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ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
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Contents

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Foreword

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

The present document is part 7-1 of a multi-part deliverable covering Transmission and Multiplexing (TM); Generic requirements for synchronization networks, as identified below:

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 Statement (ICS) proforma specification";

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 Statement (ICS) proforma specification";

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

National transposition dates	
Date of adoption of this EN:	1 June 2001
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1 Scope

The present document outlines requirements for timing devices called Synchronization Supply Units for local node applications (SSU-Ls). This SSU is used in synchronizing network equipment in the Synchronous Digital Hierarchy (SDH) transport network, in the Public Switched Telephone Network (PSTN) and in the Public Land Mobile Networks (PLMN) for local node applications.

The last SSU in a Synchronization chain, irrespective of the traffic network, provides the applications for this type of clock.

NOTE: 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 the 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 describe the minimum performance of an SSU applied as a local node clock (SSU-L). Requirements for transit node clock applications for SSU's are described in EN 300 462-4-1 [5].

The SSU-L 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 network and equipment.

A timing device within SDH equipment can also conform to EN 300 462-5-1 [6].

The characteristics related to holdover and noise generation performance make this type of clock also suitable for application in the GSM radio sub-system (see TS 100 912 [7]). In particular as a clock used by a Base Station Controller (BSC) or by a Mobile Switching Centre (MSC), further synchronizing (typically via a traffic link) the Base Station (BS). The characteristics of this clock are not optimized for a clock to be implemented in the BS.

In order to fulfil the frequency accuracy requirements required in the GSM radio interface, this clock should be connected to a synchronization network that is properly designed and correctly operating.

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 and/or edition number or version number) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

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

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

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

[4] ETSI 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] ETSI EN 300 462-4-1: "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".

[6] ETSI 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".

[7] ETSI TS 100 912 (GSM 05.10): "Digital cellular telecommunications system (Phase 2+); Radio subsystem synchronization (3GPP TS 05.10 version 8.8.0 Release 1999)".

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

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

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

[11] ITU-T Recommendation O.172: "Jitter and wander measuring equipment for digital systems which are based on the Synchronous Digital Hierarchy (SDH)".

3 Definitions and abbreviations

3.1 Definitions

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

3.2 Abbreviations

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

BS	Base Station
BSC	Base Station Controller
GSM	Global System for Mobile communications
ITU-T	International Telecommunications Union-Telecommunications Standardization Sector
MSC	Mobile Switching Centre
MTIE	Maximum Time Interval Error
NE	Network Element
PDH	Plesiochronous Digital Hierarchy
ppm	parts per million
PSTN	Public Switched Telephone Network
SASE	Stand Alone Synchronization Equipment
SDH	Synchronous Digital Hierarchy
SSU	Synchronization Supply Unit
SSU-L	SSU Local
STM-1opt	Optical STM-1 interface
STM-1el	Electrical STM-1interface

STM-N Synchronous Transport Module-N
TDEV Time DEViation
UI Unit Interval
UIpp Unit Interval peak to peak

A full list of abbreviations used in timing and synchronization is listed in EN 300 462-1-1 [2].

4 Frequency accuracy

The long-term frequency accuracy normally applies when operating in long term free running conditions. Since the SSU-L 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 ±0,5 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-L 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 MTIE and Time Deviation (TDEV) are useful for characterization of noise generation performance.

For observation intervals, τ, between 0,1 and 10 000 s, Maximum Time Interval Error (MTIE) and Time DEViation (TDEV) are measured through an equivalent 10 Hz, first order, low-pass measurement filter, at a maximum sampling time τ_0 of 1/30 s. 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 (ns)	Observation interval (s)
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 (ns)	Observation interval (s)
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 thick solid lines in figures 1 and 2 show the resultant requirements.

