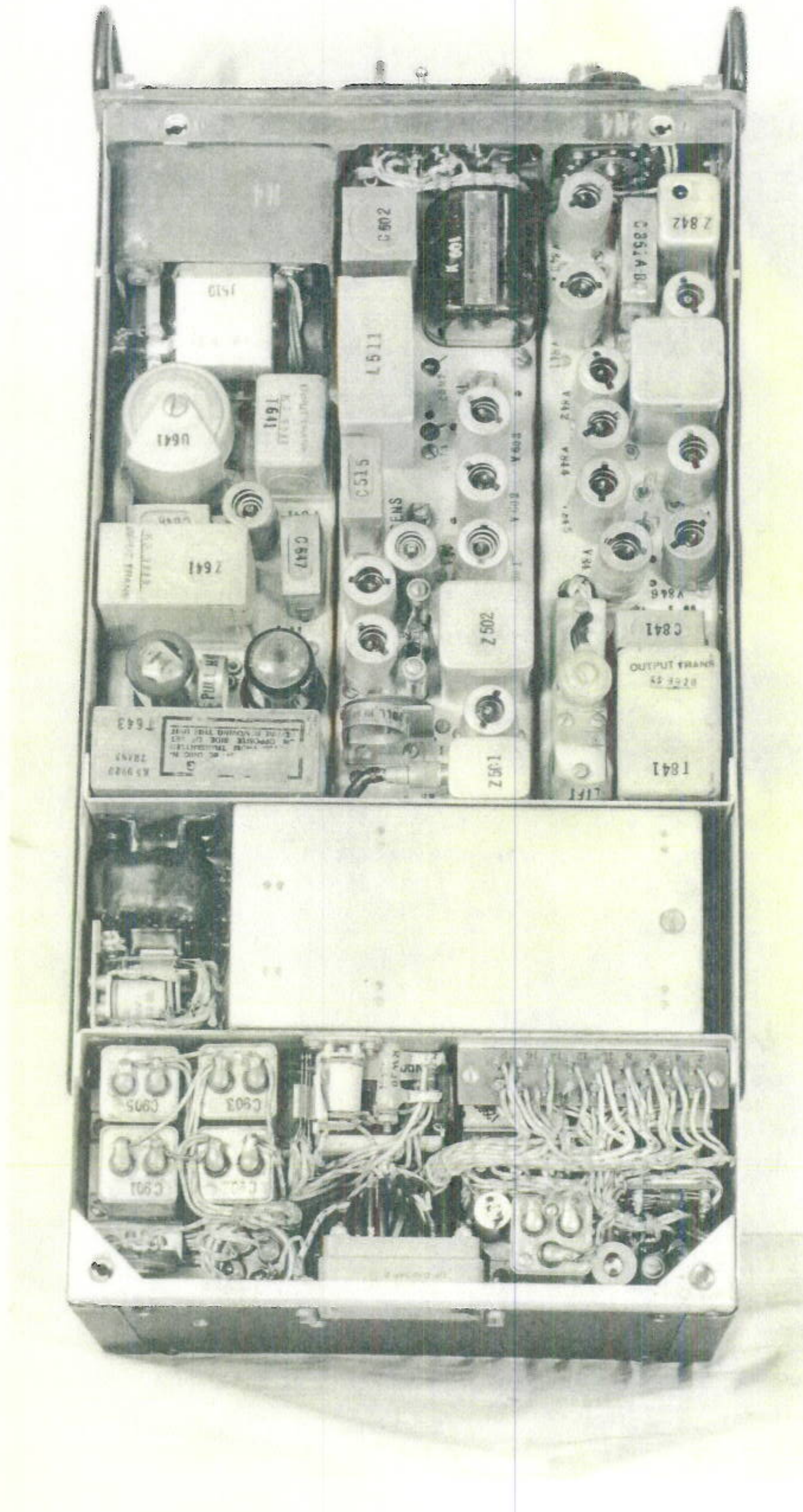
PLATE 8



DECLASSIFIED

[redacted]

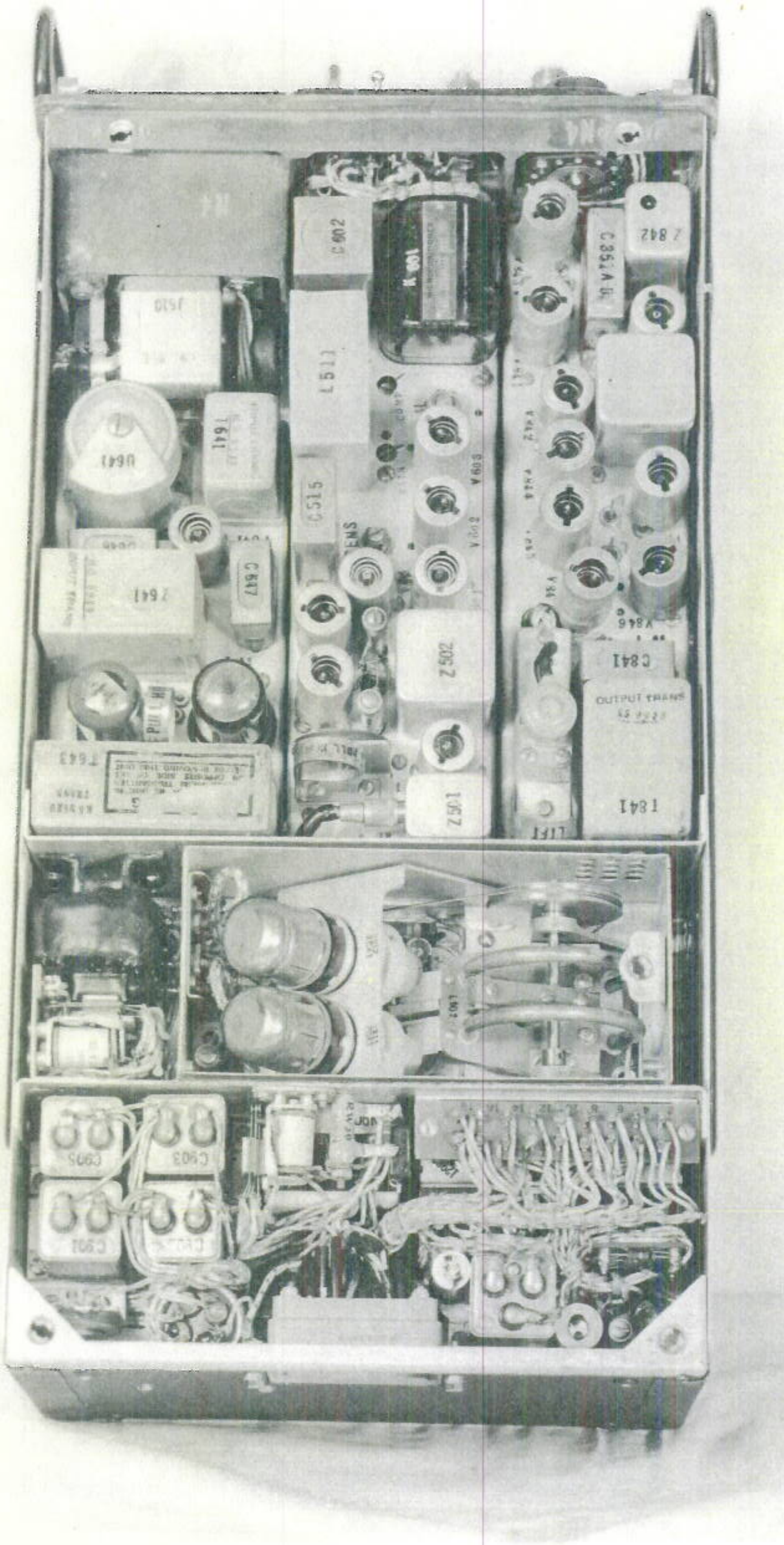
PLATE 9



[redacted]

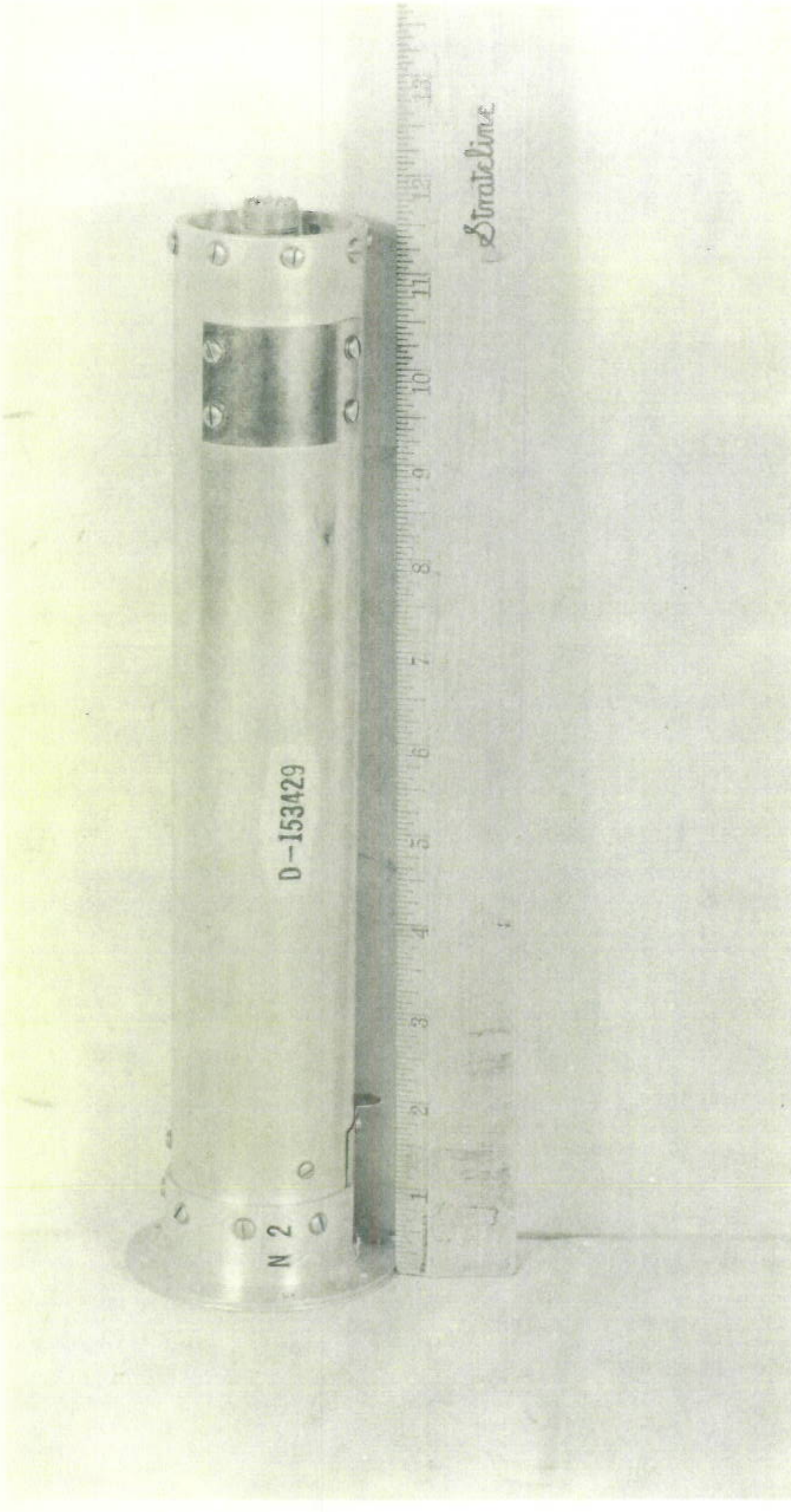
DECLASSIFIED

PLATE 10



[redacted] DECLASSIFIED

PLATE II



DECLASSIFIED

PLATE 12

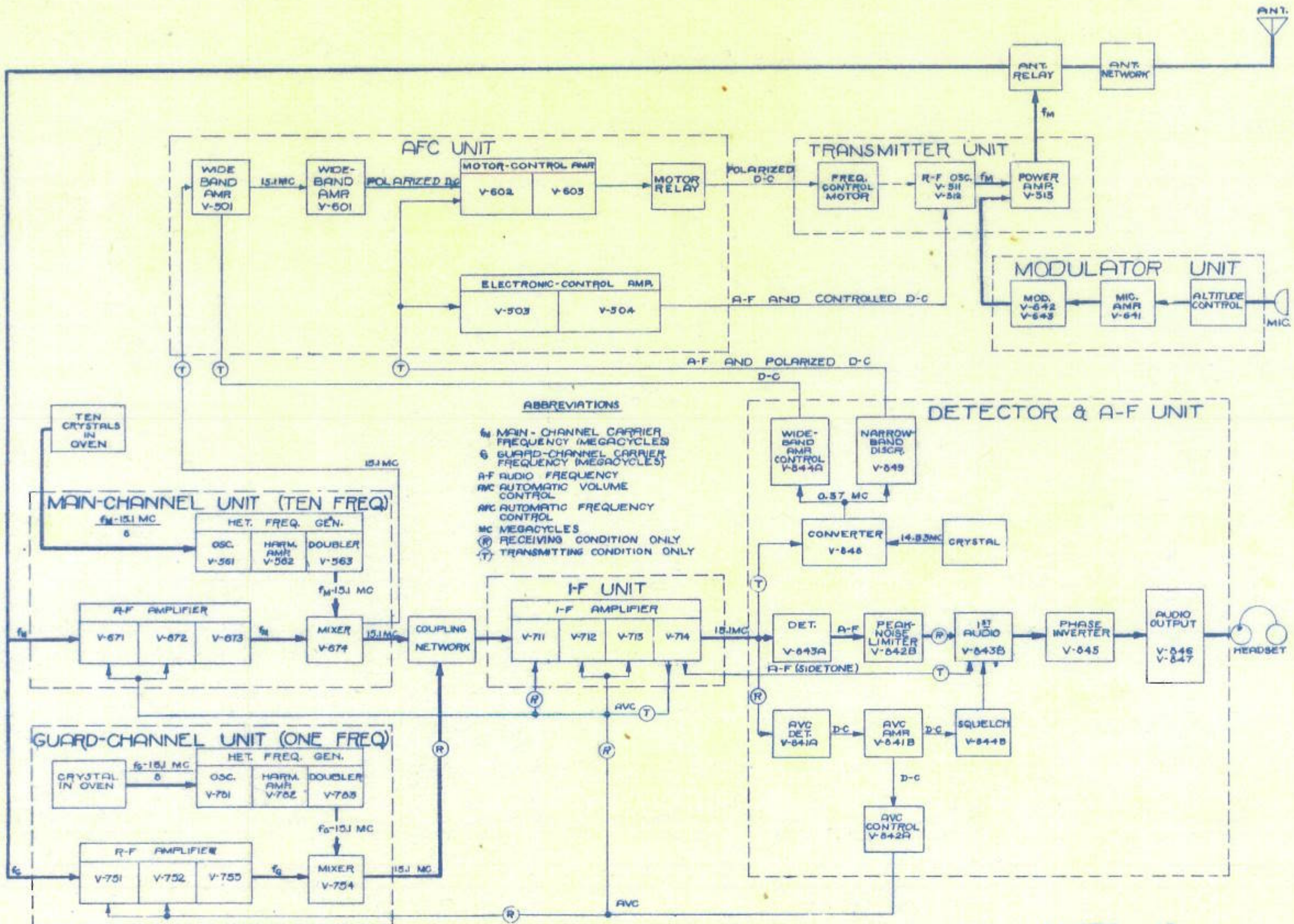
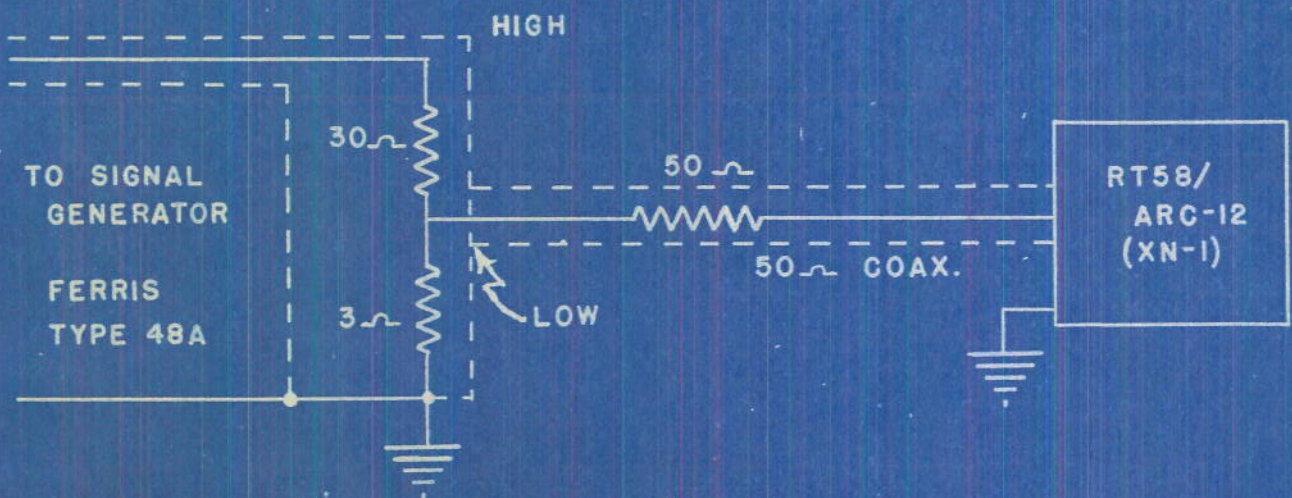


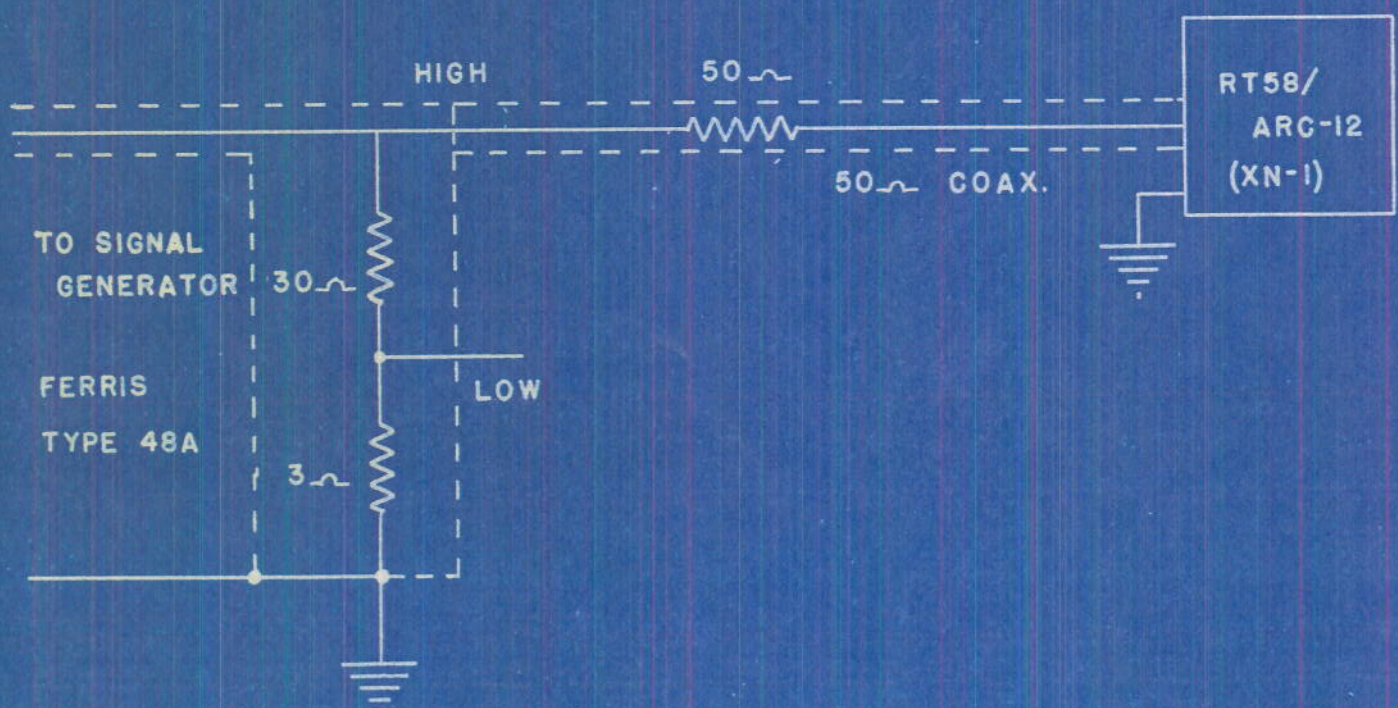
PLATE 13

Figure 4—1. Model AN/ARC-12 Aircraft Radio Equipment, Block Diagram

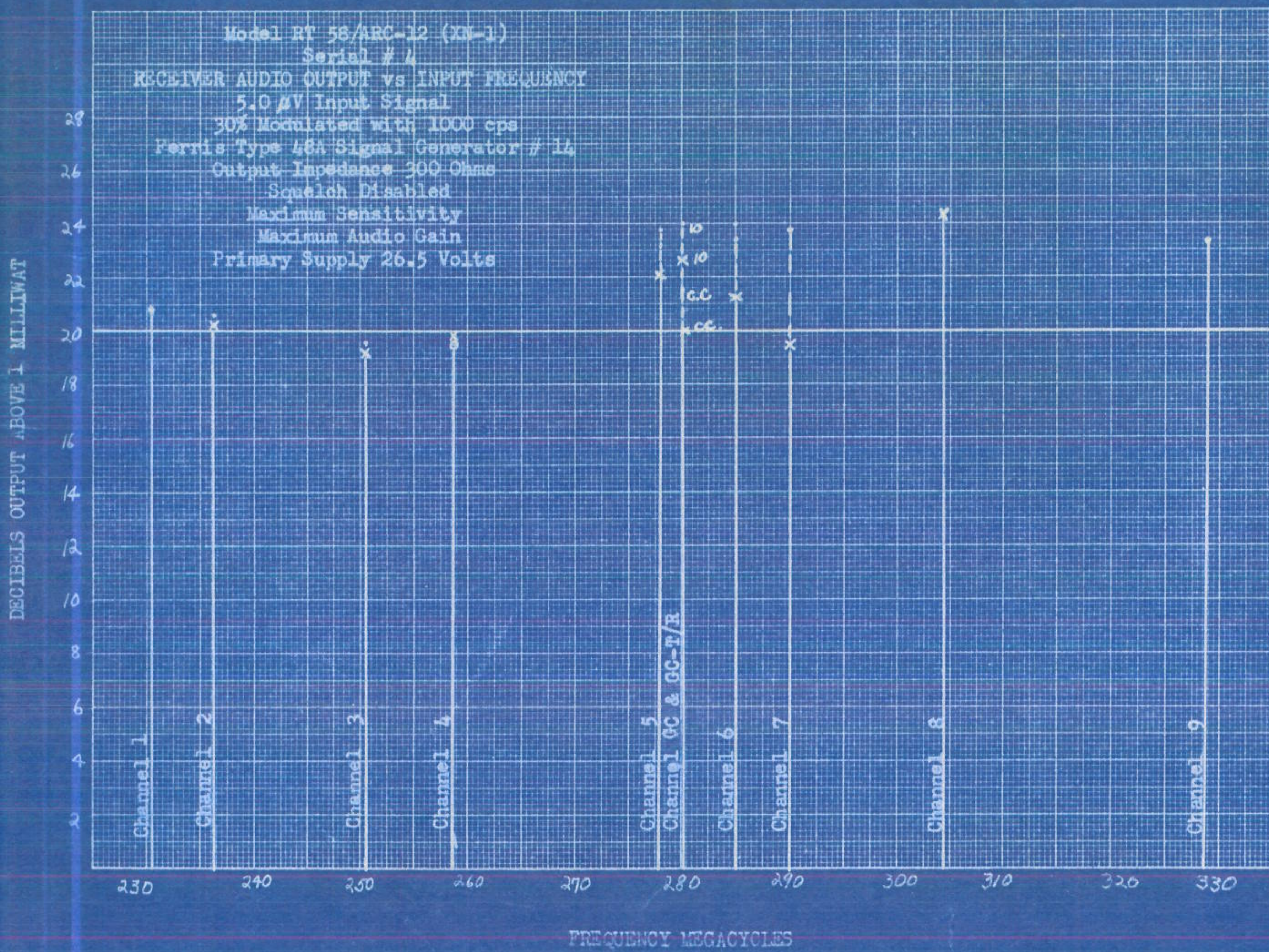
FERRIS TYPE 48A - SIGNAL GENERATOR TERMINATIONS



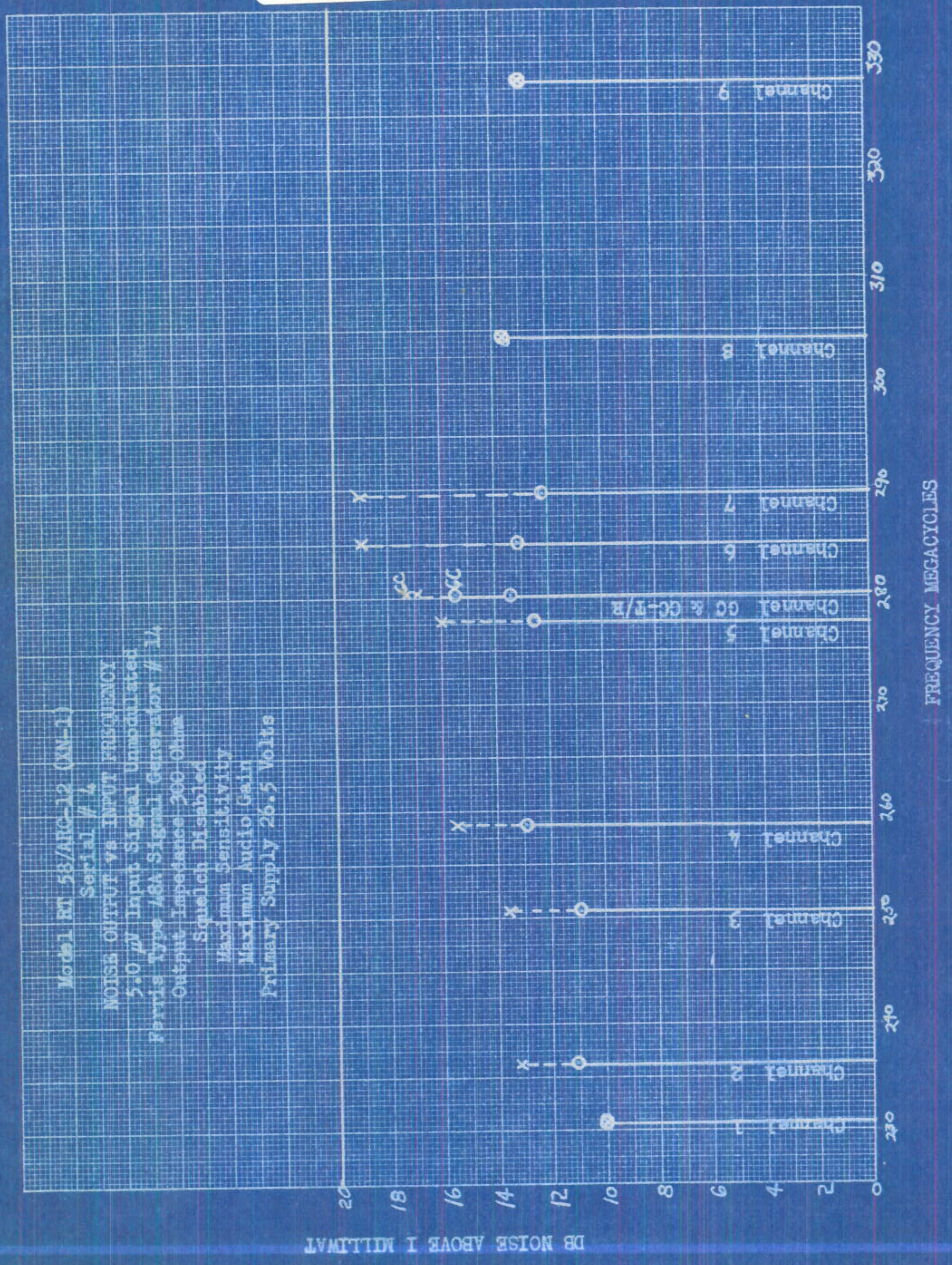
(A)



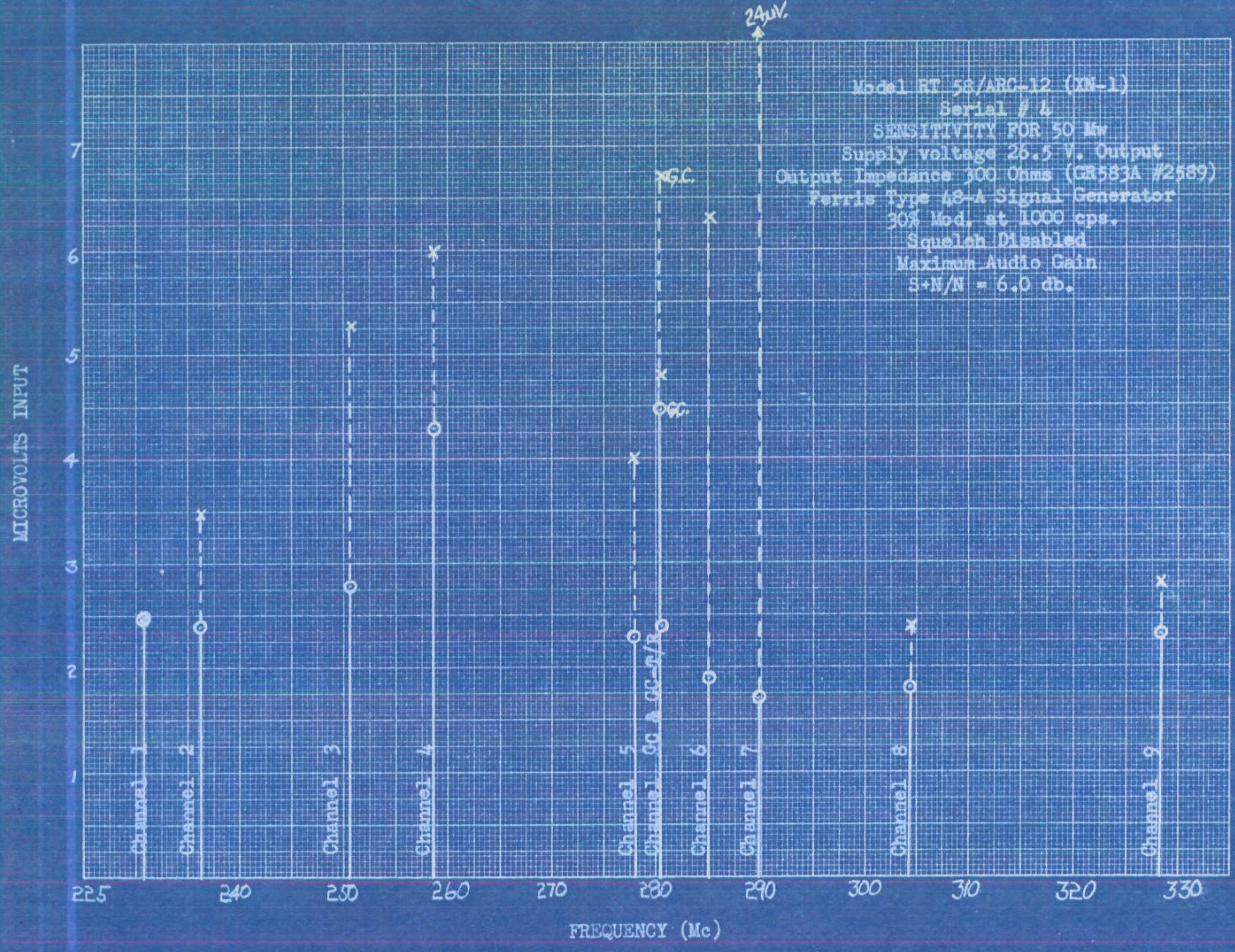
(B)


Model RT 58/ARC-12 (XN-1)
Serial # 4
RECEIVER AUDIO OUTPUT vs INPUT FREQUENCY
5.0 µV Input Signal
30% Modulated with 1000 cps
Ferris Type 48A Signal Generator # 14
Output Impedance 300 Ohms
Squelch Disabled
Maximum Sensitivity
Maximum Audio Gain
Primary Supply 26.5 Volts
Channel 1
Channel 2
Channel 3
Channel 4
Channel 5
Channel GC & GC-T/R
Channel 6
Channel 7
Channel 8
Channel 9
10
10
G.C
G.C.
DECIBELS OUTPUT ABOVE 1 MILLIWAT
2
4
6
8
10
12
14
16
18
20
22
24
26
28
230
240
250
260
270
280
290
300
310
320
330
FREQUENCY MEGACYCLES

