AD621140

TELEMETRY FM/FM BASEBAND STRUCTURE STUDY

VOLUME II
FINAL REPORT FOR:
WHITE SANDS MISSILE RANGE
NEW MEXICO
CONTRACT DA-29-040-AMC-746 (R)

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14 JUNE 1965

20050222046

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SECTION 1

INTRODUCTION

1.1 GENERAL

This volume contains the procedures used and data measured as part of a baseband expansion study sponsored by the IRIG Telemetry Working Group (TWG), funded by White Sands Missile Range (WSMR) and the Electronic Systems Division of the USAF, and undertaken by Electro-Mechanical Research, Inc. of Sarasota, Florida, on 17 June 1964 under contract DA-29-040-AMC-746(R). In essence, the program consisted of an evaluation of equipment, a study to determine a feasible baseband expansion, and a program of experimentation to evaluate expansion and provide recommendations for systems application.

Telemetry equipment representative of that typical in field use was gathered and evaluated to determine if there were any characteristics which would prohibit its use in an FM/FM baseband expanded in frequency to 200 kc. Those parameters which were thought to contribute to total system error were also evaluated. Parameters such as receiver IF-envelope delay variation, transmitter dynamic linearity, tape-recorder harmonic distortion, etc., were measured. Where possible similar units from different manufacturers were obtained.

In order to determine the feasibility of the recommended expansions of the FM/-FM basebands, a complete laboratory telemeter was constructed and several basebands were evaluted using specific system tests. The system tests included experimental optimization of the transmitter pre-emphasis, intermodulation, signal-to-noise and system error tests. Determination of the effect of post detection recording, system accuracy, and applicability for pulse modulation were considered as well.

1.2 FORMAT DESCRIPTION

The format of this report includes two volumes. Volume I contains the summarizations of the data obtained and interpretations and conclusions based upon this data. This volume, Volume II, as an appendix to Volume I, contains the detailed procecures used and the actual data measured. Both volumes are subdivided into similar sections. A description of the program objectives, the overall approach, and the design of the recommended basebands are contained in Section 1 of Volume I. Section 2 in both volumes discuss the equipment evaluation. The individual systems tests are included in Section 3 of each volume. Volume I alone contains a fourth section where the program conclusions and recommendations appear.

Throughout this report, figures and tables have been sequentially numbered within each section with the volume number, in Roman numerals, as well as the section number appearing each time.

1.3 BASEBAND DESIGN AND DESCRIPTION

1.3.1 Proportional-Bandwidth Basebands

The design of the expanded proportional-bandwidth baseband is a direct expansion of the present IRIG configuration. The center frequencies of the high frequency channels are approximately 1.3 times the previous upper channel. Thus, channels are located at 93 kc, 124 kc, 165 kc, 220 kc, etc. Like the present IRIG channels, it is desirable to operate all channels at ±7.5% deviation or by deleting alternate channels when operation at ±15% deviation is desirable.

Although the spacing of the new proportional-bandwidth channels was straightforward, the number of additional channels that can be added under the constraint of the 500 kc receiver IF bandwidth and the transmitter-radiated-spectrum limitation needed to be determined. Using a technique proposed by H. O. Jeske[1], the higher subcarrier channels can be compared to the present 70-kc channel:

> "From a study of the sideband structure of a frequency modulated signal it is found that for a given deviation the envelope formed by the sidebands have steeper skirts for the lower modulating frequencies. Since this is the case, only the highest modulation frequency is important unless a pre-emphasis taper is used opposite to the normally used tapers. Also from the theory of FM sideband structure, when multiple modulating frequencies are employed, additional modulation components are produced over the components produced by the superposition of the simple components due to the individual modulation frequencies. These additional frequencies are the sums and difference of the simple sidebands removed from the carrier. Fortunately, their amplitudes are equal to the products of the Bessel function amplitudes producing the original simple sidebands and are therefore relatively small. It therefore appears to be safe to assume that for a normal pre-emphasis taper or even no taper the bandwidth occupied by an FM/FM telemetry system is dependent on the modulation level of the highest frequency subcarrier only."

A sideband study of the higher frequency channels was made using the radiated spectrum limit: The 40 db bandwidth of the modulated carrier, referenced to the unmodulated carrier, shall not exceed ± 320 kc. Carrier components appearing outside a ± 500 kc bandwidth shall not exceed -25 dbm.

---

(1) Jeske, H. O., Extension of Proportional Bandwidth FM Subcarrier Channels, Unpublished paper.

The sideband calculation for ± 7.5% and ± 15% subcarrier deviations are shown in Tables II-1. 3-1 and II-1. 3-2 respectively.

Note that a 0.01% allowance is made for drift and the -25 dbm specification is converted to -75 db relative to a 100-watt unmodulated carrier. Since IRIG document 106-60 limits transmitter power to 100 watts, this is a worst case condition.

The procedure used for the calculation of Tables II-1. 3-1 and II-1. 3-2 is to first determine the sideband which lies just outside the bandwidth limit. Next, using a table of Bessel functions, choose the maximum modulation index (MI) that does not cause the sideband outside the particular bandwidth to exceed the radiated spectrum level. From the modulation index, the maximum transmitter deviation allotted to that particular channel can be determined. This procedure is repeated at center frequency and at the bandedges to determine the limiting case. The limiting case then determines the maximum allowable transmitter deviation for that channel.

Table II-1. 3-3 shows a comparison of the signal-to-noise performance of the high-frequency channels relative to the 70-kc channel, based upon the maximum allowable transmitter deviation derived in Tables II-1. 3-1 and II-1. 3-2.

To define further the number of channels to be added to the proportional-bandwidth baseband, the minimum transmitter deviation allotted to each subcarrier was determined. This minimum is based on the criteria that the receiver should threshold at a carrier-to-noise ratio higher than that for the subcarriers to threshold, i.e., the receiver should threshold first. For this condition to be maintained, the subcarrier-to-noise ratio must exceed the receiver IF carrier-to-noise. The minimum transmitter deviation allotted to each subcarrier is thus the deviation sufficient to cause the subcarrier-to-noise ratio to equal the IF carrier-to-noise ratio. Figure II-1. 3-4 shows the minimum deviation as a function of the subcarrier center frequency. The straight line which defines the minimum deviation is the classical 3/2-power curve and is based upon the following calculation:

Assumptions:

Triangular noise in passband.

Subcarrier-to-noise ratio equal to IF carrier-to-noise ratio

IF bandwidth = 500 kc

BPIF bandwidth = 15% of center frequency

Carrier-to-noise above threshold.

$$(S/N)_s = (S/N)_c \left[\frac{B_c}{2B_s}\right]^{1/2} \frac{f_{dc}}{f_s}$$

where,

$(S/N)_s$ = subcarrier-to-noise ratio

$(S/N)_c$ = IF carrier-to-noise ratio

B_c = IF bandwidth

B_s = Subcarrier filter bandwidth

f_{dc} = Peak carrier deviation allotted to particular subcarrier channel

f_s = Subcarrier center frequency

But, $(S/N)_s$ = $(S/N)_c$, therefore

$$f_{dc} = f_s \left[\frac{2B_s}{B_c}\right]^{1/2}$$

As an example, consider the 40 kc ±15% channel:

$$f_{dc} = 40,000 \left[\frac{2(12,000)}{500,000}\right]^{1/2}$$

$$f_{dc} = 8.76 \text{ kc}$$

In addition to the minimum deviation line in Figure II-1.3-4, the maximum carrier deviation from the sideband study shown in Table II-1.3-2 is also plotted. The area of permissible operation, i.e., peak transmitter deviation allotted to each subcarrier, is thus the region bounded by the two curves in Figure II-1.3-4. The maximum subcarrier center frequency is also found to be 135 kc. The initial expanded proportional-bandwidth baseband considered thus contained channels at 93 kc and 124 kc; however, during the system test it was found that the 165 kc channel could be added while still maintaining the subcarrier threshold above the receiver threshold. This is discussed in more detail in Volume I. Table II-1.3-5 shows the channel allocations for the basebands evaluated using the laboratory telemeter.

1.3.2 Constant-Bandwidth Baseband

A similar calculation of maximum and minimum transmitter deviation allotted to each subcarrier channel as described for the proportional-bandwidth baseband was also made for the constant-bandwidth baseband. The sideband study calculations are shown in Table II-1.3-6 for binary channels spaced 8 kc apart and with ±2 kc. Calculations are also shown for each channel with ±4 kc deviation; however, only alternate channels can be used with ±4 kc deviation.

The minimum transmitter deviation to maintain the subcarrier-to-noise equal to the IF carrier-to-noise ratio was calculated for ±2 kc deviation in an identical manner as for the proportional-bandwidth baseband and is shown in Figure II-1. 3-7. The maximum deviation based on the sideband study shown in Table II-1. 3-6 is also plotted in Figure II-1. 3-7. The area of permissible operation is then again the region bounded by the two curves. The maximum center frequency is approximately 180 kc. Thus, the constant-bandwidth-baseband configuration which most nearly meets the objectives of the baseband expansion outlined in Volume I and which was chosen for evaluation is the 21-channel system (Figure I-1. 5-2) with the highest frequency channel at 176 kc. The channel allocations and implementation for this baseband are shown in Table II-1. 3-8.

1. 3. 3 Combinational-Bandwidth Baseband

To meet the objective of a baseband providing both constant- and proportional-bandwidth channels, the combinational-bandwidth baseband was designed and evaluated. This baseband consists of taking the 21-channel constant-bandwidth baseband and filling the space between dc and the first constant-bandwidth channel at 16 kc with IRIG proportional-bandwidth channels.

With the ±2 kc constant-bandwidth channels spaced 8 kc apart, the guard-band limit associated with each channel is 2 kc or ±4 kc from band center. For the 16 kc channel, this guard band extends to 12 kc. The center of the guard band between IRIG channel 12 (10. 5 kc ±7. 5%) and channel 13 (14. 5 kc ±7. 5%) is 12. 3 kc which is above the 12 kc guard band edge for the first constant-bandwidth-baseband channel.

Thus, the highest IRIG channel used in the combinational-bandwidth baseband is channel 11 (7. 35 kc ±7. 5%). The combinational-bandwidth baseband thus consists of IRIG channels 1 through 11, Table II-1. 3-5, and constant-bandwidth channels 1 through 21, Table II-1. 3-8.

1.4 DEFINITION OF SYMBOLS AND TERMS

The abbreviations and symbols below are used throughout the text.

BPIF	Band-pass input filter of subcarrier discriminator
CBW	Constant bandwidth
Crosstalk	Interference in a given channel which has its origin in another channel, e.g., adjacent channels in a frequency division multiplex system.
db	Voltage or power levels referenced to unity in decibels
dbm	Power level in db referenced to 1 milliwatt or voltage level in db referenced to the voltage into 600 ohms which dissipates 1 milliwatt
DR	Deviation ratio; in a frequency modulation system, the ratio of the maximum frequency deviation to the maximum modulating frequency of the system.
FBW	Full bandwidth
f_c	3-db cutoff frequency
f_m	Maximum modulation frequency for a particular deviation ratio
IF	Intermediate freqeuncy amplifier of receiver
Intermodulation	The modulation of the components of a complex wave by each other, producing waves having frequencies equal to the sums and differences of integral multiples of the component frequencies of the complex wave.
LPOF	Low-pass output filter of subcarrier discriminator
MI	Modulation index; for a sinusoidal modulating wave, the ratio of the frequency deviation to the frequency of the modulating wave.
PBW	Proportional bandwidth
rms transmitter deviation	Transmitter deviation sensitivity (kc peak/voltage peak) times rms voltage input.

$(S/N)_c$	Carrier-to-noise ratio
$(S/N)_d$	Signal-to-noise ratio
$(S/N)_s$	Subcarrier-to-noise ratio

Table II-1.3-1

SIDEBAND CALCULATIONS FOR ADDITION OF
±7.5% HIGHER FREQUENCY PROPORTIONAL BANDWIDTH SUBCARRIERS

Conditions: P_t = 100 watts
Drift Allowances - 0.01%

Specification: -40db at ±320 KC
-25dbm at ±500 KC

Channel Position (%)	Frequency (kc)	Sideband Outside ±294 kc	Actual Modulation Index	Sideband Amplitude (Limit 0.010)	Maximum Transmitter Deviation (± kc)	Sideband Outside ±474 kc	Sideband Amplitude (Limit 0.000178)
-7.5	64.75	5	2.16	*0.0100	140	8	0.00004
0	70.00	5	2.00	0.0070	140	7	*0.000175
+7.5	75.25	5	1.86	0.0050	140	7	0.00011
-7.5	86.02	4	0.92	0.0018	79	6	0.000013
0	93.00	4	0.85	0.0013	79	6	0.000008
+7.5	99.98	3	0.79	*0.00987	79	5	0.00008
-7.5	114.7	3	0.54	0.0032	62	5	0.000012
0	124.0	3	0.50	0.0025	62	4	*0.00016
+7.5	133.3	3	0.46	0.0020	62	4	0.00011
-7.5	152.6	2	0.22	0.006	33	4	0.000006
0	165.0	2	0.20	0.005	33	3	*0.00016
+7.5	177.38	2	0.19	0.004	33	3	0.00014
-7.5	203.5	2	0.20	0.005	41	3	*0.00016
0	220.0	2	0.19	0.004	41	3	0.00014
+7.5	236.5	2	0.17	0.0036	41	3	0.00010

TABLE II-1.3-2
SIDEBAND CALCULATIONS FOR ADDITION OF ±15% HIGHER FREQUENCY PROPORTIONAL BANDWIDTH SUBCARRIERS

Conditions: P_t = 100 watt
Drift Allowance = 0.01%

Specification: -40 db at ±320 kc
-25 dbm at ±500 kc

Channel Position (%)	Frequency (kc)	Sideband Outside ±294 kc	Actual Modulation Index	Sideband Amplitude (Limit 0.010)	Maximum X-mtr. Deviation (± kc)	Sideband Outside ±474 kc	Sideband Amplitude (Limit 0.000178)
-15	59.50	5	1.93	0.0059	115	8	0.00[illegible]7
-7.5	64.75	5	1.78	0.0041	115	8	0.0000089
0	70.00	5	1.65	0.0028	115	7	0.000047
+7.5	75.25	5	1.54	0.0020	115	7	0.000029
+15	80.50	4	1.43	0.0098	115	6	*0.000172
-15	79.05	4	1.00	0.0025	79	7	0.0000015
-7.5	86.02	4	0.92	0.0018	79	6	0.000013
0	93.00	4	0.85	0.0013	79	6	0.000008
+7.5	99.98	3	0.79	*0.00987	79	5	0.00008
+15	106.95	3	0.74	0.0081	79	5	0.00006
-15	105.4	3	0.59	0.0042	62	5	0.000018
-7.5	114.7	3	0.54	0.0032	62	5	0.000012
0	124.0	3	0.50	0.0025	62	4	*0.00016
+7.5	133.3	3	0.46	0.0020	62	4	0.00011
+15	142.6	3	0.43	0.0016	62	4	0.00008
-15	140.2	3	0.24	0.00028	33	4	0.000008
-7.5	152.6	2	0.22	0.006	33	4	0.000006
0	165.0	2	0.20	0.005	33	3	*0.00016
+7.5	177.38	2	0.19	0.004	33	3	0.00014
+15	189.75	2	0.17	0.0036	33	3	0.00010

SIDEBAND CALCULATIONS FOR ADDITION OF ±15% HIGHER FREQUENCY PROPORTIONAL BANDWIDTH SUBCARRIERS

Conditions: P_t = 100 watt
Drift Allowance = 0.01%

Specification: -40 db at ±320 kc
-25 dbm at ±500 kc

Channel Position (%)	Frequency (kc)	Sideband Outside ±294 kc	Actual Modulation Index	Sideband Amplitude (Limit 0.010)	Maximum X-mtr. Deviation (± kc)	Sideband Outside ±474 kc	Sideband Amplitude (Limit 0.000178)
-15	187.0	2	0.041	0.0002	7.6	3	0.000001
-7.5	203.5	2	0.037	0.00018	7.6	3	0.0000009
0	220.0	2	0.035	0.00016	7.6	3	0.0000008
+7.5	236.5	2	0.031	0.00012	7.6	3	0.0000006
+15	253.0	2	0.030	0.00011	7.6	2	*0.00011

* Indicates Limiting Case

TABLE II-1.3-3

SUMMARY OF SIGNAL-TO-NOISE PERFORMANCE OF HIGHER FREQUENCY PROPORTIONAL BANDWIDTH CHANNELS RELATIVE TO THE 70 KC IRIG CHANNEL

P_t = 100 watt

Subcarrier (kc)	Channel Deviation (%)	Modulation Index	X-mtr. Deviation (± kc)	Relative X-mtr. Deviation	Relative Deviation (db)	Noise 3/2 Taper (db)	Overall Performance (db)
70	15	1.65	115	1.00	0	0	0
93	15	0.85	79	0.686	-3.27	-3.8	-7.1
124	15	0.50	62	0.538	-5.38	-7.4	-12.8
165	15	0.20	33	0.287	-10.9	-11.2	-22.1
220	15	0.035	7.6	0.066	-23.6	-14.9	-38.5
70	7.5	2.00	140	1.00	0	0	0
93	7.5	0.65	79	0.564	-5.0	-3.8	-8.8
124	7.5	0.50	62	0.443	-7.1	-7.4	-14.5
165	7.5	0.20	33	0.236	-12.6	-11.2	-23.8
220	7.5	0.19	41	0.292	-10.8	-14.9	-25.7

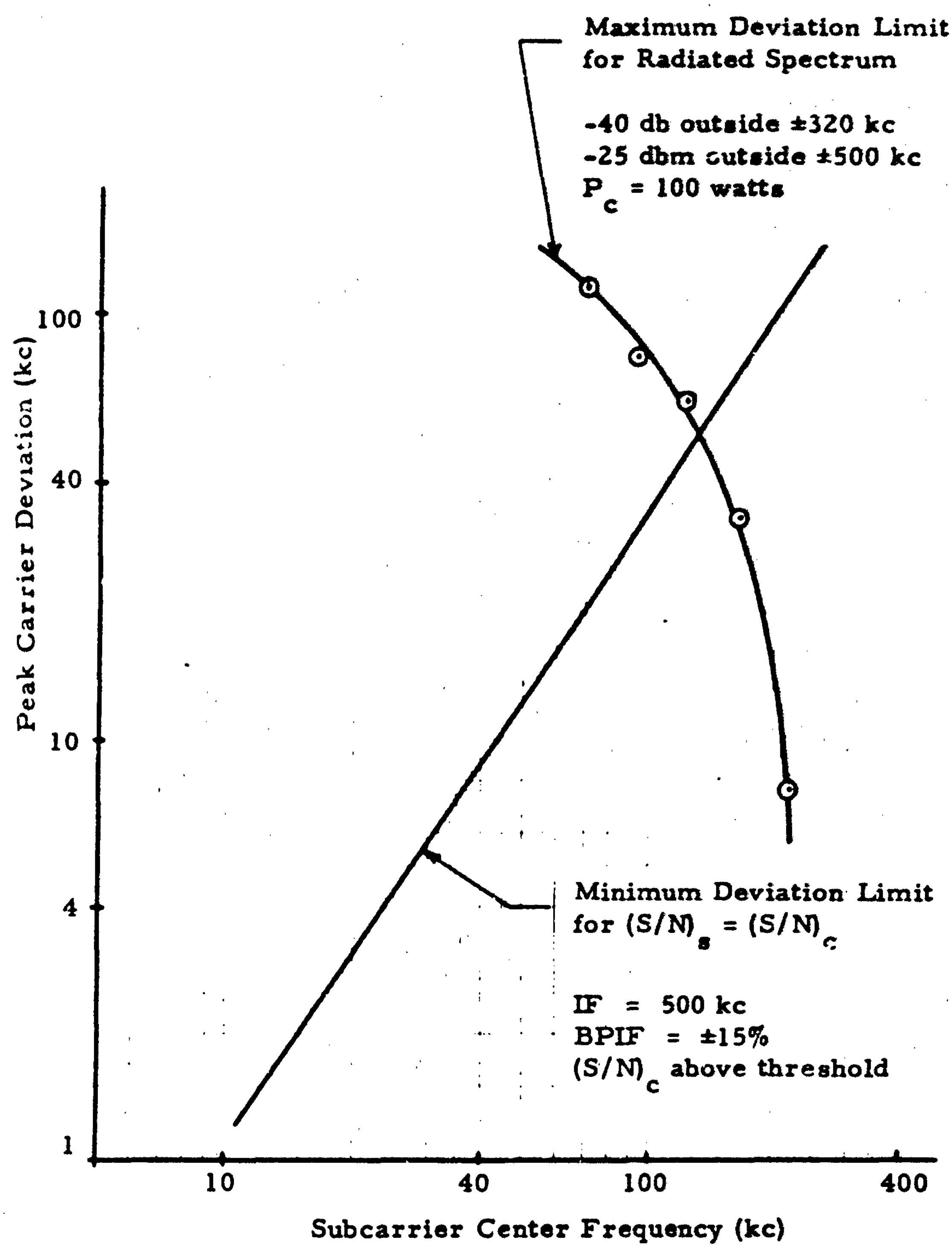


FIGURE II-1.3-4
FM/FM CARRIER DEVIATION LIMIT FOR WIDEBAND PROPORTIONAL BANDWIDTH CHANNELS

CHANNEL ALLOCATIONS FOR PROPORTIONAL BANDWIDTH BASEBANDS

Center Frequency (kc)	IRIG Baseband		IRIG Baseband with Wideband Channel		Expanded Proportional Bandwidth Baseband		Expanded Proportional Bandwidth Baseband with Wideband Channel	
0.40	1	±7.5%	1	±7.5%	1	±7.5%	1	±7.5%
0.56	2	±7.5%	2	±7.5%	2	±7.5%	2	±7.5%
0.73	3	±7.5%	3	±7.5%	3	±7.5%	3	±7.5%
0.96	4	±7.5%	4	±7.5%	4	±7.5%	4	±7.5%
1.30	5	±7.5%	5	±7.5%	5	±7.5%	5	±7.5%
1.70	6	±7.5%	6	±7.5%	6	±7.5%	6	±7.5%
2.30	7	±7.5%	7	±7.5%	7	±7.5%	7	±7.5%
3.00	8	±7.5%	8	±7.5%	8	±7.5%	8	±7.5%
3.90	9	±7.5%	9	±7.5%	9	±7.5%	9	±7.5%
5.40	10	±7.5%	10	±7.5%	10	±7.5%	10	±7.5%
7.35	11	±7.5%	11	±7.5%	11	±7.5%	11	±7.5%
10.5	12	±7.5%	12	±7.5%	12	±7.5%	12	±7.5%
14.5	13	±7.5%	13	±7.5%	13	±7.5%	13	±7.5%
22.0	14	±7.5%	14	±7.5%	14	±7.5%	14	±7.5%
30.0	15	±7.5%	15	±7.5%	15	±7.5%	15	±7.5%
40.0	16	±7.5%	16	±7.5%	16	±7.5%	16	±7.5%
52.5	17	±7.5%	—		17	±7.5%	17	±7.5%
70.0	18	±7.5%	E	±15%	18	±7.5%	18	±7.5%
93.0	—		—		19	±7.5%	19	±7.5%
124.0	—		—		20	±7.5%	—	
165.0	—		—		21	±7.5%	H	±15%

TABLE II-1.3-6

SIDEBAND CALCULATIONS FOR CONSTANT BANDWIDTH CHANNELS

Conditions: P_t = 100 watts — Specifications: -40 db at ±320 kc

Drift Allowance = 0.01% — -25 dbm at ±500 kc

Subcarrier (kc)	Channel Position (kc)	Sideband Outside ±294 kc	Actual M.I.	Sideband Amplitude (Limit 0.010)	Maximum X-mtr. Deviation (±kc)	Sideband Outside ±474 kc	Sideband Amplitude (Limit 0.000178)
94	-2	4	---	---	88.4	6	---
96	0	4	0.92	0.0017	88.4	5	*0.000166
98	+2	4	---	---	88.4	5	---
92	-4	4	---	---	79.0	6	---
96	0	4	0.82	---	79.0	5	0.00009
100	+4	3	0.79	*0.0098	79.0	5	0.000078
102	-2	3	0.79	*0.0098	80.5	5	0.000078
104	0	3	0.78	---	80.5	5	---
106	+2	3	---	---	80.5	5	---
100	-4	3	0.79	*0.0098	79.0	5	0.000078
104	0	3	0.76	---	79.0	5	---
108	+4	3	---	---	79.0	5	---
110	-2	3	0.79	*0.0098	86.8	5	0.000078
112	0	3	0.78	---	86.8	5	---
114	+2	3	---	---	86.8	5	---
108	-4	3	0.79	*0.0098	85.3	5	0.000078
112	0	3	0.76	---	85.3	5	---
116	+4	3	---	---	85.3	5	---

TABLE II-1.3-6 (CONT'D.)
SIDEBAND CALCULATIONS FOR CONSTANT BANDWIDTH CHANNELS

Conditions: P_t = 100 watts

Drift Allowance = 0.01%

Specifications: -40 db at ±320 kc

-25 dbm at ±500 kc

Subcarrier (kc)	Channel Position (kc)	Sideband Outside ±294 kc	Actual M.I.	Sideband Amplitude (Limit 0.010)	Maximum X-mtr. Deviation (±kc)	Sideband Outside ±474 kc	Sideband Amplitude (Limit 0.000178)
118	-2	3	0.52	0.0029	61.1	5	---
120	0	3	0.51	0.0027	61.1	4	*0.000174
122	+2	3	---	---	61.1	4	---
116	-4	3	0.53	0.0029	61.1	5	---
120	0	3	0.51	0.0027	61.1	4	*0.000174
124	+4	3	---	---	61.1	4	---
126	-2	3	0.51	0.0027	64.2	4	*0.000174
128	0	3	0.50	---	64.2	4	---
130	+2	3	---	---	64.2	4	---
124	-4	3	0.51	0.0027	63.3	4	*0.000174
128	0	3	0.50	---	63.3	4	---
132	+4	3	---	---	63.3	4	---
134	-2	3	0.51	0.0027	68.3	4	*0.000174
136	0	3	0.50	---	68.3	4	---
138	+2	3	---	---	68.3	4	---
132	-4	3	0.51	0.0027	67.3	4	*0.000174
136	0	3	0.50	---	67.3	4	---
140	+4	3	---	---	67.3	4	---

*Indicates Limiting Case

Conditions: P_t = 100 watts
Drift Allowance = 0.01%

Specifications: -40 db at ±320 kc
-25 dbm at ±500 kc

Subcarrier (kc)	Channel Position (kc)	Sideband Outside ±294 kc	Actual M.I.	Sideband Amplitude (Limit 0.010)	Maximum X-mtr. Deviation (±kc)	Sideband Outside ±474 kc	Sideband Amplitude (Limit 0.000178)
142	-2	3	0.51	0.0027	72.4	4	*0.000174
144	0	3	0.51	---	72.4	4	---
146	+2	3	---	---	72.4	4	---
140	-4	3	---	---	41.5	4	---
144	0	3	0.288	---	41.5	4	---
148	+4	2	0.28	*0.0097	41.5	4	0.000016
150	-2	2	0.28	*0.0097	42	4	0.000016
152	0	2	0.276	---	42	4	---
154	+2	2	0.273	---	42	4	---
148	-4	2	0.28	*0.0097	41.5	4	0.000016
152	0	2	0.273	---	41.5	4	---
156	+4	2	0.266	---	41.5	4	---
158	-2	2	0.20	0.005	31.6	3	*0.000166
160	0	2	0.198	---	31.6	3	---
162	+2	2	0.195	---	31.6	3	---
156	-4	2	0.205	0.005	32.0	4	0.000004
160	0	2	0.20	0.005	32.0	3	*0.000166
164	+4	2	0.195	---	32.0	3	---

* Indicates Limiting Case

TABLE II-1.3-6 (CONT'D.)
SIDEBAND CALCULATIONS FOR CONSTANT BANDWIDTH CHANNELS

Conditions: P_t = 100 watts
Drift Allowance = 0.01%

Specifications: -40 db at ±320 kc
-25 dbm at ±500 kc

Subcarrier (kc)	Channel Position (kc)	Sideband Outside ±294 kc	Actual M.I.	Sideband Amplitude (Limit 0.010)	Maximum X-mtr. Deviation (±kc)	Sideband Outside ±474 kc	Sideband Amplitude (Limit 0.000178)
166	-2	2	0.20	0.005	33.2	3	*0.000166
168	0	2	0.198	---	33.2	3	---
170	+2	2	0.195	---	33.2	3	---
164	-4	2	0.20	0.005	32.8	3	*0.000166
168	0	2	0.195	---	32.8	3	---
172	+4	2	0.191	---	32.8	3	---
.							
.							
.							
.							
.							
.							
230	-2	2	0.20	0.005	46.0	3	*0.000166
232	0	2	---	---	46.0	3	---
234	+2	2	---	---	46.0	3	---
238	-2	2	0.03	0.00011	7.14	2	*0.00011
240	0	2	---	---	7.14	2	---
242	+2	2	---	---	7.14	2	---

SIDEBAND CALCULATIONS FOR CONSTANT BANDWIDTH CHANNELS

Conditions: P_t = 100 watts

Drift Allowance = 0.01%

Specifications: -40 db at ±320 kc

-25 dbm at ±500 kc

Subcarrier (kc)	Channel Position (kc)	Sideband Outside ±294 kc	Actual M.I.	Sideband Amplitude (Limit 0.010)	Maximum X-mtr. Deviation (±kc)	Sideband Outside ±474 kc	Sideband Amplitude (Limit 0.000178)
236	-4	2	---	---	7.2	3	0.00016
240	0	2	0.03	0.00011	7.2	2	*0.00011
244	+4	2	---	---	7.2	2	---
246	-2	2	0.03	0.00011	7.38	2	*0.00011
248	0	2	---	---	7.38	2	---
250	+2	2	---	---	7.38	2	---
244	-4	2	0.03	0.00011	7.32	2	*0.00011
248	0	2	---	---	7.32	2	---
252	+4	2	---	---	7.32	2	---

*Indicates Limiting Case

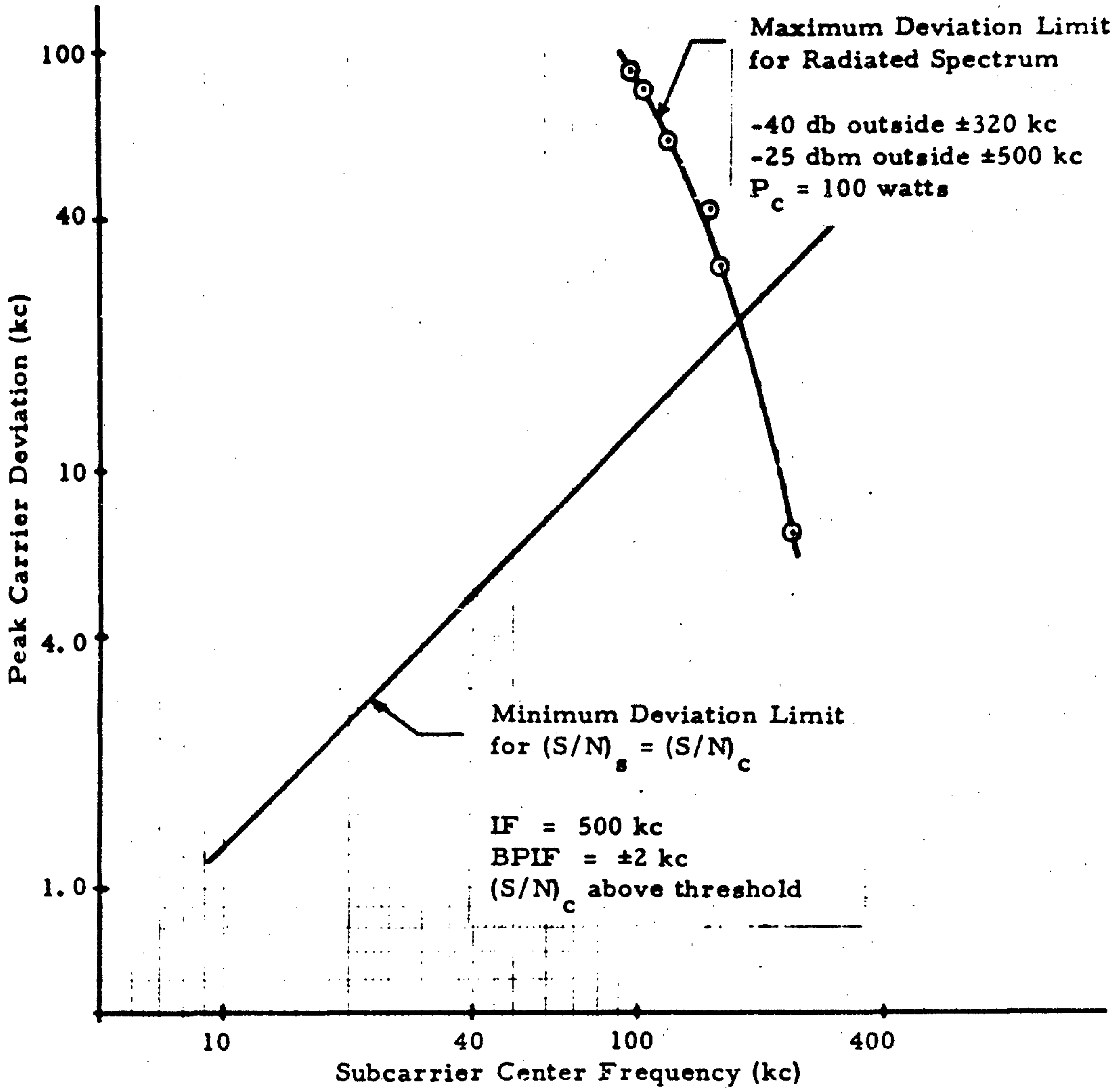


FIGURE II-1. 3-7
FM/FM CARRIER DEVIATION LIMIT FOR
±2 KC CONSTANT BANDWIDTH CHANNELS

TABLE II-1. 3-8
CHANNEL ALLOCATIONS FOR
CONSTANT BANDWIDTH BASEBAND

Channel Number	Group	VCO Frequency (kc)	Translation Frequency (kc)	Channel Frequency (kc)
1	A	16	None	16
2		24		24
3		32		32
4		40		40
5		48		48
6		56		56
7	B	56	120	64
8		48		72
9		40		80
10		32		88
11		24		96
12	C	56	160	104
13		48		112
14		40		120
15		32		128
16		24		136
17	D	56	200	144
18		48		152
19		40		160
20		32		168
21		24		176

SECTION 2

EQUIPMENT EVALUATION

2.1 GENERAL

This section contains block diagrams, procedures, and measured data for the equipment-evaluation portion of the baseband-expansion study. The equipment evaluation was undertaken to measure characteristics of the equipments used which would affect the accuracy of the telemeter or the ability to add additional higher-frequency channels to the baseband.

2.2 VOLTAGE-CONTROLLED OSCILLATORS

Of the 36 standard IRIG ±7.5% VCOs and two 93.5 kc ±15% VCOs received as GFE for the study contract, five units were selected for evaluation:

Manufacturer	Model	Frequency	Serial No.
Tele-Dynamics	1270A	3.0 kc ±7.5%	21-404
Tele-Dynamics	1270A	70.0 kc ±7.5%	27-565
Vector	TS-41	3.0 kc ±7.5%	3742-25
Vector	TS-41	70.0 kc ±7.5%	5683-25
Vector	TS-41HF	93.5 kc ±15%	8485-5

An EMR 307A, 32 kc ±2 kc VCO was also subjected to the same evaluation tests of static and dynamic linearity, modulation feedthrough, total harmonic distortion, and crosstalk.

Block diagrams and measured data for these tests are contained in Tables II-2.2-1 through -2.2-4.

TABLE II-2.2-1

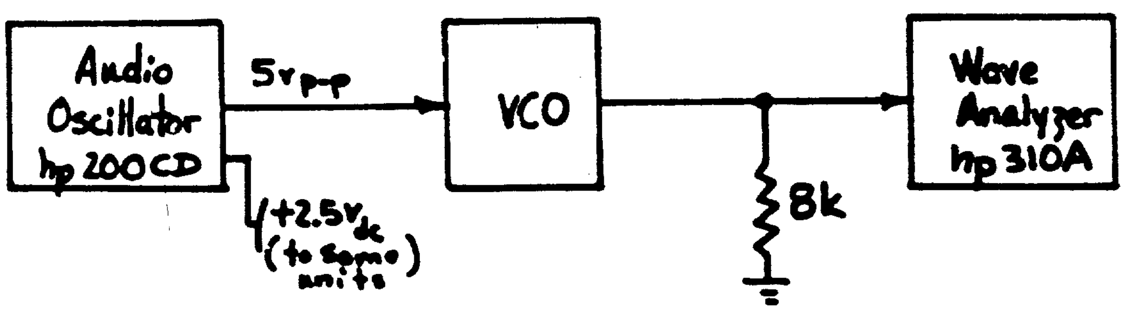
VCO STATIC AND DYNAMIC LINEARITY

Unit	Frequency, cps: HBE	HBE/2	CF	LBE/2	LBE	Static Non-Lin.	Dynamic Non-Lin.
TDI 1270A 3.0kc ± 7.5%	3 224.0	3111.8	2 999.2	2886.0	2 772.2	±0.122%	≈±0.05%
TDI 1270A 70.0kc ± 7.5%	75 275.	72 645.	70 018.	67 386.	64 743.	±0.048%	≈±0.05%
Vector TS-41 3.0kc ± 7.5%	3 225.8	3 112.7	2999.9	2 887.4	2 775.1	±0.029%	<±0.05%
Vector TS-41 70.0kc ± 7.5%	75 272.	72 625.	69,989.	67 358.	64 735.	±0.069%	≈±0.05%
Vector TS-41 HF 93.5kc ± 15%	107564.	100 606.	93 600.	86 561.	79 495.	±0.128%	—
EMR 307A 32.0kc ± 2.0kc	34 006.	33 005.	32 003.	31 003.	30 003.	±0.019%	≈±0.01%

VCO MODULATION FEEDTHROUGH

	Modulation Freq. f_m (cps)	Mod. Feedthrough (% of unmodulated VCO output voltage)
TDI 1270A 70.0kc ± 7.5%	5250 (MI=1)	0.0048%
Vector TS-41 70.0kc ± 7.5%	5250 (MI=1)	0.374%
Vector TS-41 HF 93.5kc ± 15%	14,000 (MI=1)	0.87%
"	2800 (MI=5)	0.17%
EMR 307A 32.0kc ± 2.0kc	2000 (MI=1)	0.032%

With the audio oscillator at f_m measure the f_m component at the VCO output referenced to the unmodulated VCO output voltage.



VCO TOTAL HARMONIC DISTORTION

Total Harmonic Distortion
(Percent of Unmodulated VCO Output Voltage)

		HBE	CF	LBE
TDI-1270A	3.0kc ± 7.5%	0.26%	0.42%	0.64%
TDI-1270A	70.0kc ± 7.5%	0.14%	0.15%	0.22%
Vector TS-41	3.0kc ± 7.5%	0.40%	0.36%	0.44%
Vector TS-41	70.0kc ± 7.5%	0.19%	0.24%	0.29%
Vector TS-41 HF	93.5kc ± 15%	0.45%	0.31%	0.17%
EMR 307A	32.0kc ± 2.0kc	0.07%	0.07%	0.08%

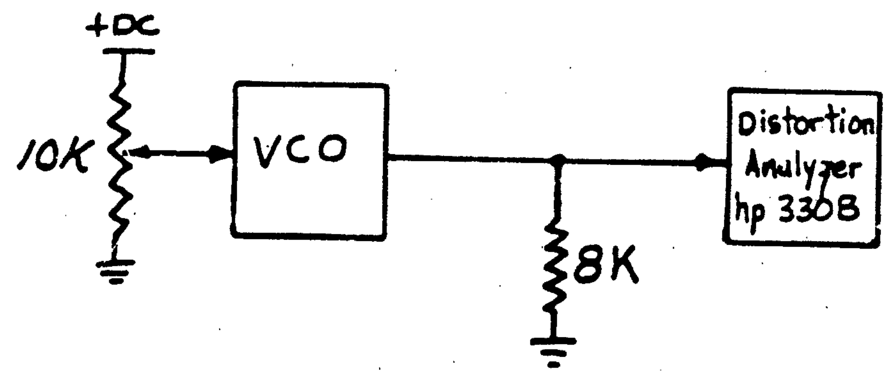
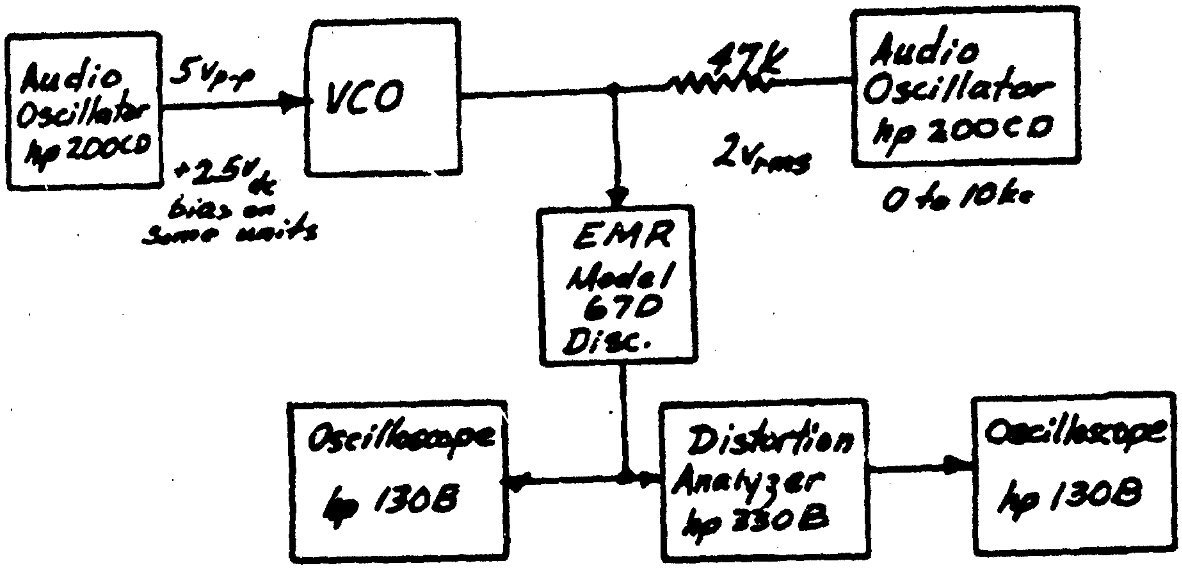


TABLE II-2.2-4

VCO CROSSTALK



VCO's were tested as above with a modulating frequency corresponding to an MI = 2 and a discriminator output filter (constant amplitude) cutoff frequency corresponding to an MI of 1. No crosstalk greater than ±0.1% of bandwidth was observed outside the passband of the discriminator input filter. The experiment was repeated with a 47k resistor substituted for the VCO, with identical results; therefore, crosstalk due to the VCO's was judged to be negligible.

2.3 MIXER AMPLIFIER

The Sonex TEX-3210 Mixer Amplifier was evaluated for frequency response, harmonic content, and intermodulation characteristics. The respective results and block diagrams for the tests are included in Tables II-2.3-1 through II-2.3

TABLE II-2.3-1

FREQUENCY RESPONSE SONEX TEX-3210 MIXER AMPLIFIER

Mixer Gain: +10 db

Frequency cps	Relative Level db
50.0	-0.8
100.0	-0.3
200.0	0.0
↓	↓
200.0 kc	0.0
500.0 kc	-1.2
850.0 kc	-3.0
1.0 Mc	-3.8
2.0 Mc	-8.8
5.0 Mc	-15.2

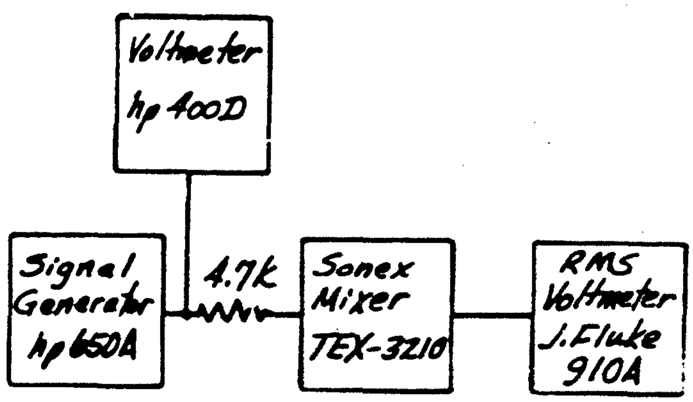


TABLE II-2.3-2

HARMONIC CONTENT
SONEX TEX-3210
MIXER AMPLIFIER

Fundamental Frequency	Harmonic Level (db relative to fundamental) 2nd	3rd	4th
1kc	-56.5	-59.5	-73.0
2kc	-56.0	-59.0	-72.5
5kc	-55.0	-58.5	-72.0
10kc	-53.0	-58.0	-72.0
20kc	-53.0	-58.0	-72.0
50kc	-49.0	-54.5	-68.0
100kc	-46.0	-60.5	-72.0
150kc	-44.0	-60.5	-73.5

Mixer Gain = +10 db
Output Level = 0 dbm into 600Ω or 790mv

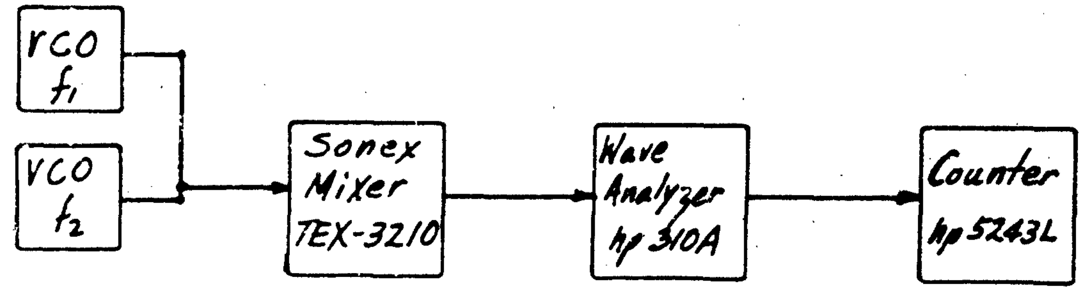
Total Harmonic Distortion • 0.64% for 150kc case is within the specification for the hp 650A Signal generator used. Measureing instrument: hp 310A Wave Analyzer.

TABLE II-2.3-3

INTERMODULATION TEST
SONEX TEX-3210
MIXER AMPLIFIER

Frequency Pair		$f_2 - f_1$		$f_1 + f_2$	
f_1	f_2	Freq.	Level	Freq.	Level
400cps	560cps	160cps	17 µvolts	960cps	8 µvolts
1.3kc	1.7kc	400cps	8 µvolts	3.0kc	3 µvolts
14.5kc	22.0kc	7.5kc	77 µvolts	36.5kc	24 µvolts
93.5kc	124.0kc	30.5kc	24 µvolts	—	—

Twenty-channel proportional multiplex pre-emphasized as used with output adjusted to 1.0 Vrms with all channels operating.



2.4 GROUP TRANSLATOR

2.4.1 General

The EMR Model 316 Frequency Translator is used in constant-bandwidth FM/FM telemetry systems to generate stable high-frequency subcarrier channels by trans lating up in frequency the outputs of standard EMR subcarrier oscillators (VCOs) operating in the lower subcarrier frequency spectrum. The block diagram of a constant-bandwidth VHF FM/FM telemeter is shown in Section 1.5 of Volume I.

The outputs of the subcarrier oscillators for CBW channels 1 through 6, 16.0 kc through 56.0 kc, are linearily mixed in the Model 316A-01 for Group "A." The outputs of five subcarrier oscillators, whose center frequencies and frequency deviations are identical to those of the VCOs for CBW channels 2 (24.0 kc) through 6 (56.0 kc), are mixed in the Model 316X-01 Frequency Translator for Group "B." The outputs are frequency translated as a group to the multiplexed subcarrier channel frequencies for CBW channels 7 through 11, 64.0 kc through 96.0 kc. Multiplexed channels 12 (104.0 kc) through 16 (136.0 kc) are similarly obtained by the Model 316X-02 for Group "C," and channels 17 (144.0 kc) through 21 (176.0 kc) by the Model 316X-02 for Group "D." The subcarrier channels in Group "A" are mixed but not translated in frequency. The Group A, B, C, and D outputs are linearily mixed in a Model 311A Mixing Amplifier and the multiplex output signal, consisting of constant-bandwidth FM subcarrier channels 1 through 21, is applied as the modulating signal to the VHF FM transmitter.

The entire telemeter may contain only six different types of subcarrier oscillators. The frequency deviation of all VCOs is within the limits of ±3.57% to ±12.5% of center frequency, which makes it possible to generate accurate and stable subcarrier FM signals. A number of proportional-bandwidth channels may be added in the lower frequency spectrum of Group "A" below 16.0 kc if additional channels are required, as is shown in Section 1.5 of Volume I.

2.4.2 Specifications

A detailed evaluation program for the group translator was not undertaken as part of the baseband expansion study. The unit was, however, evaluated by other EMR personnel and its performance to the following specifications verified:

<u>Subcarrier Frequencies</u>: Standard constant-bandwidth FM subcarrier channels spaced 8.0 kc apart from 16 kc to 176 kc. Other constant-bandwidth FM systems are available with multiplexed subcarrier channel center frequencies in the range of the 4 kc to 750 kc.

<u>Subcarrier Frequency Deviation</u>: ±2 kc, ±4 kc, and ±8 kc are standard. Other constant-bandwidth FM systems are available with subcarrier frequency deviation in the range of ±1 kc to ±16 kc.

Subcarrier Deviation Polarity: Deviation polarity of subcarrier channels in Group "A" is maintained; deviation polarity of channels in other groups is inverted. Normally overall positive polarity from VCO input to subcarrier discriminator output is maintained due to reinversion of the inverted channels in ground frequency detranslation equipment such as the EMR Model 259.

Input Signal: Model 316A (Group "A"): Outputs of EMR Models 306A, 307A, or 309 A VCOs for channels 1 through 6. Outputs of VCOs for channel A and/or proportional-bandwidth channels may be added if additional channels are required.

Model 316X (Groups "B," "C," "D,"...): Outputs of EMR Models 306A, 307A, or 309A VCOs for channels 2 through 6. For standard constant-bandwidth systems a 46.4k ohm mixing resistor, contained in the VCOs, is used. The EMR VCOs for use in standard constant-bandwidth systems have a floating output ground connection to reduce inter-group crosstalk to a negligible level.

Output Signal: Adjustable to 5 volts peak-to-peak maximum open circuit (measured at output test point), referenced to ground. A series mixing resistor of 10k ohms minimum is installed at manufacture to provide the desired system emphasis.

Heterodyne Signal: A crystal-controlled reference signal is generated within all Model 316A Frequency Translators except the Model 316A for Group "A." A test point is provided for monitoring this signal.

Frequency Range:	50 kc to 800 kc
Frequency Accuracy:	±0.005% at 25°C
Frequency Stability:	±0.0025% from the frequency at 25°C over the range -20°C to +85°C

Subcarrier Gain: Overall subcarrier gain is measured from the input of the VCO mixing resistor (VCO test point) to the open circuit frequency translator output (Model 316A output test point). The subcarrier gain of a frequency at the center of the output passband of the Model 316A is adjusted in manufacture to 0.1 (−20 db). The subcarrier gain for frequencies in the passband from low band edge to the lowest frequency output channels to high band edge of the highest frequency output channel is within ±1 db of the gain measured at the center of the output passband.

Subcarrier Emphasis: Relative subcarrier levels are adjusted by "output" controls of the VCOs. Group level is adjusted by "output" control of Model 316A Frequency Translator. Multiplex level (modulation signal to the VHF FM transmitter) is adjusted by "output" control of the Model 311A Mixing Amplifier. The output mixing resistor of each Model 316A is adjusted in manufacture for approximate mid-setting of the "output" control of the Model 316A for the desired emphasis. Recommended emphasis schedules and list of nominal system levels for standard constant-bandwidth FM/FM systems are available on request.

Spurious Output Signals: Individual spurious output signals are -46 db or less referenced to the nominal individual subcarrier output level. This specification includes the following undesired output signals:

Undesired sideband

Input multiplex feedthrough

Hetrodyne signal (fundamental, harmonics, and sidebands about harmonics)

Input signal harmonics generated in the 316A

Input signal intermodulation products

Power supply ripple components

Based on 5 subcarriers per translation group, nominal levels are:

	Measured Level	
	At Test Point of SCO	At Output Test Point of 316A
Subcarrier Level	1.5 rms	0.15 rms
Multiplex Level	...	2.2 p-p

Power Supply Sensitivity: Operation is as specified with a steady-state supply voltage or a 4-volt peak-to-peak dynamic change in supply voltage (dc to 100 kc) anywhere in the range of +24 to +32 volts.

Power Requirements: Positive 28.0 volts dc nominal referenced to ground; ±4.0 volts; 30 ma at nominal voltage.

Operating Temperature: Operation is as specified with steady-state temperature in the range of -20°C to +85°C.

Vibration: Sinusoidal vibration along each of the three major axes of the referenc oscillator at 0.06 inch double amplitude or a peak acceleration of 35g, whichever is less, up to a frequency of 2000 cycles per second, results in an offset change in output frequency of less than 0.005% and incidental FM, measured with a ±7.5% discriminator at a deviation ratio of 1, of less than 0.1% rms of bandwidth.

Shock: Shock of up to 200g, 11 millisecond duration, causes an offset change in output frequency of less than 0.005% and peak incidental FM, measured with a ±7.5% discriminator at a deviation ratio of 1, of less than 0.1% of bandwidth.

Continuous Acceleration: Continuous acceleration of up to 300g produces a change in output frequency of less than 0.005%.

Altitude: A change in altitude from sea level to 200,000 feet produces a change in output frequency of less than 0.005% provided the surface on which the unit is mounted is maintained at constant temperature.

Humidity: Operation is as specified over the humidity range of 0% to 95% relative.

2.5 TRANSMITTER

2.5.1 General

A Leach FM 200 Transmitter and an EMR 121D Transmitter were selected for evaluation as representative telemetry transmitters. The Leach FM 200 is a transistorized unit, while the EMR 121D is a vacuum tube design. Total harmonic distortion and deviation sensitivity were measured on each transmitter for deviations up to ±200 kc and modulation frequencies as high as 225 kc.

The EMR Model 270 Subcarrier Discriminator was calibrated for deviation sensitivity (±20.0±0.2%); linearity, ±0.1% BSL; and total harmonic distortion data on the particular audio oscillator used was measured; the data is included as Table II-2.5-2.

2.5.2 Total Harmonic Distortion

Equipment outlined in Figure II-2.5-3 was used to measure transmitter total harmonic distortion. Each transmitter was evaluated by using frequency translation and the EMR 270 Subcarrier Discriminator as a precision receiver. Detailed procedure for the total harmonic distortion tests is as follows:

1. With equipment set up as in Figure II-2.5-3, set the audio oscillator to the desired fundamental frequency. Fundamental frequencies of 3.0 kc, 30 kc, 70 kc, and 225 kc were used.

2. Adjust the audio oscillator amplitude to yield the desired transmitter deviation as indicated by the discriminator output voltage measured on the HP 310A Wave Analyzer. Record the transmitter input voltage level required.

3. Tune the wave analyzer to harmonics of the fundamental and record their levels.

4. Compute the total harmonic distortion as follows:

$$\%THD = \sqrt{\frac{\sigma_2^2 + \sigma_3^2 + \ldots + \sigma_n^2}{\sigma_1}} \times 100$$

where,

e_1 = rms value of fundamental voltage
e_n = rms level of nth harmonic voltage

Harmonic distortion data obtained for the EMR 121D and the Leach FM 200 are given in Tables II-2.5-4 through II-2.5-8 and Tables II-2.5-9 through II-2.5-13, respectively. This data is presented graphically in Figures I-2.5-1 and I-2.5-2 of Volume I.

2.5.3 Deviation Sensitivity

By measuring the transmitter input signal level as part of the total harmonic distortion test, data on deviation sensitivity is obtained without a separate test. Data measured on transmitter input level as a function of deviation and modulation frequency is presented in the same Tables II-2.5-8 through II-2.5-13. Graphical presentation of the data is included in Volume I, Figures I-2.5-3 through I-2.5-6.

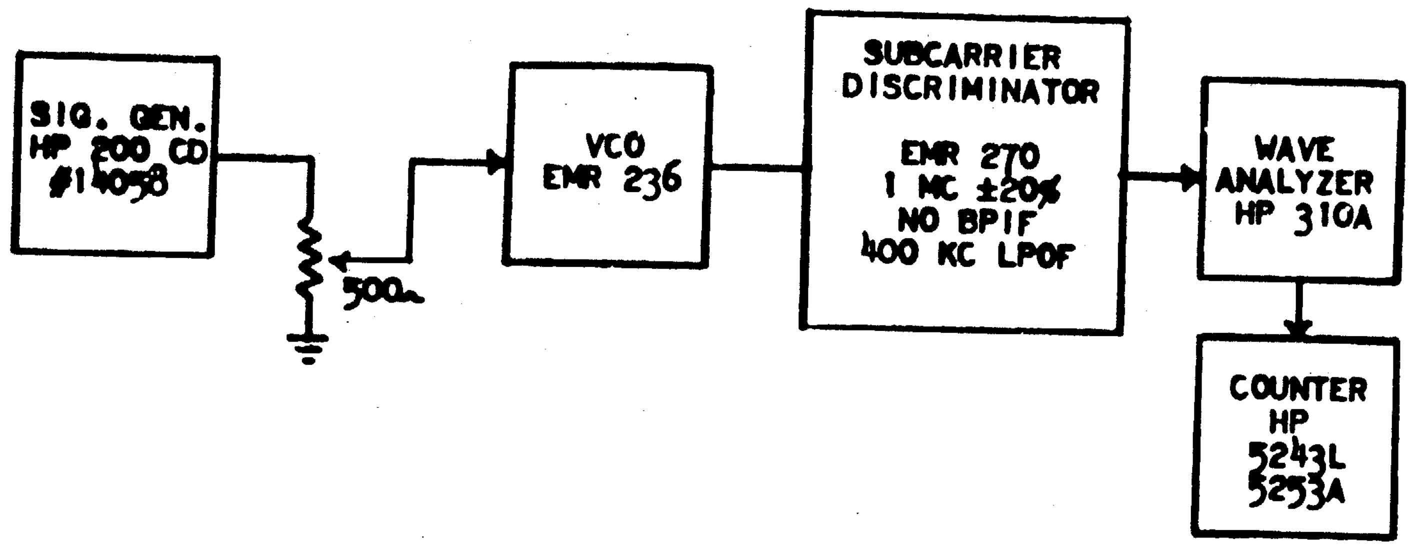


FIGURE II-2.5-1
OSCILLATOR/DISCRIMINATOR TOTAL HARMONIC DISTORTION

TABLE II-2.5-2
OSCILLATOR TEST RECORD

MFR H/P MODEL 200CD S/N 14053 ORIGINATOR WSB DATE 9-4-64

Deviation	Transmitter Input Level rms volts		Fund.	Second Harmonic	Third Harmonic	Fourth Harmonic	Fifth Harmonic	Square Root Sum ms Output	Total Harmonic Distortion
±25 kc		Frequency	3 KC	6 KC	9 KC	12 KC	15 KC		
		rms output	3.0 V	5.0 mv	6.5 mv	—	0.2 mv		
		ms output		$25 \cdot 10^{-6}$ V	$42.25 \cdot 10^{-6}$ V	—	$0.04 \cdot 10^{-6}$ V	8.2×10^{-3} V	0.273 %
±50 kc		Frequency	30 KC	60 KC	90 KC	120 KC	150 KC		
		rms output	3.0 V	5.7 mv	6.8 mv	—	0.3 mv		
		ms output		$32.49 \cdot 10^{-6}$ V	$46.24 \cdot 10^{-6}$ V	—	$0.09 \cdot 10^{-6}$ V	$8.91 \cdot 10^{-3}$ V	0.297 %
±75 kc		Frequency	70 KC	140 KC	210 KC	280 KC	350 KC		
		rms output	3.0 V	5.0 mv	3.4 mv	—	3.1 mv		
		ms output		$25.0 \cdot 10^{-6}$ V	$11.56 \cdot 10^{-6}$ V	—	$9.61 \cdot 10^{-6}$ V	$6.79 \cdot 10^{-3}$ V	0.226 %
±100 kc		Frequency	100 KC	200 KC	300 KC	400 KC	500 KC		
		rms output	3.0 V	5.0 mv	2.5 mv	—	2.7 mv		
		ms output		$25.0 \cdot 10^{-6}$ V	$6.25 \cdot 10^{-6}$ V	—	$7.29 \cdot 10^{-6}$ V	$6.21 \cdot 10^{-3}$ V	0.207 %
±125 kc		Frequency	225 KC	450 KC	675 KC	900 KC	1125 KC		
		rms output	3.0 V	4.1 mv	5.3 mv	—	1.7 mv		
		ms output		$16.8 \cdot 10^{-6}$ V	$28.09 \cdot 10^{-6}$ V	—	$2.89 \cdot 10^{-6}$ V	$6.91 \cdot 10^{-3}$ V	0.230 %
±150 kc		Frequency							
		rms output							
		ms output							
±175 kc		Frequency							
		rms output							
		ms output							
±200 kc		Frequency							
		rms output							
		ms output							

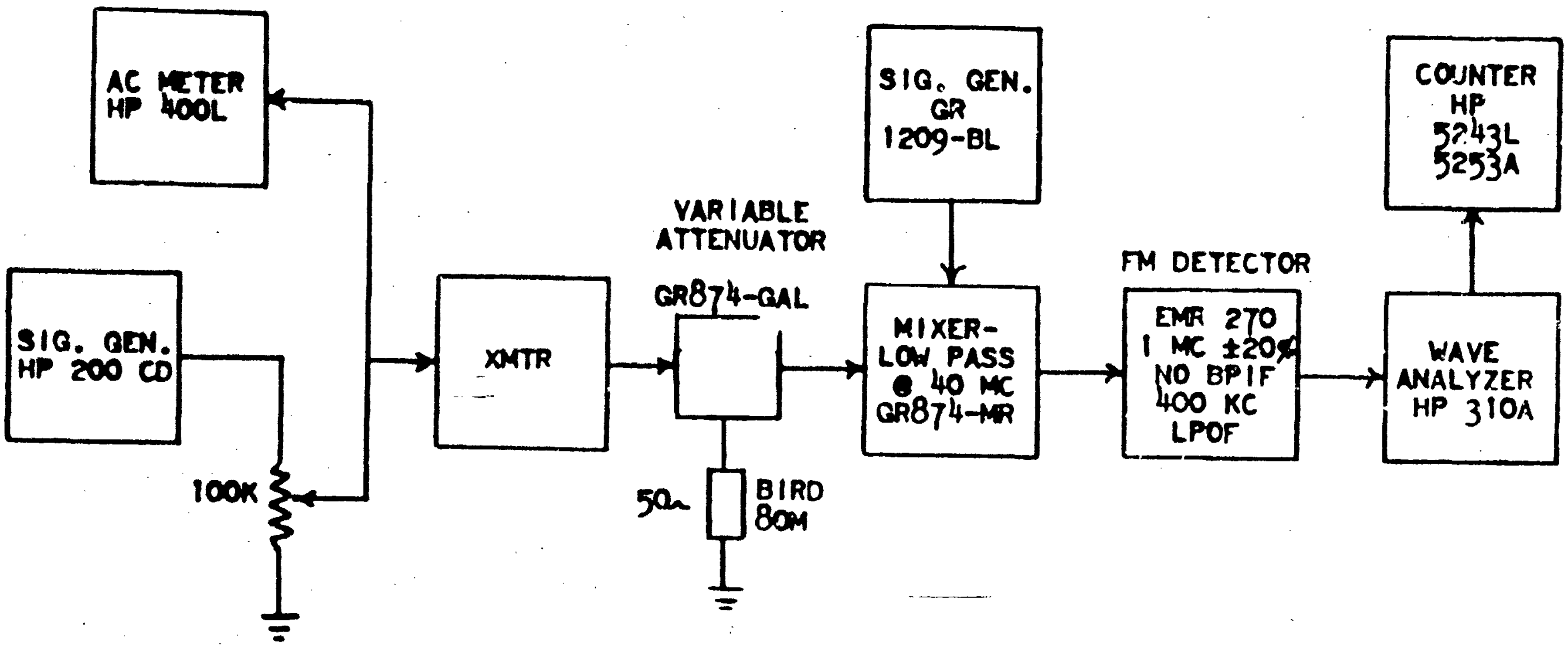


FIGURE II-2.5-3
TRANSMITTER TOTAL HARMONIC DISTORTION TEST

TABLE II-2.5-4

TRANSMITTER TEST RECORD, EMR 121D, 3 KC FUNDAMENTAL

MFR EMR MODEL 121 S/N 922 ORIGINATOR ______ DATE 9-1-64

Deviation	Transmitter Input Level rms volts	3.0KC	Fund.	Second Harmonic	Third Harmonic	Fourth Harmonic	Fifth Harmonic	Square Root Sum ms Output	Total Harmonic Distortion
±25 kc	0.210V	Frequency rms output ms output	0.885V	2.1mv	1.9mv	0.7mv	—		0.33%
±50 kc	0.415V	Frequency rms output ms output	1.77V	4.8mv	4.0mv	0.8mv	—		0.36%
±75 kc	0.628V	Frequency rms output ms output	2.66V	8.2mv	6.0mv	0.9mv	—		0.38%
±100 kc	0.832V	Frequency rms output ms output	3.54V	11.0mv	7.0mv	0.8mv	—		0.37%
±125 kc	1.05V	Frequency rms output ms output	4.42V	15.0mv	9.0mv	—	—		0.40%
±150 kc	1.25V	Frequency rms output ms output	5.31V	20.0mv	12.0mv	—	—		0.44%
±175 kc	1.46V	Frequency rms output ms output	6.19V	38.0mv	20.0mv	—	—		0.70%
±200 kc	1.66V	Frequency rms output ms output	7.07V	38.0mv	20.0mv	1.4mv	1.3mv		0.61%

TRANSMITTER TEST RECORD, EMR 121D, 30 KC FUNDAMENTAL

MFR EMR MODEL 121 S/N 922 ORIGINATOR ______ DATE 9-1-64

Deviation	Transmitter Input Level rms volts	30KC	Fund.	Second Harmonic	Third Harmonic	Fourth Harmonic	Fifth Harmonic	Square Root Sum ms Output	Total Harmonic Distortion
±25 kc	0.212V	Frequency rms output ms output	0.885V	4.6mv	1.8mv	0.4mv	———		0.56%
±50 kc	0.420V	Frequency rms output ms output	1.77V	9.0[illegible]	6.6mv	0.7mv	1.5mv		0.6[illegible]
±75 kc	0.635V	Frequency rms output ms output	2.66V	19.0[illegible]	5.2mv	1.2mv	6.2mv		0.73%
±100 kc	0.840V	Frequency rms output ms output	3.54V	27.0m[illegible]	9.0[illegible]	1.1mv	3.0[illegible]		0.81%
±125 kc	1.05V	Frequency rms output ms output	4.42V	38.0mv	9.0mv	2.7mv	6.5mv		0.40%
±150 kc	1.26V	Frequency rms output ms output	5.31V	51.0mv	9.5mv	4.4mv	8.0mv		0.99%
±175 kc	1.47V	Frequency rms output ms output	6.19V	64.0mv	13.0mv	6.5mv	6.3mv		1.07%
±200 kc	1.68V	Frequency rms output ms output	7.07V	87.0mv	19.0mv	1[illegible]mv	2.7m[illegible]		1.27%

Sheet 2 of 5

TABLE II-2.5-6

TRANSMITTER TEST RECORD, EMR 121D, 70 KC FUNDAMENTAL

MFR EMR MODEL 121 S/N 922 ORIGINATOR ______ DATE 9-1-64

Deviation	Transmitter Input Level rms volts	70KC	Fund.	Second Harmonic	Third Harmonic	Fourth Harmonic	Fifth Harmonic	Square Root Sum ms Output	Total Harmonic Distortion
±25 kc	0.207V	Frequency rms output ms output	0.835V	6.4 mv	1.7mv	———	———		0.79%
±50 kc	0.420V	Frequency rms output ms output	1.70V	13.0mv	3.6 mv	7.9 mv	2.5 mv		0.93%
±75 kc	0.620V	Frequency rms output ms output	2.51V	16.0mv	3.0 mv	9.4mv	5.5mv		0.78%
±100 kc	0.840V	Frequency rms output ms output	3.34V	40.0mv	17.0mv	6.6mv	10.0mv		1.35%
±125 kc	1.03V	Frequency rms output ms output	4.19V	66.0mv	22.0mv	6.4mv	6.2mv		1.67%
±150 kc	1.25V	Frequency rms output ms output	5.10V	94.0mv	16.0mv	5.5 mv	16.0mv		1.90%
±175 kc	1.45V	Frequency rms output ms output	5.86V	130mV	23.0mv	11.0mv	9.0mv		2.27%
±200 kc	1.65V	Frequency rms output ms output	6.70V	187mv	36.0mv	27.0mv	7.2mv		2.87%

TRANSMITTER TEST RECORD, EMR 121D, 100 KC FUNDAMENTAL

MFR EMR MODEL 121 S/N 922 ORIGINATOR ______ DATE 9-1-64

Deviation	Transmitter Input Level rms volts	100KC	Fund.	Second Harmonic	Third Harmonic	Fourth Harmonic	Fifth Harmonic	Square Root Sum ms Output	Total Harmonic Distortion
±25 kc	0.218V	Frequency rms output ms output	0.835V	8.0mv	1.7mv	—	—		0.98%
±50 kc	0.441V	Frequency rms output ms output	1.70V	21.0mv	11.0mv	1.2 mv	1.6mv		1.40%
±75 kc	0.650V	Frequency rms output ms output	2.51V	48.0mv	6.5mv	5.9mv	8.5mv		1.97%
±100 kc	0.865V	Frequency rms output ms output	3.34V	73.0mv	29.0mv	6.3mv	5.0mv		2.36%
±125 kc	1.09V	Frequency rms output ms output	4.19V	110mv	26.0mv	7.7mv	5.2mv		2.71%
±150 kc	1.32V	Frequency rms output ms output	5.10V	160mv	23.0mv	6.6mv	5.7mv		3.17%
±175 kc	1.53V	Frequency rms output ms output	5.86V	210mv	26.0mv	14.0mv	11.0mv		3.62%
±200 kc	1.76V	Frequency rms output ms output	6.70V	293mv	39.0mv	28.0mv	14.5mv		4.44%

Sheet 4 of 5.

TABLE II-2.5-8
TRANSMITTER TEST RECORD, EMR 121D, 225 KC FUNDAMENTAL

MFR EMR MODEL 121 S/N 922 ORIGINATOR DATE 9-1-64

Deviation	Transmitter Input Level rms volts	225KC	Fund.	Second Harmonic	Third Harmonic	Fourth Harmonic	Fifth Harmonic	Square Root Sum ms Output	Total Harmonic Distortion
±25 kc	0.286V	Frequency rms output ms output	0.79V	5.6mv	6.5mv	——	——		1.09%
±50 kc	0.558V	Frequency rms output ms output	1.58V	22.0mv	4.7mv	——	——		1.42%
±75 kc	0.850V	Frequency rms output ms output	2.37V	48.0mv	6.8mv	0.7mv	0.3mv		2.05%
±100 kc	1.14V	Frequency rms output ms output	3.15V	75.0mv	11.0mv	1.4mv	0.7mv		2.41%
±125 kc	1.48V	Frequency rms output ms output	3.94V	120mv	18.0mv	2.2mv	1.2mv		3.08%
±150 kc	1.88V	Frequency rms output ms output	4.73V	200mv	30.0mv	3.0mv	2.0mv		4.28%
±175 kc	2.35V	Frequency rms output ms output	5.51V	295mv	60.0mv	5.0mv	2.7mv		5.47%
±200 kc	2.93V	Frequency rms output ms output	6.30V	400mv	97.0mv	7.2mv	3.5mv		6.53%

TRANSMITTER TEST RECORD, LEACH FM 200, 3 KC FUNDAMENTAL

MFR: LEACH   MODEL FM200   S/N 39   ORIGINATOR W.S.B.   DATE 9-3-64

Deviation	Transmitter Input Level rms volts	Fund. Freq 3 KC	Fund.	Second Harmonic	Third Harmonic	Fourth Harmonic	Fifth Harmonic	Square Root Sum rms Output	Total Harmonic Distortion
±25 kc	0.220V	Frequency rms output rms output	3.0 kc 0.885V	6.0 kc 2.90 mv	9.0 kc 1.70 mv	12.0 kc 0.74 mv	15.0 kc —		0.3[illegible]%
±50 kc	0.440V	Frequency rms output rms output	3.0 kc 1.77V	6.0 kc 10.0 mv	9.0 kc 3.[illegible] mv	12.0 kc 0.75 mv	15.[illegible] —		0.60%
±75 kc	0.650V	Frequency rms output rms output	3.0 kc 2.66V	6.0 kc 22.3 mv	9.0 kc 5.0 mv	12.0 kc 0.75 mv	15.0 kc —		0.36%
±100 kc	0.860V	Frequency rms output rms output	3.0 kc 3.54V	6.0 kc 38.5 mv	9.0 kc 6.5 mv	12.0 kc 0.7[illegible] mv	15[illegible] 0.6[illegible]		1.10%
±125 kc	1.10V	Frequency rms output rms output	3.0 kc 4.42V	6.0 kc 63.0 mv	9.0 kc 8.2 mv	12.0 kc 0.78 mv	15.0 kc 0.50 mv		1.43%
±150 kc	1.34V	Frequency rms output rms output	3.0 kc 5.31V	6.0 kc 94.0 mv	9.0 kc 9.5 mv	12.0 kc 0.84 mv	15.[illegible] kc 0.64 m[illegible]		1.78%
±175 kc	1.53V	Frequency rms output rms output	3.0 kc 6.19V	6.0 kc 125 mv	9.0 kc 9.5 mv	12.0 kc 0.9 mv	15.0 [illegible] 0.60 mv		2.03%
±200 kc	1.75V	Frequency rms output rms output	3.0 kc 7.07V	6.0 kc 165 mv	9.0 [illegible] 11.0 mv	12[illegible] 1.4 mv	15[illegible] kc 1.0 mv		2.34%

Sheet 1 of 5

TABLE II-2.5-10

TRANSMITTER TEST RECORD, LEACH FM 200, 30 KC FUNDAMENTAL

MFR Leach MODEL FM 200 S/N 39 ORIGINATOR W.S.B. DATE 9-4-64

Deviation	Transmitter Input Level rms volts	30KC	Fund.	Second Harmonic	Third Harmonic	Fourth Harmonic	Fifth Harmonic	Square Root Sum ms Output	Total Harmonic Distortion
±25 kc	0.222V	Frequency rms output ms output	0.885V	3.4mv	1.1mv	0.40mv	—		0.41%
±50 kc	0.444V	Frequency rms output ms output	1.77V	10.0mv	1.9mv	1.8mv	0.90mv		0.58%
±75 kc	0.660V	Frequency rms output ms output	2.66V	24.0mv	5.6mv	2.6mv	1.20mv		0.93%
±100 kc	0.875V	Frequency rms output ms output	3.54V	43.0mv	6.5mv	2.2mv	4.0mv		1.24%
±125 kc	1.11V	Frequency rms output ms output	4.42V	65.0mv	8.2mv	2.2mv	1.6mv		1.48%
±150 kc	1.35V	Frequency rms output ms output	5.31V	95.0mv	8.0mv	2.8mv	6.4mv		1.80%
±175 kc	1.55V	Frequency rms output ms output	6.19V	125mv	9.3mv	4.3mv	5.2mv		2.03%
±200 kc	1.76V	Frequency rms output ms output	7.07V	165mv	40mv	5.6mv	6.0mv		2.34%

TABLE II-2.5-11

TRANSMITTER TEST RECORD, LEACH FM 200, 70 KC FUNDAMENTAL

MFR LEACH MODEL FM200 S/N 39 ORIGINATOR W.S.B. DATE 9-4-64

Deviation	Transmitter Input Level rms volts	70 KC.	Fund.	Second Harmonic	Third Harmonic	Fourth Harmonic	Fifth Harmonic	Square Root Sum ms Output	Total Harmonic Distortion
±25 kc	0.222V	Frequency rms output ms output	0.835V	2.9mv	1.1mv	—	—		0.37%
±50 kc	0.450V	Frequency rms output ms output	1.70V	10.5mv	2.1mv	1.85mv	—		0.64%
±75 kc	0.662V	Frequency rms output ms output	2.57V	22.5mv	3.0mv	5.2mv	1.1mv		0.93%
±100 kc	0.872V	Frequency rms output ms output	3.34V	40.0mv	8.5mv	5.4mv	8.0mv		1.26%
±125 kc	1.13V	Frequency rms output ms output	4.19V	62.0mv	14.0mv	3.0mv	2.9mv		1.52%
±150 kc	1.36V	Frequency rms output ms output	5.10V	90.0mv	10.0mv	6.3mv	7.6mv		1.79%
±175 kc	1.56V	Frequency rms output ms output	5.86V	116mv	12.0mv	3.6mv	5.4mv		1.99%
±200 kc	1.77V	Frequency rms output ms output	6.70V	155mv	12.0mv	11.0mv	7.6mv		2.33%

Sheet 3 of 5

TABLE II-2.[illegible]

TRANSMITTER TEST RECORD, LEACH FM 200, 100 KC FUNDAMENTAL

MFR LEACH MODEL FM200 S/N 39 ORIGINATOR W.S.B DATE 9-4-64

Deviation	Transmitter Input Level rms volts	100KC	Fund.	Second Harmonic	Third Harmonic	Fourth Harmonic	Fifth Harmonic	Square Root Sum ms Output	Total Harmonic Distortion
±25 kc	0.240V	Frequency rms output ms output	0.835V	3.6mv	1.7mv	0.6mv	——		0.48%
±50 kc	0.49V	Frequency rms output ms output	1.70V	11.0mv	5.2mv	2.1mv	——		0.73%
±75 kc	0.74V	Frequency rms output ms output	2.51V	24.0mv	14.0mv	2.4mv	3.0mv		0.98%
±100 kc	0.94V	Frequency rms output ms output	3.34V	40.0mv	8.6mv	2.0mv	5.6mv		1.24%
±125 kc	1.20V	Frequency rms output ms output	4.19V	64.0mv	17.5mv	3.5mv	3.2mv		1.59%
±150 kc	1.18V	Frequency rms output ms output	5.10V	100.0mv	13.6mv	5.0mv	4.2mv		1.98%
±175 kc	1.68V	Frequency rms output ms output	5.86V	127.0mv	23.0mv	9.0mv	3.0mv		2.21%
±200 kc	1.91V	Frequency rms output ms output	6.70V	145.0mv	54.0mv	47.0mv	41.0mv		2.49%

TABLE II-2.5-13

TRANSMITTER TEST RECORD, LEACH FM 200, 225 KC FUNDAMENTAL

MFR Leach MODEL FM200 S/N 39 ORIGINATOR W.S.B. DATE 9-4-64

Deviation	Transmitter Input Level rms volts	225 KC	Fund.	Second Harmonic	Third Harmonic	Fourth Harmonic	Fifth Harmonic	Square Root Sum ms Output	Total Harmonic Distortion
±25 kc	0.355 V	Frequency rms output ms output	0.79 V	3.2 mv	1.0 mv	—	—		0.42%
±50 kc	0.69 V	Frequency rms output ms output	1.58 V	7.5 mv	0.80 mv	0.[illegible] mv	—		0.48%
±75 kc	1.06 V	Frequency rms output ms output	2.37 V	19.0 mv	1.9 mv	0.60 mv	—		0.81%
±100 kc	1.40 V	Frequency rms output ms output	3.15 V	39.0 mv	3.2 mv	0.55 mv	0.7 mv		1.24%
±125 kc	1.71 V	Frequency rms output ms output	3.94 V	60.0 mv	7.0 mv	1.0 mv	1.3 mv		1.53%
±150 kc	2.06 V	Frequency rms output ms output	4.73 V	86.0 mv	15.0 mv	2.3 mv	2.1 mv		1.84%
±175 kc	2.40 V	Frequency rms output ms output	5.51 V	110.0 mv	28.5 mv	4.4 mv	3.0 mv		2.06%
±200 kc	2.75 V	Frequency rms output ms output	6.3 V	140.0 mv	44.0 mv	6.3 mv	4.0 mv		2.33%

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2.6 RECEIVER

2.6.1 General

A Vitro/Nems-Clark 1455A Telemetry Receiver and a Defense Electronics, Inc. TMR-2A Telemetry Receiver, both tunable from 215 Mc to 260 Mc, were evaluated as part of the equipment evaluation program. Intermediate frequency (IF) amplifier amplitude and time-delay characteristics, and output noise density were evaluated on each receiver. Total harmonic distortion was measured for the Nems-Clarke 1455A in combination with the EMR 121D Transmitter.

2.6.2 IF Amplifier Characteristics

2.6.2.1 Amplitude Response

The Nems-Clarke receiver was equipped with 5-Mc IF amplifier, IFM-500-1; the defense Electronics receiver was equipped with a 10 Mc-IF amplifier, IFA-D2. The amplitude response of the Nems-Clarke IF amplifier was tested using equipment as shown in Figure II-2.6-1 and the following procedure:

1. With the oscillator at 5.00 Mc select an input signal level such that the amplifier is not saturating, i.e., such that a change in input amplitude provides the same relative output change.

2. Tune the oscillator across the bandwidth of the amplifier. Record the input signal level required at a given frequency to maintain a constant output level equal to that at 5.0 Mc, bandcenter. Record the output level used.

3. The increase in signal level required relative to band center is the IF amplitude response as a function of frequency.

Results for the Nems-Clarke 1455A Receiver are given in Figure II-2.6-2 and are presented graphically in Volume I, Figure I-2.6-1.

Measurements of Defense Electronics, Inc. TMR-2A Receiver IF amplitude response characteristic were complicated by the lack of a precision voltmeter operable at and above 10 Mc. The technique employed uses the equipment as shown in Figure II-2.6-3 and the following procedure:

1. With the equipment connected as shown, disable the receiver automatic gain control (AGC) feature by grounding J-105, pin A.

2. Tune the oscillator to center frequency, 10 Mc, insert 65 db attenuation and establish a reference voltage level on the oscilloscope.

3. Tune the oscillator across the passband of the amplifier in convenient steps recording the frequency and attenuation settings required to maintain the reference level on the oscilloscope. (The response of the particular oscillator used varies smoothly from +1.0 db at 9.50 Mc to -1.0 db at 10.5 Mc, relative to 0.0 db at 10.0 Mc.)

Amplitude response data on the TMR-2A Receiver is presented in Figure II-2.6-4 and appears graphically in Figure I-2.6-2 of Volume I.

2.6.2.2 Intelligence-Delay Variation

Each receiver's IF amplifier was measured for intelligence time-delay variation across its passband relative to that at band center. The equipment used is outlined in Figure II-2.6-5. In general terms, the procedure involves using a 10-kc tone to generate narrow-deviation frequency modulation which, using the receiver's internal local oscillators, is positioned in frequency across the IF passband. The FM signal at the IF output is then translated and detected by a precision discriminator. Phase shift of the 10-kc intelligence tone as the FM signal is positioned at different frequencies across the IF passband can be easily converted to time delay variation relative to band center. The procedure in detail is as follows:

1. With the transmitter input grounded, adjust the receiver local oscillators to produce an IF amplifier bandcenter signal.

2. Adjust the HP 650 oscillator to produce a much larger signal than that of the IF output at a frequency such that a 1.00 Mc band center signal is supplied to the EMR 270 Subcarrier Discriminator.

3. Apply 10 kc to the transmitter at a level such that the 1.00 Mc ±5% EMR 270 Discriminator produces 573 mv peak or 1.15 volts peak-to-peak output.

4. Adjust the amplitude and phase through the phase shifter so that a null is obtained at the input to the oscilloscope between the discriminator output and the phase shifter output with the IF signal at center frequency.

5. Ground the phase shifter output and verify that the full-scale voltage being nulled is 573 mv peak-to-peak at the HP 130B oscilloscope input.

6. Measure the approximate time delay between the transmitter input and the discriminator output with the Tektronix 545A Oscilloscope.

7. Reestablish and record the null condition for the IF signal at bandcenter.

8. Tune the receiver local oscillator to shift the IF signal to a new frequency position in the passband.

9. Tune the HP 650A to return the discriminator input to 1.00 Mc, band center.

10. Do not adjust the phase or amplitude settings in the lower or upper paths.

11. Read the peak-to-peak voltage from the HP 130B. Each 10-mv peak-to-peak increase in the null voltage as the IF signal is positioned at various places in frequency across the IF passband corresponds to a 1^{o} phase shift at 10 kc, or 0.278 μsec of time delay variation relative to the IF bandcenter condition.

The results obtained for the time-delay variation for each of the two receivers tested are combined with the amplitude response test results as given in Volume I, Figure I-2.6-1 for the Nems-Clarke 1455A and Figure I-2.6-2 for the Defense Electronics, Inc. TMR-2A.

2.6.3 Output Noise Density

Receiver output noise density was measured on the Nems-Clarke 1455A and Defense Electronics TMR-2A for various carrier-to-noise ratios. The equipment employed is shown in Figure II-2.6-8. Procedures used in making the measurements were slightly different with each receiver due to variations between units. A general procedure with individual variations noted is as follows:

1. Establish a fixed AGC level in the receiver; -4.0 volts dc was used for the 1455A, 1.5 volts for the TMR-2A.

2. Measure noise. For 1455A 5-Mc IF amplifier, use J. Fluke 910A True RMS Voltmeter to measure total IF noise. For TMR-2A 10-Mc IF amplifier, use Sierra 158A High Frequency Wave Analyzer to measure the noise level in a 4.5 kc bandwidth (determined by separate test of 158A) and convert to total IF noise by the square root of the ratio of the IF bandwidth to 4.5 kc, the analyzer bandwidth.

3. Measure the IF amplifier output signal level with the Sierra 158A using an unmodulated carrier. Set the carrier level for the desired signal-to-noise ratio. The Sierra 158A has been calibrated to read the same as the J. Fluke 910A with a 0.6 volt, 5-Mc signal applied to both.

4. Measure the receiver output noise with the HP 310A frequency-selective voltmeter and divide the resulting voltage readings by the square root of the bandwidth used to normalize the data. Express this quotient in decibels.

Results obtained are presented in Figure II-2.6-9 for the 1455A and Figure

II-2.6-10 for the TMR-2A. Volume I, Figures I-2.6-3 and I-2.6-4 present the measured results in graphical form.

2.6.4 Total Harmonic Distortion

Total harmonic distortion characteristics of the two FM detectors of the Nems-Clarke 1455A receiver were measured in combination with the EMR 121D Transmitter which had been evaluated independently as previously described. The procedure of summation of individual harmonic components, as measured on a frequency-selective voltmeter, was used. The equipment employed is given in Figure II-2.6-11, the block diagram of the test.

The procedure used is as follows:

1. Adjust the oscillator to the desired modulating frequency. Modulation frequencies of 3 kc, 30 kc, 70 kc, 100 kc, and 225 kc were used.

2. Set the transmitter input level for the desired deviation in accordance with the previously measured transmitter sensitivity. Deviations from ±25 kc to ±200 kc in ±25 kc intervals were used.

3. Adjust the receiver gain to produce 1.0 volt rms fundamental output as measured on the HP 310A frequency-selective voltmeter.

4. Measure the harmonics individually and compute the total harmonic distortion.

Harmonic distortion data obtained from the Nems-Clarke 1455A in combination with the EMR 121D is given in Figure II-2.6-12 through II-2.6-21.

2.6.5 Intermodulation

Difference-frequency intermodulation products were measured using the block diagram of Figure II-2.6-22. Data obtained is contained in Tables II-2.6-23 and II-2.6-24. The receiver output was maintained at 1.0 volt rms.

