CONCEPT OF

RF MEASUREMENT PACKAGE

FOR SISS ZULU SYSTEM

6 August 1970

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CONCEPT OF
RF MEASUREMENT PACKAGE
FOR SISS ZULU SYSTEM

I. INTRODUCTION

A. General

This paper is in response to an interest to add an RF measurement capability to the Siss Zulu program. In nearly every RF band, the Soviets are developing emitters with frequency agility, diplexing, or other forms of frequency diversification. By adding RF measurement to Siss Zulu's proven fine grain PRF and scan determination, a more complete picture can be derived about the intercepted radar, as well as the technologies behind it.

Results from a previous RF measurement test system in two RF bands were encouraging. The system under consideration is designed to attain greater, single measurement accuracy, operate over a larger dynamic range, and provide coverage in seven high-interest RF bands. In addition, the normal Siss Zulu W, X, Y, Z video processors are recommended for each of the seven RF bands to increase the capabilities of the package. Refer to Figure 1.

B. Objectives

An RF measurement capability in the Siss Zulu system will open the door to three potentials:

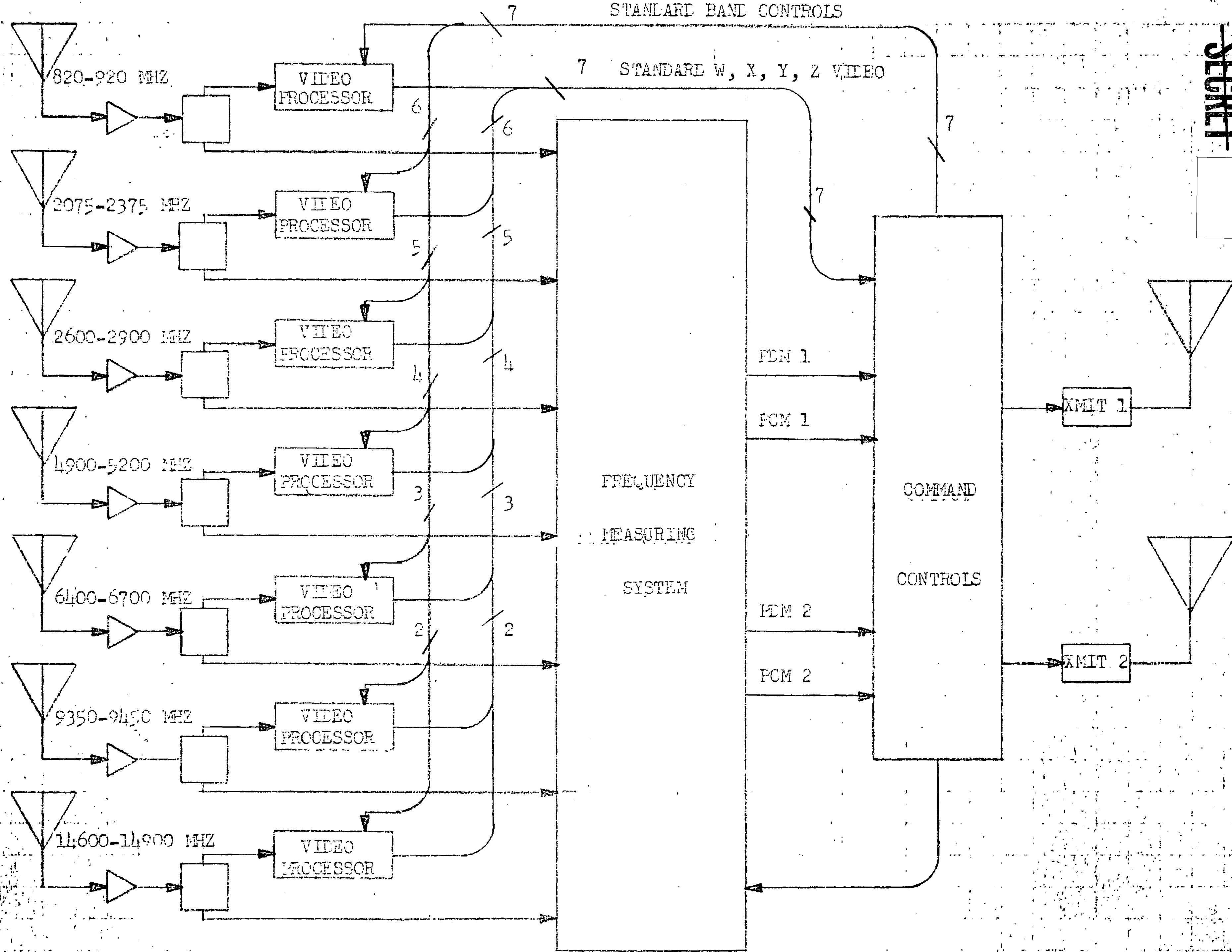


FIGURE 1. RF MEASUREMENT PACKAGE

1. In-depth analysis of signals exhibiting state-of-the-art frequency agility-- Since Siss Zulu is often the first system to observe new and unusual signals, RF measurement will provide even more dimension to this significant USIB required tip-off function.

PCM OUTPUT

2. Emitter verification by RF identification-- Siss Zulu has been highly successful at identifying [redacted] by the emitter PRF characteristics. Many other emitters may be identified by their unique RF. The shipborne navigation radars in [redacted] are prime candidates for this activity.

STABLE EMITTERS OR PCM OUT.

3. Emitter isolation by RF sorting-- Where multiple emitters of the same family exhibit similar PRF and scan characteristics, RF may be used as the sort parameter to isolate signals for further processing.

Seven RF bands have been selected for implementing RF measurement. The RF bands were chosen to cover recent Soviet developments with frequency diversified radars.

Page Denied

Page Denied

Approved for Release: 2024/06/12 C05026143

C05026143

Page Denied

With the standard W, X, Y, Z video processors available on all seven bands, normal Siss Zulu collection may be tasked for both data links. Thus in these high-interest bands, this package could serve as a back-up vehicle for [redacted] computations should one of the operational vehicles encounter difficulties.

II. SYSTEM DESCRIPTION

Figure 3 is a simplified block diagram of the proposed seven-band Frequency Measuring System. This system may be operated in several modes as described in Section I above. Control flexibility, low power consumption and high reliability with long MTBF are primary requirements for the system. Proven design concepts which were used in the previous MRF-100 test system will be the heart of the pulse signal frequency measurement unit, but specific circuit revisions will be made during the breadboard design phase of the project to reduce the power drain.

The proposed schedule of Section IV calls for delivery of a completely-tested system nine months after the project is initiated. The breadboard system to be completed in the first five months will include a complete system in one band with some critical items in additional bands also being built and tested. A modified (partial) switching unit will be built to test the concept and hardware. DC power switching must be accomplished by remote control to reduce the total power drain; latching relays are being considered for this application and will be specified following discussions with appropriate NRL personnel.

