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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,
NEXT-GENERATION NETWORKS, INTERNET OF
THINGS AND SMART CITIES

Internet protocol aspects – Transport

Timing characteristics of primary reference time clocks

Recommendation ITU-T G.8272/Y.1367

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Recommendation ITU-T G.8272/Y.1367

Timing characteristics of primary reference time clocks

Summary

Recommendation ITU-T G.8272/Y.1367 specifies the requirements for primary reference time clocks (PRTCs) suitable for time, phase and frequency synchronization in packet networks. It defines the error allowed at the time output of the PRTC.

These requirements apply under the normal environmental conditions specified for the equipment.

History

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

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Recommendation ITU-T G.8272/Y.1367

Timing characteristics of primary reference time clocks

1 Scope

This Recommendation specifies the requirements for primary reference time clocks (PRTCs) suitable for time, phase and frequency synchronization in packet networks. These requirements apply under the normal environmental conditions specified for the equipment.

A typical PRTC provides the reference signal for time, phase and frequency synchronization for other clocks within a network or section of a network. In particular, the PRTC can also provide the reference signal to the telecom grand master (T-GM) within the network nodes where the PRTC is located.

The PRTC provides a reference time signal traceable to a recognized time standard (e.g., coordinated universal time (UTC)). UTC can be obtained from a UTC time laboratory registered at Bureau International des Poids et Mesures (BIPM) (e.g., a national UTC time lab) or, most commonly, from a global navigation satellite system (GNSS).

This Recommendation defines the PRTC output requirements. The accuracy of the PRTC should be maintained as specified in this Recommendation.

This Recommendation also covers the case where a PRTC is integrated with a T-GM clock. In this case it defines the performance at the output of the combined PRTC and T-GM function, i.e., the precision time protocol (PTP) messages.

This Recommendation defines two types of PRTCs, PRTC-A and PRTC-B. The time output of PRTC-B is more accurate than that of PRTC-A. PRTC-B is intended for locations where it is possible to guarantee optimized environmental conditions (e.g., controlled temperature variation in indoor deployments). Examples are central location and large aggregation sites. PRTC-B is related to applications where more accurate absolute time is required. Achieving accurate relative time between timing chains may benefit from deploying PRTC-B clocks in all timing chains.

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.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.8260] Recommendation ITU-T G.8260 (2012), *Definitions and terminology for synchronization in packet networks*.
- [ITU-T G.8271] Recommendation ITU-T G.8271/Y.1366 (2012), *Time and phase synchronization aspects of packet networks*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following term defined elsewhere:

Definitions related to synchronization are contained in [ITU-T G.810] and [ITU-T G.8260].

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

1PPS	1 Pulse-Per-Second
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
MTIE	Maximum Time Interval Error
PRC	Primary Reference Clock
PRTC	Primary Reference Time Clock
PTP	Precision Time Protocol
RF	Radio Frequency
SSU	Synchronization Supply Unit
T-GM	Telecom Grand Master
TDEV	Time Deviation
ToD	Time of Day
UTC	Coordinated Universal Time

5 Conventions

None.

6 Time error, wander and jitter in locked mode

The noise generation of a PRTC is characterized by two main aspects:

- the constant time error (time offset) at its output compared to the applicable primary time standard (e.g., UTC);
- the amount of phase error (wander and jitter) produced at its output.

For characterization of the second aspect described above (phase error) the calculation of the maximum time interval error (MTIE) and the time deviation (TDEV) is useful. There are two types of PRTCs: PRTC-A and PRTC-B.

Clause 6.1 defines the time error requirements applicable at the output of the PRTC, which corresponds to the combination of the two aspects described above (constant time error and phase error). No requirement is defined for the constant time error component taken alone; it is combined with the phase error and not separately measurable.

Clauses 6.2 and 6.3 define the wander and jitter requirements applicable at the output of the PRTC, which correspond to the second aspect described above (phase error).

The performance specified in clauses 6.1 and 6.2, also applies to the output of the combined PRTC and T-GM function when integrated into a single piece of equipment. Therefore, for the PRTC-A, there is no additional allowance for the inclusion of the T-GM function.

NOTE – Optimization of the noise inside the equipment is possible by combining the two functions.

6.1 Time error in locked mode

Under normal, locked operating conditions, the time output of the PRTC-A, or the combined PRTC-A and T-GM function, should be accurate to within 100 ns or better when verified against the applicable primary time standard (e.g., UTC). For PRTC-A this value includes all the noise components, i.e., the constant time error (time offset) and the phase error (wander and jitter) of the PRTC-A. For the combined PRTC-A and T-GM function, time error samples are measured through a moving-average low-pass filter of at least 100 consecutive time error samples. This filter is applied by the test equipment to remove errors caused by timestamp quantization, or any quantization of packet position in the test equipment, before calculating the maximum time error.

Under normal, locked operating conditions, the time output of the PRTC-B, or the combined PRTC-B and T-GM function, should be accurate to within 40 ns or better when verified against the applicable primary time standard (e.g., UTC). For the PRTC-B this value includes all the noise components, i.e., the constant time error (time offset) and the phase error (wander and jitter) of the PRTC-B. For the combined PRTC-B and T-GM function the time error samples are measured through a moving-average low-pass filter of at least 100 consecutive time error samples. This filter is applied by the test equipment to remove errors caused by timestamp quantization, or any quantization of packet position in the test equipment, before calculating the maximum time error.

Normal, locked operating conditions mean that:

- the PRTC is fully locked to the incoming reference time signal, and is not operating in warm-up;
- there are no failures or facility errors in the reference path, including but not limited to antenna failures;
- the environmental conditions are within the operating limits specified for the equipment;
- the equipment is properly commissioned and calibrated for fixed offsets such as antenna cable length, cable amplifiers and receiver delays;
- the reference time signal (e.g., GNSS signal) is operating within limits, as determined by the relevant operating authorities;
- if the reference time signal is operated over a radio system such as a GNSS, multipath reflections and interference from other local transmissions, such as jamming, must be minimized to an acceptable level;
- there are no extreme propagation anomalies, such as severe thunderstorms or solar flares.