MIL-STD-188-311
10 December 1971
SUPERSEDING
(See Section 6)

MILITARY STANDARD

TECHNICAL DESIGN STANDARDS FOR FREQUENCY DIVISION MULTIPLEXERS

SLMC

FOREWORD

The purposes of this standard are to delineate the overall system and individual equipment performance requirements for Frequency Division Multiplexer (FDM) sets intended for use in the Defense Communications System (DCS). Furthermore, it is intended to define the standard interface points within the FDM set which assure its compatible operation with other DCS equipments.

The requirements and definitions contained within this document insure that the quality of electrical signals entering the multiplexer set is maintained to the fullest extent possible, thus providing for the overall best possible DCS system performance.

This standard is not intended for use as a procurement specification therefore, requirements such as size, weight, power consumption, reliability, maintainability, human engineering, monitors and advances....etc., which would needlessly restrict the configuration, have been specifically excluded.

This standard is compatible with performance capabilities of the AN/UCC-4(V) Multiplex Set developed by Lenkurt Electric Co., San Carlos, California, under RADC Contract AF30(602)4135. This equipment has been declared the DCS Standard Frequency Division Multiplexer (FDM) and is currently being procured by all three services for incorporation into the DCS.

DEPARTMENT OF DEFENSE

Washington, D. C.

Technical Design Standards For
Frequency Division Multiplexers
MIL-STD-188-311

1. This Military Standard is mandatory for use by all Departments and Agencies of the Department of Defense.

2. Recommended corrections, additions or deletions should be reported to the preparing activity (Rome Air Development Center). (See Defense Standardization Directory SD-1 for mailing address.)

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1. SCOPE

1.1 Purpose. This standard sets forth the electrical performance requirements for Frequency Division Multiplexer (FDM) equipment accepted by the Government for use in the Defense Communications System (DCS) and semi-fixed tactical service. It is intended to define the interface levels at interconnection points to and from local telephone facilities and to and from long distance communications trunks.

1.2 Application. The multiplexer equipment may be configured to combine from 12 to 612 lower sideband voice frequency (VF) channels for transmission over microwave radio relay, tropospheric scatter, and suitably equipped wire line systems. The VF channels (0.3 kHz to 4 kHz nominal) shall be capable of handling voice, digital data, telegraph, facsimile, or other graphic information. Multiplex high frequency (HF) line outputs (HFDF) can be placed in the frequency spectrum between 12 and 2,540 kHz or parts thereof. The specific line position (frequency) and channel capacities can be configured by selecting the appropriate variable multiplexer groups within the Multiplexer Equipment family. The multiplexer equipment is suitable for fixed plant, mobile and shipborne usage. Input power can be either 48 VDC or 115V, 50-60 Hz AC.

2. REFERENCED DOCUMENTS

MIL-STD-188-300 — Systems Design Standards Applicable to the Defense Communications System.

3. DEFINITIONS. Definitions contained in this standard are intended to amplify or supplement those definitions in MIL-STD-188-300. In case of conflict in definitions, the definitions contained herein shall govern.

CARRIER LEAK. Carrier Leak is the level of carrier expressed in dBm0 of a suppressed carrier appearing at a standard interface point.

~~HIGH FREQUENCY DISTRIBUTION FRAME (HFDF).~~ The HFDF provides terminating and interconnecting facilities for those combined supergroup modulator output and combined supergroup demodulator input circuits occupying the baseband spectrum of 12 kHz up to and including 2540 kHz.

GROUP DISTRIBUTION FRAME (GDF). The GDF provides terminating and interconnecting facilities for the modulator output and demodulator input circuits of the channel transmitting equipment and modulator input and demodulator output for the group translating equipment operating in the basic spectrum of 60 to 108 kHz.

NOISE WEIGHTING. In measurement of circuit noise, a specific amplitude-frequency characteristic of a noise measuring set, designed to give numerical readings which approximate the amount of transmission impairment due to the noise, to an average listener using a particular class of telephone subset.

Note: The noise weightings generally used were established by agencies concerned with public telephone service, and are based on characteristics of specific commercial telephone subsets, representing successive stages of technological development. The coding of commercial apparatus appears in nomenclature of certain weightings. The same weighting nomenclature and units are used in military versions of commercial noise measuring sets.

F1A-Line Weighting. A noise weighting used in a noise measuring set to measure on a line that would be terminated by a 302-type or similar subset.

OSCILLATORS - MASTER FREQUENCY GENERATORS. These standards are established for the following types of master, submaster, and slave oscillator equipments to provide system end-to-end carrier frequency synchronization, frequency accuracy of tones transmitted over the system, near term employment of master/slave techniques with integral master oscillators and eventual employment of highly accurate and stable master oscillator equipments. The following types of oscillators are employed in the DCS multiplexer systems:

Type 1 Master carrier oscillator as an integral part of the multiplexer set.

Type 2 Submaster oscillator equipment or slave oscillator equipment as an integral part of the multiplex set.

Type 3 External master oscillator equipment having extremely accurate and stable characteristics.

STANDARD TEST SIGNAL. For use at the 600 ohm audio input portion of a circuit and shall be 16 dB below one mw (-16 dBm) with a frequency of 1000 Hz and shall be applied at a zero transmission level reference point (-16 dBm = 0dBm0).

STANDARD TEST TONE. A tone of the same frequency as the standard test signal but 10 dB lower (-26 dBm or -10 dBm0).

STANDARD INTERFACE POINTS. VF patch bays, GDF, SGDF and HFDF.

SUPERGROUP. Normally 60-voice channels of a wideband path or five groups of 12-voice channels each and occupying the frequency band 312 to 552 kHz.

SUPERGROUP DISTRIBUTION FRAME (SGDF). The SGDF provides terminating and interconnecting facilities for group modulator output, group demodulator, supergroup modulator input and supergroup demodulator output circuits of the basic supergroup spectrum of 312 to 552 kHz.

THROUGH GROUP EQUIPMENT. An equipment which accepts the 60 to 108 kHz signal from the group receive output and attenuates it to the proper signal interface for insertion at the input of a group transmit equipment. This shall be accomplished without frequency translation.

THROUGH SUPERGROUP EQUIPMENT. An equipment which accepts the 312 to 552 kHz signal from the supergroup receive output, amplifies it and provides the proper signal interface to the input of a supergroup transmit equipment. This shall be accomplished without frequency translation.

VOICE FREQUENCY DISTRIBUTION FRAME (VFDF). The VFDF provides terminating and interconnecting facilities for channel modulator inputs and demodulation outputs and is designed to handle nominal 4 kHz voice signals.

4. GENERAL SYSTEM PERFORMANCE STANDARDS

4.1 END TO END SYSTEM PERFORMANCE STANDARDS. The term "set" used in these performance standards refers to a complete set of multiplex equipment and includes the following functional equipment blocks.

4.1.1 Master Frequency Generating Equipment. This equipment produces all carriers required for group and supergroup translation, synchronizing pilots, and group pilots. It also controls the frequency of the channel carrier generating equipments. Normally, only one of these blocks is installed in a station, and supplies all Frequency Division Multiplex (FDM) equipment in the station. It is capable of modular expansion to care for increases in the numbers of links, supergroups and groups installed in the station.

4.1.2 Group, Supergroup and Baseband Equipment. One of these blocks of equipment is installed for each link terminated in a station. It is capable of modular expansion to include up to 10 supergroups, each including 5 groups, and 1 Group A.

4.1.3 Channel Equipment. One of these blocks is installed in each station, and serves each FDM link in the station. It is capable of expansion in basic increments, usually of 12 channels. This block includes the channel carrier frequency generating equipment which operates under the synchronous control of the master frequency generating equipment.

4.1.4 Auxiliary Equipment. This block of equipment includes those items which are not essential parts of every FDM installation but are installed as required for specific applications. Where used, only one of these blocks is installed in a station and serves all FDM links in that station to which it is applicable. This block includes the following types of equipment:

a. Through-Group Equipment

b. Through-Supergroup Equipment

c. Regulating Equipment

d. Group "A" Equipment.

4.2 Overall Set Performance. The performance standards shall be demonstrated on a back to back basis with the set correctly looped at the High-Frequency Distribution Frame through appropriate looping equipment. (See Figure 1.)

4.2.1 Accuracy and Stability. Type 1 equipment shall have an initial setting accuracy of one part in 10^6. After an initial adjustment period, the frequency stability shall be not less than one part in 10^6 per month and 5 parts in 10^9 per hour. Two separate basic oscillator units shall be provided, with means for automatically selecting the alternate output of the operating unit if the primary unit fails.

4.2.2 Carrier Purity. The following applies to all carrier generation, amplification, and distribution within the multiplex equipment:

a. For each group and supergroup modulating and demodulating carrier frequency, any spurious frequency (except harmonics of the desired carrier) between 10 kHz and 2852 kHz shall be at least 70 dB (74 dB DO) below the level of the desired carrier.

b. For each channel modulating and demodulating carrier frequency Fo any spurious frequency, (except harmonics of the desired carrier), between 300 Hz and 328 kHz shall be below the level of the desired carrier (fo) by at least the amounts shown in Table I.

