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SECOND QUARTERLY REPORT

23 OCTOBER 1962 - 23 JANUARY 1963

MULTIBAND TELEMETRY RECEIVER

BUREAU OF NAVAL WEAPONS

UNITED STATES NAVY PURCHASING OFFICE

WASHINGTON, D.C.

CONTRACT NO. N600(19)59025
PROJECT NO. 1653-01-4360
CONTRACT ITEM NO. 9

JANUARY 1963

RADIATION
Melbourne
A Division of Radiation Incorporated

MULTIBAND TELEMETRY RECEIVER

SECOND QUARTERLY REPORT

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FOREWARD

This second quarterly report describes the design and development during the second quarter of a compact telemetry receiver for general purpose use at shore facilities and in ship and aircraft installations.

The receiver will operate with standard telemetry signals in the 215-315 Mc, 1435-1535 Mc, 2200-2300 Mc frequency bands and other frequency bands up to 10 Kmc, as required.

The receiver will be all solid-state, modular construction with interchangeable demodulators, plug-in heads and plug-in IF and video filters.

Two receivers are being developed for the Bureau of Naval Weapons under Contract N600(19)59025.

CONTENTS

1.0 INTRODUCTION

1.1 Scope of the Report

This report describes in detail the technical status, the design approach, design and test data obtained on developed circuits in the second quarter of the contract. Detailed descriptions of the individual circuit functions are included. Diagrams and sketches are included to aid in the discussion of the individual circuits. A discussion on the packaging concept is included with photographs of the finished breadboard receiver. The design of the overall equipment and subassemblies is presented with details of individual subassembly design criteria.

1.2 Design Considerations

The requirement of the contract are for the development of a compact telemetry receiver suitable for general purpose use at shore facilities and limited use in ship and aircraft installations. The receiver is all solid-state and is designed to operate with standard telemetry signals in the 215 to 315 Mc, 1435 to 1535 Mc and 2200 to 2300 Mc frequency bands, with consideration for operating at the frequencies up to 10 KMC by changing the plug-in tuning head.

Design areas which required major considerations were in the tuning heads where rigid selectivity form factor and noise figure requirements are imposed, and in mechanical packaging to meet the small package size and the relatively severe environmental requirements. The receiver is required to meet the environmental requirements for Class 4 equipment as specified in MIL-E-16400, altitude and vibration requirements established in MIL-E-5400 Class 1A equipment and RFI as specified in MIL-I-26600.

The overall dimension of the receiver is 5-1/4 inches in height, 19 inches in width for mounting in a standard cabinet rack. The depth of the receiver is approximately 16 inches. The anticipated weight of the receiver is less than 40 pounds.

Modular construction is used throughout the receiver to simplify maintenance and to easily change the mode of operation by replacement of one or more modules. Provisions are made for changing the type of demodulation from the standard FM discriminator and envelop AM detector to phase locked FM or PM demodulation, synchronous AM or double side band demodulation, or other types of demodulation which might be required in the future.

The Tuning Heads, which are made in modular form for ease of changing operating frequencies, contain a crystal controlled local oscillator and a variable frequency oscillator. Either crystal control or variable frequency control can be selected by a front panel switch. Tuning is accomplished by a single knob in either mode of operation. The tuning heads convert the incoming signal to 30 Mc which is coupled through the rear, quick disconnect connector to the IF amplifier and second mixer.

The IF assembly contains the second mixer, VCO, and 2 nd IF amplifier, all of which are separate modules. The second mixer converts the 30 Mc first IF signal to a 10 Mc second IF signal. The voltage controlled second local oscillator is a very stable 40 Mc oscillator which is contained entirely in an oven assembly. This oscillator is controlled in frequency by the AFC loop.

The demodulator assembly contains an FM discriminator and AM detector, an AFC amplifier and filter, and the AGC amplifier. These separate circuits are also contained in individual plug-in modules. The FM discriminator and the AFC amplifier module can be replaced to change the type of demodulation required.

The video and monitor assembly also contains three modules. These are the FM video amplifier, the AM video amplifier and the audio and output monitor circuits. These circuits drive the monitor speaker, headphone jack and output meter, and also provide outputs to the rear panel.

The power supply is mounted as an integral part of the receiver package in the rear of the four plug-in modules. Access to the power supply is accomplished either by removing the power supply module from the receiver or through access covers on the top, bottom or rear. This supply provides all power for receiver operation from a 115 volt ac source operating at frequencies between 50 and 450 cps.

2.0 DETAILED ELECTRICAL DESIGN

2.1 215-315 Mc Tuning Head

The design approach of the 215-315 Mc RF head was proven practical through tests made during this report period. Minor modifications have been made in the design since the last report. The latest block diagram is shown in Figure 2.1. The first local oscillator multiplier chain was changed from X6 to X4, for the reasons discussed further in Paragraph 2.1.2 and the AGC voltage to the RF amplifier is delayed as will be discussed in Paragraph 2.7.

The RF head consists of three basic modules. These are the preselector-amplifier, the first local oscillator, and the mixer-IF preamplifier. Each of the circuits has 50 ohms input and (or) 50 ohms output impedance to allow each module to be measured or adjusted independently of one another.

2.1.1 Filter-Amplifier

A complete preselector-amplifier prototype was built and tested with exceptional results. The preselection is obtained by tracking a 5 section inductuner as was discussed in the First Quarterly Report. The 5 section filter tracks exceptionally well over the required 100 Mc tuning range. The bandpass maintains its shape very well when the preselector is tuned across the band, although this presented some problems in the early design phase. Adding equalization networks across the first filter section of the 3 section filter equalized the losses and gain of the preselector across the

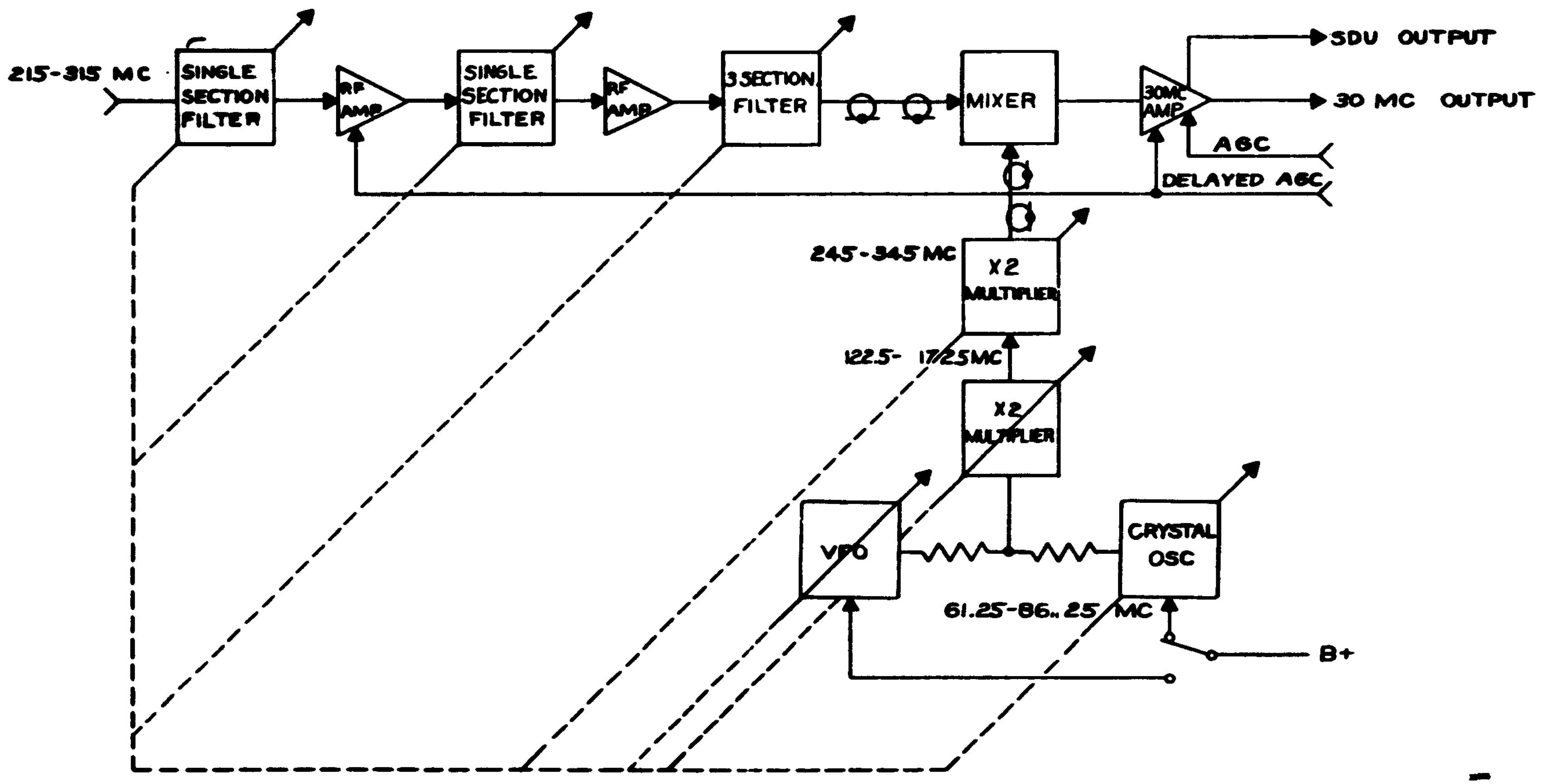

Figure 2.1 Block Diagram 215 - 315 MC Tuning Head

tuning range. The resulting noise figures obtained with the final preselector configuration is approximately 5.5 db at 215 Mc and 6.5 db at 315 Mc.

Curves showing the preselector response characteristics are shown in Figure 2.1.1. Careful examination reveals the response to be slightly asymmetrical around the center frequency. Theoretically, a 5 section fixed tuned filter will produce a uniform response, with coupling that is staggered between inductive and capacitive to preserve a symmetrical response. However, in order to maintain tracking, all stages must be capacitively coupled and since the tuning capacitors are not ideal capacitors the response will not attenuate the higher frequencies as much as the lower frequencies, thereby creating the asymmetrical characteristics.

