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G.8262/Y.1362

Corrigendum 1

(11/2016)

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

Packet over Transport aspects – Synchronization, quality and availability targets

SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS AND NEXT-GENERATION NETWORKS

Internet protocol aspects – Transport

Timing characteristics of synchronous Ethernet equipment slave clock

Corrigendum 1

Recommendation ITU-T G.8262/Y.1362 (2015) – Corrigendum 1

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Recommendation ITU-T G.8262/Y.1362

Timing characteristics of synchronous Ethernet equipment slave clock

Corrigendum 1

Summary

Recommendation ITU-T G.8262/Y.1362 outlines requirements for timing devices used in synchronizing network equipments that use synchronous Ethernet. This Recommendation defines the requirements for clocks, e.g., bandwidth, frequency accuracy, holdover and noise generation.

Corrigendum 1 replaces:

– The first equation in clause 11.2.1

– The second equation in clause 11.2.1 (above Figure 13).

History

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Clock, jitter, synchronization, wander.

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Introduction

The synchronous Ethernet method refers to the primary reference clock (PRC) or primary reference time clock (PRTC) distributed method (for instance, based on the global navigation satellite system (GNSS)), or the master-slave method using a synchronous physical layer (e.g., ETY, STM-N). These methods are widely implemented to synchronize time division multiplexing (TDM) and mobile backhaul networks.

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Recommendation ITU-T G.8262/Y.1362

Timing characteristics of synchronous Ethernet equipment slave clock

Corrigendum 1

Editorial note: This is a complete-text publication. Modifications introduced by this corrigendum are shown in revision marks relative to Recommendation ITU-T G.8262/Y.1362 (2015).

1 Scope

This Recommendation outlines minimum requirements for timing devices used in synchronizing network equipments that support synchronous Ethernet. It supports clock distribution based on the network-synchronous line-code methods (e.g., synchronous Ethernet).

This Recommendation allows for proper network operation when a synchronous Ethernet equipment clock (EEC) (Option 1 or 2) is timed from another network equipment clock or a higher-quality clock.

Included in this Recommendation are requirements for clock accuracy, noise transfer, holdover performance, noise tolerance and noise generation. These requirements apply under the normal environmental conditions specified for the equipment.

This Recommendation contains two options for synchronous Ethernet. The first option, referred to as "EEC-Option 1", applies to synchronous Ethernet equipments that are designed to interwork with networks optimized for the 2048-kbit/s hierarchy. These networks allow the worst-case synchronization reference chain as specified in Figure 8-5 of [ITU-T G.803]. The second option, referred to as "EEC-Option 2", applies to synchronous Ethernet equipments that are designed to interwork with networks optimized for the 1544-kbit/s hierarchy. The synchronization reference chain for these networks is defined in clause II.3 of [ITU-T G.813].

A synchronous Ethernet equipment slave clock should comply with all of the requirements specific to one option and should not mix requirements between EEC-Options 1 and 2. In the clauses where one requirement is specified, the requirements are common to both options. It is the intention that EEC-Options 1 and 2 should be harmonized in the future. The intent of the synchronous Ethernet is to interoperate with existing synchronization networks based on [ITU-T G.813].

Careful consideration should be taken when interworking between networks with synchronous Ethernet based on EEC-Option 1 and networks with synchronous Ethernet based on EEC-Option 2.

Some synchronous Ethernet network elements (NEs) may have a higher-quality clock. This Recommendation allows for proper network operation when a synchronous Ethernet equipment (EEC-Option 1 or 2) is timed from either another synchronous Ethernet equipment (like option), or from a SDH equipment clock (SEC), or a higher-quality clock. Hierarchical timing distribution is recommended for synchronous Ethernet networks. Timing should not be passed from a synchronous Ethernet in free-run/holdover mode to a higher-quality clock since the higher-quality clock should not follow the synchronous Ethernet signal during the fault conditions.

Certain Ethernet equipments, such as regenerators/repeaters, must provide through-timing capability to transmit timing via synchronous Ethernet. These equipments are for further study.

More information on synchronous Ethernet can be found in [ITU-T G.781], [ITU-T G.8261] and [ITU-T G.8264].

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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; 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. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T G.703] Recommendation ITU-T G.703 (2001), *Physical/electrical characteristics of hierarchical digital interfaces*.

[ITU-T G.781] Recommendation ITU-T G.781 (1999), *Synchronization layer functions*.

[ITU-T G.803] Recommendation ITU-T G.803 (2000), *Architecture of transport networks based on the synchronous digital hierarchy (SDH)*.

[ITU-T G.810] Recommendation ITU-T G.810 (1996), *Definitions and terminology for synchronization networks*.

[ITU-T G.811] Recommendation ITU-T G.811 (1997), *Timing characteristics of primary reference clocks*.

[ITU-T G.812] Recommendation ITU-T G.812 (2004), *Timing requirements of slave clocks suitable for use as node clocks in synchronization networks*.

