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ATIS-0100510.1999(R2013)

Digital Services for Rates Up to and Including DS3-Specifications

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American National Standard
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Network Performance Parameters for Dedicated Digital Services for Rates Up to and Including DS3 – Specifications

Secretariat

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Approved December 29, 1999

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Contents

Page

Foreword (This foreword is not part of American National Standard T1.510-1999.)

This American National Standard provides a standard for Dedicated Digital Communication Services specifications. This document provides numerical specifications and allocations for the parameters and tests discussed in a companion document.

These standards provide the means to verify the performance of dedicated digital services operating at 56/64 kbit/s, 1.544 Mbit/s and 44.736 Mbit/s rates. Services at multiples (N) of 64 kbit/s are not covered in this standard.

This standard was prepared by Working Group T1A1.3 of Committee T1.

There are four annexes in this standard. Annexes A-D are informative and are not considered part of this standard.

Suggestions for improvement of this standard will be welcome. They should be sent to the Alliance for Telecommunications Industry Solutions, T1 Secretariat, 1200 G Street, NW, Suite 500, Washington DC 20005.

This standard was processed and approved for submittal to ANSI by the Accredited Standards Committee on Telecommunications, T1. Committee approval of this standard does not necessarily imply that all committee members voted for its approval. At the time it approved this standard, the T1 Committee had the following members:

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(R2013)

American National Standard
for Telecommunications –

Network Performance Parameters for Dedicated Digital Services for Rates Up to and Including DS3 – Specifications

1 Scope and purpose

This standard applies to Dedicated Digital Services operating at nominal rates of 56/64 kbit/s, 1.544 Mbit/s and 44.736 Mbit/s with objectives based on the longest and most complex circuits. Dedicated Digital Services are characterized by established connections (i.e., no access or disengagement functions). The framework for this standard is provided by a companion standard: T1.503-1996 “Network Performance Parameters for Dedicated Digital Services – Definitions and Measurement Methods.” The purpose of this standard is to provide values for the parameters defined in T1.503, to apportion these values among the network sections, and to specify procedures for their measurement. While the performance objectives are intended to apply to digital services in aggregate, it is recognized that such objectives may not be readily achieved by all of today’s individual service connections.

T1.503 describes the rationale for the list of parameters used in this standard. For a given service, only a subset of these listed parameters will be referenced. This standard provides the specific parameter value limits needed for evaluating service quality and should be considered when designing network systems and equipment

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this American National Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this American National Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

T1.231-1997, *Layer 1 in-service digital transmission performance monitoring*[1)]

T1.503-1996, *network performance parameters for dedicated digital services – Definitions and measurement methods*[1)]

ANSI/IEEE 1007-1992 (R1997), *Methods and equipment for measuring the transmission characteristics of pulse-code modulation (PCM) telecommunications circuits and systems*[1)]

[1)] For electronic copies of some standards, visit ANSI’s Electronic Standards Store (ESS) at www.ansi.org. For printed versions of all these standards, contact Global Engineering Documents, 15 Inverness Way East, Englewood, CO 80112-5704, (800) 854-7179.

3 Definitions

The definitions, which have been taken from various other standards where appropriate, have been abbreviated in some cases. In the context of this standard, the following definitions apply.

3.1 alarm indication signal (AIS): A signal transmitted in lieu of the normal signal to maintain transmission continuity and to indicate to the receiving equipment that there is a transmission interruption located either at the equipment originating the AIS or upstream of that equipment (see T1.231).

3.2 alternate mark inversion (AMI): A line code that employs a ternary signal to convey binary digits, in which successive binary ones are represented by signal elements that are normally of alternating positive and negative polarity and of equal amplitude, and in which binary zeros are represented by signal amplitudes that have zero amplitude. North American implementations use signal elements representing binary ones that are non-zero for only half the unit interval (50% duty cycle). The terms bipolar, or pseudo-ternary, are also used to describe these implementations (see T1.102).

3.3 available state: A state where a service is fully usable. A service is assumed to be in the available state unless a transition to the unavailable state is observed without a subsequent transition to the available state.

NOTE – In this standard the transitions between the available and unavailable states are:

1) transition to the Unavailable state occurs at the beginning of 10 consecutive SES;

2) transition to the Available state occurs at the beginning of 10 consecutive seconds, none of which is a SES.

3.4 bipolar with eight zero substitution (B8ZS): An AMI line code with the substitution of a unique code to replace occurrences of eight consecutive zero signal elements. Each block of eight successive zeros is replaced by 000V0VB, where B represents an inserted non-zero signal element conforming to the AMI rule, and V represents an inserted non-zero signal element that is a bipolar violation (violates the AMI rule – see T1.102).

3.5 bit error ratio (BER): The ratio of the number of bit errors to the total number of bits transmitted in a given time interval.

3.6 cyclic redundancy check (CRC): A method of checking the integrity of received data, where the check uses a polynomial algorithm based on the content of the data (see T1.403).

3.7 errored second (ES): A 1-second interval with one or more bit errors (see T1.503).

NOTE – A period of loss of signal shall be considered a period of errored bits.

3.8 error free second (EFS): A 1-second interval in which no bit errors are received.

NOTE – In general, measurement is over time and is stated as a percentage, i.e., %EFS.

3.9 DS1 Frame: A 1.544 Mbit/s signal structure consisting of a set of 192 information digit time slots, preceded by a one digit time slot containing the frame (F) bit, for a total of 193 digit time slots (T1.403).

3.10 DS1 Superframe (SF): A sequence of twelve consecutive DS1 frames, for a total of 2316 digit time slots (see T1.403).

3.11 DS1 Extended Superframe (ESF): A sequence of twenty-four consecutive DS1 frames, for a total of 4632 digit time slots (see T1.403).

3.12 Inter-Network Interface (INI): The point of demarcation between networks when service is provided across multiple networks (see T1.503).

NOTE – Where a Point of Termination (POT) exists, it coincides with an INI.

3.13 Network Interface (NI): The point of demarcation between the service provider facilities and the customer's installation, which establishes the technical interface and division of operational responsibility (see T1.503).

NOTE – Customer, in this definition, refers to the end user.

3.14 pseudo-random binary sequence (PRBS): A binary sequence that approximates a random signal. The PRBS pattern is 2^n-1 bits in length and generates every combination of n-bit words.

3.15 quasi-random signal (QRS): A Pseudo-Random Binary Sequence (PRBS) with a constraint to limit the maximum number of sequential zeros occurring in the pattern.

NOTE – See IEEE 1007 and T1.403 for details on specific QRS patterns.

3.16 severely errored second (SES): A 1-second interval having a Bit Error Ratio of 10^{-3} or worse (see T1.503).

NOTES

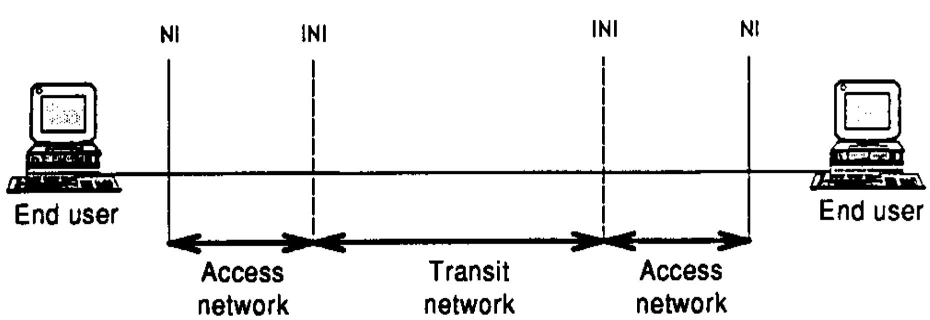
1) A period of loss of signal shall be considered a period of errored bits.

2) For in-service measurement of an SES condition see annex C.

3) ITU-T Recommendation G.826 contains a block-based definition of SES for 44.736 Mbit/s service which is not related to 10^{-3} BER.

