



INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

O.150

(05/96)

SERIES O: SPECIFICATIONS OF MEASURING EQUIPMENT

Equipment for the measurement of digital and
analogue/digital parameters

General requirements for instrumentation for performance measurements on digital transmission equipment

ITU-T Recommendation O.150

(Previously "CCITT Recommendation")

ITU-T O-SERIES RECOMMENDATIONS
SPECIFICATIONS OF MEASURING EQUIPMENT

General	O.1-O.9
Maintenance access	O.10-O.19
Automatic and semi-automatic measuring systems	O.20-O.39
Equipment for the measurement of analogue parameters	O.40-O.129
Equipment for the measurement of digital and analogue/digital parameters	O.130-O.199

For further details, please refer to ITU-T List of Recommendations.

FOREWORD

The ITU-T (Telecommunication Standardization Sector) is a permanent organ of the International Telecommunication Union (ITU). The ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Conference (WTSC), which meets every four years, establishes the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 1 (Helsinki, March 1-12, 1993).

ITU-T Recommendation O.150 was revised by ITU-T Study Group 4 (1993-1996) and was approved under the WTSC Resolution No. 1 procedure on the 12th of May 1996.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

© ITU 1996

All rights reserved. No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the ITU.

CONTENTS

	<i>Page</i>
1 Scope	1
2 References	1
3 Standardized test sequences	2
4 Properties of pseudo-random test sequences	2
4.1 Measurements through scramblers	2
4.2 Loss of sequence synchronization	2
4.3 "Framed" measurements	3
4.4 Jitter measurements	3
5 Digital test sequences used in the O-Series Recommendations	3
5.1 511-bit pseudo-random test sequence	3
5.2 2047-bit pseudo-random test sequence	4
5.3 32 767-bit pseudo-random test sequence	4
5.4 1 048 575-bit pseudo-random test sequence	4
5.5 1 048 575-bit pseudo-random test sequence with zero suppression	4
5.6 8 388 607-bit pseudo-random test sequence	5
5.7 536 870 911-bit pseudo-random test sequence	5
5.8 2 147 483 647-bit pseudo-random test sequence	5
6 Description of framed test sequences at different bit rates	6
6.1 General	6
6.1.1 Testing digital demultiplexers	6
6.2 Digital frames operating at bit rates of 1544 kbit/s	6
6.2.1 12 - Frame multiframe or superframe	6
6.2.2 24 - Frame multiframe or extended superframe	7
6.3 Digital frames operating at bit rates of 2048 kbit/s	7
6.3.1 Frames without CRC-4 procedure and providing common channel signalling	8
6.3.2 Frames without CRC-4 procedure and providing channel associated signalling	8
6.3.3 Frames with CRC-4 procedure and providing channel associated signalling	8
6.4 Digital frames operating at bit rates of 6312 kbit/s	8
6.5 Digital frames operating at bit rates of 8448 kbit/s	9
6.6 Digital frames operating at bit rates of 32 064 kbit/s	10
6.7 Digital frames operating at bit rates of 34 368 kbit/s	10
6.8 Digital frames operating at bit rates of 44 736 kbit/s	11
6.9 Digital frames operating at bit rates of 97 728 kbit/s	12
6.10 Digital frames operating at bit rates of 139 264 kbit/s	13
6.10.1 Digital frames operating at 139 264 kbit/s and multiplexing 34 368 kbit/s signals	13
6.10.2 Digital frames operating at 139 264 kbit/s and multiplexing 44 736 kbit/s signals	13
6.11 Digital frames operating at STM-N bit rates	14
7 Block-oriented error performance measurements	14
7.1 Measurement of block errors	14
7.2 Block sizes	14
7.2.1 Block sizes for out-of-service performance measurements on PDH systems	15
7.2.2 Block sizes for out-of-service performance measurements on SDH systems	15
7.2.3 Block sizes for performance measurements on cell-based systems	16
8 Detection and clearance of AIS and LOS defects	16

SUMMARY

This Recommendation contains general requirements applicable to the O-Series Recommendations for instrumentation for performance measurements on digital transmission equipment.

KEYWORDS

Block sizes, block-oriented measurement, detection and clearance of Alarm Indication Signal (AIS), detection and clearance of Loss Of Signal (LOS), digital test sequences, performance measurements, pseudo-random test sequences; tester.

Page blanche

IV

Recommendation O.150

GENERAL REQUIREMENTS FOR INSTRUMENTATION FOR PERFORMANCE MEASUREMENTS ON DIGITAL TRANSMISSION EQUIPMENT

(revised in 1996)

1 Scope

This Recommendation contains general requirements applicable to instrumentation for performance measurements on digital transmission equipment. Such equipment is specified in the O-Series Recommendations. This Recommendation is intended to give general guidance in connection with specific O-Series Recommendations and is a help in finding the right measurement conditions for different applications.