The seven RF band inputs shown on the block diagram will be supplied from the standard (previously qualified) NRL preamps used in these bands. Hybrid splitters will be used in each of these bands so that the normal W, X, Y, Z video processing circuits may be operated in parallel with this system.

SECRET

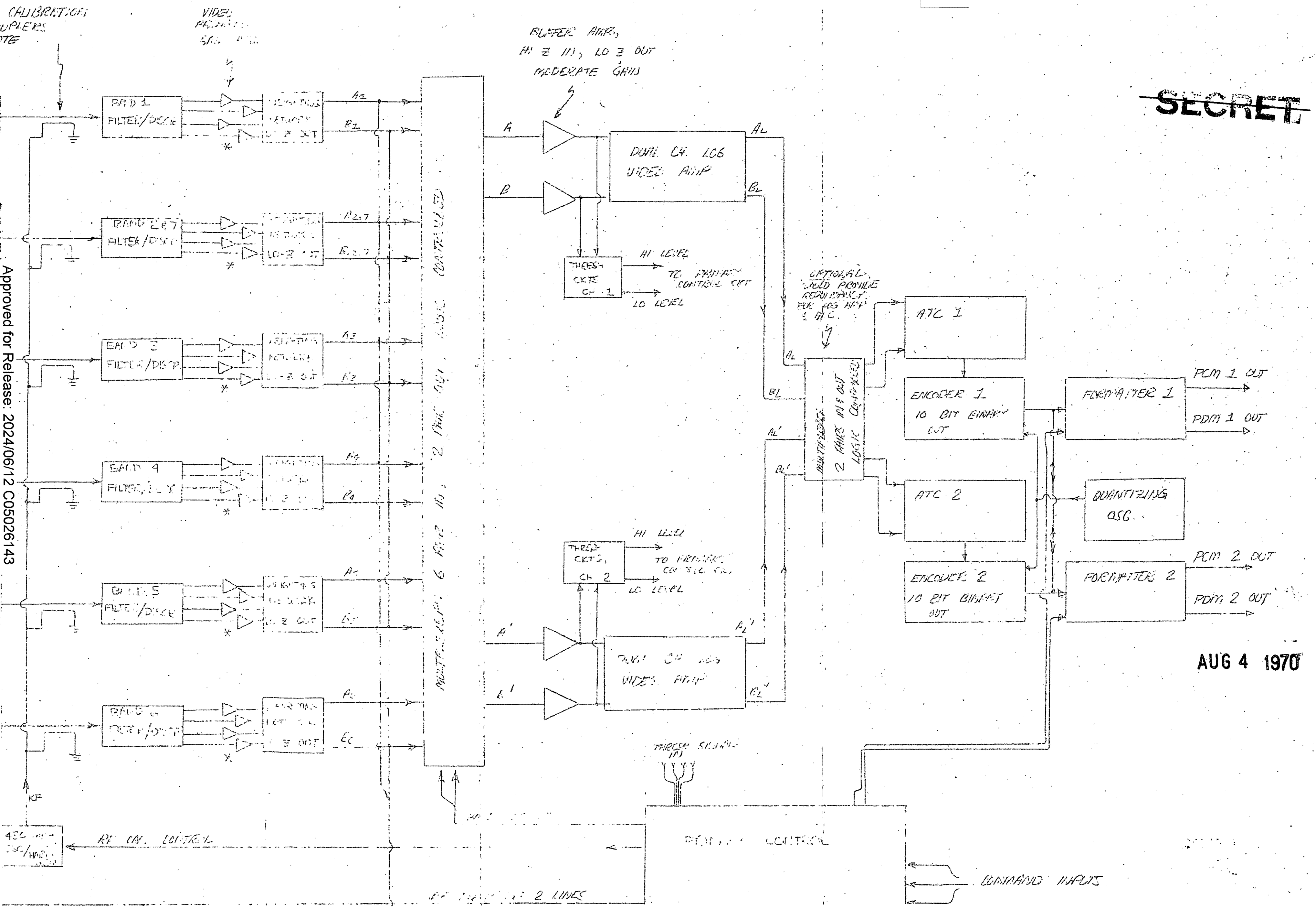
Pulse-signal frequency measurements will be made in each band by MRF-100 series receivers. These receivers are designed for automatic and unattended operation and make frequency measurements on a monopulse rather than an averaging basis, thereby allowing operation in a multisignal environment. The receiver's TRF design, employing an RF amplifier and a fixed-tuned discriminator circuit, eliminates the LO and Mixer spurious response problems typical of scanning receiver frequency measurement systems.

Accurate frequency measurements are possible with this system because of the unique multichannel-filter-discriminator circuitry which has been developed by HRB. Detected video outputs from several filters are weighted and combined to form a desired discriminator curve. Computer design and optimization programs are used to select the proper weighting functions and to match the discriminators to empirical filter response data. (Operational theory for the frequency measurement receivers used on the 176 Payload expands on this technique and is included as an Appendix to this paper.)

A complete interface and design of the Primary Control Unit will be carried out in conjunction with NRL Engineers during the first five months of this project while the breadboard system is being built. The control functions of the Frequency Measurement System will be made compatible with presently-available circuitry used on this vehicle.

