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Transmission and Multiplexing (TM); Generic requirements for synchronization networks; Part 4-1: Timing characteristics of slave clocks suitable for synchronization supply to Synchronous Digital Hierarchy (SDH) and Plesiochronous Digital Hierarchy (PDH) equipment

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European Standard (Telecommunications series)

Transmission and Multiplexing (TM); Generic requirements for synchronization networks; Part 4-1: Timing characteristics of slave clocks suitable for synchronization supply to Synchronous Digital Hierarchy (SDH) and Plesiochronous Digital Hierarchy (PDH) equipment

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Contents

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Foreword

This European Standard (Telecommunications series) has been produced by the Transmission and Multiplexing (TM) Technical Committee.

The present document has been produced to provide requirements for synchronization networks that are compatible with the performance requirements of digital networks. It is one of a family of documents covering various aspects of synchronization networks:

Part 1-1: "Definitions and terminology for synchronization networks";

Part 2-1: "Synchronization network architecture";

Part 3-1: "The control of jitter and wander within synchronization networks";

Part 4-1: "Timing characteristics of slave clocks suitable for synchronization supply to Synchronous Digital Hierarchy (SDH) and Plesiochronous Digital Hierarchy (PDH) equipment";

Part 4-2: "Timing characteristics of slave clocks suitable for synchronization supply to Synchronous Digital Hierarchy (SDH) and Plesiochronous Digital Hierarchy (PDH) equipment Implementation Conformance (ICS) Statement";

Part 5-1: "Timing characteristics of slave clocks suitable for operation in Synchronous Digital Hierarchy (SDH) equipment";

Part 6-1: "Timing characteristics of primary reference clocks";

Part 6-2: "Timing characteristics of primary reference clocks Implementation Conformance (ICS) Statement";

Part 7-1: "Timing characteristics of slave clocks suitable for synchronization supply to equipment in local node applications".

Parts 1-1, 2-1, 3-1 and 5-1 have previously been published as ETS 300 462 Parts 1, 2, 3 and 5, respectively.

Additionally, parts 4-1 and 6-1 completed the Voting phase of the Two Step Approval procedure as ETS 300 462 Parts 4 and 6, respectively.

It was decided to prepare ICS proformas for several of the parts and this necessitated a re-numbering of the individual document parts. It was also decided to create a new part 7-1.

This in turn led to a need to re-publish new versions of all six parts of the original ETS. At the same time, the opportunity was taken to convert the document type to EN.

This has involved no technical change to any of the documents. However part 5-1 has been modified, due to editorial errors which appeared in ETS 300 462-5.

National transposition dates	
Date of adoption of this EN:	22 May 1998
Date of latest announcement of this EN (doa):	31 August 1998
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	28 February 1998
Date of withdrawal of any conflicting National Standard (dow):	28 February 1998

1 Scope

This European Standard (Telecommunications series) outlines requirements for timing devices called Synchronization Supply Units (SSUs) used in synchronizing network equipment in the Synchronous Digital Hierarchy (SDH) transport network and the Public Switched Telephone Network (PSTN) network.

NOTE 1: The requirements in the present document apply under environmental conditions according to one of the environmental classes defined in ETS 300 019 [1], unless stated otherwise. The manufacturer will need to specify to which specific environmental class an equipment belongs.

A description of the Synchronization Supply Unit (SSU) logical function is given in figure 1 in EN 300 462-2-1 [3]. In general, the SSU will have multiple timing reference inputs and in the event that all timing references fail, the SSU should be capable of maintaining operation (holdover) within prescribed performance limits as detailed in the present document. The requirements laid down in the present document decribe the minimum performance of an SSU applied as a transit node clock. It is recognized that local node clock applications for SSU's exist, requiring different parameters. Those are for further study.

NOTE 2: There can be situations in which more stringent requirements are applicable, for instance, in cases where an SSU has only one independent reference (e.g. due to limitations in the network topology).

The SSU function can be implemented in a separate piece of equipment called a Stand-Alone Synchronization Equipment (SASE) or it can form a logical function of another equipment such as a telephony exchange or an SDH cross-connect.

The requirements specified in the present document refer to the design of new synchronization networks and consequently they do not necessarily represent the performance of existing synchronization networks and equipment.

A timing device within SDH equipment can also conform to EN 300 462-5-1 [5].

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, subsequent revisions do apply.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

[1] ETS 300 019: "Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment".

[2] EN 300 462-1-1: "Transmission and Multiplexing (TM); Generic requirements for synchronization networks; Part 1-1: Definitions and terminology for synchronization networks".

[3] EN 300 462-2-1: "Transmission and Multiplexing (TM); Generic requirements for synchronization networks; Part 2-1: Synchronization network architecture".

