



INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

G.824

(03/2000)

SERIES G: TRANSMISSION SYSTEMS AND MEDIA,
DIGITAL SYSTEMS AND NETWORKS

Digital transmission systems – Digital networks – Quality
and availability targets

**The control of jitter and wander within digital
networks which are based on the 1544 kbit/s
hierarchy**

ITU-T Recommendation G.824

(Formerly CCITT Recommendation)

ITU-T G-SERIES RECOMMENDATIONS

TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

INTERNATIONAL TELEPHONE CONNECTIONS AND CIRCUITS	G.100-G.199
GENERAL CHARACTERISTICS COMMON TO ALL ANALOGUE CARRIER-TRANSMISSION SYSTEMS	G.200-G.299
INDIVIDUAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON METALLIC LINES	G.300-G.399
GENERAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON RADIO-RELAY OR SATELLITE LINKS AND INTERCONNECTION WITH METALLIC LINES	G.400-G.449
COORDINATION OF RADIOTELEPHONY AND LINE TELEPHONY	G.450-G.499
TERMINAL EQUIPMENTS	G.700-G.799
DIGITAL NETWORKS	G.800-G.899
General aspects	G.800-G.809
Design objectives for digital networks	G.810-G.819
Network capabilities and functions	G.830-G.839
SDH network characteristics	G.840-G.849
Management of transport network	G.850-G.859
SDH radio and satellite systems integration	G.860-G.869
Optical transport networks	G.870-G.879
DIGITAL SECTIONS AND DIGITAL LINE SYSTEM	G.900-G.999

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

ITU-T Recommendation G.824**The control of jitter and wander within digital networks which
are based on the 1544 kbit/s hierarchy****Summary**

This ITU-T Recommendation specifies the maximum network limits of jitter and wander that shall not be exceeded at relevant transport or synchronization network interfaces and the minimum equipment tolerance to jitter and wander that shall be provided at any relevant synchronization or transport interface.

The requirements for jitter and wander characteristics that are specified in this ITU-T Recommendation must be adhered to ensure interoperability of equipment produced by different manufacturers and satisfactory network performance.

Source

ITU-T Recommendation G.824 was revised by ITU-T Study Group 13 (1997-2000) and approved under the WTSC Resolution 1 procedure on 10 March 2000.

Keywords

Clocks, input jitter tolerance, input wander tolerance, network limits, output jitter, output wander, synchronization, timing.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. 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 turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSC Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

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

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

© ITU 2001

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

	Page
1 Scope	1
2 References	1
3 Definitions	2
4 Abbreviations	3
5 Network limits for jitter and wander at traffic interfaces	4
5.1 Jitter limits	4
5.2 Wander limits	5
5.2.1 Synchronous 1544 kbit/s network interface	5
5.2.2 Synchronous 44 736 kbit/s network interface	5
5.3 Phase transients	6
6 Network limits for jitter and wander at synchronization interfaces	6
6.1 Network limits for jitter	6
6.2 Network limits for wander	6
6.2.1 Primary Reference Clock (PRC) output	6
6.2.2 1544 kbit/s reference interface	7
7 Tolerance of jitter and wander at network interfaces	9
7.1 Basic specification philosophy	9
7.2 Jitter and wander tolerance of traffic input ports	9
7.2.1 1544 kbit/s input jitter and wander tolerance	10
7.2.2 6312 kbit/s input jitter and wander tolerance	11
7.2.3 32 064 kbit/s input jitter and wander tolerance	12
7.2.4 44 736 kbit/s input jitter and wander tolerance	13
7.2.5 97 728 kbit/s input jitter and wander tolerance	14
7.3 Jitter and wander tolerance of clock input ports	15
Annex A – Wander reference models and wander budgets	16
A.1 1544 kbit/s wander accumulation	16
A.1.1 1544 kbit/s wander accumulation and slip simulation model assumptions ..	17
A.2 44 736 kbit/s wander accumulation	18

Introduction and background

In a transport network, jitter and wander accumulate on data paths according to the jitter and wander generation and transfer characteristics of each piece of equipment interconnected. This equipment may include different types of multiplexers/demultiplexers, cross-connects and line systems, for example.

An excessive amount of jitter and wander can adversely affect both digital signals (e.g. by generation of bit errors, uncontrolled slips and other abnormalities) and analogue signals (e.g. by unwanted phase modulation of the transmitted signal). The consequences of such impairment will, in general, depend on the particular service that is being carried and the terminating or adaptation equipment involved.

It is therefore necessary to set limits on the magnitude of jitter and wander at network interfaces, in order to guarantee proper quality of the transmitted signals and a proper design of the equipment.

ITU-T Recommendation G.824**The control of jitter and wander within digital networks
which are based on the 1544 kbit/s hierarchy****1 Scope**

This ITU-T Recommendation specifies the relevant parameters and their limiting values that are able to satisfactorily control the amount of jitter and wander present at synchronous digital hierarchy (SDH) and plesiochronous digital hierarchy (PDH) network-node interfaces (NNI) based on the 1544 kbit/s hierarchy.

