DEFENSE INFORMATION SYSTEMS AGENCY
P.O. BOX 4502
ARLINGTON, VIRGINIA 22204-4502

DISA CIRCULAR 300-175-9* 8 June 1998

Date last reviewed: 30 Oct 2009

STANDARDS

Global Information Grid (GIG) Operating-Maintenance Electrical Performance Standards

1. **Purpose.** This Circular specifies technical parameters and standards necessary to operate and maintain government-owned and/or leased circuits at the expected level of performance for the Global Information Grid (GIG).

2. **Applicability.** This Circular applies to DISA, the military departments (MILDEPs), and other DOD activities and Government agencies responsible for the operation and maintenance of the GIG.

3. **Authority.** This Circular is published in accordance with DOD Directive 5105.19, Defense Information Systems Agency (DISA), 25 June 1991.

4. **References.**

4.1 DISAC 310-70-1, GIG Technical Control, *25 June 1998*.

4.2 DISAC 310-70-57, GIG Quality Assurance Program, *13 April 1998*.

4.3 DISAC 310-130-1, Submission of Telecommunications Service Requests, *3 April 2000*.

4.4 *H.320 Industry Profile for Video Conferencing, VTC001-Rev. 1, 25 April 1995.*

4.5 DISA/JIEO/CFE EP 1-92, Basic Guideline for Application of Performance Standards to Commissioning of GIG Digital Circuits, June 1992. *(OPR: GE).*

4.6 MIL-STD-188-310A, Subsystem Design and Engineering Standards for Technical Control Facilities, 14 January 1980.

4.7 EIA RS-232-C, Interface Between Data Terminal Equipment and Data Communication Equipment Employing Serial Binary Data Interchange, August 1969.

4.8 EIA RS-449-1, General Purpose 37-PIN and 15-PIN Interface Data Terminal Equipment and Data Circuit Terminating Equipment Employing Serial Binary Data Interchange, February 1980.

4.9 MIL-STD-188-347, Equipment Technical Design Standards for Digital End Instruments and Ancillary Devices, 29 March 1973.

4.10 MIL-STD-188-346, Equipment Technical Design Standards for Analog End Instruments and Central Office Ancillary Devices, 30 November 1973.

4.11 MIL-STD-188-114, Electrical Characteristics of Digital Interface Circuits, *13 December 1991* (Revised).

4.12 DISAC 310-70-1 , Supplement 1, DII Technical Control, Volume II, Procedures, 6 June 1990.

4.13 DISA JRSC Test and Evaluation Master Plan, Revision 1, September 1990 *(OPR: GE).*

4.14 ANSI T1.514, Telecommunications Network Performance Parameters and Objectives for Dedicated Digital Services at SONET Bit Rates, 1995.

5. **Definitions**. For terms other than those defined below in this Circular, see reference 4.1.

5.1 **GIG Operating-Maintenance Electrical Performance Standards**. Those standards that establish the key electrical performance parameters used for the daily operation and maintenance (O&M) of the current GIG; that is, the GIG technical parameters which establish minimum performance standards for GIG links, multilinks, and end-to-end circuits.

5.2 **GIG Link and Multilink Channel Performance Standards**. The specified maximum permissible change in the electrical performance parameters that indicate specific link and multilink performance from or between technical control facilities defined with reference to measured values of the same parameters made during a comprehensive alignment and maintenance overhaul, or from official subsystem acceptance test documents.

5.3 **End-to-End Circuit Performance Standards**. For the purposes of this Circular, "end-to-end" is defined as a circuit from one user or terminal point to the other user(s) or terminal point(s) as established by the Telecommunications Service Order (TSO).

6. **Policy**. All O&M procedures employed in the GIG must be based on the preservation of maximum continuity of communication service of acceptable quality to all GIG users at all times. Accordingly, performance and maintenance tests or adjustments that require complete disruption of a service will not be scheduled regularly, except as required by references 4.1 and 4.2.

7. **Scope**. This Circular is limited to establishing circuit and link performance standards for use by (O&M) personnel in troubleshooting, testing, and correcting circuit deficiencies and by circuit engineers and allocators in selecting circuit parameters. The application of these standards is covered in other publications such as references 4.1 and 4.2.

FOR THE DIRECTOR:

A FRANK WHITEHEAD
Colonel, USA
Chief of Staff

SUMMARY OF SIGNIFICANT CHANGES. This revision updates and consolidates the GIG technical parameters for government-owned and leased circuits, completely reformats the Circular and adds parameter thresholds for GIG Performance Monitoring Systems, adds O&M and Test and Acceptance standards for SONET/SDH services, and adds or revises both analog and digital circuit parameters to more closely align GIG circuit parameters with commercial industry standards.

CHANGE 1: (24 July 2006) The references have been partially updated in Paragraph 4, all references will be corrected with the next revision to this Circular and eliminating pay for view web sites. Major changes to Chapter 3, a new Figure F3.1 has been added for OTN and new Figure F3.2 for SONET, and new information has been provided on SONET testing, plus new tables T3.13, T3.14, and T3.15 have been added. All the tables are now in separate files to accommodate easier downloading and printing. All outdated hypertext links were corrected and all tables were placed in separate files. Recommend this Circular be reviewed in its entirety.

---

*This Circular cancels DISAC 300-175-9, 8 June 1998.
OPR: GE
DISTRIBUTION: W

CONTENTS

ILLUSTRATIONS

Figures

Tables

Supplements

Return to:
Top of DISAC 300-175-9 Contents:
DISAC 300-175-9 Basic
DISAC 300-175-9 Chapter 1
DISAC 300-175-9 Chapter 2
DISAC 300-175-9 Chapter 3
DISAC 300-175-9 Chapter 4
DISAC 300-175-9 Chapter 5
DISAC 300-175-9 Supplement 1
DISAC 300-175-9 Supplement 2
DISAC 300-175-9 Supplement 3
DISA Publications Listing
DISA Home Page

cio-pubs@disa.mil *- Last Change: 24 July 2006*

C1. CHAPTER 1. GIG TECHNICAL PARAMETERS

C1.1 **Use**.

C1.1.1 The Technical Parameters provide a common language for GIG circuit ordering, allocation, activation, operation, and maintenance. (See *Table T1.1*.)

C1.1.2 For circuits that traverse both military and commercial paths or paths of more than one carrier, the allocator or engineer will apply the tables for end-to-end circuit performance measurements. In some cases, user requirements found in TSR/TSO actions may not exactly match GIG parameter code performance characteristics found in this circular. In this case the allocator or engineer will be required to specify a GIG parameter code which most closely approximates the required service and then provide the exact details of the required segmented circuit performance to be applied to the individual commercial and military circuit portions in the TSR/TSO. Details of this procedure can be found in reference 4.3.

C1.1.3 Reference 4.4 provides the overall engineering design objectives of end-to-end circuit performance for long-haul military telecommunications. Reference 4.5 provides commissioning standards for use in the development of test and acceptance criteria for statements of work (SOW) for new analog and digital circuits and links. Criteria provided in reference 4.5 shall in all cases be equal to or more stringent than performance parameters specified in the TSO. Electrical interface standards for digital circuits are contained in references 4.6, 4.7, and 4.8. Updates to this circular will be provided through official message page change or next revision of this circular.

C1.1.4 GIG parameter codes are specified in this document according to the following general categories, Analog GIG parameters, Digital GIG parameters, GIG Digital Performance Monitoring Thresholds, and Telephone Signaling Thresholds. ANSI standards and ITU-T recommendations are followed throughout the document wherever they may apply.

C1.2. **Government-Owned and Leased Circuits**. The GIG Technical Parameters for both Government-owned and leased circuits are combined in tables within this document. GIG parameter codes and circuit parameters are based on both U.S. commercial industry standards and standards developed by the ITU-T, ANSI T1, and TIA standards organizations. Government owned analog voice parameters are based upon current commercial lease parameters. Commercial leased circuit specifications (channel type or conditioning) of domestic carriers are filed with the Federal Communications Commission as tariffed items. Conflicts between commercial leased circuit specifications and GIG circuit specifications will be resolved in favor of commercial leased circuit specifications provided by commercial carriers.

C1.3. **Modifications.** Modifications to this document include the addition of C5 voice, D6 and Y5 data circuit, and Y6, Y7, and Y8 SONET parameters. Tables for JRSC/ECCM parameters (J2, J4, and J5) are added as well as thresholds for performance monitoring systems used within the GIG (DPAS, TRAMCON, DSN switches, ESF, and IDNX muxes) and tables to SONET/SDH bit rates. 50 kb/s secure voice parameters (X1, X2, and Z4) are removed from this circular.

---

cio-pubs@disa.mil *- Last Change: 24 July 2006*

TABLE T1.1 ***GIG PARAMETER CODE INDEX***

GIG PARAMETER CODES	TABLES
C0 C1 C2 C3 CT C4 C5	**Table T2.1 & Table T2.2**
D1 D6	**Table T2.4**
G1 G2 G3	**Table T2.7**
J1	**Table T3.1**
J2	**Table T3.4**
J3	**Table T3.1**
J4 J5	**Table T3.4**
M1 M2 M3	**Table T2.3**
N1	**Table T2.4**
R1 R2 R3	**Table T3.2**
S1 - S5	**Table T3.3**
W1	**Table T3.1**
Y1 Y2 Y3 Y4 Y5 Y6 Y7 Y8 *Y9* *Y10*	***Table T3.5 through Table T3.14***

Return to:
Top of DISAC 300-175-9 Table T1.1
DISAC 300-175-9 Basic
DISAC 300-175-9 Contents
DISAC 300-175-9 Chapter 1
DISAC 300-175-9 Chapter 2

[DISAC 300-175-9 Chapter 3]
[DISAC 300-175-9 Chapter 4]
[DISAC 300-175-9 Chapter 5]
[DISAC 300-175-9 Supplement 1]
[DISAC 300-175-9 Supplement 2]
[DISAC 300-175-9 Supplement 3]
[DISA Publications Listing]
[DISA Home Page]

---

cio-pubs@disa.mil - Last Change: 24 July 2006

C2. CHAPTER 2. TECHNICAL PARAMETERS FOR ANALOG GIG CIRCUITS

C2.1 **General.** The GIG Technical Parameters for Analog GIG circuits are provided in this chapter, tables T2.1 through T2.7. The minimum GIG circuit performance as measured end-to-end will be equal to, or better than, the values specified in these tables.

C2.2 **GIG Parameter.** Table T2.1 contains mandatory performance characteristics for government owned and domestic leased services. Table T2.2 contains optional performance characteristics for trouble shooting government owned and domestic leased services. Table T2.3 contains mandatory performance characteristics for international leased services. Table T2.4 contains analog parameters for unique voiceband data circuits, while tables T2.5 and T2.6 contain link and multilink performance criteria for VF circuits. Finally, table T2.7 contains "G" parameters for analog wideband secure voice circuits.

C2.2.1 **Government Owned and Domestic Leased Circuits.** This chapter includes various tariffed service offerings currently available from and recommended by U.S. common carriers to meet Government requirements for the listed analog telecommunication services. The information contained herein provides a reference for use in evaluating government owned and domestic leased systems, and for use in leasing new commercial communications services required in the GIG.

C2.2.1.1 Tables T2.1 and T2.2 contain the conditioning parameters in use today by AT&T for Tariff F.C.C. Nos 9, 10, and 11. Inclusion of this information in this circular does not constitute DOD endorsement of a particular domestic common carrier in providing required services. In addition to AT&T other competing carriers are now providing long haul service. Requirements for GIG service may be satisfied by the use of services from alternate carriers providing equal or better performance to parameters referred to in this circular.

C2.2.1.2 In addition to providing specific technical circuit parameters, the circuit conditioning specified in the tables also refer to the circuit makeup (i.e., two point, multipoint).

C2.2.2 **International Leased Circuits.** This chapter also includes the analog parameters and characteristics of GIG circuits leased from International Carriers (IC's). The characteristics are guaranteed performance values except those values indicated as "objectives". Guaranteed values are normally verified at circuit activation, periodically thereafter to ensure sustained performance, and during troubleshooting and circuit outage verification procedures. "Objective" values normally are not measured, but it is recommended that they be measured during circuit activation and when service is impaired and the guaranteed values are normal. Measurement of these parameters is at the discretion of the Government, and the contractor normally will meet the "objective" values within the capability of available facilities.

C2.2.2.1 The characteristics and values specified in ITU-T Recommendation M.1020, M.1025, and M.1040 apply to all international voiceband circuits. These recommendations have been adopted for use in the GIG. Recommendation M.1020 (with M.1045 and M.1050) is intended for use with modems that do not contain equalizers and is designated "M3". Recommendation M.1025 (with M.1050) is intended for use with modems which contain equalizers and is designated "M2". Recommendation M.1040 (with M.1050) is intended for use as a telephone circuit not requiring the special characteristics of M.1020 and M.1025 and is designated "M1". The M1, M2, and M3 schedules are provided in table T2.3.

C2.2.2.2 Terminal characteristics (impedance and balance), nonlinear distortion, phase and amplitude hits, and dropouts are not guaranteed. All values refer to "psophometrically weighted" measurements. Future measuring sets should be equipped with both "C-message" and "psophometric" filters. "C-message" filters attenuate noise in the lower end of the voice band, and "psophometric" filters attenuate noise in the upper end of the voice band. Reading taken with "C-message weighting" can be converted by using Supplement 3. In case of dispute over a value when a "C-message" filter is used, the measurement made with the "psophometric" filter should be taken as the valid measurement.

C2.2.2.3 ITU-T measurement of frequency response and net loss utilizes an 804 Hz reference, whereas U.S. carriers and GIG use 1004 Hz. When circuit responses are such that losses between 804 and 1004 Hz are more than several tenths dB, the response values will be referred to 804 Hz.

C2.2.2.4 The "M" schedules represent values which are maintainable on a worldwide basis and reflect the use of modern modems which are designed to automatically adapt to a wide variance of telephone circuit responses, noises, and distortions found in the real world.

C2.3 **GIG Voice Link and Multilink Channel Performance Standards**.

C2.3.1 **Applicability**. These standards apply to Government-owned systems and provide criteria by which both the military departments and DISA can measure how effectively new and old equipment, facilities, or systems are maintained and operated. These standards apply to link and multilink channel performance (technical control to technical control) in contrast to the Technical Parameters that apply to circuits (end-to-end).

C2.3.2 **Determination of Parameters**. In view of the nonuniform performance over many different GIG link and multilink configurations, even with optimum transmission adjustment, performance parameters should be determined individually for each GIG link and multilink. Table T2.5 specifies the minimum acceptable performance levels for each of the pertinent parameters, established and derived from the results obtained for each link or multilink during either the test and acceptance (T&A) of the facilities for operational use, subsequent major upgrade and realignment of the facilities, or the GIG Technical Evaluation Program (TEP). If performance data are not available, table T2.6 applies. Table T2.6 provides performance parameter values which may be used pending the availability of measured performance data.

C2.3.3 **Use of Voice Band Modems over Analog Voice Circuits**. Voice band modems operating only at rates greater than or equal to 28000 bits per second will be supported only by analog voice channels with GIG parameter codes using 64 kbps PCM (C2, M1, and M3). Voice band modems operating at rates less than or equal to 28000 bits per second shall be acceptable over all analog voice GIG parameter codes using 32 kbps ADPCM or 64 kbps PCM (C0, C1, C2, C3, CT, C4, C5, M1, M2, and M3)

C2.3.4 **Failure to Meet Established Baselines**. Measurements made by the technical controller that fail to meet performance baselines established in previous TEP evaluation reports within the tolerance of table T2.5 will be made the subject of continuing attention by the cognizant MILDEP until the problem has been resolved. Significant data collected by the station, (circuit/system modification, system realignments, etc.) since the last formal TEP report will be retained at the site and made available to the DISA Performance Evaluation teams upon request. All reports required under other directives will continue and may include these data, if appropriate.