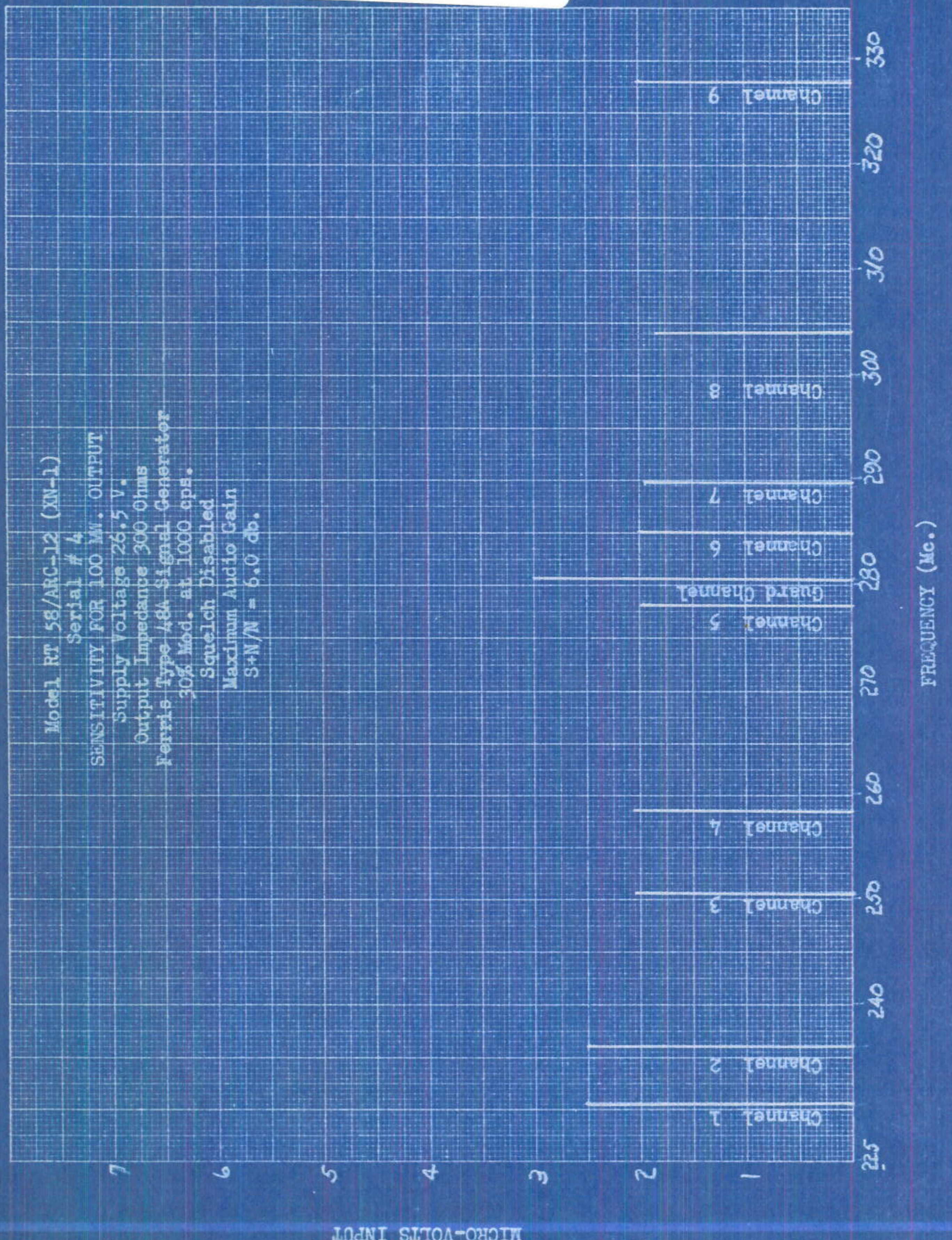
DECLASSIFIED

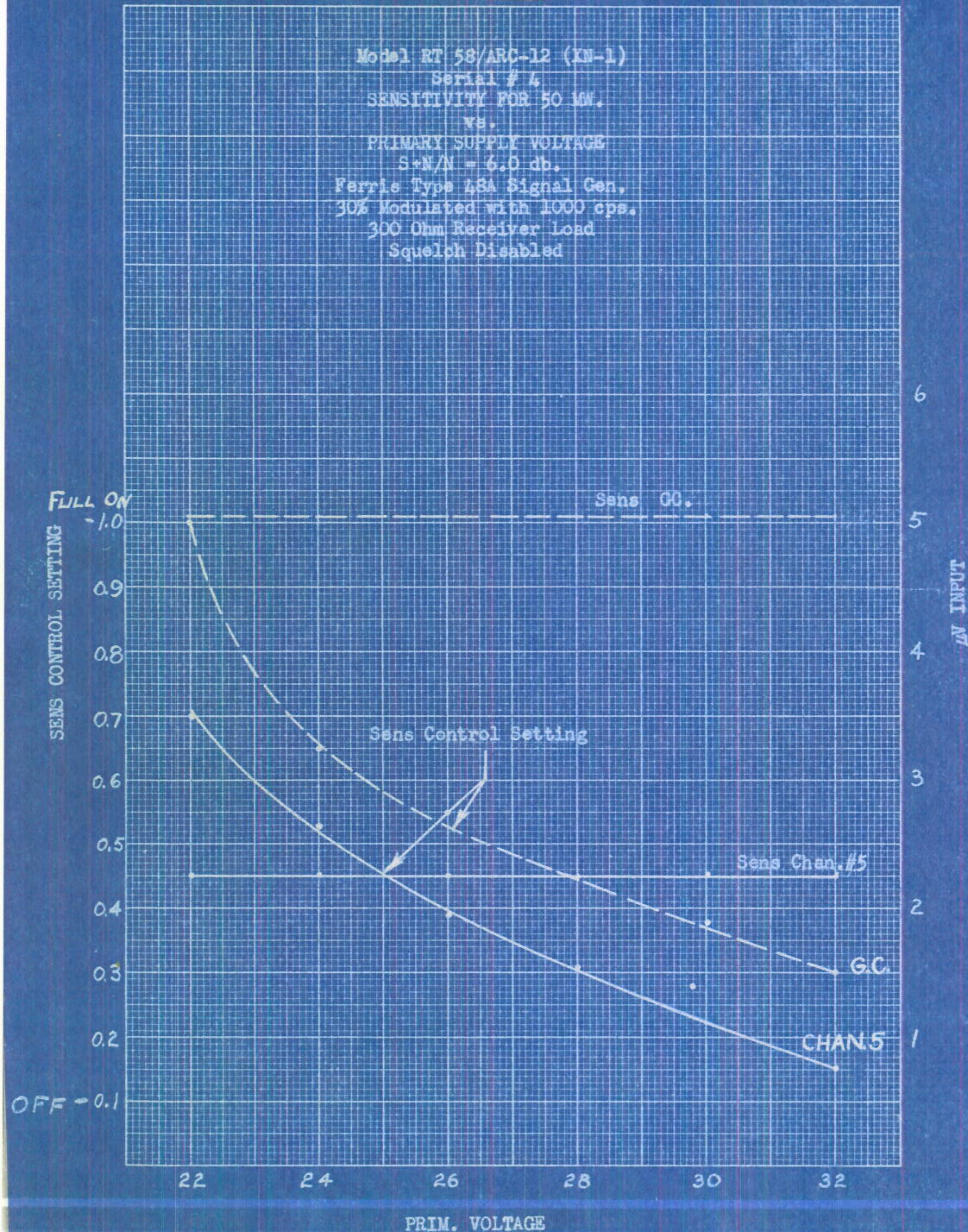


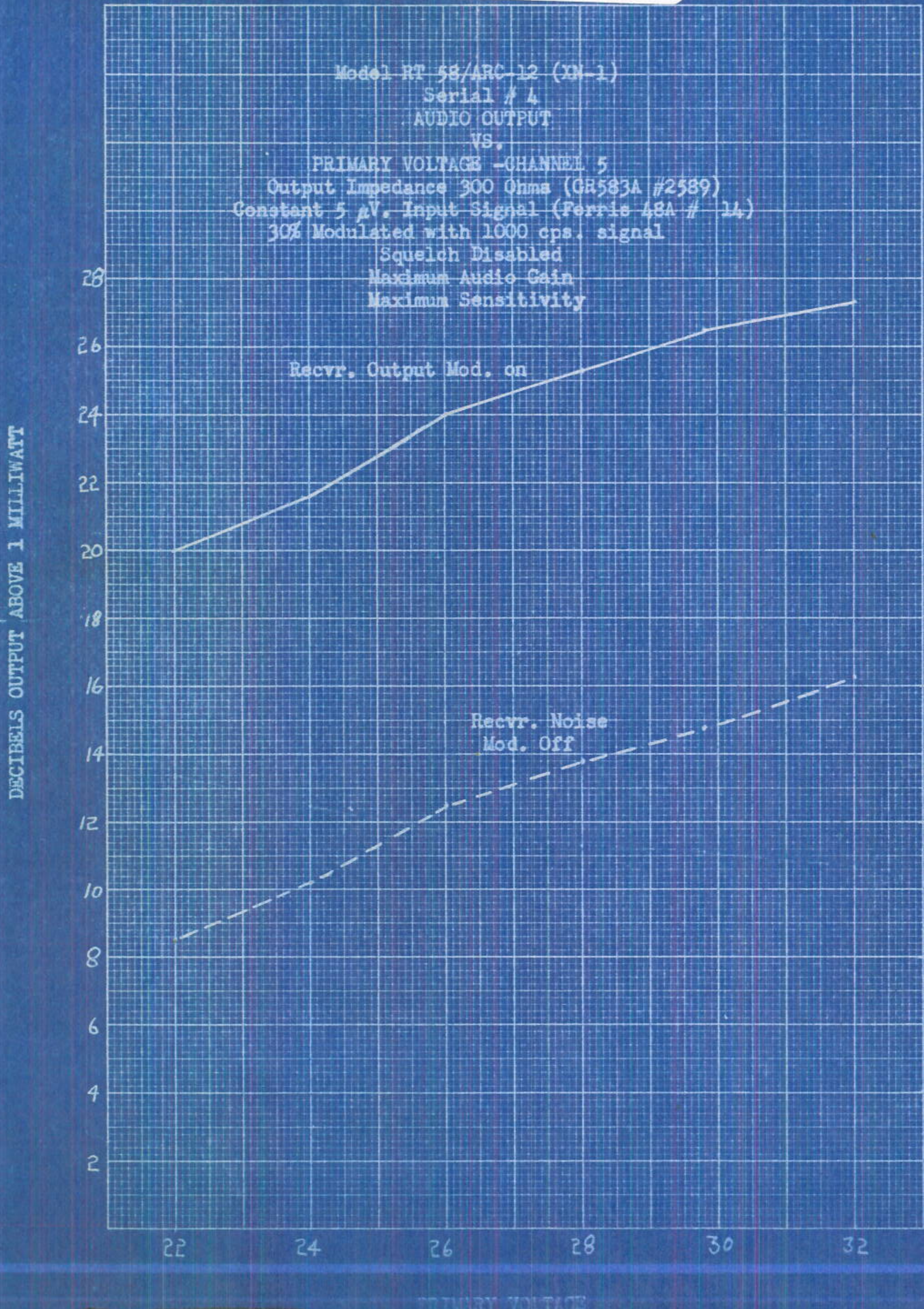
DECLASSIFIED



DECLASSIFIED



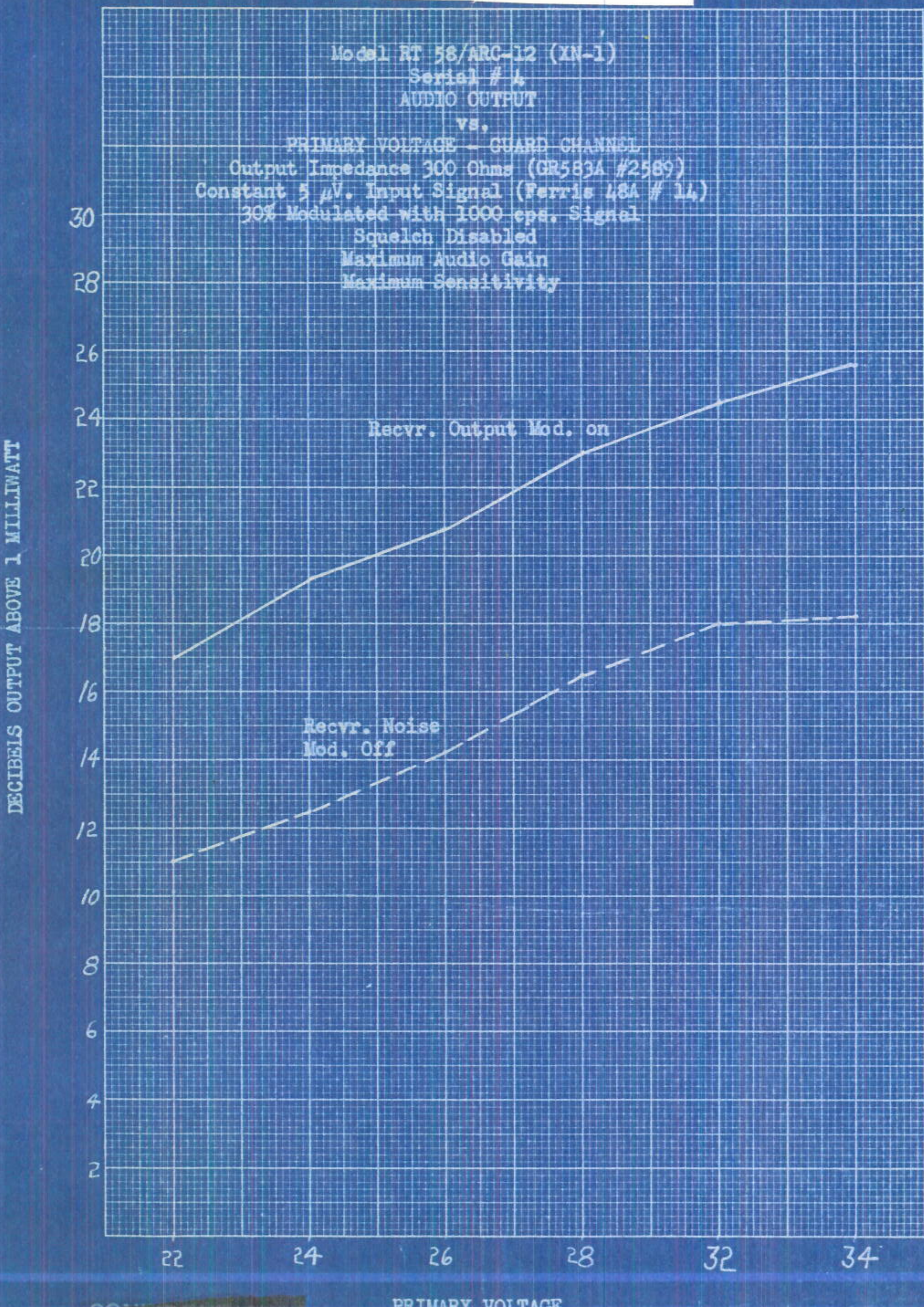

Model RT 58/ARC-12 (XN-1)
Serial # 4
SENSITIVITY FOR 50 MW.
vs.
PRIMARY SUPPLY VOLTAGE
S+N/N = 6.0 db.
Ferris Type 48A Signal Gen.
30% Modulated with 1000 cps.
300 Ohm Receiver Load
Squelch Disabled
FULL ON
OFF
SENS CONTROL SETTING
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
µV INPUT
6
5
4
3
2
1
Sens GC.
Sens Control Setting
Sens Chan. #5
G.C.
CHAN.5
22
24
26
28
30
32
PRIM. VOLTAGE



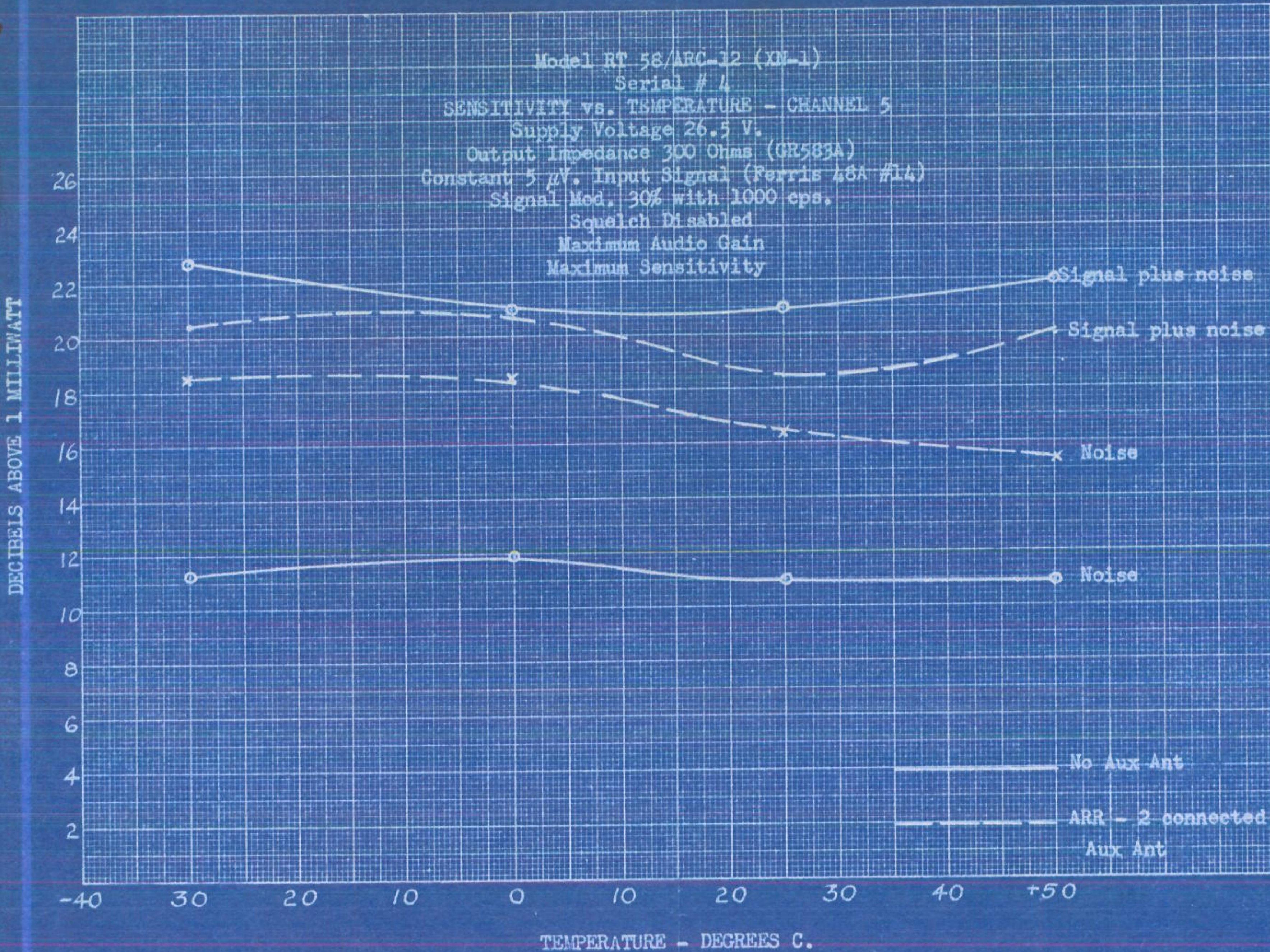
[redacted]

R-2896

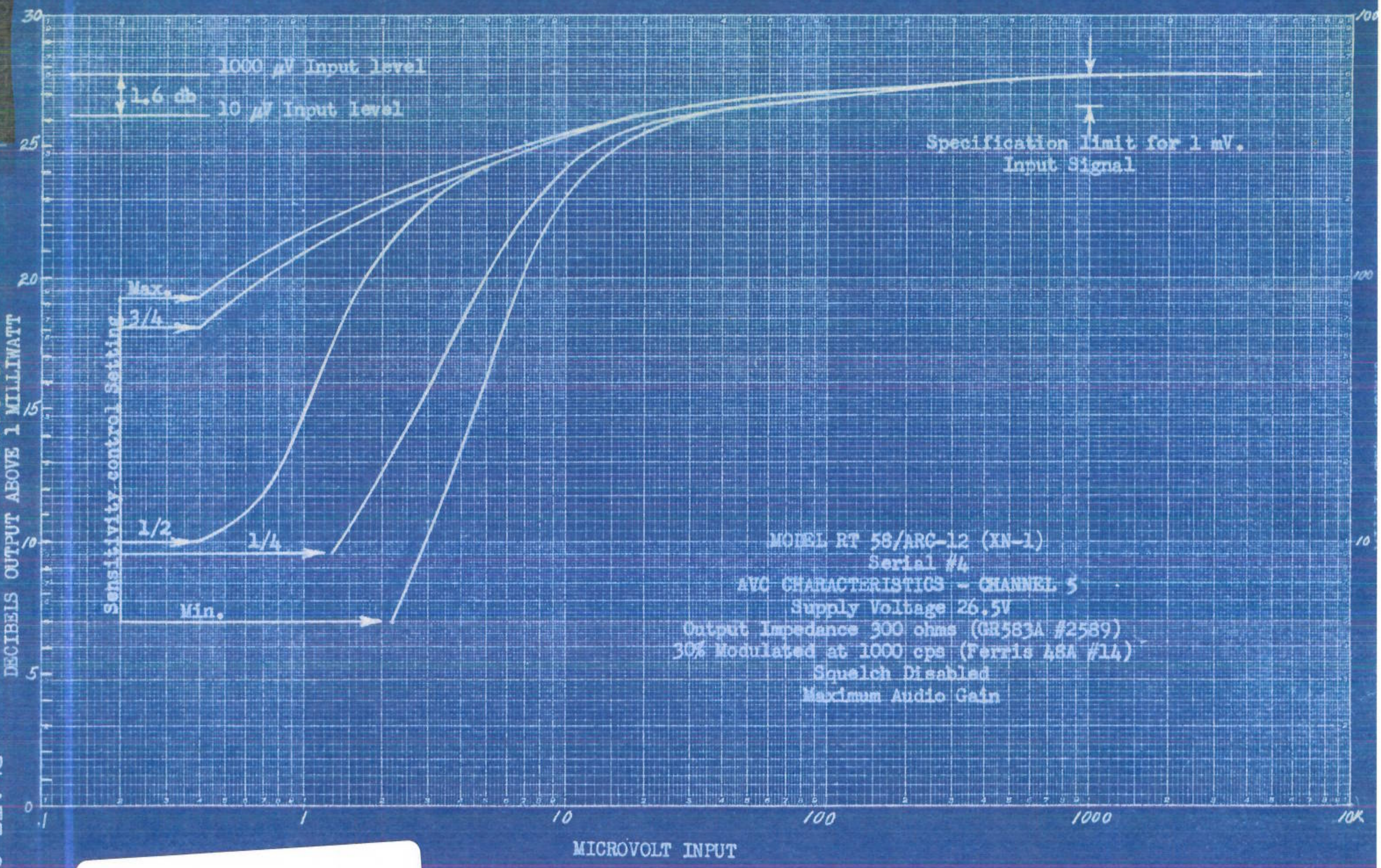
PLATE 20


Model RT 58/ARC-12 (XN-1)
Serial # 4
AUDIO OUTPUT
vs.
PRIMARY VOLTAGE - GUARD CHANNEL
Output Impedance 300 Ohms (GR583A #2589)
Constant 5 μV. Input Signal (Ferris 48A # 14)
30% Modulated with 1000 cps. Signal
Squelch Disabled
Maximum Audio Gain
Maximum Sensitivity
Recvr. Output Mod. on
Recvr. Noise
Mod. Off
DECIBELS OUTPUT ABOVE 1 MILLIWATT
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
22
24
26
28
32
34
PRIMARY VOLTAGE

DECLASSIFIED

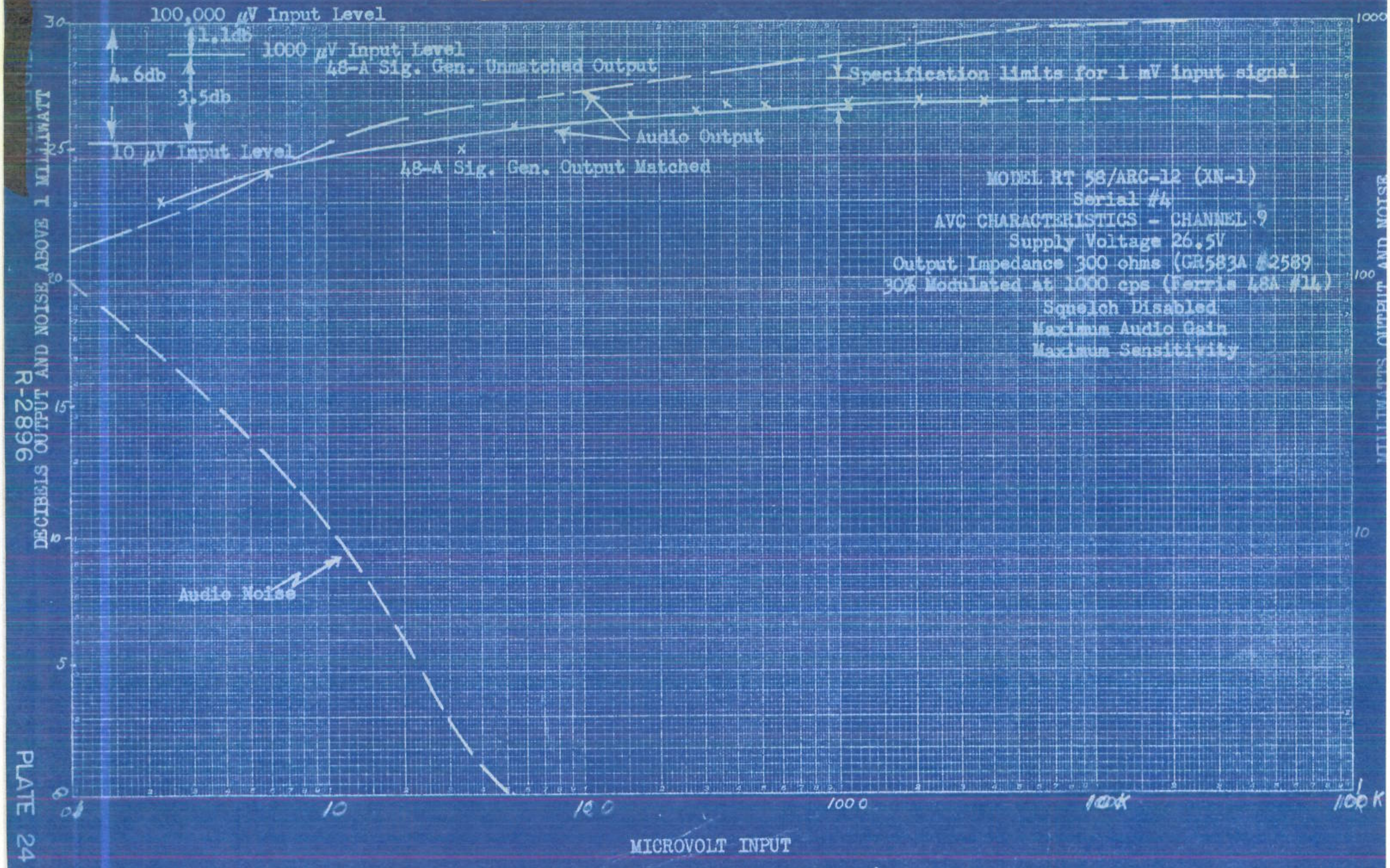


[redacted]



