CHAPTER 10

DCS SIGNAL PROCESSING STANDARDS

10.1 GENERAL

DCS Circular 330-175-1 — "DCS Engineering-Installation Standards, " establishes the basic objectives and standards for communications quality and uniformity within the Defense Communications System (DCS). The objectives apply to new design and construction whereas the standards specify acceptable lower performance limits. DCS standards and objectives are expressed in terms of circuit quality requirements. Equipment, wires, and propagation media used to interconnect the end points of a circuit must ensure that the required quality is uniformly maintained. Performance limits for and characteristics of individual equipments are specified only when necessary to standardize the interface between outputs and inputs of separate equipments. Other DCA circulars support DCAC 330-175-1 and further define the standards applicable to the individual circuit requirements. Requirements such as circuit quality, data speed, and bandwidth vary in accordance with the operational need. The subsequent paragraphs of this section refer the reader to applicable DCS circulars and present selected portions of the critera contained therein for convenient ready reference. In this chapter, tables and figures appear at the end of the text.

10.2 VOICE-FREQUENCY 4-kHz BANDWIDTH STANDARDS AND OBJECTIVES

The DCS standards and objectives for processing 4-kHz bandwidth voice-frequency channels are summarized in tables 10-1 and 10-2. Any equipment used to produce or process a signal must not degrade the signal beyond the limits of the standard and should produce a signal quality that meets the objective.

10.3 DCS CIRCUIT CODES

Operational experience has led to further definitions of the DCS standards as applicable to various types of circuits. These definitions are contained in DCAC 310-70-1 — "DCS Technical Control Procedures", Volume II, from which tables 10-3 and 10-4 have been selected. Table 10-3 categorizes various types of circuits and relates them to the DCS circuit parameter codes. Table 10-4 is a comparison of the data between the DCS circuit parameter codes and the Bell Telephone System technical data for comparable types of circuits. Table 10-5 and figure 10-1 are taken from DCAC 300-175-9 — "DCS Operating-Maintenance Electrical Performance Standards." Table 10-5 lists the circuit performance parameters required to meet various circuit parameter codes.

10.4 EQUIPMENT STANDARDS

The DCS standards prescribe individual equipment standards as necessary to (1) standardize the type of interface between equipment and (2) establish independent sideband operation and a nominal 3-kHz bandwidth channel as the standard for communications using HF radio transmission system. Figures 10-2 show the required frequency response of the standard HF radio transmission system. Tables 10-6 through 10-10 summarize (1) the performance criteria for transmitters, receivers, and wideband multiplex equipment, and (2) the quality and bandwidth limitations for the HF radio circuit. Standards for equipment used in DCS Technical Control Facilities are contained in MIL-STD-188-310 and applicable Appendices.

10.5 QUALITY CONTROL

An effective method of quality control (QC) is essential for maintaining the worldwide services required by the users of DCS. The policies of and procedures for QC within DCS are established in DCAC 310-70-1 - "DCS Technical Control Procedures," Volume II (change to current issue). The QC schedule for DCS circuits and the tests required are listed in table 10-11.

10.6 CONVERSION FACTORS AND DEFINITIONS

Table 10-12 and figure 10-5 may be used for conversion of various units of noise power measurement. Table 10-13 defines the terms appearing in this chapter.

Table 10-1. Voice-Transmission Criteria 4-kHz Circuit

CHARACTERISTIC	OBJECTIVE		STANDARD	
	Hz	dB	Hz	dB
Net Amplitude Attenuation referenced to 1000-Hz test tone *	300 400 600 2400 3000 3400	+30 to –6 +7 to –6 +2 to –2 +2 to –2 +8 to –6 +30 to –6	300 - 3400 400 - 3000 600 - 2400	+30 to –12 +15 to –10 +6 to – 6
Receive Levels		vu		vu
	Maximum Average Minimum	–21.5 –28.0 –33.5	Maximum Average Minimum	–22.9 –28.8 –34.7
Total Circuit Noise	30 dBrnc		39 dBrnc	
Single Tone Noise Limit	22 dBrnc		30 dBrnc	
Cross Talk **	55 dB below signal level		55 dB below signal level	
Echo	Echo suppression required at two-wire to four-wire connection points			

*An attenuation increase between input and output is indicated by (+). An attenuation decrease between input and output is indicated by (–).

**Measured between any two 4-kHz channels of a single system.

Table 10-2. Digital Transmission Criteria

	LOW SPEED DATA (300 BAUD OR LESS) USER TO USER	DATA GRADE CIRCUIT (2400 BAUD OR LESS) SUBSCRIBERS ACCESS LINES		DATA GRADE CIRCUIT (2400 BAUD OR LESS) NETWORK SWITCH TO NETWORK SWITCH		DATA GRADE CIRCUIT (2400 BAUD OR LESS) USER TO USER OR USER TO REGENERATIVE REPEATER	
	OBJECTIVE	OBJECTIVE	STANDARD	OBJECTIVE	STANDARD	OBJECTIVE	STANDARD
NET AMPLITUDE ATTENUATION referenced to 1000 Hz test tone. *							
300 to 3000 Hz		-1.0 to +3.0 dB		-0.7 to +2.0 dB		-2.0 to +6.0 dB	
500 to 2800 Hz		-1.0 to +1.5 dB		-0.7 to +1.0 dB		-2.0 to +3.0 dB	
DELAY DISTORTION LIMITS							
500 Hz		500 μsec	500 μsec	500 μsec	500 μsec	3000 μsec	3000 μsec
600 Hz	4280 μsec	250 μsec	250 μsec	250 μsec	260 μsec	1500 μsec	1550 μsec
800 Hz	4280 μsec	125 μsec	230 μsec	125 μsec	260 μsec	750 μsec	1550 μsec
1000 Hz	2910 μsec	50 μsec	90 μsec	50 μsec	80 μsec	300 μsec	500 μsec
2600 Hz	2910 μsec	50 μsec	90 μsec	50 μsec	260 μsec	300 μsec	1250 μsec
2800 Hz	4280 μsec	125 μsec	230 μsec	125 μsec	500 μsec	750 μsec	2500 μsec
3000 Hz	4280 μsec	250 μsec		250 μsec		1500 μsec	
TRANSMISSION VARIATIONS							
Standard deviation		1.2 dB	1.6 dB	1.0 dB		2.6 dB	3.0 dB
Bias		±0.5 dB	±0.5 dB	+0.5 dB		±1.2 dB	±1.2 dB
NOISE LIMIT		26 dBrnc at users equipment		38 dBrnc	42 dBrnc	36.4 dBrnc at users equipment	40.2 dBrnc at users equipment
NOISE, Impulse counts per thirty minute period limit		90 at 58 dBrn		90 at 63 dBrn	90 at 68 dBrn	90 at 63 dBrn	90 at 68 dBrn
AMPLITUDE HIT LIMIT	±4 dB	±2 dB	±4 dB	±2 dB	±4 dB	±2 dB	±4 dB
PHASE HIT LIMIT	35°	30°	35°	30°	35°	30°	35°
SINGLE FREQUENCY INTERFERENCE LIMIT		22 dBrnc at users equipment		30 dBrnc	38 dBrnc	22 dBrnc at users equipment	
FREQUENCY DISPLACEMENT	±2 Hz	±2 Hz		±2 Hz		±2 Hz	

* An attenuation increase between input and output is indicated with a (+). An attenuation decrease between input and output is indicated with a (-).