C2.3.5 **Relationship Between the GIG Technical Schedules (Circuit Standards) and Link and Multilink Channel Performance Standards.**

C2.3.5.1 The Technical Parameters are the standards that should be met for quality control measurements performed under DISAC 310-70-1, reference 4.1. The Link and Multilink Channel Performance Standards provide the criteria for Performance Monitoring performed under DISAC 310-70-57, reference 4.2 and the threshold levels for taking a link or multilink channel out of service.

C2.3.5.2 Deviations are specified for each parameter in the Channel Performance Standards to allow for the gradual degradation which occurs over a period of time, equipment aging, etc. In some cases, the maximum permissible deviation from the channel performance standard may result in a performance value which will not support the technical performance parameter of the circuit riding the channel. In this case, the technical control will notify the Circuit Control Office (CCO). The CCO will coordinate with the Telecommunications Service Order (TSO) issuing authority to have a TSO issued to remove or reroute the circuit or obtain an exception to its performance requirements.

C2.3.5.3 The Channel Performance Standards and not the Technical Parameters are used as a basis for removing a channel from service. Although the Channel Performance Standards specify thresholds for removing a channel from service, the procedures and authority to do so are contained in DISAC 310-70-1, reference 4.1.

C2.4 **Transmission Tests.**

C2.4.1 **Voice Signal Levels.** Voice signals are generated by human speech and present a constantly fluctuating power level. Variations up to 20 dB are common and are caused by such factors as the differences in emotional content of the speech, talker volume, background noise, telephone subset efficiency, microphone battery current, and net loss of the subscriber loop. Since power levels vary widely, circuit adjustments should not be made on the basis of voice signal power levels. All communications circuits used in the GIG should be carefully engineered and adjusted prior to operation. Circuit net losses should be measured with a standard single frequency test tone.

C2.4.1.1 **Voice Signal Levels Within the GIG.** There will be a wide variation in voice levels measured in the GIG due to the variations in user voice levels. As a general rule, voice peaks should not exceed 0 dBm0 (referred to the 0 Test Level Point). If the peak levels of a circuit consistently exceed 0 dBm0, the technical controller should investigate the cause to determine if the circuit net gain or loss is correct. If a balanced high impedance oscilloscope is used, procedures in reference 4.1 will be used. The peak to peak voltage stated in reference 4.4 will not be exceeded. GIG access facilities operating at higher levels than defined in reference 4.1 will be equipped with the GIG standard passive peak limiter as described in reference 4.11.

C2.4.1.2 **Voice Signal Levels at Non-GIG Interfaces.** Voice signal power levels to and from non-GIG facilities will be adjusted by inserting appropriate net losses or gains at facility interfaces to effect system compatibility. Circuit engineering details are provided in reference 4.4.

C2.4.2 **Test Tone Power Levels and Frequency.** The test tone power levels and test frequency to be used when testing Government-owned and commercially leased communications circuits, or channels, in the GIG will be as specified herein.

C2.4.2.1 **Standard Test Tone Frequency.** The standard test tone frequency for testing Government-owned GIG voice frequency circuits will be 1004 Hz. Items annotated with an asterisk (*) in subparagraph C2.4.2.3.2.5 use only this frequency. The reference frequency for subparagraph C2.4.2.3.2.2 will also be 1004 Hz. An 804 Hz test tone applies to harmonic distortion, subparagraph C2.4.2.3.2.9. (4 Hz is added to the basic frequencies to avoid subharmonics of the 8kHz frequency used extensively in pulse-code modulation (PCM) systems.)

C2.4.2.2 **Non-Standard Test Tone Frequency.** Certain test equipment (i.e. portable test sets) may only provide a non-standard test tone frequency. When the standard test tone frequency is not available an alternate test tone frequency of 1010 Hz may be used.

C2.4.2.3 **Expression of Power Levels.**

C2.4.2.3.1 At various points in a transmission system, signal power should be at levels determined by system design. The design power levels at these transmission level points (TLP's) are expressed in relationship to a reference point which is defined as the 0 TLP. The transmission level of any point in a transmission system is the ratio (in dB) of the power of a signal at that point to the power of the same signal at the reference point.

C2.4.2.3.2 In the GIG, TLP's are established, such as 0(dB)TLP, -8(dB)TLP, and -16(dB)TLP, normally expressed as 0 TLP, -8 TLP, and -16 TLP. Thus, a 0 dBm (1mW) signal inserted at a 0 TLP should be measured as a -8 dBm signal at the -8 TLP. In this Circular, power levels are expressed in dBm0; i.e., the power level expressed in terms of its relationship to the 0 TLP. For example, the standard test tone level in the GIG is -10 dBm0. At the 0 TLP, the absolute power level would be -10dBm. At -16 TLP, the test tone level would be -26 dBm. The standard test tone power level is used for the following measurements:

C2.4.2.3.2.1 Net loss.

C2.4.2.3.2.2 Frequency response.

C2.4.2.3.2.3 Envelope delay.

C2.4.2.3.2.4 Terminal impedance.

C2.4.2.3.2.5 * Gain hits.

C2.4.2.3.2.6 * Phase jitter.

C2.4.2.3.2.7 * Net loss variation.

C2.4.2.3.2.8 * Signal-to-noise.

C2.4.2.3.2.9 Harmonic distortion.

C2.4.2.3.2.10 * Phase hits.

C2.4.2.3.2.10 * Drop outs.

C2.4.2.3.2.11 * Signal-to-C-notched noise.

C2.4.2.3.2.12 Nonlinear distortion.

C2.4.2.3.2.13 * Impulse noise.

C2.4.2.4 **Standard Test Tone Power Level**. The standard test tone power level for testing Government-owned GIG circuits is -10 dBm0. Tests using this tone should be performed as required to ensure circuit quality.

C2.4.2.5 **Nonstandard Test Tone Power Levels.** The use of test tone power levels higher than the standard level is permissible to measure parameters that are level sensitive, such as harmonic distortion or intermodulation noise at high levels. Such test are permitted only during nonbusy hours or on systems that are out of service. Test signal power levels greater than 0 dBm0 will not be applied to operational channel systems under any circumstances, except for conducting the Impulse Noise and Voice Channel Crosstalk Tests as noted in tables T2.1 and T2.2 respectively.

C2.4.2.6 **Monitor Test Tone Power Level**. The standard monitor test tone power level to be used on voice frequency type GIG facilities when testing on an indefinite basis will be -15 dBm0.

C2.4.3 **Composite Data Signal Power Levels**. Composite data signal power levels for operation over communications circuits, links, equipment, etc., in the GIG will be as specified herein. These include all tone signals (including modulation products) used to transmit data information over GIG voice frequency channels, whether the signal is a single tone or multiple tones, or whether the information is record traffic, computer-to-computer, or secure voice communications.

C2.4.3.1 **Standard Composite Data Signal Power Level.** The standard composite data signal power level for operation in the GIG will be -13 dBm0.

C2.4.3.2 **Commercial Interface Composite Data Signal Power Levels**. The data level at the interface point of GIG and U.S. commercial facilities must be such that both systems are compatible. Therefore, the leasing authorities for the GIG and the commercial carriers must agree on the specific interface levels at the time of the lease. The composite data level at the above points interfacing GIG Technical Control Facilities is -13 dBm0 in both directions of transmission. For overseas commercial locations, the ITU-T specifies -15 dBm0 vice -13 dBm0 for composite data levels at points interfacing GIG facilities.

Return to:
Top of DISAC 300-175-9 Chapter 2
DISAC 300-175-9 Basic
DISAC 300-175-9 Contents
DISAC 300-175-9 Chapter 1
DISAC 300-175-9 Chapter 3
DISAC 300-175-9 Chapter 4
DISAC 300-175-9 Chapter 5
DISAC 300-175-9 Supplement 1
DISAC 300-175-9 Supplement 2
DISAC 300-175-9 Supplement 3
DISA Publications Listing
DISA Home Page

TABLE T2.1 **GIG TECHNICAL PARAMETERS FOR ANALOG VOICE FREQUENCY CIRCUITS**

Characteristics	Unit of Measure	C0	C1	C2	C3	CT (C3) ACCESS	C4	C5
a. Frequency Response[1]	db							
KHz								
0.3 - 2.7			-2 to +6					
0.3 - 3.0			-3 to +12	-2 to +6	-0.8 to +3.0	-0.8 to +2		-1 to +3
0.3 - 3.2							-2 to +6	
0.4 - 2.8		-4 to +12						
0.5 - 2.8				-0.5 to +1.5	-0.5 to +1			-0.5 to +1.5
0.5 - 3.0							-2 to +3	
1.0 - 2.4			-1 to +3					
b. Envelope Delay Distortion[2] (Delay variation allowed in each specific band)								
kHz	Micro-second							
0.5 - 2.8				3000	650	500		600
0.5 - 3.0							3000	
0.6 - 2.6				1500	300	260		300
0.6 - 3.0							1500	
0.8 - 2.6			1750					
0.8 - 2.8							500	
1.0 - 2.4			1000					
1.0 - 2.6			500	500	110	80	300	100
c. Signal to C-Notched Noise Ratio[3]	db	≥21	≥24	≥24	≥28	≥30	≥24	≥24
d. Nonlinear Distortion(Using 4 - tone method)[4]								
d. (1) Signal to Second Order Distortion	db		≥27	≥27	≥31	≥45	≥27	≥27
d. (2) Signal to Third Order Distortion	db		≥32	≥32	≥38	≥47	≥32	≥32
e. Maximum Net Loss (with respect to time)	db	±4	±4	±4	±3	±3	±4	±4
f. Maximum Charge in Audio Frequency[5]	db (max)	±3	±3	±3	±2	±2	±3	±3
g. C-Message Noise[6, 7] (Maximum Allowable)								
km mi					38	38		

0-81 0-50								
81-161 50-100					39	39		
161-324 100-200					41	41		
324-644 200-400					43	43		
644-1609 400-1000					45	45		
1609-2414 1000-1500					47	47		
2414-4024 1500-2500					49	49		
4024-6438 2500-4000					51	51		
h. C-Notched Noise	dbrnc0	54	51	51	47	45	51	51
i. Impulse Noise[8] (Reference Level 71 dBrncO; Measure with Tone)	Counts above ref Level (max in 15 mins)	15	15	15	15	15	15	15
j. Terminal Impedance (600 ohms)	% Tolerance	±10	±10	±10	±10	±10	±10	±10
k. Data Transmission Level (Composite)	dBmO	-13	-13	-13	-13	-13	-13	-13
l. Phase Jitter[9] (Maximum peak-to-peak)	Degrees	10	10	10	10	10	10	10

Footnotes:

1 Loss frequency characteristics are given in terms of comparison to the measured loss at 1004 Hz; i.e., in the c1 schedule the loss frequency characteristics should not exceed the range of 2db less loss (-) to 6 db more loss (+) between 0.3 - 3.0 KHz when compared to the measured loss at 1004 HZ. This frequency is used to avoid subharmonics of the 8 KHz frequency used extensively in pulse-code modulation/time-division multiplex (PCM/TDM) systems.

2 Circuits with PCM equipment will normally fail this parameter by 50 microseconds in the 2.2 to 2.6 KHz range. For this characteristic failure, additional equalization is not required. All test frequencies will be 4 Hz above those shown.

3 This parameter replaces C-Message noise except for C3 and CT. (See footnote 8.)

4 Nonlinear distortion measured using the 4-tone test method is the standard method of measurement of distortion in the GIG.

5 This measurement is not required on circuits traversing only PCM systems.

6 This parameter replaces C-Message noise except for C3 and CT.

7 This measurement to be used strictly for analog circuits end-to-end. If there are any PCM segment, use parameter "C" (signal to C-Notched noise ratio). Consider a satellite channel as equivalent to a 3219 kilometer (2000-mile) lanline channel in determining circuit length.

8 Reference level 60 dBrnc0 only for circuits traversing PCM systems W/O intermediate A/D/A conversions. Measurement made with (previously sampled) PCM channel loaded (where

practical) with 2604 Hz + 5 dBm0 tone. Includes gain and phase hits lasting less than 4 milliseconds.

[9] Not required for circuits traversing PCM system only.

Return to:
DISAC 300-175-9 Table T2.1
DISAC 300-175-9 Chapter 2
DISA Publications Listing
DISA Home Page

TABLE T2.2 **OPTIONAL ANALOG VOICE FREQUENCY PARAMETERS**

The GIG Technical Parameters are shown in table T2.1 through charateristic "1". The following characteristics are provided as a trouble shooting aid and may be used on an optional basis. They are intented to assist the technician in clearing troubles on circuits.

Characteristics	Unit of Measure	C0	C1	C2	C3 Access	CT (C3) Access	C4	C5
a. Gain Hits [1] (>4 ms) Gain Change >3 db	Counts		8	8	8	8	8	8
b. Phase Hits[2] (>20 degrees for >4 ms)	Counts (Max - 15 mins) exceeding threshold		8	8	8	8	8	8
c. Dropouts (12 db for 10 ms)	db (max in 15 mins)		7	2	2	2	2	2
d. Gain Linearity at Input levels of: dBmO	db							
0 to -37		+0.5	+0.5	+0.5	+0.5	+0.5	+0.5	+0.5
-37 to -50		+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0
-50 to -54		+3.0	+3.0	+3.0	+3.0	+3.0	+3.0	+3.0
e. Signal to Quantizing Distortion at Input Levels of: dbmO	db							
0 to -37		33	33	33	33	33	33	33
-30 to -40		27	27	27	27	27	27	27
-40 to -45		22	22	22	22	22	22	22
f. Circuit[3] Continuity (dropouts >10 db for >250 ms)	Dropouts (Max in 24 hrs)	10	10	10	10	10	10	10
g. Voice Channel Crosstalk [4] (from adjacent channels) Maximum	dBrnO	57	57	57	57	57	57	57

Notched Impulse Noise Threshold								
h. Maximum[5] Operating Signal Level (Peak) Reference Threshold 95 dBrnO Flat Wtg	**Counts above reference threshold (max in 15 mins)**	**15**	**15**	**15**	**15**	**15**	**15**	**15**

Footnotes:

[1] Gain Hits are sudden changes in the gain or loss of a circuit. Measurement made at circuit activation and as necessary as a troubleshooting aid.

[2] Phase hits are sudden changes in phase of the transmitted signal caused by the transmission path. Measurement made at circuit activation and as a troubleshooting aid.

[3] This measurement may be made on circuits where loss of synchronization of the high bit rate digital trunk is suspected. Measurements are normally made using a 1004 Hz dBm0 tone on the circuit and a Test Impairment Measurement System (TIMS) to record the dropouts.

[4] This measurement may be made on circuits wherever cross-modulation is suspected. Measurement made with previously scanned channel activated with a 1004 Hz tone at a level of 0 dBm0.

[5] This measurement is made with an impulse noise measuring set bridged across the circuit during periods of maximum signal activity. The measurement indicates the presence of high-level transient signals which can cause intermodulation distortion, cross-talk, and cross-modulation of adjacent channels. It is noted that 95 dBrn0 equates to a level of +5 dBm0.