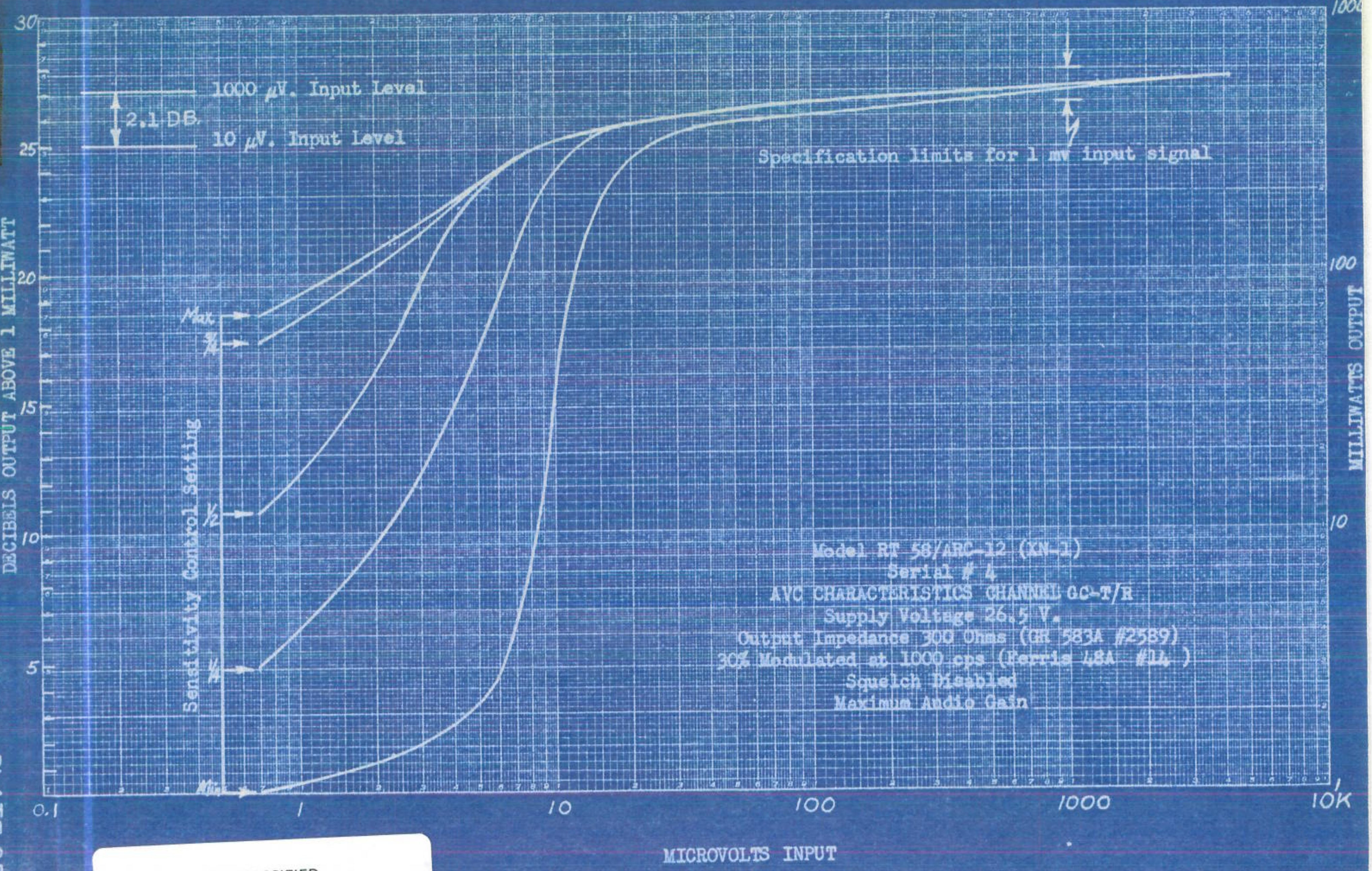
DECLASSIFIED

DECLASSIFIED



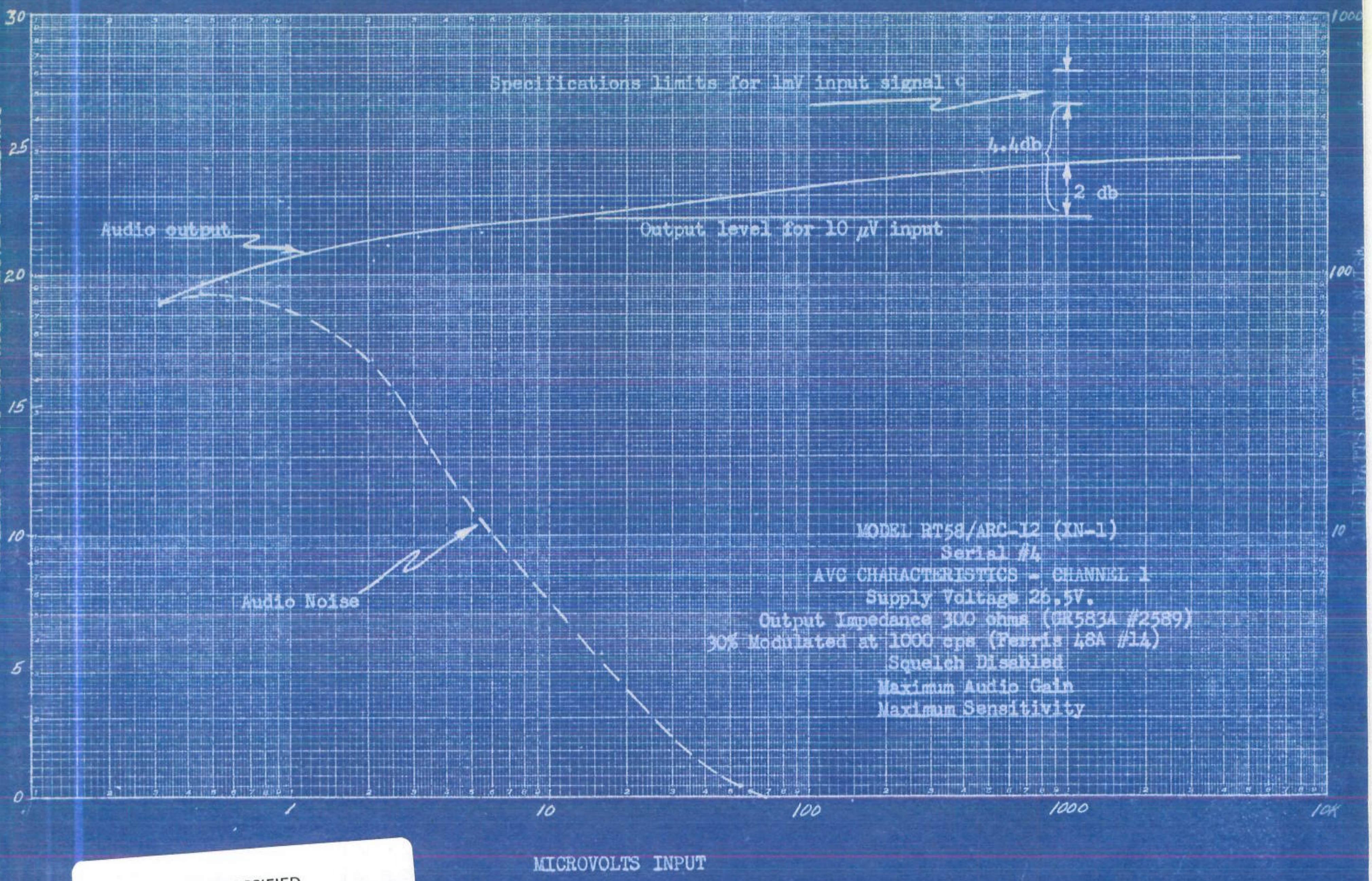
R-2896

PLATE 24



R-2896

PLATE 25

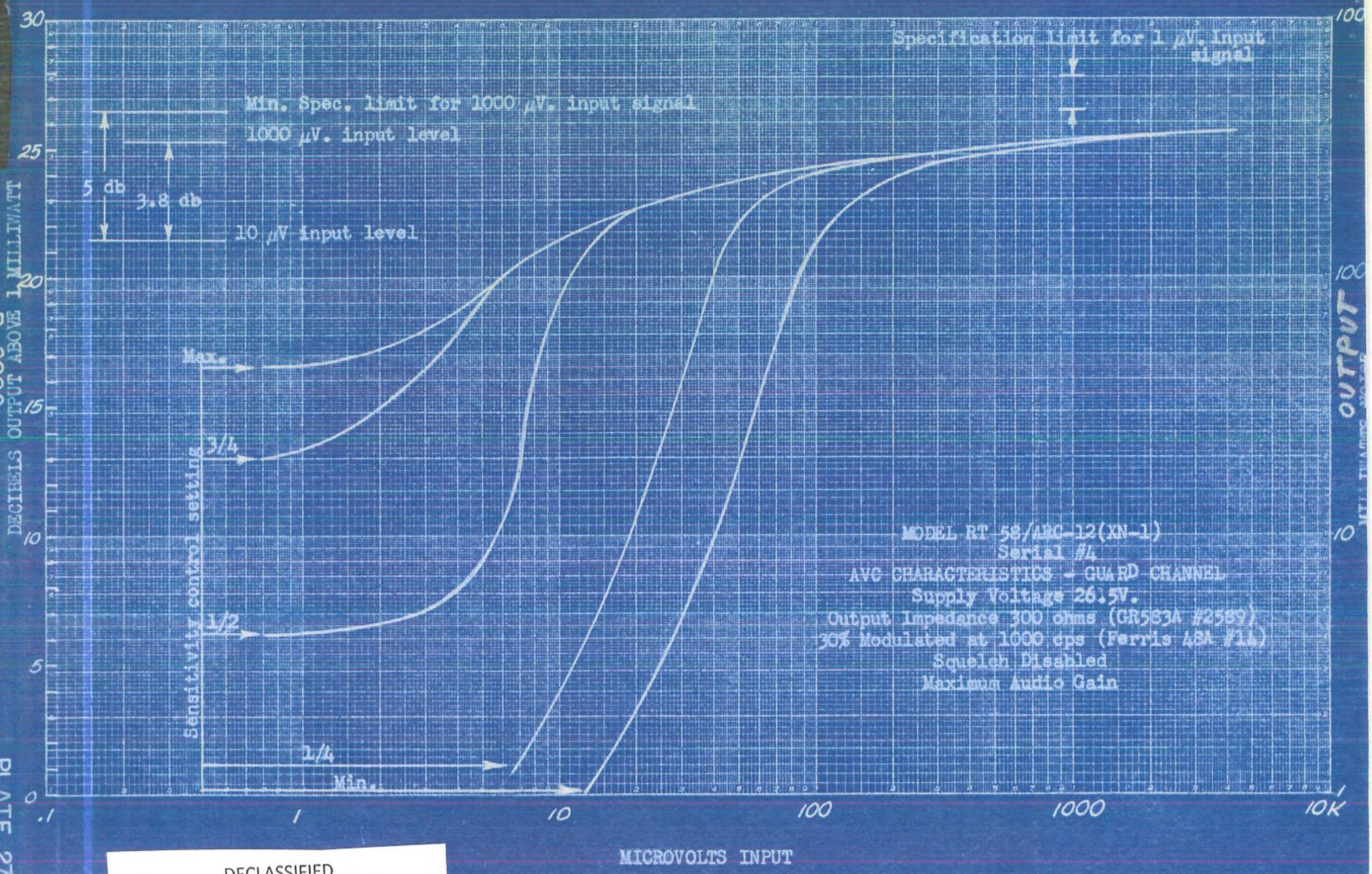


[redacted]

R-2896

PLATE 26

DECLASSIFIED

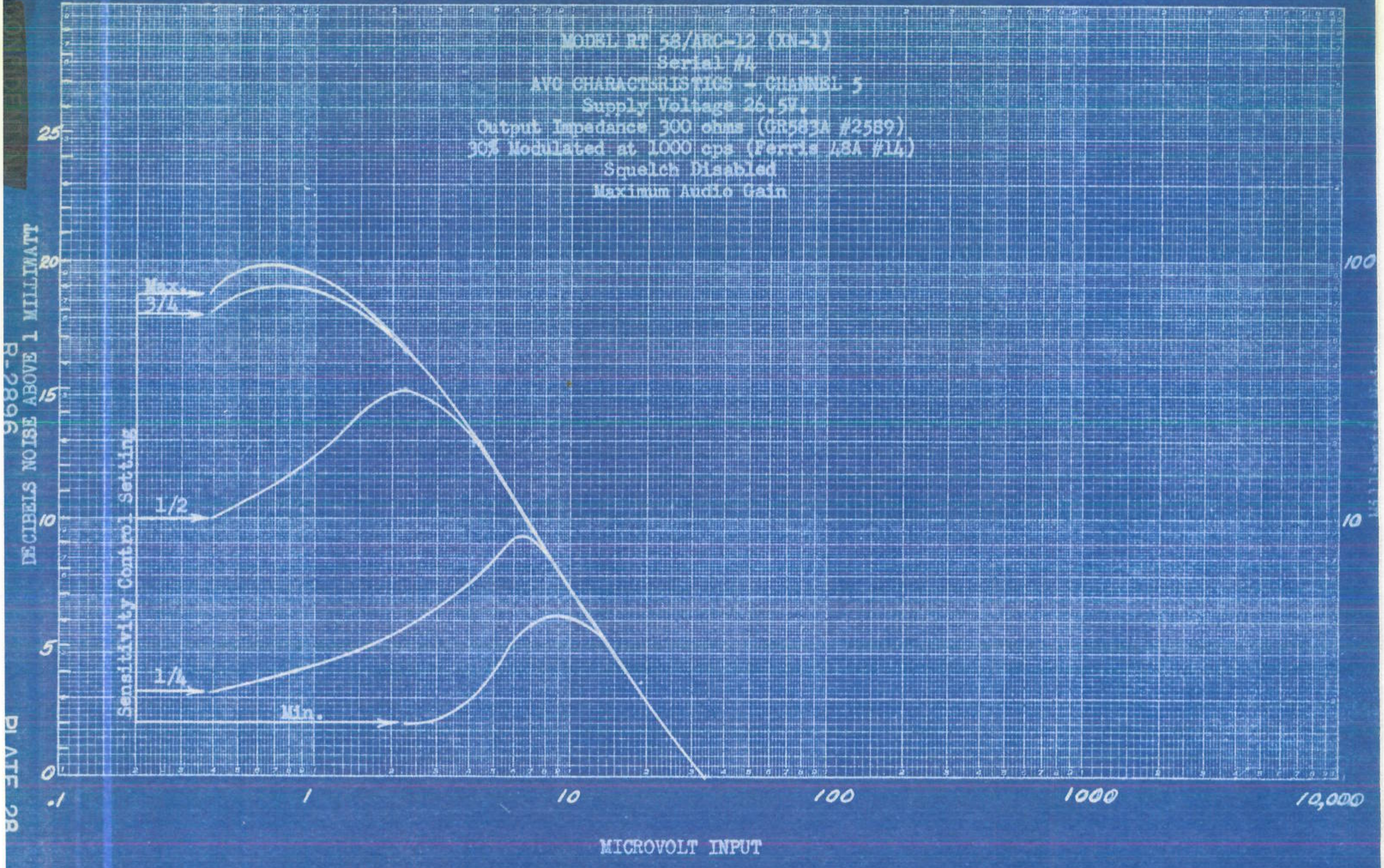


R-2896

PLATE 27

DECLASSIFIED

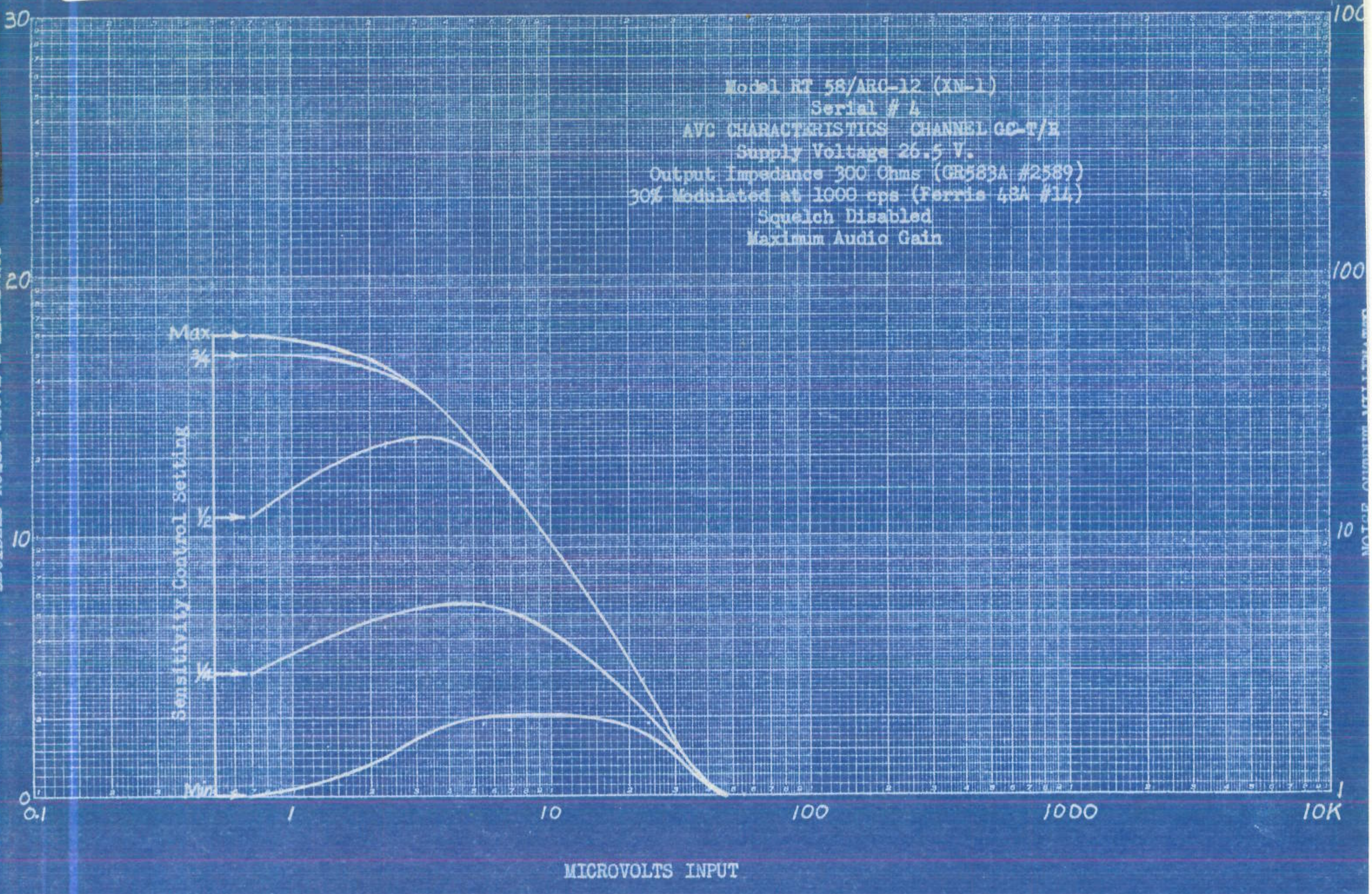
DECLASSIFIED

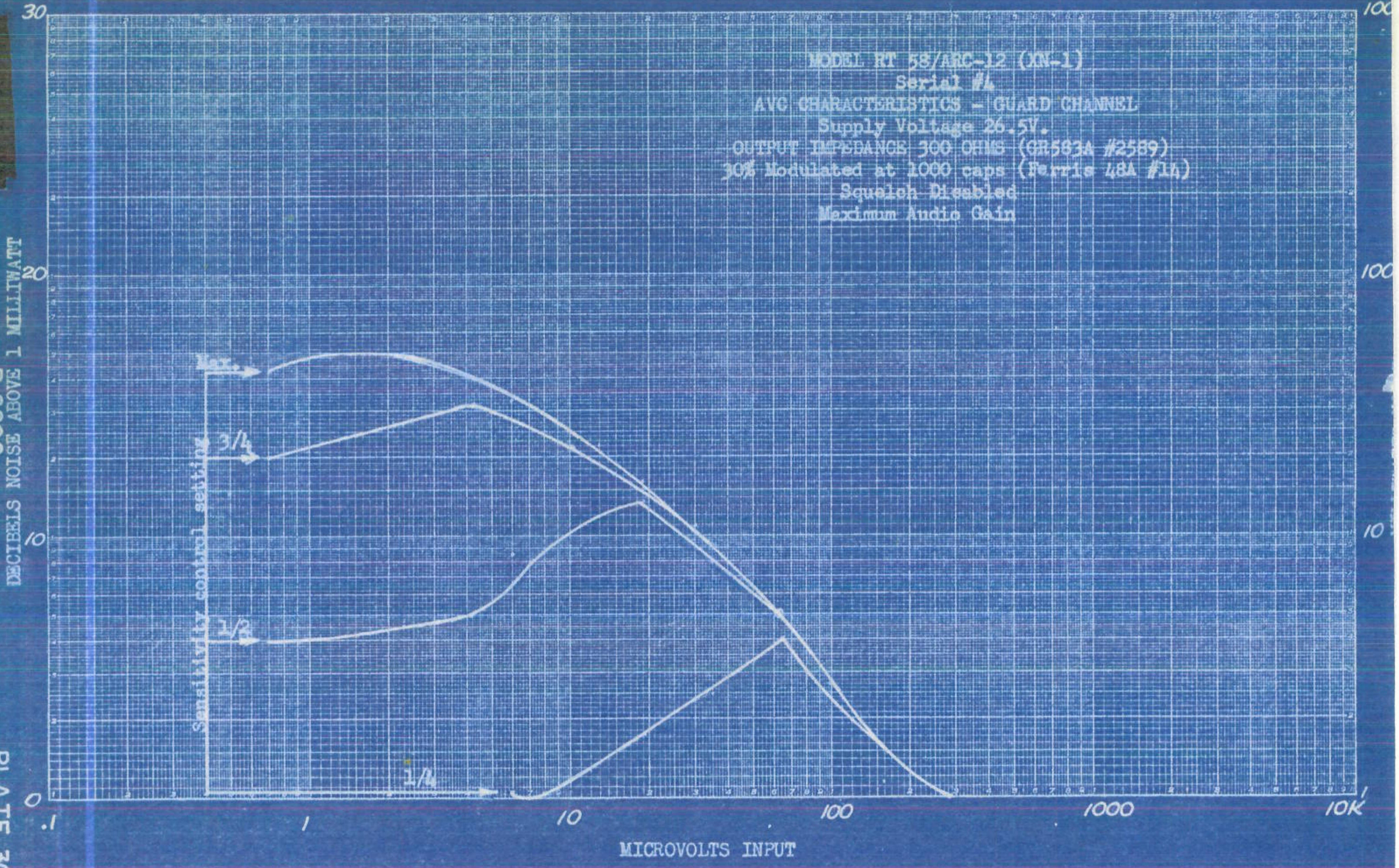


R-2896

PLATE 28

[redacted]


Model RT 58/ARC-12 (XN-1)
Serial # 4
AVC CHARACTERISTICS CHANNEL GC-T/R
Supply Voltage 26.5 V.
Output Impedance 300 Ohms (GR583A #2589)
30% Modulated at 1000 cps (Ferris 48A #14)
Squelch Disabled
Maximum Audio Gain
Max
3/4
1/2
1/4
Min
Sensitivity Control Setting
DECIBELS NOISE ABOVE 1 MILLIWATT
30
20
10
0
0.1
1
10
100
1000
10K
MICROVOLTS INPUT

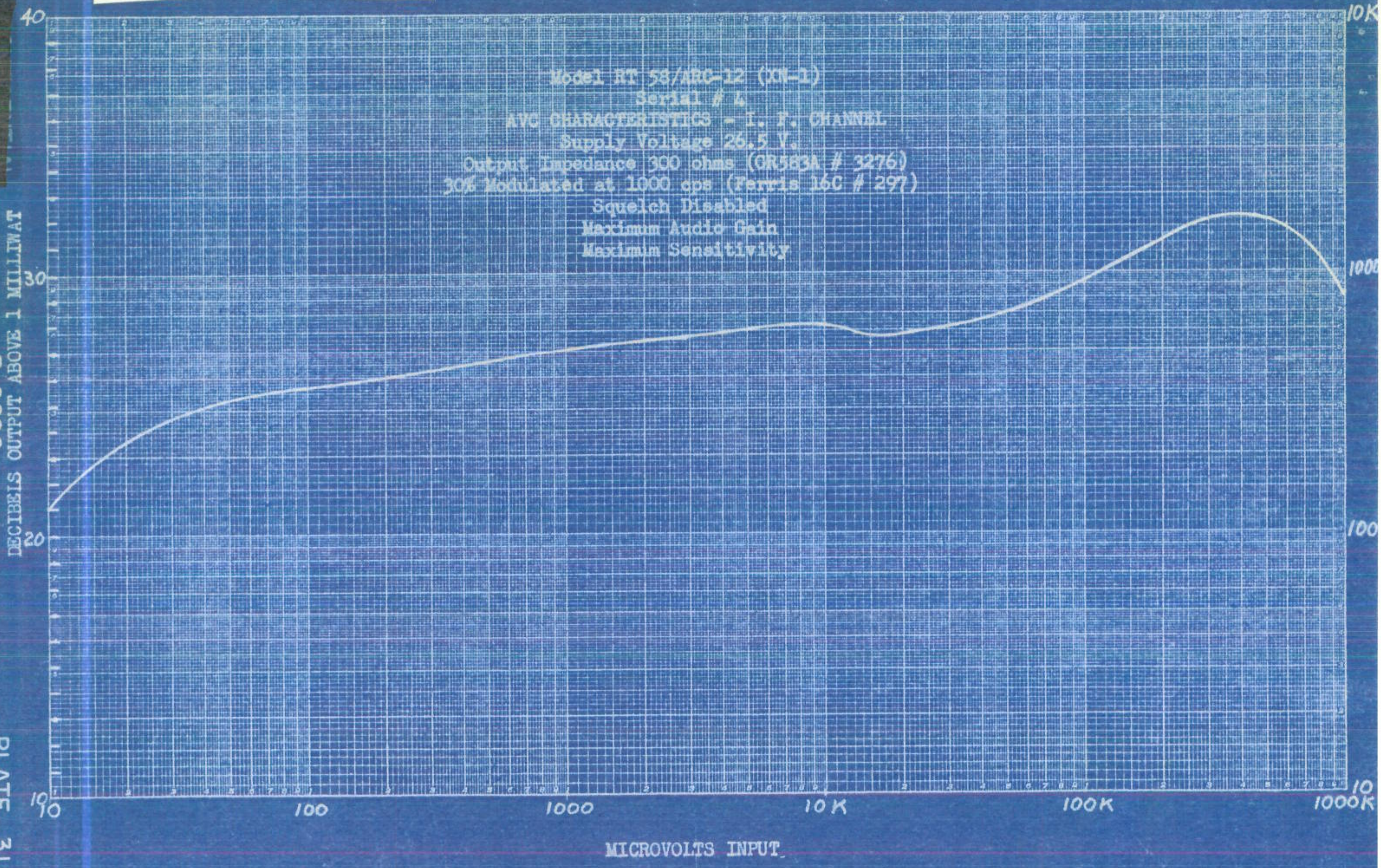


R-2896

PLATE 30

DECLASSIFIED

[redacted]



R-2896

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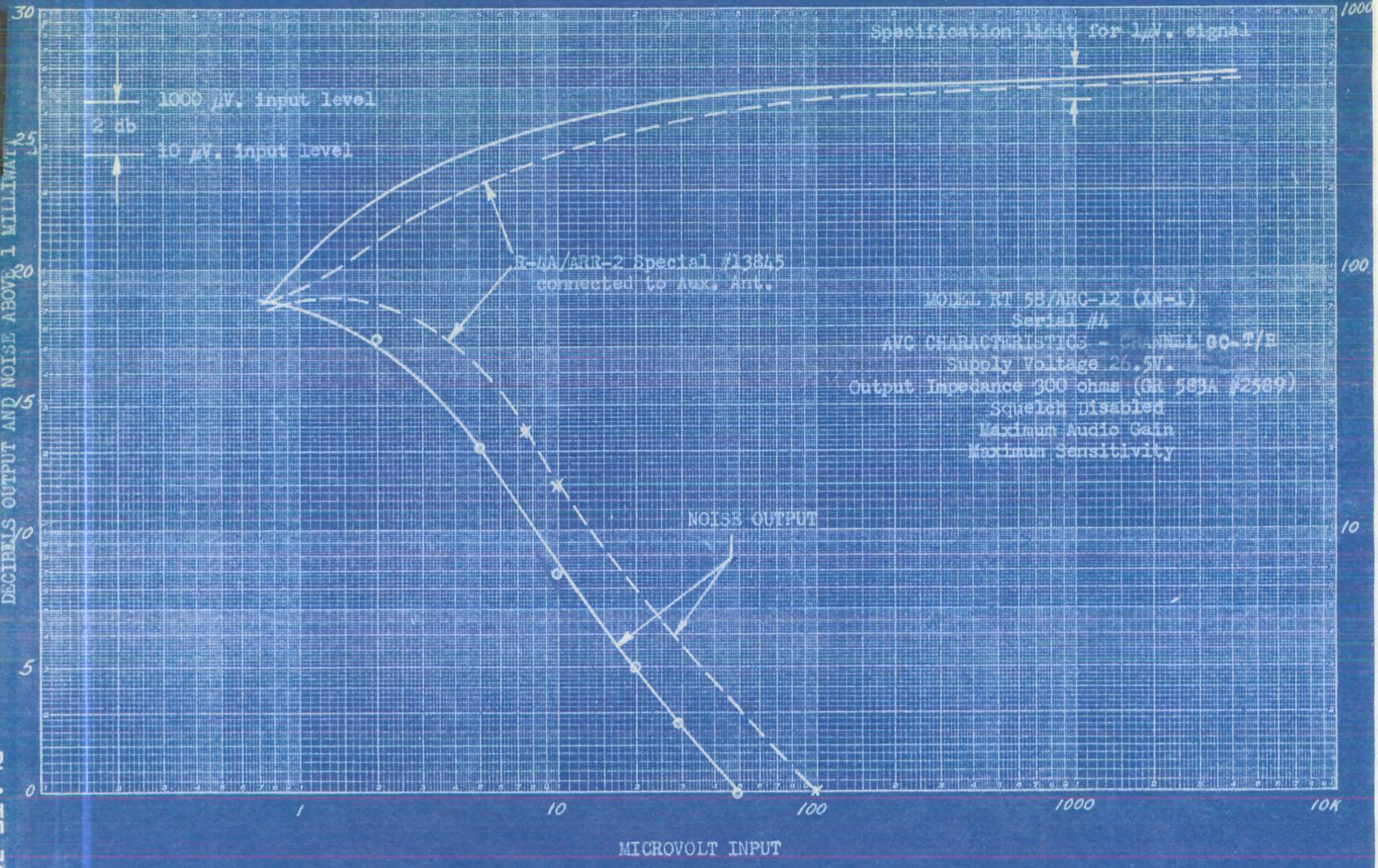
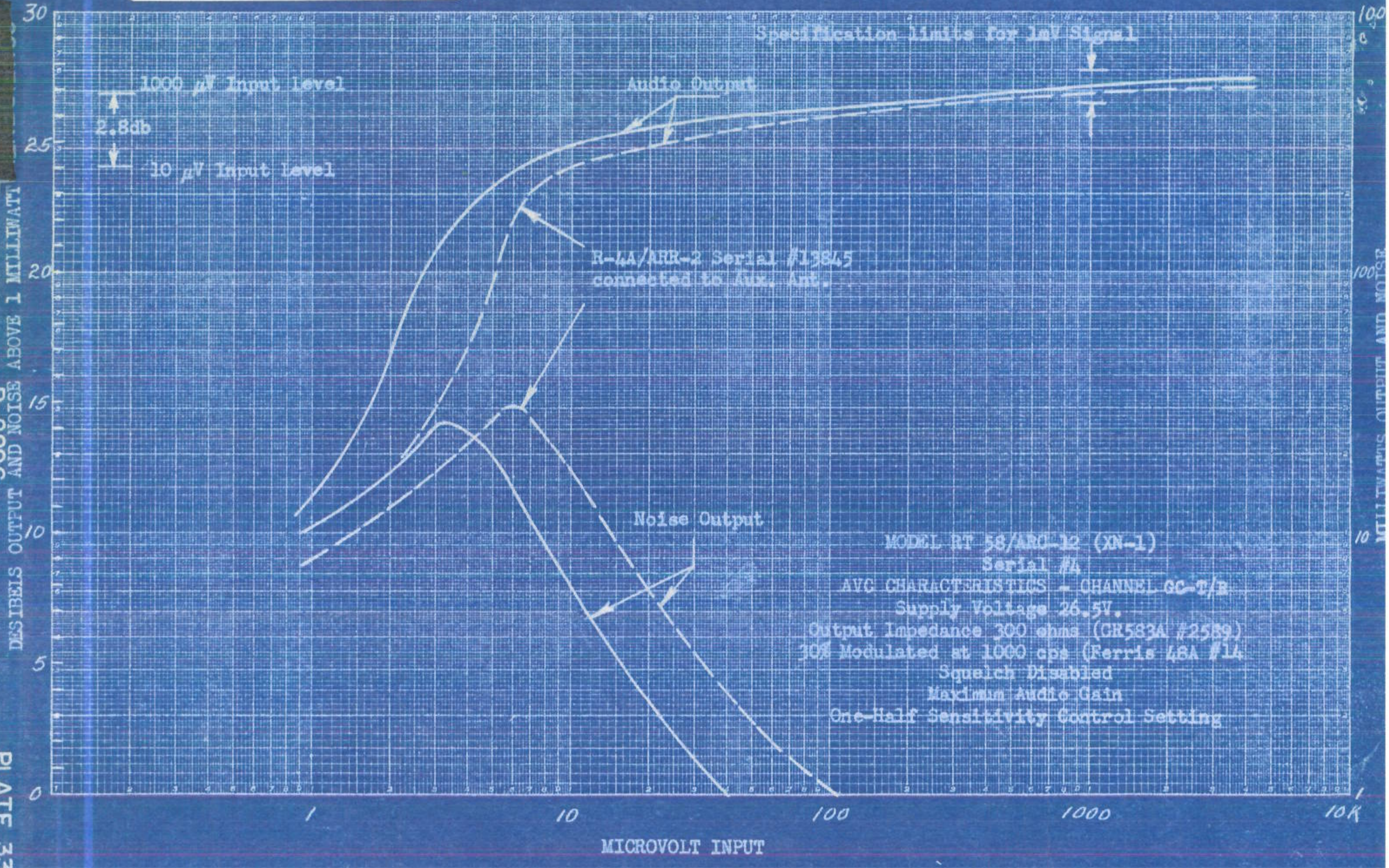


R-2896

PLATE 32

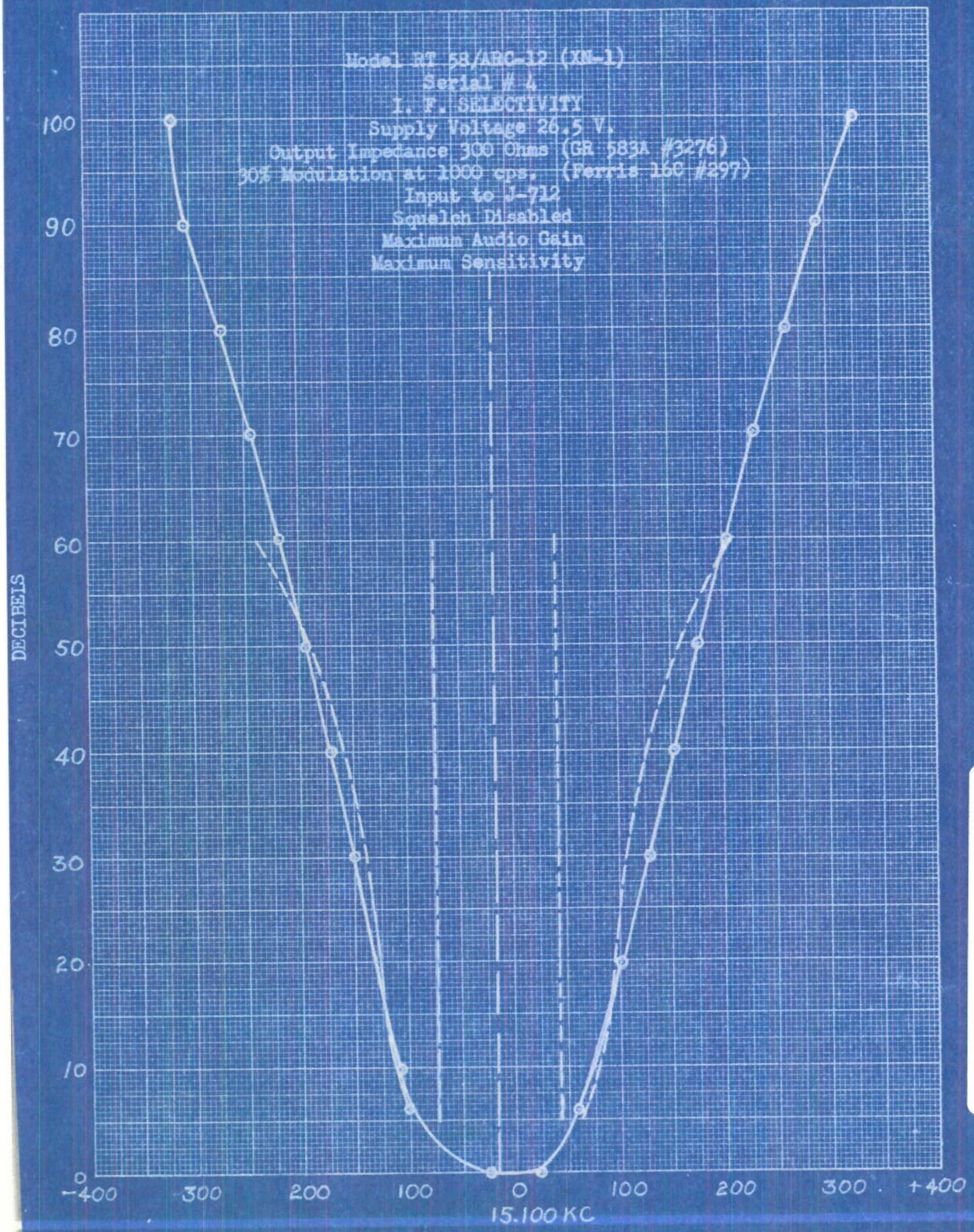
DECLASSIFIED

[redacted]



R-2896

PLATE 33



FREQUENCY DEVIATION - KILOCYCLES OFF RESONANCE

[redacted]