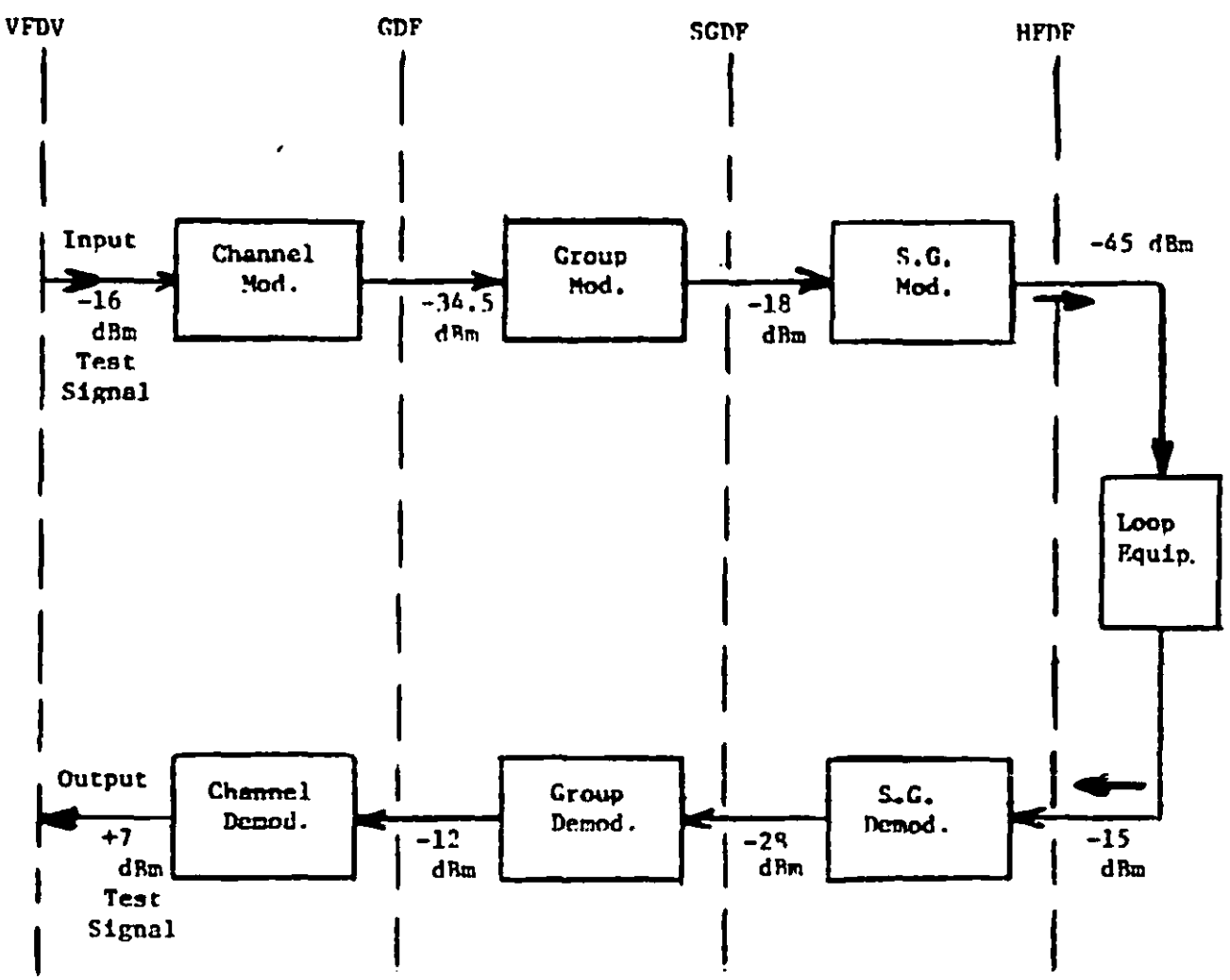


Figure 1. 4kHz Channel

TABLE I SPURIOUS FREQUENCY

From	To and Including	dB
Fo	Fo - 4 kHz	50
Fo - 4.1 kHz	Fo - 8 kHz	35
Fo - 8.1 kHz	Fo - 12 kHz	35
Fo	Fo + 4 kHz	45
Fo + 4.1 kHz	Fo + 8 kHz	30
Fo + 8.1 kHz	Fo + 12 kHz	35
Fo ± 12.1 kHz	300 Hz to 328 kHz	35

c. The above requirements shall be demonstrated by measurements at the points of carrier injection to the channel, group and supergroup modulators and demodulators as applicable.

4.2.3 CarrierSynchronizing Pilot. A single carrier synchronizing pilot at 96 kHz shall be used. This pilot shall be transmitted at Group No. 5 of Supergroup No. 1 and shall be injected prior to the HFDF in the transmit direction at a level of -16 dBm0. It shall be picked off following the HFDF in the receive direction at a level of -16 dBm0.

4.3 Reference 4kHz Channel. The performance standards of a reference 4 kHz channel shall be demonstrated on a back to back basis with the set correctly looped at the High Frequency Distribution Frame (See Figure 1) through appropriate looping equipment.

4.3.1 Gain. The gain of the set, when looped as indicated in Figure 1, shall be 23 dB.

4.3.2 Insertion Loss Versus Frequency Characteristics. The insertion loss versus frequency characteristics of the set, when looped as indicated in Figure 1 shall be within the following values. Positive figures indicate a loss, and negative figures indicate a gain relative to the insertion loss at 1000 Hz.

Frequency Band (Hz)	Looped at HFDF dB
300 - 3400 Hz (except 400 - 3000 Hz)	-0.7, + 1.9
400 - 3000 Hz	±0.7

4.3.3 Envelope Delay Distortion Versus Frequency Characteristics. The envelope delay distortion versus frequency characteristics of the set, when looped as indicated in Figure 1, shall be within the following values.

Looped at HFDF	Freq Band (Hz)	µSECS
Any channel, SG 2 & 5 G 4 - 10	600 to 3200 (except 1000 to 2500)	127
	1000 to 2500	87
Any channel, SG 1 & 3, Except Channels 1 & 2, GR 1, of SG 1 and Channels 11 & 12, GR 5, SG 3.	600 to 3200 (except 1000 to 2500)	140
	1000 to 2500	100
Channels 1 & 2, GR 1, of SG 1 and Channels 11 & 12, GR 5, of SG 3	Not specified	

4.3.4 Channel In Band Noise (4 kHz). The in band noise (idle channel noise) for any channel shall not exceed 75 pWp0 (18.8 dBrnc0), with the set looped as indicated in Figure 1 and the input and output voice frequency (VF) channel leads terminated in 600 ohms.

4.3.5 Channel Out of Band Noise (4 kHz). The out of band noise (total intrinsic and intermodulation noise) for any channel shall not exceed 131 pWp0 (21.2 dBrnco), with the set looped as indicated in Figure 1 and all other channels are loaded with white gaussian noise (0.3 to 3.4 kHz band) at an input power level of -5 dBm0.

4.3.6 Channel Level Stability (4 kHz). The channel level stability for any channel shall be +0.9 dB or better over a 30 day period, with the set looped as indicated in Figure 1.

4.3.7 Phase Jitter. The phase jitter for any channel shall not exceed 2 degrees, peak to peak, with the set looped as indicated in Figure 1.

4.3.8 Accuracy of a Single Frequency. Any single frequency between 300 and 3400 Hz injected into any channel at a level of -16 dBm shall be received at the corresponding channel output with an accuracy of +0.10 Hz

4.4 Reference 48 kHz Channel. The performance characteristics of a 48 kHz channel are derived from the individual performance characteristics of the multiplexer set and have not been fully confirmed by measurements. However, the performance characteristics are considered adequate for use in communication system and subsystem engineering and design. The performance standards of a reference 48 kHz channel shall be demonstrated on a back to back basis with the set correctly looped at the High Frequency Distribution Frame (See Figure 2) through appropriate looping equipment.

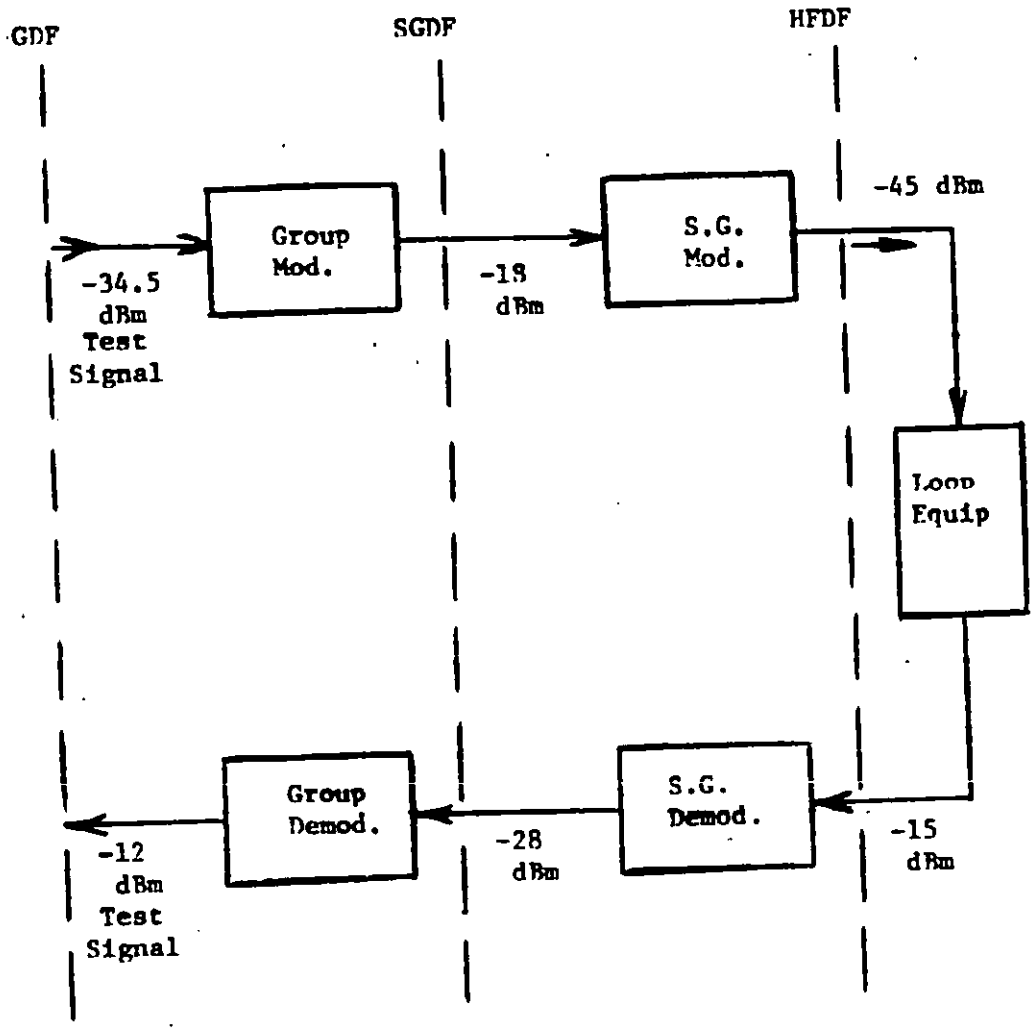


Figure 2. 48 kHz Channel

4.4.1 Gain. The gain of the set, when looped as indicated in Figure 2, shall be 22.5 dB.

4.4.2 Insertion Loss Versus Frequency Characteristics. The insertion loss versus frequency characteristics of the set, when looped as indicated in Figure 2 shall be within the following values. Positive figures indicate a loss, and negative figures indicate a gain.