2.1.2 First Local Oscillator

Since the first quarterly report, the design of the first local oscillator has been improved. The block diagram of the new approach is shown in Figure 2.1.2. A four section inductuner simultaneously tunes the VFO, the crystal oscillator, and the two doubler stages. Each oscillator has a broad band buffer-amplifier for isolation. The complete unit delivers 20 to 30 Mw over the frequency range 245 to 345 Mc with overlap at each end.

2.1.2.1 Crystal Oscillator

The crystal oscillator is a Colpitts type using a 2N918 transistor, with the inductuner as the tuning element. The crystal is inserted between the emitter and the junction of the two tuning capacitors. The crystal is a type CR-75/U which operates at the fifth overtone over the frequency range

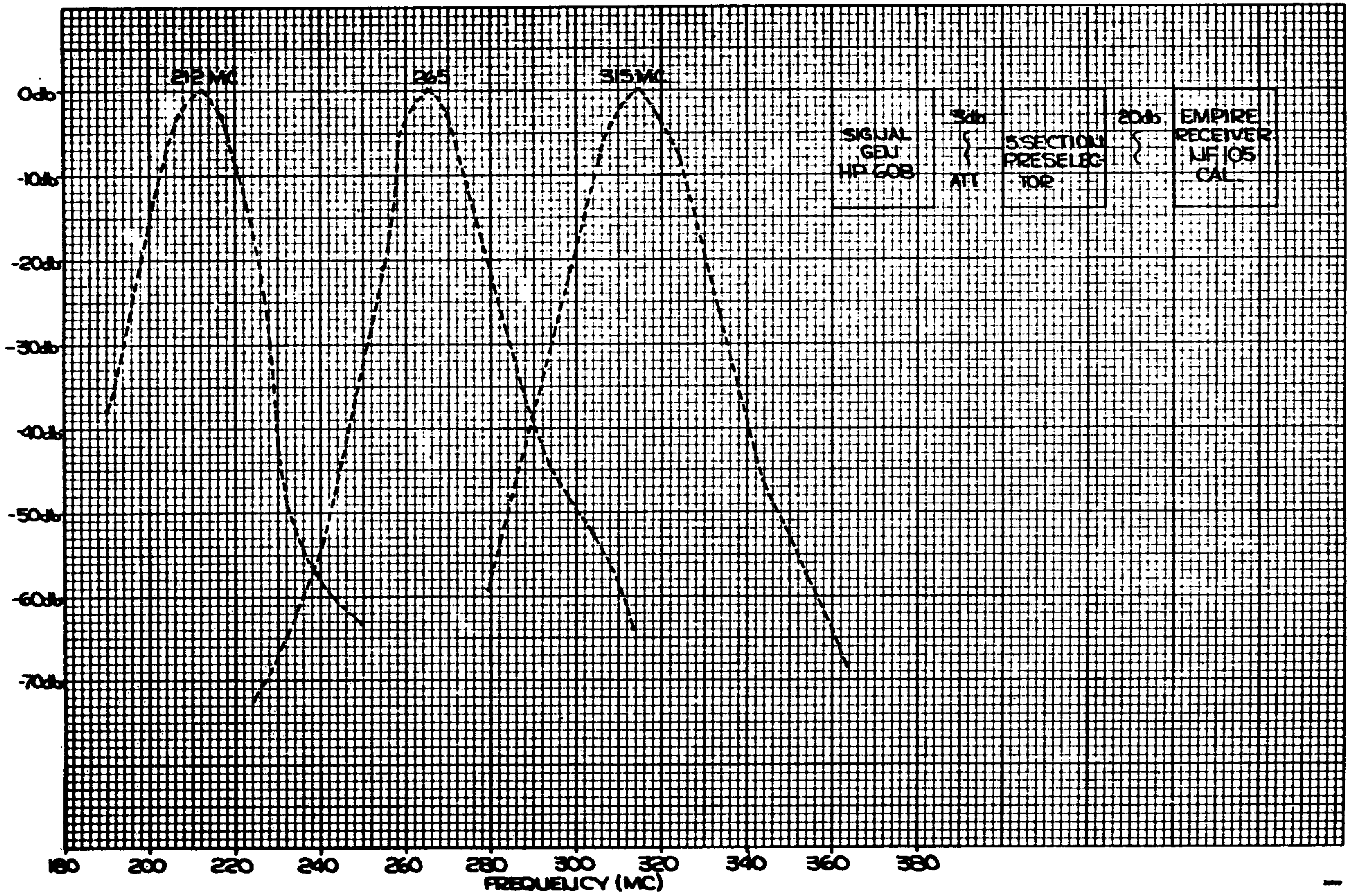

Figure 2.1.1 215 - 315 MC Head 5 Section Preselector Skirt Selectivity

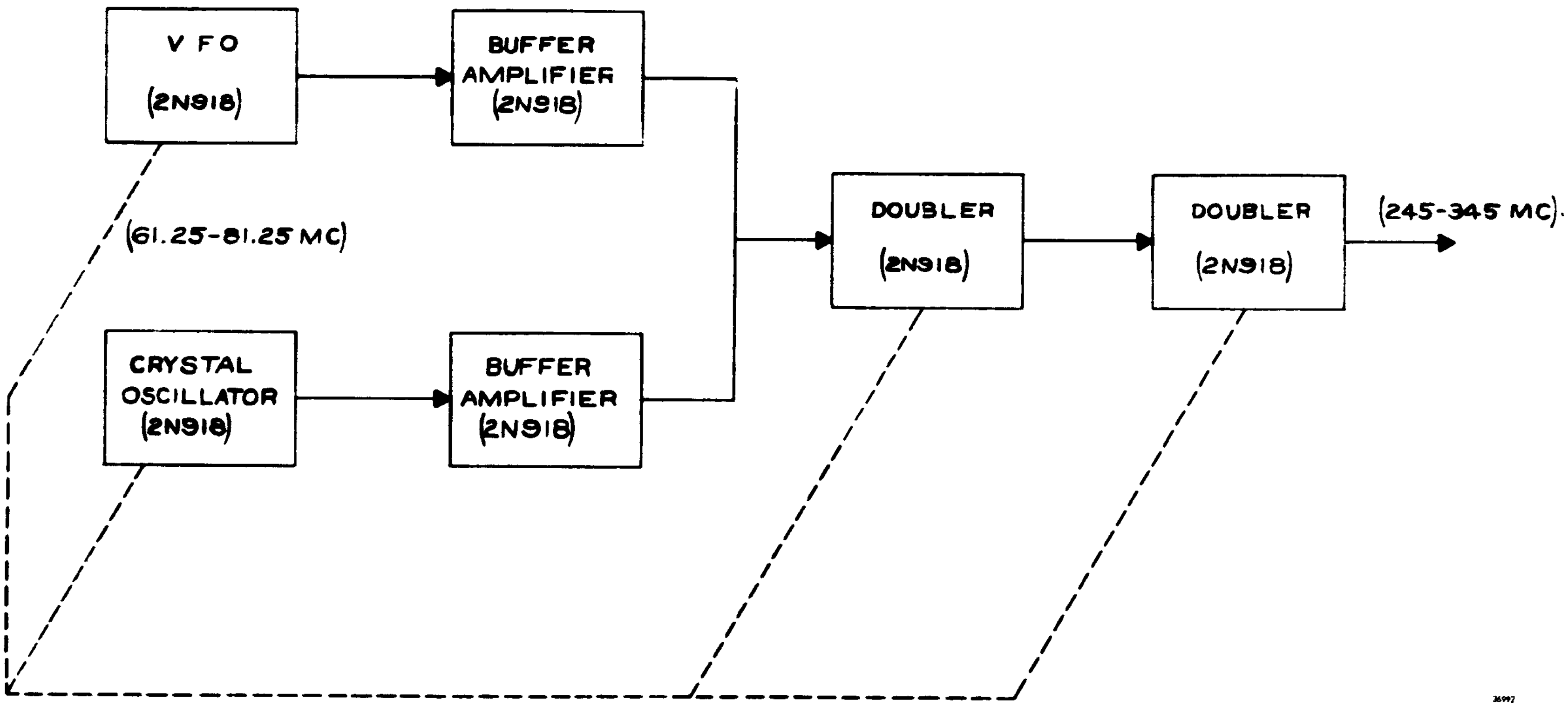

Figure 2.1.2 Block Diagram 215 - 315 MC First Local Oscillator

61.25 to 81.25 Mc. With oven control, the stability should be $\pm 0.00025\%$. The oscillator is followed by a 2N918 buffer-amplifier.

2.1.2.2 Variable Frequency Oscillator

The VFO circuit is identical to the crystal oscillator except that the crystal is replaced by a short circuit. The resonator uses all high stability elements; the inductuner has a temperature coefficient of less than +50 PPM/^{o}C; the fixed capacitors are silvered mica with a temperature coefficient of approximately +50 PPM/^{o}C; the trimmer capacitor is an air dielectric piston type with a temperature coefficient of $\pm$20 PPM/^{o}C. Temperature compensation of the oscillator is obtained by use of negative coefficient capacitors.

2.1.3 Multiplier

The multiplier consists of two doubler stages using 2N918 transistors in the grounded base configuration. The output is 20 to 30 mw over the tuning range. Since the mixer requires only a few mw, attenuation will be used between the first L.O. and the mixer. This will aid in stabilizing the operation of both units.

Tracking of the four stages is accomplished by series inductors and shunt capacitors.

2.1.4 Mixer and 30 Mc IF Amplifier

The mixer and 30 mc IF amplifier was completed during the first report period. Since the RF head gain change is only 3 db a potentiometer will not be tracked with the preselector as proposed early in the design phase. The gain variation within the receiver will be discussed further in Paragraph 2.7.