Table 10-3. DCS Circuit Parameter Codes

SERVICE	NARRATIVE DESCRIPTION OF DCS SERVICE	CIRCUIT PARAMETER CODE
USER-TO-USER CIRCUITS:		
Voice	Nonsecure voice circuit. (Secure voice included under telegraph and data service.)	V1
Facsimile	Includes facsimile transmission which can be accommodated over a voice grade channel with no special conditioning. If the required facsimile (including telephoto) service involves special conditioning of the voice channel, the specific circuit parameters will be developed based upon the characteristics of the equipment to be used in the circuit.	V1
Telegraph and Data	Less than 46 baud. Includes 60-wpm teletypewriter and other DC keying service below 46 baud.	N1
	46 through 75 baud. Includes 75-wpm and 100-wpm teletypewriter service and other DC keying service from 46 through 75 baud.	N2
	76 through 150 baud. Includes 110-baud teletypewriter and other DC keying service from 76 through 150 baud.	N3
	300 through 600 baud. Includes data transmission and other service operating at 300 through 600 baud.	D2
	066-068 IBM (10 to 40 cpm).	V1
	1200 baud. Includes data card transmission and other service operating at 1200 baud.	D2
	2400 baud. Includes all types of alternate voice and data service including secure voice operating at 2400 baud.	S1
	2400 baud. Limited to data service only.	D1
	50,000 bits/sec (within 50 kHz) secure voice. This is a special schedule pertaining to encrypted voice baseband transmission over metallic facilities without regenerators.	Z1

Table 10-3. DCS Circuit Parameter Codes (Continued)

SERVICE	NARRATIVE DESCRIPTION OF DCS SERVICE	CIRCUIT PARAMETER CODE
	50,000 bits/sec (within 48 kHz) secure voice. This is a special schedule pertaining to encrypted voice baseband transmission over long-distance carrier facilities.	Z4
VFCT Systems	Voice frequency carrier telegraph, type 1. Up to 16 teletypewriter channels provided over a voice frequency circuit between carrier terminals.	D2
	Voice frequency carrier telegraph, type 2. Up to 26 teletypewriter channels provided over a voice frequency circuit between carrier terminals.	D1
AUTOVON: Access Lines	Voice grade	V2
	Special grade, such as AUTOVON switch access (2400 bits/sec) from the following: alternate voice data terminal, AUTODIN or DSSCS switch, secure voice terminal, secure voice cordless switchboard, SEVAC, VOCOM SWITCH, and other secure voice 4-wire switchboards.	S3
Trunks Inter-Switched	Voice grade	V2
	Special grade (no regenerators at either end)	S3
	Special grade (regenerators at both ends)	S1
	Special grade (regenerators at one end)	S2
AUTODIN: Access Lines	1200 or 2400 bits/sec	D1
	1200 bits/sec multiplexed. Includes service where user and AUTODIN switching center provide modems which are frequency division multiplexed to provide a number of channels on a single VF channel. This VF channel may be multiplexed with any compatible combination of 75-, 150-, 300-, or 600-baud modems not to exceed a total of 1200 bauds. VF bridging at transmission nodal points is employed to serve non-collocated users. See N2 and N3 for schedule pertaining to 75- to 150-baud DC-keyed access lines.	D2

Table 10-3. DCS Circuit Parameter Codes (Continued)

SERVICE	NARRATIVE DESCRIPTION OF DCS SERVICE	CIRCUIT PARA-METER CODE
Trunks	2400 bits/sec dedicated circuit from one AUTODIN switch to another.	D1
AUTOSEVOCOM:		
Access Lines	Secure voice terminal (2400 bits/sec) to VOCOM switch.	S1
	Secure voice terminal (2400 bits/sec) to 4-wire JOSS or 5-D switchboard, part of AUTOSEVOCOM.	S3
	Secure voice terminal (50 kilobit) to special 758 switch, cordless switchboard or VOCOM switch.	
	over metallic facilities without regenerators	Z2
	over long distance carrier facilities	Z4
	Secure voice terminal (50 kilobit) to AN/FTC-31	
	over metallic facilities without regenerators	Z1
	over long distance carrier facilities	Z4
Trunks	50 kilobit, over metallic facilities without regenerators.	Z3
	50 kilobit, over long-distance carrier facilities.	Z4
	2400 bits/sec (VOCOM switch to either VOCOM or special 758 switch).	S1
	2400 bits/sec (JOSS to either JOSS or cordless switchboard).	S3
	2400 bits/sec (SEVAC to JOSS or 5-D switch-board).	S3

Table 10-4. Comparison of DCA and Bell System Circuit Parameters — Part I

DCA CIRCUIT PARAMETER CODE	CLOSEST BELL SYSTEM EQUIVALENT CIRCUITS (Old Designation)	CLOSEST BELL SYSTEM EQUIVALENT CIRCUITS (New Designation)
S1	4B	C2
S2	(1/2) 4B (For envelope delay distortion only)	C2 (switched)
S3	(1/5) 4B (For envelope delay distortion only)	C3
V1	-	-
V2	-	-
D1	4B	C2
D2	4A	C1

Table 10-4. Comparison of DCA and Bell System Circuit Parameters — Part II

Characteristic	DCA Circuit Parameter Code D2	Bell System Nomenclature 4A	Bell System Nomenclature C1
Frequency response (dB)			
0.3 - 2.7 kHz	-2 to +6		-2 to +6
1.0 - 2.4 kHz	-1 to +3		-1 to +3
0.3 - 3.0 kHz	-3 to +12		
0.3 - 2.6 kHz		-2 to +6	
0.5 - 2.4 kHz		-1 to +3	
Max delay distortion (μsec)			
1.0 - 2.4 kHz	1000	1000	1000
1.0 - 2.6 kHz	1750		
Max net loss variation (dB)	±4		
Short term		±3	±3
Short and long term		±4	±4
Max change in audio freq (Hz)	±5	±2	±10
Max allowable channel noise (dBrnc0) 3 kHz weighting		*	
0 - 50 Miles	31		31
51 - 100 Miles	34		34
101 - 400 Miles	37		37
401 - 1000 Miles	41		41
1001 - 1500 Miles	43		43
1501 - 2500 Miles	45		45
2501 - 4000 Miles	47		47
4001 - 8000 Miles	50		
8001 - 16000 Miles	53		
Max single tone interference below circuit noise in each above mileage category (dB)	3		
Impulse Noise Reference level 71 dBrnc0 or 72 dBrn0 voice band weighting	15	**	15
Terminal impedance 600 ohms (% tolerance)	±10 ***		
Composite data transmission level (dBm0)	-13		-12
Phase jitter peak to peak (degrees)	15		
Harmonic distortion (dBm0)	-40 ****		

* The allowable noise power at the receiving terminal is not to exceed -36 dBm using no frequency weighting.

** The impulse noise at the receiving terminals is measured with the 1556A impact set and the 2B noise measuring set using 144 weighting. Impulse noise limit is no more than 70 noise peaks above -30 dBm per hour.

*** For leased circuit, impedance is measured at 1000 Hz; for Government-owned circuits, impedance is measured at various frequencies across the band of interest.

**** Applies to the measurement of any harmonic of a 700-Hz test frequency introduced at a 10-dBm0 level.

Table 10-4. Comparison of DCA and Bell System Circuit Parameters — Part III

Characteristic	DCA S1/D1	Bell Sys 4B	Bell Sys C2	DCA S2	Bell Sys C2 1/2 4B	Bell Sys C2 Switched	DCA S3	Bell Sys 1/5 4B	Bell System C3* Access Line	Bell System C3* Trunk
Frequency response (dB) 0.3 - 3.0 kHz	-2 to +6	-2 to +6	-2 to +6	-1.5 to 4.5			-1 to +3		-08 to +3	-0.8 to +2
0.5 - 2.8 kHz	-1 to +3	-1 to +3	-1 to +3	-0.5 to -2			-0.5 to 1.5		-0.5 to 1.5	-0.5 to +1
Maximum envelope delay distortion (μsec) 0.5 - 2.8 kHz	3000	3000	3000	1500	1500	1500	600	600	650	500
0.6 - 2.6 kHz	1500	1500	1500	750	750	750	300	300	300	260
1.0 - 2.6 kHz	500	500	500	250	250	250	100	100	110	80
Max net loss variation (dB) short term	±4	±3	±3	±3			±2		±3	±3
Short and long term		±4	±4						±4	±4
Max change in audio frequency (Hz) ****	±5	±2	±10	±5**			±5**		±5	±5
Max allowable chnl noise (dBrnc0) 0-50 Miles	31	***	31				31		31	31
51-100 Miles	34		34	34			34		34	34
101-400 Miles	37		37	37			37		37	37
401-1000 Miles	41		41	41			41		41	41
1001-1500 Miles	43		43	43			43		43	43
1501-2500 Miles	45		45	45			45		45	45
2501-4000 Miles	47		47	47			47		47	47
4001-8000 Miles	50			50			50			
8001-16000 Miles	53			53						

* Conditioning limited to each interexchange or local access line - between the customer's station and switch center. Each trunk - between switching centers.