Return to:
DISAC 300-175-9 Table T2.2
DISAC 300-175-9 Chapter 2
DISA Publications Listing
DISA Home Page

TABLE T2.3 **GIG TECHNICAL PARAMETERS FOR ANALOG VOICE CIRCUITS LEASED FROM INTERNATIONAL CARRIERS**

Characteristics	Unit of Measure	M1(M.1040)	M2(M.1025)	M3(M.1020)
a. Frequency Response[1] (full bandwidth) (ref 804 HZ) KHz	dB			
0.3 - 0.4		-3.0 to undefined		
0.3 - 3.0		-3.0 to 0	-2.0 to +12.0	-2.0 to +6.0
0.4 - 2.0		-3.0 to +9.0		
2.0 - 2.8		-3.0 to +16.0		
0.5 - 2.5			2.0 to +8.0	
0.5 - 2.5				-1.0 to +3.0
0.5 - 2.8				
2.8 - 3.0		-3.0 to undefined		
b. Maximum envelope delay variation permitted in each specified band KHz	Microseconds	Not required		
0.5 - 2.8				3000
0.6 - 2.6				1500
1.0 - 2.6			1500	500
0.6 - 2.8			3000	3000
c. Variation of Net Loss with time	dB			
Short time (few seconds)	db	Not required	±3	±3
Long term (Daily/Seasonal)	db	Not required	±4	±4
d. Maximum net Loss (REF 804 Hz)	dB	28	28	28
e. Maximum change [2] in audio frequency	Hz	Not required	±5	±5
f. Idle circuit[3] noise	dBrncO/pO			

Miles				
0 - 1000		43 / -47	43 / -47	43 / -47
1000 - 1800		45 / -45	45 / -45	45 / -45
1801 - 3000		47 / -43	47 / -43	47 / -43
3001 - 4200		49 / -41	49 / -41	49 / -41
4201- 6000		50 / -40	50 / -40	50 / -40
over 6000		50 / -37	50 / -37	50 / -37
g. Single tone Interference below circuit noise in each distance category	dB	Not required	3	3
h. Impulse noise, reference level 69 dBrnO	Counts in 15 min	Not required	18	18
i. Data transmission level	dBmO	-13	- 13	- 13
j. Maximum phase jitter (peak-to-peak) Simple circuits Complex circuits	degrees	Not required Not required	10 15	10 15
k. Harmonic distortion (700Hz/ -13dBmO)	dB below fundamental	30	30	30
l. Signal-to-quantizing noise ratio (when routing over PCM section) Input signal levels: 0 to -30 dBmO -30 to -40 dBmO	dB	Not required 33 33	22 33 27	22 33 27
m. Signal to C-notched Noise ratio [4]		24	24	24

n. 4 - tone nonlinear distortion Signal to second order distortion Signal to third order distortion	dB	 25 30	 25 30	 25 30
o. Terminal impedance (600 Ohms)	% Tolerence	±10	±10	±10
p. Longitudinal balance	dB	40	40	40
q. Gain hits [5] (4 msec) gain change 3 dB 4 dB	Max counts 15 mins >threshold	Not required	 8 6	 8 6
r. Phase hits [6] (20 degrees /4msec)	Max counts 15 mins >threshold	Not required	8	8
s. Dropouts (12 db / 4 msec)	Max counts 15 mins >threshold	Not required	2	2

Footnotes:

[1] Loss frequency (frequency response) characteristics are given in terms of comparison to the measured loss at 808 Hz. This frequency is used to avoid subharmonics of the 8 KHz frequency used extensively in PCM/TDM systems.

[2] The measurement is not on circuits traversing only PCM systems.

[3] Consider a satellite channel as equivalent to a 1000 kilometer landline channel segment in determining circuit length. ITU-T uses psophometric weighting and not "C" - message, these values are reflected in "C" - message for convenience.

[4] Measurement is made with 1004 Hz/-10 dBm0 holding tone.

[5] Gain hits are sudden changes in the gain or loss of a circuit. Measurement made at circuit activation and as necessary as a troubleshooting aid.

[6] Phase hits are sudden changes in phase of the transmitted signal caused by the transmission path. Measurement made at circuit activation and as a troubleshooting aid.

Return to:
DISAC 300-175-9 Table T2.3
DISAC 300-175-9 Chapter 2

DISA Publications Listing
DISA Home Page

---

cio-pubs@disa.mil - Last Change: 24 July 2006

TABLE T2.4 **GIG ANALOG TECHNICAL PARAMETERS FOR DIGITAL DATA CIRCUITS**

CHARACTERISTICS	UNIT OF MEASURE	D1	D2	N1*
a. Signal to C-notched noise ratio [1]	B	28	32	N/A
b. Nonlinear distortion (Using 4-tone Methods) [2]				
(1) Signal to Second order distortion	B	35	45	N/A
(2) Signal to Third order distortion	B	40	46	N/A
c. Phase Jitter [3] (Max peak-to-peak)	degrees	N/A	7	N/A
d. Frequency Response [4] 0.4 - 2.8 kHz	dB	N/A	-1 to +4.5	N/A
e. Envelope delay distortion [5] (Delay variation allowed) 0.6 - 2.8 kHz	microseconds	N/A	1400	N/A
f. Total Peak distortion	max	N/A	N/A	20
g. Bias Distortion (Mark/space)	% max	N/A	N/A	5

Footnotes:

* The N1 GIG parameter code is a digital parameter. Measurements included within this table include only analog thresholds for this digital signal (See description of Service). Digital Technical Parameters for N1 are the same as those specified for J1 low speed circuits (table T3.1).

[1] This parameter replaces C-Message noise except for C3 and CT. (See Table T2.1 footnote 7.)

[2] Nonlinear distortion measured using the 4-tone test method is the standard method of measurement of distortion in the GIG.

[3] Not required for circuits traversing PCM systems only.

[4] Loss frequency characteristics are given in terms of comparison to the measured loss at 1004 Hz; i.e., in the C1 schedule the loss frequency characteristics should not exceed the range of 2db less loss (-) to 6 dB more loss (+) between 0.3 - 3.0 kHz when compared to the measured loss at 1004 Hz. This frequency is used to avoid subharmonics of the 8 KHz frequency used extensively in pulse-code moudlation/time-division multiplex (PCM/TDM) systems.

[5] Circuits with PCM equipment will normally fail this parameter by 50 microcseconds, in the 2.2 to 2.6 kHz range. For this characteristic failure, additional equalization is not required. All test frequencies will be 4 Hz above those shown.

Return to:
DISAC 300-175-9 Table T2.4
DISAC 300-175-9 Chapter 2

cio-pubs@disa.mil - Last Change: 24 July 2006

TABLE T2.5 **ELECTRICAL PERFORMANCE REQUIREMENTS APPLICABLE TO LINKS OR MULTILINKS WHERE OFFICIAL RECORDED DATA ARE AVAILABLE**

PARAMETER	CHANNEL PERFORMANCE VAULE	PERMISSIBLE DEVIATION ANALOG (FDM) SYSTEMS	PERMISSIBLE DEVIATION DIGITAL (PCM/TDM) SYSTMES
a. Channel Loss	Standard test tone level -10 dBmO	±2 dB multi ±1 dB single	± 0.5 dB ± 0.5 dB
b. Idle channel noise in VF channel	Value based upon official acceptance of the link or multilinks, values obtained during a major realignment or as a result of a TEP.	±10 dB	+ 3 dB
c. C-notched noise in a VF channel	Same as b.	+5 dB	+3 dB
d. Impulse noise in a VF channel	Same as b.	+10 dB increase in reference level, or 20% increased counts	+3 dB increase in reference level, or 20% increased counts
e. Phase jitter	Same as b.	10 % increase in magnitude	N/A
f. Maximum change in audio frequency in VF channel	0 Hz	±2 Hz	N/A

Return to:
DISAC 300-175-9 Table T2.5
DISAC 300-175-9 Chapter 2
DISA Publications Listing
DISA Home Page

---

cio-pubs@disa.mil - Last Change: 24 July 2006

TABLE T2.6 **ELECTRICAL PERFORMANCE REQUIREMENTS APPLICABLE TO LINKS OR MULTILINKS WHERE NO OFFICIAL RECORDED DATA ARE AVAILABLE**

PARAMETER	CHANNEL PERFORMANCE VAULE	PERMISSIBLE DEVIATION
a. Idle channel noise for Link or multilinks of: km mi 0 - 80 (0-50)	27 dBrncO/ -61.5 dBmO	+3 dB increase
80-161 (0-100)	31 dBrncO/ -57.5 dBmO	+3 dB increase
161-644 (100-400)	34 dBrncO/ -54.4 dBmO	+3 dB increase
644-1609 (400-1000)	38 dBrncO/ -50.5 dBmO	+3 dB increase
1609-2414 (1000-1500)	40 dBrncO/ -48.5 dBmO	+3 dB increase
2414-4024 (1500-2500)	42 dBrncO/ -46.5 dBmO	+3 dB increase
4024-6438 (2500-4000)	44 dBrncO/ -44.5 dBmO	+3 dB increase
6438-12874 (2000-8000)	47 dBrncO/ -41.5 dBmO	+3 dB increase
12874-25748 (8000-16000)	50 dBrncO/ -38.5 dBmO	+3 dB increase
b. Impulse noise in VF channel	15 counts per 15 mins exceeding 62 dBrncO	+10 dB in Level
c. Phase jitter (peak to peak) in VF channel	8.5 degrees	+1.5 degrees
d. Maximum change in audio frequency in VF channel	0 Hz	$\pm$2 Hz
e. Total telegraph distortion (including components of distortion, such as bias, characteristic, fortuitous distortion, etc.) derived via broadband facilities. Single VFCT [1] derived via HF radio facilities	5% 20%	$\pm$ 5% 5%

Footnote:

[1] Signal regeneration should be applied when the signal distortion exceeds 25 percent.

Return to:
DISAC 300-175-9 Table T2.6
DISAC 300-175-9 Chapter 2
DISA Publications Listing
DISA Home Page

TABLE T2.7 **WIDEBAND ANALOG SECURE VOICE TRANSMISSION PARAMATERS G CONDITIONING**

CHARACTERISTICS	UNIT OF MEASURE	G1 BOTH DIRECTIONS	G2 SUB TO SWITCH	G2 SWITCH TO SUB	G3 BOTH DIRECTIONS
a. Signal plus noise/noise (S+N/N) [1]	dB	20	20	20	20
b. Impulse noise wideband [2] (Threshold set 12 dB below received signal level)	Counts per seconds	1	1	1	1
c. Net loss variation (Ref 1 kHz)	dB	±4	±4	±4	±4
d. Attenuation [3, 4, 5] Lineup loss (kHz)	dB ref to 0 dBm 1 kHz xmit				
(1) .01		15		15	
0.1		13		13	
1.0		12		12	
10.0		20		20	
50.0		30		30	
(2) .01 - 50kHz			±2		±2
1.0 - 40 kHz			±1		±1
e. Envelope delay	microseconds	Not specified	Not specified	Not specified	Not specified
f. Nominal data input signal level	dBmO	0	0	0	0

Footnotes:

[1] S+N/N = Signal plus noise in dBm - Noise in dBm.

[2] The impulse nose (IPN) meter is normally configured for dBrn. After measuring the received digitized voice signal with a dB meter, use the following equation for the dBrn setting:
dBrn = 90 + signal level (measured reading) - 12 dB
Example: If the signal level is measured to be -2 dBm,
then dBrn = 90 - 2 -12 = 76 dBrn. Set reference level dBrn dials as follows:
10 dB set dial at 60.
High-level dail at 16.
Mid-level dial at 10. (60 + 16 = 76 dBrn)

Low-level dial at 4. (60 + 10 = 70 dBrn)
Use 10.2 to 51 kHz (or external wideband filters.)

[3] A 4 dB loss at 25 kHz is mazimum allowable loss. Loss from 0.1 to 18.0 kHz should be less than 4 dB. If the 25 kHz loss exceeds 4 dB, then the lineup loss will be as listed in Table T2.7 item d(2) and will require a WB repeater.

[4] For those switches which have WECO 824/303 units ons the wideband interswitch trunks or on long-distance wideband subscriber lines, all other subscribers on that switch must meet the lieup loss as listed in Table T2.7 item d(2) to provide sufficient input level to the WECO unit.

[5] If the loss limits listed in Table T2.7 item d(1) cannot be met, wideband repeater(s) will be required and the lineup loss will be as listed in Table T2.7 item d(2).

Return to:
DISAC 300-175-9 Table T2.7
DISAC 300-175-9 Chapter 2
DISA Publications Listing
DISA Home Page

C3. CHAPTER 3. TECHNICAL PARAMETERS FOR DIGITAL GIG CIRCUITS

C3.1 **General.** This chapter provides technical parameters for various Digital GIG parameter codes used in describing both government owned and commercially leased digital services. Unless otherwise specified these parameters are used to evaluate digital transmission systems on an end-to-end basis.

C3.2 **GIG Parameter Codes.** GIG parameters codes found in tables T3.1, T3.2, T3.3, T3.4, and *T3.5* are currently used with both government owned and commercially leased transmission systems. Low-speed digital data circuits derived over digital circuits found in table T3.1 are reflected in two parameters, J1 (0-64 kbps) and J3 (64-1536 kbps). J1 parameters are no longer used for JRSC/ECCM circuits. These users must now use the J5 parameter for ordering JRSC/ECCM service. Parameter codes found in tables T3.2 and T3.3 are for high speed digital channels provided over specific media (terrestrial and satellite media, respectively). GIG parameter codes found in table T3.4 refer to services provided by unique government owned systems (JRSC/ECCM) and are not available from domestic and international commercial carriers. Parameter codes found in *table T3.5* are for high-speed digital data circuits which are derived independently of media and conform to either the ANSI T-carrier or European CEPT digital hierarchy. *Tables T3.5*, *T3.6*, T3.7, *T3.8*, *T3.9*, T3.10, T3.11, T3.12, *T3.13*, and *T3.14* add O&M and Test and Acceptance performance thresholds for SONET/SDH services

C3.3 **Definitions.**

C3.3.1 **Error Free Seconds (EFS) or Error Seconds (ES).** Error Free Seconds are defined as the percentage or the probability of one-second error measurements that are error free (EFS) or in error (ES). *In the ESF mode, ES is a second in which at least one ESF error event (CRC error or OOF) occurred. In D4 mode, TNDS declares an ES when a second includes at least one OOF orBPV. ES are not counted when an Unavailable Signal State is in effect. This parameter is defined in AT&T Publication 54016.*

C3.3.2 **Average Bit Error Rate (BER).** Average Bit Error Rate is defined as the ratio of errored bits to the total bits transmitted in some time interval.

*C3.3.3 **Degraded Minutes (DM).** A Degraded Minute is one in which the estimated error rate exceeds 1E-6 but does not exceed 1E-3. Degraded Minutes are determined by collecting all of the Available Seconds, removing any Severely Errored Seconds grouping the result in 60-second long groups and counting a 60-second long group (minute) as degraded if* *the cumulative errors during the seconds present in the group exceed 1E-6. Available seconds are merely those seconds which are not unavailable as described below.*

C3.3.4 **Severely Errored Seconds (SES).** Severely Errored Seconds are defined as the percentage of probability of one-second measurements that have BER$\geq 10^{-3}$.

C3.3.5 **Residual Bit Error Rate (RBER).** Residual Bit Error Rate is defined as the remaining bit error rate which results when SES and Unavailable Seconds are subtracted out from cumulative testing results. The RBER is considered the normal “background” error rate of a system in the absence of faults or degradation.

C3.3.6 **Availability.** Unavailability is defined as 1-A, where A= Availability. A period of unavailable time begins when the bit error ratio (BER) in each second is worse than 10^{-3} for a period of ten consecutive seconds. These ten seconds are considered to be unavailable time. The period of unavailable time terminates when the BER in each second is better than 10^{-3} for a period of ten consecutive seconds. These ten seconds are considered to be available time. *The backbone transmission service availability shall meet or exceed 99.995% (equivalent to 26.3 min/yr downtime). This covers all types of failures as well as scheduled maintenance. This backbone availability is calculated between the backbone SDPs.*

C3.3.7 **Loss of Bit Count Integrity.** Bit Count Integrity is defined as the preservation of the number of bits transmitted in an interval of time. If one or more bits is either added or subtracted in a given interval of time, a loss of bit count integrity occurs which will cause a loss of synchronization in digital transmission equipment.

C3.3.8 **Delay.** Transmission delay of any circuit in the transit time of the transmitted information between the end points of the circuit. Total delay in a circuit is a function of propagation time (path distance and media dependent), buffering, equipment processing delay, and filter delay (for a voice circuit). Propagation delay is independent of data rate, while buffering and processing delay is inversely proportional to the data rate. The specification and threshold for delay is important to voice and interactive data users because of the waiting time effect.

C3.3.9 **Jitter.** Jitter is defined as a short-term variation of the transition instant from its intended position or time. Longer-term variation of the transition is sometimes called wander. Jitter can cause several forms of degradation at bit rates greater than 1.544 Mbps, from bit errors to loss of synchronization so that it must be carefully controlled in a digital communications system. Definitions of jitter used in this document are based upon definitions and thresholds established in ITU-T Recommendation G.823 for the European hierarchy and G.824 for the North American Hierarchy.C3.3.10 JSRC/ECCM Test Parameters JRSC test parameters found in *table T3.6* (Looped Circuit Establishment Time, Looped Sync Time, Looped Transport Delay, Synch Loss, and % Block Error Rate) are defined in reference 4.14.