R-2896

PLATE 34

DECLASSIFIED

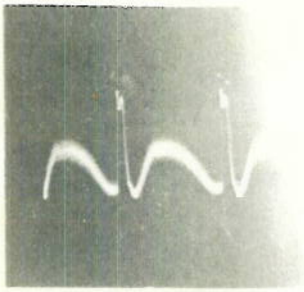


FIG. 1
LIMITER INOPERATIVE

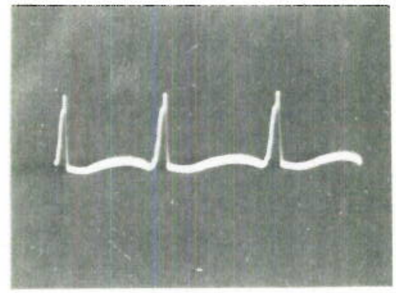


FIG. 2
LIMITER OPERATIVE

5 uV. 80% SINE WAVE MODULATED WITH 1000 c.p.s. TO "ANT".
0.1 VOLT PULSE INPUT TO "AUX" - P.R.R. 1000 c.p.s. - 10 uSEC. PULSE WIDTH

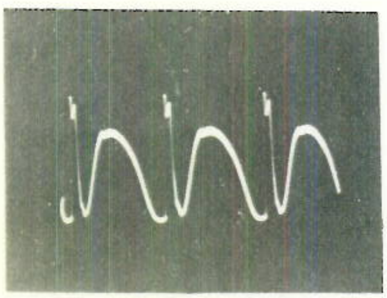


FIG. 3
LIMITER INOPERATIVE

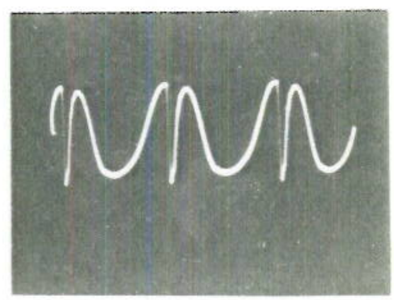


FIG. 4
LIMITER OPERATIVE

50 uV. 80% SINE WAVE MODULATED WITH 1000 c.p.s. TO "ANT".
0.1 VOLT PULSE INPUT TO "AUX" - P.R.R. 1000 c.p.s. - 10 uSEC. PULSE WIDTH

[redacted]

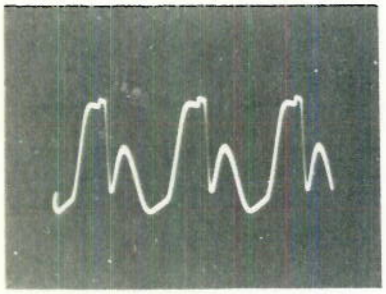


FIG. 5
LIMITER INOPERATIVE

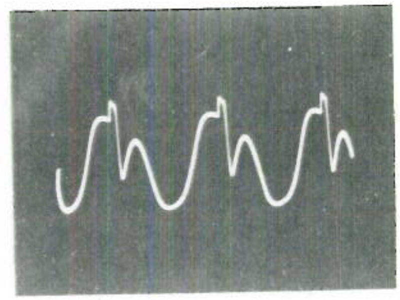


FIG. 6
LIMITER OPERATIVE

50uV. 80% SINE WAVE MODULATED WITH 1000 c.p.s. TO "ANT".
0.1 VOLT PULSE INPUT TO "AUX" - P.R.R. 1000 c.p.s. - 10 uSEC. PULSE WIDTH

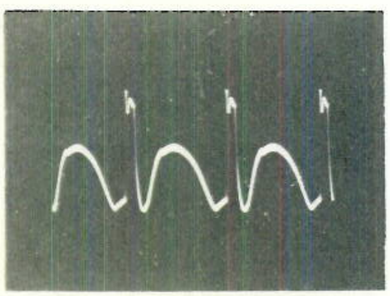


FIG. 7
LIMITER INOPERATIVE

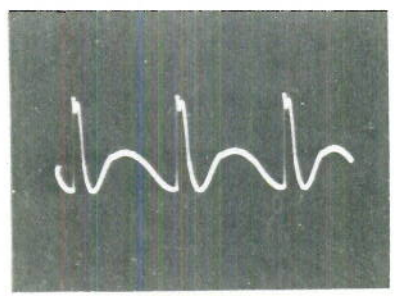


FIG. 8
LIMITER OPERATIVE

50 uV. 80% SINE WAVE MODULATED WITH 1000 c.p.s. TO "ANT".
0.1 VOLT PULSE INPUT TO "AUX" - P.R.R. 1000 c.p.s. - 30 uSEC. PULSE WIDTH

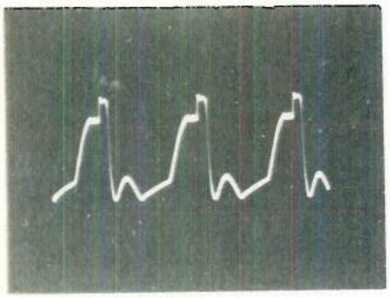


FIG. 9
LIMITER INOPERATIVE

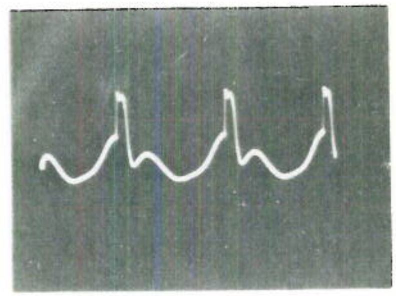


FIG. 10
LIMITER OPERATIVE

50 uV. 80% SINE WAVE MODULATED WITH 1000 c.p.s. TO "ANT".
0.1 VOLT PULSE INPUT TO "AUX" - P.R.R. 1000 c.p.s. - 30 uSEC. PULSE WIDTH

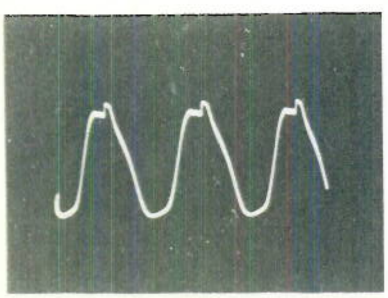


FIG. 11
LIMITER INOPERATIVE

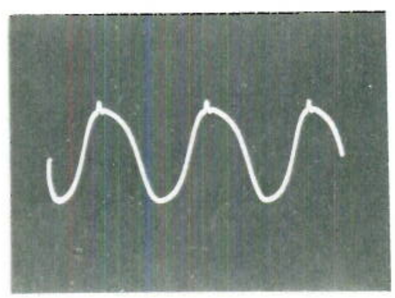


FIG. 12
LIMITER OPERATIVE

50 uV. 80% SINE WAVE MODULATED WITH 1000 c.p.s. TO "ANT".
100 uV. PULSE INPUT TO "AUX" - P.R.R. 1000 c.p.s. - 30 uSEC. PULSE WIDTH

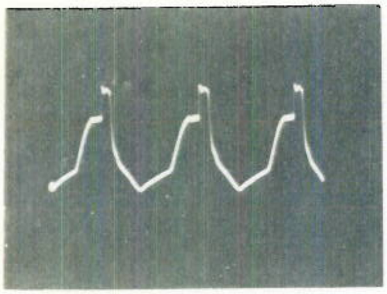


FIG. 13
LIMITER INOPERATIVE

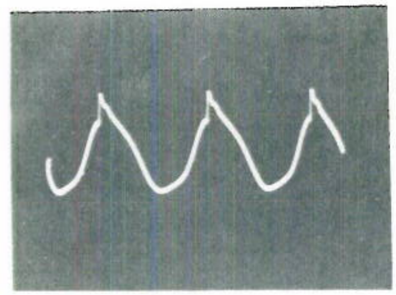


FIG. 14
LIMITER OPERATIVE

50 uV. 80% SINE WAVE MODULATED WITH 1000 c.p.s. TO "ANT".
1000 uV. PULSE INPUT TO "AUX" - P.R.R. 1000 c.p.s. - 30 uSEC. PULSE WIDTH

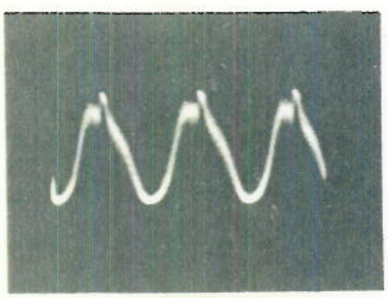


FIG. 15
LIMITER INOPERATIVE

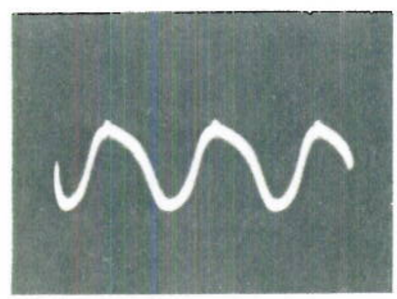


FIG. 16
LIMITER OPERATIVE

5 uV. 80% SINE WAVE MODULATED WITH 1000 c.p.s. TO "ANT".
10 uV. PULSE INPUT TO "AUX" - P.R.R. 1000 c.p.s. - 30 uSEC. PULSE WIDTH

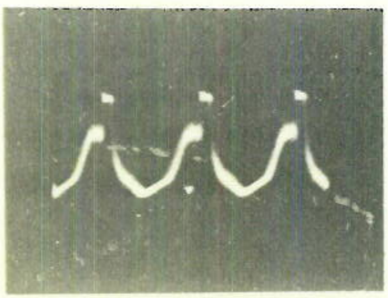


FIG. 17
LIMITER INOPERATIVE

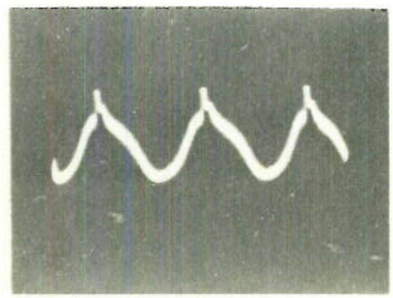
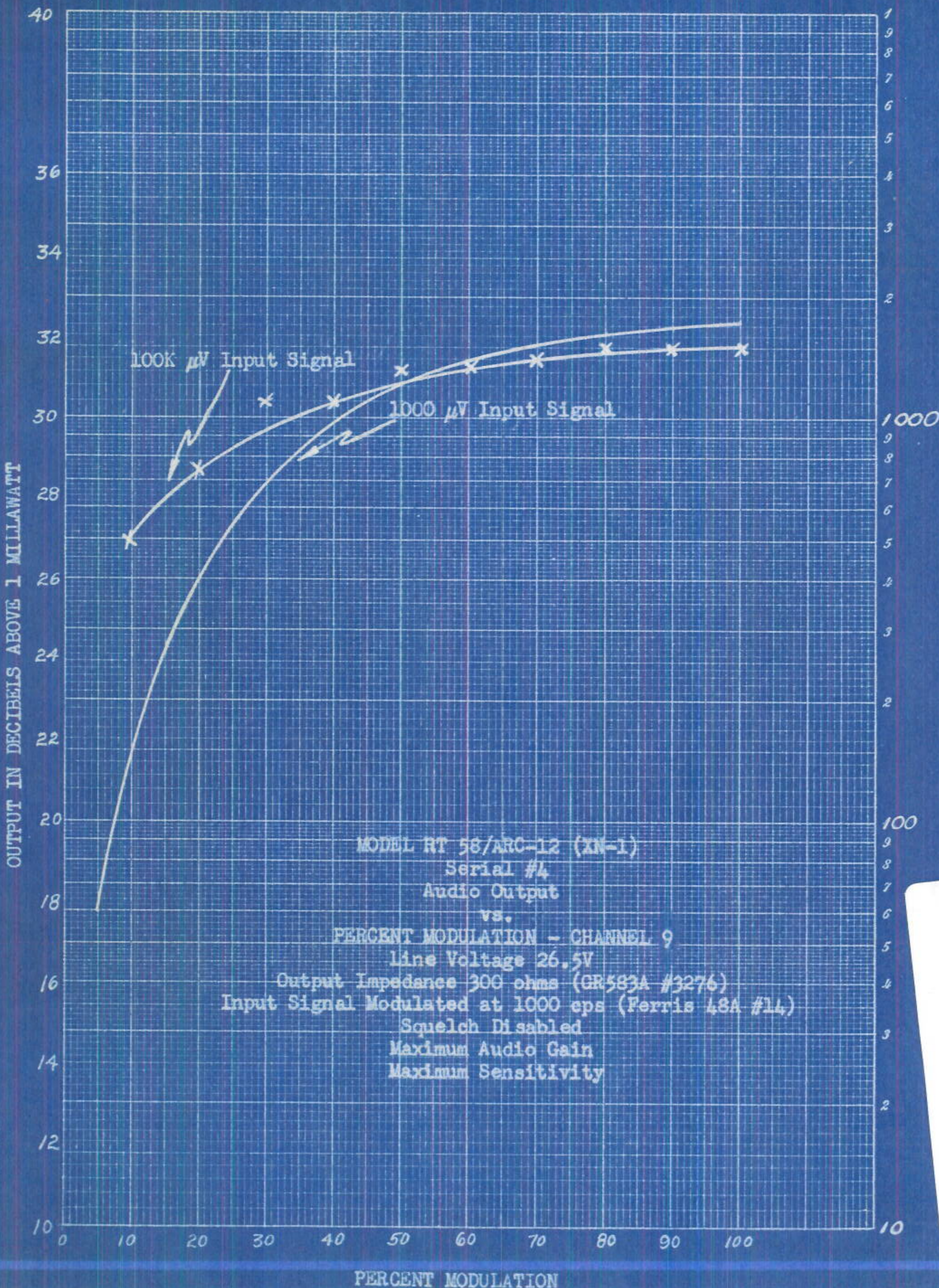
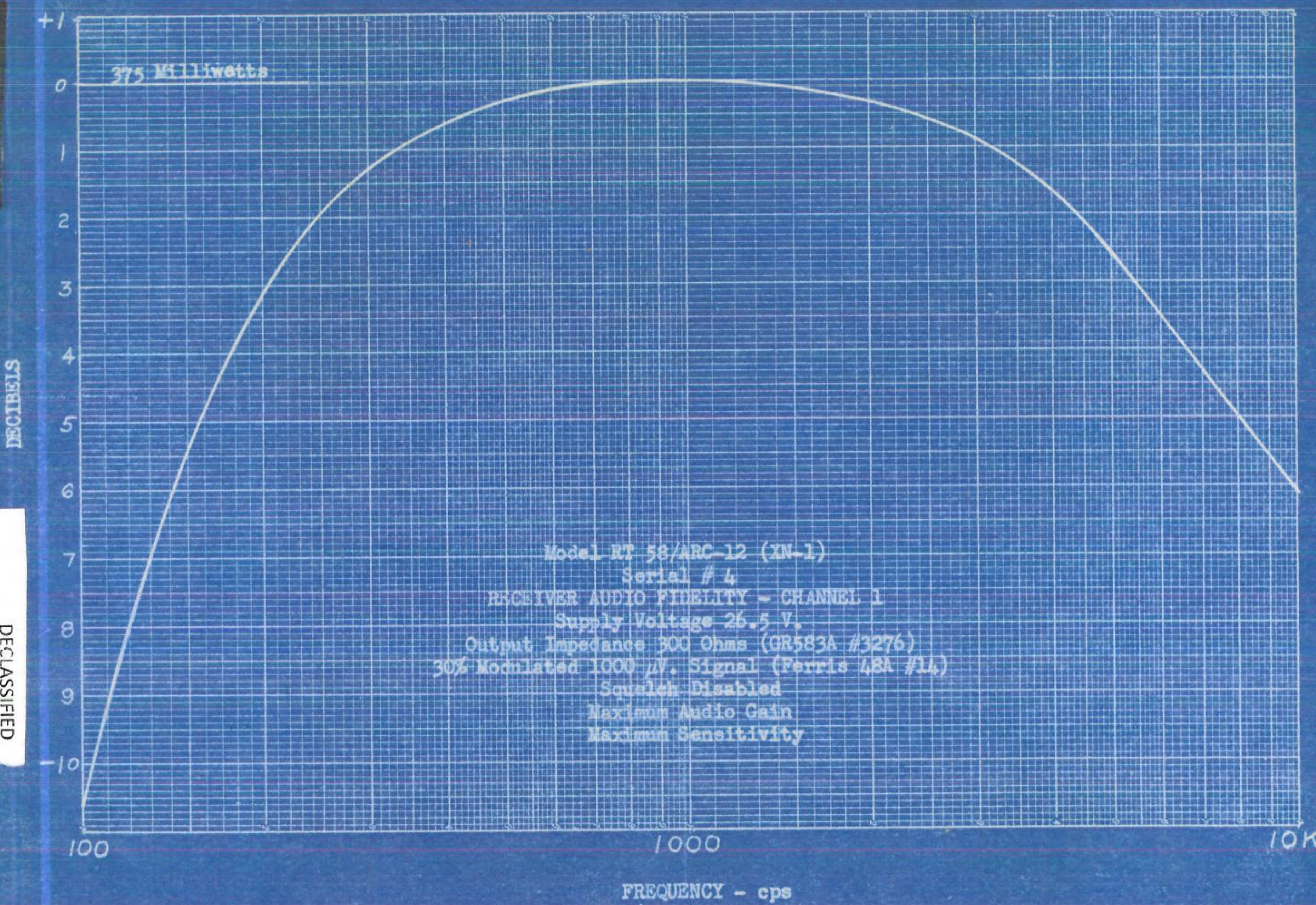


FIG. 18
LIMITER OPERATIVE

5 uV. 80% SINE WAVE MODULATED WITH 1000 c.p.s. TO "ANT".
100 uV. PULSE INPUT TO "AUX" - P.R.R. 1000 c.p.s. - 30 uSEC. PULSE WIDTH

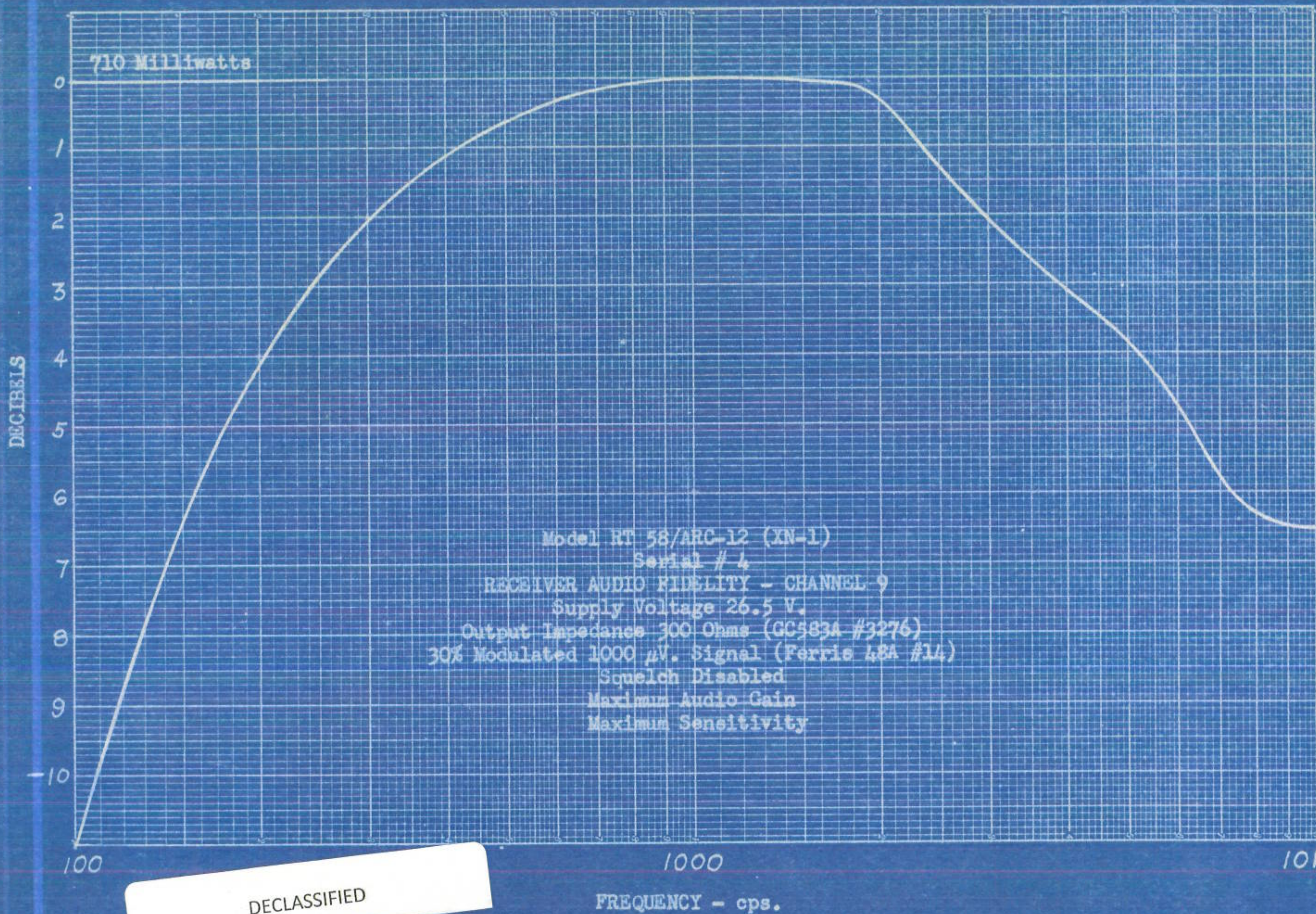


OUTPUT IN DECIBELS ABOVE 1 MILLAWATT
100K µV Input Signal
1000 µV Input Signal
MODEL RT 58/ARC-12 (XN-1)
Serial #4
Audio Output
vs.
PERCENT MODULATION - CHANNEL 9
Line Voltage 26.5V
Output Impedance 300 ohms (GR583A #3276)
Input Signal Modulated at 1000 cps (Ferris 48A #14)
Squelch Disabled
Maximum Audio Gain
Maximum Sensitivity
PERCENT MODULATION


375 Milliwatts
+1
0
1
2
3
4
5
6
7
8
9
-10
DECIBELS
100
1000
10K
FREQUENCY - cps
Model RT 58/ARC-12 (XN-1)
Serial # 4
RECEIVER AUDIO FIDELITY - CHANNEL 1
Supply Voltage 26.5 V.
Output Impedance 300 Ohms (GR583A #3276)
30% Modulated 1000 µV. Signal (Ferris 48A #14)
Squelch Disabled
Maximum Audio Gain
Maximum Sensitivity

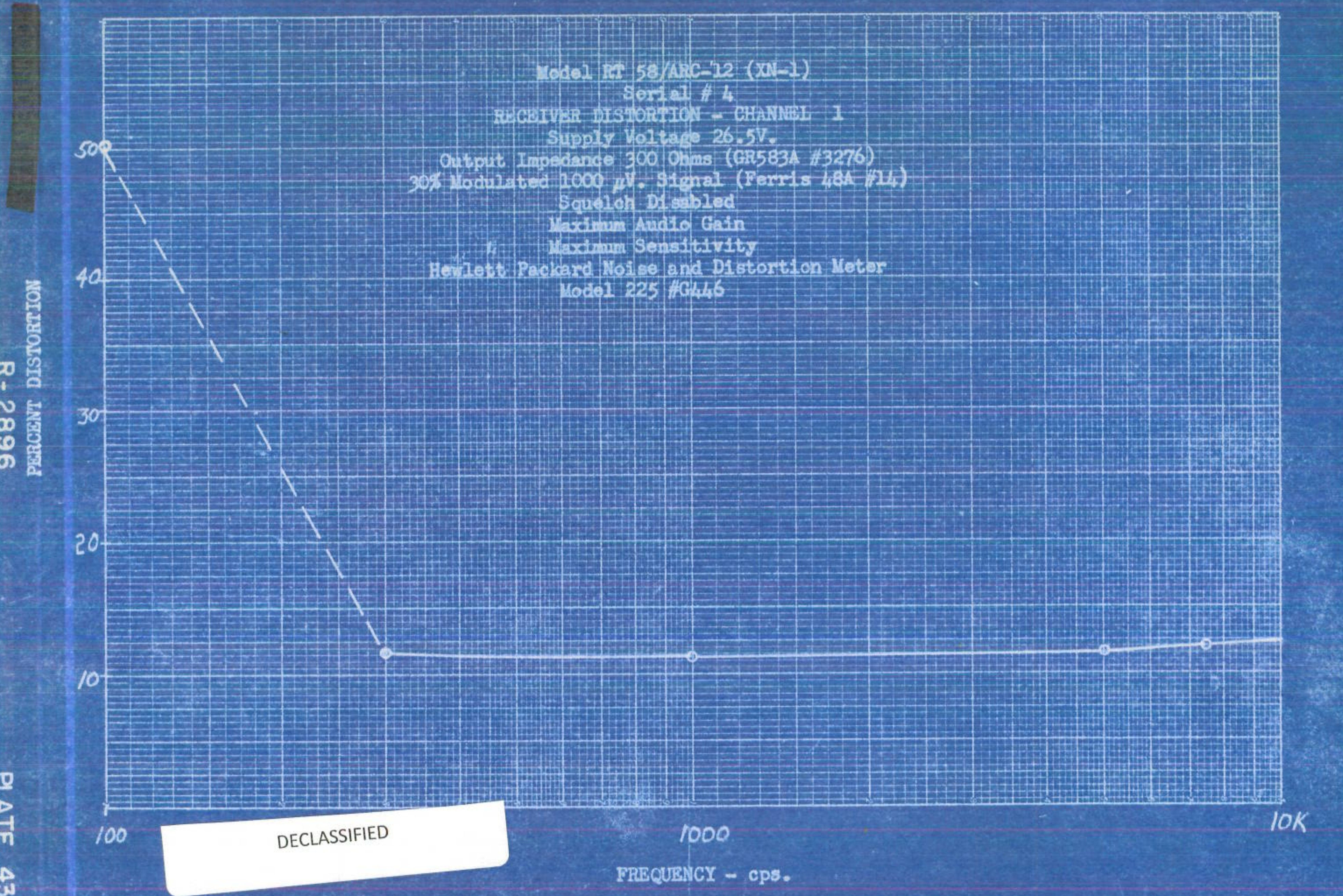
[redacted]

[redacted]



710 Milliwatts
0
1
2
3
4
5
6
7
8
9
-10
DECIBELS
100
1000
10K
FREQUENCY - cps.
Model RT 58/ARC-12 (XN-1)
Serial # 4
RECEIVER AUDIO FIDELITY - CHANNEL 9
Supply Voltage 26.5 V.
Output Impedance 300 Ohms (GC583A #3276)
30% Modulated 1000 μV. Signal (Ferris 48A #14)
Squelch Disabled
Maximum Audio Gain
Maximum Sensitivity

[redacted]



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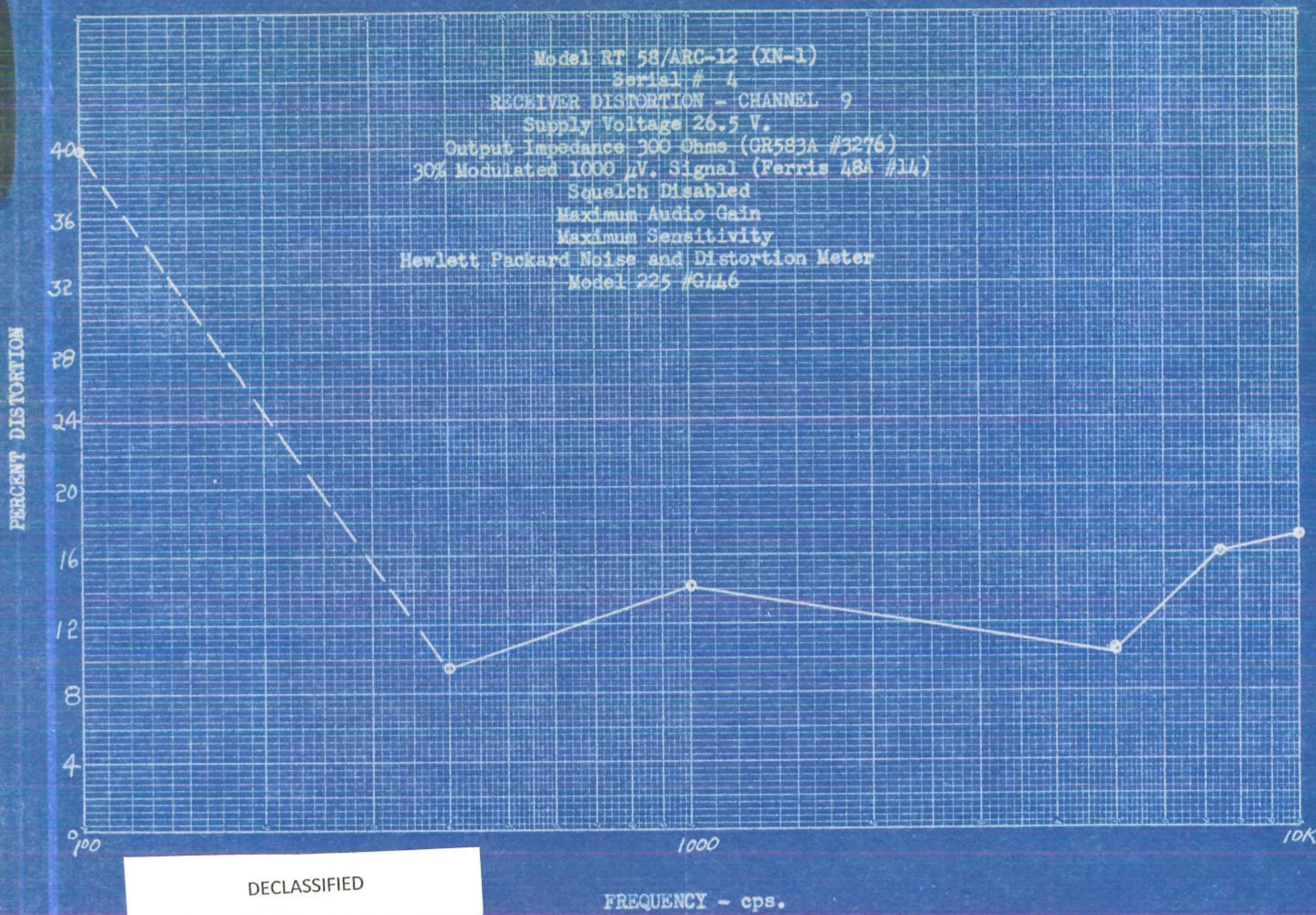
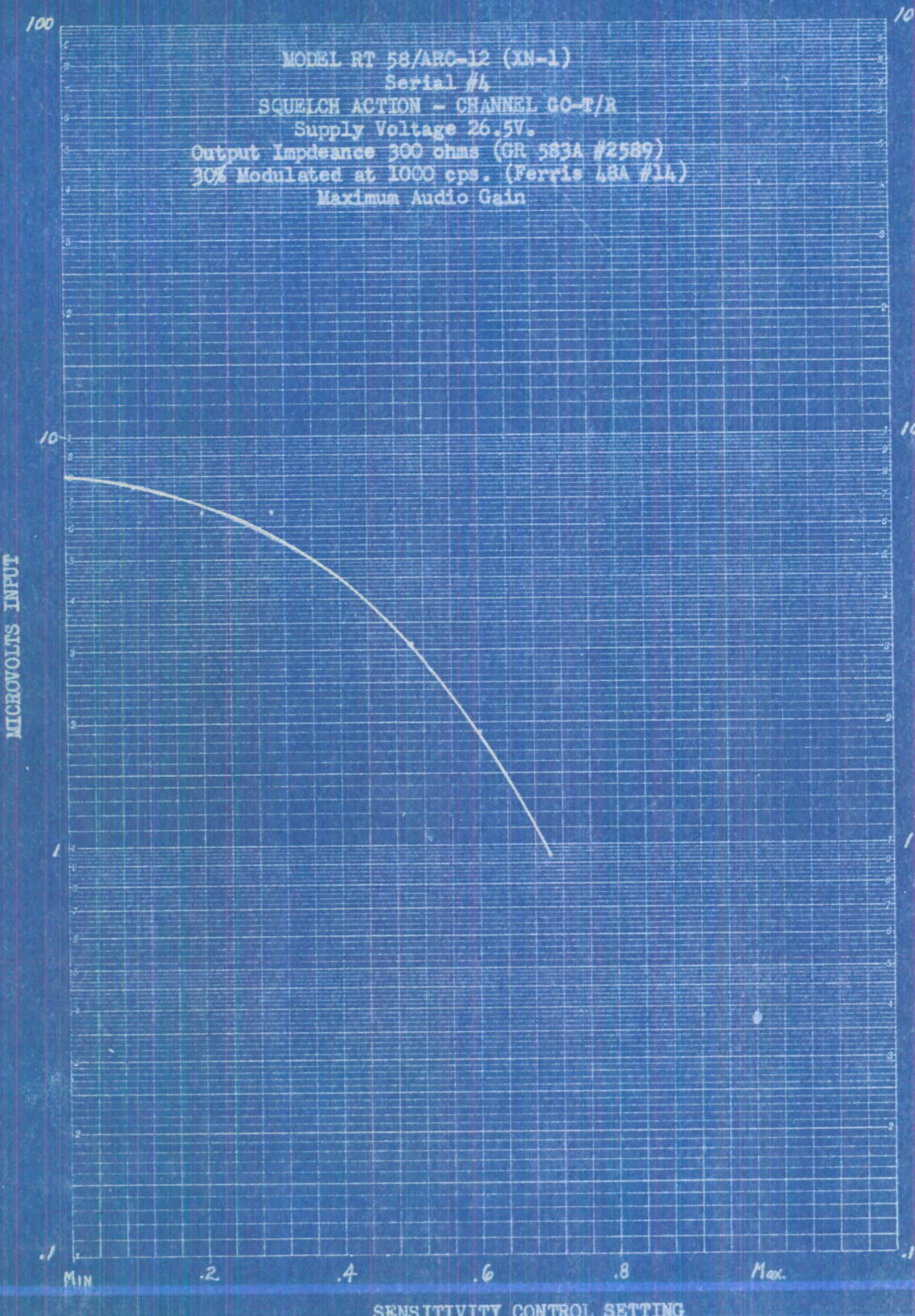
R-2896

PLATE 43

[redacted]



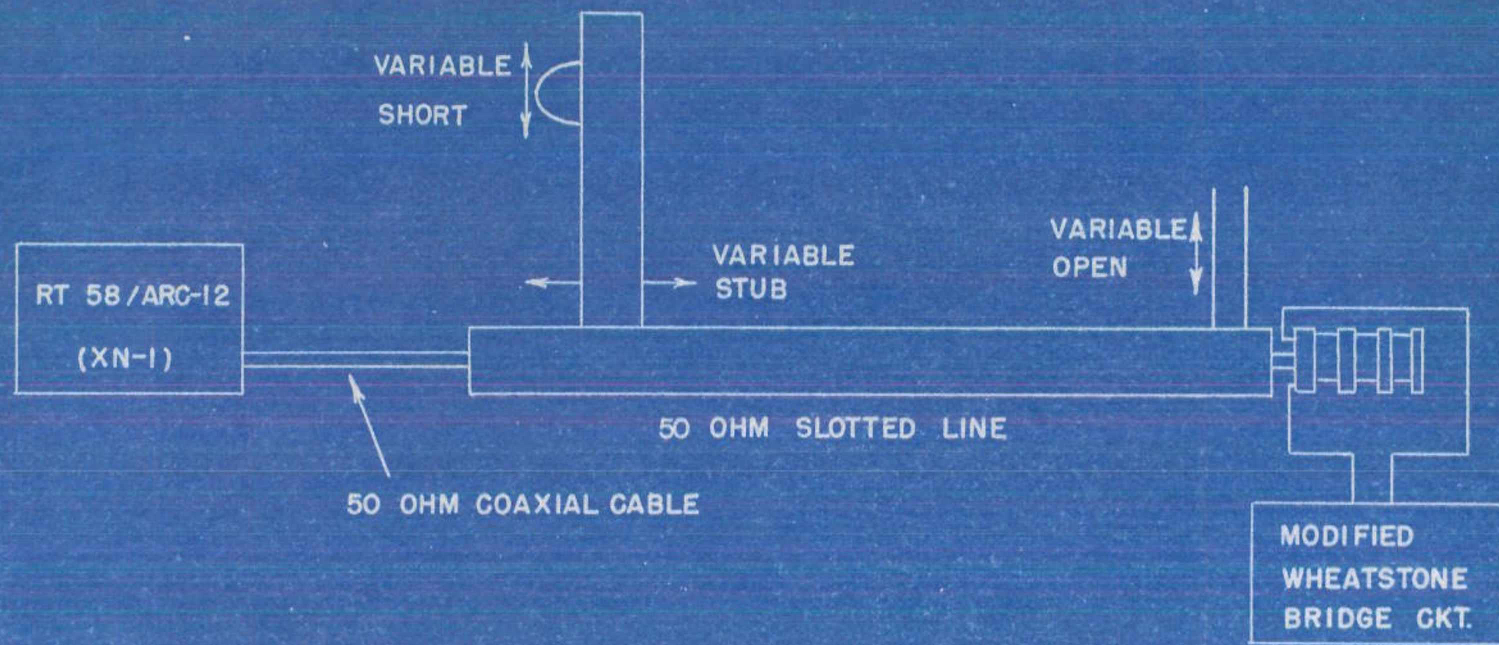
Model RT 58/ARC-12 (XN-1)
Serial # 4
RECEIVER DISTORTION - CHANNEL 9
Supply Voltage 26.5 V.
Output Impedance 300 Ohms (GR583A #3276)
30% Modulated 1000 µV. Signal (Ferris 48A #14)
Squelch Disabled
Maximum Audio Gain
Maximum Sensitivity
Hewlett Packard Noise and Distortion Meter
Model 225 #G446
PERCENT DISTORTION
40
36
32
28
24
20
16
12
8
4
0
100
1000
10K
FREQUENCY - cps.