** Circuits within CONUS ±3 Hz.

*** Noise/background noise - the average noise power at the receiving terminal as measured with no frequency weighting shall not exceed -42 dBm0.

**** D1 allowable channel noise for Government-owned circuits 47 dBrnc0 for all distances shown above. Consider a satellite channel as equivalent to a 2000-mile landline channel in determining circuit length.

Table 10-4. Comparison of DCA and Bell System Circuit Parameters — Part III (Continued)

Characteristic	DCA S1/D1	Bell Sys		DCA S2	Bell Sys C2		DCA S3	Bell Sys 1/5 4B	Bell System C3 *	
		4B	C2		1/2 4B	Switched			Access Line	Trunk
Maximum single tone interference below circuit noise in each mileage category (dB)	3			3			3			
Impulse noise (max counts in 15 min above ref level)		*								
Ref level 71 dBrnc0 or 72 dBrn0 voice band wtg.	15		15	15			15			
Ref level 62 dBrn0 voice band wtg.									15	
Terminal impedance 600 ohm (% tolerance) **	±10			±10			±10			
Composite data transmission level (dBm0)	-13		-12	-13			-13		-10	-10
Phase jitter peak to peak (degrees)	15			15			15			
Harmonic distortion (dBm0) ***	-40			-40			-40			

* The impulse noise at the receiving terminals as measured with the 1556A impact set in conjunction with the 2B noise measuring set 144 weighting may exceed -30 dBm for no more than 70 noise peaks per hour.

** For leased circuits measured at 1000 Hz, for government-owned circuits measured across the frequency band of interest.

*** Applies to the measurement of any of the harmonics of a test frequency of 700 Hz introduced at a level of -10 dBm0.

Table 10-5. DCS Technical Schedules Circuit Parameters — Part I

Characteristic	Unit of Meas	S1	S2	S3	V1	V2	D1	D2	N (1-3)
a. Frequency Response kHz	dB								
0.3-2.7								-2 to +6	
0.3-3.0		-2 to +6	-1.5 to +4.5	-1 * to +3		-3 to +8	-2 to +6	-3 to +12	
0.4-2.8					-8 to +20				
0.5-2.8		-1 to +3	-0.5 to +2	0.5 * to +1.5			-1 to +3		
0.6-2.4				*	-7 to +12				
1.0-2.4				*				-1 to +3	
0.7-2.3				*		-1 to +3			

* For CONUS AUTOVON, frequency response may be 300-499 Hz, -0.8 to +3.0 dB; 500-2800 Hz, -0.5 to 1.5 dB; 2801-3000 Hz, -0.8 to +3.0 dB. For CONUS AUTOVON special interswitch trunks, frequency response may be 300-499 Hz, -0.8 to +2.0 dB; 500-2800 Hz, -0.5 to +1.0 dB; 2801-3000 Hz, -0.8 to +2.0 dB.

Table 10-5. DCS Technical Schedules Circuit Parameters — Part I (Continued)

Characteristic	Unit of Meas	S1	S2	S3	V1	V2	D1	D2	N (1-3)
b. Maximum envelope delay distortion	micro-sec								
kHz									
0.5-2.8		3000	1500	600			3000		
0.6-2.6		1500	750	300 *			1500		
1.0-2.4				*				1000	
1.0-2.6		500	250	100 *			500	1750	
c. Maximum net loss variation	dB	±4	±3	±2	±4	±2	±4	±4	
d. Maximum change in audio frequency	Hz	±5	±5***	±5***	±5	±5	±5**	±5	

* For CONUS AUTOVON, maximum envelope delay distortion is 1000-2600 Hz, 110 microseconds; 600-2600 Hz, 300 microseconds; 500-2800 Hz, 650 microseconds. For CONUS AUTOVON special grade interswitch trunks, maximum envelope delay distortion is 1000-2600 Hz, 80 microseconds; 600-2600 Hz, 260 microseconds; 500-2800 Hz, 500 microseconds.

** For type 2 VFCT terminal ±2 Hz.

*** Circuits within CONUS ±3 Hz.

Table 10-5. DCS Technical Schedules Circuit Parameters — Part I (Continued)

Characteristic	Unit of Meas	S1	S2	S3	V1	V2	D1	D2	N (1-3)
e. Minimum longitudinal balance	dB	40	40	40	40	40	40	40	
f. Maximum total peak telegraph distortion	%								20
g. Maximum mark or space bias distortion	%								12 *
h. Maximum allowable channel noise	dBrnc0								
0-50 miles		31	31	31	31	31	31	31	
51-100		34	34	34	34	34	34	34	
101-400		37	37	37	37	37	37	37	
401-1000		41	41	41	41	41	41	41	
1001-1500		43	43	43	43	43	43	43	
1501-2500		45	45	45	45	45	45	45	
2501-4000		47	47	47	47	47	47	47	
4001-8000		50	50	50	50	50	50	50	
8001-16000		53	53	53	53	53	53	53	
i. Maximum single tone interference below circuit noise in each mileage category	dB	3	3	3	3	3	3	3	

* For Government-owned circuits: 5%.

** D1 and D2 allowable channel noise for Government-owned circuits is 47 dBrnc0 for all distances shown above. Consider a satellite channel as equivalent to a 2000-mile landline channel in determining circuit length.

Table 10-5. DCS Technical Schedules Circuit Parameters — Part I (Continued)

Characteristic	Unit of Meas	S1	S2	S3	V1	V2	D1	D2	N (1-3)
j. Impulse noise ref level 71 dBrnc0 or 72 dBrn0 voice band weighting, For CONUS AUTOVON -20 dBm0	Max Counts in 15 min above ref level	15	15	15			15	15	
k. Terminal impedance * 600 ohms	% tol-erance	±10	±10	±10	±10	±10	±10	±10	
l. Composite data transmission level	dBm0	-13	-13	-13 **	-13	-13	-13	-13	
m. Phase jitter (peak to peak)	Degrees	15	15	15			15	15	
n. Harmonic distortion ***	dBm0	-40	-40	-40	-40	-40	-40	-40	

* For leased circuits measured at 1000 Hz; for Government-owned circuits measured across the frequency band of interest.

** For CONUS AUTOVON -10 dBm0.

*** Applies to the measurement of any of the harmonics of a test frequency of 700 Hz introduced at a level of -10 dBm0.

In the above table, loss frequency characteristics are given in terms of comparison to the measured loss at 1000 hertz. For example, in the S1 schedule the loss frequency characteristic should not exceed the range of 2 dB less loss (-) to 6 dB more loss (+) between 0.3-3.0 kHz when compared to the measured loss at 1000 hertz.

Table 10-5. DCS Technical Schedules Circuit Parameters — Part II

Schedules Z1 through Z3 establish the engineering parameters for the 50 kilobit per second encrypted voice transmission system designed to provide service within the approximate bandwidth of 10-50, 000 Hz over facilities wihtout regernators.

General

Mode of Operation	Full-Duplex
Termination	4-wire
Impedance - Source and Load	135 ohms, nominal mid-band, balanced
Signal Input (Baseband)	0 dBm (1.04V p-p)

CHARACTERISTIC	UNIT OF MEASURE	CIRCUIT PARAMETERS Z1	Z2 SUBSCRIBER TO SWITCH	Z2 SWITCH TO SUBSCRIBER	Z3
a. Line-up loss* kHz	dB				
0.01		+15		+15	
0.1		+13		+13	
1.0		+12		+12	
10.0		+20		+20	
50.0		+30		+30	
0.01-50.0			-2 to +2		-2 to +2
1.0 -40.0			-1 to +1		-1 to +1
b. Delay characteristic	Microsecond	See Figure 10-1			
c. Maximum loss** variation	dB	±4	±4	±4	±4
d. Noise characteristics***	dB S+N / N	> 20	> 20	> 20	>20
e. Impulse noise	Max peaks per second exceeding 12 dB below peak signal level	1	1	1	1
f. Supervisory signal inputs	-	****	*****	*****	*****

* These are maximum values. Shorter circuits will have less and will generally correspond to the slope characteristic shown.