2.2 1400 Mc and 2200 Mc RF Tuning Head

2.2.1 Electrical Design

The electrical design is as shown in the previous quarterly report. Problems concerning the complete system will be discussed first.

2.2.2 Noise Figure

Early in the program, it was determined that a preselector with a 10 mc bandwidth and with low loss to meet a requirement of a 9 db receiver noise figure could not be fitted into the receiver package. Because of this, a compromise was necessary and the present design holds the 5-1/4 inch panels height by increasing the bandwidth to 15 mc and the noise figure to 10.5 db maximum.

The noise figure of 10.5 db also includes about 1 db loss in a filter to reduce the spurious responses of the receiver as required by MIL-I-26600.

A model of the solid state IF preamplifier with a noise figure of 2.8 db was fabricated, tested and shipped to Frequency Engineering Laboratories for measuring the noise figure of the preselector-mixer. Due to shipment damage, Frequency Engineering Laboratories substituted an IF amplifier with a 2.5 db noise figure and obtained noise figures of 9.2 db to 10.2 db between 2200 and 2300 mc. The preselector-mixer and amplifier were then shipped to Radiation Incorporated for measurement purposes to confirm these figures. Further testing is continuing on the preselector-mixer. Indications are that a noise figure of 10.5 db or less will be obtained.

2.2.3 Tracking

An additional benefit resulted from the increase in preselector bandwidth, and this is in tracking. Although complete data is not yet available on the preselector tuning curve, it is felt that no difficulty will be experienced in maintaining linearity to within ± 1 mc of the best straight line. The linearity of the VFO has been measured and is shown in Figure 2.2.3. Over the tuning range of 46 to 49 mc, which is approximately the range for the 1400 mc tuning head, the tuning curve is about ± 50 kc from the best straight line. When this is multiplied 32 times it will depart ± 1.6 mc from the best straight line. Drift will add ± 0.7 mc. The maximum tracking error will be about ± 3.3 mc, which is well within the tracking error allowable.

The preselector is designed to have a Butterworth response. For a Butterworth filter the attenuation A (in db) is expressed by:

$$A = 10 \log_{10} \left[1 + \left(\frac{\delta f}{\Delta f} \right)^{2n} \right]$$

when $\delta f = 2(f - f_o)$

Δf = 3 db bandwidth

n = number of resonant sections = 4

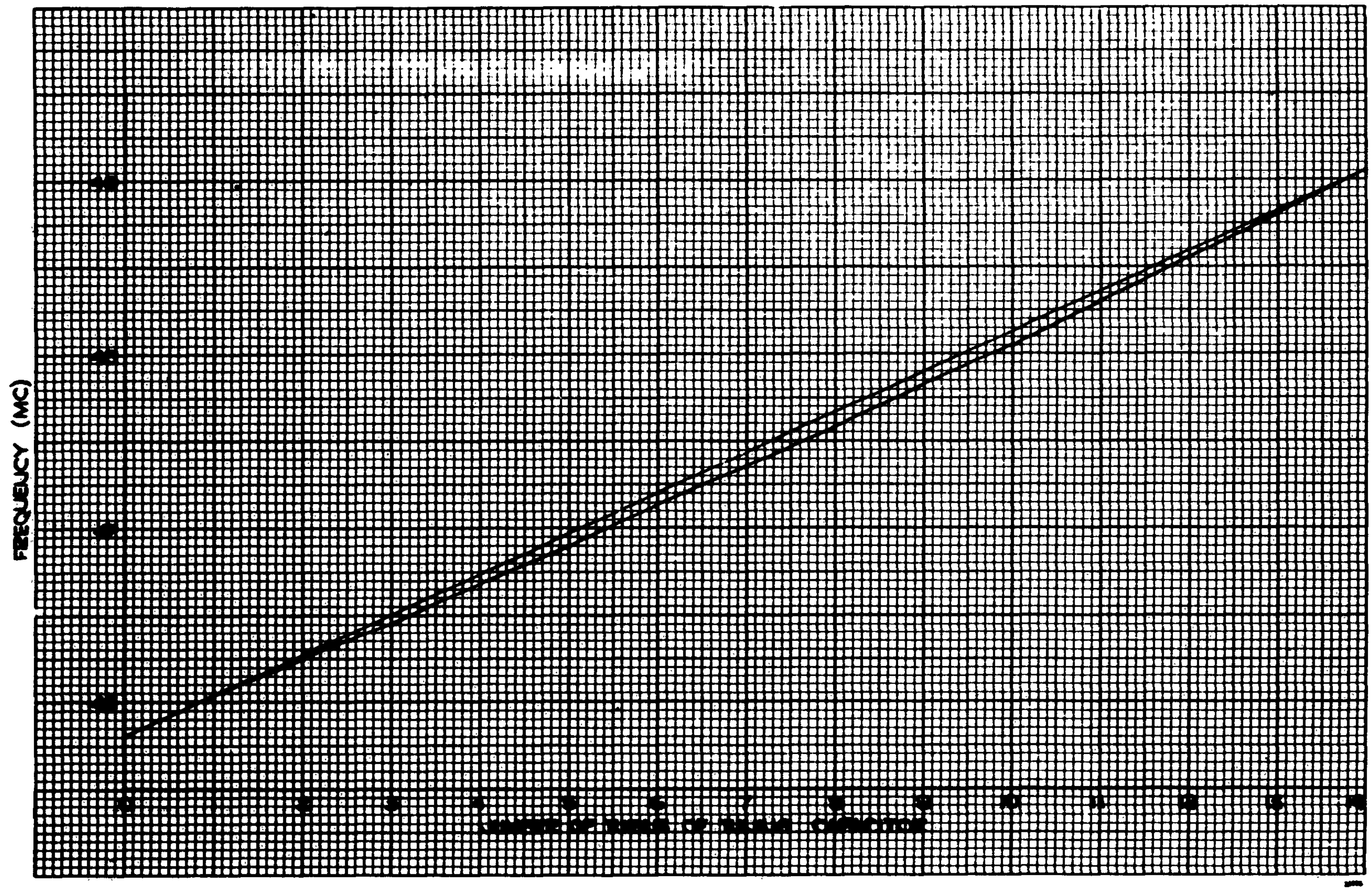

Figure 2.2.3 Oscillator Tuning Linearity

$$A = 10 \log_{10} \left[1 + \left(\frac{6.6}{15}\right)^8 \right]$$

$$A = 10 \log_{10} 1.0014 = \sim 0 \text{ db}$$

It can be seen that the attenuation in the preselector for a ± 3.3 mc tracking error is negligible, and indeed shows that considerably larger tracking errors can be tolerated without significant deterioration to the performance of the receiver.

2.2.4 Preselector-Mixer

As was mentioned previously, the bandwidth of the preselector has been increased to 15 mc and the maximum allowable noise figure of the preselector-mixer increased to 10.5 db. A 2200 mc unit has been received from Frequency Engineering Laboratories and is being tested.

2.2.5 Oscillator-Driver

The oscillator-driver has been constructed and tested. It consists of a VFO and buffer-amplifier and a crystal oscillator and buffer amplifier, which are identical except for the crystal. The VFO-XTAL switch applies power to either oscillator; the buffer-amplifier drives a three stage amplifier which develops an output power of 3 watts. The oscillator-driver for the 1400 mc head is identical to the one for the 2200 mc head, except for a small difference in frequency range.

2.2.5.1 VFO

The VFO is a Clapp oscillator using a 2N918 transistor. The resonator consists of a metalized glass inductor and a piston type variable capacitor; both elements were chosen for their low temperature coefficients. The tuning is accomplished by the piston capacitor, which is a special unit made by Johansen Manufacturing Corporation. It has been designed (1) to have a low temperature coefficient and, (2) to have a linear capacitance change as a function of angular rotation. Measurements have been made of the linearity by installing the capacitor in the oscillator and measuring the frequency as a function of angular rotation. Figure 2.2.5.1 illustrates the tracking non linearities incurred per turn of the tuning capacitor. Here it is seen that, although the excursion from linearity per turn are not cumulative, the tracking curve is not a uniform function as might be indicated by Figure 2.2.3. It shows a departure of about $\pm$5 kc from a straight line drawn through the end points. When this is multiplied 32 times in the 1400 mc tuning head the error will be 160 kc, and when multiplied 48 times in the 2200 mc tuning head the error will be 240 kc. Neither of these errors are large enough to cause any mistracking.

2.2.5.2 Crystal Oscillator

The crystal oscillator is identical to the VFO except that the crystal has been put in the feedback path. The crystal is a CR-65/U which is a third overtone crystal, and covers the tuning range from 45.8 to 48.9 mc in the 1400 mc head and 45.3 to 47.3 in the 2200 mc head. With oven control the stability of the crystal oscillator should be $\pm$0.00025%.