[ITU-T G.813] Recommendation ITU-T G.813 (2003), *Timing characteristics of SDH equipment slave clocks (SEC)*.

[ITU-T G.825] Recommendation ITU-T G.825 (2000), *The control of jitter and wander within digital networks which are based on the synchronous digital hierarchy (SDH)*.

[ITU-T G.8261] Recommendation ITU-T G.8261/Y.1361 (2008), *Timing and synchronization aspects in packet networks*.

[ITU-T G.8264] Recommendation ITU-T G.8264/Y.1364 (2008), *Distribution of timing information through packet networks*.

[ITU-T G.8272] Recommendation ITU-T G.8272 (2015), *Timing characteristics of primary reference time clocks*.

[IEEE 802.3] IEEE Standard 802.3 (2012), *IEEE Standard for Ethernet*.

3 Definitions

The terms and definitions used in this Recommendation are contained in [ITU-T G.810].

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

BITS	Building Integrated Timing Source
BPSK	Binary Phase Shift Keying
CSMA/CD	Carrier Sense Multiple Access with Collision Detection
DSL	Digital Subscriber Line
EC	Equipment Clock
EEC	synchronous Ethernet Equipment Clock

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ESMC	Ethernet Synchronization Message Channel
ETH	Ethernet MAC layer network
ETY	Ethernet PHY layer network
GNSS	Global Navigation Satellite System
MAC	Media Access Control
MTIE	Maximum Time Interval Error
NE	Network Element
NRZ	Non-Return to Zero
OAM	Operations, Administration and Maintenance
PAM	Pulse Amplitude Modulation
PHY	Physical (layer)
ppm	parts per million
PRC	Primary Reference Clock
PRTC	Primary Reference Time Clock
SDH	Synchronous Digital Hierarchy
SEC	SDH Equipment Clock
SSM	Synchronization Message Channel
SSU	Synchronization Supply Unit
STM-N	Synchronous Transport Module-N
TDEV	Time Deviation
TDM	Time Division Multiplexing
UI	Unit Interval
UTC	Coordinated Universal Time

5 Conventions

None.

6 Frequency accuracy

6.1 EEC-Option 1

Under free-running conditions, the EEC output frequency accuracy should not be greater than 4.6 ppm with regard to a reference traceable to a [ITU-T G.811] or [ITU-T G.8272] clock.

NOTE – The time interval for this accuracy is for further study. Values of one month and one year have been proposed.

6.2 EEC-Option 2

Under prolonged holdover conditions, the output frequency accuracy of the different types of node clocks should not exceed 4.6 ppm with regard to a reference traceable to a primary reference clock, over a time period T of one year.

NOTE – The time period T applies after 30 days of continuous synchronized operation.

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7 Pull-in, hold-in and pull-out ranges

7.1 Pull-in range

7.1.1 EEC-Option 1

The minimum pull-in range should be ±4.6 ppm, whatever the internal oscillator frequency offset may be.

7.1.2 EEC-Option 2

The minimum pull-in range should be ±4.6 ppm, whatever the internal oscillator frequency offset may be.

7.2 Hold-in range

7.2.1 EEC-Option 1

The hold-in range for EEC-Option 1 is not required.

7.2.2 EEC-Option 2

The hold-in range for EEC-Option 2 should be ±4.6 ppm, whatever the internal oscillator frequency offset may be.

7.3 Pull-out range

7.3.1 EEC-Option 1

The pull-out range is for further study. A minimum value of ±4.6 ppm has been proposed.

7.3.2 EEC-Option 2

The pull-out range is not applicable.

8 Noise generation

The noise generation of an EEC 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 of at least ten times more stable than the output requirements. The ability of the clock to limit this noise is described by its frequency stability. The maximum time interval error (MTIE) and time deviation (TDEV) are useful means for characterization of noise generation performance.

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 seconds. The minimum measurement period for TDEV is twelve times the integration period ($T = 12\tau$).

8.1 Wander in locked mode

8.1.1 EEC-Option 1

When the EEC is in the locked mode of operation synchronized to a wander-free reference, the MTIE measured using the synchronized clock configuration defined in Figure 1a of [ITU-T G.810] should have the limits in Table 1, if the temperature is constant (within ±1°K):

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Table 1 – Wander generation (MTIE) for EEC-Option 1 with constant temperature

MTIE limit [ns]	Observation interval τ [s]
40	$0.1 < \tau \leq 1$
$40\ \tau^{0.1}$	$1 < \tau \leq 100$
$25.25\ \tau^{0.2}$	$100 < \tau \leq 1000$

The resultant requirement is shown by the thick solid line in Figure 1.

When temperature effects are included, the allowance for the total MTIE contribution of a single EEC increases by the values in Table 2.

Table 2 – Additional wander generation (MTIE) for EEC-Option 1 with temperature effects

Additional MTIE allowance [ns]	Observation interval τ [s]
$0.5\ \tau$	$\tau \leq 100$
50	$\tau > 100$

The resultant requirements are shown by the thin solid line in Figure 1.