C3.4 **Digital Transmission Tests.**

C3.4.1 **Error Performance (EFS, ES, DM, SES, Average BER, RBER).** Error performance parameters defined above can be readily tested using available commercial off the shelf (COTS) BER test equipment supplied with certain options.

C3.4.1.1 Error Test Duration EFS, DM, and SES are the only mandatory test parameters for assessment of error performance of digital transmission services and may be used for both short term (~2 hours) and long term ($\geq$2 hours) testing and evaluation. *Note: There is issue regarding Average BER testing and Long Term Performance measurements. In general average BER is never tested for greater than the short-term test duration of two hours. However long term performance measurements are absolutely essential to ensure that a system is not impacted by variations in the environment, connector or other operational procedures that may not be detected over a short-term test.*

C3.4.1.2 **Error Test Pattern.** Various error test patterns are available in modern BER test sets to test digital performance. Different patterns are designed to test coding and clock recovery in the equipment as well as physical anomalies in copper based circuit extensions. When evaluating the performance of digital circuits it is most useful to use as stressful a data pattern as can be expected to be experienced during normal operation of the circuit. For example if the test demarcation is located at the point where encryption devices interface to leased transmission services, and the leased services are to be tested, a test pattern of 2^{23}-1 (providing the longest strings of continuous 1's and 0's in a pseudorandom stream) is highly recommended. However, if a leased service already provides encryption, a less stressful pattern such as QRSS or 2^{15}-1 would be appropriate to simulate normal operation of switch and data traffic. If a DS-1 circuit is to be extended significant distances across copper cable infrastructure, short term testing with various additional error test patterns is called for to verify error free performance across the circuit extensions. Refer to *ESONET New Tributary Acceptance Test Plan*, Revision Date: *May 2003*, for additional detail.

C3.4.2 **Availability.** Measurement of availability is based upon the definition of availability as described above and in ITU-T recommendation G.826 (Note: G.826 specifically applies only to 64 kb/s circuits, but here the definition of availability is broadened to include all GIG rates). This parameter is measurable by most COTS digital BER test Equipment.

C3.4.3 **Loss of Bit Count Integrity (LBCI).** Loss of Bit Count Integrity is the only useful quantitative measure of digital transmission system timing and synchronization performance currently available. This parameter reflects the number of Losses of BCI in the defined measurement interval. Values for LBCI found in parenthesis in tables T3.1, T3.2, T3.3, T3.4, and *T3.5* indicate objective LBCI measurements over a 24 hour period. Measurement techniques and test descriptions for LBCI can be found in references 4.5 and 4.13.

C3.4.3.1 DPAS, IDNX and ESF capable multiplex and switch equipment often monitor "frame slips" or Change of Frame Alignment (COFA) on an in-service basis. Thresholds for these parameters can be found in tables T4.1, T4.3, T4.4. *Maintenance action should start at the minor alarm threshold of 4 frame slips per 24 hour period and maintenance personnel should take the subject circuit out of sevice at the major alarm threshold of 255 slips per 24 hour period.* While frame slips or COFA's may occur due to an LBCI event, it must be noted that these in-service monitoring events can also occur due to other causes such as high error rate (SES) events due to transmission media. Thus the only true measurement of actual LBCI events can only be performed by out of service testing with appropriate test equipment designed to generate a specific pattern and measure insertions or deletions of bits into the digital bit stream. This testing is normally performed only upon Initial Test and Acceptance of a circuit and upon recommissioning existing circuits which have been taken out of service for reliability problems.

C3.4.3.2 Estimating long term LBCI performance ($\geq$ 24 hours) using short term test intervals (~ 2 hours) suggested in this circular is not recommended. However if more than a single LBCI event occurs during short term out-of-service testing the test has failed and corrective maintenance action should occur. If measurement of the Mean Time To Loss of Bit Count Integrity (MTTLBCI) is required for commissioning purposes, it is recommended that the time interval used to perform the test occur over three times the required "Mean Time" time interval. For example, if MTTLBCI = 24 hours, the minimum duration of out-of-service test for MTTLBCI should be 3 * 24 = 72 hours.

C3.4.3.3 Due to the impractical nature of routinely performing such tests, it is recommended that MTTLBCI parameters first be estimated by the use of systems which actively monitor performance of transmission facilities through the use of parity checking or other error detecting schemes described above. Performance outside of the normal performance monitoring range would indicate the need for further corrective action.

Parameters and thresholds for these performance monitoring parameters are provided in chapter 4.

C3.4.4 **Delay.** Standard COTS BER test sets include a method of measuring delay. Resolution of the measurement should be to 0.1 millisecond. The time interval to be measured can be of transmitted and received data, pseudorandom patterns, or some other user selected signals. If using a pseudorandom pattern, the length of the pattern MUST exceed the maximum expected delay. To minimize the test time, one should use the minimum usable pattern length, found as (data rate) * (maximum expected delay). For example, to make a delay measurement of 1.544 Mbps over a satellite link with maximum delay of 300 milliseconds, the pattern length should be 463,200 bits; a 2^{19} -1 pattern having length 524,287 bits is the minimum usable length pattern for this case.

C3.4.5 **Jitter.** Jitter measurements required in tables T3.2, T3.3, and T3.4 are based upon ITU-T G.823 and G.824. Measurement of Jitter is usually not a standard feature of most COTS BER test equipment but may be added as an option. These options only measure jitter at data rates greater than or equal to 1.544 Mbps.

C3.4.6 **JRSC/ECCM Parameters.** JRSC/ECCM parameters are segregated in *table T3.6* due to unique testing requirements of these systems. Definitions and test descriptions for Looped Synchronization Time, Looped Circuit Establishment Time, and Looped Transport Delay can be found in reference 4.13. Parameter thresholds are specified in reference 4.14. Measurement of JRSC/ECCM parameters requires the use of specialized software and hardware developed by the DISA for the JRSC program.

C3.5 **SONET/SDH Rate Digital Services Test & Acceptance For Optical Systems.**

C3.5.1 **General.** Tables T3.7, *T3.8*, *T3.9*, T3.10, T3.11, and T3.12 are to be used for the evaluation of SONET/SDH rate digital services. Performance objectives apply at these rates to the SONET/SDH path and are not constrained to a particular physical signal type (i.e. objectives apply for electrical (STS-n/STM-(n/3)) or optical (OC-n) signals) for both out of service testing or in-service performance monitoring. PRBS (Pseudo Random Bit Stream) test patterns shall be used for out of service testing and shall use the 2e23-1 test pattern.

C3.5.2 **Availability Objectives.** Availability objectives are stated in terms of the parameters provided in *table T3.8* Short Interruption Event Count (SIEC) and Percent (%) Availability which characterize usability of the service over time. Transition to the unavailable state occurs at the beginning of 10 consecutive SES. Transition to the available state occurs at the beginning of 10 consecutive seconds none of which is an SES.

C3.5.3 **Performance Parameters.** Performance parameters include:

C3.5.3.1 **Bit Error Ratio (BER):** The ratio of the number of bit errors to the total number of bits transmitted in a given time interval.

C3.5.3.2 **Block:** A block is a set of consecutive bits associated with the connection; each bit belongs to one and only one block.

C3.5.3.3 **Percent Errored Seconds (% ES):** 100x the ratio of ES to total seconds in available time during a fixed measurement period.

C3.5.3.4 **Percent Severely Errored Seconds (% SES):** 100x the ratio of SES to total seconds in available time during a fixed measurement period.

C3.5.3.5 **Background Block Error (BBE):** AN errored block not occurring as part of an SES .

C3.5.3.6 **Background Block Error Ratio (BBER):** The ratio of Background Block Errors (BBE) to total blocks in available time during a fixed measurement interval. No blocks that occur during an SES shall be used for the computation of BBER.

C3.5.3.7 **Short Interruption Event (SIE):** An event beginning with the occurrence of a BER of 10e-2 or worse continuously for each of three or more consecutive seconds, which can last up to 120 seconds. An SIE clears when 10 consecutive seconds none of which is an SES occur.

C3.5.3.8 **Short Interruption Event Count (SIEC):** A count of the Short Interruption Events in a given time frame (e.g. 30 Days).

C3.5.4 ***Anomalies, Defects, and Failures.***

C3.5.4.1 ***Loss Of Signal (LOS):*** *LOS is raised when the synchronous signal (STS-N) level drops below the threshold at which a BER of 1 in 103 is predicted. It could be due to a cut cable, excessive attenuation of the signal, or equipment fault. The LOS state clears when two consecutive framing patterns are received and no new LOS conditions detected.*

C3.5.4.2 ***Out Of Frame Alignment (OOF):*** *OOF state occurs when four or five consecutive SONET frames are received with invalid (errored) framing patterns (A1 and A2 bytes). The maximum time to detect OOF is 625 microseconds. OOF state clears when two consecutive SONET frames are received with valid framing patterns.*

C3.5.4.3 ***Loss Of Frame Alignment (LOF):*** *LOF state occurs when the OOF state exists for a specified time in milliseconds. The LOF state clears* *when an in-frame condition exists continuously for a specified time in milliseconds.*

C3.5.4.4 ***Loss Of Pointer (LOP):*** *LOP state occurs when N consecutive invalid pointers are received or “N” consecutive New Data Flags (NDF) are received (other than in concatenation indicator), where N=8, 9, or 10. LOP state is cleared when three equal valid pointers or three consecutive AIS indications are received. LOP can also be identified as:*

C3.5.4.4.1 LOP-P (STS Path Loss of Pointer).

C3.5.4.4.2 LOP-V (VT Path Loss of Pointer).

C3.5.4.5 ***Alarm Indication Signal (AIS):*** *The AIS is an all-ONES characteristic or adapted information signal. It is generated to replace the normal traffic signal when it contains a defect condition in order to prevent consequential downstream failures being declared or alarms being raised. AIS can also be identified as:*

C3.5.4.5.1 AIS-L (Line Alarm Indication Signal).

C3.5.4.5.2 AIS-P (STS Path Alarm Indication Signal).

C3.5.4.5.3 AIS-V (VT Path Alarm Indication Signal).

C3.5.4.6 ***Remote Error Indication (REI):*** *REI is an indication returned to a transmitting node (source) that an errored block has been detected at the receiving node (sink). This indication was formerly known as Far End Block Error (FEBE). REI can also be identified as:*

C3.5.4.6.1 REI-L (Line Remote Error Indication).

C3.5.4.6.2 REI-P (STS Path Remote Error Indication).

C3.5.4.6.3 REI-V (VT Path Remote Error Indication).

C3.5.4.7 ***Remote Defect Indication (RDI):*** *A signal returned to the Transmitting Terminating Equipment upon detecting a Loss of Signal, Los of Frame, or AIS defect. RDI was previously known as FERF. RDI can also be defined as:*

C3.5.4.7.1 RDI-L (Line Remote Defect Indication).

C3.5.4.7.2 RDI-P (STS Path Remote Defect Indication).

C3.5.4.7.3 RDI-V (VT Path Remote Defect Indication).

C3.5.4.8 ***Remote Failure Indication (RFI):*** *A failure is a defect that persists beyond the maximum time allocated to the transmission system protection mechanisms. When this situation occurs, an RFI is sent to the far end and will initiate a protection switch if this function has been enabled. RFI can also be identified as:*

C3.5.4.8.1 RFI-L (Line Remote Failure Indication).

C3.5.4.8.2 RFI-P (STS Path Remote Failure Indication).

C3.5.4.8.3 RFI-V (VT Path Remote Failure Indication).

C3.5.4.9 ***B1 Error:*** *Parity errors evaluated by the byte B1 (BIP-8) of an STS-N are monitored. If any of the eight parity checks fail, the corresponding block is assumed to be in error.*

C3.5.4.10 ***B2 Error:*** *Parity errors evaluated by the byte B2 (BIP-24xN) of an STS-N are monitored. If any of the Nx24 parity checks fail, the corresponding block is assumed to be in error.*

C3.5.4.11 ***B3 Error:*** *Parity errors evaluated by the byte B3 (BIP-8) of a VTN-N (N=3,4) are monitored. If any of the eight parity checks fail, the corresponding block is assumed to be in error.*

C3.5.4.12 ***BIP-2 Error:*** *Parity errors contained in bits 1 and 2 (BIP-2: Bit Interleaved Parity-2) of byte V5 of an VT-M (M=11, 12, 2) is monitored. If any of the two parity checks fail, the corresponding block is assumed to be in error.*

C3.5.4.13 ***Loss of Sequence Synchronization (LSS):*** *Bit error measurements using pseudo-random sequences can only be performed if the reference sequence produced on the receiving side of the test set-up is correctly synchronized to the sequence coming from the object under test. In order to achieve compatible measurement results, it is necessary that the sequence synchronization characteristics are specified. Sequence synchronization is considered to be lost and resynchronization shall be started if:*

C3.5.4.13.1 Bit error ratio is >/= 0.20 during an integration interval of 1 second; or

C3.5.4.13.2 It can be unambiguously identified that the test sequence and the reference sequence are out of phase.

C3.6 ***Test and Acceptance For Optical Systems:***

*C3.6.1 **Purpose:** This section describes test procedures to be used in the measurements for commissioning optical systems. It is oriented towards those measurements that are required by the applicable technical schedule circuit parameter codes in this Circular.*

*C3.6.2 **Definition and Parameters:** The parameter codes are found in the tables in this chapter. Routine Test & Acceptance procedures for new DS-1, DS-3, and STS-1, STS-3, and STS-12 services using SONET are enabled in conformity with DISAC 310-70-1 and DISAC 300-175-9. In this document the "line side" is the side that is connected to the backbone, while the "tributary side" is the side that is connected to the customer's equipment. It is understood that the Optical Network Element (ONE) is in the predetermined configuration and has fully tested the line side of the network, and has tested all tributary side ports and interfaces.*

*C3.6.3 **Receiver Integrity:** There are accepted ranges for transmitted power levels for optical interfaces. These are typically designated for single mode interfaces. Every vendor must fall within these ranges: Very Short Reach (VSR); Short Reach (SR – 11 dB span attenuation); Intermediate Reach (IR – 7 dB span attenuation); and Long Reach (LR – 22 dB span attenuation). There is also a Very Long Reach (V – 33 dB span attenuation). During the Initial Test and Acceptance (IT&A) process, the installer must measure the power and attenuate the Received Signal Level (RSL) if found necessary. If the received power is too high, it can induce errors and damage the receiver, while signal levels that are too low may induce SONET errors. In general, interfacing a SR to a SR/IR/LR will not overdrive the receiver. However, interfacing an IR/LR to anything without attenuation will result in receiver burn out. Discrete attenuators come in steps of 1/3/5/6/10/12/15/20 dB. Although vendors usually silk screen designations onto the faceplate, it is necessary to determine what the commercial equipment is transmitting. The Installer must measure this transmitted power and suitably attenuate using appropriate optical attenuators, or using variable attenuators that can be tuned to the proper level. Some optical equipment has a variable attenuator built into the receiver, while some transmitters have a variable output power.*

*C3.6.4 **Maximum Attenuation:** The maximum path attenuation is where the system in question operates under end-of-life conditions at a BER of 10-12 under worst-case transmit-side signal and dispersion. The maximum attenuation values for the target distances are based on the assumption of 0.275 dB/km installed fiber loss in the 1530 – 1565 nm range, and on an assumption of 0.55 dB/km for the 1310 nm single channel. From a practical point of view, attenuation spans of 11dB/40 km at 1550 nm and 11dB/20 km at 1310 nm are defined, except for very short reach and intra-office applications.*

*C3.6.5 **Minimum Attenuation:** The minimum path attenuation that allows the system in question, operating under worst-case transmitside conditions, to achieve a BER no worse than 10-12.*

*C3.6.6 **Maximum Mean Channel Input Power:** The maximum acceptable value of the average received channel power at point MPI-RM to achieve the specified maximum BER of the application mode.*

*C3.6.7 **Minimum Mean Channel Input Power:** The minimum acceptable value of the average received channel power at the multichannel receive main path interface reference point (MPI-RM)to achieve the specified maximum BER of the application code.*

*C3.6.8 **Minimum Mean Total Input Power:** The maximum acceptable total input power at point MPI-RM.*

*C3.6.9 **Maximum Channel Power Difference:** The difference between the largest value of the mean channel input power and the smallest value of the mean channel input power present at the same time within a given optical resolution bandwidth, independent of the number of channels, within the application.*

*C3.6.10 **Channel Signal-to-Noise Ratio:** This is the best measure of overall channel performance and is thus one of the most important. The higher the bit rate, the higher the SNR required. For OC-192 transmissions, the SNR should be at least 27-31 dB, compared to 18-21 for OC-48. The formula for the SNR in dB is:*

SNR = PS – L – NF – 10 log10N –10log(hf•f)

Where SNR is the channel SNR in dB, PS is the power level of the transmitter light source in dBm, L is the fiber attenuation loss before each amplifier in dB (assumed to be uniform), NF is the amplifier noise figure in dB (assuming identical amplifiers), N is the number of amplifiers, h is the Plank's constant, f is the frequency, and •f is the channel bandwidth. We can see that the more amplifiers we use, the shorter the spans we need to maintain the SNR.

