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SPACE VEHICLE SA-4, TELEMETRY SYSTEM

by E. H. REEVES, JR., J. R. STOVALL, AND W. B. THRELKELD, JR.
Astrionics Laboratory

NASA

George C. Marshall Space Flight Center, Huntsville, Alabama

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ABSTRACT

The performance evaluation of the complete telemetry system (ten links) used for flight testing Saturn vehicle SA-4 is presented. The eight operable telemetry links, the two experimental telemetry links, and the telemetry (TM) auxiliary equipment assembly have been technically analyzed on an individual basis.

Statistical analyses were performed on much of the telemetry data and results of these analyses are presented.

No RF signal fade or dropout difficulties were encountered on any of the links.

A malfunction of the PCM system occurred during the flight. An analysis of the cause and effect of this malfunction is included.

It is concluded that the overall performance of the telemetry system used for flight testing SA-4 was as anticipated. It is inferred that the derived test data will facilitate the development of more efficient telemetry systems.

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RESEARCH AND DEVELOPMENT OPERATIONS
ASTRIONICS LABORATORY

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TECHNICAL MEMORANDUM X-53153

SPACE VEHICLE SA-4, TELEMETRY SYSTEM

SUMMARY

The complete telemetry system, consisting of ten telemetry links (eight operable, two experimental), used for flight testing Saturn vehicle SA-4 is analyzed for accuracy and adequacy. Each of the ten telemetry links and the telemetry auxiliary equipment assembly are analyzed on an individual basis and are given separate coverage.

It is concluded that the overall performance of the telemetry system used for flight testing SA-4 was as anticipated. Also, it is inferred that the derived test data will facilitate the development of more efficient telemetry systems.

SECTION I. INTRODUCTION

A. GENERAL

Figure 1 is a block diagram of the SA-4 telemetry system. The links comprising the overall telemetry system were: one XO-4 system, four XO-4B systems, one XO-6C system, two XO-7 systems, one PCM system, and one UHF system. Data transmission for flight testing SA-4 was accomplished by eight telemetry system links and a TM auxiliary equipment assembly (Fig. 2).

The composite data handling capacity of the telemetry system was 154 continuous information-handling channels and 461 commutated information-handling channels.

B. TELEMETER SYSTEMS POWER SUPPLY VOLTAGES

Primary power was supplied to the ten systems from the D-11 and D-21 vehicle battery buses. Links 1, 3, 5, 7, and 9 were connected to 28-V dc battery bus D-11. Links 2, 4, 6, 8, and 10 were connected to 28-V dc battery bus D-21.

Flight test measurements were made on the D-11 and D-21 battery bus voltages. The measurement numbers were M17-13 for D-11 (carried on link 3, channel 16, subchannel 13) and M16-13 for D-21 (carried on link 3, channel 16, subchannel 12).

SECTION II. TELEMETRY LINKS

A. GENERAL

This section describes and illustrates each of the ten telemetry links and the auxiliary equipment; it also evaluates the performance of each. Flight data have been included on battery voltages and RF signal strengths for the telemetry links.

B. LINK 1

1. XO-6C System (Fig. 3)

Frequency: 242.0 MHz

Data Handling Capacity: 216 commutated channels (99% of availability was utilized) and 13 continuous channels (100% of availability was utilized).

Components: No outboard equipment was used with this system.

Channel Modifications: Connections were added to supply link 6 with the commutator output and timing and control information from this link.

Preflight Calibration: Calibration was applied to the commutated channels from the calibrator located in the multiplexer system. Calibration was applied to the continuous channels from the central calibrator located in the TM auxiliary equipment assembly. These calibrations proved to be satisfactory.

Inflight Calibration: Calibration was applied to the commutated channels from the calibrator located in the multiplexer system. Calibration was applied to the continuous channels from the central calibrator located in the TM auxiliary equipment assembly. Four inflight calibrations were performed on this link during the telemetered phase of the flight test. All calibrations proved to be satisfactory.

2. Overall Performance. The performance of this link was satisfactory. Transmitted RF power was sufficient to produce good data during a flight time of 397 seconds. No RF-signal dropout problems were encountered.

C. LINK 2

1. XO-4B System (Fig. 4)

Frequency: 246.3 MHz

Data Handling Capacity: 50 commutated channels (100% of availability was utilized) and 26 continuous channels (100% of availability was utilized).

Components: Two triple-FM outboard subassemblies.

Purpose: The triple-FM outboard subassemblies were used to increase channel availability.

Channel Modification: Continuous channels 11 and 12 were modified to accept 7.35 (± 7.5%) kHz and 10.5 (± 7.5%) kHz, respectively. This modification was accomplished by directly replacing the respective voltage controlled oscillators with ± 7.5% bandpass vibration filters. Continuous channels 14 and 18 were modified for an input range of -2.5 volts to +2.5 volts to accommodate the ac input signal from the triple-FM subassemblies. Dual mechanical commutator A and B was directly replaced by a solid-state commutator.

Preflight Calibration: Calibration was applied to this link from the central calibrator located in the TM auxiliary equipment assembly. This calibration proved to be satisfactory.

Inflight Calibration: Calibration was applied to this link from the central calibrator located in the TM auxiliary equipment assembly. Four inflight calibrations were performed on this link during the telemetered phase of the flight test. All calibrations proved to be satisfactory.

2. Overall Performance. Identical to link 1.

D. LINK 3

1. XO-4B System (Fig. 5)

Frequency: 248.6 MHz

Data Handling Capacity: 58 commutated channels (98% of availability was utilized) and 25 continuous channels (100% of availability was utilized).

Components: Two triple-FM subassemblies and commutator "C" (an 8-channel solid-state multiplexer located in the TM auxiliary equipment assembly).

Purpose: Commutator "C" time shared 8 channels of flowrate data on channel 10 at a rate of 1 second per channel. The triple-FM outboard subassemblies were used to increase channel availability.

Channel Modifications: Identical to link 2.

Preflight Calibration: Identical to link 2

Inflight Calibration: Identical to link 2.

2. Overall Performance. Identical to link 1

E. LINK 4

1. XO-4B System (Fig. 6)

Frequency: 249.9 MHz
Data Handling Capacity: 58 commutated channels (84% of availability was utilized) and 25 continuous channels (100% of availability was utilized).

Components: Identical to link 3.

Modifications: Identical to link 2.

Preflight Calibration: Identical to link 2.

Inflight Calibration: Identical to link 2.

2. Overall Performance. Identical to link 1.

F. LINK 5

1. XO-4B System (Fig. 7)

Frequency: 252.4 MHz
Data Handling Capacity: 50 commutated channels (100% of availability was utilized) and 19 continuous channels (100% of availability was utilized).

Components: Triple-FM subassembly

Purpose: This triple-FM subassembly was used to increase channel availability.

Modifications: Channels 11 and 12 (same as link 2). Channel 14 (same as link 2). Dual mechanical commutator A and B was directly replaced by 2 single solid-state commutators.

Preflight Calibration: Identical to link 2.

Inflight Calibration: Identical to link 2.

2. Overall Performance. Identical to link 1.

G. LINK 6

1. PCM System (Fig. 8)

Frequency: 253.8 MHz
Data Handling Capacity: The system received the commutator output of link 1. The system also received digital information from the horizon sensor which was inserted in place of channel 10 of the link 1 commutator.

Components: No outboard equipment was used with this system.
Channel Modifications: None
Preflight Calibration: Received from link 1.
Inflight Calibration: Received from link 1.

Because the PCM system was experimental, link 6 received the link 1 commutator output (PAM) to allow a comparison to be made between the two systems.

The PCM system received the output wavetrain of the link 1 commutator (300 x 12) and digital information from the horizon sensor. The function of this system was to convert multiplexed analog information to digital information. The system contained an analog-to-digital (A-D) converter, a programer, and an FM transmitter.

The commutator wavetrain was applied to the A-D converter which changed the analog information to digital information in the form of a serial, binary-coded non return to zero (NRZ) space wavetrain.

The programer received timing information from the link 1 commutator and supplied the A-D converter with this information at the proper time; this caused proper formating of the binary-coded wavetrain. The programer presented information (to the A-D converter) from the horizon sensor. The serial, binary-coded wavetrain output of the A-D converter is used to frequency modulate the transmitter.

2. Overall Performance. During the flight, a malfunction caused the data to decrease by a digital count weight of 9. This malfunction is evidenced by Table 33 which shows the 0%, 25%, 50%, and 75% calibration steps for the four inflight calibrations. In all cases a logic "1" binary bit becomes "0" and all subsequent bits become "1's."

The "0" probably occurred because the register switch in question in the A/D converter was not set. Investigation showed that the register switch's not being set could have been caused by three different conditions: (1) a mismatched beta in the flip-flop transistors, (2) a low beta transistor in the set side of the flip-flop, and (3) a poor drive to the flip-flop from the set-reset flip-flop.

H. LINK 7

1. XO-7 System (Fig. 9)

Frequency: 256.2 MHz
Data Handling Capacity: Fifteen continuous channels (100% of availability was utilized).

Components: No outboard equipment was used with this system.

Channel Modifications: None

Preflight Calibration: Calibration was applied to this link from the swept-frequency calibrator located in the ground support equipment rack beneath the firing pad. The calibration consisted of a swept-frequency sine wave starting at 3 kHz, proceeding to 0 Hz, and increasing to 150 Hz over a period of 10 seconds. The preflight calibration established a 2-volt peak-to-peak signal that is used for a reference when it is demodulated in the ground receiving equipment. This calibration proved to be satisfactory.

Inflight Calibration: None

2. Overall Performance. Identical to link 1

I. LINK 8

1. X0-7 System (Fig. 9)

Frequency: 259.7 MHz
Data Handling Capacity: See link 7
Components: See link 7

Channel Modifications: None
Preflight Calibration: See link 7
Inflight Calibration: See link 7

2. Overall Performance. Identical to link 1.

J. LINK 9

1. UHF System (Fig. 10)

The UHF RF assembly received and was modulated by the modulation output of the link 10 mixer amplifier. The assembly consists of an automatic frequency stabilizer, a UHF oscillator, a crystal oscillator, a buffer amplifier, a drive amplifier, and an RF power amplifier with an output of 10 watts.

The purpose of this assembly was to transmit at UHF frequencies to evaluate and improve the UHF system. Possibly the UHF band will be used more extensively in the future for transmitting telemetry data.

Frequency: 2287 MHz
Data Handling Capacity: Redundant to link 10

The UHF system was experimental, and link 9 received the mixer amplifier output of link 10 to allow a comparison between the systems.

2. Overall Performance. Identical to link 1.

K. LINK 10

1. XO-4 System (Fig. 11)

Frequency: 258.5 MHz
Data Handling Capacity: 25 commutated channels (96% of availability was utilized) and 16 continuous channels (100% of availability was utilized).

Components: No outboard equipment was used with this system.

Channel Modifications: Connection was added to supply link 9 with the mixer amplifier output.

Preflight Calibration: Identical to link 2.

Inflight Calibration: Calibration was applied to this link from the central calibrator located in the TM auxiliary equipment assembly. This calibration proved to be satisfactory.

2. Overall Performance. Identical to link 1 (Table 5).

L. TM AUXILIARY EQUIPMENT ASSEMBLY (Fig. 2)

The TM auxiliary equipment assembly was a modular package used to group the auxiliary components of the various links into one assembly. It consisted of two 8-channel flowrate multiplexers and a central calibrator. The performance of this assembly was satisfactory with no deviation from normal operation.

M. RF POWER

The following table shows the results of RF power tests performed on the S-1 stage telemetry systems by the Telemetry Field Section at Cape Kennedy. The RF power was measured at the input and output of the various multicouplers.

RESULTS OF RF POWER TESTS PERFORMED ON SA-4 S-I STAGE TELEMETRY SYSTEMS AT LVO BY THE TELEMETRY FIELD SECTION

Telemetry Link	Frequency (MHz)	Input RF Power Level to Multicoupler (Watts)	Output RF Power Level from Multicoupler (Watts)
1	242.0	35.0	27.0
2	246.3	27.0	20.0
3	248.6	26.5	18.0
4	249.9	28.0	23.0
5	252.4	25.5	22.0
6	253.8	3.0	2.6
7	256.2	28.5	20.5
8	259.7	31.0	26.0
9	2287.0	6.25 at antenna input	
10	258.5	28.5	27.5

SECTION III. THEORY OF ANALYSIS OF VARIANCE

A. THEORY OF 3-WAY ANALYSIS OF VARIANCE

The following definitions and theory are given to make the essential factors in an analysis of variance more meaningful.

The theoretical model underlying the analysis assumes that each observation at each channel level is the algebraic sum of the following components.

μ = overall average ("true" mean)

a_i^A = row effect (channel effect)

a_j^B = column effect (link effect)

a_k^C = group effect (calibration effect)

a_{ij}^{AB} = row-column (link-channel effect) interaction

a_{ik}^{AC} = row-group (channel-calibration effect) interaction

a_{jk}^{BC} = column-group (link-calibration effect) interaction

e_{ijk} = random experimental error that is normally distributed with zero mean and variance (σ'^2) for all classes.

These factors may be expressed in algebraic form as follows:

$$x_{ijk} = \mu + a_i^A + a_j^B + a_k^C + a_{ij}^{AB} + a_{ik}^{AC} + a_{jk}^{BC} + e_{ijk}$$

The following assumptions are made:

mean of $a_i^A = 0$ and variance of $a_i^A = \sigma' A^2$

mean of $a_i^B = 0$ and variance of $a_j^B = \sigma' B^2$

mean of $a_k^C = 0$ and variance of $a_k^C = \sigma' C^2$

mean of $a_{ij}^{AB} = 0$ and variance of $a_{ij}^{AB} = \sigma' AB^2$

mean of $a_{ik}^{AC} = 0$ and variance of $a_{ik}^{AC} = \sigma' AC^2$

mean of $a^{BC}_{jk} = 0$ and variance of $a^{BC}_{jk} = \sigma'^2_{BC}$

mean of $e_{ijk} = 0$ and variance of $e_{ijk} = \sigma'^2$

These assumptions indicate that only differential effects will be measured, i.e., Δa^{A}_{i}, etc. In this case, the following mean squares are unbiased estimates of certain linear functions of the universe variances.

Source of Variation	Mean Square	An Unbiased Estimate of:
Row (A)	S_1^2	$\sigma'^2 + g\,\sigma'^2_{AB} + c\,\sigma'^2_{AC} + cg\,\sigma'^2_{A}$
Column (B)	S_2^2	$\sigma'^2 + g\,\sigma'^2_{AB} + r\,\sigma'^2_{BC} + rg\,\sigma'^2_{B}$
Group (C)	S_3^2	$\sigma'^2 + c\,\sigma'^2_{AC} + r\,\sigma'^2_{BC} + rc\,\sigma'^2_{C}$
Row x Column (AB)	S_4^2	$\sigma'^2 + g\,\sigma'^2_{AB}$
Row x Group (AC)	S_5^2	$\sigma'^2 + c\,\sigma'^2_{AC}$
Column x Group (BC)	S_6^2	$\sigma'^2 + r\,\sigma'^2_{BC}$
Residual (E)	S_e^2	σ'^2

B. ANALYSIS OF DATA

The "null hypothesis" is that no significant difference exists between any two variances calculated, since both are unbiased estimates of the universe variance. To aid in this determination, an F ratio test is performed.

For example, if the null hypothesis that the a^{A}_{i} are all zero and that $\sigma'^2_A = 0$ is set up, we are assuming that none of the channels has a mean bias or systematic error. Then the ratio $\frac{S_1^2 + S_e^2}{S_4^2 + S_5^2}$ can be computed and the result compared with F_a for n_1 and n_2 as computed by Satterthwaite's rule. This test will permit us to accept the null hypothesis if the ratio is less than F_α. If the null hypothesis is accepted, there is no significant difference between the channels.

In a similar manner, note the null hypothesis that $\sigma'^{2}_{AB} = 0$ or that the interaction between links and channels is not significant. This assumption reduces S_4^2 to the same value as S_e^2. To test this hypothesis, compute the ratio S_4^2/S_e^2 and compare with F_α for $n_1 = (r-1)(c-1)$ and $n_2 = rc(g-1)$.

The extension of the preceding philosophy allows the testing of the significance of interaction and main effects for all components.

Definitions

σ' = Standard deviation of universe

g = Group size

r = Number of rows

C = Number of columns

A single value for each calibration level (0%, 25%, 50%, 75%, and 100%) for a telemeter channel is derived by averaging all calibrations for a particular level. Using the average values (raw digital data) for each level, a calibration curve is derived for each channel from which digitized data may be converted to engineering units. For purposes of an analysis of variance (ANOVA) of telemetry calibrations, the average value of each level of each calibration of a channel is used.

Since a channel has an individual calibration curve, the averages (or means) of a channel are independent with respect to the averages (or means) of another channel. Therefore, the analysis of variance performed on the data has no bearing on the data accuracy on a channel comparison basis since the ANOVA indicates if any difference exists between the means.

However, the comparison of the means on an interchannel basis from the ANOVA does give a good estimate of the magnitude of level differences to be normally expected in means between the channels and links. Most of the variables that contribute to the disagreement between channel means are controllable functions, i.e., discriminator centering, discriminator output amplitude, subcarrier oscillator band edges, Microsadic (A to D converter) range adjust, and centering adjust. Probably with the expenditure of a considerable amount of adjustment time, very close agreement between channel means could be attained. However, because of the press of time in data reduction, it is not possible to expend the

amount of time required to get precise agreement which is not necessary because the identities of means are lost in the linearization and normalization of the data and translation to engineering values.

If differences exist between the means of raw digital data for a given channel from one calibration time to the next, the test would indicate drift with respect to time. This time drift is indicated in the analysis of variance summary as a group effect (calibration effect).

SECTION IV. FM/FM SYSTEMS EVALUATION

A. FLIGHT TEST CALIBRATION DATA

The flight calibration data, consisting of the mean and standard deviations for all FM/FM telemetry systems analyzed, are presented in this section. The values are shown in percent of total range. The tables consist of data from inflight calibrated channels only.

B. MAXIMUM PRECISION OF THE FM/FM SA-4 TELEMETRY SYSTEM

1. Introduction. The data received from the SA-4 flight test provided information for determining the precision of the telemetry system. The first three inflight calibrations were used in this analysis. Each calibration level (0%, 25%, 50%, 75%, and 100%) constituted a sample of size six. For example, for link 1, there were three calibrations of five calibration levels each for a total of fifteen samples per channel. Link 1 had 10 channels, giving a total of 150 samples for that link.

All calculations were performed as shown below:

$$\overline{X} = \sum_{i=1}^{N} \frac{Xi}{N}$$

$$S = \sum_{i=1}^{N} Xi$$

$$V = \sigma^2 \sum_{i=1}^{N} \frac{(Xi)^2 S^2/N}{N-1}$$

$$\sigma = \sqrt{\sigma^2}$$

$$\sigma\% = \sigma/R \times 100$$

where: $\overline{X}$ = sample mean

N = number of readings chosen for each calibration level (constant sample size of six was chosen)

Xi = individual reading of each calibration level

V = variance

$$V\% = (\sigma\%)^2 = [(\sigma/R)(100)]^2$$

$$V_T\% = \sigma_T{}^2\% \quad \frac{V_1\%(N_1-1) + V_2\%(N_2-1) + \ldots V_R(N_k-1)}{N_1 + N_2 + \ldots N_k - K}$$

Precision = $(\mu_\alpha)(\sigma_T\%)$

μ_α = normal deviate

$V_T\%$ = total combined variance in % of range

σ = standard deviation

R = sample range

% = standard deviation in % of sample range.

K = number of samples

V% = variance in % of range

2. Precision of SA-4 FM/FM Channels by Link. The precisions * of the FM/FM channels by link are shown in Table 7. These precisions are shown in percent of total range. Ninety-five percent of the data received fell within these deviations from the mean value.

3. Detailed Breakdown of Composite Variance. See Appendix A.

C. ANALYSIS AND COMPARISON OF MULTIPLEXED DATA AS RECEIVED FROM PAM/FM/FM LINK 1 FOR SA-3 AND SA-4

1. Introduction. Data obtained from the SA-4 flight test by means of the 216 channel multiplexer were handled redundantly from the output of the multiplexer through the PAM/FM/FM link 1 system (Fig. 3) and through the PCM/FM link 6 system (Fig. 8) (except for the inserted digital data which were handled exclusively by the PCM/FM link). During the flight, a malfunction occurred in PCM/FM link 6 which affected the calibration data, thereby rendering superfluous any direct comparison of multiplexed data for link 1 and link 6. To effect a valid comparison of the multiplexed data, an F-ratio test was made with PAM/FM/FM link 1 system data for SA-3. In addition, a statistical test (Bartlett's test) was performed to determine if the variability of the samples for SA-4 was constant, or if some samples showed significantly greater variability than others (using a confidence level of 95%).

Two hundred and sixteen multiplexed channels were carried by each of the two multiplexers. The sampling rate per channel was 12 samples per second; 216 of the multiplexed channels were inflight calibrated. Four inflight calibrations were executed by the 216 channel multiplexer during the SA-4 flight test. An inflight calibration is generated by the inflight calibrator section (Fig. 12) of the 216 channel multiplexer and is derived in the calibrator by applying a 5.00 V dc level from the D-89 master measuring voltage bus to a 400 ohm series precision resistor voltage divider. The output of the calibrator is in the form of five sequential voltage levels: 0.0%, 25.0%, 75.0%, and 100.0% of the D-89 bus voltage

* The term precision is used to define the random type errors. A high precision implies small random errors.

level (5.00 V dc). Each level is synchronized to, and maintained for, one master frame of the 216 channel multiplexer. The calibrator output is inserted into the multiplexer wavetrain as shown in Figure 12. Each inflight calibration gives one sample per calibrator output level for each multiplexer channel for the point in time at which the calibration cycle is executed.

The summarized data consisting of the mean, variances, and standard deviation for the SA-3 and SA-4 PAM links are shown in Tables 18 and 19, respectively.

2. F-Ratio Test. A statistical comparison (F-ratio test) was made of the inflight calibrations applied to the two 216 channel multiplexers, link 1, used in SA-3 and SA-4. Four inflight calibrations were applied to the system during the flight test period. Each calibration level (0%, 25%, 50%, 75%, and 100%) constituted a sample; there were four calibrations of five calibration levels each, for a total of twenty samples per link. All calculations were performed as shown below.

$$\overline{X} = \sum_{i=1}^{N} Xi/N$$

$$\sigma^2 = \sum_{i=1}^{N} (Xi)^2/N - (\overline{X})^2$$

$$\sigma = \sqrt{\sigma^2}$$

$$\overline{\sigma}^2 = \frac{\sigma_1^2 (N_1-1) + \sigma_2^2 (N_2-1) \ldots \sigma_i^2 (N_x-1)}{N_1 + N_2 + \ldots . N_k - K}$$

$$F_{ratio} = \frac{\overline{\sigma}_A^2/R_A}{\sigma_B^2/R_B}$$

where

$\overline{X}$ = mean

σ^2 = variance

σ = standard deviation

N = number of readings chosen for each calibration level (sample size)

Xi = individual readings of each calibration level

K = number of samples

n = degrees of freedom for F distribution

R = range of sample

For the hypothesis that $\overline{\sigma}_A \neq \overline{\sigma}_B$, the larger of the two variances is the numerator and the smaller is the denominator. A significant difference exists between the two variances if the calculated F value is larger than the table value of a standard F distribution for degrees of freedom n_a and n_B (where n = N-1).

For an n_a and n_B of 216-1 = 215, the significant F ratio for $F_{.975} = 1.21$ and $F_{.025} = .813$ (95% confidence level). $F_{.95} = 1.32$ and $F_{.05} = .757$ (90% confidence level).

The calculated F ratios for the 5 calibration levels are:

Calibration Level	0%	25%	50%	75%	100%
F Ratio	1.259	1.042	1.216	1.211	1.299

A significant difference was found to exist between the variances for the 0% and 100% calibration levels at the 95% confidence level.

No significant differences were found to exist between variances at the 90% confidence level.

The amount of data scatter in PAM link 1 for the SA-3 and SA-4 vehicles was consistent (95% confidence level) at the 25%, 50%, and 75% calibration levels. The 0% and 100% calibrations for the two vehicles were significantly different. However, the magnitude of difference was not excessive.

3. Bartlett's Test. A statistical test (Bartlett's test) was performed to determine if the variability of SA-4, link 1 PAM samples were constant or if some samples showed significantly greater variability than others (using a confidence level of 95%). The calculations for Bartlett's test were performed as shown below:

$$M = 2.3026 \left[N \log \sum_{i=1}^{g} \frac{N_i V_i}{N} - \sum_{i=1}^{g} N_i \log V_i \right]$$

$$C = 1 + \frac{1}{3(g-1)} \left[\sum_{i=1}^{g} \frac{1}{N_i} - \frac{1}{N} \right]$$

M/C = ratio to be compared with 95% confidence level of the chi-square distribution

g = number of samples

N_i = number of readings per sample minus 1

$N = \sum_{i=1}^{g} N_i$

V_i = individual variances of each sample.

Bartlett's test was performed between the five levels of each calibration (e.g., calibration 1 at the 0%, 25%, 50%, 75%, and 100% calibration levels). There were significant differences between these variances for calibration 1, 2, and 4 at the 95% confidence level. Calibration 3 showed no significant difference between the variances.

The test was applied between the four calibrations for each of the five calibration levels (e.g., between calibrations 1, 2, 3, and 4 at the 0% calibration level, etc.) Significant differences were found between these variances for the 0% and 100% levels. The 25%, 50%, and 75% calibration levels show no significant differences between the variances.

Conclusions pertaining to the accuracy of the system were as follows: 68% of the information was within ± 0.66% of the mean value; 95% was within ± 1.32% of the mean value; and 99.7% was within ± 1.98% of the mean value.

D. ANALYSIS OF THE VARIABILITY OF XO-4B FM/FM LINKS 2, 3, 4, and 5.

1. Introduction. As indicated by a comparison of Figures 4, 5, 6, and 7, there is a commonality between links 2, 3, 4, and 5. These links were all XO-4B systems with triple-FM channels on FM/FM channels 14 and 18. Further, FM/FM channels 2, 3, 4, and 5 on all of these links were inflight calibrated, and triple-FM channels 14-2, 14-3, 14-4, 14-5, 18-2, 18-3, 18-4, and 18-5 on all of these links were inflight calibrated. The degree of commonality of these systems provided an opportunity to study the interchannel and interlink variability. Variances calculated for the inflight calibration level data from these channels were submitted to a test (Bartlett's test) to determine if the variances were substantially constant. The theory of Bartlett's test for homogeneity of variances and a three way analysis of variance, run on FM/FM links 2, 3, 4, and 5, are presented.

2. Bartlett's Test. Bartlett's test was performed on inflight calibration data acquired from FM/FM channels 2, 3, 4, and 5 of links 2, 3, 4, and 5 to determine if there were significantly different variances as shown below:

a. Link 2.

(1) Analysis of variances by calibration within the same calibration level for all channels. At a 95% confidence level:

Calibration 1 -- Significant differences were found between channels for the 25% and 50% calibration levels.

Calibration 2 - Significant differences were found between channels for the 0% and 100% calibration levels.

Calibration 3 - Significant differences were found between channels for the 0% calibration level.

(2) Analysis of variances by level for all calibrations. At a 95% confidence level:

Channel 2 - Significant differences were found between calibrations at the 25% calibration level.

Channel 3 - Significant differences were found between calibrations at the 50% calibration level.

Channels 4 and 5 - No significant differences were found.

b. Link 3.

(1) Analysis of variances by calibration within the same calibration levels for all channels. At a 95% confidence level:

Calibration 1 - Significant differences were found between channels for the 0% and 100% calibration levels.

Calibration 2 - No significant differences were found.

Calibration 3 - Significant differences were found between channels for the 0% calibration level.

(2) Analysis of variances by level for all calibrations. At a 95% confidence level:

Channels 2, 3, and 4 - No significant differences were found.

Channel 5 - Significant differences were found between calibrations at the 0% calibration level.

c. Link 4.

(1) Analysis of variances by calibration within the same calibration levels for all channels. At a 95% confidence level:

Calibration 1 - Significant differences were found between channels for the 25% calibration level.

Calibration 2 - Significant differences were found between channels for the 25%, 50%, 75%, and 100% calibration levels.

Calibration 3 - No significant differences were found.

(2) Analysis of variances by level for all calibrations. At a 95% confidence level:

Channel 2 - No significant differences were found.

Channel 3 - Significant differences were found between calibrations at the 50% calibration level.

Channel 4 - Significant differences were found between calibrations at the 25%, 75%, and 100% calibration levels.

Channel 5 - Significant differences were found between calibrations at the 25% and 100% calibration levels.

d. Link 5.

(1) Analysis of variances by calibration within the same calibration level for all channels. At a 95% confidence level:

Calibration 1 - Significant differences were found between channels for the 100% calibration levels.

Calibration 2 - Significant differences were found between channels for the 50% calibration level.

Calibration 3 - No significant differences were found.

(2) Analysis of variances by level for all calibrations. At a 95% confidence level:

Channel 2 - Significant differences were found between calibrations at the 100% calibration level.

Channels 3 and 4 - No significant differences were found.

Channel 5 - Significant differences were found at the 0% and 50% calibration levels.

e. Comparison of FM/FM Links 2, 3, 4, and 5.

(1) Analysis of variances by level for all calibrations and all links for a channel. At a 95% confidence level:

Channel 2 - Significant differences were found between variances for the 0% and 100% calibration levels.

Channel 3 - Significant differences were found between variances for the 0% and 50% calibration levels.

Channel 4 - Significant differences were found between variances for the 25%, 75%, and 100% calibration levels.

Channel 5 - Significant differences were found between variances for the 0%, 25%, 50%, 75% and 100% calibration levels.

(2) Analysis of variances by calibration and by level for all links. At a 95% confidence level:

(a) Channel 2.

Calibration 1 - Significant differences were found between links at the 100% calibration level.

Calibration 2 - No significant differences were found.

Calibration 3 - Significant differences were found between links at the 0% calibration level.

(b) Channel 3.

Calibration 1 - Significant differences were found between links at the 50% calibration level.

Calibration 2 - No significant differences were found.

Calibration 3 - Significant differences were found between links at the 50% calibration level.

(c) Channel 4.

Calibration 1 - Significant differences were found between links at the 25%, 75%, and 100% calibration levels.

Calibration 2 - Significant differences were found between links at the 25% calibration levels.

Calibration 3 - Significant differences were found between links at the 75% and 100% calibration levels.

(d) Channel 5.

Calibration 1 - Significant differences were found between links at the 0% and 75% calibration levels.

Calibration 2 - Significant differences were found between links at the 50% and 100% calibration levels.

Calibration 3 - Significant differences were found between links at the 0%, 25%, and 100% calibration levels.

3. Analysis of Variance Analysis. A three way ANOVA with replication for individual multiplexed outputs of FM/FM links 2, 3, 4, and 5, channels 2, 3, 4, and 5 (assuming all effects to be random) is presented in Tables 8, 9, 10, 11, and 12.

a. Significance of Channel Main Effects. The conclusion to be drawn from the results of the ANOVA as shown by Tables 8, 9, 10, 11, and 12 is that no significant difference exists between channels. All XO-4B channels examined are alike at the same calibration level (no differences existed between channel means).

b. Significance of Link Main Effect. Significant differences existed between links at the 75% and 100% calibration levels at a .05 level of significance.

The calibration means (from all channels and all links) for the 75% and 100% calibration levels are different from link to link.

c. Significance of Calibration Main Effect. There is no significant difference between calibrations for the XO-4B's. The means of the calibration levels did not change from one calibration period to the next.

d. Significance of the Channel X Link Interaction. Significant interaction occurred at the 0%, 25%, 50%, and 75% calibration levels at a .05 level of significance.

