

T-TC Time Error

Testing Transparent Clocks as per ITU-T G.8273.3 using Paragon-X

- Noise Generation
- Noise Tolerance
- Noise Transfer
- Transient Response
- Holdover Performance

The accuracy of Telecom Transparent Clocks (T-TCs) is essential to the successful roll-out of LTE-A and TDD-LTE. To meet the new G.8273.3 compliance limits, T-TCs must meet a very stringent constant Time Error (cTE) limit of 20 or 50 nanoseconds depending on device class. This ensures that the maximum number of nodes can be deployed within the network's Time-Error budget.

This Test Guide shows how the Calnex Paragon-X can be used to prove T-TC compliance to G.8273.3 and provides procedures to measure noise generation, time noise tolerance and transfer, packet layer transient response and holdover performance.

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1. Hardware and Software Required

Paragon-X

Option 110	1GbE interface support
Option 111	10GbE interface support (if DUT has 10G interface)
Option 201	Advanced IEEE1588v2 features
Option 205	Wander measurement
Option 206	Phase and time measurement
Option 213	SyncE wander and ESMC (if DUT uses SyncE)
Option 250	IEEE 1588v2 One-box T-BC, T-TC and OC Test
Option 133	External 1pps/ToD/Frequency Converter accessory (if required to match DUT outputs)

Software versions:

- Paragon-X: X.10.35.xx and later
- Calnex Analysis Tool (CAT): v18.xx and later

Note: Calnex recommends checking the Calnex website for access to the latest software release versions.

Accessories

- SFP or SFP+ devices as required¹
- Cables as required
- Calnex BNC/RJ-45 adapter cable (required for 1pps accuracy/time error measurement)

Frequency Reference Source

Option 132 Rubidium Interface (optional)

Document References

- Recommendation ITU-T G.8273.3 Timing Characteristics of Telecom Transparent Clocks
- IEEE Std 1588[™] -2008 IEEE Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems
- Tech Note Cabling Considerations Document [CX5009]

¹ XFP devices are not recommended for Time Error measurements as the retiming that is an integral element of the XFP introduces significant uncertainty when performing a Time Error test

2. Connecting Paragon-X to T-TC (Device under Test)



Front Panel

- 100MbE Electrical or Optical (SGMII SFP)
- 1GbE Electrical or Optical (SFP) with option 110 fitted
- 10GbE Optical (XFP or SFP+) with option 111 fitted



Rear Panel

The Paragon-X accepts the following reference clocks which should be applied to one of the reference inputs on the rear panel of the Paragon-X:

- 2.048/10MHz
- E1 (2.048Mb/s)
- DS1 (T1) (1.544Mb/s)



Connections

- 1. Connect Port 1 (Master side of Paragon-X) to the T-TC Master side.
- 2. Connect Port 2 (Slave side of Paragon-X) to the T-TC Slave side.
- 3. Connect the external reference, e.g. 10MHz, to the Paragon-X Reference Input.

3. Setting up the Paragon-X for G.8273.3 Conformance Tests

The following steps are required to set up the Paragon-X prior to performing the G.8273.3 Conformance tests:

- 3.1. Connection to Paragon-X from GUI
- 3.2. Selection of 1588 Operating Mode and Master/Slave Emulation
- 3.3. Configuration of physical connections
- 3.4. Measurement configuration
- 3.5. Preparing Master/Slave Emulation operation
- 3.6. Confirm PTP traffic on interfaces
- 3.7. Filtering capture traffic
- 3.8. Start of Master/Slave Emulation ready for test

3.1 Connection to Paragon-X from GUI

- 1. Verify the physical connections have been completed as described in Section 2.
- 2. Start the Paragon-X GUI.
- 3. Select Start Up and Connect.
- 4. Enter the IP address of the Paragon-X (displayed on Paragon-X status display).

3.2 Selection of 1588 Operating Mode and Master/Slave Mode

Select Operating Mode and enable 1588v2 and Master/Slave Emulation.



3.3 Configuration of physical connections

Select Setup Interface then Line Rate to match the T-TC under test.