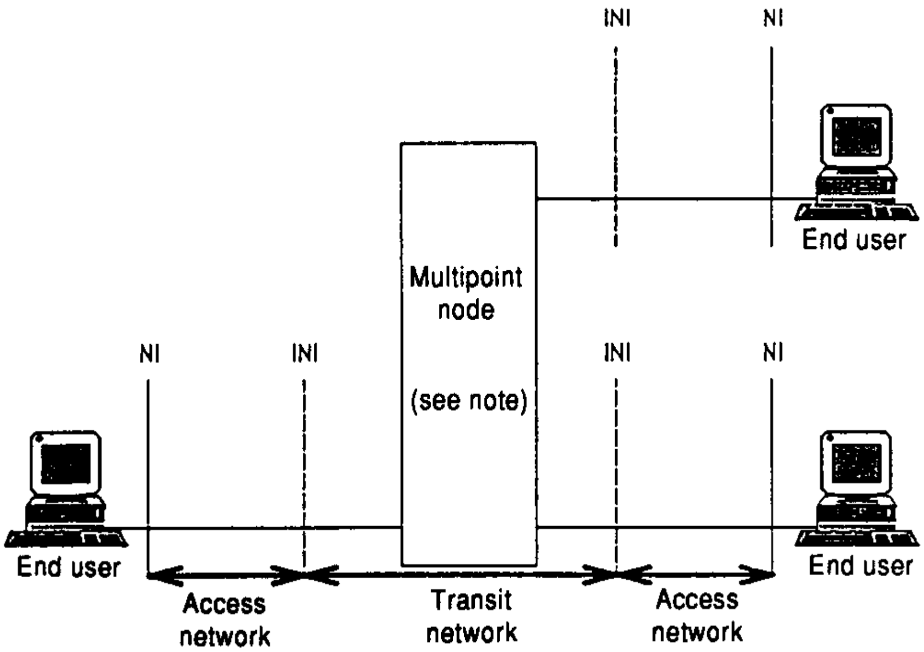
4 Reference model

The performance of dedicated digital networks shall be specified in terms of the reference model in figure 1. End-to-end performance shall be specified from NI-to-NI with performance allocated for NI-to-INI (access) and INI-to-INI (transit). For point-to-multipoint configurations (figure 1-b), the point-to-point reference model shall apply. Since connections may or may not span multiple networks, INIs are shown with dashed lines. For intra-network connections (no INIs), end-to-end performance shall apply. Since dedicated digital services are characterized by established connections (i.e., no access or disengagement phases) with a constant rate of data transfer, the reference events on which performance is evaluated consist solely of user information bits crossing a network interface. There may be arrangements in which multiple providers are used to provide a network segment. Further information regarding the impact of network subdivision with multiple providers may be found in the T1 Technical Report #51.



a) Point-to-point dedicated digital service

Figure 1 - Reference Model *(continued)*



NOTE – The multipoint node can be located within either the Access or Transit segments of the network.

b) Point-to-multipoint dedicated digital service

NOTES

1) NI – Network Interface
2) INI – Inter-Network Interface: INIs are only present when the service is provided across multiple networks.
3) Where a point of termination (POT) exists, it will coincide with an INI.

Figure 1 - Reference Model *(concluded)*

5 Derivation of end-to-end objectives

Because of the variability of performance, objectives must be determined with due consideration of the statistical distribution of the impairments in the individual provider portions. In general, error performance distributions have two components:

1) a Poisson-like distributed background bit error rate;

2) episodes of clustered error events superimposed on the background bit error rate.

Most modern digital systems have been engineered such that the Poisson component is low relative to objectives. The episodic component is difficult to model, but for today's architecture, facilities and equipment, certain statistical properties are observed.

There are a large fraction of days which are error free and a wide variation in the number of ES or SES on days with errors. Since there is a low probability that all provider portions would simultaneously operate at the worst end of their individual performance distribution, it follows that the end-to-end performance objectives will be greater than the largest objective among the provider portions, but less than the linear sum of the objectives of all portions.

The end-to-end objective in each case was chosen between these bounds according to current network behavior. For example, in the case where the objectives are all the same on all three portions, an end-to-end objective equal to a factor 2 times the objective on the individual provider portions was chosen.

6 Performance objectives

Accuracy and availability objectives provide a measure for evaluating performance of digital services. They can be used as an aid in designing, developing, and maintaining the networks providing digital services, and also should be considered in the design of terminal equipment and service applications.

6.1 Rationale

Long-term objectives are provided for the performance parameters defined in T1.503 for dedicated digital services based on the longest and most complex circuits. Services in aggregate provided in accordance with this standard should perform better than the long-term objective. However, individual circuit performance may vary as a result of factors such as technology mix, geographic factors, isolated events, etc., and may be time variant (i.e., could exceed objectives one or two days per month).

Enhanced performance capability for 1.544 Mbit/s service may be available locally through the use of computer based services/systems using Forward Error Correction or transport technologies such as fiber-optic based systems.

Many factors were taken into account in deriving these objectives: customer needs, analytical estimates of performance, empirically observed network performance, performance requirements of the service and its applications, and the practicality of implementing and maintaining a desired quality of service.

Direct determination of compliance with the performance objectives requires long test periods; therefore, the long-term objectives are used to derive limits for timed tests.

6.2 Accuracy objectives

Long-term (i.e., 30 or more days) accuracy performance objectives are stated in terms of the parameters provided in table 1. Errored Seconds (ES) and Severely Errored Seconds (SES) characterize the transmission quality of the service and are used in the test limits. Specific intervals and values are identified in clause 8.

The long-term accuracy objectives are expressed as a percentage because they apply over long periods of time (i.e., 30 or more days). For convenience, these values may be converted to a mean number of events/day by multiplication by 864 (86 400 sec/day ÷ 100). For example, access and transit objectives for 56/64 kbit/s service expressed as mean ES/day would be 0.1 x 864 or 86.

Table 1 - Long-term accuracy objectives

Segment	Parameter	56/64 kbit/s	1.544 Mbit/s	1.544 Mbit/s (Enhanced)	44.736 Mbit/s
End-to-end	%ES	0.20	0.50	0.125	0.250
	%SES	0.035	0.035	0.035	0.035
Transit	%ES	0.10	0.25	0.0625	0.125
	%SES	0.025	0.025	0.025	0.025
Access	%ES	0.10	0.25	0.0625	0.125
	%SES	0.010	0.010	0.010	0.010
NOTE – Actual performance may not meet objectives at all times.					

6.3 Availability objectives

Availability objectives are stated in terms of the parameters provided in table 2. Percentage (%) Availability characterizes usability of the service over time.

A service is assumed to be in the Available state unless a transition to the Unavailable state is observed without a subsequent transition to the Available state. The transitions between the Available and Unavailable states are:

1) Transition to the Unavailable state occurs at the beginning of 10 consecutive SES.

2) Transition to the Available state occurs at the beginning of 10 consecutive seconds none of which is an SES.

Table 2 - Availability objectives

Segment	Parameter	56/64 kbit/s	1.544 Mbit/s	1.544 Mbit/s (Enhanced)	44.736 Mbit/s
End-to-end	% Service Availability (Annual)	99.650	99.750	99.800	99.830
Transit	% Service Availability (Annual)	99.850	99.900	99.920	99.930
Access	% Service Availability (Annual)	99.900	99.925	99.940	99.950

7 Test design

7.1 Rationale

Test procedures described in this standard are intended to indicate, by comparing measured performance against threshold values, whether or not a particular circuit is likely to meet the service performance objectives specified in this standard. A circuit which passes these tests is considered “acceptable”; if it does not pass these tests it is considered “unacceptable”.

These procedures take into account the duration of a test trial and the number of trials to be run; both long-duration and short-duration tests are specified. Test limits are derived from long-term objectives through statistical and empirical procedures. Tests are provided for bringing a circuit[2)] into service, either on completion of a new installation (acceptance) or after repair activity (repair verification).