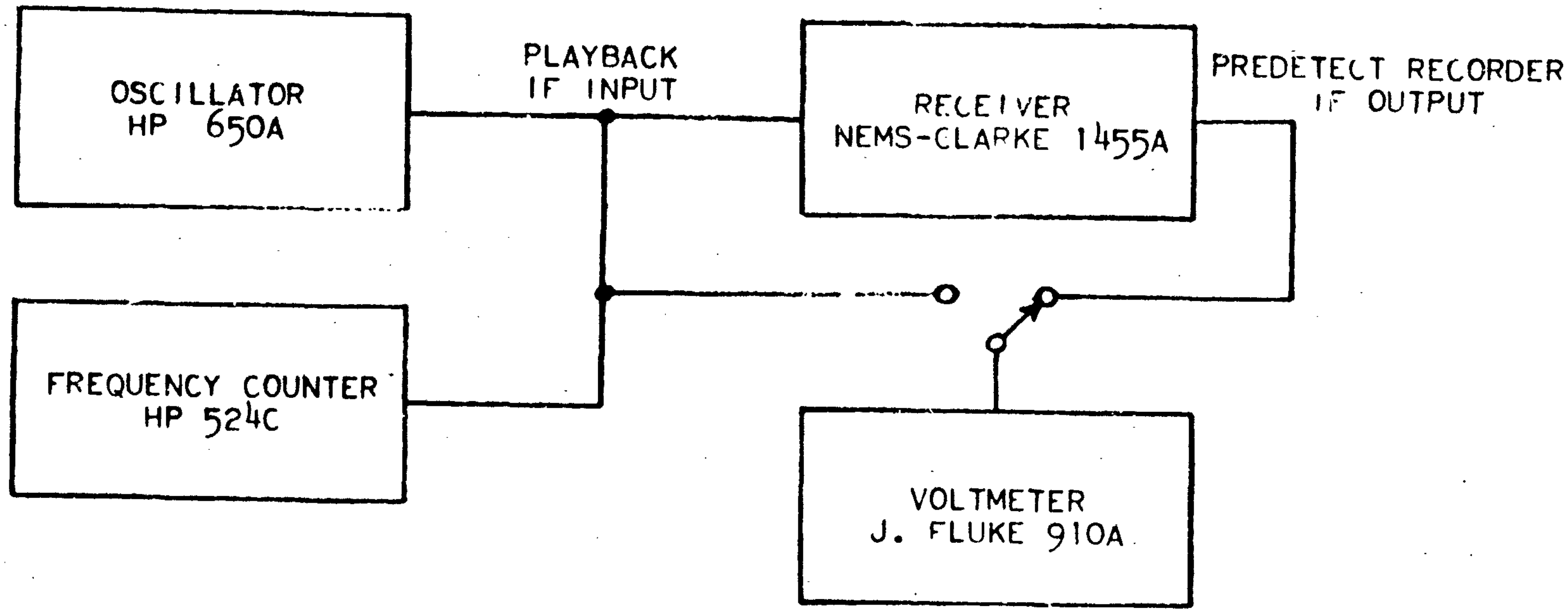


FIGURE II-2.6-1
IF FREQUENCY RESPONSE TEST, NEMS-CLARKE 1455A

TABLE II-2.6-2

IF AMPLITUDE RESPONSE

Nems-Clarke 1455A (S/N 283) & IFM 500-1 (S/N 155)

Freq. kc	Input db	Output db	Response db
4500	-1.0	-31	-60.0
4600	-26.6	-30	-33.4
4700	-50.8	-30	-9.2
4717	-54.0	-30	-6.0
4738	-57.0	-30	-3.0
4800	-61.8	-30	+1.8
4900	-61.2	-30	+1.2
5000	-60.0	-30	0.0
5100	-57.4	-30	-2.6
5200	-58.0	-30	-2.0
5300	-52.9	-30	-7.1
5400	-30.8	-30	-29.2
5500	-13.9	-30	-46.1
5270	-57.0	-30	-3.0
5294	-54.0	-30	-6.0
5603	-3.0	-33	-60.0
4821	-61.8	-30	+1.8 (Peak)
5230	-58.0	-30	-2.0 (Peak)
5130	-56.7	-30	-3.3 (valley)

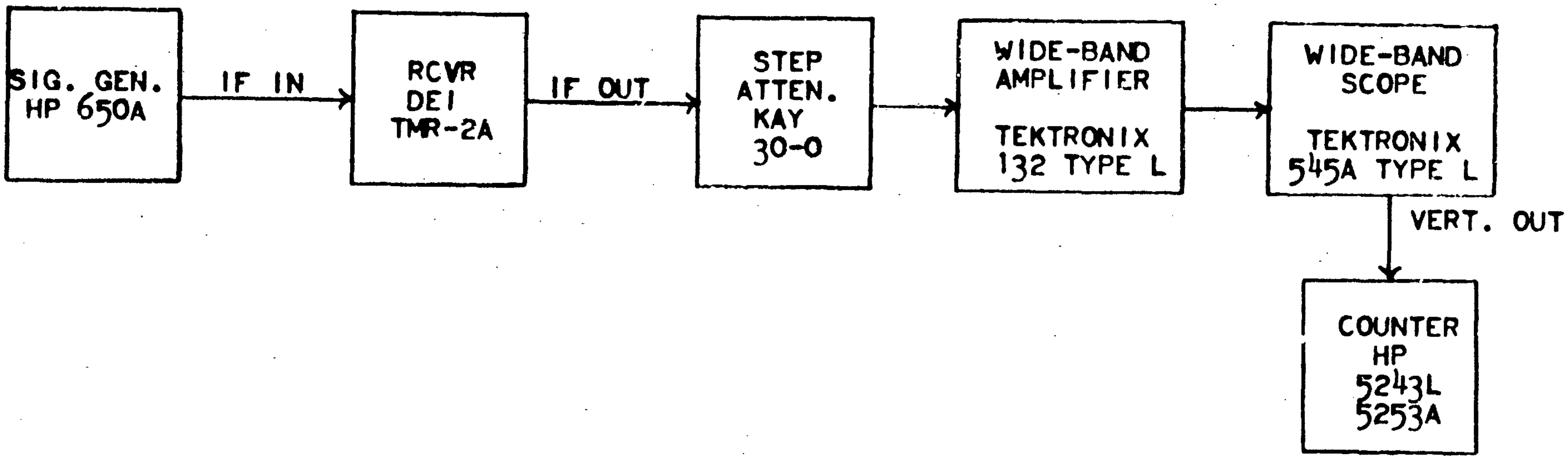


FIGURE II-2.6-3
IF AMPLITUDE RESPONSE TEST, DEFENSE ELECTRONICS, TMR-2A

TABLE II-2.6-4

IF AMPLITUDE RESPONSE
DEI TMR-2A with IFA-D2

Frequency (mc)	Response (db)
9.34	-36
9.5	-30
9.54	-24
9.64	-12
9.71	-6
9.75	-3
9.77	-2
9.78	-1
9.82	0
9.88	+1
9.95	0
10.0	0
10.1	0
10.15	-1
10.2	-2
10.23	-3
10.27	-6
10.34	-12
10.47	-24
10.52	-30
10.62	-36

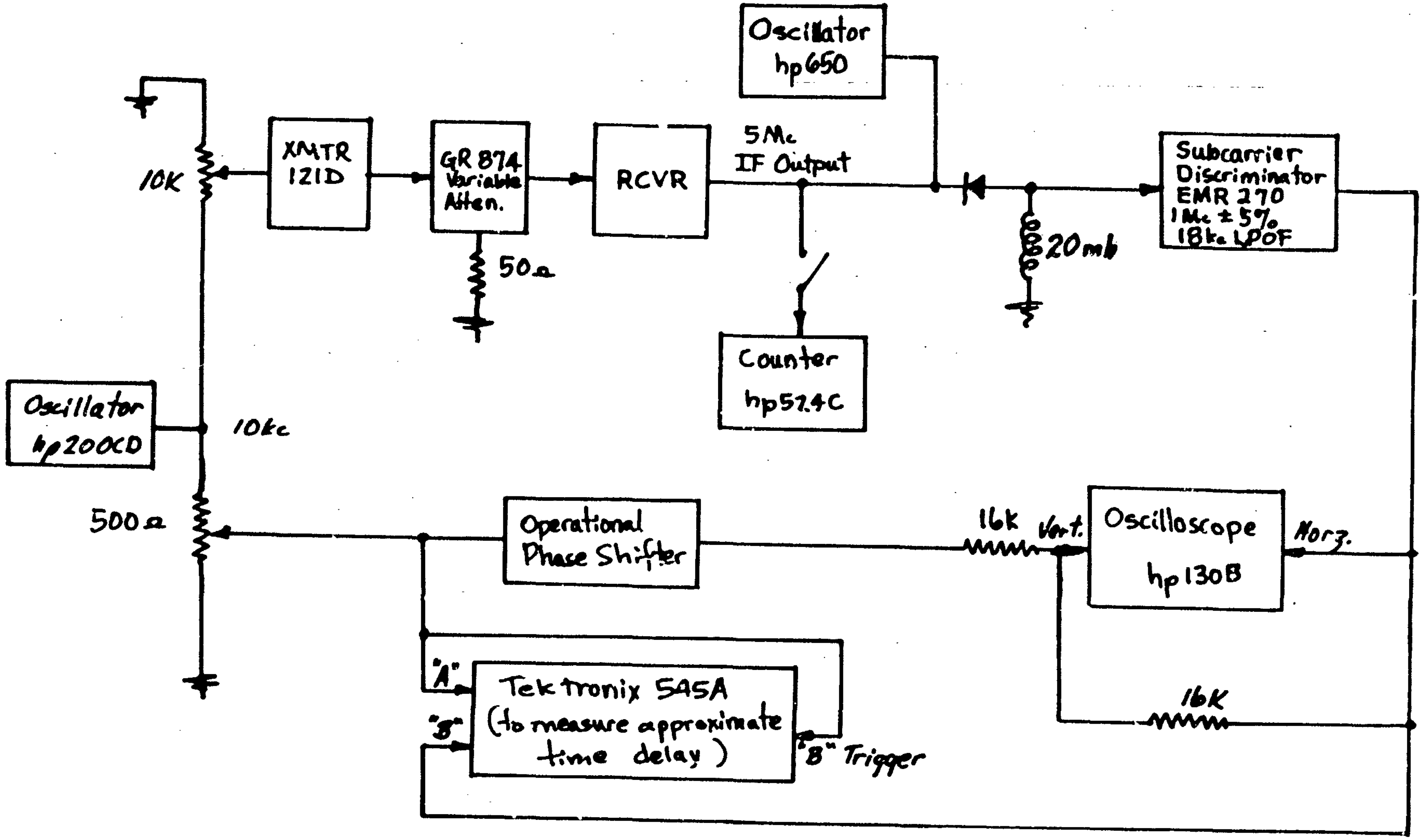


FIGURE II-2.6-5
IF AMPLIFIER INTELLIGENCE DELAY TEST

IF INTELLIGENCE DELAY
Nems-Clarke 1455A S/N 283
with IFM-500-1 S/N 155

f_m = 10.000 KC 1° @ 10.000 KC = 0.2778 μ sec.

Nominal IF Freq, KC	Measured IF Freq KC	Null Voltage Peak To Peak	Degrees Phase Shift of FM	Calculated Time Delay μ sec.	Oscilloscope Time Delay Measurement	Oscilloscope Data
4600	4600	Noise ≤ 10 mv		μsec	-31 μsec	-1 μ
4700	4700	100 mv	10°	2.778 "	-32 "	-2
4800	4800	55 mv	5.5°	1.528 "	-32 "	-2
4900	4900	Noise ≤ 10 mv			-31 "	-1 "
5000	5000	Null Pt.			-30 "	0 "
5100	5100	Noise ≤ 10 mv			-31 "	-1 "
5200	5200	40 mv	4.0°	1.1112 "	-32 "	-2 "
5300	5300	94 mv	9.4°	2.611 "	-32 "	-2 "
5400	5400	Noise ≤ 10 mv			-31 "	-1 "
4717	4717	100 mv	10°	2.778 "	-33 "	-3 "
4738	4738	96 mv	9.6°	2.669 "	-33 "	-3 "
5270	5270	84 mv	8.4°	2.334 "	-33	-3 "
5294	5294	90 mv	9.0°	2.500 "	-33 "	-3 "
4650	4650	85 mv	8.5°	2.361 "	-33 "	-3 "
5350	5350	96 mv	9.6°	2.669 "	-35 "	-5 "
5450	5450	92 mv	9.2°	2.556 "	-27 "	+3 "
5325	5325	104 mv	10.4°	2.889 "	33 "	-3 "
5425	5425	20 mv	2.0°	0.556 "	-30 "	0 "
5477	5477	104 mv	10.4°	2.889 "	-27 "	+3 "
4675	4675	90 mv	9.0°	2.500 "	-32 "	-2 "

TABLE II-2.6-7

IF INTELLIGENCE DELAY

DEI TMR-2A with IFA-D2

Frequency (mc)	Phase Shift (θ°)	Time Delay (μs)
9.6	1.0	0.28
9.7	2.7	0.75
9.8	3.4	0.94
9.9	1.4	0.39
10.0	0	0.0
10.1	1.0	0.28
10.2	2.7	0.75
10.3	3.3	0.92
10.4	1.5	0.42

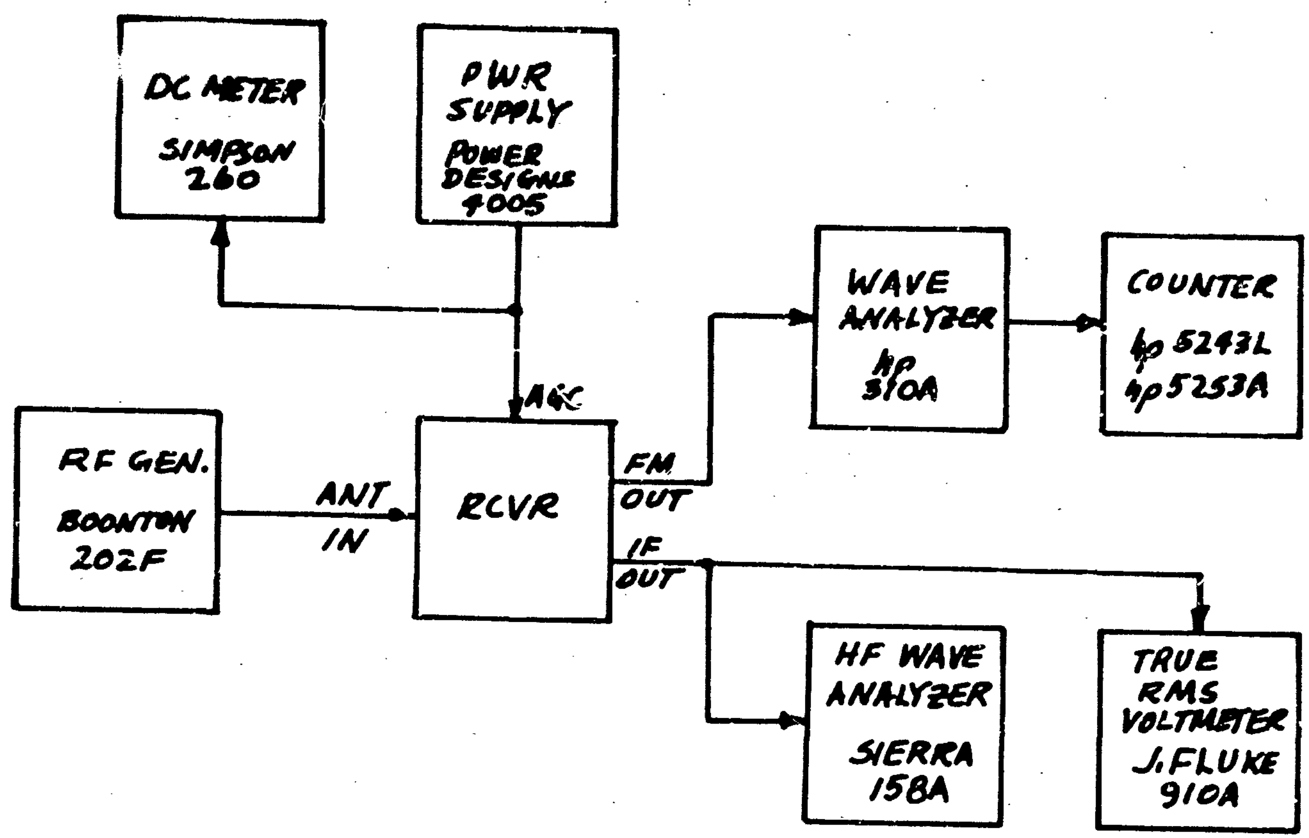


FIGURE II-2.6-8
RECEIVER OUTPUT NOISE DENSITY TEST

TABLE II-2.6-9
OUTPUT NOISE DENSITY, NEMS-CLARKE 1455A

Frequency	E_n Output Noise in 1000cps BW (millivolts)	$\frac{E_n}{\sqrt{1000}}$ (db)	E_n Output Noise in 1000cps BW (millivolts)	$\frac{E_n}{\sqrt{1000}}$ (db)	E_n Output Noise in 1000cps BW (millivolts)	$\frac{E_n}{\sqrt{1000}}$ (db)	E_n Output Noise in 1000cps BW (millivolts)	$\frac{E_n}{\sqrt{1000}}$ (db)
	No Signal Present (Noise only)		$(S/N)_c = 2$ db		$(S/N)_c = 4$ db		$(S/N)_c = 6$ db	
1kc	86*	-42*	34*	-50*	20*	-55*	12*	-59*
4kc	200	-42	76	-50	46	-54.5	27	-59
10kc	200	-42	76	-50	46	-54.5	30	-58.5
40kc	180	-42.5	72	-50.5	46	-54.5	32	-57.5
100kc	140	-45	72	-50.5	60	-52	50	-54
200kc	76	-50	82	-49.5	78	-50	76	-50
300kc	42	-55.5	34	-57	32	-58	28	-59
400kc	22	-61	16.5	-63.5	14	-65	12	-66
	$(S/N)_c = 9$ db		$(S/N)_c = 14$ db					
1kc	4.3*	68*	0.19*	-95*				
4kc	9.5	68	1.0	-88				
10kc	10.0	67.5	2.4	-80				
40kc	17.0	63	8.5	-69				
100kc	38.0	56	20.	-61.5				
200kc	64.0	52	35.	-57				
300kc	22.0	61	11.	-67				
400kc	9.0	68.5	2.4	-80				

* 200 cps bandwidth used instead of 1000 cps.

OUTPUT NOISE DENSITY, DEFENSE ELECTRONICS TMR-2A

Frequency	E_n Output Noise in 200cps BW (millivolts)	$\frac{E_n}{\sqrt{200}}$ (db)	E_n Output Noise in 200cps BW (millivolts)	$\frac{E_n}{\sqrt{200}}$ (db)	E_n Output Noise in 200cps BW (millivolts)	$\frac{E_n}{\sqrt{200}}$ (db)	E_n Output Noise in 200cps BW (millivolts)	$\frac{E_n}{\sqrt{200}}$ (db)
	No Signal Present (Noise Only)		$(S/N)_c = 0$ db		$(S/N)_c = 3$ db		$(S/N)_c = 6$ db	
1kc	230	-35.9	150	-39.2	95	-43.5	36	-52.0
2kc								
4kc								
8kc								
10kc							36	-52.0
20kc							40	-51.1
40kc	230	-35.9	150	-39.2	95	-43.5	44	-50.2
80kc	190	-37.7	140	-40.1	100	-43.0	66	-46.6
100kc	150	-39.2	140	-40.1	110	-42.1	70	-46.0
200kc	100	-43.0	140	-40.1	130	-40.7	110	-42.1
300kc	70	-46.0	100	-43.0	100	-43.0	86	-44.3
400kc	50	-49.1	56	-48.0	56	-48.0	46	-49.6
	$(S/N)_c = 9$ db		$(S/N)_c = 15$ db		$(S/N)_c = 20$			
1kc	6.0	-67.5	0.7	-86.0	0.5	-89.1		
2kc			0.7	-86.0	0.5	-89.1		
4kc	6.0	-67.5	1.1	-82.1	0.65	-86.8		
8kc	7.5	-65.5	2.2	-75.9	1.3	-80.7		
10kc	8.0	-64.9	2.5	-74.9	1.6	-79.2		
20kc	13.0	-60.7	5.5	-68.2	3.2	-72.8		
40kc	22.0	-55.9	10.0	-63.0	6.5	-66.7		
80kc	44.0	-50.2	21.0	-56.5	13.0	-60.7		
100kc	50.0	-49.1	26.0	-54.9	16.0	-59.2		
200kc	82.0	-44.7	40.0	-51.1	25.0	-54.9		
300kc	64.0	-46.9	30.0	-53.6	20.0	-57.1		
400kc	30.0	-53.6	11.0	-62.2	6.5	-66.7		

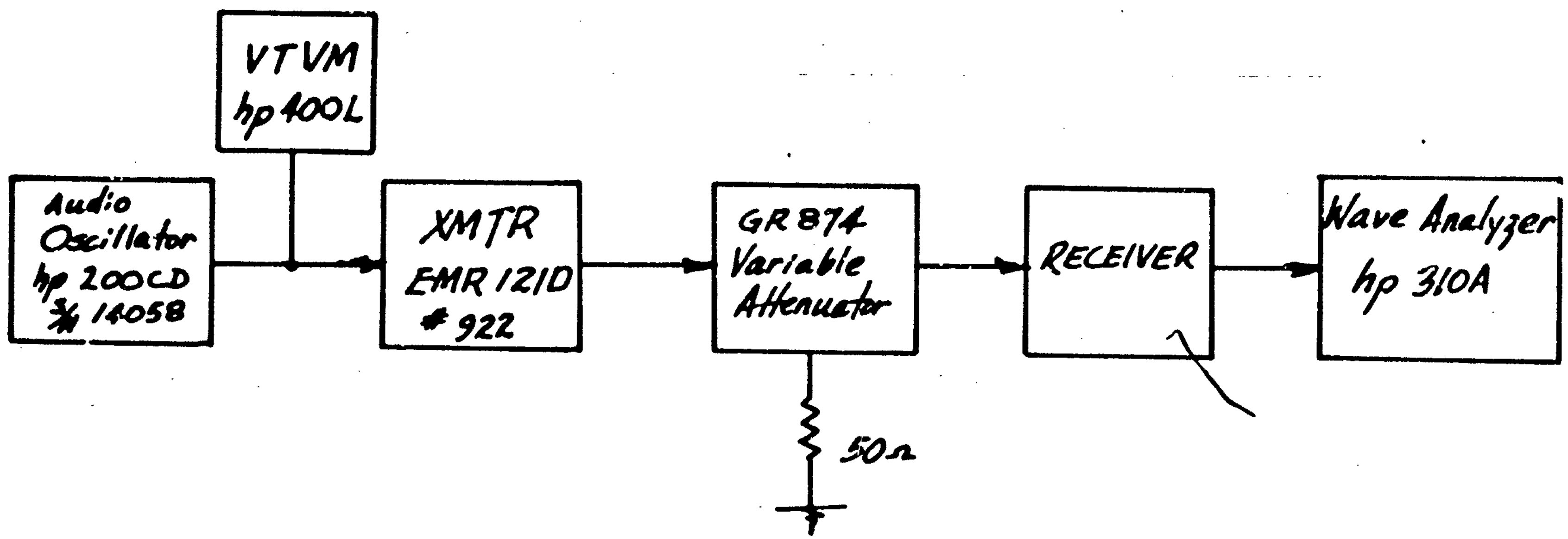


FIGURE II-2.6-11
TRANSMITTER/RECEIVER TOTAL HARMONIC DISTORTION TEST

TOTAL HARMONIC DISTORTION DATA, NEMS-CLARKE 1455A
FOSTER-SEELEY DETECTOR, 3 KC FUNDAMENTAL FREQUENCY

Transmitter: Mfg. EMR Model 121D Serial No. 922 Originator W. Bishop

Receiver: Mfg. Nems-Clark Model 1455A Serial No. 283 Detector Foster-Seeley Date 9 October 64

Fundamental Frequency 3 kc

Deviation	Transmitter Input Level	Fund.	Second Harmonic	Third Harmonic	Fourth Harmonic	Fifth Harmonic	Total Harmonic Distortion
±25 kc	0.210V rms	1.0V	1.85 mv	1.65 mv	----	----	0.248%
±50 kc	0.415V rms	1.0V	2.5 mv	1.70 mv	----	----	0.302%
±75 kc	0.628V rms	1.0V	3.4 mv	2.1 mv	----	----	0.400%
±100 kc	0.832V rms	1.0V	4.9 mv	3.0 mv	----	----	0.575%
±125 kc	1.05V rms	1.0V	7.0 mv	4.6 mv	0.46 mv	----	0.839%
±150 kc	1.25V rms	1.0V	10.5 mv	7.3 mv	0.60 mv	0.64 mv	1.282%
±175 kc	1.46V rms	1.0V	17.0 mv	11.0 mv	1.0 mv	1.1 mv	2.030%
±200 kc	1.66V rms	1.0V	24.5 mv	16.5 mv	1.75 mv	1.7 mv	2.964%

Sheet 1 of 5

TABLE II-2.6-13
TOTAL HARMONIC DISTORTION DATA, NEMS-CLARKE 1455A,
FOSTER-SEELEY DETECTOR, 30 KC FUNDAMENTAL FREQUENCY

Transmitter: Mfg. EMR Model 121D Serial No. 922 Originator W. Bishop

Receiver: Mfg. Nems-Clarke Model 1455A Serial No. 283 Detector Foster-Seeley Date 9 October 64

Fundamental Frequency 30 kc

Deviation	Transmitter Input Level	Fund.	Second Harmonic	Third Harmonic	Fourth Harmonic	Fifth Harmonic	Total Harmonic Distortion
±25 kc	0.212V rms	1.0V rms	0.8 mv	2.0 mv	----	----	0.215%
±50 kc	0.420V rms	1.0V rms	3.1 mv	2.9 mv	----	----	0.424%
±75 kc	0.635V rms	1.0V rms	6.0 mv	8.0 mv	----	----	1.000%
±100 kc	0.840V rms	1.0V rms	7.0 mv	15.0 mv	1.0 mv	1.4 mv	1.664%
±125 kc	1.05V rms	1.0V rms	9.1 mv	24.5 mv	1.6 mv	3.1 mv	2.637%
±150 kc	1.26V rms	1.0V rms	13.5 mv	36.0 mv	2.7 mv	6.3 mc	3.905%
±175 kc	1.47V rms	1.0V rms	17.0 mv	52.0 mv	3.2 mv	11.0 mv	5.589%
±200 kc	1.68V rms	1.0V rms	21.0 mv	70.0 mv	3.6 mv	17.5 mv	7.532%

TOTAL HARMONIC DISTORTION DATA, NEMS-CLARKE 1455A
FOSTER-SEELEY DETECTOR, 70 KC FUNDAMENTAL FREQUENCY

Transmitter: Mfg. EMR Model 121D Serial No. 922 . Originator WBishop

Receiver: Mfg Nems-Clarke Model 1455A Serial No. 283 Detector Foster-Seeley Date 9 October 64

Fundamental Frequency 70 kc

Deviation	Transmitter Input Level	Fund.	Second Harmonic	Third Harmonic	Fourth Harmonic	Fifth Harmonic	Total Harmonic Distortion
±25 kc	0.207V rms	1.0V rms	3.2 mv	1.6 mv	----	----	0.358%
±50 kc	0.420V rms	1.0V rms	5.6 mv	9.8 mv	0.7 mv	----	1.131%
±75 kc	0.620V rms	1.0V rms	8.0 mv	21.0 mv	1.7 mv	1.6 mv	2 259%
±100 kc	0.840V rms	1.0V rms	10.0 mv	37.0 mv	3.5 mv	5.7 mv	3.891%
±125 kc	1.03V rms	1.0V rms	12.5 mv	49.0 mv	5.0 mv	10.0 mv	5.179%
±150 kc	1.25V rms	1.0V rms	17.0 mv	65.0 mv	8.0 mv	19.0 mv	7.028%
±175 kc	1.45V rms	1.0V rms	15.5 mv	80.0 mv	9.2 mv	29.0 mv	8.698%
±200 kc	1.65V rms	1.0V rms	8.5 mv	94.0 mv	9.4 mv	40.0 mv	10.294%

Sheet 3 of 5

TABLE II-2.6-15
TOTAL HARMONIC DISTORTION DATA, NEMS-CLARKE 1455A
FOSTER-SEELEY DETECTOR, 100 KC FUNDAMENTAL FREQUENCY

Transmitter: Mfg. EMR Model 121D Serial No. 922 Originator LoBishop

Receiver: Mfg Nems-Clarke Model 1455A Serial No. 283 Detector Foster-Seeley Date 9 October 64

Fundamental Frequency 100 kc

Deviation	Transmitter Input Level	Fund.	Second Harmonic	Third Harmonic	Fourth Harmonic	Fifth Harmonic	Total Harmonic Distortion
±25 kc	0.218V rms	1.0V rms	6.6 mv	3.6 mv	----	----	0.752%
±50 kc	0.441V rms	1.0V rms	10.0 mv	15.0 mv	0.54 mv	0.58 mv	1.805%
±75 kc	0.650V rms	1.0V rms	12.5 mv	31.0 mv	1.60 mv	1.50 mv	3.350%
±100 kc	0.865V rms	1.0V rms	30.0 mv	49.0 mc	5.2 mv	3.6 mv	5.780%
±125 kc	1.09V rms	1.0V rms	50.0 mv	57.0 mv	13.0 mv	5.8 mv	7.715%
±150 kc	1.32V rms	1.0V rms	35.0 mv	80.0 mv	17.0 mv	11.5 mv	8.970%
±175 kc	1.53V rms	1.0V rms	30.0 mv	96.0 mv	24.5 mv	19.5 mv	10.534%
±200 kc	1.76V rms	1.0V rms	24.0 mv	105.0 mv	31.0 mv	29.0 mv	11.577%

TOTAL HARMONIC DISTORTION DATA, NEMS-CLARKE 1455A
FOSTER-SEELEY DETECTOR, 225 KC FUNDAMENTAL FREQUENCY

Transmitter: Mfg. EMR Model 121D Serial No. 922 Originator W Bishop

Receiver: Mfg. Nems-Clarke Model 1455A Serial No. 283 Detector Foster-Seeley Date 9 October 64

Fundamental Frequency 225 kc

Deviation	Transmitter Input Level	Fund.	Second Harmonic	Third Harmonic	Fourth Harmonic	Fifth Harmonic	Total Harmonic Distortion
±25 kc	0.286V rms	1.0V rms	9.1 mv	1.1 mv	----	----	0.917%
±50 kc	0.558V rms	1.0V rms	17.5 mv	2.75 mv	----	----	1.771%
±75 kc	0.850V rms	1.0V rms	25.0 mv	6.8 mv	----	----	2.591%
±100 kc	1.14V rms	1.0V rms	28.5 mv	11.0 mv	6.8 mv	----	3.130%
±125 kc	1.48V rms	1.0V rms	32.0 mv	17.5 mv	13.0 mv	0.42 mv	3.872%
±150 kc	1.88V rms	1.0V rms	44.0 mv	25.5 mv	2.45 mv	0.72 mv	5.092%
±175 kc	2.35V rms	1.0V rms	70.0 mv	34.0 mv	4.5 mv	1.35 mv	7.796%
±200 kc	2.93V rms	1.0V rms	76.0 mv	43.0 mv	6.8 mv	1.80 mv	8.760%

Sheet 5 of 5

TABLE II-2.6-17
TOTAL HARMONIC DISTORTION DATA, NEMS-CLARKE 1455A, PHASE LOCK DETECTOR, 3 KC FUNDAMENTAL FREQUENCY

Transmitter: Mfg. EMR Model 121D Serial No. 922 Originator W. Basher

Receiver: Mfg. Nems-Clarke Model 1455A Serial No. 283 Detector Phase Lock Date 9 October 64

Fundamental Frequency 3 kc

Deviation	Transmitter Input Level	Fund.	Second Harmonic	Third Harmonic	Fourth Harmonic	Fifth Harmonic	Total Harmonic Distortion
±25 kc	0.210V rms	1.0V	1.30 mv	1.72 mv	----	----	0.216%
±50 kc	0.415V rms	1.0V	1.9 mv	2.2 mv	----	----	0.291%
±75 kc	0.628V rms	1.0V	2.5 mv	3.2 mv	0.64 mv	----	0.411%
±100 kc	0.832V rms	1.0V	2.7 mv	4.4 mv	1.2 mv	----	0.530%
±125 kc	1.05V rms	1.0V	2.8 mv	5.6 mv	2.1 mv	----	0.660%
±150 kc	1.25V rms	1.0V	3.8 mv	7.3 mv	2.4 mv	0.9 mv	0.862%
±175 kc	1.46V rms	1.0V	7.4 mv	9.8 mv	3.0 mv	1.6 mv	1.274%
±200 kc	1.66V rms	1.0V	13.5 mv	13.0 mv	2.75 mv	2.50 mv	1.911%

TOTAL HARMONIC DISTORTION DATA, NEMS-CLARKE 1455A, PHASE LOCK DETECTOR, 30 KC FUNDAMENTAL FREQUENCY

Transmitter: Mfg. EMR Model 121D Serial No. 922 Originator W Bishop

Receiver: Mfg Nems-Clarke Model 1455A Serial No. 283 Detector Phase Lock Date 9 October 64

Fundamental Frequency 30 kc

Deviation	Transmitter Input Level	Fund.	Second Harmonic	Third Harmonic	Fourth Harmonic	Fifth Harmonic	Total Harmonic Distortion
±25 kc	0.212V rms	1.0V rms	3.1 mv	3.1 mv	----	----	0.438%
±50 kc	0.420V rms	1.0V rms	5.4 mv	3.2 mv	1.0 mv	0.8 mv	0.641%
±75 kc	0.635V rms	1.0V rms	7.5 mv	7.8 mv	1.1 mv	0.9 mv	1.091%
±100 kc	0.840V rms	1.0V rms	9.5 mv	13.0 mv	3.0 mv	1.5 mv	1.645%
±125 kc	1.05V rms	1.0V rms	11.0 mv	21.5 mv	4.9 mv	2.1 mv	2.473%
±150 kc	1.26V rms	1.0V rms	14.5 mv	32.0 mv	6.9 mv	3.6 mv	3.598%
±175 kc	1.47V rms	1.0V rms	17.5 mv	46.0 mv	6.0 mv	7.5 mv	5.014%
±200 kc	1.68V rms	1.0V rms	22.0 mv	64.0 mv	3.8 mv	12.0 mv	6.884%

Sheet 2 of 5

TABLE II-2.6-19
TOTAL HARMONIC DISTORTION DATA, NEMS-CLARKE 1455A,
PHASE LOCK DETECTOR, 70 KC FUNDAMENTAL FREQUENCY

Transmitter: Mfg. EMR Model 121D Serial No. 922 Originator W. Bishop

Receiver: Mfg. Nems-Clarke Model 1455A Serial No. 283 Detector Phase Lock Date 19 October 64

Fundamental Frequency 70 kc

Deviation	Transmitter Input Level	Fund.	Second Harmonic	Third Harmonic	Fourth Harmonic	Fifth Harmonic	Total Harmonic Distortion
±25 kc	0.207V rms	1.0V rms	5.0 mv	1.6 mv	0.9 mv	----	0.533%
±50 kc	0.420V rms	1.0V rms	8.0 mv	3.6 mv	2.2 mv	0.55 mv	0.906%
±75 kc	0.620V rms	1.0V rms	12.5 mv	8.2 mv	1.0 mv	----	1.498%
±100 kc	0.840V rms	1.0V rms	16.5 mv	11.5 mv	1.3 mv	0.5 mv	2.016%
±125 kc	1.03V rms	1.0V rms	22.0 mv	12.0 mv	1.9 mv	----	2.513%
±150 kc	1.25V rms	1.0V rms	51.0 mv	16.0 mv	7.4 mv	1.2 mv	5.397%
±175 kc	1.45V rms	1.0V rms	125.0 mv	51.0 mv	4.8 mv	4.8 mv	13.517%
±200 kc	1.65V rms	1.0V rms	610.0 mv	100.0 mv	75.0 mv	45.0 mv	62.430%

TOTAL HARMONIC DISTORTION DATA, NEMS-CLARKE 1455A, PHASE LOCK DETECTOR, 100 KC FUNDAMENTAL FREQUENCY

Transmitter: Mfg. EMR Model 121D Serial No. 922 Originator W. B[illegible]

Receiver: Mfg. Nems-Clarke Model 1455A Serial No. 283 Detector Phase Lock Date 9 October 64

Fundamental Frequency 100 kc

Deviation	Transmitter Input Level	Fund.	Second Harmonic	Third Harmonic	Fourth Harmonic	Fifth Harmonic	Total Harmonic Distortion
±25 kc	0.218V rms	1.0V rms	1.8 mv	1.45 mv	0.52 mv	0.5 mv	0.242%
±50 kc	0.441V rms	1.0V rms	5.6 mv	2.7 mv	0.44 mv	0.54 mv	0.626%
±75 kc	0.650V rms	1.0V rms	24.5 mv	2.75 mv	0.84 mv	0.88 mv	2.468%
±100 kc	0.865V rms	1.0V rms	32.0 mv	75.0 mv	2.4 mv	1.2 mv	8.159%
±125 kc	1.09V rms	1.0V rms	50.0 mv	56.0 mv	9.5 mv	7.9 mv	7.608%
±150 kc	1.32V rms	1.0V rms	Inoperative				
±175 kc	1.53V rms	1.0V rms	Inoperative				
±200 kc	1.76V rms	1.0V rms	Inoperative				

TABLE II-2.6-21
TOTAL HARMONIC DISTORTION DATA, NEMS-CLARKE 1455A, PHASE LOCK DETECTOR, 225 KC FUNDAMENTAL FREQUENCY

Transmitter: Mfg. EMR Model 121D Serial No. 922 Originator [illegible]

Receiver: Mfg. Nems-Clarke Model 1455A Serial No. 283 Detector Phase Lock Date 9 October 64

Fundamental Frequency 225 kc

Deviation	Transmitter Input Level	Fund.	Second Harmonic	Third Harmonic	Fourth Harmonic	Fifth Harmonic	Total Harmonic Distortion
±25 kc	0.286V rms	1.0V rms	4.5 mv	1.7 mv	----	----	0.481%
±50 kc	0.558V rms	1.0V rms	5.6 mv	1.2 mv	----	0.6 mv	0.576%
±75 kc	0.850V rms	1.0V rms	14.0 mv	5.8 mv	1.0 mv	0.5 mv	1.520%
±100 kc	1.14V rms	1.0V rms	30.0 mv	9.6 mv	1.0 mv	0.72 mv	3.152%
±125 kc	1.48V rms	1.0V rms	41.0 mv	13.2 mv	2.4 mv	0.62 mv	4.314%
±150 kc	1.88V rms	1.0V rms	42.0 mv	17.5 mv	4.0 mv	0.72 mv	4.568%
±175 kc	2.35V rms	1.0V rms	46.0 mv	20.5 mv	5.0 mv	1.05 mv	5.062%
±200 kc	2.93V rms	1.0V rms	51.0 mv	22.5 mv	5.8 mv	1.30 mv	5.606%

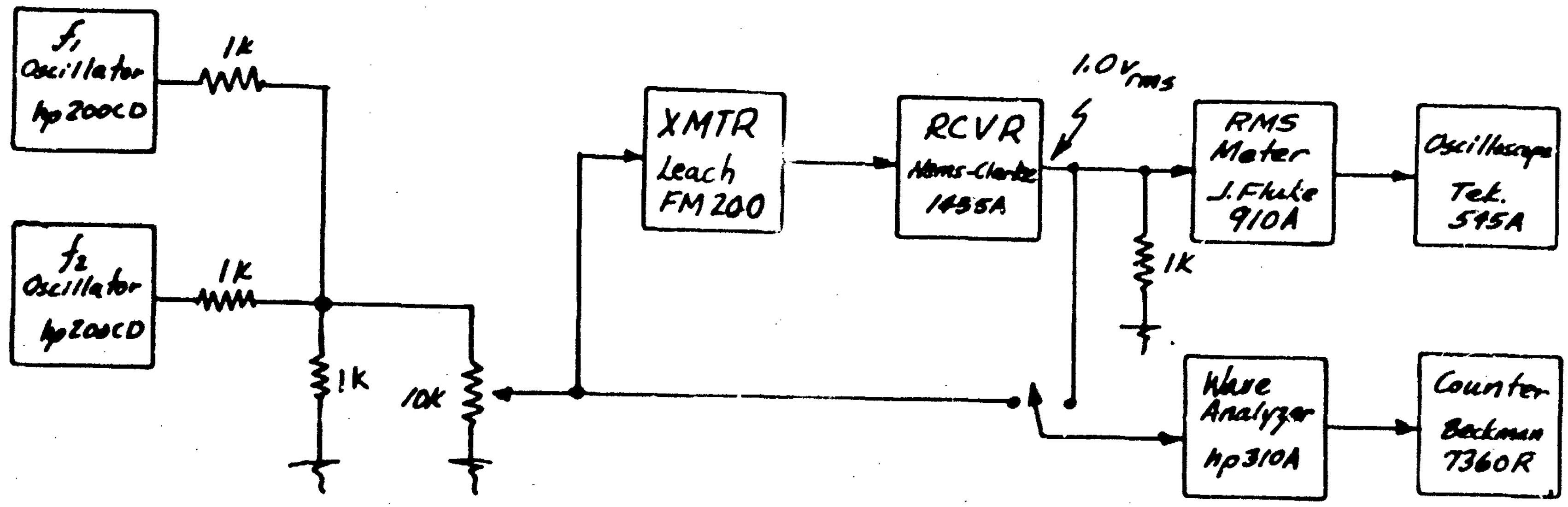


FIGURE II-2.6-22
DIFFERENCE FREQUENCY INTERMODULATION TEST,
LEACH FM 200 AND NEMS-CLARKE 1455A

TABLE II-2.6-23
DIFFERENCE FREQUENCY INTERMODULATION DATA,
LEACH FM 200 AND NEMS-CLARKE 1455A

Modulating Frequency kc	Transmitter Input V_{rms}	Peak Deviation kc	Receiver Output Frequency kc	Receiver Output Level mV_{rms}	Percentage Intermod.
70.0	1.8	200	70.0	775	
52.5	1.35	150	17.5	12	1.55%
70.0	1.62	180	70.0	775	
52.5	1.22	135	17.5	6.6	0.85%
70.0	1.44	160	70.0	790	
52.5	1.08	120	17.5	7.7	0.98%
70.0	1.26	140	70.0	785	
52.5	0.94	105	17.5	10.7	1.36%
70.0	1.08	120	70.0	790	
52.5	0.81	90	17.5	11.4	1.45%
70.0	0.90	100	70.0	805	
52.5	0.68	75	17.5	10.8	1.34%
70.0	0.72	80	70.0	790	
52.5	0.54	60	17.5	9.7	1.23%
70.0	0.54	60	70.0	790	
52.5	0.40	45	17.5	8.0	1.05%
70.0	0.36	40	70.0	795	
52.5	0.27	30	17.5	5.6	0.70%
70.0	0.18	20	70.0	795	
52.5	0.14	15	17.5	2.8	0.35%

TABLE II-2.6-24
DIFFERENCE FREQUENCY INTERMODULATION DATA,
LEACH FM 200 AND NEMS-CLARKE 1455A

Modulating Frequency kc	Transmitter Input Vrms	Peak Deviation kc	Receiver Output Frequency kc	Receiver Output Level mVrms	Percentage Intermod.
124 93	2.0 1.5	200 150	124 31	720 66	9.15%
124 93	1.8 1.4	180 135	124 31	730 35	4.80%
124 93	1.6 1.2	160 120	124 31	730 25	3.43%
124 93	1.4 1.0	140 105	124 31	750 21	2.80%
124 93	1.2 0.90	120 90	124 31	745 18.4	2.47%
124 93	1.0 0.75	100 75	124 31	755 15.5	2.06%
124 93	0.80 0.60	80 60	124 31	760 12.8	1.68%
124 93	0.60 0.45	60 45	124 31	760 10	1.32%
124 93	0.40 0.30	40 30	124 31	760 6.5	0.86%
124 93	0.20 0.15	20 15	124 31	770 3.0	0.39%

2.7 GROUP DETRANSLATOR

2.7.1 General

The EMR Model 259 Group Frequency Detranslator accepts a multiplex of FM subcarriers in the range between 5 kc and 1100 kc, and using a reference signal appearing at the input along with the data subcarriers, detranslates the multiplex into groups of multiplexed subcarriers suitable for direct application to subcarrier discriminators.

The Model 259 uses the reference signal in the input multiplex to synthesize the frequencies required to detranslate the respective subcarrier groups. Each group which is to be detranslated is selected from the input multiplex by a group band-pass filter. The separated group of subcarriers and its corresponding reference frequency are applied to a balanced modulator which drives an output amplifier which is, in turn, suitable for driving a bank of discriminators. The output signal represents the selected group of subcarriers translated down in frequency to the spectrum occupied by the lowest frequency group.

The Model 259 contains a delay line to equalize the envelope delay of the input multiplex and the envelope delay of the reference frequency so that tape-speed errors will be essentially the same in the translated channels as in the untranslated ones. Vernier adjustment of this equalization is provided for each detranslated group. The outputs of all groups are time correlated so that tape-speed compensation may be used without external delay lines. Since the deviation bandwidths of all data discriminators are equal, the data outputs are also time correlated.

Normally, one bank of discriminators is used for each group. For applications where only one bank of discriminators is used on a time-sharing basis, as was the case in the baseband evaluation, a switch on the front panel of the Model 259 makes possible the connection of the discriminator bank to any group output. A calibrate-operate switch is also provided. With this switch in the calibration position, all discriminator banks are connected to the output of the lowest-frequency group selector, thus enabling calibration of all discriminators with the calibration signals available from an EMR Model 260 Modular Three-Point Calibrator.

Section 1.5 of Volume I contains the constant-bandwidth system used in the baseband evaluation.

2.7.2 Specifications

A detailed evaluation of the EMR 289 Modular Group Frequency Detranslator used in the constant-bandwidth system was not undertaken as part of the study contract. Operation within specification was, however, certified by other EMR personnel. A summary of specifications is included below.

Subcarrier Frequencies: A multiplex of FM subcarrier frequencies in the range from 5 kc to 1100 kc is converted into groups of subcarriers suitable for direct application to subcarrier discriminators.

Data Time Correlation: Data channel time errors contributed by the Model 259 Group Frequency Detranslator are less than ±1° from the BSL delay for standard EMR systems at a deviation ratio of 2 or greater.

Multiplex Input Voltage: 10 volts peak-to-peak maximum. Normal level of each individual subcarrier is 100 mv rms.

Multiplex Input Impedance: 10, 000 ohms

Reference Input: 10 millivolts to 1 volt rms from a compatible EMR reference discriminator with constant-bandwidth reference channel selector (for example, Model 210A with 210T-03, Model 267R-03, or Model 270A with 270T-03). The normal reference input to the Model 259 is 100 millivolts rms. The level of the reference in the multiplex should be 6 db above the level of the subcarrier with with highest amplitude.

Group Outputs: (Specification applies to each output.)

Voltage:	10 volts peak-to-peak maximum (open circuit)
Current:	30 ma maximum
Impedance:	91 ohms
Stability:	If the output current does not exceed 30 ma, no instability will result from any capacitive load. An output overload or short circuit will not damage the unit.

Gain: Adjusted at the factory to 6 db ± 1 db to each subcarrier.

Intermodulation Distortion: Each intermodulation distortion product, at normal input level, is less than 0.5% of the amplitude of any subcarrier.

Subcarrier Feedthrough: For flat subcarrier emphasis, lower-group subcarriers in the detranslated group outputs are suppressed at least 46 db.

Image Rejection: For flat subcarrier emphasis, images of undesired groups which appear in the desired group are suppressed at least 46 db.

2.8 SUBCARRIER DISCRIMINATOR

No separate equipment evaluation was performed on the EMR 210 Subcarrier Discriminators. Before use in the baseband evaluation, each unit was returned to the EMR manufacturing test department and retested to certify operation within specification. A summary of performance characteristics pertinent to the baseband evaluation is presented in Volume I, Section 2.8.

2.9 TAPE RECORDER

2.9.1 Amplitude Response

Amplitude response data on the Mincom G-107 and Ampex FR 1400 Tape Recorders were obtained using the following procedure:

a. Clean and degauss the heads using the Magneraser hand degausser on the G-107 heads and the Ampex Model 111 bulk degausser on the removable Ampex heads.

b. Degauss the tape with the bulk degausser.

c. Apply 1.0 volt rms to the input and adjust the input level control until the monitor meter indicates 0.0 db. This provides normal record level to the recorder heads. The Ampex FR 1400 input level attenuator has been preset and locked (by the manufacturer's representative) so that a 1.0 volt rms input provides normal record level.

d. With the recorder operating, adjust the output attenuator for 0.0 db on the 1.0 volt rms range of the voltmeter (use high damping) with a 1.0 volt rms, 1000 cps, input applied.

e. Sweep the oscillator as required to obtain the frequency response characteristic, taking care to assure a 1.0 volt rms input signal at each measured frequency.

f. Repeat for each track of the recorder.

The measured data is contained in Tables II-2.9-1 and II-2.9-2 and is presented graphically in Figures I-2.9-1 and I-2.9-2 of Volume I. Because of recall of the tape recorders by the manufacturers, a second Ampex FR 1400 tape recorder was borrowed in-house for use with the constant-bandwidth evaluation. This machine contained 500-kc electronics, modified by Ampex to extend to 600 kc, and was capable of operation only at 120 ips. Only its frequency response was measured (Table II-2.9-14).

2.9.2 Phase Response

Tape recorder phase response was measured using equipment as shown in the block diagram, Figure II-2.9-3. The procedure used is as follows:

a. Degauss tape, heads, and transport mechanisms.

b. Set the oscillator frequency so that the last flip-flop in the string generates a square wave in the neighborhood of recorder low-frequency cutoff.

c. Use the lower frequency square wave as f_1 and the next higher as f_2 (f_2 will be second harmonic of f_1).

d. Set Khron-Hite low-frequency cutoff to 20 cps, and high-frequency cutoff to the fundamental frequency of its input square wave.

e. Observe summation of two sinusoids at "A" on one trace of a dual-trace oscilloscope.

f. Place delay line in f_1 path and, with recorder operating in record/reproduce mode, observe recorder output on second trace of oscilloscope.

g. Operate the oscilloscope on alternate trace mode and trigger the oscilloscope internally so that the trace starts at the same input voltage level on each sweep.

h. Adjust the delay through the delay line so that the waveforms at A and B are identical. Display both traces superimposed on oscilloscope, to assure best possible alignment of waveshape, and photograph.

i. Move flip-flop outputs up one flip-flop each and repeat, producing harmonic combinations across as much of recorder bandwidth as practical.

The high-frequency cutoff of the Khron-Hite filters is 200 kc. Also, the minimum step adjustment of the delay line is 1 usec. Therefore, no data was taken at frequencies higher than 200 kc. Measured data is presented in Table II-2.9-4. A typical photograph is shown in Figure II-2.9-5. Volume I, Figure I-2.9-3 presents the data graphically.

2.9.3 Noise Density

Output noise density as a function of frequency position in the band was measured on each of the two tape recorders as shown at the bottom of Table II-2.9-6. The following procedure was used:

a. Degauss heads, tape, and transport mechanism.

b. Apply a 1.0 volt rms 1000 cps sine wave to the recorder input. For the G-107, adjust the input for 0.0 db on the input meter yielding normal record level. The FR 1400 is preadjusted and locked so that 1.0 volt rms input is normal record level.

c. Operate the recorder in record/reproduce mode at 60 ips.

d. With the Hewlett-Packard 310A set for 200 cps bandwidth, measure the recorder output noise as a function of frequency, being careful to avoid 1000 cps and its harmonics.

e. As a check, disconnect the analyzer input and measure its residual noise level in 200 cps bandwidth position.

The data is contained in Tables II-2.9-6 and II-2.9-7 and presented graphically in Figure I-2.9-4.

2.9.4 Intermodulation

Intermodulation tests were made using the technique outlined in the block diagram of Figure II-2.9-8. Both sum and difference intermodulation products were measured; the measure data is tabulated in Table II-2.9-9 and presented graphically in Figure I-2. ·5 of Volume I.

2.9.5 Total Harmonic Distortion

Using equipment as described in Table II-2.9-10, total harmonic distortion was measured on the two tape recorders using the following procedure:

a. Degauss tape, heads, and transport mechanism.

b. Apply an input signal of 1.0 volt rms and 1000 cps and adjust input and output attenuators as necessary to operate recorder at normal record level.

c. Operate the tape recorder at 60 ips in record/reproduce mode.

d. Maintaining 1.0 volt rms input and output level, adjust the oscillator frequency across the band of the recorder.

e. At each input frequency, measure the harmonic content of the recorder output with the frequency-selective voltmeter operating with a 200 cps bandwidth.

f. Combine the rms voltage measure of each harmonic in rms fashion to obtain the total harmonic distortion.

The measured data is given in Tables II-2.9-10 and II-2.9-11 and presented graphically in Figure I-2.9-6 of Volume I.

2.9.6 Crosstalk

Using equipment as described at the bottom of Table II-2.9-12, crosstalk between channels was measured on the two tape recorders using the following procedure:

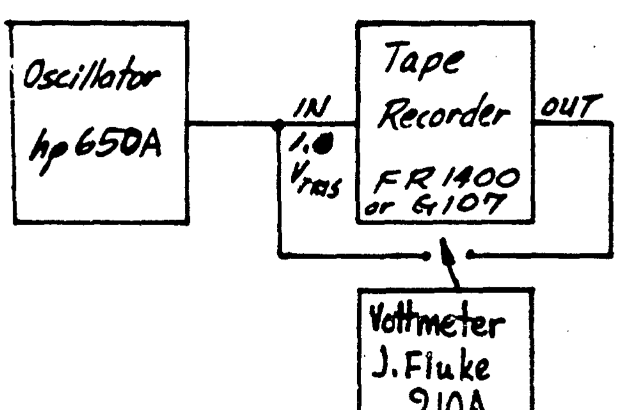
a. Repeat instructions a. through d. of section 2.9.5, above, establishing normal record conditions.

b. At each input frequency, measure the output of the channel containing the input frequency and the two higher-numbered and two lower-numbered channels. (This measures the channels on adjacent tape tracks and those on adjacent head positions.)

The measured data is given in Tables II-2.9-12 and II-2.9-13.

TABLE II-2.9-1
FREQUENCY RESPONSE TEST
AMPEX FR 1400 TRACK NO. 2, ELECTRONICS NO. 1 AND NO. 2

Electronics 1 Track 2		Electronics 1 Track 2		Electronics 2 Track 2		Electronics 2 Track 2	
Freq. cps	Relative Output db	Freq. cps	Relative Output db	Freq. cps	Relative Output db	Freq. cps	Relative Output db
252	-6.0	80kc	+1.0	230	-6.0	10kc	+0.2
310	-3.0	100kc	+1.4	275	-3.0	20kc	+0.2
329	-2.7 PEAK	160kc	+1.7 PEAK	300	-2.0	40kc	+0.4
350	-3.0	200kc	+1.6	332	-1.6 PEAK	70kc	+1.0
429	-3.7 MIN	300kc	+1.2	421	-2.6 MIN	100kc	+1.2
500	-1.9	400kc	+0.8	479	-1.0	137kc	+1.8 PEAK
700	-0.9	450kc	+0.6	556	0.0 PEAK	200kc	+1.6
1.0kc	0.0	500kc	+0.6	670	-0.5 MIN	300kc	+1.2
1.5kc	+0.3	550kc	+0.3	789	+0.2 PEAK	400kc	+0.9
3.0kc	+0.1	600kc	-0.6	1.0kc	0.0	500kc	+0.2
7.0kc	0.0	670kc	-2.0	2.0kc	+0.6	600kc	-0.4
10 kc	0.0	715 kc	-3.0	3.0kc	+0.6	714kc	-3.0
20 kc	-0.2	800kc	-6.0	4.0kc	+0.4	808 kc	-6.0
40 kc	+0.2			7.0kc	+0.4		



Output adjusted to 0.0db on 1.0Vrms range of voltmeter at 1.0kc

BLOCK DIAGRAM TAPE RECORDER
FREQUENCY RESPONSE

TABLE II-2.9-2
FREQUENCY RESPONSE TEST, MINCOM G-107

Channel One		Channel Three		Channel Four		Channel Two	
Input Freq	Output Level	Input Freq	Output Level	Input Freq	Output Level	Input Freq	Output Level
82 cps	-6.0 db	87 cps	-6.0 db	90 cps	-6.0 db	90 cps	-6.0 db
120 cps	-4.2 db	152 cps	-3.0 db	168 cps	-3.0 db	165 cps	-3.0 db
181 cps	-3.0 db	300 cps	-1.4 db	209 cps	-2.0 db	300 cps	-1.3 db
398 cps	-1.0 db	500 cps	-1.2 db	270 cps	-1.0 db	535 cps	-1.0 db
500 cps	-0.8 db	800 cps	-1.0 db	600 cps	-0.8 db	800 cps	-0.8 db
600 cps	-0.8 db	850 cps	-0.8 db	800 cps	-0.8 db	1.0 KC	0.0 db
800 cps	-0.8 db	900 cps	-0.6 db	900 cps	-0.6 db	1.2 KC	+0.9 db
900 cps	-0.5 db	1.0 KC	0.0 db	1.0 KC	0.0 db	2.0 KC	+1.2 db
1.0 KC	0.0 db	1.2 KC	+0.8 db	1.4 KC	+1.1 db	4.0 KC	+1.3 db
1.2 KC	+0.9 db	1.33 KC	Peak +1.0 db	6.0 KC	+1.3 db	5.5 KC	+1.2 db
2.0 KC	+1.0 db	1.78 KC	Min. Pt. +0.5 db	10 KC	+1.2 db	10 KC	+1.1 db
6.0 KC	Peak +1.0 db	2.46 KC	Peak +1.2 db	12 KC	Peak +1.2 db	20 KC	+0.6 db
23 KC	0.0 db	5.0 KC	+0.8 db	20 KC	+0.7 db	40 KC	+0.1 db
50 KC	-0.4 db	8.0 KC	+0.9 db	40 KC	+0.1 db	60 KC	-0.1 db
110 KC	Break Pt. -0.6 db	12 KC	+0.8 db	60 KC	0.0 db	80 KC	-0.2 db
200 KC	Break Pt. -1.0 db	20 KC	+0.4 db	100 KC	-0.1 db	120 KC	-0.3 db
284 KC	Peak 0.0 db	40 KC	Min. Pt. -0.2 db	150 KC	-0.4 db	160 KC	-0.8 db
310 KC	-1.0 db	80 KC	0.0 db	200 KC	-1.0 db	168 KC	-1.0 db
318 KC	-2.0 db	120 KC	+0.6 db	274 KC	-3.0 db	245 KC	-2.0 db
326 KC	-3.0 db	250 KC	Bk. Pt. +0.8 db	305 KC	-6.0 db	278 KC	-3.0 db
340 KC	-6.0 db	300 KC	-0.8 db			310 KC	-6.0 db
		306 KC	-1.0 db				
		326 KC	-3.0 db				
		346 KC	-6.0 db				
		350 KC	-6.8 db				

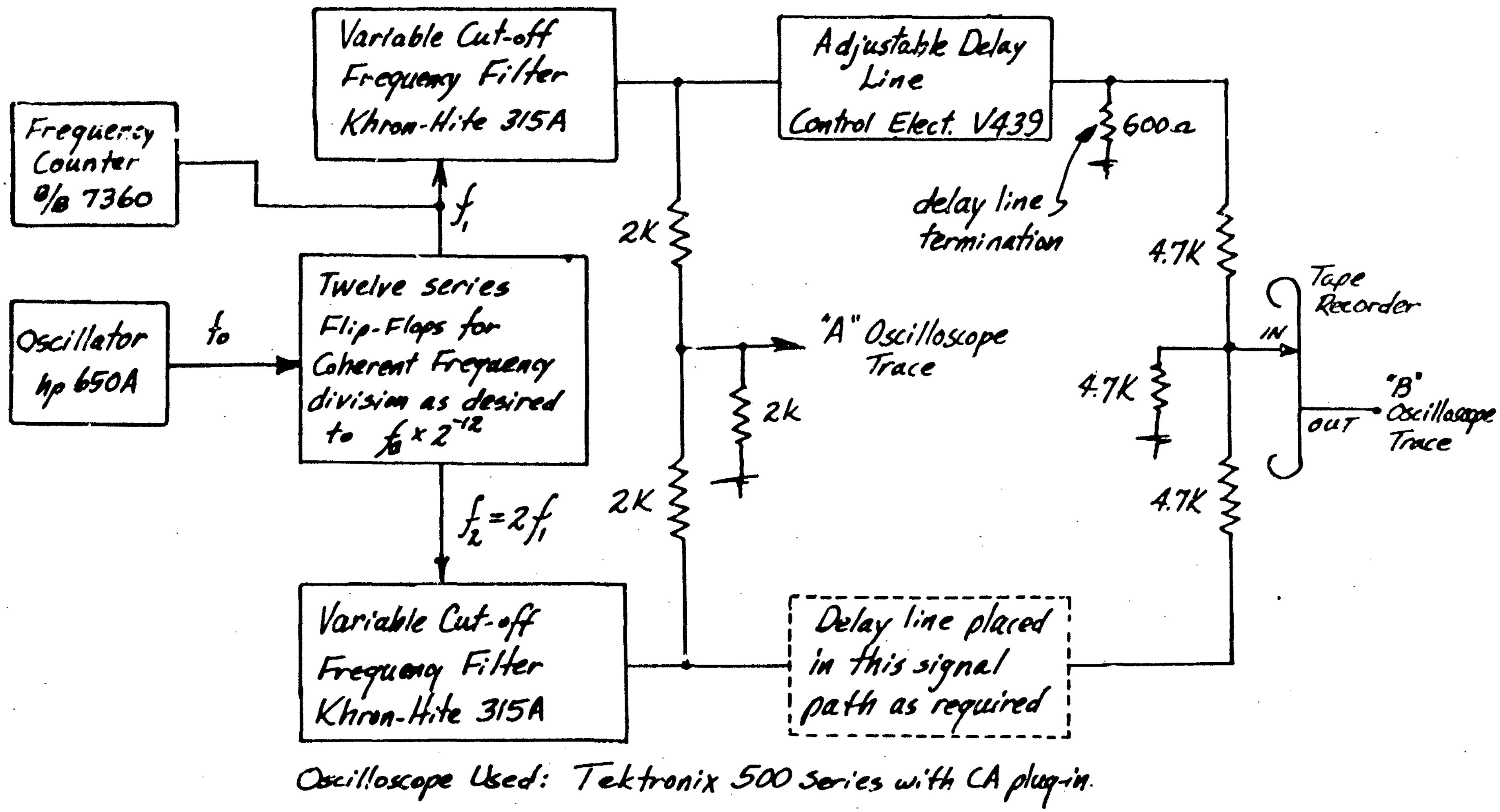


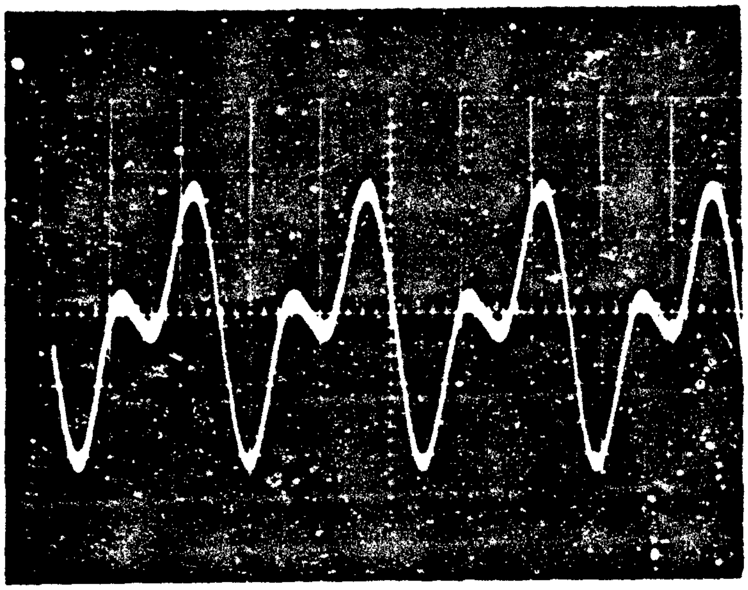
FIGURE II-2.9-3
TAPE RECORDER TIME-DELAY AND PHASE-RESPONSE TEST

TABLE II-2. 9-4

TAPE RECORDER TIME-DELAY AND PHASE-RESPONSE DATA

	Undelayed Frequency	Delayed Frequency	Delay Measured	Cumulative Delay	Phase Shift
Mincom G107:			μsec		
	32kc	16kc	0	0	0
	16kc	8kc	2.0	2	5.8°
	8kc	4kc	6	8	11.5°
	4kc	2kc	20	28	20.2°
	2kc	1kc	85	113	40.7°
	1kc	500cps	270	383	69.0°
	500cps	250cps	740	1143	127.0°
Ampex FR 1400					
	64kc	32kc	0	0	0
	32kc	16kc	1	1	5.8°
	16kc	8kc	0	1	2.9°
	8kc	4kc	7	8	11.5°
	4kc	2kc	22	30	21.6°
	2kc	1kc	100	130	46.8°
	1kc	500cps	400	530	95.4°

AMPEX FR1400 [illegible]



$f_1 = 2$ kc
$f_2 = 4$ kc

22 μsec of delay to 2kc

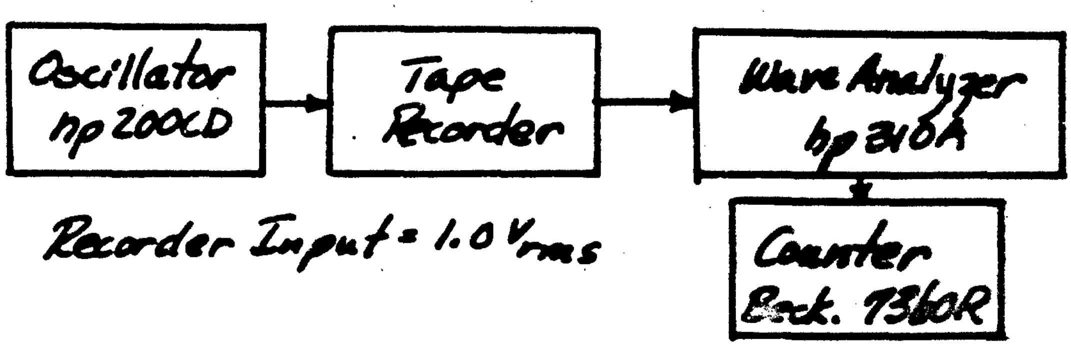
Use of oscilloscope internal trigger and alternate trace features allows trace A, before delay line and tape recorder, and trace B, recorder output, to be superimposed and held steady for nulling.

FIGURE II-2.9-5
TYPICAL OUTPUT PHOTOGRAPH TAPE RECORDER
TIME-DELAY AND PHASE-RESPONSE TEST

TABLE II-2. 9-6

NOISE TEST - MINCOM G107

Frequency	Level µv	Residual Reading µv	$\frac{\text{Level}}{\sqrt{200}}$ µv	db, Relative to 1.0 v.
400	4000	20.0	283	-71.0
2.4kc	2000		142	-77.0
5.0kc	500		35.4	-89.0
10.0kc	250		17.6	-95.0
20.0kc	200		14.2	-97.0
25.0kc	160		11.3	-98.9
40.0kc	125		8.8	-101.1
100.0kc	110		7.8	-102.2
200.0kc	150		10.6	-99.5
300.0kc	350		24.7	-92.1
400.0kc	250		17.6	-95.0
500.0kc	200		14.2	-97.0
700.0kc	150		10.6	-99.5
900.0kc	100		7.1	-103.0
1000.0kc	80	20.0	5.7	-104.9



Recorder Input = 1.0 V_{rms}

TABLE II-2. 9-7

NOISE TEST - AMPEX FR1400

Frequency	Level mv	Residual Reading	Level / $\sqrt{200}$	db, Rel. to 1.0v
400cps	14	0.06mv	0.99mv	-60.0
500cps	10		0.707mv	-63.0
2.5kc	1.7		0.12mv	-78.4
5.5kc	0.80		57μv	-84.9
8.0kc	0.65		46μv	-86.7
16.0kc	0.40		28.2μv	-91.0
32.0kc	0.25		17.7μv	-95.0
64.0kc	0.22		15.6μv	-96.2
128.0kc	0.22		15.6μv	-96.2
256.0kc	0.23		16.3μv	-95.8
512.0kc	0.32		22.6μv	-92.9
1024.0kc	0.60		42.4μv	-87.4
1.4Mc	0.62	0.06mv	43.8μv	-87.2

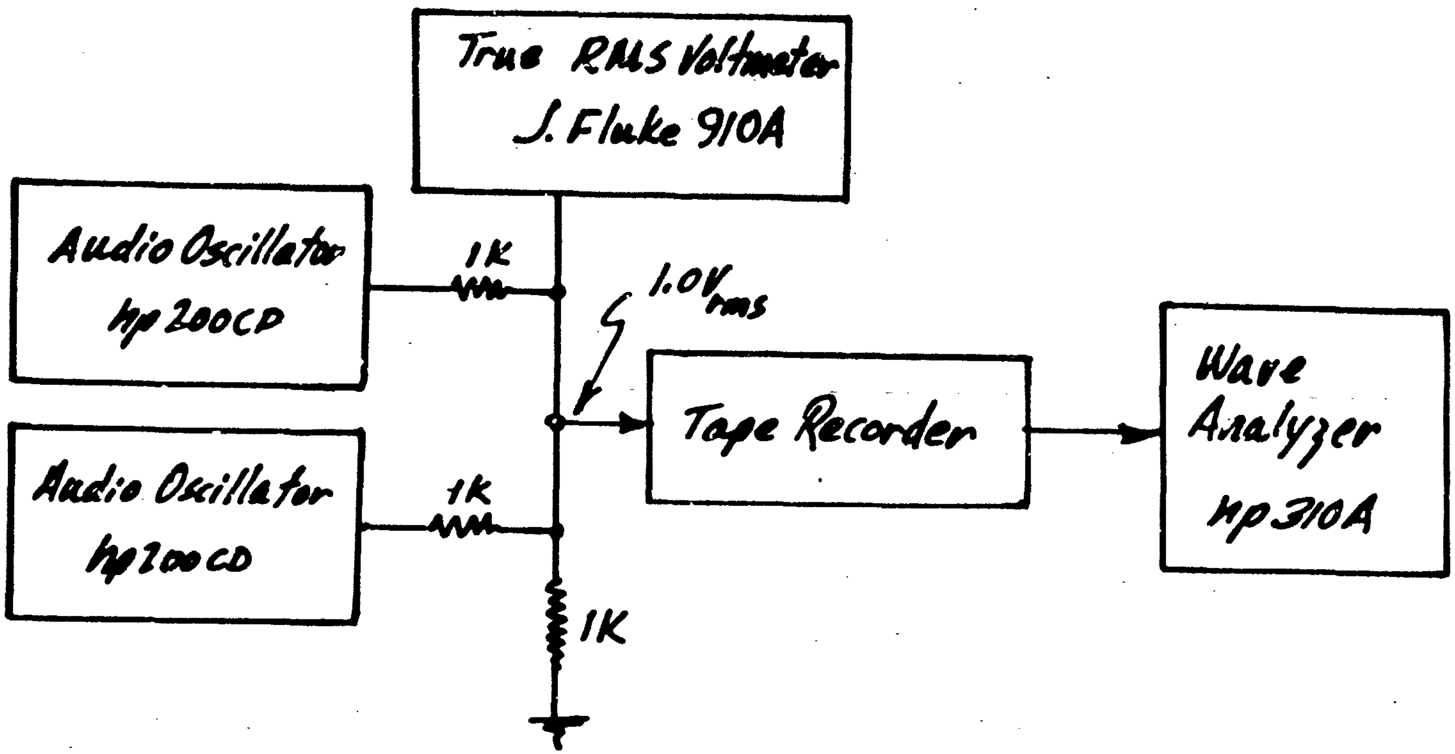


FIGURE II-2.9-8
INTERMODULATION TEST BLOCK DIAGRAM

TABLE II-2. 9-9

INTERMODULATION TEST DATA

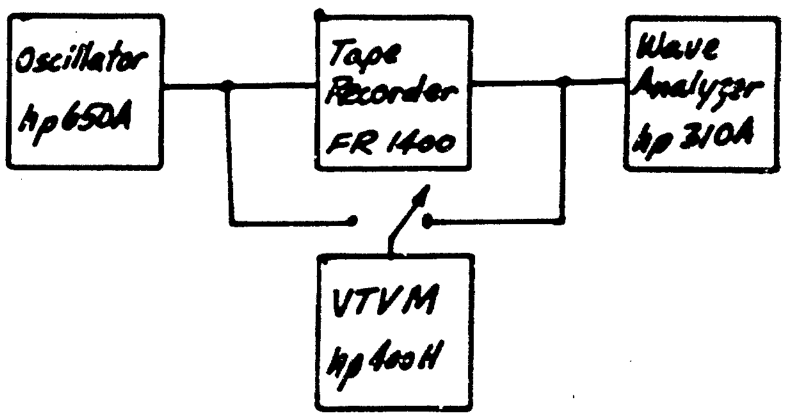
Mincom G107				AMPEX FR1400			
f_1	f_2	f_1+f_2 rms	f_1-f_2 rms	f_1	f_2	f_1+f_2	f_1-f_2
500	600	3.5mv	—	500	1kc	7.5mv	—
700	800	3.5mv	-	700	1kc	5mv	—
1kc	2kc	3.5mv	—	1kc	2kc	5.0mv	—
1.4kc	2.4kc	2.5mv	3.5mv	1.4kc	2kc	4.5mv	—
2kc	3kc	2.2mv	4.0mv	2kc	3kc	4.4mv	—
3kc	4kc	1.8mv	2.6mv	3kc	4kc	4.3mv	—
4kc	5kc	1.6mv	2.0mv	4kc	5kc	4.3mv	—
5kc	6kc	1.8mv	2.0mv	5kc	6kc	4.3mv	—
7kc	8kc	1.8mv	2.0mv	7kc	8kc	4.3mv	—
10kc	11kc	2.0mv	2.0mv	10kc	15kc	4.4mv	4.7mv
14kc	15kc	1.3mv	1.5mv	14kc	24kc	5.0mv	4.7mv
20kc	21kc	1.4mv	1.5mv	20kc	30kc	5.0mv	4.8mv
30kc	31kc	1.5mv	1.5mv	30kc	40kc	5.5mv	6.7mv
40kc	41kc	1.3mv	1.3mv	40kc	50kc	5.7mv	8.5mv
50kc	51kc	1.4mv	1.3mv	50kc	60kc	5.3mv	8.7mv
70kc	71kc	1.4mv	1.0mv	70kc	80kc	6.0mv	11mv
100kc	101kc	-	0.60mv	100kc	110kc	7.0mv	12mv
140kc	141kc	-	0.65mv	140kc	150kc	7.0mv	6.8mv
200kc	201kc	-	0.90mv	200kc	210kc	8.0mv	15.5mv
300kc	301kc	-	0.60mv	300kc	310kc	3.0mv	12.5mv
				400kc	410kc	—	14.0mv
				500kc	510kc	—	14.5mv
				600kc	650kc	—	14.5mv

In both cases $f_1 = f_2$ amplitude and $f_1 + f_2 = 1.0\ V_{rms}$, normal record level

TOTAL HARMONIC DISTORTION
AMPEX FR 1400

Fund.* Freq.	Harmonic Level 2nd	3rd	4th	T.H.D.
1.0 kc	—	8.0 mv	—	0.8%
4.0 kc	1.1 mv	7.6 mv	—	0.77%
10 kc	—	7.5 mv	—	0.75%
20 kc	1.0 mv	10.0 mv	—	1.0%
40 kc	1.5 mv	12.5 mv	—	1.3%
100 kc	3.4 mv	8.4 mv	—	0.9%
200 kc	2.7 mv	9.5 mv	2.0 mv	1.0%
400 kc	3.0 mv	3.0 mv	—	0.43%

*Fundamental Level = $1.0 V_{rms}$ input and output



TOTAL HARMONIC DISTORTION
MINCOM G107

Fund.* Freq.	Harmonic Level 2nd	3rd	4th	T.H.D.
500cps	—	7.0mv	—	0.7%
1kc	6.0mv	7.0mv	—	0.9%
4kc	5.5mv	7.0mv	—	0.9%
10kc	6.0mv	7.5mv	—	1.0%
40kc	7.5mv	10. mv	—	1.2%
100kc	4.0mv	18. mv	—	1.8%
250kc	8.0mv	5.0mv	—	0.9%

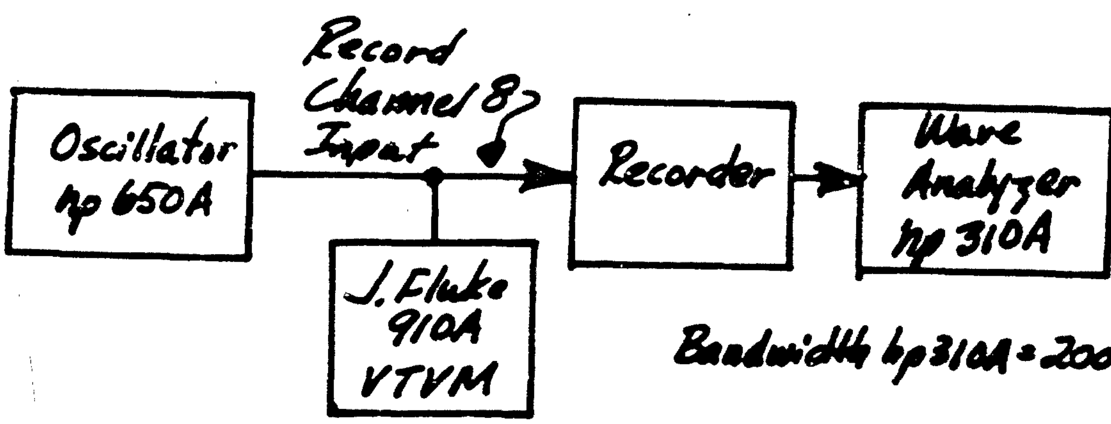
*Fundamental Level = 1.0 V_{rms} input & output.

TABLE II-2. 9-12

CROSSTALK - AMPEX FR1400

Recorder Speed: 60 ips

Frequency Record Chan. 8 cps	Record Chan. 6 mV rms	Record Chan. 7 mV rms	Record Chan. 8 V rms	Record Chan. 9 mV rms	Record Chan. 10 mV rms
400	28.	90.	1.0	90.	35.
600	10.	23.		25	15.
700	9.0	25		28.	14.
1kc	6.0	6.0		7.0	10.
4kc	4.0	1.5		2.4	8.0
10kc	4.0	0.60		3.0	8.0
40 kc	3.4	0.30		3.2	7.5
100kc	3.0	0.25		2.9	6.9
400kc	5.0	0.50		1.6	7.2
600kc	4.0	2.0	1.0	4.0	10.



Bandwidth hp310A = 200cps

TABLE II-2. 9-13

CROSSTALK - MINCOM G 107

Recorder Speed - 60 ips

Record Channel 2 Frequency cps	Record Channel 1 mV rms	Record Channel 2 V rms	Record Channel 3 mV rms	Record Channel 4 mV rms
1kc	9.0	1.0	9.0	13.
2kc	7.0		5.5	15.
5kc	4.0		2.5	14.
10kc	2.2		9.0	11.
20kc	2.5		0.80	10.
50kc	3.5		2.0	8.5
100kc	5.0		2.5	7.5
150kc	9.0		3.0	7.0
200kc	18.		13.	5.0
250kc	40.		15.	8.0
300kc	90.	1.0	50.	15.

TABLE II-2. 9-14

FREQUENCY RESPONSE TEST

AMPEX-MODIFIED FR1400

Frequency kc	Relative Attenuation db
265 cps	-3.0
330 cps	-1.0
740 cps	0.0
1.0 kc	0.0 (Ref. Point)
60.0 kc	+0.5
100.0 kc	+0.5
145.0 kc	+1.0
200.0 kc	+1.5
280.0 kc	+2.5
440.0 kc	+2.5
600.0 kc	0.0
650.0 kc	-3.0
710.0 kc	-9.0

Channel 1 Record/Reproduce ; Tape Speed: 120 ips

SECTION 3

SYSTEM EVALUATION DATA

The detailed procedure for the system test performed on each of the basebar as well as the measured data are contained in the following sections. For re erence, the block diagrams for each experimental telemeter are shown in Fi ures II-3.0-1, II-3.0-2, and II-3.0-3.

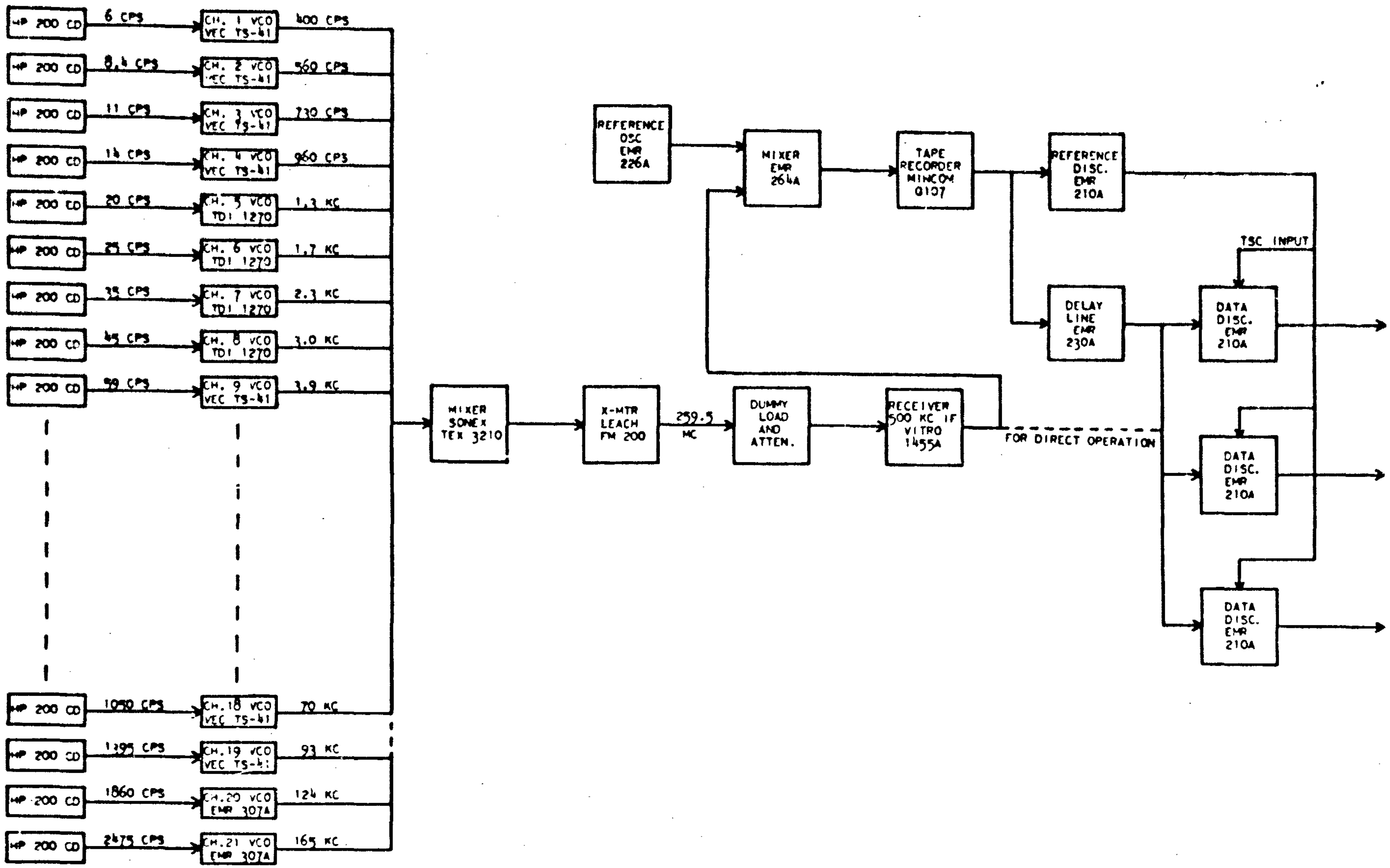


FIGURE II-3.0-1
BLOCK DIAGRAM OF LABORATORY TELEMETER USED FOR EVALUATION OF PROPORTIONAL BANDWIDTH BASEBANDS

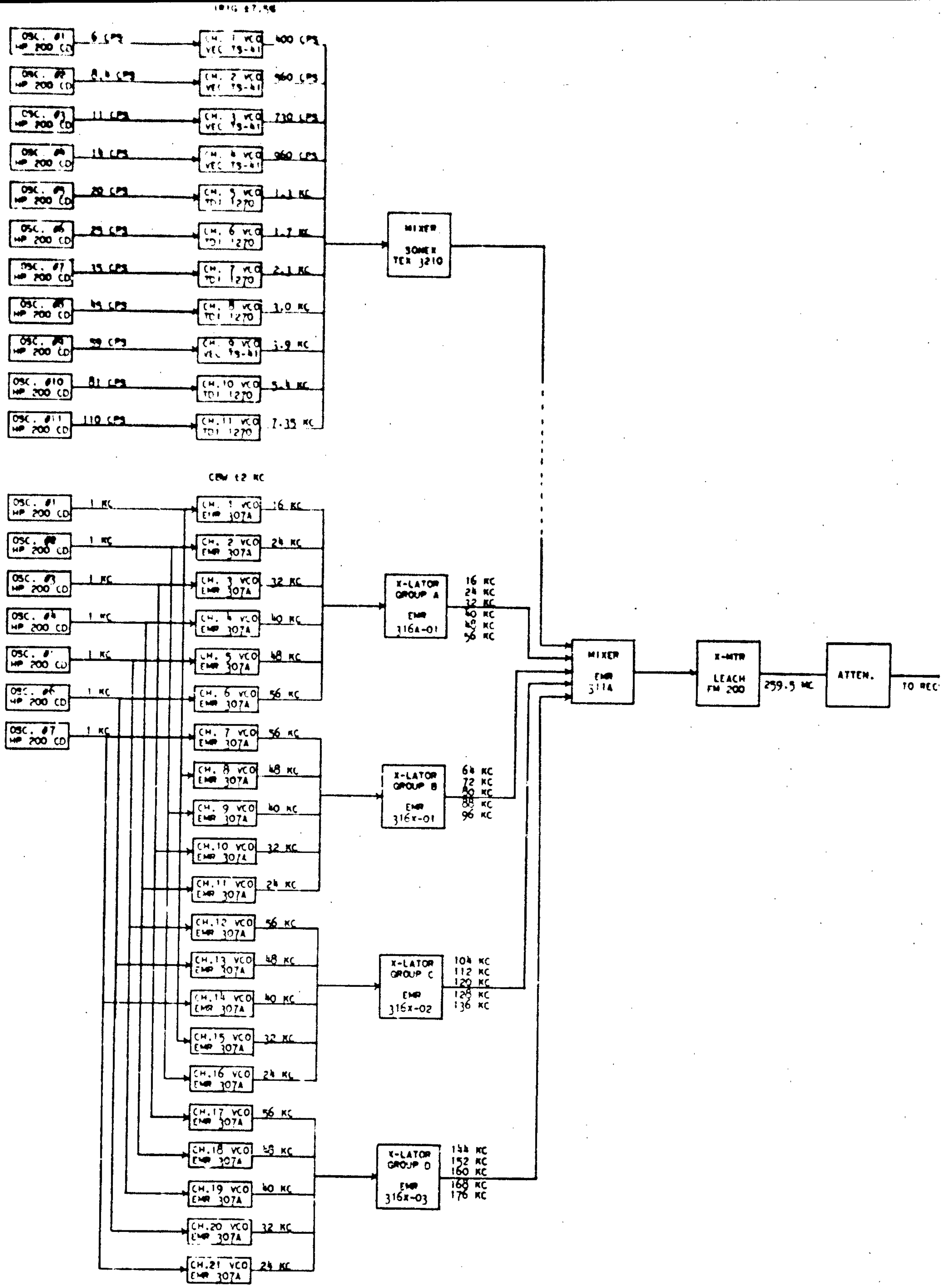


FIGURE II-3.0-2
BLOCK DIAGRAM OF AIRBORNE LABORATORY TELEMETER USED FOR EVALUATION OF CONSTANT AND COMBINATIONAL BANDWIDTH BASEBANDS

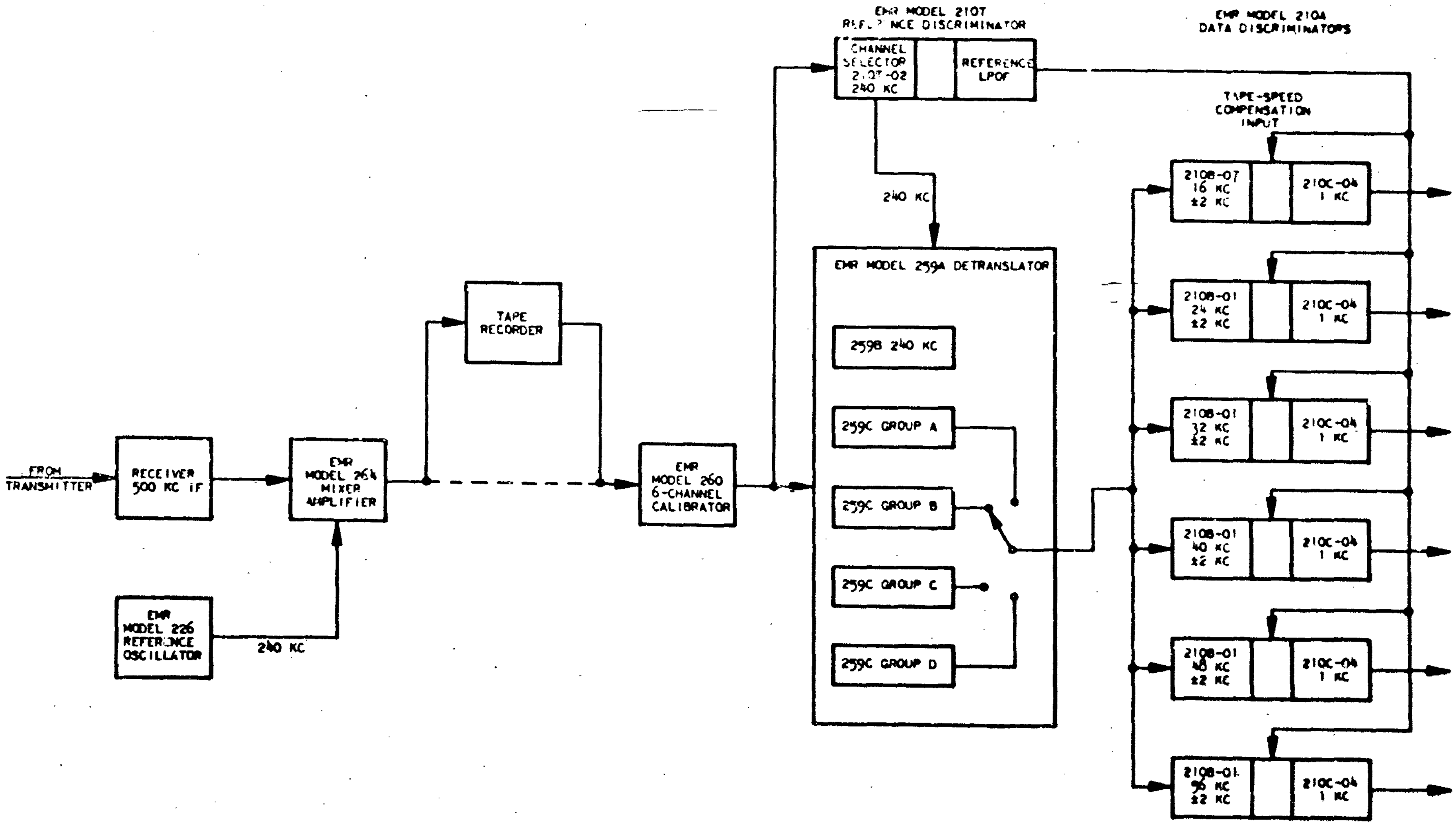


FIGURE II-3.0-3
BLOCK DIAGRAM OF GROUND LABORATORY TELEMETER USED FOR EVALUATION OF CONSTANT AND COMBINATIONAL BANDWIDTH BASEBANDS

3.1 PRE-EMPHASIS SCHEDULE PROCEDURE AND RAW DATA

3.1.1 General

A pre-emphasis schedule for a particular system is considered optimized when identical signal-to-noise ratios occur in each subcarrier discriminator output. Since the receiver output noise characteristics are dependent upon the receiver input carrier-to-noise ratio, a pre-emphasis schedule can only be optimized at one particular receiver carrier-to-noise ratio. Thus, a choice must be made as to carrier-to-noise ratio to be used. For the particular system being evaluated a carrier-to-noise ratio of 9 db, approximately the condition necessary to cause the receiver to threshold, was chosen for optimizing the pre-emphasis schedule.

