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PTP Testing with xGenius: G.8273.2 T-BC Test

Standard ITU-T G.8273.2 defines the required performance level for *Telecom Boundary Clocks* (T-BCs) and *Telecom Time Slave Clocks* (T-TSCs). The accuracy level required for these devices in terms of *Time Error* (TE) and other performance metrics derived from the TE is often in the range of a few nanoseconds. For this reason special measurement procedures are often required.

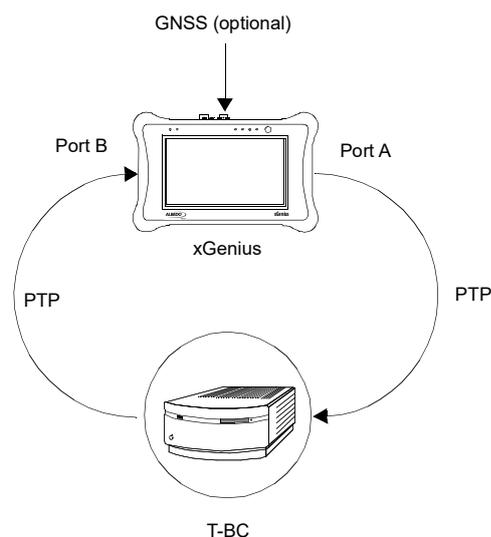


Figure 1 This test verifies the PTP performance level of a T-BC and it can be used to verify compliance of standard ITU-T G.8273.2

This document describes an scenario where the performance of a Class C T-BC is to be measured. It is considered that the device under test is running the ITU-T G.8275.1 profile, which is a PTP profile deployed in networks with full timing support in all their nodes. In practical terms, full timing support requires that all network nodes implement the T-BC function.

1. SETTING UP THE REFERENCE

xGenius may be equipped with a built in GNSS receiver. These units have a SMA female connector suitable for connecting an antenna. Units with the built in GNSS receiver are also supplied with a compact antenna with 5 m of coaxial cable plus a 10 m extension cable. Using a different antenna is possible as long as the specifications of the GNSS module are taken into account.

Since no absolute TAI or UTC time is required in T-BC tests and the only object of the test is the relative timing between two BC ports, the GNSS reference is not mandatory. It is, however, recommended if the T-BC is initially locked to an external reference because it makes easier for the device under test the transition from the network time-scale to the test time-scale.

To use the built in GNSS module follow these steps:

1. Attach the antenna to the unit. Make sure that the antenna sees as much of the sky as possible. The unit may fail to achieve synchronization if there are not enough satellites in sight. Some tests may loss accuracy if the number of satellites in sight is reduced.
2. From the *Home* panel, go to *Config*, The port setup panel is displayed.
3. Go to *Reference clock*.
4. Configure *Input clock* to *GNSS*.
5. Press *LEDS* to display the test status.
6. Wait for the REF and LOCK LEDs to become green.
Note: The locking process for the OCXO version of xGenius may take around 10 minutes. The coarse locking process in Rubidium units

requires around 20 minutes.

Note: Both Rubidium and OCXO versions of xGenius are ready for testing once the LOCK LED is green but Rubidium units are not yet prepared to supply their maximum accuracy. These units go to a *Fine locking* status before being fully *Locked* to the reference. The *Fine locking* status may last for around four hours in Rubidium units. OCXO units do not have fine locking status and they go directly to the *Locked* when they finish the coarse locking procedure. The user could check the current locking status (*Locking, Fine locking, Locked, Holdover, etc.*) from the *Oscillator* menu in the *Reference clock* menu.