Performance studies of current transmission technologies have shown that error distributions are such that long observation periods (i.e., 30 or more days) are required to indicate long-term performance with a high degree of statistical confidence. However, practical considerations require much shorter duration tests (i.e., 24 hours or less) that provide a prediction of long-term performance. The following strategies are employed to make these tests as effective as possible:

1) Sequential test procedures;

2) Pattern sensitivity testing.

[2)] Testing of subsections of access or transit segments is beyond the scope of this standard.

For short-duration tests (15 minutes to 2 hours), limits are provided for stages of a sequential test procedure. If at the conclusion of any stage in the procedure, the test result is less than or equal to the test limit, the service performance shall be considered acceptable and the test is terminated. If at any stage in the procedure the test result is greater than the test limit for the final stage, the service performance shall be considered unacceptable and the test is similarly terminated. If the test result at any stage is between these two limits, the test is thus far inconclusive and shall be continued at least through the second stage.

For long-term tests (24 hours), only a single test limit is provided; if the test result is less than or equal to the test limit the service performance shall be considered acceptable. If at any time during the test this limit is exceeded, the service performance shall be considered unacceptable.

Extended analysis using in-service monitoring, following the successful completion of a test, can provide a practical and economical method of confirming the long-term performance of the service.

7.1.1 Acceptance tests

Acceptance test measurements are made upon completion of a new service installation. Threshold levels for these tests are generally more stringent than the pro-rated levels derived from the associated long-term objective, to provide a greater assurance that a circuit meets the specified performance level. This approach minimizes the probability that the circuit will require corrective maintenance.

7.1.2 Trouble verification tests

Trouble verification tests as defined in T1.503 are made in response to a trouble indication. Setting of trouble verification thresholds is an internal provider function and is therefore not covered in this standard.

7.1.3 Repair verification tests

Repair verification measurements are made upon completion of a repair activity. Threshold levels for these tests are the same as acceptance test levels to ensure that a circuit will meet specified performance levels.

7.2 Performance determination – Thresholds and intervals

For each procedure the following criteria (See table 3) will be specified:

- the parameters to be measured, where each parameter is defined by:
  a) specifying Q, the unit of time or number of bits (see T1.503);
  b) specifying W, the threshold for the number of transmission errors which occur over the interval Q (see T1.503);
- a test interval defined by:
  Specifying Z, the number of intervals of length Q to be examined (see T1.503);
- the total number of tests;
- the method of determining performance based on the data collected.

Table 3 - Thresholds and intervals

Service parameter		Q(sec)	W(errored bits)	Z(sec)
56/64 kbit/s	ES	1	1	900 86 400
	SES	1	56/64	900 86 400
1 544 Mbit/s	ES	1	1	900 86 400
	SES	1	1 544	900 86 400
44.736 Mbit/s	ES	1	1	3600 86 400
	SES	1	44 736	3600 86 400

7.2.1 Parameters measured

For digital services operating at rates of 44.736 Mbit/s and below the appropriate interval for observations is 1 second (Q=1 second) for Errored Unit of Time (i.e., Errored Second) and Severely Errored Unit of Time (i.e., Severely Errored Second).

7.2.2 Test duration

Test durations of 15 minutes, 1 hour and 24 hours have been specified in this standard. For the shorter test durations, a series of sequential tests are specified; for the longer 24-hour duration only one test is specified. In-service monitoring, where available, may be used over longer periods of time to confirm conformance to long-term objectives.

7.3 Derivation of parameter value limits

The test limits recommended for the sequential test procedure described in clause 8 were derived for the “ES” and “SES” objectives in table 1 using the weight of evidence method presented in annex B. An expectation that an acceptance probability of at least 99.5% should exist for circuits operating on the order of four times better than the objective (assuming random errors) was a consideration in selecting the short-term test thresholds.

8 Service performance testing

For each service included in this section, the following is provided: test criteria, sequential test procedures and performance value tables. The specified procedure applies to acceptance and repair verification tests (not trouble verification). Each procedure includes the following: the parameters to be measured, the duration of a single test stage, the number of sequential stages to be conducted, and performance determination criteria. The performance value tables include the threshold performance parameter values for each of the above tests. For each service there are two tables, one for test criteria and one for test limits.

The sequential short-duration tests are structured in stages with one of three outcomes after each stage: acceptable performance, indicating confidence that the circuit under test will satisfy the long-term objective; unacceptable performance, indicating confidence that the circuit under test will not satisfy the long-term objective; or inconclusive, indicating insufficient evidence at this stage to predict the long-term performance (i.e., marginal). If at any stage the test indicates acceptable or unacceptable performance, the test is terminated. If the test is inconclusive at any stage the procedure shall be continued at least through the second stage. Testing for longer periods such as 24 hours or continuous monitoring will provide greater confidence and should be considered for marginal circuits.

For the tests specified, all measurements are to be made at the bit rate of the service. Tests conducted intrusively in accordance with clause 8 shall use the QRS or PRBS pattern[3)] appropriate for the service rate under test. Non-intrusive testing methods may be used where available; parameter mappings (e.g., CRC6 to ES) are provided in annex C. These mappings are also applicable to intrusive testing when indicated performance primitives are available. Specialized bit pattern tests, described in annex A, are also recommended in some cases to identify performance problems associated with bit pattern sensitivity.

8.1 Tests for 56/64 kbit/s services

These tests are for digital services capable of transmitting user information at rates up to 64 kbit/s. This service may be arranged via a bridging device for the inter-connection of many user sites, i.e., multipoint service as shown in figure 1-b.

8.1.1 Test criteria (see table 4)

Table 4 - Criteria for 56/64 kbit/s tests

Parameters	**ES SES**
Test stage duration Short Long	 15 min 24 hr
Number of stages Short duration Long duration	 1 to 3 1
Test limits	Table 5

8.1.2 Test procedures

8.1.2.1 Short-duration tests

Up to three sequential 15-minute stages shall be conducted to validate the general performance of the service.

The service performance shall be considered acceptable and the test terminated if, after 15 minutes, the test results for all parameters do not exceed the limits for the 15-minute tests in table 5. The service performance shall be considered unacceptable if any test result is greater than the 45-minute limit. If the test result is between these two limits, continue the test.

After 30 minutes the service performance shall be considered acceptable if the test results do not exceed the limits for the 30-minute test in Table 5. The service performance shall be considered unacceptable if the total test period is

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3) The QRS pattern recommended for 64 kbit/s tests may be either $2^{11} – 1$ with a 7 zero constraint or $2^9 – 1$ with a 7 zero constraint; for 1.544 Mbit/s tests, a $2^{20} – 1$ with a 14 zero constraint (sometimes referred to as a T1-QRSS); for 44.736 Mbit/s tests a $2^{23} – 1$ PRBS is recommended. T1 Technical Report #48 provides further information on specific DSO bit test patterns, and T1 Technical Reports #25 provides further information on specific DS1 bit test patterns.

30 minutes and any result is greater than the 30-minute limit. An additional 15 minutes (for a cumulative duration of 45 minutes) may be used to gain additional confidence in cases for which the 30-minute test result was greater than the 30-minute limit but less than or equal to the 45-minute limit. If the test duration is 45 minutes, the service performance shall be considered acceptable if the test results are less than or equal to the 45-minute limits in table 5.

Table 5 - Test limits and objectives for 56/64 kbit/s service

	Short-duration tests (15-minute stages)						Long-duration test (24 hour)	
	ES			SES			ES	SES
Parameter limit for	15 min	30 Min	45 min	15 Min	30 min	45 min	24 hour	24 hour
Access	0	≤ 2	≤ 3	0	0	≤ 2 (see note)	≤ 60	≤ 7
Transit	0	≤ 2	≤ 3	0	0	≤ 2 (see note)	≤ 60	≤ 16
End-to-end	0	≤ 2	≤ 4	0	0	≤ 2 (see note)	≤ 120	≤ 21
NOTE – Accept at 2 only if the cause of the SES is identified as an isolated event.								