File Instrument(s) Setup	Capture Impair Graph Data Tools Help	
🗃 🖬 🛲 🗰 🙀	🗜 🚰 🞾 R 🚿 😃 🔍 🔲 📧 🐭 📰 🗖	
Start Up	SETTINGS Port Packet# Byte# HE>	X Binary Filter UserLabel
Operating Mode	1GBE 1GBP N/A Setup Interface N/A	
Setup Interface	Thru: TERMII	
Master/Slave/GPS Emulation	STATUS Sync-E Clock Rx -> Tx ()	
Measurements	Link Good Pkts	
Select Flow	Port 1 Line Rate Wander 0 100MbE 0 1GbE 10GbE	Port 2 Line Rate 100MbE 10GbE 10GbE
Configure Capture	IPPS Ref Jitter	Interface
Start Capture	FLOW FILTEF Port 1 Rx	Auto Negotiate
Add Impairments/ Delay	Flow 1: xxx GbE Electrical Phy Settings Flow 2: xxx Image: Flow 3: xxx Image: Flow 3: xxx Image: Flow 3: xxx	ort 2
Add Wander	Flow 4: xxx Set) Master 💿 Slave
Add Jitter		Close

3.4 Preparing for Master/Slave Emulation

It is assumed that a G.8275.1 profile will be used in testing to the G.8273.3 standard and as a result testing will be carried out using L2 encapsulation in Multicast mode. The Master/Slave Emulation can be configured to use other profiles, e.g. using Unicast UDP/IPV4 etc., however, it should be noted that these profiles will not conform to the G.8273.3 standard.

1. Select *Master/Slave Emulation* then select *Transparent Clock* in the *Test Configuration* drop down menu.

File Instrument Setup Captu	ure Impair Graph Data Tools	Help				
*••••						
Start Up	<< Results	Test Setup	Custom Profile	•		
Operating Mode	Device Configuration Master + Slave Two Masters					
Setup Interface	Configure	GPS Emulation Calnex Paragon-)	Ref In			
Master/Slave/GPS Emulation	Test Configuration Boundary Clock Slave Test	Master	Slave			
Measurements	General Purpose Transparent Clock Boundary Clock Master Test	Capture Accuracy Master Tr.				
Select Flow	Time Aware Bridge Time Aware End Station Tpps meas. cable (ns):	Ti mpairment Wander				
Configure Capture	Capture	Capture Master Rx	Capture Slave Rx			
Start Capture	C Slave C Rx on both	Port 1	Port 2			
Add Impairments/ Delay	Measurement	1 pps/ToD 2M/TI,	EI			
Add Wander	Calibration	D.U.T.				
Add Jitter	Start					
Packet Generation						
Statistics/ Results	Apply changes	Master + Slave				

2. Select **G.8275.1** profile from the **Custom Profile** drop down menu.



Calibration

Auto-calibration

By default, the Paragon-X uses the same interface types on both sides of the T-TC. If this is the case then the end-toend delays from the Paragon-X Master to the Paragon-X Slave including the cable delays can be factored out of the measurements by carrying out an auto-calibration step.

To do this you must connect the cables to be used in the test together using a passive connector so that there is a complete path from the Paragon-X Master to the Paragon-X Slave. When this is done, press the **Calibration** button.



This will carry out a measurement that will calibrate the delays. When complete the LED which change to green.



Manual calibration

If the test set up has different interface types on each port (e.g. 1Gb Electric and 1Gb Optical) then auto-calibration cannot be performed. In this case the cable delays must be entered manually for the cables on either side of the T-TC connected to the Paragon-X.

Select *Manual calibration* and enter the DUT to Paragon-X **cable delay**. Values of 5.1 ns per 1 metre of electrical cable and 4.9 ns per 1 metre of optical cable can be expected. Only full nanosecond values are counted, so calculated values need to be rounded up or down to the nearest full nanosecond value.



3.5. Confirm PTP traffic on interfaces

1. Check the link to make sure that the PTP packets are running without error. If working successfully both Link and **Packet** status should show green status.