** Referred to line-up losses.

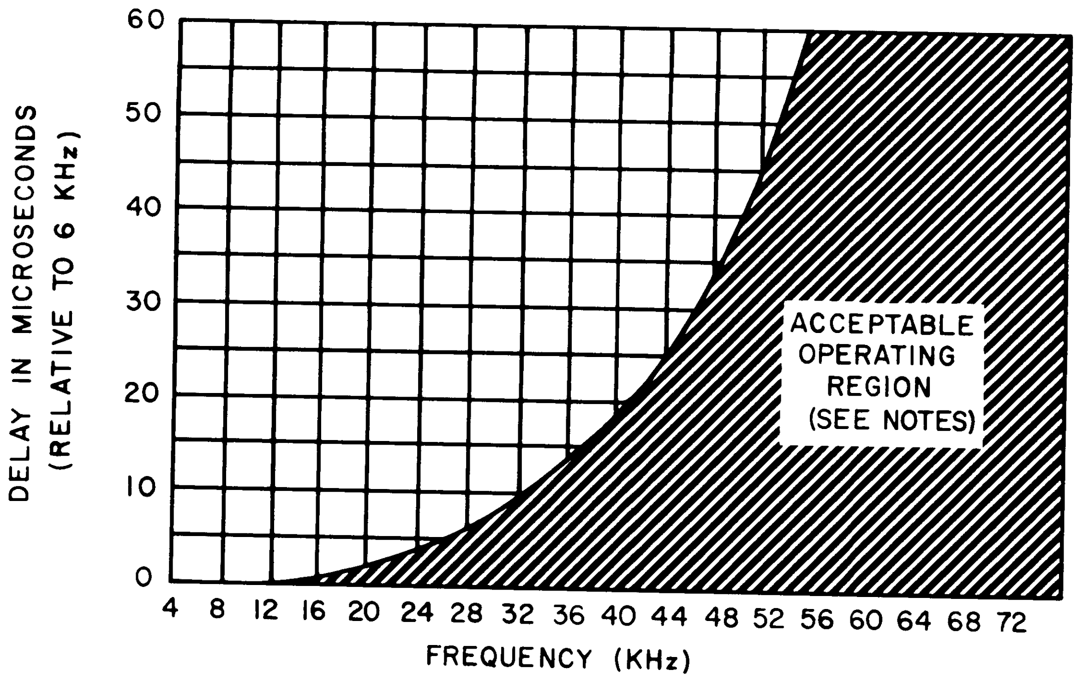
*** Signal plus noise of pseudo random signal at normal transmission level measured at the user terminal with a true RMS voltmeter and with the line terminated in 135 ohms. Noise is measured with same meter at the user terminal with signal removed and input terminated.

**** (Schedule Z1)

Ring Tone	1000 Hz (Range -6.5 to +5.0 dBm)
On Hook	2600 Hz at -21 dBm
Voice	-17.5 VU

***** (Schedules Z2 and Z3)

Ring Tone	1000 Hz (Range -6.5 to +5.0 dBm)
On Hook	2600 Hz at -21 dBm
Dial Pulsing	2600 Hz burst at -9 dBm
On Hook Return	2600 Hz at -9 dBm for nominal 260 (Range 220 to 320) milliseconds followed by 2600 Hz at -21 dBm
Voice	-17.5 VU



NOTES:

1. Above curve represents Envelope Delay Requirements. Limits are not specified below 6 kHz.

2. If the entire circuit consists of properly amplitude equalized twisted pair cable, from which all loading coils and bridge taps have been removed, no delay equalization should be required. Given the correct frequency response over the range of .01 to 50 kHz (no discontinuities or sharp rolloffs), envelope delay will not normally be an item for concern on cable pairs.

3. Should the circuit contain carrier facilities, delay equalization must be employed such that the delay versus frequency response of the circuit is a smoothly and continuously increasing function of frequency, which falls within the shaded area of this figure.

Figure 10-1. Relative Envelope Delay versus Frequency Limits

Table 10-5. DCS Technical Schedules Circuit Parameters — Part III

Schedule Z4 establishes the engineering parameters for the 50 kilobit/second encrypted voice transmission system designed to provide service, within a bandwidth of 48 kHz, over long distance carrier facilities.

Characteristic	Unit of Measurement	Schedule Z4 4-Wire Carrier Full Duplex Operation Subscriber to Subscriber or Switch to Switch
Nominal data signal amplitude (input/output)	Volts, peak-to-peak (P-P)	1
Impedance (balanced input/output)	Ohms	135
Data rate at baseband (NRZ)	Kilobits/second	50
Jitter from terminal equipment (maximum)	% Isochronous distortion (=P-P jitter)	20
Jitter to terminal equipment (maximum)	% Isochronous distortion (=P-P jitter) (Assumes 0-20% jitter from terminal equipment)	33
Error rate objective	Error rate/time	*
On-hook signal from terminal equipment	Hz	2600 at -21 dBm
Ringing signal to terminal equipment	Hz	1000 at -6.5 dBm
Dial signal from terminal equipment	Tone bursts	2600 Hz bursts at -9 dBm, 10 PPS, 61% break
On-hook signal following off-hook from terminal equipment	Hz	2600 Hz at -9 dBm for approximately 260 milliseconds
Forwarding switching time (approximately)	Milliseconds	400 (following end of last dialed digit)

*The burst rate shall not exceed one error burst per minute averaged over a 1-hour test period. One error burst is not to exceed 350 bits averaged over a 1-hour test period. The average number of bits per burst is equal to the total of bit errors divided by the number of bursts.