Normally the subcarrier discriminator output signal-to-noise ratio is measured; however, the subcarrier-to-noise ratio in the band-pass input filter is directly related to the output signal-to-noise ratio. Therefore, for convenience, the pre-emphasis is optimized to produce identical subcarrier-to-noise ratios at the output of the band-pass input filter.

In essence, the procedure is to set a receiver IF carrier-to-noise ratio of 9 db and adjust the individual VCO amplitude levels for equal subcarrier-to-noise ratios in the discriminator while maintaining a multiplex level which does not cause the transmitter output to exceed the radiated spectrum specification. There are several problems inherent to this technique.

The first problem is that of providing a receiver IF carrier-to-noise ratio of 9 db. With the receiver used in the system evaluation, the IF carrier-to-noise ratio is measured at the predetection recording output, which is the IF output just prior to the first-limiter input. If the IF amplifier is a linear system, its input and output carrier-to-noise ratios are identical; however, care must be taken to prevent IF saturation. Through experiment it was found that the maximum unmodulated IF output level which does not cause saturation is 110 mv rms. In addition, the IF saturation characteristic was found to vary somewhat with the AGC voltage. The greatest linear range occurred when the AGC voltage was externally held constant at a −4 volt level. Thus, with the AGC held at −4 volts, the unmodulated IF signal level is measured with a frequency selective voltmeter; this technique eliminates wideband noise and provides an accurate signal level measurement. The input carrier is then turned off and the IF noise measured with a true rms meter.

The second problem is that of adjusting the VCO levels to produce equal subcarrier-to-noise ratios while maintaining a fixed multiplex level so that radiated spectrum specification is not exceeded. This is a trial-and-error method consisting of choosing a trial pre-emphasis schedule, checking to determine if the radiated spectrum is exceeded, and then readjusting the pre-emphasis. There are several short-cuts to this procedure which are given in the following detailed procedure.

3.1.2 Detailed Procedure

a. Choose a trial taper and, using the radiated-spectrum test described in the next section, determine the maximum total rms transmitter deviation allowable.

b. Select the deviation for the highest frequency channel from the graph in Figure II-3.1-1.

c. Starting with the highest frequency channel, set the VCO output levels to the selected taper. A minimum deviation of 3 kc should not be exceeded; therefore, the lower channels may need to be adjusted to equal amplitudes.

d. Adjust the gain of the mixer amplifier to provide a full multiplex rms level to produce the selected rms transmitter deviation.

e. With the transmitter unmodulated, externally set the AGC voltage to −4v dc and adjust the rf signal level for an IF carrier-to-noise ratio of 9 db.

f. Set the video gain of the receiver to produce 2.0 volts rms full multiplex output.

g. With the VCOs at center frequency (unmodulated), measure the subcarrier signal-to-noise ratio at the output of the band-pass input filter by measuring the subcarrier signal level and then turning the particular VCO off and measuring the noise. Repeat for each channel.

h. Readjust the VCO levels to produce equal subcarrier signal-to-noise ratios while maintaining the multiplex level previously selected.

i. Recheck the radiated-spectrum level and readjust the total multiplex level if necessary. It has been found that once the taper has been adjusted for equal subcarrier-to-noise ratios, small variations in the total multiplex level do not alter the relative relationships of the individual subcarrier-to-noise ratios.

3.1.3 FM/FM Proportional Multiplex RMS Carrier Frequency Deviation

Refer to the graph in Figure II-3.1-1.

Problem:

> The problem is to find relationship between RMS carrier deviation (total) and deviation allocated to top subcarrier, in terms of common ratio between adjacent subcarrier center frequencies, and in terms of constant pre-emphasis slope.

Definitions and Conditions:

1. Y (>1.0) is common ratio between adjacent subcarrier center frequencies (Y ≈ 1.3 for IRIG).
2. f_{dh} is the peak carrier deviation allocated to the highest-frequency subcarrier.
3. f_{sk} is the center frequency of subcarrier channel k, where k = 1, 2...h.
4. f_{dk} is the peak carrier deviation allocated to channel k.
5. a is the slope of the log-deviation versus log-frequency pre-emphasis function. It is taken as a constant.
6. A large number of subcarriers is assumed.

The peak carrier deviation allocated to subcarrier k is

$$f_{dk} = Cf_{sk}^{a} \tag{1}$$

where C is a constant. For the highest subcarrier, k = h, hence

$$f_{dh} = Cf_{sh}^{a}$$
$$C = \frac{f_{dh}}{f_{sh}^{a}} \tag{2}$$

from (1) and (2):

$$f_{dk} = f_{dh}\left(\frac{f_{sk}}{f_{sh}}\right)^{a} \tag{3}$$

Because of the common ratio between adjacent subcarrier frequencies:

$$f_{sk} = \frac{f_{sh}}{y^{(h-k)}}$$
$$\frac{f_{sk}}{f_{sh}} = \frac{1}{y^{(h-k)}} \tag{4}$$

from (3) and (4) then:

$$f_{dk} = f_{dh}\left[\frac{1}{y^{(h-k)}}\right]^{a} \tag{5}$$

The mean-square carrier deviation due to channel k is:

$$\frac{1}{2} f_{dk}^{2} = \frac{1}{2} f_{dh}^{2}\left[\frac{1}{y^{(h-k)}}\right]^{2a} \tag{6}$$

the total mean-square carrier deviation is

$$F_d^2 = \sum_{k=1}^{h} \frac{1}{2} f_{dk}^2$$

$$= \frac{1}{2} f_{dh}^{2} \sum_{k=1}^{h} \left[\frac{1}{y^{(h-k)}}\right]^{2a}$$

$$= \frac{1}{2} f_{dh}^{2} \sum_{k=1}^{h} \left[\frac{1}{y^{2a\,(h-k)}}\right]$$

$$= \frac{1}{2} f_{dh}^{2} \sum_{k=1}^{h} \left[\frac{1}{y^{2a}}\right]^{h-k}$$

$$F_d^{2} = \frac{1}{2} f_{dh}^{2}\left[1 + \left(\frac{1}{y^{2a}}\right) + \left(\frac{1}{y^{2a}}\right)^{2} \cdots\cdots \left(\frac{1}{y^{2a}}\right)^{h-1}\right] \tag{7}$$

For very large values of h, this is approximately

$$F_d^{2} = \frac{1}{2} f_{dh}^{2}\left[\frac{1}{1 - \frac{1}{y^{2a}}}\right]$$

$$F_d^{2} = \frac{1}{2} f_{dh}^{2}\left[\frac{y^{2a}}{y^{2a} - 1}\right] \tag{8}$$

The total rms carrier deviation is

$$F_d = f_{dh} \frac{1}{\sqrt{2}} \left[\frac{y^{2a}}{y^{2a} - 1}\right]^{\frac{1}{2}} \tag{9}$$

3.1.4 Results

3.1.4.1 IRIG Baseband

For the IRIG baseband, channels 1 through 18, pre-emphasis was optimized using a multiplex level at the transmitter input of 1.0v rms. The measured data is included in Table II-3.1-2 and presented graphically in Figure I-3.2-1.

3.1.4.2 IRIG Baseband--Wideband Channel

The IRIG baseband, channels 1 through 16 and E, was optimized using a multiplex level at the transmitter input of 1.0v rms. The measured data is included in Table II-3.1-3 and presented graphically in Figure I-3.2-3.

3.1.4.3 Trial Expanded Proportional-Bandwidth Baseband

The pre-emphasis schedule for the expanded baseband, channels 1 through 20, was optimized using a multiplex level at the transmitter input of 1.0v rms. The measured data is included in Table II-3.1-4 and presented graphically in Figure I-3.2-4.

3.1.4.4 Expanded Proportional-Bandwidth Baseband

The pre-emphasis schedule for the expanded baseband, channels 1 through 21, was optimized using a multiplex level at the transmitter input of 750 mv rms. The measured data is included in Table II-3.1-5 and presented graphically in Figure I-3.2-5.

3.1.4.5 Expanded Proportional-Bandwidth Baseband--Wideband Channel

The expanded baseband, channels 1 through 19 and H, pre-emphasis schedule was optimized using a multiplex level at the transmitter input of 630 mv rms. The measured data is included in Table II-3.1-6 and presented graphically in Figure I-3.2-6.

3.1.4.6 Constant-Bandwidth Baseband

The pre-emphasis schedule for the constant-bandwidth baseband, channels 1 through 21, was optimized using a multiplex level at the transmitter input of 360 mv rms. The measured data is included in Table II-3.1-7 and presented graphically in Figure I-3.2-8. With channels 17 through 21, Group D, removed and the same taper, the multiplex level at the transmitter was increased to 615 mv rms. The data measured for one channel in each group is included in Table II-3.1-8.

3.1.4.7 Combinational-Bandwidth Baseband

The pre-emphasis schedule for the combinational-bandwidth baseband, IRIG channels 1 through 11 and constant-bandwidth channels 1 through 21, was optimized using a total multiplex level at the transmitter input of 635 mv rms; 600 mv rms for the constant-bandwidth channels and 210 mv rms for the IRIG channels. The measured data is included in Table II-3.1-9 and is plotted in Figure I-3.2-9.

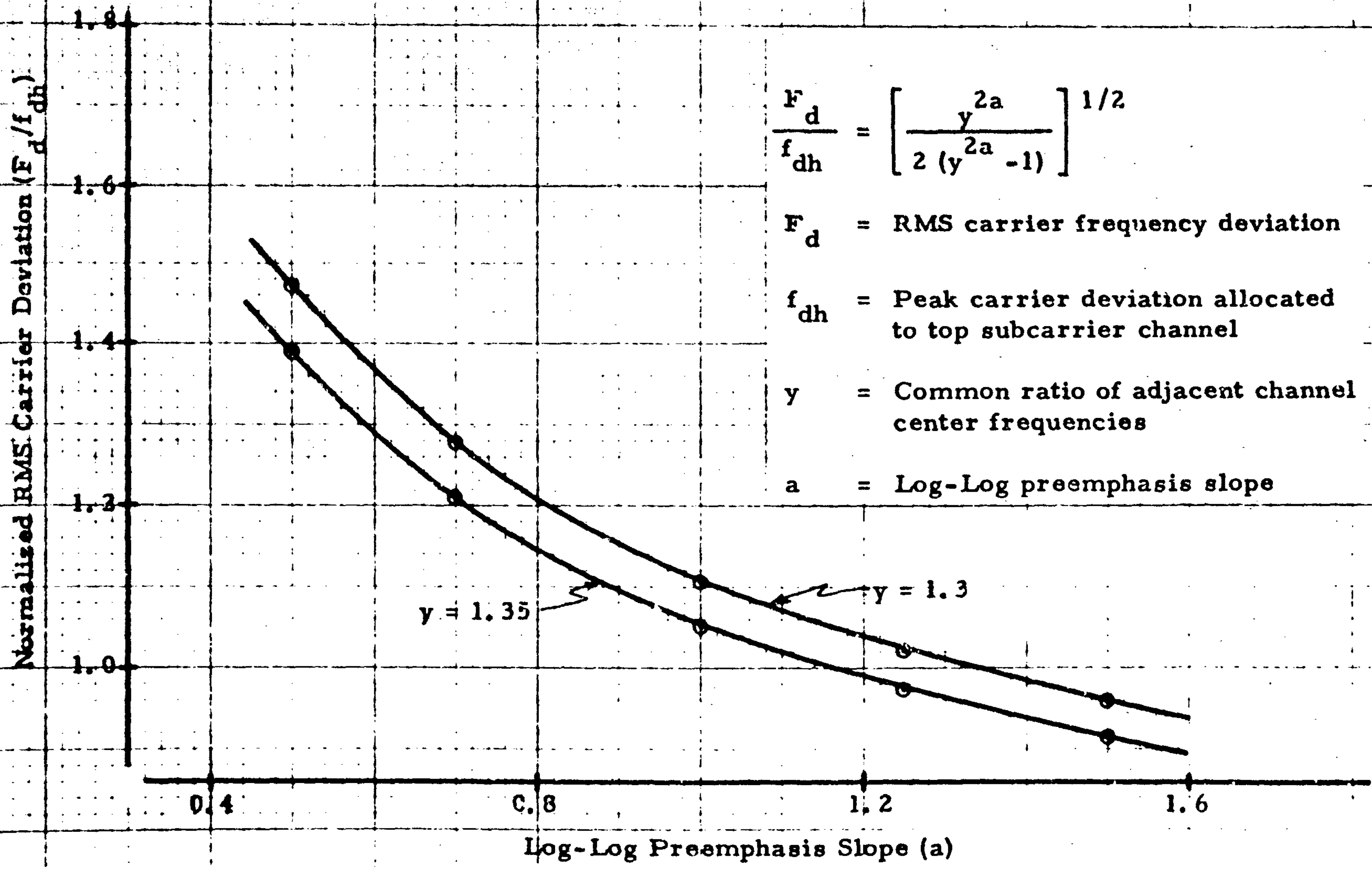


FIGURE II-3.1-1
FM/FM PROPORTIONAL MULTIPLEX RMS CARRIER FREQUENCY DEVIATION

TABLE II-3.1-2
PREEMPHASIS DATA FOR IRIG BASEBAND,
CHANNELS 1 THROUGH 18

System Description: IRIG Channels 1 Through 18

$(S/N)_c$: 9db AGC: -4.0vdc Multiplex: 1.0 Vrms

Channel Frequency (kc)	Signal (dbm)	Noise (dbm)	$(S/N)_s$ (dbm)	VCO Level (dbm)
0.40±7.5%	-25.4	-53.8	28.4	-25.0
0.56±7.5%	-24.7	-49.2	24.5	-25.0
0.73±7.5%	-24.8	-45.2	20.4	-25.0
0.96±7.5%	-24.3	-47.2	22.9	-25.0
1.30±7.5%	-24.0	-47.6	23.6	-25.0
1.70±7.5%	-23.2	-46.6	23.4	-23.5
2.30±7.5%	-21.9	-45.1	23.2	-22.5
3.00±7.5%	-21.3	-42.7	21.4	-21.5
3.90±7.5%	-20.5	-43.4	22.9	-20.5
5.40±7.5%	-18.2	-41.8	23.6	-18.5
7.35±7.5%	-16.7	-39.0	22.3	-16.6
10.5 ±7.5%	-14.3	-38.6	24.3	-14.5
14.5 ±7.5%	-13.0	-37.0	24.0	-12.7
22.0 ±7.5%	-9.8	-35.0	25.2	-10.0
30.0 ±7.5%	-8.0	-30.0	22.0	-7.8
40.0 ±7.5%	-5.9	-29.2	23.3	-5.8
52.5 ±7.5%	-4.6	-26.4	21.8	-4.0
70.0 ±7.5%	-2.8	-24.0	21.2	-2.1
93.0 ±7.5%				
124.0 ±7.5%				
165.0 ±7.5%				
70.0 ±15%				
165.0 ±15%				

Name: ERC Date: 1-3-65

TABLE II-3.1-3
PREEMPHASIS DATA FOR IRIG BASEBAND,
CHANNELS 1 THROUGH 16 AND E

System Description: IRIG Channels 1 Through 16 and E

$(S/N)_c$: 9db AGC: -4.0vdc Multiplex: 1.0vrms

Channel Frequency (kc)	Signal (dbm)	Noise (dbm)	$(S/N)_s$ (dbm)	VCO Level (dbm)
0.40±7.5%	-27.8	-52.0	24.2	-27.0
0.56±7.5%	-27.4	-48.5	21.1	-27.4
0.73±7.5%	-26.8	-46.6	19.8	-26.7
0.96±7.5%	-26.4	-46.8	20.4	-26.9
1.30±7.5%	-26.2	-46.4	20.2	-26.7
1.70±7.5%	-25.6	-45.6	20.0	-25.8
2.30±7.5%	-24.1	-44.0	19.9	-24.7
3.00±7.5%	-23.8	-43.4	19.6	-23.8
3.90±7.5%	-22.8	-42.2	19.4	-22.7
5.40±7.5%	-20.6	-40.7	20.1	-20.6
7.35±7.5%	-19.2	-39.7	20.5	-18.9
10.5 ±7.5%	-17.0	-38.2	21.2	-17.0
14.5 ±7.5%	-15.4	-36.0	20.6	-15.1
22.0 ±7.5%	-12.0	-33.8	21.8	-12.2
30.0 ±7.5%	-9.3	-30.0	20.7	-9.2
40.0 ±7.5%	-7.4	-29.0	21.6	-7.4
52.5 ±7.5%				
70.0 ±7.5%				
93.0 ±7.5%				
124.0 ±7.5%				
165.0 ±7.5%				
70.0 ±15%	0.0	-21.6	21.6	+0.8
165.0 ±15%				

Name: EBC Date: 1-12-65

TABLE II-3.1-4
FREEMPHASIS DATA FOR EXPANDED PROPORTIONAL BANDWIDTH BASEBAND, CHANNELS 1 THROUGH 20

System Description: PBW Channels 1 Through 20

$(S/N)_c$: 9db AGC: -4.0vdc Multiplex: 1.0v rms

Channel Frequency (kc)	Signal (dbm)	Noise (dbm)	$(S/N)_s$ (dbm)	VCO Level (dbm)
0.40±7.5%	-27.8	-50.0	22.2	-28.0
0.56±7.5%	-27.5	-47.0	19.5	-28.2
0.73±7.5%	-28.3	-45.0	16.7	-29.0
0.96±7.5%	-27.2	-44.5	17.3	-28.4
1.30±7.5%	-26.7	-43.5	16.8	-28.2
1.70±7.5%	-27.8	-43.0	15.2	-29.0
2.30±7.5%	-26.3	-41.0	14.7	-27.9
3.00±7.5%	-25.0	-40.5	15.5	-25.9
3.90±7.5%	-24.7	-39.2	14.5	-25.6
5.40±7.5%	-23.2	-38.0	15.8	-24.2
7.35±7.5%	-21.1	-36.8	15.7	-21.9
10.5 ±7.5%	-19.6	-35.1	15.5	-20.5
14.5 ±7.5%	-18.8	-33.2	14.4	-19.3
22.0 ±7.5%	-14.8	-30.0	15.2	-15.7
30.0 ±7.5%	-13.0	-27.2	14.2	-13.6
40.0 ±7.5%	-11.9	-26.8	14.9	-12.4
52.5 ±7.5%	-10.0	-24.7	14.7	-10.0
70.0 ±7.5%	-7.6	-22.5	14.9	-7.5
93.0 ±7.5%	-5.4	-20.5	15.1	-4.7
124.0 ±7.5%	-2.4	-17.7	15.3	-0.6
165.0 ±7.5%				
70.0 ±15%				
165.0 ±15%				

Name: W. Bishop Date: 1-22-65

TABLE II-3.1-5
PREEMPHASIS DATA FOR EXPANDED PROPORTIONAL BANDWIDTH BASEBAND, CHANNELS 1 THROUGH 21

System Description: PBW Channels 1 Through 21

$(S/N)_c$: 9 db AGC: -4.0 Vdc Multiplex: 750 mvrms

Channel Frequency (kc)	Signal (dbm)	Noise (dbm)	$(S/N)_s$ (dbm)	VCO Level (dbm)
0.40±7.5%	-25.7	-50.5	24.8	-28.8
0.56±7.5%	-25.1	-48.5	23.4	-28.8
0.73±7.5%	-24.7	-46.0	21.3	-28.5
0.96±7.5%	-24.7	-45.5	20.8	-28.8
1.30±7.5%	-24.3	-45.0	20.7	-28.5
1.70±7.5%	-24.9	-45.5	19.6	-28.8
2.30±7.5%	-24.3	-43.0	18.7	-28.6
3.00±7.5%	-25.1	-42.2	17.1	-28.8
3.90±7.5%	-25.2	-41.4	16.2	-28.8
5.40±7.5%	-25.4	-39.8	14.4	-29.2
7.35±7.5%	-25.5	-38.5	13.0	-29.1
10.5 ±7.5%	-24.9	-37.0	12.1	-28.7
14.5 ±7.5%	-24.5	-34.6	10.1	-28.2
22.0 ±7.5%	-21.4	-32.0	10.6	-25.0
30.0 ±7.5%	-19.2	-29.6	10.4	-22.8
40.0 ±7.5%	-16.6	-26.6	10.0	-20.2
52.5 ±7.5%	-14.4	-24.4	10.0	-17.7
70.0 ±7.5%	-11.6	-21.1	9.7	-14.7
93.0 ±7.5%	-8.5	-18.4	9.9	-11.2
124.0 ±7.5%	-5.1	-15.0	9.9	-6.8
165.0 ±7.5%	-2.0	-11.8	9.8	-2.6
70.0 ±15%				
165.0 ±15%				

Name: MDL/WSB Date: 1-26-65

TABLE II-3. 1-6
PREEMPHASIS DATA FOR EXPANDED PROPORTIONAL BANDWIDTH BASEBAND, CHANNELS 1 THROUGH 19 AND H

System Description: PBW Channels 1 Through 19 And H

$(S/N)_c$: 9db ACC: -4.0vdc Multiplex: 0.63Vrms

Channel Frequency (kc)	Signal (dbm)	Noise (dbm)	$(S/N)_s$ (dbm)	VCO Level (dbm)
0.40±7.5%	-26.5	-52.0	25.5	-30.6
0.56±7.5%	-25.0	-48.0	23.0	-29.5
0.73±7.5%	-25.6	-47.0	21.4	-30.4
0.96±7.5%	-24.8	-45.5	20.7	-30.0
1.30±7.5%	-24.4	-45.5	21.1	-29.8
1.70±7.5%	-25.6	-44.0	18.4	-30.6
2.30±7.5%	-24.2	-43.5	19.3	-29.5
3.00±7.5%	-26.0	-42.0	16.0	-30.6
3.90±7.5%	-25.2	-42.0	16.8	-29.8
5.40±7.5%	-25.4	-40.5	15.1	-30.3
7.35±7.5%	-25.2	-39.6	14.4	-30.0
10.5 ±7.5%	-25.2	-37.5	12.3	-30.2
14.5 ±7.5%	-25.0	-35.4	10.4	-29.7
22.0 ±7.5%	-24.7	-32.5	7.8	-29.6
30.0 ±7.5%	-22.2	-30.0	7.8	-27.6
40.0 ±7.5%	-19.6	-26.8	7.2	-24.7
52.5 ±7.5%	-16.5	-23.8	7.3	-21.1
70.0 ±7.5%	-13.0	-20.5	7.5	-17.6
93.0 ±7.5%	-10.1	-17.5	7.4	-14.2
124.0 ±7.5%				
165.0 ±7.5%				
70.0 ±15%				
165.0 ±15%	-0.2	-7.6	7.4	-2.4

Name: W. Bishop Date: 1-29-65

TABLE II-3.1-7

PREEMPHASIS DATA FOR 21-CHANNEL CONSTANT BANDWIDTH BASEBAND

System Description: Constant Bandwidth Multiplex

$(S/N)_c$: 9db AGC: -4.0 VDC Multiplex: 360 mvrms

Channel Frequency (kc)	Signal (dbm)	Noise (dbm)	$(S/N)_s$ (db)	VCO Level (dbm)
176.0	-18.0	-23.5	5.5	-15.0
168.0	-17.2	-22.8	5.6	-15.5
160.0	-16.5	-22.0	5.5	-15.9
152.0	-17.0	-22.6	5.6	-16.5
144.0	-16.9	-22.5	5.6	-17.4
136.0	-17.8	-23.0	5.2	-18.1
128.0	-16.8	-22.2	5.4	-19.0
120.0	-16.1	-21.7	5.6	-19.5
112.0	-17.2	-22.6	5.4	-20.3
104.0	-16.8	-22.0	5.2	-21.3
96.0	-16.0	-21.4	5.4	-22.1
88.0	-16.0	-21.5	5.5	-22.9
80.0	-16.0	-21.4	5.4	-23.5
72.0	-15.8	-21.5	5.7	-24.3
64.0	-15.8	-21.7	5.9	-25.1
56.0	-17.2	-22.8	5.6	-26.6
48.0	-17.7	-23.3	5.6	-27.6
40.0	-17.5	-23.3	5.8	-28.6
32.0	-18.1	-23.9	5.8	-30.5
24.0	-17.7	-24.6	6.9	-30.6
16.0	-18.3	-25.6	7.3	-31.6
7.35				
5.4				
3.9				
3.0				
2.3				
1.7				
1.3				
0.96				
0.73				
0.56				
0.40				

 Name: WJB Date: 3-12-65

TABLE II-3.1-8

PREEMPHASIS DATA FOR 16-CHANNEL CONSTANT BANDWIDTH BASEBAND

System Description: Channels 1 through 16 Constant Bandwidth

$(S/N)_c$: 9db AGC: -4.0Vdc Multiplex: 615 mvrms; Ref: 200 mvrms

Channel Frequency (kc)	Signal (dbm)	Noise (dbm)	$(S/N)_s$ (db)	VCO Level (dbm)
176.0				
168.0				
160.0				
152.0				
144.0				
* 136.0	-21.2	-32.5	11.3	
128.0				
120.0				
112.0				
104.0				
96.0				
* 88.0	-17.7	-30.0	12.3	
80.0				
72.0				
64.0				
56.0				
48.0				
* 40.0	-18.0	-30.0	12.0	
32.0				
24.0				
16.0				
7.35				
5.4				
3.9				
3.0				
2.3				
1.7				
1.3				
0.96				
0.73				
0.56				
0.40				

Name: WSB/MDL Date: 3-8-65

TABLE II-3.1-9
PREEMPHASIS DATA FOR COMBINATIONAL BANDWIDTH BASEBAND

System Description: Combinational Bandwidth Multiplex

$(S/N)_c$: 9db AGC: -4.0 vdc Multiplex: 635 mv rms

Channel Frequency (kc)	Signal (dbm)	Noise (dbm)	$(S/N)_s$ (db)	VCO Level (dbm)
176.0	-20.4	-29.1	8.7	-10.5
168.0	-19.2	-28.3	9.1	-11.0
160.0	-18.6	-27.5	8.9	-11.4
1:2.0	-19.0	-28.0	9.0	-11.9
144.0	-18.8	-27.8	9.0	-12.8
136.0	-19.7	-28.5	8.8	-13.6
128.0	-18.7	-27.5	8.8	-14.5
120.0	-18.0	-27.0	9.0	-14.8
112.0	-19.0	-27.9	8.9	-15.6
104.0	-18.4	-27.3	8.9	-16.5
96.0	-17.9	-26.6	8.7	-17.4
88.0	-17.9	-26.6	8.7	-18.2
80.0	-17.8	-26.4	8.6	-18.8
72.0	-17.6	-26.4	8.8	-19.6
64.0	-17.5	-26.5	9.0	-20.5
56.0	-18.9	-27.5	8.6	-22.0
48.0	-19.3	-27.8	8.5	-23.0
40.0	-19.2	-27.6	8.4	-24.0
32.0	-19.6	-27.8	8.2	-25.8
24.0	-19.0	-27.9	8.9	-26.0
16.0	-19.5	-28.1	8.6	-27.0
7.35	-9.1	-34.0	24.9	-16.6
5.4	-11.0	-36.0	25.0	-18.5
3.9	-13.2	-36.5	23.3	-20.5
3.0	-13.7	-37.2	23.5	-21.5
2.3	-14.2	-38.4	24.2	-22.5
1.7	-15.5	-39.8	24.3	-23.5
1.3	-16.2	-39.0	22.8	-25.0
0.96	-16.3	-41.0	24.7	-25.0
0.73	-16.8	-40.0	23.2	-25.0
0.56	-17.5	-43.0	25.5	-25.0
0.40	-18.5	-46.0	27.5	-25.0

Name: WSB Date: 3-12-65

3.2 RADIATED SPECTRUM TEST

3.2.1 General

The object of the radiated spectrum test is to determine the maximum transmitter drive that will not exceed the transmitter radiated spectrum specification:

> The power spectral density, as measured in a 1000-cps bandwidth, outside a bandwidth of ±320 kc shall not exceed −50.5 db referenced to the unmodulated carrier. Carrier components outside a ±500 kc bandwidth shall not exceed −25 dbm.

For test purposes, an allowance of 26 kc is made on each side of the spectrum for transmitter drift. Also, the ±500-kc-bandwidth specification was checked at 75 db below the unmodulated carrier which is the −25 dbm level for a 100-watt transmitter.

The general technique used in measuring the transmitter radiated power spectral density is to translate the transmitter output spectrum down to a frequency range around 1 Mc and then use a frequency selective voltmeter with a 1 kc bandwidth to measure the power spectral density. This translation technique provides a quantitative measure on an rms voltmeter of the power spectral density. Averaging by eye as required by spectrum analyzers is eliminated. The frequency selective voltmeter used in this test has a frequency range from 1.0 kc to 1.5 Mc. In order to measure the complete transmitter spectrum within this range, it is necessary to first place the local oscillator frequency 1 Mc below the carrier frequency. Measurements are then made from 1.2 Mc down to several hundred kilocycles. The local oscillator is next placed 1 Mc higher in frequency than the carrier. Having the local oscillator above the carrier inverts the output spectrum of the transmitter in the translation process. Thus, the other side of the spectrum can now be measured with the frequency selective voltmeter. This method gives an accurate, convenient, and quantitative measurement of the total transmitter power spectral density.

3.2.2 Detailed Procedure

a. The block diagram for this test is shown in Figure II-3.2-1.

b. Choose an attenuator for the local oscillator so that the local oscillator provides at least ten times as much current to the crystal diode as does the transmitter output.

c. Tune the local oscillator 1 Mc below the frequency of the transmitter.

d. With the transmitter unmodulated, tune the frequency selected voltmeter to the unmodulated carrier. This should be approximately 1 Mc. Note the level of the unmodulated carrier.

e. Modulate the transmitter with the full multiplex. The VCOs should be unmodulated and at center frequency.

f. With the frequency selective voltmeter set to the 1000-cycle bandwidth position, measure the radiated power spectral density by sweeping the frequency selective voltmeter from 1.2 Mc to 100 kc and noting the meter readings.

g. Tune the local oscillator to 1 Mc above the frequency of the carrier and repeat the previous readings.

h. The transmitter radiated power spectral density curve should be down 50.5 db from the peak of the modulated power spectral density curve.

i. If the radiated spectrum specification is exceeded, reduce the gain of the mixer amplifier and repeat the test.

3.2.3 Results

The radiated spectrum data given in Tables II-3.2-2 through II-3.2-8. Specific data may be found with the aid of the following chart:

Multiplex Description	Data Shown in Table	Data Plotted in Figure
IRIG Channels 1 through 18	II-3.2-2	I-3.3-3
IRIG Channels 1 through 16 and E	II-3.2-3	I-3.3-4
Expanded Channels 1 through 21	II-3.2-4	I-3.3-5
Expanded Channels 1 through 19 and H	II-3.2-5	I-3.3-6
Constant-Bandwidth Channels 1 through 21	II-3.2-6	I-3.3-7
Constant-Bandwidth Channels 1 through 16	II-3.2-7	I-3.3-8
Combination Bandwidth	II-3.2-8	I-3.3-9

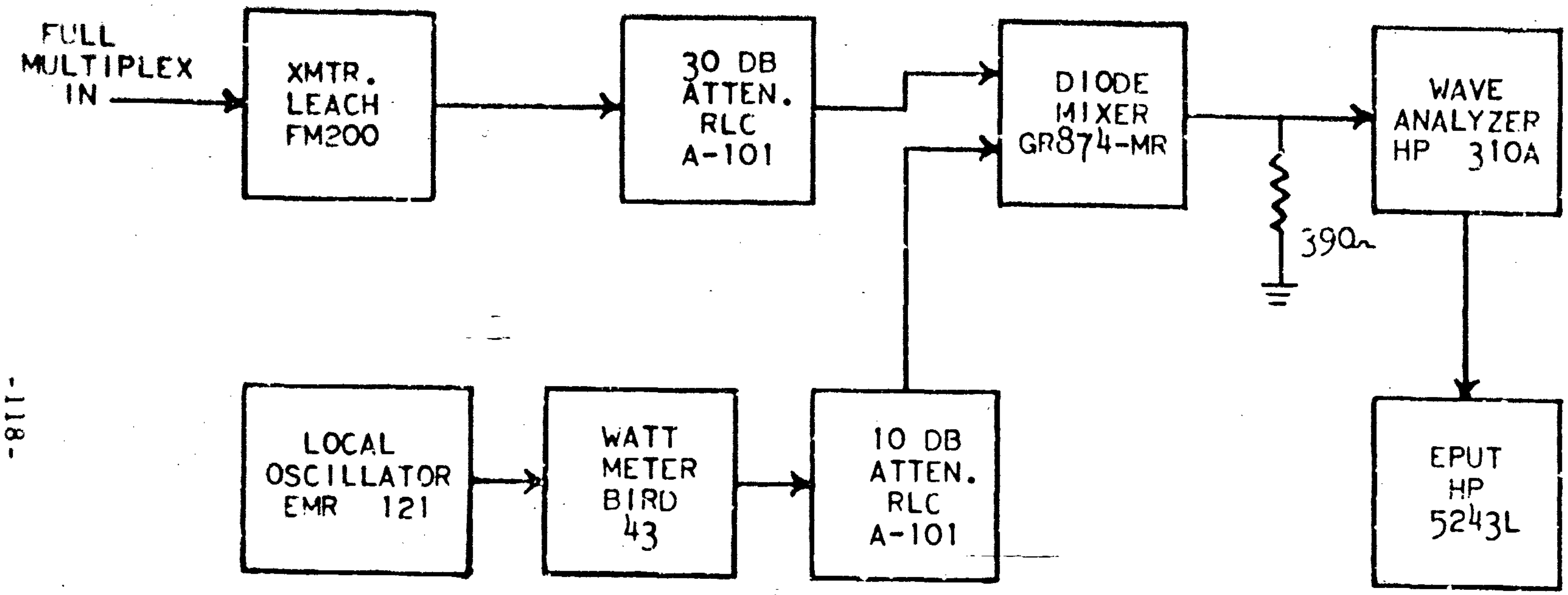


FIGURE II-3.2-1
TRANSMITTER RADIATED SPECTRUM
TEST BLOCK DIAGRAM

TABLE II-3.2-2
RADIATED SPECTRUM DATA:
IRIG CHANNELS 1 THROUGH 18

Baseband Structure: IRIG Channels 1 Through 18

Multiplex Level: 1.0 Vrms Unmodulated XMTR: 259.7 mc
-11.5 dbm

Local Oscillator 258.7 mc			Local Oscillator 260.7 mc		
Measured Frequency (kc)	Normalized Frequency (kc)	Level in 1.0 kc BW (dbm)	Measured Frequency (kc)	Normalized Frequency (kc)	Level in 1.0 kc BW (dbm)
1000	0	-35.5	1000	0	-35.5
950	-50	-36.5	950	+50	-36.2
900	-100	-39.5	900	+100	-39.0
850	-150	-43.5	850	+150	-44.0
800	-200	-49.5	800	+200	-50.5
750	-250	-56.0	750	+250	-59.0
700	-300	-64.5	700	+300	-68.0
650	-350	-74.0	650	+350	-78.0
600	-400	-84.0	600	+400	-93.0
550	-450	-94.0	550	+450	-101.0
500	-500	-100.0	500	+500	-102.0
450	-550	-101.0	450	+550	-102.0
400	-600	-102.0	400	+600	-102.0
350	-650	-101.0	350	+650	-102.0
300	-700	-101.0	300	+700	-102.0

Name: WJB Date: 11-23-64

TABLE II-3.2-3
RADIATED SPECTRUM DATA:
IRIG CHANNELS 1 THROUGH 16 AND E

Baseband Structure: IRIG Channels 1 Through 16 and E

Multiplex Level: 1.0 Vrms   Unmodulated XMTR: 259.7 mc
-18.5 dbm

Local Oscillator 258.7 mc			Local Oscillator 260.7 mc		
Measured Frequency (kc)	Normalized Frequency (kc)	Level in 1.0 kc BW (dbm)	Measured Frequency (kc)	Normalized Frequency (kc)	Level in 1.0 kc BW (dbm)
1000	0	-42.0	1000	0	-42.0
950	-50	-43.0	950	+50	-43.0
900	-100	-45.5	900	+100	-45.5
850	-150	-51.0	850	+150	-51.0
800	-200	-57.5	800	+200	-58.5
750	-250	-65.5	750	+250	-67.5
700	-300	-75.0	700	+300	-78.0
650	-350	-85.0	650	+350	-89.5
600	-400	-96.0	600	+400	-101.0

Name: MDL   Date: 1-12-65

TABLE II-3.2-4
RADIATED SPECTRUM DATA:
EXPANDED CHANNELS 1 THROUGH 21

Baseband Structure: Expanded Channels 1 Through 21

Multiplex Level: 750 mVrms Unmodulated XMTR: 259.7 mc
-15.2 dbm

Local Oscillator 258.7 mc			Local Oscillator 258.7 mc		
Measured Frequency (kc)	Normalized Frequency (kc)	Level in 1.0 kc BW (dbm)	Measured Frequency (kc)	Normalized Frequency (kc)	Level in 1.0 kc BW (dbm)
1000	0	-30.0	1000	0	-30.0
975	-25	-45.0	1025	+25	-45.0
950	-50	-47.5	1050	+50	-47.5
925	-75	-49.5	1075	+75	-49.5
907	-93	-48.0	1093	+93	-48.0
900	-100	-50.0	1100	+100	-50.0
875	-125	-47.0	1125	+125	-47.0
850	-150	-52.5	1150	+150	-52.5
835	-165	-45.5	1165	+165	-46.0
825	-175	-50.0	1175	+175	-50.0
800	-200	-60.5	1200	+200	-61.5
775	-225	-62.5	1225	+225	-63.5
750	-250	-63.5	1250	+250	-64.5
725	-275	-67.0	1275	+275	-67.5
711	-289	-62.0	1289	+289	-63.5
700	-300	-66.5	1300	+300	-68.5
675	-325	-67.2	1325	+325	-69.5
670	-330	-66.5	1330	+330	-68.5
650	-350	-76.0	1350	+350	-78.5
625	-375	-78.8	1375	+375	-82.0
600	-400	-82.0	1400	+400	-85.5
550	-450	-82.5	1450	+450	-86.5
500	-500	-90.5	1500	+500	-95.0
450	-550	-99.0	1550	+550	-104.0
400	-600	-104.0	1600	+600	-104.0

Name: WSB/MDL Date: 1-26-65

TABLE II-3.2-5
RADIATED SPECTRUM DATA:
EXPANDED CHANNELS 1 THROUGH 19 AND H

Baseband Structure: Expanded Channels 1 Through 19 and H

Multiplex Level: 630 mVrms Unmodulated XMTR: 259.7 mc
-12.8 dbm

Local Oscillator 260.7 mc			Local Oscillator 260.7 mc		
Measured Frequency (kc)	Normalized Frequency (kc)	Level in 1.0 kc BW (dbm)	Measured Frequency (kc)	Normalized Frequency (kc)	Level in 1.0 kc BW (dbm)
1000	0	-26.5	1000	0	-26.5
1025	-25	-45.5	975	+25	-45.5
1050	-50	-48.5	950	+50	-48.5
1075	-75	-49.2	925	+75	-49.0
1093	-93	-47.5	907	+93	-47.5
1100	-100	-50.5	900	+100	-49.5
1125	-125	-62.0	875	+125	-62.2
1150	-150	-52.5	850	+150	-53.0
1165	-165	-42.0	835	+165	-42.0
1175	-175	-48.0	825	+175	-47.0
1200	-200	-64.0	800	+200	-63.0
1225	-225	-65.5	775	+225	-64.5
1235	-235	-64.0	765	+235	-63.0
1250	-250	-66.0	750	+250	-66.0
1258	-258	-63.5	742	+258	-62.5
1275	-275	-76.0	725	+275	-73.0
1300	-300	-82.0	700	+300	-81.0
1325	-325	-65.0	675	+325	-64.5
1330	-330	-64.5	670	+330	-63.4
1350	-350	-82.0	650	+350	-77.0
1375	-375	-87.0	625	+375	-84.5
1400	-400	-87.0	600	+400	-83.5
1425	-425	-87.2	575	+425	-83.0
1450	-450	-97.0	550	+450	-98.0
1475	-475	-99.0	525	+475	-100.0
1500	-500	-92.5	500	+500	-88.3
1525	-525	-99.2	475	+525	-103.0

Name: WSB Date: 1-29-65

TABLE II-3.2-6
RADIATED SPECTRUM DATA:
CONSTANT BANDWIDTH MULTIPLEX
CHANNELS 1 THROUGH 21

Baseband Structure: Channel 1-21, CBW

Multiplex Level: 360 mv rms **Unmodulated XMTR:** 2597 mc
-14.8 dbm

Local Oscillator 258.2 mc			Local Oscillator 258.2 mc		
Measured Frequency (kc)	Normalized Frequency (kc)	Level in 1.0 kc BW (dbm)	Measured Frequency (kc)	Normalized Frequency (kc)	Level in 1.0 kc BW (dbm)
1500	0	-15.1	1252	- 248	-65.0
1492	- 8	-66.0	1244	- 256	-65.5
1484	- 16	-38.2	1236	- 264	-66.0
1476	- 24	-40.5	1228	- 272	-66.5
1468	- 32	-43.0	1220	- 280	-66.5
1460	- 40	-43.0	1212	- 288	-66.5
1452	- 48	-43.5	1204	- 296	-67.5
1444	- 56	-44.0	1196	- 304	-68.0
1436	- 64	-43.8	1188	- 312	-68.0
1428	- 72	-44.0	1180	- 320	-69.0
1420	- 80	-44.2	1172	- 328	-67.0
1412	- 88	-44.5	1164	- 336	-71.5
1404	- 96	-44.4	1156	- 344	-72.0
1396	-104	-44.5	1148	- 352	-78.0
1388	-112	-44.2	1140	- 360	-84.5
1380	-120	-44.2	1132	- 368	-85.0
1372	-128	-44.3	1124	- 376	-85.0
1364	-136	-44.2	1116	- 384	-86.0
1356	-144	-44.0	1108	- 392	-86.5
1348	-152	-43.8	1100	- 400	-86.5
1340	-160	-43.8	1092	- 408	-87.5
1332	-168	-44.0	1084	- 416	-87.5
1324	-176	-44.0	1076	- 424	-87.5
1316	-184	-61.0	1068	- 432	-88.0
1308	-192	-61.0	1060	- 440	-88.5
1300	-200	-63.0	1052	- 448	-88.5
1292	-208	-63.0	1044	- 456	-88.5
1284	-216	-64.0	1036	- 464	-89.0
1276	-224	-64.5	1028	- 472	-89.5
1268	-232	-64.5	1020	- 480	-90.2
1260	-240	-64.0	1012	- 488	-90.2

Sheet 1 of 2

Name: WSB/MDL Date: 3-12-65

TABLE II-3.2-6 (CONT'D.)
RADIATED SPECTRUM DATA:
CONSTANT BANDWIDTH MULTIPLEX
CHANNELS 1 THROUGH 21

Baseband Structure: Channel 1-21, CBW

Multiplex Level: 360 mvrms Unmodulated XMTR: 259.7 mc
-14.8 dbm

Local Oscillator 258.2 mc			Local Oscillator 261.2 mc		
Measured Frequency (kc)	Normalized Frequency (kc)	Level in 1.0 kc BW (dbm)	Measured Frequency (kc)	Normalized Frequency (kc)	Level in 1.0 kc BW (dbm)
1004	-496	-90.5	1220	280	-67.6
996	-504	-92.0	1212	288	-68.1
988	-512	-92.0	1204	296	-68.4
980	-520	-92.0	1196	304	-69.1
			1188	312	-69.6
			1180	320	-70.6
			1020	480	-97.6
			1012	488	-98.6
			1004	496	-99.6
			996	504	-102.0
			988	512	-102.0
			980	520	-102.0

Sheet 2 of 2

Name: WSB/MDL Date: 3-12-65

TABLE II-3.2-7
RADIATED SPECTRUM DATA:
CONSTANT BANDWIDTH MULTIPLEX
CHANNELS 1 THROUGH 16

Baseband Structure: Channel 1-16, CBW

Multiplex Level: 615 mVrms Unmodulated XMTR: 2597 mc
-14.2 dbm

Local Oscillator 2587 mc			Local Oscillator 2587 mc		
Measured Frequency (kc)	Normalized Frequency (kc)	Level in 1.0 kc BW (dbm)	Measured Frequency (kc)	Normalized Frequency (kc)	Level in 1.0 kc BW (dbm)
1000	0	-15.8	1248	248	-55.0
1008	8	-41.0	1256	256	-57.0
1016	16	-30.5	1264	264	-58.0
1024	24	-32.5	1272	272	-62.0
1032	32	-33.5	1280	280	-64.0
1040	40	-34.5	1288	288	-65.5
1048	48	-34.5	1296	296	-66.0
1056	56	-35.0	1304	304	-67.0
1064	64	-35.5	1312	312	-68.0
1072	72	-36.0	1320	320	-68.5
1080	80	-35.5	1328	328	-69.5
1088	88	-36.0	1336	336	-70.0
1096	96	-36.0	1344	344	-71.5
1104	104	-36.0	1352	352	-72.5
1112	112	-36.5	1360	360	-74.0
1120	120	-36.5	1368	368	-75.0
1128	128	-37.0	1376	376	-77.0
1136	136	-37.0	1384	384	-78.0
1144	144	-46.5	1392	392	-81.0
1152	152	-46.5	1400	400	-83.0
1160	160	-47.5	1408	408	-84.5
1168	168	-48.5	1416	416	-86.0
1176	176	-49.0	1424	424	-87.0
1184	184	-49.5	1432	432	-88.0
1192	192	-50.0	1440	440	-89.0
1200	200	-50.5	1448	448	-90.0
1208	208	-51.5	1456	456	-92.0
1216	216	-52.0	1464	464	-93.0
1224	224	-53.0	1472	472	-94.0
1232	232	-53.5	1480	480	-95.0
1240	240	-54.5	1488	488	-97.0

Name: WSB/MDK Date: 3-9-65

TABLE II-3.2-7 (CONT'D.)
RADIATED SPECTRUM DATA:
CONSTANT BANDWIDTH MULTIPLEX
CHANNELS 1 THROUGH 16

Baseband Structure: Channel 1-16, CBW

Multiplex Level: 615 mVrms Unmodulated XMTR: 259.7 mc
-14.2 dbm

Local Oscillator 258.7 mc			Local Oscillator ____ mc		
Measured Frequency (kc)	Normalized Frequency (kc)	Level in 1.0 kc BW (dbm)	Measured Frequency (kc)	Normalized Frequency (kc)	Level in 1.0 kc BW (dbm)
1496	496	-98.5			
1504	504	-99.5			
1528	528	-97.0			
1536	536	-96.0			
1544	544	-96.0			
1552	552	-94.0			

Name: WSB/MDL Date: 3-9-65

TABLE II-3.2-8
RADIATED SPECTRUM DATA:
COMBINATIONAL BANDWIDTH MULTIPLEX

Baseband Structure: Channel 1-21 CBW + 1-11 PBW

Multiplex Level: 635 mv rms Unmodulated XMTR: 259.7 mc
-15.0 dbm

Local Oscillator 258.2 mc			Local Oscillator 258.2 mc		
Measured Frequency (kc)	Normalized Frequency (kc)	Level in 1.0 kc BW (dbm)	Measured Frequency (kc)	Normalized Frequency (kc)	Level in 1.0 kc BW (dbm)
1500	0	-32.5	1252	-248	-65.2
1492	-8	-33.0	1244	-256	-65.5
1484	-16	-34.0	1236	-264	-66.0
1476	-24	-36.5	1228	-272	-66.5
1468	-32	-40.0	1220	-280	-66.8
1460	-40	-42.5	1212	-288	-67.0
1452	-48	-46.5	1204	-296	-67.5
1444	-56	-48.5	1196	-304	-68.0
1436	-64	-49.5	1188	-312	-68.5
1428	-72	-49.8	1180	-320	-69.5
1420	-80	-49.8	1172	-328	-70.0
1412	-88	-49.8	1164	-336	-70.8
1404	-96	-49.8	1156	-344	-72.5
1396	-104	-49.8	1148	-352	-73.5
1388	-112	-49.8	1140	-360	-75.5
1380	-120	-49.8	1132	-368	-77.5
1372	-128	-49.8	1124	-376	-79.5
1364	-136	-49.8	1116	-384	-81.0
1356	-144	-49.8	1108	-392	-82.5
1348	-152	-49.8	1100	-400	-83.5
1340	-160	-50.0	1092	-408	-83.5
1332	-168	-50.5	1084	-416	-84.0
1324	-176	-51.5	1076	-424	-84.5
1316	-184	-53.0	1068	-432	-85.5
1308	-192	-55.0	1060	-440	-86.0
1300	-200	-57.0	1052	-448	-86.5
1292	-208	-60.0	1044	-456	-87.0
1284	-216	-62.0	1036	-464	-87.5
1276	-224	-63.5	1028	-472	-88.0
1268	-232	-64.5	1020	-480	-89.0
1260	-240	-64.8	1012	-488	-90.0

Sheet 1 of 2

Name: WSB/MDL Date: 3-12-65

TABLE II-3.2-8 (CONT'D.)
RADIATED SPECTRUM DATA:
COMBINATIONAL BANDWIDTH MULTIPLEX

Baseband Structure: Channel 1-21 CBW & 1-11 PBW

Multiplex Level: 635 mrms Unmodulated XMTR: 2597 mc
-15.0 dbm

Local Oscillator 2582 mc			Local Oscillator 261.2 mc		
Measured Frequency (kc)	Normalized Frequency (kc)	Level in 1.0 kc BW (dbm)	Measured Frequency (kc)	Normalized Frequency (kc)	Level in 1.0 kc BW (dbm)
1004	-496	-91.0	1220	280	-67.5
996	-504	-920	1212	288	-68.0
988	-512	-930	1204	296	-68.5
980	-520	-940	1196	304	-69.5
			1188	312	-70.0
			1180	320	-70.5
			1020	480	-92.5
			1012	488	-93.0
			1004	496	-95.0
			996	504	-96.0
			988	512	-97.0
			980	520	-98.5

Sheet 2 of 2

Name: WSB/MDL Date: 3-12-65

3.3 SYSTEM INTERMODULATION TEST

3.3.1 General

The system intermodulation test consists of removing the modulation for one particular channel, called the search channel, and substituting a voltage ramp to sweep the channel slowly from low bandedge (LBE) to high bandedge (HBE). With the remaining channels in the multiplex modulated by sine-wave oscillators, the intermodulation on the search channel output is viewed on an oscilloscope and photographed. In the technique used, the oscilloscope horizontal sweep waveform deviated the search channel from LBE to HBE in 40 seconds. The block diagram for the test is shown in Figure II-3.3-1.

3.3.2 Detailed Procedure

a. With the pre-emphasis schedule and transmitter deviation selected from previous tests, provide the receiver with an rf signal so that the IF S/N ratio is greater than 20 db.

b. Calibrate all VCOs.

c. Deviate all VCOs FBW at 5 cps or 0.1 f_m, whichever is larger, where f_m is the maximum data response of the channel for the particular deviation ratio.

d. Set the discriminator output level for ±10 volts for bandedge deviation.

e. Set the oscilloscope sweep speed to 5 sec/cm and adjust the amplitude of search channel input to deviate the channel to full bandwidth (FBW). This should be verified by viewing the dc-coupled sweep on a vertical scale of 5 v/cm.

f. The ac-coupled trace can now be used to view intermodulation noise on the 0.1v/cm vertical scale. Using the single trace provision, photograph the trace with a lens setting of f:10.

3.3.3 Results

Typical data are shown in Figure II-3.3-2. In Figure II-3.3.2a, trace no. 1 is the discriminator output dc coupled and showing the horizontal calibration. Trace no. 2 is the amplified and ac-coupled discriminator output signal. This particular test has been arranged to demonstrate a beat note by holding the VCOs causing the beat at center frequency. Figure II-3.3-2b is the same channel with the same VCOs modulated. To prevent overexposure, the direct-coupled-discriminator output is not shown on the data photographs. The photograph in Figure II-3.3-2a was taken using an alternate-sweep mode. In all cases, the calibration was checked prior to taking a photograph.

3.3.3.1 IRIG Baseband

The detailed conditions for the test were:

Test channels: IRIG channels 1 through 18

Multiplex level: 1.0 volt rms

IF S/N ratio: 39 db

Deviation ratio: 5, 2, and 1

LPOF: Nominal f_c for DR, constant amplitude 18 db/octave type

Figures II-3.3-3 through II-3.3-20 show the results of the 18-channel system test. The data has been summarized in Figure I-3.4-2.

3.3.3.2 Wideband IRIG Baseband

The detailed conditions for the test were:

Test channels: IRIG channels 1 through 16 plus channel E

Multiplex level: 1.0 volt rms

IF S/N Ratio: 39 db

Deviation ratio: 5

LPOF: Nominal f_c for DR = 5, constant amplitude 18 db/octave type

Figures II-3.3-21 through II-3.3-26 show the results of the wideband IRIG system operated at a deviation ratio of 5. The data is summarized in Table I-3.4-3.

3.3.3.3 Expanded Baseband

The detailed conditions for this test were:

Test channels: 1 through 21

Multiplex level: 750 mv rms

IF S/N ratio: 39 db

Deviation ratio: 5

LPOF: Nominal f_c for DR = 5, constant amplitude 18 db/octave type

Figures II-3.3-27 through II-3.3-33 show the results of the 21-channel system. The data is summarized in Table I-3.4-3.

3.3.3.4 Wideband Expanded Baseband

The detailed conditions for this test were:

Test channels: 1 through 19 plus channel H

Multiplex level: 630 mv rms

IF S/N ratio: 39 db

Deviation ratio: 5

LPOF: Nominal f_c for DR = 5, constant amplitude 18 db/octave type

Figures II-3.3-34 through II-3.3-40 show the results of the wideband expanded baseband system. The data has been summarized in Table I-3.4-3.

3.3.3.5 Constant-Bandwidth Baseband

The detailed conditions for this test were:

Test channels: 1 through 21

Multiplex level: 360 mv rms

IF S/N ratio: 39 db

Deviation ratio: 2

LPOF: Nominal f_c for DR = 2, constant amplitude 42 db/octave type

Figures II-3.3-41 through II-3.3-47 show the results of the constant-bandwidth baseband intermodulation for a deviation ratio = 2. This data is summarized in Table I-3.4-4.

Figures II-3. 3-48 through II-3. 3-55 show the results of intermodulation data for constant-bandwidth channels 6, 10, 14, and 19 for deviation ratios of 1, 2, and 4 for these conditions of modulation on all other channels: modulation index equal to deviation ratio of search channel and with all channels at center frequency unmodulated. This data is summarized in Table I-3. 4-5.

Figure II-3. 3-56 shows a comparison of deviation ratios of 4, 2, and 1 on constant-bandwidth channel 6. Figure II-3. 3-57 shows the effect of changing the subcarrier discriminator output filter from a 7 pole (42 db/octave) to a 3 pole (18 db/-octave) type on constant-bandwidth channels 3, 6, and 19. Figure II-3. 3-58 shows the effect of bypassing the rf link in the constant-bandwidth system for channel 6 operated at a deviation ratio of 2. Figure II-3. 3-59 shows the effect of replacing the Nems-Clarke Model 1455A with a Defense Electronics Model TMR-2A Receiver in the normal constant-bandwidth system. The above data is summarized in Table I-3. 4-7.

The constant-bandwidth-system intermodulation was investigated using an EMR Model 246A in place of the Leach Model FM 200 Transmitter. Data for various system modifications was taken and is shown in Figures II-3. 3-60 and II-3. 3-61. This data is discussed in Section 3. 4 of Volume I and is summarized in Table I-3. 4-8.

3. 3. 3. 6 Combinational-Bandwidth Baseband

The detailed conditions for this test were:

Test channels: IRIG channels 1 through 11; CBW channels 1 through 21

Multiplex level: 635 mv rms; IRIG channels, 210 mv rms; CBW channels, 600 mv rms

IF S/N ratio: 39 db

Deviation ratio: IRIG channels, DR = 5; CBW channels, DR = 2

LPOF: Nominal f_c for DR used, constant amplitude: 42 db/octave for CBW channels, 18 db/octave for IRIG channels

Figures II-3. 3-62 through II-3. 3-72 show the results of the combinational-bandwidth baseband intermodulation. Figure II-3. 3-73 shows the inclusion of IRIG channel 12 into the baseband. This data is summarized in Table I-3. 4-6.

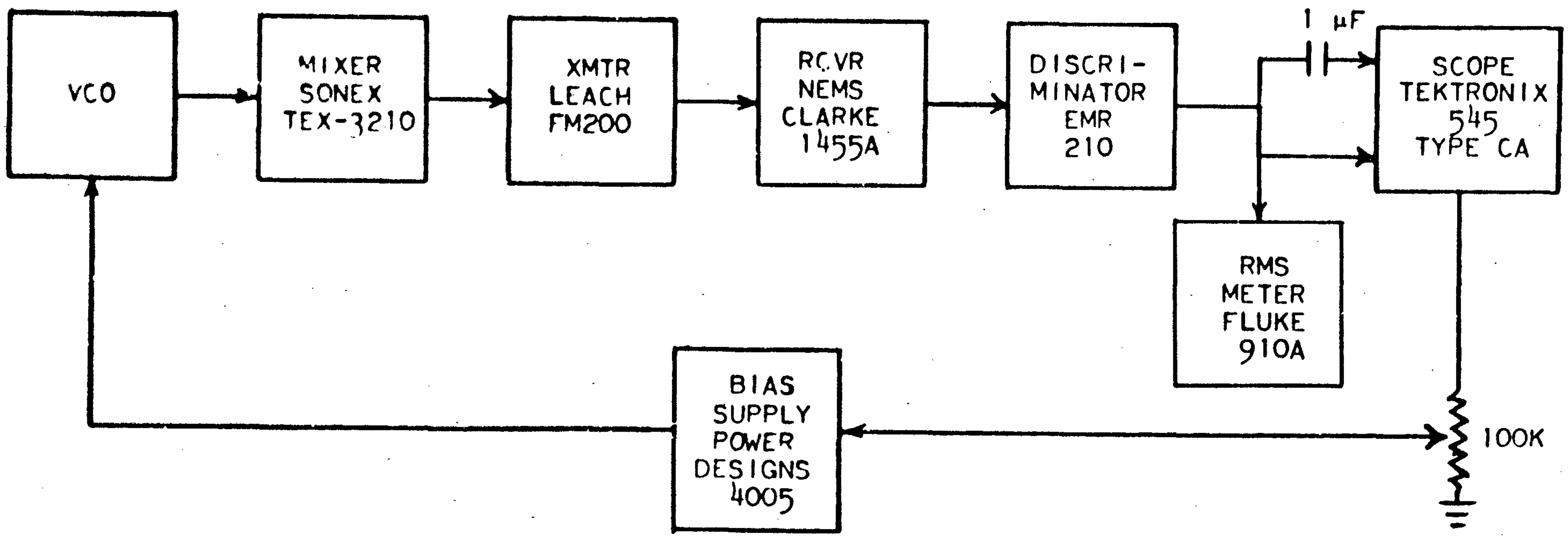
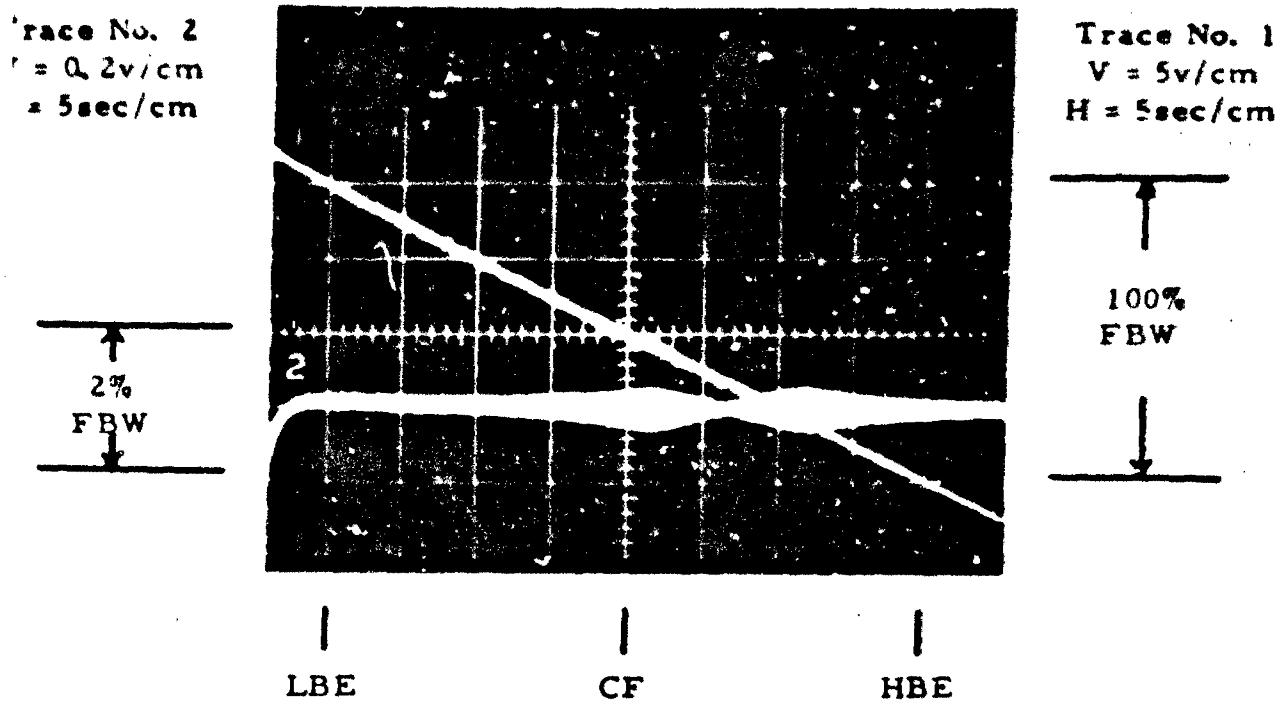
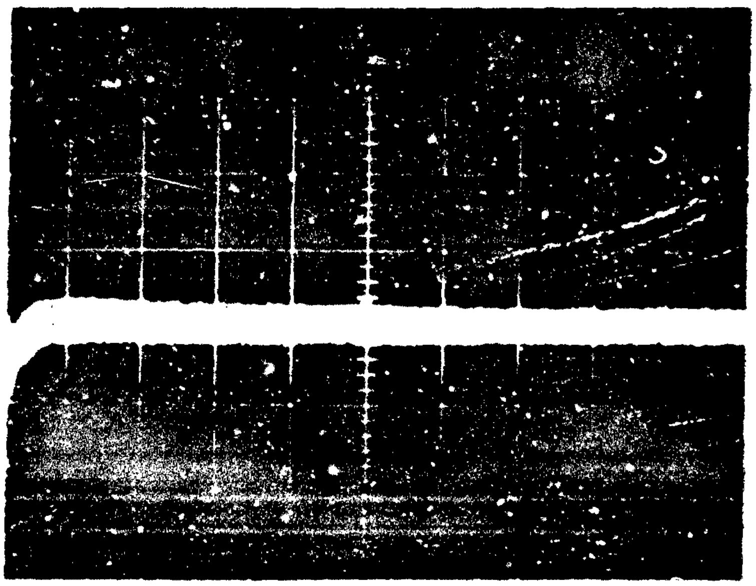


FIGURE II-3.3-1
INTERMODULATION TEST BLOCK DIAGRAM

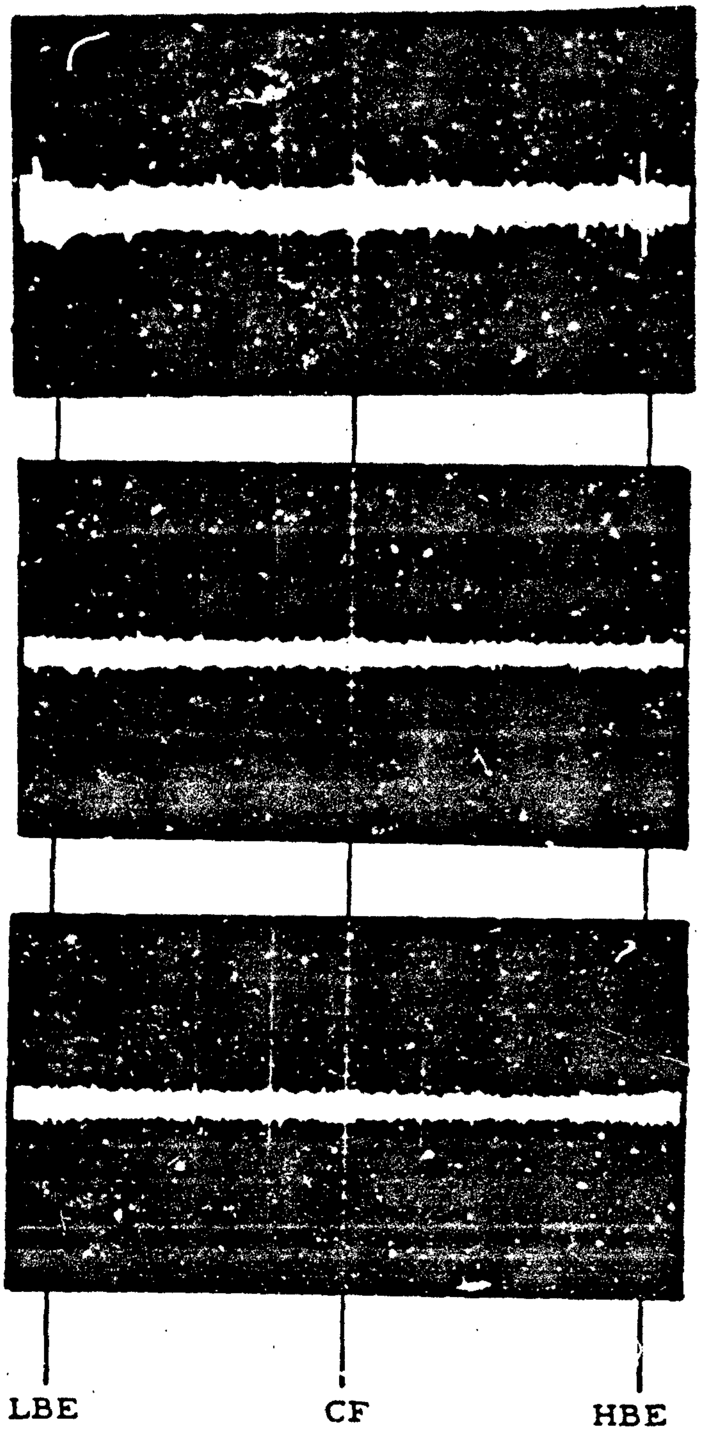


a. Search Channel: 22 kc. 52.5 kc and 30.0 kc at center frequency, all other channels off. RMS level - 35 mv max.



b. Search Channel: 22 kc. 52.5 kc and 30.0 kc modulated FBW at 0.1 f_m. All other channels off. RMS level = 12 mv max.

FIGURE II-3.3-2
MODULATION TEST: CALIBRATION AND EXPLANATION OF TECHNIQUE

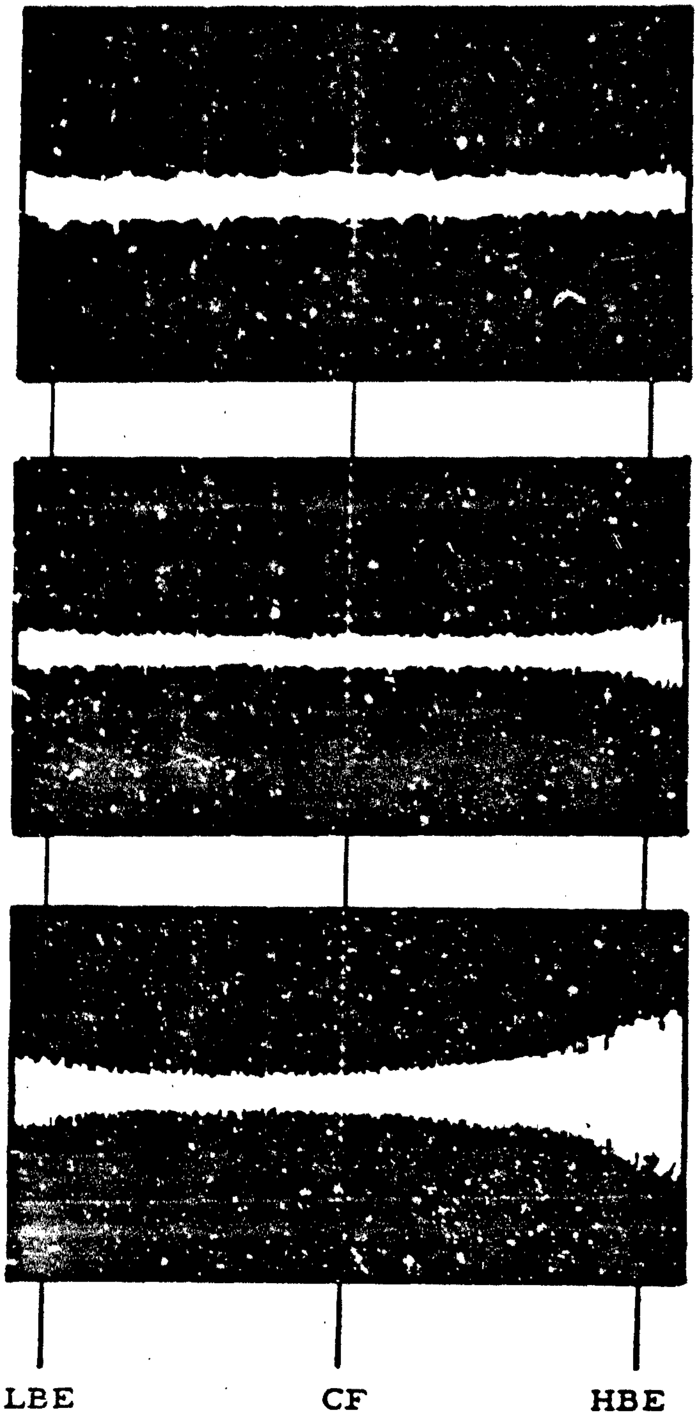


a. DR = 5
Vertical: 0.5% FBW/cm
RMS Level = 14 mv max

b. DR = 2
Vertical: 2.5% FBW/cm
RMS Level = 46 mv max

c. DR = 1
Vertical: 5.0% FBW/cm
RMS Level = 90 mv max

FIGURE II-3.3-3
INTERMODULATION TEST: IRIG MULTIPLEX;
SEARCH CHANNEL DR = 5, 2, AND 1; CHANNEL 1

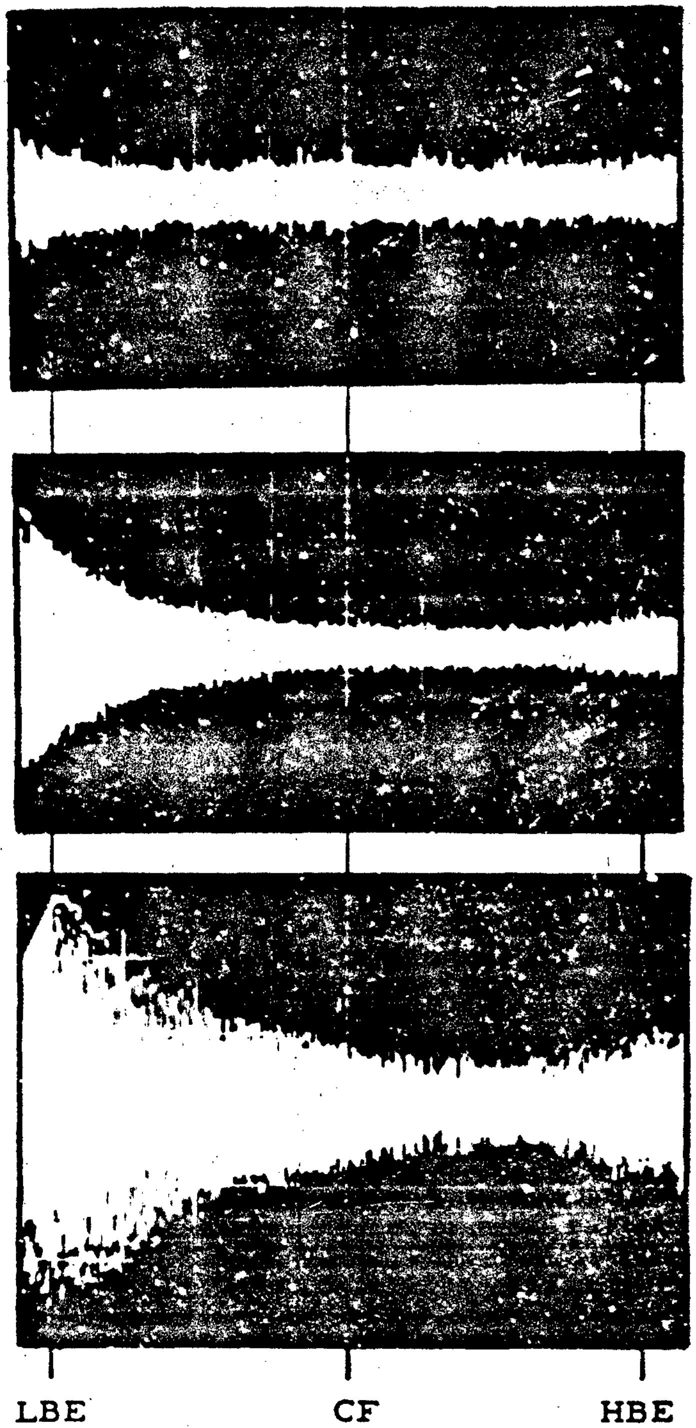


a. DR = 5
Vertical: 0.5% FBW/cm
RMS Level = 11 mv max

b. DR = 2
Vertical: 2.5% FBW/cm
RMS Level = 50 mv max

c. DR = 1
Vertical: 5.0% FBW/cm
RMS Level = 300 mv max

FIGURE II-3.3-4
INTERMODULATION TEST: IRIG MULTIPLEX;
SEARCH CHANNEL DR = 5, 2, AND 1; CHANNEL 2

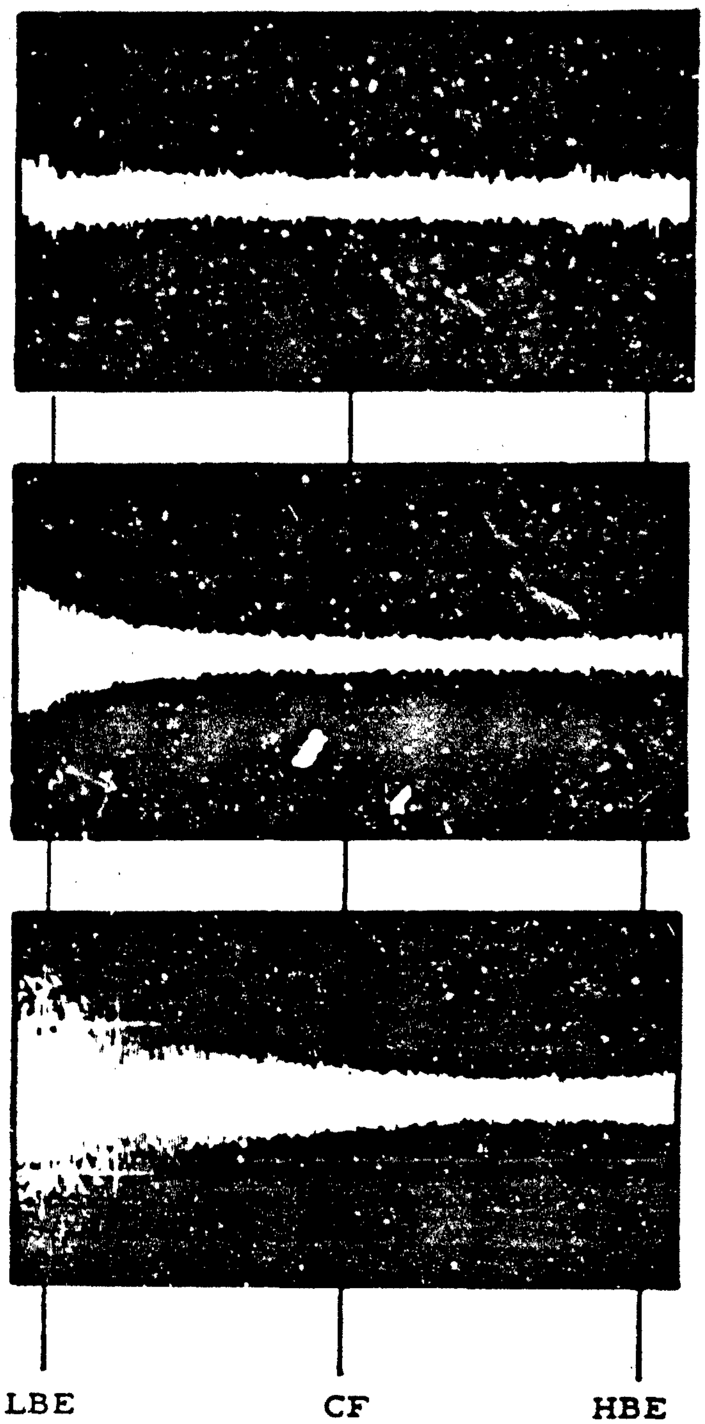


a. **DR = 5**
Vertical: 0.5% FBW/cm
RMS Level = 20 mv max

b. **DR = 2**
Vertical: 2.5% FBW/cm
RMS Level = 280 mv max

c. **DR = 1**
Vertical: 5.0% FBW/cm
RMS Level = 1050 mv max

FIGURE II-3.3-5
INTERMODULATION TEST: IRIG MULTIPLEX;
SEARCH CHANNEL DR = 5 2, AND 1; CHANNEL 3



a. DR = 5
Vertical: 0.5% FBW/cm
RMS Level = 15 mv max

b. DR = 2
Vertical: 2.5% FBW/cm
RMS Level = 130 mv max

c. DR = 1
Vertical: 5.0% FBW/cm
RMS Level = 630 mv max

FIGURE II-3.3-6
INTERMODULATION TEST: IRIG MULTIPLEX;
SEARCH CHANNEL DR = 5, 2, AND 1; CHANNEL 4

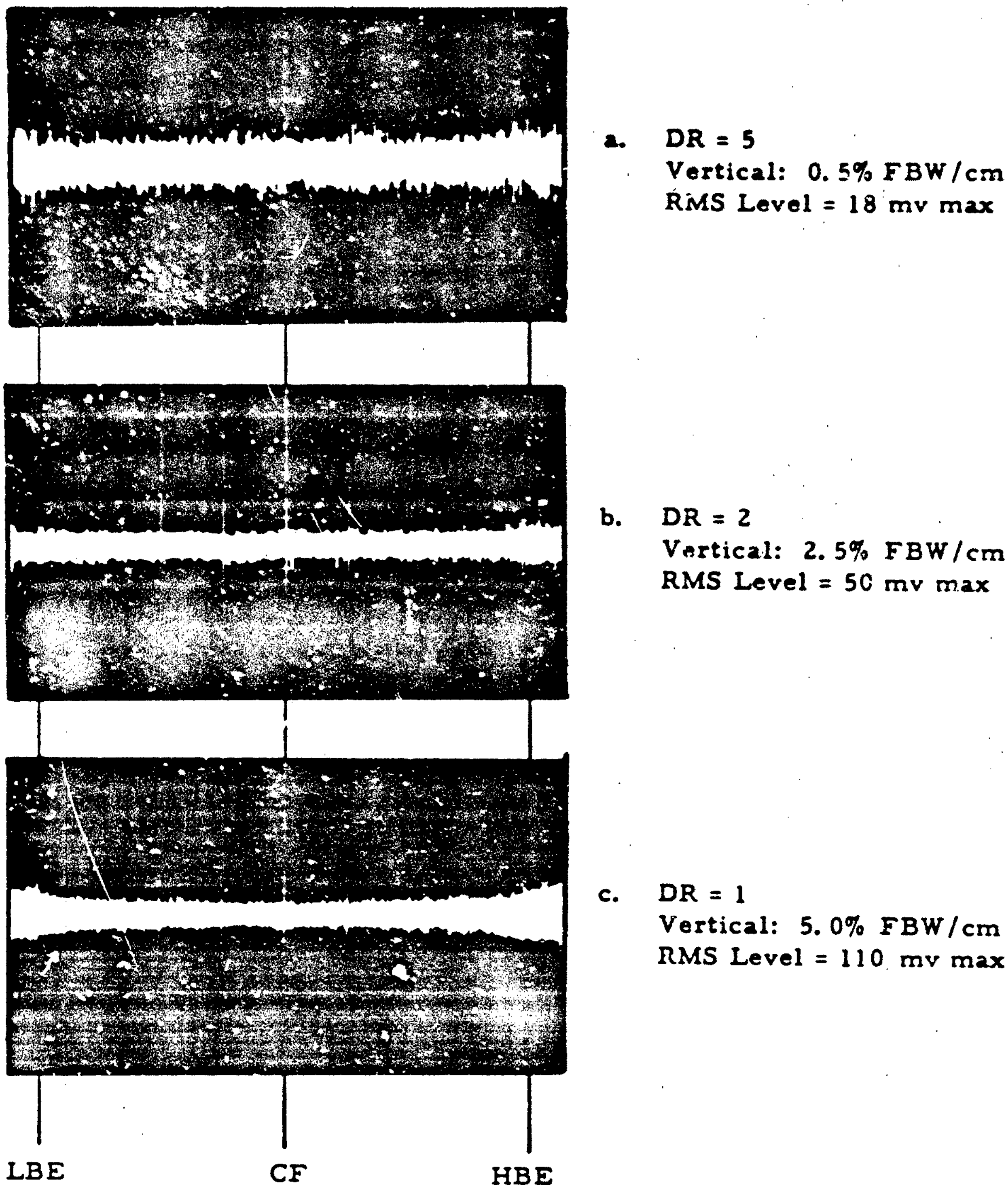
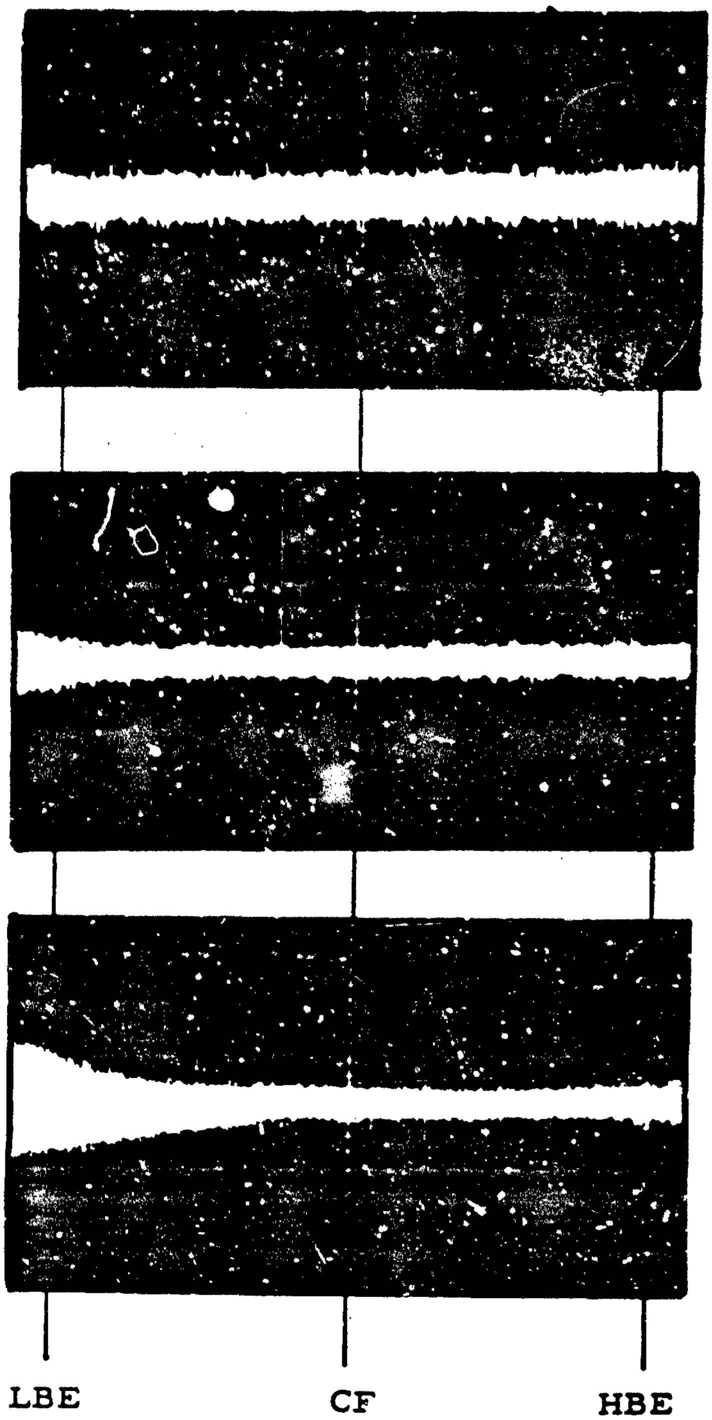