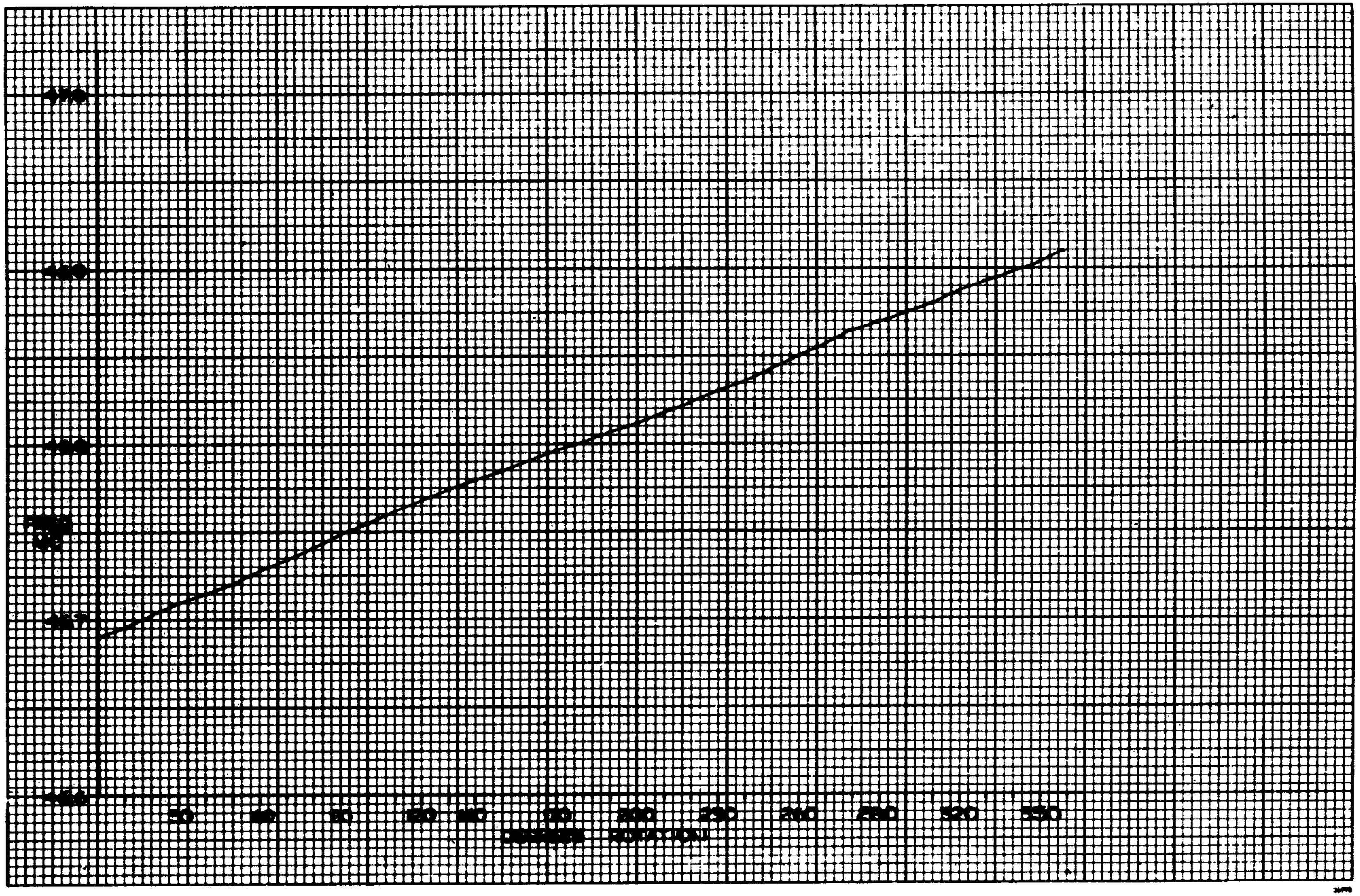

Figure 2.2.5.1 Oscillator Linearity for one Revolution of Tuning Capacitor

2.2.5.3 Multiplier Driver

The multiplier driver is a three stage amplifier which develops three watts. It has a gain of about 30 db and a 3 db bandwidth of about 8 mc. The transistor line up is a 2N2219, a TA1938, and a 2N1710 power amplifier. All stages are operated grounded emitter and all coupling networks are series capacitance transforming networks. The last two stages, the TA1938 and the 2N1710, are mounted on beryllium oxide washers to conduct the heat to the chassis. The power amplifier stage operates at a collector efficiency of about 60 percent. A three db attenuator will be put between the output of the multiplier driver and the input of the multiplier. This will help to stabilize the load impedance that the multiplier driver will be working into, and will also make the source impedance, as seen by the multiplier, look like 50 ohms. A small portion of the multiplier driven output will be brought out to a connector on the rear apron of the receiver so that the oscillator frequency may be measured.

2.3 Second Mixer

A one-stage 30 mc amplifier, the second mixer and a one-stage 10 mc preamplifier, make up the 2nd mixer module. This module has been constructed and checked out. The schematic and mechanical drawings have been completed.

The module has an overall gain of approximately 20 db. The 30 mc amplifier has a gain of 15 db and 10 mc preamp has a gain of 15 db with the diode mixer having an insertion loss of approximately 10 db. A diode mixer was used to minimize stages of gain that could not be controlled. If a mixer with gain had been used it would have been undesirable to control this with the AGC loop.

The mechanical configuration of the 2nd mixer module mating with the IF filter is shown in Figure 2.3. This configuration of the module was used so as to insure maximum isolation between input and output connections of the IF filter.

2.4 Bandpass Filter and Second IF Amplifier

The second IF is operated at a center frequency of 10 mc with a gain of approximately 80 db. The bandwidth is 2.5 mc. This circuit has been constructed and tested. The design is frozen with schematics and mechanical drawings completed.

The IF bandpass filters have been received with the exception of the 50 kc and the 100 kc bandwidths. Some minor difficulty was encountered by the vendor in meeting the specifications of these two filters, but delivery is promised within the next few days.

A passband response of the 300 kc and the 1 mc bandwidth filters are shown in Figures 2.4 and 2.4.1.

2.5 Demodulators

2.5.1 AM Detector, FM Discriminator and Limiters

Two changes have been made in the demodulator circuitry during this reporting period. One change is the addition of a broadband