This Recommendation defines such items as digital (pseudo-random) test sequences, block sizes for error performance measurements and the criteria for the detection and clearance of loss of frame and of alarm indication signal.

2 References

The following Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of currently valid ITU-T Recommendations is regularly published.

- [1] ITU-T Recommendation G.823 (1993), *The control of jitter and wander within digital networks which are based on the 2048 kbit/s hierarchy.*
- [2] CCITT Recommendation O.153 (1992), *Basic parameters for the measurement of error performance at bit rates below the primary rate.*
- [3] CCITT Recommendation O.152 (1992), *Measuring equipment for bit rates of 64 kbit/s and $N \times 64$ kbit/s.*
- [4] CCITT Recommendation O.151 (1992), *Error performance measuring equipment operating at the primary rate and above.*
- [5] ITU-T Recommendation G.826 (1993), *Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate.*
- [6] ITU-T Recommendation G.704 (1995), *Synchronous frame structures used at 1544, 6312, 2048, 8488 and 44 736 kbit/s.*
- [7] CCITT Recommendation G.752 (1988), *Characteristics of digital multiplex equipments based on a second order bit rate of 6312 kbit/s and using positive justification.*
- [8] CCITT Recommendation G.751 (1988), *Digital multiplex equipments operating at the third order bit rate of 34 368 kbit/s and the fourth order bit rate of 139 264 kbit/s and using positive justification.*
- [9] CCITT Recommendation G.703 (1991), *Physical/electrical characteristics of hierarchical digital interfaces.*
- [10] ITU-T Recommendation G.775 (1994), *Loss Of Signal (LOS) and Alarm Indication Signal (AIS) defect detection and clearance criteria.*
- [11] American National Standard for telecommunications ANSI T1.107-1988, *Digital hierarchy formats specifications.*
- [12] CCITT Recommendation G.743 (1988), *Second order digital multiplex equipment operating at 6312 kbit/s and using positive justification.*

- [13] CCITT Recommendation G.742 (1988), *Second order digital multiplex equipment operating at 8448 kbit/s and using positive justification.*
- [14] CCITT Recommendation G.755 (1988), *Digital multiplex equipment operating at 139 264 kbit/s and multiplexing three tributaries at 44 736 kbit/s.*

3 Standardized test sequences

Bit error measurements are important means to assess the performance of digital transmission equipment. So-called "true" bit error measurements, during which every error can be detected, can only be carried out if the bit sequence of the pattern used for the measurement is exactly known. Because of its random nature, this condition is normally not fulfilled by real traffic.

Therefore, it is necessary to specify reproducible test sequences which simulate real traffic as closely as possible. Reproducible test sequences are also a prerequisite to perform end-to-end measurements.

Pseudo-random sequences with a length of $2^n - 1$ bits are the most common answers to this problem. In addition to strings of n consecutive ZEROs (so-called inverted signal) and $n - 1$ consecutive ONES, such sequences contain any possible combination of ZEROs and ONES within a string length depending on n . (For the value of n see Clauses 4 and 5.)

Pseudo-random sequences of different lengths are specified in this Recommendation.

4 Properties of pseudo-random test sequences

The properties of a test sequence should meet the requirements of the system under test. In general, the length of a pseudo-random sequence shall increase with the bit rate at which measurements are performed. This avoids the sequence repetition frequency becoming too high which would not be in accordance with the situation found in practice.

Pseudo-random sequences may be produced by means of shift registers with appropriate feedback. If the shift register has n stages, the maximum sequence length will be $2^n - 1$ bits.

If the digital signal is directly taken from the output of the shift register (non-inverted signal) the longest string of consecutive ZEROs will be equal $n - 1$. If the signal is inverted, n consecutive ZEROs will be produced.

It is possible to generate pseudo-random sequences with these properties by other means than shift registers.

4.1 Measurements through scramblers

The unit under test may contain scramblers. This may yield unexpected measurement results if the value n as described in clause 4 has common integer multiples with the number of stages of the scrambler. To reduce the probability that this problem will occur, the value of n for test sequences specified more recently is a prime number.

4.2 Loss of sequence synchronization

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.

The following requirement is applicable to all O-Series Recommendations dealing with error performance measurements using pseudo-random sequences.

Sequence synchronization shall be considered to be lost and resynchronization shall be started if:

- a) the bit error ratio is ≥ 0.20 during an integration interval of 1 second; or
- b) it can be unambiguously identified that the test sequence and the reference sequence are out of phase.

NOTE – One method to recognize the out-of-phase condition is the evaluation of the error pattern resulting from the bit-by-bit comparison. If the error pattern has the same structure as the pseudo-random test sequence, the out-of-phase condition is reached.