A channel will possibly have different calibration level means at the levels stated above on a link-to-link comparison basis.

e. Significance of the Channel X Calibration Interaction. No significant interaction occurred between channels and calibrations at the .05 level of significance. There is no significant difference in the effects of calibration on the analyzed XO-4B channel means at the same calibration levels.

f. Significance of the Link X Calibration Interaction. No significant interaction occurred between links and calibrations at the .05 level of significance. There is no significant difference in the effects of calibrations on the analyzed XO-4B links for the same calibration level.

E. ANALYSIS OF FM/FM LINK 1 VARIABILITY

1. Introduction. A one way analysis of variance was performed to determine if significant differences in means occurred between channels, or if a drift in means occurred from one calibration period to the next. A Bartlett's test was also performed to determine if significant differences occurred among the variances.

2. Analysis of Variance Analysis. A one way analysis of variance was performed on the individual outputs of FM/FM link 1, channels 2, 3, and 4. The results of this analysis are presented in Tables 13 and 14.

a. Significance of Channel Main Effects. Significant differences occurred between the channel means at the 75% and 100% calibration levels.

b. Significance of Calibration Main Effects. No significant differences occurred between calibrations; therefore, the means of the calibrations did not change from one inflight calibration time to the next.

3. Bartlett's Test. Bartlett's test was performed on link 1, channels 2, 3, and 4, to determine if there were significantly different variances.

a. Analysis of variances by calibration within the same calibration level for all channels. At a 95% confidence level:

(1) Calibration 1 - Significant differences were found between channels for the 50% and 100% calibration levels.

(2) Calibration 2 - Significant differences were found between channels at the 75% calibration level.

(3) Calibration 3 - Significant differences were found between channels at the 0% calibration level.

b. Analysis of variances by calibration level for all calibrations. At a 95% confidence level:

(1) Channel 1 - No significant differences were found.

(2) Channel 2 - Significant differences were found between calibrations at the 25% calibration level.

(3) Channel 3 - Significant differences were found between calibrations at the 0% calibration level.

F. ANALYSIS OF FM/FM LINK 10 VARIABILITY

1. Introduction. One way analysis of variance was performed to determine if significant differences in means occurred between channels, or if a drift in means occurred from one calibration period to the next. A Bartlett's test was also performed to determine if significant differences occurred among the variances.

2. Analysis of Variance Analysis. A one way analysis of variance was performed on the individual outputs of FM/FM link 10, channels 3, 4, and 5. The results of this analysis are presented in Tables 15 and 16.

a. Significance of Channel Main Effects. Significant differences occurred between the channel means at the 25%, 50%, and 75% calibration levels.

b. Significance of Calibration Main Effects. No significant differences occurred between calibrations; therefore, the means of the calibrations did not change from one calibration period to the next.

3. Bartlett's Test. Bartlett's test was performed on link 10, channels 3, 4, and 5 to determine if there were significantly different variances.

a. Analysis of variances by calibrations within the same calibration level for all channels. At a 95% confidence level:

(1) Calibration 1 - Significant differences were found between channels for the 25% calibration level.

(2) Calibration 2 - Significant differences were found between channels for the 0% and 25% calibration levels.

(3) Calibration 3 - Significant differences were found between channels for the 0% calibration levels.

b. Analysis of variances by calibration level for all calibrations. At a 95% confidence level:

(1) Channels 3 and 4 - No significant differences were found.

(2) Channel 5 - Significant differences were found between calibrations at the 0% and 50% calibration levels.

SECTION V. TRIPLE FM SYSTEMS EVALUATION

A. FLIGHT TEST CALIBRATION DATA

The flight test calibration data consisting of the mean and standard deviations for all triple-FM telemetry systems analyzed are presented. The values are shown in percent of total range. The tables consist of data from inflight calibrated channels only.

B. MAXIMUM PRECISION OF THE TRIPLE-FM SA-4 FLIGHT TEST TELEMETRY SYSTEMS

1. Introduction. The data received from the SA-4 flight test provided information for determining the precision of the telemetry system, including the data reduction process. The triple-FM subchannels evaluated were carried by links 2, 3, 4, and 5 on FM/FM channels 14 and 17. The first three inflight calibrations were used for this analysis. Each calibration level (10%, 25%, 50%, 75%, and 100%) constituted a sample of size six. The calculations are identical to those performed in Section IV.

2. Precision of SA-4 Triple-FM Subchannels by Link. The precisions of the triple-FM subchannels by link are shown in Table 24. These precisions are shown in percent of total range. Ninety-five percent of the data received fell within these deviations from the mean value.

3. Detailed Breakdown of the Composite Variances. See Appendix B.

C. ANALYSIS OF TRIPLE-FM SUBCHANNELS CARRIED BY XO-4B FM/FM LINKS 2, 3, 4, AND 5, CHANNELS 14 AND 18

1. Introduction. As indicated by a comparison of Figures 4, 5, 6, and 7, there is a commonality between links 2, 3, 4, and 5. These links were all XO-4B systems with triple-FM channels on FM/FM channels 14 and 18. Further, FM/FM channels 2, 3, 4, and 5 on all of these links were inflight calibrated, and triple-FM channels 14-2, 14-3, 14-4, 14-5, 18-2, 18-3, 18-4, and 18-5 on all of these links were inflight calibrated. The degree of commonality of these systems provided an opportunity to study the interchannel and interlink variability. Variances calculated for the inflight calibration level data from these channels were submitted to a test (Bartlett's Test) to determine if the variances were substantially constant. The theory of Bartlett's test for homogeneity of variances and a three way analysis of variance, run on links 2, 3, 4, and 5, channels 14 and 18 are presented.

2. Bartlett's Test. Bartlett's test was performed to determine if the variability of SA-4 triple-FM samples was constant or if some samples showed significantly greater variability than others (using a confidence level of 95%). Each calibration level (0%, 25%, 50%, 75%, and 100%) constituted a sample of size 6.

a. Link 2.

(1) Analysis of variances by calibration within the same calibration level for all channels. At a 95% confidence level:

Calibration 1 - Significant differences were found between channels for the 0% calibration level.

Calibration 2 - Significant differences were found between channels for the 50% calibration level.

Calibration 3 - No significant differences were found.

(2) Analysis of variances by calibration level for all calibrations. At a 95% confidence level:

Channel 14-2 - Significant differences were found between calibrations at the 0% calibration level.

Channels 14-3 - Significant differences were found between calibrations at the 0% and 100% calibration levels.

Channels 14-4 and 14-5 - No significant differences were found.

b. Link 3

(1) Analysis of variances by calibrations within the same calibration level for all channels. At a 95% confidence level:

Calibration 1 - Significant differences were found between channels for the 0% and 50% calibration levels.

Calibration 2 - Significant differences were found between channels for the 50% and 100% calibration levels.

Calibration 3 - No significant differences were found.

(2) Analysis of variances by level for all calibrations. At a 95% confidence level:

Channel 14-2 - Significant differences were found between calibrations at the 50% calibration level.

Channels 14-2, 14-3, and 14-4 - No significant differences were found.

c. Link 4.

(1) Analysis of variances by calibration within the same calibration level for all channels. At a 95% confidence level:

Calibration 1 - Significant differences were found between channels for the 50% and 100% calibration levels.

Calibration 2 - Significant differences were found between channels for the 25% and 75% calibration levels.

Calibration 3 - Significant differences were found between channels for the 25%, 50%, 75%, and 100% calibration levels.

(2) Analysis of variances by level for all calibrations. At a 95% confidence level:

Channels 14-2, 14-3, and 14-5 - No significant differences were found.

Channel 14-4 - Significant differences were found between calibrations at the 75% calibration level.

d. Link 5.

(1) Analysis of variances by calibration within the same calibration level for all channels. At a 95% confidence level:

Calibration 1 - Significant differences were found between channels for the 0% calibration level.

Calibration 2 and 3 - Significant differences were found between channels for the 25% calibration level.

(2) Analysis of variances by level for all calibrations. At a 95% confidence level:

Channels 14-2 and 14-5 - No significant differences were found.

Channels 14-3 and 14-4 - Significant differences were found between calibrations at the 25% calibration levels.

e. Comparison of Triple-FM Links 2, 3, 4, and 5.

(1) Analysis of variances by level for all calibrations and all links for a channel. At a 95% confidence level:

Channel 14-2 - Significant differences were found between variances for the 0% and 50% calibration levels.

Channel 14-3 - Significant differences were found between variances for the 25% and 50% calibration levels.

Channel 14-4 - Significant differences were found between variances for the 25%, 50%, and 75% calibration levels.

Channel 14-5 - Significant differences were found between variances for the 25% and 50% calibration levels.

(2) Analysis of variances by calibration, and by level, for all links. At a 95% confidence level:

(a) Channel 14-2.

Calibration 1 - Significant differences were found between links at the 0% calibration level.

Calibration 2 - No significant differences were found.

Calibration 3 - Significant differences were found between links at the 75% calibration level.

(b) Channel 14-3.

Calibration 1 - Significant differences were found between links at the 0% and 25% calibration levels.

Calibration 2 - Significant differences were found between links at the 50% calibration level.

Calibration 3 - Significant differences were found between links at the 50% and 100% calibration levels.

(c) Channel 14-4.

Calibrations 1 and 2 - No significant differences were found.

Calibration 3 - Significant differences were found between links at the 50% and 100% calibration levels.

(d) Channel 14-5.

Calibration 1 - Significant differences were found between links at the 0%, 25%, and 50% calibration levels.

Calibration 2 and 3 - No significant differences were found.

3. Analysis of Variance Analysis for FM/FM Links 2, 3, 4, and 5, Channel 14, Triple-FM, Subchannels 2, 3, 4, and 5.

a. Introduction. A three way analysis of variance with replication for individual multiplexed outputs of FM/FM links 2, 3, 4, and 5, channel 14, triple-FM subchannels 2, 3, 4, and 5 (assuming all effects to be random) is presented in Tables 25, 26, 27, and 28.

b. Significance of channel main effects. The results of the ANOVA indicate that no significant difference occurred between channels; all XO-4B channels examined are alike at the same calibration level. Their performance, as measured by the SA-4 flight, provided conclusive evidence that no mean bias existed between channels of the XO-4B's at the same calibration level.

c. Significance of link main effect. No significant differences existed between links. The link main effect was not significant; all the links performed alike, indicating that no mean bias (difference in means) existed between links.

d. Significance of calibration main effect. All of the calibrations through the XO-4B's were alike; the means of the calibration did not change from one calibration period to the next.

e. Significance of the interaction between channel and link (channel X link interaction). Significant interaction occurred at the 25%, 50%, and 100% calibration levels at a .05 level of significance. This means that the channels react differently from between links at the 25%, 50%, and 100% calibration levels.

f. Significance of the channel X calibration interaction. No significant interaction occurred between channels and calibrations at the .05 level of significance. There is no significant difference in the effects of calibration on the analyzed XO-4B channels at the same calibration level.

g. Significance of the link X calibration interaction. Significant interaction occurred at the 25%, 50%, and 100% calibration levels at the .05 level of significance.

4. Analysis of Variance Analysis - Triple-FM Links 2, 3, 4, Channel 18, Subchannels 2-5.

a. Introduction. A three way analysis of variance was performed on links 2, 3, and 4, FM/FM channel 18, to determine if significant mean differences occurred between channels, links, or calibrations and if any interactions existed.

(1) Analysis of Variance. A three way analysis of variance with replication for individual multiplexed outputs of FM/FM links 2, 3, 4, channel 18 triple-FM, and subchannels 2-5 (assuming all effects to be random) is presented in Tables 29, 30, 31, and 32.

(2) Significance of channel main effects. Tables 29, 30, 31, and 32 show that there is no significant difference between channels. All channels examined are alike at the same calibration level. Their performance, as measured by the SA-4 flight, provided conclusive evidence that no mean bias existed between channels at the same calibration level.

(3) Significance of link main effect. No significant differences existed between links. The link main effect was not significant. That is, all the links performed alike, indicating that no mean bias (difference in means) existed between links.

(4) Significance of calibration main effect. There is no significant difference between calibrations; all calibrations applied to the systems were alike, indicating that the means of the calibrations did not change from one calibration period to the next.

(5) Significance of the channel X link interaction. Significant interaction occurred at the 50%, 75%, and 100% calibration levels at a .05 level of significance.

(6) Significance of the channel X calibration interaction. There is no significant interaction between channels and calibrations at the .05 level of significance; that is, there is no significant difference in the effects of calibrations on the analyzed channels at the same calibration level.

(7) Significance of the link X calibration interaction. Significant interaction occurred at the 50%, 75%, and 100% calibration levels at the .05 level of significance.