Link Status					
Port	Link		Rx Packet		
1	0	0	GOOD PACKETS		
2	0	Θ	GOOD PACKETS		

2. Stop Master/Slave Emulation in order to configure capture characteristics and to enable impairment operation.

3.6. Filtering capture and impairment traffic

The tests detailed in Sections 4 to 7 of this document are dependent on the generation, capture and impairment of the 1588 messages associated with T-TC phase and sync performance. It is therefore necessary to ensure that the correct messages are handled by the Paragon-X in Master/Slave Emulation mode. This is achieved by defining a set of traffic filters which will determine the messages that are captured and impaired.

By default, the capture filters are automatically enabled for the Transparent Clock test when the **Start** button is pressed in the **Master/Slave Emulation** Test Configuration window.

4. Noise Generation – G.8273.3 Section 7.1

Test Description

The noise generation of a T-TC represents the amount of noise produced at the output of the T-TC when there is an ideal input reference packet timing signal and, if the T-TC is supporting physical layer frequency reference, an ideal physical layer reference. The noise generation has two components, the constant time error (cTE) and the time noise generation (Max|TE|, dTE).

Measurement Process

The standard specifies that the test should be carried out with both PTP and SyncE active.

Note: The Master/Slave Emulation Configuration steps described in Section 3 must be performed prior to this test. **Impairments are not required for this test.**

4.1.Test Procedure

 To enable SyncE, select *Packet Generation* with SSM code of *QL_PRC*. To start ESMC generation click on the Start button.

File Instrument(s) Setup	Capture Impair Graph Dat	Packet Generation	
📽 🔲 🚥 👹 🏣 💕	📲 🎜 🎜 R 🛛 🛞 🔶 🌒	ESMC TestPackets	
Start Up	SETTINGS Ethemet	Ethernet Source MAC Address 00:00:00:00:2b	<mark>∕</mark> se
Operating Mode	N/A N/A	Port 1 Port 2	
Setup Interface	Thru: TERMINATED	Injection Settings IPG 1000 ms Stop	
Master/Slave/GPS Emulation	STATUS Reset History	VLAN Encapsulation Apply Change	
Measurements	Port 1 Link Link Good Pkts Good Pkts	OFF ON Number of streams 1	
Select Flow	Ref SyncE Wander	Stream 1 Stream 2 Stream 3 Stream 4	
Configure Capture	1PPS Ref 1PPS Meas Jitter	TPID 88 09 SSM Code QL-PRC V Veve Flag	
Stop Capture	FLOW FILTER	PCP 7	
Add Impairments/ Delay	Flow 1: SET Flow 1: xxx Flow 2: xxx Flow 2: SET Flow 3: xxx Flow 3: SET	CFI 0 0 0 1 VID 11	
Add Wander	Flow 4: xxx Flow 4: SET Set Clear		
Add Jitter			
Packet Generation			
Statistics/ Results			
		Close	

2. With Master/Slave Emulation mode running, start a capture using the *Start* button in the Master/Slave *Test Setup* page.

File Instrument Setup Capture Impair Graph Data Tools Help						
🛎 🖬 🛥 🖬 📽	💒 💴 🎦 R 🛛 📈 C 🔍					
Start Up	<< Results	Test Setup	G.8275.1 Phase Profile	•		
	Device Configuration					
Operating Mode	 Master + Slave Two Masters 					
	GPS Emulation					
Setup Interface	Configure	GPS Emulation	Ref In			
Master/Slave/GPS	Test Configuration	Callex Palagori A				
Emulation	Transparent Clock	Master	Slave			
Measurements	DUT Ethernet cable (ns):		T I			
Coloct Flow	1pps Ref. cable (ns): 0					
SCIECCITION	1pps Meas.	To Provide Anticipation				
Configure Capture	cable (ris):					
	Capture C Master	Capture Master Rx	Capture Slave Rx			
Start Capture	C Slave					
	Flow Filter	Port 1	Port 2			
Delay		l II				
	Measurement					
Add Wander	Calibration	Traffic Clock				
Add Jitter	Start	Generator				
Packet						
Statistics/ Results	Apply changes	Master + Slave				
Statistics/ Results	Apply changes	Master + Slave				

- 3. Allow the capture to run for at least 2000s. Then use the Stop Capture button to stop the capture.
- 4. Measurements: Time Error results can either be viewed during capture or after capture has been stopped.

