

60802 Time Sync – Draft Contribution

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Version 1

PTP Instance requirements

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Table 9 – Required values

Topic	Value
Local Clock, range of fractional frequency offset relative to the nominal frequency	-50 ppm to +50 ppm
Local Clock, range of rate of change of fractional frequency offset	-1,35 ppm/s to +2,12 ppm/s
Working Clock at Grandmaster PTP Instance, range of fractional frequency offset relative to the nominal frequency	-50 ppm to +50 ppm
Working Clock at Grandmaster PTP Instance, range of rate of change of fractional frequency offset	-1,35 ppm/s to +2,12 ppm/s
Working Clock at PTP End Instance, maximum value of frequency adjustment	±250 ppm over any observation interval of 1 ms
Global Time at Grandmaster PTP Instance, range of fractional frequency offset relative to the nominal frequency	-200 ppm to +200 ppm
Global Time at Grandmaster PTP Instance, range of rate of change of fractional frequency offset	-10 ppm/s to +10 ppm/s
Global Time at PTP End Instance, maximum value of frequency adjustment	±1000 ppm over any observation interval of 1 ms

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NOTE The Maximum value of frequency adjustment represents an upper bound that limits how much a PTP End Instance can change the frequency of its Working Clock or Global Time during a given period. However, these adjustments would be incremental rather than instantaneous over the defined interval.

PTP Protocol Requirements

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Table 10 – Protocol settings

Topic	Working Clock	Global Time
Nominal time between successive Announce messages (announce interval)	1 s	
Nominal time between successive Pdelay_Req messages (Pdelay_Req message transmission interval)	125 ms	
Range of allowed time between successive Pdelay_Req messages	119 ms to 131 ms	
Nominal time between successive Sync messages at the Grandmaster (Sync message transmission interval)	125 ms	
Range of allowed time between successive Sync messages at the Grandmaster	119 ms to 131 ms	
Time between reception of a Sync message and transmission of the subsequent Sync message (i.e. residence time) at a PTP Relay instance	Maximum 15 ms Mean \leq 5 ms Standard deviation \leq 1,8 ms	
Maximum time between transmission of a Sync message and transmission of the related Follow_Up message	2,5 ms	
ClockSlave (servo controller)	Maximum Bandwidth (Hz): 2.6 Hz Maximum Gain Peaking (dB): 1.3 dB Minimum absolute value of Roll-off: 20 dB/decade	

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Error Generation Requirements - GM

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Table 11 – Error generation limits for Grandmaster PTP Instance

Topic	Value
Working Clock when Sync message is transmitted minus <u>preciseOriginTimestamp</u> field in Sync message	-6 to +14 ns <u>or ?</u> Mean +4 ns +/- 2 ns Standard Deviation ≤ 2 ns
Rate Ratio between Working Clock and Local Clock when Sync message is transmitted minus <u>rateRatio</u> field in Sync message	Mean 0 ppm +/- 0,1 ppm Standard deviation ≤ 0.1 ppm

Error Generation Limits – PTP Relay – 1

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Table 12 – Error generation limits for PTP Relay Instance

Topic	Value
Output Correction Field error* when <ul style="list-style-type: none">• Maximum absolute value of rate of change of fractional frequency offset for LocalClock at the Grandmaster is $\leq 0,1$ ppm/s (Origin Timestamp)• Input Rate Ratio field is zero.• Correction field is zero.• Maximum absolute value of rate of change of fractional frequency offset for LocalClock at upstream node is $\leq 0,1$ ppm/s (determining <u>pDelayResp</u>, from which NRR is calculated, but not affecting Input Rate Ratio field)	Mean 0 ns +/- 2 ns Standard deviation ≤ 2 ns
Output Rate Ratio error** when <ul style="list-style-type: none">• Maximum absolute value of rate of change of fractional frequency offset for LocalClock at the Grandmaster is $\leq 0,1$ ppm/s (Origin Timestamp)• Input Rate Ratio field is zero.• Correction field is zero.• Maximum absolute value of rate of change of fractional frequency offset for LocalClock at upstream node is $\leq 0,1$ ppm/s (determining <u>pDelayResp</u>, from which NRR is calculated, but not affecting Input Rate Ratio field)	Mean 0 ppm +/- 0,1 ppm Standard deviation ≤ 0.05 ppm