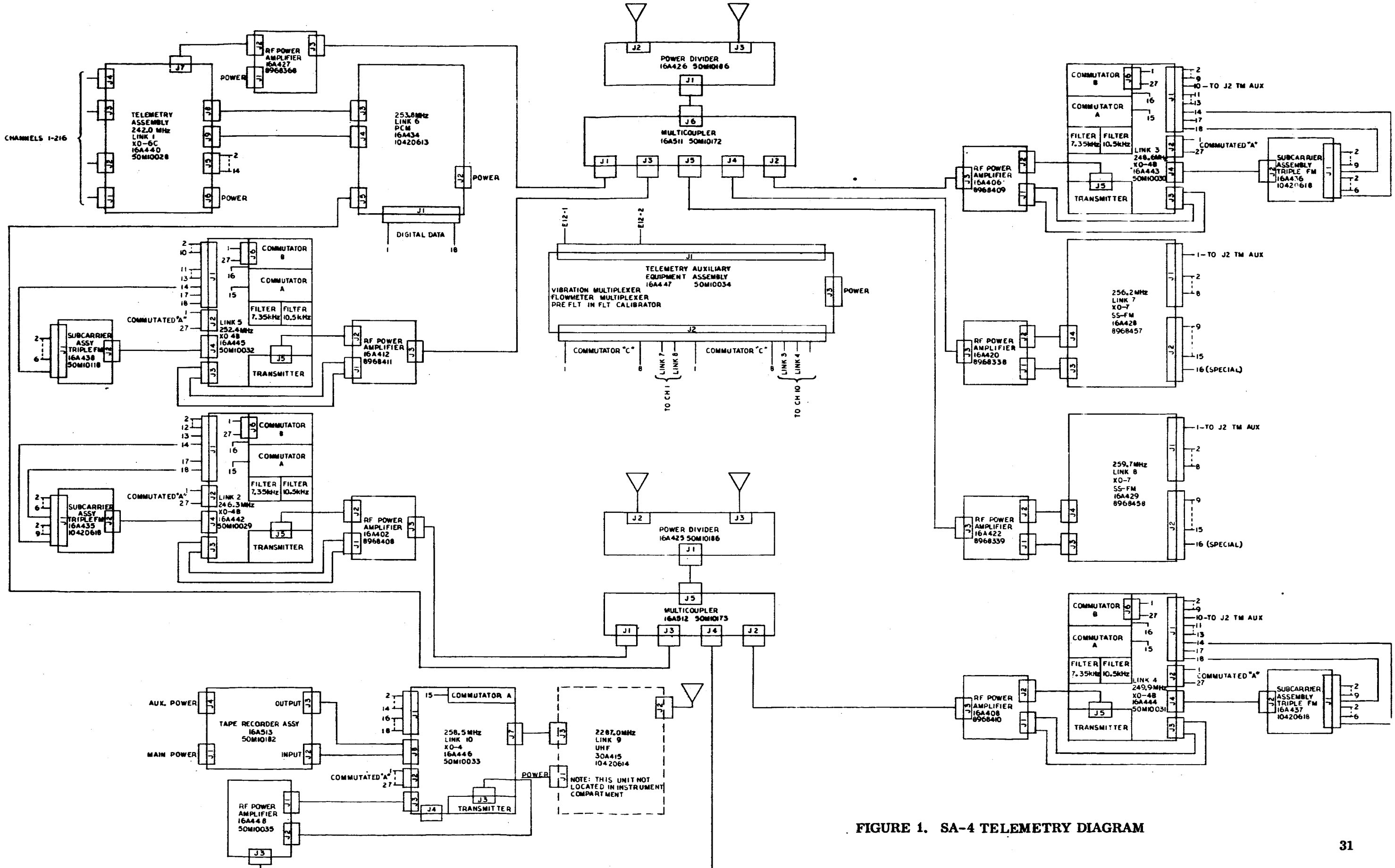


FIGURE 1. SA-4 TELEMETRY DIAGRAM

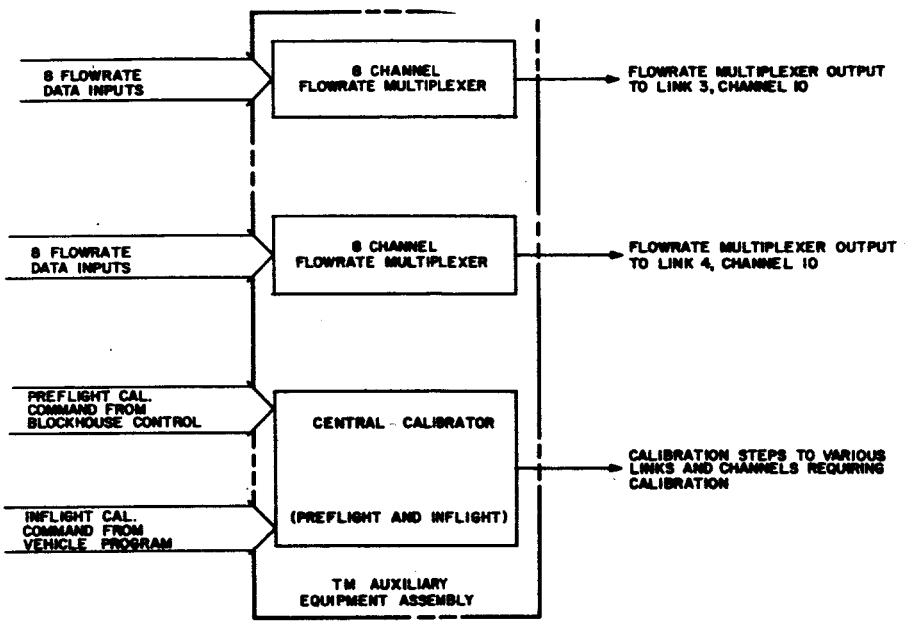


FIGURE 2. SA-3 TELEMETRY AUXILIARY EQUIPMENT

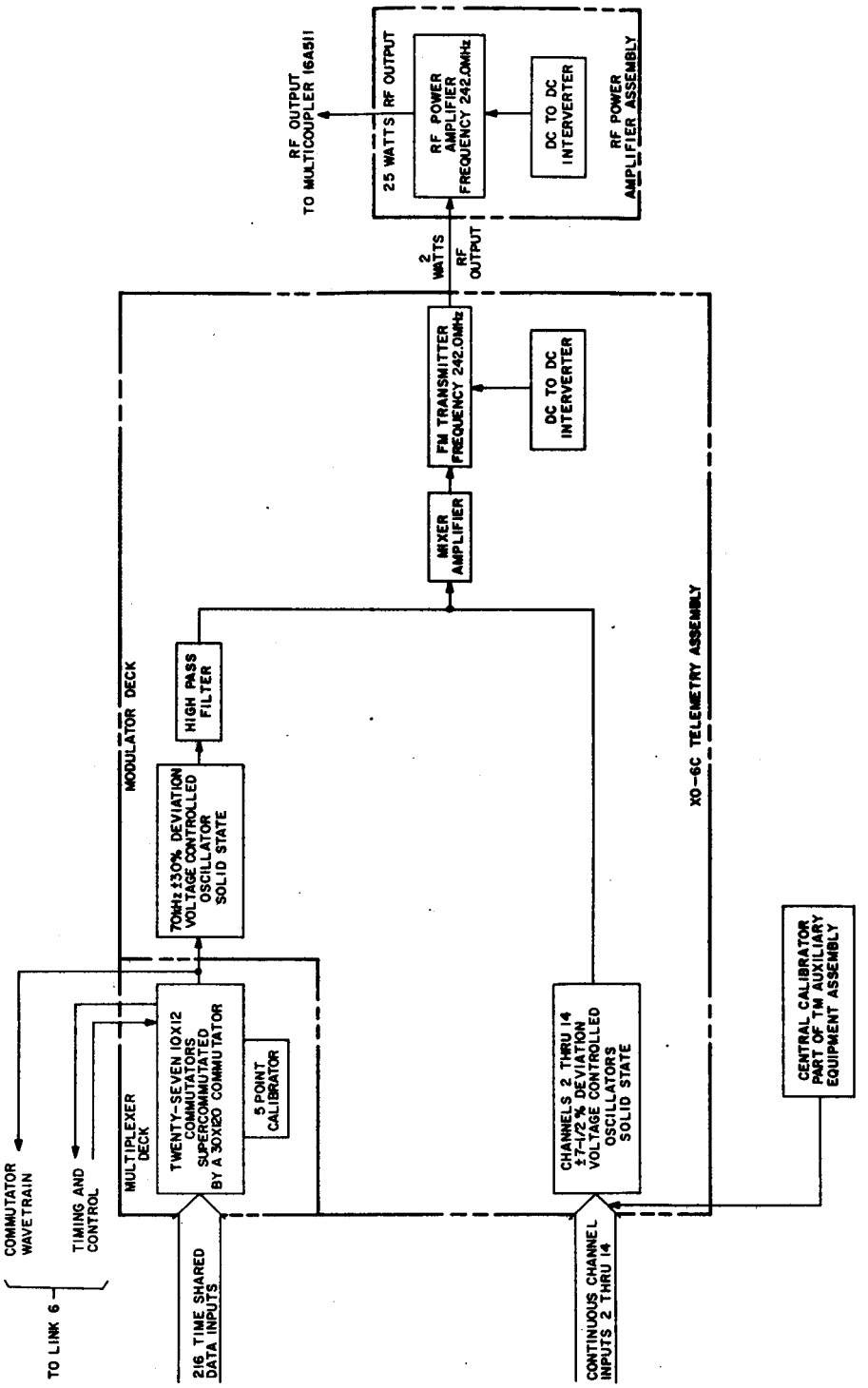


FIGURE 3. SATURN SA-4 TELEMETER LINK 1

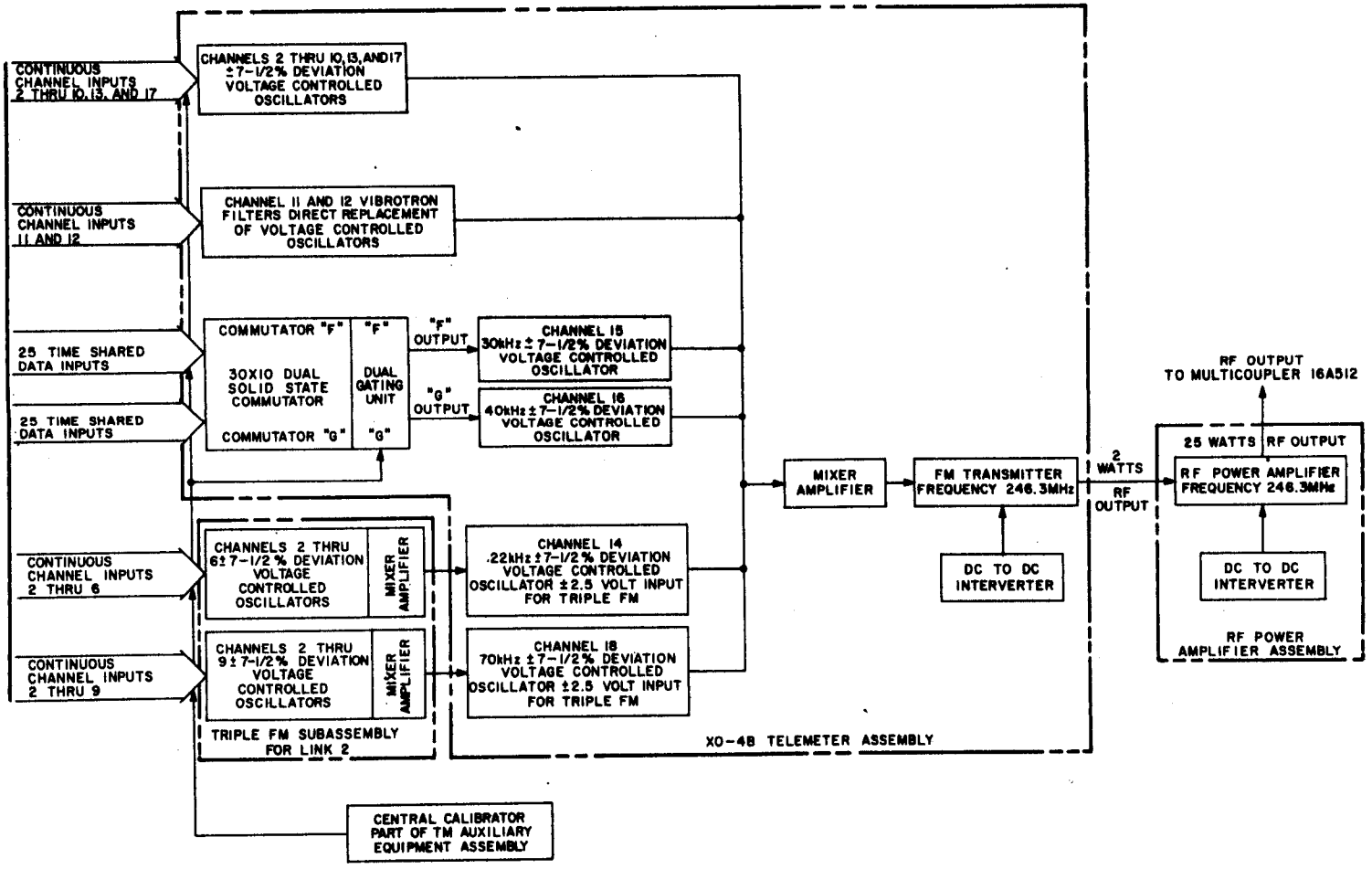


FIGURE 4. SATURN SA-4 TELEMETER LINK 2

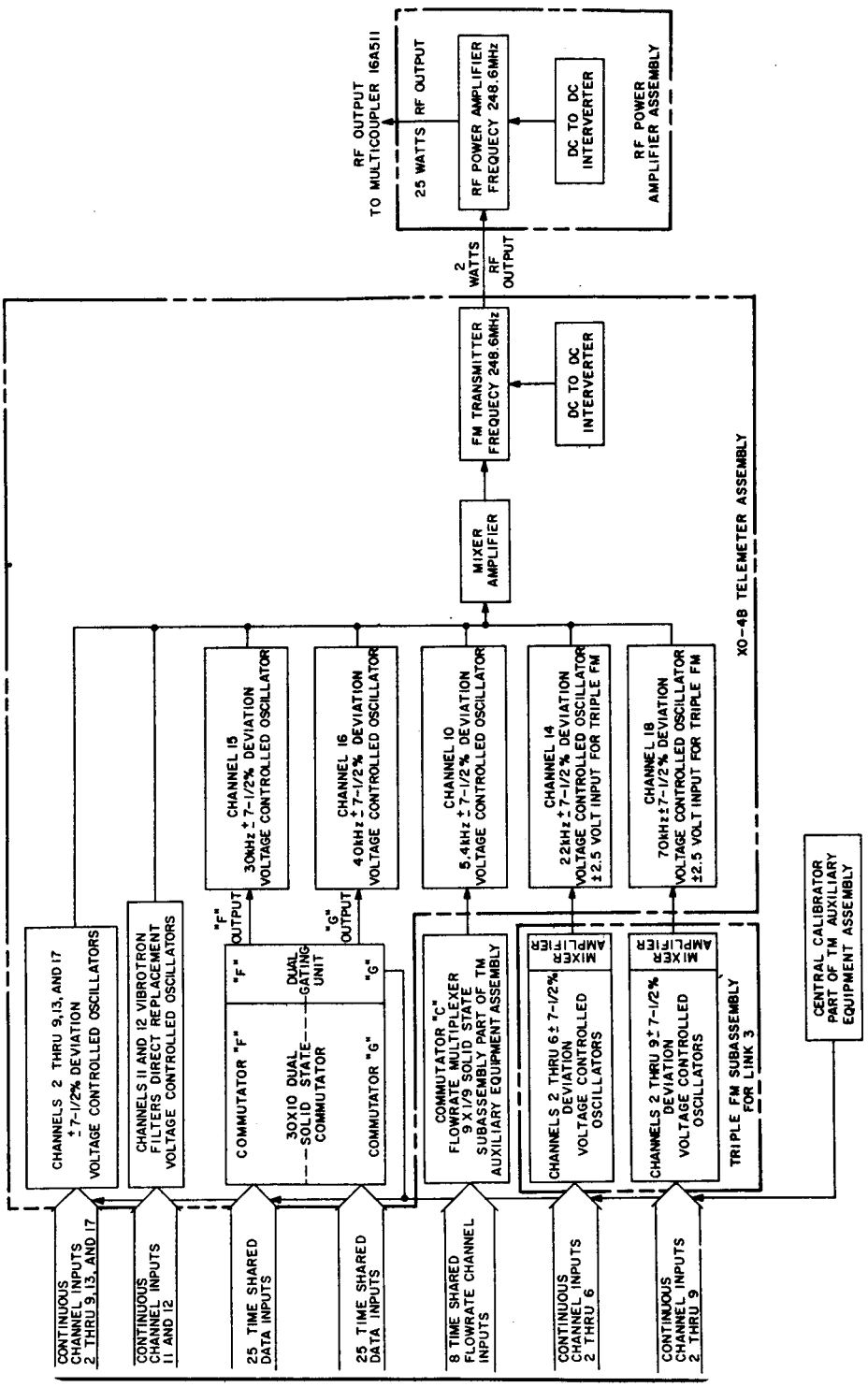


FIGURE 5. SATURN SA-4 TELEMETER LINK 3

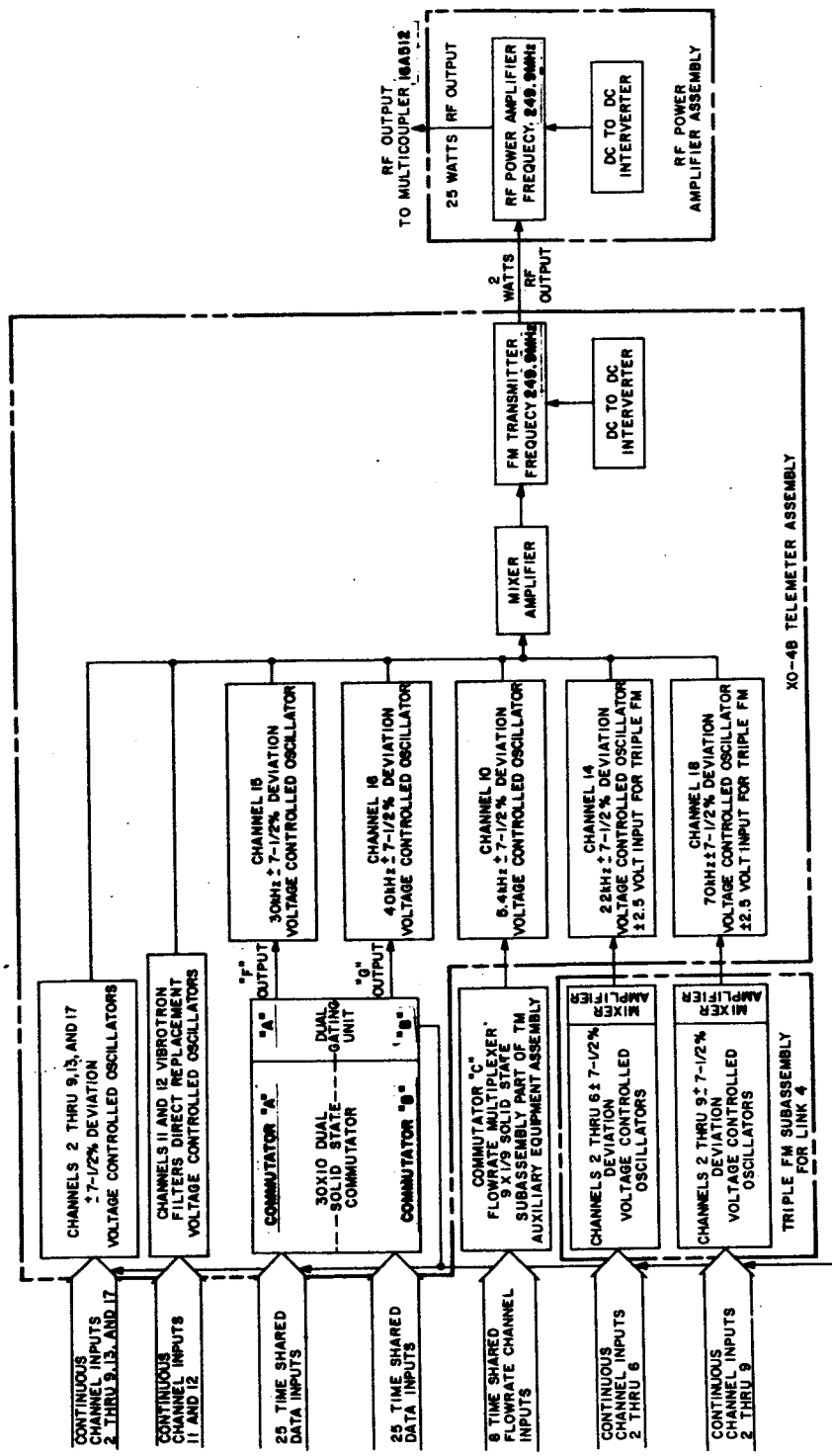


FIGURE 6. SATURN SA-4 TELEMETER LINK 4

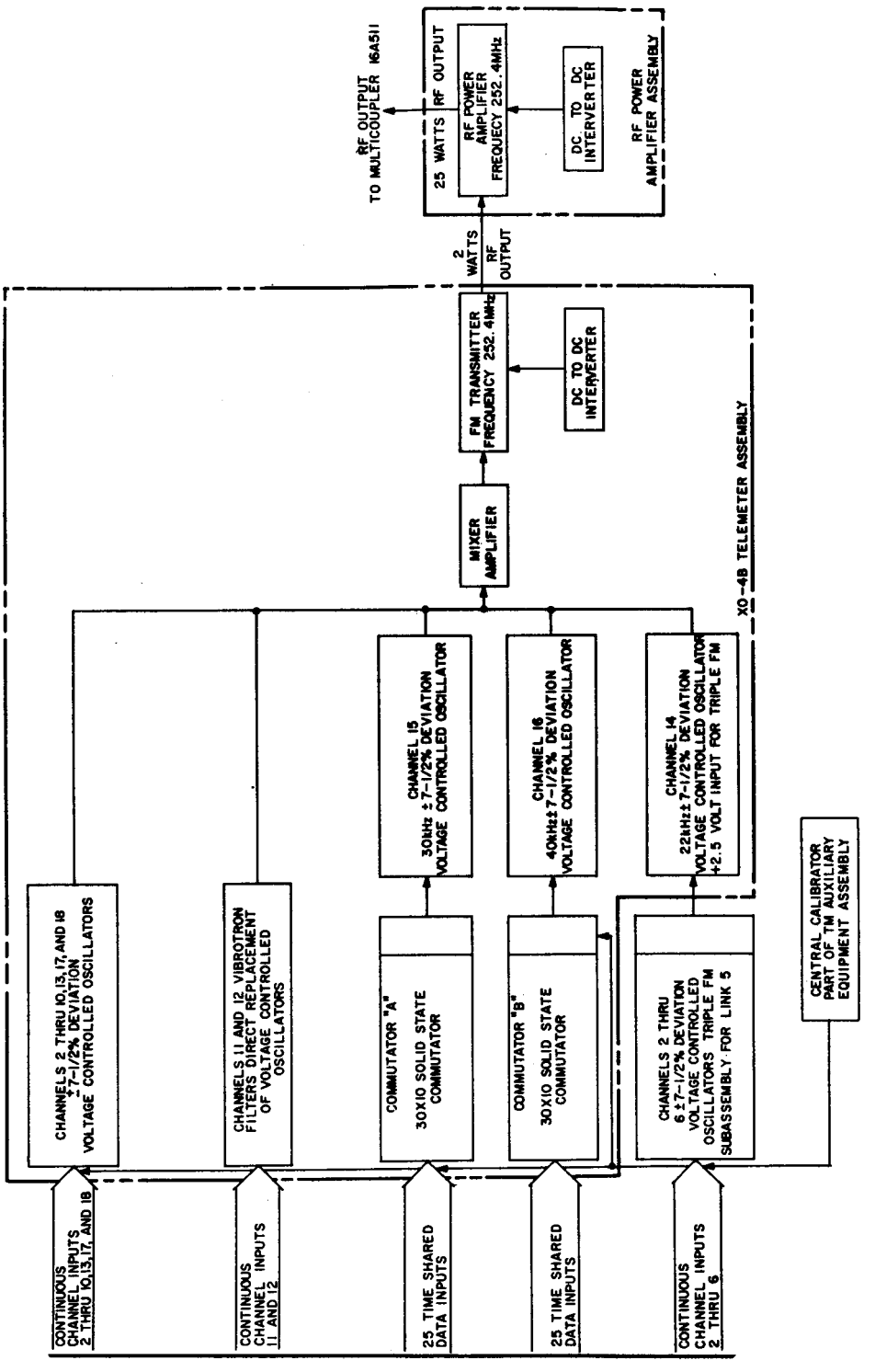


FIGURE 7. SATURN SA-4 TELEMETER LINK 5

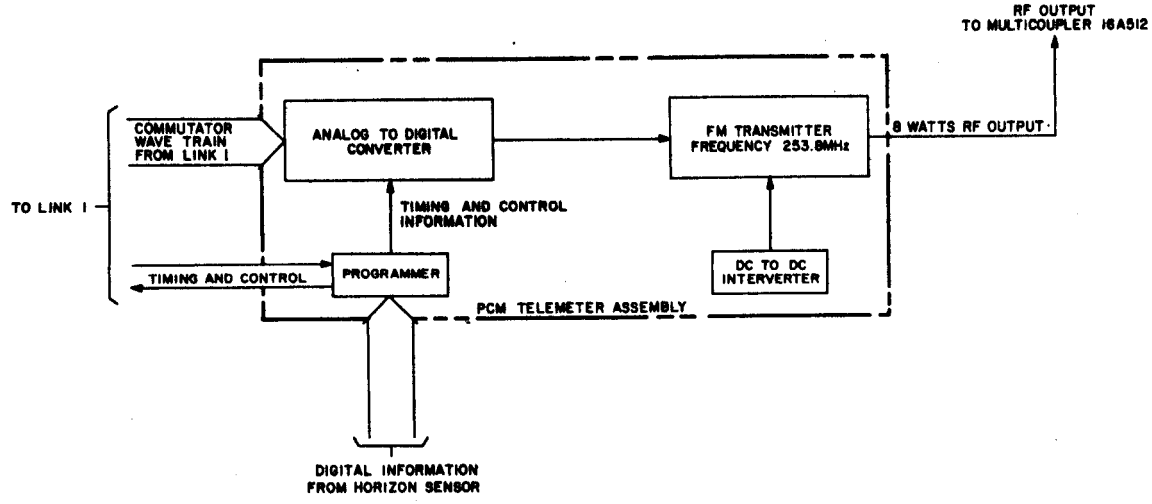


FIGURE 8. SATURN SA-4 TELEMETER LINK 6

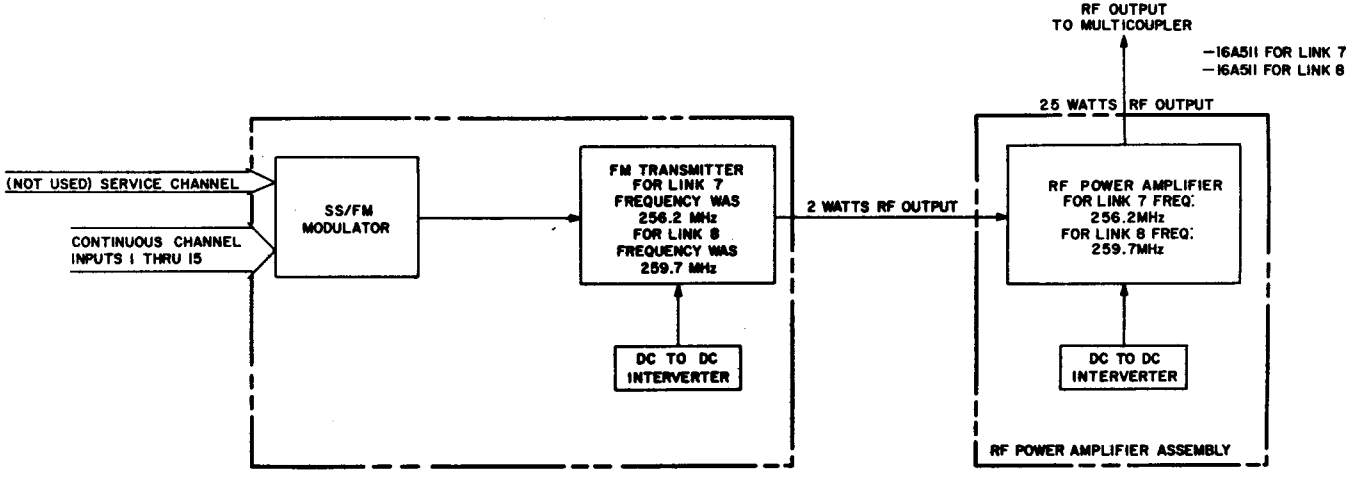


FIGURE 9. SATURN SA-4 TELEMETER LINKS 7 AND 8

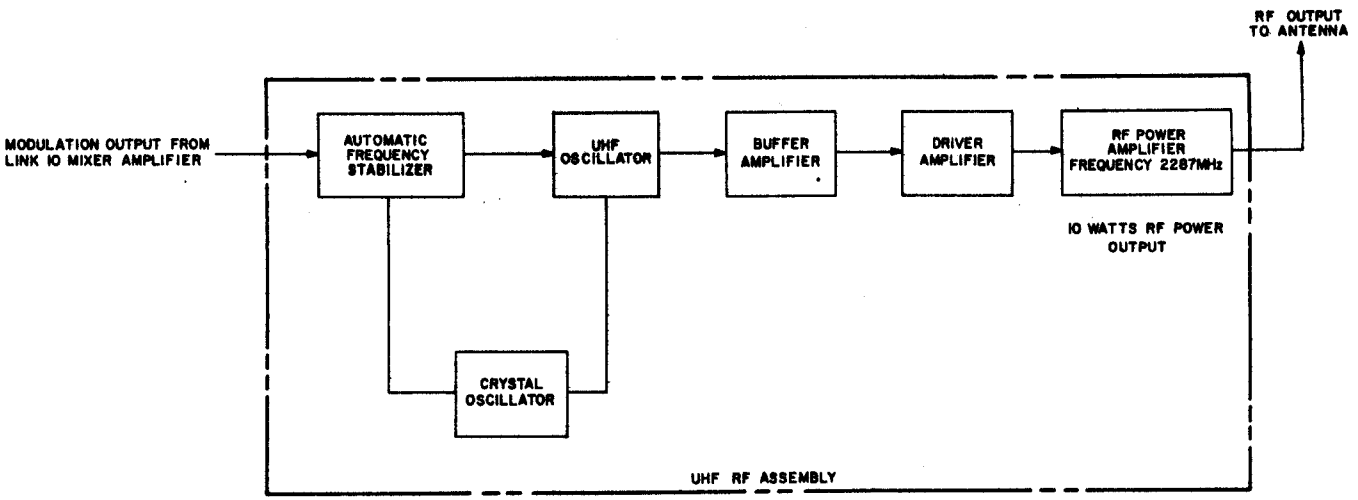


FIGURE 10. SATURN SA-4 TELEMETER LINK 9

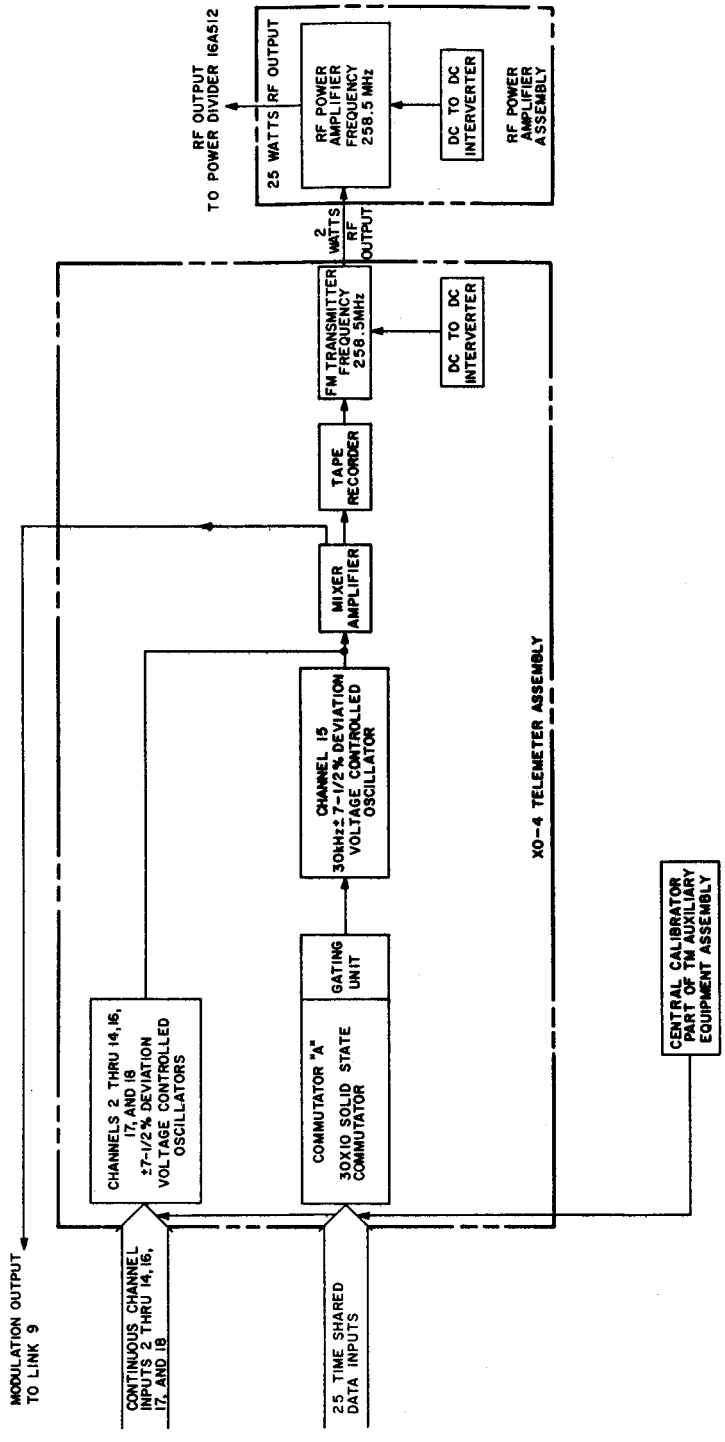


FIGURE 11. SATURN SA-4 TELEMETER LINK 10

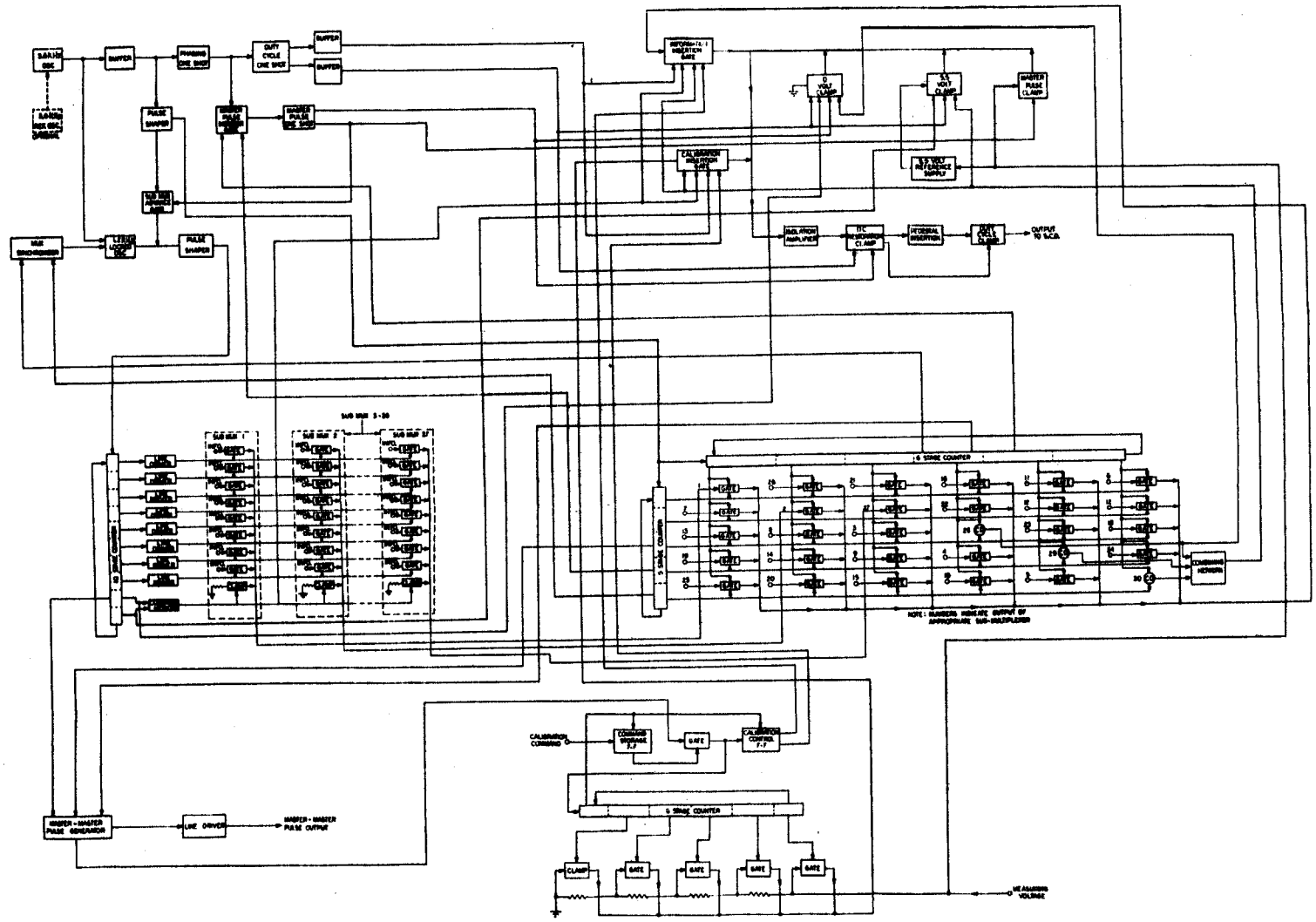


FIGURE 12. THE 216 TIME DIVISION MULTIPLEXER

TABLE 1. SA-4 FM/FM L-2 FLIGHT TEST CALIBRATION DATA

Channels	Flight Time	0% Cal. Step		25% Cal. Step		50% Cal. Step		75% Cal. Step		100% Cal. Step		0% Change Based on First Cal.	
	Cal. No.	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	0% Cal. Step in %	Range in %
2	1	0	.28	24.00	.19	49.19	.26	74.47	.20	100	.16	--	--
	2	0	.53	24.06	.29	49.36	.07	74.47	.12	100	.08	-0.23	-0.09
	3	0	.51	24.47	.09	49.46	.12	74.08	.32	100	.15	-0.49	-0.08
3	1	0	.37	24.13	.10	49.18	.09	74.29	.18	100	.13	--	--
	2	0	.19	24.26	.22	49.16	.11	74.14	.09	100	.14	-0.35	0.00
	3	0	.54	23.91	.33	48.92	.21	74.21	.22	100	.21	-0.12	-0.52
4	1	0	.21	24.06	.18	48.88	.14	74.17	.17	100	.12	--	--
	2	0	.16	24.12	.30	49.10	.30	74.10	.23	100	.30	-0.22	-0.05
	3	0	.29	24.26	.22	49.08	.25	74.26	.16	100	.15	-0.60	+0.21
5	1	0	.19	24.10	.22	48.76	.40	74.16	.25	100	.16	--	--
	2	0	.20	23.98	.20	48.71	.24	74.08	.11	100	.15	-0.14	+0.01
	3	0	.21	23.93	.18	48.95	.13	74.15	.21	100	.16	-0.10	+0.02
10	1	0	.22	24.51	.17	49.34	.13	74.66	.15	100	.21	--	--
	2	0	.20	24.37	.25	49.22	.39	74.30	.25	100	.19	+0.04	-0.10
	3	0	.25	23.98	.30	49.37	.49	74.45	.45	100	.23	+0.21	+0.36

TABLE 2. SA-4 FM/FM L-3 FLIGHT TEST CALIBRATION DATA

Channels	Flight Time	0% Cal. Step		25% Cal Step		50% Cal. Step		75% Cal. Step		100% Cal. Step		0% Change Based on First Cal.	
	Cal. No.	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	0% Cal Step in %	Range in %
2	1	0	.24	23.31	.19	48.02	.23	73.46	.19	100	.10	--	--
	2	0	.13	26.35	.19	48.26	.12	73.63	.16	100	.15	+0.27	-0.59
	3	0	.31	23.23	.19	48.18	.14	73.59	.15	100	.10	+0.45	-0.81
3	1	0	.36	23.79	.18	48.72	.21	74.10	.19	100	.12	--	--
	2	0	.22	23.92	.20	49.08	.19	74.19	.17	100	.10	-0.18	+0.06
	3	0	.57	23.83	.10	48.99	.23	74.29	.15	100	.09	-0.11	-0.05
4	1	0	.13	24.32	.22	49.15	.08	74.49	.15	100	.11	--	--
	2	0	.25	24.24	.25	49.32	.14	74.49	.13	100	.10	+0.29	-0.29
	3	0	.19	24.24	.15	49.42	.17	74.53	.13	100	.17	+0.08	-0.22
5	1	0	.14	24.58	.14	49.42	.15	74.55	.09	100	.08	--	--
	2	0	.19	24.51	.14	49.57	.15	74.60	.18	100	.12	-0.47	-0.06
	3	0	.07	24.66	.19	49.76	.10	74.70	.15	100	.10	-0.63	-0.08
6	1	0	.16	24.33	.12	49.07	.18	74.31	.23	100	.09	--	--
	2	0	.19	24.32	.09	49.32	.28	74.36	.16	100	.09	+0.18	+0.12
	3	0	.10	24.51	.11	49.45	.12	74.46	.07	100	.06	-0.26	+0.17
8	1	0	.09	24.04	.14	48.78	.09	74.10	.09	100	.06	--	--
	2	0	.13	24.00	.07	48.98	.20	74.18	.07	100	.07	-0.13	-0.11
	3	0	.12	25.11	.08	49.71	.09	74.74	.11	100	.07	-1.54	-0.89
13	1	0	.53	23.88	.17	48.64	.18	73.96	.08	100	.09	--	--
	2	0	.14	23.73	.19	48.75	.17	73.88	.18	100	.13	+0.27	-0.03
	3	0	.04	23.67	.18	48.68	.15	74.09	.10	100	.04	+0.35	-0.47

TABLE 3. SA-4 FM/FM L-4 FLIGHT TEST CALIBRATION DATA

Channels	Flight Time	0% Cal. Step		25% Cal. Step		50% Cal. Step		75% Cal. Step		100% Cal. Step		0% Change Based on First Cal.	
	Cal. No.	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	0% Cal Step in %	Range in %
2	1	0	.18	23.81	.28	48.97	.10	74.22	.26	100	.18	--	--
	2	0	.30	24.03	.32	49.08	.31	74.29	.12	100	.13	-0.13	+0.06
	3	0	.18	24.44	.22	49.15	.14	74.45	.13	100	.17	-0.62	+0.11
3	1	0	.16	23.92	.28	48.96	.06	74.21	.26	100	.14	--	--
	2	0	.25	23.97	.26	49.16	.21	74.31	.17	100	.11	-0.11	-0.18
	3	0	.20	23.84	.14	49.12	.07	74.38	.19	100	.14	+0.03	-0.12
4	1	0	.26	24.30	.07	49.17	.09	74.41	.21	100	.24	--	--
	2	0	.16	24.38	.13	49.48	.09	74.61	.11	100	.03	-3.16	+0.30
	3	0	.06	24.50	.14	49.45	.09	74.50	.13	100	.08	-3.33	+0.51
5	1	0	.20	24.10	.03	48.89	.15	74.06	.18	100	.15	--	--
	2	0	.15	24.18	.17	49.16	.10	74.31	.11	100	.04	-0.37	-0.04
	3	0	.15	24.19	.12	49.13	.16	74.37	.17	100	.03	-0.22	-0.08
6	1	0	.09	23.63	.07	48.72	.11	74.10	.12	100	.07	--	--
	2	0	.08	24.48	.12	49.42	.10	74.48	.04	100	.16	-1.15	+0.96
	3	0	.05	24.50	.09	49.40	.12	74.50	.08	100	.10	-1.18	+1.05

TABLE 4. SA-4 FM/FM L-5 FLIGHT TEST CALIBRATION DATA

Channels	Flight Time	0% Cal. Step		25% Cal. Step		50% Cal. Step		75% Cal. Step		100% Cal. Step		0% Change Based on First Cal.	
	Cal. No.	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	0% Cal Step in %	Range in %
2	1	0	.17	23.75	.09	48.55	.13	73.96	.32	100	.49	--	--
	2	0	.25	24.16	.23	48.98	.18	74.43	.09	100	.10	-0.37	-0.53
	3	0	.28	23.92	.38	49.12	.25	74.18	.24	100	.08	+0.35	-0.56
3	1	0	.33	24.08	.17	49.12	.31	74.35	.42	100	.26	--	--
	2	0	.48	24.21	.30	49.22	.30	74.41	.38	100	.29	+0.13	-0.52
	3	0	.30	24.01	.24	49.07	.18	74.37	.23	100	.25	+0.41	-0.60
4	1	0	.35	23.97	.28	48.88	.18	74.21	.13	100	.13	--	--
	2	0	.20	24.36	.21	49.16	.11	74.34	.10	100	.23	-0.27	-0.25
	3	0	.23	24.50	.17	49.32	.15	74.41	.18	100	.12	-0.54	+0.16
5	1	0	.45	24.26	.19	49.44	.11	74.74	.29	100	.13	--	--
	2	0	.18	24.59	.11	49.69	.06	74.57	.20	100	.20	-0.27	-0.11
	3	0	.06	24.66	.17	49.73	.18	74.62	.13	100	.18	-0.29	-0.11
6	1	0	.31	24.29	.19	49.10	.18	74.36	.28	100	.24	--	--
	2	0	.20	24.46	.12	49.36	.10	74.38	.19	100	.22	-0.47	-0.08
	3	0	.17	24.51	.18	49.38	.13	74.44	.20	100	.16	-0.44	+0.05
7	1	0	.16	24.52	.26	49.21	.14	74.42	.22	100	.17	--	--
	2	0	.21	24.50	.11	49.43	.12	74.36	.25	100	.09	+0.17	-0.27
	3	0	.19	24.52	.14	49.36	.19	74.49	.15	100	.11	+0.26	-0.27
10	1	0	.27	24.70	.38	49.38	.32	74.52	.43	100	.43	--	--
	2	0	.16	24.68	.09	49.58	.24	74.43	.09	100	.24	-0.22	-0.12
	3	0	.15	24.48	.15	49.42	.10	74.48	.08	100	.17	-0.16	-0.23

TABLE 5. SA-4 FM/FM L-10 FLIGHT TEST CALIBRATION DATA

Channels	Flight Time	0% Cal. Step		25% Cal. Step		50% Cal. Step		75% Cal. Step		100% Cal. Step		0% Change Based on First Cal.	
	Cal. No.	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	0% Cal. Step in. %	Range in %
3	1	0	.16	24.03	.20	48.96	.15	74.18	.13	100	.13	--	--
	2	0	.21	23.91	.29	48.83	.19	73.96	.18	100	.14	+0.23	-0.44
	3	0	.24	23.94	.07	48.92	.14	74.17	.12	100	.15	+0.06	-0.52
4	1	0	.07	24.16	.05	49.08	.25	74.26	.13	100	.08	--	--
	2	0	.08	24.18	.15	48.82	.15	73.90	.13	100	.06	+0.24	-0.35
	3	0	.14	24.17	.18	49.03	.06	74.26	.09	100	.11	+0.14	-0.44
5	1	0	.07	24.21	.08	49.07	.19	74.29	.14	100	.10	--	--
	2	0	.03	24.21	.10	48.93	.10	74.00	.10	100	.20	-0.02	-0.57
	3	0	.78	23.03	.18	48.32	.10	73.93	.19	100	.06	+1.28	-1.64
6	1	0	0.0	24.75	.21	49.63	.19	74.61	.16	100	.12	--	--
	2	0	.09	24.71	.07	49.63	.13	74.37	.08	100	.13	+0.06	-0.48
	3	0	.93	23.98	.12	49.15	.04	74.38	.20	100	.10	+0.91	-1.48
7	1	0	.02	24.23	.07	49.65	.16	74.28	.13	100	.16	--	--
	2	0	.16	24.22	.11	48.94	.09	73.93	.18	100	.14	+0.28	-0.43
	3	0	1.16	23.19	.10	48.45	.08	73.92	.18	100	.04	+1.44	-1.73
8	1	0	.10	23.95	.13	48.70	.16	74.05	.13	100	.15	--	--
	2	0	.11	24.04	.12	48.66	.14	73.86	.12	100	.16	+0.48	-0.41
	3	0	.33	23.92	.13	48.90	.13	74.13	.10	100	.12	+0.36	-0.42
9	1	0	.15	24.21	.18	49.15	.18	74.37	.13	100	.11	--	--
	2	0	.14	24.38	.15	49.12	.14	74.13	.15	100	.22	-0.04	-0.20
	3	0	.12	24.39	.09	49.40	.15	74.54	.15	100	.09	-0.24	-0.22
10	1	0	.15	24.36	.17	49.31	.16	74.41	.08	100	.12	--	--
	2	0	.12	24.54	.14	49.27	.18	74.38	.04	100	.19	+0.20	-0.53
	3	0	.11	24.53	.15	49.56	.13	74.50	.10	100	.07	+0.13	-0.13

TABLE 5. SA-4 FM/FM L-10 FLIGHT TEST CALIBRATION DATA (Cont'd)