*C3.7 **Test Arrangements:** <u>Figure F3.1</u> shows a generic reference points for optical elements in the optical transport network (OTN). From the reference configuration, assess single channel characteristics such as extinction ratio, eye mask and optical path penalty. The extinction ratio and eye mask are to be measured by submitting the single channel signal at Sx to be "measurement set-up for transmitter eye diagram as shown in the figure. The reference points in the figure are:*

- Ss – is a single channel reference point on the optical fiber just after a single channel client NE transmitter optical connector.

- Rs – is a single channel reference point just before a single channel client NE receiver optical connector.

- Sm-s – is a single channel reference point just after each of the optical network element tributary interface output optical connectors (the “m-s” subscript indicating a single channel output from a multi channel system).

- Rs-m – is a single channel reference point on the optical fiber just before each of the optical network element tributary interface input optical connectors (the “s-m” subscript indicating a single channel input into a multi channel system).

- MPI-Sm – is a multi channel reference point on the optical fiber just after the optical network element transport interface output optical connector.

- MPI-Rm – is a multi channel reference point on the optical fiber just before the optical network element transport interface input optical connector.

- Sm – is a reference point just after the line multi channel OA output optical connector, and

- Rm – is a reference point on the optical fiber just before the line multi channel OA input optical connector.

C3.7.1.1 ***SONET Test Issues:*** *SONET is optical, while many test sets are electrical. A customer may buy a DS-3, but it is still delivered over SONET networks over optical fiber. The differences between SONET operating at a BER of 10-12 and10-13 seems trivial, but is important for billing and service level purposes. Well designed SONET systems operate virtually error free, yet some method of measurement to evaluate BER is needed. SONET is synchronous, but effects of jitter and wander may still exist. Detecting the timing defects can be an important issue. These issues are resolved by measuring and confirming short-reach output wavelength power, BER performance, long term interoperability test, output extinction ratio and mask test, and short-reach return loss.*

C3.7.1.2 ***Test Arrangement Check:*** *A typical test arrangement is shown here. A commercial Standard Test Equipment/equivalent will be used to test the SONET ports. During these tests only two sites will be tested at any given time. The diagram in figure F3.2 shows the basic test philosophy. Each test should have a minimum duration of 24 hours.*

C3.7.1.3 ***Test Procedures:*** *The channel under test should be in its normal operating condition. Some basic steps in the procedure include, but not limited to the following:*

C3.7.1.3.1 Connect the short-reach output to an Optical Spectrum Analyzer. Confirm the short-reach output wavelength in between 1530nm to 1560 nm. Record this output wavelength.

C3.7.1.3.2 Connect the short-reach output to an optical power meter. The output power should be within the specified range: -5dBm < Pout < -3dBm. Record this short-reach output power.

C3.7.1.3.3 Vary the power level going in and monitor the BER on the performance- monitoring (PM) counter in the transceiver and the network router. Observe at three different power levels within the operating range. The expected result is BER < 10-13 for –13dBm < Pin < -3dBm. Record this result.

C3.7.1.3.4 Connect the short-reach output to a Digital Communications Analyzer (DCA). Set the electrical bandwidth (STM-64 SONET filter on). Use the built-in oscilloscope algorithm to measure extinction ratio. Record the extinction ratio. The expected result should exceed 8.2.

C3.7.1.3.5 Select the STM-64 mask on the DCA. Run a mask test. The mask test should be error free. Attach a copy of the eye diagram with the record.

C3.7.1.3.6 Measure the short-reach input return loss with an optical return loss test meter. The transceiver should be plugged in, and the shelf power may be ON or OFF. The return loss should be less than 27 dB for a nominal wavelength of 1550nm.

C3.7.1.3.7 Measure the short-reach output return loss with an optical return loss test meter. The transceiver should be plugged in, and the shelf power must be OFF. The return loss should be less than 27 dB for 1550 nm nominal.

C3.7.1.4 Make sure that the power readings comply with standards. Table T3.15 provides prevalent ITU standards for various wavelengths and data rates.

C3.7.1.4.1 The mentioned rates in the table T3.15 are in compliance with ATM Forum AF-PHY-0046.000; ITU I.432, G.707, G.783; ITU-T G.959.1; ANSI T1.105-1995, T1.646-1995; Bellcore GR-253-CORE; and the "Hitachi Review Vol. 48 (1999), No. 4, Matsuda et al".

C3.7.1.4.2 It is also important to clean all the fiber-optic ports with a *commercial quality fiber-optics cleaning kit before any test activities begin. The parameters are specified relative to an optical system design objective of a BER not worse than 10-13 (OC-1 through OC-192) for the extreme case of optical path attenuation and dispersion conditions for each application.*

C3.7.1.4.3 The required tests include: interoperability testing; node testing; network testing; system testing; cutover testing; and routine test & acceptance. The thresholds for routine test and acceptance are to be performed for all DS-1, DS-3, and OC-N services.

C3.8 ***Optical Testing.*** *Several measurements, mechanical, geometrical and optical tests are performed only once on optical fiber, as these parameters suffer only minor variations during a fiber's life. However, many other measurements need to be performed in order to characterize them before their use for transmission. Many of these measurements are described in the Fiber Optic Test Procedure (FOTP) propositions of the Electronic Industries Association (EIA), and also are defined by the ITU-T G650 recommendations or the EN 188000 document. These transmission tests include measurements for Bandwidth, Optical Power, Optical Loss and Reflectometry.*

C3.8.1 ***Transmission Tests.*** *The main measurements are:*

C3.8.1.1 End-to-End Optical Link Loss.

C3.8.1.2 Rate of attenuation per unit length.

C3.8.1.3 Attenuation contribution to splices, connectors, couplers (events).

C3.8.1.4 Length of fiber or distance to an event.

C3.8.1.5 Linearity of fiber loss per unit length (Attenuation discontinuities).

C3.8.1.6 Reflectance or Optical Return Loss.

C3.8.2 Other measurements such as bandwidth or polarization mode dispersion, except for specific applications, are less important. During field testing, there are three main important tasks – installation, maintenance and restoration – where testing is required.

C3.8.3 Installation testing is performed to ensure that the fiber cables conform to specifications and are not damaged in any way. These tests also determine the quality of cables splices and cable terminations, and suitability for the intended application and provide complete *documentation for maintenance purposes.*

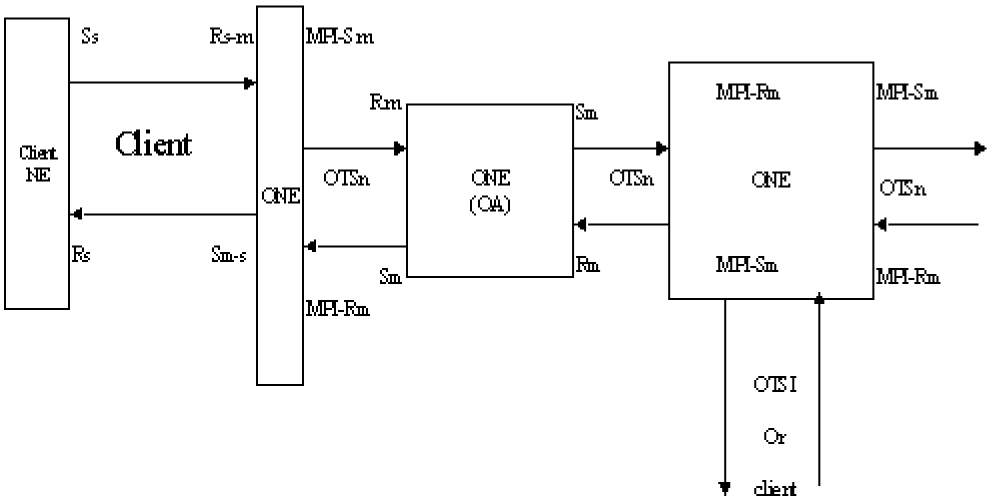
C3.8.4 Maintenance testing involves periodic evaluation of the system to ensure quality (i.e. no degradation of the cable, splices or connections has occurred). Maintenance tests must be performed periodically every few months and/or automated to test the integrity of the system every few minutes to give immediate warning of degradation or an outage.

C3.8.5 During cable restoration, testing is performed to locate faults/outage, assess the quality of the repaired system (permanent splices) similar to the testing performed at the conclusion of cable installation.

C3.8.6 One of the major parameters to measure is optical loss budget or end-to-end optical link loss. When calculating the budget, consideration must be given to: the source, the detector and the optical transmission line. The transmission link includes the source-to-fiber coupling loss, the fiber attenuation loss, and the loss of all components along the line (connectors, splices, passive components etc.).

***cio-pubs@disa.mil** - Last Change: 24 July 2006*

FIGURE F3.1 **REFERENCE POINTS FOR OPTICAL ELEMENTS IN THE OPTICAL TRANSPORT NETWORK (OTN)**

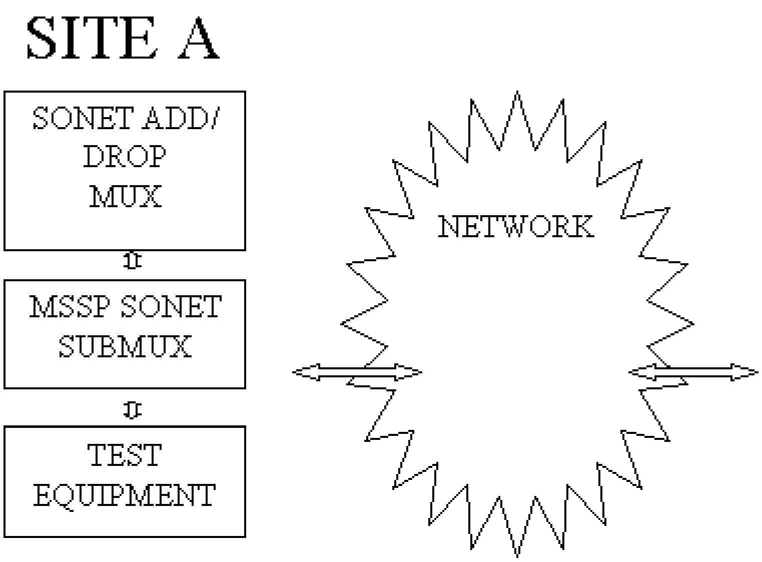


Return to:
[DISAC 300-175-9 Figure F3.1]
[DISAC 300-175-9 Chapter 3]
[DISA Publications Listing]
[DISA Home Page]

---

cio-pubs@disa.mil *- Last Change: 24 July 2006*

FIGURE F3.2 ***SYNCHRONOUS OPTICAL NETWORK (SONET) TYPICAL TEST SET-UP***



Return to:
[DISAC 300-175-9 Figure F3.2]
[DISAC 300-175-9 Chapter 3]
[DISA Publications Listing]
[DISA Home Page]

---

cio-pubs@disa.mil *- Last Change: 24 July 2006*

TABLE T3.1 **GIG TECHNICAL PARAMETERS FOR END-TO-END LOW SPEED DIGITAL DATA CIRCUITS DERIVED OVER GOVERNMENT AND COMMERCIAL LEASED TRANSMISSION SYSTEMS**

SERVICE	UNIT OF MEASURE	J1[1]	J3[2]	W1[3]
a. Digital Line Rate		0 - 64 kbps	64 - 1536 kbps	19 - 50 kbps
b. Measurement Interval	hours	2	2	0.5
c. % Error Free Seconds	%	98.0	96.0	98.0
d. Severely Errored Seconds	%	< 0.2	< 0.2	< 0.2
e. Degraded Minutes	%	< 10	< 10	< 10
f. Bit Error Rate (BER)	errors/bits	1×10^{-5}	1×10^{-6}	1×10^{-6}
g. Residual BER	errors/bits	1×10^{-5}	1×10^{-6}	1×10^{-6}
h. Availability	%	98.0	98.0	98.0
i. LBCI[4]	max occur	1 (1/24 hrs)	1 (1/24 hrs)	1 (1/24 hrs)
j. Delay all terrestrial 1 satellite hop 2 satellite hops	milli-seconds	 150 300 600	 125 300 600	 150 300 600
k. Jitter	UI	n/a	n/a	n/a

Footnotes:

1 Low speed end-to-end digital data service either synchronous, asynchronous, or isochronous provided by either government owned or commercial leased systems (independent of media) to include switched-56 services and voice-band modem data.

2 Low speed digital data service to include FCC-100, fractional T-1 service, and switched ISDN data service.

3 Circuits at rates of 19.2 kbps to 50 kbps, synchronous or isochronous mode.

4 Objective values are shown in parentheses.

Return to:
DISAC 300-175-9 Table T3.1
DISAC 300-175-9 Chapter 3

TABLE T3.2 **GIG TECHNICAL PARAMETERS FOR HIGH SPEED DIGITAL LINKS DERIVED OVER DIGITAL RADIO/FIBER OPTIC/TROPSCATTER MEDIA**

SERVICE[1]	UNIT OF MEASURE	R1[2]	R2[3]	R3[4]
a. Digital Line Rate		1.544 - 200 Mb	1.544 - 2488.32 Mb	1.544 - 10 Mb
b. Measurement Interval	hours	2	2	2
c. % Error Free Seconds	%	(98.0)	(96.5)	(98.0)
d. Severely Errored Seconds	%	< 0.054	< 0.054	< 0.054
e. Degraded Minutes	%	< 0.4	< 0.4	< 0.4
f. Bit Error Rate (BER)	errors/bits	($5 X 10^{-9}$)	($5 X 10^{-9}$)	$1 X 10^{-4}$
g. Residual BER	errors/bits	$5 X 10^{-9}$	$5 X 10^{-9}$	$5 X 10^{-4}$
h. Availability	%	99.5	99.5	99
i. LBCI	max occur	1 (1/2688 hrs)	1 (1/2688 hrs)	1 (1/2688 hrs)
j. Delay	milli-seconds	2	2	2
k. Jitter	UI	n/a	n/a	n/a

Footnotes:

[1] Objective values are shown in parentheses.

[2] Digital radio (not digital tropo, fiber, or satellite) rates.

[3] Fiber optic and metallic cable rate (not digital tropo or satellite).

[4] Digital tropo.