SECRET

SECRET



AUG 4 1970

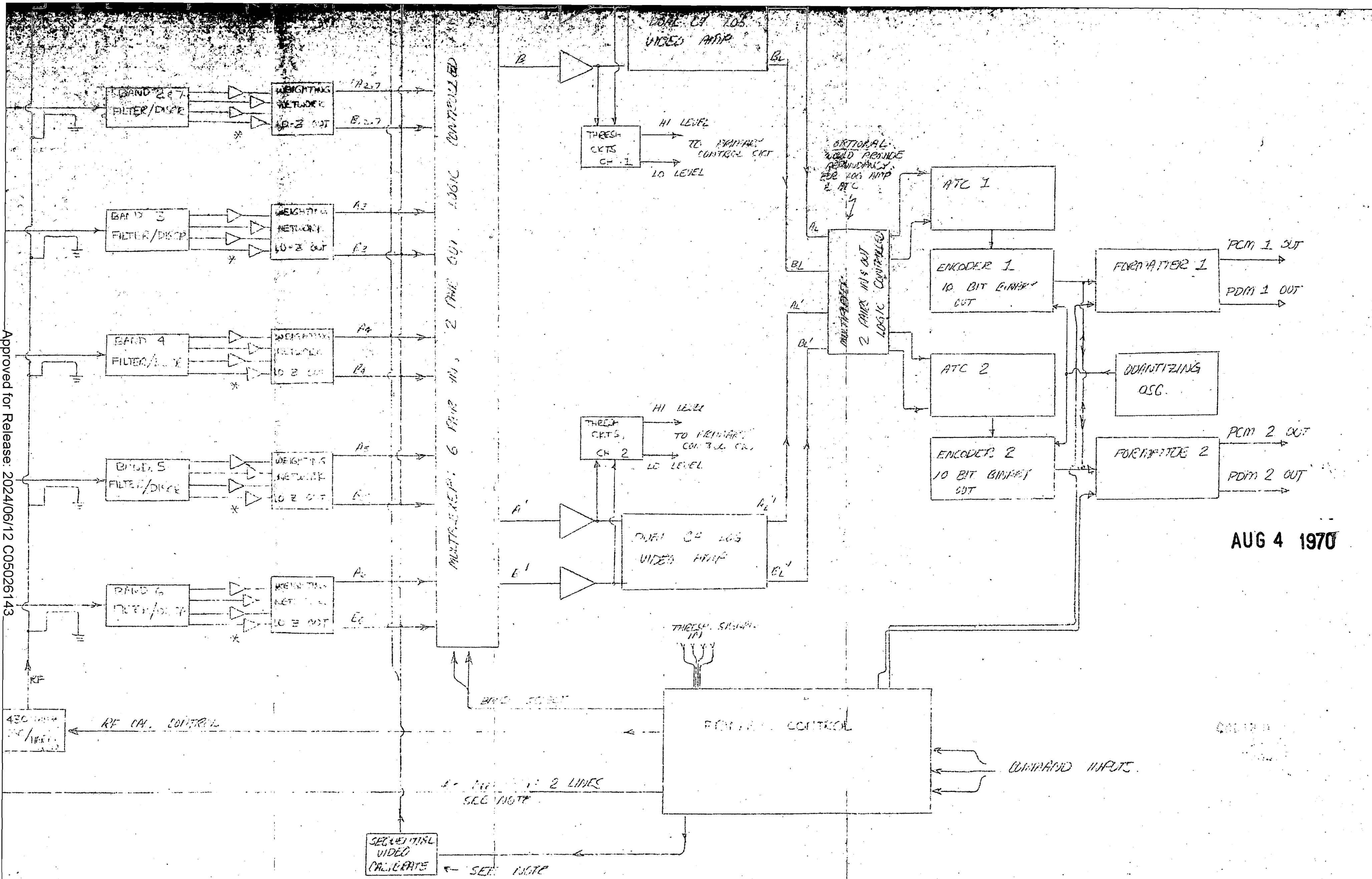


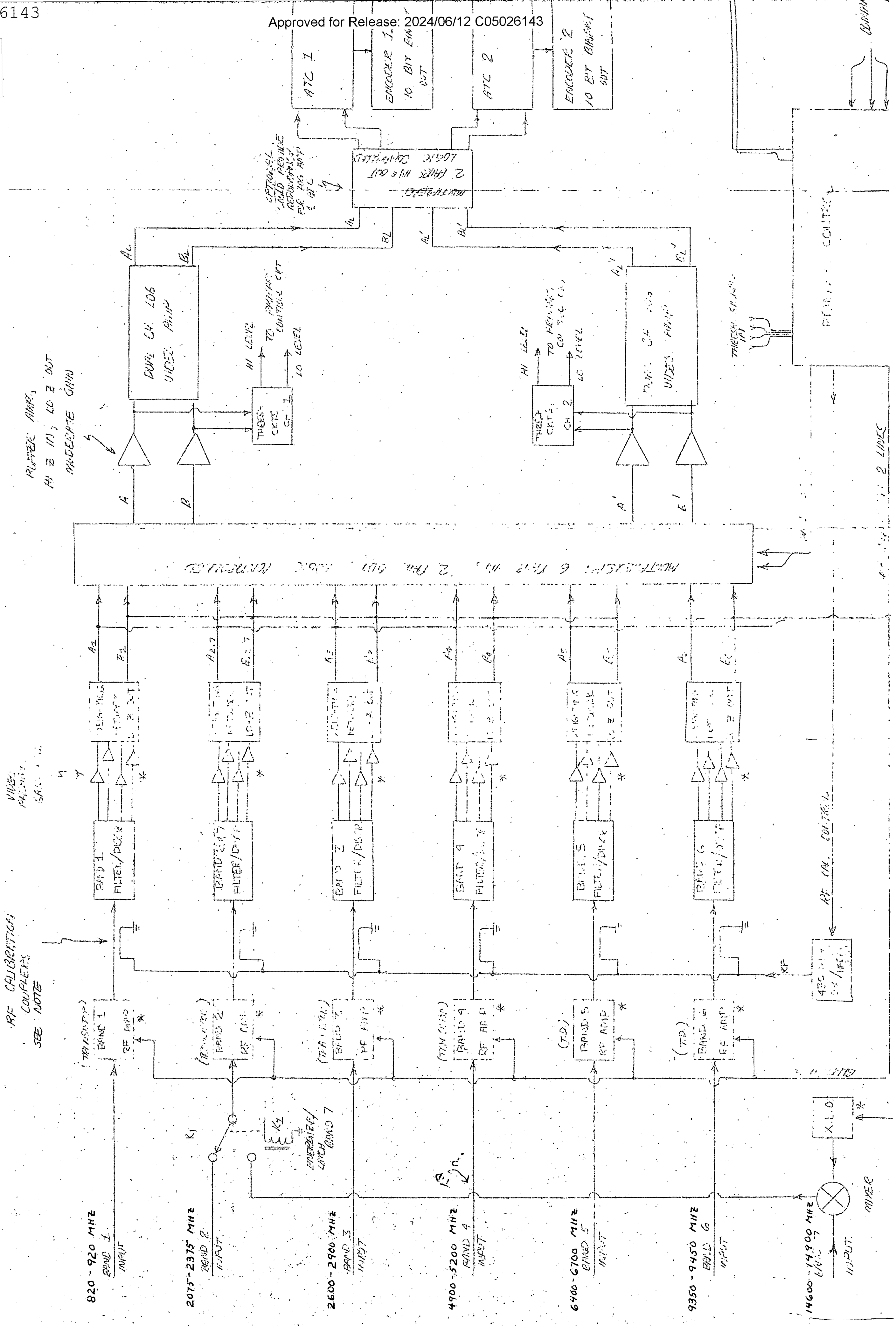
FIGURE 3.