Channels	Flight Time	0% Cal. Step		25% Cal. Step		50% Cal. Step		75% Cal. Step		100% Cal. Step		0% Change Based on First Cal.	
	Cal. No.	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	0% Cal. Step in %	Range in %
11	1	0	.19	24.64	.18	49.48	.24	74.62	.15	100	.17	--	--
	2	0	.23	24.58	.17	49.55	.31	74.39	.24	100	.19	-0.08	-0.32
	3	0	.25	24.71	.22	49.58	.20	74.64	.17	100	.03	-0.25	-0.29
12	1	0	.08	24.87	.18	49.54	.25	74.68	.22	100	.17	--	--
	2	0	.22	24.52	.21	49.47	.23	74.50	.12	100	.24	+0.35	-0.72
	3	0	.28	24.74	.03	49.64	.22	74.66	.18	100	.08	-0.03	-0.57
13	1	0	.07	24.04	.24	48.61	.28	73.85	.16	100	.20	--	--
	2	0	.20	23.94	.15	48.90	.19	73.95	.10	100	.24	+0.23	-0.54
	3	0	.24	24.07	.07	48.96	.28	74.16	.22	100	.20	+0.08	-0.39

TABLE 6. SA-4 FM/FM L-1 FLIGHT TEST CALIBRATION DATA

Channels	Flight Time Cal.	0% Cal. Step		25% Cal. Step		50% Cal. Step		75% Cal. Step		100% Cal. Step		0% Change Based on First Cal.	
	Cal. No.	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	0% Cal. Step in %	Range in %
2	1	0	.23	24.45	.12	49.64	.36	74.88	.09	100	.31	--	--
	2	0	.13	24.75	.19	49.57	.13	74.83	.38	100	.27	-0.42	+0.05
	3	0	.21	24.74	.10	49.86	.14	74.96	.21	100	.23	-0.25	-0.18
3	1	0	.19	24.68	.05	49.73	.18	74.84	.17	100	.14	--	--
	2	0	.31	24.52	.25	49.72	.18	74.90	.15	100	.16	-0.51	-0.37
	3	0	.09	24.84	.16	50.03	.13	74.99	.17	100	.12	-0.05	+0.01
4	1	0	.14	24.64	.24	49.67	.15	74.99	.26	100	.14	--	--
	2	0	.29	24.80	.21	49.93	.13	74.97	.25	100	.13	-0.17	+0.01
	3	0	.08	24.76	.27	49.98	.19	74.93	.17	100	.12	+0.05	+0.18
6	1	0	.17	24.74	.24	49.71	.10	74.76	.28	100	.24	--	--
	2	0	.05	24.93	.40	49.96	.17	75.08	.21	100	.26	-0.07	+0.03
	3	0	.20	24.76	.22	49.81	.18	74.95	.20	100	.26	-0.05	+0.04
7	1	0	.18	24.77	.10	49.85	.09	74.83	.18	100	.19	--	--
	2	0	.14	24.96	.26	49.99	.14	74.93	.09	100	.25	+0.07	+0.23
	3	0	.15	24.77	.20	49.95	.15	74.99	.17	100	.13	+0.08	+0.12
9	1	0	.31	24.90	.16	49.75	.19	74.88	.33	100	.19	--	--
	2	0	.25	25.10	.30	49.95	.19	75.10	.26	100	.20	+0.15	+0.33
	3	0	.20	24.82	.28	50.11	.16	74.94	.41	100	.13	+0.08	+0.31
10	1	0	.19	24.84	.11	49.59	.09	74.80	.17	100	.13	--	--
	2	0	.16	24.92	.15	49.93	.20	75.04	.13	100	.11	+0.19	+0.23
	3	0	.10	24.88	.15	49.97	.13	74.95	.16	100	.11	+0.24	+0.24

TABLE 6. SA-4 FM/FM L-1 FLIGHT TEST CALIBRATION DATA (Cont'd)

Channels	Flight Time Cal.	0% Cal. Step		25% Cal. Step		50% Cal. Step		75% Cal. Step		100% Cal. Step		0% Change Based on First Cal.	
	Cal. No.	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	0% Cal. Step in %	Range in %
12	1	0	.26	24.91	.32	49.73	.12	74.81	.25	100	.19	---	---
	2	0	.18	24.92	.33	49.80	.19	74.89	.22	100	.09	-0.01	+0.13
	3	0	.22	25.01	.19	50.05	.20	74.97	.15	100	.21	+0.19	+0.03
13	1	0	.28	24.80	.18	49.83	.18	74.92	.26	100	.28	---	---
	2	0	.13	24.90	.27	49.72	.13	74.93	.16	100	.22	+0.04	+0.14
	3	0	.20	24.93	.21	50.02	.19	74.98	.21	100	.25	+0.24	+0.35
14	1	0	.16	24.81	.22	49.72	.08	75.00	.22	100	.15	---	---
	2	0	.18	24.87	.12	50.03	.11	74.99	.24	100	.30	+0.08	+0.23
	3	0	.44	24.86	.19	49.85	.39	74.74	.25	100	.32	+0.15	+0.42

TABLE 7. PRECISION OF SA-4 FM/FM CHANNELS BY LINK

	95% Confidence Limits									
LINK	2	3	4	6	7	9	10	12	13	14
1 ±.49	±.54	±.40	±.44	±.52	±.42	±.59	±.32	±.52	±.52	±.52
2 ±.56	2 ±.61	3 ±.56	4 ±.52	5 ±.49	10 ±.64					
3	2 ±.42	3 ±.56	4 ±.38	5 ±.31	6 ±.31	8 ±.24	13 ±.47			
4 ±.37	2 ±.49	3 ±.44	4 ±.32	5 ±.32	6 ±.24					
5 ±.54	2 ±.59	3 ±.73	4 ±.47	5 ±.47	6 ±.47	7 ±.44	10 ±.59			
10 ±.47		3 ±.44	4 ±.30	5 ±.54	6 ±.64	7 ±.76	8 ±.35	9 ±.41	10 ±.30	

NOTE: All figures shown in per cent of calibration level range

TABLE 8. THREE-WAY ANOVA WITH REPLICATION FOR INDIVIDUAL OUTPUTS OF FM/FM LINKS 2-5, CHANNELS 2-5 AT THE 0% CALIBRATION LEVELS

ASSUMPTIONS: ALL FACTORS RANDOM

Source	Sum of Squares	Degrees of Freedom	Mean Square	Variance Ratio
Channel	3881.	$N_1 = 3.311$ $N_2 = 10.0$	$S_1 = 1293.$	$\frac{S_1^2 + S_e^2}{S_4^2 + S_5^2} = .9157$
Link	4951.	$N_1 = 3.24$ $N_2 = 9.94$	$S_2 = 1650.$	$\frac{S_2^2 + S_e^2}{S_4^2 + S_6^2} = 1.159$
Calibration	382.3	$N_1 = 3.57$ $N_2 = 11.9$	$S_3 = 191.1$	$\frac{S_3^2 + S_e^2}{S_5^2 + S_6^2} = 1.667$
Channel X Link	12640.	9.	$S_4 = 1405.$	$\frac{S_4^2}{S_e^2} = 23.34^*$
Channel X Calibration	477.8	6.	$S_5 = 79.64$	$\frac{S_5^2}{S_e^2} = 1.209$
Link X Calibration	446.9	6.	$S_6 = 74.49$	$\frac{S_6^2}{S_e^2} = 1.131$
Exp. Error	1185.	18.	$S_e = 65.83$	
TOTAL	23970.			

* Significantly Different at .05 Level of Significance

TABLE 9. THREE-WAY ANOVA WITH REPLICATION FOR INDIVIDUAL OUTPUTS OF FM/FM, LINKS 2-5, CHANNELS 2-5 AT THE 25% LEVELS

ASSUMPTIONS: ALL FACTORS RANDOM

Source	Sum of Squares	Degrees of Freedom	Mean Square	Variance Ratio
Channel	1023.	$N_1 = 4.12$ $N_2 = 10.6$	$S_1^2 = 341.2$	$\frac{S_1^2 + S_e^2}{S_4^2 + S_5^2} = .6378$
Link	2775.	$N_1 = 3.40$ $N_2 = 10.8$	$S_2^2 = 925.1$	$\frac{S_2^2 + S_e^2}{S_4^2 + S_6^2} = 1.552$
Calibration	206.7	$N_1 = 4.79$ $N_2 = 11.9$	$S_3^2 = 103.3$	$\frac{S_3^2 + S_e^2}{S_5^2 + S_6^2} = 1.401$
Channel X Link	5158.	9.0	$S_4^2 = 573.1$	$\frac{S_4^2}{S_e^2} = 9.616$ *
Channel X Calibration	331.9	6.0	$S_5^2 = 55.32$	$\frac{S_5^2}{S_e^2} = .9281$
Link X Calibration	365.9	6.0	$S_6^2 = 60.98$	$\frac{S_6^2}{S_e^2} = 1.023$
Exp. Error	1072.	18.0	$S_e^2 = 59.60$	
TOTAL	10930.			

* Significantly Different at .05 Level of Significance

TABLE 10. THREE-WAY ANOVA WITH REPLICATION FOR INDIVIDUAL OUTPUTS OF FM/FM, LINKS 2-5, CHANNELS 2-5 AT THE 50% LEVELS

ASSUMPTIONS: ALL FACTORS RANDOM

Source	Sum of Squares	Degrees of Freedom	Mean Square	Variance Ratio
Channel	445.1	$N_1 = 5.60$ $N_2 = 12.0$	$S_1^2 = 148.3$	$\frac{S_1^2 + S_e^2}{S_4^2 + S_5^2} = .7959$
Link	287.	$N_1 = 3.46$ $N_2 = 13.0$	$S_2^2 = 762.6$	$\frac{S_2^2 + S_e^2}{S_4^2 + S_6^2} = 2.980$
Calibration	143.	$N_1 = 6.02$ $N_2 = 11.6$	$S_3^2 = 71.52$	$\frac{S_3^2 + S_e^2}{S_5^2 + S_6^2} = 1.303$
Channel X Link	1954.	9.	$S_4^2 = 217.1$	$\frac{S_4^2}{S_e^2} = 3.820^*$
Channel X Calibration	244.1	6.	$S_5^2 = 40.69$	$\frac{S_5^2}{S_e^2} = .7160$
Link X Calibration	346.9	6.	$S_6^2 = 57.82$	$\frac{S_6^2}{S_e^2} = 1.017$
Exp. Error	1023.	18.	$S_e^2 = 56.84$	
TOTAL	6444.			

* Significantly Different at .05 Level of Significance

TABLE 11. THREE-WAY ANOVA WITH REPLICATION FOR INDIVIDUAL OUTPUTS OF FM/FM LINKS 2-5, CHANNELS 2-5 AT THE 75% LEVELS

ASSUMPTIONS: ALL FACTORS RANDOM

Source	Sum of Squares	Degrees of Freedom	Mean Square	Variance Ratio
Channel	269.4	$N_1 = 6.79$ $N_2 = 14.9$	$S_1^2 = 89.82$	$\frac{S_1^2 + S_e^2}{S_4^2 + S_5^2} = .6479$
Link	2850.	$N_1 = 3.31$ $N_2 = 12.0$	$S_2^2 = 950.2$	$\frac{S_2^2 + S_e^2}{S_4^2 + S_6^2} = 5.652^*$
Calibration	496.5	$N_1 = 2.84$ $N_2 = 10.3$	$S_3^2 = 248.2$	$\frac{S_3^2 + S_e^2}{S_5^2 + S_6^2} = 3.195$
Channel X Link	338.	9.	$S_4^2 = 148.6$	$\frac{S_4^2}{S_e^2} = 3.063^*$
Channel X Calibration	389.1	6.	$S_5^2 = 64.86$	$\frac{S_5^2}{S_e^2} = 1.336$
Link X Calibration	168.1	6.	$S_6^2 = 28.03$	$\frac{S_6^2}{S_e^2}$ .5775
Exp. Error	873.6	18.	$S_e^2 = 48.53$	
TOTAL	6386.			

* Significantly Different at .05 Level of Significance

TABLE 12. THREE-WAY ANOVA WITH REPLICATION FOR INDIVIDUAL OUTPUTS OF FM/FM, LINKS 2-5, CHANNELS 2-5 AT THE 100% LEVELS

ASSUMPTIONS: ALL FACTORS RANDOM

Source	Sum of Squares	Degrees of Freedom	Mean Square	Variance Ratio
Channel	75.77	$N_1 = 18.2$ $N_2 = 14.7$	$S_1^2 = 25.25$	$\frac{S_1^2 + S_e^2}{S_4^2 + S_5^2} = .4373$
Link	4127.	$N_1 = 3.29$ $N_2 = 14.9$	$S_2^2 = 375.$	$\frac{S_2^2 + S_e^2}{S_4^2 + S_6^2} = 6.512^*$
Calibration	576.4	$N_1 = 2.99$ $N_2 = 11.9$	$S_3^2 = 288.2$	$\frac{S_3^2 + S_e^2}{S_5^2 + S_6^2} = 2.324$
Channel X Link	1241.	9.	$S_4^2 = 137.9$	$\frac{S_4^2}{S_e^2} = 2.118$
Channel X Calibration	412.3	6.	$S_5^2 = 68.72$	$\frac{S_5^2}{S_e^2} = 1.055$
Link X Calibration	499.8	6.	$S_6^2 = 83.30$	$\frac{S_6^2}{S_e^2} = 1.279$
Exp. Error	1172.	18.	$S_e^2 = 65.12$	
TOTAL	8105.			

* Significantly Different at .05 Level of Significance

TABLE 13. ONE-WAY ANOVA FOR INDIVIDUAL OUTPUTS OF FM/FM LINK -1, CHANNELS 2, 3, and 4 TO DETERMINE THE CHANNEL EFFECT

Level	Source of Variation	Mean	df	Mean Square	Variance Ratio
25%	Channel (Columns)	430.051	2	$S_1^2 = 25.609$	$S_1^2/S_e^2 = 1.380$
	Experimental Error	-------	6	$S_e^2 = 18.553$	
	TOTAL ----------	-------	8	.....	.....
50%	Channel (Columns)	2.202	2	$S_1^2 = 22.193$	$S_1^2/S_e^2 = 1.657$
	Experimental Error	-------	6	$S_e^2 = 13.392$	
	TOTAL ----------	-------	8	.....	.....
75%	Channel (Columns)	426.221	2	$S_1^2 = 62.08$	$S_1^2/S_e^2 = 8.503$ *
	Experimental Error	-------	6	$S_e^2 = 7.3$	
	TOTAL ----------	-------	8	.....	.....
100%	Channel (Columns)	854.515	2	$S_1^2 = 68.510$	$S_1^2/S_e^2 = 5.967$ *
	Experimental Error	-------	6	$S_e^2 = 11.480$	
	TOTAL ----------	-------	8	.....	.....

* Significantly Different at .05 Level of Significance

TABLE 14. ONE-WAY ANOVA FOR INDIVIDUAL OUTPUTS OF FM/FM LINK-1, CHANNELS 2, 3, and 4 TO DETERMINE THE CALIBRATION EFFECT

Level	Source of Variation	Mean	df	Mean Square	Variance Ratio
25%	Calibrations (Columns)	476.851	2	S_1^2 = 18302.2	S_1^2/S_e^2 = .917
	Experimental Error	-------	6	S_e^2 = 19939.89	
	TOTAL ----------	-------	8	.....	.....
50%	Calibrations (Columns)	2.203	2	S_1^2 = 39.418	S_1^2/S_e^2 = 5.144
	Experimental Error	-------	6	S_e^2 = 7.662	
	TOTAL ----------	-------	8	.....	.....
75%	Calibrations (Columns)	426.222	2	S_1^2 = 17.693	S_1^2/S_e^2 = .8
	Experimental Error	-------	6	S_e^2 = 22.092	
	TOTAL ----------		8	.....	.....
100%	Calibrations (Columns)	853.518	2	S_1^2 = 15.661	S_1^2/S_e^2 = .380
	Experimental Error	-------	6	S_e^2 = 41.158	
	TOTAL ----------	-------	8	.....	.....

* Significantly Different at .05 Level of Significance

TABLE 15. ONE-WAY ANOVA FOR INDIVIDUAL OUTPUTS OF FM/FM LINK -10, CHANNELS 2, 3, AND 4 TO DETERMINE THE CALIBRATION EFFECT

Level	Source of Variation	Mean	df	Mean Square	Variance Ratio
25%	Calibrations (Columns)	456.222	2	$S_1^2 = 6.783$	$S_1^2/S_e^2 = .038$
	Experimental Error	-------	6	$S_e^2 = 178.145$	
	TOTAL ----------	-------	8	.....	.....
50%	Calibrations (Columns)	31.851	2	$S_1^2 = 16.936$	$S_1^2/S_e^2 = .115$
	Experimental Error	-------	6	$S_e^2 = 147.213$	
	TOTAL ----------	-------	8	.....	.....
75%	Calibrations (Columns)	397.666	2	$S_1^2 = 52.128$	$S_1^2/S_e^2 = .493$
	Experimental Error	------	6	$S_e^2 = 105.645$	
	TOTAL ----------	------	8	.....	.....
100%	Calibrations (Columns)	838.870	2	$S_1^2 = 50.375$	$S_1^2/S_e^2 = .659$
	Experimental Error	------	6	$S_e^2 = 76.401$	
	TOTAL ----------	------	8	.....	.....

* Significantly Different at .05 Level of Significance

TABLE 16. ONE-WAY ANOVA FOR INDIVIDUAL OUTPUTS OF FM/FM LINK-10, CHANNELS 2, 3, and 4 TO DETERMINE THE CHANNEL EFFECT

Level	Source of Variation	Mean	df	Mean Square	Variance Ratio
25%	Channel (Columns)	456.220	2	$S_1^2 = 529.395$	$S_1^2/S_e^2 = 134.227^*$
	Experimental Error	-------	6	$S_e^2 = 3.944$	
	TOTAL ----------	-------	8	.....	.....
50%	Channel (Columns)	31.848	2	$S_1^2 = 434.686$	$S_1^2/S_e^2 = 54.427^*$
	Experimental Error	-------	6	$S_e^2 = 7.986$	
	TOTAL ----------	-------	8	.....	.....
75%	Channel (Columns)	397.662	2	$S_1^2 = 308.462$	$S_1^2/S_e^2 = 15.252^*$
	Experimental Error	-------	6	$S_e^2 = 20.223$	
	TOTAL ----------	-------	8	.....	.....
100%	Channel (Columns)	835.867	2	$S_1^2 = 34.317$	$S_1^2/S_e^2 = .511$
	Experimental Error	-------	6	$S_e^2 = 67.088$	
	TOTAL ----------	-------	8	.....	.....

* Significantly Different at .05 Level of Significance

TABLE 17. SA-4 FM/FM/FM LINK 2 CH 4 FLIGHT TEST CALIBRATION DATA

Sub-Channels	Flight Time	0% Cal. Step		25% Cal. Step		50% Cal. Step		75% Cal. Step		100% Cal. Step		0% Change Based on First Cal.	
	Cal. No.	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	0% Cal. Step in %	Range in %
2	1	0	.12	23.10	.20	48.68	.24	74.31	.22	100	.34	--	--
	2	0	.13	22.90	.24	48.57	.20	74.29	.19	100	.29	-.02	+.14
	3	0	.48	22.81	.25	48.62	.26	74.10	.43	100	.20	+.76	+.98
3	1	0	.04	22.70	.17	48.42	.16	74.08	.21	100	.10	--	--
	2	0	.28	22.81	.32	48.51	.09	74.23	.18	100	.34	+.17	+.11
	3	0	.43	22.76	.34	48.61	.38	74.36	.09	100	.06	-.08	-.01
4	1	0	.20	23.41	.11	41.0	.09	74.45	.13	100	.18	--	--
	2	0	.23	23.37	.17	48.92	.23	74.47	.15	100	.18	-.16	-.06
	3	0	.15	23.46	.21	49.02	.21	74.43	.34	100	.17	-.73	-.53
5	1	0	.07	22.74	.06	48.36	.13	74.16	.13	100	.22	--	--
	2	0	.13	22.84	.10	48.43	.06	74.25	.23	100	.23	-.05	-.10
	3	0	.20	22.81	.14	48.68	.18	74.24	.27	100	.13	-.21	-.18
6	1	0	.13	23.78	.21	48.51	.17	74.52	.18	100	.14	--	--
	2	0	.25	25.00	.16	48.64	.22	74.73	.26	100	.33	0	-.15
	3	0	.18	24.01	.25	49.38	.24	74.69	.35	100	.4	-.08	-.04

TABLE 18. SA-4 FM/FM/FM LINK 3 CHANNEL 14 FLIGHT TEST DATA

Sub-Channels	Flight Time	0% Cal. Step		25% Cal. Step		50% Cal. Step		75% Cal. Step		100% Cal. Step		0% Change Based on First Cal.	
	Cal. No.	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	0% Cal. Step in %	Range in %
2	1	0	.81	22.82	.14	48.62	.11	74.14	.12	100	.26	--	--
	2	0	.27	22.78	.37	48.40	.33	74.24	.15	100	.22	+.79	+.98
	3	0	.17	22.91	.14	48.04	.16	74.17	.21	100	.25	+.92	+.92
3	1	0	.50	22.60	.06	48.49	.17	74.11	.18	100	.37	--	--
	2	0	.27	22.61	.16	48.43	.07	74.08	.16	100	.23	+.02	+.27
	3	0	.44	22.75	.12	48.41	.09	74.09	.16	100	.22	0	+.37
4	1	0	.32	22.93	.12	48.73	.12	74.22	.10	100	.14	--	--
	2	0	.37	23.0	.19	48.80	.09	74.39	.10	100	.06	+.08	+.14
	3	0	.33	23.0	.15	48.70	.04	74.22	.10	100	.20	+.39	+.39
5	1	0	.25	23.46	.22	48.98	.32	74.45	.26	100	.21	--	--
	2	0	.20	27.74	.20	49.12	.22	74.52	.17	100	.41	-.16	-.13
	3	0	.24	23.45	.17	48.84	.21	74.34	.28	100	.28	+.02	+.45

TABLE 19. SA-4 FM/FM/FM LINK 2 CHANNEL 18 FLIGHT TEST CALIBRATION DATA

Sub-Channels	Flight Time	0% Cal. Step		25% Cal. Step		50% Cal. Step		75% Cal. Step		100% Cal. Step		0% Change Based on First Cal.	
	Cal. No.	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	0% Cal. Step in %	Range in %
2	1	0	.08	22.62	.16	48.51	.11	74.11	.21	100	.22	--	--
	2	0	.19	22.69	.17	48.54	.09	74.29	.11	100	.21	+.03	+.01
	3	0	.09	22.76	.17	48.64	.15	74.31	.21	100	.25	-.15	-.08
3	1	0	.51	23.82	.23	49.1	.18	74.46	.14	100	.05	--	--
	2	0	.18	23.99	.21	49.38	.20	25.35	.17	100	.21	+.06	-.03
	3	0	.13	23.92	.23	49.56	.17	74.67	.13	100	.07	-.04	-.04
4	1	0	.27	23.37	.09	48.89	.13	74.48	.17	100	.20	--	--
	2	0	.10	23.28	.10	48.83	.09	74.47	.13	100	.09	-.14	-.03
	3	0	.31	23.59	.15	49.12	.11	74.62	.23	100	.21	-.44	-.41
5	1	0	.14	22.68	.09	48.41	.16	74.21	.09	100	.08	--	--
	2	0	.20	22.53	.12	48.29	.12	74.25	.11	100	.16	-.12	+.02
	3	0	.14	22.70	.12	48.55	.17	74.27	.13	100	.22	+.02	+.28
6	1	0	.21	22.63	.19	48.42	.21	74.12	.10	100	.09	--	--
	2	0	.19	22.65	.14	48.31	.22	74.30	.12	100	.16	+.06	+.05
	3	0	.11	22.74	.18	48.54	.09	74.22	.29	100	.13	+.03	+.03
7	1	0	.17	22.71	.12	48.35	.10	74.16	.08	100	.12	--	--
	2	0	.22	22.63	.16	48.31	.30	74.2	.22	100	.28	+.12	+.17
	3	0	.15	22.93	.15	48.66	.16	74.45	.20	100	.36	-.12	-.15
8	1	0	.07	23.19	.17	48.69	.12	74.25	.09	100	.14	--	--
	2	0	.21	23.24	.08	48.71	.13	74.39	.19	100	.16	-.09	-.28
	3	0	.15	23.19	.17	48.81	.20	74.35	.10	100	.22	-.08	-.18

TABLE 20. SA-4 FM/FM/FM LINK 3 CHANNEL 18 FLIGHT TEST CALIBRATION DATA

Sub-Channels	Flight Time	0% Cal. Step		25% Cal. Step		50% Cal. Step		75% Cal. Step		100% Cal. Step		0% Change Based on First Cal.	
	Cal. No.	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	0% Cal. Step in %	Range in %
2	1	0	.18	22.59	.26	48.58	.07	74.11	.07	100	.20	--	--
	2	0	.10	22.65	.27	48.02	.23	74.09	.26	100	.09	+.05	+.19
	3	0	.16	22.58	.32	48.46	.09	74.14	.10	100	.23	-.20	+.14
3	1	0	.23	22.92	.17	48.49	.11	74.25	.06	100	.11	--	--
	2	0	.20	23.10	.09	48.76	.13	74.35	.11	100	.13	-.10	+.06
	3	0	.05	22.51	.12	48.72	.14	74.33	.07	100	.24	-.18	+.15
4	1	0	.22	22.80	.13	48.63	.12	74.17	.09	100	.11	--	--
	2	0	.21	22.92	.18	48.93	.07	74.29	.09	100	.10	+.05	+.03
	3	0	.08	22.85	.08	48.58	.07	76.0	.08	100	.17	+.19	+.19
5	1	0	.26	22.79	.09	48.56	.15	74.14	.11	100	.09	--	--
	2	0	.28	23.07	.08	48.70	.20	74.80	.15	100	.16	-.10	-.10
	3	0	.15	22.83	.17	48.54	.12	74.18	.09	100	.19	+.06	+.06
8	1	0	.30	22.75	.13	48.47	.14	74.13	.22	100	.23	--	--
	2	0	.18	22.74	.27	48.71	.17	74.24	.13	100	.14	+.10	+.10
	3	0	.15	22.80	.21	48.51	.18	74.19	.19	100	.23	+.23	-.23
9	1	0	.32	22.67	.26	48.35	.26	73.97	.42	100	.17	--	--
	2	0	.12	22.86	.23	48.41	.13	74.01	.18	100	.09	-.05	+.12
	3	0	.14	22.73	.17	48.51	.10	74.28	.22	100	.11	+.48	-.18

TABLE 21. SA-4 FM/FM/FM LINK 4 CHANNEL 14 FLIGHT TEST CALIBRATION DATA

Sub-Channels	Flight Time	0% Cal. Step		25% Cal. Step		50% Cal. Step		75% Cal. Step		100% Cal. Step		0% Change Based on First Cal.	
	Cal. No.	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	0% Cal. Step in %	Range in %
2	1	0	.29	22.89	.35	48.56	.26	74.12	.25	100	.09	--	--
	2	0	.28	23.01	.31	48.62	.35	74.18	.26	100	.15	+.02	-.11
	3	0	.33	22.91	.32	48.60	.28	74.20	.29	100	.13	+.08	-.08
3	1	0	.35	23.01	.31	48.87	.13	74.35	.06	100	.17	--	--
	2	0	.39	23.35	.22	48.89	.23	74.41	.13	100	.11	-.05	-.05
	3	0	.37	23.10	.39	48.81	.15	74.33	.13	100	.06	-.02	-.02
4	1	0	.16	22.84	.12	48.65	.21	74.28	.20	100	.22	--	--
	2	0	.18	22.90	.12	48.64	.21	74.80	.07	100	.23	+.24	+.21
	3	0	.31	22.86	.09	48.53	.17	74.35	.09	100	.19	-.15	+.21
5	1	0	.25	21.71	.32	47.95	.08	73.99	.23	100	.36	--	--
	2	0	.25	21.96	.16	48.0	.15	73.9	.12	100	.17	+.02	+.06
	3	0	.22	27.82	.19	47.86	.15	73.82	.05	100	.16	-.07	-.07

TABLE 22. SA-4 FM/FM/FM LINK 4 CHANNEL 18 FLIGHT TEST CALIBRATION DATA

Channels	Flight Time	0% Cal. Step		25% Cal. Step		50% Cal. Step		75% Cal. Step		100% Cal. Step		0% Change Based on First Cal.	
	Cal. No.	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	0% Cal. Step in %	Range in %
2	1	0	.21	22.86	.17	48.66	.26	74.31	.21	100	.32	--	--
	2	0	.18	22.92	.17	48.58	.20	74.33	.21	100	.32	-.07	-.08
	3	0	.16	24.55	.22	49.75	.24	74.83	.23	100	.27	-.18	-.08
3	1	0	.27	22.76	.17	48.69	.10	74.33	.09	100	.11	--	--
	2	0	.24	22.80	.21	48.63	.10	74.31	.04	100	.14	-.13	-.06
	3	0	.23	24.79	.15	49.97	.08	74.92	.15	100	.09	-.15	-.08
4	1	0	.21	23.37	.15	49.0	.24	74.48	.13	100	.26	--	--
	2	0	.23	23.52	.15	48.96	.21	74.39	.13	100	.20	+.01	0
	3	0	.25	24.86	.15	49.87	.15	74.80	.16	100	.16	-.12	-.05
5	1	0	.10	22.25	.15	48.81	.14	74.11	.07	100	.23	--	--
	2	0	.20	22.48	.18	48.39	.20	74.18	.10	100	.10	-.05	-.25
	3	0	.06	24.93	.10	50.0	.08	74.90	.14	100	.22	-.17	-.18
9	1	0	.26	23.42	.16	49.03	.17	74.42	.24	100	.25	--	--
	2	0	.20	25.00	.15	50.00	.16	75.01	.23	100	.13	-.01	-.09
	3	0	.17	24.97	.15	49.98	.15	74.94	.24	100	.21	-.14	-.02

TABLE 23. SA-4 FM/FM/FM LINK 5 CHANNEL 14 FLIGHT TEST CALIBRATION DATA

Sub-Channels	Flight Time	0% Cal. Step		25% Cal. Step		50% Cal. Step		75% Cal. Step		100% Cal. Step		0% Change Based on First Cal.	
	Cal. No.	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	Mean in %	σ in %	0% Cal. Step in %	Range in %
2	1	0	.09	22.99	.37	48.33	.27	74.22	.15	100	.18	--	--
	2	0	.11	22.68	.09	51.59	.13	74.16	.15	100	.17	-.08	+.18
	3	0	.30	22.74	.15	48.38	.11	74.16	.12	100	.12	-.09	+.12
3	1	0	.11	24.50	.41	49.74	.16	74.22	.14	100	.11	--	--
	2	0	.30	23.96	.13	49.55	.28	74.57	.12	100	.17	-.38	-.12
	3	0	.38	23.86	.08	49.46	.21	74.43	.12	100	.14	-.34	-.13
4	1	0	.21	23.64	.12	49.17	.13	74.44	.37	100	.18	--	--
	2	0	.43	23.54	.09	48.97	.29	74.57	.21	100	.24	+.24	+.09
	3	0	.38	23.57	.02	48.99	.15	74.45	.12	100	.19	+.13	+.13
5	1	0	.36	23.65	.30	48.98	.27	74.39	.35	100	.40	--	--
	2	0	.25	23.58	.26	49.02	.14	23.22	.13	100	.22	+.18	+.07
	3	0	.27	23.5	.07	48.99	.25	74.43	.12	100	.07	+.08	+.01

TABLE 24. PRECISION OF SA-4 FM/FM/FM SUBCHANNELS BY LINK

95% Confidence Limits							
Link	2	3	4	5	6		
2 Channel 14 ±.52	±.64	±.59	±.42	±.40	±.52		
2 Channel 18 ±.44	2 ±.40	3 ±.42	4 ±.40	5 ±.32	6 ±.40	7 ±.47	8 ±.35
3 Channel 14 ±.59	2 ±.71	3 ±.59	4 ±.44	5 ±.59			
3 Channel 18 ±.42*	2 ±.44	3 ±.32	4 ±.35	5 ±.37	8 ±.47	9 ±.49	
4 Channel 14 ±.54	2 ±.64	3 ±.56	4 ±.42	5 ±.49			
4 Channel 18 ±.47	2 ±.54	3 ±.47	4 ±.44	5 ±.35	9 ±.44		
5 Channel 14 ±.56	2 ±.42	3 ±.52	4 ±.56	5 ±.59			

NOTE: All figures shown in per cent of calibration level range

TABLE 25. THREE-WAY ANOVA WITH REPLICATION FOR INDIVIDUAL OUTPUTS OF FM/FM/FM LINKS 2, 3, 4, AND 5, CHANNEL 14, SUBCHANNELS 2-5 AT THE 25% CALIBRATION LEVEL

ASSUMPTIONS: ALL FACTORS RANDOM

Source	Sum of Squares	Degrees of Freedom	Mean Square	Variance Ratio
Channel	224.8	$N_1 = 3.14$ $N_2 = 9.10$	$S_1^2 = 74.96$	$\frac{S_1^2 + S_e^2}{S_4^2 + S_5^2} = .3983$
Link	940.2	$N_1 = 3.03$ $N_2 = 10.4$	$S_2^2 = 313.4$	$\frac{S_2^2 + S_e^2}{S_4^2 + S_6^2} = 1.515$
Calibration	45.72	$N_1 = 2.32$ $N_2 = 6.76$	$S_3^2 = 22.86$	$\frac{S_3^2 + S_e^2}{S_5^2 + S_6^2} = 1.426$
Channel X Link	1725.	9.	$S_4^2 = 191.6$	$\frac{S_4^2}{S_e^2} = 107.5$ *
Channel X Calibration	5.933	6.	$S_5^2 = .9889$	$\frac{S_5^2}{S_e^2} = .5550$
Link X Calibration	97.69	6.	$S_6^2 = 16.28$	$\frac{S_6^2}{S_e^2} = 9.137$ *
Exp. Error	32.07	18.	$S_e^2 = 1.782$	
TOTAL	3071.			