Testing for longer periods, such as 24 hours, will provide greater confidence and should be considered for marginal circuits.

Pattern sensitivity tests are available for 56/64 kbit/s service. Pattern sensitivity tests, test patterns and test limits are described in annex A.

8.1.2.2 Long-duration tests

Long-duration tests (i.e., 24 hours) are an option. If a 24-hour test is performed, the service performance shall be considered acceptable if the results for each parameter measured do not exceed the 24-hour limits in table 5.

8.1.3 Performance limits for 56/64 kbit/s service

The test limits in table 5 are designed to support the accuracy objectives given in table 1. While some of the entries are “0”, it should be noted that an isolated error event is not necessarily indicative of a service affecting problem.

8.2 Tests for 1.544 Mbit/s service

This test is for a service capable of carrying user information at 1.536 Mbit/s.

8.2.1 Test criteria (See table 6)

Table 6 - Criteria for 1.544 Mbit/s tests

Parameters	ES SES
Test stage duration Short Long	 15 min 24 hr
Number of stages Short duration Long duration	 1 to 3 1
Test limits	Tables 7a & 7b

8.2.2 Test procedures

8.2.2.1 Short-duration tests

Up to three sequential 15-minute stages shall be conducted to validate the general performance of the service.

The service performance shall be considered acceptable and the test terminated if, after 15 minutes, the test results for all parameters do not exceed the limits for the 15-minute tests in tables 7a and 7b. The service performance shall be considered unacceptable if any test result is greater than the 45-minute limit. If the test result is between these two limits, continue the test.

After 30 minutes the service performance shall be considered acceptable if the test results do not exceed the limits for the 30-minute test in tables 7a and 7b. The service performance shall be considered unacceptable if the total test period is 30 minutes and any result is greater than the 30-minute limit. An additional 15 minutes (for a cumulative duration of 45 minutes) may be used to gain additional confidence in cases for which the 30-minute test was greater than the 30-minute limit but less than or equal to the 45-minute limit. If the test duration is 45 minutes, the service performance shall be considered acceptable if the test results are less than or equal to the 45-minute limits in tables 7a and 7b.

Table 7a - Test limits and objectives for 1.544 Mbit/s service

	Short-duration tests (15-minute stages)						**Long-duration test (24 hour)**	
	ES			**SES**			**ES**	**SES**
Parameter limit for	15 min	30 Min	45 min	15 Min	30 min	45 min	24 hour	24 hour
Access	0	≤ 3	≤ 5	0	0	≤ 2 (see note)	≤ 150	≤ 7
Transit	0	≤ 3	≤ 5	0	0	≤ 2 (see note)	≤ 150	≤ 16
End-to-end	0	≤ 6	≤ 9	0	0	≤ 2 (see note)	≤ 300	≤ 21
NOTE – Accept at 2 only if the cause of the SES is identified as an isolated event.								

Table 7b - Test limits and objectives for 1.544 Mbit/s service (enhanced)

Parameter limit for	Short-duration tests (15-minute stages)						Long-duration test (24 hour)	
	ES			SES			ES	SES
	15 min	30 Min	45 min	15 Min	30 min	45 min	24 hour	24 hour
Access	0	≤ 2	≤ 3	0	0	≤ 2 (see note)	≤ 40	≤ 7
Transit	0	≤ 2	≤ 3	0	0	≤ 2 (see note)	≤ 40	≤ 16
End-to-end	0	≤ 3	≤ 4	0	0	≤ 2 (see note)	≤ 80	≤ 21
NOTE – Accept at 2 only if the cause of the SES is identified as an isolated event.								

Testing for longer periods such as 24 hours or continuous monitoring will provide greater confidence and should be considered for marginal circuits.

Pattern sensitivity testing should also be done. Pattern sensitivity tests, test patterns and test limits are described in annex A.

8.2.2.2 Long-duration tests

Long-duration tests (i.e., 24 hours) are an option. If a 24-hour test is performed, the service performance shall be considered acceptable if the results for each parameter measured do not exceed the 24-hour limits in tables 7a and 7b.

8.2.3 Performance limits for 1.544 Mbit/s service

The test limits in tables 7a and 7b are designed to support the accuracy objectives given in table 1. While some of the entries are “0”, it should be noted that an isolated error event is not necessarily indicative of a service affecting problem.

8.3 Tests for 44.736 Mbit/s service

This test is for a service capable of carrying user information at 44.210 Mbit/s.

8.3.1 Test criteria (See table 8)

Table 8 - Criteria for 44.736 Mbit/s tests

Parameters	ES SES
Test stage duration Short Long	 1 hour 24 hour
Number of stages Short duration Long duration	 1 to 2 1
Test limits	Table 9

8.3.2 Test procedures

8.3.2.1 Short-duration tests

Up to two sequential 1-hour stages shall be conducted to validate the general performance of the service.

The service performance shall be considered acceptable and the test terminated if, after 1 hour, the test results for all parameters do not exceed the limits for the 1-hour tests in table 9. The service performance shall be considered unacceptable if any test result is greater than the 2-hour limit. If the test result is between these two limits, continue the test.

After 2 hours the service performance shall be considered acceptable if the test results do not exceed the limits in Table 9 for the 2-hour test. The service performance shall be considered unacceptable if any test result is greater than the 2-hour limit. Testing for longer periods such as 24 hours or continuous monitoring will provide greater confidence and should be considered for marginal circuits.

The use of pattern sensitivity testing for 44.736 Mbit/s is under study by subcommittee T1M1.

Table 9 - Test limits and objectives for 44.736 Mbit/s service

	Short-duration tests (15-minute stages)				Long-duration test (24 hour)	
	ES		SES		ES	SES
Parameter limit for	1 hour	2 hour	1 hour	2 hour	24 hour	24 hour
Access	≤ 4	≤ 8	0	≤ 2 (see note)	≤ 80	≤ 7
Transit	≤ 4	≤ 8	0	≤ 2 (see note)	≤ 80	≤ 16
End-to-end	≤ 8	≤ 16	0	≤ 2 (see note)	≤ 160	≤ 21
NOTE – Accept at 2 only if the cause of the SES is identified as an isolated event.						

8.3.2.2 Long-duration tests

Long-duration tests (i.e., 24 hours) are an option. If a 24-hour test is performed, the service performance shall be considered acceptable if the results for each parameter measured do not exceed the 24-hour limits in table 9.

8.3.3 Performance limits for 44.736 Mbit/s service

The test limits in table 9 are designed to support the accuracy objectives given in table 1. While some of the entries are “0”, it should be noted that an isolated error event is not necessarily indicative of a service affecting problem.

Annex A
(informative)
Pattern sensitivity tests

This annex provides pattern sensitivity tests which may be used in addition to the short-duration acceptance tests described in 8.1 and 8.2. Pattern sensitivity tests should be conducted following the successful completion of short-duration tests.

A.1 56/64 kbit/s pattern sensitivity test criteria

One or more of the tests in table A.1 should be performed for pattern sensitivity testing. Sensitivity of equipment to a pattern is generally evident within the first few minutes of a test.

A.2 56/64 pattern sensitivity testing

The service is acceptable if the results measured for the appropriate tests do not exceed the acceptance limits. If, however, the acceptance values are exceeded, an additional test may be conducted. This test shall employ the same test pattern as the one used during the test that failed. If this test passes the service is considered acceptable. Further information regarding pattern sensitivity testing may be found in T1 Technical Report #48.