Frequency Band	Looped at HFDF
kHz	dB
60.6 to 107.7	±2.1

4.4.3 Envelope Delay Distortion Versus Frequency Characteristics. The envelope delay distortion versus frequency characteristics of the set, when looped as indicated in Figure 2, shall be within the following values.

Looped at HFDF	Frequency Band	μSEC
Any Group, SG 2 and 4 - 10	64 to 104	22
Any Group except GR 1 of SG 1 and GR 5 of SG 3	64 to 104	68
GR 1 of SG 1 and GR 5 of SG 3	Not specified.	

4.4.4 Channel In Band Noise (48 kHz). The in band noise (idle channel noise) for any channel shall not exceed 1850 pW0, with the set looped as indicated in Figure 2 and the GDF input and output terminated in 135 ohms.

4.4.5 Channel Out of Band Noise (48 kHz). The out of band noise (total intrinsic and intermodulation noise) for any channel shall not exceed 2850 pW0, with the set looped as indicated in Figure 2 and all other groups are loaded with white gaussian noise (60 to 108 kHz band) at an input level of +0.8 dBm0.

4.4.6 Channel Level Stability (48 kHz). The channel level stability for any channel shall be ±0.7 dB or better over a 30 day period, with the set looped as indicated in Figure 2.

4.5 Reference 240 kHz Channel. The performance characteristics of a 240 kHz channel are derived from the individual performance characteristics of the multiplexer set and have not been fully confirmed by measurements. However, the performance characteristics are considered adequate for use in communication system and subsystem engineering and design. The performance standards of a reference 240 kHz channel shall be demonstrated on a back to back basis with the set correctly looped at the High Frequency Distribution Frame (See Figure 3) through appropriate looping equipment.

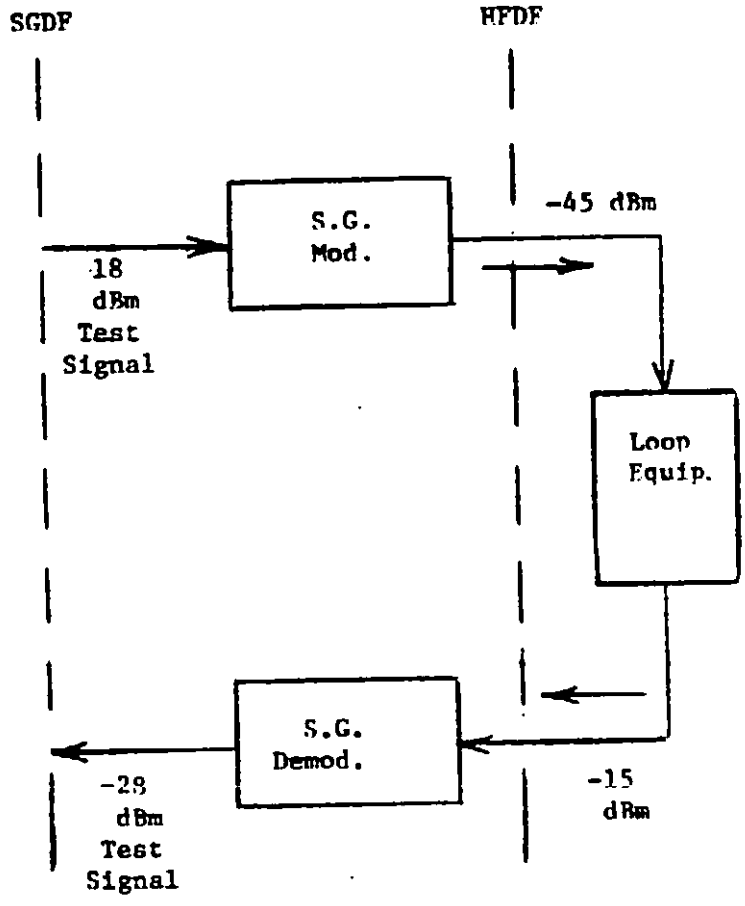


Figure 3. 240 kHz Channel

4.5.1 Gain. The gain of the set, when looped as indicated in Figure 3 shall be -10 dB.

4.5.2 Insertion Loss Versus Frequency Characteristics. The insertion loss versus frequency characteristics of the set, when looped as indicated in Figure 3, shall be within the following values. Positive figures indicate a loss, and negative figures indicate a gain.

Super Group No's.	Looped at HFDF dB
SG 1 - 10 (312 to 552 kHz)	±2.0

4.5.3 Envelope Delay Distortion Versus Frequency Characteristics. The envelope delay distortion versus frequency characteristics of the set, when looped as indicated in Figure 2, shall be within the following values.

Looped at HFDF	Frequency Band	μSEC
SG 2 and 4 - 10	312 to 552 kHz	10
SG 1	320 to 552 kHz	56
SG 3	312 to 544 kHz	56

4.5.4 Channel In Band Noise (240 kHz). The in band noise (idle channel noise) for any channel shall not exceed 710 pW0, with the set looped as indicated in Figure 3 and the SGDF input and output terminated in 75 ohms.

4.5.5 Channel Out of Band Noise (240 kHz). The out of band noise (total intrinsic and intermodulation noise) for any channel shall not exceed 1425 pW0, with the set looped as indicated in Figure 3 and all other super groups are loaded with white gaussian noise (312 to 552 kHz band) at an input level of 7.8 dBm0.

4.5.6 Channel Level Stability (240 kHz). The channel level stability for any channel shall be ±0.5 dB or better over a 30 day period, with the set looped as indicated in Figure 3.

4.6 Reference Through 48 kHz Channel. The performance characteristics of a through 48 kHz channel are derived from the individual performance characteristics of the multiplexer set and have not been fully confirmed by measurements. However, the performance characteristics are considered adequate for use in communication system and subsystem engineering and design. The performance standards of a reference through 48 kHz channel shall be demonstrated on a back to back basis with the set correctly looped at the Group Distribution Frame (See Figure 4) through the through group equipment.

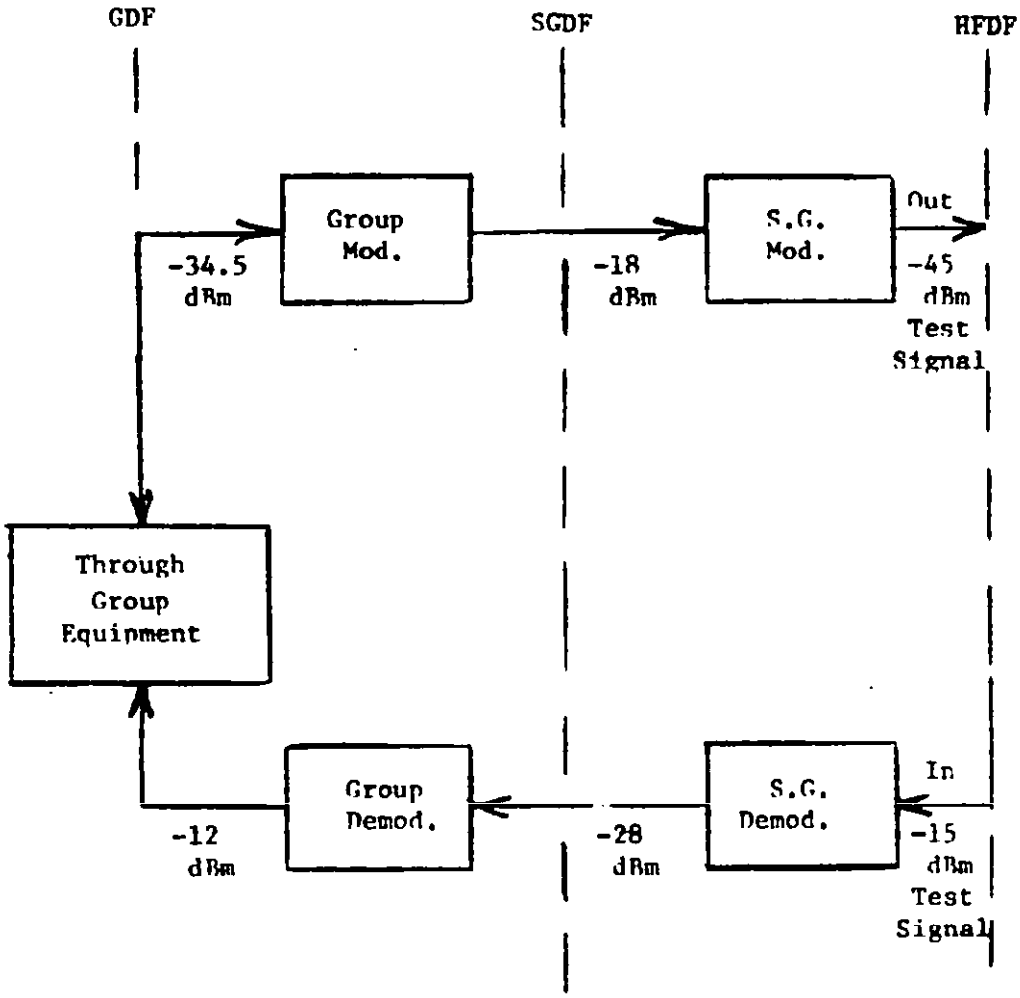


Figure 4. Through 48 kHz Channel

4.6.1 Gain. The gain of the set, when looped as indicated in Figure 4 shall be -30 dB.

4.6.2 Insertion Loss Versus Frequency Characteristics. The insertion loss versus frequency characteristics of the set, when looped as indicated in Figure 4, shall be within the following values. Positive figures indicate a loss, and negative figures indicate a gain.

Frequency Band	Looped at GDF
kHz	dB
60.6 to 107.7	±2.3

4.6.3 Envelope Delay Distortion Versus Frequency Characteristics. The envelope delay distortion versus frequency characteristics of the set, when looped as indicated in Figure 4, shall be within the following values.

Looped at GDF	Frequency Band	µSEC
	kHz	
Any Group, SG 2 and 4 - 10	64 to 104 kHz	142
Any Group except GR 1 of SG 1 and GR 5 of SG 3	64 to 104	188
GR 1 of SG 1 and GR 5 of SG 3	Not specified	

4.6.4 Through 48 kHz Channel In Band Noise. The in band noise (idle channel noise) for any channel shall not exceed 1850 pW0, with the set looped as indicated in Figure 4 and the HFDF input and output terminated in 75 ohms.