[redacted]

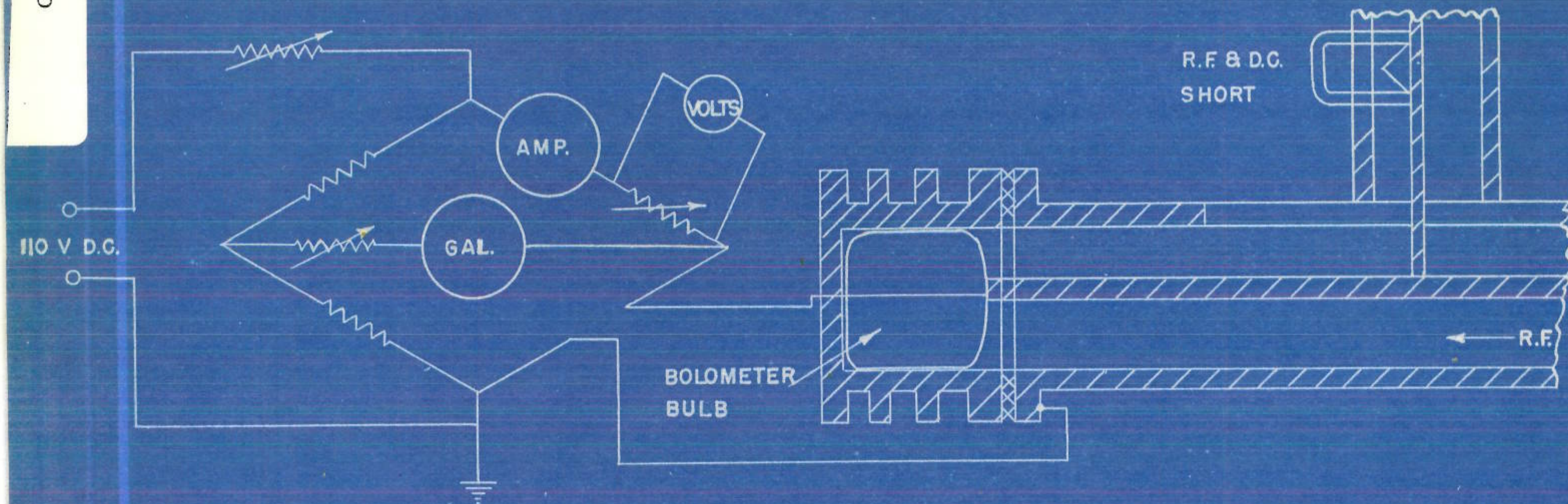
R-2896

PLATE 45



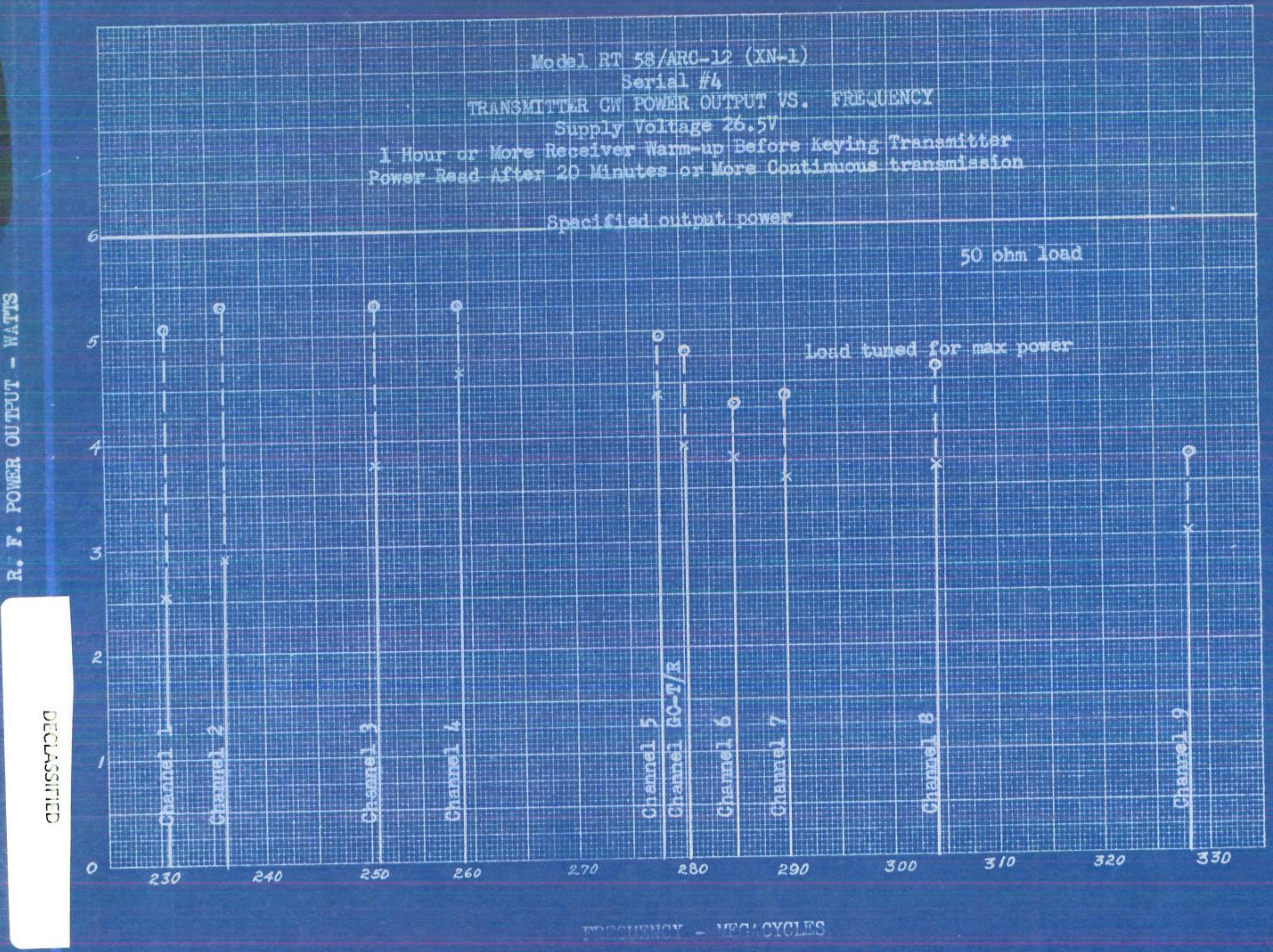
ELECTRICAL CONNECTIONS OF MODIFIED WHEATSTONE BRIDGE

PLATE 46



ELECTRICAL CONNECTIONS OF MODIFIED WHEATSTONE BRIDGE

PLATE 47



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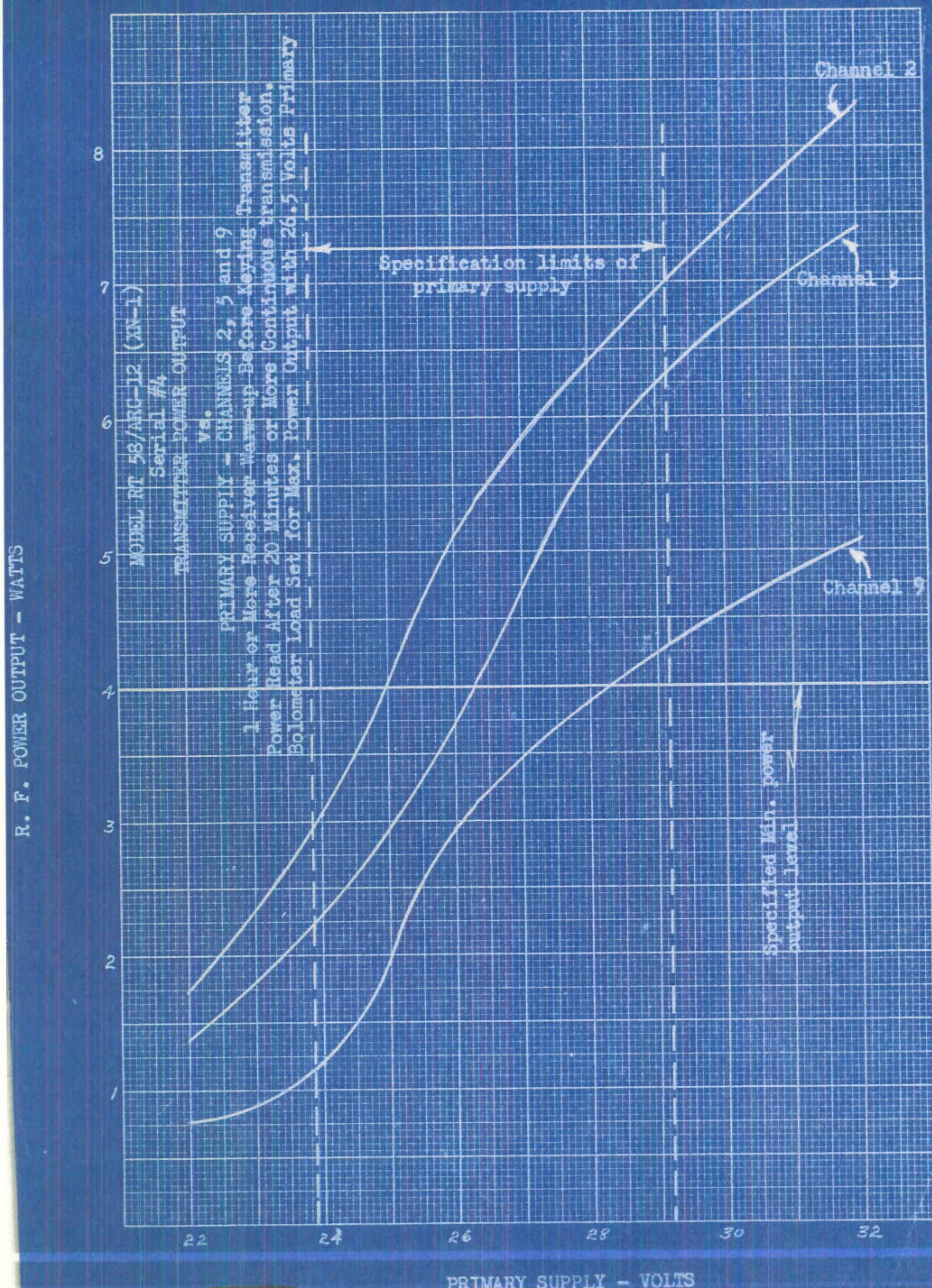
DECLASSIFIED



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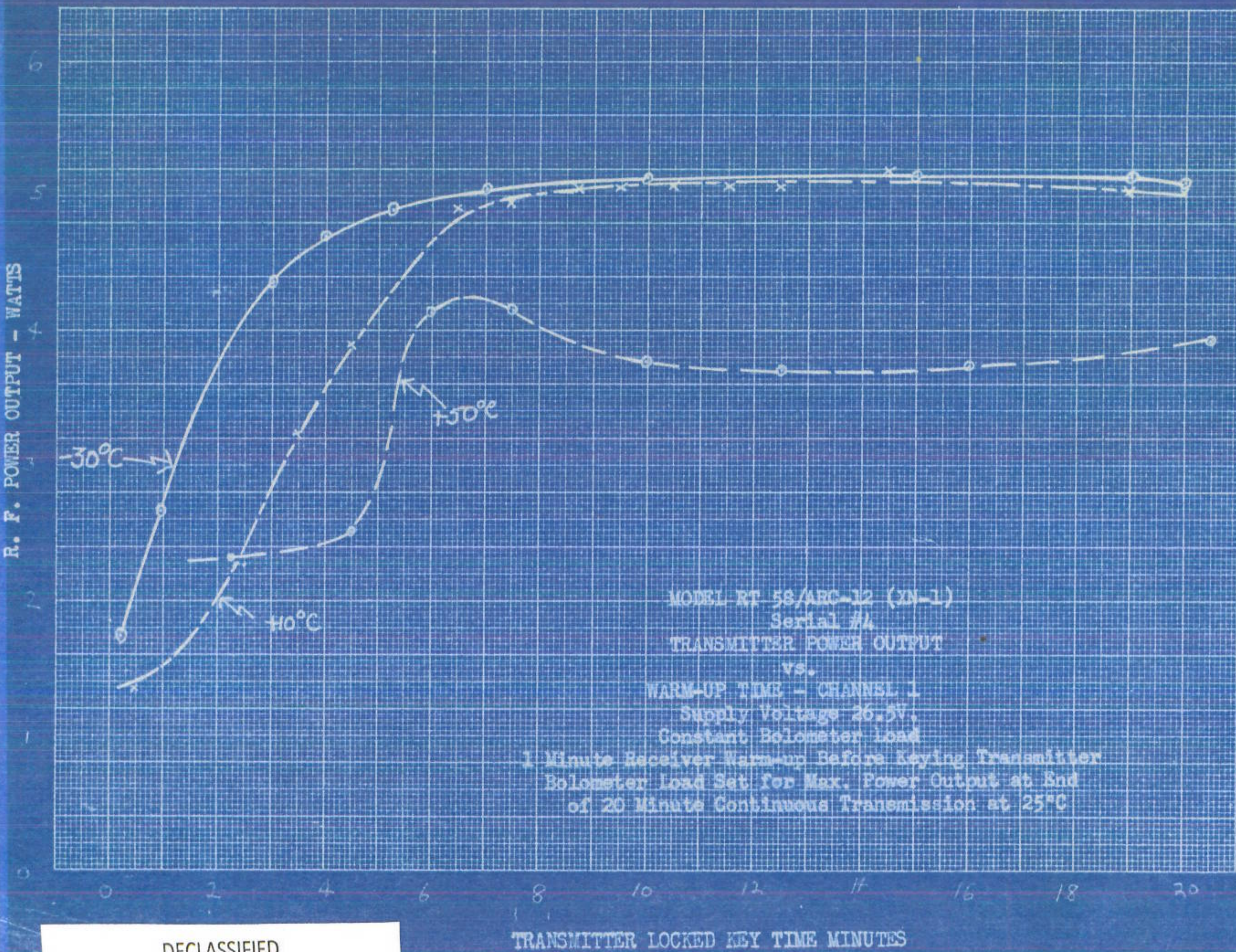

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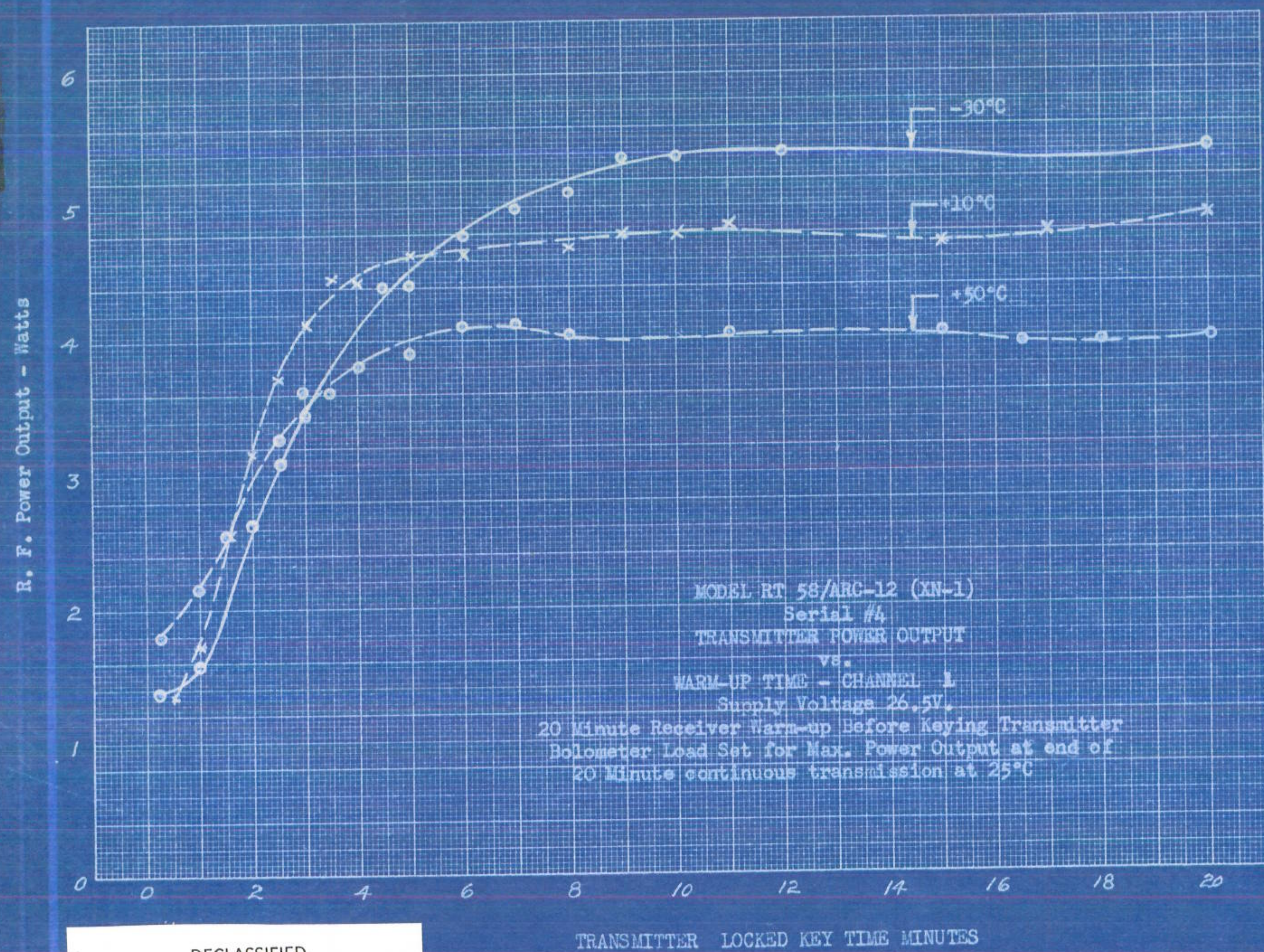

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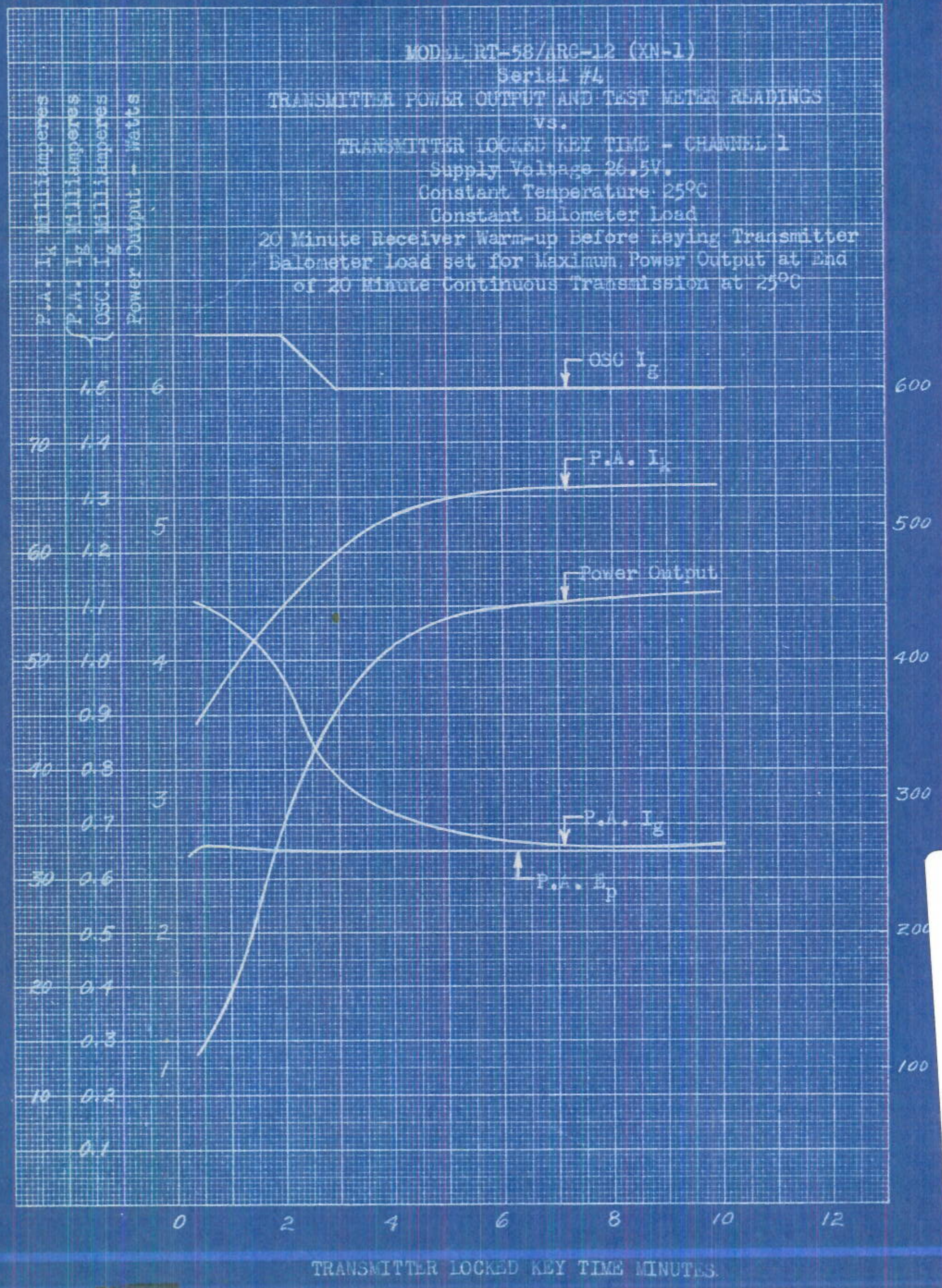
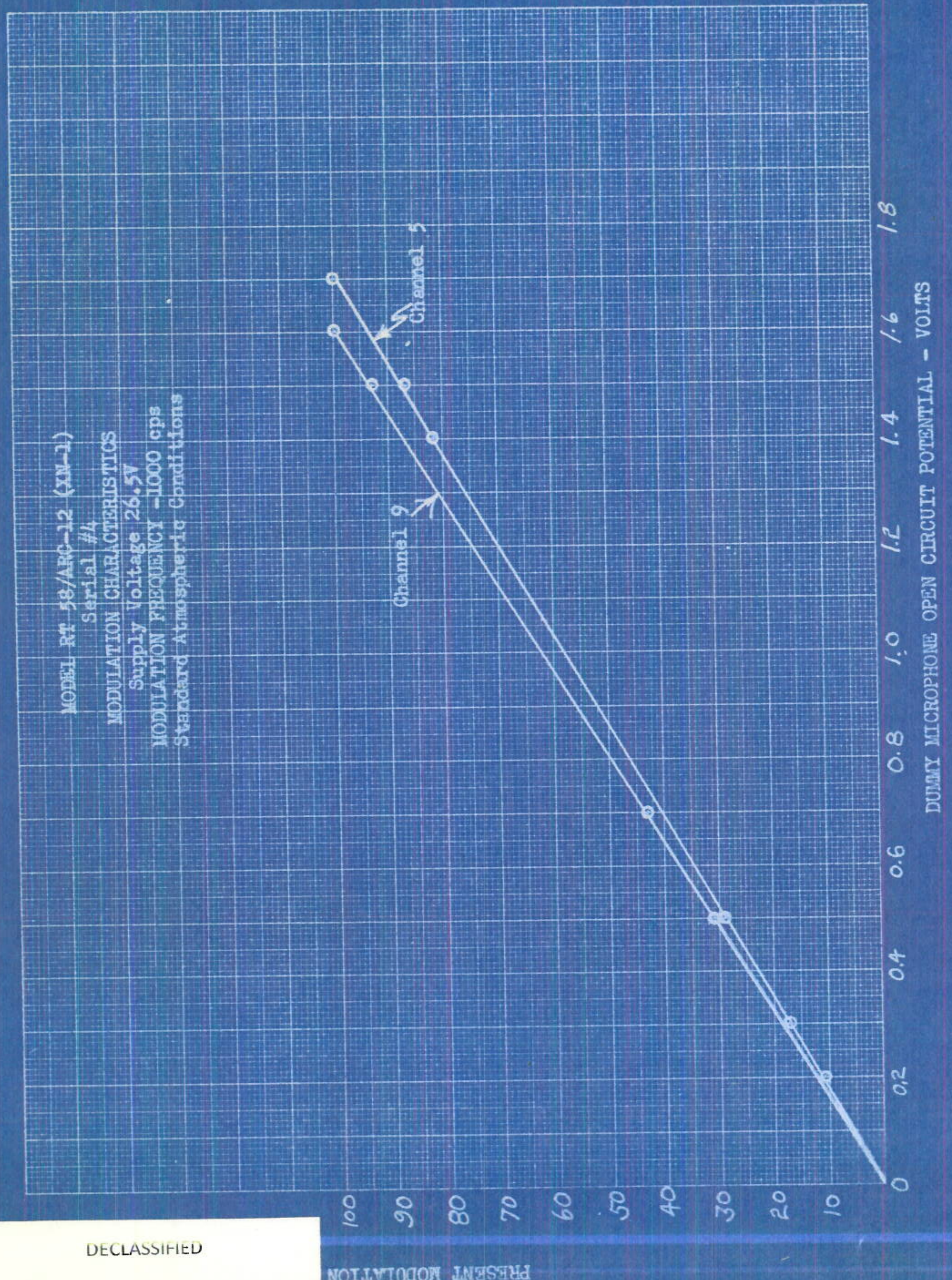
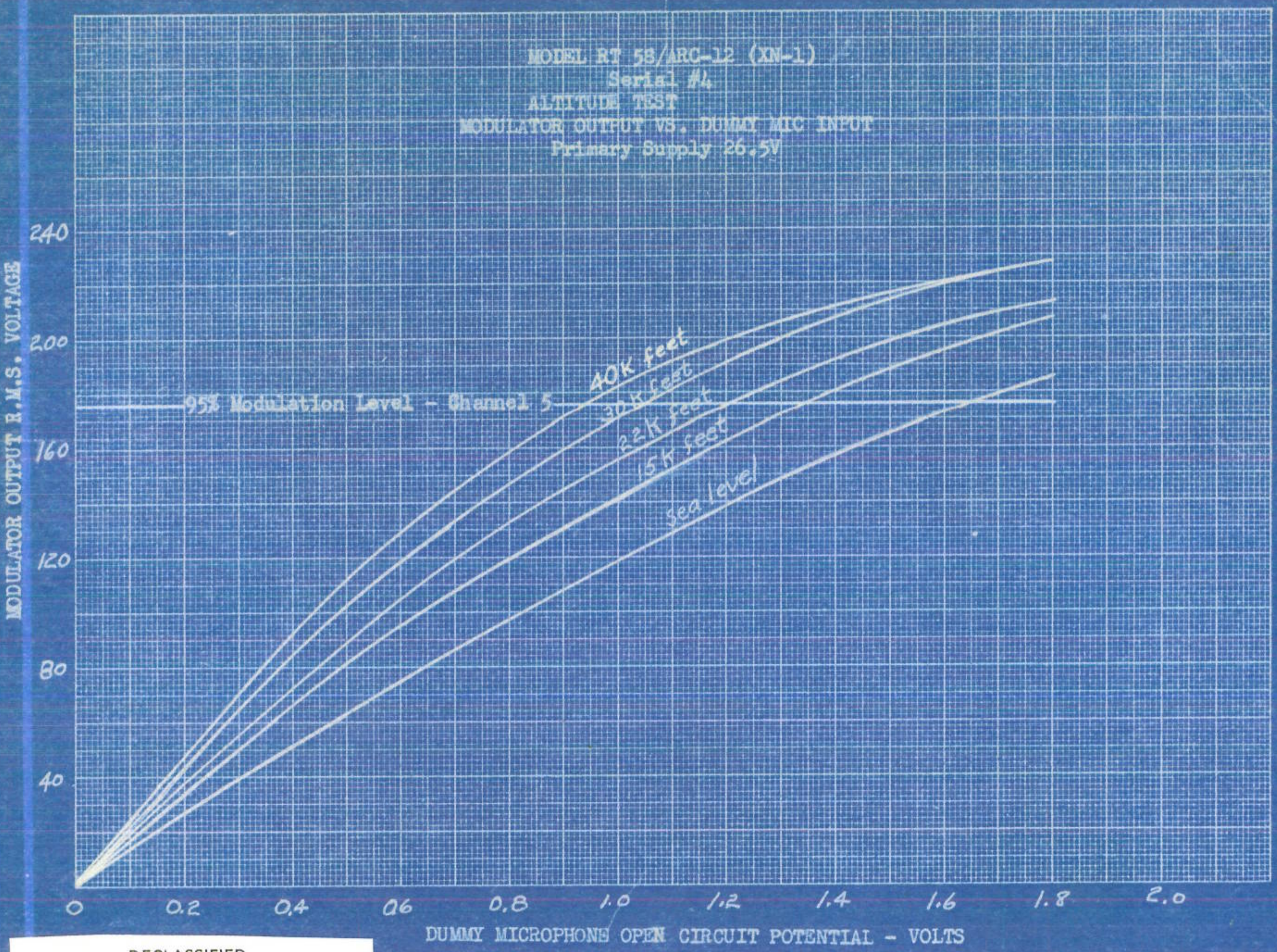