[4] EN 300 462-3-1: "Transmission and Multiplexing (TM); Generic requirements for synchronization networks; Part 3-1: The control of jitter and wander within synchronization networks".

[5] EN 300 462-5-1: "Transmission and Multiplexing (TM); Generic requirements for synchronization networks; Part 5-1: Timing characteristics of slave clocks suitable for operation in Synchronous Digital Hierarchy (SDH) equipment".

[6] EN 300 462-6-1: "Transmission and Multiplexing (TM); Generic requirements for synchronization networks; Part 6-1: Timing characteristics of primary reference clocks".

[7] ETS 300 166: "Transmission and Multiplexing (TM); Physical and electrical characteristics of hierarchical digital interfaces for equipment using the 2 048 kbit/s-based pleisiochronous or synchronous digital hierarchies".

[8] ITU-T Recommendation G.825: "The control of jitter and wander within digital networks which are based on the synchronous digital hierarchy (SDH)".

[9] ITU-T Recommendation G.823: "The control of jitter and wander within digital networks which are based on the 2 048 kbit/s hierarchy".

3 Definitions, abbreviations and symbols

3.1 Definitions

For the purposes of the present document, the definitions given in EN 300 462-1-1 [2] apply.

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in EN 300 462-1-1 [2], together with the following, apply:

MTIE	Maximum Time Interval Error
NE	Network Element
PDH	Plesiochronous Digital Hierarchy
PLL	Phase Locked Loop
ppm	parts per million
PSTN	Public Switched Telephone Network
SASE	Stand Alone Synchronization Equipment
SDH	Synchronous Digital Hierarchy
SEC	SDH Equipment Clock
SSU	Synchronization Supply Unit
STM-N	Synchronous Transport Module-N
TDEV	Time DEViation
UI	Unit Interval
UIpp	Unit Interval peak to peak
VCO	Voltage Controlled Oscillator

3.3 Symbols

For the purposes of the present document, the following symbols apply:

K	Kelvin
τ	Tau

4 Frequency accuracy

The long term frequency accuracy normally applies when operating in long term free running conditions. Since the SSU is a slave clock, then the normal operating modes are either locked or holdover. The frequency accuracy specification in holdover mode is specified in clause 9.

5 Pull-in and pull-out ranges

The minimum pull-in range shall be ± 0,01 ppm, whatever the internal oscillator frequency offset may be. The pull-out range is for further study.

6 Noise generation

The noise generation of an SSU represents the amount of phase noise produced at the output when there is an ideal input reference signal or the clock is in holdover state. A suitable reference, for practical testing purposes, implies a performance level at least 10 times more stable than the output requirements. The ability of the clock to limit this noise is described by its frequency stability. The measures Maximum Time Interval Error (MTIE) and Time Deviation (TDEV) are useful for characterization of noise generation performance.

For observation intervals, τ, between 0,1 s and 10 000 s, MTIE and TDEV are measured through an equivalent 10 Hz, first order, low-pass measurement filter, at a maximum sampling time τ_0 of 1/30 second. The minimum measurement period, T, for TDEV is twelve times the observation interval (T = 12τ). Further guidance is provided in clause A.2 of EN 300 462-3-1 [4].

6.1 Wander in locked mode

When the SSU is in the locked mode of operation, the MTIE and TDEV measured using the synchronized clock configuration defined in figure 1a) of EN 300 462-1-1 [2] shall have the limits in tables 1 and 2, if the temperature is constant (± 1 K).

Table 1: Wander in locked mode for constant temperature specified in TDEV

Requirement	Observation interval
3 ns	$0,1 < \tau \leq 25$ s
$0,12\tau$ ns	$25 < \tau \leq 100$ s
12 ns	$100 < \tau \leq 10\ 000$ s

Table 2: Wander in locked mode for constant temperature specified in MTIE

Requirement	Observation interval
24 ns	$0,1 < \tau \leq 9$ s
$8\tau^{0,5}$ ns	$9 < \tau \leq 400$ s
160 ns	$400 < \tau \leq 10\ 000$ s

The model used to derive these numbers is described in (informative) annex A. The resultant requirements are shown by the thick solid lines in figures 1 and 2.