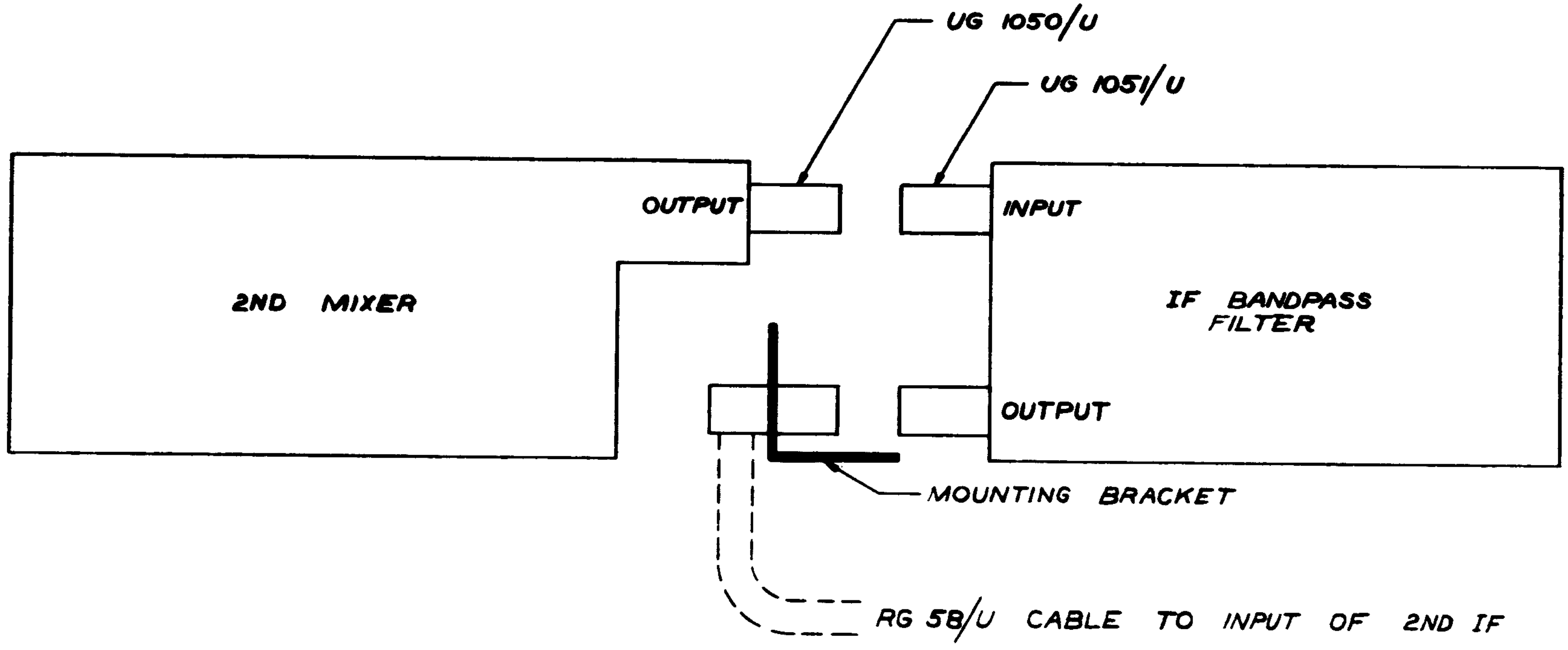

Figure 2.3 Mechanical Outline of 2nd Mixer and IF Filter

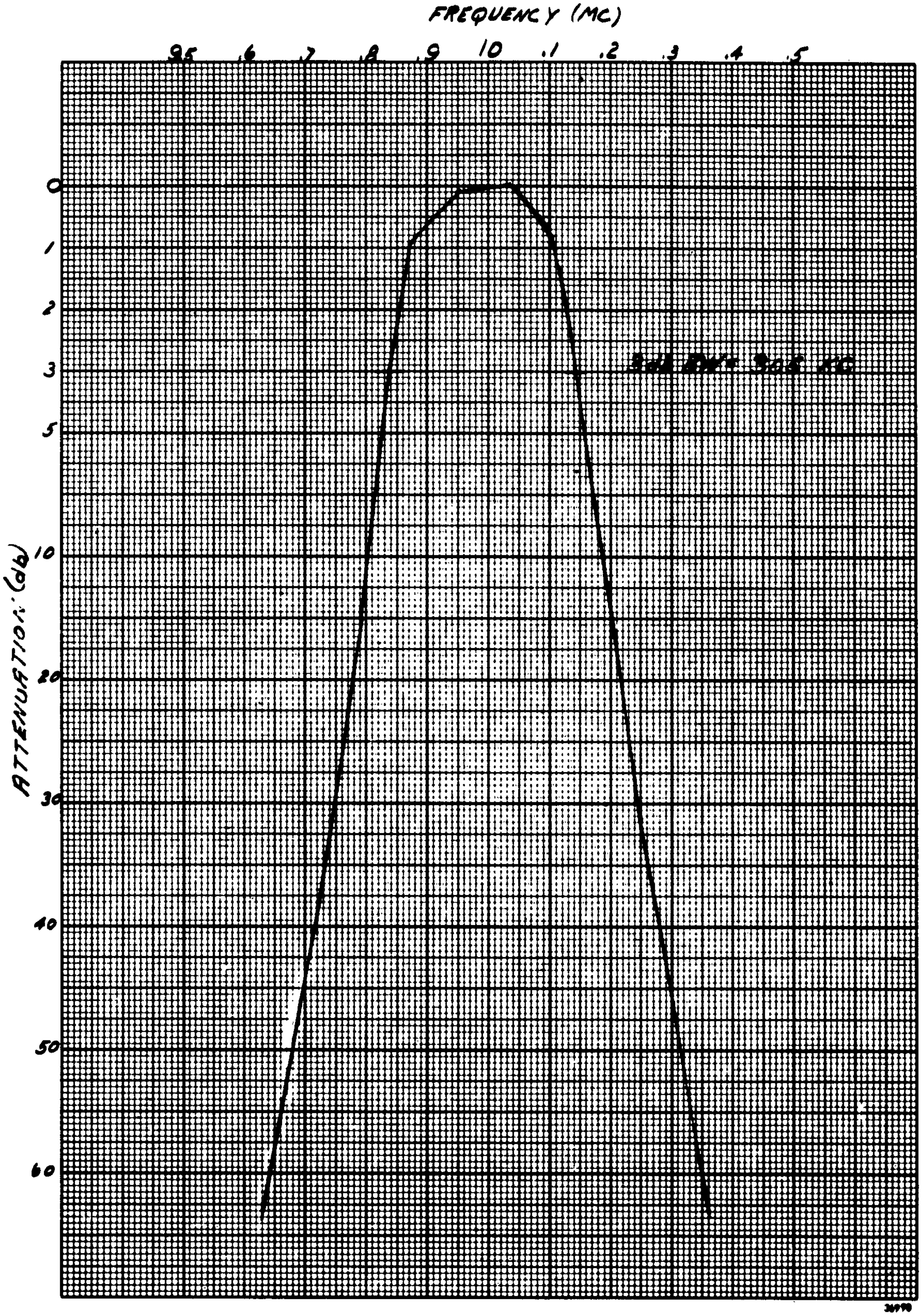

Figure 2.4 Passband Response of 300 KC BW IF Filter

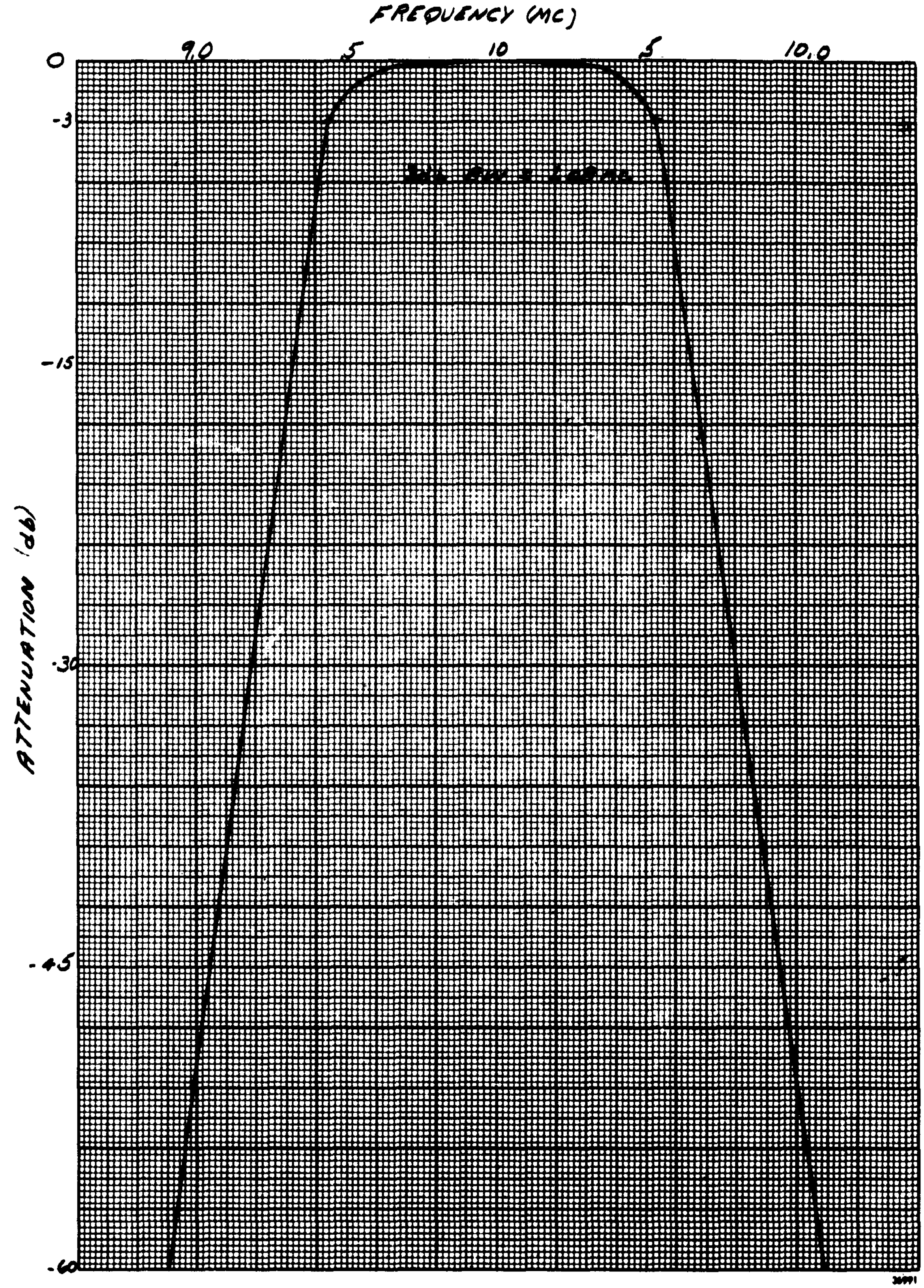

Figure 2.4.1 Passband Response of 1 MC IF Filter

amplifier to boost the level of the limited predetection output to 100 millivolts. The second change is the addition of a second discriminator to be used with IF bandwidths of 300 kc and lower.

It was necessary to add an amplifier ahead of the limited predetection output in order to boost this output to a value compatible with existing predetection recording systems. Particular care was taken in the design of this amplifier to insure stable gain and wide bandwidth. The gain of this amplifier is down only 0.2 db, with respect to the gain at 10.0 mc, at the $\pm$1.5 mc points. Incidental amplitude modulation re-introduced in this stage will therefore be negligible even with high modulation rates and wide deviation.

A narrow band discriminator was incorporated in order to improve the gain and stability of the receiver with respect to narrow band signals. This discriminator has a peak-to-peak bandwidth of 1.0 mc and a sensitivity of 7.5 mv/kc. It is extremely linear over a range of $\pm$200 kc. A front panel switch has been added to the receiver for the purpose of switching between the narrow band and wide band discriminator outputs and making appropriate changes in the gains of the AFC and deviation meter circuitry.

The advisability of using separate discriminators for narrow band and wide band signals became apparent after laboratory measurements revealed that the available sensitivity from the wide band discriminator is only 1.0 to 1.5 mv/kc. This factor, coupled with the fact that the AFC amplifier may drift 5 to 10 mv, referred to its input, over the operating temperature range, might conceivably cause a closed loop AFC drift on 10 kc. A drift of this magnitude could cause a signal to be outside of a 12.5 kc IF bandwidth so the signals would not be acquired by the AFC. On the other hand, with the 7.5 mv/kc sensitivity obtainable with the narrow band discriminator, the maximum closed loop drift attributable to the AFC amplifier is only 1.3 kc so the signal would be well within a 12.5 kc IF bandwidth and would therefore be easily acquired by the AFC.

The preceding argument overlooks another cause of equal importance: drift in the discriminator itself. In the worst case, this drift may add directly to the drift contributed by the AFC amplifier. It is evident that maximum narrow band discriminator drift must be held to perhaps 2 kc over the operating temperature range.

This tight specification, however, applies to the narrow band discriminator only. Since the wide band discriminator is intended for use only with IF bandwidths of 500 kc and greater, it may be permitted to drift as much as, say, 20 kc without adversely affecting the signal.

Adding the 2 kc discriminator drift to the 1.3 kc of possible drift due to the AFC amplifier, we obtain a figure of 3.3 kc maximum drift with the narrow band discriminator.- 0.03% of the 10 mc intermediate frequency. This is in accordance with the letter of Paragraph 3.3.1.8 of XWS 1925, which states that the center frequency stability must be 0.1% or better. However, the instability of the wide band discriminator may be 30 kc or 0.3% of the 10 mc IF. This will not degrade the performance of the receiver, because of the wide IF bandwidths with which it is associated.

The foregoing argument on discriminating stability is somewhat hypothetical, since final testing of the breadboard discriminators has not yet been accomplished. This testing will be performed by 1 February.

Figure 2.5.1 is a plot of the narrow band discriminator output voltage versus frequency. Over a range of ±200 kc the maximum deviation from the least mean square linear curve fit is 0.3 kc or 0.15%.