MODEL RT-58/ARC-12 (XN-1)
Serial #4
TRANSMITTER POWER OUTPUT AND TEST METER READINGS
vs.
TRANSMITTER LOCKED KEY TIME - CHANNEL 1
Supply Voltage 26.5V.
Constant Temperature 25°C
Constant Balometer Load
20 Minute Receiver Warm-up Before Keying Transmitter
Balometer Load set for Maximum Power Output at End
of 20 Minute Continuous Transmission at 25°C
P.A. Ik Milliamperes
P.A. Ig Milliamperes
OSC. Ig Milliamperes
Power Output - Watts
OSC Ig
P.A. Ik
Power Output
P.A. Ig
P.A. Ep
Ep - Volts
0 2 4 6 8 10 12
TRANSMITTER LOCKED KEY TIME MINUTES

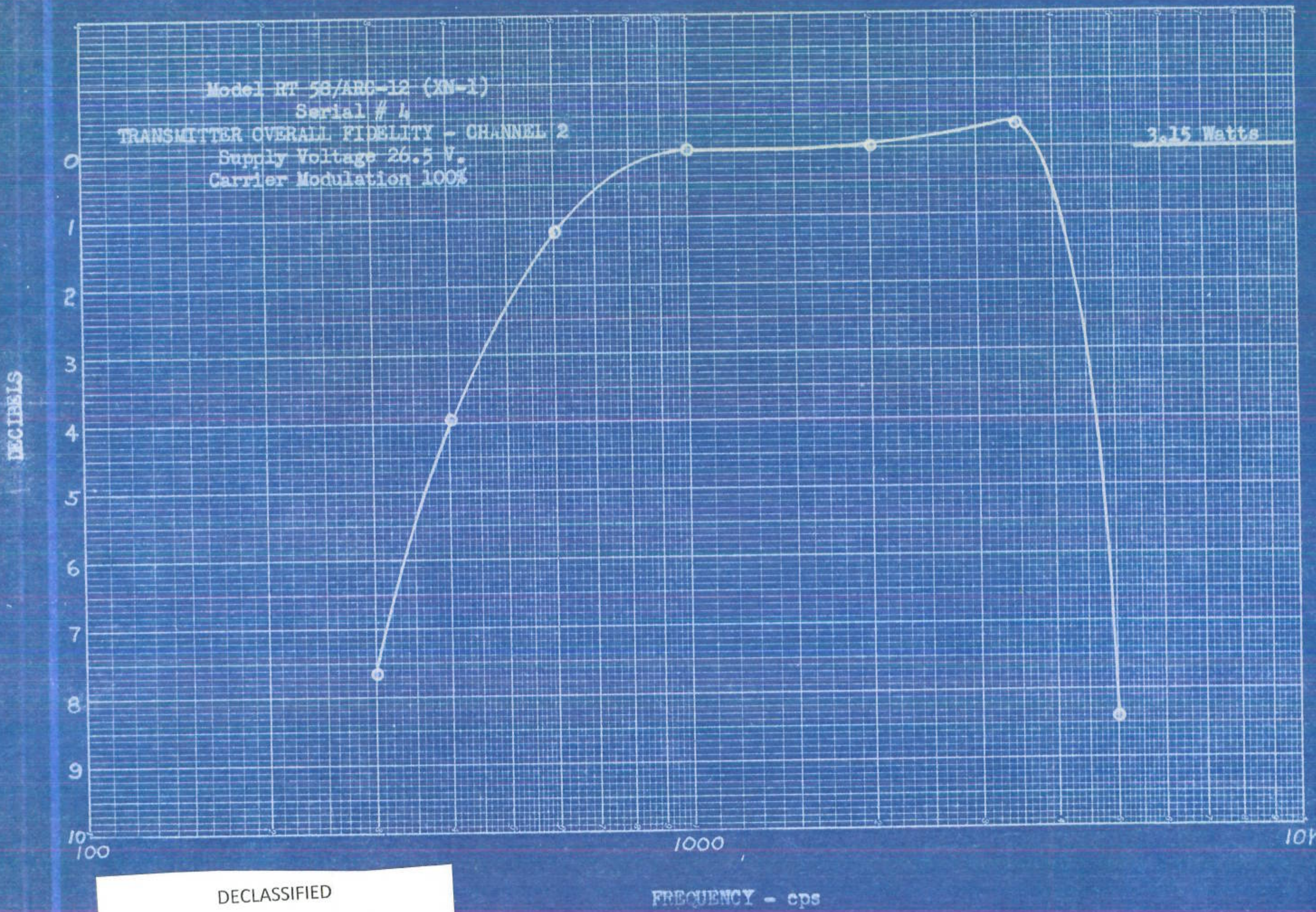

MODEL RT 58/ARC-12 (XN-1)
Serial #4
MODULATION CHARACTERISTICS
Supply Voltage 26.5V
MODULATION FREQUENCY -1000 cps
Standard Atmospheric Conditions
Channel 5
Channel 9
DUMMY MICROPHONE OPEN CIRCUIT POTENTIAL - VOLTS
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
10
20
30
40
50
60
70
80
90
100
PRESENT MODULATION

[redacted]

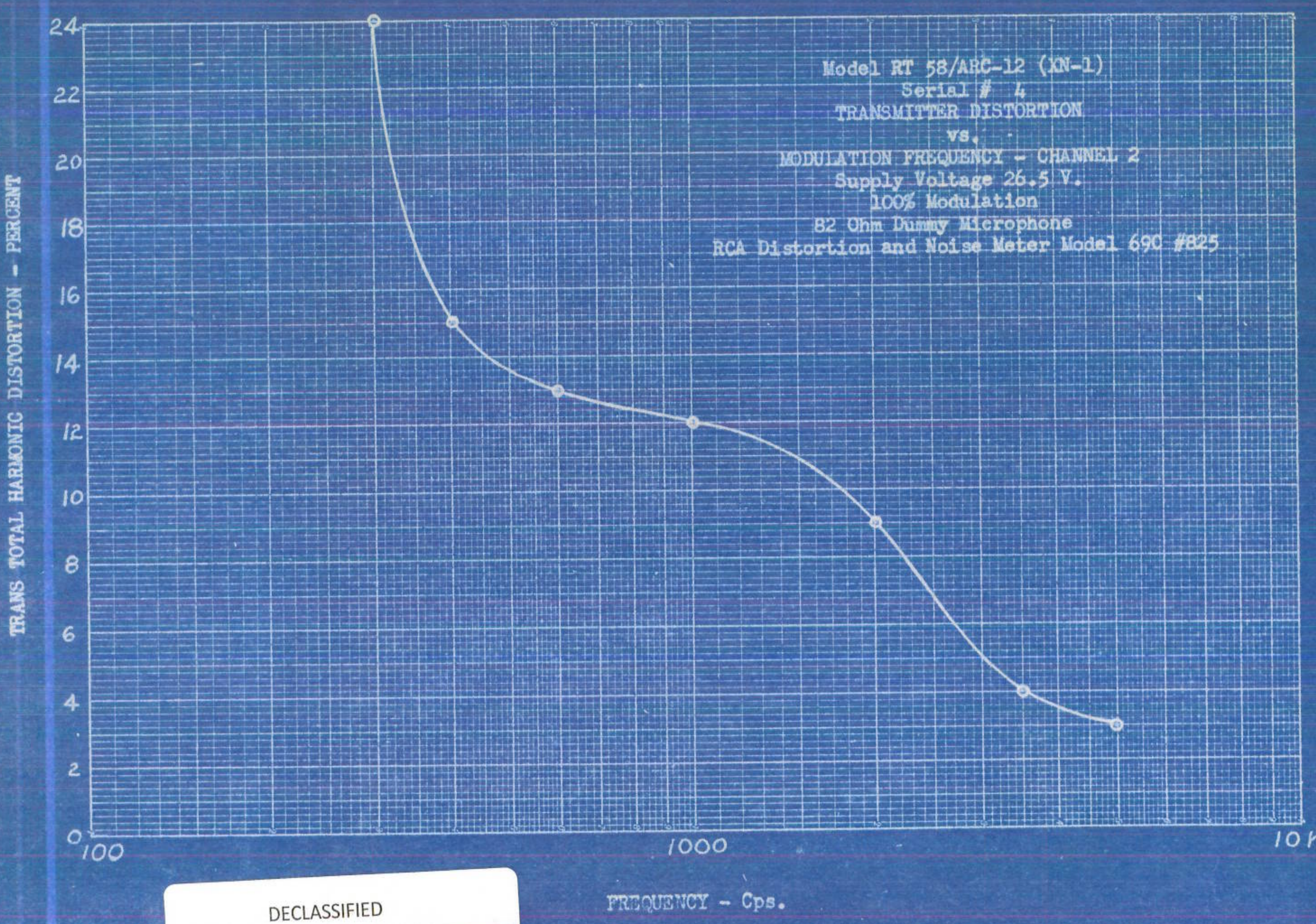


MODEL RT 58/ARC-12 (XN-1)
Serial #4
ALTITUDE TEST
MODULATOR OUTPUT VS. DUMMY MIC INPUT
Primary Supply 26.5V
MODULATOR OUTPUT R.M.S. VOLTAGE
240
200
160
120
80
40
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
DUMMY MICROPHONE OPEN CIRCUIT POTENTIAL - VOLTS
95% Modulation Level - Channel 5
40K feet
30K feet
22K feet
15K feet
Sea level

[redacted]



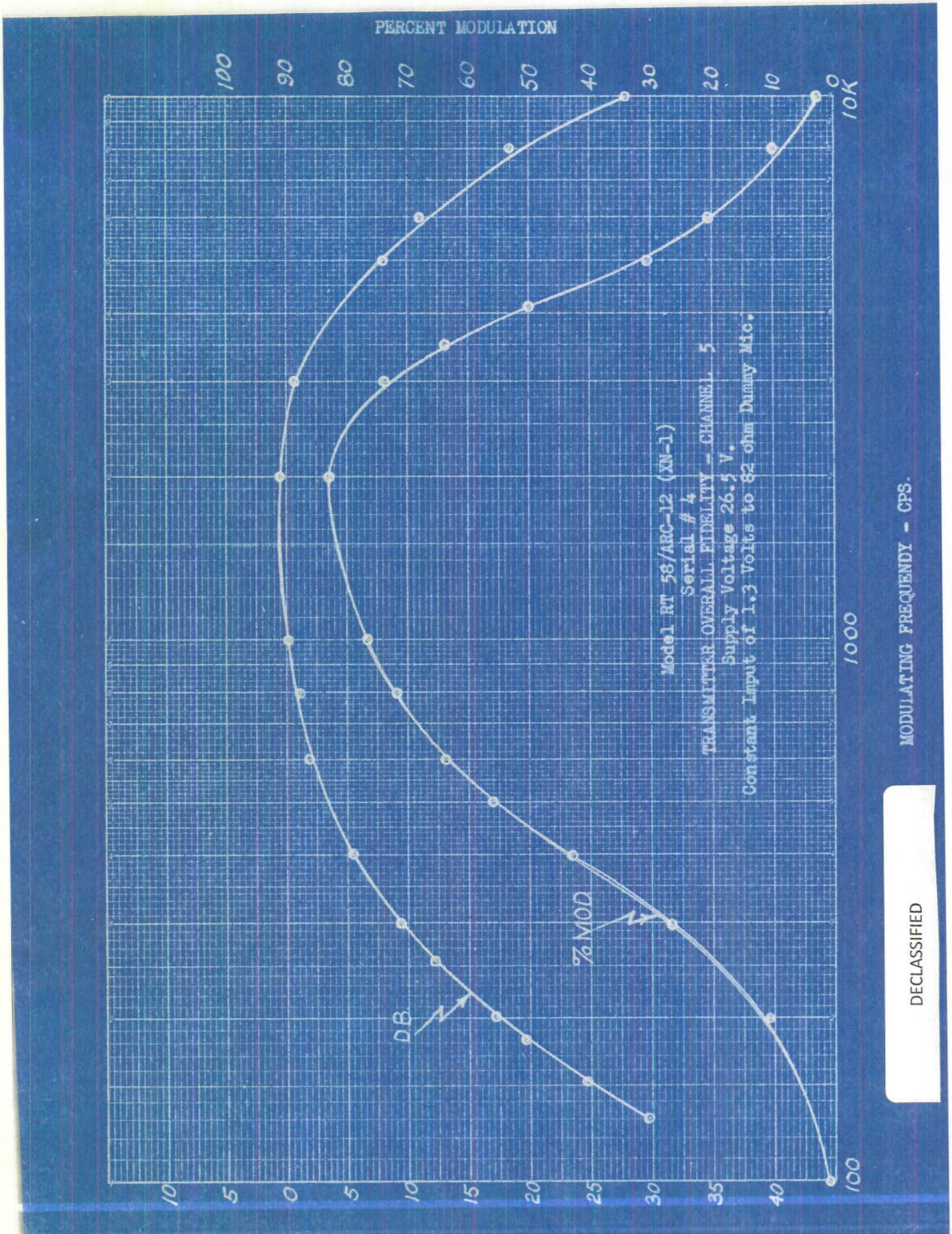
R-2896

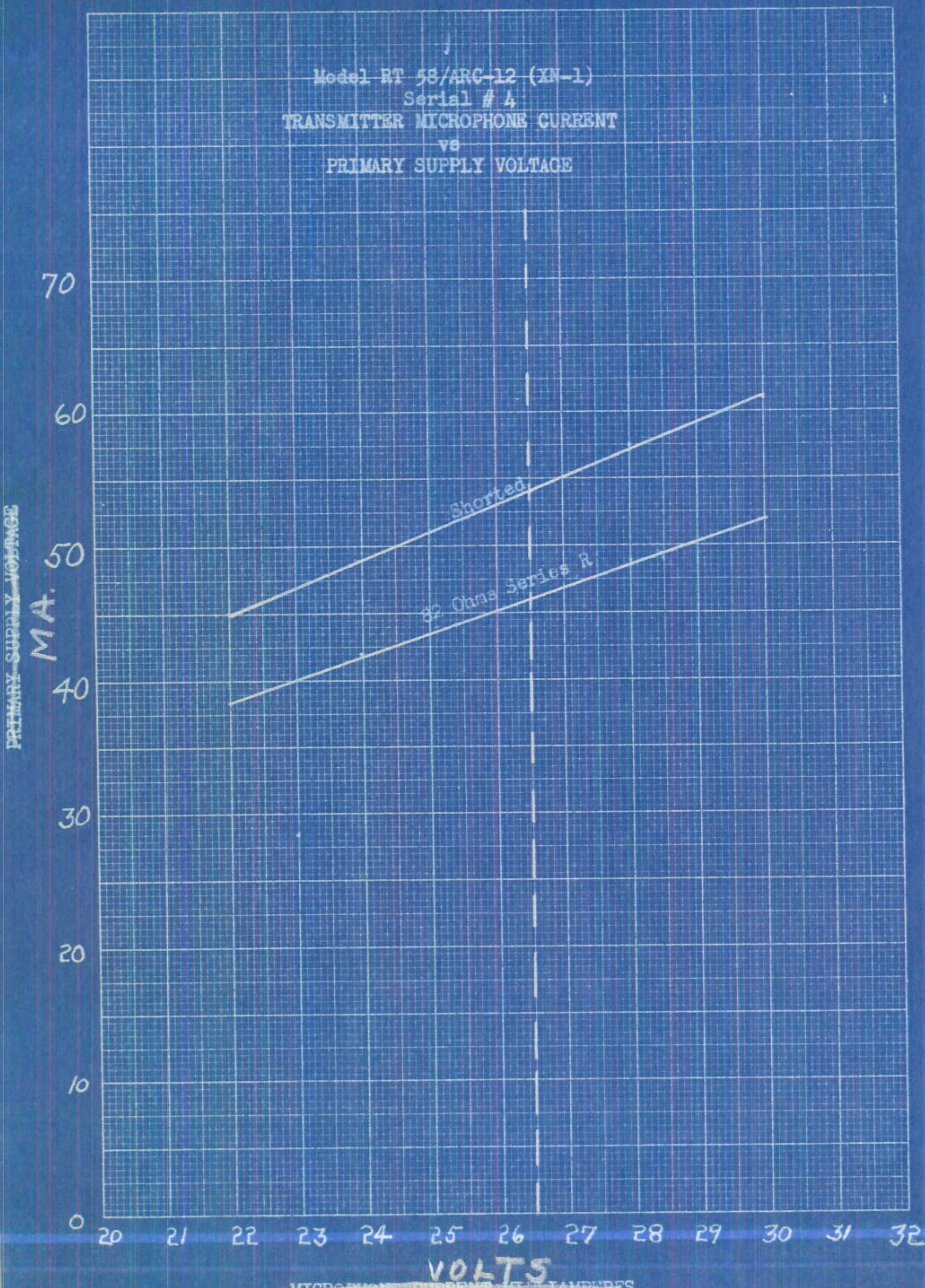


[redacted]

R-2896

PLATE 56


PERCENT MODULATION
100
90
80
70
60
50
40
30
20
10
0
10K
1000
100
Model RT 58/ARC-12 (XN-1)
Serial # 4
TRANSMITTER OVERALL FIDELITY - CHANNEL 5
Supply Voltage 26.5 V.
Constant Input of 1.3 Volts to 82 ohm Dummy Mic.
MODULATING FREQUENDY - CPS.
DB
% MOD
10
5
0
5
10
15
20
25
30
35
40
DECIBELS
DECLASSIFIED



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R-2896

PLATE 58

BLOCK DIAGRAM - COUPLING FACTOR TEST EQUIPMENT

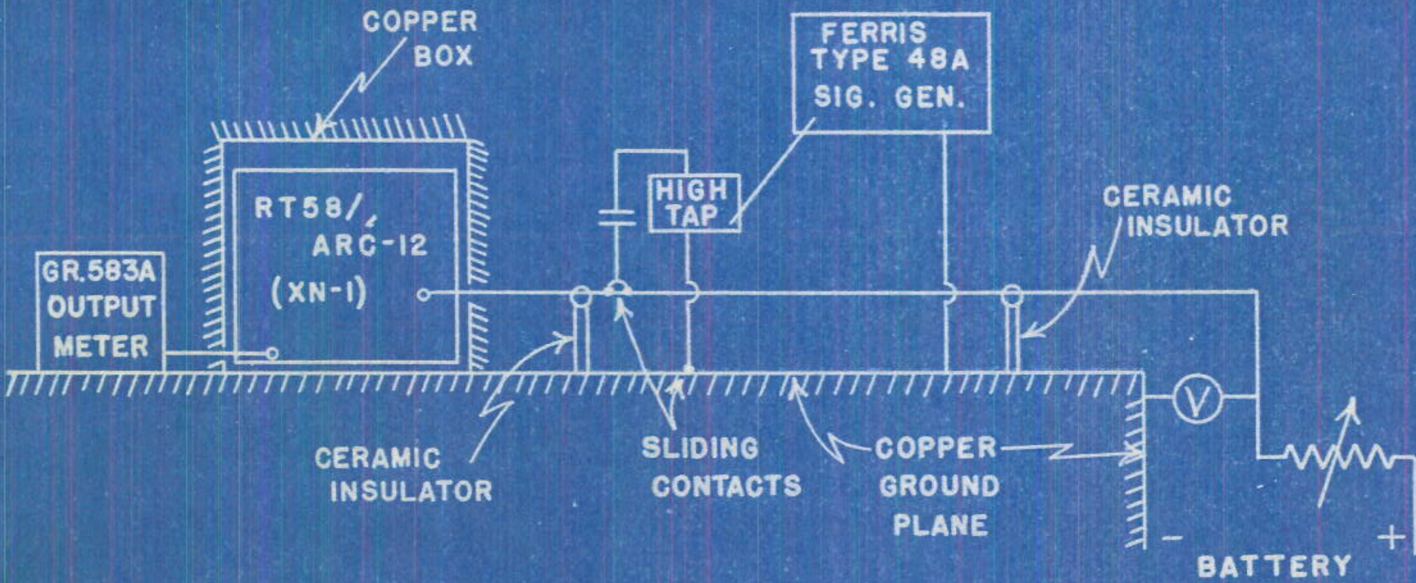

FIG. 1 - POWER LINE INJECTION

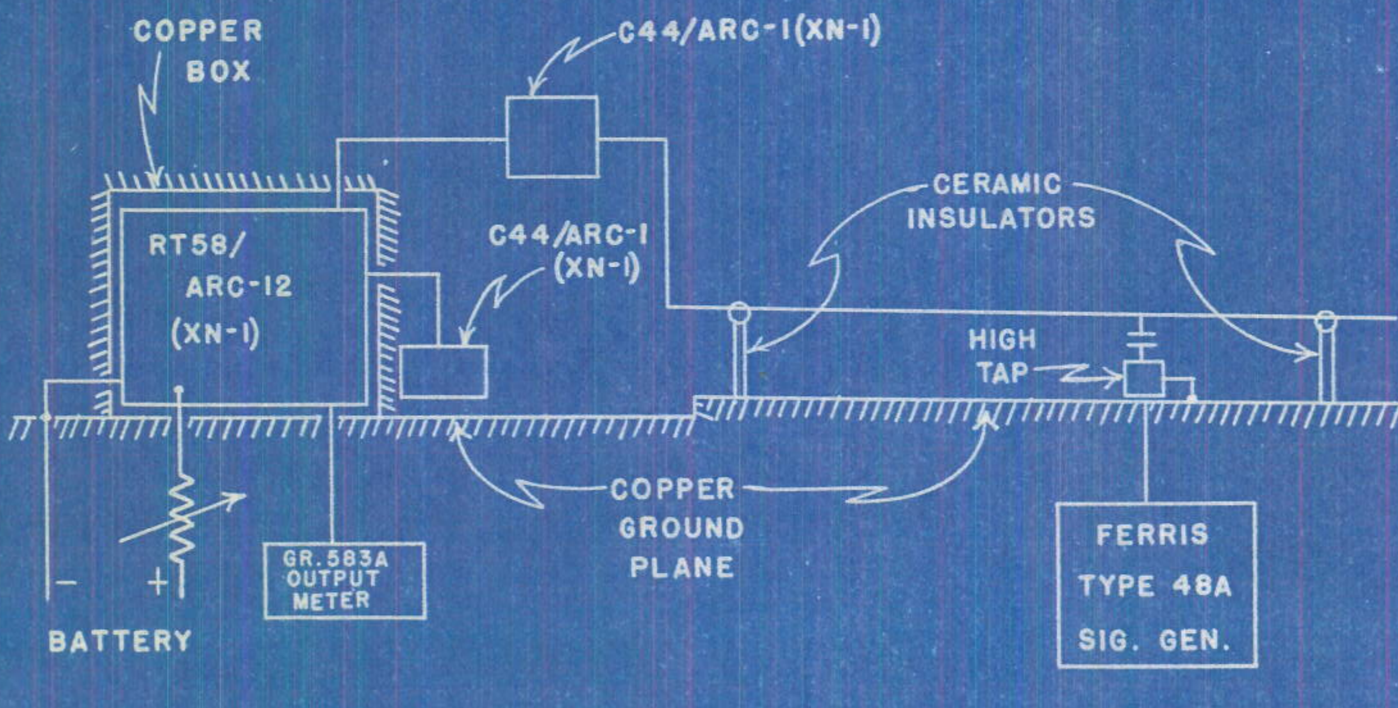

FIG. 2 - AUDIO INJECTION

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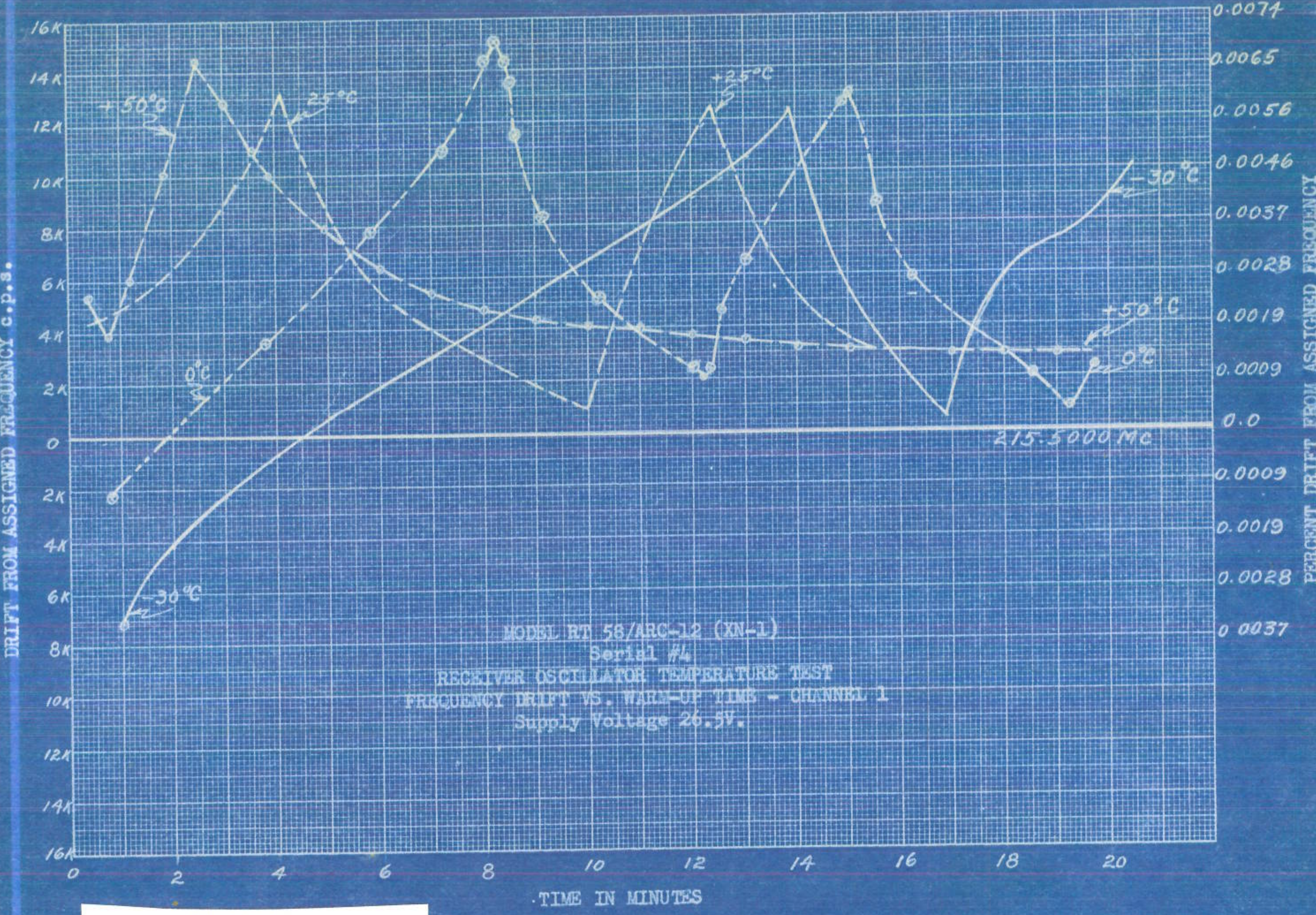

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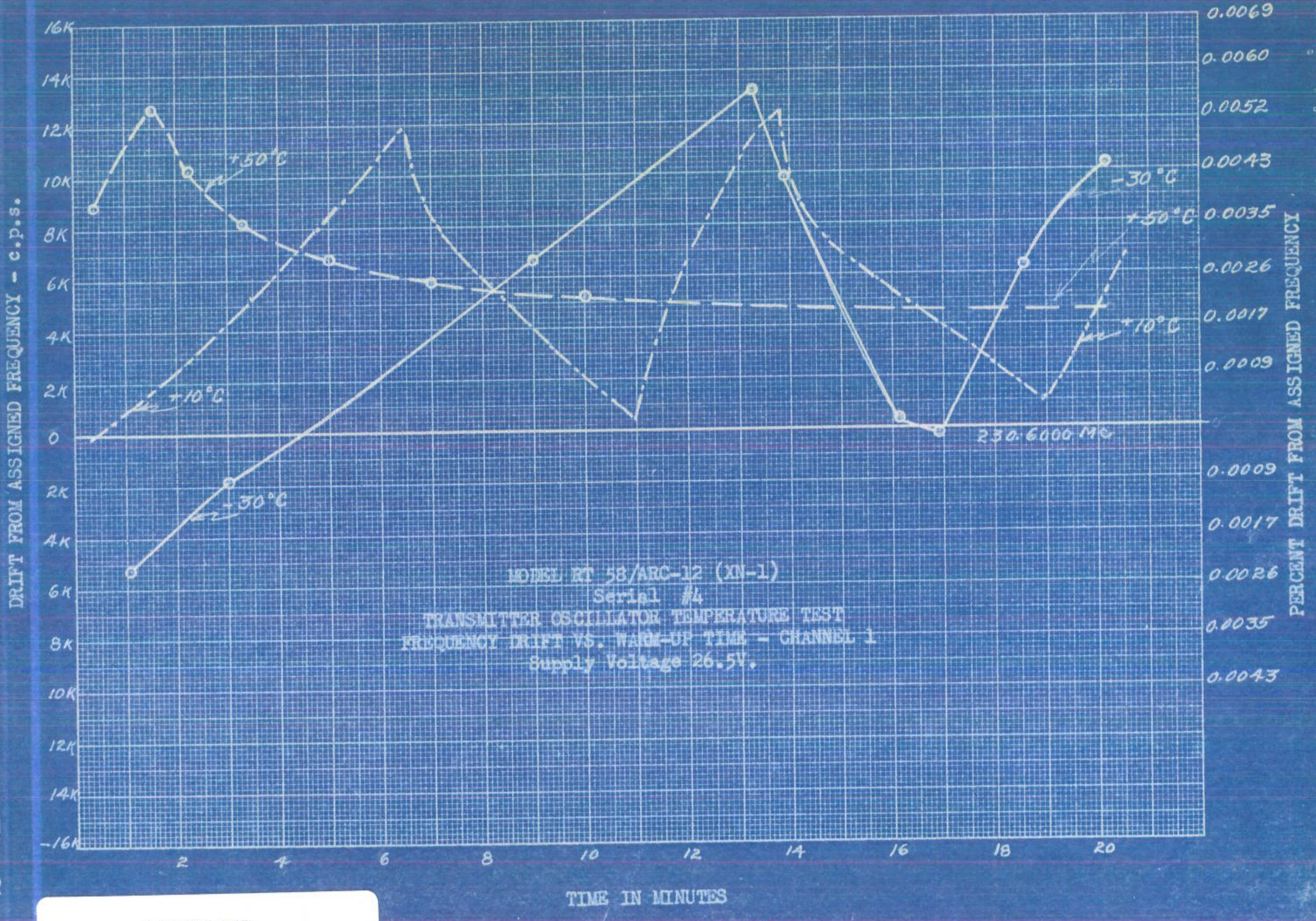
R-2896

PLATE 60



[redacted]