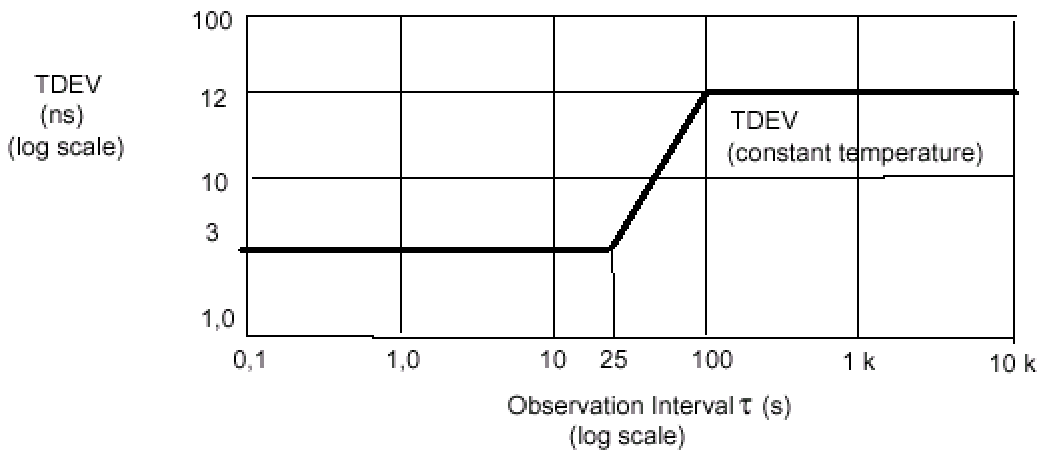

Figure 1: TDEV as a function of an observation interval τ

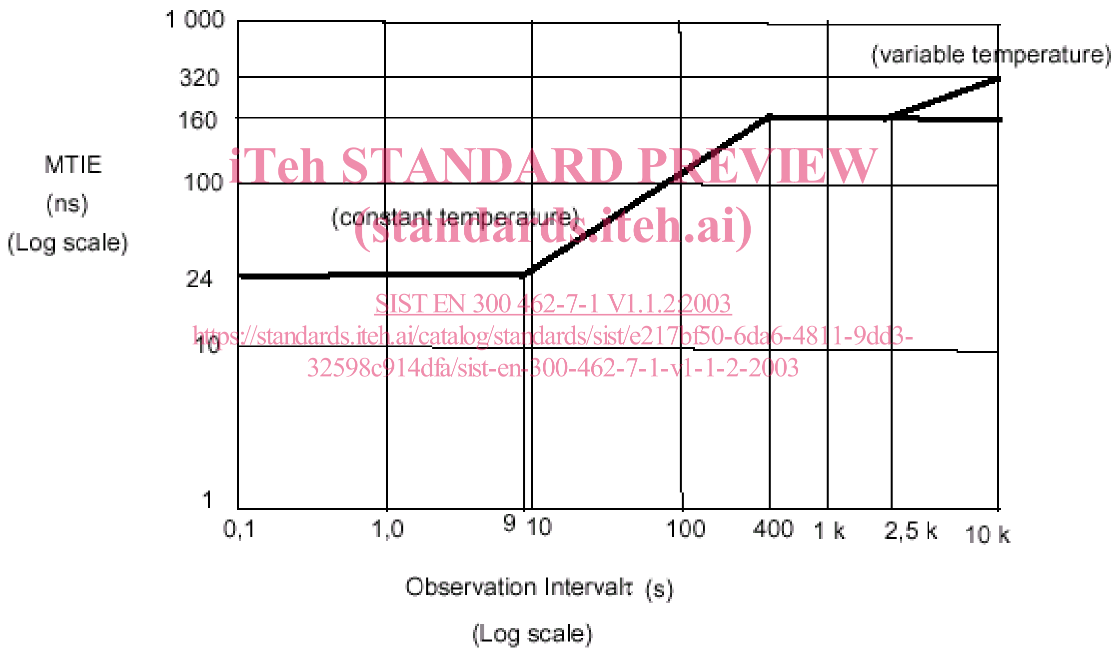

Figure 2: MTIE as a function of an observation interval τ

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-L is given by the values in table 3.

Table 3: Total Wander in Locked Mode for variable temperature specified in MTIE

Requirement (ns)	Observation interval (s)
$3,2\ \tau^{0,5}$	$2\,500 < \tau \leq 10\,000$

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

The upper solid line in figure 2 shows the resultant requirement.

6.2 Non-locked wander

When a clock is not locked to a synchronization reference, the random noise components are negligible compared to deterministic effects like initial frequency offset. Consequently the non-locked wander effects are included in clause 9.2.

6.3 Jitter

While most specifications in the present document are independent of the output interface at which they are measured, this is not the case for jitter production; jitter generation specifications shall utilize existing specifications that are currently specified differently for different interface rates. These requirements are stated separately for the interfaces identified in clause 10. To be consistent with other jitter requirements the specifications are in UIpp, where the UI corresponds to the reciprocal of the bit rate of the interface.

Due to the stochastic nature of jitter, the peak-to-peak values given in this clause eventually are exceeded. The requirements shall therefore be fulfilled with a probability of 99 %.

The functional description for measuring output jitter at a digital interface can be found in ITU-T Recommendation O.172 [11] and instrumentation in accordance with this Recommendation is appropriate for measurement of jitter in SDH systems.

The high-pass measurement filters of the following clauses have a single-order characteristic and a roll-off of 20 dB/decade. The low-pass measurement filters have a maximally flat, Butterworth characteristic and a roll-off of 60 dB/decade. Further specifications for the frequency response of the jitter measurement function such as measurement filter accuracy and additional allowed filter poles are given in ITU-T Recommendation O.172 [11].

6.3.1 Output jitter at a 2 048 kHz and 2 048 kbit/s interface

In the absence of input jitter, the intrinsic jitter at a 2 048 kHz or 2 048 kbit/s output interface as measured over a 60 seconds interval shall not exceed 0,05 UIpp when measured through a band-pass filter with corner frequencies at 20 Hz and 100 kHz.

6.3.2 Output jitter at a Synchronous Transport Module N (STM-N) interface

In the absence of input jitter at the synchronization interface, the intrinsic jitter at STM-N output interfaces as measured over a 60 seconds interval shall not exceed the limits given in table 4.

Table 4: Output jitter requirements for STM-N interfaces

Interface	Measuring filter Hz	Peak-to-peak amplitude UI
STM-1el.	500 to 1,3 M	0,50
	65 k to 1,3 M	0,075
STM-1opt.	500 to 1,3 M	0,50
	65 k to 1,3 M	0,10
STM-4	1 k to 5 M	0,50
	250 k to 5 M	0,10
STM-16	5 k to 20 M	0,50
	1 M to 20 M	0,10
NOTE: for STM-1: 1 UI = 6,43 ns; for STM-4: 1 UI = 1,61 ns; for STM-16: 1 UI = 0,40 ns.		