Design parameters of the standard FM demodulator are:

Input Impedance:	50 ohms nominal
Input Signal Level*:	0.2 volts ±6 db
AM Detector Bandwidth:	dc to 500 kc at upper 3 db point
Limiter Bandwidth:	3.0 ±0.3 mc at 3 db point
Limited Predetection Output Level*:	100 mv nominal into 50 ohms
Discriminator Bandwidth*:	
Wide Band Discriminator:	3.0 ±0.3 mc at peaks of static deviation response curve
Narrow Band Discriminator:	1.0 ±0.1 mc at peaks of static deviation response curves

*Revised since First Quarterly Report

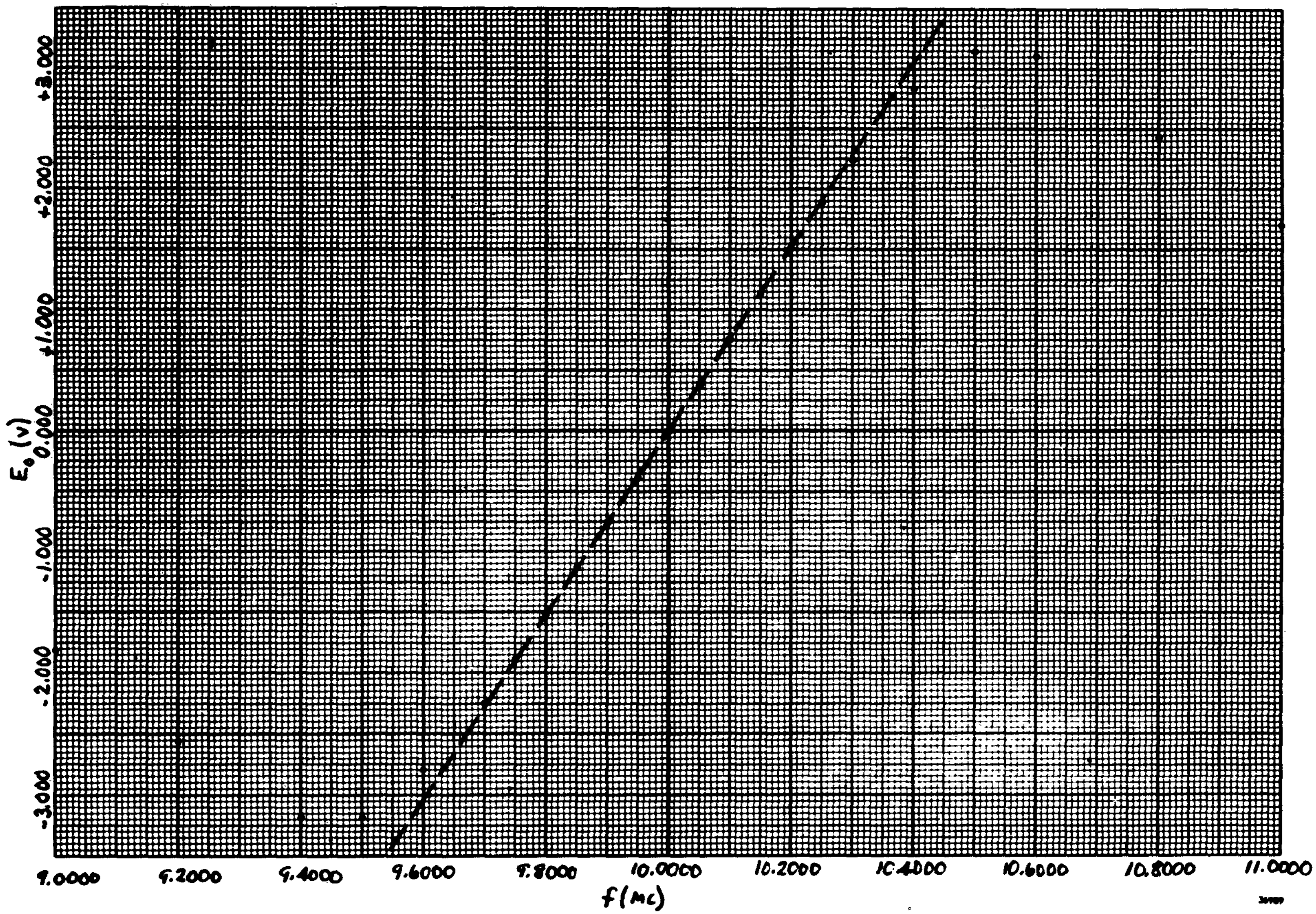

Figure 2.5.1 Narrow-Band Discriminator Characteristic of 1653 Telemetry Receiver

Video Bandwidth*:

Wide Band Discriminator:	dc to 2 mc at upper 3 db point
Narrow Band Discriminator:	dc to 200 kc at upper 3 db point

Discriminator Sensitivity*:

Wide Band Discriminator:	1 mv minimum per kc deviation
Narrow Band Discriminator:	7.5 mv nominal per kc deviation

Discriminator Center Frequency Stability*:

Wide Band Discriminator:	± 20 kc maximum drift, $0^{\circ}C$ to $50^{\circ}C$ ambient
Narrow Band Discriminator:	± 2.0 kc maximum drift, $0^{\circ}C$ to $50^{\circ}C$ ambient

2.5.2 Phase-Lock and Synchronous AM Demodulators

Most of the circuitry for the phase-lock FM and PM demodulator and the synchronous AM demodulator has been designed. While these demodulators are not a part of the present contract, it was felt that it was necessary to design the demodulators to show compliance with the compatibility requirement of the contract.

*Revised since First Quarterly Report

2.6 Automatic Frequency Control

2.6.1 AFC Loop

The AFC loop uses two cascaded low drift transistorized integrators to achieve high loop gain at zero frequency. The tuning mode of the second local oscillator may be selected from the front panel as AFC/APC or manual. The gain in the integrators is automatically adjusted to the proper value when the front panel discriminator switch is set to the wide or narrow position.

2.6.2 Second Local Oscillator (VCO)

A VCO has been constructed and tested and is shown in Figure 2.6.2.

It consists of a Clapp oscillator and a buffer-amplifier, with both stages using 2N918 transistors. Large capacitors (350 pf) shunt the base-emitter and collector-emitter impedances of the oscillator transistor. The manual tuning control is a precision potentiometer on the front panel. Considerable care has been taken to achieve the stability requirements. The resonator uses low temperature coefficient elements such as a metallized glass inductor and silvered mica capacitors. The voltages for the transistors and Varicap have been very carefully regulated. These voltages are Zener regulated and the voltage source that feeds the Zeners has 0.1 percent regulation. The complete oscillator, including Zeners, is in an oven which is thermostatically controlled. The manual tuning control, which mounts on the

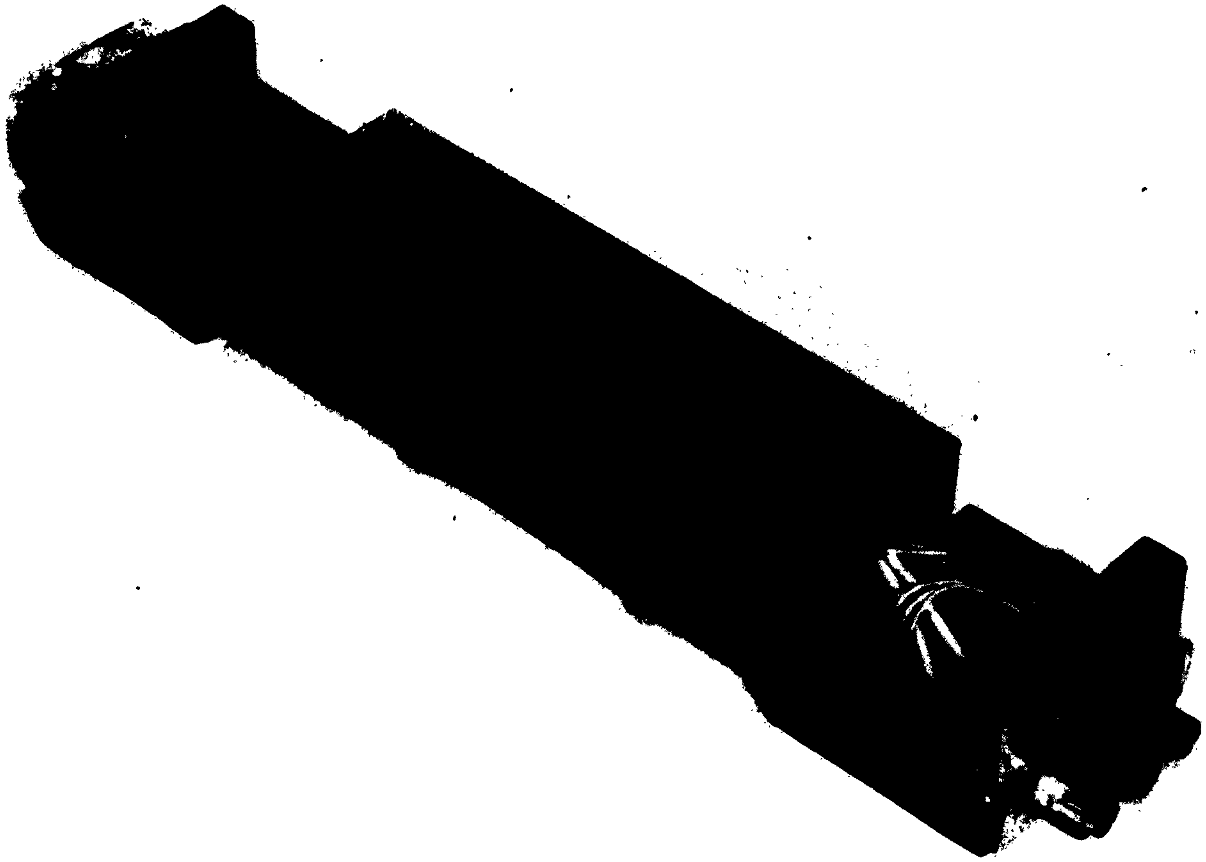

Figure 2.6.2 VCO Module

front panel and is outside the oven, is a low temperature coefficient, precision potentiometer. Final compensation is made with temperature compensating capacitors.