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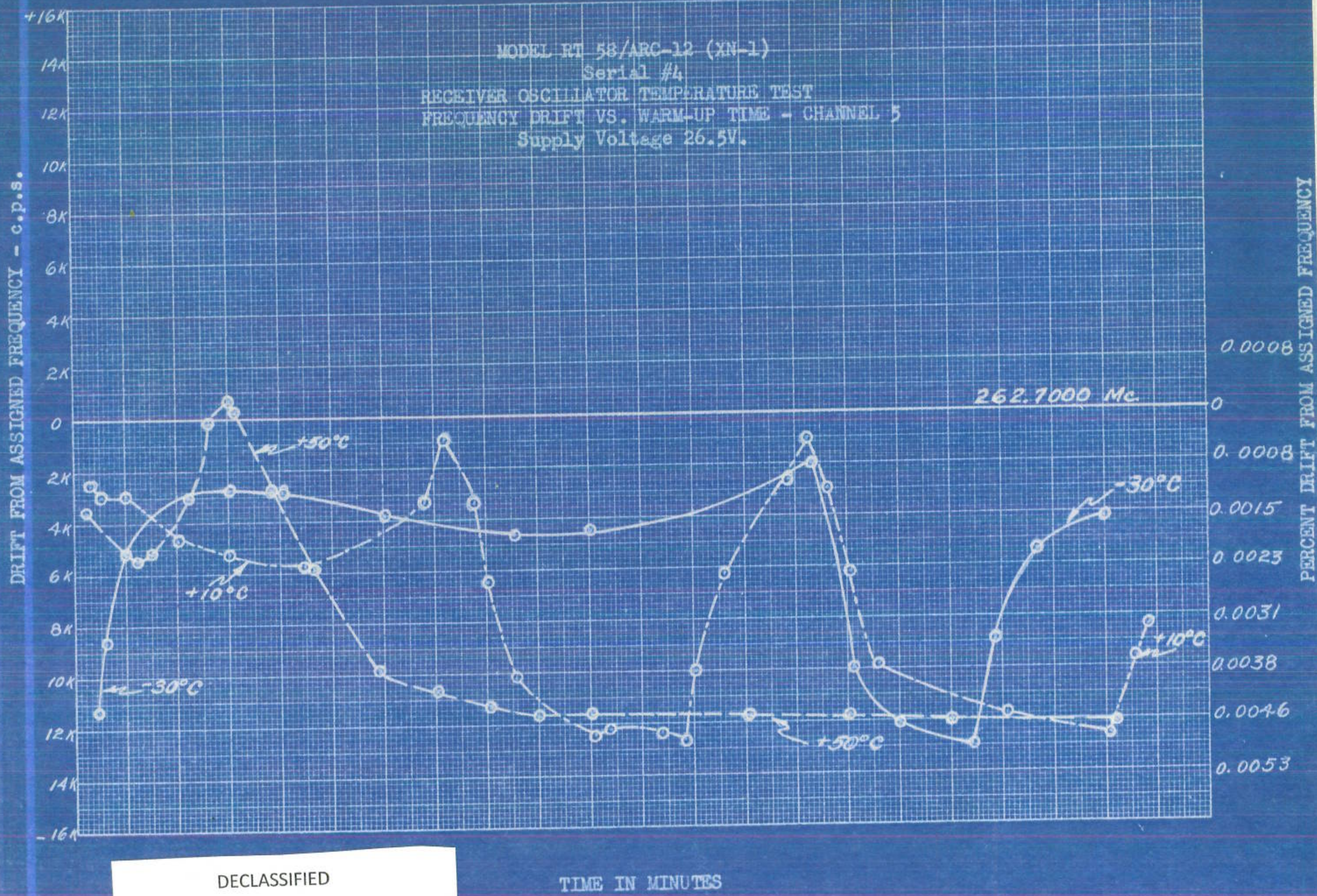
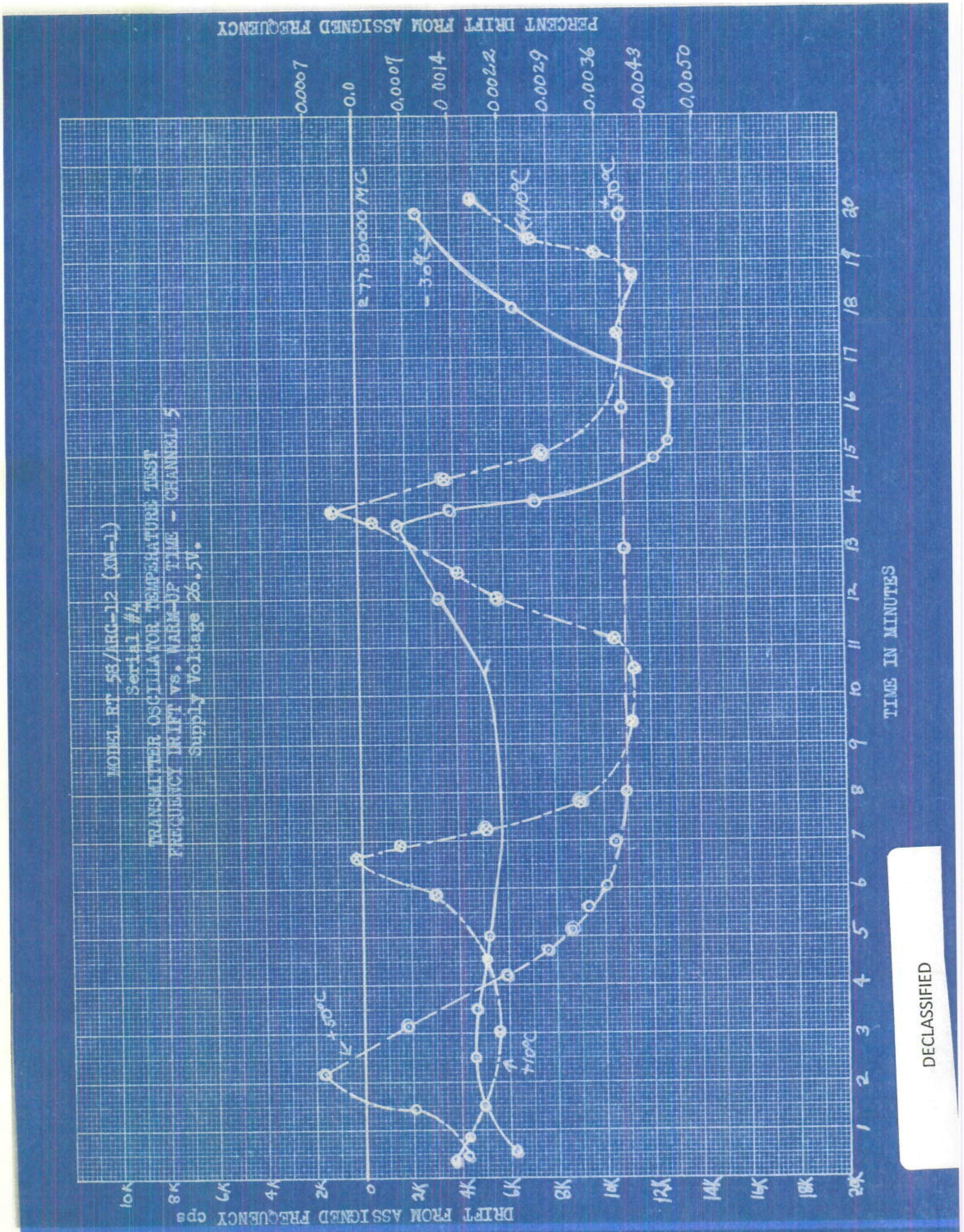
[redacted]


MODEL RT 58/ARC-12 (XN-1)
Serial #4
RECEIVER OSCILLATOR TEMPERATURE TEST
FREQUENCY DRIFT VS. WARM-UP TIME - CHANNEL 5
Supply Voltage 26.5V.
262.7000 Mc.
+50°C
+10°C
-30°C
DRIFT FROM ASSIGNED FREQUENCY - c.p.s.
PERCENT DRIFT FROM ASSIGNED FREQUENCY
TIME IN MINUTES



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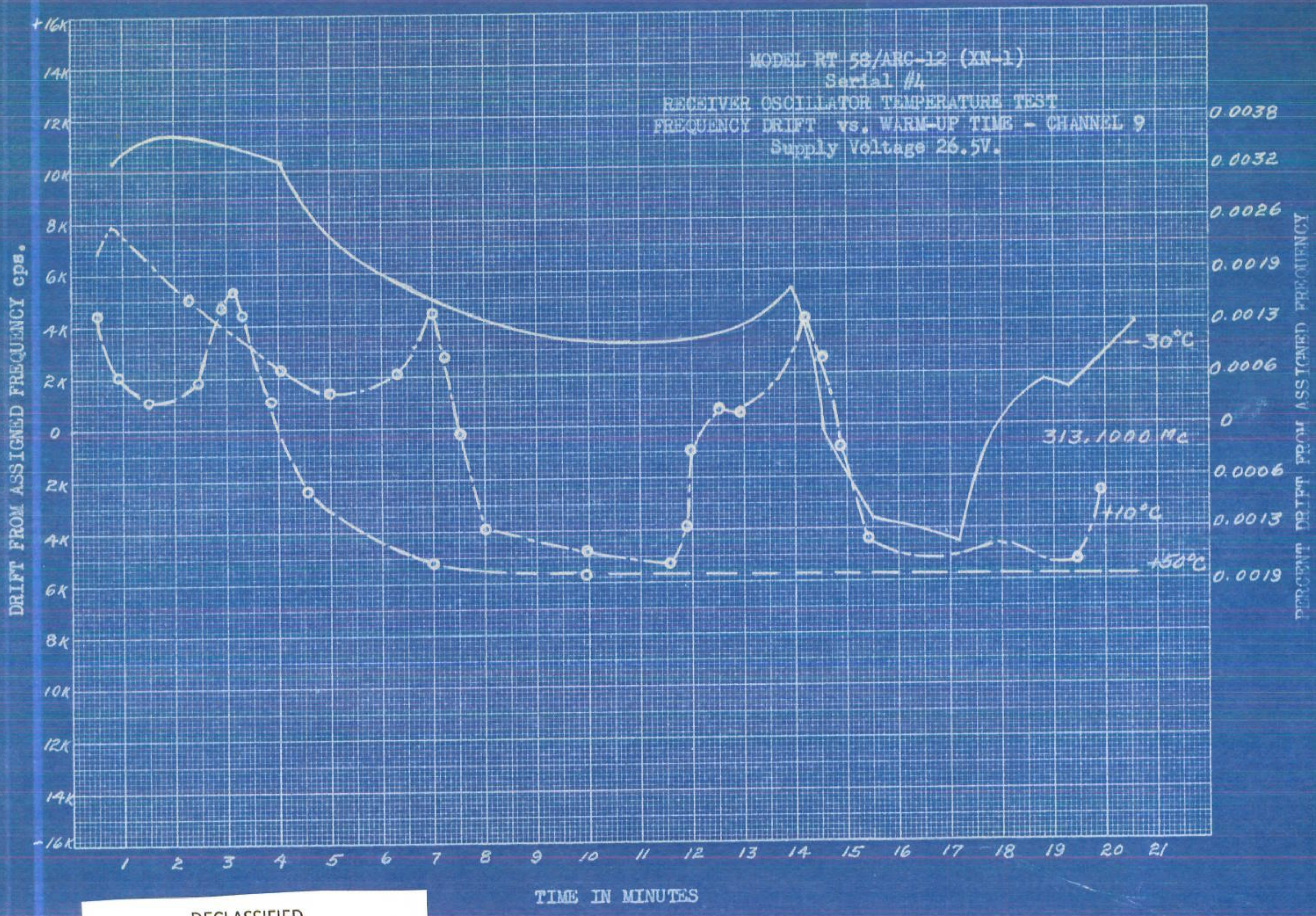

[redacted]

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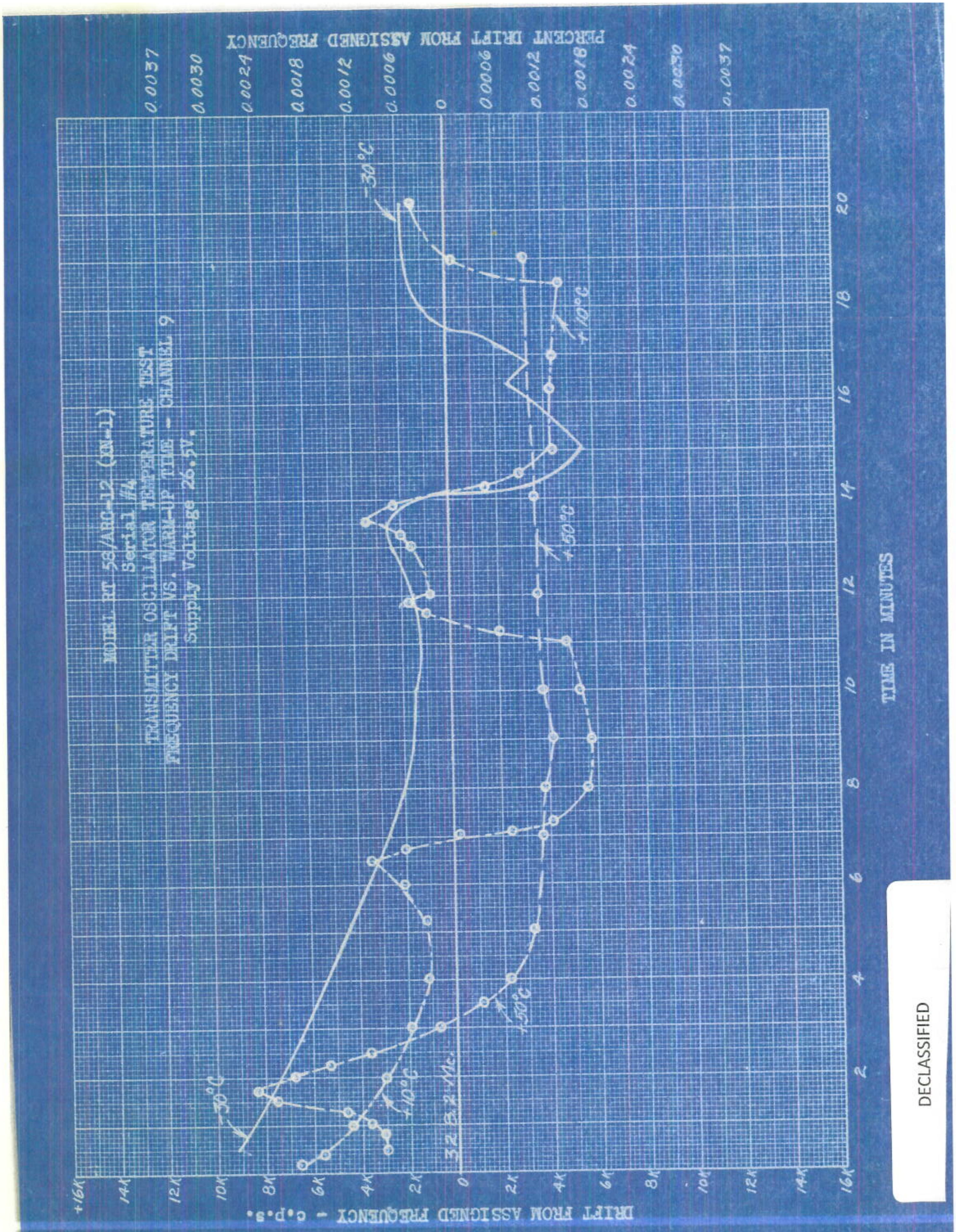
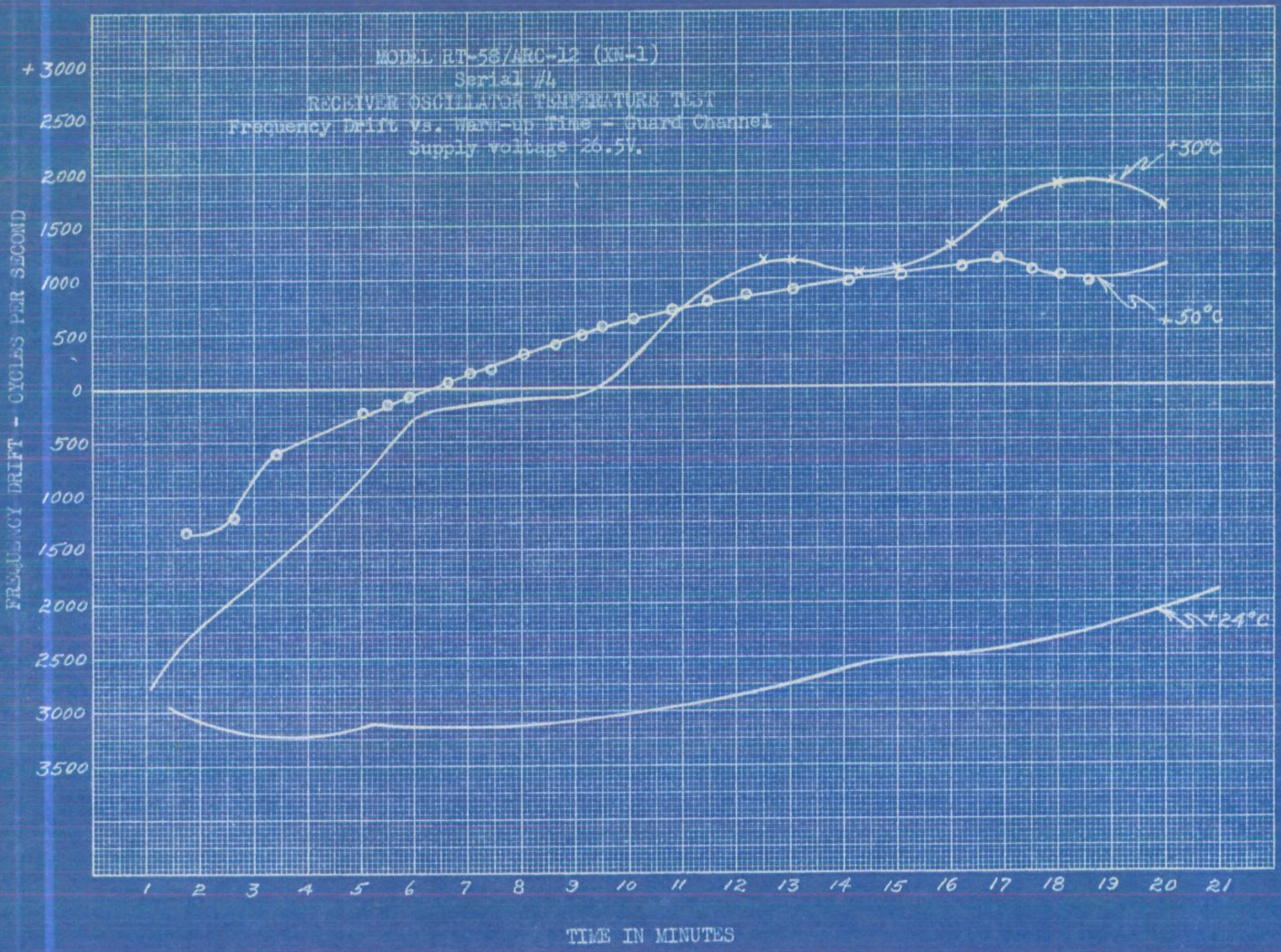
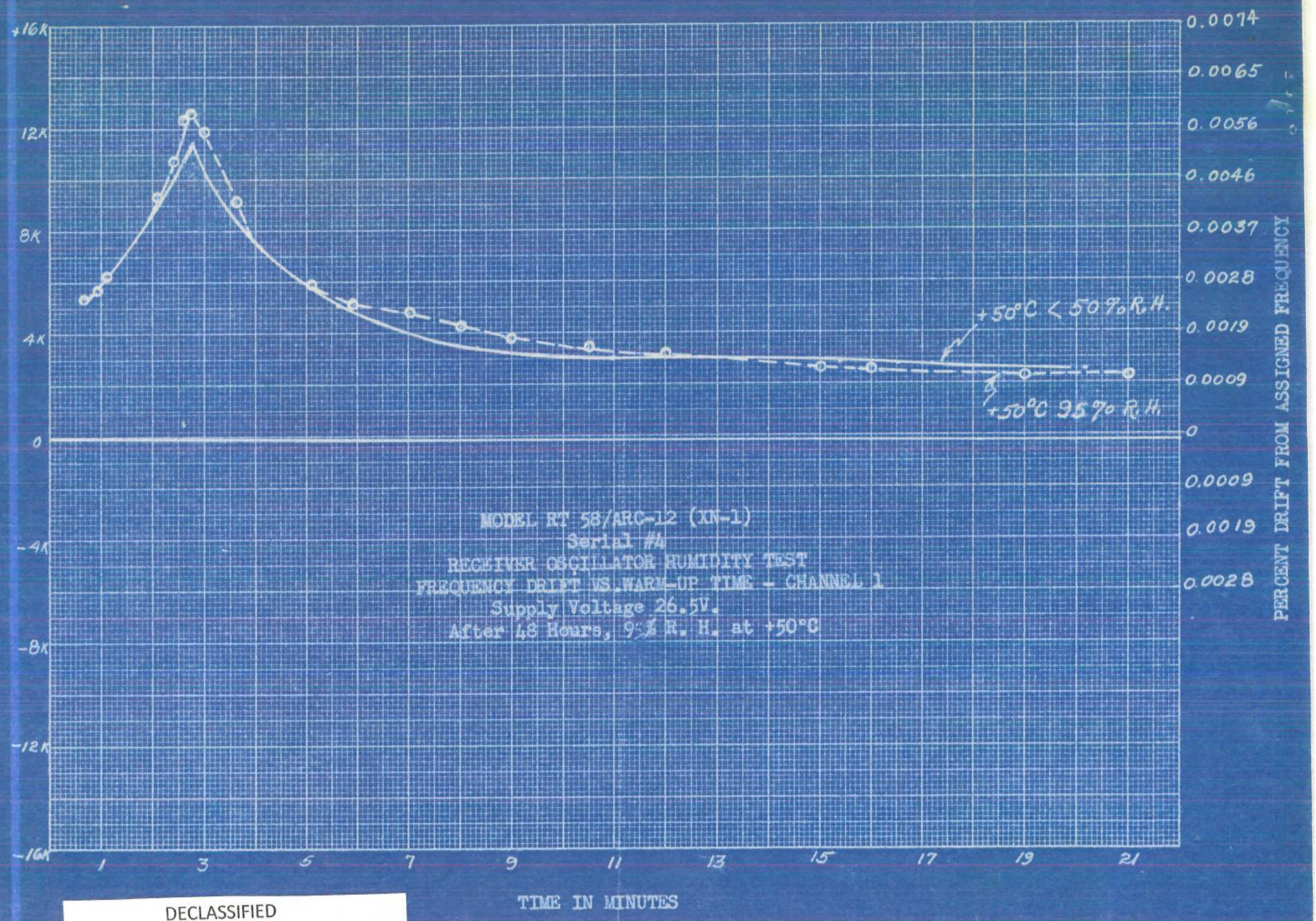
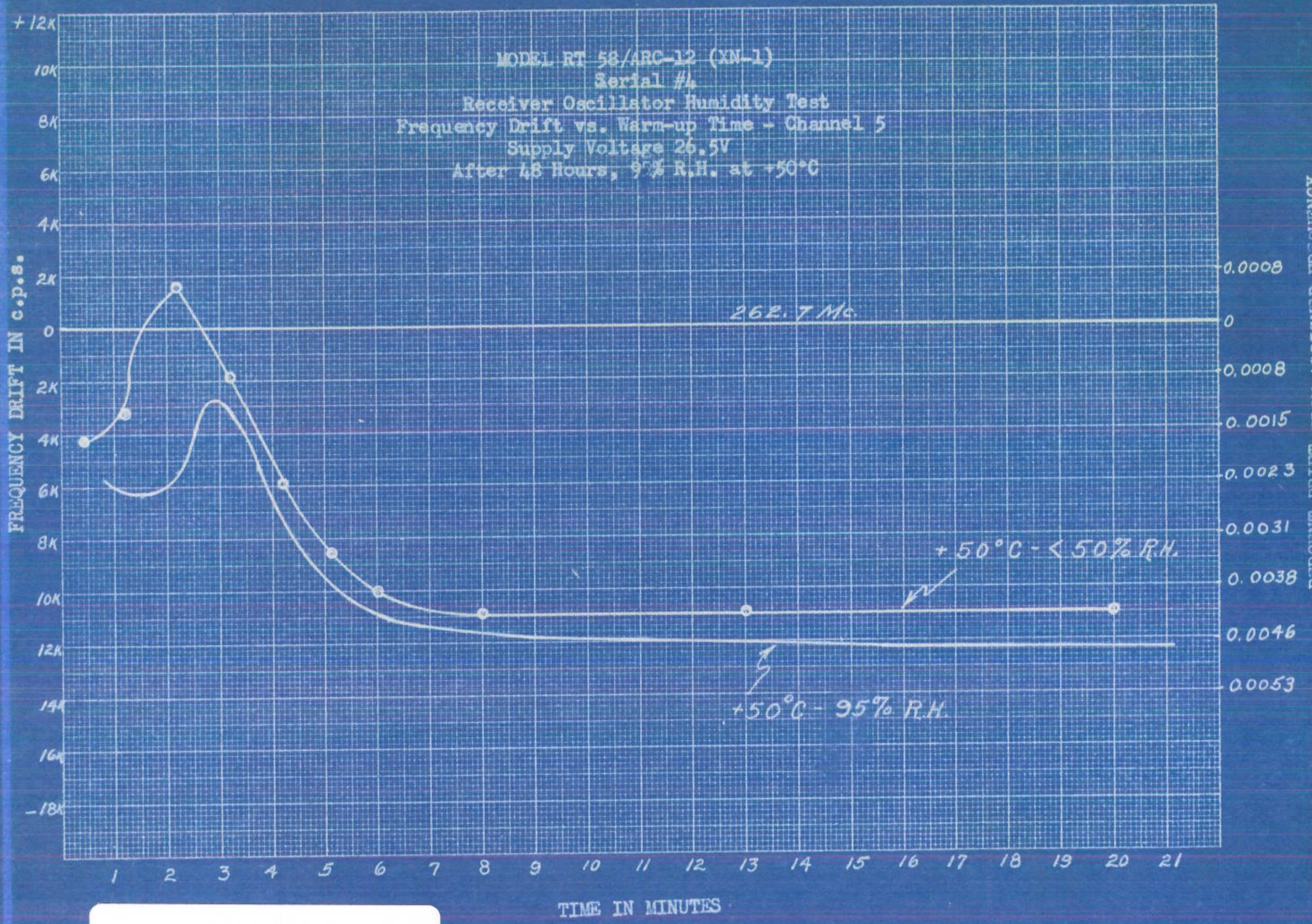

MODEL RT 58/ARC-12 (XN-1)
Serial #4
TRANSMITTER OSCILLATOR TEMPERATURE TEST
FREQUENCY DRIFT VS. WARM-UP TIME - CHANNEL 9
Supply Voltage 26.5V.
PERCENT DRIFT FROM ASSIGNED FREQUENCY
0.0037
0.0030
0.0024
0.0018
0.0012
0.0006
0
0.0006
0.0012
0.0018
0.0024
0.0030
0.0037
DRIFT FROM ASSIGNED FREQUENCY - c.p.s.
+16K
14K
12K
10K
8K
6K
4K
2K
0
2K
4K
6K
8K
10K
12K
14K
16K
TIME IN MINUTES
2
4
6
8
10
12
14
16
18
20
32.832 Mc.
-30°C
+10°C
+50°C


MODEL RT-58/ARC-12 (XN-1)
Serial #4
RECEIVER OSCILLATOR TEMPERATURE TEST
Frequency Drift vs. Warm-up Time - Guard Channel
Supply voltage 26.5V.
FREQUENCY DRIFT - CYCLES PER SECOND
+3000
2500
2000
1500
1000
500
0
500
1000
1500
2000
2500
3000
3500
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
TIME IN MINUTES
+30°C
+50°C
+24°C

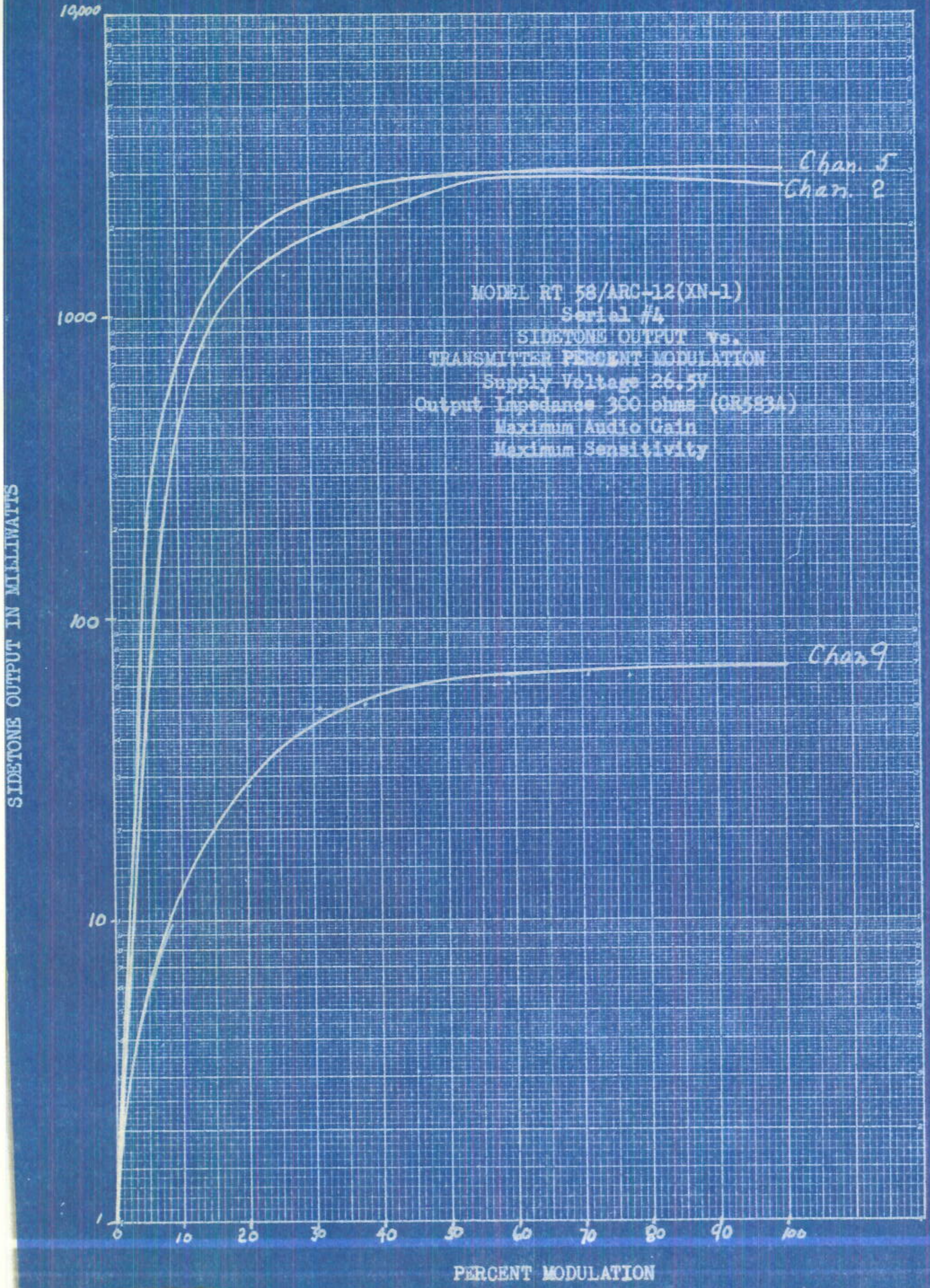
[redacted]


MODEL RT 58/ARC-12 (XN-1)
Serial #4
RECEIVER OSCILLATOR HUMIDITY TEST
FREQUENCY DRIFT VS. WARM-UP TIME - CHANNEL 1
Supply Voltage 26.5V.
After 48 Hours, 95% R. H. at +50°C
+50°C < 50% R.H.
+50°C 95% R.H.
DRIFT FROM ASSIGNED FREQUENCY c.p.s.
PERCENT DRIFT FROM ASSIGNED FREQUENCY
TIME IN MINUTES
+16K
12K
8K
4K
0
-4K
-8K
-12K
-16K
0.0074
0.0065
0.0056
0.0046
0.0037
0.0028
0.0019
0.0009
0
0.0009
0.0019
0.0028
1
3
5
7
9
11
13
15
17
19
21

[redacted]



DECLASSIFIED



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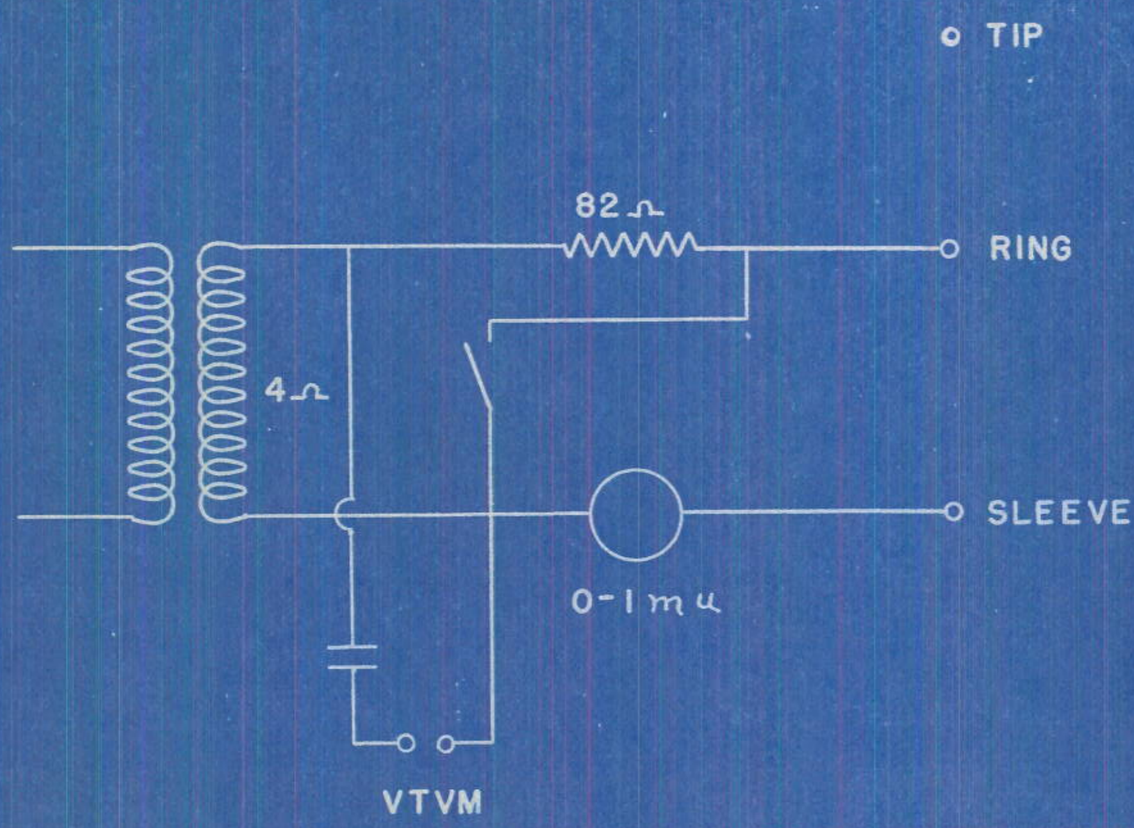
DUMMY MICROPHONE