FIGURE II-3.3-7
INTERMODULATION TEST: IRIG MULTIPLEX;
SEARCH CHANNEL DR = 5, 2, AND 1; CHANNEL 5

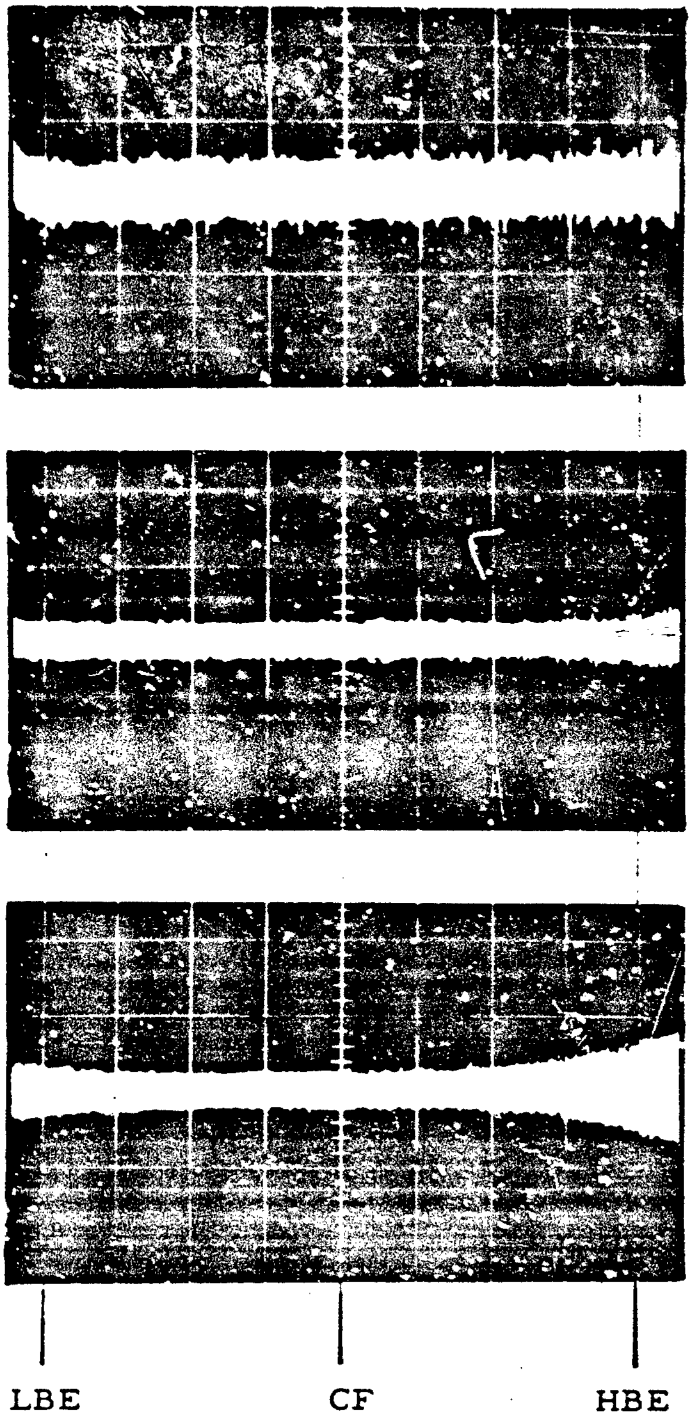


a. DR = 5
Vertical: 0.5% FBW/cm
RMS Level = 15 mv max

b. DR = 2
Vertical: 2.5% FBW/cm
RMS Level = 55 mv max

c. DR = 1
Vertical: 5.0% FBW/cm
RMS Level = 240 mv max

FIGURE II-3.3-8
INTERMODULATION TEST: IRIG MULTIPLEX;
SEARCH CHANNEL DR = 5, 2, AND 1; CHANNEL 6

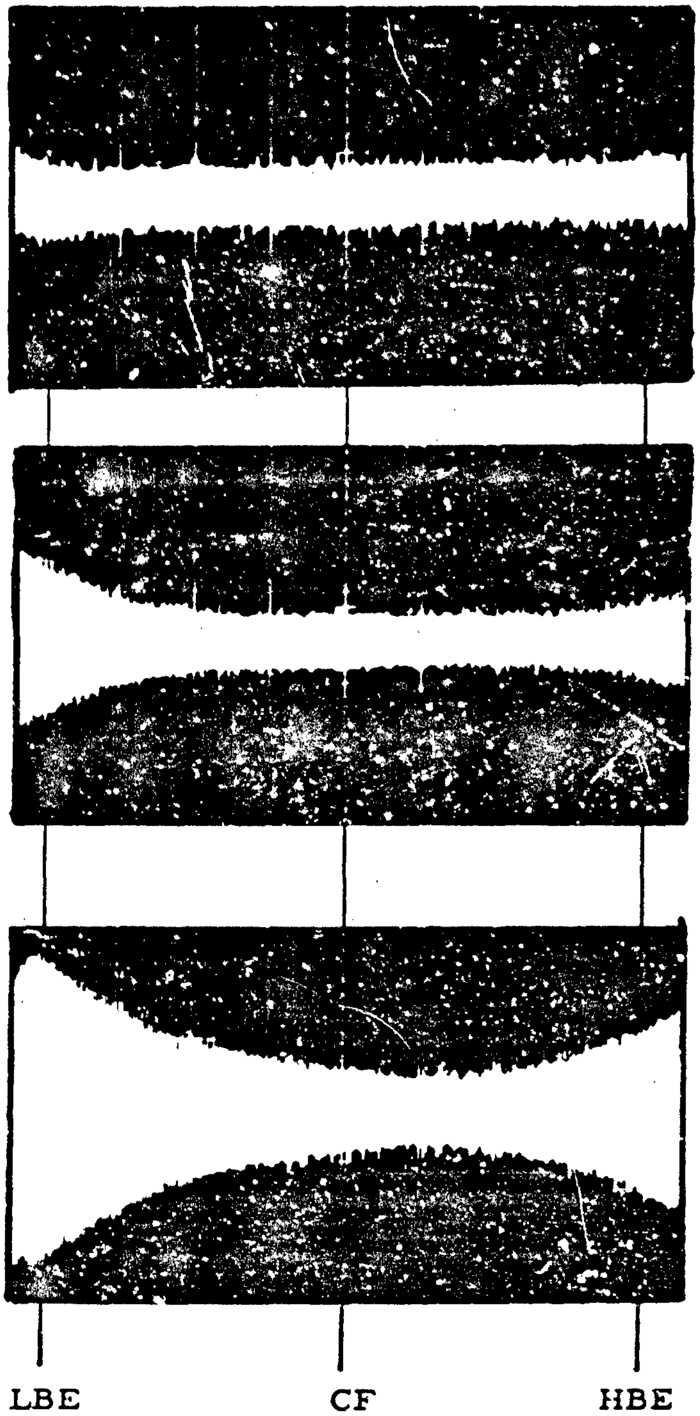


a. DR = 5
Vertical: 0.5% FBW/cm
RMS Level = 16 mv max

b. DR = 2
Vertical: 2.5% FBW/cm
RMS Level = 45 mv max

c. DR = 1
Vertical: 5.0% FBW/cm
RMS Level = 140 mv max

FIGURE II-3.3-9
INTERMODULATION TEST: IRIG MULTIPLEX;
SEARCH CHANNEL DR = 5, 2, AND 1; CHANNEL 7

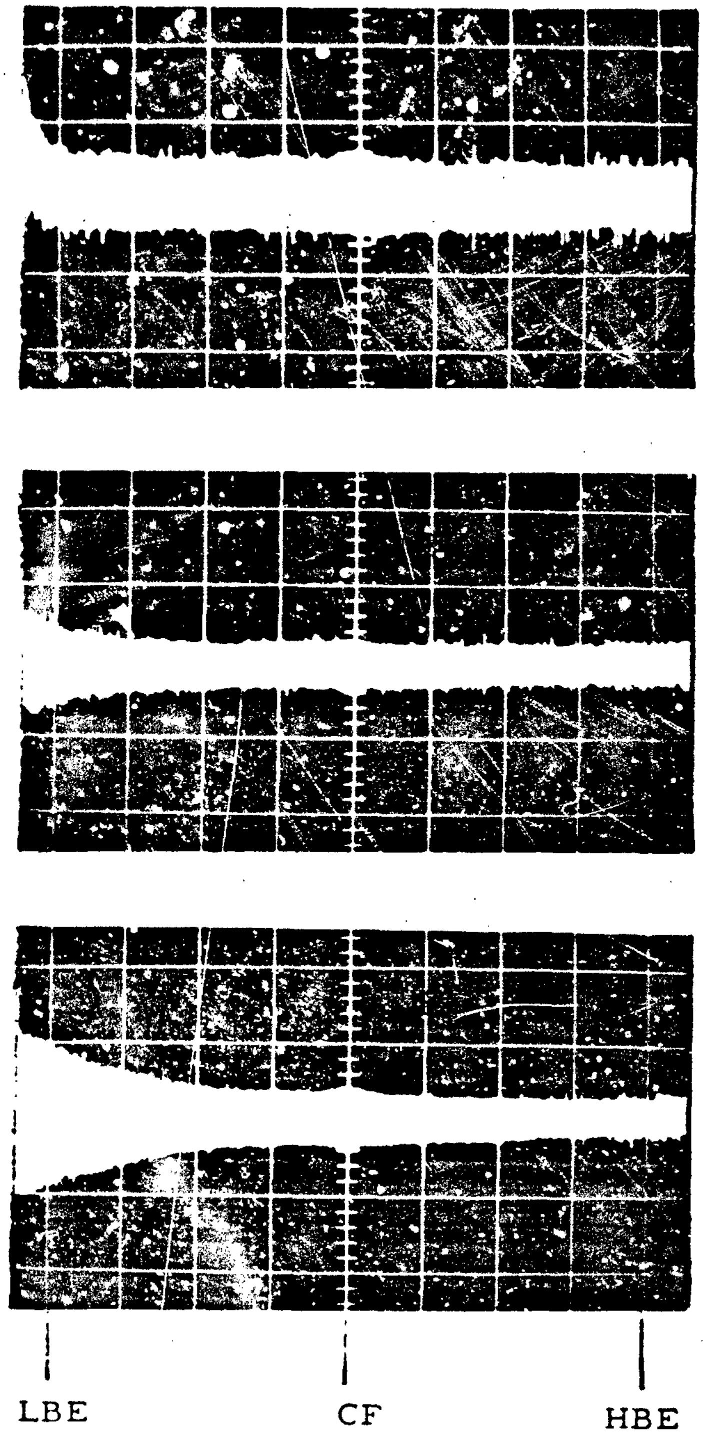


a. DR = 5
Vertical: 0.5% FBW/cm
RMS Level = 15.5 mv max

b. DR = 2
Vertical: 2.5% FBW/cm
RMS Level = 170 mv max

c. DR = 1
Vertical: 5.0% FBW/cm
RMS Level = 680 mv max

FIGURE II-3.3-10
INTERMODULATION TEST: IRIG MULTIPLEX;
SEARCH CHANNEL DR = 5, 2, AND 1; CHANNEL 8

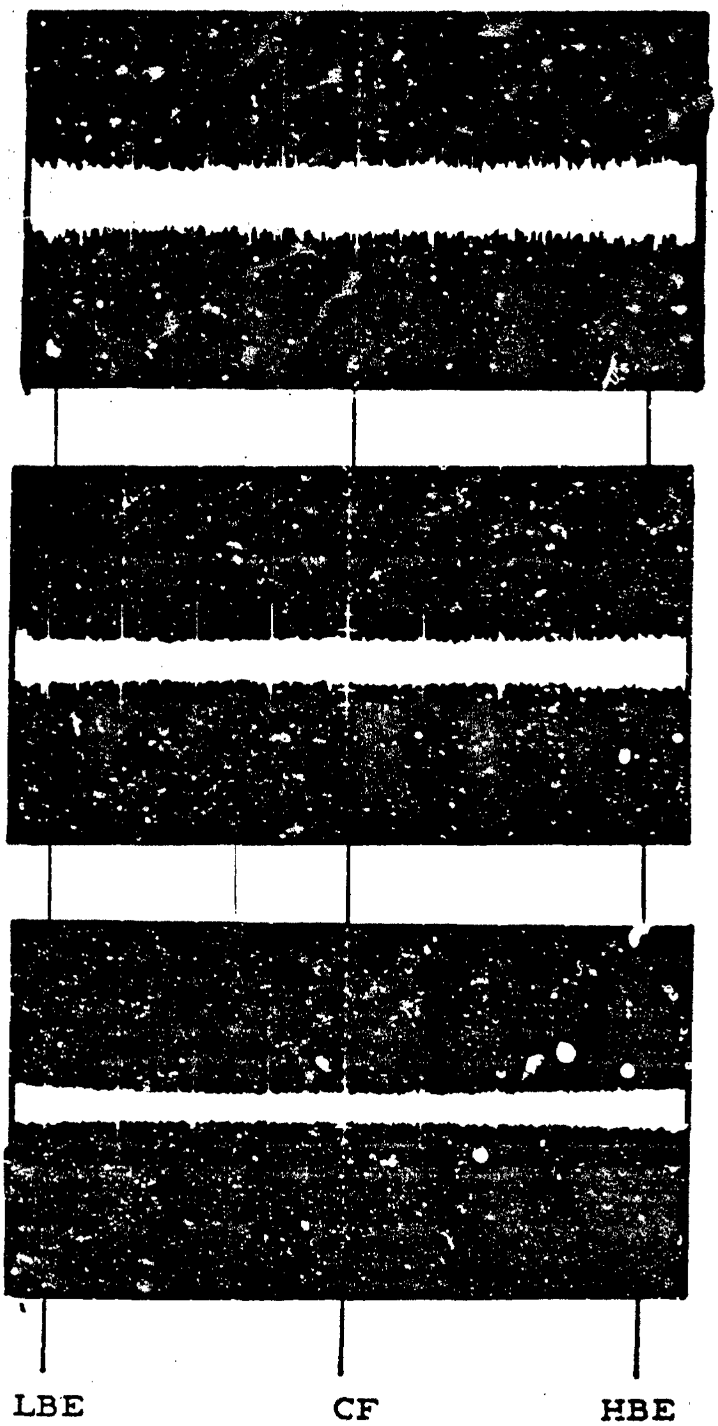


a. DR = 5
Vertical: 0.5% FBW/cm
RMS Level = 17 mv max

b. DR = 2
Vertical: 2.5% FBW/cm
RMS Level = 75 mv max

c. DR = 1
Vertical: 5.0% FBW/cm
RMS Level = 300 mv max

FIGURE II-3.3-11
INTERMODULATION TEST: IRIG MULTIPLEX;
SEARCH CHANNEL DR = 5, 2, AND 1; CHANNEL 9

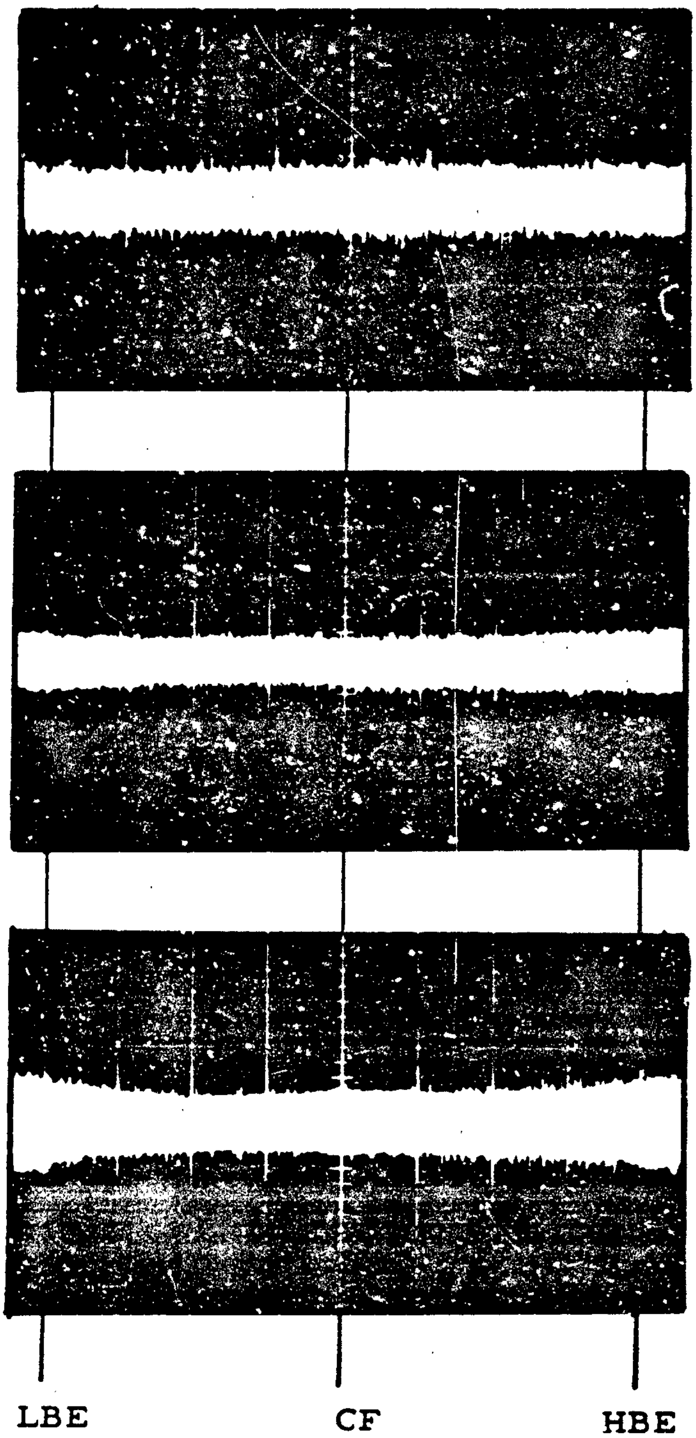


a. DR = 5
Vertical: 0. 5% FBW/cm
RMS Level = 18 mv max

b. DR = 2
Vertical: 2. 5% FBW/cm
RMS Level = 53 mv max

c. DR = 1
Vertical: 5. 0% FBW/cm
RMS Level = 85 mv max

FIGURE II-3. 3-12
INTERMODULATION TEST: IRIG MULTIPLEX;
SEARCH CHANNEL DR = 5, 2, AND 1; CHANNEL 10

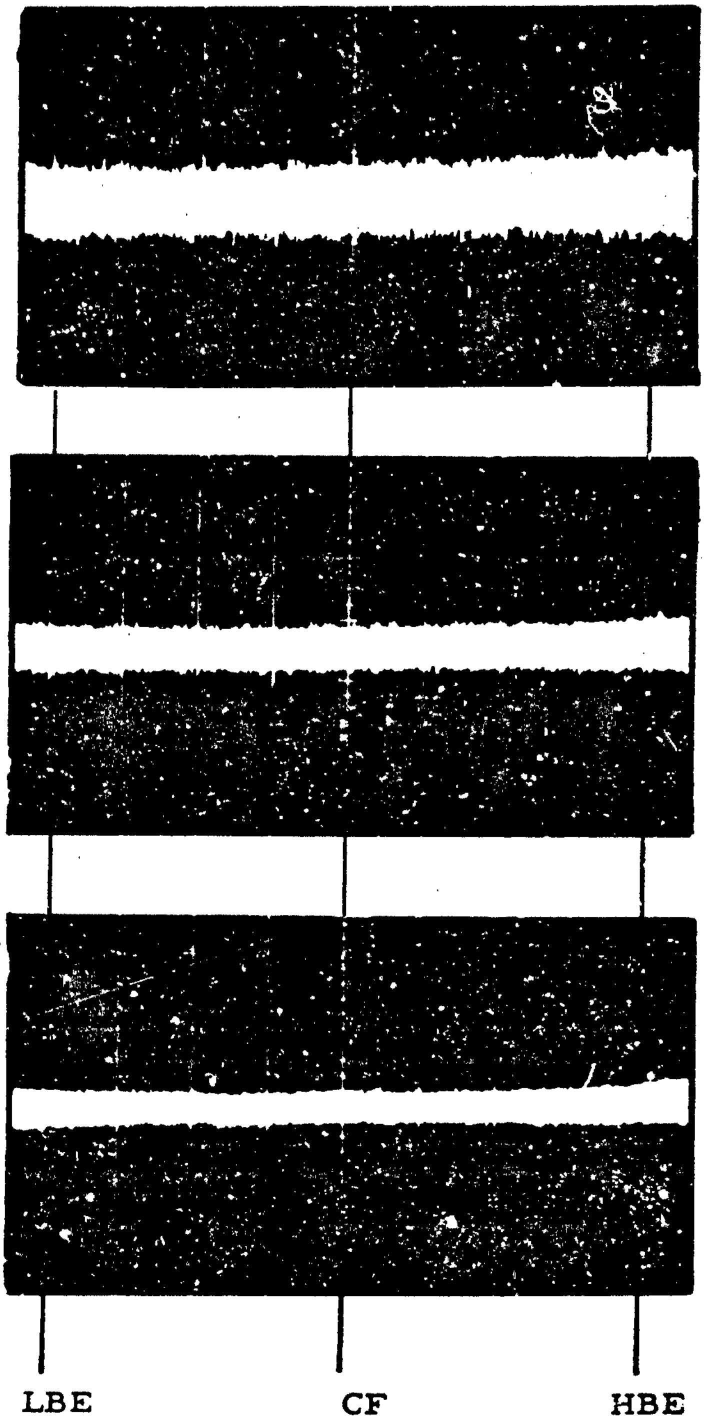


a. DR = 5
Vertical: 0.5% FBW/cm
RMS Level =17 mv max

b. DR = 2
Vertical: 2.5% FBW/cm
RMS Level: 70 mv max

c. DR = 1
Vertical: 5.0% FBW/cm
RMS Level: 170 mv max

FIGURE II-3.3-13
INTERMODULATION TEST: IRIG MULTIPLEX;
SEARCH CHANNEL DR = 5, 2, AND 1; CHANNEL 11

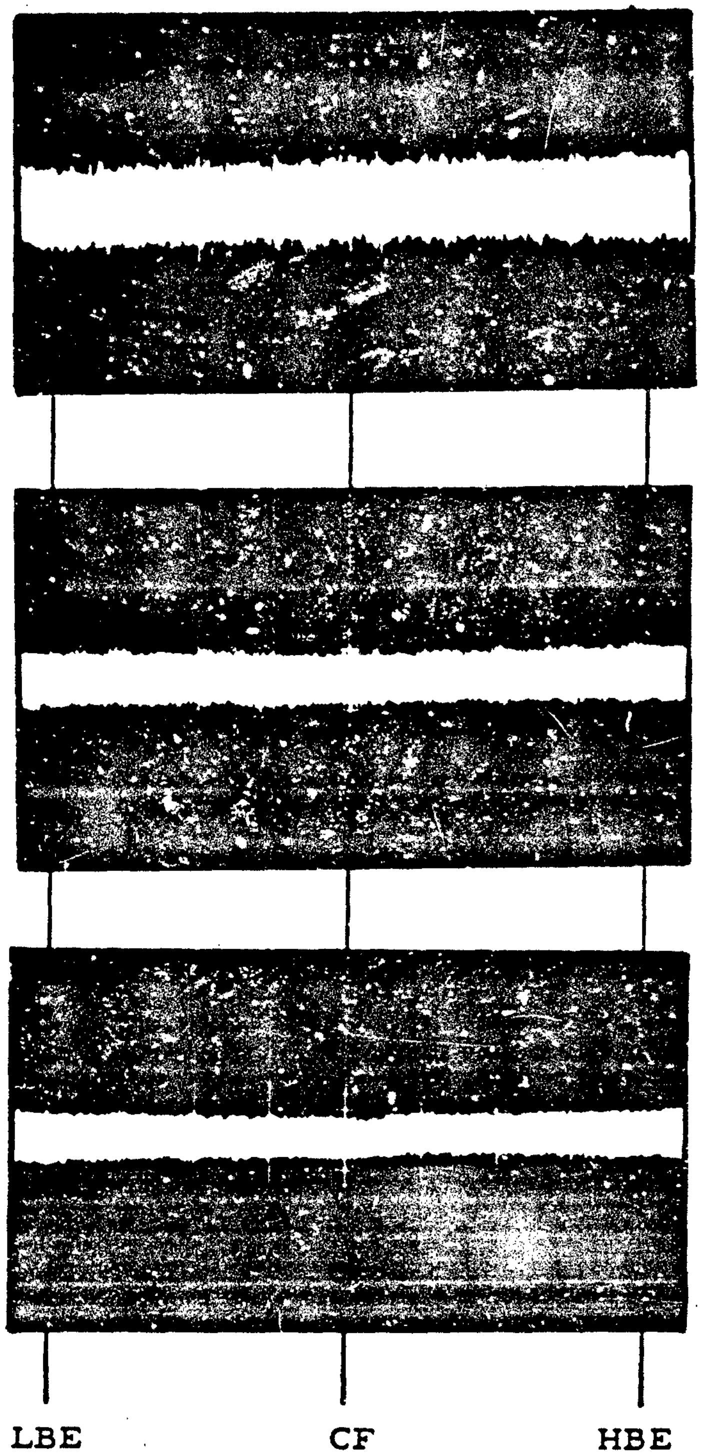


a. DR = 5
Vertical: 0.5% FBW/cm
RMS Level = 19 mv max

b. DR = 2
Vertical: 2.5% FBW/cm
RMS Level = 55 mv max

c. DR = 1
Vertical: 5.0% FBW/cm
RMS Level = 90 mv max

FIGURE II-3. 3-14
INTERMODULATION TEST: IRIG MULTIPLEX;
SEARCH CHANNEL DR = 5, 2, AND 1; CHANNEL 12

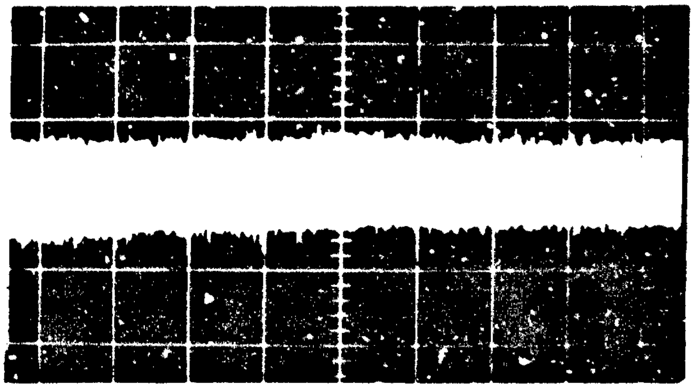


a. DR = 5
Vertical: 0.5% FBW/cm
RMS Level = 20 mv max

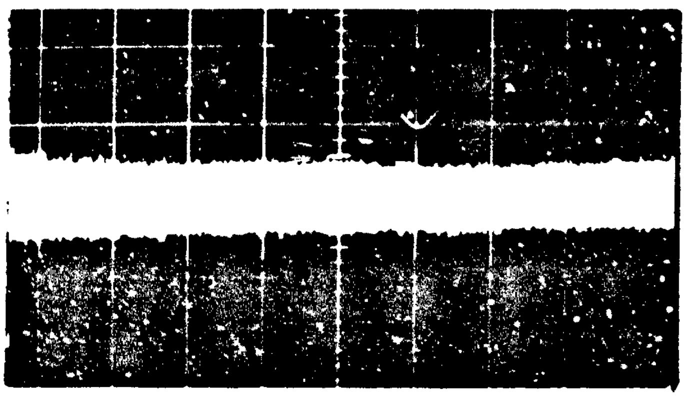
b. DR = 2
Vertical: 2.5% FBW/cm
RMS Level = 55 mv max

c. DR = 1
Vertical: 5.0% FBW/cm
RMS Level = 100 mv max

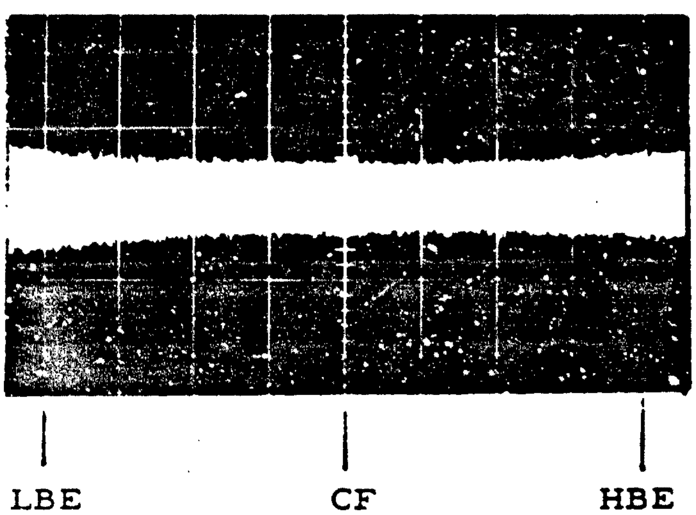
FIGURE II-3.3-15
INTERMODULATION TEST: IRIG MULTIPLEX;
SEARCH CHANNEL DR = 5, 2, AND 1; CHANNEL 13



a. DR = 5
Vertical: 0. 5% FBW/cm
RMS Level: 19 mv max



b. DR = 2
Vertical: 2. 5% FBW/cm
RMS Level = 78 mv max



c. DR = 1
Vertical: 5. 0% FBW/cm
RMS Level = 200 mv max

FIGURE II-3. 3-16
INTERMODULATION TEST: IRIG MULTIPLEX;
SEARCH CHANNEL DR = 5, 2, AND 1; CHANNEL 14

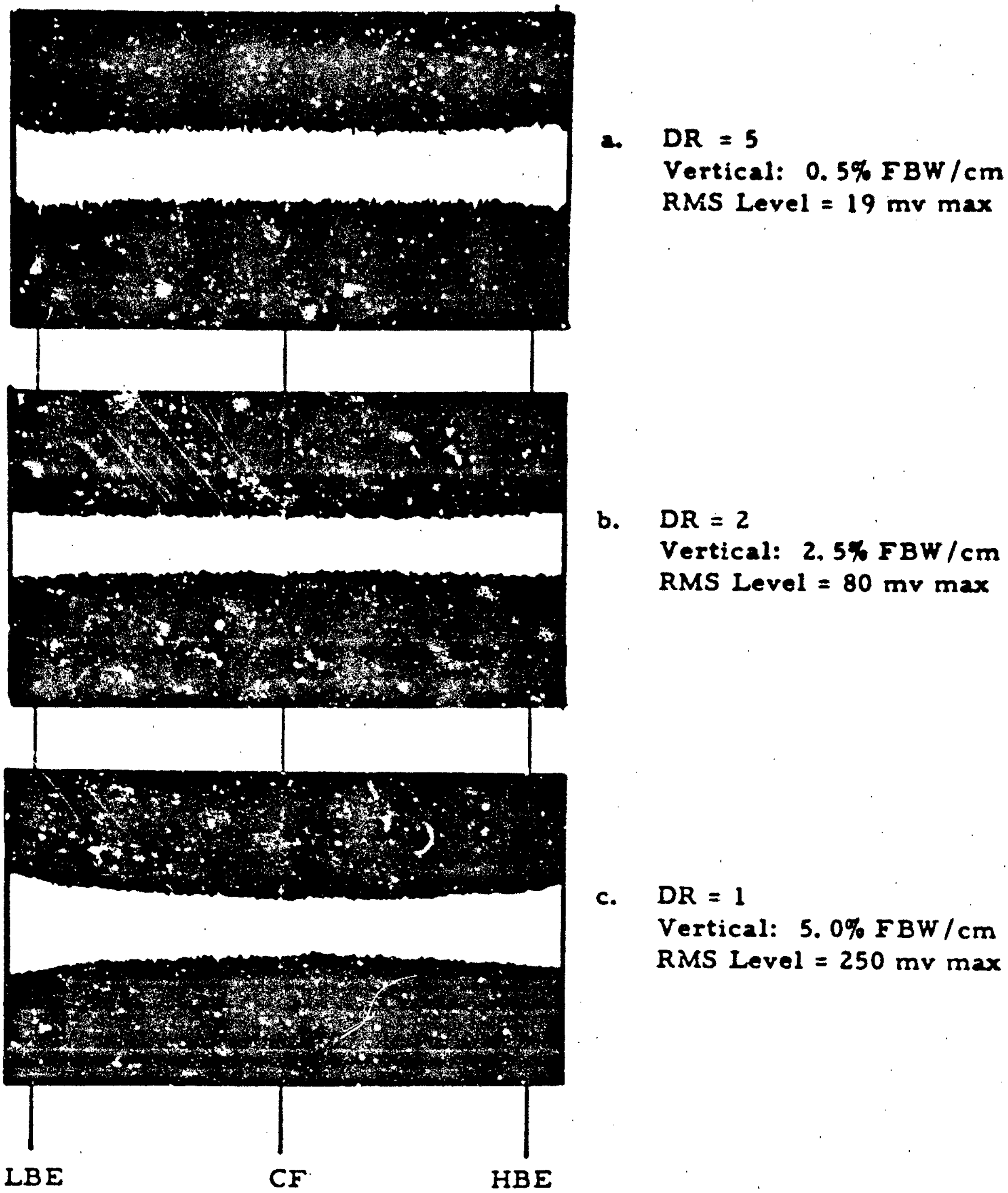
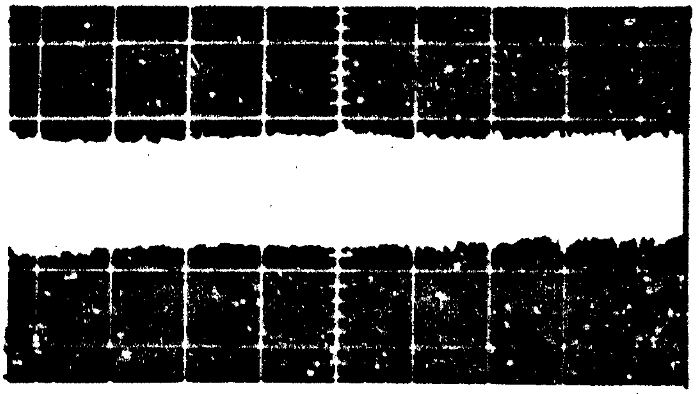
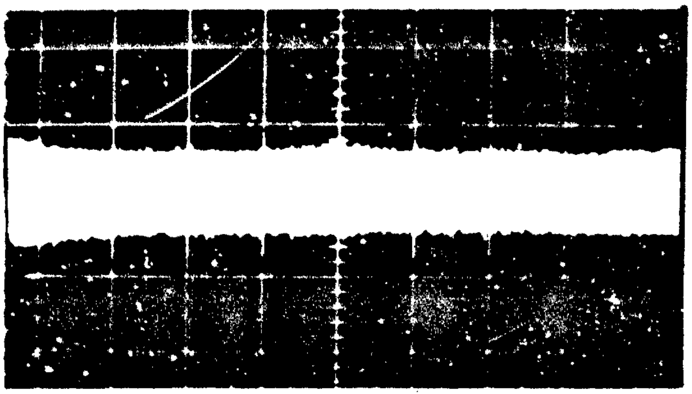


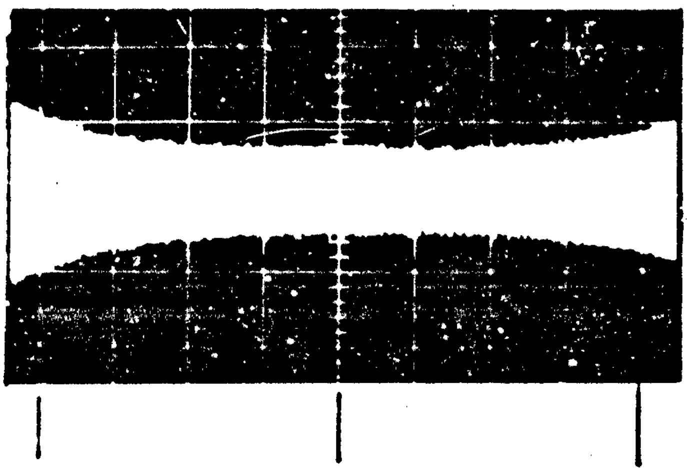
FIGURE II-3.3-17
INTERMODULATION TEST: IRIG MULTIPLEX;
SEARCH CHANNEL DR = 5, 2, AND 1; CHANNEL 15



a. DR = 5
Vertical: 0.5% FBW/cm
RMS Level = 19.5 mv max



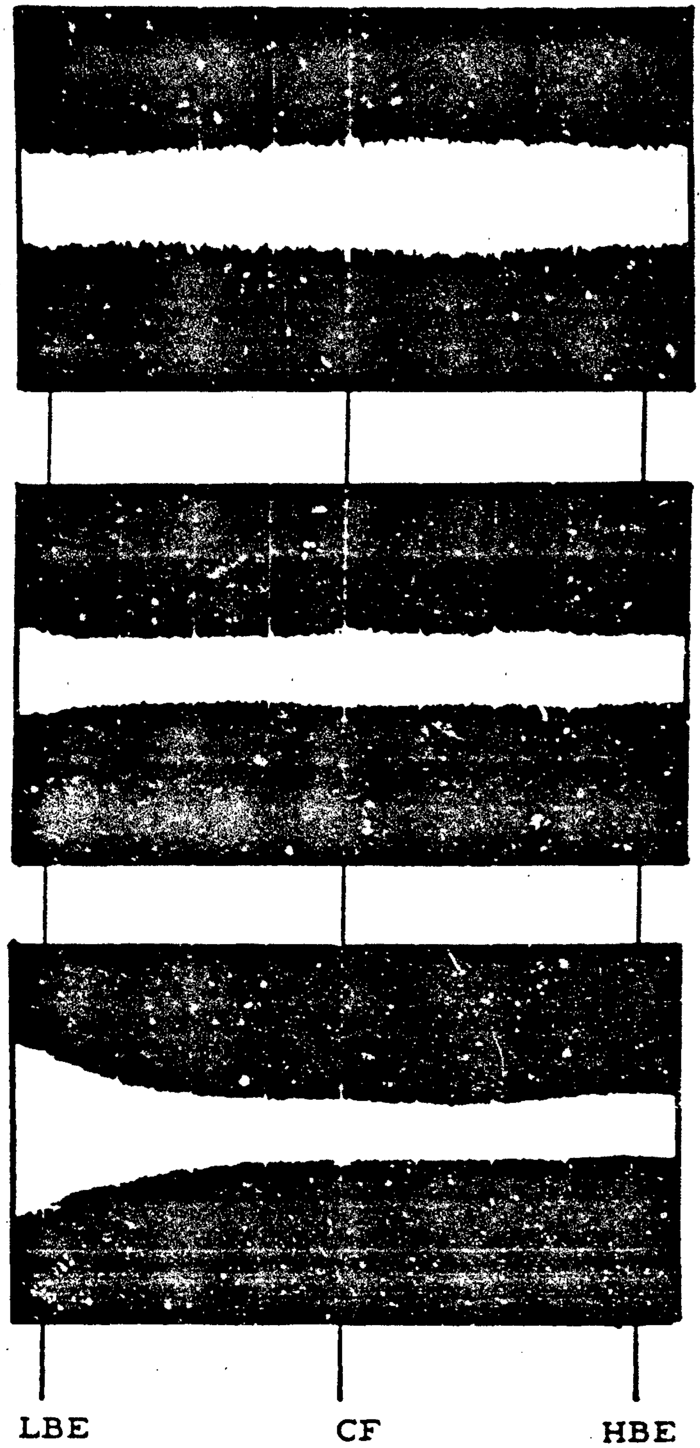
b. DR = 2
Vertical: 2.5% FBW/cm
RMS Level = 90 mv max



c. DR = 1
Vertical: 5.0% FBW/cm
RMS Level = 350 mv max

LBE CF HBE

FIGURE II-3.3-18
INTERMODULATION TEST: IRIG MULTIPLEX;
SEARCH CHANNEL DR = 5, 2, AND 1; CHANNEL 16

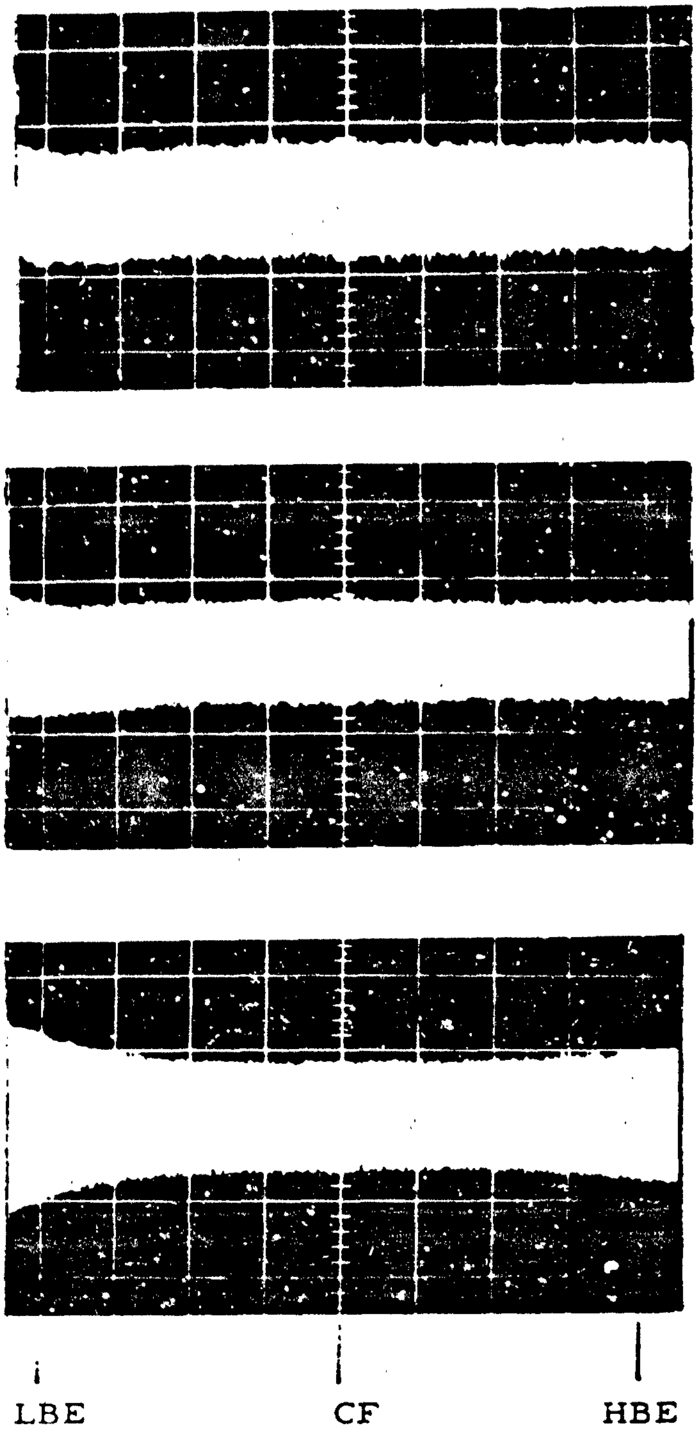


a. DR = 5
Vertical: 0.5% FBW/cm
RMS Level = 25 mv max

b. DR = 2
Vertical: 2.5% FBW/cm
RMS Level = 80 mv max

c. DR = 1
Vertical: 5.0% FBW/cm
RMS Level = 300 mv max

FIGURE II-[illegible]. 3-19
INTERMODULATION TEST: IRIG MULTIPLEX;
SEARCH CHANNEL DR = 5, 2, AND 1; CHANNEL 17

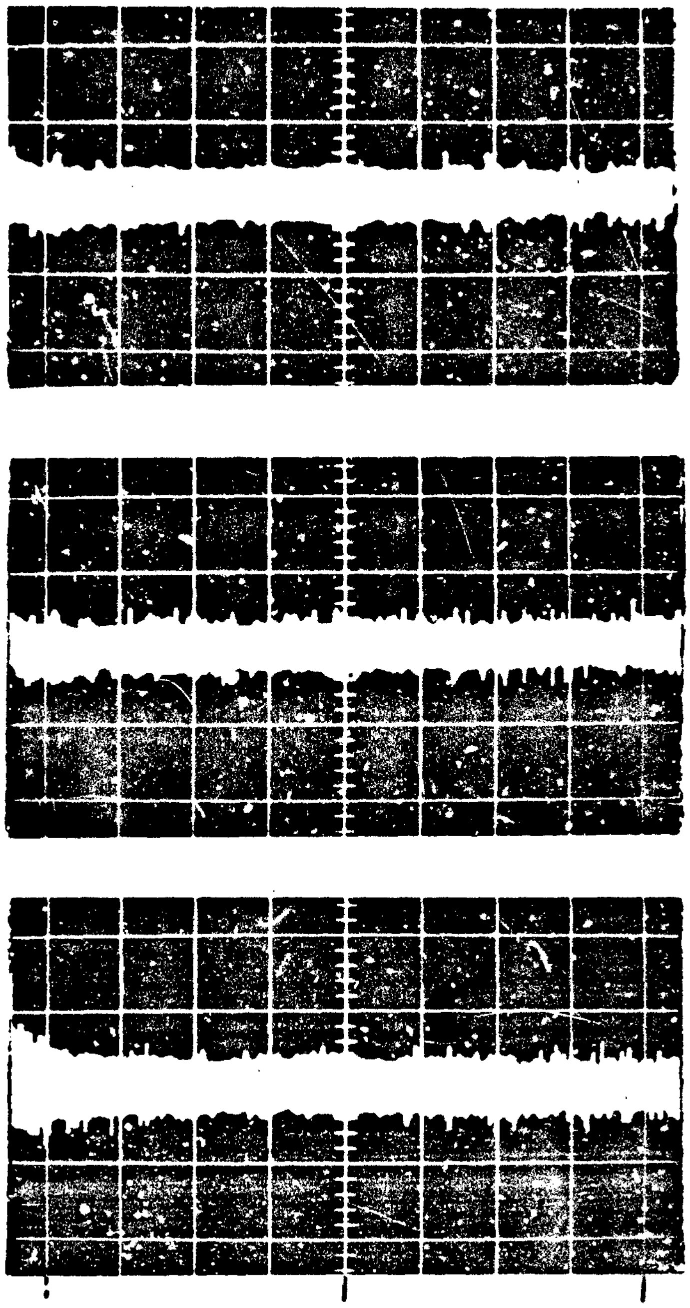


a. DR = 5
Vertical: 0.5% FBW/cm
RMS Level = 21 mv max

b. DR = 2
Vertical: 2.5% FBW/cm
RMS Level = 90 mv max

c. DR = 1
Vertical: 5.0% FBW/cm
RMS Level = 350 mv max

FIGURE II-3.3-20
INTERMODULATION TEST: IRIG MULTIPLEX;
SEARCH CHANNEL DR = 5, 2, AND 1; CHANNEL 18



Channel 1, 400 cps ±7.5%
DR = 5
RMS Level = 28 mv max.

Channel 2, 560 cps ±7.5%
DR = 5
RMS Level = 23 mv max.

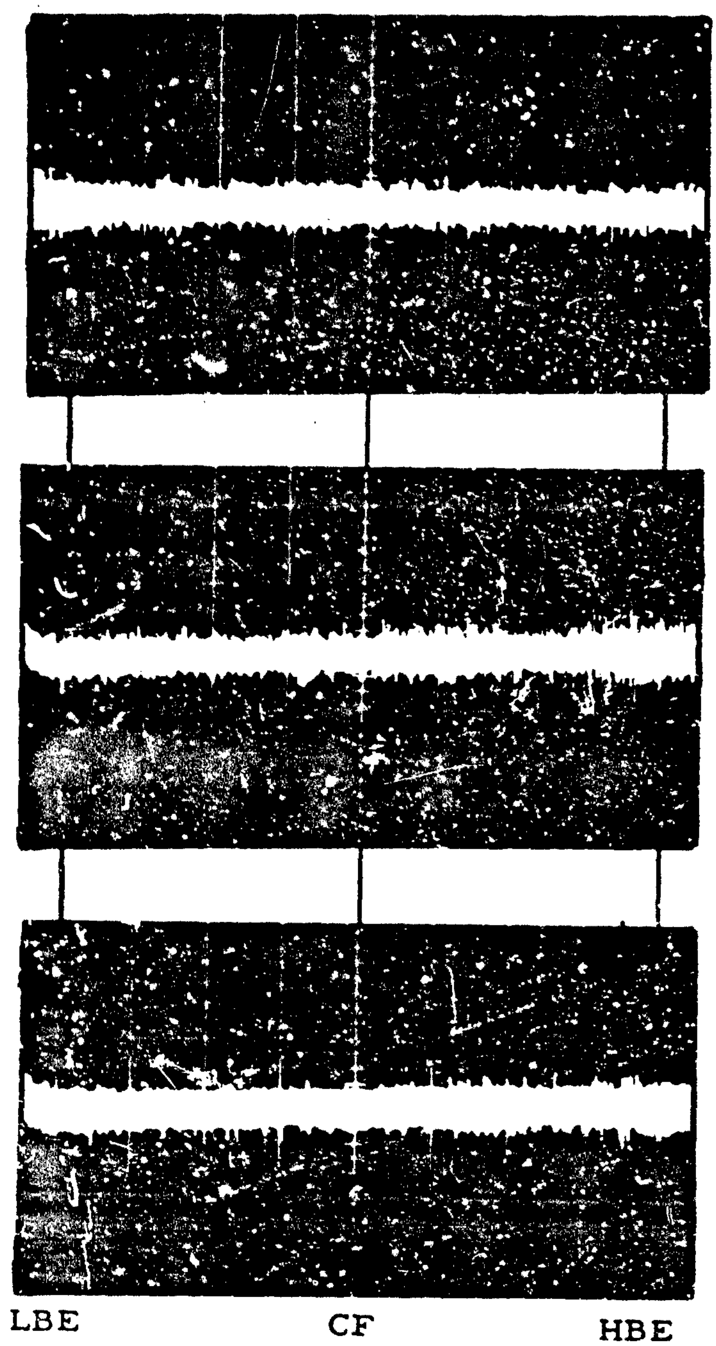
Channel 3, 730 cps
DR = 5
RMS Level = 26 mv max.

LBE CF HBE

Horizontal: 5 sec/cm

Vertical: 0.5% FBW/cm

FIGURE II-3.3-21
INTERMODULATION TEST: IRIG WIDEBAND MULTIPLEX;
SEARCH CHANNEL DR = 5; CHANNELS 1, 2, AND 3



Channel 4, 960 cps ±7.5%
DR = 5
RMS Level = 15 mv max.

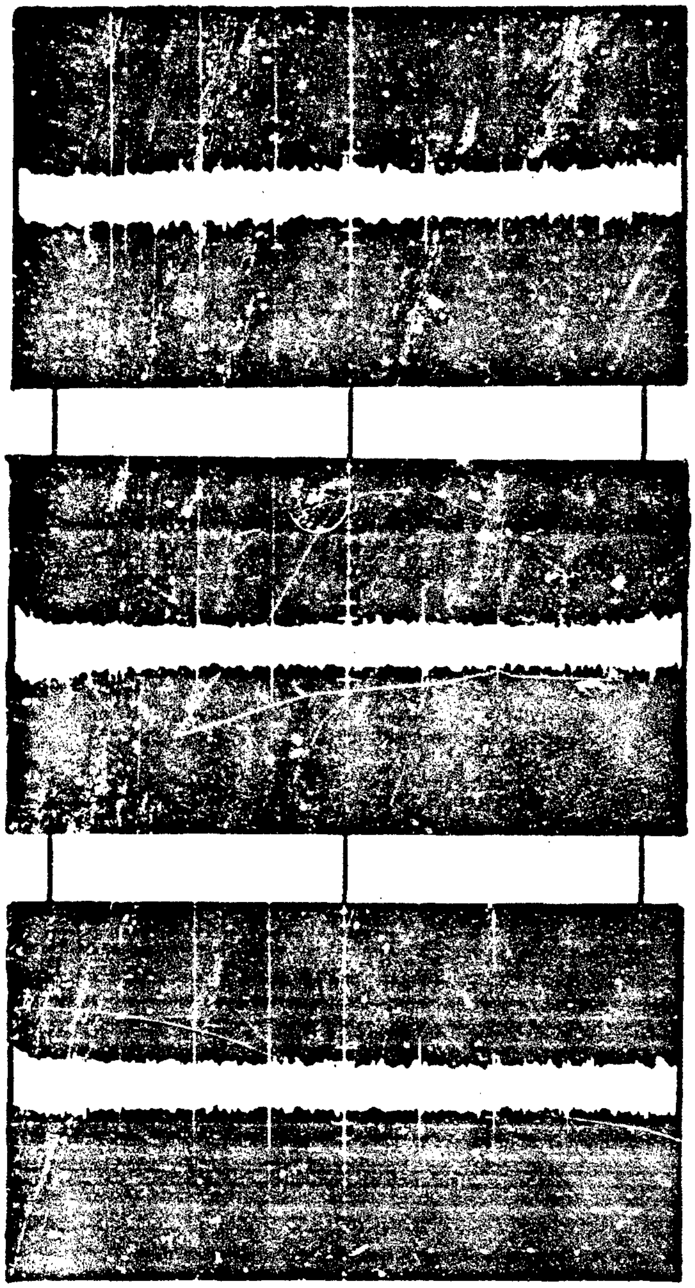
Channel 5, 1.3 kc ±7.5%
DR = 5
RMS Level = 18 mv max.

Channel 6, 1.7 kc ±7.5%
DR = 5
RMS Level = 15 mv max.

Horizontal: 5 sec/cm

Vertical: 0.5% FBW/cm

FIGURE II-3.3-22
INTERMODULATION TEST: IRIG WIDEBAND MULTIPLEX;
SEARCH CHANNEL DR = 5; CHANNELS 4, 5, AND 6



Channel 7, 2. 3 kc ±7. 5%
DR = 5
RMS Level = 14 mv max.

Channel 8, 3 kc ±7. 5%
DR = 5
RMS Level = 12 mv max.

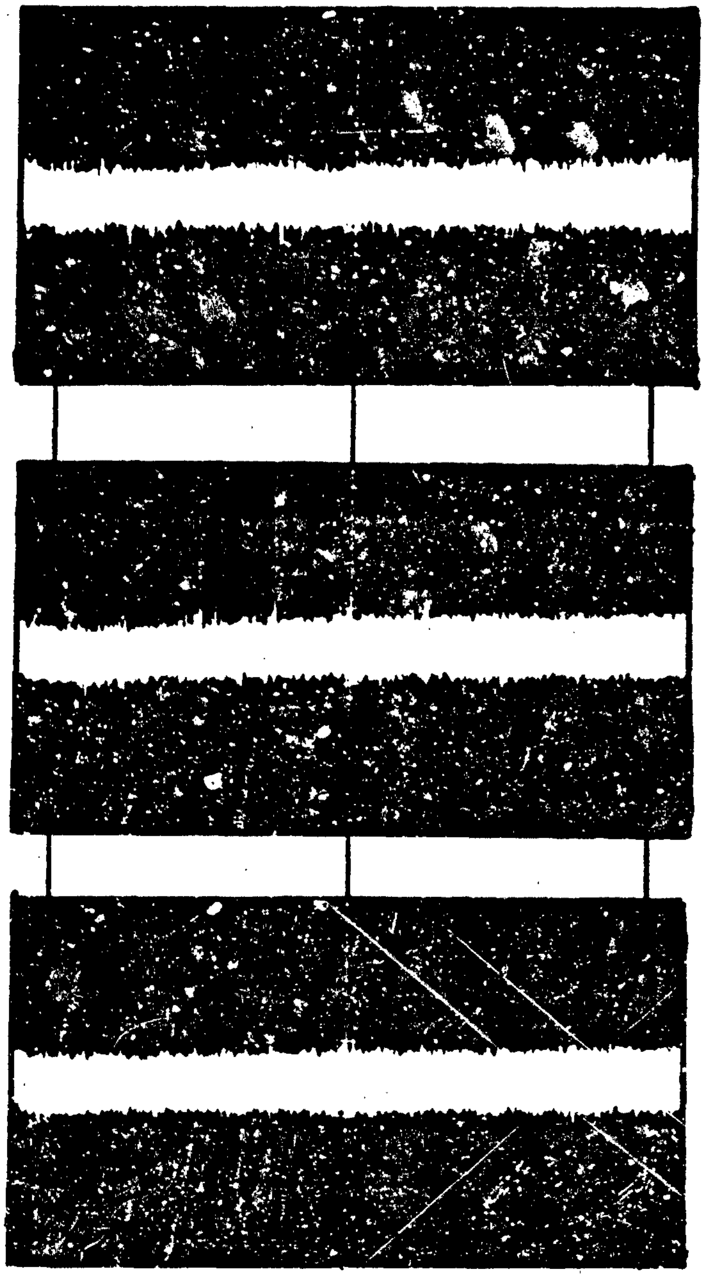
Channel 9, 3. 9 kc ±7. 5%
DR = 5
RMS Level = 12. 5 mv max.

LBE CF HBE

Horizontal: 5 sec/cm

Vertical: 0. 5% FBW/cm

FIGURE II-3. 3-23
INTERMODULATION TEST: IRIG WIDEBAND MULTIPLEX;
SEARCH CHANNEL DR = 5; CHANNELS 7, 8, AND 9



Channel 10, 5.4 kc ±7.5%
DR = 5
RMS Level = 17.5 mv max.

Channel 11, 7.35 kc ±7.5%
DR = 5
RMS Level = 16.5 mv max.

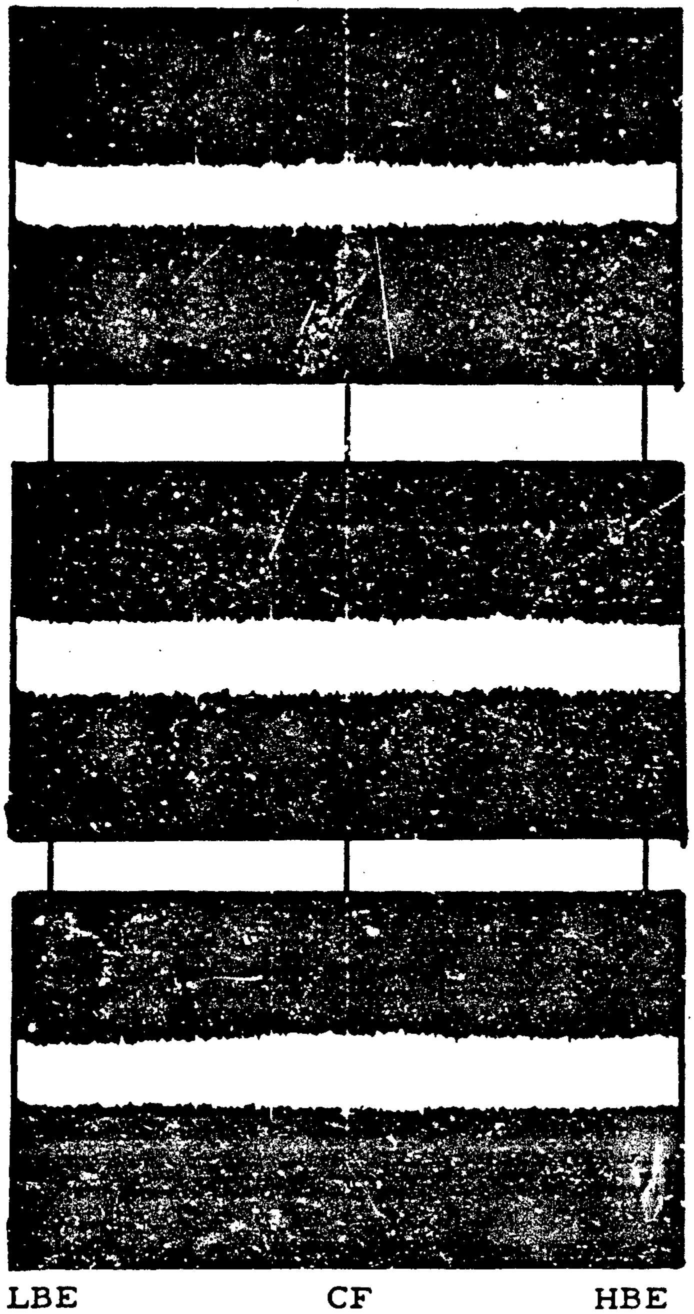
Channel 12, 10.5 kc ±7.5%
DR = 5
RMS Level = 17 mv max.

LBE CF HBE

Horizontal: 5 sec/cm

Vertical: 0.5% FBW/cm

FIGURE II-3.3-24
INTERMODULATION TEST: IRIG WIDEBAND MULTIPLEX;
SEARCH CHANNEL DR = 5; CHANNELS 10, 11, AND 12



Channel 13, 14.5 kc ±7.5%
DR = 5
RMS Level = 15 mv max.

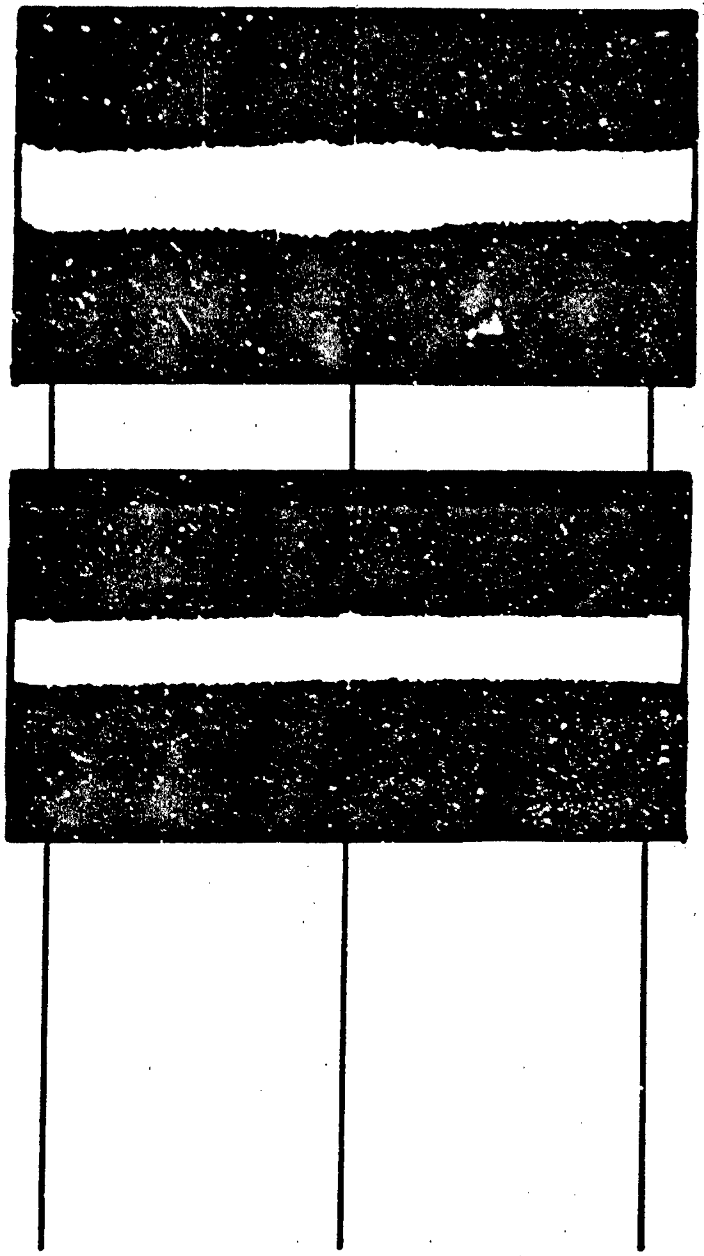
Channel 14, 22 kc ±7.5%
DR = 5
RMS Level = 17 mv max.

Channel 15, 30 kc ±7.5%
DR = 5
RMS Level = 19 mv max.

Horizontal: 5 sec/cm

Vertical: 0.5% FBW/cm

FIGURE II-3.3-25
INTERMODULATION TEST: IRIG WIDEBAND MULTIPLEX;
SEARCH CHANNEL DR = 5; CHANNELS 13, 14, AND 15



Channel 16, 40 kc ±7.5%
DR = 5
RMS Level = 25 mv max.

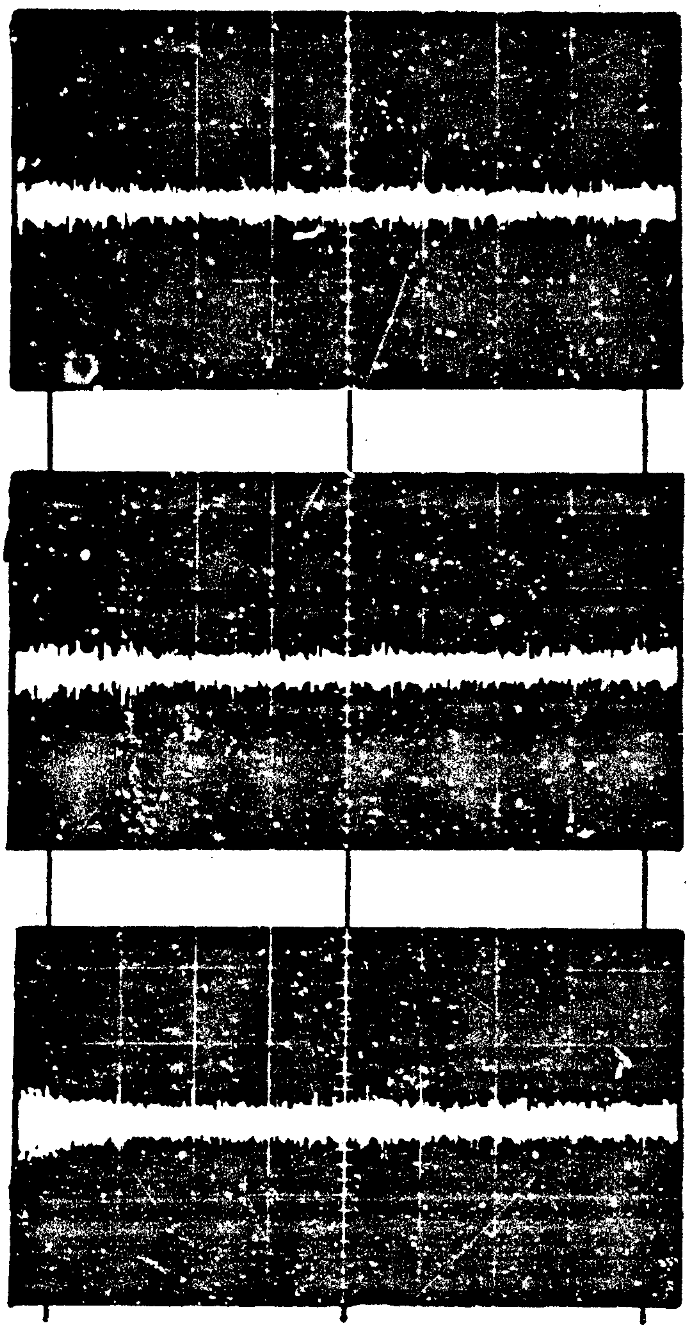
Channel E, 70 kc ±15%
DR = 5
RMS Level = 16.5 mv max.

LBE CF HBE

Horizontal: 5 sec/cm

Vertical: 0.5% FBW/cm

FIGURE II-3.3-26
INTERMODULATION TEST: IRIG WIDEBAND MULTIPLEX;
SEARCH CHANNEL DR = 5; CHANNELS 16 AND E



Channel 1, 400 cps ±7.5%
DR = 5
RMS Level = 20 mv max.

Channel 2, 560 cps ±7.5%
DR = 5
RMS Level = 25 mv max.

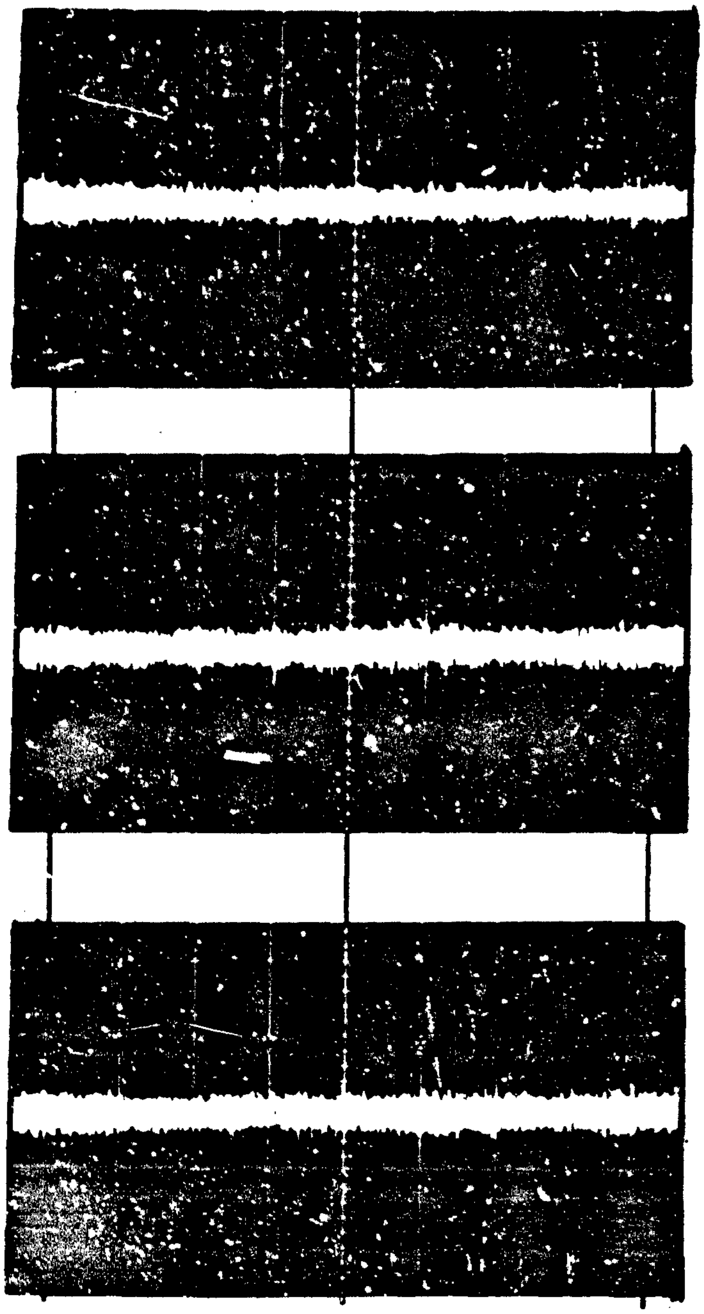
Channel 3, 730 cps ±7.5%
DR = 5
RMS Level = 18 mv max.

LBE CF HBE

Horizontal: 5 sec/cm

Vertical: 0.5% FBW/cm

FIGURE II-3.3-27
INTERMODULATION TEST: EXPANDED MULTIPLEX;
SEARCH CHANNEL DR = 5; CHANNELS 1, 2, AND 3



Channel 4, 960 cps ±7. 5%
DR = 5
RMS Level = 13 mv max.

Channel 5, 1. 3 kc ±7. 5%
DR = 5
RMS Level = 20 mv max.

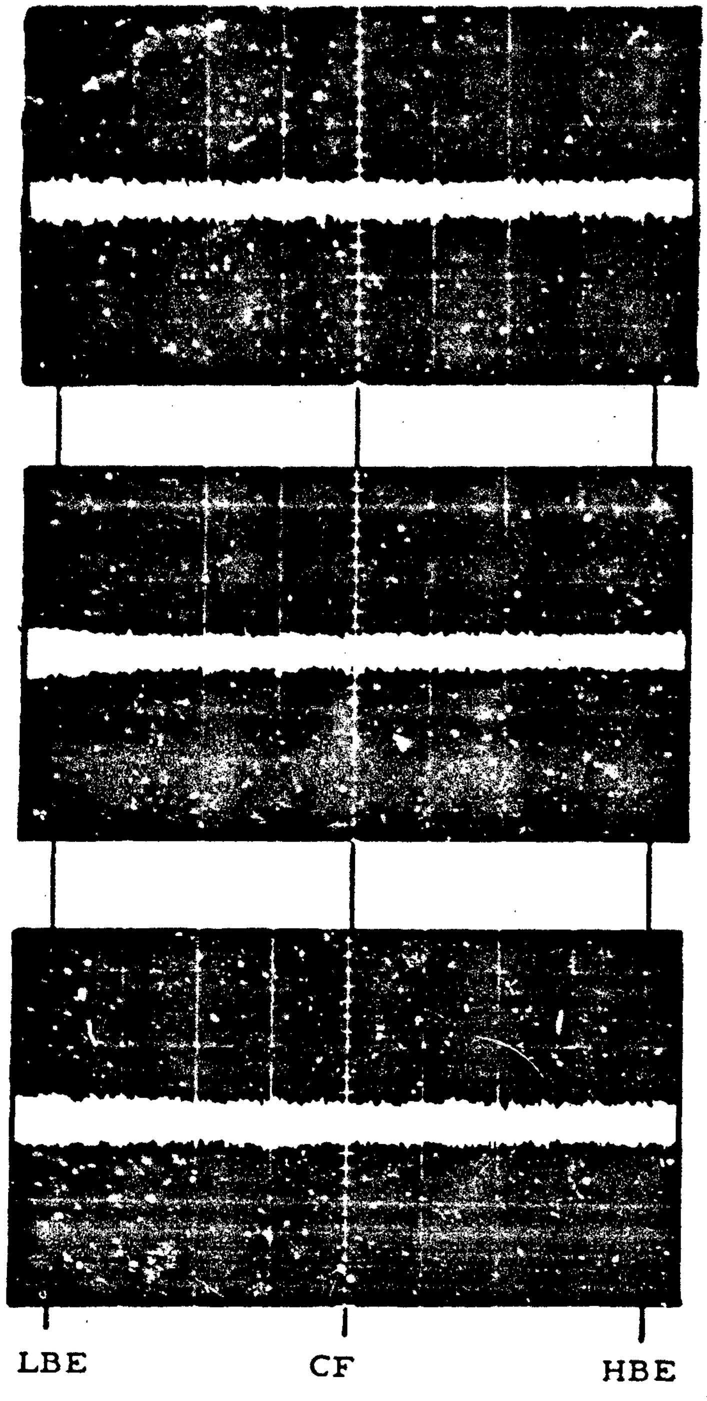
Channel 6, 1. 7 kc ±7. 5%
DR = 5
RMS Level = 18 mv max.

LBE CF HBE

Horizontal: 5 sec/cm

Vertical: 0. 5% FBW/cm

FIGURE II-3. 3-28
INTERMODULATION TEST: EXPANDED MULTIPLEX;
SEARCH CHANNEL DR = 5; CHANNELS 4, 5, AND 6



Channel 7, 2. 3 kc ±7. 5%
DR = 5
RMS Level = 15 mv max.

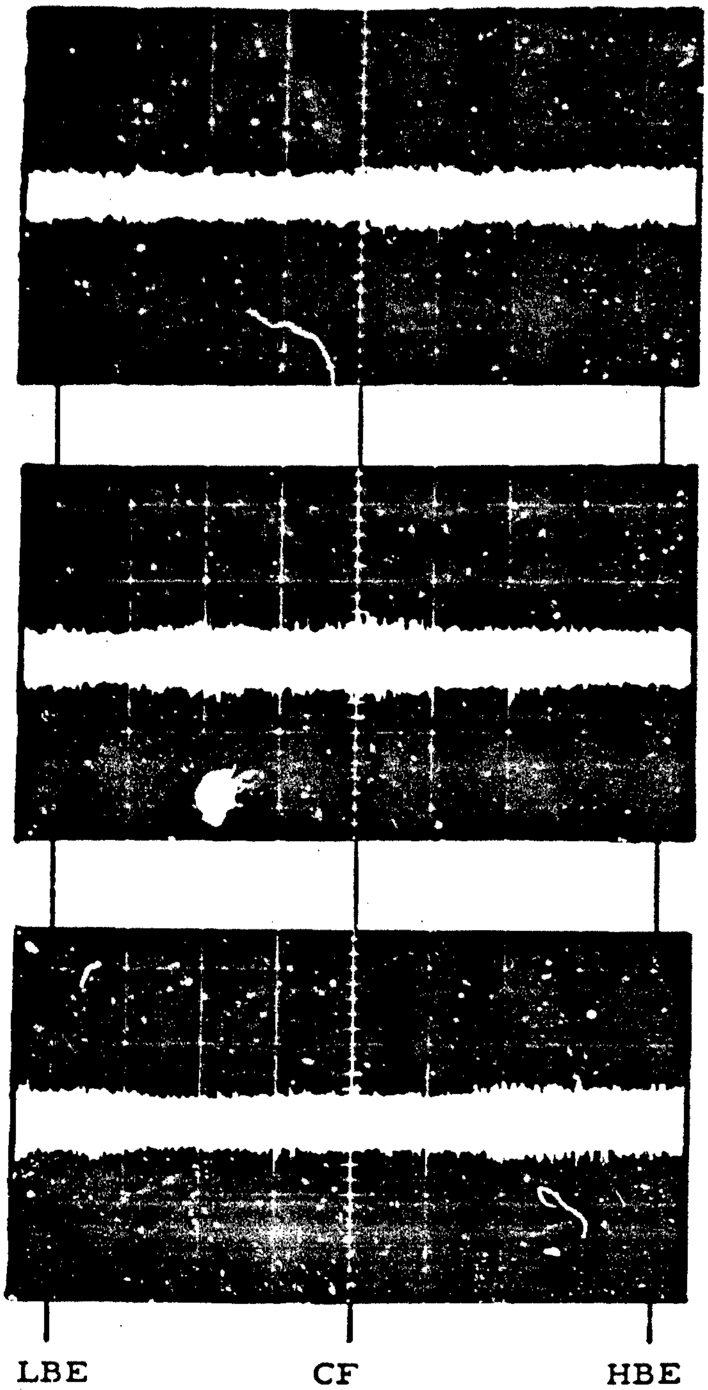
Channel 8, 3. 0 kc ±7. 5%
DR = 5
RMS Level = 15 mv max.

Channel 9, 3. 9 kc ±7. 5%
DR = 5
RMS Level = 15 mv max.

Horizontal: 5 sec/cm

Vertical: 0. 5% FBW/cm

FIGURE II-3. 3-29
INTERMODULATION TEST: EXPANDED MULTIPLEX;
SEARCH CHANNEL DR = 5; CHANNELS 7, 8, AND 9



Channel 10, 5.4 kc ±7.5%
DR = 5
RMS Level = 19 mv max.

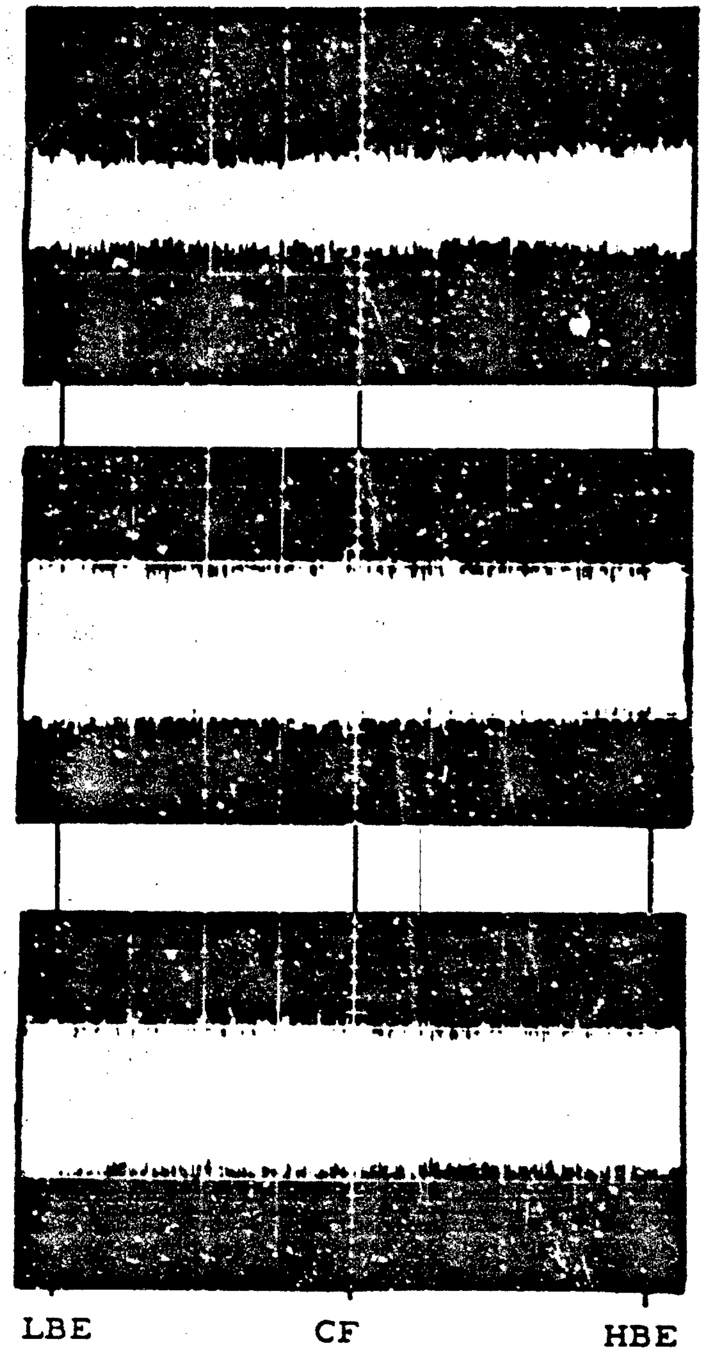
Channel 11, 7.35 kc ±7.5%
DR = 5
RMS Level = 18 mv max.

Channel 12, 10.5 kc ±7.5%
DR = 5
RMS Level = 19 mv max.

Horizontal: 5sec/cm

Vertical: 0.5% FBW/cm

FIGURE II-3.3-30
INTERMODULATION TEST: EXPANDED MULTIPLEX;
SEARCH CHANNEL DR = 5; CHANNELS 10, 11, AND 12



Channel 13, 14.5 kc ±7.5%
DR = 5
RMS Level = 24 mv max.

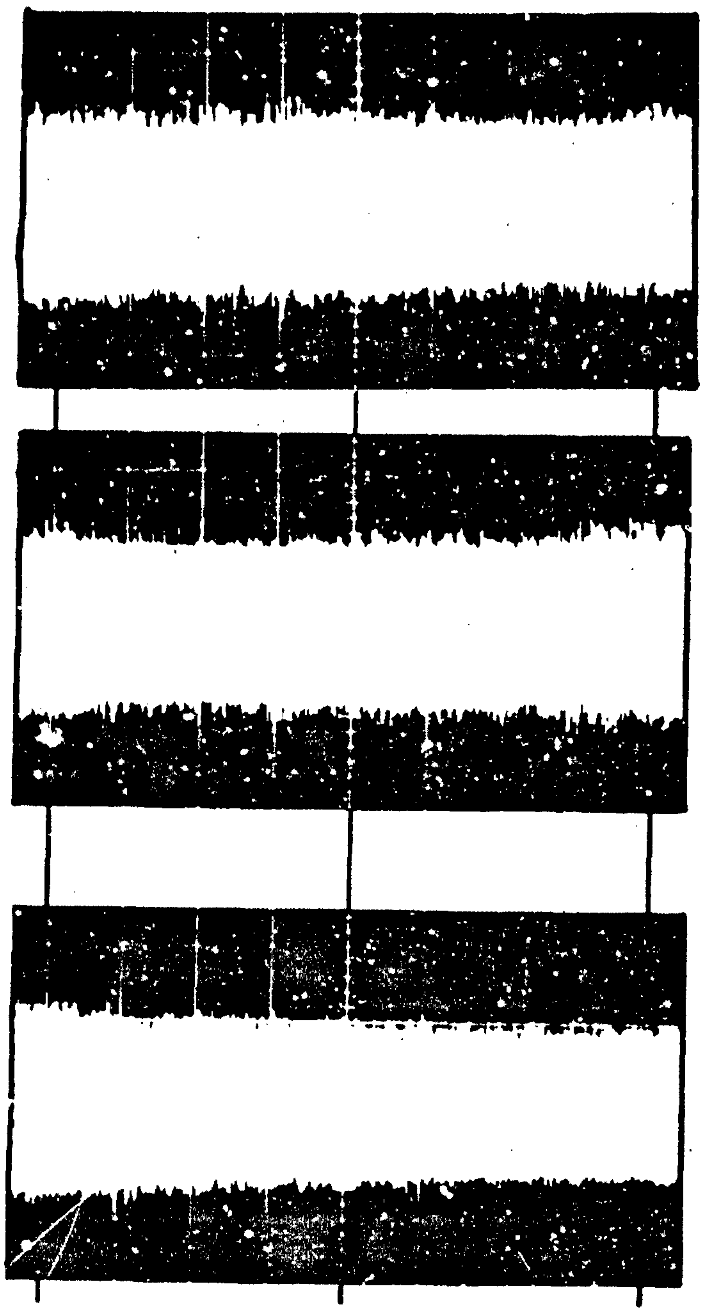
Channel 14, 22.0 kc ±7.5%
DR = 5
RMS Level = 31 mv max.

Channel 15, 30.0 kc ±7.5%
DR = 5
RMS Level = 32 mv max.

Horizontal: 5 sec/cm

Vertical: 0.5% FBW/cm

FIGURE II-3.3-31
INTERMODULATION TEST: EXPANDED MULTIPLEX;
SEARCH CHANNEL DR = 5; CHANNELS 13, 14, AND 15



LBE CF HBE

Channel 16, 40.0 kc ±7.5%
DR = 5
RMS Level = 35 mv max.

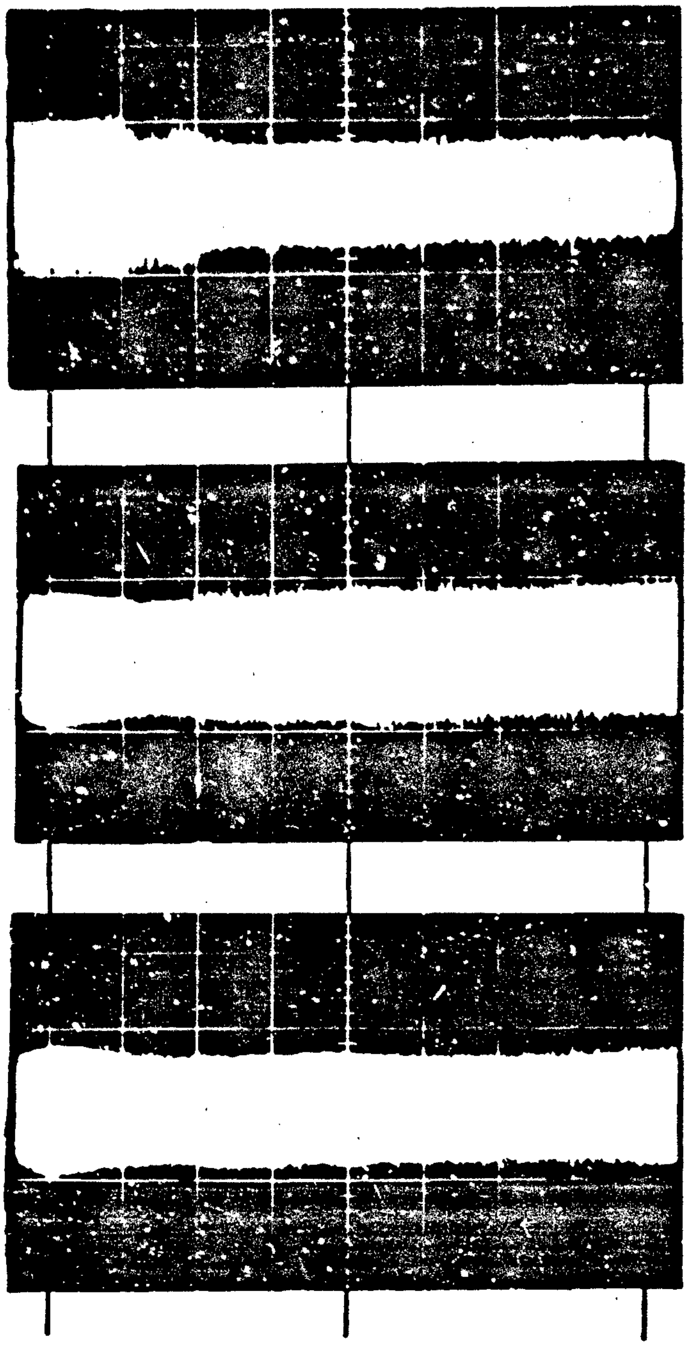
Channel 17, 52.5 kc ±7.5%
DR = 5
RMS Level = 36 mv max.

Channel 18, 70.0 kc ±7.5%
DR = 5
RMS Level = 31 mv max.

Horizontal: 5 sec/cm.

Vertical: 0.5% FBW/cm

FIGURE II-3.3-32
INTERMODULATION TEST: EXPANDED MULTIPLEX;
SEARCH CHANNEL DR = 5; CHANNELS 16, 17, AND 18



Channel 19, 93.0 kc ±7.5%
DR = 5
RMS Level = 27 mv max.

Channel 20, 124.0 kc ±7.5%
DR = 5
RMS Level = 26 mv max.

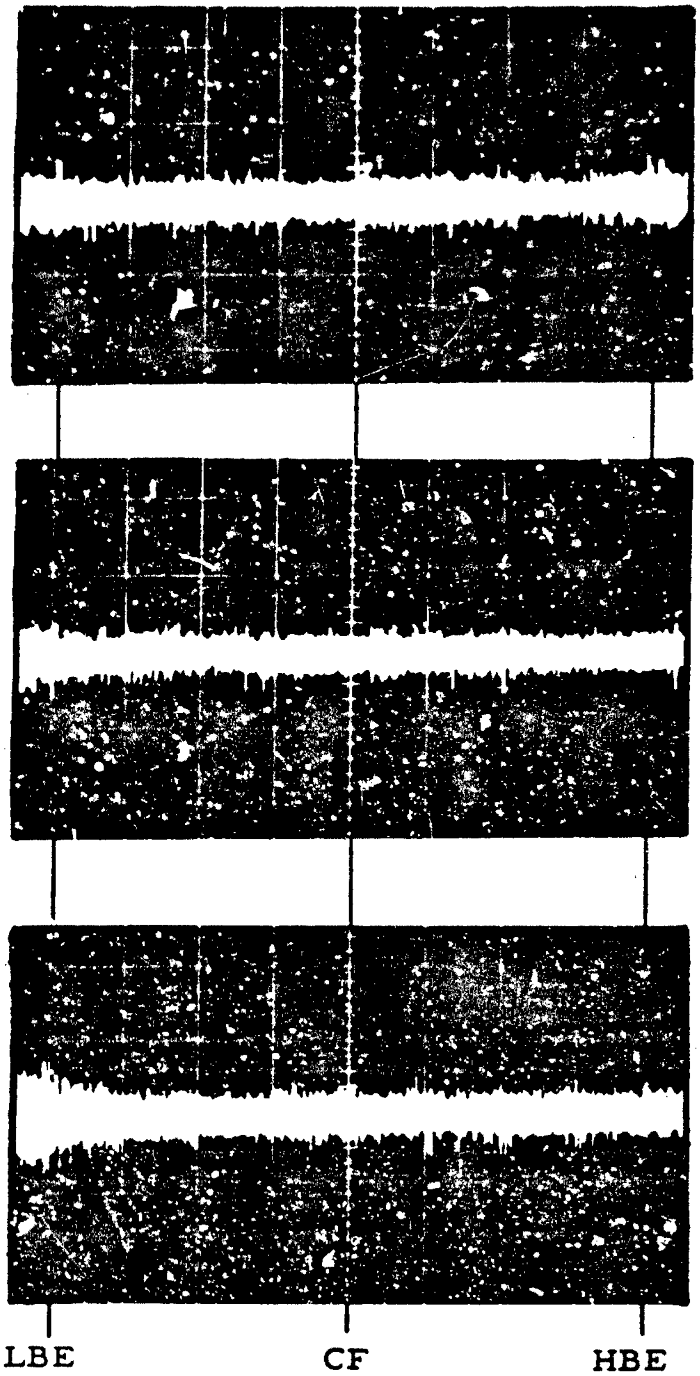
Channel 21, 165.0 kc ±7.5%
DR = 5
RMS Level = 21 mv max.

LBE CF HBE

Horizontal: 5 sec/cm

Vertical: 0.5% FBW/cm

FIGURE II-3.3-33
INTERMODULATION TEST: EXPANDED MULTIPLEX;
SEARCH CHANNEL DR = 5; CHANNELS 19, 20, AND 21



Channel 1, 400 cps ±7.5%
DR = 5
RMS Level = 24 mv max.