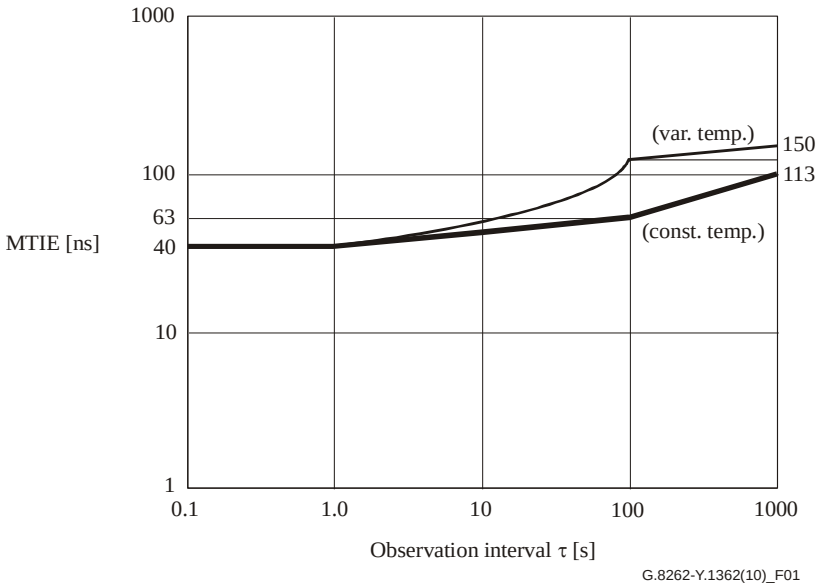

Figure 1 – Wander generation (MTIE) for EEC-Option 1

When the EEC is in the locked mode of operation, the TDEV measured using the synchronized clock configuration defined in Figure 1a of [ITU-T G.810] should have the limits in Table 3, if the temperature is constant (within ±1°K):

Table 3 – Wander generation (TDEV) for EEC-Option 1 with constant temperature

TDEV limit [ns]	Observation interval τ [s]
3.2	$0.1 < \tau \leq 25$
$0.64\ \tau^{0.5}$	$25 < \tau \leq 100$
6.4	$100 < \tau \leq 1000$

The resultant requirements are shown in Figure 2.

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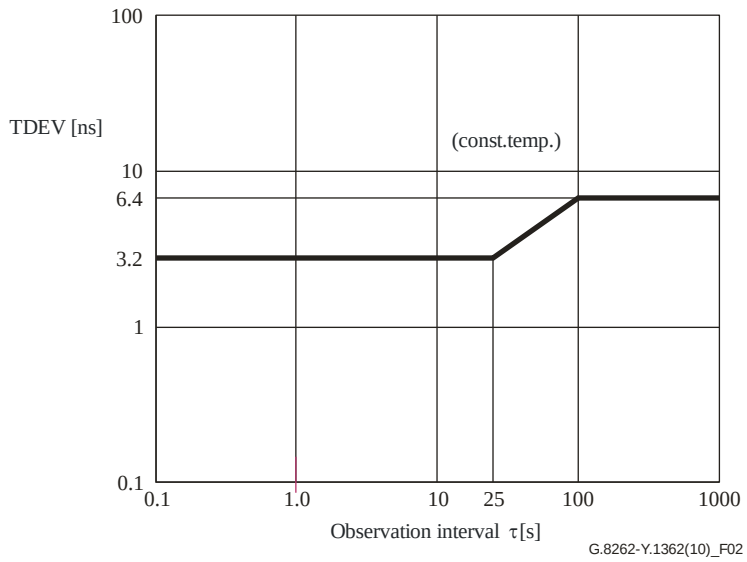

Figure 2 – Wander generation (TDEV) for EEC-Option 1 with constant temperature

The allowance for the total TDEV contribution of a single EEC when temperature effects are included is for further study.

8.1.2 EEC-Option 2

When the EEC clock is in the locked mode of operation synchronized to a wander-free reference, the MTIE and TDEV measured at the output under constant temperature (within ±1°K) shall be below the limits in Tables 4 and 5 respectively.

Table 4 – Wander generation (MTIE) for EEC-Option 2 with constant temperature

MTIE limit [ns]	Observation interval τ [s]
20	$0.1 < \tau \leq 1$
$20\ \tau^{0.48}$	$1 < \tau \leq 10$
60	$10 < \tau \leq 1000$

Table 5 – Wander generation (TDEV) for EEC-Option 2 with constant temperature

TDEV limit [ns]	Observation interval τ [s]
$3.2\ \tau^{-0.5}$	$0.1 < \tau \leq 2.5$
2	$2.5 < \tau \leq 40$
$0.32\ \tau^{0.5}$	$40 < \tau \leq 1000$
10	$1000 < \tau \leq 10\ 000$

The resultant requirements are shown in Figures 3 and 4.

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