Time Error Results (Constant Time Error)

1. Select Tools > Calnex Analysis Tool (1588v2) > Transparent Clock Accuracy Measurement.

	Tools Help			
<	1588 Transparent Clock Latency Calculate differential PDV			
1	Split PDV files	ie Inter-Packet T	i messaaeTvpe	🗾 📈 sec
	Join CSV files	0.0000000	00 DEL-REQ	
l	PDV Editor	0.000025	i00 SYNC	
l	File Converter	0.0000185	i60 DEL-RESP	:
l	Seriet Decender	0.0624787	75 DEL-REQ	:
l	View Deserded Script	0.0000031	35 SYNC	
	view Recorded Script	0 0.0000243	20 DEL-RESP	
l	PTP Field Verifier	75 0.0624723	85 DEL-REQ	
l	Logging •	0 0 000031	35 SYNC	
8	Plot PDF/CDF/Histogram	Min/Max:	ords:	
ł	Calnex Analysis Tool (1588v2)	Transparent Clock /	Accuracy Measurement	
	-m0.002 +10 +20000 -010A-	Time Error Measure	ment	
cta	0.065ຮົບ327ບ	PDV		
_				

The *Calnex Analysis Tool* will launch and display the *Time Error* metrics tab. This will include the metrics **Time Error**, **Avg Time Error (cTE)** and **Dynamic Time Error**.

₩ 01 T		Application System Help
Select File	Time Error Avg Time Error (cTE) Dynamic Time Error	Mask Status >>>
	Way Time Error	No metrics with active masks
Select Metrics	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	Chart Tools >>>
View Results	₩ 0 <u> </u>	Markers Editor Marker 1 Marker 2 🗃
Generate Report	11 Time Error Min [ns]: -16, Max [ns]: 4, Mean [ns]: 8.774	- Chart & Zoom mode
Export	Elapsed Time (s)	♥ Fit ♥ Fit
	Lapsed Time [s] Lapsed Time	 Errors Labels Markers Autohide Threshold Statistics Save As Image
	Fwd Latency Soon ↓ So	X-Axis Display Format: Elapsed Time
	Fwed CF Delta Fund CF Delta Min [ns]: 4957, Max [ns]: 5245, Mean [ns]: 5102.054 ✔ 5 000 1000 2 000 3 000 ● 6 1000 2 000 3 000 ● <td>Max TE Limit +/- 2Way Time Error: 1.1</td>	Max TE Limit +/- 2Way Time Error: 1.1
Caiculate 100% Cainex	Elapsed Time [s] En Rev CF Delta \$ \$ \$000 Part CF Delta \$ \$ \$ \$000 Part CF Delta \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$	I.1 FAPPly

The key measurement for T-TC Time Error is the **2Way Time Error** result for the above metrics. Focus should be placed on the analysis of this result.

T1 and T4 results are useful in the case where further analysis is required investigate issues raised by the 2Way result values.

Note: The complete set of metrics can be viewed by expanding the appropriate list in the **Measurement Analysis** block by clicking on the + symbol against each metric.

Time Error Measurements	?
 Time Error Way Time Error T1 Time Error T4 Time Error Fwd Latency Fwd CF Delta Rev Latency Rev CF Delta 	? 100% 100% 100% 100% 100% 100%
 Avg Time Error (cTE) Dynamic Time Error 	100% ~ ? 100% ~ ?