FREQUENCY MEASURING SYSTEM BLOCK DIAGRAM

AUG 4 1970

Approved for Release: 2024/06/12 C05026143

SECRET



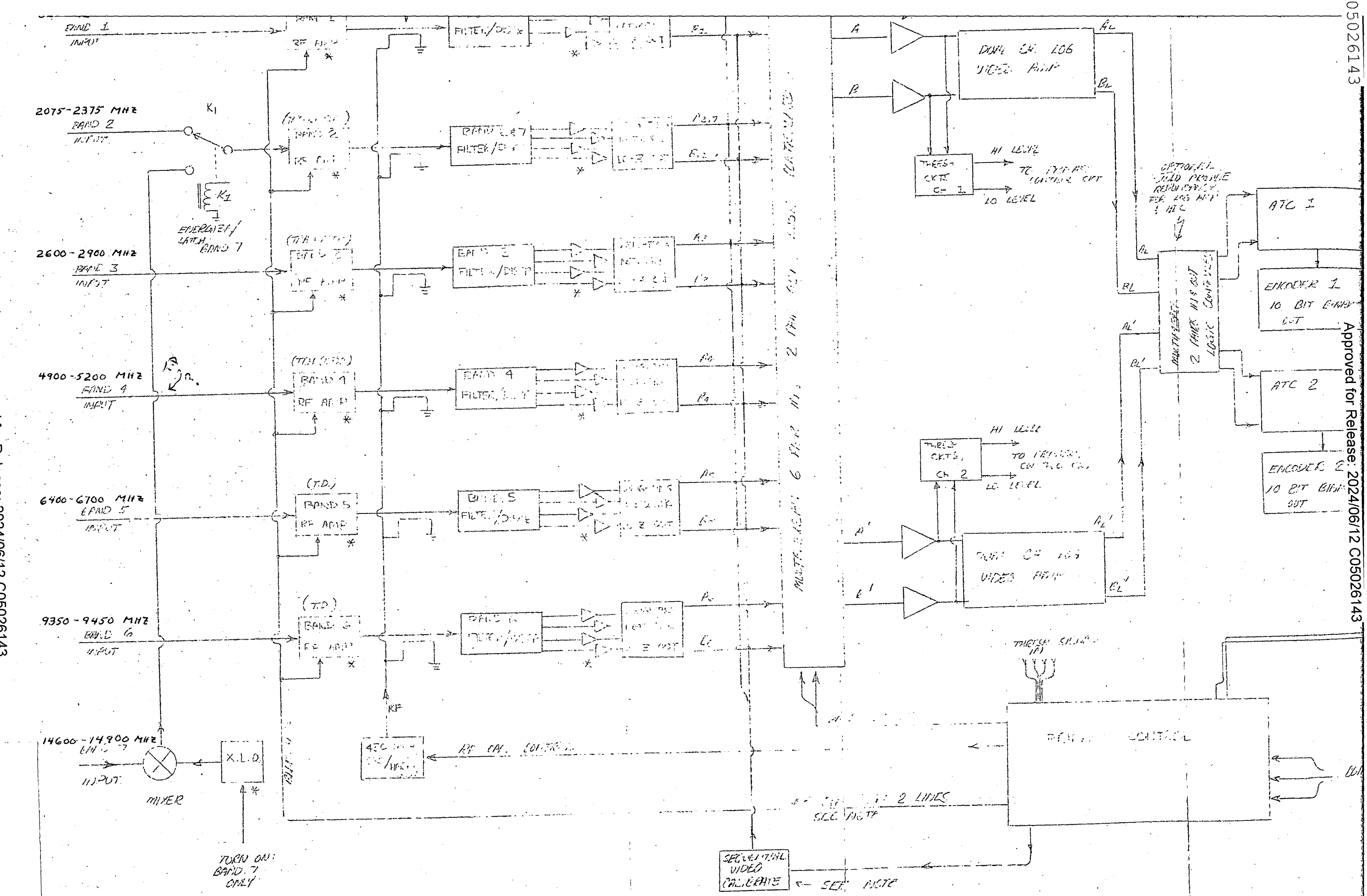


FIGURE 3.

FREQUENCY MEASURING SYSTEM BLOCK DIAGRAM

* POWER SWITCHED TO THESE MODULES AS REQUIRED.

Approved for Release: 2024/06/12 C05026143

III. MEASUREMENT ACCURACY

Frequency measurements made on a pulse-to-pulse basis have an instantaneous or peak error and an average or rms error when considered over some time interval. Measurement of pulse-to-pulse frequency agile signals place primary importance on the peak error system characteristics as do the RF signal sorting techniques where an RF window width is used to presort interleaved pulse trains. However, fine grain RF frequency tagging can be accomplished by using averaged time periods and statistical distributions.

Table I below is a summary of the expected system performance in the various bands. A complete discussion of the system's error budget follows this summary.

TABLE I. FREQUENCY PEAK ERROR EQUIVALENTS

Mid-Band Frequency (MHz)	Peak Frequency Error (MHz)	Peak Frequency Error (% of Mid-Band Freq.)	Pulse-Pulse Noise Error (MHz)	Pulse-Pulse Noise Error (% of Mid-Band Freq.)	Calibration Oscillator Stability 1* 10^4 (KHz)
870	±3.0	±0.345	±1	0.115	87
2225	±8.7	±0.391	±3	0.136	221
2750	±8.7	±0.317	±3	0.109	275
5050	±8.7	±0.175	±3	0.059	505
6550	±8.7	±0.133	±3	0.046	655
9400	±3.0	±0.032	±1	0.011	940
14,750	±8.7	±0.059	±3	0.020	1,475

Tables II and III below show a computer printout of the systematic error present in the system when the discriminators

Table II

SYSTEMATIC ERROR FOR 100 MHz BANDWIDTH

```
4 FILTERS     ITERATION NO. 3
COMPUTED FOR SIGNAL FREQUENCY     FROM -50 TO 50    MC
IN STEPS OF  5  MC  .
ASSUMING BANDWIDTHS OF  85.
ERROR SENSITIVITY (SLOPE) IS 4.33   MC    PER DB.
WITH A RANGE OF -15.01 DB
WITH ZERO INTERCEPT AT  870.0  MC   .
**********************************************

         FREQ                  AND ATTENUATORS

                 FREQ       A ATTEN       B ATTEN

                -65.0    -0.0    DB   -32.926 DB
                -21.7   -14.897 DB   -20.483 DB
                 21.7   -20.483 DB   -14.897 DB
                 65.0   -32.926 DB    -0.0   DB
```

Computer derived optimum attenuator values for a 100 MHz RF Bandwidth Discriminator Weighting Network

85. MC BANDWIDTH

****

FREQ	Peak Error MC	Peak Error DB	READOUT
820	0.10	0.02	-11.52
825	-0.12	-0.03	-10.42
830	-0.09	-0.02	-9.26
835	0.01	0.00	-8.08
840	0.09	0.02	-6.91
845	0.08	0.02	-5.75
850	0.02	0.01	-4.61
855	-0.05	-0.01	-3.48
860	-0.08	-0.02	-2.33
865	-0.06	-0.01	-1.17
870	0.00	0.00	0.00
875	0.06	0.01	1.17
880	0.08	0.02	2.33
885	0.05	0.01	3.48
890	-0.02	-0.01	4.61
895	-0.08	-0.02	5.75
900	-0.09	-0.02	6.91
905	-0.01	-0.00	8.09
910	0.09	0.02	9.26
915	0.12	0.03	10.42
920	-0.10	-0.02	11.52

```
TOTAL  6.64E-03

TOTAL SQUARE ERROR =    0.66389E-02

ERROR IN MC     0.08

TOTAL OVER ALL BEAMWIDTHS #     0.66389E-02
  AT   805. MC   Q=   9.47
  AT   848. MC   Q=   9.98
  AT   892. MC   Q=  10.49
  AT   935. MC   Q=  11.00
```

Filter bandwidths are selected by the computer program to obtain least square error over the RF band.