* Significantly Different at .05 Level of Significance

TABLE 26. THREE-WAY ANOVA WITH REPLICATION FOR INDIVIDUAL OUTPUTS OF FM/FM/FM LINKS 2, 3, 4, AND 5, CHANNEL 14, SUBCHANNELS 2-5 AT THE 50% CALIBRATION LEVEL

ASSUMPTIONS: ALL FACTORS RANDOM

Source	Sum of Squares	Degrees of Freedom	Mean Square	Variance Ratio
Channel	256.7	$N_1 = 3.05$ $N_2 = 9.14$	$S_1^2 = 85.58$	$\frac{S_1^2 + S_e^2}{S_4^2 + S_5^2} = .8226$
Link	625.7	$N_1 = 3.02$ $N_2 = 10.7$	$S_2^2 = 208.5$	$\frac{S_2^2 + S_e^2}{S_4^2 + S_6^2} = 1.822$
Calibration	49.02	$N_1 = 2.13$ $N_2 = 6.90$	$S_3^2 = 24.51$	$\frac{S_3^2 + S_e^2}{S_5^2 + S_6^2} = 2.197$
Channel X Link	937.6	9.	$S_4^2 = 104.1$	$\frac{S_4^2}{S_e^2} = 132.9^*$
Channel X Calibration	4.832	6.	$S_5^2 = .8054$	$\frac{S_5^2}{S_e^2} = 1.027$
Link X Calibration	64.23	6.	$S_6^2 = 10.70$	$\frac{S_6^2}{S_e^2} = 13.65^*$
Exp. Error	14.10	18.	$S_e^2 = .7838$	
TOTAL	1952.			

* Significantly Different at .05 Level of Significance

TABLE 27. THREE-WAY ANOVA WITH REPLICATION FOR INDIVIDUAL OUTPUTS OF FM/FM/FM LINKS 2, 3, 4, AND 5, CHANNEL 14, SUBCHANNEL 2-5 AT THE 75% CALIBRATION LEVEL

ASSUMPTIONS: ALL FACTORS RANDOM

Source	Sum of Squares	Degrees of Freedom	Mean Square	Variance Ratio
Channel	5080.	$N_1 = 11.2$ $N_2 = 14.9$	$S_1^2 = 1693.$	$\frac{S_1^2 + S_e^2}{S_4^2 + S_5^2} = .8605$
Link	5951.	$N_1 = 10.0$ $N_2 = 14.9$	$S_2^2 = 1983.$	$\frac{S_2^2 + S_e^2}{S_4^2 + S_6^2} = .9484$
Calibration	4361.	$N_1 = 6.48$ $N_2 = 12.0$	$S_3^2 = 2180.$	$\frac{S_3^2 + S_e^2}{S_5^2 + S_6^2} = 1.143$
Channel X Link	21200.	9.	$S_4^2 = 2355.$	$\frac{S_4^2}{S_e^2} = 1.236$
Channel X Calibration	10960.	6.	$S_5^2 = 1827.$	$\frac{S_5^2}{S_e^2} = .9589$
Link X Calibration	10470.	6.	$S_6^2 = 1745.$	$\frac{S_6^2}{S_e^2} = .9159$
Exp. Error	34300.	18.	$S_e^2 = 1905.$	
TOTAL	92330.			

* Significantly Different at .05 Level of Significance

TABLE 28. THREE-WAY ANOVA WITH REPLICATION FOR INDIVIDUAL OUTPUTS OF FM/FM/FM LINKS 2, 3, 4, AND 5, CHANNEL 14, SUBCHANNELS 2-5 AT THE 100% CALIBRATION LEVEL

ASSUMPTIONS: ALL FACTORS RANDOM

Source	Sum of Squares	Degrees of Freedom	Mean Square	Variance Ratio
Channel	186.0	$N_1 = 3.09$ $N_2 = 9.14$	$S_1^2 = 62.$	$\frac{S_1^2 + S_e^2}{S_4^2 + S_5^2} = .5501$
Link	715.2	$N_1 = 3.02$ $N_2 = 10.4$	$S_2^2 = 238.4$	$\frac{S_2^2 + S_e^2}{S_4^2 + S_6^2} = 1.946$
Calibration	69.36	$N_1 = 2.10$ $N_2 = 7.12$	$S_3^2 = 34.68$	$\frac{S_3^2 + S_e^2}{S_5^2 + S_6^2} = 3.440$
Channel X Link	1021.	9.	$S_4^2 = 13.4$	$\frac{S_4^2}{S_e^2} = 124.8$ *
Channel X Calibration	5.328	6.	$S_5^2 = .888$	$\frac{S_5^2}{S_e^2} = .9771$
Link X Calibration	56.73	6.	$S_6^2 = 9.456$	$\frac{S_6^2}{S_e^2} = 10.40$ *
Exp. Error	16.36	18.	$S_e^2 = 18.$	
TOTAL	2070.			

* Significantly Different at .05 Level of Significance

TABLE 29. THREE-WAY ANOVA WITH REPLICATION FOR INDIVIDUAL OUTPUTS OF FM/FM/FM LINKS 2, 3, AND 4, CHANNEL 18, SUBCHANNELS 2-5 AT THE 25% CALIBRATION LEVEL

ASSUMPTIONS: ALL FACTORS RANDOM

Source	Sum of Squares	Degrees of Freedom	Mean Square	Variance Ratio
Channel	14250.	$N_1 = 10.3$ $N_2 = 11.9$	$S_1^2 = 4752.$	$\frac{S_1^2 + S_e^2}{S_4^2 + S_5^2} = 1.081$
Link	9072.	$N_1 = 7.76$ $N_2 = 9.44$	$S_2^2 = 4536.$	$\frac{S_2^2 + S_e^2}{S_4^2 + S_6^2} = 1.052$
Calibration	12670.	$N_1 = 6.12$ $N_2 = 9.58$	$S_3^2 = 6336.$	$\frac{S_3^2 + S_e^2}{S_5^2 + S_6^2} = 1.201$
Channel X Link	27140.	6.	$S_4^2 = 4523.$	$\frac{S_4^2}{S_e^2} = .8390$
Channel X Calibration	29130.	6.	$S_5^2 = 4855.$	$\frac{S_5^2}{S_e^2} = .9005$
Link X Calibration	19620.	4.	$S_6^2 = 4905.$	$\frac{S_6^2}{S_e^2} = .9098$
Exp. Error	64700.	12.	$S_e^2 = 5391.$	
TOTAL	176600.			

* Significantly Different at .05 Level of Significance

TABLE 30. THREE-WAY ANOVA WITH REPLICATION FOR INDIVIDUAL OUTPUTS OF FM/FM/FM LINKS 2, 3, AND 4, CHANNEL 18, SUBCHANNELS 2-5 AT THE 50% CALIBRATION LEVEL

ASSUMPTIONS: ALL FACTORS RANDOM

Source	Sum of Squares	Degrees of Freedom	Mean Square	Variance Ratio
Channel	28.81	$N_1 = 3.49$ $N_2 = 2.65$	$S_1^2 = 9.605$	$\frac{S_1^2 + S_e^2}{S_4^2 + S_5^2} = .1218$
Link	9.904	$N_1 = 2.65$ $N_2 = 7.01$	$S_2^2 = 4.952$	$\frac{S_2^2 + S_e^2}{S_4^2 + S_6^2} = .06316$
Calibration	87.86	$N_1 = 2.07$ $N_2 = 6.06$	$S_3^2 = 43.93$	$\frac{S_3^2 + S_e^2}{S_5^2 + S_6^2} = 4.930$
Channel X Link	99.2	6.	$S_4^2 = 83.20$	$\frac{S_4^2}{S_e^2} = 109.7$ *
Channel X Calibration	11.16	6.	$S_5^2 = 1.860$	$\frac{S_5^2}{S_e^2} = 2.454$
Link X Calibration	28.81	4.	$S_6^2 = 7.202$	$\frac{S_6^2}{S_e^2} = 9.499$ *
Exp. Error	9.098	12.	$S_e^2 = 7582.$	
TOTAL	674.8			

* Significantly Different at .05 Level of Significance

TABLE 31. THREE-WAY ANOVA WITH REPLICATION FOR INDIVIDUAL OUTPUTS OF FM/FM/FM LINKS 2, 3, AND 4, CHANNEL 18, SUBCHANNELS 2-5 AT THE 75% CALIBRATION LEVEL

ASSUMPTIONS: ALL FACTORS RANDOM

Source	Sum of Squares	Degrees of Freedom	Mean Square	Variance Ratio
Channel	176.8	$N_1 = 3.06$ $N_2 = 6.09$	$S_1^2 = 58.93$	$\frac{S_1^2 + S_e^2}{S_4^2 + S_5^2} = .4272$
Link	5.775	$N_1 = 2.98$ $N_2 = 6.86$	$S_2^2 = 2.887$	$\frac{S_2^2 + S_e^2}{S_4^2 + S_6^2} = .02381$
Calibration	76.95	$N_1 = 2.07$ $N_2 = 4.78$	$S_3^2 = 38.47$	$\frac{S_3^2 + S_e^2}{S_5^2 + S_6^2} = 3.509$
Channel X Link	831.0	6.	$S_4^2 = 138.5$	$\frac{S_4^2}{S_e^2} = 212.4$ *
Channel X Calibration	5.9	6.	$S_5^2 = .9834$	$\frac{S_5^2}{S_e^2} = 1.508$
Link X Calibration	40.66	4.	$S_6^2 = 10.16$	$\frac{S_6^2}{S_e^2} = 15.59$ *
Exp. Error	7.822	12.	$S_e^2 = .6518$	
TOTAL	1144.			

* Significantly Different at .05 Level of Significance

TABLE 32. THREE-WAY ANOVA WITH REPLICATION FOR INDIVIDUAL OUTPUTS OF FM/FM/FM LINKS 2, 3, AND 4, CHANNEL 18, SUBCHANNELS 2-5, AT THE 100% CALIBRATION LEVEL

ASSUMPTIONS: ALL FACTORS RANDOM

Source	Sum of Squares	Degrees of Freedom	Mean Square	Variance Ratio
Channel	413.2	$N_1 = 3.21$ $N_2 = 6.45$	$S_1^2 = 137.7$	$\frac{S_1^2 + S_e^2}{S_4^2 + S_5^2} = 1.018$
Link	91.29	$N_1 = 2.43$ $N_2 = 9.27$	$S_2^2 = 45.64$	$\frac{S_2^2 + S_e^2}{S_4^2 + S_6^2} = .2755$
Calibration	40.91	$N_1 = 3.00$ $N_2 = 4.85$	$S_3^2 = 20.45$	$\frac{S_3^2 + S_e^2}{S_5^2 + S_6^2} = .4757$
Channel X Link	809.3	6.	$S_4^2 = 134.8$	$\frac{S_4^2}{S_e^2} = 28.60 *$
Channel X Calibration	30.24	6.	$S_5^2 = 5.040$	$\frac{S_5^2}{S_e^2} = .068$
Link X Calibration	191.5	4.	$S_6^2 = 47.87$	$\frac{S_6^2}{S_e^2} = 10.15 *$
Exp. Error	56.58	12.	$S_e^2 = 4.715$	
TOTAL	1576.42			

* Significantly Different at .05 Level of Significance

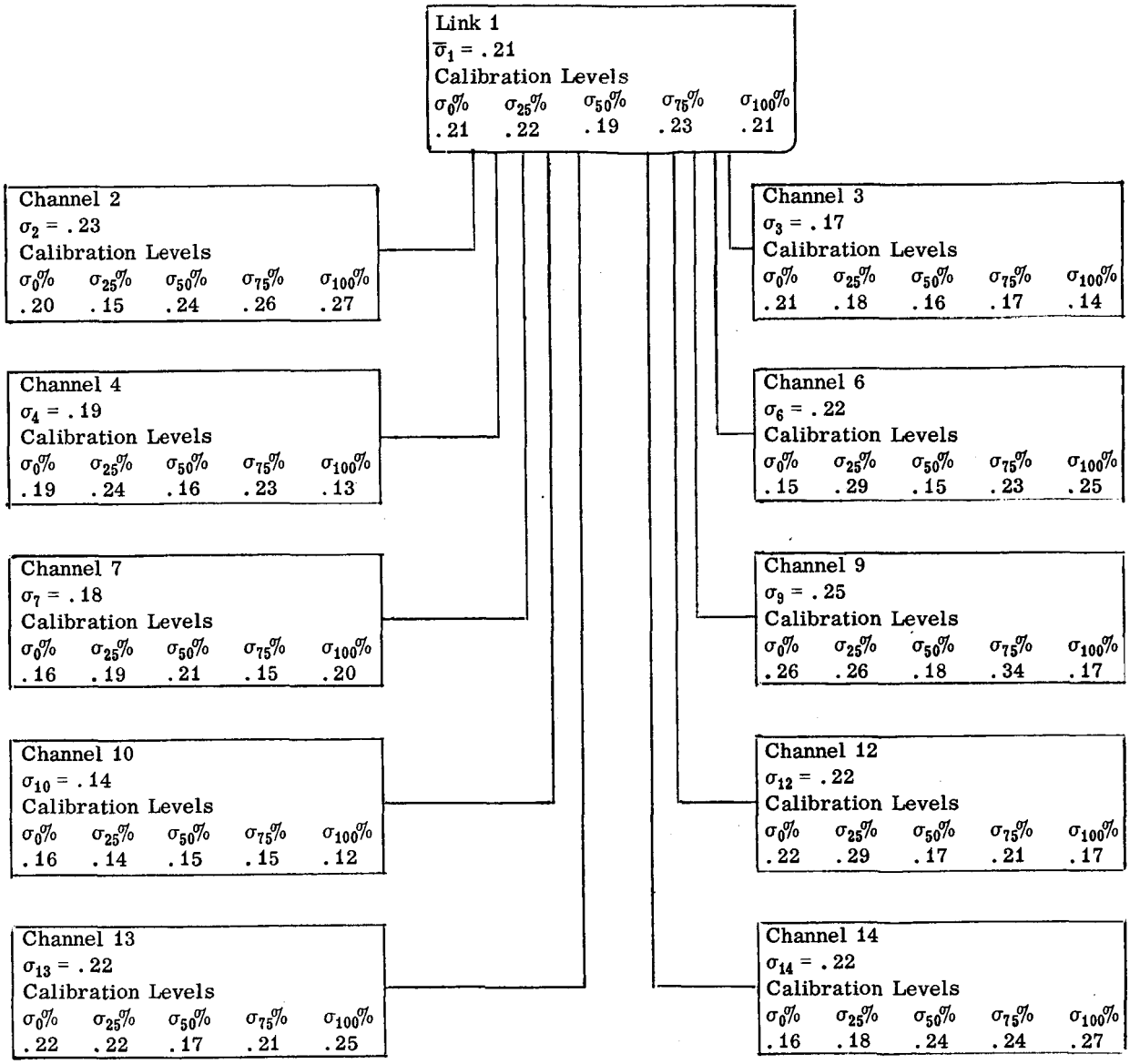
TABLE 33. SA-4 PCM CALIBRATION

cal. level	read-ing	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
0%	24	0	0	0	0	0	1	0	0	0	0
	15	0	0	0	0	0	0	1	1	1	1
25%	264	0	1	0	0	0	0	1	0	0	0
	255	0	0	1	1	1	1	1	1	1	1
	254	0	0	1	1	1	1	1	1	1	0
50%	504	0	1	1	1	1	1	1	0	0	0
	495	0	1	1	1	1	0	1	1	1	1
	494	0	1	1	1	1	0	1	1	1	0
75%	744	1	0	1	1	1	0	1	0	0	0
	735	1	0	1	1	0	1	1	1	1	1
	734	1	0	1	1	0	1	1	1	1	0
	733	1	0	1	1	0	1	1	1	0	1

APPENDIX A

This appendix contains a detailed breakdown of the composite variances for the SA-4 FM/FM telemetry systems.

TABLE I-1. FM/FM



NOTE: A - All σ's are shown in % of total range.
B - See Tables 28, 29, and 30 for elaboration of subchannel σ's.

TABLE I-2. LINK 1 FM/FM

NOTE: All σ's are Shown in % of total range.

Channel 2
$\bar{\sigma}_2 = .23$
$\sigma_{cal-1} = .25$ $\sigma_{cal-2} = .16$ $\sigma_{cal-3} = .19$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .20$	$\sigma_{25} = .15$	$\sigma_{50} = .24$	$\sigma_{75} = .26$	$\sigma_{100} = .27$
$\sigma_{cal-1} = .23$	$\sigma_{cal-1} = .12$	$\sigma_{cal-1} = .36$	$\sigma_{cal-1} = .09$	$\sigma_{cal-1} = .31$
$\sigma_{cal-2} = .13$	$\sigma_{cal-2} = .19$	$\sigma_{cal-2} = .13$	$\sigma_{cal-2} = .38$	$\sigma_{cal-2} = .27$
$\sigma_{cal-3} = .21$	$\sigma_{cal-3} = .16$	$\sigma_{cal-3} = .14$	$\sigma_{cal-3} = .21$	$\sigma_{cal-3} = .23$

Channel 3
$\bar{\sigma}_3 = .17$
$\sigma_{cal-1} = .15$ $\sigma_{cal-2} = .22$ $\sigma_{cal-3} = .14$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .21$	$\sigma_{25} = .18$	$\sigma_{50} = .16$	$\sigma_{75} = .17$	$\sigma_{100} = .14$
$\sigma_{cal-1} = .19$	$\sigma_{cal-1} = .05$	$\sigma_{cal-1} = .18$	$\sigma_{cal-1} = .17$	$\sigma_{cal-1} = .14$
$\sigma_{cal-2} = .31$	$\sigma_{cal-2} = .25$	$\sigma_{cal-2} = .18$	$\sigma_{cal-2} = .15$	$\sigma_{cal-2} = .16$
$\sigma_{cal-3} = .09$	$\sigma_{cal-3} = .16$	$\sigma_{cal-3} = .13$	$\sigma_{cal-3} = .17$	$\sigma_{cal-3} = .12$

Channel 4
$\bar{\sigma}_4 = .19$
$\sigma_{cal-1} = .19$ $\sigma_{cal-2} = .21$ $\sigma_{cal-3} = .18$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .19$	$\sigma_{25} = .24$	$\sigma_{50} = .16$	$\sigma_{75} = .23$	$\sigma_{100} = .13$
$\sigma_{cal-1} = .14$	$\sigma_{cal-1} = .24$	$\sigma_{cal-1} = .15$	$\sigma_{cal-1} = .26$	$\sigma_{cal-1} = .14$
$\sigma_{cal-2} = .29$	$\sigma_{cal-2} = .21$	$\sigma_{cal-2} = .13$	$\sigma_{cal-2} = .25$	$\sigma_{cal-2} = .13$
$\sigma_{cal-3} = .08$	$\sigma_{cal-3} = .27$	$\sigma_{cal-3} = .19$	$\sigma_{cal-3} = .17$	$\sigma_{cal-3} = .13$

Channel 6
$\bar{\sigma}_6 = .22$
$\sigma_{cal-1} = .22$ $\sigma_{cal-2} = .24$ $\sigma_{cal-3} = .21$

Calibration Level				
0%	25%	50%	75%	100%
σ_0 .15	σ_{25} .29	σ_{50} .15	σ_{75} .23	σ_{100} .25
σ_{cal-1} .17	σ_{cal-1} .24	σ_{cal-1} .10	σ_{cal-1} .28	σ_{cal-1} .24
$\sigma_{cal-2} = .05$	$\sigma_{cal-2} = .40$	$\sigma_{cal-2} = .17$	$\sigma_{cal-2} = .21$	$\sigma_{cal-2} = .26$
$\sigma_{cal-3} = .20$	$\sigma_{cal-3} = .22$	$\sigma_{cal-3} = .18$	$\sigma_{cal-3} = .20$	$\sigma_{cal-3} = .26$

TABLE I-3. LINK 1 FM/FM

NOTE: All σ's are shown in % of total range

Channel 7

$\bar{\sigma}_7 = .18$

$\sigma_{cal-1} = .15$ $\sigma_{cal-2} = .19$ $\sigma_{cal-3} = .16$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .16$	$\sigma_{25} = .19$	$\sigma_{50} = .21$	$\sigma_{75} = .15$	$\sigma_{100} = .20$
$\sigma_{cal-1} = .18$	$\sigma_{cal-1} = .10$	$\sigma_{cal-1} = .09$	$\sigma_{cal-1} = .18$	$\sigma_{cal-1} = .19$
$\sigma_{cal-2} = .14$	$\sigma_{cal-2} = .26$	$\sigma_{cal-2} = .14$	$\sigma_{cal-2} = .09$	$\sigma_{cal-2} = .25$
$\sigma_{cal-3} = .14$	$\sigma_{cal-3} = .20$	$\sigma_{cal-3} = .15$	$\sigma_{cal-3} = .17$	$\sigma_{cal-3} = .13$

Channel 9

$\bar{\sigma}_9 = .25$

$\sigma_{cal-1} = .24$ $\sigma_{cal-2} = .24$ $\sigma_{cal-3} = .26$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .26$	$\sigma_{25} = .26$	$\sigma_{50} = .18$	$\sigma_{75} = .34$	$\sigma_{100} = .17$
$\sigma_{cal-1} .31$	$\sigma_{cal-1} = .16$	$\sigma_{cal-1} = .19$	$\sigma_{cal-1} = .33$	$\sigma_{cal-1} = .19$
$\sigma_{cal-2} .25$	$\sigma_{cal-2} = .30$	$\sigma_{cal-2} = .19$	$\sigma_{cal-2} = .26$	$\sigma_{cal-2} = .20$
$\sigma_{cal-3} .20$	$\sigma_{cal-3} = .28$	$\sigma_{cal-3} = .16$	$\sigma_{cal-3} = .41$	$\sigma_{cal-3} = .13$

Channel 10

$\bar{\sigma}_{10} = .14$

$\sigma_{cal-1} = .14$ $\sigma_{cal-2} = .15$ $\sigma_{cal-3} = .13$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .16$	$\sigma_{25} = .14$	$\sigma_{50} = .15$	$\sigma_{75} = .15$	$\sigma_{100} = .12$
$\sigma_{cal-1} = .19$	$\sigma_{cal-1} = .11$	$\sigma_{cal-1} = .09$	$\sigma_{cal-1} = .17$	$\sigma_{cal-1} = .13$
$\sigma_{cal-2} = .16$	$\sigma_{cal-2} = .15$	$\sigma_{cal-2} = .20$	$\sigma_{cal-2} = .13$	$\sigma_{cal-2} = .11$
$\sigma_{cal-3} = .11$	$\sigma_{cal-3} = .15$	$\sigma_{cal-3} = .13$	$\sigma_{cal-3} = .16$	$\sigma_{cal-3} = .11$

Channel 12

$\bar{\sigma}_{12} = .22$

$\sigma_{cal-1} = .24$ $\sigma_{cal-2} = .22$ $\sigma_{cal-3} = .19$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .22$	$\sigma_{25} = .29$	$\sigma_{50} = .17$	$\sigma_{75} = .21$	$\sigma_{100} = .17$
$\sigma_{cal-1} = .26$	$\sigma_{cal-1} = .32$	$\sigma_{cal-1} = .12$	$\sigma_{cal-1} = .25$	$\sigma_{cal-1} = .19$
$\sigma_{cal-2} = .18$	$\sigma_{cal-2} = .33$	$\sigma_{cal-2} = .19$	$\sigma_{cal-2} = .22$	$\sigma_{cal-2} = .09$
$\sigma_{cal-3} = .22$	$\sigma_{cal-3} = .19$	$\sigma_{cal-3} = .20$	$\sigma_{cal-3} = .15$	$\sigma_{cal-3} = .21$

TABLE I-4. LINK 1 FM/FM

Channel 13
$\bar{\sigma}_{13} = .22$ $\sigma_{cal-1} = .24$ $\sigma_{cal-2} = .19$ $\sigma_{cal-3} = .21$

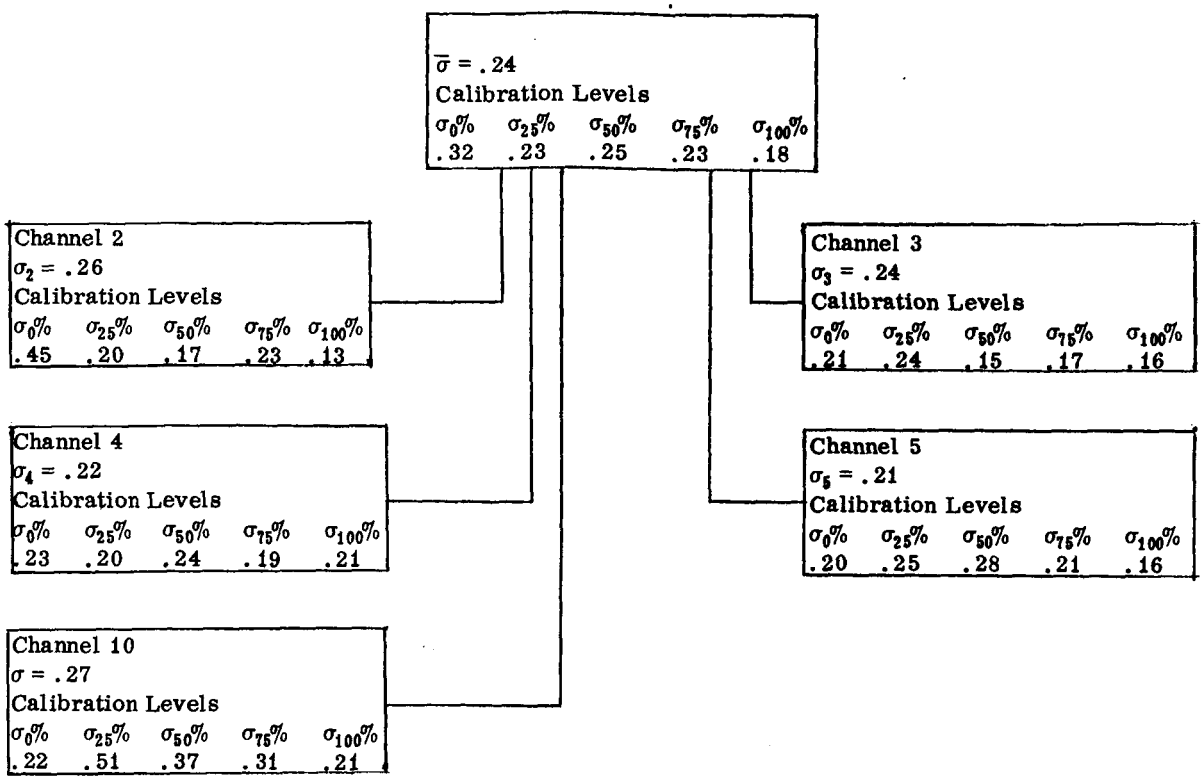
NOTE: All σ's are shown in % of total range.

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .22$ $\sigma_{cal-1} = .28$ $\sigma_{cal-2} = .13$ $\sigma_{cal-3} = .20$	$\sigma_{25} = .22$ $\sigma_{cal-1} = .18$ $\sigma_{cal-2} = .27$ $\sigma_{cal-3} = .21$	$\sigma_{50} = .17$ $\sigma_{cal-1} = .18$ $\sigma_{cal-2} = .13$ $\sigma_{cal-3} = .20$	$\sigma_{75} = .21$ $\sigma_{cal-1} = .26$ $\sigma_{cal-2} = .16$ $\sigma_{cal-3} = .21$	$\sigma_{100} = .25$ $\sigma_{cal-1} = .29$ $\sigma_{cal-2} = .22$ $\sigma_{cal-3} = .25$

Channel 14
$\bar{\sigma}_{14} = .22$ $\sigma_{cal-1} = .17$ $\sigma_{cal-2} = .26$ $\sigma_{cal-3} = .27$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .16$ $\sigma_{cal-1} = .16$ $\sigma_{cal-2} = .18$ $\sigma_{cal-3} = .13$	$\sigma_{25} = .18$ $\sigma_{cal-1} = .22$ $\sigma_{cal-2} = .12$ $\sigma_{cal-3} = .19$	$\sigma_{50} = .24$ $\sigma_{cal-1} = .08$ $\sigma_{cal-2} = .11$ $\sigma_{cal-3} = .39$	$\sigma_{75} = .24$ $\sigma_{cal-1} = .22$ $\sigma_{cal-2} = .24$ $\sigma_{cal-3} = .25$	$\sigma_{100} = .27$ $\sigma_{cal-1} = .15$ $\sigma_{cal-2} = .30$ $\sigma_{cal-3} = .32$

TABLE II-1. LINK 2 FM/FM



NOTE: A - All σ's are shown in % of total range.
B - See Tables 2 and 3 for elaboration of Channel σ's.

TABLE II-2. LINK 2 FM/FM

Channel 2
$\bar{\sigma}_2 = .26$
$\sigma_{cal-1} = .22$ $\sigma_{cal-2} = .27$ $\sigma_{cal-3} = .28$

NOTE: All σ's are shown in % of total range.