6/1 Application System * Heir Time Error Avg Time Error (cTE) Dynamic Time Error Mask Status Select File No metrics with active masks 2Way Time Error lime Error (r 📔 Select Metrics 0 2Way Time Error Chart Tools Þ Min [ns]: -6.5, Max [ns]: 6.5, Mean [ns]: -1.6(4 ers Editor View Results 1 000 2 000 sed Time (s) 3 000 ы Marker 1 Marker 2 💼 T1 Time Error 0 - T1 Time Error Generate Report Time Error (r <mark>|</mark> Chart & Zoom mode Min [ns]: -16, Max [ns]: 4, Mean [ns]: -8.774 🛃 +1 □ + B Export 2 000 d Time [s] 3 000 🔽 Fit Visible Elements T4 Time Error Time Error (r 🧗 🖌 Errors 🖌 Labels 🖌 Markers o - T4 Time Error Min [ns]: 1, Max [ns]: 10, Mean [ns]: 5.565 📝 Autohide Threshold Statistics B 1 000 3 000 2 000 Elapsed Time [s] Save As Image Fwd Latency X-Axis Display Format: Latency [n: 5 500 - Ewd La Min (ns): 4959, Max (ns): 5254, Mean (ns): 5110.828 Elapsed Time 5 000 -B 1 000 3 000 2 000 Elapsed Time (s ne ísi Parameters * Fwd CF Delta 5 500 -CF Delta [n <mark>|</mark> Max TE Limit +/ Min [ns]: 4957, Max [ns]: 5245, Mean [ns]: 5102.054 🚽 5 000 -<mark>1</mark> 0 1 000 2 000 Elapsed Time [s] 3 000 B 🗘 µs Apply **1.1** Rev Latency ŝ 1.1 1 us Apply Min [ns]: 4954, Max [ns]: 5244, Mean [ns]: 5099.614 5 000 B 3 000 ■ 1.1 ⁺ µs Apply Elapsed Time [s] Rev CF Delta CF Delta [n 🧗 Boy Min [ns]: 4949, Max [ns]: 5237, Mean [ns]: 5094.048 B 1 000 2 000 Time [s] 3 000 Caln

Individual graphs can be displayed by clicking on the highlighted area in the display below.

This will display:



To return to the multi graph display click on the same icon in the single graph display.

 Select the Avg Time Error (cTE) metric tab and this will show the 2Way Avg Time Error (cTE) graph. This is a measure of the timing being delivered by the egress 1588 PTP flow and is the best view of the core data. The Constant Time Error value will be displayed. This result can expose the underlying phase movement, significant to the slave.

G.8273.3 refers to Constant Time Error stating:

"Note: Constant time error and the method to estimate are defined in G.8260. For the purpose of testing the limits in Table 1, an estimate of constant time error should be obtained by averaging the time error sequence over 1000s."

To cater for this definition, the Constant Time Error displayed is a result of a moving average of 1000s being applied to the raw Time Error results.



3. Check your result conforms to the G.8273.3 spec [1.4.1].

There are two classes of device:

- Class A for devices which conform to ±50ns cTE
- + Class B for devices which conform to $\pm 20 \text{ns} \text{ cTE}$

Check with the vendor which class of device is being tested.

Further Analysis (Optional)

- Although not part of the standard test, further analysis can be provided by repeating the test for T1 and T4 constant Time Error to inspect for patterns and/or offsets.
- For further analysis, select the *Time Error* tab for unfiltered Time Error results i.e. *2Way Time Error*, *T1 Time Error (forward)* and *T4 Time Error (reverse)* to further characterise the T-TC. These raw Time Error results containing both Constant and Dynamic Time Error may be useful as a troubleshooting aid.

Time Error Results (Dynamic Time Error)

4. Select the **Dynamic Time Error** tab to display the **filtered** Time Error results. This will display the Dynamic Time Error results as Low Frequency measurements and High Frequency measurements.