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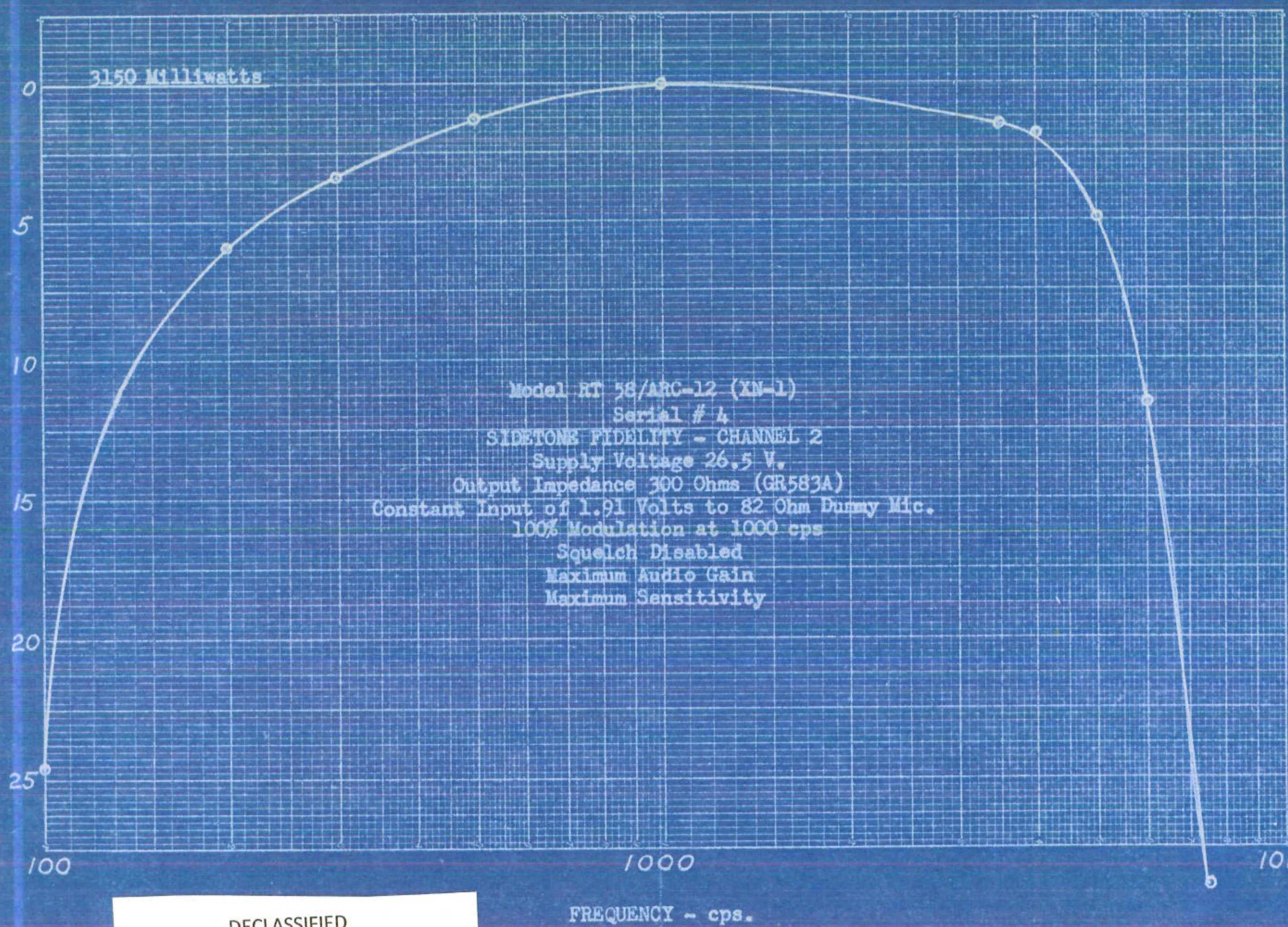
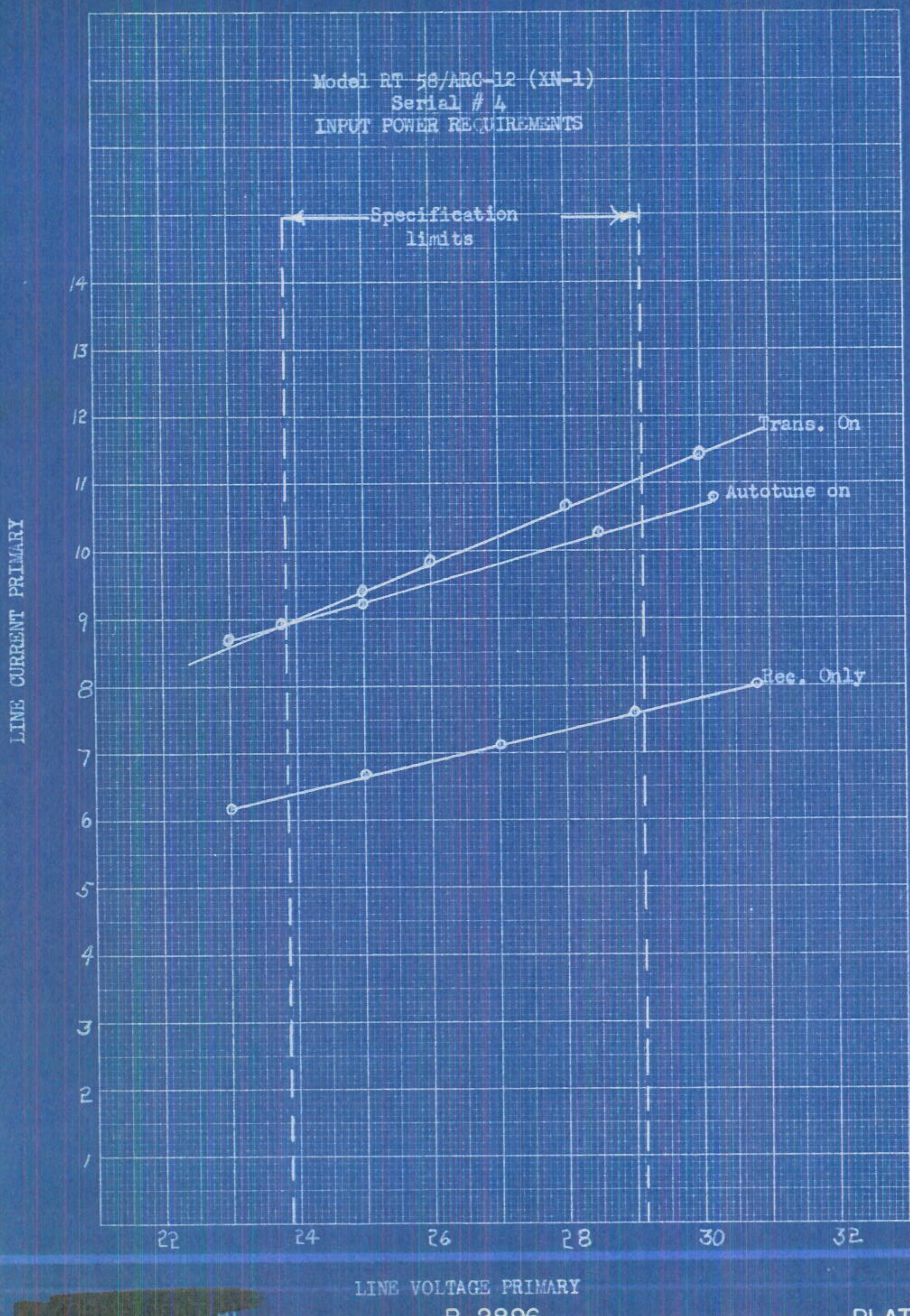
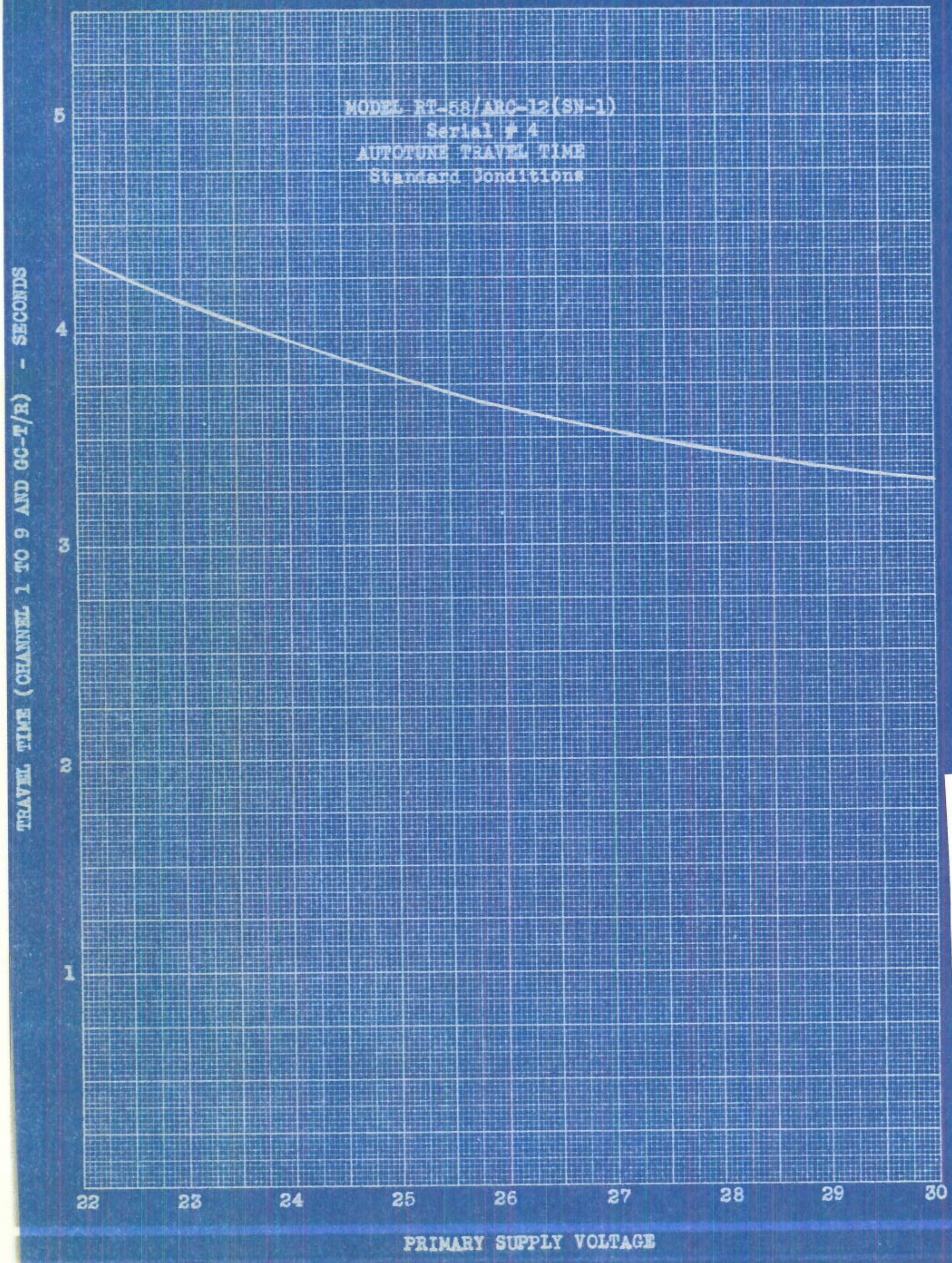


R-2896

PLATE 71


Model RT 58/ARC-12 (XN-1)
Serial # 4
INPUT POWER REQUIREMENTS
Specification limits
Trans. On
Autotune on
Rec. Only
LINE CURRENT PRIMARY
LINE VOLTAGE PRIMARY
14
13
12
11
10
9
8
7
6
5
4
3
2
1
22
24
26
28
30
32



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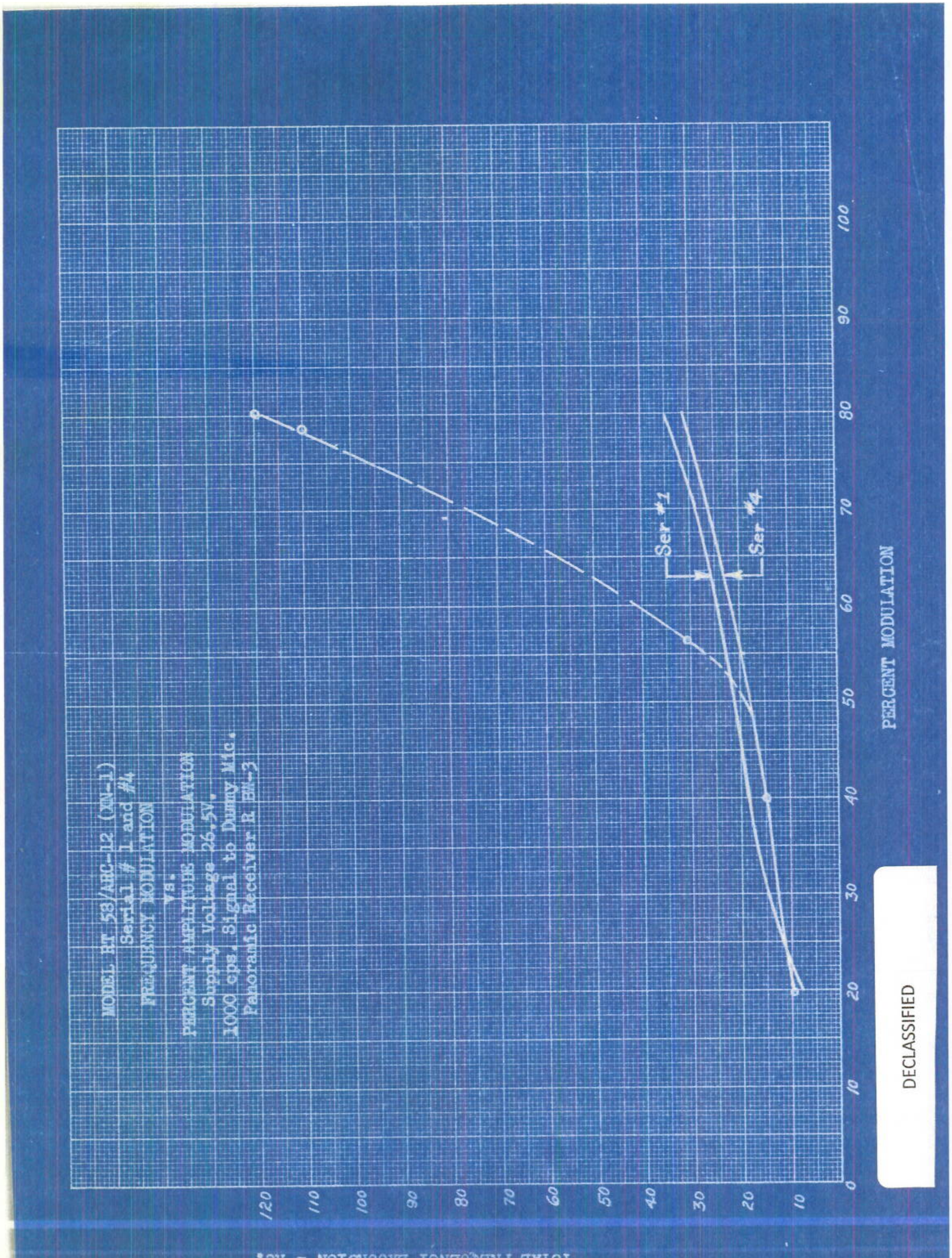
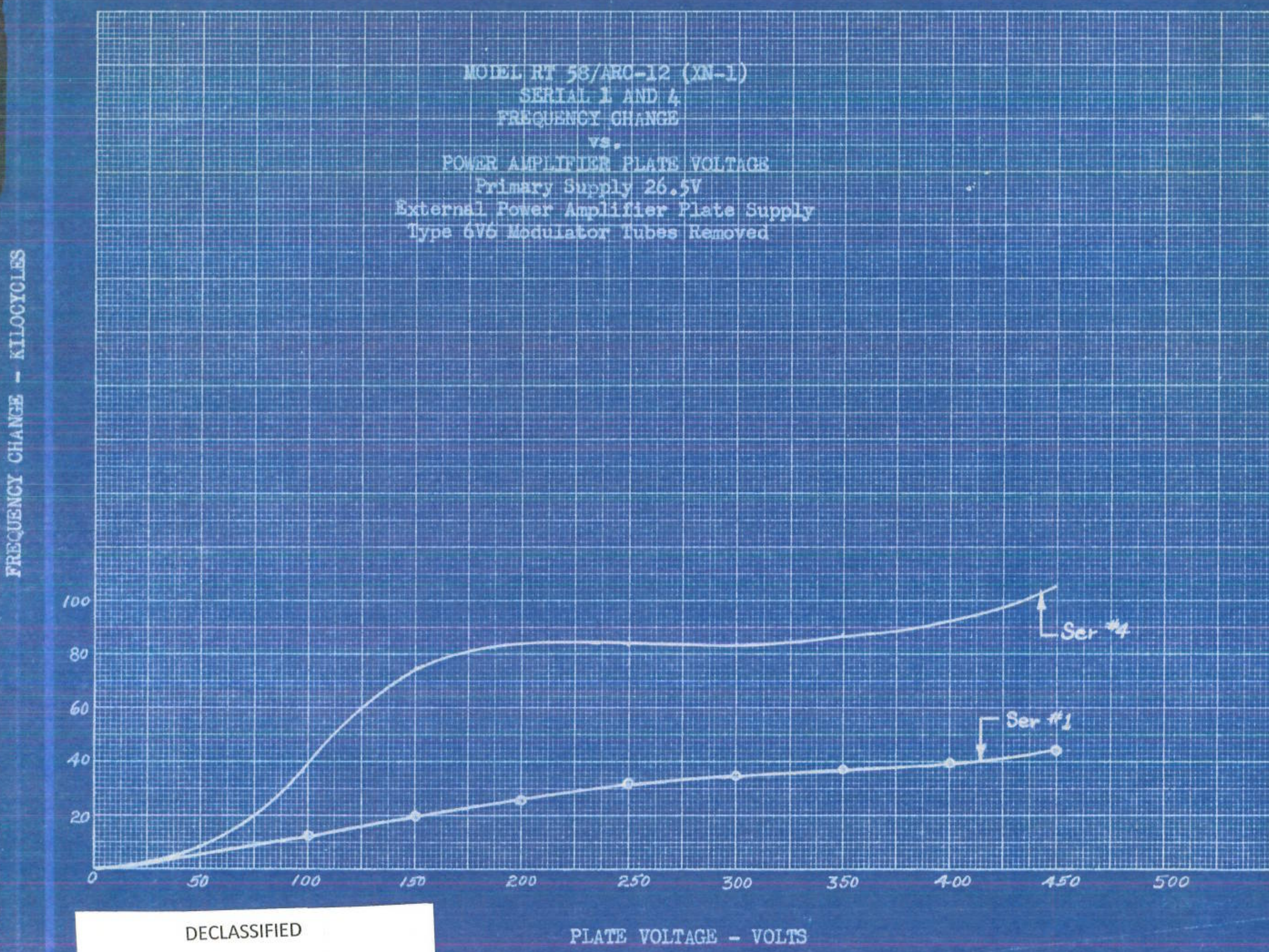

MODEL RT 58/ARC-12 (XN-1)
Serial # 1 and #4
FREQUENCY MODULATION
Vs.
PERCENT AMPLITUDE MODULATION
Supply Voltage 26.5V.
1000 cps. Signal to Dummy Mic.
Panoramic Receiver R BM-3
Ser #1
Ser #4
PERCENT MODULATION
TOTAL FREQUENCY EXCURSION - Kc.

[redacted]



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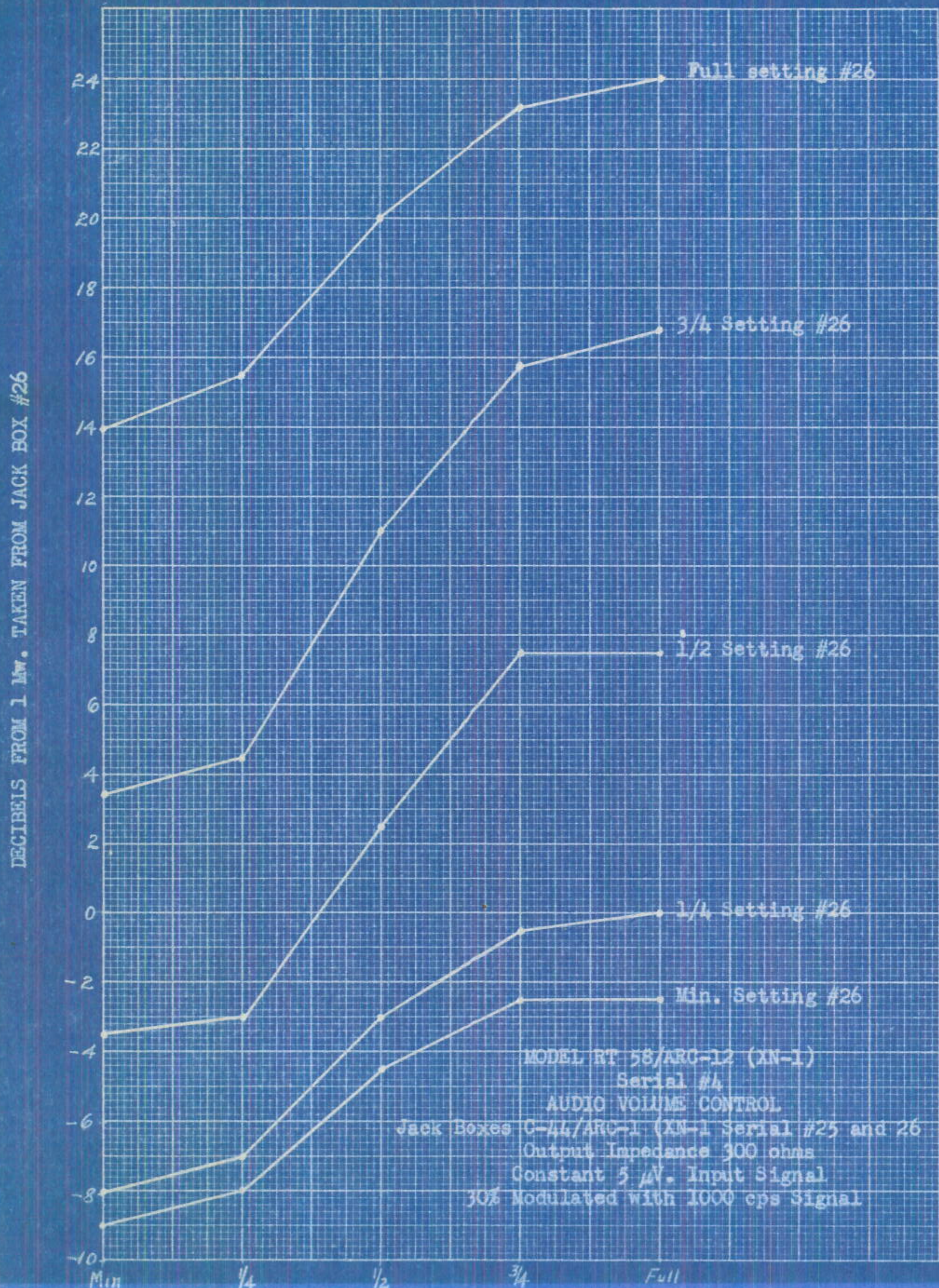
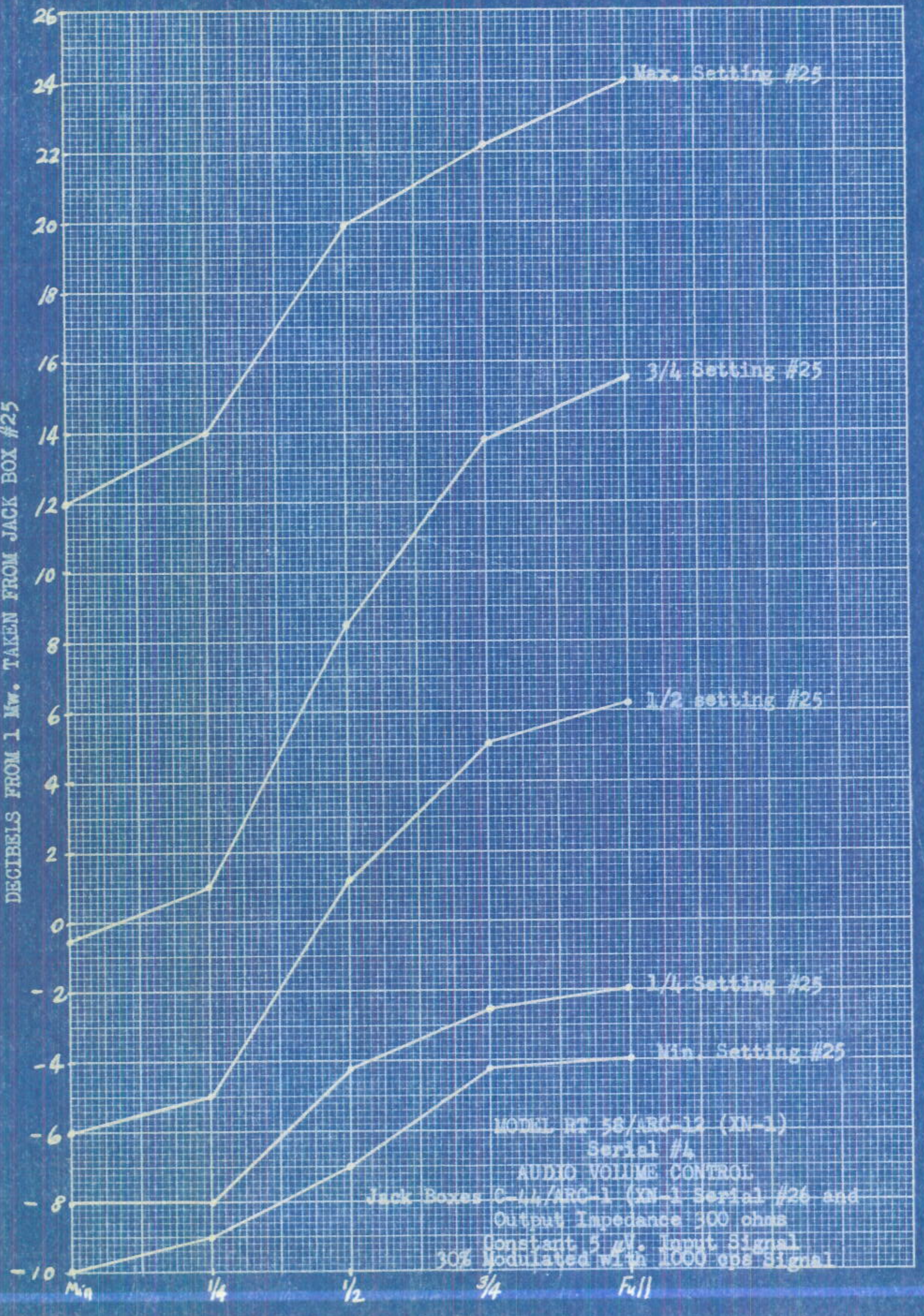


VOLUME CONTROL SETTING JACK BOX #25

[redacted]

R- 2896



VOLUME CONTROL SETTING JACK BOX #26

C-L5-2(2)/S62(1552)

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Report No, M298
1550-132/46 (prh)

From: Shock and Vibration Section, Code 1550

To: Airborne Radio Division, Code 1400

Subj: AN/ARC-12(XN-1) Airborne Equipment - Vibration Tests of - Report on.

Ref: (a) Memo from NRL, Code 1430 to NRL Code 1550, 1400-173A/46(1430:MMF) dated 15 April 1946.
(b) BuShips Specification RE 13A 585B dated 15 December 1943.
(c) BuShips Specification RE 13A 825C dated 4 May 1944.

Encl: (HW)
(A) Photograph: Equipment Mounted on Vibration Machine.
(B) Transmissibility Curve: Equipment Mounted on Airborne Radio Rack Ser. No. 230A/ARC.
(C) Photograph: Record Tape Taken with Mechanical Vibration Recording Meter.

INTRODUCTION

1. The AN/ARC-12(XN-1) Airborne Equipment was subjected to vibration tests on the 15th and 16th of April 1946. The tests were authorized by reference (a) and conducted according to specification, references (b) and (c). Representatives of the Airborne Radio Division witnessed the tests and were responsible for observation of the electrical operation of the equipment.

2. The unit, which weighed 55 pounds, was enclosed in a sheet metal cabinet of the following dimensions: 10 inches wide x 9 inches high x 24 inches long. The cabinet was mounted on an airborne radio rack serial number 230A/ARC.

VIBRATION TESTS

3. The test procedure, in general, was as outlined in reference (c), and in detail was as follows:

(a) The unit was mounted on a horizontal, direct drive vibration machine, the excursion of which was set at 0.060 inch. The unit was vibrated in a direction parallel to its front and transmissibility

[redacted]

(ratio of unit displacement to table displacement) data were obtained. The exciting vibration was then varied continuously and uniformly in periods of about three minutes from a frequency of 11 to 45 and back to 11 cps for a period of 30 minutes. The unit was then vibrated for 15 minutes at 27 cps.

(b) The equipment was rotated 90 degrees on the table and was fastened to a horizontal vibration machine. The unit was then vibrated in a direction perpendicular to its front at an impressed amplitude of 0.030 inch (0.060 inch total excursion) and transmissibility data were obtained. The frequency of the exciting vibration was then varied continuously and uniformly in periods of about three minutes from a frequency of 11 to 45 and back to 11 cps for a period of 30 minutes. The excursion of the vibration machine was then changed to 0.030 inch and the unit was vibrated for 15 minutes at a frequency of 14 cps.

(c) The unit was mounted on a vertical, direct drive vibration machine and it was vibrated in a vertical direction at an impressed amplitude of 0.030 inch. Data for a transmissibility curve were again taken. The frequency of the exciting vibration was then varied continuously and uniformly in periods of about three minutes from a frequency of 11 to 45 and back to 11 cps for a period of 30 minutes. The unit was vibrated at an impressed amplitude of 0.030 inch (0.060 inch total excursion) for a period of 15 minutes at each of the resonant frequencies of 20, 29, and 31 cps. The excursion of the vibration machine was readjusted to 0.030 inch and the unit was vibrated for 15 minutes at a frequency of 10 cps.

(d) At an impressed vibration frequency of 29 cps the unit vibrated at approximately 14 cps with constantly varying amplitudes. Enclosure (C) is a record of this phenomenon taken with a mechanical vibragraph. This record was obtained while the unit was vibrated in a vertical direction at an impressed amplitude of 0.03 inch and a constant exciting frequency of 29 cps.

COMMENTS

4. Although there was no failure in the operation of the unit throughout the tests, it is felt that the resonances and amplifications at high frequencies, as measured, are excessive from a mechanical viewpoint, and will be contributing factors toward shortening the unit's life. It is felt that a mount which would impart better vibration characteristics could be applied.

CONCLUSIONS

5. The unit withstood the specified tests, mechanically, and is therefore considered satisfactory for vibration as outlined in specification, reference (c). Reference (c) contains no resonant

[redacted]

frequency limitations or isolation efficiency requirements, therefore, no conclusions regarding these vibration characteristics can be made with reference to the governing specification.

RECOMMENDATIONS

6. Due to the excessive amplifications measured and the resonances found to exist at high frequencies it is felt that the unit is not mounted for vibration as well as it might be. It is recommended that a mount with more suitable vibration characteristics be provided for the equipment.

Approved by

E. J. Birgelaitis
E. J. Birgelaitis CBQ

Report prepared by

Carl J. Bastien
Carl J. Bastien

TRANSMISSIBILITY CURVES OF AN/ARC-12 (XN-1) AIRCRAFT EQUIPMENT
TESTED UNDER SPEC. AE 13A825C MODIFIED.