Channel 2, 560 cps ±7.5%
DR = 5
RMS Level = 20 mv max.

Channel 3, 730 cps ±7.5%
DR = 5
RMS Level = 22 mv max.

Horizontal: 5 sec/cm

Vertical: 0.5% FBW/cm

FIGURE II-3.3-34
INTERMODULATION TEST: EXPANDED WIDEBAND MULTIPLEX;
SEARCH CHANNEL DR = 5; CHANNELS 1, 2, AND 3

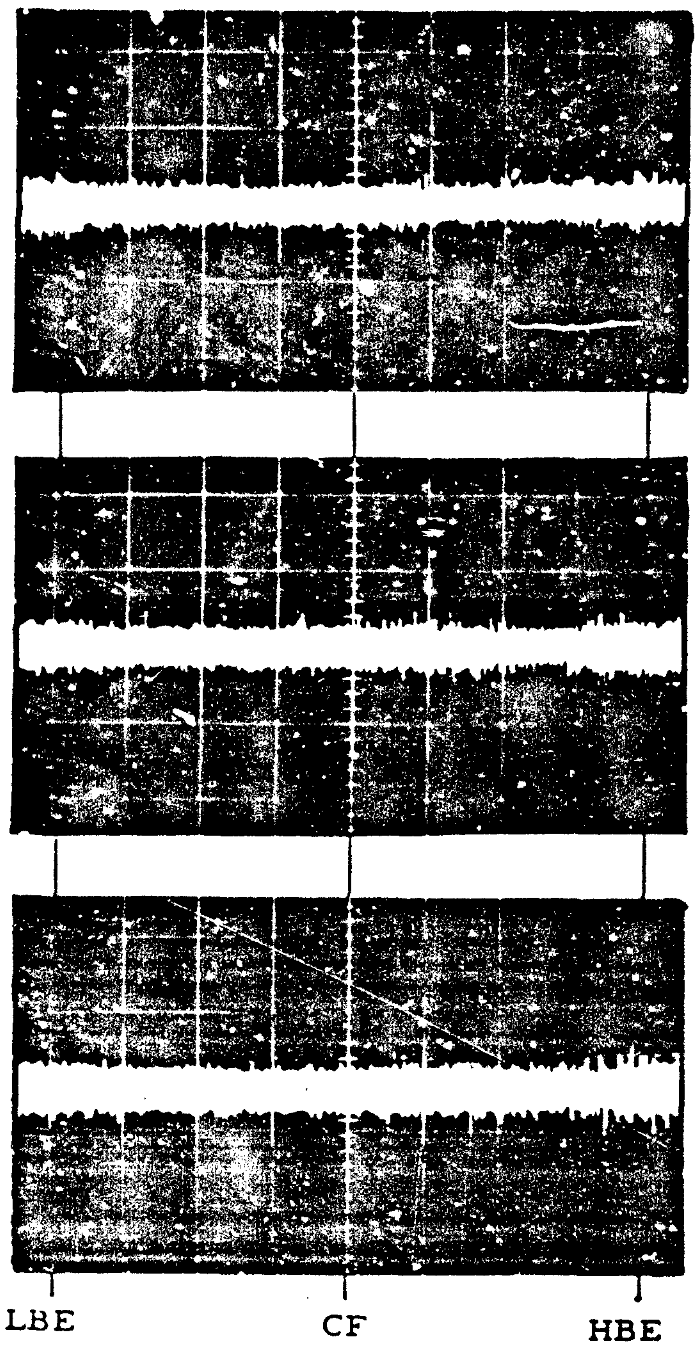
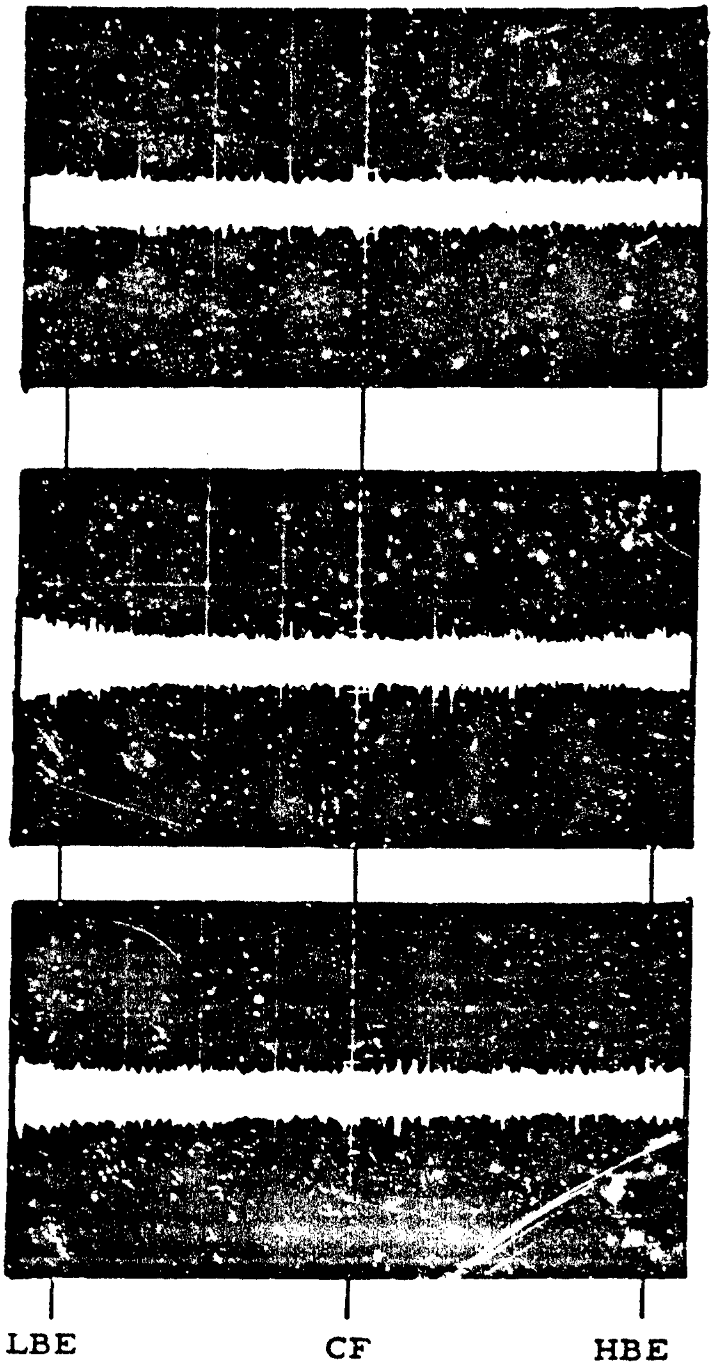


FIGURE II-3.3-35
INTERMODULATION TEST: EXPANDED WIDEBAND MULTIPLEX;
SEARCH CHANNEL DR = 5; CHANNELS 4, 5, AND 6



Channel 7, 2. 3 kc ±7. 5%
DR = 5
RMS Level = 17 mv max.

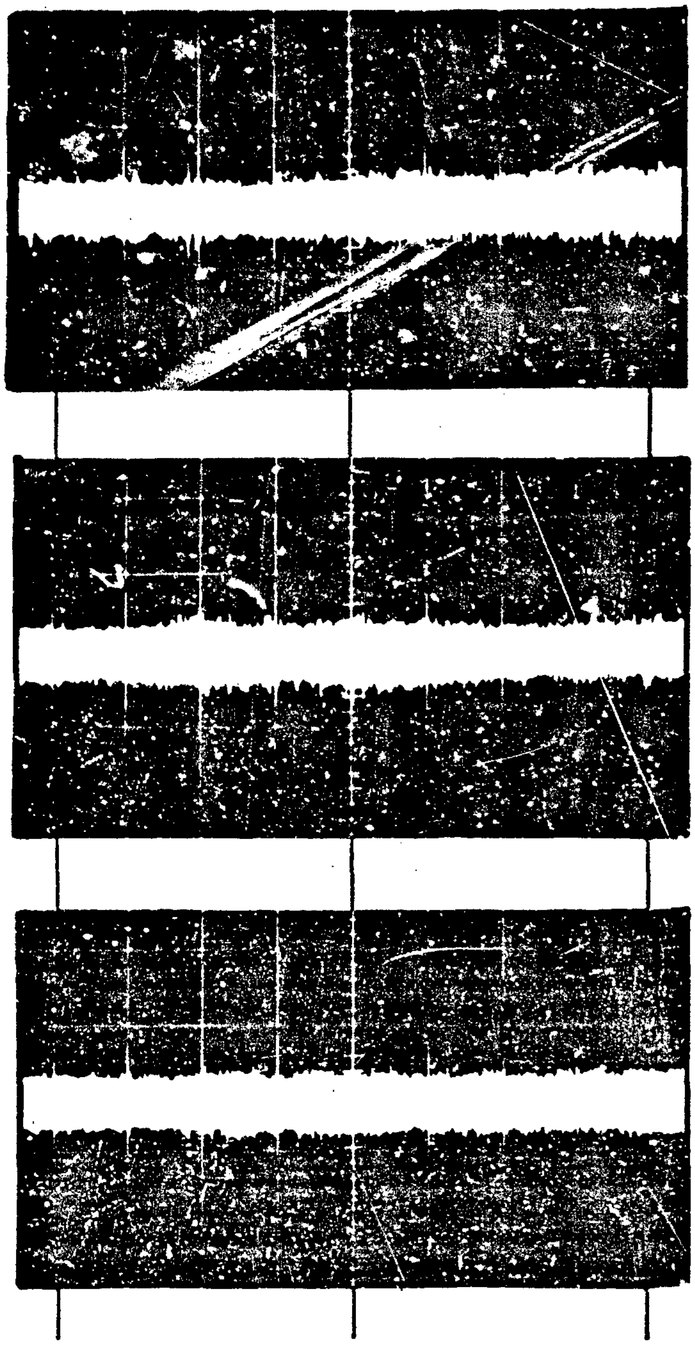
Channel 8, 3. 0 kc ±7. 5%
DR = 5
RMS Level = 15 mv max.

Channel 9, 3. 9 kc ±7. 5%
DR = 5
RMS Level = 16 mv max.

Horizontal: 5 sec/cm

Vertical: 0. 5% FBW/cm

FIGURE II-3. 3-36
INTERMODULATION TEST; EXPANDED WIDEBAND MULTIPLEX;
SEARCH CHANNEL DR = 5; CHANNELS 7, 8, AND 9



LBE CF HBE

Channel 10, 5. 4 kc ±7. 5%
DR = 5
RMS Level = 18 mv max.

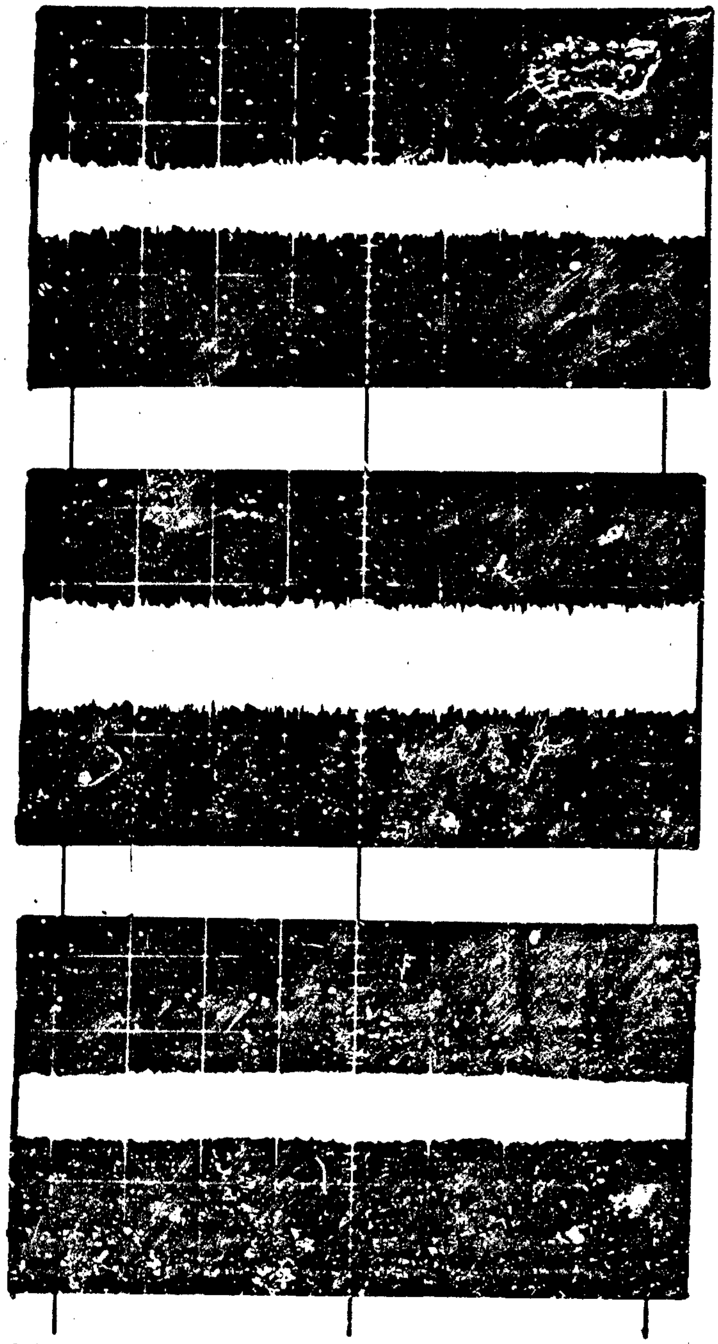
Channel 11, 7. 35 kc ±7. 5%
DR = 5
RMS Level = 18 mv max.

Channel 12, 10. 5 kc ±7. 5%
DR = 5
RMS Level = 16 mv max.

Horizontal: 5 sec/cm

Vertical: 0. 5% BW/cm

FIGURE II-3. 3-37
INTERMODULATION TEST: EXPANDED WIDEBAND MULTIPLEX;
SEARCH CHANNEL DR = 5; CHANNELS 10, 11, AND 12



Channel 13, 14. 5 kc ±7. 5%
DR = 5
RMS Level = 20 mv max.

Channel 14, 22 kc ±7. 5%
DR = 5
RMS Level = 27 mv max.

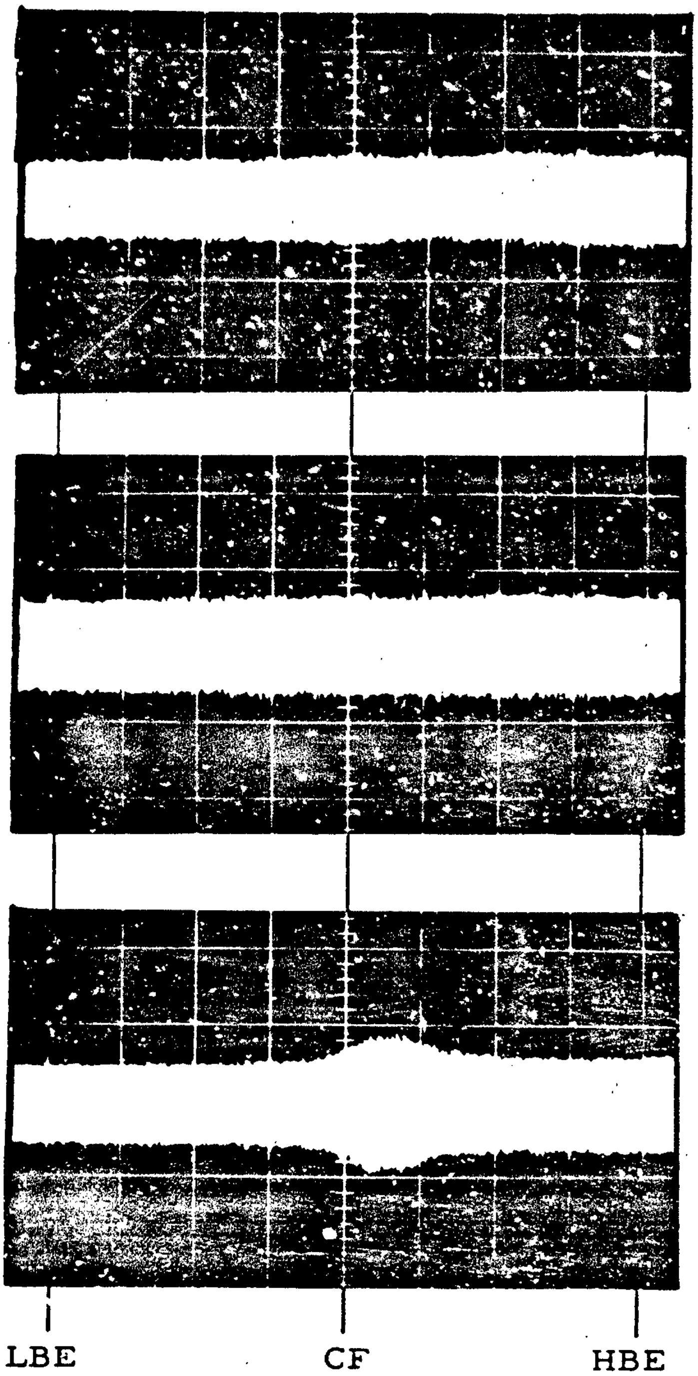
Channel 15, 30 kc ±7. 5%
DR = 5
RMS Level = 22 mv max.

LBE CF HBE

Horizontal: 5 sec/cm

Vertical: 0. 5% FBW/cm

FIGURE II-3. 3-38
INTERMODULATION TEST: EXPANDED WIDEBAND MULTIPLEX;
SEARCH CHANNEL DR = 5; CHANNELS 13, 14, AND 15



Channel 16, 40 kc ±7.5%
DR = 5
RMS Level = 23 mv max.

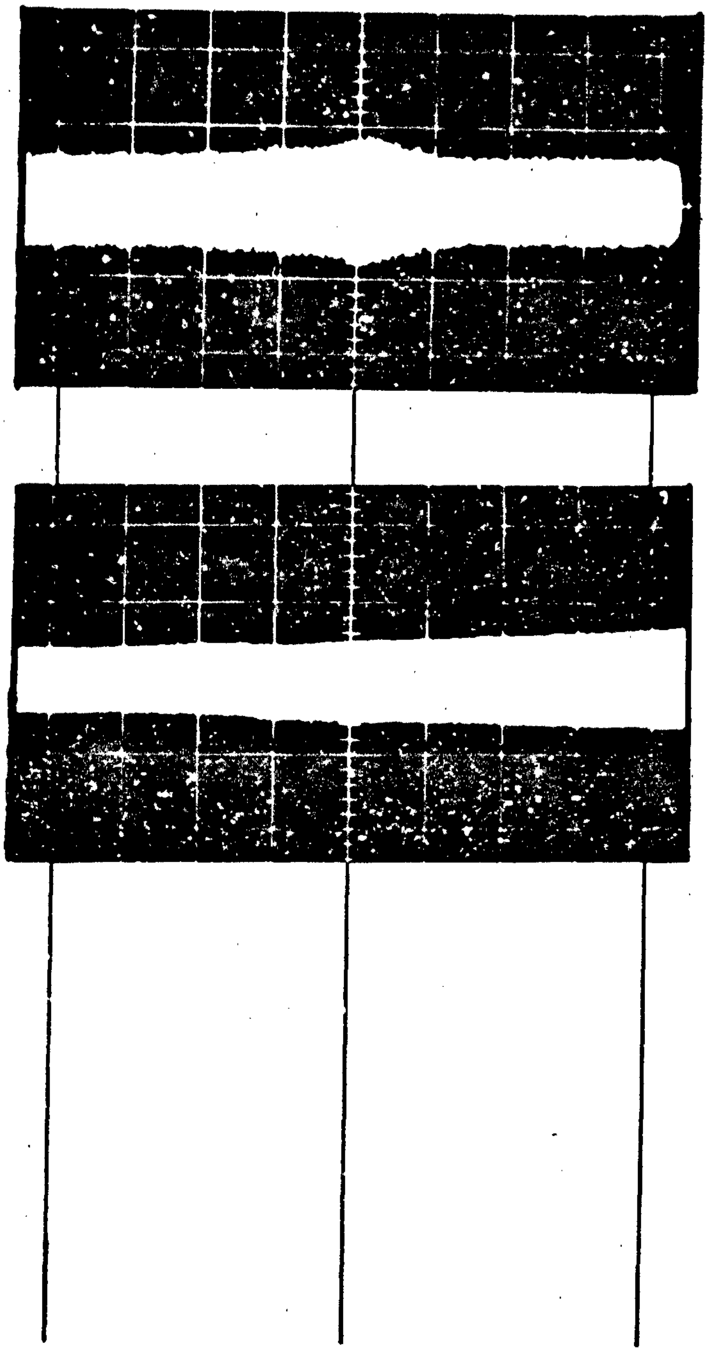
Channel 17, 52.5 kc ±7.5%
DR = 5
RMS Level = 24 mv max.

Channel 18, 70 kc ±7.5%
DR = 5
RMS Level = 30 mv max.

Horizontal: 5 sec/cm

Vertical: 0.5% FBW/cm

FIGURE II-3.3-39
INTERMODULATION TEST: EXPANDED WIDEBAND MULTIPLEX;
SEARCH CHANNEL DR = 5; CHANNELS 16, 17, AND 18



Channel 19, 93 kc ±7.5%
DR = 5
RMS Level = 25 mv max.

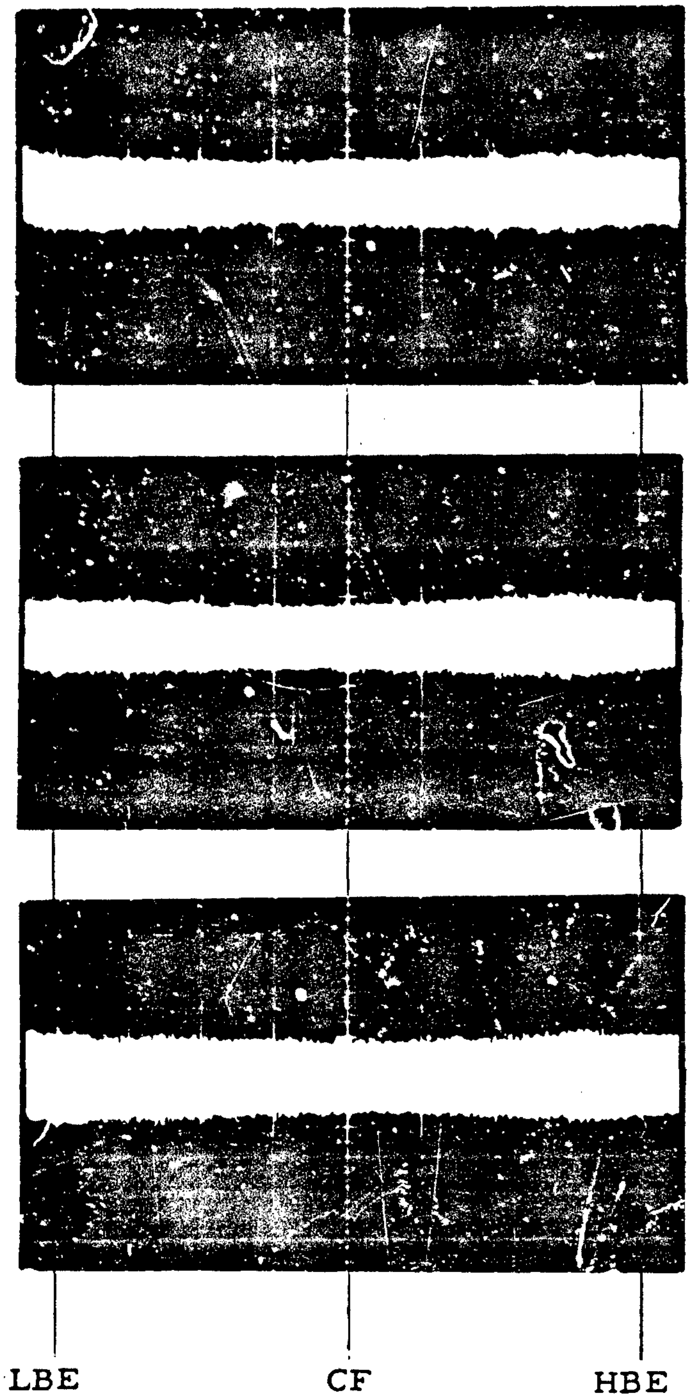
Channel H, 165 kc ±15%
DR = 5
RMS Level = 25 mv max.

LBE CF HBE

Horizontal: 5 sec/cm

Vertical: 0.5% FBW/cm

FIGURE II-3.3-40
INTERMODULATION TEST: EXPANDED WIDEBAND MULTIPLEX;
SEARCH CHANNEL DR = 5; CHANNEL 19 AND H



Channel 1, 16.0 kc ±2 kc

RMS Level - 86 mv max.

Channel 2, 24.0 kc ±2 kc

RMS Level = 94 mv max.

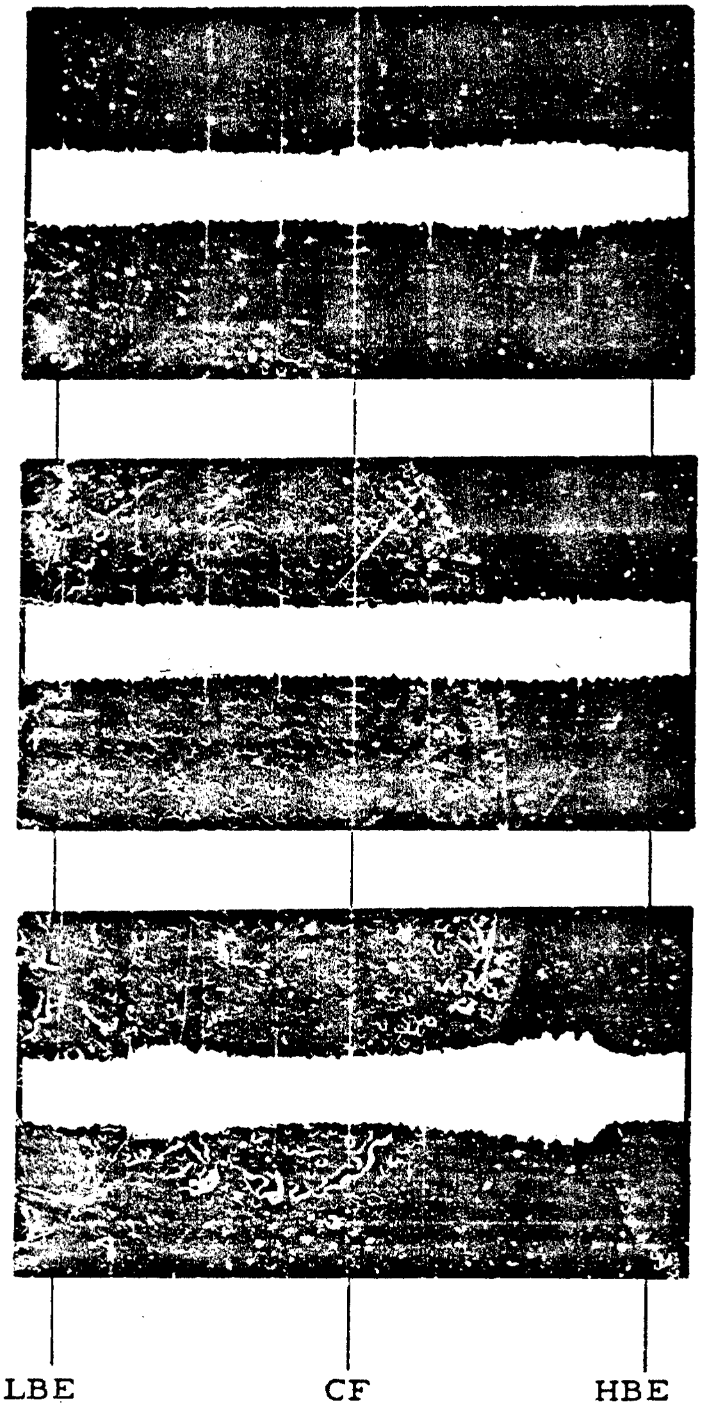
Channel 3, 32.0 kc ±2 kc

RMS Level = 110 mv max.

Horizontal: 5 sec/cm

Vertical: 2.5% FBW/cm

FIGURE II-3.3-41
INTERMODULATION TEST: CONSTANT-BANDWIDTH MULTIPLEX, MI = 20; SEARCH CHANNEL DR = 2; CHANNELS 1, 2, AND 3



Channel 4, 40.0 kc ±2 kc

RMS Level = 97 mv max.

Channel 5, 48.0 kc ±2 kc

RMS Level = 94 mv max.

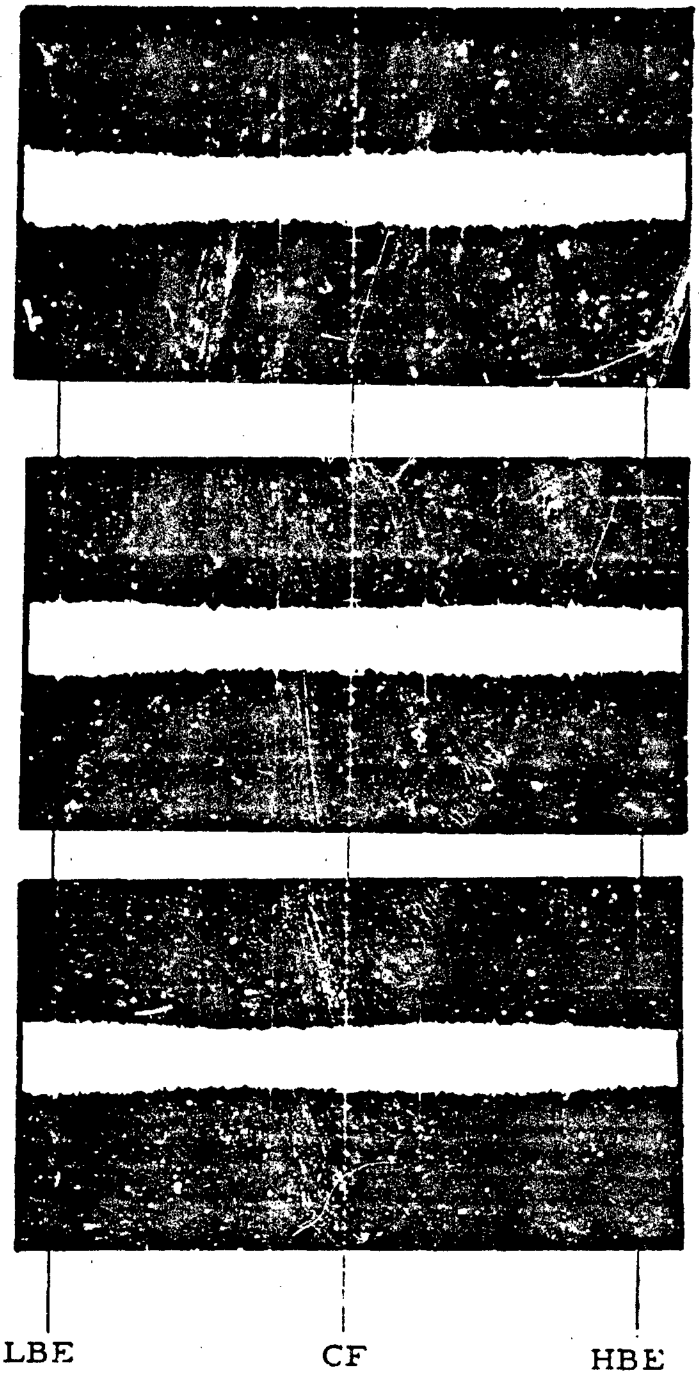
Channel 6, 56.0 kc ±2 kc

RMS Level = 140 mv max.

Horizontal: 5 sec/cm

Vertical: 2.5% FBW/cm

FIGURE II-3.3-42
INTERMODULATION TEST: CONSTANT-BANDWIDTH MULTIPLEX, MI = 20;
SEARCH CHANNEL DR = 2; CHANNELS 4, 5, AND 6



Channel 7, 64.0 kc ±2 kc

RMS Level = 86 mv max.

Channel 8, 72.0 kc ±2 kc

RMS Level = 85 mv max.

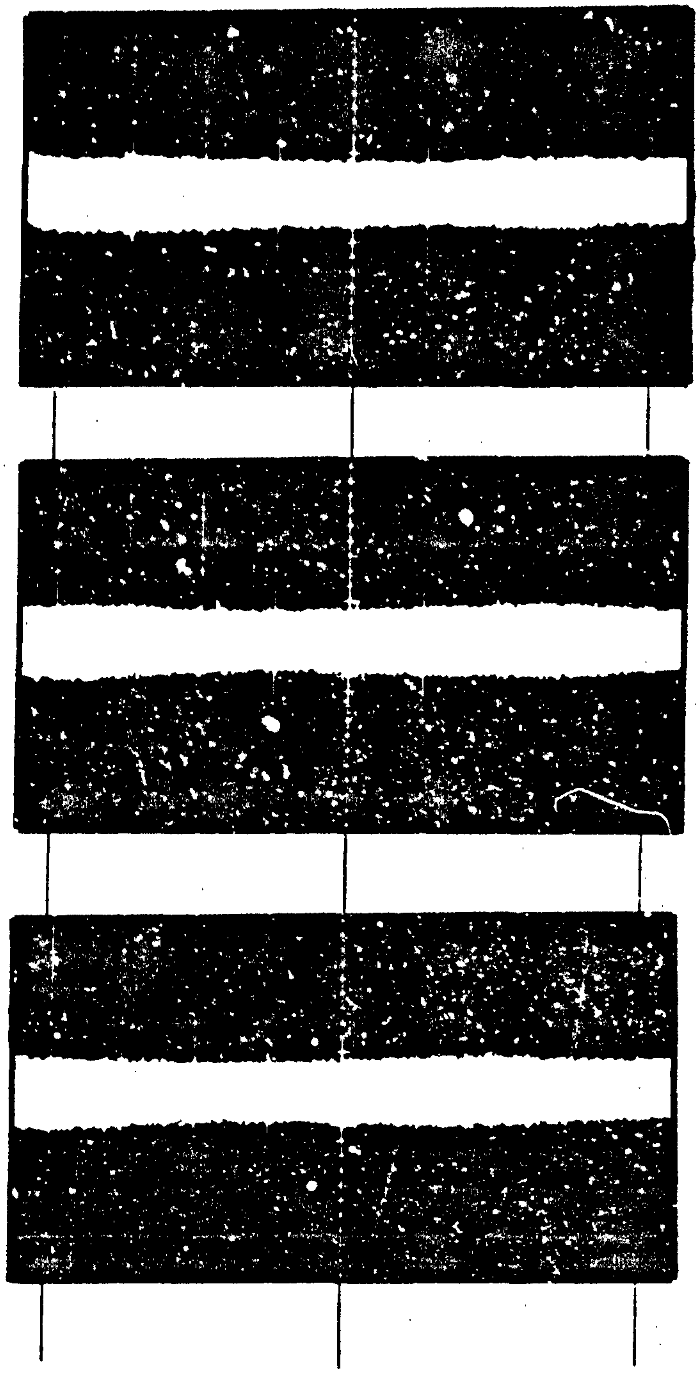
Channel 9, 80.0 kc ±2 kc

RMS Level = 86 mv max.

Horizontal: 5 sec/cm

Vertical: 2.5% FBW/cm

FIGURE II-3.3-43
INTERMODULATION TEST: CONSTANT-BANDWIDTH MULTIPLEX, MI = 20; SEARCH CHANNEL DR = 2; CHANNELS 7, 8, and 9



Channel 10, 88.0 kc ±2 kc

RMS Level = 89 mv max.

Channel 11, 96.0 kc ±2 kc

RMS Level = 87 mv max.

Channel 12, 104.0 kc ±2 kc

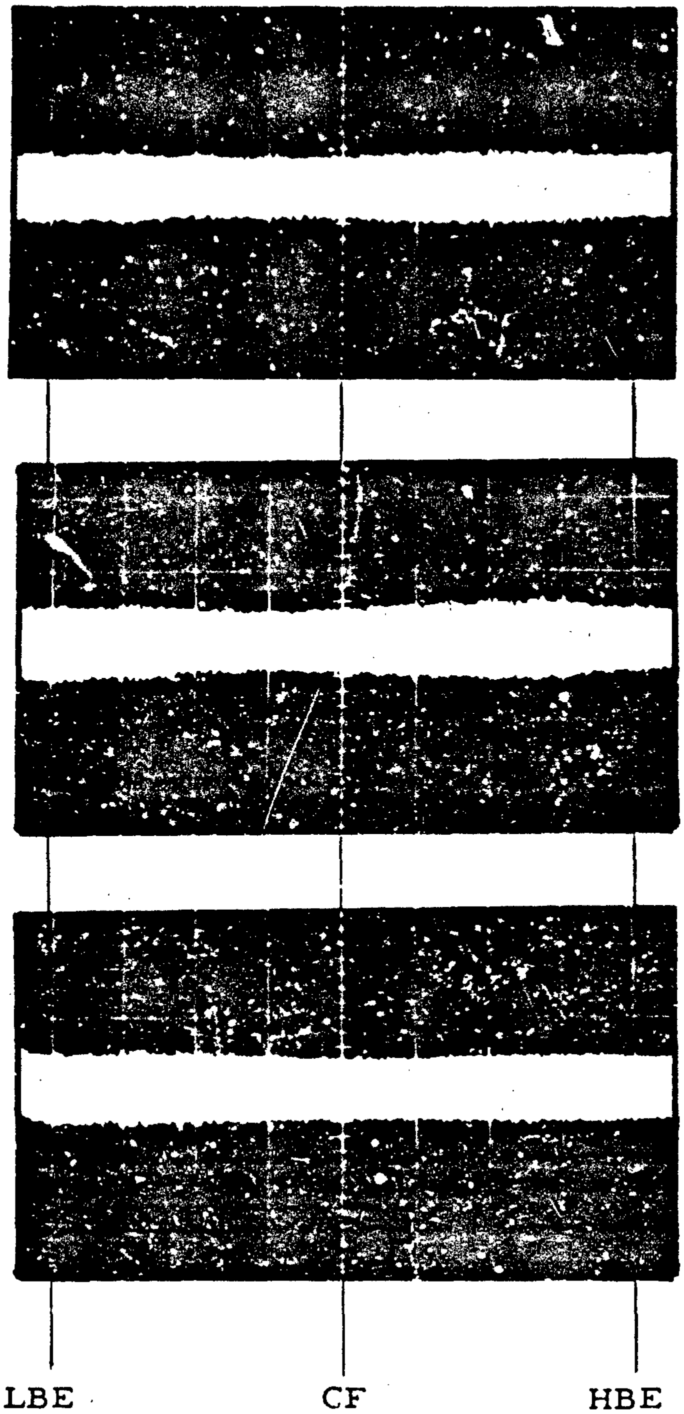
RMS Level = 86 mv max.

LBE CF HBE

Horizontal: 5 sec/cm

Vertical: 2.5% FBW/cm

FIGURE II-3.3-44
INTERMODULATION TEST: CONSTANT-BANDWIDTH MULTIPLEX, MI =20;
SEARCH CHANNEL DR = 2; CHANNELS 10, 11, AND 12



Channel 13, 112.0 kc ±2 kc

RMS Level = 81 mv max.

Channel 14, 120.0 kc ±2 kc

RMS Level = 90 mv max.

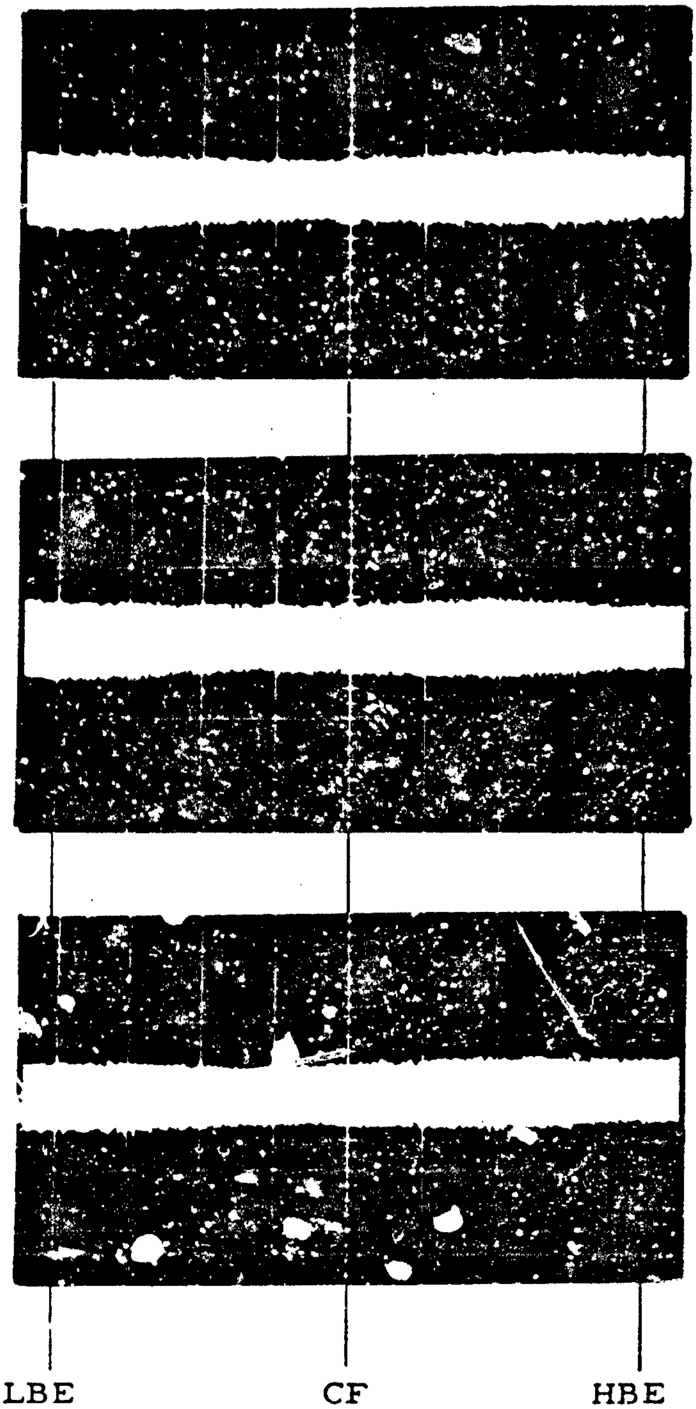
Channel 15, 128.0 kc ±2 kc

RMS Level = 83 mv max.

Horizontal: 5 sec/cm

Vertical: 2.5% FBW/cm

FIGURE II-3.3-45
INTERMODULATION TEST: CONSTANT-BANDWIDTH MULTIPLEX, MI = 20; SEARCH CHANNEL DR = 2; CHANNELS 13, 14, AND 15



Channel 16, 136.0 kc ±2 kc

RMS Level = 85 mv max.

Channel 17, 144.0 kc ±2 kc

RMS Level = 86 mv max.

Channel 18, 152.0 kc ±2 kc

RMS Level = 81 mv max.

Horizontal: 5 sec/cm

Vertical: 2.5% FBW/cm

FIGURE II-3.3-46
INTERMODULATION TEST: CONSTANT-BANDWIDTH MULTIPLEX, MI = 20;
SEARCH CHANNEL DR = 2; CHANNELS 16, 17, AND 18

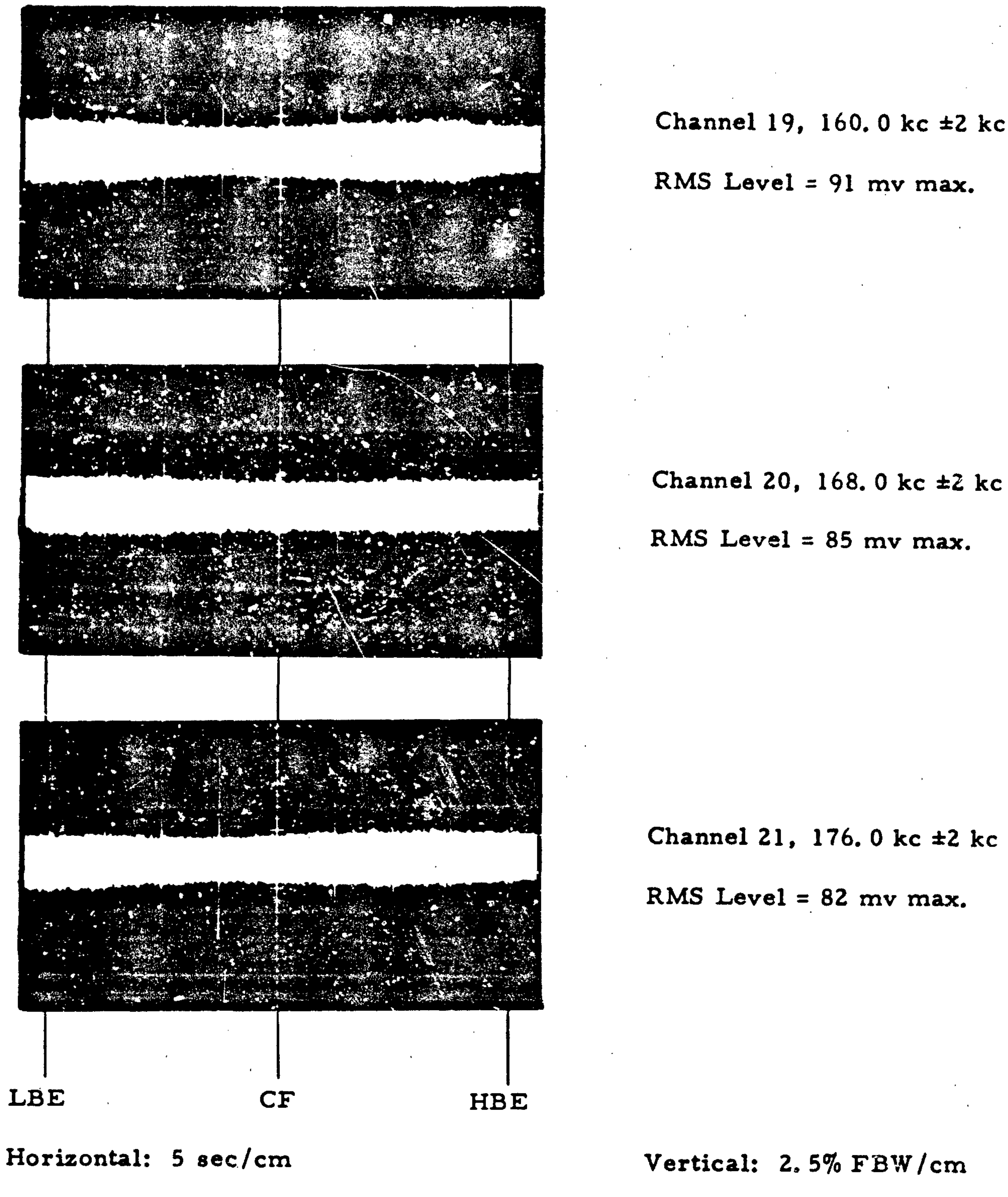
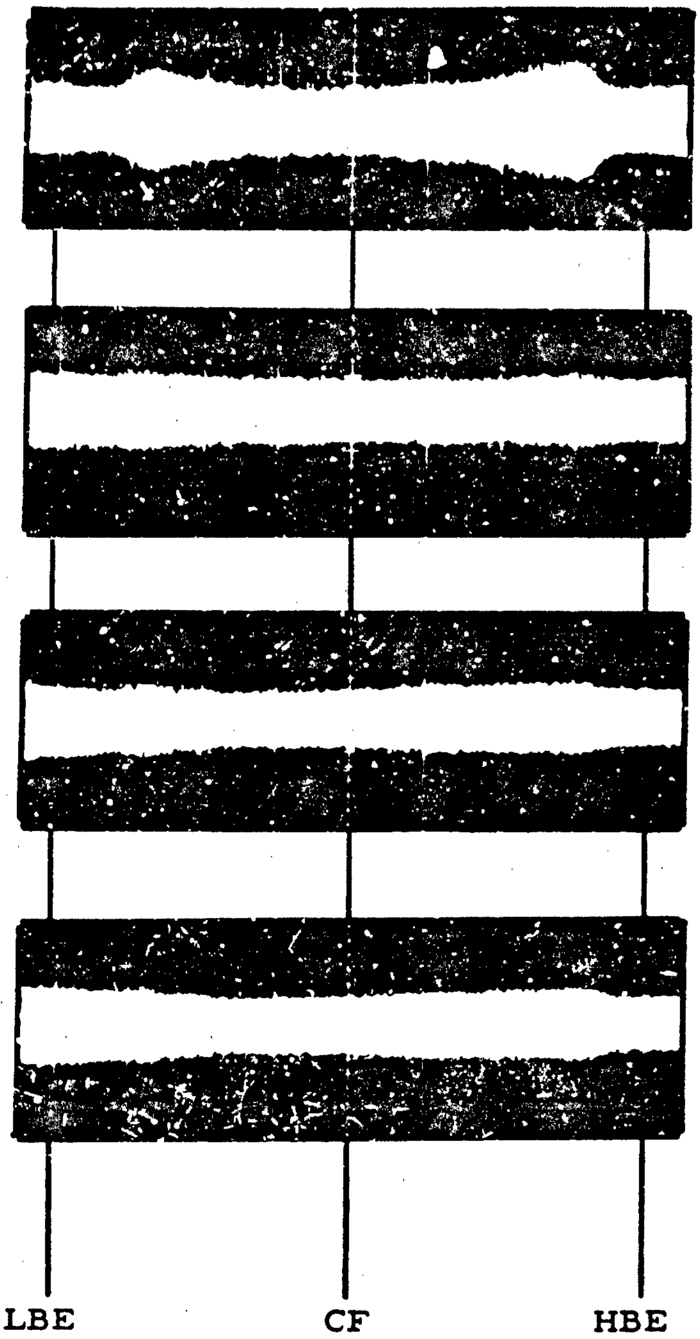


FIGURE II-3.3-47
INTERMODULATION TEST: CONSTANT-BANDWIDTH MULTIPLEX, MI = 20; SEARCH CHANNEL DR = 2; CHANNELS 19, 20, AND 21



Channel 6: 56. 0 kc ±2 kc

RMS Level = 152 mv max.

Channel 10: 88. 0 kc ±2 kc

RMS Level = 93 mv max.

Channel 14: 120. 0 kc ±2 kc

RMS Level = 92 mv max.

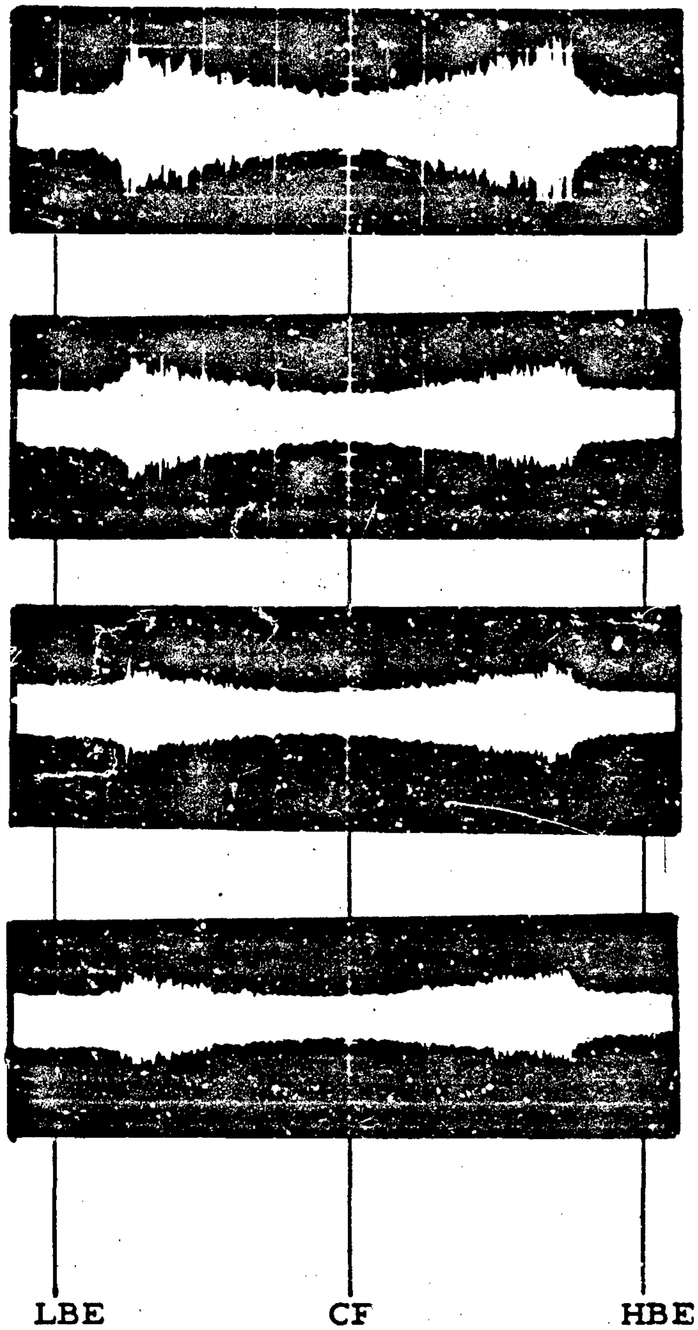
Channel 19: 160. 0 kc ±2 kc

RMS Level = 94 mv max.

Horizontal: 5 sec/cm

Vertical: 2. 5% FBW/cm

FIGURE II-3. 3-48
INTERMODULATION TEST: CONSTANT-BANDWIDTH MULTIPLEX, MI = 2;
SEARCH CHANNEL DR = 2; CHANNELS 6, 10, 14, AND 19



Channel 6, 56. 0 kc ±2 kc

RMS Level = 200 mv max.

Channel 10, 88. 0 kc ±2 kc

RMS Level = 128 mv max.

Channel 14, 120. 0 kc ±2 kc

RMS Level = 120 mv max.

Channel 19, 160. 0 kc ±2 kc

RMS Level = 106 mv max.

Horizontal: 5 sec/cm

Vertical: 2. 5% FBW/cm

FIGURE II-3. 3-49
INTERMODULATION TEST: CONSTANT BANDWIDTH MULTIPLEX, VCO'S AT CENTER FREQUENCY; SEARCH CHANNEL DR = 2; CHANNELS 6, 10, 14, AND 19

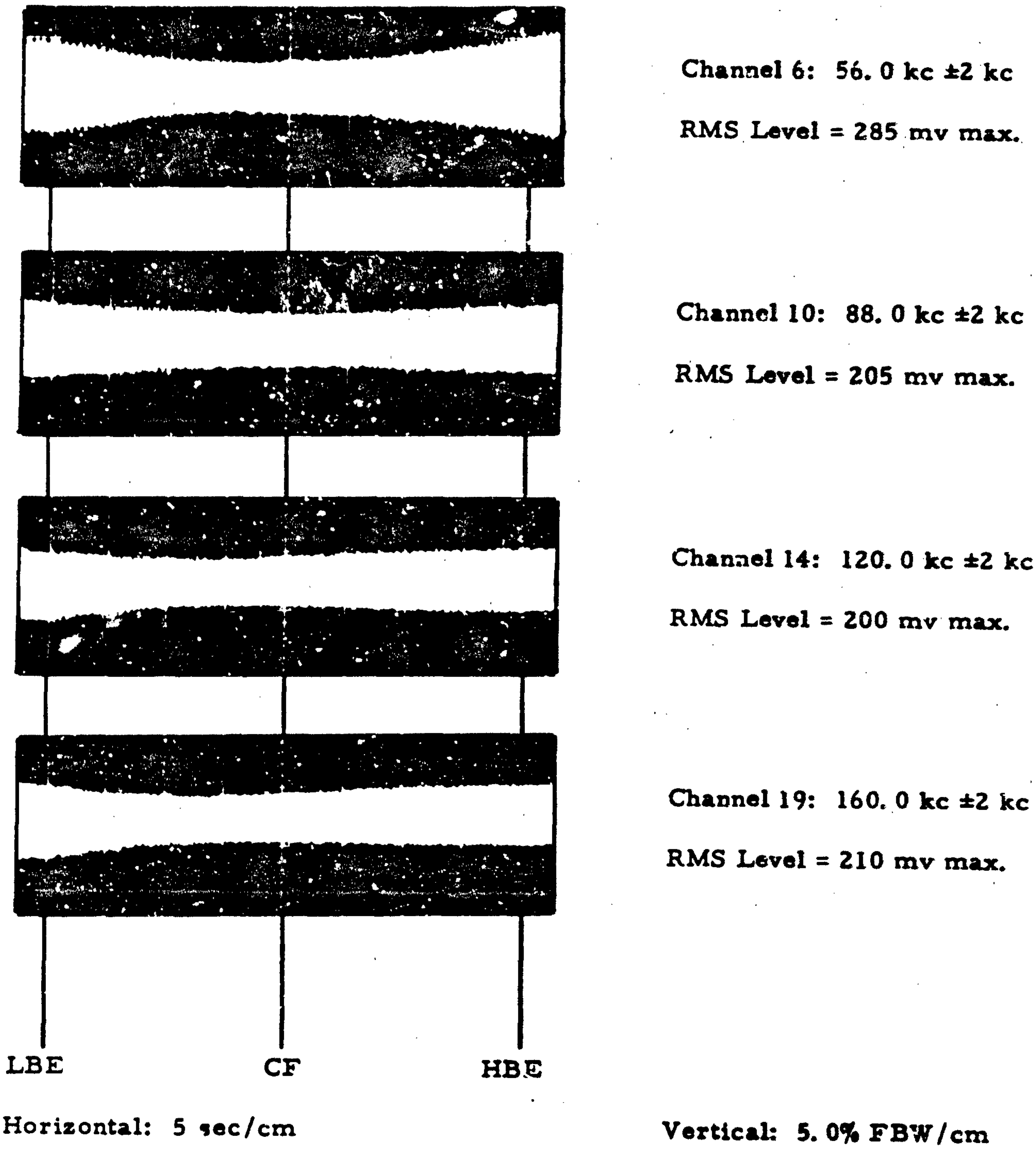
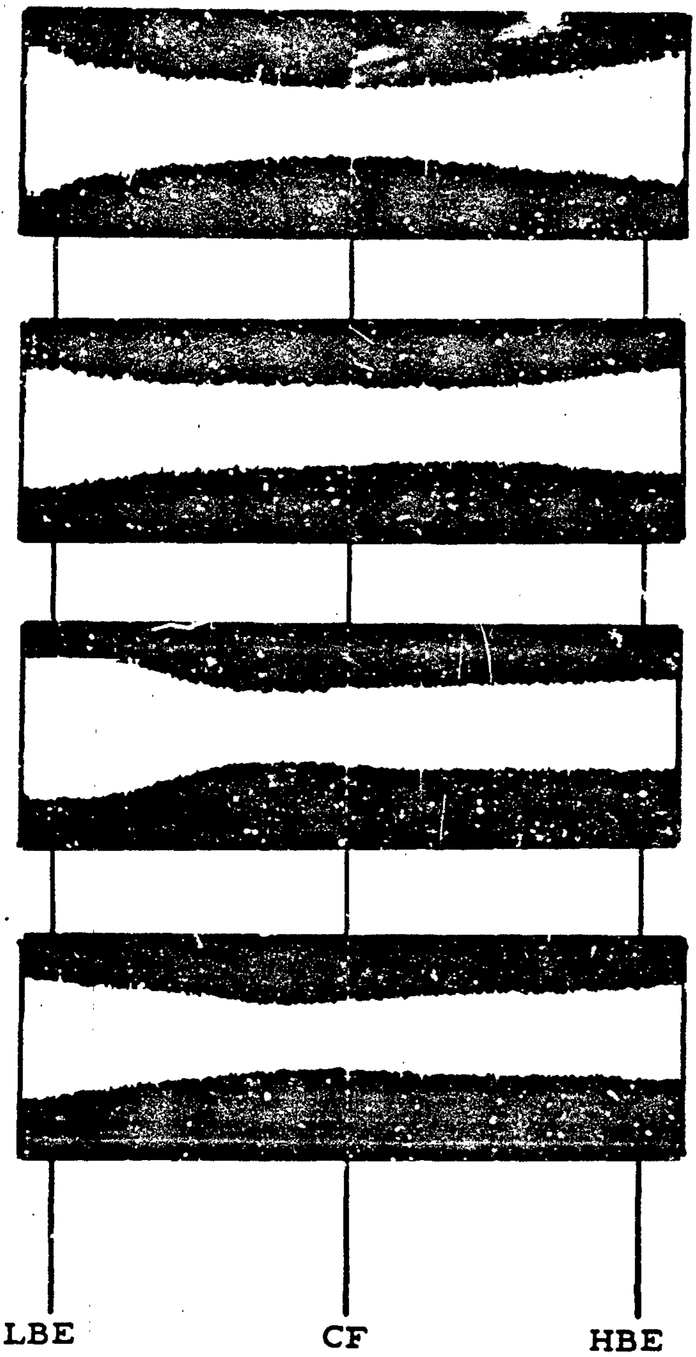


FIGURE II-3. 3-50
INTERMODULATION TEST: CONSTANT-BANDWIDTH MULTIPLEX, MI = 20;
SEARCH CHANNEL DR = 1; CHANNELS 6, 10, 14, AND 19



Channel 6: 56.0 kc ±2 kc

RMS Level = 330 mv max.

Channel 10: 88.0 kc ±2 kc

RMS Level = 310 mv max

Channel 14: 120.0 kc ±2 kc

RMS Level = 440 mv max

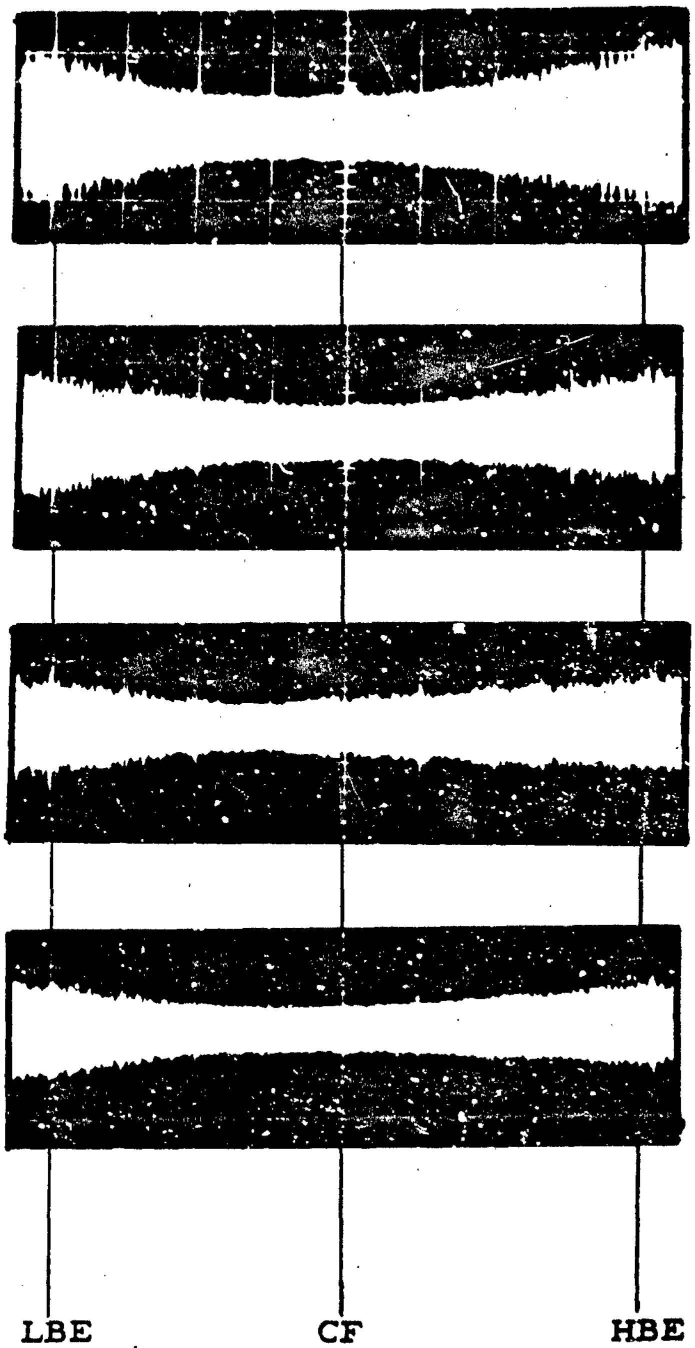
Channel 19: 160.0 kc ±2 kc

RMS Level = 300 mv max.

Horizontal: 5 sec/cm

Vertical: 5.0% FBW/cm

FIGURE II-3.3-51
INTERMODULATION TEST: CONSTANT-BANDWIDTH MULTIPLEX, MI = 1;
SEARCH CHANNEL DR = 1; CHANNELS 6, 10, 14, AND 19



Channel 6, 56.0 kc ±2 kc

RMS Level = 330 mv max.

Channel 10, 88.0 kc ±2 kc

RMS Level = 260 mv max.

Channel 14, 120.0 kc ±2 kc

RMS Level = 220 mv max.

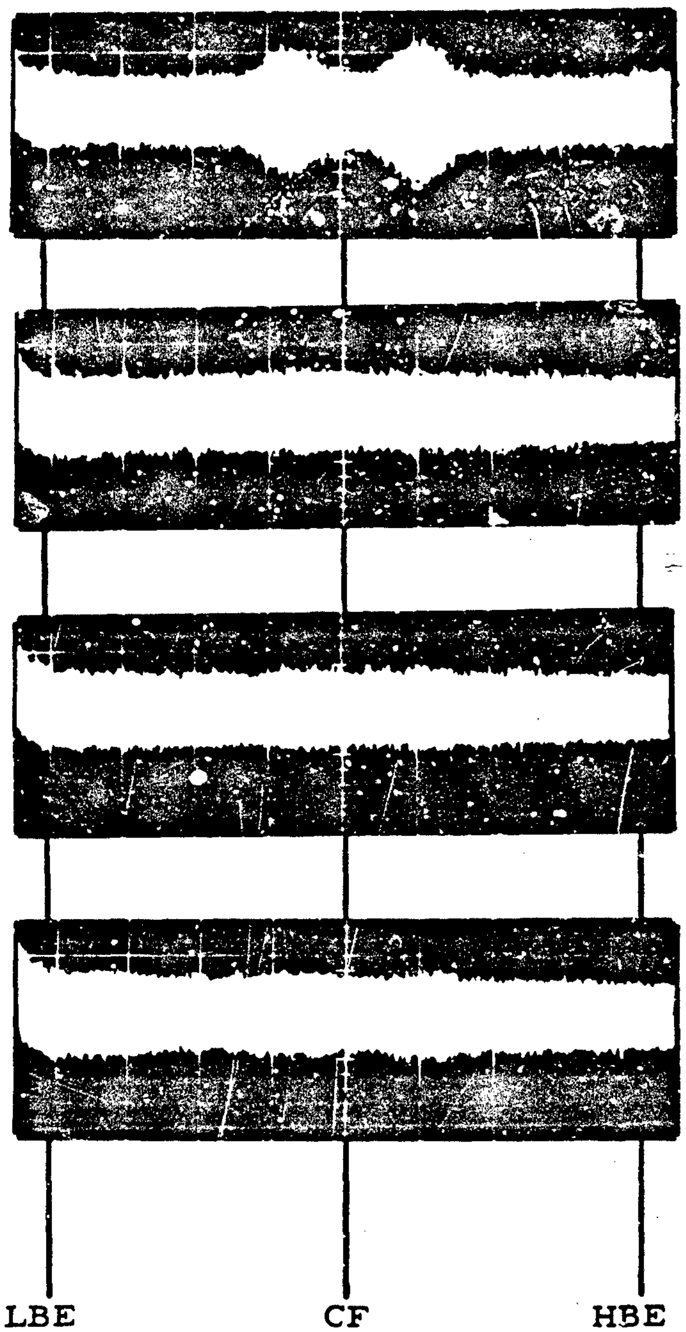
Channel 19, 160.0 kc ±2 kc

RMS Level = 218 mv max.

Horizontal: 5 sec/cm

Vertical: 5.0% FBW/cm

FIGURE II-3.3-52
INTERMODULATION TEST: CONSTANT BANDWIDTH MULTIPLEX,
VCO'S AT CENTER FREQUENCY; SEARCH CHANNEL DR = 1;
CHANNELS 6, 10, 14, AND 19



Channel 6: 56.0 kc ±2 kc

RMS Level = 34 mv max.

Channel 10: 88.0 kc ±2 kc

RMS Level = 17.5 mv max.

Channel 14: 120.0 kc ±2 kc

RMS Level = 18.6 mv max.

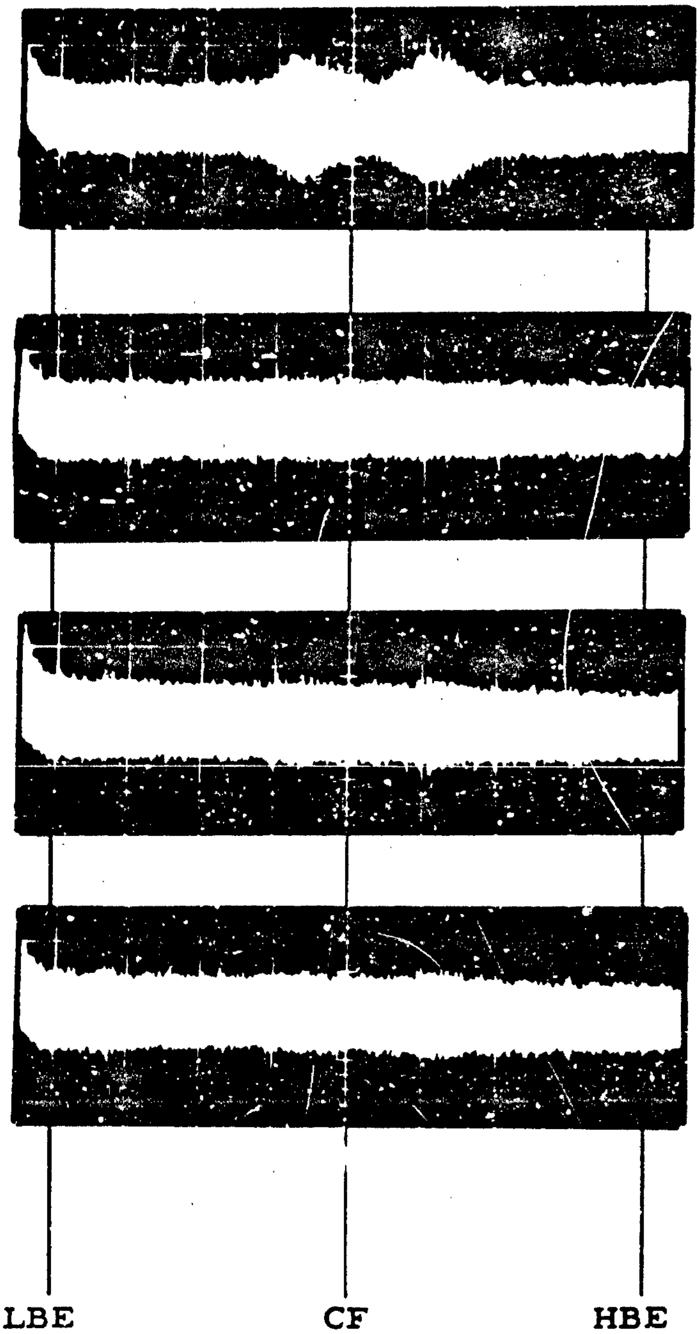
Channel 19: 160.0 kc ±2 kc

RMS Level = 19.5 mv max.

Horizontal: 5 sec/cm

Vertical: 0.5% FBW/cm

FIGURE II-3.3-53
INTERMODULATION TEST: CONSTANT-BANDWIDTH MULTIPLEX, MI = 20;
SEARCH CHANNEL DR = 4; CHANNELS 6, 10, 14, AND 19



Channel 6: 56. 0 kc ±2 kc

RMS Level = 32. 0 mv max.

Channel 10: 88. 0 kc ±2 kc

RMS Level = 18. 0 mv max.

Channel 14: 120. 0 kc ±2 kc

RMS Level = 19. 2 mv max.

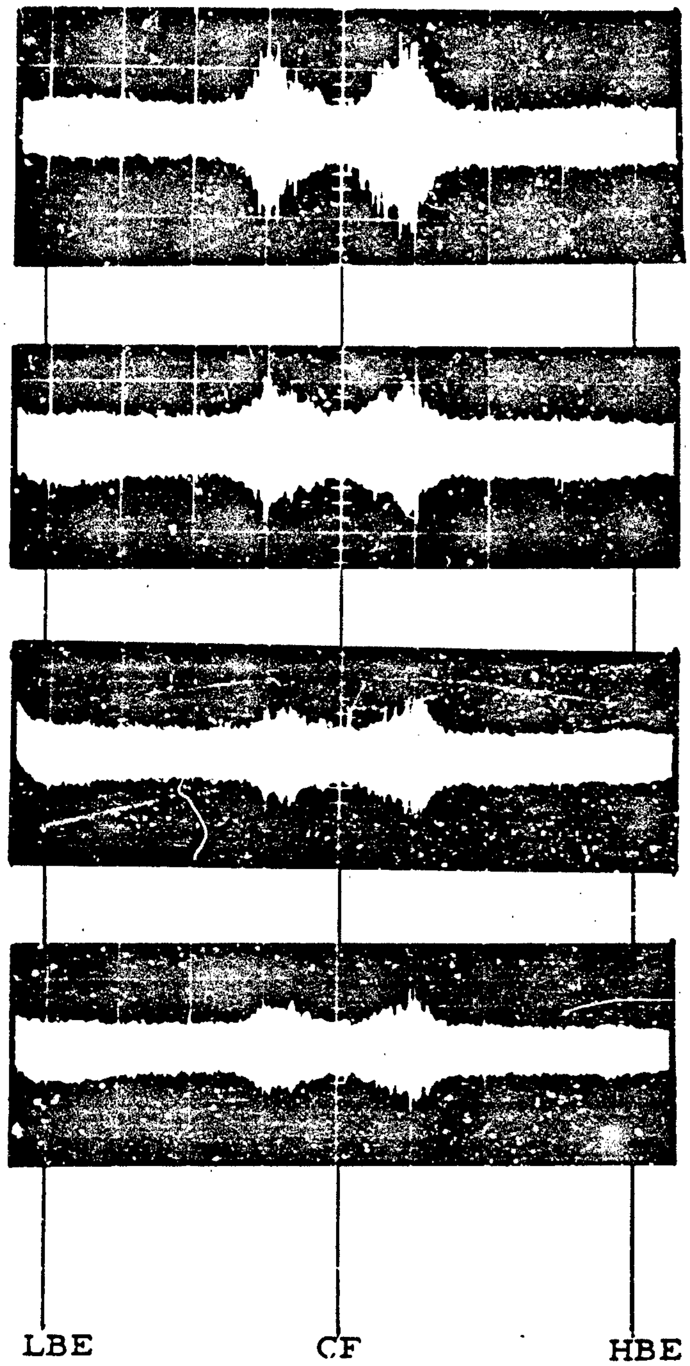
Channel 19: 160. 0 kc ±2 kc

RMS Level = 19. 6 mv max.

Horizontal: 5 sec/cm

Vertical: 0. 5% FBW/cm

FIGURE II-3. 3-54
INTERMODULATION TEST: CONSTANT-BANDWIDTH MULTIPLEX, MI = 4;
SEARCH CHANNEL DR = 4; CHANNELS 6, 10, 14, AND 19



Channel 6, 56.0 kc ±2 kc

RMS Level = 40.0 mv max.

Channel 10, 88.0 kc ±2 kc

RMS Level = 26.0 mv max.

Channel 14, 120.0 kc ±2 kc

RMS Level = 26.0 mv max.

Channel 19, 160.0 kc ±2 kc

RMS Level = 23.6 mv max.

Horizontal: 5 sec/cm

Vertical: 0.5% FBW/cm

FIGURE II-3.3-55
INTERMODULATION TEST: CONSTANT BANDWIDTH MULTIPLEX, VCO'S AT CENTER FREQUENCY; SEARCH CHANNEL DR = 4; CHANNELS 6, 10, 14, AND 19

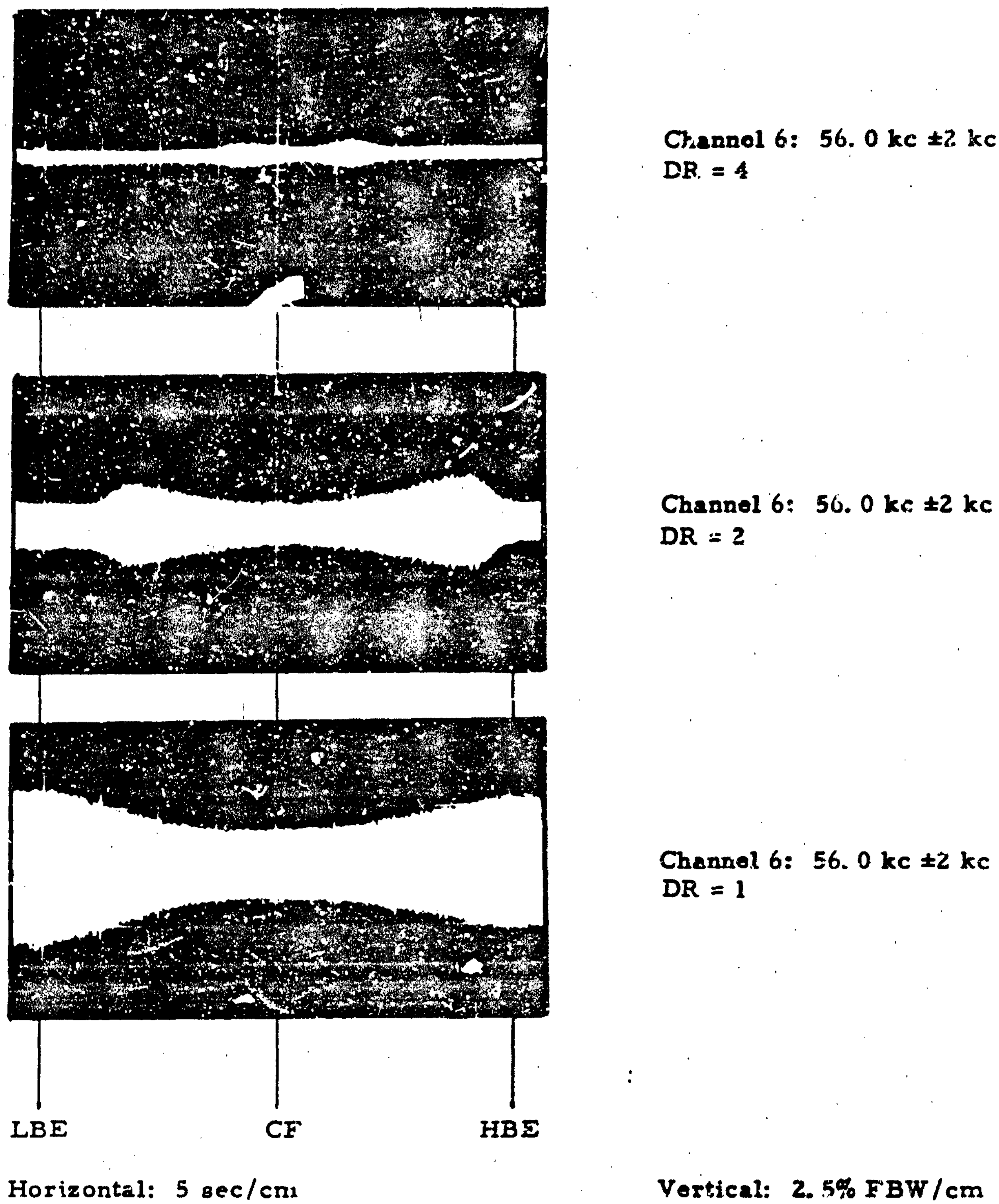


FIGURE II-3. 3-56
INTERMODULATION TEST: CONSTANT-BANDWIDTH MULTIPLEX, DEVIATION RATIO COMPARISON, MI = 20; SEARCH CHANNEL DR = 4, 2, AND 1; CHANNEL 6

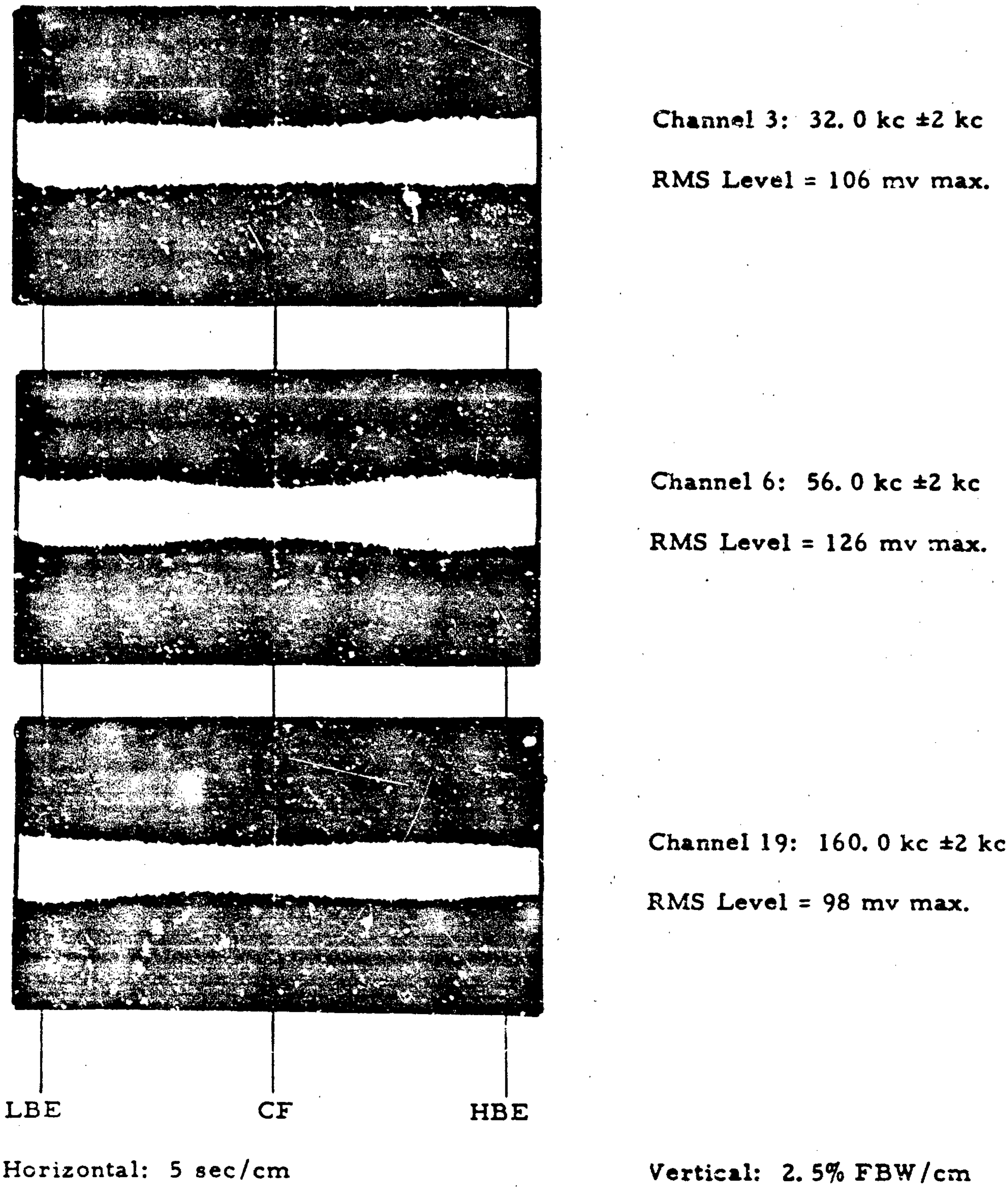
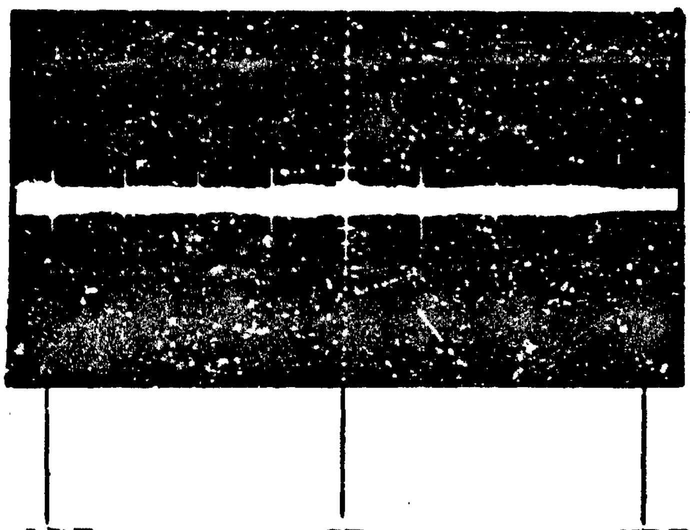


FIGURE II-3. 3-57
INTERMODULATION TEST: CONSTANT-BANDWIDTH MULTIPLEX, MI = 20, WITH CONSTANT-AMPLITUDE, 18 DB/OCT OUTPUT FILTERS; SEARCH CHANNEL DR = 2; CHANNELS 3, 6, AND 19



Channel 6, 56.0 kc ±2 kc

RMS Level = 30 mv

Horizontal: 5 sec/cm

Vertical: 2.5% FBW/cm

FIGURE II-3.3-58
INTERMODULATION TEST: CONSTANT BANDWIDTH MULTIPLEX,
WITH RADIO FREQUENCY EQUIPMENT BYPASSED, MI = 20;
SEARCH CHANNEL DR = 2; CHANNEL 6

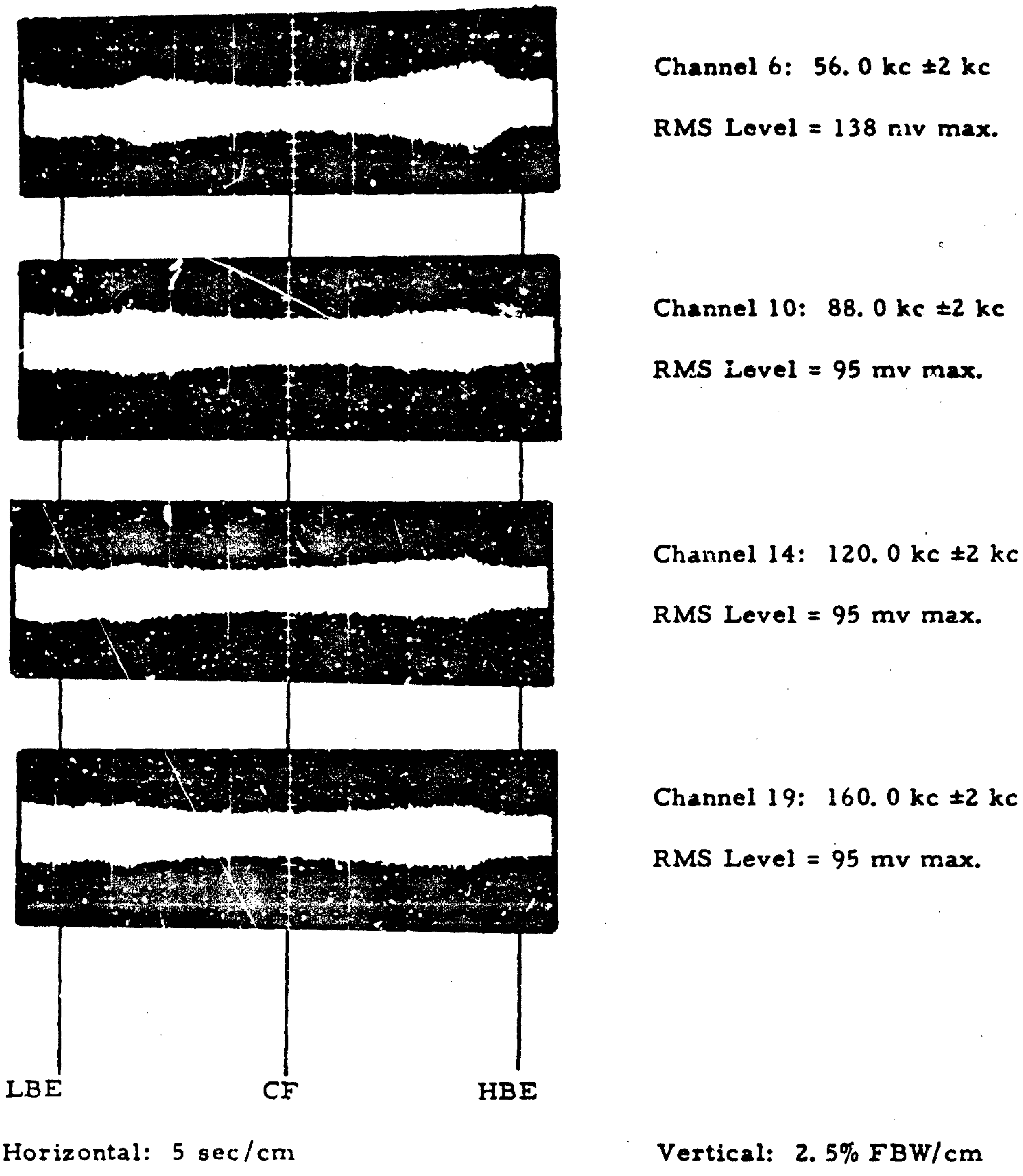
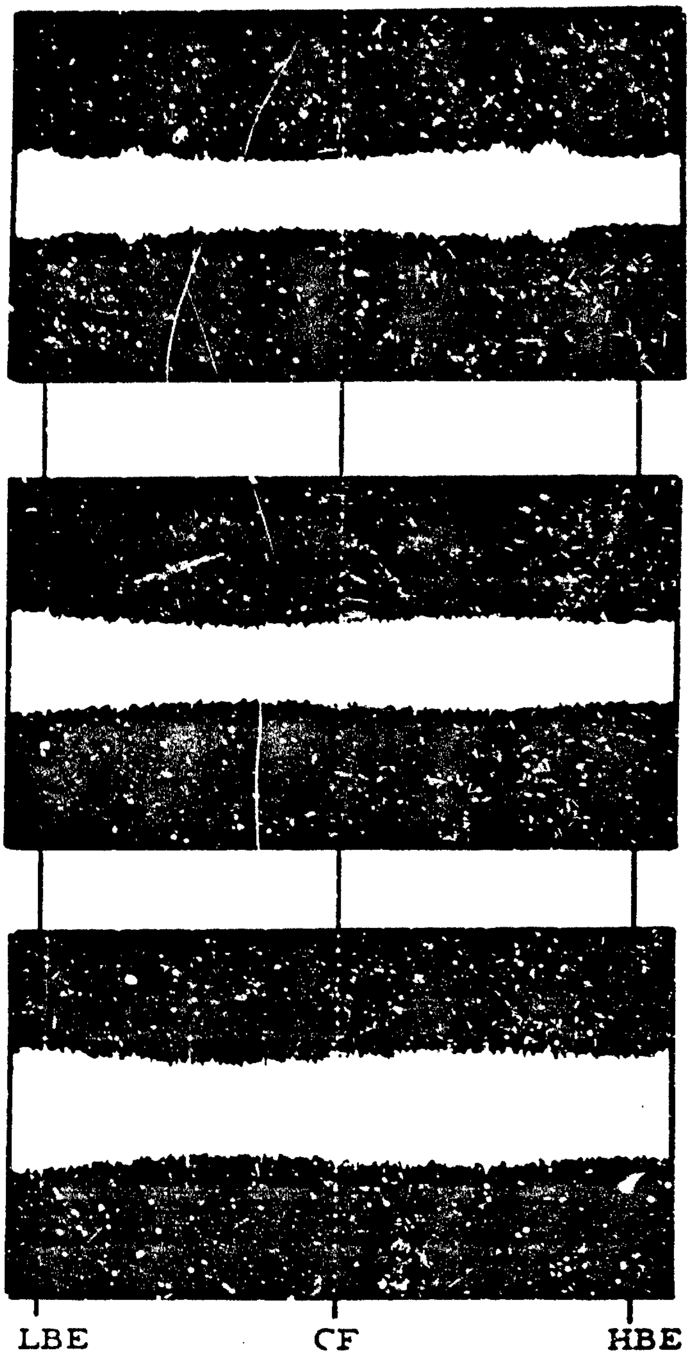


FIGURE II-3. 3-59
INTERMODULATION TEST: CONSTANT-BANDWIDTH MULTIPLEX, MI = 20,
USING DEFENSE ELECTRONICS TMR-2A RECEIVER;
SEARCH CHANNEL DR = 2; CHANNELS 6, 10, 14 AND 19



Standard Intermodulation Test: Leach FM 200 replaced by EMR 246A Transmitter
RMS Level = 134 mv max.