Return to:
DISAC 300-175-9 Table T3.2
DISAC 300-175-9 Chapter 3
DISA Publications Listing
DISA Home Page

TABLE T3.3 **GIG TECHNICAL PARAMETERS FOR HIGH SPEED DIGITAL LINKS DERIVED OVER SATELLITE MEDIA**

SERVICE[1,2]	UNIT OF MEASURE	S1	S2	S3	S4	S5
a. Digital Line Rate		50kb-50Mb	50kb-50Mb	50kb-50Mb	50kb-50Mb	50kb-50Mb
b. Measurement Interval	hours	2	2	2	2	2
c. % Error Free Seconds	%	90	90	90	90	90
d. Severely Errored Seconds	%	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
e. Degraded Minutes	%	< 2	< 2	< 2	<2	<2
f. Bit Error Rate (BER)	errors/bits	1 X 10-5	5 X 10-6	1 X 10-6	5 X 10-7	1 X 10-7
g. Residual BER	errors/bits	1 X 10-5	5 X 10-6	1 X 10-6	5 X 10-7	1 X 10-7
h. Availability	%	99.4	99.4	99.4	99.4	99.4
i. LBCI	max occur	1 (<1/78 hrs)	1 (<1/78 hrs)	1 (<1/78 hrs)	1 (<1/78 hrs)	1 (<1/78 hrs)
j. Delay	milliseconds	300	300	300	300	300
k. Jitter	UI	n/a	n/a	n/a	n/a	n/a

Footnotes:

1 Satellite (one hop) earth terminal to earth terminal.

2 Objective values shown in parentheses.

Return to:
DISAC 300-175-9 Table T3.3
DISAC 300-175-9 Chapter 3
DISA Publications Listing
DISA Home Page

TABLE T3.4 **GIG TECHNICAL PARAMETERS FOR JRSC ECCM CIRCUITS**				
SERVICE	**UNIT OF MEASURE**	**J2[1]**	**J4[2]**	**J5[3]**
a. Measurement[4] Interval				
Black-to-Black	**Hours**	**2**	**2**	**2**
Red-to-Red	**Hours**	**1**	**N/A**	**1**
b. Bit error rate	**errors/bit**	**1 X 10^{-6}**	**1 X 10-7**	**1 X 10-5**
c. % Error Free Seconds	**%**	**(98.0)**	**(99.9)**	**(98.0)**
d. % Block Error[5]	**%**	**0.1**	**0.01**	**1.0**
Block Size	**Bits**	**1000**	**1000**	**1000**
Error Bits Per Block	**Bits**	**1**	**1**	**1**
e. LBCI	**max occur**	**<1 (1/24 hrs)**	**<1 (1/24 hrs)**	**<1 (1/24 hrs)**
f. SES	**total seconds**	**1 (2/24hrs)**	**1 (1/24hrs)**	**1 (2/24hrs)**
g. Looped sync Time[5]	**sec**	**DISA EP 2-87[5]**	**N/A**	**N/A**
h. Looped circuit Establishment time[5]	**sec**	**DISA EP 2-87[5]**	**N/A**	**DISA EP 2-87[5]**
I. Looped Transport Delay[5]	**sec**	**DISA EP 2-87[5]**	**N/A**	**DISA EP 2-87[5]**
h. Availability	**%**	**99.5**	**99.5**	**99**

Footnotes:

[1] J2 parameter is for 75 bps and 2400 bps long distance user-to-user shared access (multiple users sharing a single channel) conference mode circuits (AN/USC-28 modem), using a combination of terrestrial cable, fiber optic, and/or LOS radio carrier facilities in conjunction with the Electronic Counter Counter-Measure subsystem of the DSCD using one satellite link in normal and nuclear scintillation mitigation modes. The criteria must be met under stressed conditions. Therefore, the tests will be conducted with the DSCS satellite link adjusted to simulate threat level jamming; and with nuclear scintillation effects simulated for mitigated links. The tests shall be conducted from both Black and Red patch panels to a loopback at the satellite, unless specified otherwise.

[2] J4 parameter is for terrestrial extension circuits from the user facility TCF/PTF to the SATCOM Terminal TCF/PTF, using a combination of cable, fiber optic, and/or LOS radio carrier facilities. The circuits are either carried individually over the terrestrial extension or multiplexed. The testing is to be conducted end-to-end (user TCF/PTF-to-SATCOM-TCF/PTF).

[3] J5 parameter is for 75 bps to 4800 bps non-conferencing (AN/USC-28 and OM-55 modems) long distance user circuits (to include broadcast circuits) using a combination of terrestrial cable, fiber optic, and/or LOS radio carrier facilities in conjunction with the Electronic counter counter-Measure subsystem of the DSCD using one or more satellite links. Included are full-period and partial-period circuits in normal and nuclear scintillation mitigation modes. The criteria must be met under stressed conditions. Therefore, the test will be conducted with the DCSC satellite link adjusted to simulate threat level jamming; and with nuclear scintillation effects simulated for mitigated links. The tests shall be conducted end-to-end from both Black and Red patch panels, unless specified otherwise.

[4] Measurement interval is extended to 24 hours Black-to-Black and 8 hours Red-to-Red for DT&E, including IAT&E, and FOT&E.

[5] Refer to DISA Engineering Publication No. 2-87, JRSC System Specification (SECRET), for definitions, thresholds, and testing procedures for Looped Synchronization Time, Looped Circuit Establishment Time, and Looped Transport Delay specifications (which are classified), and Block Error Rate.

Return to:
DISAC 300-175-9 Table T3.4
DISAC 300-175-9 Chapter 3
DISA Publications Listing
DISA Home Page

TABLE T3.5 GIG TECHNICAL PARAMETERS FOR HIGH SPEED DIGITAL CIRCUITS USING T-CARRIER, EUROPEAN CEPT, OR SONET DIGITAL HIERARCHIES (TRAVERSING VARIOUS MEDIA)							
SERVICE[7]	**UNIT OF MEASURE**	**Y1**[1,2]	**Y2**[3]	**Y3**[4]	**Y4**[5]	**Y5**[6]	***Y***[7]
a. Digital Line Rate		**1.544 - 6.312Mb**	**1.544Mb**	**2.048Mb**	**1.544Mb**	**44.736 - 2488.32Mb**	***9953.280 Mb***
b. Measurement Interval	**hours**	**2**	**2**	**2**	**2**	**2**	***2***
c. % Error Free Seconds	**%**	**96.5**	**96.5**	**96.5**	**96.5**	**90**	***Stds***
d. Severely Errored Seconds	**%**	**< 0.2**	**< 0.2**	**< 0.2**	**< 0.2**	**< 0.2**	***<0.2***
e. Degraded Minutes	**%**	**< 10**	**< 10**	**< 10**	**< 10**	**< 10**	***<10***
f. Bit Error Rate (BER)	**errors/ bits**	**1×10^{-7}**	**1×10^{-7}**	**1×10^{-7}**	**1×10^{-7}**	**1×10^{-7}**	***$1x10^{-12}$***
g. Residual BER	**errors/ bits**	**1×10^{-7}**	**1×10^{-7}**	**1×10^{-7}**	**1×10^{-7}**	**1×10^{-7}**	***$1x10^{-12}$***
h. Availability	**%**	**98.5**	**98.5**	**98.5**	**98.5**	**98.5**	***99.98***
i. LBCI	**max occur**	**1 (<4/24 hrs)**	**1 (<4/24 hrs)**	**1 (<4/24 hrs)**	**1 (<4/24 hrs)**	**1 (<4/24 hrs)**	***1 (<4/24 hrs)***
j. Delay **All terrstrial** **1 satellite hops** **2 satellite hops**	**milliseconds**	**125** **300** **600**	**125** **300** **600**	**125** **300** **600**	**125** **300** **600**	**125** **300** **600**	***125*** ***300*** ***600***
k. Jitter	**UI**	**(See ITU-T Rec. G.924)**	**(See ITU-T Rec. G.824)**	**(See ITU-T Rec. G.823)**	**(See ITU-T Rec. G.824)**	**(See ITU-T Rec. G.824)**	***< 0.01UI rms***

Footnotes:

1 Multiplexer rate (traversing various transmission media).

2 AN/FCC-98, CY-104, 2.048 Mbps, and other rates up to 6.312 Mbps.

[3] Bell System Technical Reference 41451 (PCM-24 IST, CONUS lease).

[4] PCM-30 (2.048 Mbps) complying with ITU-T G.732 (PCM-30 IST).

[5] This includes DSN PCM-24 interswitch trunks (PCM-24 IST, Gov't owned).

[6] T-3 multiplex rate through OC-48 SONET rate.

[7] J2 parameter is for 75 bps and 2400 bps long distance user-to-user shared access (multiple users sharing a single channel) conference mode circuits (AN/USC-28 modem), using a combination of terrestrial cable, fiber optic, and/or LOS radio carrier facilities in conjunction with the Electronic Counter Counter-Measure subsystem of the DSCD using one satellite link in normal and nuclear scintillation mitigation modes. The criteria must be met under stressed conditions. Therefore, the tests will be conducted with the DSCS satellite link adjusted to simulate threat level jamming; and with nuclear scintillation effects simulated for mitigated links. The tests shall be conducted from both Black and Red patch panels to a loopback at the satellite, unless specified otherwise.

Return to:
DISAC 300-175-9 Table T3.5
DISAC 300-175-9 Chapter 3
DISA Publications Listing
DISA Home Page

TABLE T3.6 **DATA BLOCK SIZE SONET/SDH TESTING**					
Parameter Code	**Y6**	**Y7**	**Y8**	***Y9***	***Y10***
Rate Mbit/s	**51.84 (STS-1)**	**155.52 (STS_3c)**	**622.08 (STS-12c)**	***2488.32 (STS-48)***	***9953.28 (STS-192)***
Bits/block	**6,264**	**18,92**	**75,168**	***300,672***	***1,202,688***

Return to:
DISAC 300-175-9 Table T3.6
DISAC 300-175-9 Chapter 3
DISA Publications Listing
DISA Home Page

TABLE T3.7 **SONET/SDH LONG TERM ACCURACY OBJECTIVES**

Segment	Parameter	Y6 51.84 Mbit/s (STS-1)	Y7 155.52 Mbit/s (STS-3c/STM-1)	Y8 622.08 Mbit/s (STS-12c/STM-4)
End-to-End	BBER	(Note 1)	(Note 1)	10^{-5}
	% ES	0.25	0.5	(Note 2)
	% SES	0.035	0.035	0.035
Transit	BBER	(Note 1)	(Note 1)	5×10^{-6}
	% ES	0.125	0.25	(Note 2)
	% SES	0.025	0.025	0.025
Access	BBER	(Note 1)	(Note 1)	5×10^{-6}
	% ES	0.125	0.25	(Note 2)
	% SES	0.01	0.01	0.01

(There may be periods of time when these objectives are not met.)

NOTES.
1. BBER is only specified for rates above 160 Mbit/s.
2. ES processing should be implemented within any error performance measuring device operating at these rates for maintenance or monitoring purposes (including SONET/SDH section and line layer monitoring).

Return to:
DISAC 300-175-9 Table T3.7
DISAC 300-175-9 Chapter 3
DISA Publications Listing
DISA Home Page

TABLE T3.8 **SONET AVAILABILITY OBJECTIVES**						
Segment	**Parameter**	**Y6 51.84 Mbit/s (STS-1)**	**Y7 155.52 Mbit/s (STS-3c/STM-1)**	**Y8 622.08 Mbit/s (STS-12c/STM-4)**	***Y9 2488.32 Mbit/s (STS-48)***	***Y10 9953.28 Mbit/s (STS-192)***
End-to-End	**% Service Availability (Annual)**	**99.830**	**99.830**	**99.830**	***99.830***	***99.830***
	SIEC (Monthly)	**9**	**9**	**9**	***9***	***9***
Transit	**% Service Availability (Annual)**	**99.930**	**99.930**	**99.930**	***99.95***	***99.95***
	SIEC (Monthly)	**6**	**6**	**6**	***6***	***6***
Access	**% Service Availability (Annual)**	**99.950**	**99.950**	**99.950**	***99.98***	***99.98***
	SIEC (Monthly)	**6**	**6**	**6**	***6***	***6***

Return to:
DISAC 300-175-9 Table T3.8
DISAC 300-175-9 Chapter 3
DISA Publications Listing
DISA Home Page

TABLE T3.9 **SONET/SDH TEST CRITERIA**					
Parameter Code Bit rate	**Y6 51.84 Mbit/s (STS-1)**	**Y7 155.52 Mbit/s (STS-3c/STM-1)**	**Y8 622.08 Mbit/s (STS-2c/STM-4)**	***Y9 2488.32 Mbit/s (STS-48)***	***Y10 9953.28 Mbit/s (STS-192)***
Parameter	**ES, SES**	**ES, SES**	**BBE, SES**	***BBE, SES***	***BBE, SES***
Test stage duration Short Long	**1 Hour 24 hours**	**1 Hour 24 hours**	**1 Hour 24 hours**	***1 Hour 24 hours***	***1 Hour 24 hours***
Number of stages Short duration Long duration	**1 to 2 1**	**1 to 2 1**	**1 to 2 1**	***1 to 2 1***	***1 to 2 1***
Test limits	**Table T3.10**	**Table T3.11**	**Table T3.12**	***Table T3.13***	***Table T3.14***

Return to:
DISAC 300-175-9 Table T3.9
DISAC 300-175-9 Chapter 3
DISA Publications Listing
DISA Home Page

TABLE T3.10 **ACCEPTANCE AND REPAIR VERIFICATION TEST LIMITS FOR 51.84 Mbit/s SONET SERVICE, Y6 (STS-1)**

Parameter Limit for:	Short duration test (1 hour stages)				Long duration test (24 hour)	
	ES		SES		ES	SES
	1 hour	2 hour	1 hour	2 hour	24 hours	24 hours
End-to-End	≤6	≤12	0	<2 (Note 1)	≤150	≤20
Transit	≤3	≤6	0	≤2 (Note 1)	≤75	≤14
Access	≤3	≤6	0	≤2 (Note 1)	≤75	≤5

NOTES
1. Accept at 2 only if the cause of the SES is identified as an isolated event.
2. This standard does not provide trouble verification test limits.

Return to:
DISAC 300-175-9 Table T3.10
DISAC 300-175-9 Chapter 3
DISA Publications Listing
DISA Home Page

TABLE T3.11 **ACCEPTANCE AND REPAIR VERIFICATION TEST LIMITS FOR 155.52 Mbit/s SONET/SDH SERVICE, Y7 (STS-3c/STM-1)**

Parameter Limit for:	Short duration test (1 hour stages)				Long duration test (24 hour)	
	ES		SES		ES	SES
	1 hour	2 hour	1 hour	2 hour	24 hours	24 hours
End-to-End	≤12	≤24	0	≤2 (Note 1)	≤300	≤20
Transit	≤6	≤12	0	≤2 (Note 1)	≤150	≤14
Access	≤6	≤12	0	≤2 (Note 1)	≤150	≤5

NOTES
1. Accept at 2 only if the cause of the SES is identified as an isolated event.
2. This standard does not provide trouble verification test limits.

Return to:
DISAC 300-175-9 Table T3.11
DISAC 300-175-9 Chapter 3
DISA Publications Listing
DISA Home Page

TABLE T3.12 **ACCEPTANCE AND REPAIR VERIFICATION TEST LIMITS FOR 6222.08 Mbit/s SONET/SDH SERVICE, Y8 (STS-12c/STM-4)**

Parameter Limit for:	Short duration test (1 hour stages)				Long duration test (24 hour)	
	ES		SES		ES	SES
	1 hour	2 hour	1 hour	2 hour	24 hours	24 hours
End-to-End	≤80	≤170	0	≤2 (Note 1)	≤5000	≤20
Transit	≤40	≤85	0	≤2 (Note 1)	≤2500	≤14
Access	≤40	≤85	0	≤2 (Note 1)	≤2500	≤5

NOTES
1. Accept at 2 only if the cause of the SES is identified as an isolated event.
2. This standard does not provide trouble verification test limits.

Return to:
DISAC 300-175-9 Table T3.12
DISAC 300-175-9 Chapter 3
DISA Publications Listing
DISA Home Page

TABLE T3.13 ACCEPTANCE AND REPAIR VERIFICATION TEST LIMITS FOR 2488.32 Mbit/s SONET/SDH SERVICE, Y9 (STS-48)

Parameter Limit for:	Short duration test (1 hour stages)				Long duration test (24 hour)	
	ES		SES		ES	SES
	1 hour	2 hour	1 hour	2 hour	24 hours	24 hours
End-to-End	≤ 80	≤ 170	0	≤ 2 (Note 1)	≤ 5000	≤ 20
Transit	≤ 40	≤ 85	0	≤ 2 (Note 1)	≤ 2500	≤ 14
Access	≤ 40	≤ 85	0	≤ 2 (Note 1)	≤ 2500	≤ 5

NOTES
1. Accept at 2 only if the cause of the SES is identified as an isolated event.
2. This standard does not provide trouble verification test limits.