2.7 Automatic Gain Control

The design for the AGC loop has been completed, tested and proven. Extensive effort has been applied to the design to provide a linear AGC response characteristic. An integrator is used in the AGC amplifier to linearize this characteristic which results in a very stable closed loop condition even though the AGC loop gain approaches infinity.

Staggered delays are placed throughout the tuning head and the IF amplifier to further linearize the AGC response as well as to increase the over-all dynamic range of the AGC circuit.

The excellent design of the AGC circuit is reflected in a curve showing AGC voltage versus receiver input signal level is shown in Figure 2.7. It is of interest to note that the curve covers a dynamic range of approximately 128 db, which is far in excess of the requirements. The demodulated AM output was noted to have negligible change with an input signal level from -128 to 0 dbm.

Care has been taken to delay the AGC applied to the input stage of the preselector in the 215-315 mc head and the first IF amplifier stage in the other heads, to permit development of a good signal to noise ratio before the gain of these stages is reduced.

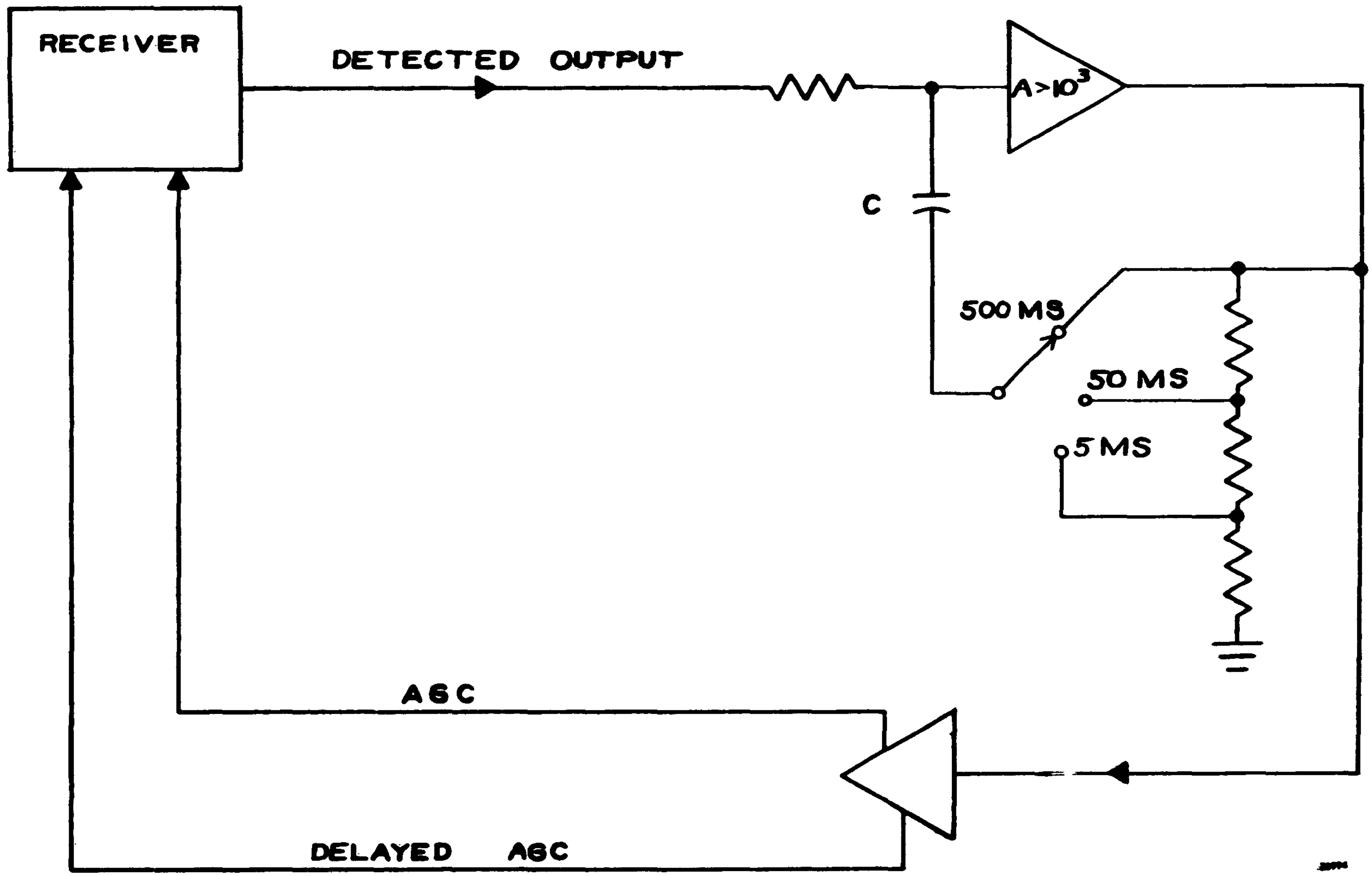

Figure 2.7.1 Block Diagram AGC Loop

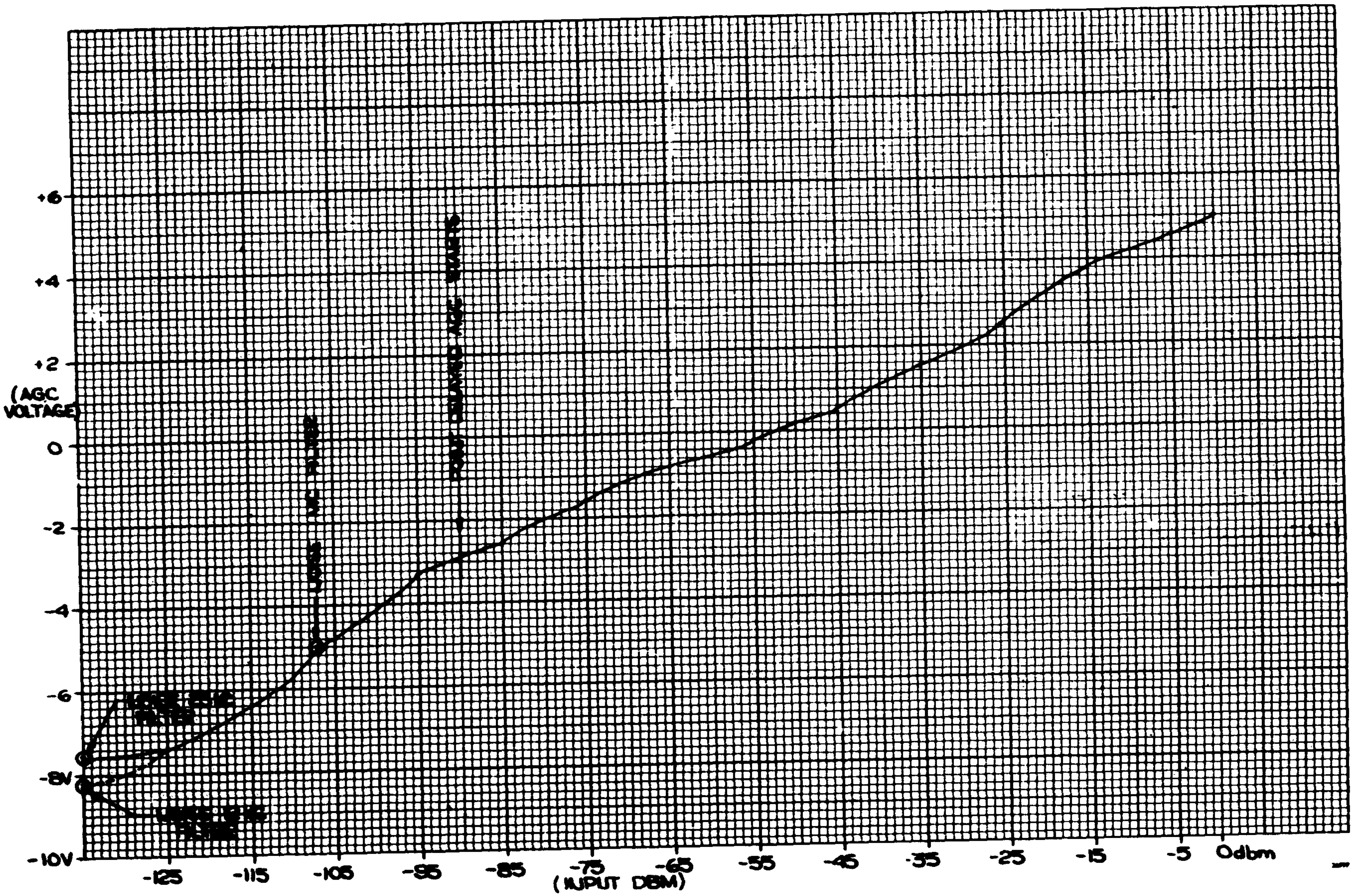

Figure 2.7.2 Plot AGC Voltage Vs Signal Strength Solid State Receiver with 215- 315 MC Head Receiver Output Held Constant

The AGC is designed to operate on noise when a 12.5 kc pre-detection bandwidth is selected. To accomplish this, additional AGC dynamic range is required, but the advantages gained in not requiring additional equilization gain controls in the tuning heads and IF amplifier greatly exceed the disadvantages in obtaining the additional dynamic range required.

2.8 Video Amplifier

The video/monitor chassis of the receiver consists of three modules, the FM video, AM video and the monitor and output meter amplifiers.

The FM video module contains the circuitry for the high level video output (output no. 2) which supplies a minimum of 10 VRMS into a 5000 ohm load, shunted by 1800 pf with a frequency response of 10 cps to 150 kc.

The AM video module contains the circuitry for the low level video output and the AM video output. The low level video output (output no. 1) supplies a minimum of 1 VRMS into a 50 ohm load with a frequency response from 10 cps to 1.5 mc. The AM video output supplies a minimum of .5 VRMS into 50 ohm from 10 cps to 100 kc.

The third module contains amplifiers for the headphone monitor, the monitor speaker, and output meter.

The design has been frozen on this entire subassembly with shop fabrication now in progress for the final receiver.