Table A.1 - Pattern sensitivity test criteria for 56/64 kbit/s

Test	**Pattern length** (bytes)	**Binary representation** (see notes 1 and 2)	**Test interval**	**# of tests** (see note 3)	**ES test limit**
S1	100 100	1111 1111 0000 0000	(see note 4)	1	0
S2	100 100	0111 1110 0000 0000	(see note 4)	1	0
S3	Continuous	0100 1100	(see note 4)	1	0
S4	Continuous	0000 0010	(see note 4)	1	0
S5 (see note 5)	(see note 5)	(see note 5)	(see note 4)	1	0

NOTES

1 For 56 kbit/s service, these patterns will appear only in the customer data bits.

2 All binary presentations are transmitted left to right.

3 One retest is allowed if the initial test fails.

4 3-minute intervals are currently used; longer intervals may be recommended by the service provider. If test intervals of 15 minutes or longer are used, the test procedures, intervals, and limits given in 8.1.2 and 8.1.3 should be followed.

5 This test utilizes all the test patterns defined above and, as an option, may be used in lieu of any or all of the tests S1 through S4 if available. S1 through S4 are run sequentially; a minimum pattern length of 200 bytes for S3 and S4 is suggested.

A.3 1.544 Mbit/s pattern sensitivity testing

The service is acceptable if the measured results over the test period do not exceed the ES test limits. If, however, the values are exceeded, an additional test may be conducted. This test shall employ the same test pattern as the one used during the test that failed. If this test passes the service is considered acceptable. Further information regarding pattern sensitivity testing may be found in T1 Technical Report #25.

Table A.2 – Pattern sensitivity test criteria for 1.544 Mbit/s

Test pattern (see note 1)	**Applicable line code**	**Binary representation** (see notes 2 and 3)	**Test interval**	**# of tests** (see note 4)	**ES test limit**
All 1s	All	F11111111 11111111 11111111.....F	5 min	1	0
3 in 24	AMI only	F01000100 00000000 00000100.....F	5 min	1	0
1 in 8	All	F01000000 01000000 01000000.....F	5 min	1	0
All 0s (see note 5)	B8ZS	F00000000 00000000 00000000.....F	30 sec	1	(see note 6)

NOTES

1 In order to implement test procedures employing the above test criteria, refer to T1 Technical Report #25.

2 F represents the framing bits: the bit patterns repeat as indicated to complete the 192-bit payload of the frame.

3 All binary presentations are transmitted left to right.

4 One retest is allowed if the initial test fails.

5 The framed all-zeros pattern is only recommended for use on circuits optioned with B8ZS and then at the discretion of the service provider as a pattern used in the test sequence of a job aid to determine the presence of mis-optioned equipment. If used with DS1 superframe format (SF), zeros will occur in time slot 2 of every octet (channel). Connected terminal equipment will display a false Remote Alarm Indication (RAI), a.k.a. yellow alarm. In addition, the use of the framed all-zeros pattern through some types of DS3 multiplex equipment may cause DS1 failure if the equipment is not properly optioned for B8ZS. Reference Figure 6-2 in the technical report in note 1 above for the job aid.

6 As an equipment option check, failure will typically be seen as large error counts. Very low counts, e.g., 1 or 2 errors, are not indicative of an optioning problem.

Annex B
(informative)

Derivation of sequential test limits

The sequential test limits used in clause 8 were derived using the mathematical models and techniques described below. Different models and techniques will result in different limits. Final validation of these sequential test procedures and limits requires practical field experience.

B.1 A model for circuit performance and a weight of evidence test

To derive short-duration test limits, assume that the circuit under test is randomly chosen from a population consisting of a mixture of “good” and “bad” sub-populations, controlled by a mixing constant *a*, an attribute of the total population. Each sub-population is described by a *distribution* of *p* (p_g and p_b), the probability that a given second is errored. In general, this probability is higher on a bad circuit than on a good one, but the *distribution* of probabilities allows for both the stochastic nature of error performance on a given circuit as well as the variation in performance over the circuit population. Assume further that errored and severely errored seconds occur according to a binomial model, and that the distributions of the probabilities p_g and p_b have the beta form.

The approach taken is to answer the following question directly: if H_g is the hypothesis that the circuit under test belongs to the “good” sub-population, and H_b is the hypothesis that it belongs to the “bad” subpopulation, how does the result *k* of a short test change our initial beliefs about the likelihood of H_g vs. H_b? In other words, how do the test results, the “weight of evidence”, change the odds favoring one hypothesis over the other?

B.1.1 Error probability distributions for a single population

Assume that within a 15-minute interval, errored seconds occur according to a binomial model with parameters *n* and *p*. So

$$\Pr(e = k \mid p) = \binom{n}{k} p^k (1-p)^{n-k} = Bi(k \mid n, p)$$

where $n = 900$ is the number of seconds in 15 minutes.

Now let $N = 96$, the number of 15-minute intervals in a day. The number of ES that occur in a day is

$$E = e_1 + \ldots + e_N.$$

Assuming that the e_i are independent and the value *p* is fixed for the duration of the day, *E* also has a binomial density, with parameters *nN* and *p*.

$$\Pr(E = m \mid p) = \binom{nN}{m} p^m (1-p)^{nN-m} = Bi(m \mid nN, p)$$

Now assume that the parameter *p*, which is the probability that a particular second is errored (or severely errored), is constant during any day on any circuit, but varies among days and among circuits in the population. Assume that the distribution of this parameter is represented by a beta “prior” density with parameters *a* and *b*:

$$\pi(p \mid a,b) = Be(p \mid a,b) = \frac{1}{B(a,b)} p^{a-1}(1-p)^{b-1},\ a,b \geq 1$$

where $B(a,b)$ is the Beta function.

It follows that the probability density of *E* is

$$\Pr(E = m \mid a,b) = \binom{nN}{m} \frac{B(a+m, b+nN-m)}{B(a,b)} = BeBi(m \mid nN, a, b)$$

This probability density is known as the “beta-binomial”. If the parameters a, b that characterize p are known, then this equation gives the probability that a circuit in the population produces mES or SES in a day. The equation describes our *a priori* knowledge of E, that is, it summarizes what is known about E before making any tests.

B.1.2 A model for the total circuit population

Assume that the population from which our test circuit was selected consists of a mixture of two populations, called “good” and “bad”; each is defined by a beta probability density, with parameters a_1,b_1 and a_2,b_2 respectively.

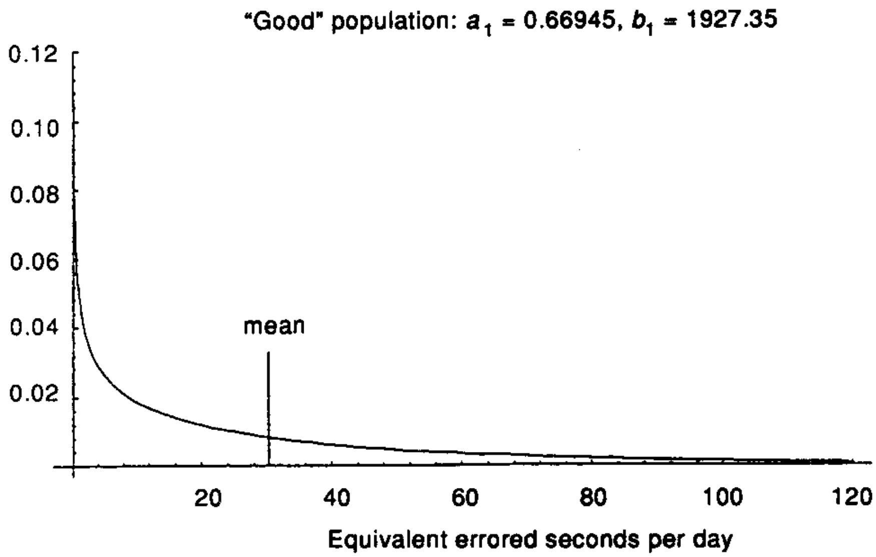
In the context of this annex, the concepts of “good” and “bad” are related to the circuit’s ability to perform at or better than its allocated objectives for long periods of time. The parameters a_1,b_1 describing the distribution of p_g for the good population are chosen so that the ratio of the mean to the objective is a constant less than one (=0.139), and so that the ratio of the standard deviation to the mean is another constant (=1.222). This selection in effect assumes that many good circuits spend most of their days with performance significantly better than the objective (i.e., mean performance of the good circuit days is 7 times better than the objective). From figure B.1, one can also infer that a small fraction of the distribution of p_g may correspond to a performance worse than the objective. This accounts for the possibility of a “good circuit” having a bad day.