Outside filters are placed 15 MHz beyond the desired RF band limits to obtain better accuracy and eliminate band edge ambiguities.

(Q's on the order of 50 at X band are attainable on microstrip)

SECRET

Table III

SYSTEMATIC ERROR FOR 300 MHz BANDWIDTH

SECRET

```
4 FILTERS     ITERATION NO. 3
COMPUTED FOR SIGNAL FREQUENCY     FROM -150 TO 150  MC
IN STEPS OF  10   MC
ASSUMING BANDWIDTHS OF 225.
ERROR SENSITIVITY (SLOPE) 1512.00  MC  PER DB.
WITH A RANGE OF -15.00 DB
WITH ZERO INTERCEPT AT 2210.0  MC.
*************************************************

FREQ                AND ATTENUATORS

            FREQ     A ATTEN      B ATTEN

          -180.0   -0.0    DB  -31.827 DB
           -60.0  -14.430 DB  -20.336 DB
            60.0  -20.336 DB  -14.430 DB
           180.0  -31.827 DB   -0.0    DB

225.   MC   BANDWIDTH
**********************
```

Computer derived optimum attenuator values for a 100 MHz RF Bandwidth Discriminator Weighting Network

Peak Error

FREQ	MC	DB	READOUT
2060	0.80	0.07	-12.43
2070	-0.25	-0.02	-11.69
2080	-0.61	-0.05	-10.88
2090	-0.53	-0.04	-10.04
2100	-0.22	-0.02	-9.18
2110	0.12	0.01	-8.32
2120	0.37	0.03	-7.47
2130	0.45	0.04	-6.63
2140	0.37	0.03	-5.80
2150	0.17	0.01	-4.99
2160	-0.06	-0.01	-4.17
2170	-0.26	-0.02	-3.36
2180	-0.36	-0.03	-2.53
2190	-0.34	-0.03	-1.69
2200	-0.20	-0.02	-0.85
2210	0.0	-0.0	0.0
2220	0.20	0.02	0.85
2230	0.34	0.03	1.69
2240	0.36	0.03	2.53
2250	0.26	0.02	3.36
2260	0.06	0.01	4.17
2270	-0.17	-0.01	4.99
2280	-0.37	-0.03	5.80
2290	-0.45	-0.04	6.63
2300	-0.37	-0.03	7.47
2310	-0.12	-0.01	8.32
2320	0.22	0.02	9.18
2330	0.53	0.04	10.04
2340	0.61	0.05	10.88
2350	0.25	0.02	11.69
2360	-0.80	-0.07	12.43

```
TOTAL  3.16E-02

TOTAL SQUARE ERROR =     0.31583E-01

ERROR IN MC     0.38

TOTAL OVER ALL BEAMWIDTHS #     0.31583E-01
AT   2030. MC   Q=   9.02
AT   2150. MC   Q=   9.56
AT   2270. MC   Q=  10.09
AT   2390. MC   Q=  10.62
```

Filter bandwidths are selected by the computer program to obtain least square error over the RF band. (Q's on the order of 50 at X band are attainable on microstrip)

Outside filters are placed 30 MHz beyond the desired RF band limits to obtain better accuracy and eliminate band edge amb ... es.

SECRET

HANDLE VIA BYEMAN CONTROL SYSTEM

are matched to a linear output characteristic. These tables cover a system optimized over a 100 MHz bandwidth and a 300 MHz bandwidth. A discriminator ratio slope of 4.33 MHz/db is used for the 100 MHz band and 12 MHz/db is used for the 300 MHz coverage.

Table IV shows an error budget for both the 100 MHz and the 300 MHz RF bandwidth systems.

TABLE IV. PEAK ERROR BUDGET

Item		100 MHz B.W.	300 MHz B.W.	
1	Systematic Error (rms)	0.08 MHz	0.38 MHz	
2	Systematic Error (peak)	0.12 MHz	0.61 MHz	
3	Preamp/Detector Tracking (0.1 db)	0.33 MHz	0.90 MHz	(worst case limit filter)
4	Log Amplifier Channel Tracking (0.1 db)	0.43 MHz	1.20 MHz	
5	Log Amplifier Linearity Tracking (0.3 db)	1.30 MHz	3.60 MHz	
6	ATC/Encoder Tracking (0.2 db)	0.86 MHz	2.40 MHz	
	TOTAL ITEMS 2 THRU 6	±3.04 MHz	±8.71 MHz	

The total errors of Items 2 thru 6 above are equivalent to ±3% of the 100 MHz band and to ±2.9% of the 300 MHz band. A calibration system such as that proposed here could be used in conjunction with system test data to eliminate the tracking errors shown as Items 3 and 6 to reduce the total log amplifier errors of Items 4 and 5 to a combined value equivalent to Item 5. This calibration will reduce the peak error in each band to approximately 1.5% of the band.

Short term pulse-to-pulse error distribution on a previously-tested DF system using similar ATC units was equivalent to $\pm$1.08 MHz in the 100 MHz band and to $\pm$3 MHz in the 300 MHz band.

Preamp/detector tracking errors listed as Item 3 of Table IV above are not independent of frequency. Also, tracking errors which occur ahead of the weighting networks create less readout error than those which occur after the signal enters the two-channel processing chain. Preamp and detector tracking errors peak at approximately 75% of the error caused by the same amplitude shift in the two-channel processor if the error is in the two outside filters (i. e., near the band edges). This error is only 25% of the two-channel error if the change is in the two inside filters. The actual error function is complex and can best be studied by computer printouts which are available upon request.

Information will be encoded to 0.25% of band increments (0.25 MHz steps in the 100 MHz band and 0.75 MHz steps in the 300 MHz band).

IV. COMPONENT REQUIREMENTS

The following paragraphs give a minimal description of the function and operating characteristics of the various components shown on the block diagram of Figure 3. The discussion proceeds from left to right across the diagram in a normal signal flow sequence.