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .45$	$\sigma_{25} = .20$	$\sigma_{50} = .17$	$\sigma_{75} = .23$	$\sigma_{100} = .13$
$\sigma_{cal-1} = .28$	$\sigma_{cal-1} = .19$	$\sigma_{cal-1} = .26$	$\sigma_{cal-1} = .20$	$\sigma_{cal-1} = .16$
$\sigma_{cal-2} = .53$	$\sigma_{cal-2} = .29$	$\sigma_{cal-2} = .07$	$\sigma_{cal-2} = .12$	$\sigma_{cal-2} = .08$
$\sigma_{cal-3} = .51$	$\sigma_{cal-3} = .09$	$\sigma_{cal-3} = .12$	$\sigma_{cal-3} = .32$	$\sigma_{cal-3} = .15$

Channel 3
$\bar{\sigma}_3 = .24$
$\sigma_{cal-1} = .20$ $\sigma_{cal-2} = .16$ $\sigma_{cal-3} = .32$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .21$	$\sigma_{25} = .24$	$\sigma_{50} = .15$	$\sigma_{75} = .17$	$\sigma_{100} = .16$
$\sigma_{cal-1} = .37$	$\sigma_{cal-1} = .10$	$\sigma_{cal-1} = .09$	$\sigma_{cal-1} = .18$	$\sigma_{cal-1} = .13$
$\sigma_{cal-2} = .19$	$\sigma_{cal-2} = .22$	$\sigma_{cal-2} = .11$	$\sigma_{cal-2} = .09$	$\sigma_{cal-2} = .14$
$\sigma_{cal-3} = .54$	$\sigma_{cal-3} = .33$	$\sigma_{cal-3} = .21$	$\sigma_{cal-3} = .22$	$\sigma_{cal-3} = .21$

Channel 4
$\bar{\sigma}_4 = .22$
$\sigma_{cal-1} = .17$ $\sigma_{cal-2} = .26$ $\sigma_{cal-3} = .22$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .23$	$\sigma_{25} = .20$	$\sigma_{50} = .24$	$\sigma_{75} = .19$	$\sigma_{100} = .21$
$\sigma_{cal-1} = .21$	$\sigma_{cal-1} = .18$	$\sigma_{cal-1} = .14$	$\sigma_{cal-1} = .17$	$\sigma_{cal-1} = .12$
$\sigma_{cal-2} = .16$	$\sigma_{cal-2} = .30$	$\sigma_{cal-2} = .30$	$\sigma_{cal-2} = .23$	$\sigma_{cal-2} = .30$
$\sigma_{cal-3} = .29$	$\sigma_{cal-3} = .22$	$\sigma_{cal-3} = .25$	$\sigma_{cal-3} = .16$	$\sigma_{cal-3} = .15$

Channel 5
$\bar{\sigma}_5 = .21$
$\sigma_{cal-1} = .25$ $\sigma_{cal-2} = .18$ $\sigma_{cal-3} = .16$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .20$	$\sigma_{25} = .20$	$\sigma_{50} = .28$	$\sigma_{75} = .21$	$\sigma_{100} = .16$
$\sigma_{cal-1} = .19$	$\sigma_{cal-1} = .22$	$\sigma_{cal-1} = .40$	$\sigma_{cal-1} = .25$	$\sigma_{cal-1} = .16$
$\sigma_{cal-2} = .20$	$\sigma_{cal-2} = .20$	$\sigma_{cal-2} = .24$	$\sigma_{cal-2} = .11$	$\sigma_{cal-2} = .16$
$\sigma_{cal-3} = .21$	$\sigma_{cal-3} = .18$	$\sigma_{cal-3} = .13$	$\sigma_{cal-3} = .23$	$\sigma_{cal-3} = .16$

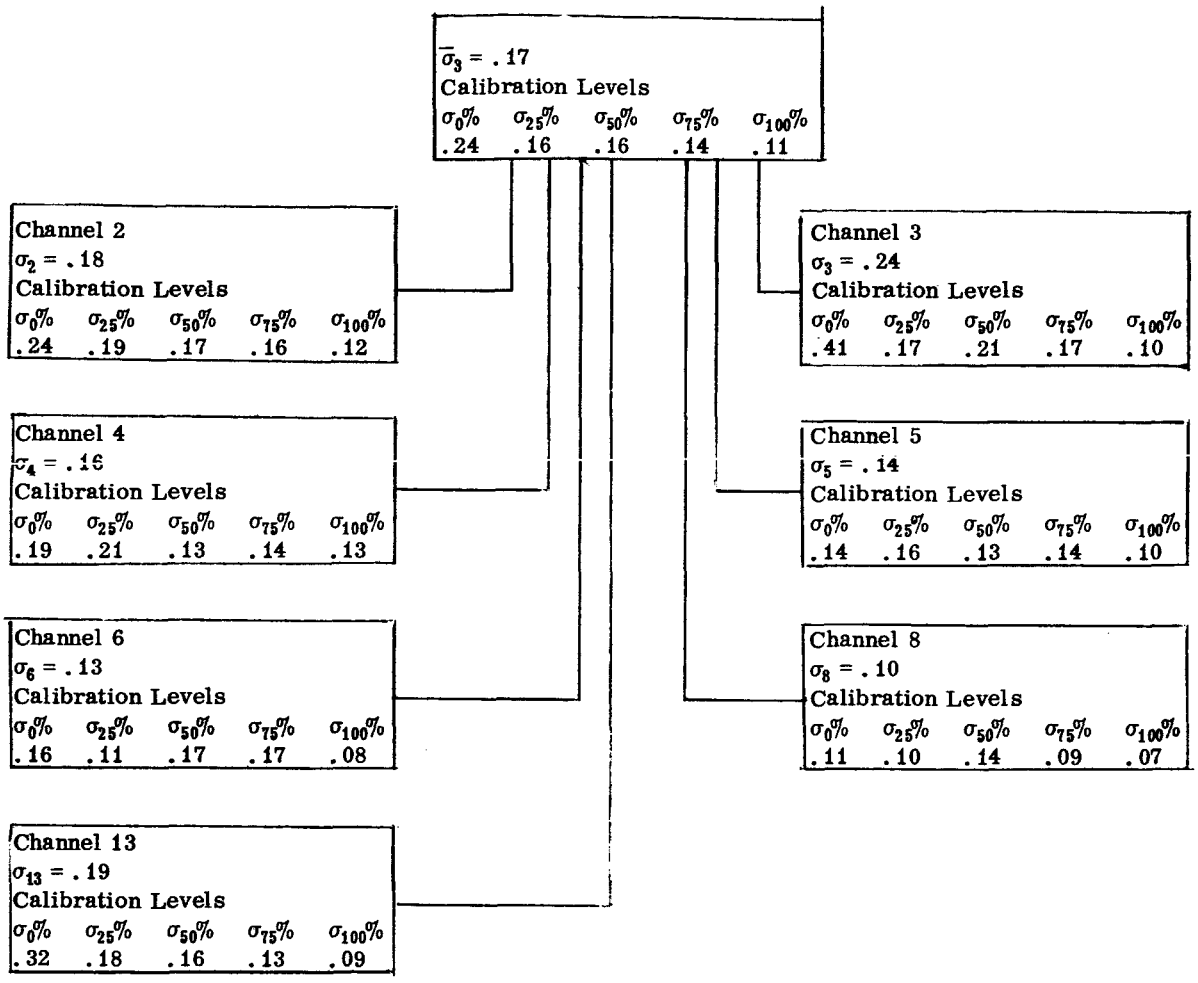
TABLE II-3. LINK 2 FM/FM

Channel 10

$\sigma_{10} = .27$		
$\sigma_{cal-1} = .16$	$\sigma_{cal-2} = .26$	$\sigma_{cal-3} = .36$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .22$	$\sigma_{25} = .51$	$\sigma_{50} = .37$	$\sigma_{75} = .31$	$\sigma_{100} = .21$
$\sigma_{cal-1} = .22$	$\sigma_{cal-1} = .17$	$\sigma_{cal-1} = .13$	$\sigma_{cal-1} = .15$	$\sigma_{cal-1} = .21$
$\sigma_{cal-2} = .20$	$\sigma_{cal-2} = .25$	$\sigma_{cal-2} = .39$	$\sigma_{cal-2} = .25$	$\sigma_{cal-2} = .19$
$\sigma_{cal-3} = .25$	$\sigma_{cal-3} = .30$	$\sigma_{cal-3} = .49$	$\sigma_{cal-3} = .45$	$\sigma_{cal-3} = .23$

TABLE III-1. LINK 3 FM/FM



NOTE: A - All σ's are shown in % of total range.
B - See Tables 4 and 5 for elaboration of Channel σ's.

TABLE III-2. LINK 3 FM/FM

Channel 2
$\bar{\sigma}_2 = .18$
$\sigma_{cal-1} = .20$ $\sigma_{cal-2} = .15$ $\sigma_{cal-3} = .19$

NOTE: All σ's are shown in % of total range.

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .24$	$\sigma_{25} = .19$	$\sigma_{50} = .17$	$\sigma_{75} = .16$	$\sigma_{100} = .12$
$\sigma_{cal-1} = .24$	$\sigma_{cal-1} = .19$	$\sigma_{cal-1} = .23$	$\sigma_{cal-1} = .19$	$\sigma_{cal-1} = .10$
$\sigma_{cal-2} = .13$	$\sigma_{cal-2} = .19$	$\sigma_{cal-2} = .12$	$\sigma_{cal-2} = .16$	$\sigma_{cal-2} = .15$
$\sigma_{cal-3} = .31$	$\sigma_{cal-3} = .19$	$\sigma_{cal-3} = .14$	$\sigma_{cal-3} = .10$	$\sigma_{cal-3} = .10$

Channel 3
$\bar{\sigma}_3 = .24$
$\sigma_{cal-1} = .23$ $\sigma_{cal-2} = .18$ $\sigma_{cal-3} = .29$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .41$	$\sigma_{25} = .17$	$\sigma_{50} = .21$	$\sigma_{75} = .17$	$\sigma_{100} = .10$
$\sigma_{cal-1} = .36$	$\sigma_{cal-1} = .18$	$\sigma_{cal-1} = .21$	$\sigma_{cal-1} = .19$	$\sigma_{cal-1} = .12$
$\sigma_{cal-2} = .22$	$\sigma_{cal-2} = .20$	$\sigma_{cal-2} = .19$	$\sigma_{cal-2} = .17$	$\sigma_{cal-2} = .10$
$\sigma_{cal-3} = .57$	$\sigma_{cal-3} = .10$	$\sigma_{cal-3} = .23$	$\sigma_{cal-3} = .15$	$\sigma_{cal-3} = .09$

Channel 4
$\bar{\sigma}_4 = .16$
$\sigma_{cal-1} = .15$ $\sigma_{cal-2} = .18$ $\sigma_{cal-3} = .16$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .19$	$\sigma_{25} = .21$	$\sigma_{50} = .13$	$\sigma_{75} = .14$	$\sigma_{100} = .13$
$\sigma_{cal-1} = .14$	$\sigma_{cal-1} = .22$	$\sigma_{cal-1} = .08$	$\sigma_{cal-1} = .15$	$\sigma_{cal-1} = .11$
$\sigma_{cal-2} = .25$	$\sigma_{cal-2} = .25$	$\sigma_{cal-2} = .14$	$\sigma_{cal-2} = .13$	$\sigma_{cal-2} = .10$
$\sigma_{cal-3} = .19$	$\sigma_{cal-3} = .15$	$\sigma_{cal-3} = .17$	$\sigma_{cal-3} = .13$	$\sigma_{cal-3} = .17$

Channel 5
$\bar{\sigma}_5 = .13$
$\sigma_{cal-1} = .12$ $\sigma_{cal-2} = .16$ $\sigma_{cal-3} = .13$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .14$	$\sigma_{25} = .16$	$\sigma_{50} = .13$	$\sigma_{75} = .14$	$\sigma_{100} = .10$
$\sigma_{cal-1} = .14$	$\sigma_{cal-1} = .14$	$\sigma_{cal-1} = .15$	$\sigma_{cal-1} = .09$	$\sigma_{cal-1} = .08$
$\sigma_{cal-2} = .19$	$\sigma_{cal-2} = .14$	$\sigma_{cal-2} = .15$	$\sigma_{cal-2} = .18$	$\sigma_{cal-2} = .12$
$\sigma_{cal-3} = .07$	$\sigma_{cal-3} = .19$	$\sigma_{cal-3} = .10$	$\sigma_{cal-3} = .15$	$\sigma_{cal-3} = .11$

TABLE III-3. LINK 3 FM/FM

Channel 6
$\overline{\sigma}_6 = .13$
$\sigma_{cal-1} = .16$ $\sigma_{cal-2} = .15$ $\sigma_{cal-3} = .10$

NOTE: All σ's are shown in % of total range.

Channel 8
$\overline{\sigma}_8 = .10$
$\sigma_{cal-1} = .10$ $\sigma_{cal-2} = .12$ $\sigma_{cal-3} = .10$

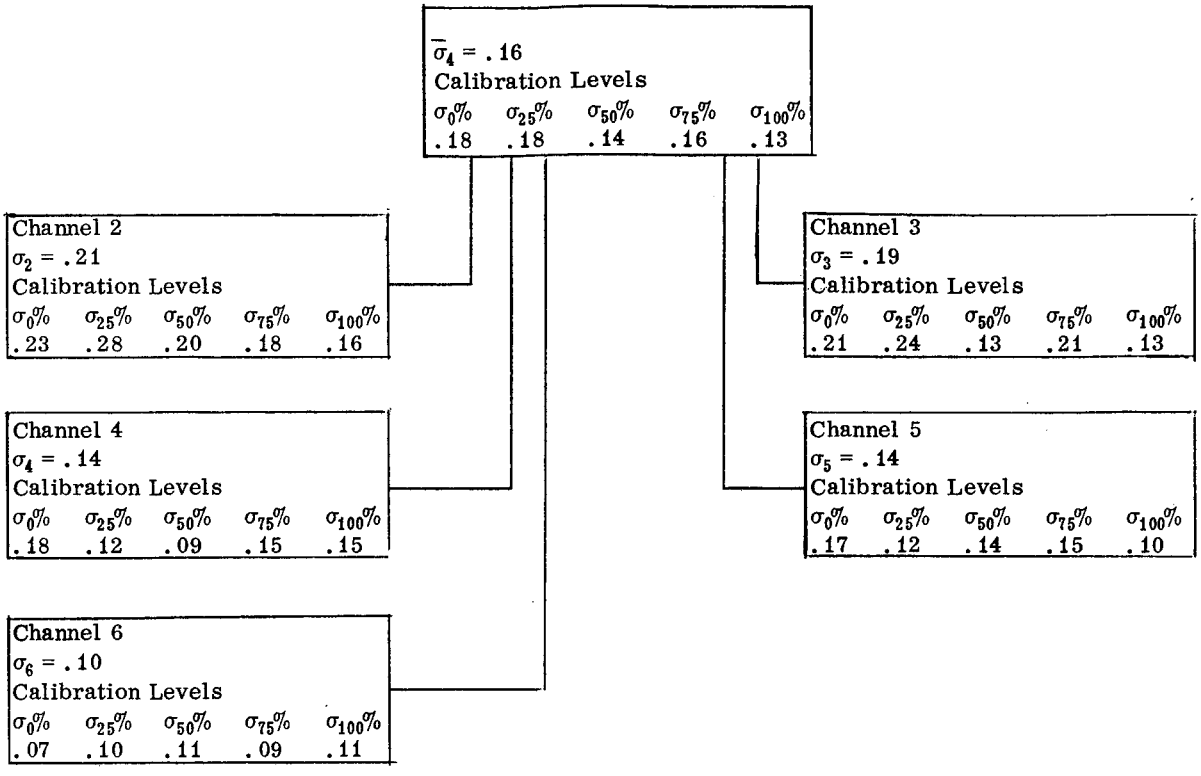
Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .16$	$\sigma_{25} = .11$	$\sigma_{50} = .17$	$\sigma_{75} = .17$	$\sigma_{100} = .08$
$\sigma_{cal-1} = .16$	$\sigma_{cal-1} = .12$	$\sigma_{cal-1} = .18$	$\sigma_{cal-1} = .23$	$\sigma_{cal-1} = .09$
$\sigma_{cal-2} = .19$	$\sigma_{cal-2} = .09$	$\sigma_{cal-2} = .20$	$\sigma_{cal-2} = .16$	$\sigma_{cal-2} = .09$
$\sigma_{cal-3} = .10$	$\sigma_{cal-3} = .11$	$\sigma_{cal-3} = .12$	$\sigma_{cal-3} = .07$	$\sigma_{cal-3} = .06$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .11$	$\sigma_{25} = .10$	$\sigma_{50} = .14$	$\sigma_{75} = .09$	$\sigma_{100} = .07$
$\sigma_{cal-1} = .09$	$\sigma_{cal-1} = .14$	$\sigma_{cal-1} = .09$	$\sigma_{cal-1} = .09$	$\sigma_{cal-1} = .06$
$\sigma_{cal-2} = .13$	$\sigma_{cal-2} = .07$	$\sigma_{cal-2} = .20$	$\sigma_{cal-2} = .06$	$\sigma_{cal-2} = .07$
$\sigma_{cal-3} = .12$	$\sigma_{cal-3} = .08$	$\sigma_{cal-3} = .09$	$\sigma_{cal-3} = .11$	$\sigma_{cal-3} = .07$

Channel 13
$\overline{\sigma}_{13} = .19$
$\sigma_{cal-1} = .29$ $\sigma_{cal-2} = .16$ $\sigma_{cal-3} = .12$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .32$	$\sigma_{25} = .18$	$\sigma_{50} = .16$	$\sigma_{75} = .13$	$\sigma_{100} = .09$
$\sigma_{cal-1} = .53$	$\sigma_{cal-1} = .17$	$\sigma_{cal-1} = .18$	$\sigma_{cal-1} = .08$	$\sigma_{cal-1} = .09$
$\sigma_{cal-2} = .14$	$\sigma_{cal-2} = .19$	$\sigma_{cal-2} = .17$	$\sigma_{cal-2} = .18$	$\sigma_{cal-2} = .13$
$\sigma_{cal-3} = .04$	$\sigma_{cal-3} = .18$	$\sigma_{cal-3} = .15$	$\sigma_{cal-3} = .10$	$\sigma_{cal-3} = .04$

TABLE IV-1. LINK 4 FM/FM



NOTE: A - All σ's are shown in % of total range.
B - See Tables 7 and 8 for elaboration of Channel σ's.

TABLE IV-2. LINK 4 FM/FM

Channel 2
$\bar{\sigma}_2 = .21$
$\sigma_{cal-1} = .21$ $\sigma_{cal-2} = .25$ $\sigma_{cal-3} = .17$

NOTE: All σ's are shown in % of total range.

Channel 3
$\bar{\sigma}_3 = .19$
$\sigma_{cal-1} = .21$ $\sigma_{cal-2} = .21$ $\sigma_{cal-3} = .15$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .23$	$\sigma_{25} = .28$	$\sigma_{50} = .20$	$\sigma_{75} = .18$	$\sigma_{100} = .16$
$\sigma_{cal-1} = .18$	$\sigma_{cal-1} = .28$	$\sigma_{cal-1} = .10$	$\sigma_{cal-1} = .26$	$\sigma_{cal-1} = .19$
$\sigma_{cal-2} = .30$	$\sigma_{cal-2} = .32$	$\sigma_{cal-2} = .31$	$\sigma_{cal-2} = .12$	$\sigma_{cal-2} = .13$
$\sigma_{cal-3} = .17$	$\sigma_{cal-3} = .22$	$\sigma_{cal-3} = .14$	$\sigma_{cal-3} = .13$	$\sigma_{cal-3} = .17$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .21$	$\sigma_{25} = .24$	$\sigma_{50} = .13$	$\sigma_{75} = .21$	$\sigma_{100} = .13$
$\sigma_{cal-1} = .16$	$\sigma_{cal-1} = .28$	$\sigma_{cal-1} = .06$	$\sigma_{cal-1} = .26$	$\sigma_{cal-1} = .14$
$\sigma_{cal-2} = .25$	$\sigma_{cal-2} = .26$	$\sigma_{cal-2} = .21$	$\sigma_{cal-2} = .17$	$\sigma_{cal-2} = .11$
$\sigma_{cal-3} = .20$	$\sigma_{cal-3} = .14$	$\sigma_{cal-3} = .07$	$\sigma_{cal-3} = .19$	$\sigma_{cal-3} = .14$

Channel 4
$\bar{\sigma}_4 = .14$
$\sigma_{cal-1} = .19$ $\sigma_{cal-2} = .11$ $\sigma_{cal-3} = .10$

Channel 5
$\bar{\sigma}_5 = .14$
$\sigma_{cal-1} = .15$ $\sigma_{cal-2} = .12$ $\sigma_{cal-3} = .09$

Calibration Level				
$\sigma_0 = .18$	$\sigma_{25} = .12$	$\sigma_{50} = .09$	$\sigma_{75} = .15$	$\sigma_{100} = .15$
$\sigma_{cal-1} = .26$	$\sigma_{cal-1} = .07$	$\sigma_{cal-1} = .09$	$\sigma_{cal-1} = .21$	$\sigma_{cal-1} = .24$
$\sigma_{cal-2} = .16$	$\sigma_{cal-2} = .13$	$\sigma_{cal-2} = .09$	$\sigma_{cal-2} = .11$	$\sigma_{cal-2} = .03$
$\sigma_{cal-3} = .06$	$\sigma_{cal-3} = .14$	$\sigma_{cal-3} = .09$	$\sigma_{cal-3} = .13$	$\sigma_{cal-3} = .08$

Calibration Level				
$\sigma_0 = .17$	$\sigma_{25} = .12$	$\sigma_{50} = .14$	$\sigma_{75} = .15$	$\sigma_{100} = .10$
$\sigma_{cal-1} = .20$	$\sigma_{cal-1} = .03$	$\sigma_{cal-1} = .15$	$\sigma_{cal-1} = .18$	$\sigma_{cal-1} = .15$
$\sigma_{cal-2} = .15$	$\sigma_{cal-2} = .17$	$\sigma_{cal-2} = .10$	$\sigma_{cal-2} = .11$	$\sigma_{cal-2} = .04$
$\sigma_{cal-3} = .15$	$\sigma_{cal-3} = .16$	$\sigma_{cal-3} = .16$	$\sigma_{cal-3} = .17$	$\sigma_{cal-3} = .03$

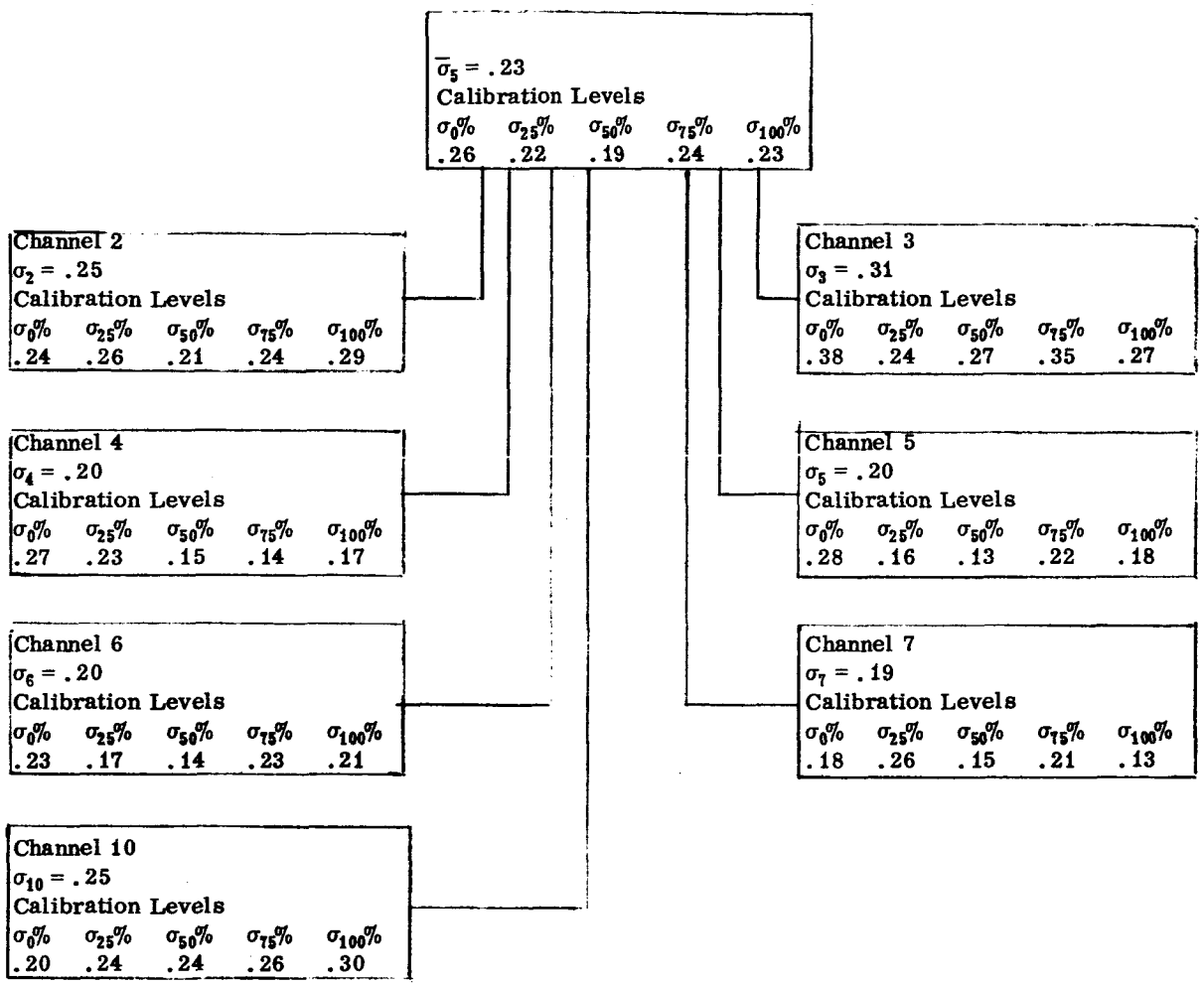
TABLE IV-3. LINK 4 FM/FM

Channel 6
$\overline{\sigma}_6 = .10$
$\sigma_{cal-1} = .09$ $\sigma_{cal-2} = .11$ $\sigma_{cal-3} = .08$

NOTE: All σ's are shown in % of total range.

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .07$	$\sigma_{25} = .10$	$\sigma_{50} = .11$	$\sigma_{75} = .09$	$\sigma_{100} = .11$
$\sigma_{cal-1} = .09$	$\sigma_{cal-1} = .07$	$\sigma_{cal-1} = .11$	$\sigma_{cal-1} = .12$	$\sigma_{cal-1} = .07$
$\sigma_{cal-2} = .08$	$\sigma_{cal-2} = .12$	$\sigma_{cal-2} = .10$	$\sigma_{cal-2} = .04$	$\sigma_{cal-2} = .16$
$\sigma_{cal-3} = .05$	$\sigma_{cal-3} = .09$	$\sigma_{cal-3} = .12$	$\sigma_{cal-3} = .08$	$\sigma_{cal-3} = .10$

TABLE V-1. LINK 5 FM/FM



NOTE: A - All σ's are shown in % of total range.
B - See Tables 10 and 11 for elaboration of channel σ's.

TABLE V-2. LINK 5 FM/FM

Channel 2
$\overline{\sigma}_2 = .25$
$\sigma_{cal-1} = .28$ $\sigma_{cal-2} = .18$ $\sigma_{cal-3} = .26$

NOTE: All σ's are shown in % of total range.

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .24$	$\sigma_{25} = .26$	$\sigma_{50} = .21$	$\sigma_{75} = .24$	$\sigma_{100} = .29$
$\sigma_{cal-1} = .17$	$\sigma_{cal-1} = .09$	$\sigma_{cal-1} = .13$	$\sigma_{cal-1} = .32$	$\sigma_{cal-1} = .49$
$\sigma_{cal-2} = .25$	$\sigma_{cal-2} = .23$	$\sigma_{cal-2} = .18$	$\sigma_{cal-2} = .09$	$\sigma_{cal-2} = .10$
$\sigma_{cal-3} = .28$	$\sigma_{cal-3} = .38$	$\sigma_{cal-3} = .25$	$\sigma_{cal-3} = .24$	$\sigma_{cal-3} = .08$

Channel 3
$\overline{\sigma}_3 = .31$
$\sigma_{cal-1} = .31$ $\sigma_{cal-2} = .36$ $\sigma_{cal-3} = .24$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .38$	$\sigma_{25} = .24$	$\sigma_{50} = .27$	$\sigma_{75} = .35$	$\sigma_{100} = .27$
$\sigma_{cal-1} = .33$	$\sigma_{cal-1} = .17$	$\sigma_{cal-1} = .31$	$\sigma_{cal-1} = .42$	$\sigma_{cal-1} = .26$
$\sigma_{cal-2} = .48$	$\sigma_{cal-2} = .30$	$\sigma_{cal-2} = .30$	$\sigma_{cal-2} = .38$	$\sigma_{cal-2} = .29$
$\sigma_{cal-3} = .30$	$\sigma_{cal-3} = .24$	$\sigma_{cal-3} = .18$	$\sigma_{cal-3} = .23$	$\sigma_{cal-3} = .25$

Channel 4
$\overline{\sigma}_4 = .20$
$\sigma_{cal-1} = .23$ $\sigma_{cal-2} = .18$ $\sigma_{cal-3} = .17$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .27$	$\sigma_{25} = .23$	$\sigma_{50} = .15$	$\sigma_{75} = .14$	$\sigma_{100} = .17$
$\sigma_{cal-1} = .28$	$\sigma_{cal-1} = .28$	$\sigma_{cal-1} = .18$	$\sigma_{cal-1} = .13$	$\sigma_{cal-1} = .13$
$\sigma_{cal-2} = .20$	$\sigma_{cal-2} = .21$	$\sigma_{cal-2} = .11$	$\sigma_{cal-2} = .10$	$\sigma_{cal-2} = .23$
$\sigma_{cal-3} = .23$	$\sigma_{cal-3} = .17$	$\sigma_{cal-3} = .15$	$\sigma_{cal-3} = .18$	$\sigma_{cal-3} = .12$

Channel 5
$\overline{\sigma}_5 = .20$
$\sigma_{cal-1} = .27$ $\sigma_{cal-2} = .16$ $\sigma_{cal-3} = .15$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .28$	$\sigma_{25} = .16$	$\sigma_{50} = .13$	$\sigma_{75} = .22$	$\sigma_{100} = .18$
$\sigma_{cal-1} = .45$	$\sigma_{cal-1} = .19$	$\sigma_{cal-1} = .11$	$\sigma_{cal-1} = .29$	$\sigma_{cal-1} = .13$
$\sigma_{cal-2} = .18$	$\sigma_{cal-2} = .11$	$\sigma_{cal-2} = .06$	$\sigma_{cal-2} = .20$	$\sigma_{cal-2} = .20$
$\sigma_{cal-3} = .06$	$\sigma_{cal-3} = .17$	$\sigma_{cal-3} = .18$	$\sigma_{cal-3} = .13$	$\sigma_{cal-3} = .18$

TABLE V-3. LINK 5 FM/FM

Channel 6
$\overline{\sigma}_6 = .20$
$\sigma_{cal-1} = .24$ $\sigma_{cal-2} = .17$ $\sigma_{cal-3} = .17$

NOTE: All σ's are shown in % of total range.