Conversely, the parameters a_2,b_2 for the bad population are chosen so that the ratio of the mean to the objective is a constant greater than one (=1.358), and so that the ratio of the standard deviation to the mean is another constant (=0.384). Again looking at figure B1, many bad circuits spend most of their days with a value of p_b worse than the objective (i.e., mean performance for the bad circuit population is worse than the objective), but a large fraction of circuit-days from the bad circuit population may be somewhat better than the objective.

Keeping the distribution means and standard deviations in constant proportions with the objectives has the effect of making all of the distribution plots similar to those illustrated in figure B.1 (after scaling the abscissa to the relevant objective). These curves have been chosen to model the distributions of daily error performance for actual “good” and “bad” circuits. Table B.1 lists the parameters a_1,b_1,a_2 and b_2 computed relative to each ES and SES objective.

Let $0 = a = 1$ be the proportion by which the “good” and “bad” populations are believed to be mixed. That is, a circuit belongs to the good population with probability a and to the bad population with probability $1 – a$.

In the context of acceptance and repair verification testing, this standard begins by assuming that the probability that a newly provisioned or repaired circuit is good is 10 times the probability that the circuit is bad (a = 0.90909)



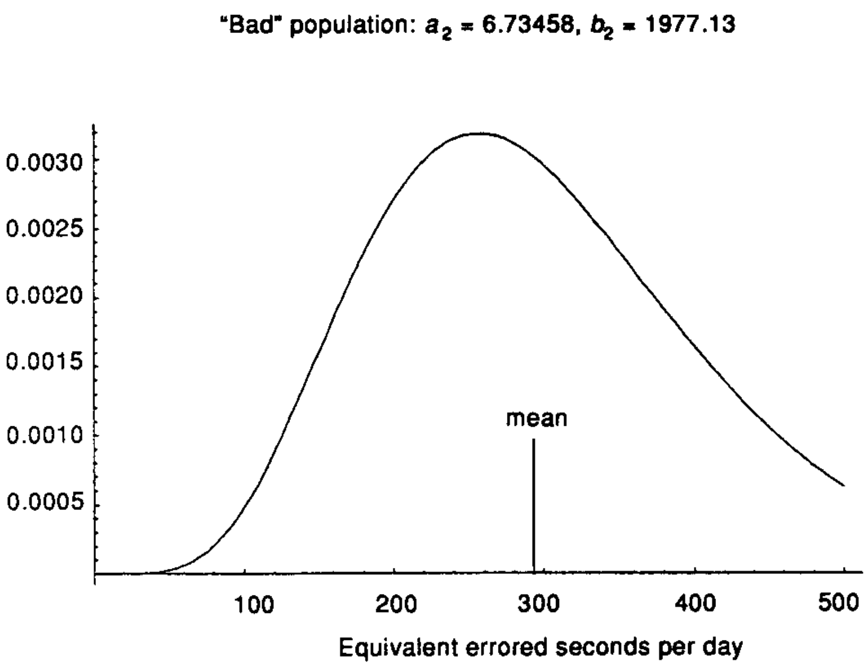


Figure B.1 Beta "prior" distributions for p_g and p_b derived from the 0.25% objective (216 ES/day)

Table B.1 – Beta distribution parameters based on ES and SES objectives

Objectives	Good population (p_g)		Bad population (p_b)	
	a_1	b_1	a_2	b_2
0.0625% ES	0.6695	7706	6.775	7976
0.10% ES	0.6694	4815	6.771	4979
0.125% ES	0.6694	3852	6.768	3981
0.20% ES	0.6692	2407	6.761	2482
0.25% ES	0.6691	1925	6.755	1983
0.50% ES	0.6685	961	6.729	984
1.00% ES	0.6673	479	6.676	485
0.010% SES	0.6696	48 175	6.781	49 924
0.025% SES	0.6696	19 269	6.779	19 961
0.035% SES	0.6696	13 763	6.778	14 254

B.1.3 The hypotheses H_g and H_b: Weight of evidence

Let H_g be the hypothesis that the circuit under test was randomly selected from the "good" population, and H_b the hypothesis that it was selected from the "bad" population. In terms of the beta priors introduced above,

H_g: $(a,b) = (a_1,b_1)$,

H_b: $(a,b) = (a_2,b_2)$,

The prior belief about these two hypotheses is given by a: the probability of H_g is a and that of H_b is $1 – a$. In other words, the initial odds of H_g vs. H_b are $a/(1 – a)$. The logarithm of this number, the *log-odds*: $\log_{10}(a/(1 – a))$ is used. The *weight of evidence* provided by the observation $e = k$ on the question of H_g vs. H_b is

$$W(H_g/H_b{:}k) = \log_{10}\left(\frac{\Pr(e = k \mid H_g)}{\Pr(e = k \mid H_b)}\right)$$

(The r.h.s. without the log is known in classical statistics as the *likelihood ratio*.) The weight of evidence has a natural significance: when it is 0, the data provides no evidence for one hypothesis vs. the other; however, a positive weight of evidence favors H_g while a negative weight favors H_b. Further, the final (posterior) log-odds of H_g vs. H_b are obtained by adding the weight of evidence to the initial log-odds:

$$\log_{10}\left(\frac{\Pr(H_g \mid k)}{\Pr(H_b \mid k)}\right) = W(H_g/H_b{:}k) + \log_{10}\left(\frac{a}{1-a}\right) \quad (1)$$

Note that

$$\Pr(e = k|H_g) = \frac{\int_0^1 \Pr(e = k \mid p)\, \pi(p \mid a_1,b_1)\, dp}{\int_0^1 \pi(p \mid a_1,b_1)\, dp} = \int_0^1 \Pr(e = k \mid p)\, Be(p \mid a_1,b_1)\, dp\,.$$

and that Pr ($e = k|H_g$) is computed similarly. So the weight of evidence provided by the 15-minute test with result k is

$$W(H_g / H_b{:}k) = \log_{10}\left(\frac{B(a_1 + k, b_1 + n - k)\, B(a_2, b_2)}{B(a_2 + k, b_2 + n - k)\, B(a_1, b_1)}\right).$$

It is worth noting that the weight of evidence is independent of the population mixing constant a, which is the initial estimate of the probability of H_g vs. H_b. The result of the 15-minute test modifies this estimate according to equation (1).

B.1.4 Sequential testing

The analysis is now extended to the case of sequential testing, taking for concreteness the case where one observes in three successive tests, $e_1 = k$, $e_2 = l$, $e_3 = m$, and wants to make a decision after each test according to the weights of evidence

$W(H_g / H_b{:}k)$, $W(H_g / H_b{:}k,l)$, $W(H_g / H_b{:}k,l,m)$.

It can be shown that

$$W(H_g / H_b{:}k,l) = log_{10}\left(\frac{B(a_1 + k + l, b_1 + 2n - (k + l))\, B(a_2, b_2)}{B(a_2 + k + l, b_2 + 2n - (k + l))\, B(a_1, b_1)}\right),$$

and

$$W(H_g / H_b{:}k,l,m) = log_{10}\left(\frac{B(a_1 + k + l + m, b_1 + 3n - (k + l + m))\, B(a_2, b_2)}{B(a_2 + k + l + m, b_2 + 3n - (k + l + m))\, B(a_1, b_1)}\right)$$

These expressions depend only on the sum of the results of the tests, so the weight of evidence after, for example, the second test is the same whether k was observed first and l second, or l first and k second, or even $k + l$ first and 0 second.