4.6.5 Through 48 kHz Channel Out of Band Noise. The out of band noise (total intrinsic and intermodulation noise) for any channel shall not exceed 3134 pW0, with the set looped as indicated in Figure 4 and all other groups are loaded with white gaussian noise (60 to 108 kHz band) at an input level of 0.8 dBm0.

4.6.6 Through 48 kHz Channel Level Stability. The channel level stability for any channel shall be ±0.8 dB or better over a 30 days period, with the set looped as indicated in Figure 4.

4.7 Reference Through 240 kHz Channel. The performance characteristics of a through 240 kHz channel are derived from the individual performance characteristics of the multiplexer set and have not been fully confirmed by measurements. However, the performance characteristics are considered adequate for use in communication system and subsystem engineering and design.

The performance standards of a reference through 240 kHz channel shall be demonstrated on a back to back basis with the set correctly looped at the Super Group Distribution Frame (See Figure 5) through the through super group equipment.

4.7.1 Gain. The gain of the set, when looped as indicated in Figure 5, shall be -30 dB.

4.7.2 Insertion Loss Versus Frequency Characteristics. The insertion loss versus frequency characteristics of the set, when looped as indicated in Figure 5, shall be within the following values. Positive figures indicate a loss, and negative figures indicate a gain.

Super Group No's	Looped at SGDF dB
SG 1 - 10 (312 to 552 kHz)	±2.5

4.7.3 Envelope Delay Distortion Versus Frequency Characteristics. The envelope delay distortion versus frequency characteristics of the set, when looped as indicated in Figure 5, shall be within the following values.

Looped at SGDF	Frequency Band	µSECS
SG 2 and 4 - 10	312 to 552 kHz	80
SG 1	320 to 552 kHz	126
SG 3	312 to 544 kHz	126

4.7.4 Through 240 kHz Channel In Band Noise. The in band noise (idle channel noise) for any channel shall not exceed 1,420 pW0, with the set looped as indicated in Figure 5 and the HFDF input and output terminated in 75 ohms.

4.7.5 Through 240 kHz Channel Out of Band Noise. The out of band noise (total intrinsic and intermodulation noise) for any channel shall not exceed 2850 pW0 with the set looped as indicated in Figure 5 and all other super groups are loaded with white gaussian noise (312 to 552 kHz band) at an input level of 7.8 dBm0.

4.7.6 Through 240 kHz Channel Level Stability. The channel level stability for any channel shall be ±0.6 dB or better over a 30 day period, with the set looped as indicated in Figure 5.

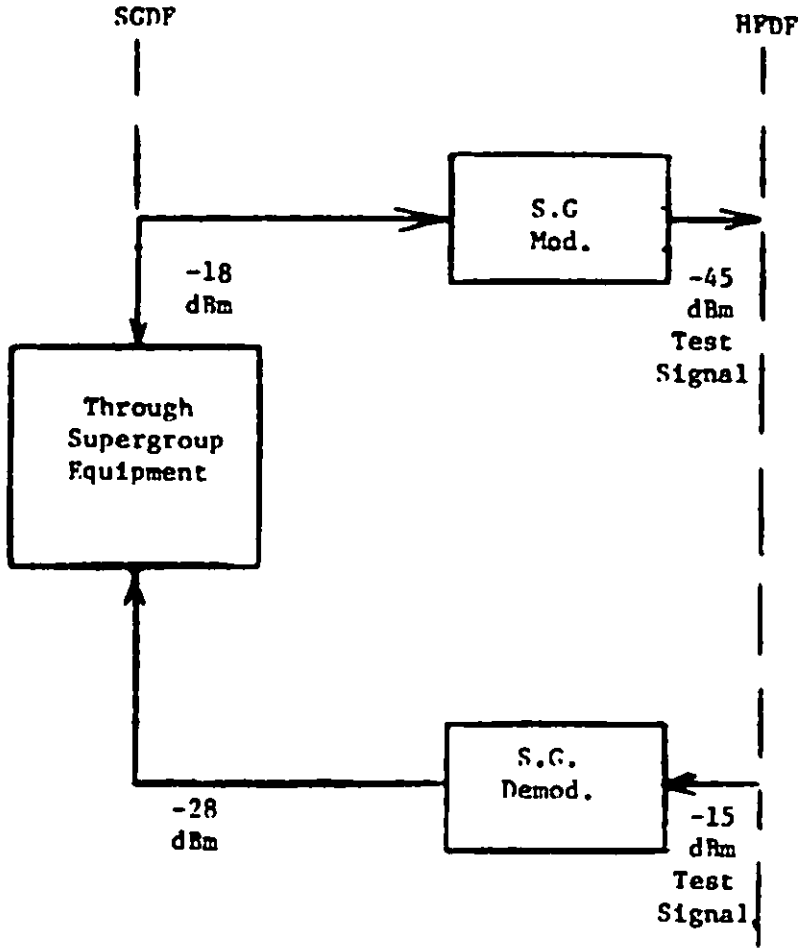


Figure 5. Through 240 kHz Channel

4.8 Preferred Channels for Data Transmission. The digital data transmission circuits, as described in MIL-STD-188-101, -201, and -301, require the use of through-group equipment and through-super group equipment at intermediate terminals of the reference circuits. Further, the use of regeneration of digital data is either implied or stated. Based upon the FDM equipment characteristics, the following channels are recommended for data transmission.

4.8.1 4 kHz Channels. The preferred 4 kHz channels for data transmission are channels 3 through 10 of all groups of all super groups. Channels 1 and 2 of Group 1, of Supergroup 1 and channels 11 and 12 of Group 5 of Supergroup 3 are not recommended for digital data (Quasi-analog) transmission.

4.8.2 48 kHz Channels. The preferred 48 kHz channels for high speed data transmission are all 48 kHz channels (groups) of super groups 2, and 4 through 10. Groups 2 through 5 of Super Group 1 and Groups 1 through 4 of Super Group 3 are also preferred for 48 kHz high speed data transmission. Group 1 of Super Group 1 and Group 5 of Super Group 3 are not recommended for data transmission.

4.8.3 240 kHz Channels. The preferred 240 kHz channels for high speed data transmission are Super Groups 2, and 4 through 10. Super Groups 1 and 3 may be used if the envelope delay distortion characteristics can be tolerated.

5. Detailed Equipment Performance Characteristics. The following requirements as specified in this section delineate the detailed performance of the multiplexer set. Sections are included for the channel, groups and super group translating equipment including carrier generation. Also included are the performance standards for the following options: through group, Group A group regulation and through super group equipment.

5.1 Channel Translating Equipment.

5.1.1 Channel Modulation and Demodulation Plan. The Channel Translating Equipment shall modulate or demodulate 12 four-wire audio channels to or from the 60 to 108 kHz frequency spectrum. Standard configuration shall be lower sideband configuration, twin channel shall be used only when necessary to interface with existing nonstandard, twin channel equipments. Both lower sideband and twin channel (Double Sideband) modulation schemes shall be provided on a selectable basis (See Figure 6.). The translated channels shall appear at the Group Distribution Frame (GDF) or equivalent point as single-sideband suppressed-carrier 4 kHz-spaced channels with either lower sideband or twin-channel orientation for all channels.

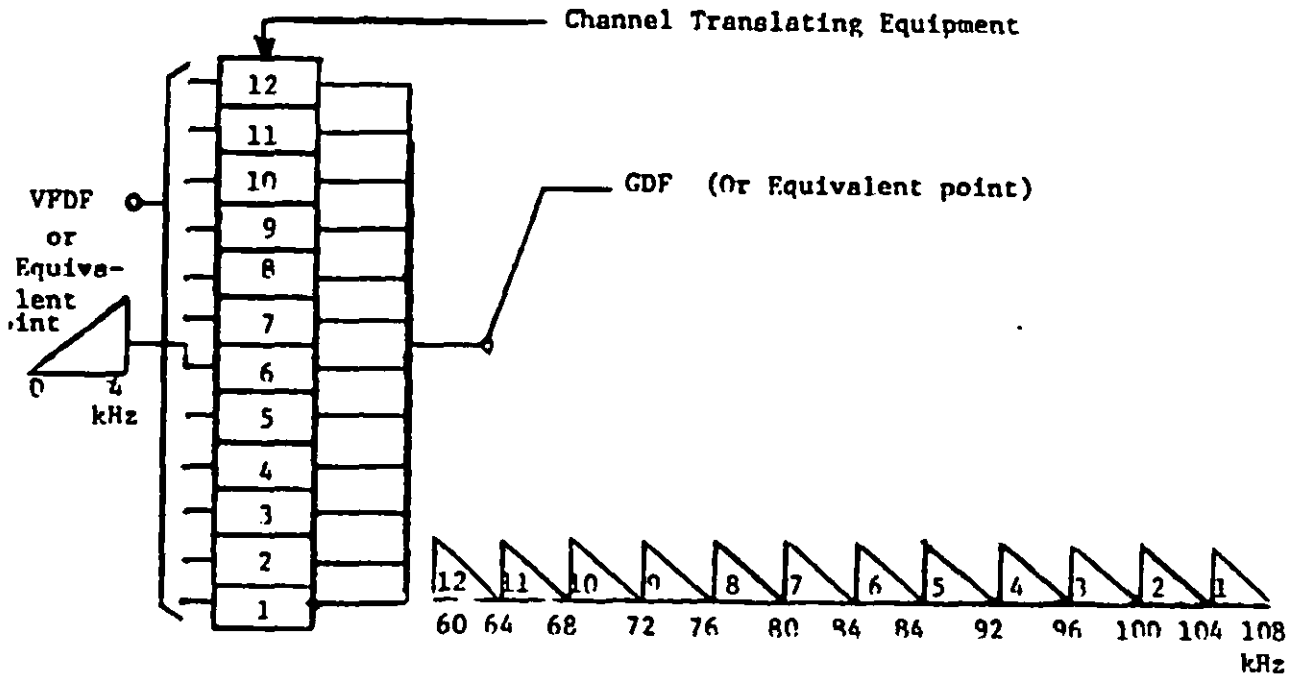


Figure 6a. Plan for the Lower Sideband 12-Channel Basic Group

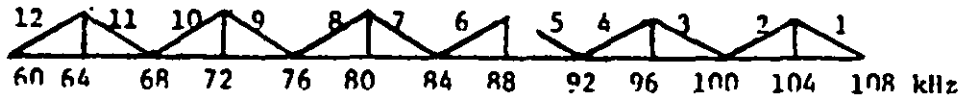


Figure 6b. Plan for the Twin-Channel 12-Channel Basic Group.