A. RF amplifiers

The amplifiers shown are used to match the RF impedance of the vehicle RF distribution system and to provide gain to pick up the signal splitting loss and the discriminator filter's input loss. In addition, these amplifiers will be used to drive diode limiter networks in Bands 1, 2, 3, and 4 in an effort to extend the previous system's 20 db processing dynamic range to at least 30 db. The tunnel diode amplifiers of Bands 5 and 6 will be investigated to determine whether their normal saturating characteristics can be used to satisfy the desired limiting effect. Processing sensitivities in each band will be set equivalent to the normal video processing thresholds of the standard W, X, Y, Z video system. Processing sensitivities required at the RF inputs to the Frequency Measurement System in order to match the video processing sensitivities of the 06 packages are shown for each band:

	Frequency Measuring System Sensitivity	Video Processing Sensitivity (from 06 Technical Description Document)
Band 1 (820-920 MHz)	-39 dbm	-48 dbm
Band 2 (2075-2375 MHz)	-36 dbm	-50 dbm
Band 3 (2600-2900 MHz)	-37 dbm	-52 dbm
Band 4 (4900-5200 MHz)	-57 dbm	-75 dbm
Band 5 (6400-6700 MHz)	-57 dbm	-75 dbm
Band 6 (9350-9450 MHz)	-50 dbm	-75 dbm
Band 7 (14,600-14,900 MHz)	-49 dbm	-97 dbm

The differences between the Frequency Measuring System and Video Processing Sensitivities are the anticipated gains of the NRL preamplifiers and antennas less 3 db for the hybrid splitters.

B. RF Calibration Couplers

These couplers will be 10 or 20 db directional couplers built with microwave integrated circuit (MIC) substrate techniques. It should be noted that RF calibration is added to the system to permit absolute, fine grain frequency measurements to be made on the received signals. RF sorting and frequency agility measurements can be accomplished without this feature. The RF calibrator will be a crystal-controlled RF source which generates a frequency such that a single harmonic falls in each receiver band. This source will be pulse modulated and will turn on only upon command.

For the lower four bands, a single comb generator will be used and only the proper harmonic will be passed by a filter which is an integral part of the RF coupler. In order to get enough power to properly calibrate Bands 5 and 6, it may be necessary to use tuned harmonic generators for each band. These tuned generators would be incorporated on the same MIC substrate as the RF coupler. No RF calibration of Band 7 is planned in that the down-converter local oscillator will be crystal controlled.

SECRET

C. Filter/Discriminator

These units will be built on MIC substrates for Bands 1 through 5. Band 6 will also be built on substrate if the temperature stability of the substrate material works out satisfactorily. Quartz substrate, in place of alumina, for the Band 6 unit will be investigated in the breadboard phase of the project. If the substrate material is not stable enough to maintain the desired tuning accuracy, cavity tuned circuits will be used in this band. MIC substrate discriminators used in the previous P-band test system were cheap, reliable, and had repeatable design characteristics. Four RF filters will be used in each discriminator, and their outputs will be detected by diodes mounted directly on the substrate. Bands 1 and 6 will be approximately 100 MHz wide and Bands 2, 3, 4, 5, and 7 will cover a 300 MHz bandwidth.

D. Video Preamps

Integrated circuit preamps will be used in each unit. Gain adjustments will be included to balance the four discriminator filter outputs at their peak input frequencies. Detector/preamp tangential sensitivities on the order of -50 dbm will be used in each band. Video bandwidths will be tailored in each band to handle the expected pulse widths of:

Band 1	0.4-5.0 microseconds	40 to 41.5 usec (system will sample wide pulses at 5 usec)
Band 2	0.1-6.0 microseconds	
Band 3	0.4-3.6 microseconds	
Band 4	0.2-1.2 microseconds	
Band 5	0.4-2.2 microseconds	
Band 6	0.1-2.5 microseconds	
Band 7	0.2-1.8 microseconds	

E. Weighting Networks

The video weighting technique used here is an HRB developed circuit technique to get accurate wide band frequency discriminator performance. Computer programs exist which have been developed to a high degree of sophistication over a period of years in company Direction-Finding-System development. They are used to optimize the fit between actual measured filter characteristics and the desired discriminator output voltage response. Detected outputs from the four discriminator process of measuring the amplitude ratio of the two weighted channels, simple subtraction circuitry being substituted for the necessary division circuitry. New lower power drain amplifiers will be used in this system and, in addition, the new Texas Instrument integrated circuit log amplifiers will be considered in the breadboard phase of the project. Amplitude tracking of ±0.1 db between channels and linear output voltage curve tracking within 0.2 db over each 15 db segment of the 65 db dynamic range is desired.

H. Threshold Circuits

These circuits are used to sense the minimum and maximum processing signal levels. The logic level outputs of these blocks are sent to the Primary Control block where signals which do not meet the preset dynamic range characteristics are gated out of the processing chain. This prevents undesired signals from tying up the slow speed readout circuitry used in the formatter.

I. Four-Channel Multiplexer

Use of a multiplexer between the log-amplifiers and the ATC units would provide some circuit redundancy if one of the log amps, ATC, or encoder modules had a failure. Additional switch control complexity is the price for this option, and the decision to use this circuit will not be made until further discussions can be held with NRL personnel.

J. Amplitude/Time Converter (ATC) Unit

The ATC circuitry is used to compare the amplitude differences between the two log amplifier channels and thereby interval is, in turn, quantized into a digital number by counting a crystal-controlled oscillator signal. A quantizing rate which will provide nine or ten bit (0.2 or 0.1% of band) accuracy will be used. Outputs from the encoder units will be truncated in the data formatter units to provide 8-bit binary accuracy (0.4% of band). This accuracy is consistent with the link bandwidth and the total expected accuracy of the frequency measurement system.

L. Formatter

The formatter units shown on the block diagram can be switched back and forth between the two processor channels. Each formatter will put out a PDM word (60-360 microseconds duration) and a PCM word which will provide a greater readout accuracy capability. PDM or PCM outputs from each processing unit can be selected on an independent basis, or can be used in conjunction with the processed video data system. Time coincidence between channel system outputs will be recoverable or readout. Leading edge pulse coincidence or a fixed delay time will be maintained on the frequency readout words in order that higher PRF rate signals can be tagged in a sampled pulse sequence. PDM output words will have a maximum rate of 2.5 KHz and PCM words will have a maximum rate of 625 Hz.

M. K-Band Downconverter

In order to obtain the desired sensitivity in K-Band, it was decided to use a downconverter technique in lieu of cascading Tunnel Diode Preamps. In addition, it would require mechanical cavity resonators to get the desired filter Q's in this band, and temperature stability of the mechanical setup was considered to be a significant problem in maintaining the desired frequency measurement accuracy. A crystal-controlled downconverter oscillator is proposed that will convert a 300 MHz bandwidth segment down into the Band 2 RF discriminator unit. Use of this discriminator prohibits the simultaneous collection of frequency measurement data from Bands 2 and 7, but multiple band study of these two bands is not considered of primary importance at this time.