B.2 Calculation of the weight of evidence from sequential tests

Tables B.2 to B.11 make use of the beta priors defined in table B.1. Tables B.2 to B.11 present the (cumulative) weight of evidence obtained by observing a total of k ES (SES) in 15 minutes, 30 minutes, and 45 minutes respectively. For 44.736 Mbit/s services, weights of evidence are presented for one hour and two-hour tests. The tables do not include any information about the prior belief (a). To compute the final log-odds, equation (1) must be used.

B.3 The philosophy used in deriving short-duration test limits

In creating the test limits in clause 8 the weight of evidence method was used as described above. For acceptance and repair verification testing it is assumed *a priori* that the circuit under test is ten times more likely to be from the “good” population than the “bad”, 10:1 prior odds, a = 0.90909. The circuit will be considered acceptable after the first test only if either the posterior odds are =100:1 or the first result is 0 ES. With the 10:1 prior belief, achieving posterior odds =100:1 using equation (1) requires a weight of evidence =1.0.[4)]

Because some administrations do not wish to extend testing to 45 minutes, they may accept after 30 minutes if the posterior odds are =2:1. With the 10:1 prior belief, this equates to a weight of evidence –0.699. If the circuit cannot be considered acceptable under these conditions, some administrations may extend the test to 45 minutes. The circuit may be considered acceptable after this third and final 15 minutes if the final odds are =2:1. With the 10:1 prior belief, the combined tests must present a final weight of evidence =–0.699.

Using this philosophy and the weight of evidence tables (B.3,B.5,B.6,B.7), test thresholds for the 0.125%, 0.20%, 0.25% and 0.50% ES objectives in table B.12 were derived. Application of this philosophy to small objective values (i.e., 0.01% to 0.10%) for 15-minute through 45-minute intervals can result in small test limits. For this reason, the limits in table B.12 for 0.0625% and 0.10% have been adjusted upward from tables B.2 and B.4 to increase the probability of accepting good circuits.

Table B.2 – Weight of evidence for H_g vs. H_b populations based on the 0.10% ES objective (Test limits derived in B.3)

Total ES observed	in 15 minutes	in 30 minutes	in 45 minutes
0	0.44	0.81	1.14
1	–0.56	–0.18	0.14
2	–1.21	–0.84	–0.51
3	–1.72	–1.35	–1.02
4	–2.13	–1.76	–1.44

4) In each case an observation of 0 ES in the first test increases the odds that the circuit came from the "good" population (the weight of evidence >0.0), but in many cases the posterior odds are still <100:1. Despite this, it was agreed that the circuit would be considered acceptable if in 15 minutes of testing the result was 0 ES and 0 SES.

Table B.3 – Weight of evidence for H_g vs. H_b populations based on the 0.20% ES objective (Test limits derived in B.3)

Total ES observed	in 15 minutes	in 30 minutes	in 45 minutes
0	0.82	1.44	1.94
1	–0.18	0.44	0.94
2	–0.84	–0.22	0.28
3	–1.34	–0.73	–0.23
4	–1.76	–1.14	–0.65
5	–2.11	–1.50	–1.00

Table B.4 – Weight of evidence for H_g vs. H_b populations based on the 0.0625% ES objective (Test limits derived in B.3)

Total ES observed	in 15 minutes	in 30 minutes	in 45 minutes	in 1 hour	in 2 hours
0	0.28	0.54	0.77	0.98	1.70
1	-0.71	-0.46	-0.22	-0.01	0.70
2	-1.36	-1.11	-0.88	-0.67	0.43
3				-1.18	-0.47
4				-1.59	-0.88
5				-1.94	-1.24

Table B.5 – Weight of evidence for H_g vs. H_b populations based on the 0.125% ES objective (Test limits derived in B.3)

Total ES observed	in 15 minutes	in 30 minutes	in 45 minutes	in 1 hour	in 2 hours
0	0.54	0.98	1.37	1.70	2.73
1	-0.46	-0.01	0.37	0.70	1.73
2	-1.11	-0.67	-0.29	0.43	1.07
3		-1.17	-0.80	-0.47	0.55
4			-1.21	-0.88	0.13
5				-1.24	-0.22
6					-0.54
7					-0.81
8					-1.06
9					-1.29

Table B.6 – Weight of evidence for H_g vs. H_b populations based on the 0.25% ES objective (Test limits derived in B.3)

Total ES observed	in 15 minutes	in 30 minutes	in 45 minutes
0	0.98	1.70	2.26
1	–0.01	1.70	1.26
2	–0.67	0.04	0.60
3	–1.18	–0.47	0.09
4	–1.59	–0.88	–0.33
5	–1.95	–1.24	–0.68
6	–2.25	–1.55	–1.00

Table B.7 – Weight of evidence for H_g vs. H_b populations based on the 0.50% ES objective (Test limits derived in B.3)

Total ES observed	in 15 minutes	in 30 minutes	in 45 minutes	in 1 hour	in 2 hours
0	1.70	2.72	3.46	4.03	5.55
1	0.70	1.72	2.46	3.03	4.55
2	0.04	1.06	1.80	2.37	3.89
3	–0.47	0.55	1.28	1.86	3.37
4	–0.88	0.13	0.86	1.44	2.95
5	–1.24	–0.22	0.51	1.08	2.59
6	–1.55	–0.54	0.19	0.76	2.28
7	–1.83	–0.81	–0.08	0.48	2.00
8	–2.07	–1.06	–0.34	0.23	1.75
9	–2.30	–1.29	–0.56	0.01	1.52
10	–2.51	–1.50	–0.77	–0.20	1.31
11	-2.70	–1.69	–0.96	–0.40	1.12
12	–2.87	–1.87	–1.14	–0.57	0.94
13	–3.04	–2.03	–1.31	–0.74	0.77
14	–3.19	–2.19	–1.47	–0.90	0.61
15	–3.34	–2.34	–1.61	–1.05	0.46
16	–	–	–	–1.19	0.32
17	–	–	–	–1.32	0.19
18	–	–	–	–1.45	0.06
19	–	–	–	–1.57	–0.06
20	–	–	–	–1.68	–0.18
21	–	–	–	–1.79	–0.29
22	–	–	–	–1.89	–0.39
23	–	–	–	–1.99	–0.49
24	–	–	–	–2.09	–0.59
25	–	–	–	–2.18	–0.68
26	–	–	–	–2.27	–0.78
27	–	–	–	–2.36	–0.86
28	–	–	–	–2.45	–0.95
29	–	–	–	–2.53	–1.03
30	–	–	–	–2.61	–1.11
31	–	–	–	–2.68	–1.19

Table B.8 – Weight of evidence for H_g vs. H_b populations based on the 1.00% ES objective (Test limits derived in B.3)

Total ES observed	in 1 hour	in 2 hours	Total ES observed	in 1 hour	in 2 hours
0	5.53	7.17	26	–0.78	0.86
1	4.53	6.18	27	–0.86	0.77
2	3.87	5.51	28	–0.95	0.69
3	3.36	5.00	29	–1.03	0.61
4	2.94	4.58	30	–1.11	0.53
5	2.58	4.23	31	–1.19	0.45
6	2.27	3.91	32	–1.26	0.38
7	1.99	3.63	33	–1.33	0.30
8	1.74	3.38	34	–1.40	0.23
9	1.51	3.16	35	–1.47	0.16
10	1.31	2.95	36	–1.54	0.10
11	1.11	2.75	37	–1.61	0.03
12	0.93	2.57	38	–1.67	–0.03
13	0.76	2.41	39	–1.73	–0.10
14	0.61	2.25	40	–1.79	–0.16
15	0.46	2.10	41	–1.85	–0.22
16	0.32	1.96	42	–1.91	–0.27
17	0.19	1.83	43	–1.97	–0.33
18	0.06	1.70	44	–2.02	–0.39
19	–0.06	1.58	45	–2.08	–0.44
20	–0.18	1.46	46	–2.13	–0.49
21	–0.29	1.35	47	–2.18	–0.55
22	–0.39	1.25	48	–2.23	–0.60
23	–0.49	1.15	49	–2.28	–0.65
24	–0.59	1.05	50	–2.33	–0.70
25	–0.68	0.95	51	–2.38	–0.75