Effect of IF Bandwidth: Nems-Clarke 1455A 500 kc IF replaced with Nems-Clarke Special 1703A 1.0 Mc IF Receiver
RMS Level = 118 mv max.

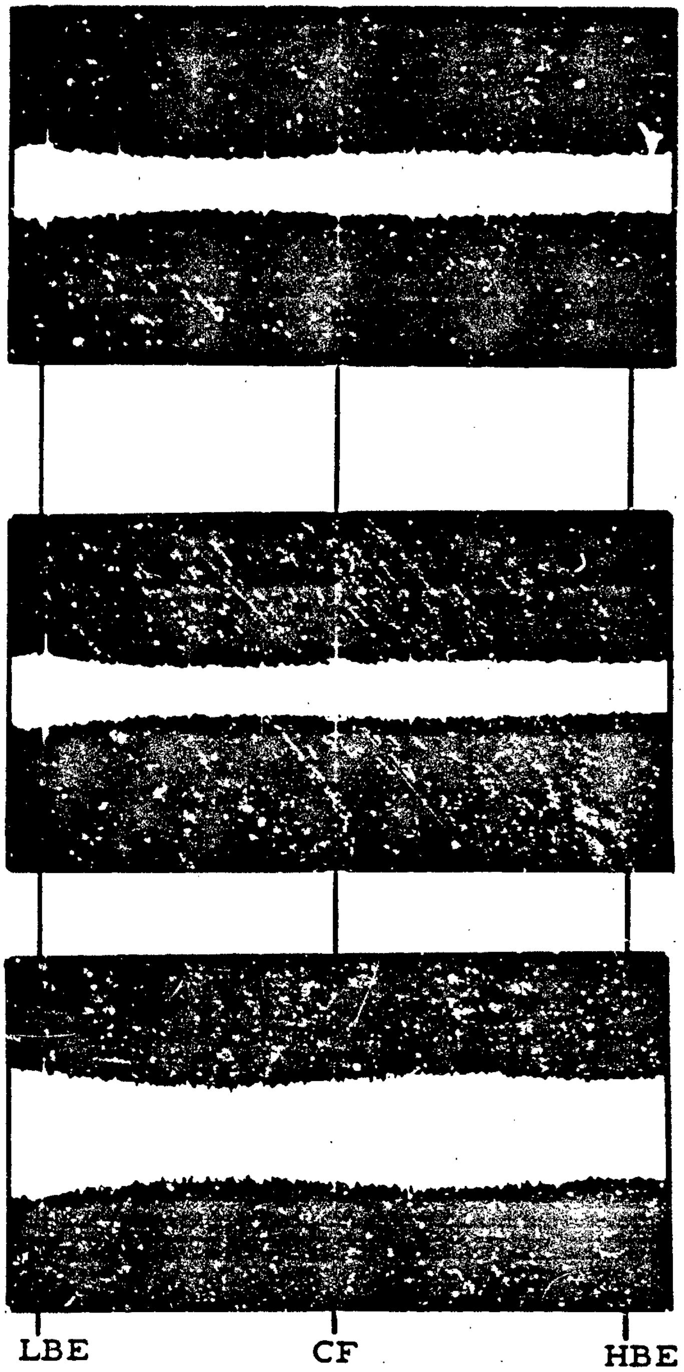
Effect of Uncorrelated VCO Modulation: EMR 246A and 500 kc IF Nems-Clarke 1455A with VCO's individually modulated with 100 cps sources.
RMS Level = 132 mv max.

Horizontal: 5 sec/cm

Vertical: 2.5% FBW/cm

Search Channel: CBW Channel 6, 56.0 kc ±2 kc, DR = 2
All Other Channels: MI = 2

FIGURE II-3.3-60
INTERMODULATION TEST: CONSTANT BANDWIDTH MULTIPLEX USING EMR 246A TRANSMITTER; EFFECTS OF 1.0 MC IF BANDWIDTH AND SEPARATE 100 CPS SOURCES; CBW CHANNEL 6



Error Due to Receiver Noise: Search Channel Only Turned On RMS Level = 72 mv max.

Effect of a Reduced Number of Channels: EMR 246A and 500 kc IF Nems-Clarke 1455A with only 16 lower frequency VCO's individually modulated at 100 cps RMS Level = 60 mv max.

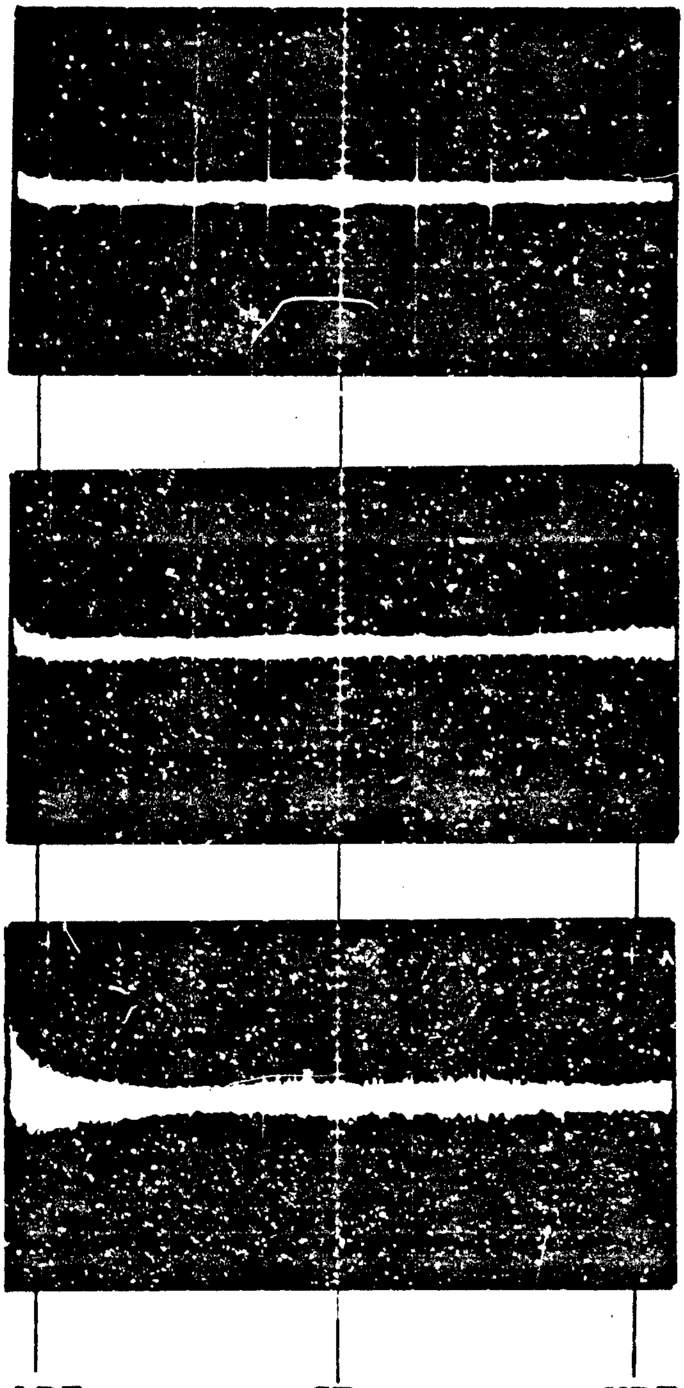
Effect of Reduced Transmitter Deviation: EMR 246A and 500 kc IF Nems-Clarke with transmitter drive reduced by half; all 21 channels individually modulated at 100 cps RMS Level = 144 mv max.

Horizontal: 5 sec/cm

Vertical: 2.5% FBW/cm

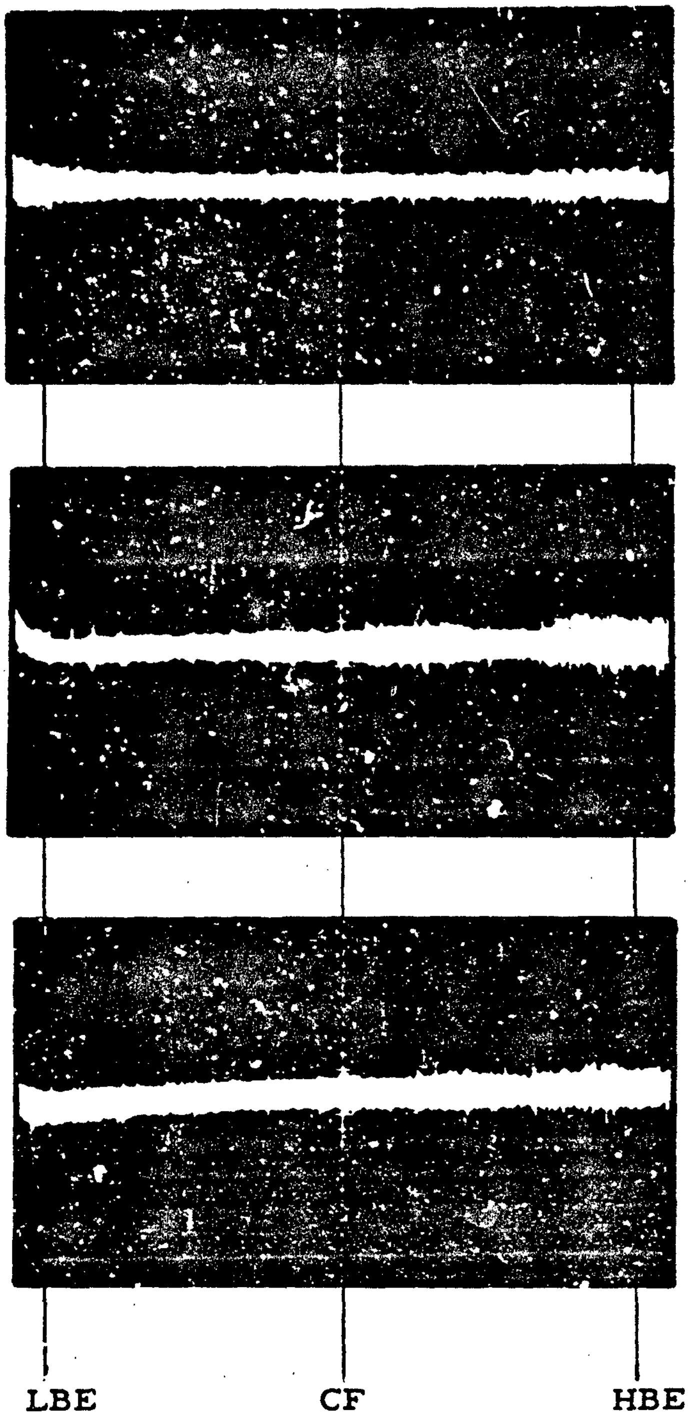
Search Channel: CBW Channel 6, 56.0 kc ±2 kc, DR = 2
All Other Channels: MI = 2

FIGURE II-3.3-61
INTERMODULATION TEST: CONSTANT BANDWIDTH MULTIPLEX USING EMR 246A TRANSMITTER; EFFECTS OF A REDUCED NUMBER OF CHANNELS AND REDUCED TRANSMITTER DRIVE; CBW CHANNEL 6



Channels deviated at one-tenth nominal cutoff frequency or 5 cps, whichever is larger.

FIGURE II-3.3-62
INTERMODULATION TEST: COMBINATIONAL BANDWIDTH MULTIPLEX; SEARCH CHANNEL DR = 5; FBW CHANNELS 1, 2, and 3



Channel 4, 0.96 kc ±7.5%

RMS Level = 9 mv max.

Channel 5, 1.30 kc ±7.5%

RMS Level = 12 mv max.

Channel 6, 1.70 kc ±7.5%

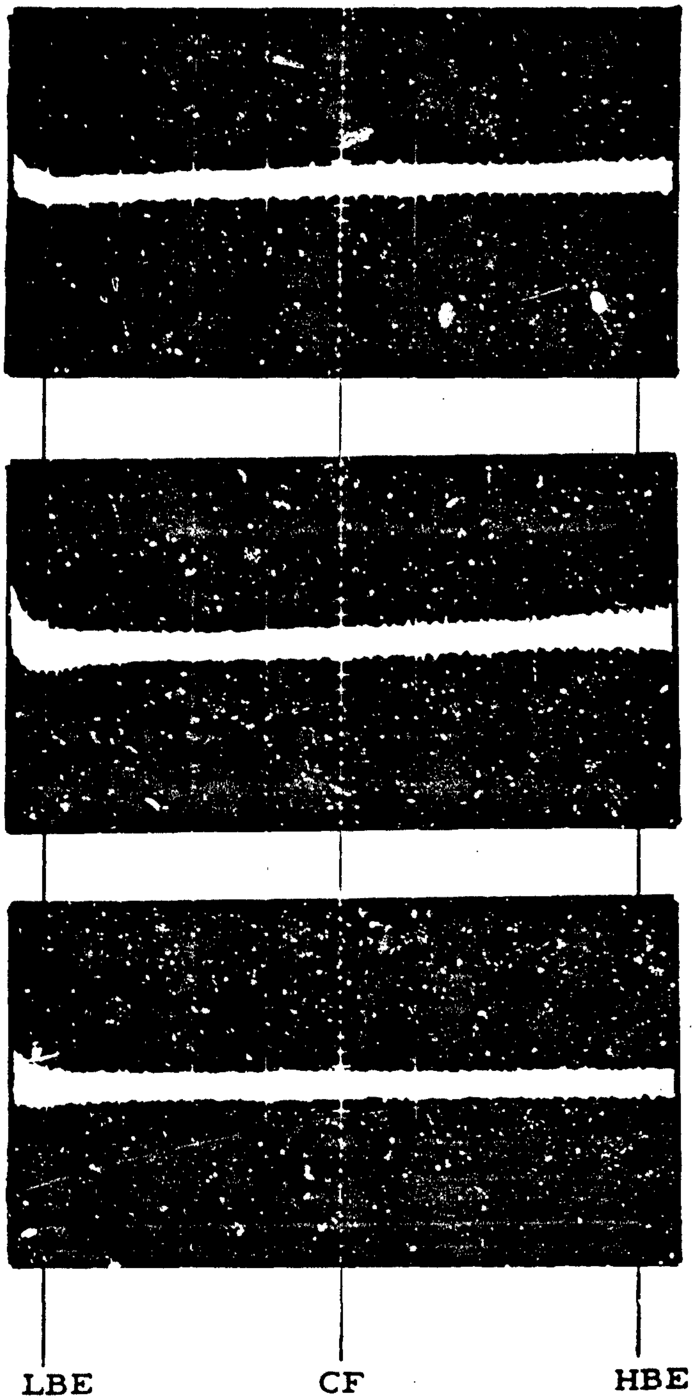
RMS Level = 11 mv max.

Horizontal: 5 sec/cm

Vertical: 0.5% FBW/cm

Channels deviated at one-tenth nominal cutoff frequency or 5 cps, whichever is larger.

FIGURE II-3.3-63
INTERMODULATION TEST: COMBINATIONAL BANDWIDTH MULTIPLEX; SEARCH CHANNEL DR = 5; PBW CHANNELS 4, 5, and 6



Channel 7, 2.30 kc ±7.5%

RMS Level = 6.5 mv max.

Channel 8, 3.00 kc ±7.5%

RMS Level = 9 mv max.

Channel 9, 3.90 kc ±7.5%

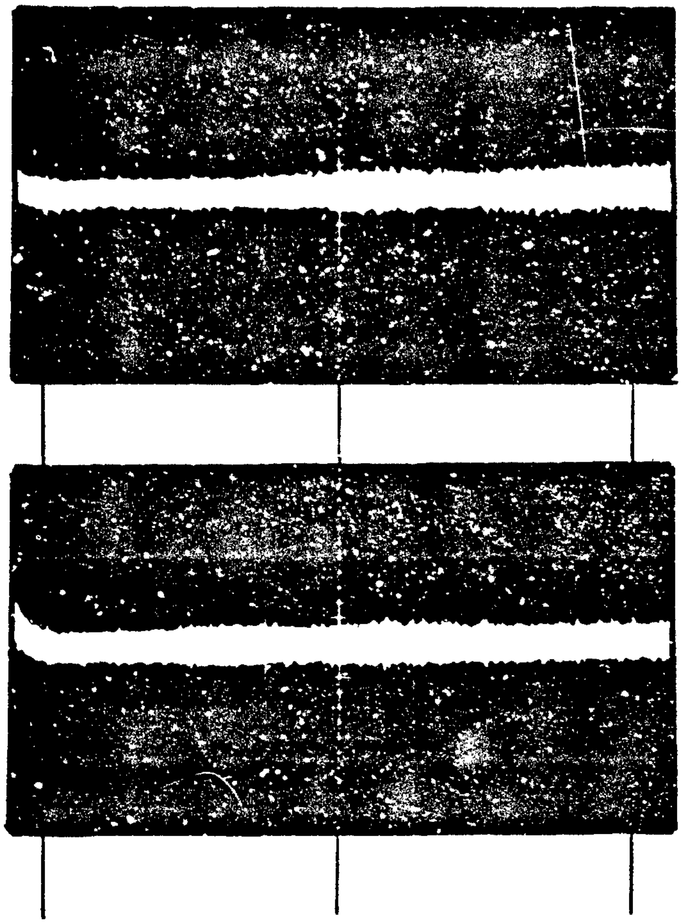
RMS Level = 8 mv max.

Horizontal: 5 sec/cm

Vertical: 0.5% FBW/cm

Channels deviated at one-tenth nominal cutoff frequency or 5 cps, whichever is larger.

FIGURE II-3.3-64
INTERMODULATION TEST: COMBINATIONAL BANDWIDTH MULTIPLEX; SEARCH CHANNEL DR = 5; PBW CHANNELS 7, 8, and 9



Channel 10, 5.40 kc ±7.5%

RMS Level = 10 mv max.

Channel 11, 7.35 kc ±7.5%

RMS Level = 8.5 mv max.

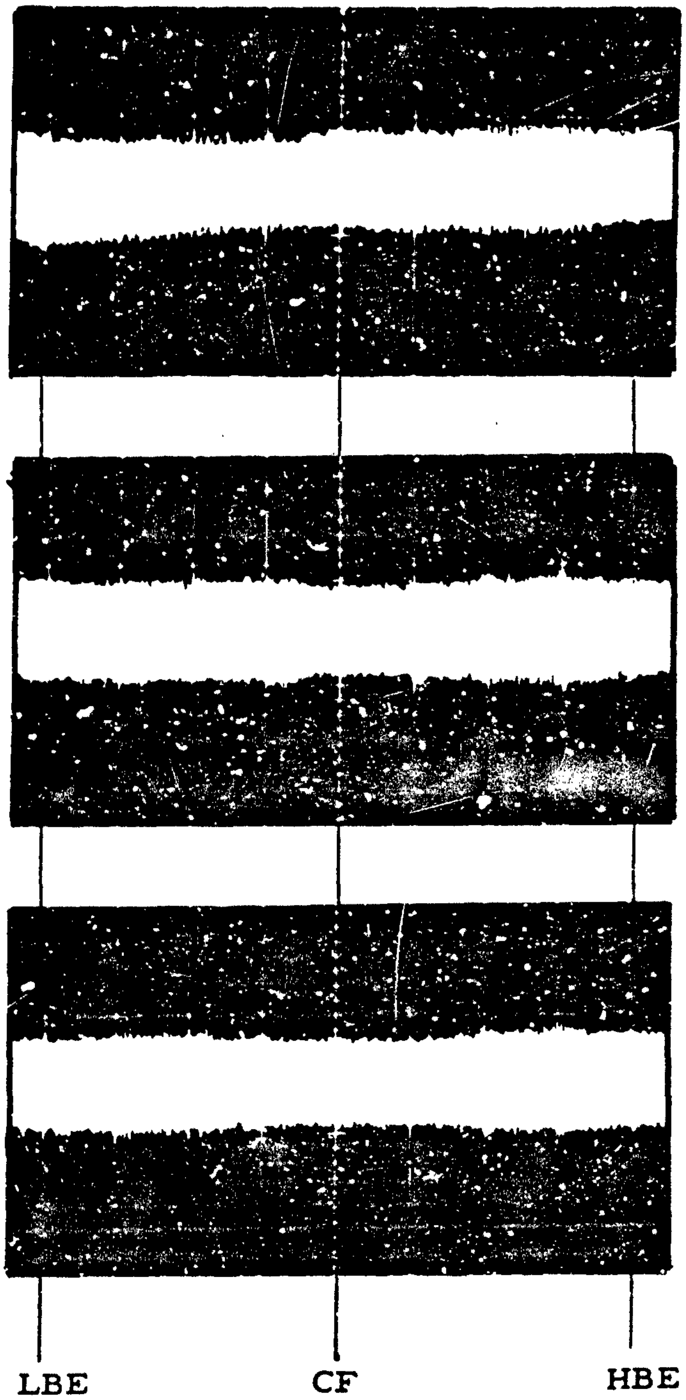
LBE CF HBE

Horizontal: 5 sec/cm

Vertical: 0.5% FBW/cm

Channels deviated at one-tenth nominal cutoff frequency or 5 cps, whichever is larger.

FIGURE II-3.3-65
INTERMODULATION TEST: COMBINATIONAL BANDWIDTH MULTIPLEX; SEARCH CHANNEL DR = 5; PBW CHANNELS 10 and 11



Channel 1, 16.0 kc ±2 kc

RMS Level = 125 mv max.

Channel 2, 24.0 kc ±2 kc

RMS Level = 130 mv max.

Channel 3, 32.0 kc ±2 kc

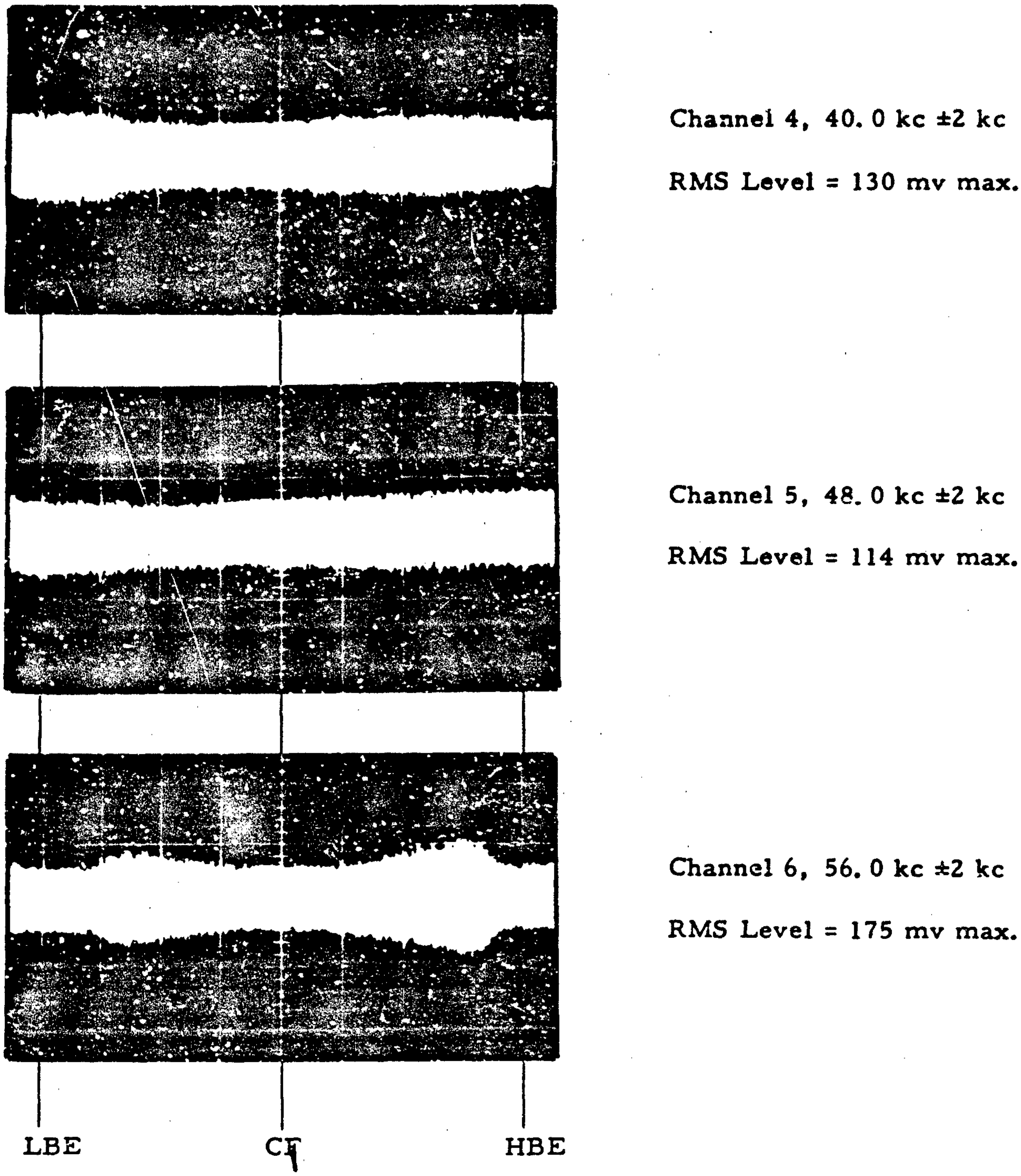
RMS Level = 132 mv max.

Horizontal: 5 sec/cm

Vertical: 2.5% FBW/cm

Channels deviated at one-tenth nominal cutoff frequency or 5 cps, whichever is larger.

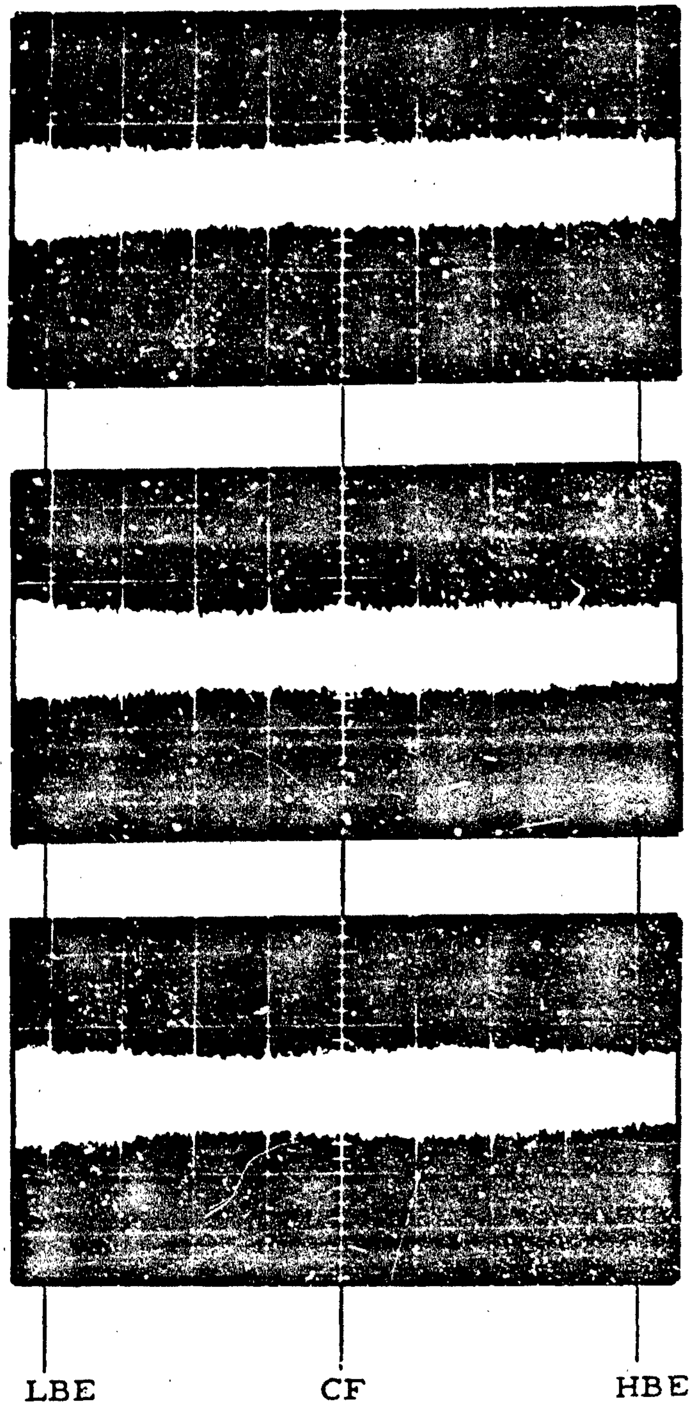
FIGURE II-3.3-66
INTERMODULATION TEST: COMBINATIONAL BANDWIDTH MULTIPLEX; SEARCH CHANNEL DR = 2; CBW CHANNELS 1, 2, and 3



Horizontal: 5 sec/cm Vertical: 2. 5% FBW/cm

Channels deviated at one-tenth nominal cutoff frequency or 5 cps, whichever is larger.

FIGURE II-3. 3-67
INTERMODULATION TEST: COMBINATIONAL BANDWIDTH MULTIPLEX; SEARCH CHANNEL DR = 2; CBW CHANNELS 4, 5, and 6



Channel 7, 64.0 kc ±2 kc

RMS Level = 97 mv max.

Channel 8, 72.0 kc ±2 kc

RMS Level = 94 mv max.

Channel 9, 80.0 kc ±2 kc

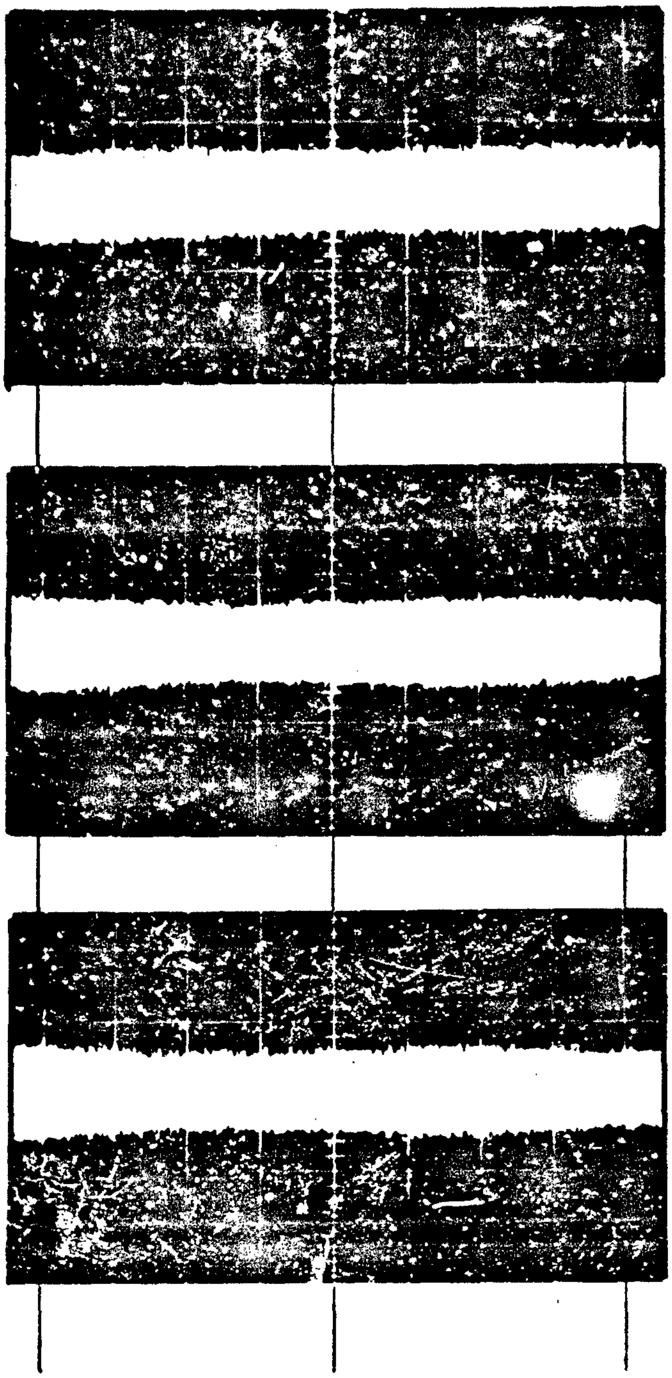
RMS Level = 100 mv max.

Horizontal: 5 sec/cm

Vertical: 2.5% FBW/cm

Channels deviated at one-tenth nominal cutoff frequency or 5 cps, whichever is larger.

FIGURE II-3.3-68
INTERMODULATION TEST: COMBINATIONAL BANDWIDTH MULTIPLEX; SEARCH CHANNEL DR = 2; CBW CHANNELS 7, 8, and 9



Channel 10, 88.0 kc ±2 kc

RMS Level = 100 mv max.

Channel 11, 96.0 kc ±2 kc

RMS Level = 102 mv max.

Channel 12, 104.0 kc ±2 kc

RMS Level = 102 mv max.

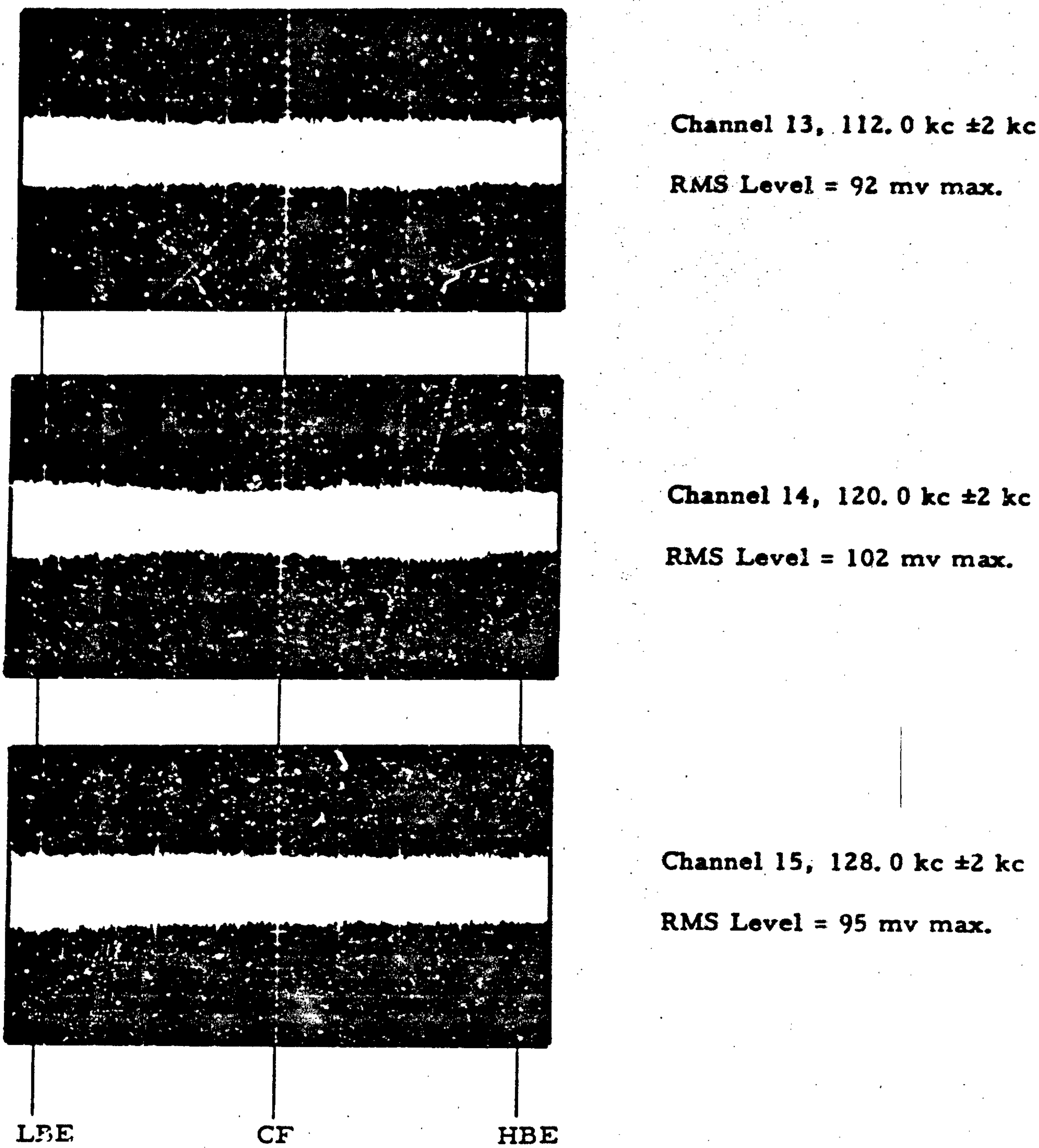
LBE CF HBE

Horizontal: 5 sec/cm

Vertical: 2.5% FBW/cm

Channels deviated at one-tenth nominal cutoff frequency or 5 cps, whichever is larger.

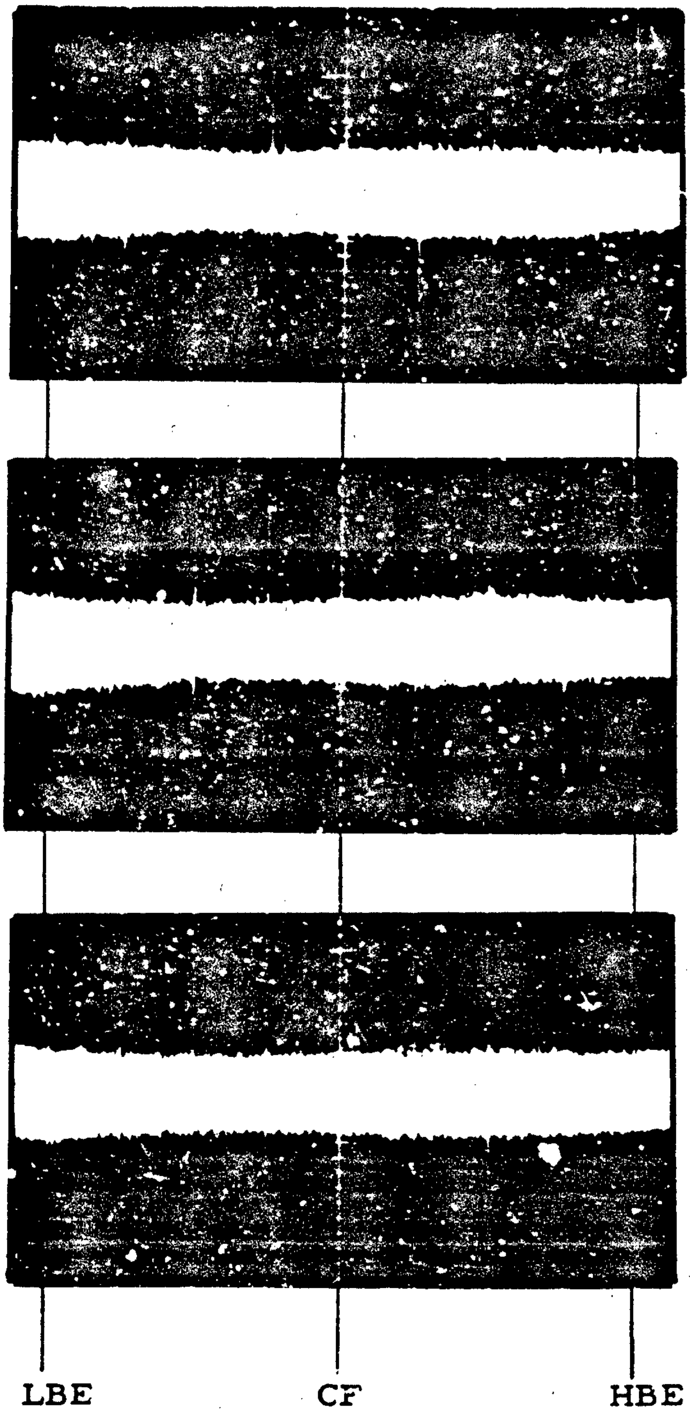
FIGURE II-3.3-69
INTERMODULATION TEST: COMBINATIONAL BANDWIDTH MULTIPLEX; SEARCH CHANNEL DR = 2; CBW CHANNELS 10, 11, and 12



Horizontal: 5 sec/cm Vertical: 2.5% FBW/cm

Channels deviated at one-tenth nominal cutoff frequency or 5 cps, whichever is larger.

FIGURE II-3. 3-70
INTERMODULATION TEST: COMBINATIONAL BANDWIDTH MULTIPLEX; SEARCH CHANNEL DR = 2; CBW CHANNELS 13, 14 and 15



Channel 16, 136.0 kc ±2 kc

RMS Level = 102 mv max.

Channel 17, 144.0 kc ±2 kc

RMS Level = 104 mv max.

Channel 18, 152.0 kc ±2 kc

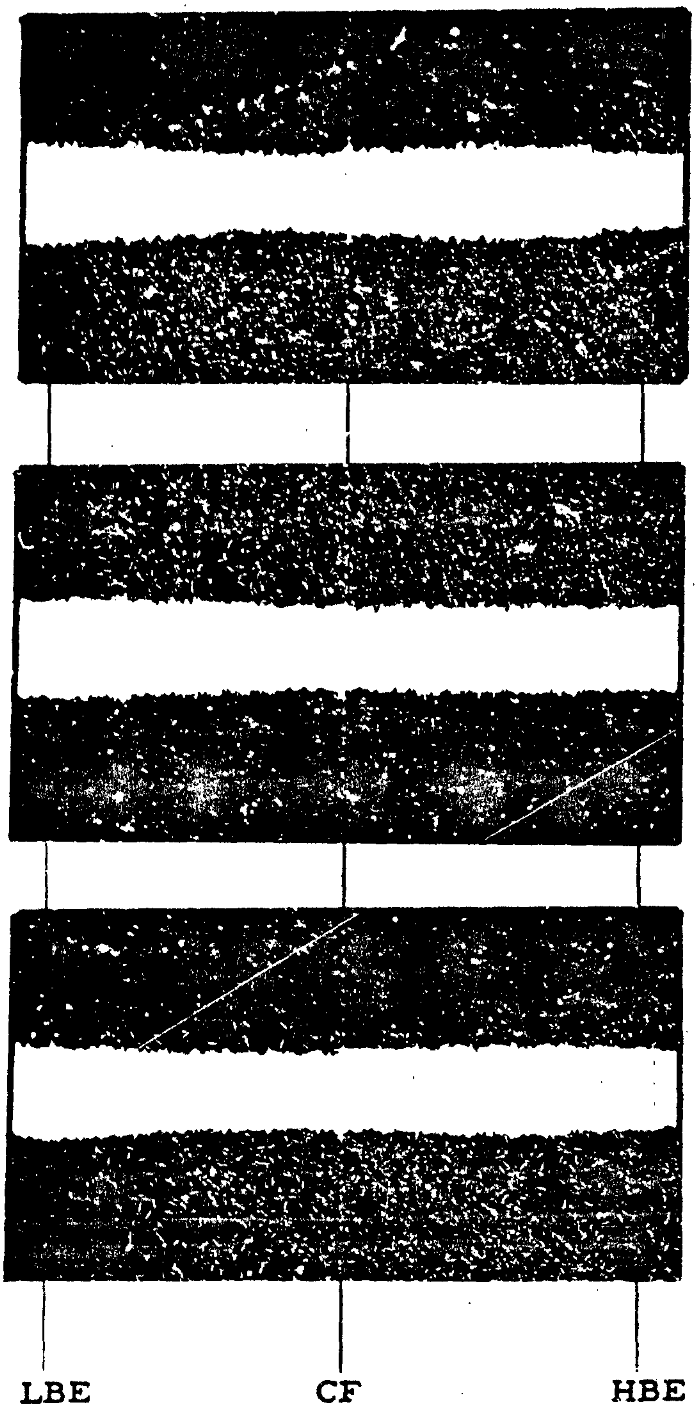
RMS Level = 100 mv max.

Horizontal: 5 sec/cm

Vertical: 2.5% FBW/cm

Channels deviated at one-tenth nominal cutoff frequency or 5 cps, whichever is larger.

FIGURE II-3.3-71
INTERMODULATION TEST: COMBINATIONAL BANDWIDTH MULTIPLEX; SEARCH CHANNEL DR = 2; CBW CHANNELS 16, 17, and 18



Channel 19, 160.0 kc ±2 kc

RMS Level = 115 mv max.

Channel 20, 168.0 kc ±2 kc

RMS Level = 109 mv max.

Channel 21, 176.0 kc ±2 kc

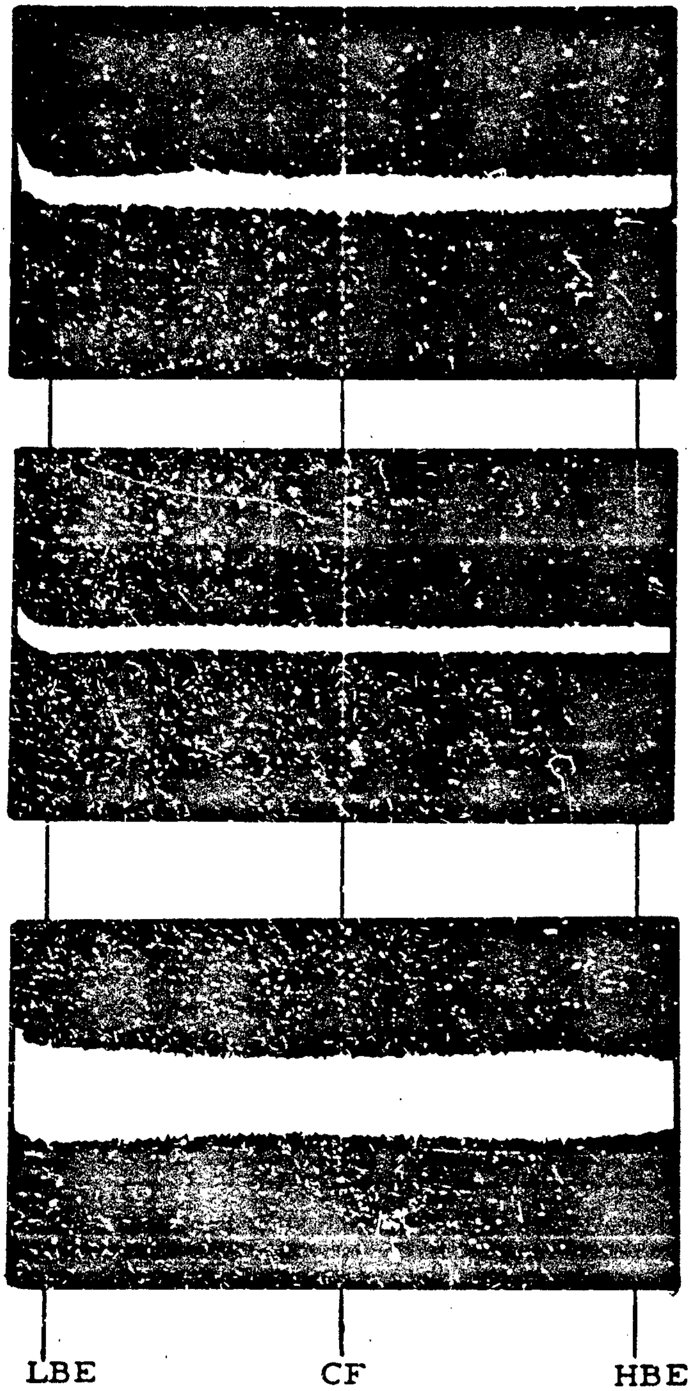
RMS Level = 110 mv max.

Horizontal: 5 sec/cm

Vertical: 2.5% FBW/cm

Channels deviated at one-tenth nominal cutoff frequency or 5 cps, whichever is larger.

FIGURE II-3.3-72
INTERMODULATION TEST: COMBINATIONAL BANDWIDTH MULTIPLEX
SEARCH CHANNEL DR = 2; CBW CHANNELS 19, 20, and 21



Channel 11, 7.35 kc ±7.5%
DR = 5
RMS Level = 9.4 mv max.
Vertical = 0.5% FBW/cm

Channel 12, 10.5 kc ±7.5%
DR = 5
RMS Level = 7.0 mv max.
Vertical = 0.5% FBW/cm

Channel 1, 16.0 kc ±2 kc
DR = 2
RMS Level = 155 mv max.
Vertical = 2.5% FBW/cm

Horizontal: 5 sec/cm

Vertical: as specified

FIGURE II-3.3-73
INTERMODULATION TEST: INSERTION OF 10.5 KC ±7.5%, PBW CHANNEL 12, INTO COMBINATIONAL BANDWIDTH MULTIPLEX; PBW CHANNELS 11 and 12 and CBW CHANNEL 1

3.4 SYSTEM SIGNAL-TO-NOISE TEST

3.4.1 General

The system signal-to-noise test consists of selecting particular receiver IF carrier-to-noise ratios and determining the subcarrier discriminator output signal-to-noise ratio. The test is accomplished with the pre-emphasis and transmitter deviation selected in the respective system test. The IF signal-to-noise level is determined by monitoring the IF at the predetection recording output. With an unmodulated rf carrier input and the AGC externally held constant, the IF signal level is measured and then the noise is measured with the input carrier signal turned off.

During the initial system test, it was found that the IF output noise was a function of input signal level with the AGC voltage externally held at a constant value. Through the experiment it was determined that the IF amplifiers tended to saturate on large input signals thus suppressing the noise. The level that significant saturation took place was found to depend on the AGC voltage. With an AGC level of −4 volts, saturation was found to occur with IF output signal levels in excess of −17 dbm into 600 ohms or 110 mv rms. The manufacturer's specification on the predetection output level is 1.0v p-p or 350 mv rms. Thus, some saturation occurs at the specified level. In any event the maximum IF output signal should not exceed −17 dbm.

To obtain the desired IF signal-to-noise ratio, the noise is held constant and the input signal level adjusted. The test is made at IF signal-to-noise ratios of 4, 9, and 14 db. For the low signal-to-noise cases, the measurement of signal is difficult with an rms meter since both signal and noise are measured, i.e., the noise cannot be turned off. To provide accurate signal measurements, a frequency selective voltmeter is used to measure the signal level. Since the bandwidth of the frequency selective voltmeter is very narrow compared to the IF bandwidth, the signal level can be measured without the attendent noise background. For reference and to determine if saturation is occuring in the IF, the frequency selective voltmeter is tuned to 4.9 mc and the noise level noted with and without the rf carrier on. The block diagram for the test is shown in Figure II-3.4-1.

3.4.2 Detailed Procedure

a. Calibrate all VCOs.

b. Deviate all VCOs to FBW at f_m, where f_m is the maximum modulating frequency for the particular deviation ratio.

c. Set receiver AGC voltage to −4 volts dc.

d. Set IF signal-to-noise ratio to 4, 9, and 14 db. Check S/N with both Sierra frequency selective voltmeter and Fluke rms meter.

e. Determine discriminator input signal-to-noise ratio by measuring the S/N ratio at the BPIF output. Measure signal with the search channel unmodulated. Measure the noise with all VCOs except the search channel operating in the multiplex and deviating FBW.

f. Measure discriminator output noise with the search channel at center frequency and low bandedge.

g. Modulate the search channel FBW at f_m and null output with comparison signal. Measure rms level of null voltage. Also measure full scale modulating signal at nulling point.

h. With only the search channel in the multiplex, repeat f. and g., above.

3.4.3 Results

Detailed conditions and actual measured data are contained in this volume in tables beginning with II. Summarizations of the data are contained in Volume I and have table or figure numbers beginning with I.

3.4.3.1 IRIG Baseband

The IRIG baseband, channels 1 through 18, was evaluated for signal-to-noise performance under the following conditions:

Test channels: 70 kc ±7.5%; 3 kc ±7.5%

Multiplex level: 1.0 volt rms

AGC voltage: −4 volts dc

Deviation ratio: 5

LPOF: Constant amplitude, 18 db/octave, nominal cutoff frequency for DR = 5

The results of the signal-to-noise test are shown in Table II-3.4-2 and summarized in Table I-3.5-2, Volume I. For each IF signal-to-noise ratio, the search-channel output noise is measured for two multiplex conditions and three deviation conditions. The two multiplex conditions are full multiplex and search channels only. The latter condition eliminates intermodulation noise. The three cases of search channel deviation include: center frequency, low bandedge, and FBW modulation at the maximum channel rate for the particular deviation ratio.

3.4.3.2 IRIG Baseband--Wideband Channel

The IRIG baseband with a wideband (±15%) channel in the highest frequency position was evaluated under the following conditions:

Test channels: 70 kc ±15%; 3 kc ±7.5%

Multiplex level: 1.0 volt rms

AGC voltage: −4 volts dc

Deviation ratio: 5

LPOF: Constant amplitude, 18 db/octave, nominal f_c for DR = 5

The results are shown in Table II-3.4-3 and summarized in Volume I, Table I-3.5-3. Pages 4 and 5 of Table II-3.4-3 are data that was taken at a later date for recheck and additional data.

3.4.3.3 IRIG Baseband--Deviation Ratio of 1 and 2

The IRIG baseband, channels 1 through 18, were operated at deviation ratios of 1 and 2 and the signal-to-noise performance determined under the following conditions:

Test channels: 70.0 kc ±7.5%; 22.0 kc ±7.5%; 7.35 kc ±7.5%; 3.0 kc ±7.5%; 960 cps ±7.5%

Multiplex level: 1.0 volt rms

Deviation ratio: 1 or 2

AGC: −4 volts dc

LPOF: Constant amplitude, nominal cutoff frequency for the particular deviation ratio for DR = 1, 18 db/octave.

The results for DR = 1 are shown in Table II-3.4-4 and the results for DR = 2 are shown in Table II-3.4-5. The results for both deviation ratios are summarized in Table I-3.5-4 of Volume I.

3.4.3.4 Expanded Proportional-Bandwidth Baseband

The expanded baseband, channels 1 through 21, was evaluated for signal-to-noise performance under the following conditions:

Test channels: 165 kc ±7.5%; 124 kc ±7.5%; 93 kc ±7.5%; 70 kc ±7.5%; 3 kc ±7.5%

Multiplex level: 750 mv rms

Deviation ratio: 5

AGC voltage: −4 volts dc

LPOF: Constant amplitude 18 db/octave, nominal cutoff frequency for DR = 5

The results of the signal-to-noise test are shown in Table II-3.4-6. The results are summarized in Table I-3.5-5. Page 5 of Table II-3.4-6 was additicnal data taken for recheck and verification at a later date than the original data.

3.4.3.5 Expanded Proportional-Bandwidth Baseband--Wideband Channel

The expanded baseband, channels 1 through 19 and wideband channel H, was evaluated for signal-to-noise performance under the following conditions:

Test channels: 165 kc ±15%; 93 kc ±7.5%; 70 kc ±7.5%; 3 kc ±7.5%

Multiplex level: 630 mv rms

Deviation ratio: 5

AGC voltage: −4 volts dc

LPOF: Constant amplitude, 18 db/octave, nominal cutoff frequency for DR = 5

The results are shown in Table II-3.4-7 and summarized in Table I-3.5-6. The data shown on page 5 of Table II-3.4-7 was taken at a later date for recheck and for additional data.

3.4.3.6 Constant-Bandwidth Baseband

The constant-bandwidth baseband, channels 1 through 21, was evaluated under the following conditions:

Test channels: 56 kc ±2 kc; 88 kc ±2 kc; 120 kc ±2 kc; 160 kc ±2 kc

Multiplex level: 360 mv rms

Deviation ratio: 2, also 4 and 1 on the 120 kc ±2 kc channel only

AGC voltage: −4 volts dc

LPOF: Constant amplitude, 42 db/octave, nominal cutoff frequency for specified deviation ratio.

The results are shown in Table II-3.4-8 and summarized in Tables I-3.5-8 and I-3.5-9.

3.4.3.7 Combinational-Bandwidth Baseband

The combinational-bandwidth baseband, IRIG channels 1 through 11 and constant-bandwidth channels 1 through 21, was evaluated under the following conditions:

Test channels: 3 kc ±7.5%; 56 kc ±2 kc; 88 kc ±2 kc; 120 kc ±2 kc; 160 kc ±2 kc

Multiplex level: Total; 635 mv rms; IRIG channels; 210 mv rms, and CBW channels; 600 mv rms.

Deviation ratio: 2 on the constant-bandwidth channels and 5 on the IRIG channels

AGC voltage: −4 volts dc

LPOF: Constant amplitude, 42 db/octave for CBW channels and 18 db/octave for IRIG channels, nominal cutoff frequency for specified deviation ratio.

The results are shown in Table II-3.5-10 and summarized in Table I-3.5-11.

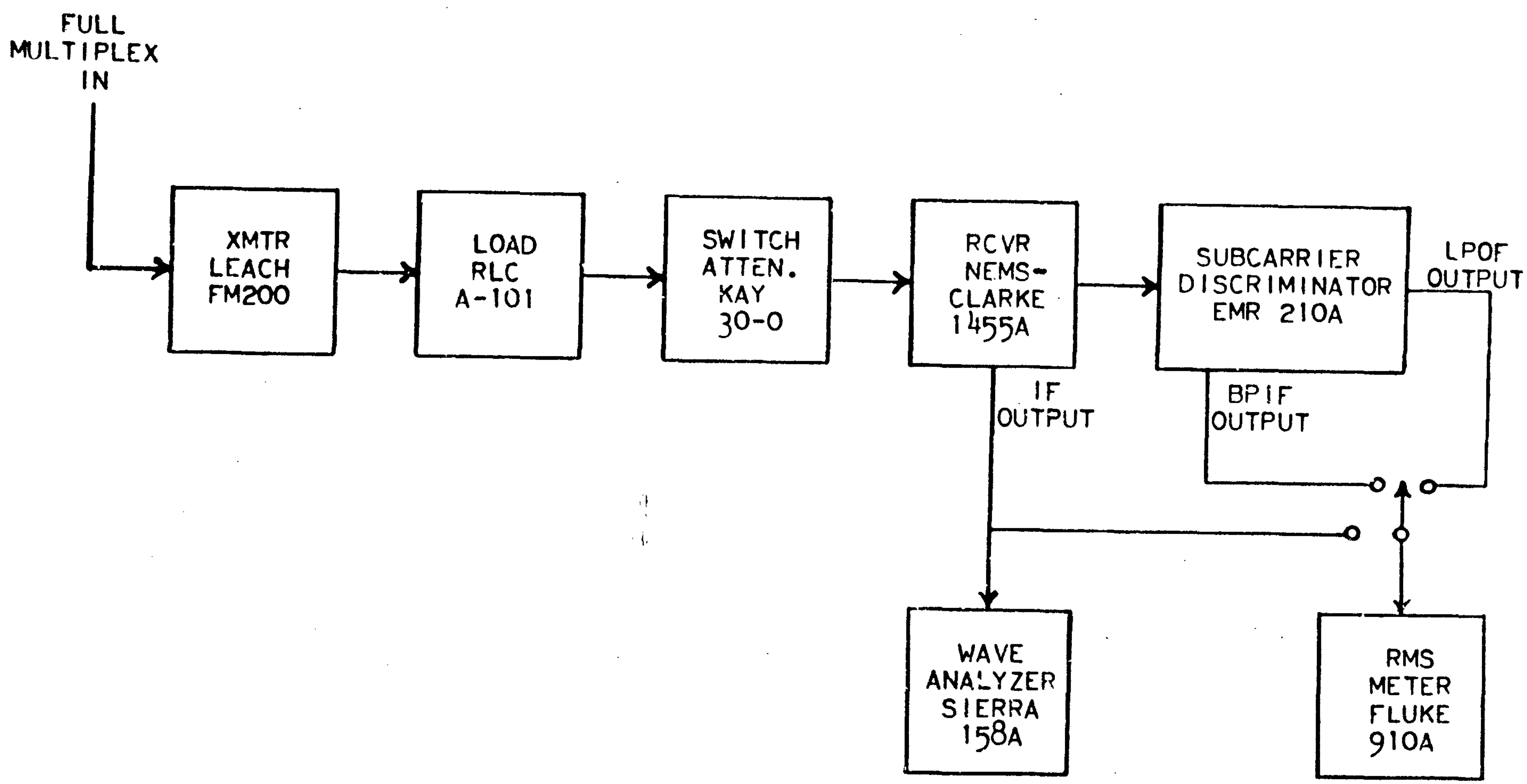


FIGURE II-3.4-1
SIGNAL-TO-NOISE TEST BLOCK DIAGRAM

TABLE II-3.4-2
SIGNAL-TO-NOISE TEST DATA

System Description: Standard 18 IRIG Channels, DR=5

IF Signal-To-Noise Ratio: 2 db Receiver AGC Voltage: -4.0VDC

Discriminator Full Scale Output: 5.0vrms/14.14vpp @ 0.1fm or 20cps

Sierra: Signal: -28.5db Fluke: Signal + Noise: -25.7db

Noise: -53.5 db Noise: -30.5db

Discriminator Channel: #18, 70 KC

BPIF: Signal: -5.6db Noise: -13.6db -14.5db

Full Scale Modulation At Summing Point: 2.4v

Output Noise:

Full Multiplex: CF: 650mv

LBE: 1.7v

Modulated: 650mv

Search Channel Only:

CF: 650mv

LBE: 1.75v

Modulated: 450mv

Discriminator Channel: #8, 3.0KC

BPIF: Signal: -23db Noise: -26 db -28.0db

Full Scale Modulation At Summing Point: 2.4v

Output Noise:

Full Multiplex: CF: 1.9v

LBE: 3.6v

Modulated: 1.6v

Search Channel Only:

CF: 1.2v

LBE: 3.0v

Modulated: 1.4v

1 of 5

Date 1-4-65 Name [illegible signature]

TABLE II-3.4-2 (CONT'D.)
SIGNAL-TO-NOISE TEST DATA

System Description: Standard 18 IRIG Channels, DR=5

IF Signal-To-Noise Ratio: 4db   Receiver AGC Voltage: -4.0 vdc

Discriminator Full Scale Output: 14.14 vPP / 5.0 vrms @ 0.1 fm or 20

Sierra: Signal: -26.5 db   Fluke: Signal + Noise: -25.0 db

Noise: -53.5 db   Noise: -30.6 db

Discriminator Channel: #18, 70 KC

BPIF: Signal: -4.6 db   Noise: -17.0 db   -17.5 db

Full Scale Modulation At Summing Point: 2.5 vrms

Output Noise:

Full Multiplex: CF: 144 mvrms

LBE: 360 mvrms

Modulated: ≈ 65 mvrms (with 6vpp Spik null Point)

Search Channel Only:

CF: 130 mvrms

LBE: 250 mvrms

Modulated: ≈ 65 mvrms (with 6vpp Spik null Point)

Discriminator Channel: #8, 3.0 KC

BPIF: Signal: -22.5 db   Noise: -30.5 db   -32.0

Full Scale Modulation At Summing Point: 2.4 Vrms

Output Noise:

Full Multiplex: CF: 250 mvrms

LBE: 1.35 vrms

Modulated: ≈ 90 mvrms (with 6vpp Sp. null Point)

Search Channel Only:

CF: 160 mvrms

LBE: ≈ 400 mvrms

Modulated: 85 mvrms

Date 1-4-65   Name W. Bishop

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TABLE II-3.4-2 (CONT'D.)
SIGNAL-TO-NOISE TEST DATA

System Description: Standard 18 IRIG Channels, DR=5

IF Signal-To-Noise Ratio: 6 db Receiver AGC Voltage: -4.0 vdc

Discriminator Full Scale Output: 5.0 vrms/14.14 vpp @ 0.1 fm or 20 cps.

Sierra: Signal: -25.0 db Fluke: Signal + Noise: -23.3 db

Noise: -53 db Noise: -31.0 db

Discriminator Channel: #18, 70 KC

BPIF: Signal: -4.4 db Noise: -21.0 db -21.3 db

Full Scale Modulation At Summing Point: 2.4 vrms

Output Noise:

Full Multiplex: CF: 110 mvrms

LBE: 140 mvrms

Modulated: 58 mvrms

Search Channel Only:

CF: 85 mvrms

LBE: 85 mvrms

Modulated: 45 mvrms

Discriminator Channel: #8, 3.0 KC

BPIF: Signal: -22.2 db Noise: -34.0 db -37.6 db

Full Scale Modulation At Summing Point: 2.4 vrms

Output Noise:

Full Multiplex: CF: 170 mvrms

LBE: 180 mvrms

Modulated: 95 mvrms

Search Channel Only:

CF: 95 mvrms

LBE: 110 mvrms

Modulated: 50 mvrms

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TABLE II-3.4-2 (CONT'D.)
SIGNAL-TO-NOISE TEST DATA

System Description: Standard 18 IRIG Channels, DR=5

IF Signal-To-Noise Ratio: 9 db Receiver AGC Voltage: -4.0 vdc

Discriminator Full Scale Output: 5 vrms/14.14 vpp @ a1 fm or 20 cps

Sierra: Signal: -21.5 db Fluke: Signal + Noise: -21.7 db

Noise: -54.0 db Noise: -30.5 db

Discriminator Channel: #18 70 KC

BPIF: Signal: -3.1 db Noise: -24.2 db -24.8 db

Full Scale Modulation At Summing Point: 2.4 Vrms

Output Noise:

Full Multiplex: CF: 47 mvrms

LBE: 45 mvrms

Modulated: 25 mvrms

Search Channel Only:

CF: 42 mvrms

LBE: 39 mvrms

Modulated: 23 mvrms

Discriminator Channel: #8 3.0 KC

BPIF: Signal: -21.5 db 21.5 Noise: -41.5 db -51.0 db

Full Scale Modulation At Summing Point: 2.4 Vrms

Output Noise:

Full Multiplex: CF: 41 mvrms

LBE: 44 mvrms

Modulated: 21 mvrms

Search Channel Only:

CF: 11 mvrms

LBE: 12.5 mvrms

Modulated: 8.5 mvrms

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Date 1-4-65 Name W. Bishop

TABLE II-3.4-2 (CONT'D.)
SIGNAL-TO-NOISE TEST DATA

stem Description: Standard 18 IRIG Channels, DR=5

Signal-To-Noise Ratio: 14 db Receiver AGC Voltage: -4.0 vdc

iscriminator Full Scale Output: 5.0 v rms / 14.14 v pp @ 0.1 fm or 20 cps

erra: Signal: -16.5 db Fluke: Signal + Noise: -16.0 db

Noise: -54.0 db Noise: -30.5

iscriminator Channel: #18, 70 KC

BPIF: Signal: -2.8 db Noise: -28.1 db -30.0

Full Scale Modulation At Summing Point: 2.4 v rms

Output Noise:

Full Multiplex: CF: 26 mv rms

LBE: 25 mv rms

Modulated: 16 mv rms

Search Channel Only:

CF: 22 mv rms

LBE: 21 mv rms

Modulated: 13.8 mv rms

scriminator Channel: #8, 3.0 KC

BPIF: Signal: -21.3 db Noise: -42.0 db -56.0 db

Full Scale Modulation At Summing Point: 2.4 v rms

Output Noise:

Full Multiplex: CF: 9.5 mv rms

LBE: 11.5 mv rms

Modulated: 8.2 mv rms

Search Channel Only:

CF: 3.0 mv rms

LBE: 3.2 mv rms

Modulated: 6.0 mv rms

Date 1-4-65 Name W. Bishop

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TABLE II-3.4-3
SIGNAL-TO-NOISE TEST DATA

System Description: Channels 1-16 Narrow + E, DR=5

IF Signal-to-Noise Ratio: 4 db   Receiver AGC Voltage: -4.0 vdc

Discriminator Full Scale Output: 10 VPP

Sierra: Signal: -28.2 db   Fluke: Signal + Noise: -26.2 db

Noise: -54 db   Noise: -32.0 db

Discriminator Channel: E, 70 KC ± 15%

BPIF: Signal: -1.8 db   Noise: M.M. -13.7 db UMM -13.7 db

Full Scale Modulation At Summing Point: 3.6 Vrms

Output Noise:

Full Multiplex: CF: 270 mVrms

LBE: 600 mVrms

Modulated: 700 mVrms

Search Channel Only:

CF: 270 mVrms

LBE: 600 mVrms

Modulated: 700 mVrms

Discriminator Channel: 3.0 KC ± 7.5%

BPIF: Signal: -24.6 db   Noise: M.M. -29.0 db UMM -29.5 db

Full Scale Modulation At Summing Point: 3.6 Vrms

Output Noise:

Full Multiplex: CF: 900 mVrms

LBE: 2.0 Vrms

Modulated: 2.4 Vrms

Search Channel Only:

CF: 250 mVrms

LBE: 1.5 Vrms

Modulated: 1.7 Vrms

Tek #132 Set for gain of 10 therefore recorded values are 1/10 of actual value read on meter.

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Date 1-13-65   Name W. Bishop

TABLE II-3.4-3 (CONT'D.)
SIGNAL-TO-NOISE TEST DATA

stem Description: Channels 1-16 Narrow + E, DR=5

Signal-To-Noise Ratio: 9 db   Receiver AGC Voltage: -4.0 vdc

scriminator Full Scale Output: 10 v PP

rra: Signal: -23.5 db   Fluke: Signal + Noise: -23.0 db

Noise: -55.5 db   Noise: -32.5 db

criminator Channel: E, 70 KC ± 15%

BPIF: Signal: +0.4 db   Noise: MM -21.1 db UMM -21.1 db

Full Scale Modulation At Summing Point: 3.6 Vrms

Output Noise:

Full Multiplex: CF: 48 mvrms

LBE: 37 mvrms

Modulated: 58 mvrms *

Search Channel Only:

CF: 40 mvrms

LBE: 35 mvrms

Modulated: 55 mvrms *

criminator Channel: 3.0 KC ± 7.5%

BPIF: Signal: -23.3   Noise: MM -41 db UMM -42.5 db

Full Scale Modulation At Summing Point: 3.6 vrms

Output Noise:

Full Multiplex: CF: 49 mvrms

LBE: 45 mvrms

Modulated: 65 mvrms *

Search Channel Only:

CF: 18 mvrms

LBE: 16 mvrms

Modulated: 27 mvrms *

ek. #132 Set for
in of 10 Therefore
corded values are
of actual value
ad on meter.

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Date 1-13-65   Name W. Bishop

TABLE II-3.4-3 (CONT'D.)
SIGNAL-TO-NOISE TEST DATA

System Description: Channels 1-16 Narrow + E, DR=5

IF Signal-to-Noise Ratio: 14db Receiver AGC Voltage: -4.0vdc

Discriminator Full Scale Output: 10vpp

Sierra: Signal: -18.5 db Fluke: Signal + Noise: -18.5 db

Noise: -56.0 db Noise: -32.5 db

Discriminator Channel: E, 70KC ±15%

BPIF: Signal: +0.5 db Noise: MM -26.5 db umm -26.5

Full Scale Modulation At Summing Point: 3.6 vrms

Output Noise:

Full Multiplex: CF: 18 mvrms

LBE: 18 mvrms

Modulated: 39 mvrms *

Search Channel Only:

CF: 17.0 mvrms

LBE: 16.9 mvrms

Modulated: 38 mvrms *

Discriminator Channel: 3.0 KC ±7.5%

BPIF: Signal: -23.0 db Noise: MM -42.5 db umm -49.5

Full Scale Modulation At Summing Point: 3.6 vrms

Output Noise:

Full Multiplex: CF: 7.5 mvrms

LBE: 8.5 mvrms

Modulated: 20 mvrms *

Search Channel Only:

CF: 4.5 mvrms

LBE: 5.0 mvrms

Modulated: 11 mvrms *

* Type #132 (Tek) Set for gain of 10 therefore recorded values are 1/10 of actual value read on meter

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Date 1-13-65 Name W. Bishop

TABLE II-3.4-3 (CONT'D.)
SIGNAL-TO-NOISE TEST DATA

System Description: Channels 1-16 Narrow + E
IF Signal-to-Noise Ratio As Listed AGC Voltage -4.0 vdc

Channel No. E Channel Frequency 70 kc ± 15% $(S/N)_c$ = 14db
BPIF: Signal +0.3 db Noise: Full Mult. -26.6 db Search Ch. Only -27.0 db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 2100 cps db:
Full Bandwidth Voltage . . . . 10 vpp +13.4 db
Output Noise: Full Multiplex . . . . . . 18.0 mvrms -32.8 db
Search Channel Only . . . . 16.5 mvrms -33.5 db

Channel No. E Channel Frequency 70 kc ± 15% $(S/N)_c$ = 11db
BPIF: Signal +0.1 db Noise: Full Mult. -24.2 db Search Ch. Only -24.5 db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 2100 cps db:
Full Bandwidth Voltage . . . . 10 vpp +13.4 db
Output Noise: Full Multiplex . . . . . . 24 mvrms -30.2 db
Search Channel Only . . . . 22.5 mvrms -30.7 db

Channel No. E Channel Frequency 70 kc ± 15% $(S/N)_c$ = 7 db
BPIF: Signal -0.3 db Noise: Full Mult. -21.8 db Search Ch. Only -22.1 db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 2100 cps db:
Full Bandwidth Voltage . . . . 10 vpp +13.4 db
Output Noise: Full Multiplex . . . . . . 35.5 mvrms -26.8 db
Search Channel Only . . . . 33 mvrms -27.4 db

Channel No. E Channel Frequency 70 kc ± 15% $(S/N)_c$ = 6 db
BPIF: Signal -0.9 db Noise: Full Mult. -18.5 db Search Ch. Only -19.1 db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 2100 cps db:
Full Bandwidth Voltage . . . . 10 vpp +13.4 db
Output Noise: Full Multiplex . . . . . . 59 mvrms -22.4 db
Search Channel Only . . . . 54 mvrms -23.2 db

Channel No. E Channel Frequency 70 kc ± 15% $(S/N)_c$ = 4db
BPIF: Signal -2.1 db Noise: Full Mult. -14.9 db Search Ch. Only -15.6 db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 2100 cps db:
Full Bandwidth Voltage . . . . 10 vpp +13.4 db
Output Noise: Full Multiplex . . . . . . 115 mvrms -16.7 db
Search Channel Only . . . . 100 mvrms -17.6 db

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Name W. Bishop Date 2-9-65

TABLE II-3.4-3 (CONT'D.)
SIGNAL-TO-NOISE TEST DATA

System Description: Channels 1-16 Narrow + E
IF Signal-to-Noise Ratio 2 db AGC Voltage -4.0 Vdc

Channel No. E Channel Frequency 70 kc ±15%
BPIF: Signal -3.4 db Noise: Full Mult. -12.2 db Search Ch. Only -12.8 db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 2100 cps db: 2
Full Bandwidth Voltage . . . . 10 Vpp +13.4 db
Output Noise: Full Multiplex . . . . 420 mvrms -5.4 db
Search Channel Only . . . . 400 mvrms -6.0 db

Channel No. ______ Channel Frequency ______
BPIF: Signal ______ Noise: Full Mult. ______ Search Ch. Only ______
Deviation Ratio . . . . ______
LPOF Cutoff Frequency . . . . ______
Full Bandwidth Voltage . . . . ______
Output Noise: Full Multiplex . . . . ______
Search Channel Only . . . . ______

Channel No. ______ Channel Frequency ______
BPIF: Signal ______ Noise: Full Mult. ______ Search Ch. Only ______
Deviation Ratio . . . . ______
LPOF Cutoff Frequency . . . . ______
Full Bandwidth Voltage . . . . ______
Output Noise: Full Multiplex . . . . ______
Search Channel Only . . . . ______

Channel No. ______ Channel Frequency ______
BPIF: Signal ______ Noise: Full Mult. ______ Search Ch. Only ______
Deviation Ratio . . . . ______
LPOF Cutoff Frequency . . . . ______
Full Bandwidth Voltage . . . . ______
Output Noise: Full Multiplex . . . . ______
Search Channel Only . . . . ______

Channel No. ______ Channel Frequency ______
BPIF: Signal ______ Noise: Full Mult. ______ Search Ch. Only ______
Deviation Ratio . . . . ______
LPOF Cutoff Frequency . . . . ______
Full Bandwidth Voltage . . . . ______
Output Noise: Full Multiplex . . . . ______
Search Channel Only . . . . ______

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TABLE 3.4-4

SIGNAL-TO-NOISE TEST DATA

System Description: Channel 1-18 PBW

IF Signal-to-Noise Ratio 2db AGC Voltage -4.0Vdc

Channel No. 18 Channel Frequency 70kc ± 7.5%

BPIF: Signal -6.3db Noise: Full Mult. -13.7db Search Ch. Only -14.7db

Deviation Ratio 1

LPOF Cutoff Frequency 5252cps

Full Bandwidth Voltage 20Vp-p

Output Noise: Full Multiplex . . . . 3600 mV

Search Channel Only . . . . 3100 mV

Channel No. 14 Channel Frequency 22kc ± 7.5%

BPIF: Signal -13.5kc Noise: Full Mult. -17.6db Search Ch. Only -19.2db

Deviation Ratio 1

LPOF Cutoff Frequency 1650cps

Full Bandwidth Voltage 20Vp-p

Output Noise: Full Multiplex . . . . 5200 mV

Search Channel Only . . . . 4200 mV

Channel No. 11 Channel Frequency 7.35kc ± 7.5%

BPIF: Signal -18.5db Noise: Full Mult. -21.5db Search Ch. Only -23.0db

Deviation Ratio 1

LPOF Cutoff Frequency 551cps

Full Bandwidth Voltage . . . . 20V p-p

Output Noise: Full Multiplex . . . . 6500 mV

Search Channel Only . . . . 5000 mV

Channel No. 8 Channel Frequency 3kc ± 7.5%

BPIF: Signal -23.5db Noise: Full Mult. -26.5db Search Ch. Only -28.5db

Deviation Ratio 1

LPOF Cutoff Frequency 225cps

Full Bandwidth Voltage . . . . 20V p-p

Output Noise: Full Multiplex . . . . 6000 mV

Search Channel Only . . . . 5000 mV

Channel No. 4 Channel Frequency 960cps ± 7.5%

BPIF: Signal -28.0db Noise: Full Mult. -31.5db Search Ch. Only -33.5db

Deviation Ratio 1

LPOF Cutoff Frequency 72cps

Full Bandwidth Voltage 20Vp-p

Output Noise: Full Multiplex . . . . 4500 mV

Search Channel Only . . . . 4000 mV

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FIGURE II-3.4-4 CONT'D.)
SIGNAL-TO-NOISE TEST DATA

System Description: Channel 1-18, PBW
IF Signal-to-Noise Ratio 4db AGC Voltage -4.0Vdc

Channel No. 18 Channel Frequency 70 kc ± 7.5%
BPIF: Signal -4.3db Noise: Full Mult. -17.2db Search Ch. Only -19.0d
Deviation Ratio 1
LPOF Cutoff Frequency . . . . 5250 cps
Full Bandwidth Voltage . . . . 20V p-p
Output Noise: Full Multiplex. . . . . . . 1820 mv
Search Channel Only . . . 1400 mv

Channel No. 14 Channel Frequency 22 kc ± 7.5%
BPIF: Signal -14.3db Noise: Full Mult. -20.5db Search Ch. Only -24.0d
Deviation Ratio 1
LPOF Cutoff Frequency . . . . 1650 cps
Full Bandwidth Voltage . . . . 20V p-p
Output Noise: Full Multiplex. . . . . . . 3200 mv
Search Channel Only . . . 2200 mv

Channel No. 11 Channel Frequency 7.35 kc ± 7.5%
BPIF: Signal -18.5db Noise: Full Mult. -25.5db Search Ch. Only -28.5d
Deviation Ratio 1
LPOF Cutoff Frequency . . . . 551 cps
Full Bandwidth Voltage . . . . 20V p-p
Output Noise: Full Multiplex. . . . . . . 3000 mv
Search Channel Only . . . 1800 mv

Channel No. 8 Channel Frequency 3kc ± 7.5%
BPIF: Signal -22.5db Noise: Full Mult. -30.0db Search Ch. Only -34.0d
Deviation Ratio 1
LPOF Cutoff Frequency . . . . 225 cps
Full Bandwidth Voltage . . . . 20V p-p
Output Noise: Full Multiplex. . . . . . . 2500 mv
Search Channel Only . . . 1700 mv

Channel No. 4 Channel Frequency 960 cps ± 7.5%
BPIF: Signal -27.0db Noise: Full Mult. -36.0db Search Ch. Only -39.0db
Deviation Ratio 1
LPOF Cutoff Frequency . . . . 72 cps
Full Bandwidth Voltage . . . . 20V p-p
Output Noise: Full Multiplex. . . . . . . 2200 mv
Search Channel Only . . . 1400 mv

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FIGURE II-3.4-4 (CONT'D.)
SIGNAL-TO-NOISE TEST DATA

System Description: Channel 1-18, PBW
IF Signal-to-Noise Ratio 9db AGC Voltage -4.0Vdc

Channel No. 18 Channel Frequency 70kc ± 7.5%
BPIF: Signal -2.7db Noise: Full Mult. -24.0db Search Ch. Only -25.4db
Deviation Ratio 1
LPOF Cutoff Frequency . . . . 5250 cps
Full Bandwidth Voltage 20Vp-p
Output Noise: Full Multiplex. 540mv
Search Channel Only 450mv

Channel No. 14 Channel Frequency 22kc ± 7.5%
BPIF: Signal -9.8db Noise: Full Mult. -33.8db Search Ch. Only -40.0db
Deviation Ratio 1
LPOF Cutoff Frequency 1650cps
Full Bandwidth Voltage 20Vp-p
Output Noise: Full Multiplex. 400mv
Search Channel Only 198mv

Channel No. 11 Channel Frequency 7.35 kc ±7.5%
BPIF: Signal -16.5db Noise: Full Mult. -39.0db Search Ch. Only -49.0db
Deviation Ratio 1
LPOF Cutoff Frequency . . . . 551 cps
Full Bandwidth Voltage 20Vp-p
Output Noise: Full Multiplex. 500mv
Search Channel Only 150mv

Channel No. 8 Channel Frequency 3kc ± 7.5%
BPIF: Signal -21.0db Noise: Full Mult. -42.0db Search Ch. Only -56.0db
Deviation Ratio 1
LPOF Cutoff Frequency . . . . 225 cps
Full Bandwidth Voltage 20Vp-p
Output Noise: Full Multiplex. 450mv
Search Channel Only 100mv

Channel No. 4 Channel Frequency 960cps ± 7.5%
BPIF: Signal -25.0db Noise: Full Mult. -47.0db Search Ch. Only -60.0db
Deviation Ratio 1
LPOF Cutoff Frequency . . . . 72 cps
Full Bandwidth Voltage 20Vp-p
Output Noise: Full Multiplex. 350mv
Search Channel Only 822mv

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FIGURE II-3. 4-4 (CONT'D.)
SIGNAL-TO-NOISE TEST DATA

System Description: Channel 1-18, PBW
IF Signal-to-Noise Ratio 14 db, AGC Voltage -4.0Vdc

Channel No. 18 Channel Frequency 70Kc ± 7.5%
BPIF: Signal -2.5db Noise: Full Mult. -27.8db Search Ch. Only -30.6d
Deviation Ratio 1
LPOF Cutoff Frequency . . . . 5250 cps
Full Bandwidth Voltage . . . . 20V p-p
Output Noise: Full Multiplex. . . . . . . 300 mv
Search Channel Only . . . . 240 mv

Channel No. 14 Channel Frequency 22 Kc ± 7.5%
BPIF: Signal -9.5db Noise: Full Mult. -38.9db Search Ch. Only -45.2db
Deviation Ratio 1
LPOF Cutoff Frequency . . . . 1650 cps
Full Bandwidth Voltage . . . . 20V p-p
Output Noise: Full Multiplex. . . . . . . 170 mv
Search Channel Only . . . . 100 mv

Channel No. 11 Channel Frequency 7.35 Kc ± 7.5%
BPIF: Signal -16.3db Noise: Full Mult. -46.8db Search Ch. Only -57.2d
Deviation Ratio 1
LPOF Cutoff Frequency . . . . 551 cps
Full Bandwidth Voltage . . . . 20V p-p
Output Noise: Full Multiplex. . . . . . . 130 mv
Search Channel Only . . . . 43 mv

Channel No. 8 Channel Frequency 3 Kc ± 7.5%
BPIF: Signal -20.8db Noise: Full Mult. -44.0db Search Ch. Only -62.0db
Deviation Ratio 1
LPOF Cutoff Frequency . . . . 225 cps
Full Bandwidth Voltage . . . . 20V p-p
Output Noise: Full Multiplex. . . . . . . 170 mv
Search Channel Only . . . . 22 mv

Channel No. 4 Channel Frequency 960 cps ± 7.5%
BPIF: Signal -24.8db Noise: Full Mult. -49.0db Search Ch. Only -63.0db
Deviation Ratio 1
LPOF Cutoff Frequency . . . . 72 cps
Full Bandwidth Voltage . . . . 20V p-p
Output Noise: Full Multiplex. . . . . . . 130 mv
Search Channel Only . . . . 22 mv

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FIGURE II-3.4-5
SIGNAL-TO-NOISE TEST DATA

System Description: Channel 1-18, PBW
IF Signal-to-Noise Ratio 2db AGC Voltage -4.0Vdc

Channel No. 18 Channel Frequency 70kc ±7.5%
BPIF: Signal -6.3db Noise: Full Mult. -13.7db Search Ch. Only -14.7db
Deviation Ratio 2
LPOF Cutoff Frequency . . . . 2625 cps
Full Bandwidth Voltage . . . . 20V p-p
Output Noise: Full Multiplex. . . . . . . 3000 mV
Search Channel Only . . . . 2200 mV

Channel No. 14 Channel Frequency 22kc ±7.5%
BPIF: Signal -13.5db Noise: Full Mult. -17.6db Search Ch. Only -19.0db
Deviation Ratio 2
LPOF Cutoff Frequency . . . . 825 cps
Full Bandwidth Voltage . . . . 20V p-p
Output Noise: Full Multiplex. . . . . . . 3200 mV
Search Channel Only . . . . 2400 mV

Channel No. 11 Channel Frequency 7.35 kc ±7.5%
BPIF: Signal -19.5db Noise: Full Mult. -21.5db Search Ch. Only -23.0db
Deviation Ratio 2
LPOF Cutoff Frequency . . . . 276 cps
Full Bandwidth Voltage . . . . 20V p-p
Output Noise: Full Multiplex. . . . . . . 4000 mV
Search Channel Only . . . . 3600 mV

Channel No. 8 Channel Frequency 3kc ±7.5%
BPIF: Signal -23.5db Noise: Full Mult. -26.5db Search Ch. Only -28.5db
Deviation Ratio 2
LPOF Cutoff Frequency . . . . 113 cps
Full Bandwidth Voltage . . . . 20V p-p
Output Noise: Full Multiplex. . . . . . . 4000 mV
Search Channel Only . . . . 3000 mV

Channel No. 4 Channel Frequency 960 cps ±7.5%
BPIF: Signal -28.0db Noise: Full Mult. -31.5db Search Ch. Only -33.5db
Deviation Ratio 2
LPOF Cutoff Frequency . . . . 36 cps
Full Bandwidth Voltage . . . . 20V p-p
Output Noise: Full Multiplex. . . . . . . 3000 mV
Search Channel Only . . . . 2500 mV