2.9 Video Plug-In Filters

The electrical and mechanical design of the plug-in video filters is complete. These filters are constant K, maximally linear phase response, six section filters. Testing of the completed filters indicate that they follow the anticipated cutoff characteristics. The requirement for cutoff is that the attenuation be 13 db at two times the 3 db cutoff frequency and 30 db at three times the 3 db cutoff frequency.

3.0 DETAILED MECHANICAL DESIGN

3.1 General

The mechanical prototype (Figure 3.0-1 and 3.0-2) was essentially complete December 17, 1962. All current effort is directed toward the pre-production units.

All packaging decisions have been made at this time. Detail work remains only on the power supply and RF head portions of the design. As was indicated in the last report, the power on-off switch and indicator has become an integral part of each RF head as opposed to the separate panel originally conceived.

3.2 VCO

The VCO oven has been cycled to determine thermal characteristics. Although performing near expectations with 10 watts total power consumption, the temperature gradient between the two ends of the oven was found to be 17°C, due mainly to the uneven heat transfer at the two ends of the oven. A second thermostat will be added to control the two heaters at opposite ends of the oven independently.

3.3 RF Heads

The RF heads are being mechanically finalized. The design of the gears for the low frequency head was much simplified over our original approach. This is due primarily to the combining of the VFO and mixer functions with a common tuning shaft. The intermediate and high frequency heads also lend themselves to a very straightforward approach to gearing.

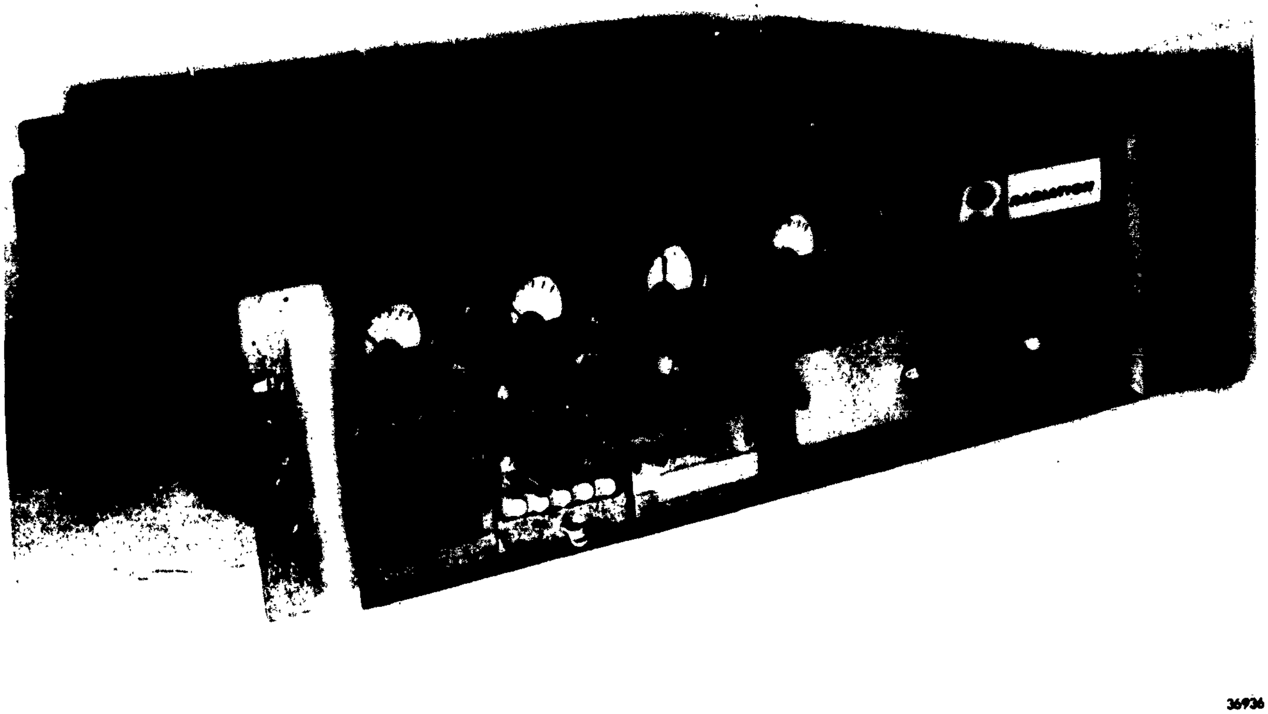

Figure 3.0-1 Breadboard Receiver

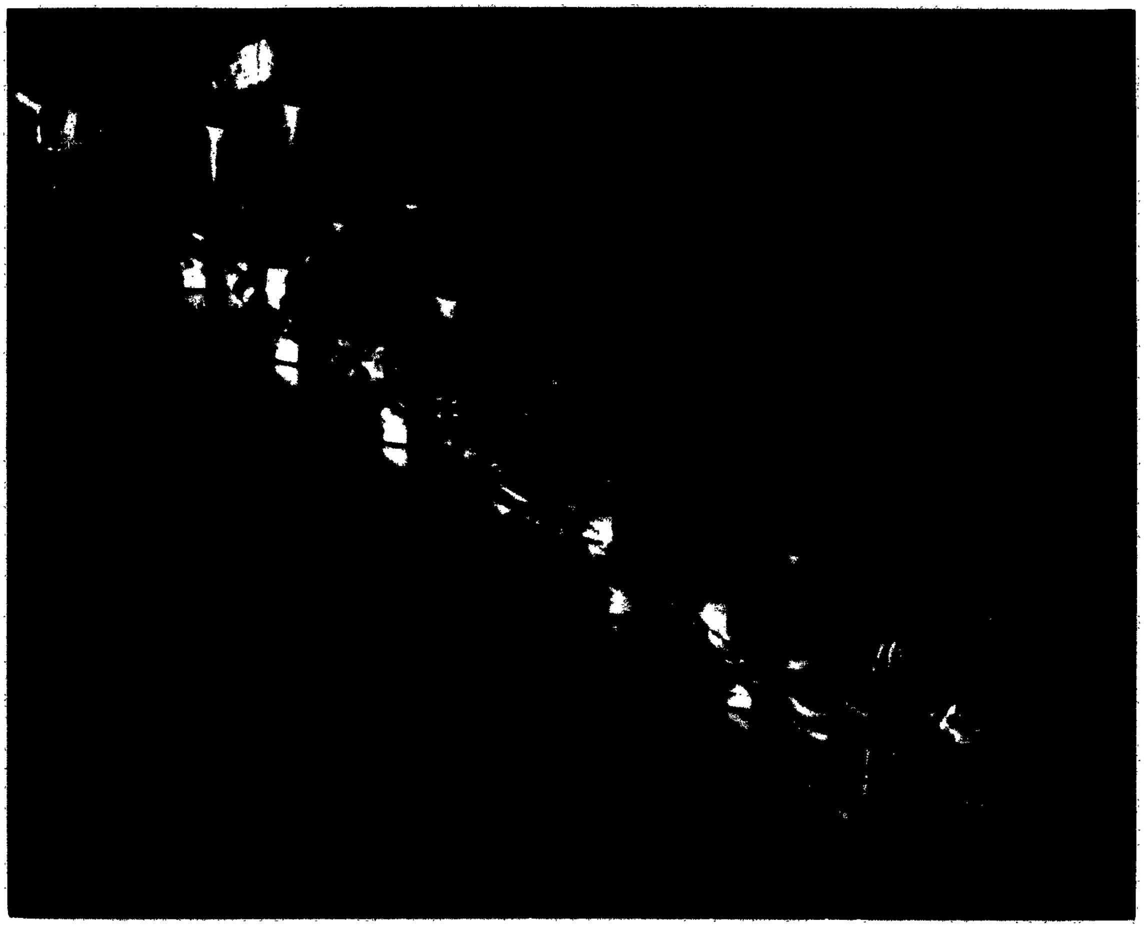

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Figure 3.0-2 AFC Module

The oscillator crystal is located behind a removable front panel cover plate as opposed to the original concept of plugging directly into the front panel. The ability to use standard crystal ovens with no mechanical modification (such as installing a handle on each), the improved design from an RFI standpoint, and the increased vibrational resistance are the primary factors leading to this change.

3.4 Power Supply

The power supply circuit components have been determined and it has been decided that a modular power supply will be provided for ease of maintenance. Access to the power supply is accomplished either by removing the power supply module from the receiver or through access covers on the top, bottom, or rear. The power supply will be attached to the rear panel so that for access to the connector area, the power supply is removed with the rear panel. Connectors will be used to achieve complete physical separation from the main chassis. A side benefit results from this technique in that, in large systems, where external power is readily available, the power supply could be omitted from the receiver.

4.0 SUMMARY, CONCLUSIONS AND FUTURE EFFORTS

Work on the contract is progressing on schedule. The delivery date appears to be firm on all items of the contract. Testing is continuing on the complete breadboard receiver, including vibration and heat surveys.

The design of the power supply, which was withheld until all voltage and current requirements were firm, has been completed. The packaging design of this item is essentially complete and ready for fabrication. Some packaging design remains on the 1435-1535 mc and 2200-2300 mc tuning heads due to a delay in receiving sufficient dimensional data from the vendors. This effort will be completed within the next few days. After completion and analysis of the vibration survey on the breadboard receiver, some minor redesign may be required. Since extensive considerations have been given to the vibration requirements of overall mechanical design few problems are expected in this area.

The next quarter of the contract will be devoted to completing fabrication and assembly of the final receivers. Electrical acceptance tests will be well underway at the end of the next quarter. Electrical acceptance procedures have already been submitted for approval and the procedures for type testing and RFI will be submitted by the end of January. All mechanical design, design drafting effort, and mechanical fabrication will be completed in approximately one month.

Tasks which must be completed within the next period include:

a. Electrical design

b. Mechanical design

c. Drawings

d. Fabrication and assembly of the final receivers

e. Electrical bench acceptance tests