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .23$	$\sigma_{25} = .17$	$\sigma_{50} = .14$	$\sigma_{75} = .23$	$\sigma_{100} = .21$
$\sigma_{cal-1} = .31$	$\sigma_{cal-1} = .19$	$\sigma_{cal-1} = .18$	$\sigma_{cal-1} = .28$	$\sigma_{cal-1} = .24$
$\sigma_{cal-2} = .20$	$\sigma_{cal-2} = .12$	$\sigma_{cal-2} = .10$	$\sigma_{cal-2} = .19$	$\sigma_{cal-2} = .22$
$\sigma_{cal-3} = .17$	$\sigma_{cal-3} = .18$	$\sigma_{cal-3} = .13$	$\sigma_{cal-3} = .20$	$\sigma_{cal-3} = .16$

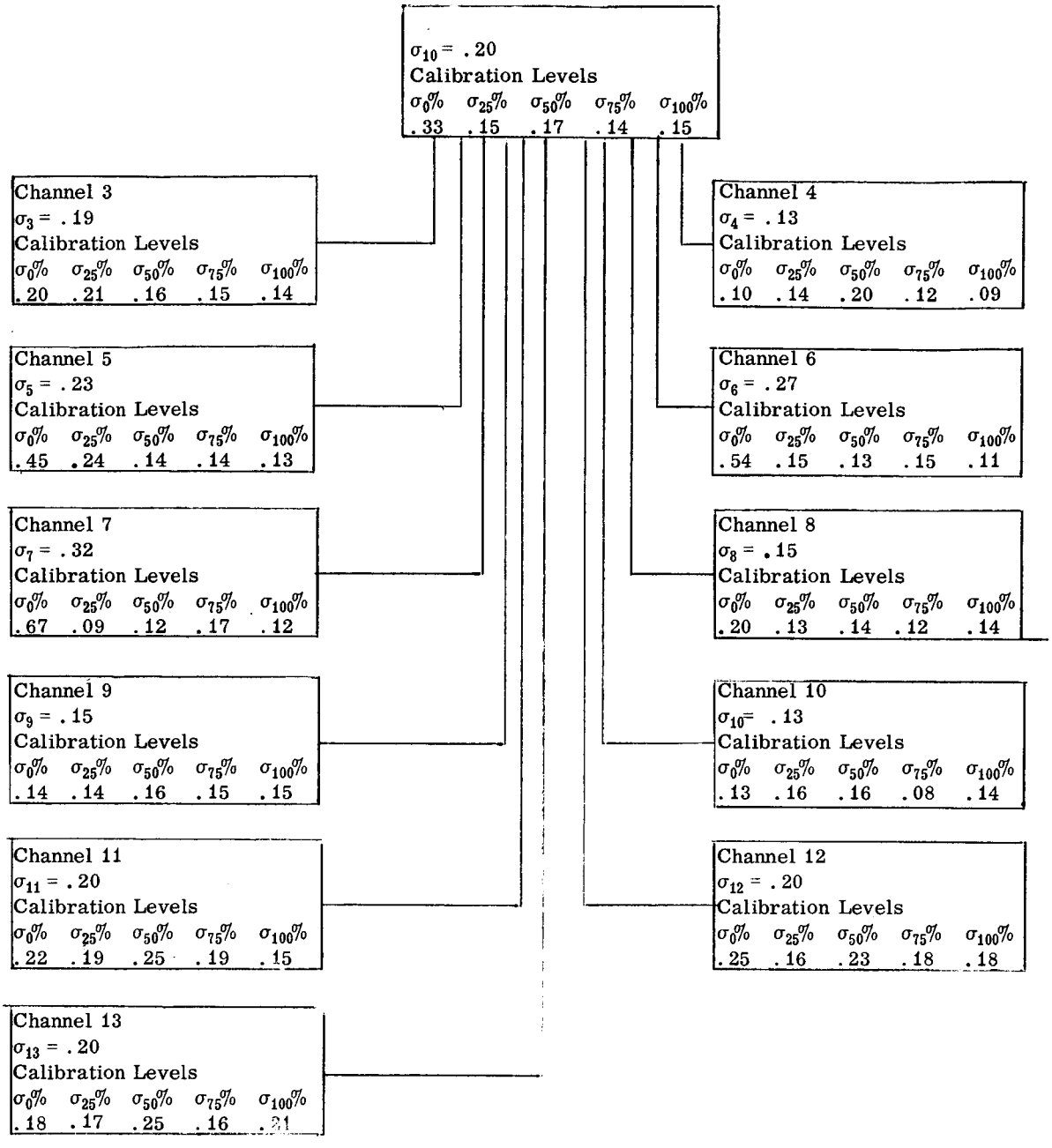
Channel 7
$\overline{\sigma}_7 = .19$
$\sigma_{cal-1} = .19$ $\sigma_{cal-2} = .17$ $\sigma_{cal-3} = .16$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .18$	$\sigma_{25} = .26$	$\sigma_{50} = .15$	$\sigma_{75} = .21$	$\sigma_{100} = .13$
$\sigma_{cal-1} = .16$	$\sigma_{cal-1} = .26$	$\sigma_{cal-1} = .14$	$\sigma_{cal-1} = .22$	$\sigma_{cal-1} = .17$
$\sigma_{cal-2} = .21$	$\sigma_{cal-2} = .11$	$\sigma_{cal-2} = .12$	$\sigma_{cal-2} = .25$	$\sigma_{cal-2} = .09$
$\sigma_{cal-3} = .19$	$\sigma_{cal-3} = .14$	$\sigma_{cal-3} = .19$	$\sigma_{cal-3} = .15$	$\sigma_{cal-3} = .11$

Channel 10
$\sigma_{10} = .25$
$\sigma_{cal-1} = .37$ $\sigma_{cal-2} = .18$ $\sigma_{cal-3} = .13$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .20$	$\sigma_{25} = .24$	$\sigma_{50} = .24$	$\sigma_{75} = .26$	$\sigma_{100} = .30$
$\sigma_{cal-1} = .27$	$\sigma_{cal-1} = .38$	$\sigma_{cal-1} = .32$	$\sigma_{cal-1} = .43$	$\sigma_{cal-1} = .43$
$\sigma_{cal-2} = .16$	$\sigma_{cal-2} = .09$	$\sigma_{cal-2} = .24$	$\sigma_{cal-2} = .09$	$\sigma_{cal-2} = .24$
$\sigma_{cal-3} = .15$	$\sigma_{cal-3} = .15$	$\sigma_{cal-3} = .10$	$\sigma_{cal-3} = .08$	$\sigma_{cal-3} = .17$

TABLE VI-1. LINK 10 FM/FM



NOTE: A - All σ's are shown in % of total range.
B - See Tables 34, 35, and 36 for elaboration of subchannel σ's.

TABLE VI-2. LINK 10 FM/FM

NOTE: All σ's are shown in % of total range.

Channel 3			
$\bar{\sigma}_3$ = .19			
σ_{cal-1} = .16	σ_{cal-2} = .21	σ_{cal-3} = .15	

Calibration Level				
0%	25%	50%	75%	100%
σ_0 = .20	σ_{25} = .21	σ_{50} = .16	σ_{75} = .15	σ_{100} = .14
σ_{cal-1} = .16	σ_{cal-1} = .20	σ_{cal-1} = .15	σ_{cal-1} = .13	σ_{cal-1} = .13
σ_{cal-2} = .21	σ_{cal-2} = .29	σ_{cal-2} = .19	σ_{cal-2} = .18	σ_{cal-2} = .14
σ_{cal-3} = .24	σ_{cal-3} = .07	σ_{cal-3} = .14	σ_{cal-3} = .12	σ_{cal-3} = .15

Channel4			
$\bar{\sigma}_4$ = .13			
σ_{cal-1} = .14	σ_{cal-2} = .12	σ_{cal-3} = .12	

Calibration Level				
0%	25%	50%	75%	100%
σ_0 = .10	σ_{25} = .14	σ_{50} = .20	σ_{75} = .12	σ_{100} = .09
σ_{cal-1} = .07	σ_{cal-1} = .05	σ_{cal-1} = .25	σ_{cal-1} = .13	σ_{cal-1} = .08
σ_{cal-2} = .08	σ_{cal-2} = .15	σ_{cal-2} = .15	σ_{cal-2} = .13	σ_{cal-2} = .06
σ_{cal-3} = .14	σ_{cal-3} = .18	σ_{cal-3} = .06	σ_{cal-3} = .09	σ_{cal-3} = .11

Channel 5			
$\bar{\sigma}_5$ = .23			
σ_{cal-1} = .13	σ_{cal-2} = .12	σ_{cal-3} = .37	

	Calibration Level			
0%	25%	50%	75%	100%
σ_0 = .45	σ_{25} = .12	σ_{50} = .14	σ_{75} = .15	σ_{100} = .13
σ_{cal-1} = .07	σ_{cal-1} = .08	σ_{cal-1} = .19	σ_{cal-1} = .14	σ_{cal-1} = .10
σ_{cal-2} = .03	σ_{cal-2} = .10	σ_{cal-2} = .10	σ_{cal-2} = .10	σ_{cal-2} = .20
σ_{cal-3} = .78	σ_{cal-3} = .18	σ_{cal-3} = .10	σ_{cal-3} = .19	σ_{cal-3} = .06

Channel 6			
$\bar{\sigma}_6$ = .27			
σ_{cal-1} = .15	σ_{cal-2} = .10	σ_{cal-3} = .43	

Calibration Level				
0%	25%	50%	75%	100%
σ_0 = .54	σ_{25} = .15	σ_{50} = .13	σ_{75} = .15	σ_{100} = .11
σ_{cal-1} = .0	σ_{cal-1} = .21	σ_{cal-1} = .19	σ_{cal-1} = .16	σ_{cal-1} = .12
σ_{cal-2} = .09	σ_{cal-2} = .07	σ_{cal-2} = .13	σ_{cal-2} = .08	σ_{cal-2} = .13
σ_{cal-3} = .93	σ_{cal-3} = .12	σ_{cal-3} = .04	σ_{cal-3} = .20	σ_{cal-3} = .10

TABLE VI-3. LINK 10 FM/FM

NOTE: All σ's are shown in % of total range.

Channel 7

$\bar{\sigma}_7 = .32$

$\sigma_{cal-1} = .12$ $\sigma_{cal-2} = .14$ $\sigma_{cal-3} = .52$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .67$	$\sigma_{25} = .09$	$\sigma_{50} = .12$	$\sigma_{75} = .17$	$\sigma_{100} = .12$
$\sigma_{cal-1} = .03$	$\sigma_{cal-1} = .07$	$\sigma_{cal-1} = .16$	$\sigma_{cal-1} = .13$	$\sigma_{cal-1} = .16$
$\sigma_{cal-2} = .16$	$\sigma_{cal-2} = .11$	$\sigma_{cal-2} = .09$	$\sigma_{cal-2} = .18$	$\sigma_{cal-2} = .14$
$\sigma_{cal-3} = 1.15$	$\sigma_{cal-3} = .10$	$\sigma_{cal-3} = .08$	$\sigma_{cal-3} = .19$	$\sigma_{cal-3} = .04$

Channel 8

$\bar{\sigma}_8 = .15$

$\sigma_{cal-1} = .13$ $\sigma_{cal-2} = .13$ $\sigma_{cal-3} = .18$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .20$	$\sigma_{25} = .13$	$\sigma_{50} = .14$	$\sigma_{75} = .12$	$\sigma_{100} = .14$
$\sigma_{cal-1} = .10$	$\sigma_{cal-1} = .13$	$\sigma_{cal-1} = .16$	$\sigma_{cal-1} = .13$	$\sigma_{cal-1} = .15$
$\sigma_{cal-2} = .11$	$\sigma_{cal-2} = .12$	$\sigma_{cal-2} = .14$	$\sigma_{cal-2} = .12$	$\sigma_{cal-2} = .16$
$\sigma_{cal-3} = .33$	$\sigma_{cal-3} = .13$	$\sigma_{cal-3} = .13$	$\sigma_{cal-3} = .10$	$\sigma_{cal-3} = .12$

Channel 9

$\bar{\sigma}_9 = .15$

$\sigma_{cal-1} = .15$ $\sigma_{cal-2} = .16$ $\sigma_{cal-3} = .12$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .14$	$\sigma_{25} = .14$	$\sigma_{50} = .16$	$\sigma_{75} = .15$	$\sigma_{100} = .15$
$\sigma_{cal-1} = .15$	$\sigma_{cal-1} = .18$	$\sigma_{cal-1} = .18$	$\sigma_{cal-1} = .13$	$\sigma_{cal-1} = .11$
$\sigma_{cal-2} = .14$	$\sigma_{cal-2} = .15$	$\sigma_{cal-2} = .14$	$\sigma_{cal-2} = .15$	$\sigma_{cal-2} = .22$
$\sigma_{cal-3} = .12$	$\sigma_{cal-3} = .09$	$\sigma_{cal-3} = .15$	$\sigma_{cal-3} = .15$	$\sigma_{cal-3} = .09$

Channel 10

$\bar{\sigma}_{10} = .13$

$\sigma_{cal-1} = .14$ $\sigma_{cal-2} = .15$ $\sigma_{cal-3} = .12$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .13$	$\sigma_{25} = .16$	$\sigma_{50} = .16$	$\sigma_{75} = .08$	$\sigma_{100} = .14$
$\sigma_{cal-1} = .15$	$\sigma_{cal-1} = .17$	$\sigma_{cal-1} = .16$	$\sigma_{cal-1} = .09$	$\sigma_{cal-1} = .12$
$\sigma_{cal-2} = .12$	$\sigma_{cal-2} = .14$	$\sigma_{cal-2} = .18$	$\sigma_{cal-2} = .04$	$\sigma_{cal-2} = .19$
$\sigma_{cal-3} = .11$	$\sigma_{cal-3} = .15$	$\sigma_{cal-3} = .13$	$\sigma_{cal-3} = .10$	$\sigma_{cal-3} = .07$

TABLE VI-4. LINK 10 FM/FM

Channel 11
$\bar{\sigma}_{11} = .20$
$\sigma_{cal-1} = .19$ $\sigma_{cal-2} = .23$ $\sigma_{cal-3} = .19$

NOTE: All σ's are shown in % of total range.

Channel 12
$\bar{\sigma}_{12} = .20$
$\sigma_{cal-1} = .22$ $\sigma_{cal-2} = .21$ $\sigma_{cal-3} = .18$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .22$	$\sigma = .19$	$\sigma = .25$	$\sigma = .19$	$\sigma = .15$
$\sigma_{cal-1} = .19$	$\sigma_{cal-1} = .18$	$\sigma_{cal-1} = .24$	$\sigma_{cal-1} = .15$	$\sigma_{cal-1} = .17$
σ_{cal-2} .17	σ_{cal-2} .17	σ_{cal-2} .31	σ_{cal-2} .24	σ_{cal-2} .19
$\sigma_{cal-3} = .25$	$\sigma_{cal-3} = .22$	$\sigma_{cal-3} = .20$	$\sigma_{cal-3} = .17$	$\sigma_{cal-3} = .03$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .25$	$\sigma_{25} = .16$	$\sigma_{50} = .23$	$\sigma_{75} = .18$	$\sigma_{100} = .18$
$\sigma_{cal-1} = .08$	$\sigma_{cal-1} = .18$	$\sigma_{cal-1} = .25$	$\sigma_{cal-1} = .22$	$\sigma_{cal-1} = .17$
σ_{cal-2} .22	σ_{cal-2} .21	σ_{cal-2} .23	σ_{cal-2} .12	σ_{cal-2} .24
$\sigma_{cal-3} = .27$	$\sigma_{cal-3} = .03$	$\sigma_{cal-3} = .22$	$\sigma_{cal-3} = .18$	$\sigma_{cal-3} = .08$

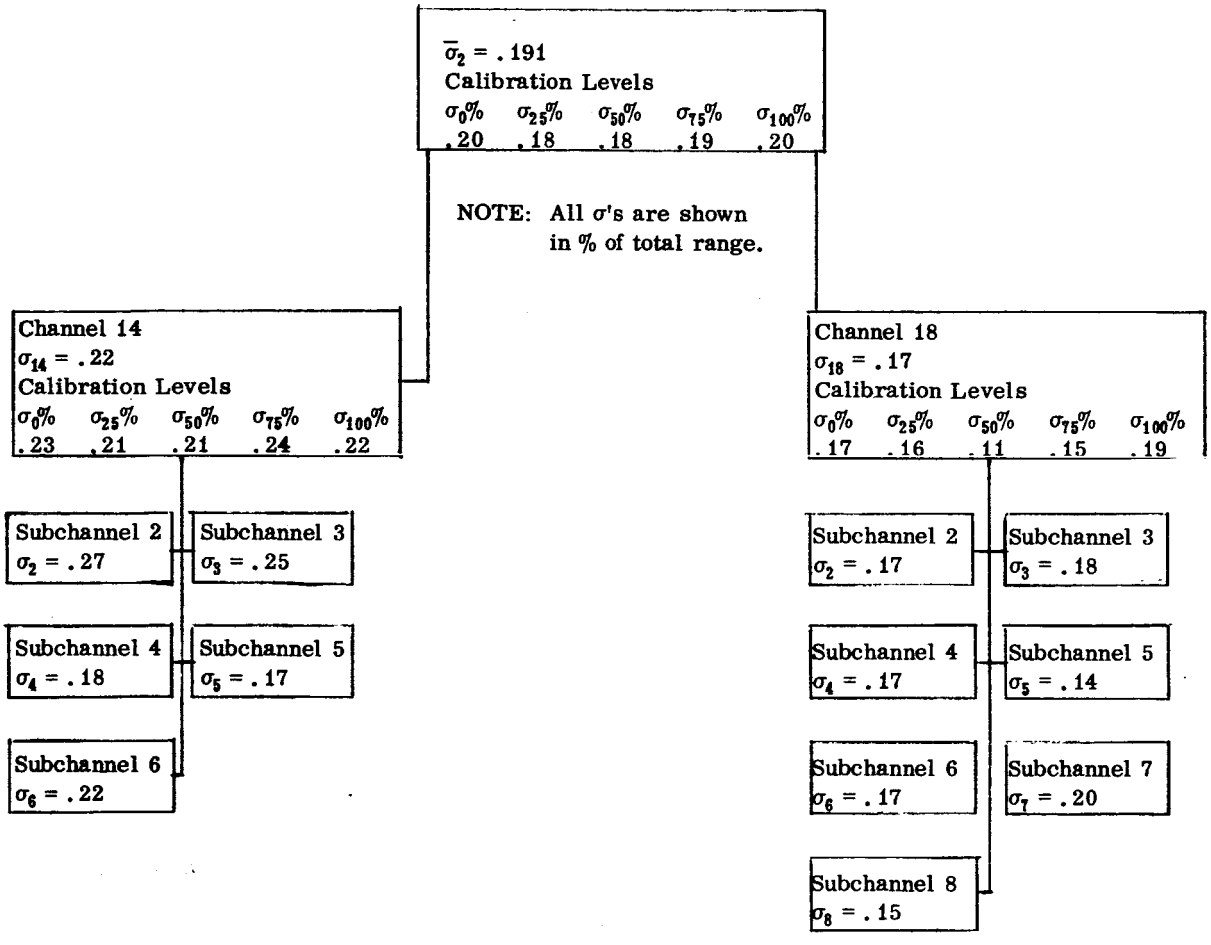
Channel 13
$\sigma_{13} = .20$
$\sigma_{cal-1} = .20$ $\sigma_{cal-2} = .18$ $\sigma_{cal-3} = .21$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .18$	$\sigma_{25} = .17$	$\sigma_{50} = .25$	$\sigma_{75} = .16$	$\sigma_{100} = .21$
$\sigma_{cal-1} = .07$	$\sigma_{cal-1} = .24$	$\sigma_{cal-1} = .28$	$\sigma_{cal-1} = .16$	$\sigma_{cal-1} = .20$
$\sigma_{cal-2} = .20$	$\sigma_{cal-2} = .15$	$\sigma_{cal-2} = .19$	$\sigma_{cal-2} = .10$	$\sigma_{cal-2} = .24$
$\sigma_{cal-3} = .24$	$\sigma_{cal-3} = .07$	$\sigma_{cal-3} = .28$	$\sigma_{cal-3} = .22$	$\sigma_{cal-3} = .20$

APPENDIX B

This appendix contains a detailed breakdown of the composite variances for the SA-4 triple-FM telemetry systems.

TABLE I-1. LINK 2 FM/FM/FM



NOTE: See Tables 42, 43, 44, and 45 for elaboration of Subchannel σ's.

TABLE I-2. LINK 2 FM/FM/FM CHANNEL 14

NOTE: All σ's are shown in % of total range.

Subchannel 2

$\bar{\sigma}_2 = .27$

$\sigma_{cal-1} = .23 \quad \sigma_{cal-2} = .22 \quad \sigma_{cal-3} = .34$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .29$	$\sigma_{25} = .23$	$\sigma_{50} = .24$	$\sigma_{75} = .30$	$\sigma_{100} = .28$
$\sigma_{cal-1} = .12$	$\sigma_{cal-1} = .20$	$\sigma_{cal-1} = .24$	$\sigma_{cal-1} = .22$	$\sigma_{cal-1} = .34$
$\sigma_{cal-2} = .13$	$\sigma_{cal-2} = .24$	$\sigma_{cal-2} = .20$	$\sigma_{cal-2} = .19$	$\sigma_{cal-2} = .29$
$\sigma_{cal-3} = .48$	$\sigma_{cal-3} = .25$	$\sigma_{cal-3} = .26$	$\sigma_{cal-3} = .43$	$\sigma_{cal-3} = .20$

Subchannel 3

$\bar{\sigma}_3 = .25$

$\sigma_{cal-1} = .15 \quad \sigma_{cal-2} = .26 \quad \sigma_{cal-3} = .30$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .30$	$\sigma_{25} = .22$	$\sigma_{50} = .24$	$\sigma_{75} = .17$	$\sigma_{100} = .21$
$\sigma_{cal-1} = .04$	$\sigma_{cal-1} = .17$	$\sigma_{cal-1} = .16$	$\sigma_{cal-1} = .21$	$\sigma_{cal-1} = .10$
$\sigma_{cal-2} = .28$	$\sigma_{cal-} = .32$	$\sigma_{cal-2} = .09$	$\sigma_{cal-2} = .18$	$\sigma_{cal-2} = .34$
$\sigma_{cal-3} = .43$	$\sigma_{cal-3} = .34$	$\sigma_{cal-3} = .38$	$\sigma_{cal-3} = .09$	$\sigma_{cal-3} = .06$

Subchannel 4

$\bar{\sigma}_4 = .18$

$\sigma_{cal-1} = .15 \quad \sigma_{cal-2} = .19 \quad \sigma_{cal-3} = .23$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .15$	$\sigma_{25} = .17$	$\sigma_{50} = .18$	$\sigma_{75} = .23$	$\sigma_{100} = .18$
$\sigma_{cal-1} = .20$	$\sigma_{cal-1} = .11$	$\sigma_{cal-1} = .09$	$\sigma_{cal-1} = .13$	$\sigma_{cal-1} = .18$
$\sigma_{cal-2} = .23$	$\sigma_{cal-2} = .17$	$\sigma_{cal-2} = .23$	$\sigma_{cal-2} = .15$	$\sigma_{cal-2} = .18$
$\sigma_{cal-3} = .15$	$\sigma_{cal-3} = .21$	$\sigma_{cal-3} = .21$	$\sigma_{cal-3} = .34$	$\sigma_{cal-3} = .17$

Subchannel 5

$\bar{\sigma}_5 = .17$

$\sigma_{cal-1} = .13 \quad \sigma_{cal-2} = .17 \quad \sigma_{cal-3} = .19$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .14$	$\sigma_{25} = .10$	$\sigma_{50} = .13$	$\sigma_{75} = .22$	$\sigma_{100} = .20$
$\sigma_{cal-1} = .07$	$\sigma_{cal-1} = .06$	$\sigma_{cal-1} = .13$	$\sigma_{cal-1} = .13$	$\sigma_{cal-1} = .22$
$\sigma_{cal-2} = .13$	$\sigma_{cal-2} = .10$	$\sigma_{cal-2} = .06$	$\sigma_{cal-2} = .23$	$\sigma_{cal-2} = .23$
$\sigma_{cal-3} = .20$	$\sigma_{cal-3} = .14$	$\sigma_{cal-3} = .18$	$\sigma_{cal-3} = .27$	$\sigma_{cal-3} = .13$

TABLE I-3. LINK 2 FM/FM/FM CHANNEL 14

Subchannel 6
$\overline{\sigma}_6 = .22$
$\sigma_{cal-1} = .17$ $\sigma_{cal-2} = .25$ $\sigma_{cal-3} = .24$

NOTE: All σ's are shown in % of total range.

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .19$	$\sigma_{25} = .21$	$\sigma_{50} = .21$	$\sigma_{75} = .27$	$\sigma_{100} = .22$
$\sigma_{cal-1} = .13$	$\sigma_{cal-1} = .21$	$\sigma_{cal-1} = .17$	$\sigma_{cal-1} = .18$	$\sigma_{cal-1} = .14$
$\sigma_{cal-2} = .25$	$\sigma_{cal-2} = .16$	$\sigma_{cal-2} = .22$	$\sigma_{cal-2} = .26$	$\sigma_{cal-2} = .33$
$\sigma_{cal-3} = .18$	$\sigma_{cal-3} = .25$	$\sigma_{cal-3} = .24$	$\sigma_{cal-3} = .35$	$\sigma_{cal-3} = .14$

TABLE I-4. LINK 2 FM/FM/FM CHANNEL 18

Subchannel 2			
$\bar{\sigma}_2 = .17$			
$\sigma_{cal-1} = .16$	$\sigma_{cal-2} = .16$	$\sigma_{cal-3} = .18$	

NOTE: All σ's are shown in % of total range

Subchannel 3			
$\bar{\sigma}_3 = .18$			
$\sigma_{cal-1} = .27$	$\sigma_{cal-2} = .20$	$\sigma_{cal-3} = .15$	

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .13$	$\sigma_{25} = .16$	$\sigma_{50} = .12$	$\sigma_{75} = .18$	$\sigma_{100} = .23$
$\sigma_{cal-1} = .09$	$\sigma_{cal-1} = .16$	$\sigma_{cal-1} = .11$	$\sigma_{cal-1} = .21$	$\sigma_{cal-1} = .22$
$\sigma_{cal-2} = .19$	$\sigma_{cal-2} = .17$	$\sigma_{cal-2} = .09$	$\sigma_{cal-2} = .11$	$\sigma_{cal-2} = .21$
$\sigma_{cal-3} = .09$	$\sigma_{cal-3} = .17$	$\sigma_{cal-3} = .15$	$\sigma_{cal-3} = .21$	$\sigma_{cal-3} = .25$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .18$	$\sigma_{25} = .22$	$\sigma_{50} = .19$	$\sigma_{75} = .15$	$\sigma_{100} = .13$
$\sigma_{cal-1} = .51$	$\sigma_{cal-1} = .23$	$\sigma_{cal-1} = .18$	$\sigma_{cal-1} = .14$	$\sigma_{cal-1} = .05$
$\sigma_{cal-2} = .18$	$\sigma_{cal-2} = .21$	$\sigma_{cal-2} = .20$	$\sigma_{cal-2} = .17$	$\sigma_{cal-2} = .21$
$\sigma_{cal-3} = .13$	$\sigma_{cal-3} = .23$	$\sigma_{cal-3} = .17$	$\sigma_{cal-3} = .13$	$\sigma_{cal-3} = .07$

Subchannel 4			
$\bar{\sigma}_4 = .17$			
$\sigma_{cal-1} = .18$	$\sigma_{cal-2} = .10$	$\sigma_{cal-3} = .21$	

Subchannel 5			
$\bar{\sigma}_5 = .14$			
$\sigma_{cal-1} = .12$	$\sigma_{cal-2} = .14$	$\sigma_{cal-3} = .16$	

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .25$	$\sigma_{25} = .11$	$\sigma_{50} = .11$	$\sigma_{75} = .18$	$\sigma_{100} = .18$
$\sigma_{cal-1} = .27$	$\sigma_{cal-1} = .09$	$\sigma_{cal-1} = .13$	$\sigma_{cal-1} = .17$	$\sigma_{cal-1} = .20$
$\sigma_{cal-2} = .10$	$\sigma_{cal-2} = .10$	$\sigma_{cal-2} = .09$	$\sigma_{cal-2} = .13$	$\sigma_{cal-2} = .09$
$\sigma_{cal-3} = .31$	$\sigma_{cal-3} = .15$	$\sigma_{cal-3} = .11$	$\sigma_{cal-3} = .23$	$\sigma_{cal-3} = .21$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .16$	$\sigma_{25} = .11$	$\sigma_{50} = .16$	$\sigma_{75} = .11$	$\sigma_{100} = .16$
$\sigma_{cal-1} = .14$	$\sigma_{cal-1} = .09$	$\sigma_{cal-1} = .16$	$\sigma_{cal-1} = .09$	$\sigma_{cal-1} = .22$
$\sigma_{cal-2} = .20$	$\sigma_{cal-2} = .12$	$\sigma_{cal-2} = .12$	$\sigma_{cal-2} = .11$	$\sigma_{cal-2} = .16$
$\sigma_{cal-3} = .14$	$\sigma_{cal-3} = .12$	$\sigma_{cal-3} = .17$	$\sigma_{cal-3} = .13$	$\sigma_{cal-3} = .22$

TABLE I-5. LINK 2 FM/FM/FM CHANNEL 18

Subchannel 6
$\bar{\sigma}_6 = .17$
$\sigma_{cal-1} = .17$ $\sigma_{cal-2} = .17$ $\sigma_{cal-3} = .18$

NOTE: All σ's are shown in % of total range

Subchannel 7
$\bar{\sigma}_7 = .20$
$\sigma_{cal-1} = .12$ $\sigma_{cal-2} = .24$ $\sigma_{cal-3} = .22$

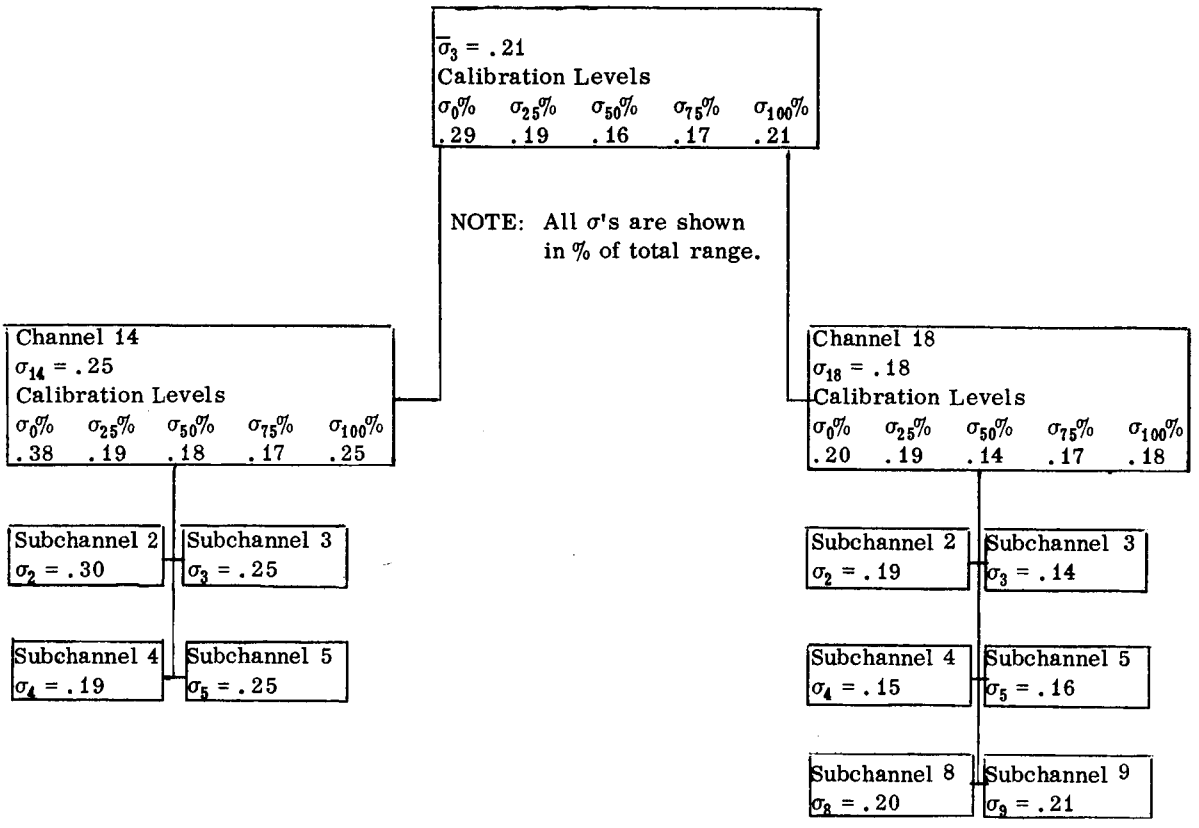
Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .17$ $\sigma_{cal-1} = .20$ $\sigma_{cal-2} = .19$ $\sigma_{cal-3} = .11$	$\sigma_{25} = .17$ $\sigma_{cal-1} = .19$ $\sigma_{cal-2} = .14$ $\sigma_{cal-3} = .18$	$\sigma_{50} = .18$ $\sigma_{cal-1} = .21$ $\sigma_{cal-2} = .22$ $\sigma_{cal-3} = .09$	$\sigma_{75} = .19$ $\sigma_{cal-1} = .10$ $\sigma_{cal-2} = .12$ $\sigma_{cal-3} = .29$	$\sigma_{100} = .13$ $\sigma_{cal-1} = .09$ $\sigma_{cal-2} = .16$ $\sigma_{cal-3} = .13$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .18$ $\sigma_{cal-1} = .17$ $\sigma_{cal-2} = .22$ $\sigma_{cal-3} = .15$	$\sigma_{25} = .15$ $\sigma_{cal-1} = .12$ $\sigma_{cal-2} = .16$ $\sigma_{cal-3} = .15$	$\sigma_{50} = .20$ $\sigma_{cal-1} = .10$ $\sigma_{cal-2} = .30$ $\sigma_{cal-3} = .16$	$\sigma_{75} = .18$ $\sigma_{cal-1} = .08$ $\sigma_{cal-2} = .22$ $\sigma_{cal-3} = .36$	$\sigma_{100} = .27$ $\sigma_{cal-1} = .12$ $\sigma_{cal-2} = .28$ $\sigma_{cal-3} = .36$

Subchannel 8
$\bar{\sigma}_8 = .15$
$\sigma_{cal-1} = .13$ $\sigma_{cal-2} = .16$ $\sigma_{cal-3} = .17$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .16$ $\sigma_{cal-1} = .07$ $\sigma_{cal-2} = .21$ $\sigma_{cal-3} = .15$	$\sigma_{25} = .15$ $\sigma_{cal-1} = .17$ $\sigma_{cal-2} = .08$ $\sigma_{cal-3} = .17$	$\sigma_{50} = .15$ $\sigma_{cal-1} = .12$ $\sigma_{cal-2} = .13$ $\sigma_{cal-3} = .20$	$\sigma_{75} = .14$ $\sigma_{cal-1} = .09$ $\sigma_{cal-2} = .19$ $\sigma_{cal-3} = .10$	$\sigma_{100} = .18$ $\sigma_{cal-1} = .14$ $\sigma_{cal-2} = .16$ $\sigma_{cal-3} = .22$

TABLE II-1. LINK 3 FM/FM/FM



NOTE: See Tables 47, 48 and 49 for elaboration of subchannel σ's.