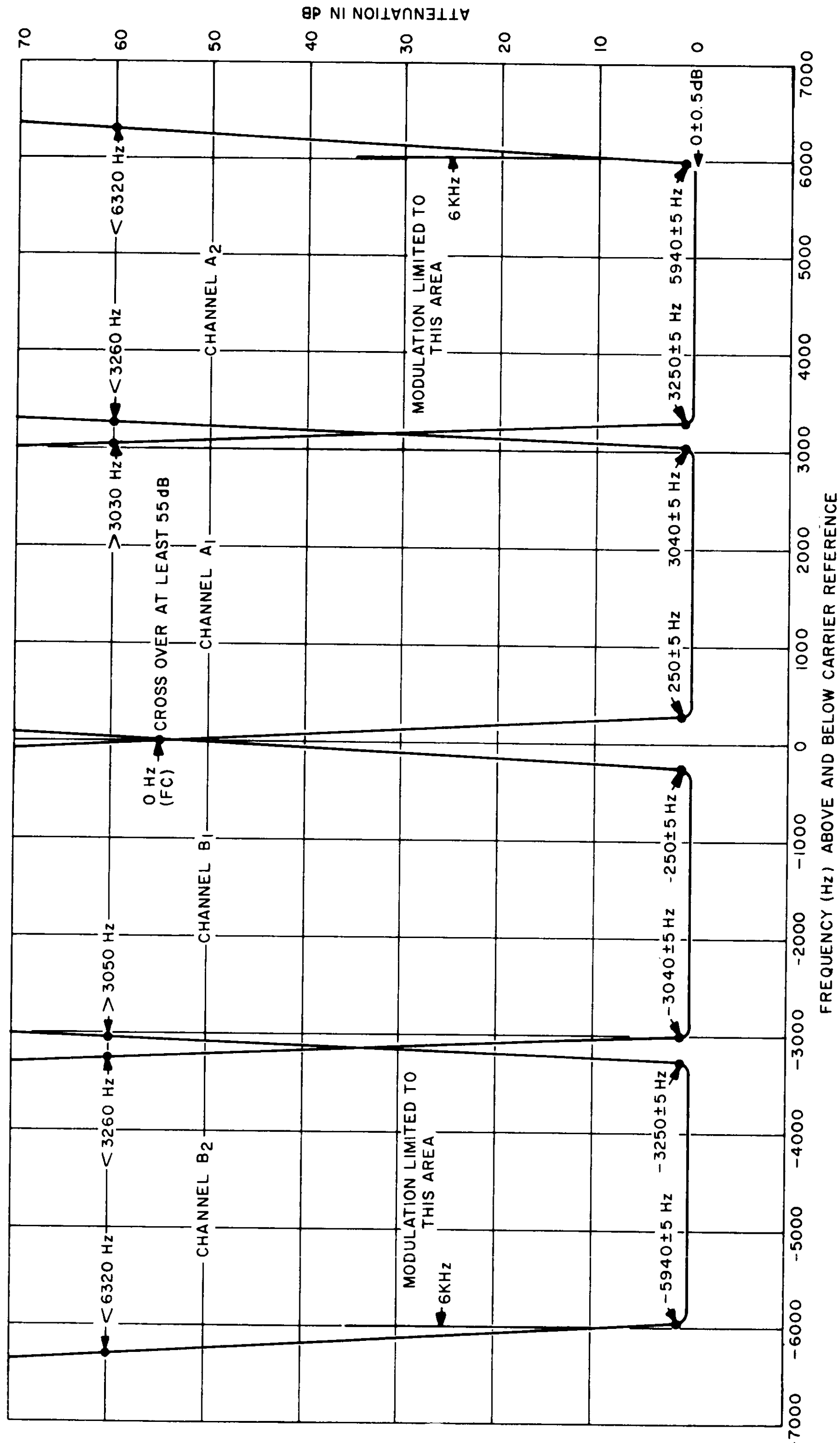


Figure 10-2. Independent Sideband Transmitter and Receiver Frequency Response

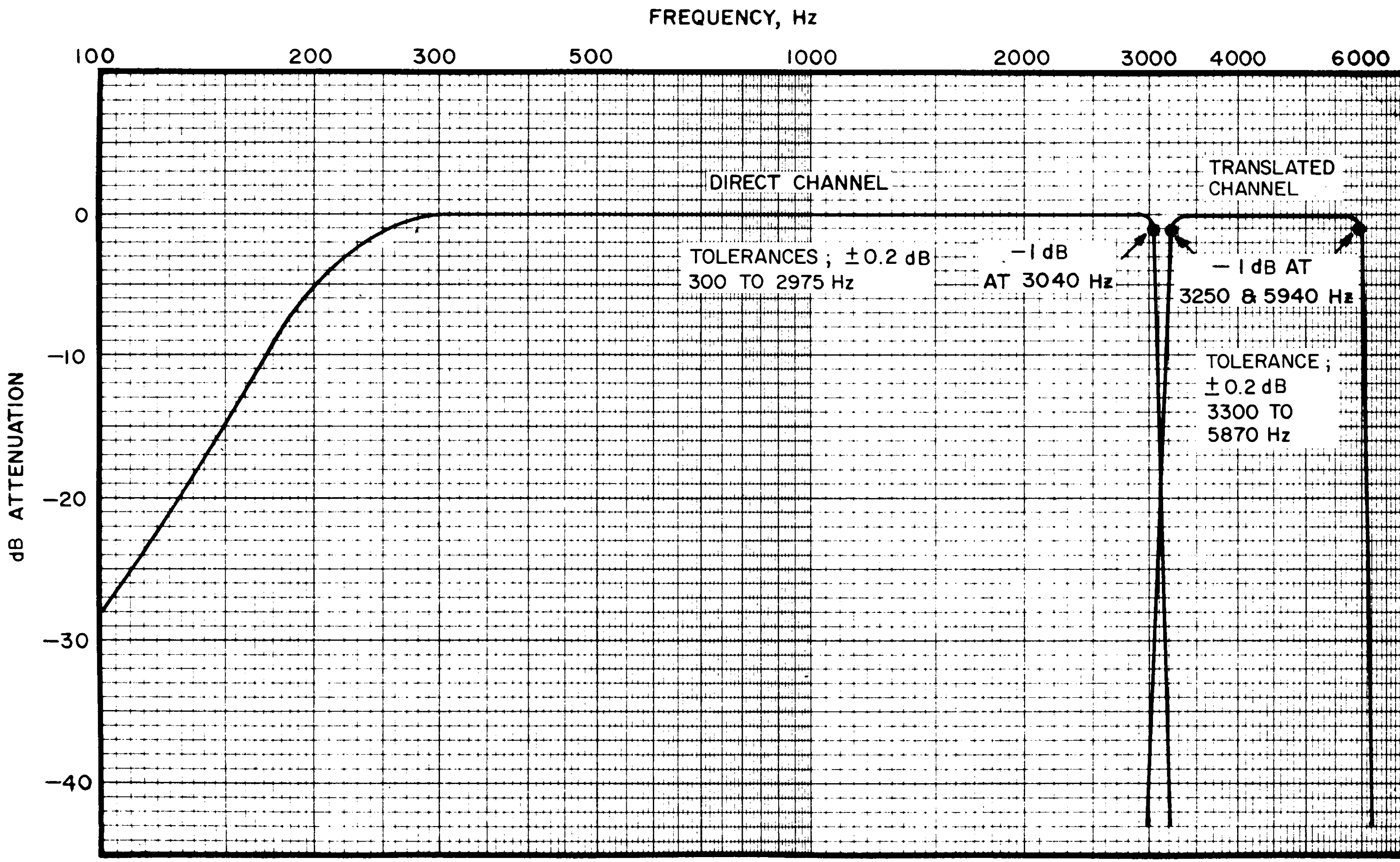


Figure 10-3. Overall Frequency Response of Multiplexer and Demultiplexer

Table 10-6. HF Radio Transmission Criteria 3-kHz Circuit

Characteristic	Standard
Channel Spacing, Nominal Bandwidth	3-kHz
Maximum Bandwidth	12-kHz
Bandpass	Channel A_1 and B_1 250 to 3040-kHz, ±5 Hz Channel A_2 and B_2 360 to 3040-kHz, ±5 Hz
Frequency Response	±0.5 dB over bandpass each channel
Noise Each Channel	55 dBm0 "c"
Frequency Stability Each Channel	±1 Hz
Cross Talk Each Channel	Not greater than -39 dBm0 "c'
Envelope Delay	Channel A_1 and B_1 1.2 milliseconds from 250 to 3040 Hz Channel A_2 and B_2 1.2 milliseconds from 360 to 2990 Hz
Transmitter, Input Level Each Channel	-9 dBm for speech, 0-dBm for test tone
Receiver, Output Level Each Channel	-0 dBm for test tone

Table 10-7. HF Receiver Performance and Interface Criteria

Characteristic	Criteria
Frequency Range	2-30 MHz
Output	Two 6-kHz channels or four 3-kHz channels
Input Impedance	50 Ohms unbalanced
Output Impedance Each Channel	600 Ohms balanced to ground. Minimum return loss of 26 dB from 250-3040 Hz. Longitudinal current at least 40 dB below input level.
Output Level	0-dBm each channel
Sensitivity Each Channel	$\frac{\text{Signal + Noise}}{\text{Noise}}$ greater than 10 dB with 0.2 μvolt input
Automatic Gain Control Each Channel	±1.5 dB with variation of input from 1.0 μvolt to 1.0 volt
Envelope Delay	<25 μsec between 550 to 2600 Hz and <500 μsec between 370 and 3040 Hz
Frequency Accuracy	Within 1 part in 10^8
Frequency Stability	1 part in 10^8 per day and not to exceed 5 parts in 10^8 in 30 days.
Phase Stability	Within 0.0524 radians in 10 milliseconds controlled by external standard. Within 0.0873 radians in 10 milliseconds controlled by internal standard.
Image Rejection	>100 dB
IF Rejection	>100 dB
Tuning	Continuous with readout in 100 Hz increments or not less than 20 preset selectable frequencies.
Mean Time Between Failures	12,000 hours for unit, 20,000 hours for individual vacuum tubes.