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FIGURE II-3.4-5 (CONT'D.)
SIGNAL-TO-NOISE TEST DATA

System Description: Channel 1-18, PBW
IF Signal-to-Noise Ratio 4db AGC Voltage -4.0 Vdc

Channel No. 18 Channel Frequency 70kc ±7.5%
BPIF: Signal -4.3db Noise: Full Mult. -12.2db Search Ch. Only -19.0db
Deviation Ratio 2
LPOF Cutoff Frequency 2625
Full Bandwidth Voltage . . . . 20V p-p
Output Noise: Full Multiplex. 850mv
Search Channel Only . . . 650mv

Channel No. 14 Channel Frequency 22kc ±7.5%
BPIF: Signal -14.3db Noise: Full Mult. -20.5db Search Ch. Only -24.1db
Deviation Ratio 2
LPOF Cutoff Frequency . . . . 825 cps
Full Bandwidth Voltage 20Vp-p
Output Noise: Full Multiplex. . . . . . 2000 mv
Search Channel Only . . . 1000 mv

Channel No. 11 Channel Frequency 7.35Kc ±7.5%
BPIF: Signal -18.5db Noise: Full Mult. -25.5db Search Ch. Only -28.5db
Deviation Ratio 2
LPOF Cutoff Frequency . . . . 276 cps
Full Bandwidth Voltage 20Vp-p
Output Noise: Full Multiplex. . . . . . 1620 mv
Search Channel Only . . . 900 mv

Channel No. 8 Channel Frequency 3Kc ±7.5%
BPIF: Signal -22.5db Noise: Full Mult. -30.0db Search Ch. Only -34.0db
Deviation Ratio 2
LPOF Cutoff Frequency . . . . 113 cps
Full Bandwidth Voltage 20Vp-p
Output Noise: Full Multiplex. 1400mv
Search Channel Only . . . 900mv

Channel No. 4 Channel Frequency 960 cps ±7.5%
BPIF: Signal -27.0db Noise: Full Mult. -36.0db Search Ch. Only -39.0db
Deviation Ratio 2
LPOF Cutoff Frequency . . . . 36 cps
Full Bandwidth Voltage 20Vp-p
Output Noise: Full Multiplex. . . . . . 1100 mv
Search Channel Only . . . 750 mv

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Name WRH/MDL Date 1-6-65

FIGURE II-3.4-5 (CONT'D.)
SIGNAL-TO-NOISE TEST DATA

System Description: Channel 1-18, PEW
IF Signal-to-Noise Ratio 9db, AGC Voltage -4.0Vdc

Channel No. 18 Channel Frequency 70 Kc ± 7.5%
BPIF: Signal -2.7db Noise: Full Mult. -24.0db Search Ch. Only -25.4db
Deviation Ratio 2
LPOF Cutoff Frequency . . . . 2625 cps
Full Bandwidth Voltage . . . . 20V p-p
Output Noise: Full Multiplex. 261mv
Search Channel Only 233mv

Channel No. 14 Channel Frequency 22 kc ± 7.5%
BPIF: Signal -9.5db Noise: Full Mult. -33.5db Search Ch. Only -41.0db
Deviation Ratio 2
LPOF Cutoff Frequency . . . . 825 cps
Full Bandwidth Voltage . . . . 20V p-p
Output Noise: Full Multiplex. 192mv
Search Channel Only 96mv

Channel No. 11 Channel Frequency 7.35 kc ± 7.5%
BPIF: Signal -16.5db Noise: Full Mult. -39.0db Search Ch. Only -49.0db
Deviation Ratio 2
LPOF Cutoff Frequency . . . . 276 cps
Full Bandwidth Voltage . . . . 20V p-p
Output Noise: Full Multiplex. 250mv
Search Channel Only . . . . 75 mv

Channel No. 8 Channel Frequency 3Kc ± 7.5%
BPIF: Signal -21.0db Noise: Full Mult. -42.0db Search Ch. Only -56.0db
Deviation Ratio 2
LPOF Cutoff Frequency . . . . 113 cps
Full Bandwidth Voltage . . . . 20V p-p
Output Noise: Full Multiplex. 240mv
Search Channel Only 55mv

Channel No. 4 Channel Frequency 960 cps ± 7.5%
BPIF: Signal -25.0db Noise: Full Mult. -47.0db Search Ch. Only -61.0db
Deviation Ratio 2
LPOF Cutoff Frequency 36cps
Full Bandwidth Voltage . . . . 20V p-p
Output Noise: Full Multiplex. 182mv
Search Channel Only 53mv

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Name WRH/MDL Date 1-6-65

FIGURE II-3.4-5 (CONT'D.)
SIGNAL-TO-NOISE TEST DATA

System Description: Channel 1-18, PBW
IF Signal-to-Noise Ratio 14 db AGC Voltage -4.0Vdc

Channel No. 18 Channel Frequency 70Kc ± 1.5%
BPIF: Signal -2.5db Noise: Full Mult. -27.8db Search Ch. Only -30.6db
Deviation Ratio 2
LPOF Cutoff Frequency . . . . 2625 cps
Full Bandwidth Voltage 20Vp-p
Output Noise: Full Multiplex. . . . . . . 140 mv
Search Channel Only . . . . 120 mv

Channel No. 14 Channel Frequency 22 kc ± 7.5%
BPIF: Signal -9.5db Noise: Full Mult. -38.4db Search Ch. Only -45.2db
Deviation Ratio 2
LPOF Cutoff Frequency . . . . 825 cps
Full Bandwidth Voltage 20Vp-p
Output Noise: Full Multiplex. . . . . . . 85 mv
Search Channel Only . . . . 50 mv

Channel No. 11 Channel Frequency 1.35 kc ± 7.5%
BPIF: Signal -16.3db Noise: Full Mult. -46.8db Search Ch. Only -57.2db
Deviation Ratio 2
LPOF Cutoff Frequency . . . . 276 cps
Full Bandwidth Voltage 20Vp-p
Output Noise: Full Multiplex. 70mv
Search Channel Only . . . . 23 mv

Channel No. 8 Channel Frequency 3kc ± 7.5%
BPIF: Signal -20.8db Noise: Full Mult. -44.0db Search Ch. Only -62.0db
Deviation Ratio 2
LPOF Cutoff Frequency . . . . 113 cps
Full Bandwidth Voltage 20Vp-p
Output Noise: Full Multiplex. 60mv
Search Channel Only . . . . 14 mv

Channel No. 4 Channel Frequency 960 cps ± 7.5%
BPIF: Signal -24.8db Noise: Full Mult. -49.0db Search Ch. Only -63.0db
Deviation Ratio 2
LPOF Cutoff Frequency . . . . 36 cps
Full Bandwidth Voltage 20Vp-p
Output Noise: Full Multiplex. 45mv
Search Channel Only . . . . 13 mv

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FIGURE II-3.4-6
SIGNAL-TO-NOISE TEST DATA

System Description: Standard IRIG + 93, 124 & 165 KC ±7.5% Chan
IF Signal-to-Noise Ratio 4 db AGC Voltage -4.0vdc

Channel No. #8 Channel Frequency 3.0 KC ±7.5%
BPIF: Signal -25 db Noise: Full Mult. -26.2 Search Ch. Only -27.8
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 45 cps CA
Full Bandwidth Voltage . . . . 10 vpp
Output Noise: Full Multiplex. . . . . . . 1700 mvrms
Search Channel Only . . . . 1200 mvrms

Channel No. #18 Channel Frequency 70 KC ±7.5%
BPIF: Signal -10.5 db Noise: Full Mult. -12.2 db Search Ch. Only -13.5 db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 1050 cps CA
Full Bandwidth Voltage . . . . 10 vpp
Output Noise: Full Multiplex. . . . . . . 1700 mvrms
Search Channel Only . . . . 1350 mvrms

Channel No. #19 Channel Frequency 93 KC ±7.5%
BPIF: Signal -6.8 db Noise: Full Mult. -11.7 Search Ch. Only -12.5 db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 1395 cps CA
Full Bandwidth Voltage . . . . 10 vpp
Output Noise: Full Multiplex. . . . . . . 950 mvrms
Search Channel Only . . . . 700 mvrms

Channel No. #20 Channel Frequency 124 KC ±7.5%
BPIF: Signal -6.4 db Noise: Full Mult. -10 db Search Ch. Only -10.4 db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 1860 cps CA
Full Bandwidth Voltage . . . . 10 vpp
Output Noise: Full Multiplex. . . . . . . 1300 mvrms
Search Channel Only . . . . 1050 mvrms

Channel No. #21 Channel Frequency 165 KC ±7.5%
BPIF: Signal -4.2 db Noise: Full Mult. -8.0 db Search Ch Only -8.0 db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 2475 cps CA
Full Bandwidth Voltage . . . . 10 vpp
Output Noise: Full Multiplex. . . . . . . 1050 mvrms
Search Channel Only . . . . 900 mvrms

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FIGURE II-3.4-6 (CONT'D.)
SIGNAL-TO-NOISE TEST DATA

System Description: Standard IRIG + 93, 124 & 165 kc ± 7.5% Cha
IF Signal-to-Noise Ratio 9db **AGC Voltage** -4.0vdc

Channel No. #8 **Channel Frequency** 3.0 KC ± 7.5%
BPIF: Signal -25.1 **Noise: Full Mult.** -39.6db **Search Ch. Only** -46.4d
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 45cps CA
Full Bandwidth Voltage 10vpp
Output Noise: Full Multiplex . . . . . . 65 mvrms
Search Channel Only . . . . 31 mvrms

Channel No. #18 **Channel Frequency** 70 KC ± 7.5%
BPIF: Signal -11.6db **Noise: Full Mult.** -20.6db **Search Ch. Only** -21.7db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 1050cps CA
Full Bandwidth Voltage 10vpp
Output Noise: Full Multiplex . . . . . . 156 mvrms
Search Channel Only . . . . 135 mvrms

Channel No. #19 **Channel Frequency** 93 KC ± 7.5%
BPIF: Signal -5.4db **Noise: Full Mult.** -18.5db **Search Ch. Only** -18.7db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 1395cps CA
Full Bandwidth Voltage 10vpp
Output Noise: Full Multiplex . . . . . . 92 mvrms
Search Channel Only . . . . 85 mvrms

Channel No. #20 **Channel Frequency** 124 KC ± 7.5%
BPIF: Signal -5.5db **Noise: Full Mult.** -15.3db **Search Ch. Only** -15.3db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 1860cps CA
Full Bandwidth Voltage 10vpp
Output Noise: Full Multiplex . . . . . . 140 mvrms
Search Channel Only . . . . 134 mvrms

Channel No. #21 **Channel Frequency** 165 KC ± 7.5%
BPIF: Signal -2.7db **Noise: Full Mult.** -12.2db **Search Ch. Only** -11.9db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 2475cps CA
Full Bandwidth Voltage 10vpp
Output Noise: Full Multiplex . . . . . . 140 mvrms
Search Channel Only . . . . 134 mvrms

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FIGURE II-3.4-6 (CONT'D.)
SIGNAL-TO-NOISE TEST DATA

System Description: Standard IRIG + 93, 124 & 165 KC ± 7.5% Channels
IF Signal-to-Noise Ratio 14 db AGC Voltage -4.0 vdc

Channel No. #8 Channel Frequency 3.0 KC ± 7.5%
BPIF: Signal -24.7 db Noise: Full Mult. -42.5 db Search Ch. Only -56.8 db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 45 cps CA
Full Bandwidth Voltage . . . . 10 vpp
Output Noise: Full Multiplex . . . . 9.5 mvrms
Search Channel Only . . . 4.5 mvrms

Channel No. #18 Channel Frequency 70 KC ± 7.5%
BPIF: Signal -11.5 db Noise: Full Mult. -25.7 db Search Ch. Only -26.6 db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 1050 cps CA
Full Bandwidth Voltage . . . . 10 vpp
Output Noise: Full Multiplex . . . . 75 mvrms
Search Channel Only . . . 70 mvrms

Channel No. #19 Channel Frequency 93 KC ± 7.5%
BPIF: Signal -5.0 db Noise: Full Mult. -23.2 db Search Ch. Only -23.6 db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 1395 cps CA
Full Bandwidth Voltage . . . . 10 vpp
Output Noise: Full Multiplex . . . . 46 mvrms
Search Channel Only . . . 44 mvrms

Channel No. #20 Channel Frequency 124 KC ± 7.5%
BPIF: Signal -5.2 db Noise: Full Mult. -20.0 db Search Ch. Only -20.3 db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 1860 cps CA
Full Bandwidth Voltage . . . . 10 vpp
Output Noise: Full Multiplex . . . . 75 mvrms
Search Channel Only . . . 70 mvrms

Channel No. #21 Channel Frequency 165 KC ± 7.5%
BPIF: Signal -2.6 db Noise: Full Mult. -17.1 db Search Ch. Only -17.0 db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 2475 cps CA
Full Bandwidth Voltage . . . . 10 vpp
Output Noise: Full Multiplex . . . . 73 mvrms
Search Channel Only . . . 70 mvrms

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FIGURE II-3.4-6 (CONT'D.)
SIGNAL-TO-NOISE TEST DATA

System Description: Standard IRIG + 93, 124, & 165 KC ±7.5% Channel
IF Signal-to-Noise Ratio 19 db AGC Voltage -4.0 vdc

Channel No. #8 Channel Frequency 3.0 KC ±7.5%
BPIF: Signal -24.6 db Noise: Full Mult. -42.5 db Search Ch. Only -54.5
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 45 cps CA
Full Bandwidth Voltage . . . . 10 VPP
Output Noise: Full Multiplex . . . . . . 6.5 mvrms
Search Channel Only . . . . 3.5 mvrms

Channel No. #18 Channel Frequency 70 KC ±7.5%
BPIF: Signal -11.5 db Noise: Full Mult. -29.1 db Search Ch. Only -31.2 db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 1050 cps CA
Full Bandwidth Voltage . . . . 10 VPP
Output Noise: Full Multiplex . . . . . . 44 mvrms
Search Channel Only . . . . 41 mvrms

Channel No. #19 Channel Frequency 93 KC ±7.5%
BPIF: Signal -5.0 db Noise: Full Mult. -27.1 db Search Ch. Only -28.0 db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 1395 cps CA
Full Bandwidth Voltage . . . . 10 VPP
Output Noise: Full Multiplex . . . . . . 28 mvrms
Search Channel Only . . . . 26 mvrms

Channel No. #20 Channel Frequency 124 KC ±7.5%
BPIF: Signal -5.2 db Noise: Full Mult. -23.6 db Search Ch. Only -24.7 db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 1860 cps CA
Full Bandwidth Voltage . . . . 10 VPP
Output Noise: Full Multiplex . . . . . . 44 mvrms
Search Channel Only . . . . 42 mvrms

Channel No. #21 Channel Frequency 165 KC ±7.5%
BPIF: Signal -2.4 db Noise: Full Mult. -21.4 db Search Ch. Only -21.4 db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 2475 cps CA
Full Bandwidth Voltage . . . . 10 VPP
Output Noise: Full Multiplex . . . . . . 43 mvrms
Search Channel Only . . . . 41 mvrms

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FIGURE II-3.4-6 (CONT'D.)
SIGNAL-TO-NOISE TEST DATA

System Description: Standard IRIG + 93, 124, & 165 KC ±7.5%
IF Signal-to-Noise Ratio (As listed) AGC Voltage -4.0 v dc

Channel No. 21 Channel Frequency 165 KC ±7.5% $(S/N)_c = 11$ db
BPIF: Signal -2.6 db Noise: Full Mult. ______ Search Ch. Only -12.7 db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 2475 cps CA
Full Bandwidth Voltage . . . . 10 vpp +13.4 db
Output Noise: Full Multiplex. . . . . . .
Search Channel Only . . . 114 mvrms -16.7 db

Channel No. 21 Channel Frequency 165 KC ±7.5% $(S/N)_c = 9$ db
BPIF: Signal -2.7 db Noise: Full Mult. ______ Search Ch. Only -12.3
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 2475 cps CA
Full Bandwidth Voltage . . . . 10 vpp +13.4 db
Output Noise: Full Multiplex. . . . . . .
Search Channel Only . . . 136 mvrms -15.0 db

Channel No. 21 Channel Frequency 165 KC ±7.5% $(S/N)_c = 6$ db
BPIF: Signal -3.0 db Noise: Full Mult. ______ Search Ch. Only -10.6 db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 2475 cps CA
Full Bandwidth Voltage . . . . 10 vpp +13.4 db
Output Noise: Full Multiplex. . . . . . .
Search Channel Only . . . 230 mvrms -10.5 db

Channel No. 21 Channel Frequency 165 KC ±7.5% $(S/N)_c = 4$ db
BPIF: Signal -3.7 db Noise: Full Mult. ______ Search Ch. Only -9.0 db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 2475 cps CA
Full Bandwidth Voltage . . . . 10 vpp +13.4 db
Output Noise: Full Multiplex. . . . . . .
Search Channel Only . . . 620 mvrms -2.0 db

Channel No. 21 Channel Frequency 165 KC ±7.5% $(S/N)_c = 9$ db
BPIF: Signal -2.6 Noise: Full Mult. ______ Search Ch. Only -12.7
Deviation Ratio 5
LPOF Cutoff Frequency 2475
Full Bandwidth Voltage . . . . 10 vpp +13.4 db
Output Noise: Full Multiplex. . . . . . .
Search Channel Only . . . 130 mvrms -15.6 db
(No Modulation Input to any VCO)

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FIGURE II-3.4-7

SIGNAL-TO-NOISE TEST DATA

System Description: Channel 1-19 + H Proportional Bandwidth

IF Signal-to-Noise Ratio 4db AGC Voltage -4.0Vdc

Channel No. H Channel Frequency 165 kc ±15%

BPIF: Signal -0.1 db Noise: Full Mult. -3.6 db Search Ch. Only -3.4 db

Deviation Ratio 5

LPOF Cutoff Frequency . . . . 4950 cps CA

Full Bandwidth Voltage 10vp-p

Output Noise: Full Multiplex . . . . 1150 mv

Search Channel Only . . . . 1100 mv

Channel No. 19 Channel Frequency 93 kc ±7.5%

BPIF: Signal -9.5db Noise: Full Mult. -12.4db Search Ch. Only -12.6db

Deviation Ratio 5

LPOF Cutoff Frequency . . . . 1400 cps CA

Full Bandwidth Voltage . . . . 10V p-p

Output Noise: Full Multiplex . . . . 750 mv

Search Channel Only . . . . 660 mv

Channel No. 18 Channel Frequency 70 kc ±7.5%

BPIF: Signal -11.8db Noise: Full Mult. -13.9db Search Ch. Only -14.7db

Deviation Ratio 5

LPOF Cutoff Frequency . . . . 1050 cps CA

Full Bandwidth Voltage . . . . 10V p-p

Output Noise: Full Multiplex . . . . 1500 mv

Search Channel Only . . . . 1200 mv

Channel No. 8 Channel Frequency 3.0 kc ±7.5%

BPIF: Signal -25.5db Noise: Full Mult. -29.4db Search Ch. Only -31.8db

Deviation Ratio 5

LPOF Cutoff Frequency . . . . 45 cps CA

Full Bandwidth Voltage . . . . 10V p-p

Output Noise: Full Multiplex . . . . 1100 mv

Search Channel Only . . . . 600 mV

Channel No. ______ Channel Frequency ______

BPIF: Signal ______ Noise: Full Mult. ______ Search Ch. Only ______

Deviation Ratio . . . . ______

LPOF Cutoff Frequency . . . . ______

Full Bandwidth Voltage . . . . ______

Output Noise: Full Multiplex . . . . ______

Search Channel Only . . . . ______

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FIGURE II-3.4-7 (CONT'D.)
SIGNAL-TO-NOISE TEST DATA

System Description: Channel 1-19 + H Proportional Bandwidth
IF Signal-to-Noise Ratio 9 db AGC Voltage -4.0 vdc

Channel No. H Channel Frequency 165 kc ± 15%
BPIF: Signal 0 db Noise: Full Mult. -7.4 db Search Ch. Only -7.3 db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 4950 cps CA
Full Bandwidth Voltage . . . . 10 vpp
Output Noise: Full Multiplex. . . . . . . 230 mv
Search Channel Only . . . . 220 mv

Channel No. 19 Channel Frequency 95 kc ± 7.5%
BPIF: Signal -10 db Noise: Full Mult. -17.4 db Search Ch. Only -17.2 db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 1400 cps CA
Full Bandwidth Voltage . . . . 10 vpp
Output Noise: Full Multiplex. . . . . . . 160 mv
Search Channel Only . . . . 120 mv

Channel No. 18 Channel Frequency 70 kc ± 7.5%
BPIF: Signal -12.9 db Noise: Full Mult. -20.2 db Search Ch. Only -20.4 db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 1050 cps CA
Full Bandwidth Voltage . . . . 10 vpp
Output Noise: Full Multiplex. . . . . . . 210 mv
Search Channel Only . . . . 190 mv

Channel No. 8 Channel Frequency 3 kc ± 7.5%
BPIF: Signal -25.8 db Noise: Full Mult. -41.5 db Search Ch. Only -47.5 db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 45 cps CA
Full Bandwidth Voltage . . . . 10 vpp
Output Noise: Full Multiplex. . . . . . . 50 mv
Search Channel Only . . . . 24 mv

Channel No. _____ Channel Frequency _____
BPIF: Signal _____ Noise: Full Mult. _____ Search Ch. Only _____
Deviation Ratio . . . . _____
LPOF Cutoff Frequency . . . . _____
Full Bandwidth Voltage . . . . _____
Output Noise: Full Multiplex. . . . . . . _____
Search Channel Only . . . . _____

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FIGURE II-3.4-7 (CONT'D.)
SIGNAL-TO-NOISE TEST DATA

System Description: Channel 1-19 + H Proportional Bandwidth
IF Signal-to-Noise Ratio 14 db AGC Voltage -4.0Vdc

Channel No. H Channel Frequency 165 kc ±15%
BPIF: Signal +0.6 db Noise: Full Mult. -11.3 db Search Ch. Only -11.3 db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 4950 cps CA
Full Bandwidth Voltage . . . . 10 Vp-p
Output Noise: Full Multiplex . . . . 104 mv
Search Channel Only . . . . 100 mv

Channel No. 19 Channel Frequency 93 kc ±7.5%
BPIF: Signal -9.2 db Noise: Full Mult. -21.1 db Search Ch. Only -21.1 d
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 1400 cps CA
Full Bandwidth Voltage . . . . 10 Vp-p
Output Noise: Full Multiplex . . . . 51 mv
Search Channel Only . . . . 50 mv

Channel No. 18 Channel Frequency 70 kc ±7.5%
BPIF: Signal -12.1 db Noise: Full Mult. -24.1 db Search Ch. Only -24.3
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 1050 cps CA
Full Bandwidth Voltage . . . . 10 Vp-p
Output Noise: Full Multiplex . . . . 102 mv
Search Channel Only . . . . 100 mv

Channel No. 8 Channel Frequency 3.0 kc ±7.5%
BPIF: Signal -24.6 db Noise: Full Mult. -42. db Search Ch. Only -52.5
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 45 cps CA
Full Bandwidth Voltage . . . . 10 Vp-p
Output Noise: Full Multiplex . . . . 9.0 mv
Search Channel Only . . . . 5.2 mv

Channel No. ______ Channel Frequency ______
BPIF: Signal ______ Noise: Full Mult. ______ Search Ch. Only ______
Deviation Ratio . . . . ______
LPOF Cutoff Frequency . . . . ______
Full Bandwidth Voltage . . . . ______
Output Noise: Full Multiplex . . . . ______
Search Channel Only . . . . ______

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FIGURE II-3.4-7 (CONT'D.)
SIGNAL-TO-NOISE TEST DATA

System Description: Channel 1-19 + H Proportional Bandwidth
IF Signal-to-Noise Ratio 19db AGC Voltage -4.0Vdc

Channel No. H Channel Frequency 165kc ±15%
BPIF: Signal +0.9db Noise: Full Mult. -15.7db Search Ch. Only -15.7db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 4850 cps CA
Full Bandwidth Voltage 10Vp-p
Output Noise: Full Multiplex. . . . . . . 61 mv
Search Channel Only 57mv

Channel No. 19 Channel Frequency 93kc ±7.5%
BPIF: Signal -8.8db Noise: Full Mult. -25.3db Search Ch. Only -25.5db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 1400 cps CA
Full Bandwidth Voltage 10Vp-p
Output Noise: Full Multiplex. 29mv
Search Channel Only 28.5mv

Channel No. 18 Channel Frequency 70kc ±7.5%
BPIF: Signal -11.6db Noise: Full Mult. -28db Search Ch. Only -28.7db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 1050cps CA
Full Bandwidth Voltage 10Vp-p
Output Noise: Full Multiplex. . . . . . . 58 mv
Search Channel Only . . . . 56 mv

Channel No. 8 Channel Frequency 3.0kc ±7.5%
BPIF: Signal -23.9db Noise: Full Mult. -42 db Search Ch. Only -53 db
Deviation Ratio 5
LPOF Cutoff Frequency . . . . 45 cps CA
Full Bandwidth Voltage 10Vp-p
Output Noise: Full Multiplex. . . . . . . 5.8 mv
Search Channel Only . . . . 3.1 mv

Channel No. ______ Channel Frequency ______
BPIF: Signal ______ Noise: Full Mult. ______ Search Ch. Only ______
Deviation Ratio . . . . ______
LPOF Cutoff Frequency . . . . ______
Full Bandwidth Voltage . . . . ______
Output Noise: Full Multiplex. . . . . . . ______
Search Channel Only . . . . ______

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FIGURE II-3.4-7 (CONT'D.)
SIGNAL-TO-NOISE TEST DATA

System Description: Channels 1-19 & H
IF Signal-to-Noise Ratio (As Listed) AGC Voltage - [illegible]

Channel No. H Channel Frequency 165 KC ±15% (S/N)c = 11[illegible]
BPIF: Signal -0.[illegible] Noise: Full Mult. ______ Search Ch. Only -9.5[illegible]
Deviation Ratio . . . . ______
LPOF Cutoff Frequency . . . . 4950 cps CA
Full Bandwidth Voltage . . . . 10VPP +13.4db
Output Noise: Full Multiplex. . . . . . . ______
Search Channel Only . . . . 132 mv rms -15db

Channel No. H Channel Frequency 165 KC ±15% (S/N)c = 9 db
BPIF: Signal 0db Noise: Full Mult. ______ Search Ch. Only -[illegible]
Deviation Ratio . . . . ______
LPOF Cutoff Frequency . . . . 4950 cps CA
Full Bandwidth Voltage . . . . 10VPP +13.4db
Output Noise: Full Multiplex. . . . . . . ______
Search Channel Only . . . . 250 mv rms -10db

Channel No. H Channel Frequency 165 ±15% (S/N)c = 6 db
BPIF: Signal -0.1db Noise: Full Mult. ______ Search Ch. Only -5.0db
Deviation Ratio . . . . ______
LPOF Cutoff Frequency . . . . 4950 cps CA
Full Bandwidth Voltage . . . . 10VPP +13.4db
Output Noise: Full Multiplex. . . . . . . ______
Search Channel Only . . . . 725 mv rms -0.5db

Channel No. H Channel Frequency 165 ±15% (S/N)c = 4 db
BPIF: Signal -0.4 db Noise: Full Mult. ______ Search Ch. Only -[illegible]
Deviation Ratio . . . . ______
LPOF Cutoff Frequency . . . . 4950 cps CA
Full Bandwidth Voltage . . . . 10VPP +13.4db
Output Noise: Full Multiplex. . . . . . . ______
Search Channel Only . . . . 1250 mv rms +4.2db

Channel No. ______ Channel Frequency ______
BPIF: Signal ______ Noise: Full Mult. ______ Search Ch. Only ______
Deviation Ratio . . . . ______
LPOF Cutoff Frequency . . . . ______
Full Bandwidth Voltage . . . . ______
Output Noise: Full Multiplex. . . . . . . ______
Search Channel Only . . . . ______

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TABLE II-3.4-8
SIGNAL-TO-NOISE TEST DATA

System: Constant [illegible] $(S/N)_c$: 6db AGC: -4.0V Output FBW Signal: 10.0 dbm*

CHANNEL				INPUT					OUTPUT			
					Noise		$(S/N)_s$		Noise		$(S/N)_d$	
No.	Frequency	DR	LPOF Frequency	Signal dbm*	Full Multiplex dbm*	Search Channel Only dbm*	Full Multiplex db	Search Channel Only db	Full Multiplex dbm*	Search Channel Only dbm*	Full Multiplex db	Search Channel Only db
	Measurements made with test channel at center frequency:											
6	56.0kc	2	1.0kc	-15.2	-17.3	-17.6	2.1	2.4	7.8	7.4	2.2	2.6
10	88.0kc	2	1.0kc	-14.5	-16.1	-16.9	2.4	2.4	6.8	6.6	3.2	3.4
14	120.0kc	2	1.0kc	-14.8	-17.5	-17.5	2.7	2.7	6.9	6.9	3.1	3.1
19	160.0kc	2	1.0kc	-15.5	-18.5	-18.5	3.0	3.0	6.3	6.3	3.7	3.7
14	120.0kc	1	2.0kc	-14.8	-17.5	—	2.7	—	11.1	—	-1.1	—
14	120.0kc	4	0.5kc	-14.8	-17.5	—	2.7	—	4.4	—	5.[illegible]	—
	Measurements made with test channel at high band edge:											
14	120.0kc	2	1.0kc	-14.8	-17.5	—	2.7	—	13.4	—	-0.4	—
14	120.0kc	1	2.0kc	-14.8	-17.5	—	2.7	—	13.3	—	-3.5	—
14	120.0kc	4	0.5kc	-14.8	-17.5	—	[illegible]	—	8.0	—	2.0	—
	Measurements made with test channel mo[illegible]ed:											
14	[illegible]kc	[illegible]	1.0kc	-1[illegible]	-17.5	—	2.7	—	11.2	—	-1.2	—
14	120.0kc	1	[illegible]kc	14.[illegible]	[illegible]	—	2.7	—	13.[illegible]	—	-3.[illegible]	—
14	1[illegible].0kc	4	[illegible]	14.[illegible]	17.5	—	[illegible]	-	9.[illegible]	—	[illegible]	—

*db referenced to one milliwatt into 600 ohms. 1 of 7 Name: [illegible] MD[illegible] Date: 2-25-65

TABLE II-3.4-8 (CONT'D.)
SIGNAL-TO-NOISE TEST DATA

System: Constant Bandwidth (S/N)$_c$: 9.0db AGC: -4.0V Output FBW Signal: 10.0 dbm*

CHANNEL				INPUT					OUTPUT			
					Noise		$(S/N)_s$		Noise		$(S/N)_d$	
No.	Frequency	DR	LPOF Frequency	Signal dbm*	Full Multiplex dbm*	Search Channel Only dbm*	Full Multiplex db	Search Channel Only db	Full Multiplex dbm*	Search Channel Only dbm*	Full Multiplex db	Search Channel Only db
	Test channel at center frequency:											
6	56.0 kc	2	1.0kc	-16.6	-21.7	-21.7	5.1	5.1	2.0	2.0	8.0	8.0
10	88.0 kc	2	1.0kc	-15.3	-20.4	-20.4	5.1	5.1	1.0	1.0	9.0	9.0
14	120.0 kc	2	1.0 kc	-15.3	-20.5	-20.5	5.2	5.2	1.5	1.5	8.5	8.5
19	160.0 kc	2	1.0kc	-15.9	-21.3	-21.3	4.4	4.4	0.8	0.8	9.2	9.2
14	120.0 kc	1	2.0kc	-15.3	-20.5	—	5.2	—	7.6	—	2.4	—
14	120.0 kc	4	0.5kc	-15.3	-20.5	—	5.2	—	-1.0	—	9.0	—
	Test channel at high bandedge:											
14	120.0kc	2	1.0kc	-15.3	-20.5	—	5.2	—	9.0	—	1.0	—
14	120.0kc	1	2.0kc	-15.3	-20.5	—	5.2	—	12.0	—	-2.0	—
14	120.0kc	4	0.5kc	-15.3	-20.5	—	5.2	—	6.2	—	3.8	—
	Test channel modulated:											
14	120.0 kc	2	1.0kc	-15.3	-20.5	—	5.2	—	7.8	—	2.2	—
14	120.0kc	1	2.0 kc	-15.3	-20.5	—	5.2	—	10.0	—	0.0	—
14	[illegible]	4	[illegible]	[illegible]	-20.5	—	5.2	—	4.5	—	[illegible]	—

*db referenced to one milliwatt into 600 ohms.

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Name: WSK/[illegible] Date: 3-2[illegible]-6[illegible]

SIGNAL-TO-NOISE TEST DATA

System: Constant Bandwidth (S/N)$_c$: 12.0 db AGC: -4.0 V Output FBW Signal: 10.0 dbm*

CHANNEL				INPUT					OUTPUT			
					Noise		(S/N)$_s$		Noise		(S/N)$_d$	
No.	Frequency	DR	LPOF Frequency	Signal dbm*	Full Multiplex dbm*	Search Channel Only dbm*	Full Multiplex db	Search Channel Only db	Full Multiplex dbm*	Search Channel Only dbm*	Full Multiplex db	Search Channel Only db
	Test channel at center frequency:											
6	56.0 kc	2	1.0 kc	-17.0	-24.5	-24.5	7.5	7.5	-2.5	-2.5	12.5	12.5
10	88.0 kc	2	1.0 kc	-15.7	-23.1	-23.1	7.4	7.4	-3.5	-3.5	13.5	13.5
14	120.0 kc	2	1.0 kc	-15.8	-23.1	-23.1	7.3	7.3	-3.5	-3.5	13.5	13.5
19	160.0 kc	2	1.0 kc	-16.3	-23.8	-23.8	7.5	7.5	-4.0	-4.0	14.0	14.0
14	120.0 kc	1	2.0 kc	-15.8	-23.1	—	7.3	—	3.2	—	6.8	—
14	120.0 kc	4	0.5 kc	-15.8	-23.1	—	7.3	—	-9.8	—	19.8	—
	Test channel at high bandedge:											
14	120.0 kc	2	1.0 kc	-15.8	-23.1	—	7.3	—	4.4	—	5.6	—
14	120.0 kc	1	2.0 kc	-15.8	-23.1	—	7.3	—	8.1	—	1.9	—
14	120.0 kc	4	0.5 kc	-15.8	-23.1	—	7.3	—	1.5	—	8.5	—
	Test channel modulated:											
14	120.0 kc	2	1.0 kc	-15.8	-23.1	—	7.3	—	2.1	—	7.9	—
14	120.0 kc	1	2.0 kc	-15.8	-23.1	—	7.3	—	5.3	—	4.7	
14	120.0 kc	4	0.5 kc	-15.8	-23.1	—	7.3	—	-1.5	—	11.5	—

*db referenced to one milliwatt into 600 ohms.

3 of 7

Name: [illegible] Date: 3-25-65

TABLE II-3.4-8 (CONT'D.)
SIGNAL-TO-NOISE TEST DATA

System: Constant Bandwidth $(S/N)_c$: 15.0 db AGC: -4.0V Output FBW Signal: 10.0 dbm*

CHANNEL				INPUT					OUTPUT			
					Noise		$(S/N)_s$		Noise		$(S/N)_d$	
No.	Frequency	DR	LPOF Frequency	Signal dbm*	Full Multiplex dbm*	Search Channel Only dbm*	Full Multiplex db	Search Channel Only db	Full Multiplex dbm*	Search Channel Only dbm*	Full Multiplex db	Search Channel Only db
	Test channel at center frequency:											
6	56.0kc	2	1.0kc	-17.2	-27.2	-27.2	10.0	10.0	-6.9	-7.0	16.9	17.0
10	88.0kc	2	1.0kc	-15.9	-25.6	-25.7	9.7	9.8	-7.6	-7.7	17.6	17.7
14	120.0kc	2	1.0kc	-16.0	-25.6	-25.6	9.6	9.6	-6.8	-6.9	16.8	16.9
19	160.0kc	2	1.0kc	-16.6	-26.3	-26.3	9.7	9.7	-7.3	-7.3	17.3	17.3
14	120.0kc	1	2.0kc	-16.0	-25.6	—	9.6	—	0.0	—	10.0	—
14	120.0kc	4	0.5kc	-16.0	-25.6	—	9.6	—	-18.0	—	28.0	—
	Test channel at high bandedge:											
14	120.0kc	2	1.0kc	-16.0	-25.6	—	9.6	—	-2.5	—	12.5	—
14	120.0kc	1	2.0kc	-16.0	-25.6	—	9.6	—	3.2	—	6.8	—
14	120.0kc	4	0.5kc	-16.0	-25.6	—	9.6	—	-7.2	—	17.2	—
	Test channel modulated:											
14	120.0kc	2	1.0kc	-16.0	-25.6	—	9.6	—	-4.0	—	14.0	—
14	120.0kc	1	2.0kc	-16.0	-25.6	—	9.6	—	1.0	—	9.0	—
14	120.0kc	4	0.5kc	[illegible]	[illegible]	—	9.6		-10.0		20.0	—

*db referenced to one milliwatt into 600 ohms.

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Name: [illegible] Date: 3-25-65

SIGNAL-TO-NOISE TEST DATA

System: Constant Bandwidth (S/N)$_c$: 18.0 db AGC: -4.0 V Output FBW Signal: 13.0 dbm*

CHANNEL				INPUT					OUTPUT			
					Noise		(S/N)$_s$		Noise		(S/N)$_d$	
No.	Frequency	DR	LPOF Frequency	Signal dbm*	Full Multiplex dbm*	Search Channel Only dbm*	Full Multiplex db	Search Channel Only db	Full Multiplex dbm*	Search Channel Only dbm*	Full Multiplex db	Search Channel Only db
	Test channel at center frequency:											
6	56.0 kc	2	1.0 kc	-17.3	-30.7	-30.8	13.4	13.5	-10.7	-10.7	20.7	20.7
10	88.0 kc	2	1.0 kc	-16.1	-29.0	-29.0	12.9	12.9	-11.3	-11.3	21.3	21.3
14	120.0 kc	2	1.0 kc	-16.2	-29.1	-29.2	12.9	13.0	-10.6	-10.6	20.6	20.6
19	160.0 kc	2	1.0 kc	-16.9	-29.9	-30.0	13.0	13.1	-10.9	-11.1	20.9	21.1
14	120.0 kc	1	2.0 kc	-16.2	-29.1	—	12.9	—	-3.9	—	13.9	—
14	120.0 kc	4	0.5 kc	-16.2	-29.1	—	12.9	—	-22.5	—	32.5	—
	Test channel at high bandedge:											
14	120.0 kc	2	1.0 kc	-16.2	-29.1	—	12.9	—	-10.5	—	20.5	—
14	120.0 kc	1	2.0 kc	-16.2	-29.1	—	12.9	—	-1.9	—	11.9	—
14	120.0 kc	4	0.5 kc	-16.2	-29.1	—	12.9	—	-22.5	—	32.5	—
	Test channel modulated:											
14	120.0 kc	2	1.0 kc	-16.2	-29.1	—	12.9	—	-11.0	—	21.0	—
14	120.0 kc	1	2.0 kc	-16.2	-29.1	—	12.9	—	-3.3	—	13.3	—
14	120.0 kc	4	0.5 kc	-16.2	-29.1	—	12.9	—	-22.5		32.5	

*db referenced to one milliwatt into 600 ohms.

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Name: [illegible] Date: 3-2[illegible]

TABLE II-3.4-8 (CONT'D.)
SIGNAL-TO-NOISE TEST DATA

System: Constant Bandwidth (S/N)$_c$: 21.0 db AGC: -4.0V Output FBW Signal: 10.0 dbm*

CHANNEL				INPUT					OUTPUT			
					Noise		(S/N)$_s$		Noise		(S/N)$_d$	
No.	Frequency	DR	LPOF Frequency	Signal dbm*	Full Multiplex dbm*	Search Channel Only dbm*	Full Multiplex db	Search Channel Only db	Full Multiplex dbm*	Search Channel Only dbm*	Full Multiplex db	Search Channel Only db
	Test channel at center frequency:											
6	56.0 kc	2	1.0 kc	-17.4	-33.0	-33.2	15.6	15.8	-13.1	-13.1	23.1	23.1
10	88.0 kc	2	1.0 kc	-16.2	-31.5	-31.7	15.3	15.5	-13.5	-13.7	23.5	23.7
14	120.0 kc	2	1.0 kc	-16.4	-31.5	-31.7	15.1	15.3	-13.0	-13.1	23.0	23.1
19	160.0 kc	2	1.0 kc	-16.9	-32.2	-32.2	15.3	15.3	-13.1	-13.4	23.1	23.4
14	120.0 kc	1	2.0 kc	-16.4	-31.5	—	15.1	—	-6.3	—	16.3	—
14	120.0 kc	4	0.5 kc	-16.4	-31.5	—	15.1	—	-24.9	—	34.9	—
	Test channel at high bandedge:											
14	120.0 kc	2	1.0 kc	-16.4	-31.5	—	15.1	—	-13.1	—	23.1	—
14	120.0 kc	1	2.0 kc	-16.4	-31.5	—	15.1	—	-4.0	—	14.0	—
14	120.0 kc	4	0.5 kc	-16.4	-31.5	—	15.1	—	-24.9	—	34.9	—
	Test channel modulated:											
14	120.0 kc	2	1.0 kc	16.4	-31.5	—	15.1	—	-13.6	—	23.6	—
14	120.0 kc	1	2.0 kc	16.4	-31.5	—	15.1	—	-5.6		15.6	—
14	120.0 kc	4	0.5 kc	-16.4	-31.5	—	15.1	—	-23.9	—	33.4	—

*db referenced to one milliwatt into 600 ohms 1 of 7 Name: WSR/MW Date: 2-25-65

TABLE II-3.4-8 (CONT'D.)
SIGNAL-TO-NOISE TEST DATA

System: Constant Bandwidth $(S/N)_c$: 24.0db AGC: −4.0V Output FBW Signal: 10.0 dbm*

CHANNEL				INPUT					OUTPUT			
					Noise		$(S/N)_s$		Noise		$(S/N)_d$	
No.	Frequency	DR	LPOF Frequency	Signal dbm*	Full Multiplex dbm*	Search Channel Only dbm*	Full Multiplex db	Search Channel Only db	Full Multiplex dbm*	Search Channel Only dbm*	Full Multiplex db	Search Channel Only db
	Test channel at center frequency:											
6	56.0kc	2	1.0kc	-17.5	-36.2	-36.7	18.7	19.2	-17.0	-17.0	27.0	27.0
10	88.0kc	2	1.0kc	-16.3	-34.8	-35.2	18.5	18.9	-17.1	-17.4	27.1	27.4
14	120.0kc	2	1.0kc	-16.5	-34.8	-35.1	18.3	18.6	-16.3	-16.6	26.3	26.6
19	160.0kc	2	1.0kc	-17.1	-35.5	-35.9	18.4	18.8	-16.6	-16.8	26.6	26.8
14	120.0kc	1	2.0kc	-16.5	-34.8	—	18.3	—	-9.3	—	19.3	—
14	120.0kc	4	0.5kc	-16.5	-34.8	—	18.3	—	-28.4	—	38.4	—
	Test channel at high bandedge:											
14	120.0 kc	2	1.0kc	-16.5	-34.8	—	18.3	—	-16.5	—	26.5	—
14	120.0 kc	1	2.0kc	-16.5	-34.8	—	18.3	—	-7.2	—	17.2	—
14	120.0 kc	4	0.5kc	-16.5	-34.8	—	18.3	—	-28.6	—	38.6	—
	Test channel modulated:											
14	120.0 kc	2	1.0kc	-16.5	-34.8	—	18.3	—	-17.0	—	27.0	—
14	120.0 kc	1	2.0kc	-16.5	-34.8	—	18.3	—	-8.0	—	18.0	—
14	120.0 kc	4	0.5kc	-16.5	-34.8	—	18.3	—	-26.5	—	36.5	—

*db referenced to one milliwatt into 600 ohms.

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Name: WSB/MLL Date: 3-25-65

TABLE II-3.4-9
SIGNAL-TO-NOISE TEST DATA

System: Combinitional (S/N)$_c$: 6.0db ; GC: -4.0V Output FBW Signal: 10.0 dbm*

CHANNEL				INPUT					OUTPUT			
					Noise		(S/N)$_s$		Noise		(S/N)$_d$	
No.	Frequency	DR	LPOF Frequency	Signal dbm*	Full Multiplex dbm*	Search Channel Only dbm*	Full Multiplex db	Search Channel Only db	Full Multiplex dbm*	Search Channel Only dbm*	Full Multiplex db	Search Channel Only db
	Test channel at center frequency:											
6	56.0 kc	2	1.0kc	-18.1	-21.2	-22.6	3.1	4.5	6.0	4.4	4.0	5.6
10	88.0 kc	2	1.0kc	-18.2	-22.4	-23.1	4.2	4.9	3.3	1.5	6.7	8.5
14	120.0 kc	2	1.0kc	-17.0	-23.8	-23.8	4.8	4.8	3.5	2.3	6.5	7.7
19	160.0 kc	2	1.0kc	-19.6	-25.1	-24.8	5.5	5.2	2.2	1.5	7.8	8.5
8	3.0 kc	5	45cps	-15.4	-26.6	-28.9	10.2	13.5	-19.7	-22.2	29.7	32.2
	Test channel at bandedge:											
14	120.0 kc	2	1.0kc	-19.0	-23.8	—	4.8	—	9.5	—	0.5	—
8	3.0 kc	5	45cps	-15.4	-26.6	—	10.2	—	-20.0	—	30.0	—
	Test channel modulated:											
14	120.0 kc	2	1.0kc	-19.0	-23.8	—	4.8	—	7.2	—	2.8	—
8	3.0 kc	5	45cps	-15.4	-26.6	—	10.2	—	-21.0	—	31.0	—

*db referenced to one milliwatt into 600 ohms. 1 of 7

TABLE II-5.4-9 (CONT'D.)

SIGNAL-TO-NOISE TEST DATA

System: Combinational (S/N)$_c$: 9.0 db AGC: -4.3V Output FBW Signal: 10.0 dbm*

CHANNEL				INPUT					OUTPUT			
					Noise		(S/N)$_s$		Noise		(S/N)$_d$	
No.	Frequency	DR	LPOF Frequency	Signal dbm*	Full Multiplex dbm*	Search Channel Only dbm*	Full Multiplex db	Search Channel Only db	Full Multiplex dbm*	Search Channel Only dbm*	Full Multiplex db	Search Channel Only db
	Test channel at center frequency:											
6	56.0 kc	2	1.0 kc	-19.2	-27.2	-28.0	8.0	8.8	-4.0	-5.5	14.0	15.5
10	88.0 kc	2	1.0 kc	-18.0	-26.5	-26.8	8.5	8.8	-5.8	-6.6	15.8	16.6
14	120.0 kc	2	1.0 kc	-18.5	-27.0	-27.0	8.5	8.5	-4.2	-4.8	14.2	14.8
19	160.0 kc	2	1.0 kc	-19.0	-27.8	-27.5	8.8	8.5	-4.4	-5.0	14.4	15.0
8	3.0 kc	5	45 cps	-14.2	-34.3	-42.8	20.1	28.6	-32.0	-37.5	42.0	47.5
	Test channel at bandedge:											
14	120.0 kc	2	1.0 kc	-18.5	-27.0	—	8.5	—	0.8	—	9.2	—
8	3.0 kc	5	45 cps	-14.2	-34.3	—	20.1	—	-32.0	—	42.0	—
	Test channel modulated:											
14	120.0 kc	2	1.0 kc	-18.5	-27.0	—	8.5	—	-1.0	—	11.0	—
8	3.0 kc	5	45 cps	-14.2	-34.3	—	20.1	—	-31.0	—	41.0	—

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*db referenced to one milliwatt into 600 ohms.

Name: [illegible] Date: [illegible]

TABLE II-3.4-9 (CONT'D.)
SIGNAL-TO-NOISE TEST DATA

System: Combinational $(S/N)_c$: 12.0 db AGC: -4.0V Output FBW Signal: [illegible] dbm*

CHANNEL				INPUT					OUTPUT			
					Noise		$(S/N)_s$		Noise		$(S/N)_d$	
No.	Frequency	DR	LPOF Frequency	Signal dbm*	Full Multiplex dbm*	Search Channel Only dbm*	Full Multiplex db	Search Channel Only db	Full Multiplex dbm*	Search Channel Only dbm*	Full Multiplex db	Search Channel Only db
	Test channel at center frequency:											
6	56.0 kc	2	1.0 kc	-19.0	-30.1	-30.6	11.1	11.6	-8.6	-8.8	18.6	18.8
10	88.0 kc	2	1.0 kc	-17.9	-29.1	-29.1	11.2	11.2	-9.2	-9.6	19.2	19.6
14	120.0 kc	2	1.0 kc	-18.2	-29.4	-29.4	11.2	11.2	-7.4	-7.7	17.4	17.7
19	160.0 kc	2	1.0 kc	-18.8	-30.0	-30.0	11.2	11.2	-7.4	-8.0	17.4	18.0
8	3.0 kc	5	45 cps	-13.8	-35.8	-52.0	22.0	38.2	-39.7	-46.6	49.7	56.6
	Test channel at bandedge:											
14	120.0 kc	2	1.0 kc	-18.2	-29.4	—	11.2	—	-5.0	—	15.0	—
8	3.0 kc	5	45 cps	-13.8	-35.8	—	22.0	—	-40.5	—	50.5	—
	Test channel modulated:											
14	120.0 kc	2	1.0 kc	-18.2	-29.4	—	11.2	—	-8.0	—	18.0	—
8	3.0 kc	5	45 cps	-13.8	-35.8	—	22.0	—	-36.5	—	46.5	—

*db referenced to one milliwatt into 600 ohms.

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Name: [illegible] Date: [illegible]

TABLE II-3.4-9 (CONT'D.)
SIGNAL-TO-NOISE TEST DATA

System: Combinational $(S/N)_c$: 15.0 db AGC: -4.0V Output FBW Signal: 10.0 dbm*

CHANNEL				INPUT					OUTPUT			
					Noise		$(S/N)_s$		Noise		$(S/N)_d$	
No.	Frequency	DR	LPCF Frequency	Signal dbm*	Full Multiplex dbm*	Search Channel Only dbm*	Full Multiplex db	Search Channel Only db	Full Multiplex dbm*	Search Channel Only dbm*	Full Multiplex db	Search Channel Only db
Test channel at center frequency:												
6	56.0 kc	2	1.0 kc	-19.0	-33.0	-33.1	14.0	14.1	-11.5	-11.7	21.5	21.7
10	88.0 kc	2	1.0 kc	-17.8	-30.6	-31.6	12.8	13.8	-12.0	-12.3	22.0	22.3
14	120.0 kc	2	1.0 kc	-18.3	-31.8	-31.8	13.5	13.5	-10.0	-10.2	20.0	20.2
19	160.0 kc	2	1.0 kc	-18.8	-32.5	-32.5	13.7	13.7	-10.1	-10.5	20.1	20.5
8	3.0 kc	5	45 cps	-13.6	-36.1	-55.1	22.5	22.5	-46.3	-49.5	56.3	59.5
Test Channel at bandedge:												
14	120.0 kc	2	1.0 kc	-18.3	-31.8	—	13.5	—	-10.8	—	20.8	—
8	3.0 kc	5	45 cps	-13.6	-36.1	—	22.5	—	-45.2	—	55.2	—
Test channel modulated:												
14	120.0 kc	2	1.0 kc	-18.3	-31.8	—	13.5	—	-12.0	—	22.0	—
8	3.0 kc	5	45 cps	-13.6	-36.1	—	22.5	—	-38.0	—	48.0	—

*db referenced to one milliwatt into 600 ohms.

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Name: [illegible] Date: 3-26-65

TABLE II-3.4-9 (CONT'D.)
SIGNAL-TO-NOISE TEST DATA

System: Combinational (S/N)$_c$: 18.0 AGC: -4.0V Output FBW Signal: 10.0 dbm*

CHANNEL				INPUT					OUTPUT			
					Noise		(S/N)$_s$		Noise		(S/N)$_d$	
No.	Frequency	DR	LPOF Frequency	Signal dbm*	Full Multiplex dbm*	Search Channel Only dbm*	Full Multiplex db	Search Channel Only db	Full Multiplex dbm*	Search Channel Only dbm*	Full Multiplex db	Search Channel Only db
	Test channel at center frequency:											
6	56.0 kc	2	1.0 kc	-18.9	-36.3	-36.7	17.4	17.8	-15.1	-15.4	25.1	25.4
10	88.0 kc	2	1.0 kc	-17.8	-35.0	-35.2	17.2	17.4	-15.7	-16.0	25.7	26.0
14	120.0 kc	2	1.0 kc	-18.2	-35.2	-35.4	17.0	17.2	-13.7	-13.9	23.7	23.9
19	160.0 kc	2	1.0 kc	-18.8	-35.8	-36.0	17.0	17.2	-13.6	-14.3	23.6	24.3
8	3.0 kc	5	45 cps	-13.5	-36.0	-55.4	12.5	41.9	-48.0	-49.9	58.0	59.9
	Test channel at bandedge:											
14	56.0 kc	2	1.0 kc	-18.2	-35.2	—	17.0	—	-14.3	—	24.3	—
8	3.0 kc	5	45 cps	-13.5	-36.0	—	12.5	—	-46.0	—	56.0	—
	Test channel modulated:											
14	56.0 kc	2	1.0 kc	-13.2	-35.2	—	17.0	—	-15.4	—	25.4	—
8	3.0 kc	5	45 cps	-13.5	-36.0	—	12.5	—	-38.0	—	48.0	—

*db referenced to one milliwatt into 600 ohms

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Name: [illegible] Date: [illegible]

TABLE II-3.4-9 (CONT'D.)

SIGNAL-TO-NOISE TEST DATA

System: Combinational $(S/N)_c$: 21.0db AGC: -4.0V Output FBW Signal: 13.0 dbm*

CHANNEL				INPUT					OUTPUT			
					Noise		$(S/N)_s$		Noise		$(S/N)_d$	
No.	Frequency	DR	LPOF Frequency	Signal dbm*	Full Multiplex dbm*	Search Channel Only dbm*	Full Multiplex db	Search Channel Only db	Full Multiplex dbm*	Search Channel Only dbm*	Full Multiplex db	Search Channel Only db
	Test channel at center frequency:											
6	56.0kc	2	1.0kc	-18.8	-38.3	-39.0	19.5	20.2	-17.5	-17.8	27.5	27.5
10	88.0 kc	2	1.0kc	-17.8	-37.1	-37.5	19.3	19.7	-17.9	-18.5	27.9	28.5
14	120.0 kc	2	1.0kc	-18.2	-37.4	-37.8	19.2	19.6	-15.9	-16.3	25.9	26.3
19	160.0 kc	2	1.0kc	-18.9	-37.9	-38.4	19.0	19.5	-15.8	-16.5	25.8	26.5
8	3.0 kc	5	45cps	-13.4	-36.0	-55.2	22.6	41.8	-48.0	-50.0	58.0	60.0
	Test channel at bandedge:											
14	120.0kc	2	1.0kc	-18.2	-37.4	—	19.2	—	-16.6	—	26.6	—
8	3.0kc	5	45cps	-13.4	-36.0	—	22.6	—	-46.0	—	56.0	—
	Test channel modulated:											
14	120.0kc	2	1.0kc	-18.2	-37.4	—	19.2	—	-17.6	—	27.6	—
8	3.0kc	5	45cps	-13.4	-36.0	—	22.6	—	-38.0	—	48.0	—

*db referenced to one milliwatt into 600 ohms.

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TABLE II-3.4-9 (CONT'D.)
SIGNAL-TO-NOISE TEST DATA

System: Combinational (S/N)$_c$: 24.0 db AGC: -4.0V Output FBW Signal: 10.0 dbm*

CHANNEL				INPUT					OUTPUT			
					Noise		(S/N)$_s$		Noise		(S/N)$_d$	
No.	Frequency	DR	LPOF Frequency	Signal dbm*	Full Multiplex dbm*	Search Channel Only dbm*	Full Multiplex db	Search Channel Only db	Full Multiplex dbm*	Search Channel Only dbm*	Full Multiplex db	Search Channel Only db
	Test channel at center frequency:											
6	56.0 kc	2	1.0 kc	-18.8	-40.8	-42.3	22.0	23.5	-20.5	-21.3	30.5	31.3
10	88.0 kc	2	1.0 kc	-17.8	-39.8	-40.8	22.0	23.0	-21.0	-22.0	31.0	32.0
14	120.0 kc	2	1.0 kc	-18.2	-40.2	-41.3	22.0	23.1	-19.0	-19.8	29.0	29.8
19	160.0 kc	2	1.0 kc	-18.8	-40.6	-42.0	21.8	23.3	-18.9	-19.7	28.9	29.9
8	3.0 kc	5	45 cps	-13.3	-36.0	-54.5	22.7	41.2	-48.0	-50.0	58.0	60.0
	Test channel at bandedge:											
14	120.0 kc	2	1.0 kc	-18.2	-40.2	—	22.0	—	-19.8	—	29.8	—
8	3.0 kc	5	45 cps	-13.3	-36.0	—	22.7	—	-46.0	—	56.0	—
	Test channel modulated:											
14	120.0 kc	2	1.0 kc	-18.2	-40.2	—	22.0	—	-20.5	—	30.5	—
8	3.0 kc	5	45 cps	-13.3	-36.0	—	22.7	—	-38.2	—	48.2	—

*db referenced to one milliwatt into 600 ohms.

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Name: WSB/MLK Date: 3-26-65

3.5 SYSTEM ERROR TEST

3.5.1 General

The system error test uses a null technique to measure any variation between the system input and output. In essence, the input to the VCO of the particular channel under test is delayed and compared to the subcarrier discriminator output signal. The test is first performed by adjusting the system gain and delay (phase shift) for a null between the system input and output at a low modulating frequency. The frequency of the modulation is then increased and the null maintained by adjusting only the phase shift. The rms as well as the peak-to-peak magnitude of the null is then measured as total system error at several points within the data passband. The test is repeated and gain as well as phase shift is adjusted for a null at the same positions in the data passband. This latter measurement removes the effect of any system filter rolloff that occurs as the modulation frequency is increased.

The block diagram of the test is shown in Figure II-3.5-1. The phase and amplitude adjustment network would normally be placed in the comparison signal path; however, due to the difficulty of adjusting phase shift without attendant amplitude changes, it is necessary to use the configuration shown in Figure II-3.5-1. In this configuration, the all-pass phase network is driven from the low output impedance of the subcarrier discriminator and drives the high input impedance of the differential amplifier. The output-level control of the discriminator is used to adjust system gain. Thus, in this manner the system input signal is unaltered prior to the comparison with the system output.

In order to improve the signal-to-noise ratio through the differential amplifier, the amplifier is operated with a calibrated gain of 10. Since the amplifier output noise is independent of gain setting, this procedure improves the obtainable null voltage. The measured value of rms and peak-to-peak level are then divided by ten. In addition to the test with the full multiplex, the tests are repeated with only the channel under test in the multiplex. This technique isolates the effect of intermodulation on the system error.

3.5.2 Detailed Procedure

a. Calibrate all VCOs.

b. Deviate all VCOs full bandwidth at maximum rate for a deviation ratio of 5.

c. Adjust the discriminator for approximately ±5 volts, i.e., 10 volts peak-to-peak with full bandwidth deviation.

d. Establish IF signal-to-noise ratio greater than 20 db to assure that the receiver and discriminator are operating above threshold.

e. Operate the AGC in its normal mode, but measure and note the level. This level can be used as a check on the actual input carrier level.

f. Measure the residual system output rms and peak-to-peak noise voltage at the nulling point with the seach channel unmodulated. Repeat this measurement with only the search channel in the multiplex, i.e., with all other VCOs turned off. These readings of minimum attainable system noise serve as a lower limit on the null voltage possible.

(The follow ng steps should be performed on the search-channel VCO with the complete multiplex operating and then repeated for the search channel only i.e., with all other VCOs turned off.)

g. Set the level, R1, of the comparison modulating signal to the exactly 10 volts peak-to-peak. Adjust, R2, the input to the search-channel VCO for a full-bandwidth deviation.

h. Establish a null by adjusting the phase shift and discriminator output control for a null at a sufficiently low modulating frequency to avoid all system rolloffs. The frequency used in the test is 0.3 f_{m5}, where f_{m5} is the maximum frequency for a deviation ratio of 5 operation of the search channel under test. Measure the peak-to-peak and rms null voltage at the output to the differential amplifier. If a gain of 10 in the differential amplifier is used, divide the output readings by 10.

i. Change the modulating frequency to 0.5 f_m where f_m is the maximum modulation frequency for the particular deviation ratio and channel under test. Obtain a null by operating only the phase adjustment.

j. Repeat step i. for a modulating frequency of 1.0 f_m.

k. Repeat steps i. and j. for null voltages where both the phase and amplitude adjustments are made to obtain a null. Record both the rms and peak-to-peak levels of the null voltage.

3.5.3 Results

Details of the tests and measured data are included in this volume in figures and tables numbered with II. Summarized test results are presented in Volume I in figures and tables numbered with I.

3.5.3.1 IRIG Baseband

For the IRIG 18-channel ±7.5% system operating at a deviation ratio of 5, the system error was obtained for the following conditions:

Test channels: 70 kc ±7.5%; 3 kc ±7.5%

Multiplex level: 1.0 volt rms

IF S/N: 39 db

Deviation ratio: 5

LPOF: Constant amplitude, 18 db/octave, nominal cutoff frequency for DR = 5

The test data is shown in Table II-3.5-2 and summarized in Tables I-3.6-2 and I-3.6-3.

3.5.3.2 IRIG Baseband--Wideband Channel

The IRIG baseband, channels 1 through 16 and E, was evaluated for system error under the following conditions:

Test channels: 70 kc ±15%; 3 kc ±7.5%

Multiplex level: 1.0 volt rms

IF S/N: 39 db

Deviation ratio: 5

LPOF: Constant amplitude, 18 db/octave, nominal cutoff frequency for DR = 5

The test data is shown in Table II-3.5-3 and summarized in Tables I-3.6-4 and I-3.6-5.

3.5.3.3 IRIG Baseband--Deviation Ratios 1 and 2

The IRIG baseband, channels 1 through 18 operating at a deviation ratio of 1 and 2, was evaluated for system error under the following conditions:

Test channels: 70.0 kc ±7.5%; 22.0 kc ±7.5%; 7.35 kc ±7.5%; 3.0 kc ±7.5%; 960 cps ±7.5%

Multiplex level: 1.0 volt rms

IF S/N: 39 db

Deviation ratio: 1 or 2

LPOF: Constant amplitude, 18 db/octave, nominal cutoff frequency for DR = 1 or 2

The test data shown in Table II-3.5-4 and summarized in Tables I-3.6-2 and I-3.6-3. The low deviation ratios increased the system output noise sufficiently to require the null to be obtained first with only the search channel VCO in the multiplex. The corresponding full multiplex reading was then made at the same amplitude and phase settings after turning on the remaining VCOs. The voltage level at null was often such that a gain of 10 in the differential amplifier was not used.

3.5.3.4 Expanded Baseband

The expanded baseband, channels 1 through 21, was evaluated for system error under the following conditions:

Test channels: 165 kc ±7.5%; 125 kc ±7.5%; 93 kc ±7.5%; 70 kc ±7.5%; 3 kc ±7.5%

Multiplex level: 750 mv rms

IF S/N: 39 db

Deviation ratio: 5

LPOF: Constant amplitude, 18 db/octave, nominal cutoff frequency for DR = 5

The test data is shown in Table II-3.5-5 and summarized in Tables I-3.6-4 and I-3.6-5.

3.5.3.5 Expanded Baseband--Wideband Channel

The expanded baseband, channels 1 through 19 and H, was evaluated for system error under the following conditions:

Test channels: 165 kc ±15%; 93 kc ±7.5%; 70 kc ±7.5%; 3 kc ±7.5%

Multiplex level: 630 mv rms

IF S/N: 39 db

Deviation ratio: 5

LPOF: Constant amplitude, 18 db/octave, nominal cutoff frequency for DR = 5

The test data is shown in Table II-3.5-6 and summarized in Tables I-3.6-4 and I-3.6-5.

3.5.3.6 Constant-Bandwidth Baseband

The constant-bandwidth multiplex, channels 1 through 21, was evaluated for system error under the following conditions:

Test channels: 56 kc ±2 kc; 88 kc ±2 kc; 120 kc ±2 kc; 160 kc ±2 kc

Multiplex level: 360 mv rms

IF S/N: 39 db

Deviation ratio: 2

LPOF: Constant amplitude, 42 db/octave, nominal cutoff frequency for DR = 2

The test data is shown in Table II-3.5-7 and summarized in Tables I-3.6-6 and I-3.6-7.

3.5.3.7 Combinational-Bandwidth Baseband

The combinational-bandwidth multiplex, IRIG channels 1 through 11 and constant-bandwidth channels 1 through 21, was evaluated for system error under the following conditions:

Test channels: 3.0 kc ±7.5%; 56 kc ±2 kc; 88 kc ±2 kc; 120 kc ±2 kc; 160 kc ±2 kc

Multiplex level: 635 mv rms; 600 mv rms for CBW channels and 210 mv rms for IRIG channels

IF S/N: 39 db

Deviation ratio: 2 for CBW channels, 5 for IRIG channels

LPOF: Constant amplitude, 42 db/octave in the CBW channels and 18 db/octave in the IRIG channels, nominal cutoff frequency for specific deviation ratio.

The test data is shown in Table II-3.5-8 and summarized in Tables I-3.6-8 and I-3.6-9.

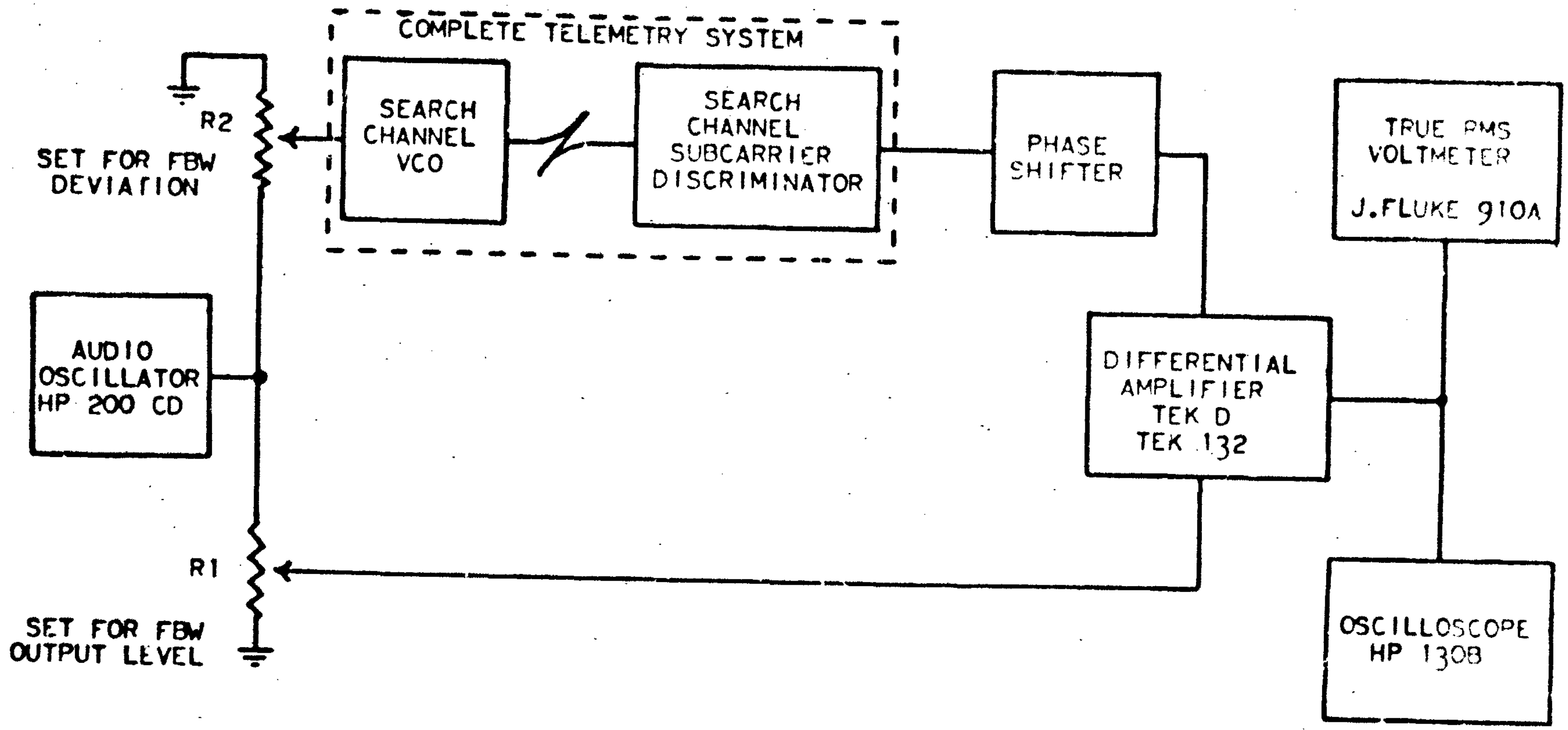

FIGURE II-3.5-1
SYSTEM ERROR TEST BLOCK DIAGRAM

TABLE II-3.5-2
SYSTEM ERROR TEST DATA

System Description: IRIG Multiplex, Channels 1 Through 18, DR=5

IF Signal-to-Noise Ratio: 39 db

Discriminator Full Scale Output: 10 VPP Receiver AGC Voltage: -5.2 v dc

Discriminator Channel: 70.0 KC ±7.5% DR=5

Residual Noise: Full Multiplex 8.5 mvrms Search Channel Only 2.9 mVrms

Full Scale Level at Summing Point: 3.6 Vrms and 10.4 VPP

	315 cps 0.3 f_m		525 cps 0.5 f_m		1050 cps 1.0 f_m	
	mv rms	mv p-p	mv rms	mv p-p	mv rms	mv p-p
Full Multiplex:						
Phase Null Only	—	—	23	140	242	750
Phase & Amplitude Null	20	120	23	140	18	100
Search Channel Only:						
Phase Null Only	—	—	21	90	242	700
Phase & Amplitude Null	19	90	21	90	15.8	70

Discriminator Channel: 3.0 KC ±7.5% DR=5

Residual Noise: Full Multiplex 60 mVrms Search Channel Only 2.8 mVrms

Full Scale Level at Summing Point: 3.7 Vrms and 10.8 Vpp

	15 cps 0.3 f_m		22 cps 0.5 f_m		45 cps 1.0 f_m	
	mv rms	mv p-p	mv rms	mv p-p	mv rms	mv p-p
Full Multiplex:						
Phase Null Only	—	—	17	60	190	580
Phase & Amplitude Null	16	60	16	60	10	40
Search Channel Only:						
Phase Null Only	—	—	15	50	190	580
Phase & Amplitude Null	14	50	14.5	50	7.5	40

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TABLE II-3.5-3
SYSTEM ERROR TEST DATA

System Description: IRIG Multiplex, Channels 1 Through 16 And E

IF Signal-to-Noise Ratio: 39db

Discriminator Full Scale Output: 10Vpp Receiver AGC Voltage: -5.2Vdc

Discriminator Channel: E, 70kc ± 15%, DR=5

Residual Noise: Full Multiplex 7.2mvrms Search Channel Only 2.4mvrms

Full Scale Level at Summing Point: 3.5Vrms and 10.2Vpp

	$0.3 f_m$ mv rms	$0.3 f_m$ mv p-p	$0.5 f_m$ mv rms	$0.5 f_m$ mv p-p	$1.0 f_m$ mv rms	$1.0 f_m$ mv p-p
Full Multiplex:						
Phase Null Only	—	—	41	150	114	380
Phase & Amplitude Null	29	125	41	150	33	140
Search Channel Only:						
Phase Null Only	—	—	40	130	114	360
Phase & Amplitude Null	28	100	40	130	32	120

Discriminator Channel: 8, 3kc ± 7.5%, DR=5

Residual Noise: Full Multiplex 5 mvrms Search Channel Only 4 mvrms

Full Scale Level at Summing Point: 3.5Vrms and 10 Vpp

	$0.3 f_m$ mv rms	$0.3 f_m$ mv p-p	$0.5 f_m$ mv rms	$0.5 f_m$ mv p-p	$1.0 f_m$ mv rms	$1.0 f_m$ mv p-p
Full Multiplex:						
Phase Null Only	—	—	16.5	70	116	360
Phase & Amplitude Null	14.5	70	15.5	60	8.5	40
Search Channel Only:						
Phase Null Only	—	—	16	60	116	360
Phase & Amplitude Null	13	60	15	60	7.5	30

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TABLE II-3.5-4
SYSTEM ERROR TEST DATA

System Description: IRIG MULTIPLEX, CHANNELS 1 THROUGH 18, DR-1 and 2

IF Signal-to-Noise Ratio: 39 db

Discriminator Full Scale Output: 10 Vpp Receiver AGC Voltage: -5.2 Vdc

Discriminator Channel: 70.0 KC ±7.5%, DR-1

Residual Noise: Full Multiplex 85 mVrms Search Channel Only 7.4 mVrms

Full Scale Level at Summing Point: 3.6 Vrms and 10.4 Vpp

	315 cps $0.3 f_m$		2625 cps $0.5 f_m$		5250 cps $1.0 f_m$	
	mv rms	mv p-p	mv rms	mv p-p	mv rms	mv p-p
Full Multiplex:						
Phase Null Only	—	—	490	2500	118	1200
Phase & Amplitude Null	122	1200	130	1000	118	900
Search Channel Only:						
Phase Null Only	—	—	480	1600	18.0	120
Phase & Amplitude Null	15.2	120	76	350	18.2	140

Discriminator Channel: 70.0 KC ±7.5%, DR-2

Residual Noise: Full Multiplex 31 mVrms Search Channel Only 4.5 mVrms

Full Scale Level at Summing Point: 3.6 Vrms and 10.4 Vpp

	315 cps $0.3 f_m$		1313 cps $0.5 f_m$		2625 cps $1.0 f_m$	
	mv rms	mv p-p	mv rms	mv p-p	mv rms	mv p-p
Full Multiplex:						
Phase Null Only	—	—	94	500	190	1000
Phase & Amplitude Null	42	400	53	450	47	450
Search Channel Only:						
Phase Null Only	—	—	85	320	186	600
Phase & Amplitude Null	13.5	80	37	180	25	120

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TABLE II-3.5-4 (CONT'D.)
SYSTEM ERROR TEST DATA

System Description: IRIG Multiplex, Channels 1 through 18, DR=1&2

IF Signal-to-Noise Ratio: 39db

Discriminator Full Scale Output: 10VPP Receiver AGC Voltage: -5.2Vdc

Discriminator Channel: 7.35KC ±7.5%, DR=1

Residual Noise: Full Multiplex 51 mVrms Search Channel Only 6.2mVr

Full Scale Level at Summing Point: 3.6Vrms and 10.4Vpp

	33cps 0.3 f_m		276cps 0.5 f_m		551cps 1.0 f_m	
Full Multiplex:	mv rms	mv p-p	mv rms	mv p-p	mv rms	mv p-p
Phase Null Only	—	—	510	2000	185	100[illegible]
Phase & Amplitude Null	71	500	165	1000	100	60[illegible]
Search Channel Only:						
Phase Null Only	—	—	500	1600	175	580
Phase & Amplitude Null	16.5	90	144	650	45	200

Discriminator Channel: 7.35KC ±7.5%, DR=2

Residual Noise: Full Multiplex 26 mVrms Search Channel Only 5.5mVr

Full Scale Level at Summing Point: 3.6Vrms and 10.4Vpp

	33cps 0.3 f_m		138cps 0.5 f_m		276cps 1.0 f_m	
Full Multiplex:	mv rms	mv p-p	mv rms	mv p-p	mv rms	mv p-p
Phase Null Only	—	—	135	700	162	700
Phase & Amplitude Null	34	300	70	400	60	350
Search Channel Only:						
Phase Null Only	—	—	130	500	154	500
Phase & Amplitude Null	17	90	57	200	57	200

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TABLE II-3.5-4 (CONT'D.)
SYSTEM ERROR TEST DATA

System Description: IRIG Multiplex, Channels 1 through A, DR=1+2

IF Signal-to-Noise Ratio: 39db

Discriminator Full Scale Output: 10Vpp Receiver AGC Voltage: -5.2Vdc

Discriminator Channel: 22.0KC ± 7.5%, DR=1

Residual Noise: Full Multiplex 55mVrms Search Channel Only 4.5mVrms

Full Scale Level at Summing Point: 3.60Vrms and 10.4Vpp

	100cps 0.3 f_m		825cps 0.5 f_m		1650cps 1.0 f_m	
	mv rms	mv p-p	mv rms	mv p-p	mv rms	mv p-p
Full Multiplex:						
Phase Null Only	—	—	480	1700	132	600
Phase & Amplitude Null	67	500	136	600	85	400
Search Channel Only:						
Phase Null Only	—	—	475	1500	98	300
Phase & Amplitude Null	15	60	121	450	45	150

Discriminator Channel: 22.0KC ± 7.5%, DR=2

Residual Noise: Full Multiplex 25mVrms Search Channel Only 2.8mVrms

Full Scale Level at Summing Point: 3.60Vrms and 10.4Vpp

	100 cps 0.3 f_m		412cps 0.5 f_m		825cps 1.0 f_m	
	mv rms	mv p-p	mv rms	mv p-p	mv rms	mv p-p
Full Multiplex:						
Phase Null Only	—	—	143	500	200	700
Phase & Amplitude Null	32	150	70	300	50	250
Search Channel Only:						
Phase Null Only	—	—	140	500	200	600
Phase & Amplitude Null	15	60	58	200	41	150

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TABLE II-3.5-4 (CONT'D.)
SYSTEM ERROR TEST DATA

System Description: IRIG Multiplex, Channels 1 Through 18, DR=1+2

IF Signal-to-Noise Ratio: 39db

Discriminator Full Scale Output: 10Vpp Receiver AGC Voltage: -5.2Vdc

Discriminator Channel: 3.0KC ±7.5%, DR=1

Residual Noise. Full Multiplex 85mVrms Search Channel Only 5.5mVrms

Full Scale Level at Summing Point: 3.7Vrms and 10.8Vpp

	15cps 0.3 f_m		113cps 0.5 f_m		225cps 1.0 f_m	
	mv rms	mv p-p	mv rms	mv p-p	mv rms	mv p-p
Full Multiplex:						
Phase Null Only	—	—	430	2000	410	1500
Phase & Amplitude Null	180	1500	160	800	145	600
Search Channel Only:						
Phase Null Only	—	—	410	1500	380	1200
Phase & Amplitude Null	18.5	80	70	300	25	100

Discriminator Channel: 3.0KC ±7.5%, DR=2

Residual Noise: Full Multiplex 25mVrms Search Channel Only 4.4mVrms

Full Scale Level at Summing Point: 3.7Vrms and 10.8Vpp

	15cps 0.3 f_m		56cps 0.5 f_m		113cps 1.0 f_m	
	mv rms	mv p-p	mv rms	mv p-p	mv rms	mv p-p
Full Multiplex:						
Phase Null Only	—	—	126	400	148	600
Phase & Amplitude Null	43	300	50	200	42	250
Search Channel Only:						
Phase Null Only	—	—	120	360	143	480
Phase & Amplitude Null	13	60	32	130	17.5	75

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TABLE II-3.5-4 (CONT'D.)
SYSTEM ERROR TEST DATA

System Description: IRIG Multiplex, Channels 1 through 18, DR=1&2

IF Signal-to-Noise Ratio: 39db

Discriminator Full Scale Output: 10Vpp Receiver AGC Voltage: -5.2Vdc

Discriminator Channel: 960cps ±7.5%, DR=1

Residual Noise: Full Multiplex 67mVrms Search Channel Only 8.5mVrms

Full Scale Level at Summing Point: 3.6Vrms and 10.4Vpp

	5cps 0.3 f_m		36cps 0.5 f_m		72cps 1.0 f_m	
	mv rms	mv p-p	mv rms	mv p-p	mv rms	mv p-p
Full Multiplex:						
Phase Null Only	—	—	410	2000	350	1600
Phase & Amplitude Null	140	1600	130	1200	120	1000
Search Channel Only:						
Phase Null Only	—	—	400	1320	335	1000
Phase & Amplitude Null	16	80	48	200	23	140

Discriminator Channel: 960cps ±7.5%, DR=2

Residual Noise: Full Multiplex 21mVrms Search Channel Only 6.2mVrms

Full Scale Level at Summing Point: 3.6Vrms and 10.4Vpp

	5cps 0.3 f_m		18cps 0.5 f_m		36cps 1.0 f_m	
	mv rms	mv p-p	mv rms	mv p-p	mv rms	mv p-p
Full Multiplex:						
Phase Null Only	—	—	125	500	135	600
Phase & Amplitude Null	33	400	37	350	37	300
Search Channel Only:						
Phase Null Only	—	—	120	400	125	450
Phase & Amplitude Null	17	90	20	100	17	80

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TABLE II-3.5-5
SYSTEM ERROR TEST DATA

System Description: Expanded Multiplex, Channels 1 Through 21
IF Signal-to-Noise Ratio: 39db
Discriminator Full Scale Output: 10 Vpp Receiver AGC Voltage: -5.1 vdc
Discriminator Channel: 165 KC ± 7.5%, DR=5
Residual Noise: Full Multiplex 8.5 mVrms Search Channel Only 5.4 mVrms
Full Scale Level at Summing Point: 10 Vpp and 3.5 Vrms

	742 cps 0.3 f_m		1238 cps 0.5 f_m		2475 cps 1.0 f_m	
	mv rms	mv p-p	mv rms	mv p-p	mv rms	mv p-p
Full Multiplex:						
Phase Null Only	—	—	16.5	140	16.5	550
Phase & Amplitude Null	13	100	15.5	110	15	110
Search Channel Only:						
Phase Null Only	—	—	15	90	164	520
Phase & Amplitude Null	10.5	70	14	80	13	80

Discriminator Channel: 124 KC ± 7.5%, DR=5
Residual Noise: Full Multiplex 12 mVrms Search Channel Only 5.0 mVrms
Full Scale Level at Summing Point: 10 Vpp and 3.5 Vrms

	558 cps 0.3 f_m		930 cps 0.5 f_m		1860 cps 1.0 f_m	
	mv rms	mv p-p	mv rms	mv p-p	mv rms	mv p-p
Full Multiplex:						
Phase Null Only	—	—	29	160	81	350
Phase & Amplitude Null	18	120	21	140	16.5	120
Search Channel Only:						
Phase Null Only	—	—	27	140	80	275
Phase & Amplitude Null	15	80	18	100	13	80

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TABLE II-3.5-5 (CONT'D.)
SYSTEM ERROR TEST DATA

System Description: Expanded Multiplex, Channels 1 Through 21

IF Signal-to-Noise Ratio: 39db

Discriminator Full Scale Output: 10Vpp Receiver AGC Voltage: -5.1Vdc

Discriminator Channel: 93KC ±7.5%, DR=5

Residual Noise: Full Multiplex 6.2 mVrms Search Channel Only 4.0 mVrms

Full Scale Level at Summing Point: 10Vpp and 3.5Vrms

	420 cps 0.3 f_m		700 cps 0.5 f_m		1400 cps 1.0 f_m	
	mv rms	mv p-p	mv rms	mv p-p	mv rms	mv p-p
Full Multiplex:						
Phase Null Only	—	—	29	160	83	300
Phase & Amplitude Null	14.4	100	19	100	16	100
Search Channel Only:						
Phase Null Only	—	—	28	120	83	275
Phase & Amplitude Null	12.2	70	17	80	13.2	70

Discriminator Channel: 70KC ±7.5%, DR=5

Residual Noise: Full Multiplex 12 mVrms Search Channel Only 5.2 mVrms

Full Scale Level at Summing Point: 10Vpp and 3.5Vrms

	315 cps 0.3 f_m		525 cps 0.5 f_m		1050 cps 1.0 f_m	
	mv rms	mv p-p	mv rms	mv p-p	mv rms	mv p-p
Full Multiplex:						
Phase Null Only	—	—	24	160	82	350
Phase & Amplitude Null	16	140	15	120	14	100
Search Channel Only:						
Phase Null Only	—	—	22	100	80	275
Phase & Amplitude Null	11	80	11	60	9	60

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TABLE II-3.5-5 (CONT'D.)
SYSTEM ERROR TEST DATA

System Description: Expanded Multiplex, Channels 1 Through 21

IF Signal-to-Noise Ratio: 39 db

Discriminator Full Scale Output: 10 Vpp Receiver AGC Voltage: -5.1 Vdc

Discriminator Channel: 3.0 KC ±7.5%, DR=5

Residual Noise: Full Multiplex 5.5 mVrms Search Channel Only 3.0 mVrms

Full Scale Level at Summing Point: 10 Vpp and 3.5 Vrms

	15 cps $0.3\ f_m$		22 cps $0.5\ f_m$		45 cps $1.0\ f_m$	
	mv rms	mv p-p	mv rms	mv p-p	mv rms	mv p-p
Full Multiplex:						
Phase Null Only	—	—	16	80	100	325
Phase & Amplitude Null	12	70	12.5	70	9	50
Search Channel Only:						
Phase Null Only	—	—	14	70	100	325
Phase & Amplitude Null	9.5	60	11	60	7	40

Discriminator Channel: ________

Residual Noise: Full Multiplex ________ Search Channel Only ________

Full Scale Level at Summing Point: ________ and ________

	$0.3\ f_m$		$0.5\ f_m$		$1.0\ f_m$	
	mv rms	mv p-p	mv rms	mv p-p	mv rms	mv p-p
Full Multiplex:						
Phase Null Only						
Phase & Amplitude Null						
Search Channel Only:						
Phase Null Only						
Phase & Amplitude Null						

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TABLE II-3.5-6
SYSTEM ERROR TEST DATA

System Description: Expanded Multiplex, Channels 1 through 19 and H

IF Signal-to-Noise Ratio: 39 db

Discriminator Full Scale Output: 10 Vpp Receiver AGC Voltage: -5.1 Vdc

Discriminator Channel: 165 KC ± 15%, DR = 5

Residual Noise: Full Multiplex 8.5 mVrms Search Channel Only 7.5 mVrms

Full Scale Level at Summing Point: 10 Vpp and 3.55 Vrms

	1485 cps $0.3 f_m$		2475 cps $0.5 f_m$		4950 cps $1.0 f_m$	
	mv rms	mv p-p	mv rms	mv p-p	mv rms	mv p-p
Full Multiplex:						
Phase Null Only	—	—	21.5	140	150	500
Phase & Amplitude Null	17.5	120	20	120	14	100
Search Channel Only:						
Phase Null Only	—	—	20	120	150	500
Phase & Amplitude Null	17	120	18.5	110	13	90

Discriminator Channel: 93 KC ± 7.5% DR = 5

Residual Noise: Full Multiplex 9.0 mVrms Search Channel Only 7.5 mVrms

Full Scale Level at Summing Point: 10 Vpp and 3.55 Vrms

	420 cps $0.3 f_m$		700 cps $0.5 f_m$		1400 cps $1.0 f_m$	
	mv rms	mv p-p	mv rms	mv p-p	mv rms	mv p-p
Full Multiplex:						
Phase Null Only	—	—	32	180	92	350
Phase & Amplitude Null	17	120	22	120	15	120
Search Channel Only:						
Phase Null Only	—	—	31	140	92	300
Phase & Amplitude Null	15	100	20	100	16	100

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TABLE II-3.5-6 (CONT'D.)
SYSTEM ERROR TEST DATA

System Description: Expanded Multiplex, Channels 1 through 19 and 1

IF Signal-to-Noise Ratio: 39db

Discriminator Full Scale Output: 10Vpp Receiver AGC Voltage: -5.1Vdc

Discriminator Channel: 70KC ±7.5%, DR=5

Residual Noise: Full Multiplex 7.5mVrms Search Channel Only 6.5mV

Full Scale Level at Summing Point: 10Vpp and 3.55Vrms

	315cps 0.3 f_m		525cps 0.5 f_m		1050cps 1.0 f_m	
	mv rms	mv p-p	mv rms	mv p-p	mv rms	mv p-p
Full Multiplex:						
Phase Null Only	—	—	107	400	212	70
Phase & Amplitude Null	13	100	15	110	12.4	90
Search Channel Only:						
Phase Null Only	—	—	105	350	212	65
Phase & Amplitude Null	10	70	12.5	80	9.5	60

Discriminator Channel: 30KC ±7.5%, DR=5

Residual Noise: Full Multiplex 5.0mVrms Search Channel Only 3.0mVrms

Full Scale Level at Summing Point: 10Vpp and 3.55Vrms

	13.5cps 0.3 f_m		22.5cps 0.5 f_m		45cps 1.0 f_m	
	mv rms	mv p-p	mv rms	mv p-p	mv rms	mv p-p
Full Multiplex:						
Phase Null Only	—	—	20	100	95	35
Phase & Amplitude Null	13	80	15	90	10	60
Search Channel Only:						
Phase Null Only	—	—	19	90	95	30
Phase & Amplitude Null	12	50	14	70	9	50

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TABLE II-3.5-7
SYSTEM ERROR TEST DATA

System Description: Constant Bandwidth Multiplex

IF Signal-to-Noise Ratio: 39 db

Discriminator Full Scale Output: 10 vpp Receiver AGC Voltage: -5.0 vdc

Discriminator Channel: 14, 120 KC ± 2 KC, DR=2

Residual Noise: Full Multiplex 31 mvrms Search Channel Only 26 mvrms

Full Scale Level at Summing Point: 10 vpp and 3.54 vrms

	300 cps $0.3 f_m$		500 cps $0.5 f_m$		1.0 KC $1.0 f_m$	
	mv rms	mv p-p	mv rms	mv p-p	mv rms	mv p-p
Full Multiplex:						
Phase Null Only	—	—	175	740	238	850
Phase & Amplitude Null	57	350	158	750	35	250
Search Channel Only:						
Phase Null Only	—	—	175	740	235	800
Phase & Amplitude Null	54	320	158	700	31	215

Discriminator Channel: 19, 160 KC ± 2 KC, DR=2

Residual Noise: Full Multiplex 30 mvrms Search Channel Only 25 mvrms

Full Scale Level at Summing Point: 10 vpp and 3.54 vrms

	$0.3 f_m$		$0.5 f_m$		$1.0 f_m$	
	mv rms	mv p-p	mv rms	mv p-p	mv rms	mv p-p
Full Multiplex:						
Phase Null Only	—	—	202	800	194	700
Phase & Amplitude Null	62	400	180	800	34	250
Search Channel Only:						
Phase Null Only	—	—	202	800	194	700
Phase & Amplitude Null	60	380	179	800	30	200

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TABLE II-3.5-7 (CONT'D.)
SYSTEM ERROR TEST DATA

System Description: Constant Bandwidth Multiplex

IF Signal-to-Noise Ratio: 39 db

Discriminator Full Scale Output: 10 vpp Receiver AGC Voltage: -5.0 vdc

Discriminator Channel: 6.56 KC ± 2 KC, DR = 2

Residual Noise: Full Multiplex 31 mVrms Search Channel Only 25.5 mVrms

Full Scale Level at Summing Point: 10 vpp and 3.54 Vrms

	300 cps $0.3 f_m$		500 cps $0.5 f_m$		1.0 KC $1.0 f_m$	
	mv rms	mv p-p	mv rms	mv p-p	mv rms	mv p-p
Full Multiplex:						
Phase Null Only	—	—	145	760	245	1000
Phase & Amplitude Null	55	450	128	700	48	400
Search Channel Only:						
Phase Null Only	—	—	134	600	244	850
Phase & Amplitude Null	42	300	120	540	30	220

Discriminator Channel: 10.88 KC ± 2 KC, DR = 2

Residual Noise: Full Multiplex 32 mVrms Search Channel Only 25 mVrms

Full Scale Level at Summing Point: 10 vpp and 3.54 Vrms

	300 cps $0.3 f_m$		500 cps $0.5 f_m$		1.0 KC $1.0 f_m$	
	mv rms	mv p-p	mv rms	mv p-p	mv rms	mv p-p
Full Multiplex:						
Phase Null Only	—	—	150	750	192	700
Phase & Amplitude Null	45	300	114	500	37	280
Search Channel Only:						
Phase Null Only	—	—	146	680	190	700
Phase & Amplitude Null	39	250	110	450	27	200

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TABLE II-3.5-8
SYSTEM ERROR TEST DATA

System Description: Combinational Bandwidth Multiplex

IF Signal-to-Noise Ratio: 39 db

Discriminator Full Scale Output: 10 VPP Receiver AGC Voltage: -5.2 vdc

Discriminator Channel: 6 CBW, 56 KC ± 2KC, DR=2

Residual Noise: Full Multiplex 40 mVrms Search Channel Only 15 mVrms

Full Scale Level at Summing Point: 10 VPP and 3.54 Vrms

	300cps 0.3 f_m		500cps 0.5 f_m		1.0 KC 1.0 f_m	
	mv rms	mv p-p	mv rms	mv p-p	mv rms	mv p-p
Full Multiplex:						
Phase Null Only	—	—	170	800	270	1100
Phase & Amplitude Null	125	650	135	700	55	300
Search Channel Only:						
Phase Null Only	—	—	135	550	240	800
Phase & Amplitude Null	110	450	110	460	25	140

Discriminator Channel: 10 CBW, 88 KC ± 2KC, DR=2

Residual Noise: Full Multiplex 40 mVrms Search Channel Only 15 mVrms

Full Scale Level at Summing Point: 10 VPP and 3.54 Vrms

	300cps 0.3 f_m		500cps 0.5 f_m		1.0 KC 1.0 f_m	
	mv rms	mv p-p	mv rms	mv p-p	mv rms	mv p-p
Full Multiplex:						
Phase Null Only	—	—	150	800	200	850
Phase & Amplitude Null	85	400	115	500	42	200
Search Channel Only:						
Phase Null Only	—	—	140	600	180	600
Phase & Amplitude Null	74	300	110	350	20	100

Date 3-29-65 Name MDL

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TABLE II-3.5-8 (CONT'D.)
SYSTEM ERROR TEST DATA

System Description: Combinational Bandwidth Multiplex

IF Signal-to-Noise Ratio: 39db

Discriminator Full Scale Output: 10vpp Receiver AGC Voltage: -5.2Vdc

Discriminator Channel: 14 CBW, 120 KC ± 2KC, DR=2

Residual Noise: Full Multiplex 40mvrms Search Channel Only 16mVrms

Full Scale Level at Summing Point: 10vpp and 3.54Vrms

	300cps 0.3 f_m		500cps 0.5 f_m		1.0kc 1.0 f_m	
	mv rms	mv p-p	mv rms	mv p-p	mv rms	mv p-p
Full Multiplex:						
Phase Null Only	—	—	190	800	265	1000
Phase & Amplitude Null	148	650	160	700	44	250
Search Channel Only:						
Phase Null Only	—	—	190	700	270	950
Phase & Amplitude Null	142	550	155	550	25	100

Discriminator Channel: 19 CBW, 160KC ± 2KC, DR=2

Residual Noise: Full Multiplex 45mVrms Search Channel Only 15.5mVrms

Full Scale Level at Summing Point: 10vpp and 3.54Vrms

	300cps 0.3 f_m		500cps 0.5 f_m		1.0kc 1.0 f_m	
	mv rms	mv p-p	mv rms	mv p-p	mv rms	mv p-p
Full Multiplex:						
Phase Null Only	—	—	220	900	240	950
Phase & Amplitude Null	160	700	190	800	51	300
Search Channel Only:						
Phase Null Only	—	—	198	700	205	700
Phase & Amplitude Null	155	600	190	700	27	100

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TABLE II-3.5-8 (CONT'D.)
SYSTEM ERROR TEST DATA

System Description: Combinational Bandwidth Multiplex

F Signal-to-Noise Ratio: 39db

Discriminator Full Scale Output: 10VPP Receiver AGC Voltage: -5.2Vdc

Discriminator Channel: 8 PBW, 3.0KC±7.5%, DR=5

Residual Noise: Full Multiplex 4mVrms Search Channel Only 3 mVrms

Full Scale Level at Summing Point: 10VPP and 3.54Vrms

	13.5cps $0.3 f_m$		23.5cps $0.5 f_m$		45cps $1.0 f_m$	
	mv rms	mv p-p	mv rms	mv p-p	mv rms	mv p-p
Full Multiplex:						
Phase Null Only	—	—	17.5	80	145	450
Phase & Amplitude Null	15.5	60	17.5	80	12	50
Search Channel Only:						
Phase Null Only	—	—	17.5	80	142	400
Phase & Amplitude Null	15	60	17.5	70	11	60

Discriminator Channel: ____

Residual Noise: Full Multiplex ____ Search Channel Only ____

Full Scale Level at Summing Point: ____ and ____

	$0.3 f_m$		$0.5 f_m$		$1.0 f_m$	
	mv rms	mv p-p	mv rms	mv p-p	mv rms	mv p-p
Full Multiplex:						
Phase Null Only						
Phase & Amplitude Null						
Search Channel Only:						
Phase Null Only						
Phase & Amplitude Null						

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3.6 TAPE-RECORDER ERRORS

3.6.1 General

The tape-recorder error test was made to determine the effect of post-detection recording on the system performance. The test was accomplished using the system block diagrams shown in Figure II-3.0-1 for the proportional basebands, and Figures II-3.0-2 and II-3.0-3 for the constant- and combinational-bandwidth basebands. In all cases the mixer amplifier de-emphasizes the receiver output and adds the reference tone to the total multiplex. The de-emphasis network was a simple RC network in the input of the mixer amplifier driven by the receiver output. In all cases the level of the reference oscillator signal is twice the level of the highest frequency channel in the multiplex.