Figure 6. Channel Modulation and Demodulation Plan

5.1.2 Channel Equipment Input/Output Levels. The input and output levels specified provide a net gain of 23 dB. These levels shall apply to all channels of the multiplex equipment, without regard for the net loss to be provided for any particular trunk, whether terminated on a two-wire or a four-wire basis. All audio channels shall be maintained on the same basis so that a -16 dBm test signal (1000 Hz) at any input to the channel translating equipment shall result in a +7 dBm level at the corresponding channel output of the demodulator, insuring that all channels are interchangeable and may be freely patched at multiplex access points without need to change adjustments integral to the multiplex equipment.

5.1.2.1 The test signal level at the audio input to the channel translating equipment shall be -16 dBm at 1000 Hz. An alternate strap selectable level of 0 dBm shall also be provided.

5.1.2.2 The test signal level at the audio output from the channeling equipment shall be +7 dBm with an continuous adjustment range of not less than +3 dB, -7 dB to accommodate variations in the receive direction at the GDF or equivalent point.

5.1.2.3 The test signal level at the GDF or equivalent point in the transmit direction shall be -34.5 dBm, $\pm$0.5 dB.

5.1.2.4 The test signal level in the receive direction at the GDF or equivalent point shall be -12 dBm.

5.1.3 Channel Equipment Impedances.

5.1.3.1 Audio Input and Output. The impedance at the audio input and output, measured over the frequency band of 300 to 3400 Hz, shall be 600 ohms with a longitudinal balance of not less than 40 dB. The return loss shall be not less than 26 dB when compared against a nonreactive impedance of 600 ohms.

5.1.3.2 GDF Input and Output. The impedance of the channel translating equipment at the GDF shall be 135 ohms balanced with a return loss of not less than 20 dB when compared with a non-reactive impedance of 135 ohms. This performance shall exist across each of the translated frequency spectrums which correspond to the modulated frequencies of each of the audio channels (300 to 3400 Hz) as well as each of the pilot frequencies.

5.1.4 Channel Limiting. The channel translating equipment shall provide limiting in the transmit direction such that the level at the GDF or equivalent point cannot exceed +9 dBm0 per channel. The limiting shall be such that if a 1000 Hz tone is applied to the channel input at a level of -16 dBm and the level of this tone is increased in a linear manner to a level of 3.5 dB

above -16 dBm, the output level at the GDF or equivalent point shall also increase in a linear manner with a maximum departure not exceeding ±0.3 dB. In the event of an increase in level up to 16 dB above the initial setting, the limiting shall insure that the transmit level does not exceed +9 dBm0 per channel.

5.1.5 Channel Equipment Carrier Leak. The power level of any individual channel carrier at the common output of the channel bank shall not be greater than -27 dBm0 for each channel. The actual measurements shall be made at the group distribution frame or equivalent point.

5.1.6 Channel Equipment Insertion Loss Versus Frequency Characteristics. With the channel translating equipment properly looped at the GDF or equivalent point, the insertion loss versus frequency response for the 4 kHz channels shall be within the following values. Positive figures indicate a loss, and negative figures indicate a gain, relative to the insertion loss at 1000 Hz.

Frequency Band (Hz)	Insertion Loss
300 to 3400 (except 400 to 3000)	±0.3 dB.
400 to 3000	-0.3 dB. +1.5 dB

5.1.7 Channel Equipment Envelope Delay Distortion. With the channel translating equipment properly looped at the GDF the envelope delay distortion versus frequency response shall not exceed 60 microseconds over the 600 to 3200 Hz and 40 microseconds over the 1000 to 2500 Hz ranges. This performance shall exist for all voice frequency line terminations.

5.1.8 Channel Equipment Non-Linear Distortion and Harmonics. With the channel translating equipment properly looped at the GDF, and a -16 dBm, 1000 Hz test signal applied to the input of the channel and the corresponding channel output set for a test signal output level of +7 dBm, the distortion products shall not exceed -40 dBm0 for the second harmonic and -40 dBm0 for the third harmonic.

5.1.9 Channel Equipment Noise (Idle Channel). With the channel translating equipment properly looped at the GDF and the VF leads terminated in 600 ohms, the idle channel noise shall not exceed 10 picowatts psophometrically weighted and referred to a zero level point (pWp0).

5.1.10 Channel Equipment Intelligible Crosstalk.

5.1.10.1 Crosstalk Between Channels in a Channel Bank. The intelligible crosstalk level on any channel in a group, at any frequencies between 300 and 3400 Hz, shall not exceed -70 dBm0 when sending at the test signal level (-16 dBm) on any other channel.

5.1.10.2 Near-End Crosstalk Within the Channel Bank. With the transmit and receive sides of the channel bank properly terminated at the GDF, the transmit-to-receive and receive-to-transmit Near-End Crosstalk level shall not exceed -50 dBm0 for all frequencies between 300 and 3400 Hz (or equivalent carrier frequencies) when sending at the test tone level.

5.1.11 Channel Equipment Unintelligible Crosstalk. With the channel bank properly looped at the GDF and the disturbed channel is terminated at its sending end and the adjacent (disturbing) channel is loaded with (300 to 3400 Hz band) white gaussian noise at a power level of -16 dBm (0dBm0) at the channel input. Using a psophometer or equivalent, the noise produced in the disturbed channel is then compared with the signal applied to the disturbing channel. The resultant crosstalk power ratio shall be 60 dB minimum.

5.1.12 Channel Equipment Loaded Noise. With the channel bank properly looped at the GDF, the total intrinsic and intermodulation noise occurring in any channel shall not exceed 31 pWp0 when all other channels are loaded with (300 to 3400 Hz band) white gaussian noise at an input level equivalent to -5.0 dBm0 per channel.

5.1.13 Channel Equipment Channel Level Stability. With the channel bank properly looped at the GDF, the channel level stability measured at the channel demodulator output shall be ±0.5 dB or better over any 30-day period.

5.1.14 Channel Equipment Spurious Products. The level of any product falling in the ranges of 300 Hz to 59.4 kHz and 112.6 kHz to 328 kHz shall ~~not exceed -65 dBm0 as measured at the GDF in the transmit direction.~~

Note: This performance requirement shall be demonstrated with a test signal applied to each of any two channels. In addition, the sideband rejection characteristic for the undesired sideband for Channels 1 and 12 shall be at least as good as the corresponding characteristic for any other channel for both the transmit and receive directions.

5.1.15 Channel Carrier Generation Equipment. The channel carrier generation equipment is regarded as an integral part of the channel translating equipment.

This equipment shall supply all carriers required for the operation of the associated channeling equipment and shall permit the channel translating equipment to satisfy the performance requirement as defined in 5.1.1 thru 5.1.14 and the channel carrier purity requirements defined in 4.2.2. This equipment shall be capable of ultimate expansion to either 2400 twin channel or lower sideband carrier taps.

5.1.15.1 Input to Channel Carrier Generation Equipment. The equipment shall operate with an input supplied from the master frequency generation equipment. Operation shall be such that the carriers are always synchronized with the master frequency oscillator. Provisions shall be made for synchronized operation from an input supplied by an external oscillator source for both pilot and carrier frequency generation.

5.1.16 Optional Channel Equipment - None.

5.2 Group Translation Equipment

5.2.1 Group Modulation and Demodulation Plan. The group translating equipment shall modulate and demodulate five 12 channel groups, each in the 60 to 108 kHz band, or other 60 to 108 kHz wideband signal (48 kHz channel) to or from a frequency spectrum of 312 to 552 kHz as shown in Figure 7.

5.2.2 Group Equipment, Input/Output Levels.

5.2.2.1 In the transmit direction, the test signal input (83 kHz) to the group translating equipment, measured at the GBP, shall be -34.5 dBm.

5.2.2.2 In the receiving direction, the test signal output (83 kHz) from the group equipment at the GDF or equivalent point shall be -12 dBm $\pm$0.5 dB.

5.2.2.3 The test signal level (337, 385, 433, 481 and 529 kHz) at the SGDF or equivalent point in the transmit direction shall be -18 dBm $\pm$0.5 dB.

5.2.2.4 The test signal input level (337, 385, 433, 481 and 529 kHz) at the SGDF or equivalent point in the receive direction shall be -28 dBm.

5.2.3 Group Input/Output Impedance

5.2.3.1 Group Distribution Frame Input/Output Impedance. The impedance at the GDF or equivalent point measured over the frequency band of 60 to 108 kHz shall be 135 ohms with a longitudinal balance of not less than 40 dB. The return loss shall be not less than 20 dB when compared against a non-reactive impedance of 135 ohms. For this requirement, the test signal level shall be used.

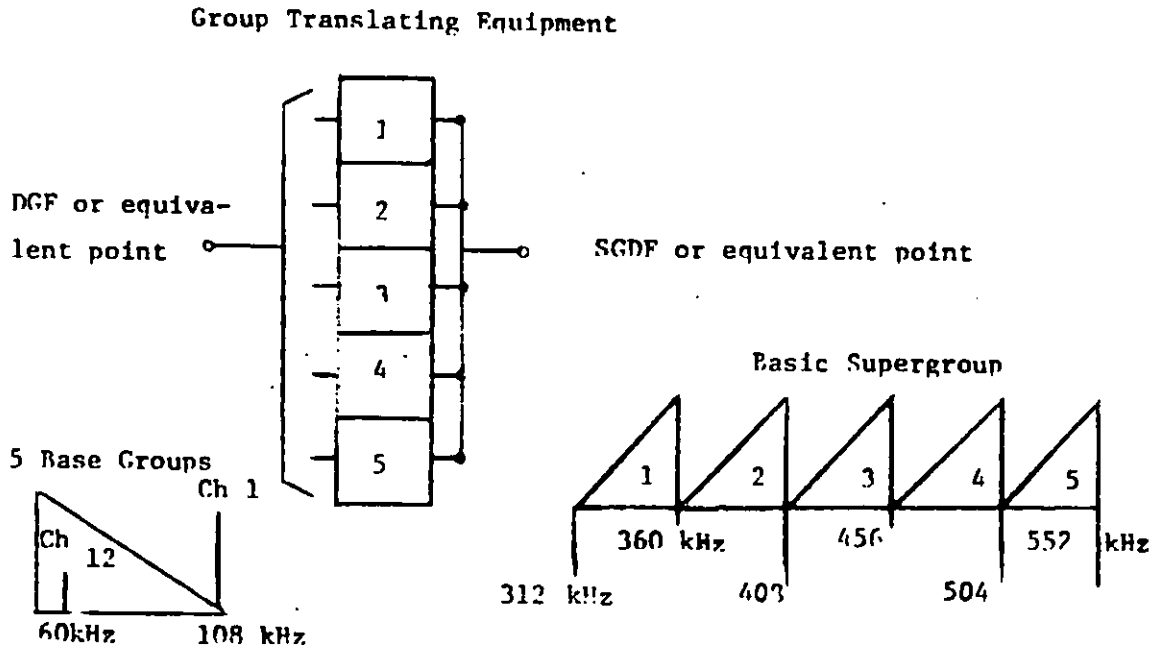


Figure 7. Group Modulation Plan:
Formation of 5 Group Basic Supergroup

5.2.3.2 Supergroup Distribution Frame (SGDF) Input/Output Impedance. The impedance of the group translating equipment at the supergroup distribution frame measured in either direction of transmission shall be 75 ohms unbalanced with a return loss of not less than 20 dB when compared against a non-reactive impedance of 75 ohms. This measurement shall be made at the sideband frequencies corresponding to the modulation frequencies of 60 to 108 kHz for each of the five groups.