TABLE II-2. LINK 3 FM/FM/FM CHANNEL 14

NOTE: All σ's are shown in % of total range.

Subchannel 2

$\bar{\sigma}_2 = .30$

$\sigma_{cal-1} = .39 \quad \sigma_{cal-2} = .28 \quad \sigma_{cal-3} = .19$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .50$	$\sigma_{25} = .24$	$\sigma_{50} = .22$	$\sigma_{75} = .16$	$\sigma_{100} = .24$
$\sigma_{cal-1} = .81$	$\sigma_{cal-1} = .14$	$\sigma_{cal-1} = .11$	$\sigma_{cal-1} = .12$	$\sigma_{cal-1} = .26$
$\sigma_{cal-2} = .27$	$\sigma_{cal-2} = .37$	$\sigma_{cal-2} = .33$	$\sigma_{cal-2} = .15$	$\sigma_{cal-2} = .22$
$\sigma_{cal-3} = .17$	$\sigma_{cal-3} = .14$	$\sigma_{cal-3} = .16$	$\sigma_{cal-3} = .21$	$\sigma_{cal-3} = .25$

Subchannel 3

$\bar{\sigma}_3 = .25$

$\sigma_{cal-1} = .30 \quad \sigma_{cal-2} = .19 \quad \sigma_{cal-3} = .24$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .42$	$\sigma_{25} = .12$	$\sigma_{50} = .12$	$\sigma_{75} = .17$	$\sigma_{100} = .28$
$\sigma_{cal-1} = .50$	$\sigma_{cal-1} = .06$	$\sigma_{cal-1} = .17$	$\sigma_{cal-1} = .18$	$\sigma_{cal-1} = .37$
$\sigma_{cal-2} = .27$	$\sigma_{cal-2} = .16$	$\sigma_{cal-2} = .07$	$\sigma_{cal-2} = .16$	$\sigma_{cal-2} = .23$
$\sigma_{cal-3} = .44$	$\sigma_{cal-3} = .12$	$\sigma_{cal-3} = .09$	$\sigma_{cal-3} = .16$	$\sigma_{cal-3} = .22$

Subchannel 4

$\bar{\sigma}_4 = .19$

$\sigma_{cal-1} = .17 \quad \sigma_{cal-2} = .19 \quad \sigma_{cal-3} = .19$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .34$	$\sigma_{25} = .15$	$\sigma_{50} = .09$	$\sigma_{75} = .10$	$\sigma_{100} = .14$
$\sigma_{cal-1} = .32$	$\sigma_{cal-1} = .12$	$\sigma_{cal-1} = .12$	$\sigma_{cal-1} = .10$	$\sigma_{cal-1} = .14$
$\sigma_{cal-2} = .37$	$\sigma_{cal-2} = .19$	$\sigma_{cal-2} = .09$	$\sigma_{cal-2} = .10$	$\sigma_{cal-2} = .06$
$\sigma_{cal-3} = .33$	$\sigma_{cal-3} = .15$	$\sigma_{cal-3} = .04$	$\sigma_{cal-3} = .10$	$\sigma_{cal-3} = .20$

Subchannel 5

$\bar{\sigma}_5 = .25$

$\sigma_{cal-1} = .25 \quad \sigma_{cal-2} = .26 \quad \sigma_{cal-3} = .24$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .23$	$\sigma_{25} = .20$	$\sigma_{50} = .26$	$\sigma_{75} = .24$	$\sigma_{100} = .31$
$\sigma_{cal-1} = .25$	$\sigma_{cal-1} = .22$	$\sigma_{cal-1} = .32$	$\sigma_{cal-1} = .26$	$\sigma_{cal-1} = .21$
$\sigma_{cal-2} = .20$	$\sigma_{cal-2} = .20$	$\sigma_{cal-2} = .22$	$\sigma_{cal-2} = .17$	$\sigma_{cal-2} = .41$
$\sigma_{cal-3} = .24$	$\sigma_{cal-3} = .17$	$\sigma_{cal-3} = .21$	$\sigma_{cal-3} = .28$	$\sigma_{cal-3} = .28$

TABLE II-3. LINK 3 FM/FM/FM CHANNEL 18

Subchannel 2				
$\bar{\sigma}_2 = .19$				
$\sigma_{cal-1} = .17$	$\sigma_{cal-2} = .25$	$\sigma_{cal-3} = .20$		

NOTE: All σ's are shown in % of total range.

Subchannel 3				
$\bar{\sigma}_3 = .14$				
$\sigma_{cal-1} = .15$	$\sigma_{cal-2} = .14$	$\sigma_{cal-3} = .14$		

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .07$	$\sigma_{25} = .24$	$\sigma_{50} = .07$	$\sigma_{75} = .08$	$\sigma_{100} = .10$
$\sigma_{cal-1} = .18$	$\sigma_{cal-1} = .26$	$\sigma_{cal-1} = .07$	$\sigma_{cal-1} = .07$	$\sigma_{cal-1} = .20$
$\sigma_{cal-2} = .10$	$\sigma_{cal-2} = .27$	$\sigma_{cal-2} = .23$	$\sigma_{cal-2} = .26$	$\sigma_{cal-2} = .09$
$\sigma_{cal-3} = .16$	$\sigma_{cal-3} = .32$	$\sigma_{cal-3} = .09$	$\sigma_{cal-3} = .10$	$\sigma_{cal-3} = .23$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .10$	$\sigma_{25} = .05$	$\sigma_{50} = .05$	$\sigma_{75} = .02$	$\sigma_{100} = .09$
$\sigma_{cal-1} = .23$	$\sigma_{cal-1} = .17$	$\sigma_{cal-1} = .11$	$\sigma_{cal-1} = .06$	$\sigma_{cal-1} = .11$
$\sigma_{cal-2} = .20$	$\sigma_{cal-2} = .09$	$\sigma_{cal-2} = .13$	$\sigma_{cal-2} = .11$	$\sigma_{cal-2} = .13$
$\sigma_{cal-3} = .05$	$\sigma_{cal-3} = .12$	$\sigma_{cal-3} = .14$	$\sigma_{cal-3} = .07$	$\sigma_{cal-3} = .24$

Subchannel 4				
$\bar{\sigma}_4 = .15$				
$\sigma_{cal-1} = .14$	$\sigma_{cal-2} = .13$	$\sigma_{cal-3} = .10$		

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .10$	$\sigma_{25} = .03$	$\sigma_{50} = .02$	$\sigma_{75} = .02$	$\sigma_{100} = .16$
$\sigma_{cal-1} = .22$	$\sigma_{cal-1} = .13$	$\sigma_{cal-1} = .12$	$\sigma_{cal-1} = .09$	$\sigma_{cal-1} = .11$
$\sigma_{cal-2} = .21$	$\sigma_{cal-2} = .18$	$\sigma_{cal-2} = .07$	$\sigma_{cal-2} = .09$	$\sigma_{cal-2} = .10$
$\sigma_{cal-3} = .08$	$\sigma_{cal-3} = .08$	$\sigma_{cal-3} = .07$	$\sigma_{cal-3} = .08$	$\sigma_{cal-3} = .17$

Subchannel 5				
$\bar{\sigma}_5 = .16$				
$\sigma_{cal-1} = .15$	$\sigma_{cal-2} = .18$	$\sigma_{cal-3} = .15$		

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .17$	$\sigma_{25} = .04$	$\sigma_{50} = .08$	$\sigma_{75} = .04$	$\sigma_{100} = .07$
$\sigma_{cal-1} = .26$	$\sigma_{cal-1} = .09$	$\sigma_{cal-1} = .15$	$\sigma_{cal-1} = .11$	$\sigma_{cal-1} = .09$
$\sigma_{cal-2} = .28$	$\sigma_{cal-2} = .08$	$\sigma_{cal-2} = .20$	$\sigma_{cal-2} = .15$	$\sigma_{cal-2} = .16$
$\sigma_{cal-3} = .15$	$\sigma_{cal-3} = .17$	$\sigma_{cal-3} = .12$	$\sigma_{cal-3} = .09$	$\sigma_{cal-3} = .19$

TABLE II-4. LINK 3 FM/FM/FM CHANNEL 18

Subchannel 8				
$\bar{\sigma}_8 = .20$				
$\sigma_{cal-1} = .21$	$\sigma_{cal-2} = .18$	$\sigma_{cal-3} = .19$		

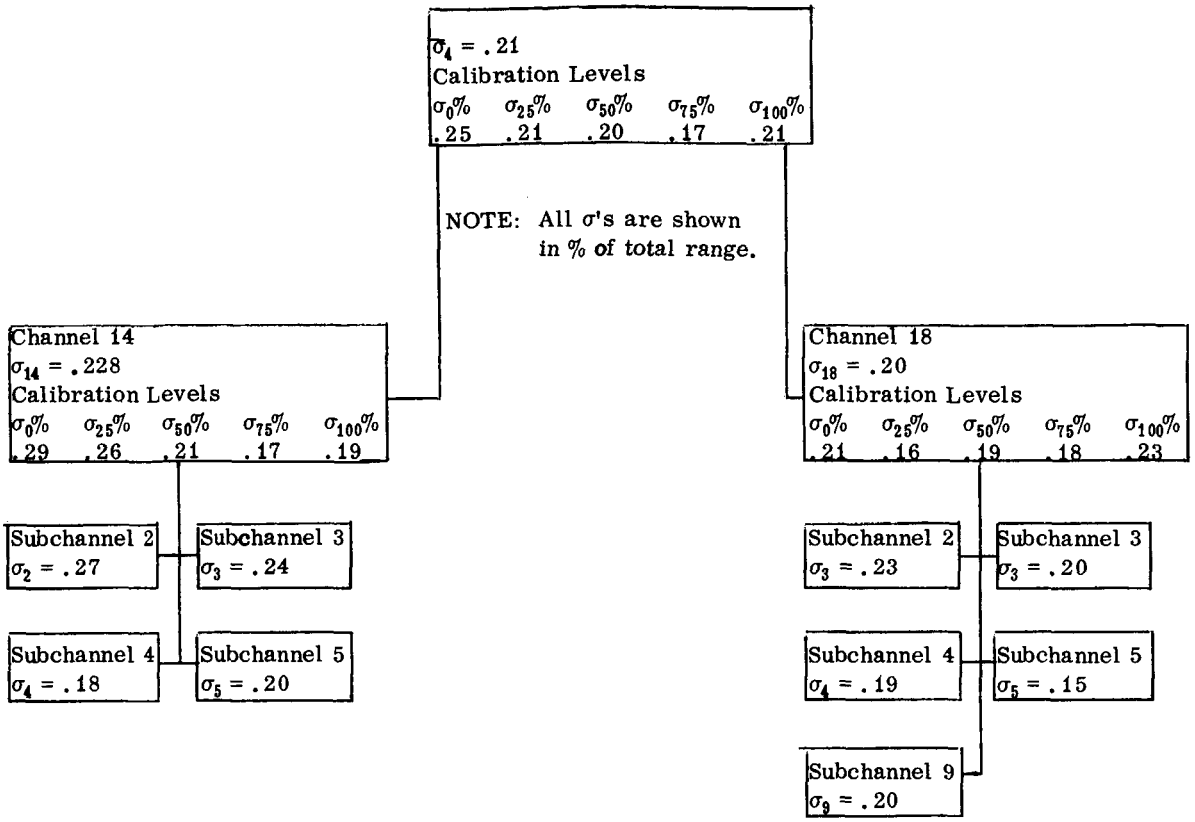
NOTE: All σ's are shown in % of total range.

Subchannel 9				
$\bar{\sigma}_9 = .21$				
$\sigma_{cal-1} = .30$	$\sigma_{cal-2} = .16$	$\sigma_{cal-3} = .15$		

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .14$	$\sigma_{25} = .13$	$\sigma_{50} = .08$	$\sigma_{75} = .10$	$\sigma_{100} = .12$
$\sigma_{cal-1} = .30$	$\sigma_{cal-1} = .13$	$\sigma_{cal-1} = .14$	$\sigma_{cal-1} = .22$	$\sigma_{cal-1} = .23$
$\sigma_{cal-2} = .18$	$\sigma_{cal-2} = .27$	$\sigma_{cal-2} = .17$	$\sigma_{cal-2} = .13$	$\sigma_{cal-2} = .14$
$\sigma_{cal-3} = .15$	$\sigma_{cal-3} = .21$	$\sigma_{cal-3} = .18$	$\sigma_{cal-3} = .19$	$\sigma_{cal-3} = .23$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .14$	$\sigma_{25} = .15$	$\sigma_{50} = .08$	$\sigma_{75} = .26$	$\sigma_{100} = .05$
$\sigma_{cal-1} = .32$	$\sigma_{cal-1} = .26$	$\sigma_{cal-1} = .26$	$\sigma_{cal-1} = .42$	$\sigma_{cal-1} = .17$
$\sigma_{cal-2} = .12$	$\sigma_{cal-2} = .23$	$\sigma_{cal-2} = .13$	$\sigma_{cal-2} = .18$	$\sigma_{cal-2} = .09$
$\sigma_{cal-3} = .14$	$\sigma_{cal-3} = .17$	$\sigma_{cal-3} = .10$	$\sigma_{cal-3} = .22$	$\sigma_{cal-3} = .11$

TABLE III-1. LINK 4 FM/FM/FM



NOTE: See Tables 13 and 15 for elaboration of subchannel σ's.

TABLE III-2. LINK 4 FM/FM/FM CHANNEL 14

NOTE: All σ's are shown in % of total range.

Subchannel 2

$\bar{\sigma}_0 = .27$

$\sigma_{cal-1} = .26 \quad \sigma_{cal-2} = .28 \quad \sigma_{cal-3} = .28$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .30$	$\sigma_{25} = .33$	$\sigma_{50} = .30$	$\sigma_{75} = .27$	$\sigma_{100} = .13$
$\sigma_{cal-1} = .29$	$\sigma_{cal-1} = .35$	$\sigma_{cal-1} = .26$	$\sigma_{cal-1} = .25$	$\sigma_{cal-1} = .09$
$\sigma_{cal-2} = .28$	$\sigma_{cal-2} = .31$	$\sigma_{cal-2} = .35$	$\sigma_{cal-2} = .26$	$\sigma_{cal-2} = .15$
$\sigma_{cal-3} = .33$	$\sigma_{cal-3} = .32$	$\sigma_{cal-3} = .28$	$\sigma_{cal-3} = .30$	$\sigma_{cal-3} = .13$

Subchannel 3

$\bar{\sigma}_0 = .24$

$\sigma_{cal-1} = .23 \quad \sigma_{cal-2} = .24 \quad \sigma_{cal-3} = .28$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .37$	$\sigma_{25} = .31$	$\sigma_{50} = .17$	$\sigma_{75} = .11$	$\sigma_{100} = .12$
$\sigma_{cal-1} = .35$	$\sigma_{cal-1} = .31$	$\sigma_{cal-1} = .13$	$\sigma_{cal-1} = .06$	$\sigma_{cal-1} = .17$
$\sigma_{cal-2} = .39$	$\sigma_{cal-2} = .22$	$\sigma_{cal-2} = .23$	$\sigma_{cal-2} = .13$	$\sigma_{cal-2} = .11$
$\sigma_{cal-3} = .37$	$\sigma_{cal-3} = .39$	$\sigma_{cal-3} = .15$	$\sigma_{cal-3} = .13$	$\sigma_{cal-3} = .06$

Subchannel 4

$\sigma_4 = .18$

$\sigma_{cal-1} = .18 \quad \sigma_{cal-2} = .17 \quad \sigma_{cal-3} = .19$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .22$	$\sigma_{25} = .11$	$\sigma_{50} = .20$	$\sigma_{75} = .11$	$\sigma_{100} = .22$
$\sigma_{cal-1} = .16$	$\sigma_{cal-1} = .12$	$\sigma_{cal-1} = .21$	$\sigma_{cal-1} = .20$	$\sigma_{cal-1} = .22$
$\sigma_{cal-2} = .18$	$\sigma_{cal-2} = .12$	$\sigma_{cal-2} = .21$	$\sigma_{cal-2} = .07$	$\sigma_{cal-2} = .23$
$\sigma_{cal-3} = .31$	$\sigma_{cal-3} = .09$	$\sigma_{cal-3} = .17$	$\sigma_{cal-3} = .09$	$\sigma_{cal-3} = .19$

Subchannel 5

$\sigma_5 = .20$

$\sigma_{cal-1} = .26 \quad \sigma_{cal-2} = .17 \quad \sigma_{cal-3} = .18$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .24$	$\sigma_{25} = .23$	$\sigma_{50} = .13$	$\sigma_{75} = .15$	$\sigma_{100} = .24$
$\sigma_{cal-1} = .25$	$\sigma_{cal-1} = .32$	$\sigma_{cal-1} = .08$	$\sigma_{cal-1} = .23$	$\sigma_{cal-1} = .36$
$\sigma_{cal-2} = .25$	$\sigma_{cal-2} = .16$	$\sigma_{cal-2} = .15$	$\sigma_{cal-2} = .12$	$\sigma_{cal-2} = .17$
$\sigma_{cal-3} = .22$	$\sigma_{cal-3} = .19$	$\sigma_{cal-3} = .15$	$\sigma_{cal-3} = .05$	$\sigma_{cal-3} = .16$

TABLE III-3. LINK 4 FM/FM/FM CHANNEL 18

Subchannel 2				
$\bar{\sigma}_2$ = .23				
σ_{cal-1} = .24	σ_{cal-2} = .22	σ_{cal-3} = .23		

NOTE: All σ's are shown in % of total range.

Subchannel 3				
$\bar{\sigma}_3$ = .19				
σ_{cal-1} = .16	σ_{cal-2} = .16	σ_{cal-3} = .15		

Calibration Level				
0%	25%	50%	75%	100%
σ_0 = .18	σ_{25} = .19	σ_{50} = .23	σ_{75} = .21	σ_{100} = .30
σ_{cal-1} = .21	σ_{cal-1} = .17	σ_{cal-1} = .26	σ_{cal-1} = .21	σ_{cal-1} = .32
σ_{cal-2} = .18	σ_{cal-2} = .17	σ_{cal-2} = .19	σ_{cal-2} = .21	σ_{cal-2} = .32
σ_{cal-3} = .16	σ_{cal-3} = .22	σ_{cal-3} = .24	σ_{cal-3} = .23	σ_{cal-3} = .27

Calibration Level				
0%	25%	50%	75%	100%
σ_0 = .25	σ_{25} = .18	σ_{50} = .09	σ_{75} = .15	σ_{100} = .23
σ_{cal-1} = .27	σ_{cal-1} = .17	σ_{cal-1} = .10	σ_{cal-1} = .09	σ_{cal-1} = .11
σ_{cal-2} = .24	σ_{cal-2} = .21	σ_{cal-2} = .10	σ_{cal-2} = .04	σ_{cal-2} = .14
σ_{cal-3} = .23	σ_{cal-3} = .15	σ_{cal-3} = .08	σ_{cal-3} = .15	σ_{cal-3} = .09

Subchannel 4				
$\bar{\sigma}_4$ = .19				
σ_{cal-1} = .20	σ_{cal-2} = .19	σ_{cal-3} = .18		

Calibration Level				
0%	25%	50%	75%	100%
σ_0 = .23	σ_{25} = .15	σ_{50} = .20	σ_{75} = .14	σ_{100} = .21
σ_{cal-1} = .21	σ_{cal-1} = .15	σ_{cal-1} = .24	σ_{cal-1} = .13	σ_{cal-1} = .26
σ_{cal-2} = .23	σ_{cal-2} = .15	σ_{cal-2} = .21	σ_{cal-2} = .13	σ_{cal-2} = .20
σ_{cal-3} = .25	σ_{cal-3} = .14	σ_{cal-3} = .16	σ_{cal-3} = .16	σ_{cal-3} = .16

Subchannel 5				
$\bar{\sigma}_5$ = .15				
σ_{cal-1} = .15	σ_{cal-2} = .16	σ_{cal-3} = .13		

Calibration Level				
0%	25%	50%	75%	100%
σ_0 = .13	σ_{25} = .15	σ_{50} = .15	σ_{75} = .11	σ_{100} = .19
σ_{cal-1} = .10	σ_{cal-1} = .15	σ_{cal-1} = .14	σ_{cal-1} = .07	σ_{cal-1} = .23
σ_{cal-2} = .20	σ_{cal-2} = .18	σ_{cal-2} = .20	σ_{cal-2} = .10	σ_{cal-2} = .10
σ_{cal-3} = .06	σ_{cal-3} = .10	σ_{cal-3} = .08	σ_{cal-3} = .14	σ_{cal-3} = .22

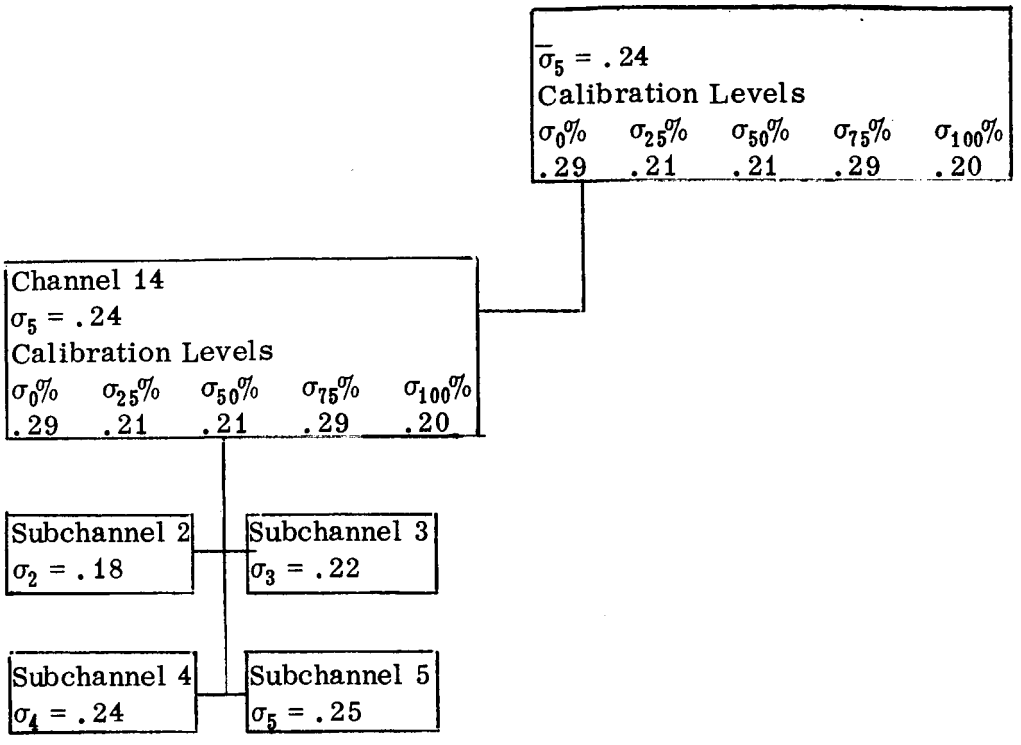
TABLE III-4. FM/FM/FM CHANNEL 18

Subchannel 9
$\overline{\sigma}_9 = .20$
$\sigma_{cal-1} = .22$ $\sigma_{cal-2} = .18$ $\sigma_{cal-3} = .19$

NOTE: All σ's are shown in % of total range.

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .21$	$\sigma_{25} = .15$	$\sigma_{50} = .15$	$\sigma_{75} = .24$	$\sigma_{100} = .20$
$\sigma_{cal-1} = .26$	$\sigma_{cal-1} = .16$	$\sigma_{cal-1} = .17$	$\sigma_{cal-1} = .24$	$\sigma_{cal-1} = .25$
$\sigma_{cal-2} = .20$	$\sigma_{cal-2} = .15$	$\sigma_{cal-2} = .16$	$\sigma_{cal-2} = .23$	$\sigma_{cal-2} = .13$
$\sigma_{cal-3} = .17$	$\sigma_{cal-3} = .15$	$\sigma_{cal-3} = .15$	$\sigma_{cal-3} = .24$	$\sigma_{cal-3} = .21$

TABLE IV-1. LINK 5 FM/FM/FM



NOTE: See Table 17 for elaboration of the subchannel σ's.

TABLE IV-2. LINK 5 FM/FM/FM CHANNEL 14

Subchannel 2
$\sigma_2 = .18$
$\sigma_{cal-1} = .23$ $\sigma_{cal-2} = .13$ $\sigma_{cal-3} = .17$

NOTE: All σ's are shown in % of total range.

Subchannel 3
$\sigma_3 = .22$
$\sigma_{cal-1} = .22$ $\sigma_{cal-2} = .21$ $\sigma_{cal-3} = .22$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .20$	$\sigma_{25} = .23$	$\sigma_{50} = .19$	$\sigma_{75} = .14$	$\sigma_{100} = .16$
$\sigma_{cal-1} = .09$	$\sigma_{cal-1} = .37$	$\sigma_{cal-1} = .27$	$\sigma_{cal-1} = .15$	$\sigma_{cal-1} = .18$
$\sigma_{cal-2} = .11$	$\sigma_{cal-2} = .09$	$\sigma_{cal-2} = .13$	$\sigma_{cal-2} = .15$	$\sigma_{cal-2} = .17$
$\sigma_{cal-3} = .30$	$\sigma_{cal-3} = .15$	$\sigma_{cal-3} = .11$	$\sigma_{cal-3} = .12$	$\sigma_{cal-3} = .12$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .29$	$\sigma_{25} = .26$	$\sigma_{50} = .22$	$\sigma_{75} = .13$	$\sigma_{100} = .14$
$\sigma_{cal-1} = .11$	$\sigma_{cal-1} = .41$	$\sigma_{cal-1} = .16$	$\sigma_{cal-1} = .14$	$\sigma_{cal-1} = .11$
$\sigma_{cal-2} = .30$	$\sigma_{cal-2} = .13$	$\sigma_{cal-2} = .28$	$\sigma_{cal-2} = .12$	$\sigma_{cal-2} = .17$
$\sigma_{cal-3} = .38$	$\sigma_{cal-3} = .08$	$\sigma_{cal-3} = .21$	$\sigma_{cal-3} = .12$	$\sigma_{cal-3} = .14$

Subchannel 4
$\sigma_4 = .24$
$\sigma_{cal-1} = .22$ $\sigma_{cal-2} = .27$ $\sigma_{cal-3} = .21$

Subchannel 5
$\sigma_5 = .25$
$\sigma_{cal-1} = .34$ $\sigma_{cal-2} = .21$ $\sigma_{cal-3} = .18$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .35$	$\sigma_{25} = .09$	$\sigma_{50} = .20$	$\sigma_{75} = .26$	$\sigma_{100} = .20$
$\sigma_{cal-1} = .21$	$\sigma_{cal-1} = .12$	$\sigma_{cal-1} = .13$	$\sigma_{cal-1} = .37$	$\sigma_{cal-1} = .18$
$\sigma_{cal-2} = .43$	$\sigma_{cal-2} = .09$	$\sigma_{cal-2} = .29$	$\sigma_{cal-2} = .21$	$\sigma_{cal-2} = .24$
$\sigma_{cal-3} = .38$	$\sigma_{cal-3} = .02$	$\sigma_{cal-3} = .15$	$\sigma_{cal-3} = .12$	$\sigma_{cal-3} = .19$

Calibration Level				
0%	25%	50%	75%	100%
$\sigma_0 = .30$	$\sigma_{25} = .23$	$\sigma_{50} = .22$	$\sigma_{75} = .23$	$\sigma_{100} = .27$
$\sigma_{cal-1} = .36$	$\sigma_{cal-1} = .30$	$\sigma_{cal-1} = .27$	$\sigma_{cal-1} = .35$	$\sigma_{cal-1} = .40$
$\sigma_{cal-2} = .25$	$\sigma_{cal-2} = .26$	$\sigma_{cal-2} = .14$	$\sigma_{cal-2} = .13$	$\sigma_{cal-2} = .22$
$\sigma_{cal-3} = .27$	$\sigma_{cal-3} = .07$	$\sigma_{cal-3} = .25$	$\sigma_{cal-3} = .12$	$\sigma_{cal-3} = .07$

SPACE VEHICLE SA-4, TELEMETRY SYSTEM

By

E. H. Reeves, Jr., J. R. Stovall,
and W. B. Threldeld, Jr.

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This document has also been reviewed and approved for technical accuracy.

James E Rorex

J. E. ROREX
Chief, Telemetry Systems Branch

O. A. Hoberg

O. A. HOBERG
Chief, Instrumentation and Communication Division

O. A. Hoberg

W. HAEUSSERMANN
Director, Astrionics Laboratory

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