An excessive amount of jitter and wander can adversely affect both digital (generation of bit errors, uncontrolled slips) and analogue signals (unwanted phase modulation of the transmitted signal). It is therefore necessary to set limits to the presence of jitter and wander at the network interfaces, in order to guarantee a proper quality of the transmitted signals.

The scope of this ITU-T Recommendation is to define the parameters and the relevant values that are able to control satisfactorily the amount of jitter and wander present at PDH network interfaces.

The electrical characteristics of the relevant network interfaces are described in ITU-T Recommendation G.703.

The jitter and wander control philosophy is based on the need:

- a) to recommend a maximum network limit that should not be exceeded at any relevant interface (i.e. jitter and wander transfer, generation, and tolerance);
- b) to recommend a consistent framework for the specification of individual digital equipment;
- c) to provide sufficient information and guidelines for organizations to measure and study jitter and wander accumulation in any network configuration.

2 References

The following ITU-T 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 the currently valid ITU-T Recommendations is regularly published.

- [1] ITU-T Recommendation G.703 (1998), *Physical/electrical characteristics of hierarchical digital interfaces*.
- [2] CCITT Recommendation G.743 (1988), *Second order digital multiplex equipment operating at 6312 kbit/s and using positive justification*.
- [3] CCITT Recommendation G.752 (1988), *Characteristics of digital multiplex equipment based on a second order bit rate of 6312 kbit/s and using positive justification*.
- [4] ITU-T Recommendation G.783 (1997), *Characteristics of synchronous digital hierarchy (SDH) equipment functional blocks*.
- [5] CCITT Recommendation G.801 (1988), *Digital transmission models*.
- [6] ITU-T Recommendation G.803 (2000), *Architecture of transport networks based on the Synchronous Digital Hierarchy (SDH)*.

- [7] ITU-T Recommendation G.810 (1996), *Definitions and terminology for synchronization networks.*
- [8] ITU-T Recommendation G.811 (1997), *Timing characteristics of primary reference clocks.*
- [9] ITU-T Recommendation G.812 (1998), *Timing requirements for slave clocks suitable for use as node clocks in synchronization networks.*
- [10] ITU-T Recommendation G.813 (1996), *Timing characteristics of SDH equipment slave clocks (SEC).*
- [11] CCITT Recommendation G.822 (1988), *Controlled slip rate objectives on an international digital connection.*
- [12] ITU-T Recommendation G.823 (2000), *The control of jitter and wander within digital networks which are based on the 2048 kbit/s hierarchy.*
- [13] ITU-T Recommendation G.825 (2000), *The control of jitter and wander within digital networks which are based on the synchronous digital hierarchy (SDH).*
- [14] ITU-T Recommendation G.957 (1999), *Optical interfaces for equipments and systems relating to the synchronous digital hierarchy.*
- [15] ITU-T Recommendation I.431 (1993), *Primary rate user-network interface – Layer 1 specification.*
- [16] ITU-T Recommendation O.150 (1996), *General requirements for instrumentation for performance measurements on digital transmission equipment.*
- [17] ITU-T Recommendation O.171 (1997), *Timing jitter and wander measuring equipment for digital systems which are based on the Plesiochronous Digital Hierarchy(PDH).*
- [18] ITU-T Recommendation O.172 (1999), *Jitter and wander measuring equipment for digital systems which are based on the synchronous digital hierarchy (SDH).*
- [19] ITU-T Recommendation Q.541 (1993), *Digital exchange design objectives – General.*

3 Definitions

This ITU-T Recommendation defines the following terms. Additional definitions relating to synchronization networks are provided in ITU-T Recommendation G.810.

3.1 synchronous interface: For the purpose of this ITU-T Recommendation, a synchronous interface is defined such that the bit rate of the interface is derived from a source that is ultimately traceable to a PRC.

3.2 asynchronous interface: These interfaces provide an output signal with frequency that is not traceable to a PRC and that meets the frequency offset requirements given in ITU-T Recommendation G.703.

3.3 traffic interface: These interfaces may be synchronous (i.e. normally PRC-traceable) or asynchronous (i.e. meeting the frequency offset requirements of ITU-T Recommendation G.703) and network limits are specified using the MRTIE (Maximum Relative Time Interval Error) parameter in this ITU-T Recommendation. Input jitter/wander tolerance is also specified in this ITU-T Recommendation. This interface category can be further sub-divided as follows:

- a) Interface is not able or required to provide synchronization. An example is an interface supporting only 44 736 kbit/s PDH signals according to ITU-T Recommendation G.703.
- b) Interface is not able to provide synchronization at the defined performance level, but nevertheless is used to provide timing to other network elements such as terminal equipment, remote concentrators, etc. Examples include 1544 and 44 736 kbit/s signals