Table B.9 – Weight of evidence for H_g vs. H_b populations based on the 0.010% SES objective (Test limits derived in B.3)

Total SES observed	in 15 minutes	in 30 minutes	in 45 minutes	in 1 hour	in 2 hours
0	0.05	0.09	0.14	0.18	0.36
1	–0.94	–0.90	–0.85	–0.81	–0.64
2	–1.60	–1.55	–1.51	–1.46	–1.29
3	–2.10	–2.05	–2.01	–1.96	–1.80
4	–2.51	–2.47	–2.42	–2.38	–2.21

Table B.10 – Weight of evidence for H_g vs. H_b populations based on the 0.025% SES objective (Test limits derived in B.3)

Total SES observed	in 15 minutes	in 30 minutes	in 45 minutes	in 1 hour	in 2 hours
0	0.12	0.23	0.33	0.44	0.81
1	–0.87	–0.76	–0.66	–0.55	–0.18
2	–1.53	–1.42	–1.31	–1.21	–0.84
3	–2.03	–1.92	–1.82	–1.71	–1.34
4	–2.44	–2.33	–2.23	–2.13	–1.76

Table B.11 – Weight of evidence for H_g vs. H_b populations based on the 0.035% SES objective (Test limits derived in B.3)

Total SES observed	in 15 minutes	in 30 minutes	in 45 minutes	in 1 hour	in 2 hours
0	0.16	0.31	0.46	0.60	1.08
1	–0.83	–0.68	–0.53	–0.40	–0.08
2	–1.48	–1.33	–1.19	–1.05	–0.57
3	–1.99	–1.84	–1.69	–1.56	–1.08
4	–2.40	–2.25	–2.11	–1.97	–1.50
5	–2.75	–2.60	–2.46	–2.33	–1.85

Table B.12 – 15-minute interval sequential test limits for ES

ES objective	15-Minute acceptance limit	30-Minute acceptance limit	45-Minute acceptance limit
0.0625%	0	1 (see note)	1 (see note)
0.10%	0	1 (see note)	2 (see note)
0.125%	0	3	4
0.20%	0	2	4
0.25%	0	3	5
0.50%	0	6	9

NOTE – The clause 8 limits have been adjusted upward (2 and 3 for 30 and 45 minutes, respectively) to increase the probability of accepting good circuits.

The philosophy used in deriving the 44.736 Mbit/s test limits was somewhat more stringent. Again it was assumed that the circuit under test is ten times more likely to be from the "good" population than the "bad", 10:1 prior odds. The circuit will be considered acceptable after the first test only if the resulting posterior odds are =100:1. With the 10:1 prior belief, achieving posterior odds =100:1 using equation (1) requires a weight of evidence =1.0. The circuit may be considered acceptable after the second test if the total testing has not diminished our prior beliefs. Equivalently, the two hours of testing must yield a non-negative weight of evidence.

Using this philosophy and the weight of evidence tables (B.7 and B.8), the following test thresholds (See table B.13) were derived:

Table B.13 – 1-hour interval sequential test limits for ES

ES objective	1-hour acceptance limit	2-hour acceptance limit
0.50%	5	18
1.00%	11	37

Applying a similar philosophy (prior odds = 10:1, odds required for acceptance after first test =100:1, odds required for acceptance after last test =2:1) to the weight of evidence tables for SES yields very small test limits. From tables B.9 to B.11, all of the limits except one would be either 0 or 1 SES. Because many SES are known to occur in pairs (protection switch and restoral switch) it is unreasonable to set a limit at one SES. For these reasons, the following limits shown in tables B.14 and B.15 were agreed.

Table B.14 – 15-minute interval sequential test limits for SES (56/64 kbit/s and 1.554 Mbit/s)

SES objective	15-minute acceptance limit	30-minute acceptance limit	45-minute acceptance limit
0.010%	0	0	2 (see note)
0.025%	0	0	2 (see note)
0.035%	0	0	2 (see note)
NOTE – Accept at 2 only if the cause of the SES is identified as an isolated event.			

Table B.15 – 1-hour interval sequential test limits for SES (44.736 Mbit/s)

ES objective	1-hour acceptance limit	2-hour acceptance limit
0.010%	0	2 (see note)
0.025%	0	2 (see note)
0.035%	0	2
NOTE – Accept at 2 only if the cause of the SES is identified as an isolated event.		

B.4 Alternative uses of the weight of evidence tables

The values derived for clause 8 result from a specific application of the weight of evidence model to establish standard thresholds.

The distributions for the “good” and “bad” circuit populations and the resulting weight of evidence tables could be used in other applications with different prior beliefs and different acceptance criteria. For example, if service providers wished to lower their risk of accepting a bad circuit, then they could require a final log-odds of 20:1 instead of 2:1 in favor of H_g vs. H_b. Starting with the prior belief of 10:1 in favor of H_g vs. H_b (a = 0.90909) the requirement would be a weight of evidence from testing =0.301 instead of =–0.699.

As a second example, for a completely new fiber circuit there is reason to believe that once connectivity has been confirmed, there will be no errors on this length of fiber circuit. In such cases one might wish to adjust the prior belief upward to 50:1 (a = 0.98039) for H_g vs. H_b.

In using the weight of evidence tables, one needs to consider both the risk of accepting bad circuits and the risk of rejecting good circuits (i.e., the impact on operating level required for a good circuit to pass the test with high probability). In general, longer test intervals can improve both of these risks.

Annex C
(informative)

Mapping between performance parameters (*Non-intrusive measurements*)

Users of this standard should be aware that while the mappings presented were current at the time this standard was approved, they are subject to change. Therefore, the reader is encouraged to consult the latest approved version of T1.231 for further details. The following gives an overview of T1.231 path parameters that can be used for non-intrusive measurements.

Non-intrusive measurements for 1.544 Mbit/s and 44.736 Mbit/s services make use of performance indicators (primitives) termed performance anomalies and performance defects. An anomaly is a discrepancy such as an error in a performance checking code. The generic term used for performance checking code anomalies is a Code Violation (CV). A defect is a limited interruption of function, such as a Severely Errored Frame (SEF). An SEF is defined by an error criterion similar to that used to declare Out Of Frame (OOF). Alarm Indication Signal (AIS) and Loss Of Frame (LOF) are other performance significant defects.

1) 1.544 Mbit/s service

   a) *Framing format:* Superframe (SF)

      i) *ES:* a 1-second interval with one or more Frame bit Error (FE) CVs, SEF defects, or AIS defects;

      ii) *SES:* a 1-second interval with eight or more FE CV events, or one or more SEF or AIS defects.
      NOTE – Due to limitations of the FE CV, Superframe mappings should be used with caution.

   b) *Framing format:* Extended Superframe (ESF)

      i) *ES:* a 1-second interval with one or more CRC-6 CVs, SEF defects, or AIS defects;

      ii) *SES:* a 1-second interval with 320 or more CRC-6 CVs, or one or more SEF or AIS defects.

2) 44.736 Mbit/s service

   a) *ES:* a 1-second interval with one or more CVs, SEF defects, or AIS defects;

   b) *SES:* a 1-second interval with more than 44 CVs, or one or more SEF or AIS defects.

   NOTES

   1) In b), 44 is the default. See T1.231 for further information.

   2) For Framing Format Applications, ES and SES are defined using C bit or P bit based CVs:
   P bit parity CVs apply for all applications of 44.736 Mbit/s service;
   C bit parity CVs apply for C bit applications.

Annex D
(informative)

Bibliography

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