Return to:
DISAC 300-175-9 Table T3.13
DISAC 300-175-9 Chapter 3
DISA Publications Listing
DISA Home Page

TABLE T3.14 ***ACCEPTANCE AND REPAIR VERIFICATION TEST LIMITS FOR 9953.28 Mbit/s SONET/SDH SERVICE, Y10 (STS-192)***

Parameter Limit for:	Short duration test (1 hour stages)				Long duration test (24 hour)	
	ES		SES		ES	SES
	1 hour	2 hour	1 hour	2 hour	24 hours	24 hours
End-to-End	≤80	170	0	2 (Note 1)	5000	20
Transit	40	85	0	2 (Note 1)	2500	14">
Access	40	85	0	2 (Note 1)	2500	5

NOTES

1. **Accept at 2 only if the cause of the SES is identified as an isolated event.**
2. **This standard does not provide trouble verification test limits.**

Return to:
DISAC 300-175-9 Table T3.14
DISAC 300-175-9 Chapter 3
DISA Publications Listing
DISA Home Page

TABLE T3.15 **PREVALENT ITU STANDARDS FOR VARIOUS WAVELENGTHS AND DATA RATES**

Data Rate Mbps	Fiber Media	Wavelength nm	Typical Line Length	Transmit Power	Receive Power	Path Attenuation
155.2 622.08	MM	1270 – 1380	To STM12 – 2 km OC12c/STM4c – 500 m	-14 to –20 dBm -14 to –20 dBm	-14 to –30 dBm -14 to –26 dBm	0 to 10 dB 0 to 6 dB
155.52 622.08	SM	1261 – 1360 (OC3c/STM1) 1274 – 1356 (OC12c/STM4c)	15 km (Intermediate reach)	-8 to –15 dBm	-8 to –28 dBm	0 to 12 dB
2488	SM (STM16c)	1266 – 1360 (Short reach) 1280 – 1335 (Long reach)	2 km (Short reach) 40 km (Long reach)	-3 to –10 dBm +3 to 2 dBm	-3 to –18 dBm -9 to –27 dBm	0 to 7 dB 10 to 24 dB
155.52	MM	1270 – 1380	2 km	-14 to –21 dBm	-14 to –29 dBm	0 to 6 dB
622.08	SM	1274 – 1356 (Intermediate reach) 1480 – 1580 (Long reach)	15 km (Intermediate reach) 60 km (Long reach)	-8 to –15 dBm +2 to –3 dBm (Long reach)	-8 to –28 dBm -8 to –28 dBm (Long reach)	0 to 12 dB 10 to 24 dB
10 Gb*	SM or DWDM	1530 – 1560 (Transmit) 1480 – 1580 (Receive)	160 km (Very Long Reach) Hitachi	-1 to 2 dBm	-14 to 0.0 dBm	0 to 2 dB BER=10^{-12}

Return to:
DISAC 300-175-9 Table T3.15
DISAC 300-175-9 Chapter 3
DISA Publications Listing
DISA Home Page

C4. **CHAPTER 4. THRESHOLDS FOR GIG PERFORMANCE MONITORING SYSTEMS**

C4.1 **General.** This chapter establishes thresholds for use with in-service performance monitoring systems currently in use with GIG digital transmsission and switching systems. Tables T4.1, T4.2, and T4.3 establish threshold parameters for DPAS, TRAMCON, and DSN switches respectively. Thresholds for multiplexer equipment which uses the Extended Superframe Format (ESF) at the T-1 (Y1) digital rate are established in table T4.4. Performance monitoring thresholds for IDNX or Timeplex multiplex equipment using a T-1 Trunk interface can be extrapolated from values of corresponding parameters found in table T4.4 for ESF multiplex equipment.

C4.2 ***THRESHOLDS.*** Thresholds established in the following tables formalize previously provided guidance for in service performance monitoring thresholds. It is not intended for these monitoring parameter thresholds to usurp or replace parameter thresholds established for out of service testing of digital GIG parameter codes established elsewhere in this circular, but to supplement their use with available GIG performance monitoring systems.

Return to:
Top of DISAC 300-175-9 Chapter 4
DISAC 300-175-9 Basic
DISAC 300-175-9 Contents
DISAC 300-175-9 Chapter 1
DISAC 300-175-9 Chapter 2
DISAC 300-175-9 Chapter 3
DISAC 300-175-9 Chapter 4
DISAC 300-175-9 Chapter 5
DISAC 300-175-9 Supplement 1
DISAC 300-175-9 Supplement 2
DISAC 300-175-9 Supplement 3
DISA Publications Listing
DISA Home Page

TABLE T4.1 **PERFORMANCE MONITORING THRESHOLDS FOR DPAS**			
Parameter	**Framing Format**	**Threshold**	***Alarm Type***
a. Bit Error rate	**ALL** **ALL**	**10-3** **10-6**	**Major**[1] **Minor**[2]
b. Change-of-Frame Alignment[3]	**ALL** **ALL**	**511**[4] **17**[4]	**Major**[1] **Minor**[2]
c. Frame Slip[3]	**ALL** **ALL**	**255**[4] **4**[4]	**Major**[1] **Minor**[2]
d. Errored Seconds	**ESF**	**864**[4]	**Message**[5]
e. Severely Errored Seconds	**ESF**	**225**[4]	**Message**[5]
f. CRC-6	**ESF**	**None**	**On-Demand**[6]
g. Out-of-Frame[3]	**ALL**	**None**	**On-Demand**[6]
h. Bipolar Violations[7]	**ALL**	**None**	**On-Demand**[6]

[1] Major alarm thresholds are set at values where service is unacceptable. These degradations are serious enough to cause the di-group to go into local alarm on the DPAS, thereby automatically removing that di-group from service.

[2] Minor alarm thresholds are degradation values at which the di-group should have maintenance performed at hte earliest opportunity.

[3] One or more events in 10 seconds count as one event.

[4] Maximum number of counts per 24 hours.

[5] Autonomously generated message by DPAS to the DPAS Control Terminal (DCT).

[6] Information stored in the DPAS internal registers and requires input commands from the DPAS control terminal to obtain the information.

[7] One or mor BPV's in 3 mS count as one event.

Return to:
DISAC 300-175-9 Table T4.1
DISAC 300-175-9 Chapter 4
DISA Publications Listing
DISA Home Page

TABLE T4.2 **PERFORMANCE MONITORING THRESHOLDS FOR TRAMCON**

Parameter	Framing Format	Threshold	Alarm Type
a. Received Signal Level [1] (RSL) Received Signal Level [2] (RSL)	dBm	-49 -68 -60 -72	Amber Red Amber Red
b. Signal Quality Monitor[2] (SQM)	Volts	5.00 3.00	Amber Red
c. Frame Error Count[3] (FEC) DRAMA Radio FCC-99	Count/Day	 2238 4476	N/A
d. Frame Error Seconds[3] DRAMA Radio FCC-99	Seconds/Day	 0.25 0.5	N/A

Footnotes:

[1] Note these parameter thresholds only apply to AN/FCC-170 (V11), AN/FCC-171 (V10), and AN/FCC-173 (V10). See DISAC 310-70-1, DISA-EUR Supplement 2 for more detail.

[2] Note these parameter thresholds only apply to AN/FCC-162 (165). See DISAC 310-70-1, DISA-EUR Supplement 2 for more detail.

[3] Normalized to Errored Second Criteria for 1.544 Mbps ESF T-1.

Return to:
DISAC 300-175-9 Table T4.2
DISAC 300-175-9 Chapter 4
DISA Publications Listing
DISA Home Page

TABLE T4.3 **PERFORMANCE MONITORING THRESHOLDS FOR DSN SWITCHES**

Parameter	*Framing Format*	Threshold	Alarm Type
a. Bit Error rate	ALL ALL	10-3 10-6	Major[1] Minor[2]
b. Change-of-Frame Alignment[3]	ALL ALL	511[4] 17[4]	Major[1] Minor[2]
c. Frame Slip[5]	ALL ALL	255[4] 4[4]	Major[1] Minor[2]
d. Errored Seconds	ESF	864[4]	Message[6]
e. Severely Errored Seconds	ESF	225[4]	Message[6]
f. CRC-6	ESF	None	On-Demand[7]
g. Out-of-Frame[5]	ALL	None	On-Demand[7]
h. Bipolar Violations[8]	ALL	None	On-Demand[7]

[1] Major alarm thresholds are set at values where service is unacceptable. These degradations are serious enough to cause the di-group to go into local alarm on the DPAS, thereby automatically removing that di-group from service.

[2] Minor alarm thresholds are degradation values at which the di-group should have maintenance performed at the earliest opportunity.

[3] One or more events in 10 seconds count as one event.

[4] Maximum number of counts per 24 hours.

[5] One or more events in 10 seconds count as one event.

[6] Autonomously generated message by DPAS to the DPAS Control Terminal (DCT).

[7] Information stored in the DPAS internal registers and requires input commands from the DPAS control terminal to obtain the information.

[8] One or mor BPV's in 3 mS count as one event.

Return to:
DISAC 300-175-9 Table T4.3
DISAC 300-175-9 Chapter 4

[DISA Publications Listing](#)
[DISA Home Page](#)

TABLE T4.4 **PERFORMANCE MONITORING THRESHOLDS FOR EQUIPMENT USING EXTENDED SUPERFRAM SIGNALLING (ESF).**			
Parameter	**Framing Format**	**Threshold**	**Alarm Type**
a. Change-of-Frame Alignment [1]	**ESF**	**511** [2] **17** [2]	**Major** [3] **Minor** [4]
b. Errored Seconds	**ESF**	**864** [2]	**Message** [5]
c. Severely Errored Seconds	**ESF**	**225** [2]	**Message** [5]
d. Out-of-Frame [1]	**ESF**	**None**	**On-Demand** [5]
e. Unavailable Seconds (Failed Seconds [FS]) [6]	**ESF**	**43** [2]	**On-Demand** [5]

[1] One or more events in 10 seconds count as one event.

[2] Maximum number of counts per 24 hours.

[3] Major alarm thresholds are set at values where service is unacceptable. These degradations are serious enough to cause the di-group to go into local alarm on the DPAS, thereby automatically removing that di-group from service.

[4] Minor alarm thresholds are degradation values at which the di-group should have maintenance performed at hte earliest opportunity.

[5] Autonomously generated message by DPAS to the DPAS Control Terminal (DCT).

[6] Failed Seconds based upon Availability criteria defined in ITU-T G.826 for a 24 hour period.

Return to:
DISAC 300-175-9 Table T4.4
DISAC 300-175-9 Chapter 4
DISA Publications Listing
DISA Home Page

C5. CHAPTER 5. TELEPHONE SIGNALING STANDARDS

C5.1 **Telephone Signaling Parameters.** Telephone signaling tone power levels for operations over communications circuits, links, equipment, etc., in the GIG will be as specified herein. These include single frequency (SF) tones, dial tones, ring back tones, preempt tones, busy tones, various other supervisory tones, dual-tone multifrequency (DTMF) signals, and multifrequency (MF) signals.

C5.1.1 **Standard DSN Telephone Signaling Tone Power Levels.** Standard signaling and supervisory tone power levels for operation of DSN in the GIG are specified in table T5.1.

C5.1.2 **Standard Telephone Signaling Tone Power Levels.** Standard telephone signaling and supervisory tone power levels for all other services provided by the GIG and not covered previously are specified in subparagraph 5.3.1.1 of reference 4.10.

C5.1.3 **Nonstandard Telephone Signaling Tone Power Levels.** Signaling and supervisory signals (including signaling impulses) interfacing the GIG from commercial or non-GIG facilities will be engineered to comply with the levels in subparagraph 5.3.1.2 of reference 4.10. Interfacing signaling tones and associated impulses should not exceed 0 dBm0. If the peak levels of a circuit consistently exceed 0 dBm0, the technical controller will investigate the cause to determine if the circuit net gain or loss is correct. If a balanced high impedance oscilloscope is used, procedures contained in reference 4.1 will be used. The peak-to-peak voltage stated in reference 4.4 will not be exceeded. DISA access facilities which operate at higher levels will be equipped with the GIG standard passive peak limiter as described in reference 4.11.

Return to:
Top of DISAC 300-175-9 Chapter 5
DISAC 300-175-9 Basic
DISAC 300-175-9 Contents
DISAC 300-175-9 Chapter 1
DISAC 300-175-9 Chapter 2
DISAC 300-175-9 Chapter 3
DISAC 300-175-9 Chapter 4
DISAC 300-175-9 Supplement 1
DISAC 300-175-9 Supplement 2
DISAC 300-175-9 Supplement 3

[DISA Publications Listing]
[DISA Home Page]

---

cio-pubs@disa.mil - Last Change: 24 July 2006

TABLE T5.1 **STANDARD DSN TELEPHONE SIGNALING TONE POWER LEVELS**

SIGNAL	COMPOSITE POWER LEVEL
1. Dial tone. [1] 350 Hz + 440 Hz mixed.	-10 dBmo ± 3 dB
2. Dial tone. 600 Hz amplitude modulated at 120 Hz.	-18 dBmo ± 3 dB
3. Busy tone. [1] (line busy) 480 Hz + 620 Hz mixed.	-21 dBmo ± 3 dB
4. No circuit tone[1] (trunk busy). 480 Hz + 620 Hz mixed.	-21 dBmo ± 3 dB
5. No circuit tone (trunk busy). 600 Hz amplitude modulated at 120 Hz.	-18 dBmo ± 3 dB
6. Busy tone (line busy). 600 Hz amplitude modulated at 120 Hz.	-18 dBmo ± 3 dB
7. Reorder tone. [1] 480 Hz + 620 Hz mixed.	-21 dBmo ± 3 dB
8. Audible ringing tone.[1] 440 Hz + 480 Hz mixed.	-13 dBmo ± 3 dB
9. Audible ringing tone (ringback). 400 Hz amplitude modulated at 40 Hz.	-18 dBmo ± 3 dB
10. Preemption tone. 440 Hz + 620 Hz mixed.	-15 dBm0 ± 3 dB
11. Conference notification tone.[1] 852 Hz + 1336 Hz alternating.	-21 dBm0 ± 3 dB
12. Permanent tone. 350 Hz + 480 Hz. mixed.	-14 dBmo ± 3 dB
13. Permanent tone. 600 hz amplitude modulated at 120 hz.	-18 dBm0 ± 3 dB
14. Multifrequency (MF) signaling tones (2/6).	-3 dBm0 ± 1 dB
15. Dual tone multifrequency (DTMF) tones.	-11 to -3 dBm0
16. Single frequency (SF) signaling, 2600 Hz. a. Pulsing b. Idle.	 -8 dBm0 ± 1.5 dB -20 dBm0 ± 1.5 dB
17. Dual frequency (DF) signaling, 2600 Hz and 2800 Hz. a. 2600 Hz and 2800 Hz pulsing. b. 2600 Hz idle.	 -8dBm0 ± 1.5 dB -20 dBm0 ± 1.5 dB

Footnote:

[1] Indicates preferred signaling tone.

Return to:
DISAC 300-175-9 Table T5.1

[DISAC 300-175-9 Chapter 5](#)
[DISA Publications Listing](#)
[DISA Home Page](#)

DESCRIPTION OF GIG SERVICE

CIRCUIT PARAMETER CODE	DESCRIPTION OF SERVICE
C0	Nonsecure voice circuit. (32 kbps ADPCM or 64 kbps PCM) Facsimile transmission which can be accommodated over a voice grade channel with no special conditioning. If the required facsimile service (including telephoto) involves special channel conditioning, specific circuit parameters will be based on transmission means, circuit length, and characteristics of the equipment used to terminate the circuits. This is a service which may be specified whenever the circuit is to be terminated with modems employing adaptive equalizers. This service is normally obtained without special equalization equipment being introduced into the circuit.
C1	Voice grade access line. (32 kbps ADPCM or 32 kbps PCM) Interswitch trunk voice grade. Secure voice, operating at 2.4 through 4.8 kb/s (derived over analog channels). 300 through 4800 b/s. Includes card data or other service. (Derived over analog channels.)