- 5. Compare the results against the ITU-T limits by applying the appropriate mask to the **2Way Dynamic MTIE LF** metric to match the class of the device under test:
 - G.8273.3 T-TC Class A Dynamic TE LF Const. Temp
 - G.8273.3 T-TC Class B Dynamic TE LF Const. Temp



 Check for PASS/FAIL versus masks. If the masks pass then the status in the Mask Status Block will indicate PASS Mask failure will be indicated by FAIL

Time Error Results (MaxITEI)

7. Select the *Time Error* tab to display the **raw unfiltered** Time Error results.

₩ 6 21 T			Application	System Help
Select File	Time Error Avg Time Error (cTE) Dynamic Time Error		Mask Statu	s ++
	👞 2Wav Time Error	No metrics with active		tive masks
Select Metrics	40	*	Metric Statist	ics ++
View Results		2	Mean (ns)	-1.604
	30		Min [ns] Max [ns]	-6.5
Generate Report	30	e	Max-Min [ns]	13
Export		~	Fwd Messages Rev Messages	57601 57601
CAPOIT	20 -		Forward Rate	16.00/second
		-	Reverse Rate	16.00/second
		1	Forward One-step TC Reverse One-step TC	clock detected
	10 -		Chart Task	choon doubled
			Markers Editor	
			Marker 1 Mar	ker2 🗊
			Chart & Zoom mode	
	-10 -			
			Close Singl	e View
		Í	Visible Elements	a 📆 Martinan
	-20 -		Autohide T	hreshold
			Save As I	mage
	20	ų r	X-Axis Display Form	at:
Calculate			Elapsed Time	۱ • ۱
100%		1	Daramotore	
<u> </u>	40 0 1000 2000 3000		Parameters	
Lainex	Elapsed Time (s)	Ī	Max TE Limit +/-	

8. Click on the **Select Metrics** button, then select the **2Way Time Error** metric only. This will display the following graph:

₩ 62 1		Application System Help
Select File	Time Error Avg Time Error (cTE) Dynamic Time Error	Mask Status 🔹 🕨
	👞 2Way Time Error	No metrics with active masks
Select Metrics	Endy Time Error Min [ns]: -6.5, Max [ns]: 6.5, Mean [ns]: -1.604	Chart Tools >>>
View Results		Markers Editor
	Elepsed Time [s]	Marker 1 Marker 2 💼
Generate Report	E _ T1 Time Error Min [ns]: -16, Max [ns]: 4, Mean [ns]: -8.774	Chart & Zoom mode
Export		↔ L ++
	Elapsed Time [s]	Visible Elements
	Image: Second	Errors Z Labels Z Markers
		Autohide Threshold Statistics
	Elapsed Time (s)	Save As Image
	E 500 1 Fund Latency Min [ns]: 4959 Max [ns]: 5254 Mean [ns]: 5110.828	X-Axis Display Format:
	Elapsed Time (s)	Parameters >>
	▲ Fwd CF Delta	Max TE Limit +/-
		2Way Time Error:
	Elapsed Time [s]	T1 Time Error:
	Kev Latency ⁵ ⁵⁵⁰⁰ Rev Latency Min [ne]: 4054 May [ne]: 5244 Mean [ne]: 5099 614	🗖 1.1 🌲 µs Apply
		T4 Time Error:
Calculate	Elapsed Time [s]	🔲 1.1 🌲 µs Apply
100%	Rev CF Delta Solo Deve of Delta Min fact: 4040, Max fact: 6027, Maan fact: 6004.048	
	5 000	
Calnex	Elapsed Time [s]	

- 9. Set the MaxITEI limit to either **100ns** for **Class A** devices or **70ns** for **Class B** devices. This will change the **Thresholds** on the graph.
- 10. Compare the results against the thresholds.



5. Time Noise Tolerance – G.8273.3 Section 7.2

Test Description

This test checks whether the clock can maintain network limits at the output with maximum noise at the input.

Measurement Process

The standard recommends testing by stressing only the SyncE input. This is reflected in the test procedure detailed below.

Note: The Master/Slave Emulation Configuration steps described in Section 3 must be performed prior to this test.