5.2.4 Group Carrier Leak

5.2.4.1 Transmit Direction. When measured at the output of the group translating equipment at the SGDF, the individual carrier leak power level for any group shall not exceed -40 dBm0. The actual measurement shall be made at the supergroup distribution frame or equivalent point.

5.2.4.2 Receive Direction. The carrier leak power level measured at the GDF shall not exceed -20 dBm0 for any group. The actual measurement shall be made at the Group Distribution Frame or equivalent point.

5.2.5 Group Insertion Loss Frequency Characteristics

5.2.5.1 With the Group Translating Equipment properly looped at the SGDF, the insertion loss versus frequency response shall be within the following values:

Frequency Band	Insertion Loss
60.6 to 107.7 kHz (Nominal 48 kHz channel)	±0.6 dB
0.3 to 3.4 kHz (Any nominal 4 kHz channel within any group)	±0.3 dB

5.2.6 Group Equipment Envelope Delay Distortion. With the Group Translating Equipment properly looped at the SGDF, the envelope delay distortion versus frequency response shall be within the following values:

Frequency Band	μUSEC
60.6 to 107.7 kHz (Any nominal 48 kHz channel)	12
0.3 to 3.4 kHz (Any nominal 4 kHz channel in any group)	4

5.2.7 Group Equipment Idle Noise. With the group translating equipment properly looped at the SGDF and terminated in 135 ohms at the GDF, the noise occurring in any nominal 4 kHz bandwidth, corresponding to any translated VF channel shall not exceed 40 pWp0.

5.2.8 Group Loaded Noise. The total noise in any nominal 4 kHz bandwidth corresponding to any translated VF channel shall not exceed 50 pWp0 when the group translating equipment is properly looped at the SGDF and when:

a. One of the groups, including group regulation equipment is loaded with a 60 to 108 kHz band-limited spectrum of white noise at a level of -5.0 dBm0 per channel or when:

b. All five groups are each simultaneously loaded with a 60 to 108 kHz band-limited spectrum of white noise at a level of -5.0 dBm0 per channel.

5.2.9 Group Equipment Transmit to Receive Crosstalk. With the group inputs and outputs properly terminated at the SGDF with 75 ohm resistors and with a test tone level applied at the input of the GDF or equivalent point between 60 kHz and 108 kHz, the crosstalk level measured at the output of the GDF or equivalent point and at the same frequency shall not exceed -50 dBm0.

5.2.10 Group Equipment Receive-to-Transmit Crosstalk (Within the Group Translation Equipment). With the group inputs and outputs properly terminated in 135 ohm and with the test signal applied at the input (receive direction) at the SGDF or equivalent point between 312 and 552 kHz, the crosstalk level measured at the output (transmit direction) at the SFGF or equivalent point at the same frequency shall not exceed -50 dBm0.

5.2.11 Group Equipment Level Stability. With the group translating equipment properly looped at the SGDF, excluding group regulation, the group level stability measured at the GDF or equivalent point shall be ±0.5 dB or better over any 30-day period.

5.2.12 Group Equipment Spurious Products Transmit Direction. The level of any product other than carrier frequencies falling in the ranges of 300 Hz to 304 kHz and 560 kHz to 3092 kHz shall not exceed -70 dBm0. This shall be demonstrated by applying any two tones in the 60 to 108 kHz range to any group at test signal level at the GDF (transmit direction) and measuring at the SGDF.

5.2.13 Group Equipment Spurious Products Receive Direction. The level of any product falling in the range of 60 to 108 kHz shall not exceed -70 dBm0. This shall be demonstrated by applying any two tones in the 300 Hz to 304 kHz range and the 560 kHz to 2852 kHz range to any group at test signal level at the SGDF (receive direction) and measuring at the GDF.

5.2.14 Group Pilot. The multiplex equipment shall provide a group reference and control monitoring pilot (104.08 kHz). This pilot shall always be associated either with the channel or the group translating equipment. The group pilot shall be injected in such a manner as to be present at the input to each group except when groups are patched or switched in tandem. Means shall be provided for manually disabling the group pilot, regulator and alarms.

5.2.14.1 Group Pilot Frequency. Group reference and control monitoring pilot frequency shall be 104.080 kHz with a tolerance of ±1 Hz.

5.2.14.2 Group Pilot Frequency Stability. The pilot frequency shall remain within limits (±1 Hz) for at leact ninety (90) days without adjustment.

5.2.14.3 Group Pilot Level. The level of the group reference and control monitoring pilot at the GDF or equivalent point shall be -20 dBm0 with an adjustment accuracy of ±0.1 dB.

5.2.14.4 Group Pilot Level Stability. The level stability of the group pilot generator shall be ±0.3 dB or better over any thirty (30) day period.

5.2.15 Group Carrier Generating Equipment. The group carrier generating equipment shall be regarded as an integral part of the group translating equipment. This equipment shall supply all group carriers required for the operation of the associated grouping equipment in accordance with 5.2.1 thru 5.2.4.5. The Group carrier generating equipment shall be capable of expansion to 200 carrier taps to provide the necessary carriers for hub station configurations. Group Carrier purity shall be as specified in 4.2.2. The group carrier generating equipment shall be capable of synchronized operation with an input supplied by either the type 1, 2 or 3 oscillator equipment.

5.2.16 Optional Group Equipment

5.2.16.1 Group A Equipment. Group A translating equipment shall be capable of multiplexing and demultiplexing a group of 12 channels in the 60 to 108 kHz frequency band and inserting at the MFDF in the 12 to 60 kHz frequency band.

5.2.16.1.1 Group A Equipment Modulation Plan. The group translating equipment shall modulate one 12 channel group in the 60 to 108 kHz band to a line frequency spectrum of 12 to 60 kHz as shown in Figure 8.

5.2.16.1.2 Group A Equipment Input/Output Levels.

5.2.16.1.2.1 The test signal input to the Group A translating equipment measured at the GDF or equivalent point in the transmitting direction shall be -34.5 dBm.

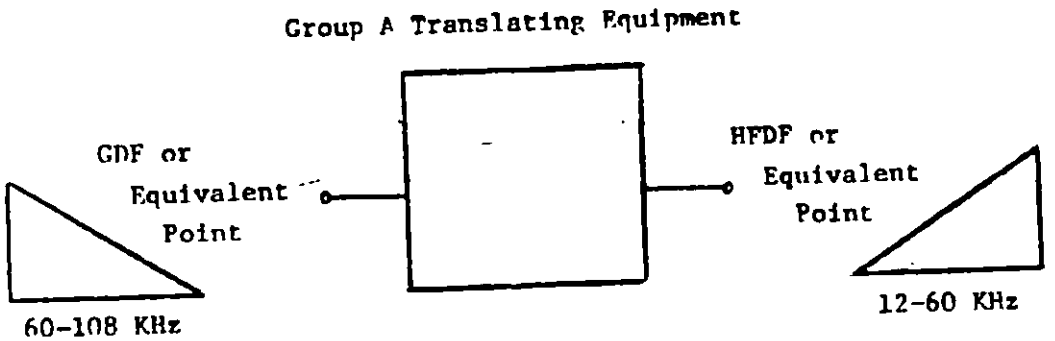


Figure 8. Translating Equipment Basic Group "A"

.2.16.1.2.2 The test signal output from the Group A translating equipment measured at the GDF or equivalent point in the receive direction shall be -12.0 dBm ±0.5 dB.

.2.16.1.2.3 The test signal output at the HFDF or equivalent point of the Group A equipment in the transmitting direction shall be -45 dBm ±0.5 dB.

.2.16.1.2.4 The test signal input at the HFDF or equivalent point of the Group A equipment in the receiving direction shall be -15 dBm.

.2.16.1.3 Group A Equipment Input/Output Impedances.

.2.16.1.3.1 Group Distribution Frame. The impedance at the GDF or equivalent point measured over the frequency band of 60.6 to 107.7 kHz shall be 135 ohms balanced. The return loss shall be not less than 20 dB when compared against a non-reactive impedance of 135 ohms.

.2.16.1.3.2 High Frequency Distribution Frame (HFDF). The impedance of the Group A translating equipment measured at the HFDF or equivalent point in either direction of transmission shall be 75 ohms unbalanced with a return loss of not less than 20 dB when compared against a non-reactive impedance of 75 ohms. This requirement shall be demonstrated over the frequency range of 2.3 to 59.4 kHz.

.2.16.1.4 Group A Equipment Carrier Leak.

.2.16.1.4.1 Transmit Direction. When measured at the output of the group translating equipment at the HFDF or equivalent point the carrier leak shall not exceed -30 dBm0.

.2.16.1.4.2 Receive Direction. The carrier leak measured at the GDF or equivalent point shall not exceed -20 dBm0.