N. Video Calibrate Unit

Operation of the previous test system has pointed out the great advantage of having an on board calibration system. The RF calibration signal discussed in Section B above will pinpoint a particular RF frequency in each band. A video calibrate signal can be readily inserted at the 12-channel multiplexer outputs to calibrate the video processing circuitry. Simultaneous pulses of predetermined amplitude ratios can be sequentially fed into the processor channels to simulate the low end, center, and high end of the RF band. These pulses would supply a real time test of processor drift and linearity changes. It should be noted that only the ratio of the two pulse signal amplitudes is critical for good calibration results; the absolute amplitude does not have to be extremely stable.

This calibration signal would be inserted by command or at a preset time interval. During the calibration sequence, the RF inputs would be disconnected from the RF amplifiers. Power consumption of this on/off controlled pulse signal generator would be negligible.

SECRET

Table V. Proposed Project Schedule

	Sep 1	Oct 2	Nov 3	Dec 4	Jan 5	Feb 6	Mar 7	Apr 8	May 9	Jun 10	Jul 11	Aug 12	Sep 13
1. System Design Review	→												
2. Order long lead items and special materials	→												
3. Order materials and parts	—	→											
4. Build and test breadboard system	—	—	—	—	→								
5. Mechanical design of flight unit		—	—	→									
6. Construction of flight hdwre modules		—	—	—	—	→							
7. Fabrication of flight unit					—	—	→						
8. Calibration and electrical testing of flight unit							—	→					
9. Mechanical and environmental testing								→					
10. Electrical and environmental acceptance tests									→				
11. Delivery of flight unit										◆			
Design and Fabrication Schedule													
a. Design and fabricate discriminators	—	—	→										
b. Build and evaluate new log ampl.	—	—	→										
c. Fabricate RF amplifiers	—	—	—	—	→								
d. Evaluate limiters	—	→											
e. Design and evaluate control circuitry	—	—	—	—	→								
f. Design and test ATC and encoder		—	—	—	→								
g. Design and test formatter				—	→								
h. Fabricate and evaluate K-band downconverter	—	—	—	→									
i. Design and fabricate calibration unit		—	—	—	—	→							

CHAPTER 3
OPERATIONAL THEORY

3-1. GENERAL

This chapter presents the overall operation of an MRF-100 series receiver. Each receiver module is discussed separately referencing the typical receiver block diagram shown in Figure 2. In addition, each module discussion references the appropriate response curves, simplified schematic diagrams, and timing diagrams. Where applicable, schematic diagrams of specific receivers are contained in Chapter 4.

3-2. RF AMPLIFIER

The RF amplifier used in a specific receiver depends upon the requirements of that particular receiver. The amplifiers are of conventional miniature design employing ceramic substrate hybrid I.C. construction techniques. The receiver input VSWR is determined by the RF amplifier and will be 2.0:1 or less. A blanking circuit, which receives a logic level signal, is incorporated into the RF amplifier to allow receiver shutdown during signal processing. This prevents subsequent signals from interfering with the processing of a measurable signal.

3-3. DISCRIMINATOR

The incoming signal is amplified by the RF amplifier and fed to the discriminator assembly where it is divided into four equal parts by three 3 dB power dividers. Each power divider output is approximately 6 dB below the level at the discriminator input, and is isolated from all other outputs by a minimum of 15 dB. Each output of the power divider drives an independent filter-detector combination with a response similar to that of a single-tuned circuit. The filter center frequencies are evenly spaced across the desired band as shown in figure 3.

Note that the two "end" filters (f1 and f4) have center frequencies just outside the band edges. This improves the linearity of the discriminator and aids in suppressing ambiguous responses to signals just outside the desired band.

The detectors operate in their square-law region; i.e., at levels where the diode voltage output is proportional to the RF power input.

3-4. PREAMPLIFIER BOARD

a. Preamplifiers. Each detector output drives a high gain video preamplifier which raises the video signal to a level adequate for further processing. In addition, a small bias current is fed back through each detector cable to bias the detector diodes for optimum operation. Each preamplifier has a gain control to allow "balancing" of the filter/detector/preamplifier channels so that, at the center frequency of each filter and for a given RF level, each channel has the same video output.

b. Weighting Network. The four filter channels are completely independent in their operation through the preamplifier stages. At the output of the preamplifiers the actual discriminator action takes place by means of a resistive attenuator or "weighting" network. The function of this network is to