Table 10-8. HF Transmitter Performance and Interface Criteria

Characteristic	Criteria
Input	1 to 4 voice frequency 3-kHz audio channels
Emission	3A9A, 6A9B, 9A9B, or 12A9B
Bandpass	Channels A_1 and B_1, 250-3040 Hz ±5 Hz Channels A_2 and B_2, 360-3040 Hz ±5 Hz
Frequency Response	±0.5 dB over bandpass each channel
Adjacent Channel Separation	70 dB rejection of unwanted sideband
Output Power	Distributed evenly over each channel transmitted
Input Impedance for Each Channel	600 Ohm balanced to ground, minimum return loss of 26 dB, 250-3040 Hz, longitudinal currents at least 40 dB below reference input-level.
Input Level Range	-20 dBm to +4 dBm
Idle Noise Each Channel	55 dB below input required for full rated output
Envelope Delay	25 μsec between 550 to 2600 Hz and 500 μsec between 370 and 3040 Hz.
Tuning	Increments not greater than 100 Hz.
Output Impedance	50 Ohm with a maximum VSWR of 2:1
Frequency Accuracy	Within 1 part in 10^8
Frequency Stability	1 part in 10^8 per day and not to exceed 5 parts in 10^8 in 30 days
Carrier Level Suppression Control	Variable to at least 55 dB below the rms power of a single tone at full rated output
Carrier Level Control Stabilization	±3.0 dB at all output levels when using maximum carrier suppression.
Spurious Emission Suppression	80 dB when more than 100% outside bandpass 25 dB when outside bandpass to 100% outside bandpass
Mean Time Between Failures	12,000 hours for unit. For individual tubes: 5-24 watt power output . . . . 20,000 hr. 25-500 watt power output . . . . 10,000 hr. 500 watt power output . . . . . . 5,000 hr.
Acoustic Noise	65 dB when 10 feet from transmitter

Table 10-9. Voice Frequency Carrier Telegraph Terminal Equipment Performance and Interface Criteria

<table>
<tr><th>Characteristic</th><th>Criteria</th></tr>
<tr><td>Input and Output,
DC Channels</td><td>High or low level DC keying 1 to 18 channels</td></tr>
<tr><td>Input Impedance
DC Channels</td><td>High level 100 to 200 Ohms
Low level 6000 Ohms</td></tr>
<tr><td>Output Impedance
DC Channels</td><td>High level <150 Ohms
Low level <50 Ohms</td></tr>
<tr><td>Audio Frequency (AF)
Output and Input</td><td>1 to 18 channels spaced at 170 Hz modulated with ±42.5 Hz as follows:
<table>
<tr><th>Channel Designation</th><th>Mark Frequency (Hz)</th><th>Center Frequency (Hz)</th><th>Space Frequency (Hz)</th></tr>
<tr><td>1</td><td>382.5</td><td>425</td><td>467.5</td></tr>
<tr><td>2</td><td>552.5</td><td>595</td><td>637.5</td></tr>
<tr><td>3</td><td>722.5</td><td>765</td><td>807.5</td></tr>
<tr><td>4</td><td>892.5</td><td>935</td><td>977.5</td></tr>
<tr><td>5</td><td>1062.5</td><td>1105</td><td>1147.5</td></tr>
<tr><td>6</td><td>1232.5</td><td>1275</td><td>1317.5</td></tr>
<tr><td>7</td><td>1402.5</td><td>1445</td><td>1487.5</td></tr>
<tr><td>8</td><td>1572.5</td><td>1615</td><td>1657.5</td></tr>
<tr><td>9</td><td>1742.5</td><td>1785</td><td>1827.5</td></tr>
<tr><td>10</td><td>1912.5</td><td>1955</td><td>1997.5</td></tr>
<tr><td>11</td><td>2082.5</td><td>2125</td><td>2167.5</td></tr>
<tr><td>12</td><td>2252.5</td><td>2295</td><td>2337.5</td></tr>
<tr><td>13</td><td>2422.5</td><td>2465</td><td>2507.5</td></tr>
<tr><td>14</td><td>2592.5</td><td>2635</td><td>2677.5</td></tr>
<tr><td>15</td><td>2762.5</td><td>2805</td><td>2847.5</td></tr>
<tr><td>16</td><td>2932.5</td><td>2975</td><td>3017.5</td></tr>
<tr><td>17</td><td>3102.5</td><td>3145</td><td>3187.5</td></tr>
<tr><td>18</td><td>3272.5</td><td>3315</td><td>3357.5</td></tr>
</table></td></tr>
<tr><td>Noise, AF Channels</td><td>Not to exceed 20 dBrnc at output</td></tr>
<tr><td>Input and Output Impedance,
AF Channels</td><td>600 Ohm balanced to ground, minimum return loss of 26 dB from 370-3400 Hz, longitudinal current at least 40 dB below input reference level.</td></tr>
<tr><td>Harmonic Distortion, AF Channels</td><td>Each channel center frequency harmonic distortion at least 60 dB below signal level</td></tr>
<tr><td>AF Signal Input Minimum</td><td>-20.7 dBm each channel</td></tr>
<tr><td>Fade Limit</td><td>-50.0 dBm each channel for diversity system
-30.0 dBm each channel for non diversity system.</td></tr>
</table>

Table 10-10. Wide Band Multiplex Performance and Interface Criteria

Characteristic	Criteria
Input Frequency Band, Each Channel	300 to 3400 Hz
Input and Output Impedance, Each Channel	600 Ohm balanced to ground, longitudinal current at least 40 dB below input level
Group Output	12 channels multiplexed and translated to 60-108 kHz band
Input Output Impedance, Each Group	135 Ohm balanced to ground. Minimum return loss 20 dB, measured for each of the 12 channels
Supergroup Output	5 groups multiplexed and translated to 312-552 kHz band
Input Output Impedance, Each Supergroup	75 Ohms unbalanced, minimum return loss 20 dB, measured for each of the 5 groups
Test Tone Level, Channel Input	-16 dBm
Test Tone Level, Channel Output	+7 dB ±0.1 dB
Test Tone Level, Group Transmitter Input	-42 dBm or -37 dBm
Test Tone Level, Group Receiver Output	-5 dBm or -8 dBm
Test Tone Level, Supergroup Transmitter Input	-18 dBm ±0.5 dBm
Test Tone Level, Supergroup Receiver Output	-28 dBm ±0.5 dBm
Channel Insertion Loss Relative to 1000 Hz	600 - 2400 Hz ±0.35 dB 400 - 3000 Hz -0.35 dB to +0.75 dB 300 - 3400 Hz
Group Insertion Loss Relative to 83 kHz	60 - 108 kHz ±0.2 dB
Supergroup Insertion Loss	312-552 kHz -1.0 dB Any 48 kHz band limited to 0.5 dB
Channel Envelope Delay	600 - 3200 Hz . . . . <90 μsec 1000 - 2500 Hz . . . . <55 μsec
Group Envelope Delay	60 - 108 kHz . . . . <15 μsec 68 - 100 kHz . . . . <5 μsec Any 4-kHz channel portion less than 2 μsec
Supergroup Envelope Delay	312 - 552 kHz . . . . <5 μsec

Table 10-11. Quality Control Schedule

TYPE TESTS	D. C.		Voice Channel & Spare VF Channels		VFCT		150-2400 Digital Modems		Secure Voice	
	In Service	Out of Service	In Service	Out Service	In Service	Out Service	In Service	Out Service	In Service	Out Service
Test Tone Level			72 (2)	Q (1)		Q (1)		Q (1)		Q (1)
Voltage Level		M (1)				M (1)				
Current Level		M (1)				M (1)				
Maximum Allowable Channel Noise			72	Q (1)		Q (1)		Q		Q
Impulse Noise				Q		Q (1)		Q (1)		Q (1)
Frequency Response				Q		Q (1)		Q (1)		Q (1)
Envelop Delay Distortion								Q (1)		Q (1)
Maximum Net Loss Variation				Q		Q		Q (1)		Q (1)
Maximum Change in Audio Frequency				Q		Q (1)		Q (1)		Q (1)
Minimum Longitu-dinal Balance				Y		Y		Y		Y
Maximum Single Tone Interference				Y		Y		Y		Y
Terminal Impedance				Y		Y		Y		Y
Composite Data Transmission Level			72 (4)		72 (3)		72 (3)		72 (3)	
Harmonic Distortion				Y		Y		Y		Y

Table 10-11. Quality Control Schedule (Continued)

TYPE TESTS	D. C.		Voice Channel & Spare VF Channels		VFCT		150-2400 Digital Modems		Secure Voice	
	In Service	Out of Service	In Service	Out Service	In Service	Out Service	In Service	Out Service	In Service	Out Service
Phase Jitter				Y		Y		Y		Y
Total Peak Distortion	72	M (1)			72	M (1)	72		72	
Signaling Test				Y						Y
Mark/Space Current Balance		Q								

LEGEND:

72 - Every 72 hours

M - Monthly

Q - Quarterly

Y - Yearly

NOTE 1. These tests will be conducted after equipment substitution or maintenance and after circuit reroute.

NOTE 2. Voice circuits having in-band tone on idle signaling always have a tone present. The level of this tone should be checked at the monitor jacks. It is very important that the monitor jacks are used when checking this tone as false rings will be caused by breaking the circuit. The proper tone level in the channel is specified in chapter 3 or the CLR.