.2.16.1.5 Group A Equipment Insertion Loss Versus Frequency Characteristics. With the Group A Equipment properly looped at the HFDF, the insertion loss versus frequency response shall be within the following limits:

Frequency Band	Insertion Loss
60.6 to 107.7 kHz (Nominal 48 kHz channel)	±1.0 dB
0.3 to 3.4 kHz (Any nominal 4 kHz channel)	±0.3 dB

5.2.16.1.6 Group A Equipment Envelope Delay Distortion. With the Group A Translating Equipment properly looped at the HFDF, the envelope delay versus frequency response shall be within the following values:

Frequency Band	μSEC
60.6 to 107.7 kHz (Nominal 48 kHz channel)	100
0.3 to 3.4 kHz (Any nominal 4 kHz channel in 64-104 kHz)	30

5.2.16.1.7 Group A Equipment Idle Noise. With the group translating equipment properly looped at the HFDF and terminated at the GDF, the noise occurring at any nominal 4 kHz band corresponding to any translated VF channel shall not exceed 50 pWp0.

5.2.16.1.8 Group A Equipment Loaded Noise. With the group translating equipment properly looped at the HFDF, the total noise contribution of the group translating equipment, including group regulating equipment, in any translated VF frequency bandwidth corresponding to any nominal 4 kHz channel shall not exceed 200 pWp0. The white noise source used shall be band-limited to the 60 to 108 kHz spectrum and the input level to the group translating equipment shall be equivalent to -5.0 dBm0 per channel.

5.2.16.1.9 Group A Transmit to Receive Crosstalk. With the input and output at the HFDF correctly terminated in 75 ohms and with a test tone level applied at the GDF or equivalent point between 60 and 108 kHz the crosstalk measured at the output of the GDF or equivalent point at the same frequency shall not exceed -50 dBm0.

5.2.16.1.10 Group A Equipment Receive-to-Transmit Crosstalk. With the input and output at the GDF correctly terminated in 135 ohms and with a test signal level applied at the HFDF or equivalent point between 12 to 60 kHz, the crosstalk level measured at the output of the HFDF or equivalent point at the same frequency, shall not exceed -50 dBm0.

5.2.16.1.11 Group A Equipment Level Stability. With the group translating equipment properly looped at the HFDF or equivalent point, excluding the group regulation equipment, the group level stability measured at the GDF or equivalent point shall be ±0.5 dB over any 30-day period.

5.2.16.1.12 Group A Equipment Spurious Products/Transmit Direction. The level of any product other than carrier frequency falling in the ranges of 300 Hz to 117 kHz and 60.6 to 2540 kHz shall not exceed -70 dBm0. This shall be measured by applying any two tones in the 60 to 108 kHz range each at test level at the GDF and measuring at the HFDF.

5.2.16.1.13 Group A Equipment Spurious Products Receive Direction. The level of any product falling outside the range of 60 to 108 kHz shall not exceed -70 dBm0. This shall be demonstrated by applying any two tones in the 12 to 60 kHz range to the group each at test tone level at the HFDF and measuring at the GDF.

5.2.16.1.14 Group A Equipment CarrierSupply. The group carrier distribution equipment is regarded as an intrinsic part of the group translating equipment. This equipment shall supply one or more carriers required for the operation of the associated group equipment and shall permit the group translating equipment to satisfy the Standards as defined in 5.2.16.1 through 5.2.16.1.13. Carrier purity shall be as specified in 5.2.2.

5.2.16.2 Through Group Equipment

5.2.16.2.1 Through Group Equipment Level and Insertion Loss. The translated VF channel test signal level (83 kHz) at the input to the through group equipment shall be -12 dBm. The insertion loss, measured at the same frequency, shall be 22.5 dB ±0.5 dB.

5.2.16.2.2 Through Group Equipment Impedances. The impedance at the input and output of the through group equipment measured over the frequency band of 60.6 kHz to 107.7 kHz shall be 135 ohms balanced with a return loss of not less than 20 dB when measured against a non-reactive impedance of 135 ohms. Longitudinal balance shall not be less than 40 dB.

5,2.16.2.3 Through Group Equipment Insertion Loss Frequency Response Characteristics. The insertion loss frequency characteristics for the through group equipment shall be within the following values:

Frequency Band	Insertion Loss
60.6 to 107.7 kHz (Nominal 48 kHz channel)	±1 dB
0.3 to 3.4 kHz (Any nominal 4 kHz channel within 60.6 - 107.7 kHz)	±0.5 dB

5.2.16.2.4 Through Group Equipment Rejection Characteristics. The insertion loss at frequencies from 300 Hz to 59.7 kHz and at frequencies from 108.6 kHz to 612 kHz shall be at least 70 dB greater than the insertion loss at 83 kHz.

5.2.16.2.5 Through Group Equipment Envelope Delay Distortion. The envelope delay distortion versus frequency response for the through group equipment shall be within the following limits:

Frequency Band	μSEC
64 to 104 kHz	120
68 to 100 kHz (Nominal 48 kHz channel)	40
0.6 to 3.2 kHz (Nominal 4 kHz channel within 68 to 100 kHz)	20
0.6 to 3.2 kHz (~~Nominal 4 kHz channel~~ 64 to 68 kHz and 100 to 104 kHz)	

5.2.16.2.6 Through Group Equipment Noise and Crosstalk. With the through group ~~equipment loaded with white gaussian noise at a level of -5.0 dBm0~~ per channel, the total noise and crosstalk in any frequency band corresponding to a translated channel shall be less than 10 pWp0.

5.2.16.2.7 Through Group Equipment Level Stability. The level stability shall be ±0.2 dB for a frequency of 83 kHz for any 30 day period.

5.2.16.3 Group Regulating Equipment. Group regulating equipment may be ~~required to compensate for excessive variation in the group receive level~~ on long distance circuits. When such equipment is utilized it shall be considered as an integral part of the group translating equipment. However, it shall be possible to remove or insert on a patching basis the regulating equipment depending upon requirements. The level regulating equipment shall maintain the overall system gain within close limits and shall be controlled by the group reference and control pilot (104.08 kHz) as specified in 5.2.15.

5.2.16.3.1 Group Regulating Equipment Control Ratio. The gain of the regulating equipment shall be controlled automatically by the group reference and control pilot such that a change in the group reference pilot level of the SGDF or equivalent point of ±4 dB in the receiving direction shall give an output level change, at the GDF or equivalent point of not greater than ±0.25 dB for any test signal in the frequency band 60 to 108 kHz.

5.2.16.3.2 Group Regulating Equipment Insertion Loss Frequency Response Characteristics. With a nominal input level of the group reference pilot of -20 dBm0 at the SGDF or equivalent point, the group regulating equipment shall have an insertion loss such that the output level of the GDF or equivalent point at a frequency of 83 kHz shall be -12 dB with an adjustment accuracy of ±0.1 dB. The insertion loss characteristic shall have a maximum spread of 0.2 dB for all frequencies from 60 to 108 kHz over the full gain range of the regulator.

5.2.16.3.3 Group Regulating Equipment Level Stability. With a constant input level of the group reference pilot of -20 dBm0, the pilot level stability measured at the regulator output over any 30-day period shall not exceed ±0.5 dB.

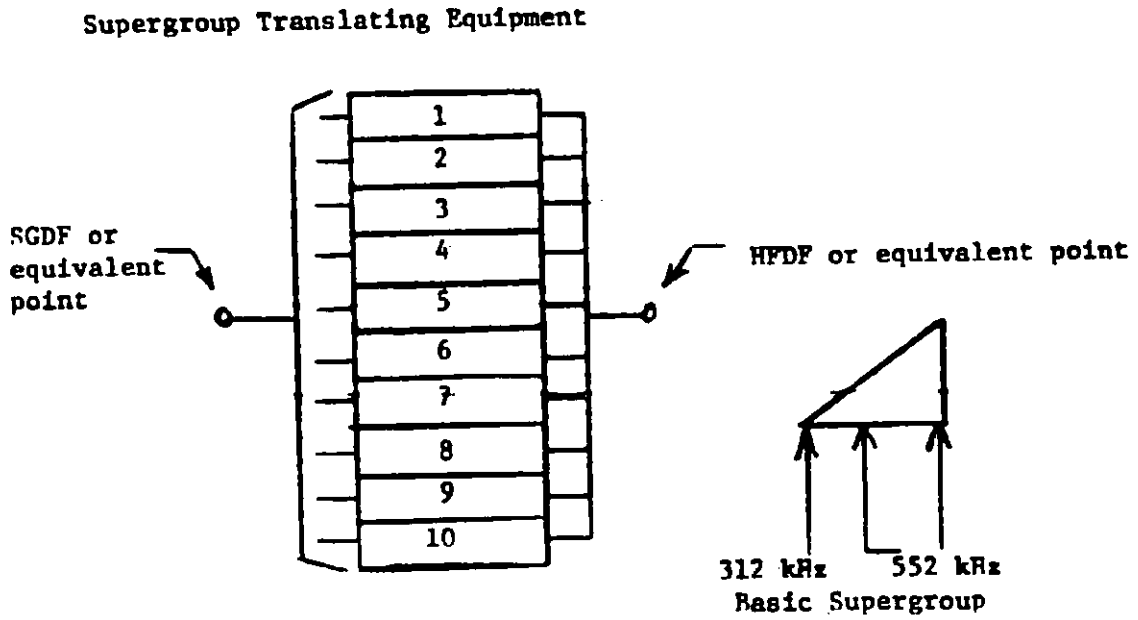
5.3 Supergroup Translating Equipment. This section deals with the performance standards for supergroup translating and regulating equipment.

5.3.1 Supergroup Modulation and Demodulation Plan. In the transmit direction, the supergroup translating equipment shall modulate the 60-channel basic supergroup (312 to 552 kHz) to one of the ten supergroup line frequency allocations in accordance with Figure 9. In the receive direction, the supergroup translating equipment shall demodulate the 60 to 108 kHz line frequency band into (up to) ten 312 to 552 kHz basic supergroups.

5.3.2 Supergroup Input/Output Levels

5.3.2.1 In the transmit direction, the test signal (433 kHz) input to the supergroup translating equipment at the SGDF or equivalent point shall be -18 dBm.

5.3.2.2 In the receive direction, the test signal (433 kHz) output from the supergroup translating equipment at the SGDF or equivalent point shall be -28 dBm ±0.5 dB.