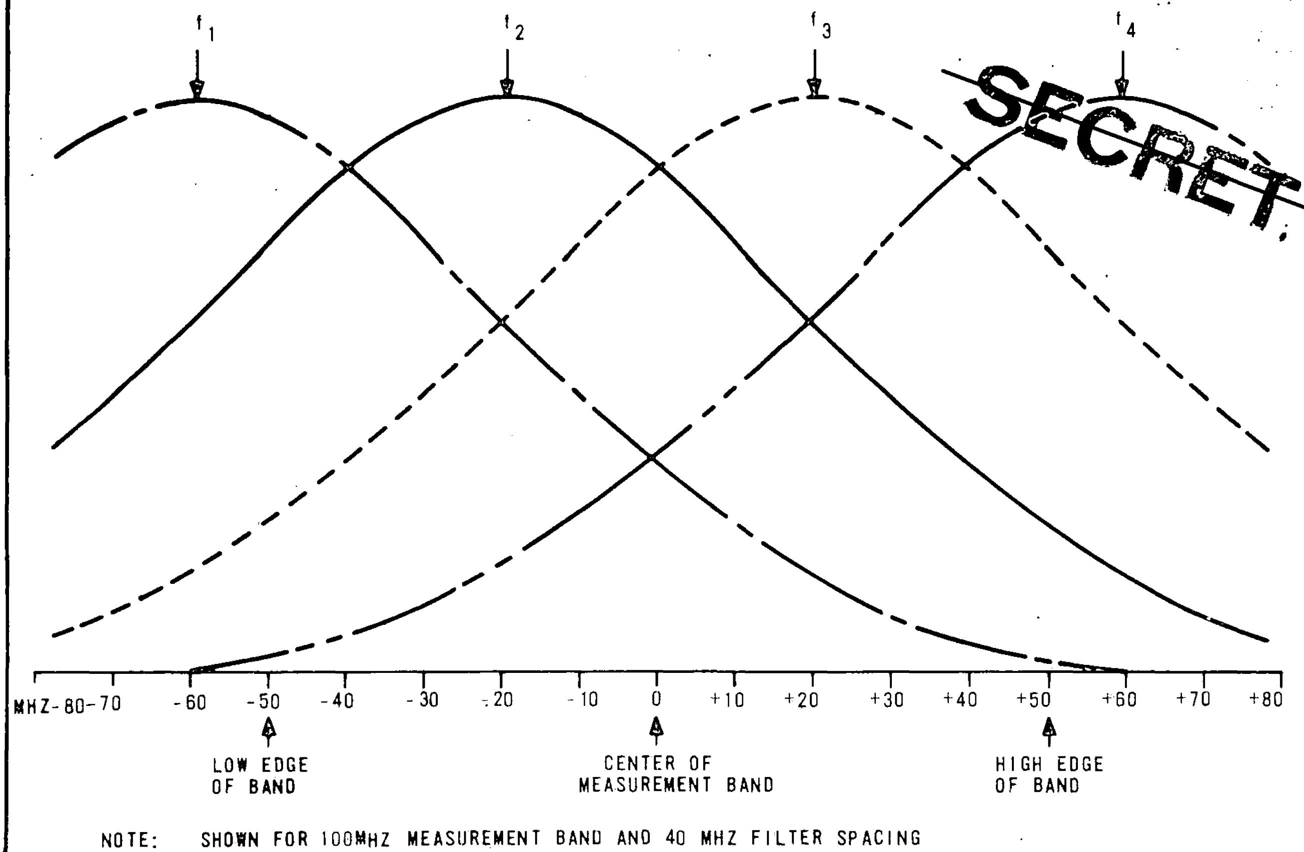


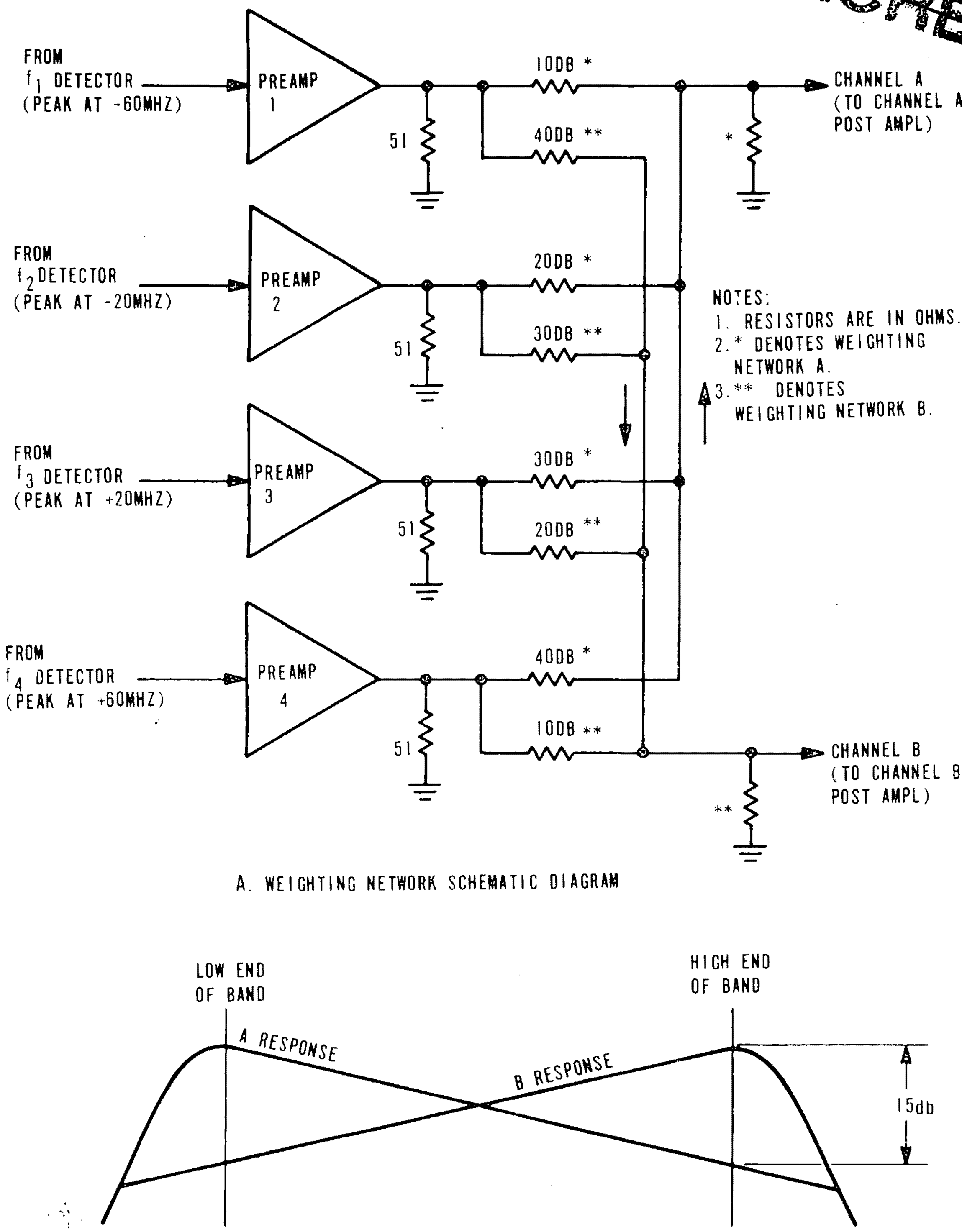
FIG. 3 TYPICAL FILTER RESPONSE

AP5525

take the pulse signals from the four independent filter channels and transform them into two signals whose amplitude ratio is proportional to the frequency of the received signal.

The operation of the weighting network can be visualized by referring to Figure 4A, a simplified diagram showing only the two outer filter channels. The 51 ohm resistors terminating the preamplifiers stabilize the source impedance driving the weighting network. With the circuit shown in Figure 4A, a signal at the low end of the band causes a larger output from preamplifier 1 and a smaller one from preamplifier 4. Note the filter response curves of Figure 4B. The large signal from preamplifier 1 is attenuated by 10 dB into channel A and by 20 dB into channel B. The small signal from preamplifier 4 is attenuated by 20 dB into channel A and 10 dB into channel B. This signal makes a relatively small contribution to the weighting network A output, and the result is that the signal appearing at the channel A output will be nearly 10 dB stronger than the output of channel B. At the high end of the band the situation is reversed, with channel B receiving the stronger signal. At the center of the band the two signals are equal.

SECRET



A. WEIGHTING NETWORK SCHEMATIC DIAGRAM

B. WEIGHTING NETWORK RESPONSE

FIG.5 WEIGHTING NETWORK TYPICAL RESPONSE

AP5524

SECRET

HANDLE VIA
BYEMAN
CONTROL SYSTEM ONLY