NOTE 3. The composite signal level should be measured at the monitor jack and compared against a known reading on a VU or db meter which is generated from a known source and corresponds to a channel level of -13 dbm0.

NOTE 4. The speech level should be monitored at the monitor jack and compared to a known reading which corresponds to a channel level of -12 VU when measured at the 0 dbm test level point.

Table 10-12. Noise Power Conversion

PICO-WATTS	MILLI-WATTS	dBm	NEPERS	NOISE WEIGHTING C-1000 Hz dBrn	C-0-3 kHz dBrnc	FIA 1000 Hz dBa	FIA 0-3 kHz dBa	PSOPHOMETRIC 800 Hz dBm
1.0	10^{-9}	-90	-10.4	0				-89
1.3	$0.13X10^{-8}$	-89	-10.2	1				-88
1.6	$0.16X10^{-8}$	-88	-10.1	2	0			-87
2.0	$0.20X10^{-8}$	-87	-10.0	3	1			-86
2.5	$0.25X10^{-8}$	-86	-9.90	4	2			-85
3.2	$0.32X10^{-8}$	-85	-9.79	5	3	0		-84
4.0	$0.40X10^{-8}$	-84	-9.67	6	4	1		-83
5.0	$0.50X10^{-8}$	-83	-9.55	7	5	2		-82
6.3	$0.63X10^{-8}$	-82	-9.44	8	6	3	0	-81
7.9	$0.80X10^{-8}$	-81	-9.32	9	7	4	1	-80
10	10^{-8}	-80	-9.21	10	8	5	2	-79
1.3X10	$0.13X10^{-7}$	-79	-9.09	11	9	6	3	-78
1.6X10	$0.16X10^{-7}$	-78	-8.98	12	10	7	4	-77
2.0X10	$0.20X10^{-7}$	-77	-8.87	13	11	8	5	-76
2.5X10	$0.25X10^{-7}$	-76	-8.75	14	12	9	6	-75
3.2X10	$0.32X10^{-7}$	-75	-8.63	15	13	10	7	-74
4.0X10	$0.40X10^{-7}$	-74	-8.52	16	14	11	8	-73
5.0X10	$0.50X10^{-7}$	-73	-8.40	17	15	12	9	-72
6.3X10	$0.63X10^{-7}$	-72	-8.29	18	16	13	10	-71
7.9X10	$0.80X10^{-7}$	-71	-8.17	19	17	14	11	-70
10^{-2}	10^{-7}	-70	-8.06	20	18	15	12	-69

Table 10-12. Noise Power Conversion (Continued)

PICO-WATTS	MILLI-WATTS	dBm	NEPERS	NOISE WEIGHTING				
				C-1000 Hz dBrn	C-0-3 kHz dBrnc	FIA 1000 Hz dBa	FIA 0-3 kHz dBa	PSOPHOMETRIC 800 Hz dBm
1.3×10^{2}	0.13×10^{-6}	-69	-7.94	21	19	16	13	-68
1.6×10^{2}	0.16×10^{-6}	-68	-7.83	22	20	17	14	-67
2.0×10^{2}	0.20×10^{-6}	-67	-7.71	23	21	18	15	-66
2.5×10^{2}	0.25×10^{-6}	-66	-7.60	24	22	19	16	-65
3.2×10^{2}	0.32×10^{-6}	-65	-7.48	25	23	20	17	-64
4.0×10^{2}	0.40×10^{-6}	-64	-7.37	26	24	21	18	-63
5.0×10^{2}	0.50×10^{-6}	-63	-7.25	27	25	22	19	-62
6.3×10^{2}	0.63×10^{-6}	-62	-7.14	28	26	23	20	-61
7.9×10^{2}	0.80×10^{-6}	-61	-7.02	29	27	24	21	-60
10^{3}	10^{-6}	-60	-6.91	30	28	25	22	-59
1.3×10^{3}	0.13×10^{-5}	-59	-6.79	31	29	26	23	-58
1.6×10^{3}	0.16×10^{-5}	-58	-6.68	32	30	27	24	-57
2.0×10^{3}	0.20×10^{-5}	-57	-6.56	33	31	28	25	-56
2.5×10^{3}	0.25×10^{-5}	-56	-6.45	34	32	29	26	-55
3.2×10^{3}	0.32×10^{-5}	-55	-6.33	35	33	30	27	-54
4.0×10^{3}	0.40×10^{-5}	-54	-6.22	36	34	31	28	-53
5.0×10^{3}	0.50×10^{-5}	-53	-6.10	37	35	32	29	-52
6.3×10^{3}	0.63×10^{-5}	-52	-5.99	38	36	33	30	-51
7.9×10^{3}	0.80×10^{-5}	-51	-5.87	39	37	34	31	-50
10^{4}	10^{-5}	-50	-5.76	40	38	35	32	-49

Table 10-12. Noise Power Conversion (Continued)

PICO-WATTS	MILLI-WATTS	dBm	NEPERS	NOISE WEIGHTING C-1000 Hz dBrn	C-0-3 kHz dBrnc	FIA 1000 Hz dBa	FIA 0-3 kHz dBa	PSOPHO-METRIC 800 Hz dBm
1.3×10^4	0.13×10^{-4}	-49	-5.64	41	39	36	33	-48
1.6×10^4	0.16×10^{-4}	-48	-5.52	42	40	37	34	-47
2.0×10^4	0.20×10^{-4}	-47	-5.41	43	41	38	35	-46
2.5×10^4	0.25×10^{-4}	-46	-5.30	44	42	39	36	-45
3.2×10^4	0.32×10^{-4}	-45	-5.18	45	43	40	37	-44
4.0×10^4	0.40×10^{-4}	-44	-5.06	46	44	41	38	-43
5.0×10^4	0.50×10^{-4}	-43	-4.95	47	45	42	39	-42
6.3×10^4	0.63×10^{-4}	-42	-4.84	48	46	43	40	-41
7.9×10^4	0.80×10^{-4}	-41	-4.72	49	47	44	41	-40
10^5	10^{-4}	-40	-4.61	50	48	45	42	-39
1.3×10^5	0.13×10^{-3}	-39	-4.49	51	49	46	43	-38
1.6×10^5	0.16×10^{-3}	-38	-4.37	52	50	47	44	-37
2.0×10^5	0.20×10^{-3}	-37	-4.26	53	51	48	45	-36
2.5×10^5	0.25×10^{-3}	-36	-4.14	54	52	49	46	-35
3.2×10^5	0.32×10^{-3}	-35	-4.03	55	53	50	47	-34
4.0×10^5	0.40×10^{-3}	-34	-3.91	56	54	51	48	-33
5.0×10^5	0.50×10^{-3}	-33	-3.80	57	55	52	49	-32
6.3×10^5	0.63×10^{-3}	-32	-3.68	58	56	53	50	-31
7.9×10^5	0.80×10^{-3}	-31	-3.57	59	57	54	51	-30
10^6	10^{-3}	-30	-3.45	60	58	55	52	-29

Table 10-12. Noise Power Conversion (Continued)

PICO-WATTS	MILLI-WATTS	dBm	NEPERS	NOISE WEIGHTING C-1000 Hz dBrn	C-0-3 kHz dBrnc	FIA 1000 Hz dBa	FIA 0-3 kHz dBa	PSOPHOMETRIC 800 Hz dBm
1.3×10^6	0.13×10^{-2}	-29	-3.34	61	59	56	53	-28
1.6×10^6	0.16×10^{-2}	-28	-3.22	62	60	57	54	-27
2.0×10^6	0.20×10^{-2}	-27	-3.11	63	61	58	55	-26
2.5×10^6	0.25×10^{-2}	-26	-2.99	64	62	59	56	-25
3.2×10^6	0.32×10^{-2}	-25	-2.88	65	63	60	57	-24
4.0×10^6	0.40×10^{-2}	-24	-2.76	66	64	61	58	-23
5.0×10^6	0.50×10^{-2}	-23	-2.65	67	65	62	59	-22
6.3×10^6	0.63×10^{-2}	-22	-2.53	68	66	63	60	-21
7.9×10^6	0.80×10^{-2}	-21	-2.42	69	67	64	61	-20
10^7	10^{-2}	-20	-2.30	70	68	65	62	-19
1.3×10^7	0.13×10^{-1}	-19	-2.19	71	69	66	63	-18
1.6×10^7	0.16×10^{-1}	-18	-2.07	72	70	67	64	-17
2.0×10^7	0.20×10^{-1}	-17	-1.96	73	71	68	65	-16
2.5×10^7	0.25×10^{-1}	-16	-1.84	74	72	69	66	-15
3.2×10^7	0.32×10^{-1}	-15	-1.73	75	73	70	67	-14
4.0×10^7	0.40×10^{-1}	-14	-1.61	76	74	71	68	-13
5.0×10^7	0.50×10^{-1}	-13	-1.50	77	75	72	69	-12
6.3×10^7	0.63×10^{-1}	-12	-1.38	78	76	73	70	-11
7.9×10^7	0.80×10^{-1}	-11	-1.27	79	77	74	71	-10
10^8	10^{-1}	-10	-1.15	80	78	75	72	- 9