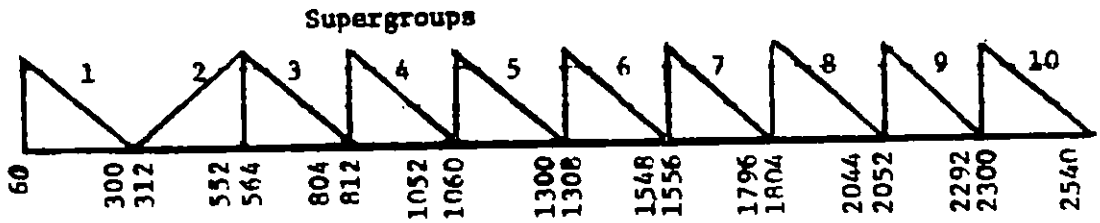


Figure 9. Formulation of the Line Frequency Allocation, One to Ten Supergroups

5.3.2.3 The test signal level, from the supergroup translating equipment at the HPDF or equivalent point in the transmit direction, shall be -45 dBm ±0.5 dB. For frequency see Table II.

TABLE II

SUPERGROUP TEST SIGNAL FREQUENCIES

SGP NUMBER	TEST SIGNAL FREQUENCY (kHz) AT HPDF
1	181
2	433
3	685
4	933
5	1181
6	1429
7	1677
8	1925
9	2173
10	2421

5.3.2.4 The test signal level input, to the supergroup translating equipment at the HPDF or equivalent point in the receive direction, shall be -15 dBm. For frequency see Table II.

5.3.3 Supergroup Input/Output Impedances

5.3.3.1 Supergroup Distribution Frame Input/Output Impedances. The input and output impedances of the supergroup translating equipment at the SGDF or equivalent point shall be 75 ohms unbalanced, with a return loss of at least 20 dB when compared against a non-reactive impedance of 75 ohms over the 312 to 552 kHz frequency band.

5.3.3.2 ~~High Frequency Distribution Frame~~ Input/Output Impedances. The input and output impedances of the supergroup translating equipment at the HPDF or equivalent point shall be 75 ohms unbalanced, with a return loss of at least 20 dB when compared against a non-reactive impedance of 75 ohms. This measurement shall be made at the sideband frequencies corresponding to the modulation frequencies of 312 to 552 kHz for each of the supergroups.

5.3.4 Supergroup Carrier Leak

5.3.4.1 Transmit Direction. Where measured at the output of the supergroup translating equipment at the HFDF or equivalent point the supergroup carrier leak shall not exceed -40 dBm0.

5.3.4.2 Receive Direction. When measured at the output of the supergroup translating equipment at the SGDF or equivalent point the supergroup carrier leak shall not exceed -20 dBm0.

5.3.5 Supergroup Insertion Loss Versus Frequency Characteristics. With the supergroup translating equipment properly looped at the HFDF, the insertion loss versus frequency response shall be within the following values:

Frequency Band	Insertion Loss
312 to 552 kHz (Nominal 240 kHz channel)	±2.0 dB
60 to 108 kHz (Any nominal 48 kHz channel within any supergroup)	±1.0 dB
0.3 to 3.4 kHz (Any nominal 4 kHz channel within any group within any supergroup)	±0.5 dB

5.3.6 Supergroup Envelope Delay Distortion. With the super group translating equipment properly looped at the HFDF, the envelope delay distortion versus frequency response shall be within the following values:

Frequency Band	µSEC
312 to 552 kHz (Nominal 240 kHz channel but supergroups 2 and 4 - 10)	10
320 to 552 kHz (Nominal 240 kHz channel in supergroup 1)	56
312 to 544 kHz (Nominal 240 kHz channel in supergroup 3)	56

Frequency Band	μSEC
60.6 to 107.7 kHz (Any nominal 48 kHz channel in supergroups 2, and 4 - 10)	10
60.6 to 107.7 kHz (Nominal 48 kHz channel in supergroups 1 and 3)	56
0.6 to 3.2 kHz (Any nominal 4 kHz channel within any group of supergroups 2, and 4 - 10)	3
0.6 to 3.2 kHz (All nominal 4 kHz channels except channels 1 and 2 of Group 1, Supergroup 1 and channels 11 and 12 of Group 5, Supergroup 3)	16

5.3.7 Supergroup Idle Noise. With the supergroup properly looped at the HFDF, the idle noise measured in any translated 4 kHz bandwidth corresponding to a VF channel allocation shall not exceed 25 pWp0.

5.3.8 Supergroup Loaded Noise. With the supergroup correctly looped at the HFDF or equivalent point, the total loaded noise contribution of the supergroup translating equipment, including supergroup regulation equipment, if any, in any translated 4 kHz bandwidth corresponding to a VF channel allocation shall not exceed 50 pWp0. The noise source shall be band-limited to the 312 to 552 kHz and the noise input level to the supergroup translating equipment shall be equivalent to -5.0 dBm0 per channel.

5.3.9 ~~Supergroup Equipment Transmit-to-Receive Crosstalk~~. With the input and output at the HFDF correctly terminated with 75 ohm resistors and with a test signal level applied at the input of the SGDF or equivalent point between 312 kHz to 552 kHz, the crosstalk level at the output of the SGDF or equivalent point in the receive direction at the same frequency, shall not exceed -50 dBm0.

5.3.10 Supergroup Equipment Receive-to-Transmit Crosstalk. With the input and output at the SGDF correctly terminated with 75 ohm resistors and with a test signal level applied at the input of the HFDF or equivalent point (receive direction) at frequencies corresponding to SGDF frequencies of 312 to 552 kHz, the crosstalk level measured at the output of the HFDF or equivalent point at the same frequency (transmit direction), shall not exceed -50 dBm0.

5.3.11 Supergroup Level Stability. With the supergroup translating equipment correctly looped at the HFDF, the supergroup level stability measured at the SGDF or equivalent point (receive direction) shall be ±0.5 dB or better over any 30 day period.

5.3.12 Supergroup Equipment Spurious Products Transmit Direction. The level of any product other than carrier frequencies falling outside the range of (carrier frequency minus 304 kHz to carrier frequency minus 560 kHz) shall not exceed -70 dBm0. This shall be demonstrated by applying any two tones in the 312 to 552 kHz range to any supergroup at test signal level at the SGDF and measuring at the HFDF between 300 Hz and 3092 kHz.

5.3.13 Supergroup Equipment Spurious Products Receive Direction. The level of any product falling in the range of 312 to 552 kHz shall not exceed -70 dBm0. This shall be demonstrated by applying any two tones each at test signal level at the HFDF in the range of 300 Hz to 2852 kHz (except within the range of carrier frequency minus 304 kHz to carrier frequency minus 560 kHz) and measuring at the SGDF.

5.3.14 Supergroup Carrier Supply. The supergroup carrier generating equipment is regarded as an integral part of the supergroup translating equipment. This equipment shall supply all supergroup carriers required for the operation of the associated supergroup equipment, and shall permit the supergroup translating equipment to satisfy the Standards, as defined in 5.3.1 thru 5.3.13. Expansion capability up to a maximum of forty supergroups shall be provided. Supergroup carrier purity shall be specified in 4.2.2. The equipment shall be capable of operating with an input supplied by Type 1, 2 or 3 oscillator equipment. Operation shall be such that the carriers are always synchronous with either the Type 1 or 2 oscillator frequency. The carriers for the supergroup one modulator and demodulator may be supplied by the group carrier supply. Provision shall be made for synchronous operation when the input frequency is supplied from an external oscillator source (Type 3).

5.3.15 Optional Supergroup Equipment

5.3.15.1 Through Supergroup Equipment

5.3.15.1.1 Through Supergroup Equipment Level and Insertion Loss. The channel test tone level at the input to the through supergroup equipment shall be -28 dBm. The gain measured at 433 kHz shall be 10 dB ±0.5 dB.

5.3.15.1.2 Through Supergroup Equipment Impedances. The impedance at the input and output of the through supergroup equipment over the frequency range of 312 to 552 kHz shall be 75 ohms unbalanced. The return loss measured at the input and output shall be not less than 20 db.

5.3.15.1.3 Through Supergroup Equipment Insertion Loss Frequency Characteristics. The insertion loss versus frequency response for the through supergroup equipment shall be within the following values:

Frequency Band	Insertion Loss
312 to 552 kHz (Nominal 240 kHz channel)	±1.4 dB
0.3 to 3.4 kHz (Any nominal 4 kHz channel within 316 to 548 kHz)	±0.5 dB

5.3.15.1.4 Through Supergroup Equipment Rejection Characteristics. The insertion loss at frequencies from 300 Hz to 304 kHz and from 560 to 2540 kHz shall be at least 70 dB greater than the insertion loss at 433 kHz. The 96 kHz pilot (516 kHz supergroup frequency) shall be suppressed to at least 40 dB.

5.3.15.1.5 Through Supergroup Equipment Envelope Delay Distortion. The envelope delay distortion versus frequency response for the through supergroup equipment shall be within the following values:

Frequency Band	μSEC
316 to 548 kHz (Nominal 240 kHz channel)	70
0.6 to 3.2 kHz (Any nominal 4 kHz channel within 316 to 548 kHz)	30

5.3.15.1.6 Through Supergroup Equipment Idle Noise. With the through supergroup equipment idle noise terminated in 75 ohms at the input, the idle channel noise corresponding to a 4 kHz channel shall not exceed 10 pWp0.

5.3.15.1.7 Through Supergroup Equipment Loaded Noise. With the through supergroup equipment loaded with noise at a level of -5.0 dBm0 per channel, the total noise and crosstalk in any frequency band corresponding to translated channel shall not be more than 50 pWp0.

5.3.15.1.8 Through Supergroup Equipment Level Stability. The level stability shall be $\pm$0.2 dB for any frequency in the 312 to 552 kHz range for any 30 day period.

6. Notes

6.1 Supersession Data. This standard supersedes paragraphs 3.2.5 thru 3.2.5.8.2.3 of Defense Communications Agency Circular DCAC 330-175-1 (DCS Engineering Installation Standards Manual).

CUSTODIANS
ARMY - SC
NAVY - EC
AIR FORCE - 17

REVIEW ACTIVITIES
ARMY - SC, EL, CE, ME
NAVY - AS, OS, YD, MC, CG, SH
AIR FORCE - 1, 11, 13, 71, 80, 89
DCA - DC

USER ACTIVITIES
ARMY -
NAVY - YD, SH
AIR FORCE -

PREPARING ACTIVITY
AIR FORCE - 17

PROJECT SLHC-0006

OTHER INTEREST
JCS - J6
NSA - NS