To determine the effect of the addition of the tape recorder, the system was first operated with the tape recorder bypassed, i.e., the mixer output feeding directly into the remainder of the ground system. The discriminator output noise is measured and then the tape recorder was included in the system and the test repeated. Measurements were made with and without tape-speed compensation for the test channel unmodulated at center frequency and at bandedge.

In addition to the test for increase in channel output noise due to the inclusion of the tape recorder, the intermodulation test (Section 3.3) was repeated on the constant- and combinational-bandwidth multiplexes with the tape recorder included in the system.

3.6.2 Detailed Procedure for Tape-Recorder Error Test

a. Calibrate all VCOs.

b. Deviate all channels, with the exception of the test channel, full bandwidth at the maximum modulation frequency for the particular deviation ratio.

c. Allow the receiver AGC to assume normal operating condition.

d. The IF carrier-to-noise ratio should be greater than 20 db.

e. Set subcarrier discriminator output for 10 volts, peak-to-peak.

f. Adjust the reference oscillator output for a level equal to twice the level of the highest channel in the multiplex.

g. Adjust the tape-recorder input and output for normal record level.

h. Measure the rms discriminator output noise at center frequency and low bandedge with and without the tape recorder bypassed and also with and without tape-speed compensation.

3.6.3 Results of Tape Recorder Error Test

Measured data and experimental conditions described in illustrations numbered with II are included in this volume. Summarized data and conclusions are presented in Volume I in illustrations numbered with I.

3.6.3.1 IRIG Baseband

The IRIG baseband channels 1 through 18 were evaluated for tape-recorder error. The detailed conditions were:

Test channels: 70.0 kc ±7.5%; 3.0 kc ±7.5%

Deviation ratio: 5

De-emphasis corner frequency: 4 kc

Discriminator full-bandwidth output: 10 volts peak-to-peak

Tape recorder: Mincom G107

Tape speed: 60 ips

Record level: 1.0v rms

IF S/N ratio: 39 db

Table II-3.6-1 shows the measured data for the IRIG baseband evaluation. A summary of the data is shown in Table I-3.7-1.

3.6.3.2 IRIG Baseband--Wideband Channel

The IRIG baseband containing a wideband channel in the highest frequency position was evaluated for tape-recorder error. The detailed conditions were:

Test channels: 70 kc ±7.5%; 3 kc ±7.5%

Deviation ratio: 5

De-emphasis corner frequency: 4 kc

Discriminator full-bandwidth output: 10 volts peak-to-peak

Tape recorder: Mincom G107

Tape speed: 60 ips

Record level: 1.0v rms

IF S/N ratio: 39 db

Table II-3.6-2 shows the measured data for the wideband IRIG baseband evaluation. A summary of the data is shown in Table I-3.7-1.

3.6.3.3 IRIG Baseband--Deviation Ratio of 1 and 2

The IRIG baseband, channels 1 through 18 operating at deviation ratios 1 and 2, was evaluated for tape-recorder error. The detailed conditions were:

Test channels: 70.0 kc ±7.5%; 22.0 kc ±7.5%; 7.35 kc ±7.5%; 3.0 kc ±7.5%; 960 cps ±7.5%

Deviation ratio: 1 and 2

De-emphasis corner frequency: 4 kc

Discriminator full-bandwidth output: 10 volts, peak-to-peak

Tape recorder: Mincom G107

Tape speed: 60 ips

Record level: 1.0v, rms

IF S/N ratio: 39 db

Table II-3.6-1 shows the measured data for the 70 kc, 22 kc, 7.35 kc, 3 kc, and 960 cycle, respectively, for a deviation ratio of 1 and 2. The data is summarized in Table I-3.7-1.

3.6.3.4 Expanded Baseband

The expanded baseband, channels 1 through 21, was evaluated for tape-recorder errors. The detailed conditions were:

Test channels: 165 kc ±7.5%; 124 kc ±7.5%; 93 kc ±7.5%; 70 kc ±7.5%; 3 kc ±7.5%

Deviation ratio: 5

De-emphasis corner frequency: 25 kc

Tape recorder: Mincom G107

Discriminator output FB' ': 10 volts, peak-to-peak

Tape speed: 60 ips

Record level: 1.0v, rms

IF S/N ratio: 39 db

Table II-3.6-3 shows the tape-speed errors for the expanded-baseband channels operating at a deviation ratio of 5. The data is summarized in Table I-3.7-2.

3.6.3.5 Expanded Baseband--Wideband Channel

The expanded baseband was operated with a wideband channel in the highest frequency position. The tape-recorder errors were evaluated for channels 1 through 19 plus channel H. The detailed conditions were:

Test channels: 165 kc ±15%; 93 kc ±7.5%; 70 kc ±7.5%;
3 kc ±7.5%

Deviation ratio: 5

De-emphasis corner frequency: 25 kc

Discriminator full-bandwidth output: 10 volts, peak-to-peak

Tape recorder: Mincom G107

Tape speed: 60 ips

Record level: 1.0v, rms

IF S/N ratio: 39 db

Table II-3.6-4 shows the performance of the expanded baseband including the wideband channel. The data is summarized in Table I-3.7-2.

3.6.3.6 Constant-Bandwidth Baseband

The constant-bandwidth multiplex, channels 1 through 21, was evaluated for tape-recorder errors under the following conditions:

Test channels: 56 kc ±2 kc; 80 kc ±2 kc; 120 kc ±2 kc;
160 kc ±2 kc

Deviation ratio: 2

De-emphasis corner frequency: 40 kc

Discriminator full-bandwidth output: 20 volts, peak-to-peak

Tape recorder: Ampex modified FR 1400

Tape speed: 120 ips

Record level 0.5v, rms

IF S/N ratio: 39 db

The data is contained in Table II-3.6-5 and summarized in Table I-3.7-5.

3.6.3.7 Combinational-Bandwidth Baseband

The combinational-bandwidth multiplex, IRIG channels 1 through 11 and constant-bandwidth channels 1 through 21, was evaluated for tape-recorder errors under the following conditions:

Test channels: 3.0 kc ±7.5%; 56 kc ±2 kc; 88 kc ±2 kc;
120 kc ±2 kc; 160 kc ±2 kc

Deviation ratio: 5 for IRIG channels; 2 for CBW channels

Discriminator full-bandwidth output: 20 volts, peak-to-peak

De-emphasis corner frequency: 40 kc

Tape recorder: Ampex modified FR 1400

Tape speed: 120 ips

Record level: 0.5v rms

IF S/N ratio: 39 db

The data is contained in Table II-3.6-6 and summarized in Table I-3.7-6.

3.6.4 Tape-Recorder Intermodulation Test

The intermodulation test, described in Section 3.3, was repeated with the tape recorder in the system. All conditions for the test are identical to those given above in Section 3.6.3. The data photographs are shown in Figures II-3.6-7 through II-3.6-10 and summarized in Table I-3.7-6.

TABLE II-3.6-1
TAPE SPEED ERROR TEST DATA

System Description: IRIG; 1-18; DR:5,2,1 Discriminator Full Scale Output: 10 VPP (S/N)$_c$: 39db

Channel				Output Noise With Tape Recorder				Output Noise Without Tape Recorder			
				TSC On		TSC Off		TSC On		TSC Off	
No.	Frequency	LPOF cps	DR	CF mv	BE mv	CF mv	BE mv	CF mv	BE mv	CF mv	BE mv
18	70KC ± 7.5%	5250	1	202	315	204	350	109	210	106	210
18	70KC ± 7.5%	2625	2	90	150	95	110	42	50	39	48
18	70KC ± 7.5%	1050	5	22	22	35	33	9.5	9.5	9.5	9.5
14	22KC ± 7.5%	1650	1	130	200	130	200	68	90	68	90
14	22KC ± 7.5%	825	2	60	80	60	80	32	36	32	36
11	7.35KC ± 7.5%	551	1	85	13	85	13	55	90	55	90
11	7.35KC ± 7.5%	276	2	40	42	45	46	25	26	25	26
8	3.0KC ± 7.5%	225	1	105	350	105	350	90	330	90	330
8	3.0KC ± 7.5%	112	2	32	70	38	75	23	65	23	65
8	3.0KC ± 7.5%	45	5	8	9	16	17	5.5	7.5	5.5	7.5
4	960cps ± 7.5%	72	1	80	300	80	300	70	300	70	300
4	960cps ± 7.5%	36	2	25	55	25	55	18	53	18	53

TABLE II-3.6-2

TAPE SPEED ERROR TEST DATA

System Description: IRIG, 1-16+E, DR:5 Discriminator Full Scale Output: 10 VPP (S/N)$_c$: 39db

Channel				Output Noise With Tape Recorder				Output Noise Without Tape Recorder			
				TSC On		TSC Off		TSC On		TSC Off	
No.	Frequency	LPOF cps	DR	CF mv	BE mv	CF mv	BE mv	CF mv	BE mv	CF mv	BE mv
E	70KC ± 15%	2100	5	21	20	28	25	8	8.5	8	8.5
8	3.0KC ± 7.5%	45	5	7	10	15	15	5	7	5	7

Name: ERI/MRJ Date: 1-14-65

TABLE II-3, 6-3

TAPE SPEED ERROR TEST DATA

System Description: Expanded; 1-21 Discriminator Full Scale Output: 10 Vpp (S/N)c: 39 db

Channel		LPOF	DR	Output Noise With Tape Recorder				Output Noise Without Tape Recorder			
				TSC On		TSC Off		TSC On		TSC Off	
No.	Frequency	cps		CF mv	BE mv	CF mv	BE mv	CF mv	BE mv	CF mv	BE mv
21	165 kc ±7.5%	2475	5	18	16	30	27	8.5	7.5	8.5	7.5
20	124 kc ±7.5%	1860	5	18	13	29	25	13.5	9	13.5	9
19	93 kc ±7.5%	1400	5	15	14	25	25	9.5	10	9.5	10
18	70 kc ± 7.5%	1050	5	14	15	25	25	10.5	11	10.5	11
8	3.0 kc ±7.5%	45	5	5	8	17	17	3.5	6.5	3.5	6.5

Name: WSB/MDL Date: 2-4-65

TABLE II-3.6-4

TAPE SPEED ERROR TEST DATA

System Description: Expanded, 1-19 + H Discriminator Full Scale Output: 10 Vpp (S/N)$_c$: 39 db

Channel				Output Noise With Tape Recorder				Output Noise Without Tape Recorder			
				TSC On		TSC Off		TSC On		TSC Off	
No.	Frequency	LPOF cps	DR	CF mv	BE mv	CF mv	BE mv	CF mv	BE mv	CF mv	BE mv
H	165 KC ± 15%	4950	5	18	13	23	18	9.5	8.5	9.5	8.5
19	93 KC ± 7.5%	1400	5	14	12.5	25	24	11	9.5	11	9.5
18	70 KC ± 7.5%	1050	5	13	13	26	24	9.5	10	9.5	10
8	3.0 KC ± 7.5%	45	5	5.5	7.5	18	19	3.4	5.5	3.4	5.5

TAPE SPEED ERROR TEST DATA

System Description: Constant BW Discriminator Full Scale Output: 20 VPP $(S/N)_c$: 39db

Channel		LPOF	DR	Output Noise With Tape Recorder				Output Noise Without Tape Recorder			
				TSC On		TSC Off		TSC On		TSC Off	
No.	Frequency	cps		CF mv	BE mv	CF mv	BE mv	CF mv	BE mv	CF mv	BE mv
19	160KC ± 2KC	1000	2	72	77	77	82	60	58	60	58
14	120KC ± 2KC	1000	2	72	78	78	84	62	67	62	67
10	88KC ± 2KC	1000	2	68	78	78	82	62	69	62	69
6	56KC ± 2KC	1000	2	71	75	78	85	64	65	64	65

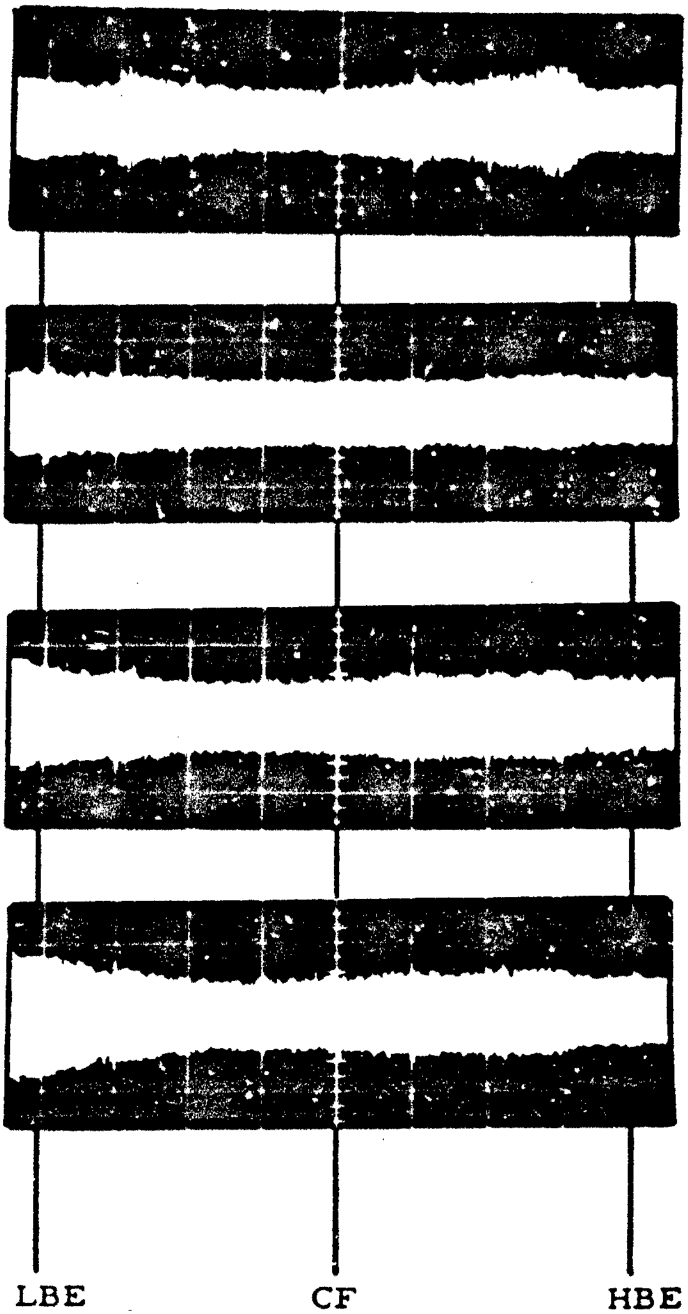
Name: WSB/MDL Date: 3-30-65

TABLE II-3.6-6
TAPE SPEED ERROR TEST DATA

System Description: Combinational Bcc Discriminator Full Scale Output: 20 VPP (S/N)$_c$: 39db

Channel				Output Noise With Tape Recorder				Output Noise Without Tape Recorder			
				TSC On		TSC Off		TSC On		TSC Off	
No.	Frequency	LPOF cps	DR	CF mv	BE mv	CF mv	BE mv	CF mv	BE mv	CF mv	BE mv
19	160 kc ± 2 kc	1000	2	108	106	110	108	85	85	85	85
14	120 kc ± 2 kc	1000	2	96	102	106	107	82	86	82	86
10	88 kc ± 2 kc	1000	2	94	104	118	114	83	89	83	89
6	56 kc ± 2 kc	1000	2	95	108	108	112	80	80	80	80
8	3.0 kc ± 7.5%	45	5	8.0	12	12	15	6.3	11	6.3	11

Name: WSB/MDL Date: 3-30-65



Channel 6, 56.0 kc ±2 kc
RMS Level = 134 mv max.
DR = 2

Channel 10, 88.0 kc ±2 kc
RMS Level = 90 mv max.
DR = 2

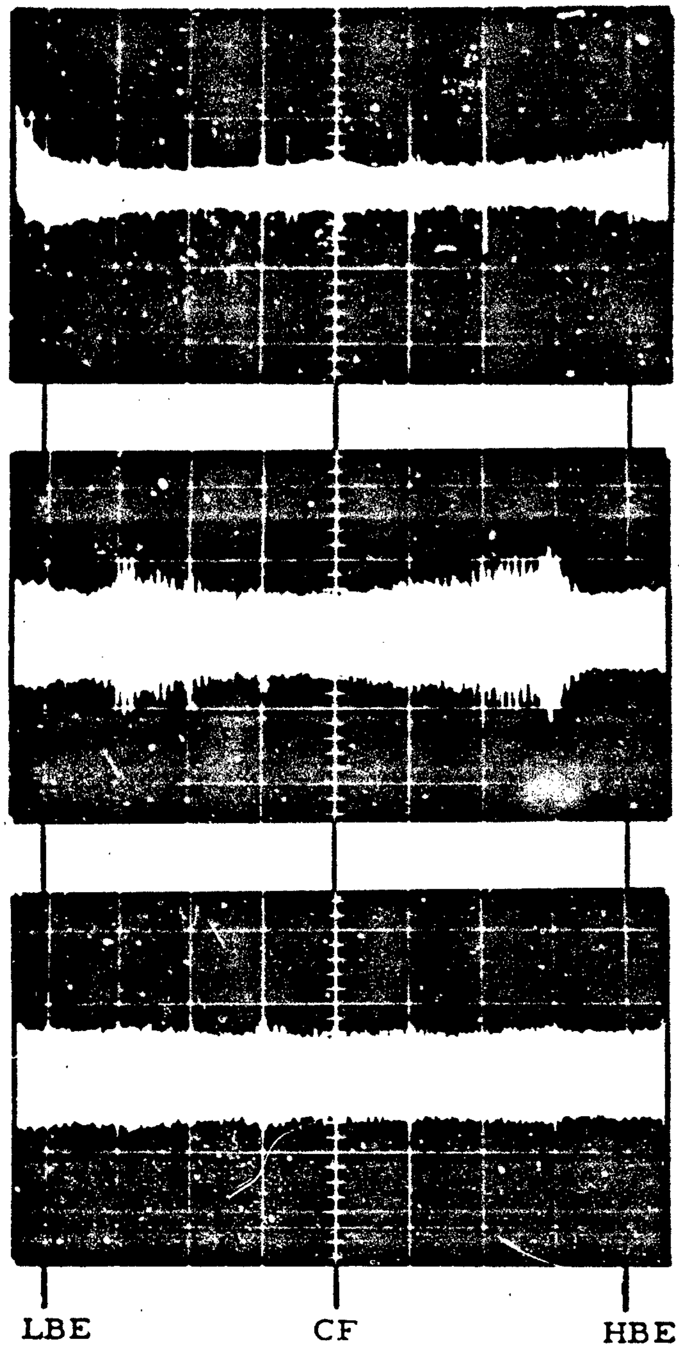
Channel 14, 120.0 kc ±2 kc
RMS Level = 98 mv max.
DR = 2

Channel 19, 160.0 kc ±2 kc
RMS Level = 106 mv max.
DR = 2

Horizontal: 5 sec/cm

Vertical: 2.5% FBW/cm

FIGURE II-3.6-7
TAPE RECORDER INTERMODULATION TEST DATA:
CONSTANT BANDWIDTH MULTIPLEX



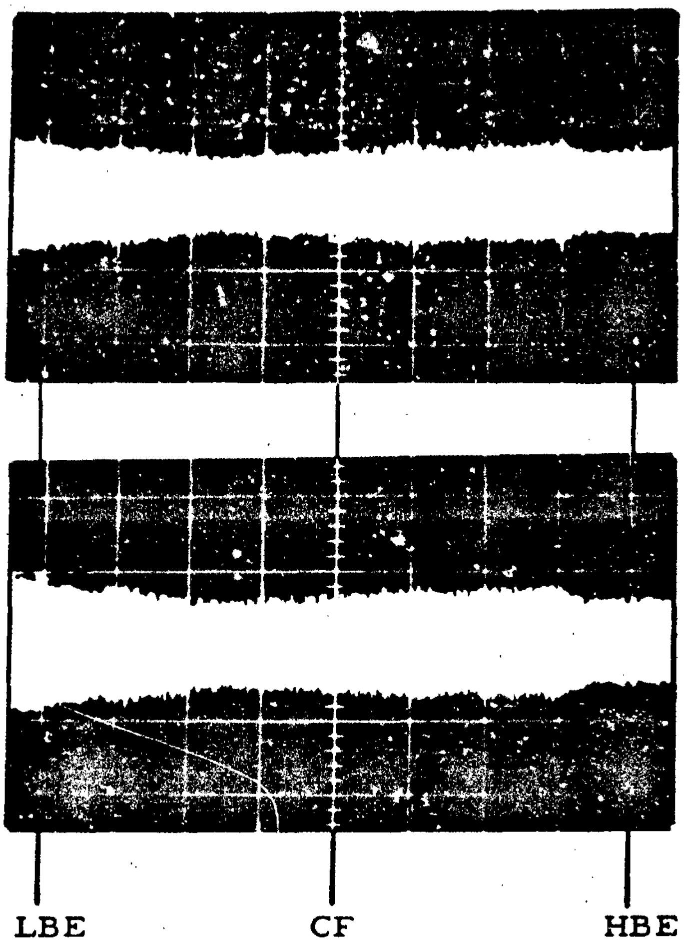
IRIG Channel 8, 3. 0 kc ±7. 5%
DR = 5
RMS Level = 13. 5 mv max.
Vertical: 0. 5% FBW/cm

CBW Channel 6, 56. 0 kc ±2 kc
DR = 2
RMS Level = 205 mv max.
Vertical: 2. 5% FBW/cm

CBW Channel 10, 88. 0 kc ±2 kc
DR = 2
RMS Level = 112 mv max.
Vertical: 2. 5% FBW/cm

Horizontal: 5 sec/cm

FIGURE II-3. 6-8
TAPE RECORDER INTERMODULATION TEST DATA:
COMBINATIONAL BANDWIDTH MULTIPLEX, IRIG CHANNEL 8,
CBW CHANNELS 6 AND 10

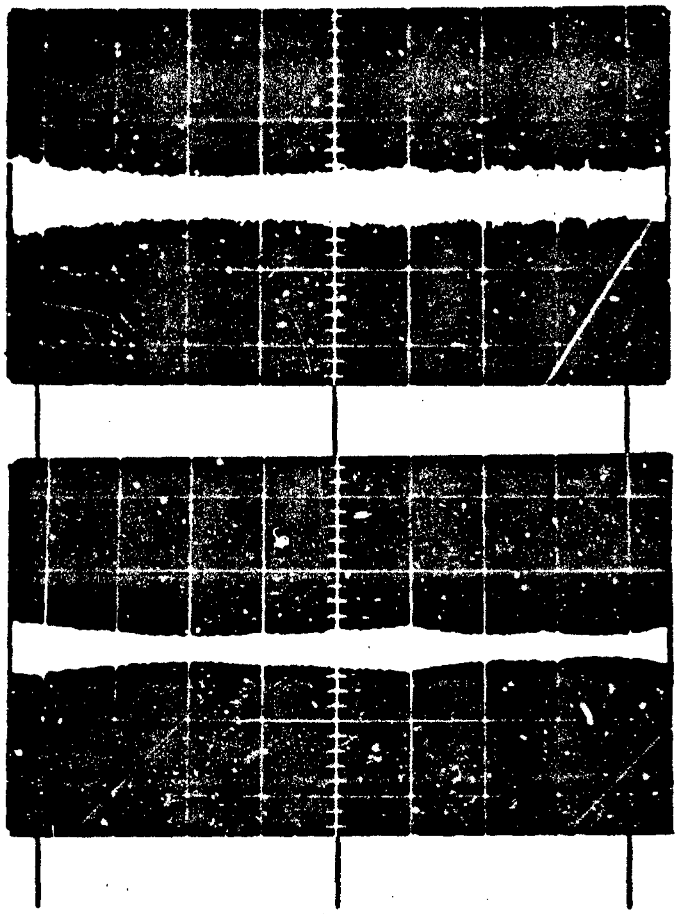


CBW Channel 14, 120.0 kc ±2 kc
DR = 2
RMS Level = 118 mv max.
Vertical: 2.5% FBW/cm

CBW Channel 19, 160.0 kc ±2 kc
DR = 2
RMS Level = 136 mv max.
Vertical: 2.5% FBW/cm

Horizontal: 5 sec/cm

FIGURE II-3.6-9
TAPE RECORDER INTEMODULATION TEST DATA:
COMBINATIONAL BANDWIDTH MULTIPLEX, CBW CHANNELS 14 AND 19



Horizontal: 5 sec/cm

Vertical: 2.5% FBW/cm

Search Channel: CBW Channel 6, 56.0 kc ±2 kc, DR = 2

FIGURE II-3.6-10
TAPE RECORDER INTERMODULATION TEST DATA:
COMBINATIONAL BANDWIDTH MULTIPLEX,
NO RF LINK, CBW CHANNEL 6

3.7 PULSE MODULATION

3.7.1 PAM/FM/FM System Test

3.7.1.1 General

The PAM/FM/FM test was made to determine the system accuracy for pulse-amplitude modulation (PAM). Since the system used in this evaluation program includes all equipment from the VCO input to the subcarrier discriminator output, errors due to sampling and data interpolation are not considered. The PAM error of interest is interchannel (pulse-to-pulse) crosstalk caused by various filters in the system and appearing as limited output rise and fall times. For example, if one pulse is at zero scale and the next at full scale, the output cannot rise to its new value instantaneously. A sampling detector was assumed in the decommutator; therefore, if the output reaches its full value (steady-state condition) within the pulse duration time no error is assumed, e.g., if the pulse can be sampled at its full height, no crosstalk error occurs. Thus, the crosstalk error test is reduced to determining at what degree the pulse reaches its full steady-state value. Since the worst-case crosstalk occurs when the output must traverse the greatest distance, the test PAM wave train consisted of a zero-scale pulse followed by three full-scale pulses and then another zero-scale pulse. The discriminator output was observed using a Tektronix type Z plug-in which allows the exact full-scale voltage to be subtracted from the pulse train and the resulting error examined. Data was recorded by photographing the oscilloscope display. The sampling time was periodic and positioned so that a minimum error would occur.

For each proportional-bandwidth baseband, the wideband channel was modulated with PAM at 900 sps for the IRIG baseband and 2100 sps for the expanded baseband. The subcarrier discriminator 18 db/octave LPOF was operated at its normal cutoff frequency for a deviation ratio of 5. This condition is approximately correct for sampling type decommutators. Figure II-3.7-1 shows the block diagram of the test setup.

3.7.1.2 Detailed Procedure

a. Calibrate all VCOs.

b. Deviate all channels with the exception of the test channel, full bandwidth at the maximum modulating frequency for a deviation ratio of 5.

c. Allow the receiver AGC to assume its normal operating condition.

d. The IF carrier-to-noise ratio should be greater than 20 db.

e. Deviate the test channel full bandwidth at the appropriate pulse rate with the output of the PAM/PDM simulator.

f. Set subcarrier discriminator output for 20v, peak-to-peak

g. With a Tektronix type Z plug-in, determine the error from full scale at duty cycles of 40, 50, and 70%. (The PAM simulator does not have a 65% duty cycle position; therefore, 70% is used instead.)

3.7.1.3 Results

3.7.1.3.1 IRIG Baseband

The IRIG baseband channels 1 through 16 plus channel E were evaluated with PAM on channel E. The detailed conditions were:

Sample rate: 900 samples per second

Test channel: 70 kc ±15%

LPOF: 2100 cps constant delay, 18 db/octave type

Discriminator FBW output: 20v, peak-to-peak

IF S/N ratio: 39 db

Figure II-3.7-2a shows a photograph of the system input and output with no vertical scale expansion. Figure II-3.7-2b shows the discriminator output using the Tektronix type Z plug-in. The top trace is the system input and the bottom trace is the system output. The two middle traces are the system output minus full-scale voltage. The straight line thus represents zero error for full-scale modulation. The expanded PAM pulses are shown just below the zero reference line. Thus, using a sampling detector, an instantaneous sample could be taken anywhere within 50 μsec and produce an error less than 0.5% of FBW. The data in Figure II-3.7-3 shows the performance for 40% and 70% duty-cycle PAM.

3.7.1.3.2 Expanded Baseband

The expanded baseband, channels 1 through 19 plus channel H, was evaluated with PAM on channel H. The detailed conditions are:

Sample rate: 2100 sps

Test channel: 165 kc ±15%

LPOF: 4950 cps constant-delay 18 db/octave type

Discriminator FBW output: 20v, peak-to-peak

IF S/N ratio: 39 db

Figure II-3.7-4a shows a photograph of the system input and output with no vertical scale expansion. Figure II-3.7-4b shows the discriminator output using the Tektronix type Z plug-in. The photographs present similar data described in Section 3.7.1.3.1 for the IRIG baseband. Figure II-3.7-5 shows the performance for 40% and 70% duty-cycle PAM.

3.7.2 PDM/FM/FM System Test

3.7.2.1 General

The PDM/FM/FM test was made to determine the system accuracy for pulse duration modulation (PDM). For each proportional-bandwidth baseband, the wideband channel was modulated with PDM at 900 sps rate for the IRIG baseband and 2100 sps for the expanded baseband. The zero- and full-scale pulse lengths are standard at 100 and 700 microseconds, respectively, for the expanded baseband. The discriminator low-pass output filter used was a constant delay, 18 db/octave type with the cutoff frequency equal to five times the repetition rate. The cutoff frequency was selected to be as narrow as possible without affecting the zero-scale pulse duration.

In all cases, photographs were taken of the oscilloscope display to show the variation in pulse duration. In addition to the pulse duration measurements, the adjacent channel in each baseband was checked for an increase in intermodulation (crosstalk) noise due to the PDM. The block diagram for the test is identical to the PAM test setup shown in Figure II-3.7-1.

3.7.2.2 Detailed Procedure

a. Calibrate all VCOs.

b. Deviate all channels with the exception of the test channel full bandwidth at the maximum modulating frequency for a deviation ratio of 5.

c. Set the receiver AGC to its normal operating condition.

d. The IF signal-to-noise ratio should be greater than 20 db.

e. Deviate the test channel full bandwidth at the appropriate pulse rate with the output of the PAM/PDM simulator.

f. Set subcarrier discriminator full-scale output for 20v peak-to-peak.

g. Observe and photograph the dual-trace oscilloscope display of the PDM input and discriminator output waveform.

h. Repeat the intermodulation test (described in Section 3. 3) on the adjacent channel for both 7.5% and 15% PDM deviation of the test channel.

3.7.2.3 Results

3.7.2.3.1 IRIG Baseband

The IRIG baseband, channels 1 through 16 plus channel E was evaluated with PDM on channel E. The detailed conditions were:

Repetition rate: 900 pulses per second

Test channel: 70 kc ±15%

LPOF: 4500 cps, constant-delay, 18 db/octave

Discriminator FBW output: 20v peak-to-peak

IF S/N ratio: 39 db

Zero-scale pulse: 100 microseconds

Full-scale pulse: 700 microseconds

Figure II-3.7-6 shows a photograph of the system input and output for 0, 25, 50, 75, and 100% full scale (FS) PDM. The time delay through the system is contained in this photograph. Figure II-3.7-7 shows the system input and output for a 0 and 100% FS PDM modulation with double exposure used to remove the relative system delay and simplify comparison of pulse duration.

The effect of PDM of the 70 kc ±15% channel on the intermodulation level in the 40 kc ±7.5% channel is shown in Figure II-3.7-8. The worst-case intermodulation was found to occur with all channels of the PDM input at 100% FS; therefore, intermodulation was measured with this PDM. Figure II-3.7-8a shows the intermodulation effect for full ±15% PDM deviation of the 70 kc ±15% channel while Figure II-3.7-8b shows the same effect for ±7.5% deviation. No differences in pulse duration were found between ±7.5% or ±15% deviation.

3.7.2.3.2 Expanded Baseband

The expanded baseband, channels 1 through 19 plus channel H, was evaluated with PDM on channel H. The detailed conditions were:

Repetition rate: 2100 pulses per second

Test channel: 165 kc ±15%

LPOF: 10500 cps, constant-delay, 18 db/octave

Discriminator FBW output: 20v peak-to-peak

IF S/N ratio: 39 db

Zero-scale pulse: 50 microseconds

Full-scale pulse: 300 microseconds

Figure II-3.7-9 shows a photograph of the system input and output with 0, 25, 50, 75, and 100% FS PDM. For ease of comparison, the system time delay has been removed through use of a double exposure. Figure II-3.9-10 shows the system input and output for 0 and 100% FS PDM with the system delay removed.

The effect of PDM of the 165 kc ±15% channel on the intermodulation level in the 93 ±7.5% channel is shown in Figure II-3.7-11. The worst-case intermodulation was found to occur with all channels of the PDM input at 0% FS; therefore, the intermodulation was measured with this modulation. Figure II-3.7-11a shows the intermodulation effect for full ±15% PDM deviation and Figure II-3.7-11b shows the intermodulation for ±7.5% deviation. No differences in pulse duration were found between ±7.5% and ±15% deviation.

3.7.3 PCM/FM/FM Systems Test

3.7.3.1 General

The PCM/FM/FM test was made to determine the bit-error probability for pulse-code modulation as a function of carrier-to-noise ratio. For the proportional-bandwidth basebands, the wideband channel is modulated with PCM at 21,000 bits per second for the IRIG baseband and 49,500 bits per second for the expanded baseband. In each case, the bit rate is equal to the bandwidth of the channel and the channel was deviated at 70% of full bandwidth. This modulation condition has been shown to be optimum for PCM/FM.[1, 2]

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[1] Experimental Determination of Signal-to-Noise Relationships in PCM/FM and PCM/PM Transmission, Interim Report for NASA, GSFC, Contract NAS 5-505, Electro-Mechanical Research, Inc., Sarasota, Florida, October 20, 1961.

[2] Telemetry System Study, Final Report, Volume II of III, Experimental Evaluation Program, U.S. Army Signal Research and Development Laboratories, Contract No. DA-36-039SC-73182, Aeronutric, Newport Beach, California, December 18, 1959

An EMR Model 219 PCM Signal Conditioner is used to reconstruct the PCM output of the wideband subcarrier discriminator. The discriminator low-pass output filter (LPOF) was bypassed and the PCM output signal fed directly into the signal conditioner. (Normally the LPOF should be operated several times the bit rate; however, one was not immediately available.) The signal conditioner is operated in the filter sample mode, i.e., a constant-delay input filter followed by an instantaneous sampling detector is used. The reconstructed PCM wave form from the signal conditioner and the input PCM wave train are then compared in the bit-error detector. The bit errors are accumulated in an electronic counter for a fixed interval of time, thus enabling the bit-error probability to be calculated. The block diagram for the PCM system test is shown in Figure II-3.7-12.

3.7.3.2 Detailed Procedure

a. Calibrate all VCOs.

b. Deviate all channels with the exception of the test channel full bandwidth at f_m where f_m is the maximum modulation frequency for deviation ratio of 5.

c. Hold the receiver AGC voltage at −4 volts dc.

d. Set the subcarrier discriminator output for 20 volts, peak-to-peak.

e. Deviate the test channel 70% full bandwidth at the appropriate PCM rate with the output of the PCM random bit generator.

f. Set the IF carrier-to-noise ratio to greater than 20 db.

g. Operate the EMR Model 219 Signal Conditioner at the appropriate rate and in the filter-sample mode.

h. Adjust the delay in the bit-error detector to align the input PCM waveform and the reconstructed waveform. Under this condition, there should be no errors occuring at the output of the bit-error detector.

i. Invert the output of the PCM signal conditioner and count the errors that occur at the output of the bit-error detector. The number of errors should equal the bit rate. Set the signal conditioner to normal output.

j. Select appropriate carrier-to-noise ratios and determine the error count at each carrier-to-noise ratio.

k. The bit-error probability can be calculated from the number of errors that occur in the total interval measured divided by the total number of bits occuring in that same interval.

1. Repeat the intermodulation test described in Section 3.3, on the adjacent lower channel.

3.7.3.3 Results

3.7.3.3.1 IRIG Baseband

The IRIG baseband, channels 1 through 16 plus channel E was evaluated with PCM on channel E. The detailed conditions were:

Repetition rate: 21,000 bits per second

Test channel: 70 kc ±15%

LPOF: None (bypassed)

Discriminator full-bandwidth output: 20 volts, peak-to-peak

Table II-3.7-13 shows the bit-error rates measured with the various carrier-to-noise ratios. The effect of the random bit PCM modulation of the 70 kc ±15% channel on the intermodulation (crosstalk) level in the 40 kc ±7.5% channel is shown in Figure II-3.7-14a. The effect of intermodulation for an alternate ONE/ZERO bit pattern is shown in Figure II-3.7-15a.

3.7.3.3.2 Expanded Baseband

The expanded baseband, channels 1 through 19 plus channel H, was evaluated with PCM modulation on Channel H. The detailed conditions were:

Bit rate: 49,500 bits per second

Test channel: 165 kc ±15%

LPOF: None (bypassed)

Discriminator full-bandwidth output: 20 volts, peak-to-peak

Table II-3.7-13 shows the bit-error rate for PCM operation of the expanded baseband. The effect of the random-bit PCM modulation of the 165 kc ±15% channel on the intermodulation level in the 93 kc ±7.5% channel is shown in Figure II-3.7-14b. The intermodulation for an alternate ONE/ZERO bit pattern is shown in Figure II-3.7-15b.

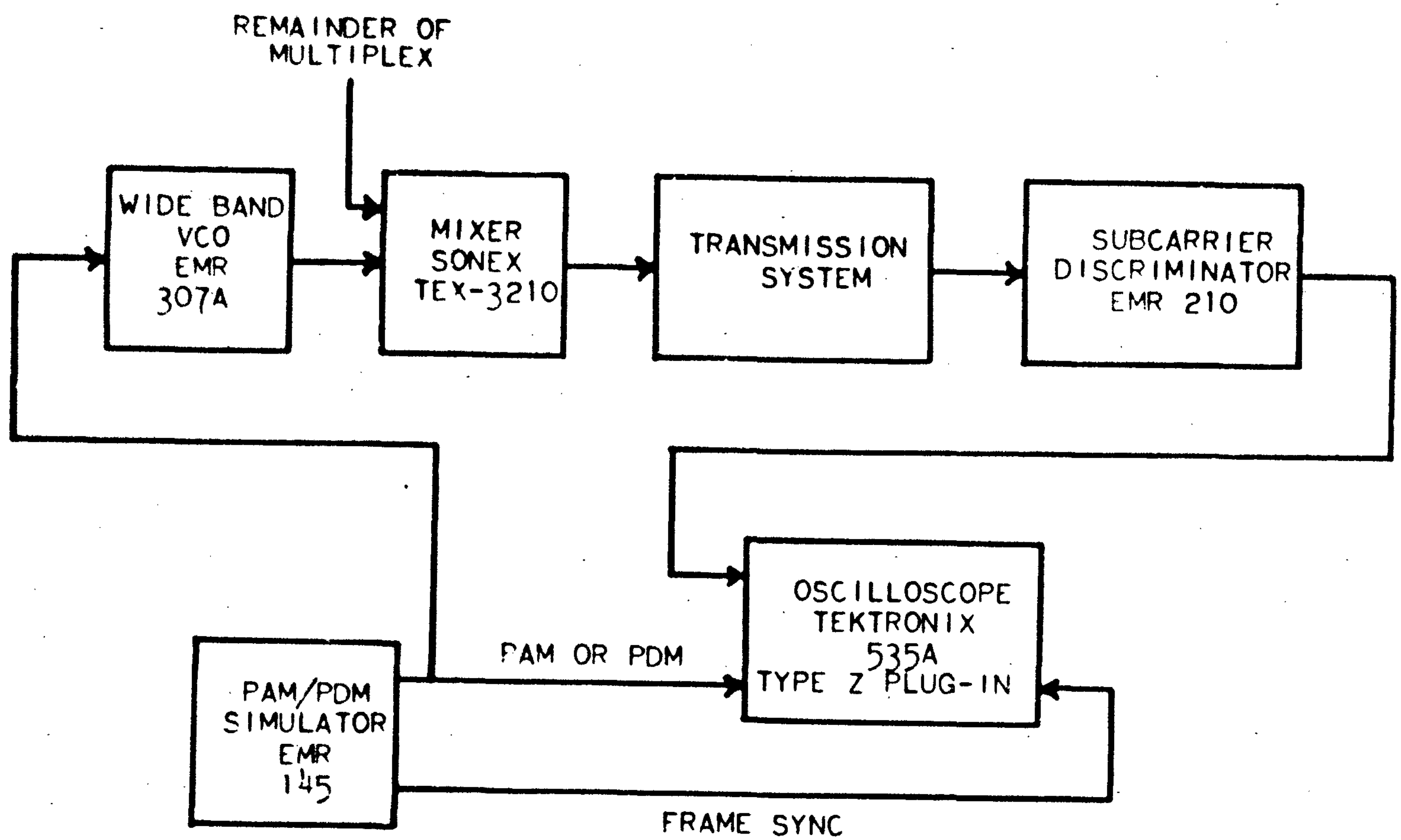
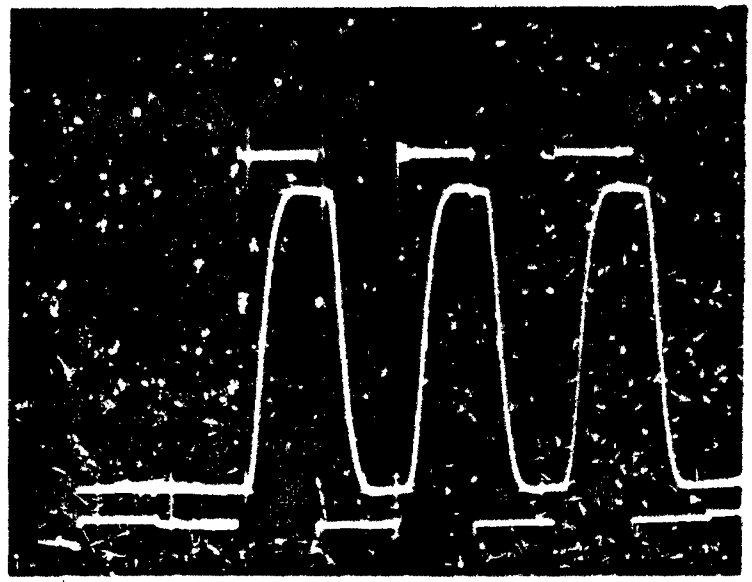


FIGURE II-3. 7-1
PAM/PDM BLOCK DIAGRAM

Discriminator Output
Vertical Scale:
5V/cm
(25% FBW/cm)

PAM Input
Vertical Scale:
1V/cm
(20% FBW/cm)

orizontal Scale:
1 ms/cm



PAM INPUT AND OUTPUT - NO SCALE EXPANSION

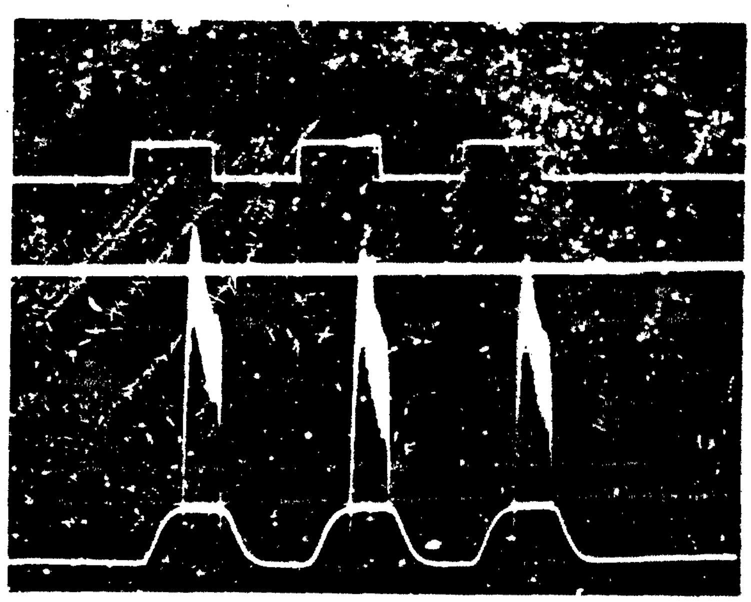
PAM Input
Vertical Scale:
10V/cm

Full Scale Level
Vertical Scale:
0. 05V/cm
(0. 25% FBW/cm)

Discriminator Output
Vertical Scale:
0. 05V/cm
(0. 25% FBW/cm)

Discriminator Output
Vertical Scale:
25V/cm

rizontal Scale:
1 ms/cm



EXPANDED SCALE PAM OUTPUT - 50% DUTY CYCLE

FIGURE II-3. 7-2
50% PAM ON 70 kc ±15% CHANNEL

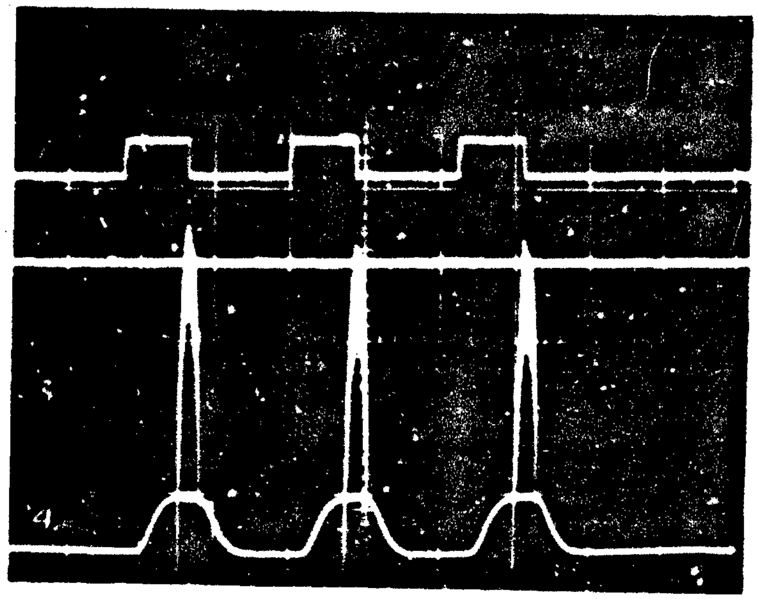
1. PAM Input
   Vertical Scale:
   10V/cm

2. Full Scale Level
   Vertical Scale:
   0.05V/cm
   (0.25% FBW/cm)

3. Discriminator Output
   Vertical Scale:
   0.05V/cm
   (0.25% FBW/cm)

4. Discriminator Output
   Vertical Scale:
   25V/cm

Horizontal Scale:
0.1 ms/cm



a. 40% PAM

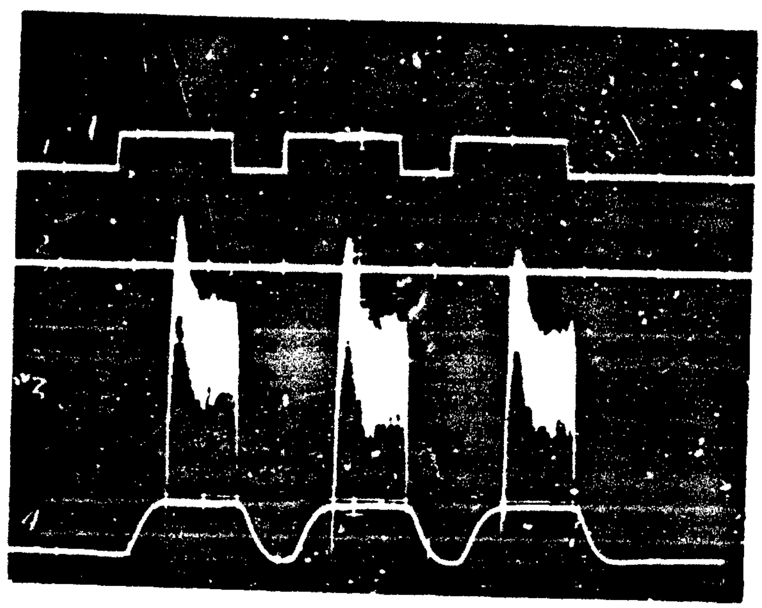
1. PAM Input
   Vertical Scale:
   10V/cm

2. Full Scale Level
   Vertical Scale:
   0.05V/cm
   (0.25% FBW/cm)

3. Discriminator Output
   Vertical Scale:
   0.05V/cm
   (0.25% FBW/cm)

4. Discriminator Output
   Vertical Scale:
   25V/cm

Horizontal Scale:
0.1 ms/cm



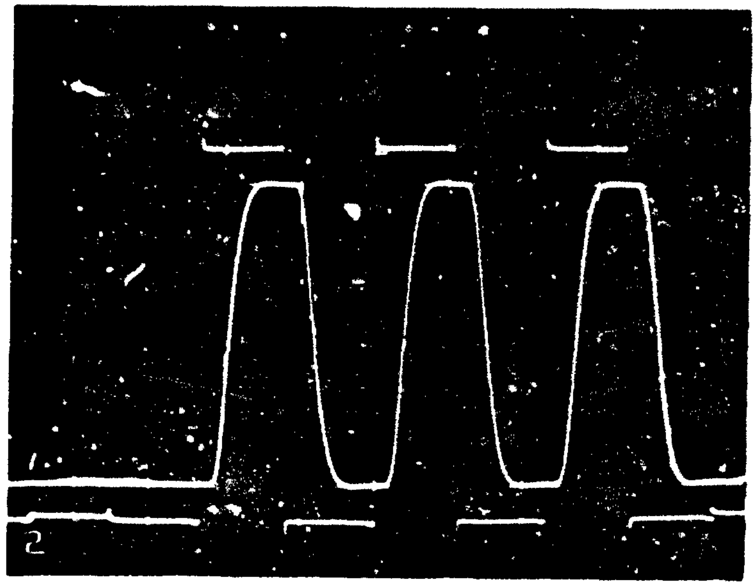
b. 70% PAM

FIGURE II-3.7-3
40% AND 70% PAM ON 70 kc ±15% CHANNEL

1. Discriminator Output
Vertical Scale:
5V/cm
(25% FBW/cm)

2. PAM Input
Vertical Scale:
1V/cm
(20% FBW/cm)

Horizontal Scale:
0.2 ms/cm



a. PAM INPUT AND OUTPUT - NO SCALE EXPANSION

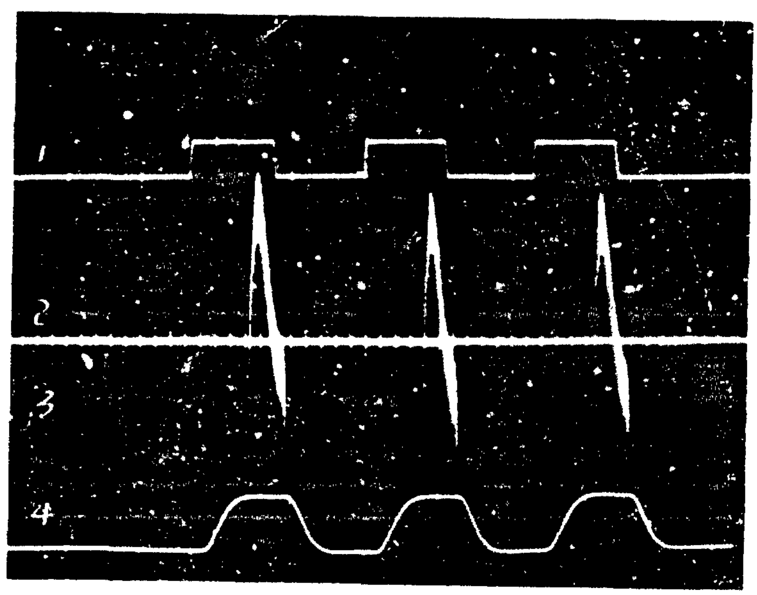
.. PAM Input
Vertical Scale:
10V/cm

:. Full Scale Level
Vertical Scale:
0.05V/cm
(0.25% FBW/cm)

. Discriminator Output
Vertical Scale:
0.05V/cm
(0.25% FBW/cm)

. Discriminator Output
Vertical Scale:
25V/cm

Iorizontal Scale:
.2 ms/cm



. EXPANDED SCALE PAM OUTPUT - 50% DUTY CYCLE

FIGURE II-3.7-4
50% PAM ON 165 kc ±15% CHANNEL

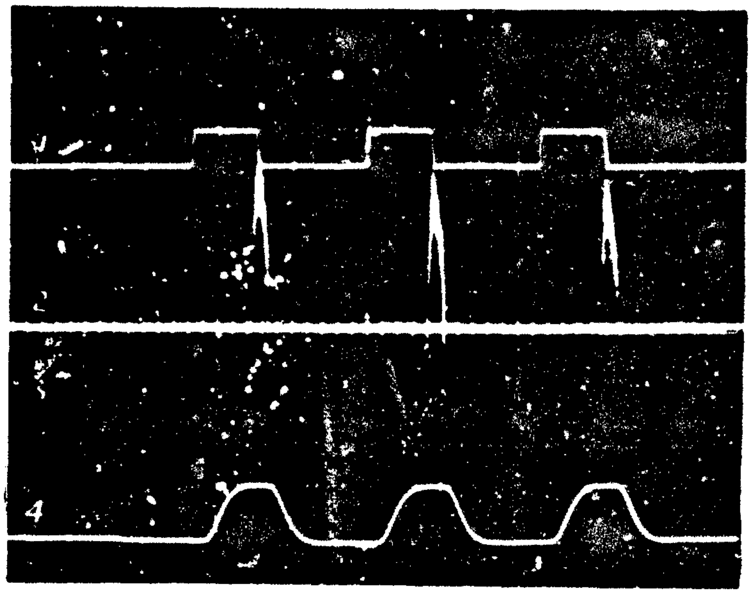
1. PAM Input
   Vertical Scale:
   10V/cm

2. Full Scale Level
   Vertical Scale:
   0.05V/cm
   (0.25% FBW/cm)

3. Discriminator Output
   Vertical Scale:
   0.05V/cm
   (0.25% FBW/cm)

4. Discriminator Output
   Vertical Scale:
   25V/cm

Horizontal Scale:
0.2 ms/cm



a. 40% PAM

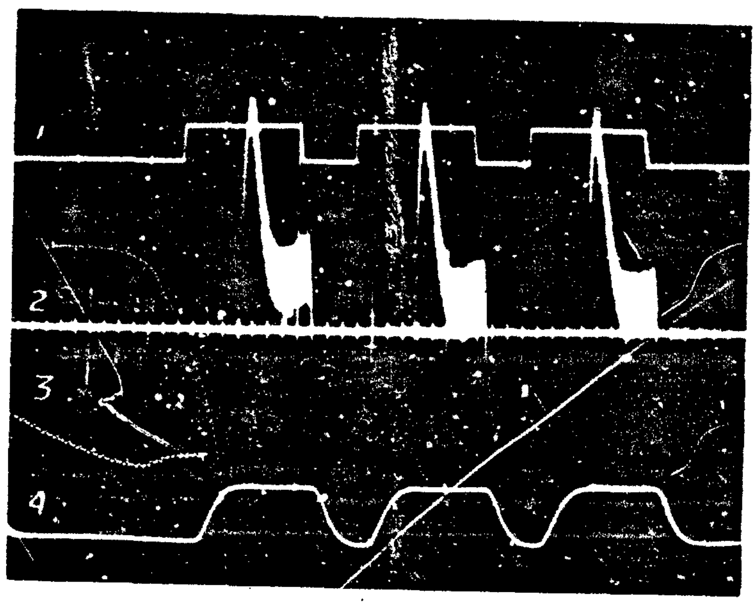
1. PAM Input
   Vertical Scale:
   10V/cm

2. Full Scale Level
   Vertical Scale:
   0.05V/cm
   (0.25% FBW/cm)

3. Discriminator Output
   Vertical Scale:
   0.05V/cm
   (0.25% FBW/cm)

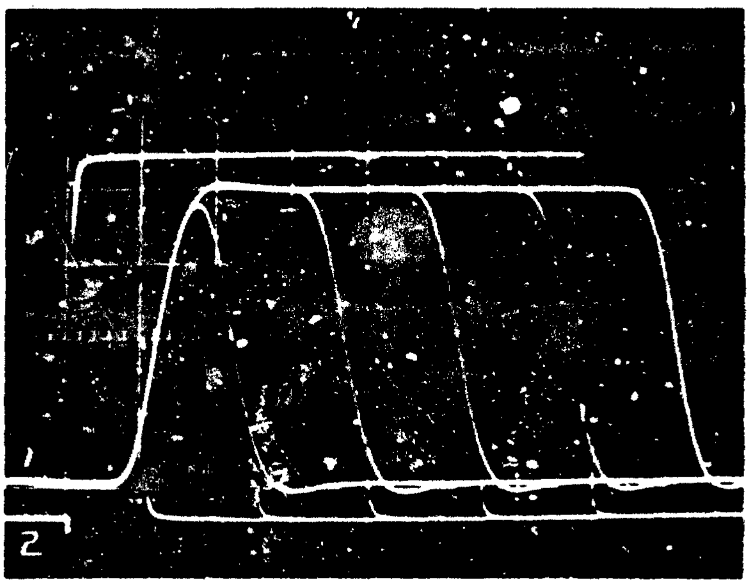
4. Discriminator Output
   Vertical Scale:
   25V/cm

Horizontal Scale:
0.2 ms/cm



b. 70% PAM

FIGURE II-3.7-5
40% AND 70% PAM ON 165 kc ±15% CHANNEL



0%   25%   50%   75%   100%

PDM Input Pulse Duration In Percent Full Scale

Trace 1. Discriminator Output
Vertical Scale: 5v/cm (25% FBW/cm)

Trace 2. PAM Input
Vertical Scale: 1v/cm (20% FBW/cm)

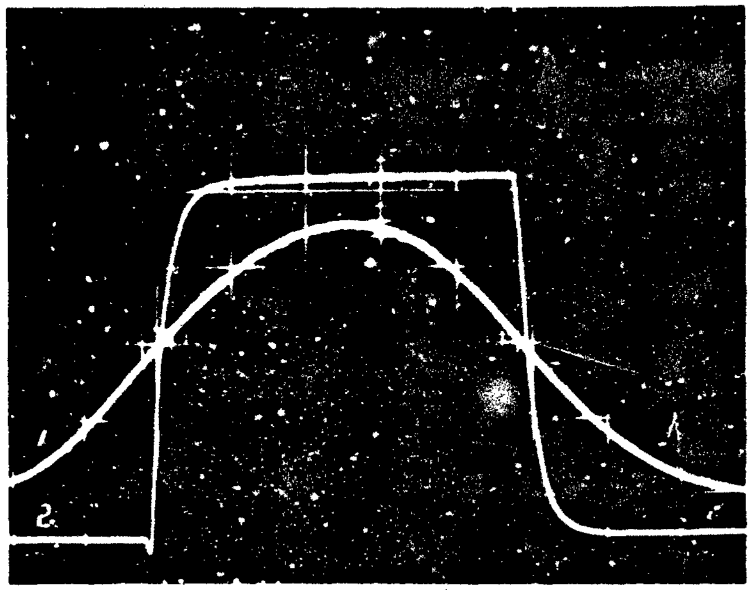
Horizontal Scale: 100 microseconds/cm

FIGURE II-3. 7-6
PDM ON 70 kc ±15% CHANNEL

1. Discriminator Output
   Vertical Scale:
   5v/cm

2. PAM Input
   Vertical Scale:
   1v/cm

Horizontal Scale:
20 microseconds

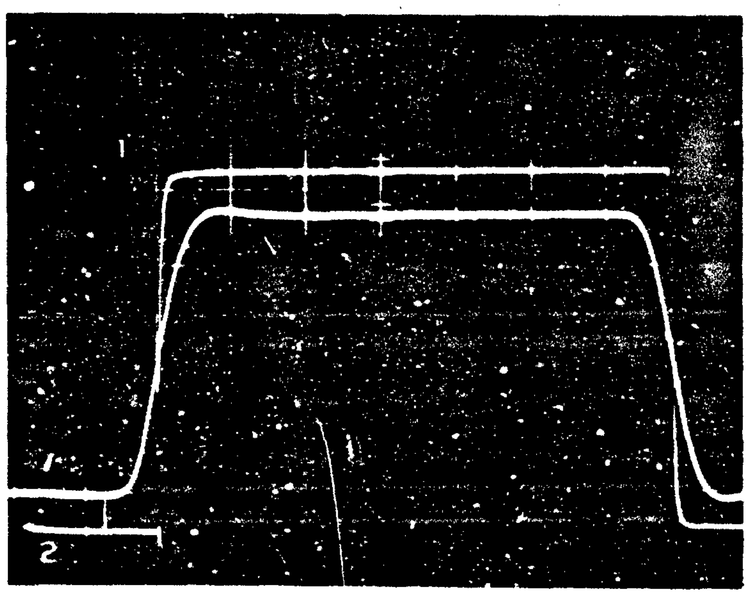


a. 0% FS PDM Input and Output

1. Discriminator Output
   Vertical Scale:
   5v/cm

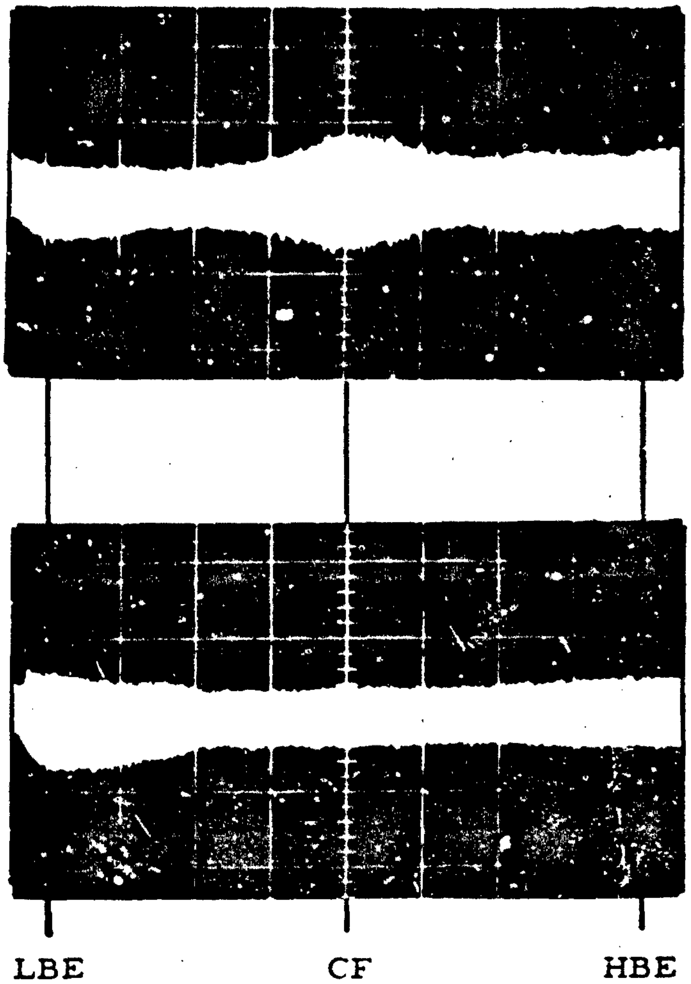
2. PAM Input
   Vertical Scale:
   1v/cm

Horizontal Scale:
100 microseconds/cm



b. 100% FS PDM Input and Output

FIGURE II-3. 7-7
0% AND 100% PDM ON 70 kc ±15% CHANNEL

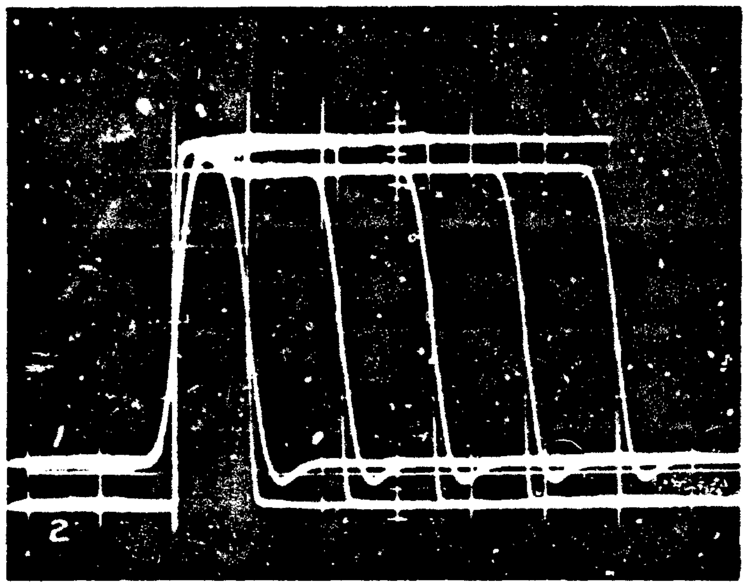


a. ±15% PDM Deviation
Vertical: 0.5% FBW/cm
RMS Level: 27 mv max.

b. ±7.5% PDM Deviation
Vertical: 0.5% FBW/cm
RMS Level: 24 mv max.

100% FS PDM Modulation on the 70 kc ±15% Channel
Search Channel: 40 kc ±7.5%

FIGURE-3.7-8
EFFECT OF PDM MODULATION ON ADJACENT
CHANNEL INTERMODULATION - IRIG BASEBAND



0% 25% 50% 75% 100%

PDM Input Pulse Duration In Percent Full Scale

Trace 1. Discriminator Output
Vertical Scale: 5v/cm (25% FBW/cm)

Trace 2. PAM Input
Vertical Scale: 1v/cm (20% FBW/cm)

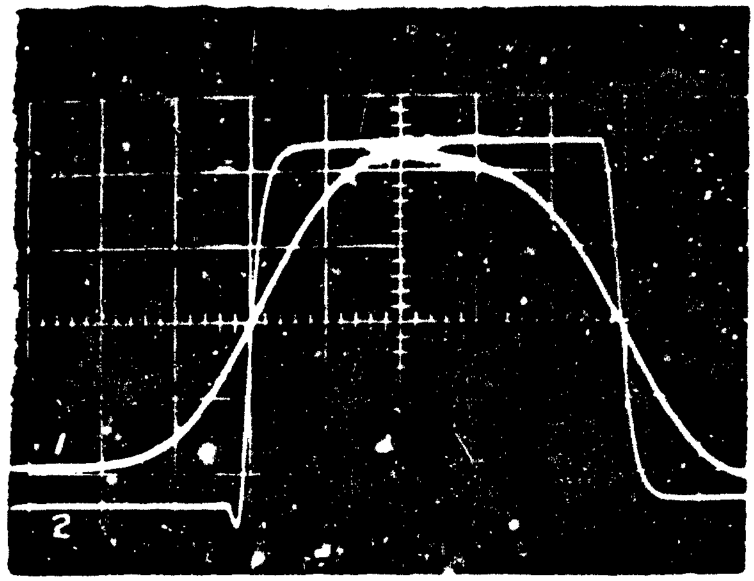
Horizontal Scale: 50 microseconds/cm

FIGURE II-3.7-9
PDM ON 165 kc ±15% CHANNEL

1. Discriminator Output
Vertical Scale:
5V/cm

2. PAM Input
Vertical Scale:
1V/cm

Horizontal Scale:
10 microseconds/cm

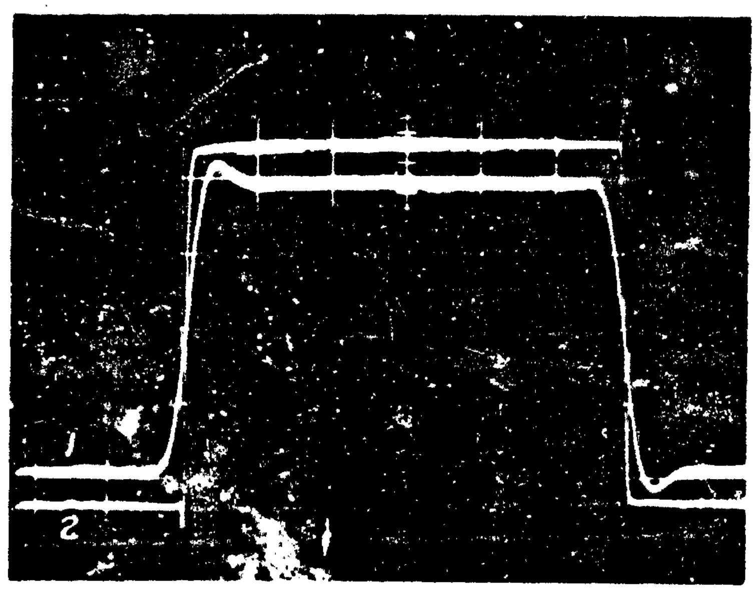


a. 0% FS PDM Input and Output

1. Discriminator Output
Vertical Scale:
5V/cm

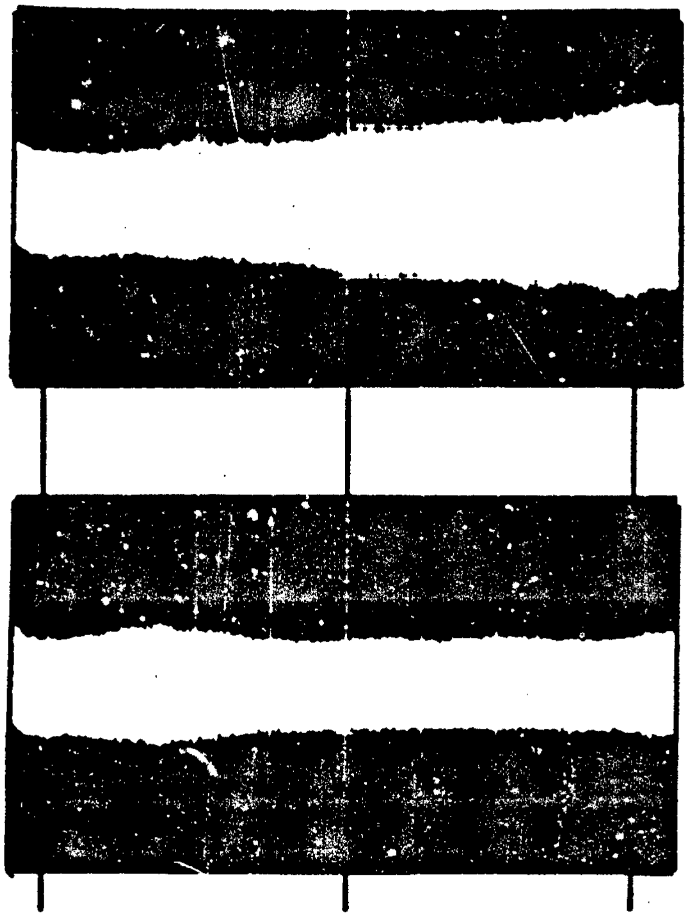
2. PAM Input
Vertical Scale:
1V/cm

Horizontal Scale:
50 microseconds/cm



b. 100% FS PDM Input and Output

FIGURE II-3.7-10
0% AND 100% PDM ON 165 kc ±15% CHANNEL



a. ±15% PDM Deviation
Vertical: 0.5% FBW/cm
RMS Level: 49 mv max.

b. ±7.5% PDM Deviation
Vertical: 0.5% FBW/cm
RMS Level: 21 mv max.

LBE CF HBE

100% FS PDM Modulation on the 165 kc ±15% Channel
Search Channel: 93 kc ±7.5%

FIGURE II-3.7-11
EFFECT OF PDM MODULATION ON ADJACENT CHANNEL
INTERMODULATION - EXPANDED PROPORTIONAL BANDWIDTH BASEBAND

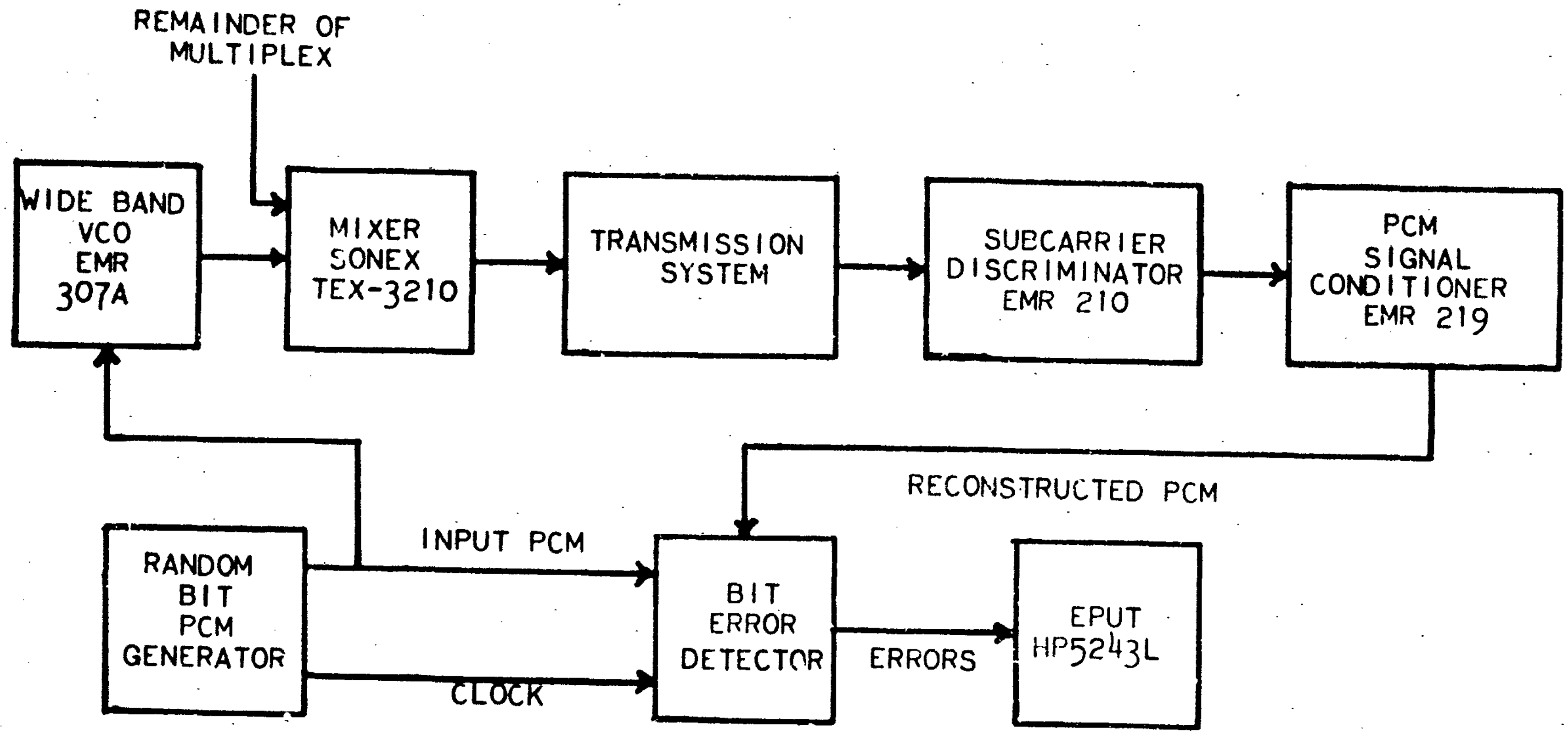


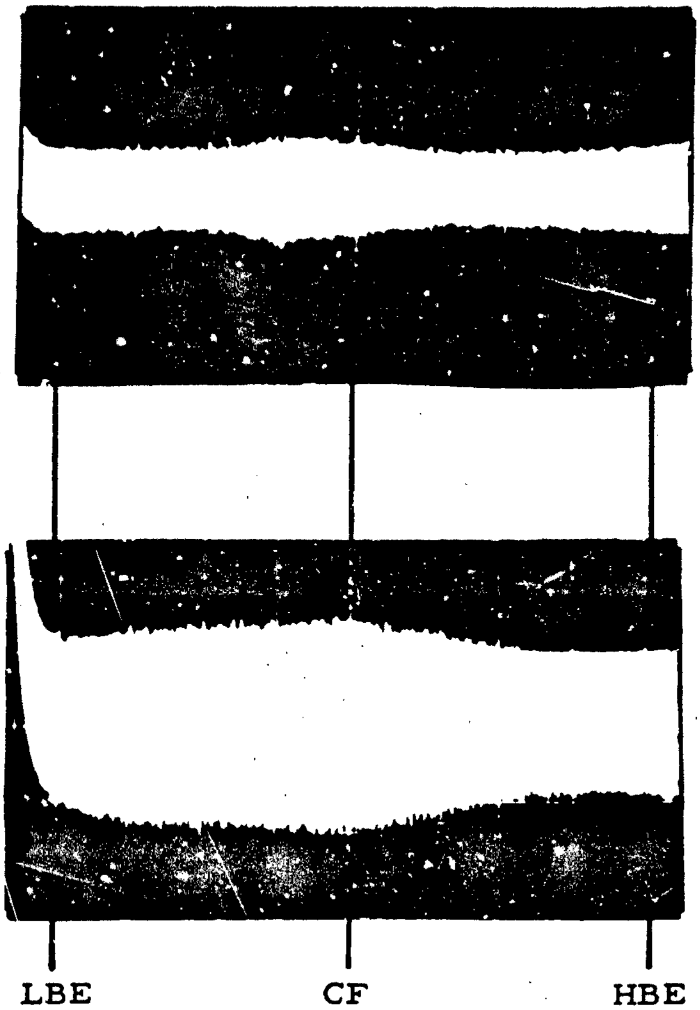
FIGURE II-3. 7-12
PCM BLOCK DIAGRAM

TABLE II-3.7-13
PCM BIT ERROR DATE

	IRIG Baseband	Expanded Baseband
AGC Level:	-4.0 vdc	-4.0 vdc
Mult. Level:	1.0 Vrms	630 mVrms
Bit Rate:	21,000 b/s	49,500 b/s
Channel:	70KC±15%	165KC±15%
Deviation:	0.7FBW	0.7FBW

$(S/N)_c$ (db)	Bit Errors	Time Interval (Sec.)	Bit Error Probability
IRIG Baseband			
8	27	600	2.14×10^{-6}
7	41	60	3.25×10^{-5}
6	472	60	3.75×10^{-4}
5	6,442	60	5.11×10^{-3}
4	21,865	60	1.74×10^{-2}
2	108,328	60	8.60×10^{-2}
No Signal	622,362	60	4.94×10^{-1}
Expanded Baseband			
18	147	180	1.65×10^{-6}
17	73	60	2.46×10^{-5}
16	856	60	2.88×10^{-4}
14	3,415	60	1.15×10^{-3}
13	12,932	60	4.35×10^{-3}
12	39,313	60	1.32×10^{-2}
10	175,222	60	5.89×10^{-2}
9	279,747	60	9.42×10^{-2}

Name W Bishop Date 2/16/65

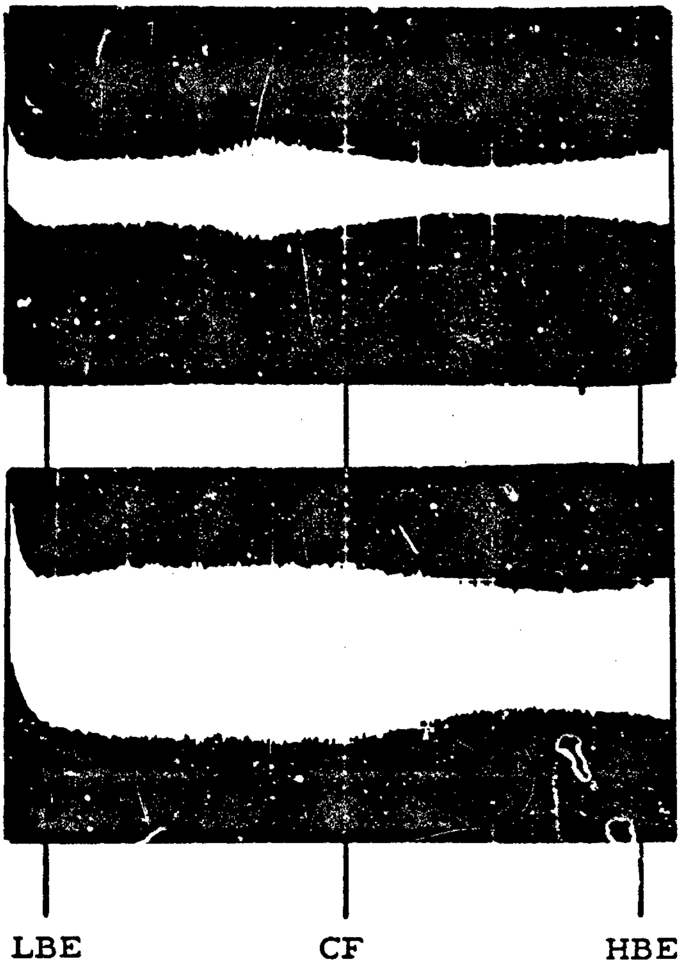


a. **IRIG Baseband**
Search Channel: 40 kc ±7.5%
PCM Channel: 70 kc ±15%
Vertical: 0.5% FBW/cm
RMS Level: 25 mv max.

b. **Expanded Baseband**
Search Channel: 93 kc ±7.5%
PCM Channel: 165 kc ±15%
Vertical: 0.5% FBW/cm
RMS Level: 60 mv max.

All other channels in baseband modulated FBW at 0.1 f_m where f_m is the maximum rate for a deviation ratio of 5.

FIGURE II-3.7-14
EFFECT OF PCM MODULATION ON
ADJACENT CHANNEL INTERMODULATION



a. IRIG Baseband
Search Channel: 40 kc ±7.5%
PCM Channel: 70 kc ±15%
Vertical: 0.5% FBW/cm
RMS Level: 15 mv max.

b. Expanded Baseband
Search Channel: 93 kc ±7.5%
PCM Channel: 165 kc ±15%
Vertical: 0.5% FBW/cm
RMS Level: 54 mv max.

All other channels in baseband are turned off.

FIGURE II-3.7-15
EFFECT OF PCM MODULATION ON ADJACENT
CHANNEL INTERMODULATION - TWO CHANNEL MULTIPLEX