Error Generation Limits – PTP Relay – 2

<p>Output Rate Ratio error** when</p> <ul style="list-style-type: none">• Maximum absolute value of rate of change of fractional frequency offset for LocalClock at the Grandmaster is $\leq 0,1$ ppm/s (determining Input Origin Timestamp)• Input Rate Ratio field increasing at 2 ppm/s with each input field including a noise component with uniform distribution between -1 ppm/s and + 1 ppm/s.• Correction field is zero.• Maximum absolute value of rate of change of fractional frequency offset for LocalClock at upstream node is $\leq 0,1$ ppm/s (determining <u>pDelayResp</u>, from which NRR is calculated, but not affecting Input Rate Ratio field)	<p>Mean 0 ppm +/- 0,1 ppm Standard deviation ≤ 0.2 ppm</p>
<p>Output Rate Ratio inverse error*** when</p> <ul style="list-style-type: none">• Maximum absolute value of rate of change of fractional frequency offset for LocalClock at the Grandmaster is $\leq 0,1$ ppm/s (determining Input Origin Timestamp)• Input Rate Ratio field is zero.• Correction field is zero.• Maximum absolute value of rate of change of fractional frequency offset for LocalClock at upstream node is increasing at 2 ppm/s with each input field including a noise component with uniform distribution between -1 ppm/s and + 1 ppm/s. (determining <u>pDelayResp</u>, from which NRR is calculated, but not affecting Input Rate Ratio field)	<p>Mean 0 ppm +/- 0,1 ppm Standard deviation ≤ 0.1 ppm</p>

Error Generation Limits – PTP Relay – 3

1684 |* Output Correction Field error is:

1685 Output correctionField – Input correctionField – measured residence time

1686 ** Output Rate Ratio error is the difference between the output Rate Ratio field and the measured
1687 Rate Ratio at the time the output Rate Ratio is transmitted.

1688 rateRatio – actual rate ratio when a Sync message is transmitted

1689 Where rateRatio is calculated from the cumulativeScaledRateOffset in the Sync message or
1690 related Follow_Up message

1691 *** Output Rate Ratio inverse error is

1692 rateRatio - $\frac{1}{\text{actual rate ratio at upstream node when a Sync message is transmitted}}$

1693 Where rateRatio is calculated from the cumulativeScaledRateOffset in the Sync message or
1694 related Follow_Up message

1695 This is used because increasing the fractional frequency offset of the Local Clock at the
1696 upstream PTP Relay instance while the Input Rate Ratio field remains zero is similar to
1697 decreasing the fractional frequency offset of the Local Clock at the current PTP Relay instance.
1698 See Annex C for more information.

Error Generation Limits – End Instance – 1

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Table 13 – Error generation limits for PTP End Instance

Topic	Value
<p>Time error* when</p> <ul style="list-style-type: none"> • Maximum absolute value of rate of change of fractional frequency offset for LocalClock at the Grandmaster is $\leq 0,1$ ppm/s (Origin Timestamp) • Input Rate Ratio field is zero. • Correction field is zero. • Maximum absolute value of rate of change of fractional frequency offset for LocalClock at upstream node is $\leq 0,1$ ppm/s (determining <u>pDelayResp</u>, from which NRR is calculated, but not affecting Input Rate Ratio field) 	<p>Mean 0 ns +/- 2 ns Standard deviation ≤ 3 ns</p>
<p>Time error* when</p> <ul style="list-style-type: none"> • Maximum absolute value of rate of change of fractional frequency offset for LocalClock at the Grandmaster is $\leq 0,1$ ppm/s (determining Input Origin Timestamp) • Input Rate Ratio field increasing at 2 ppm/s with each input field including a noise component with uniform distribution between -1 ppm/s and + 1 ppm/s. • Correction field is zero. • Maximum absolute value of rate of change of fractional frequency offset for LocalClock at upstream node is $\leq 0,1$ ppm/s (determining <u>pDelayResp</u>, from which NRR is calculated, but not affecting Input Rate Ratio field) 	<p>Mean 0 ns +/- 2 ns Standard deviation ≤ 5 ns</p>

Error Generation Limits – End Instance – 2

Topic	Value
<p>Time error* when</p> <ul style="list-style-type: none">• Maximum absolute value of rate of change of fractional frequency offset for LocalClock at the Grandmaster is $\leq 0,1$ ppm/s (determining Input Origin Timestamp)• Input Rate Ratio field is zero.• Correction field is zero.• Maximum absolute value of rate of change of fractional frequency offset for LocalClock at upstream node is increasing at 2 ppm/s with each input field including a noise component with uniform distribution between -1 ppm/s and + 1 ppm/s. (determining <u>pDelayResp</u>, from which NRR is calculated, but not affecting Input Rate Ratio field)	<p>Mean 0 ns +/- 2 ns Standard deviation ≤ 4 ns</p>

1703 *Time error is the difference between the time of the Clock used to generate the
1704 preciseOriginTimestamp fields of the incoming Sync messages, for either Working Clock or
1705 Global Time domain, and the output of the Working Clock or Global Time domain respectively
1706 at the PTP End Instance.

Thank you!

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