C2	Interswitch special grade, not transoceanic. (regenerators at both ends)(64 kbps PCM ONLY)
	Interswitch trunk operating at 2.4 or 9.6 kb/s providing secure voice service. (This service is derived from the DSN.)
	Alternate voice/record service, including secure C2 voice or data, operating at rates from 2.4 up to 9.6 kb/s.
	2.4 to 9.6 kb/s alternate voice/record service.
C3	Circuit parameter code C3 is not available for user-to-user service, but was developed to permit interconnecting up to five tandem C3 links while still obtaining C2 circuit performance on an end-to-end basis. (64 kbps PCM ONLY)
	Special grade, alternate voice/record access from DSN switch.
C4	Interswitch special grade, not transoceanic (regenerators at one end). (64 kbps PCM ONLY)
CT	Interswitch special grade, alternate voice/record, not transoceanic. (64 kbps PCM ONLY)
C5	C5 conditioning is available for two-point channels where both customer's premises are located in the CONUS. This conditioning is for the additional control of attenuation distortion and envelope delay distortion. (64 kbps PCM ONLY)
D1	This is an optional service that may be specified whenever the circuit is to be terminated with modems employing

multilevel modulation techniques that require above average signal-to-noise and linearity characteristics. Provision of this service normally requires special routing of the circuit over "hand-selected" transmission channels.

D6	This is an optional service that may be specified whenever the circuit is to be terminated with modems employing multilevel modulation techniques which do not provide any compensating adaptive equalization techniques. These are typically older modems which require the highest level of signal to noise linearity, and phase characteristics for proper operation over the longhaul channel. Additionally, local access links will require C1 and D1 conditioning in order to support the end-to-end performance. D6 conditioning is available only on 2-point non-switched services. NOTE: For those circumstances where the carrier cannot provide D6 (or sometimes even D1), substitute "data capability" to obtain the best available parameter.
G1	Secure Voice Terminal, 56 kb/s baseband, over metallic facilities without regenerators.
G2	Secure Voice Terminal, 56 kb/s baseband, over metallic facilities without regenerators.
G3	Secure Voice Terminal, 56 kb/s baseband, over metallic facilities without regenerators.
J1	Digital data service (access).

	45 b/s through 14.4 kb/s access/interswitch line. (Derived over digital channels.) Subsystem (WINCS)
	0 through 64 kb/s digital data service. (Derived over digital channels.)
J2	Secure voice conference at 2.4 kb/s (SCP, BCC, & SCIS)
	Secure data conference at 2.4 kb/s (BCC)
J3	Synchronous 56/64 kb/s digital circuit supporting WWMCCS Intercomputer Network Communications.
	Digital package system 64kb/s through 1536 kb/s.
J4	JRSC Digital Package (AN/FCC-100 Trunk).
	Terrestrial extension circuits (individual or multiplexed) from SATCOM to user TCF
J5	75 to 4800 bps JRSC digital data service (non-conferencing)
M1	Interswitch trunk international voice grade. (32 kbps ADPCM or 64 kbps PCM)
	ITU-T parameter M1040. For use with telephone circuits that do not require special characteristics to be provided by U.S. International Carriers.
	ITU-T parameter M1040. Has been adapted for telephone circuits that do not require special characteristics that are provided by U.S. International Carriers.
M2	ITU-T parameter M1025. For use with modems which contain equalizers. 3H has been adapted for use in lieu of

	parameters CO and C1 for service provided by U.S. International Carriers. (32 kbps ADPCM or 64 kbps PCM)
	ITU-T parameter M1025. For use with modems which contain equalizers. It has been adapted for use in lieu of parameters C0 and C1 for service provided by U.S. International Carriers.
M3	Interswitch trunk international special grade. (64 kbps PCM ONLY)
	ITU-T parameter M1020. For use with modems that do not contain equalizers. 3G has been adapted for use in lieu of parameters C2, D1, C1, and C3 for service provided by U.S. International Carriers.
	ITU-T parameter M1020. For use with modems that do not contain equalizers. It has been adapted for use in lieu of parameters C2, D1, C1, and C3 for service provided by U.S. International Carriers.
N1	0 through 4.8 kb/s async service. (Derived over digital channels.)
R1	Digital radio system operating at 1.544 Mb/s through 90 Mb/s. (Not satellite or tropo.)
R2	A single Digital Fiber Optic or Metallic Cable multiplex link operating at rates from 1.544 Mb/s (T1) through 2488.32 Mb/s (OC-48).(Not satellite or tropo.)
R3	Digital radio/multiplex operating at 1.544 Mb/s through 10 Mb/s. (Tropo.)

S1 A Single Digital satellite radio/multiplex link.
Bit-error-rate< 1X110-5

S2 A Single Digital satellite radio/multiplex link.
Bit-error-rate< 5X10-6

S3 A Single Digital satellite radio/multiplex link.
Bit-error-rate< 1X10-6

S4 A Single Digital satellite radio/multiplex link.
Bit-error-rate< 5X10-7

S5 A Single Digital satellite radio/multiplex link.
Bit-error-rate< 1X10-7

W1 Circuits supporting WWMCCS at rates of 19.2 kb/s to 50kb/s. Synchronous or isochronous mode.

Y1 1.544 through 6.312 Mb/s digital service (Derived over digital channels.)

Digital package system 1.544 through 6.312 Mb/s

Y2 Interswitch service PCM-24.(CONUS LEASE)

1.544 Mb/s basic digroup Time Division Multiplexing using commercial "D Type" PCM terminals. This service is often provided via commercial DS1 or Data Under Voice (DUV) transmission systems. The PCM terminals normally derive 24 telephone-type channels, although lower speed data channels may be substituted for some of the voice channels. The terminals used to derive the service are often dubbed "PCM 24" terminals and may consist of any of the commercial "D Type" banks (D1,D2,D3,D4, etc.)[1]

[1] Refer to Bell Systems Technical Reference 41451.

The use of this referencedoes not constitute endorsement or acceptance of the service quality standards contained therein as adequate to meet Government service requirements.

Y2	1.544 Mb/s service. Provides for point-to- point, full duplex transmission of serial bipolar isochronous pulses compatible with Bell System Technical Reference 41451.
Y3	Interswitch service PCM-30 2.048 Mb/s basic digroups Time Division Multiplexing using PCM-30 channel terminal equipment complying with CCITT G.732. This equipment provides 30 voice channels. This is an end-to-end service. 2.048 Mb/s basic digroups Time division multiplexing using PCM-30 channel terminal equipment complying with CCITT G.732. This equipment provides 30 voice channels. This is an end-to-end service.
Y4	Interswitch service PCM-24.(GOV'T OWNED)
Y5	44.736 Mb/s service using DS-3
Y6	SONET STS-1 service at 51.84 Mbits/s
Y7	SONET/SDH STS-3c/STM-1 service at 155.52 Mbits/s
Y8	SONET/SDH STS-12C/STM-4 service at 6222.08 Mbits/s

cio-pubs@disa.mil - Last Change: 24 July 2006

Supplement 2: DISAC 300-175-9

ITU-T RECOMMENDATION G.826 DEFINITION OF AVAILABILITY

A period of unavailable time begins when the bit error ratio (BER) in each second is worse than 10^{-3} for a period of ten consecutive seconds. These ten seconds are considered to be unavailable time. The period of unavailable time terminates when the BER in each second is better than 10^{-3} for a period of ten consecutive seconds. These ten seconds are considered to be available time.

Return to:
Top of DISAC 300-175-9 Supplement 2
DISAC 300-175-9 Basic
DISAC 300-175-9 Contents
DISAC 300-175-9 Chapter 1
DISAC 300-175-9 Chapter 2
DISAC 300-175-9 Chapter 3
DISAC 300-175-9 Chapter 4
DISAC 300-175-9 Chapter 5
DISAC 300-175-9 Supplement 1
DISAC 300-175-9 Supplement 3
DISA Publications Listing
DISA Home Page

---

cio-pubs@disa.mil - Last Change: 24 July 2006

Supplement 3: DISAC 300-175-9

NOISE POWER CONVERSION TABLE

				Weighting	Weighting	Weighting	Weighting	
Pico-watts	**Milli-watts**	**dBm**	**NEPERS**	**C-1004 Hz dBrnC**	**C-0-3 kHz dBrnC**	**F1A 1004 Hz dBa**	**F1A 0-3 kHz dBa**	**Psopho-metric 804 Hz dBm**
1.0	10^{-9}	-90	-10.4	0	n/a	n/a	n/a	-89
1.3	0.13×10^{-8}	-89	-10.2	1	n/a	n/a	n/a	-88
1.6	0.16×10^{-8}	-88	-10.1	2	0	n/a	n/a	-87
2.0	0.20×10^{-8}	-87	-10.0	3	1	n/a	n/a	-86
2.5	0.25×10^{-8}	-86	-9.90	4	2	n/a	n/a	-85
3.2	0.32×10^{-8}	-85	-9.78	5	3	0	n/a	-84
4.0	0.40×10^{-8}	-84	-9.67	6	4	1	n/a	-83
5.0	0.50×10^{-8}	-83	-9.55	7	5	2	n/a	-82
6.3	0.63×10^{-8}	-82	-9.44	8	6	3	0	-81
7.9	0.79×10^{-8}	-81	-9.32	9	7	4	1	-80
10	10^{-8}	-80	-9.21	10	8	5	2	-79
1.3×10	0.13×10^{-7}	-79	-9.09	11	9	6	3	-78
1.6×10	0.16×10^{-7}	-78	-8.98	12	10	7	4	-77
2.0×10	0.20×10^{-7}	-77	-8.86	13	11	8	5	-76
2.5×10	0.25×10^{-7}	-76	-8.75	14	12	9	6	-75
3.2×10	0.32×10^{-7}	-75	-8.63	15	13	10	7	-74
4.0×10	0.40×10^{-7}	-74	-8.52	16	14	11	8	-73
5.0×10	0.50×10^{-7}	-73	-8.4	17	15	12	9	-72
6.3×10	0.63×10^{-7}	-72	-8.29	18	16	13	10	-71
7.9×10	0.79×10^{-7}	-71	-8.17	19	17	14	11	-70
10^2	10^{-7}	-70	-8.06	20	18	15	12	-69
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	0.79×10^{-6}	-61	-7.02	29	27	24	21	-60
10^3	10^{-6}	-60	-6.91	30	28	25	22	-59

$1.3x10^{3}$	$0.13x10^{-5}$	-59	-6.79	31	29	26	23	-58
$1.6x10^{3}$	$0.16x10^{-5}$	-58	-6.68	32	30	27	24	-57
$2.0x10^{3}$	$0.20x10^{-5}$	-57	-6.56	33	31	28	25	-56
$2.5x10^{3}$	$0.25x10^{-5}$	-56	-6.45	34	32	29	26	-55
$3.2x10^{3}$	$0.32x10^{-5}$	-55	-6.33	35	33	30	27	-54
$4.0x10^{3}$	$0.40x10^{-5}$	-54	-6.22	36	34	31	28	-53
$5.0x10^{3}$	$0.50x10^{-5}$	-53	-6.10	37	35	32	29	-52
$6.3x10^{3}$	$0.63x10^{-5}$	-52	-5.99	38	36	33	30	-51
$7.9x10^{3}$	$0.79x10^{-5}$	-51	-5.87	39	37	34	31	-50
10^{4}	10^{-5}	-50	-5.76	40	38	35	32	-49
$1.3x10^{4}$	$0.13x10^{-4}$	-49	-5.64	41	39	36	33	-48
$1.6x10^{4}$	$0.16x10^{-4}$	-48	-5.52	42	40	37	34	-47
$2.0x10^{4}$	$0.20x10^{-4}$	-47	-5.41	43	41	38	35	-46
$2.5x10^{4}$	$0.25x10^{-4}$	-46	-5.29	44	42	39	36	-45
$3.2x10^{4}$	$0.32x10^{-4}$	-45	-5.18	45	43	40	37	-44
$4.0x10^{4}$	$0.40x10^{-4}$	-44	-5.06	46	44	41	38	-43
$5.0x10^{4}$	$0.50x10^{-4}$	-43	-4.95	47	45	42	39	-42
$6.3x10^{4}$	$0.63x10^{-4}$	-42	-4.83	48	46	43	40	-41
$7.9x10^{4}$	$0.79x10^{-4}$	-41	-4.72	49	47	44	41	-40
10^{5}	10^{-4}	-40	-4.60	50	48	45	42	-39
$1.3x10^{5}$	$0.13x10^{-3}$	-39	-4.49	51	49	46	43	-38
$1.6x10^{5}$	$0.16x10^{-3}$	-38	-4.37	52	50	47	44	-37
$2.0x10^{5}$	$0.20x10^{-3}$	-37	-4.26	53	51	48	45	-36
$2.5x10^{5}$	$0.25x10^{-3}$	-36	-4.14	54	52	49	46	-35
$3.2x10^{5}$	$0.32x10^{-3}$	-35	-4.03	55	53	50	47	-34
$4.0x10^{5}$	$0.40x10^{-3}$	-34	-3.91	56	54	51	48	-33
$5.0x10^{5}$	$0.50x10^{-3}$	-33	-3.80	57	55	52	49	-32
$6.3x10^{5}$	$0.63x10^{-3}$	-32	-3.68	58	56	53	50	-31
$7.9x10^{5}$	$0.79x10^{-3}$	-31	-3.57	59	57	54	51	-30
10^{6}	10^{-3}	-30	-3.45	60	58	55	52	-29
$1.3x10^{6}$	$0.13x10^{-2}$	-29	-3.34	61	59	56	53	-28
$1.6x10^{6}$	$0.16x10^{-2}$	-28	-3.22	62	60	57	54	-27
$2.0x10^{6}$	$0.20x10^{-2}$	-27	-3.11	63	61	58	55	-26
$2.5x10^{6}$	$0.25x10^{-2}$	-26	-2.99	64	62	59	56	-25
$3.2x10^{6}$	$0.32x10^{-2}$	-25	-2.88	65	63	60	57	-24
$4.0x10^{6}$	$0.40x10^{-2}$	-24	-2.76	66	64	61	58	-23
$5.0x10^{6}$	$0.50x10^{-2}$	-23	-2.65	67	65	62	59	-22

$6.3x10^6$	$0.63x10^{-2}$	-22	-2.53	68	66	63	60	-21
$7.9x10^6$	$0.79x10^{-2}$	-21	-2.42	69	67	64	61	-20
10^7	10^{-2}	-20	-2.30	70	68	65	62	-19
$1.3x10^7$	$0.13x10^{-1}$	-19	-2.19	71	69	66	63	-18
$1.6x10^7$	$0.16x10^{-1}$	-18	-2.07	72	70	67	64	-17
$2.0x10^7$	$0.20x10^{-1}$	-17	-1.96	73	71	68	65	-16
$2.5x10^7$	$0.25x10^{-1}$	-16	-1.84	74	72	69	66	-15
$3.2x10^7$	$0.32x10^{-1}$	-15	-1.73	75	73	70	67	-14
$4.0x10^7$	$0.40x10^{-1}$	-14	-1.61	76	74	71	68	-13
$5.0x10^7$	$0.50x10^{-1}$	-13	-1.50	77	75	72	69	-12
$6.3x10^7$	$0.63x10^{-1}$	-12	-1.38	78	76	73	70	-11
$7.9x10^7$	$0.79x10^{-1}$	-11	-1.27	79	77	74	71	-10
10^8	10^{-1}	-10	-1.15	80	78	75	72	-9
$1.3x10^8$	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
$7.9x10^8$	0.79	-1	-0.115	89	87	84	81	0
10^9	1.0	0	0	90	88	85	82	+1