Test Procedure

- 1. To enable SyncE ESMC Generation, select *Packet Generation* with SSM code of *QL_PRC*.
- 2. To start ESMC generation press the *Start* button.

ile Instrument(s) Setup	Capture Impair Graph Dat	Packet Generation
📽 🖬 🛲 🛲 🚔	San that the R ∞ ● ●	ESMC TestPackets
Start Up	SETTINGS Ethernet 1GBE 1GBE	Ethernet Source MAC Address 00:00:00:00:00:2b
	N/A N/A	Port 1 Port 2
Setup Interface	Thru: TERMINATED	Injection Settings Start IPG 1000 ms Store
Master/Slave/GPS Emulation	STATUS Reset History	VLAN Encapsulation Apply Change
	Port 1 Link Good Pkts Good Pkts	OFF ON Number of streams 1
Select Flow	Ref SyncE Wander	Stream 1 Stream 2 Stream 3 Stream 4 VLAN Tag ESMC Packet
Configure Capture	1PPS Ref 1PPS Meas Jitter	TPID 88 09 SSM Code [QL-PRC] 2015; Flag
Stop Capture	FLOW FILTER	PCP 7
Add Impairments/ Delay	Flow 1: SET Flow 1: xxx Flow 2: xxx Flow 2: SET Flow 3: xxx Flow 3: SET	CFI 0 0 1 VID 11
Add Wander	Flow 4: xxx Flow 4: SET Set Clear	
Add Jitter		
Packet Generation		
Statistics/ Results		
		Close

 Select Add wander > Wander Tolerance > Table to apply sinusoidal wander to the SyncE input based on G.8262 Section 9.1.1 Table 9.

Freq	uency (Offset Wand	er tolerance	wander Transfer			
art Up	Single	\sim T	able \sim	MTIE/TDEV Mask			
ing Mode	Enable	Frequency (Hz)	Amplitude (us)	Dwell Time (Cydes)	Status	Restore De	faults
	J	10.00000	0.25	300	0%		
	J	0.13000	0.25	10	0%		
rface	J	0.01600	2.00	3	0%		
	J	0.00080	2.00	3	0%		
JODE	1	0.00032	5.00	3	0%		
gara s				-	0%		
	Ē.				0%		
					0%		
ents					0%		
					0%		
low (r	Frequer Amplituc Owell Tir	cy Range: 0.0001 le Range: 0.01 µs me Range: 1 cycle	Hz to 100 Hz) to 10 µs) to 500 cycles)				
re Capture	Frequen Amplituc Owell Tir	cy Range: 0.0001 le Range: 0.01 µs ne Range: 1 cycle :	Hz to 100 Hz) to 10 µs) to 500 cycles)	t of max tolerable	sinusoidal i	nput wander	
Flow Capture F apture F arments/ ay ander F	Frequen Amplituc Dwell Tir Peak-t War Ampl (J	cy Range: 0.0011 le Range: 0.0101 le Range: 1 cycle: o-Peak 2 dder 2 litude (s) 0.25	Hz to 100 Hz) to 10 µs) to 500 cycles)	t of max tolerable	sinusoidal i	nput wander	10
2 Capture F apture F irments/ awder F	Frequen Amplituc Owell Tir Wai Ampl (J	c-Peak 5 o-Peak 2 der ange: 1 cycle o-Peak 2 der 2 litude s) 0.25 0.25	Hz to 100 Hz) to 10 µs) to 500 cycles) Lower limi	t of max tolerable	sinusoidal i 0.13 ency (Hz)	nput wander	10
Flow Capture F structure F siments/ ander F structure	Peak-t Wai Ampi (i	cv Range: 0.001 us he Range: 0.01 us he Range: 1 cvde : o-Peak 5 o-Peak 2 is) 0.25 0.25	Hz to 100 Hz) to 10 µz) to 500 cydes) Lower limi	t of max tolerable	sinusoidal i	nput wander	10

- dd Wander File Instrument(s) Setup Ca 📽 🖬 🚥 🖮 💒 🚰 Frequency Offset Wander Tolerance Wander Transfer Single 🔨 Table \frown MTIE/TDEV Mask Restore Defaults Enable Frequency (Hz) Amplitude (µs) Dwell Time (Cycles) Status 10.00000 0.13000 0.25 300 0% 10 0% 0% 0% 0% 0% 0% 0% 2.00 2.00 5.00 0.01600 3 0.00080 3 Master/Slave/GPS Emulation (Frequency Range: 0.0001 Hz to 100 Hz) (Amplitude Range: 0.01 µs to 10 µs) (Dwell Time Range: 1 cycle to 500 cycles) Lower limit of max tolerable sinusoidal input wander Peak-to-Pea Wander Amplitude (µs) Add Impairments/ Delay Add Wander 0.016 0.13 Wander Frequency (Hz) Packet Generation 0 s Generate Wander Stop Wander Elapsed Time: Statistics/ Results ОК
- 4. Select Generate Wander to stress the SyncE input accordingly.