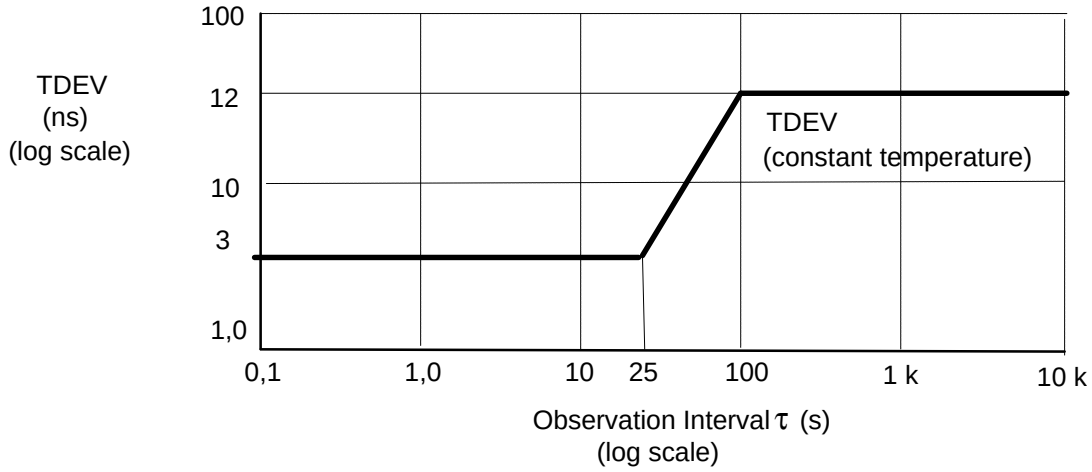

Figure 1: TDEV as a function of an observation interval τ

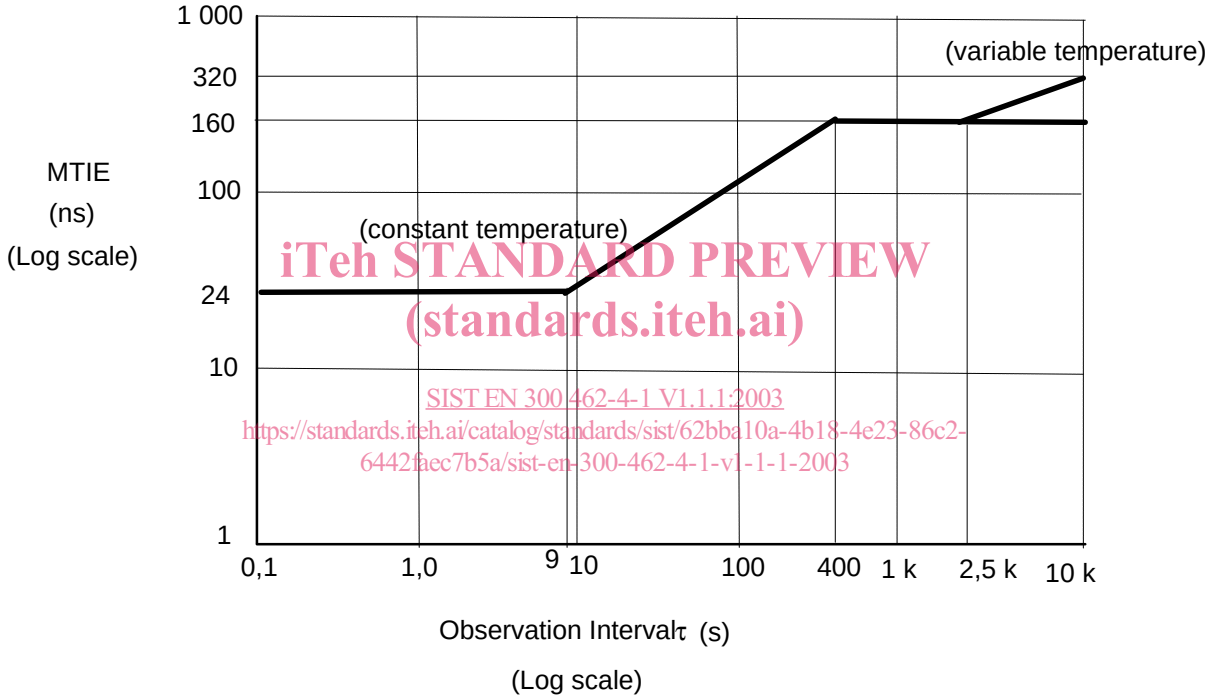

Figure 2: MTIE as a function of an observation interval τ

When temperature effects are included of which the limits and rate of change are defined in ETS 300 019 [1], corresponding to the environmental class to which the equipment belongs, the allowance for the total MTIE contribution of a single SSU is given by the values in table 3.

Table 3: Total wander in locked mode for variable temperature specified in MTIE

Requirement	Observation interval
$3{,}2 \times \tau^{0{,}5}$	2 500 to 10 000 s

NOTE: For observation intervals greater than 10 000 s the MTIE is expected not to exceed 320 ns.

The resultant requirement is shown by the upper solid line in figure 2.