Table 10-12. Noise Power Conversion (Continued)

PICO-WATTS	MILLI-WATTS	dBm	NEPERS	NOISE WEIGHTING				
				C-1000 Hz dBrn	C-0-3 kHz dBrnc	FIA 1000 Hz dBa	FIA 0-3 kHz dBa	PSOPHOMETRIC 800 Hz dBm
$1.3X10^8$	0.13	-9	-1.04	81	79	76	73	-8
$1.6X10^8$	0.16	-8	-0.921	82	80	77	74	-7
$2.0X10^8$	0.20	-7	-0.806	83	81	78	75	-6
$2.5X10^8$	0.25	-6	-0.691	84	82	79	76	-5
$3.2X10^8$	0.32	-5	-0.576	85	83	80	77	-4
$4.0X10^8$	0.40	-4	-0.460	86	84	81	78	-3
$5.0X10^8$	0.50	-3	-0.345	87	85	82	79	-2
$6.3X10^8$	0.63	-2	-0.230	88	86	83	80	-1
$7.9X10^8$	0.80	-1	-0.115	89	87	84	81	0
10^9	1.0	0	0	90	88	85	82	+1

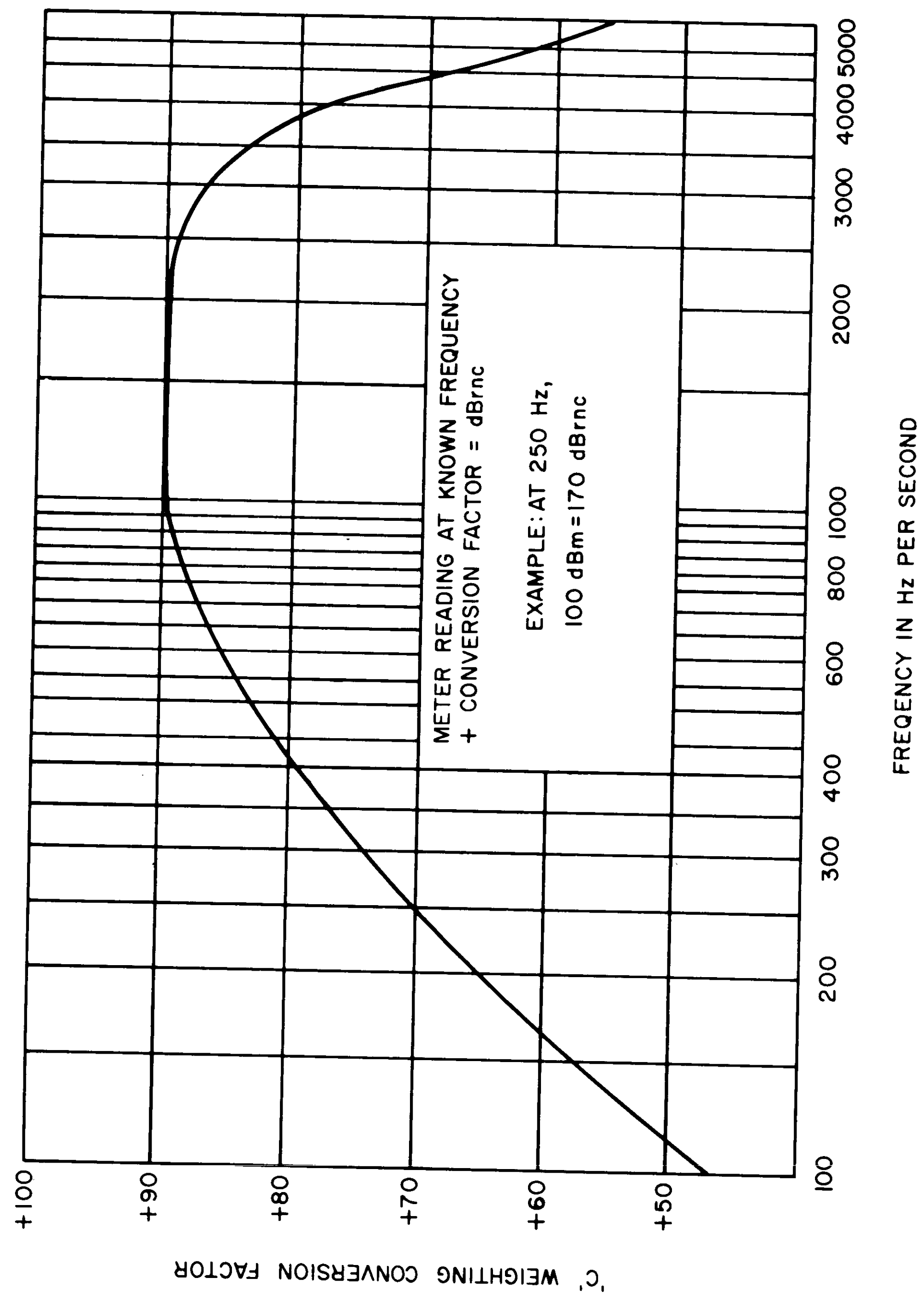


Figure 10-4. Conversion dBm to dBrnc

Table 10-13. Definition of Terms

TERM	DEFINITION
dBm	A power ratio referred to one milliwatt in 600 ohms. The power level at any point in a transmission system is the ratio of the power at that point to some arbitrary amount of power chosen as reference.
Noise weighting	A specific amplitude-frequency characteristic which approximates the effect of noise components at various frequencies upon an average listener using a particular class of telephone set.
dBm (psoph)	Circuit noise in dBm, measured with psophometric weighting.
Psophometric weighting	A noise weighting established by the International Consultative Committee for Telephony (CCIF, now CCITT), designated as CCIF-1951 weighting, for use in a noise measuring set or "Psophometer." The shape of this characteristic is virtually identical to that of F1A weighting. The Psophometer is, however, calibrated with a tone of 800 Hz, 0 dBm, instead of 1000 Hz, dBm. This introduces a -1 dB adjustment factor when converting between dBm and dBm (psoph).
C-message weighting	A noise weighting used in a noise measurement set to measure noise on a line that would be terminated by a 500-type or similar telephone set. The meter scale readings are in dBrn (C-Message), or dBrnc.
dBrn	Noise power, in dB referred to 1.0 picowatts (-90 dBm) with no weighting except for limiting the bandwidth of the measuring instrument to the 30-3000 Hz band.
dBrnc	C-Message weighted circuit noise power, in dB referred to 1.0 picowatts (-90 dBm), which is 0 dBrn.
dBm0"C"	dBm zero referenced and "C" weighted. These units do not include a specification of the transmission level at which they were (or, are to be) measured. A corresponding set of units, defined as above except that they are referred to a point of Zero Transmission Level, is as follows: Absolute units — Referred to zero transmission level dBrnc — dBrnc0 dBm (psoph) — dBm0p
pwp	Noise power in picowatts (10^{-12} watts, psophometrically weighted).
vu	Volume unit, the unit of measurement for electrical speech power in communication work as measured by a vu meter in the prescribed manner. The vu meter is a volume indicator conforming to American Standards Association c 1615-1942. It has a dB scale and specified dynamic and other characteristics in order to obtain correlated readings of speech power necessitated by the rapid fluctuation in level of voice currents. Zero vu equals zero dBm in measurement of sine wave test tone power.