- 5. Select Start Capture to begin the measurement.
- 6. Once Wander Generation has finished and at least **1000s** have passed, select **Stop Capture** to end the measurement.

Expected Outcome

The Vendor DUT should maintain reference and not be subjected to switching reference or enter holdover state. This must be determined from the device itself (e.g. via the management interface).

6. Time Noise Transfer – G.8273.3 Clause 7.3

Test Description

Measures how Time Error on the input is transferred to the output.

Measurement Process

The Noise Transfer requirements for a T-TC device have not yet been finalised.

The test procedure will appear here once the Noise Transfer requirements are more fully defined.

7. Packet Layer Transient Response and Holdover Performance – G.8273.3 Clause 7.4

7.1. Test Description – Packet Layer Transient Response

The PTP to PTP transient response requirements applicable to a T-TC have not yet been defined.

The test procedure will appear here when such a definition is available.

7.2. Test Description – Holdover Performance

A T-TC does not support time holdover.

Appendix 1 – Tests for a G.8273.3 T-TC

Test	Objective	Test Method	Output Limit (PTP and 1pps) ²		
Time Error Generation (G.8273.3, Clause 7.1)	With stable input references, measure the inherent time error (MaxITEI, cTE and dTE) produced by the internal clock.	Apply a stable time reference to the PTP input. Apply a stable frequency reference to the SyncE input. Repeat without a SyncE reference ³ .		Class A	Class B
			MaxITEI:4	≤ 100ns	≤ 70ns
			cTE:	≤ 50ns	≤ 20ns
			dTE _{LF} :5	40ns MTIE, 4ns TDEV	
			dTE _{HF} :6	70ns p-p	
Time Error Tolerance (G.8273.3, Clause 7.2)	Measures whether the clock can operate correctly with maximum noise input at the input. The test must be carried out with noise on the SyncE input. Clock under test should not: • generate alarms • switch reference • go into holdover	SyncE tolerance: Simultaneously apply sine wave phase wander to the SyncE input according to G.8262, Table 9. Repeat without a SyncE reference ⁷ .	No output performance limit. Clock under test should not: • generate alarms • switch reference • go into holdover		
Time Error Transfer (G.8273.3, Clause 7.3)	Measures how time error on the input is transferred to the output. SyncE-to-PTP transfer function : Upper cut-off from 1 to 10Hz	SyncE to PTP: Apply a stable time reference to the PTP input. Apply a set of sine wave phase modulations of 200ns p-p amplitude at several different frequencies.	Tone frequencies and amplitudes		
Transients and Holdover (G.8273.3, Clause 7.4, plus Annex B,	Measure the response to a SyncE rearrangement transient.	No procedure defined yet.	No performance limit defined		
	Measures the response to entry into holdover caused by loss of packets at PTP input.	A T-TC does not support Time holdover.	No performance limit defined		

² Same limits apply to 1pps and PTP outputs. It is assumed that the 1pps should track the PTP output closely, although there is no specification for how closely they should track.

³ G.8273.3 doesn't currently specify the performance in the absence of SyncE, therefore repeating the test without the use of SyncE input reference is optional.

⁴ Max|TE| is calculated on the raw, unfiltered time error data.

⁵ MTIE and TDEV are calculated after low-pass filtering by 0.1Hz. Same values apply to both Class A and Class B devices.

⁶ TIE is measured after high-pass filtering by 0.1Hz. Same values apply to both Class A and Class B devices.

⁷ G.8273.3 doesn't currently specify the performance in the absence of SyncE, therefore repeating the test without the use of SyncE input reference is optional.



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