Configuring the GNSS Properties

The user could optionally configure the GNSS interface in the test unit. Despite being not mandatory, the increase in accuracy it could be obtained in this way is quite important. This is the required procedure:

1. From the *Home* panel, go to *Config*, The port setup panel is displayed.
 2. Go to *Reference clock*.
 3. Go to *GNSS receiver*.
 4. Configure a compensation for the antenna cable through the *Antenna delay correction* field.
 5. Enable or disable any of the *GPS, GLONASS, Beidou* or *Galileo* constellations through the *Active GNSS* setting.
 6. Go to *Fixed-position mode*.
 7. Adjust the *Position averaging time* and enable position averaging by configuring *Fixed-position mode* to *Auto-average*. The *Fixed-position status* field now displays *Averaging*
- Note:* At least one hour of position averaging is required for a reasonable accuracy.
Note: The position averaging procedure should run only once as long as the test unit geographical location is not changed. The unit checks any change in position (longitude, latitude, altitude) every time it is connected to a GPS antenna. If a change in the coordinates is detected, then an error message is displayed in

the status field and the mode is disabled.

8. Wait to the *Fixed position status* to become *Active*. The unit is now ready for testing.
Note: Theoretically, testing could start before the end of the position averaging process. The improved time estimation due to this function would be automatically applied starting from the end of the auto-averaging process.

2. PTP TEST

xGenius Port A can be configured to behave as a PTP grandmaster. At the same time, Port B in the same unit can be configured to become a PTP pseudo-slave with the ability to compare the input phase with its own internal time and generate miscellaneous performance parameters, including TE. Using a single unit to simulate the PTP grandmaster and the slave simultaneously has two important advantages:

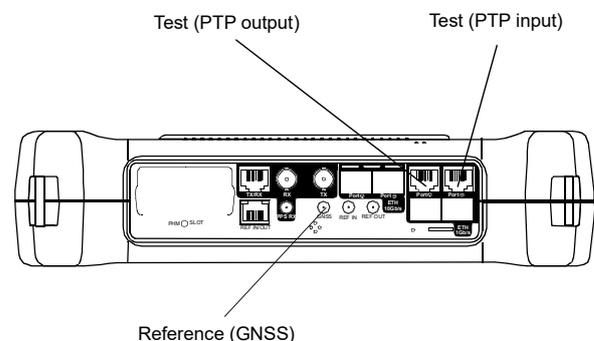


Figure 2 Albedo xGenius test and clock reference interfaces used in this testing scenario.

1. It enables users to run the T-BC test with a single unit and save the resources required in test configurations based in two units.
2. Since the same oscillator is used to generate the PTP output and analyze the input, many error sources compensate and the test accuracy increases.

Connecting the Unit

This scenario assumes that the test interfaces are electrical. Connect the Port A RJ-45 port to the T-BC PTP input and Port B RJ-45 port to the T-BC PTP output.

1. From the *Home* panel, go to *Config*,
The port configuration panel is displayed.
2. Select *Mode* to enter in the mode selection menu.
3. Choose *Ethernet endpoint*.

Enable the BC / TC Test

xGenius includes different test options for PTP. Here we are interested in the test option for BCs and TCs. Follow these steps to enable the required test mode:

1. From the *Home* panel, go to *Test*.
The test configuration panel is displayed.
2. Go to *PTP*.
3. Configure *PTP mode* to *BC/TC test*.
Two labels are displayed in the top notification area. The former (*PTP*) shows that PTP is enabled in the unit, the latter (*MS*) shows that the unit is emulating a PTP master and a PTP slave at the same time.

Configuring the PTP Master

The following sequence is required to generate the PTP stimulus signal in Port A. It is assumed that the port is running the ITU-T G.8275.1 profile:

1. From the *Home* panel, go to *Test*,
The test configuration panel is displayed.
2. Go to *PTP*.
3. Go to *Grandmaster A* settings
4. Go to *Message timing*.
5. Configure *Sync TX interval* to *16 pkt/s*, *Delay Request TX interval* to *16 pkt/s* and *Announce TX interval* to *8 pkt/s*.
6. Leave the *Message timing* panel by clicking the *BACK* button.
7. Configure the *Domain*, *Priority 1* and *Priority 2*

to the right values for your network.

8. Configure *Clock class* to *Synchronized to PRC*.
9. Configure *Clock accuracy* to *100 ns*.
10. Go to *Time properties*.
11. Configure *Mode* to *Manual*.
12. Set *UTC Offset valid* to *Yes*, *Timescale* to *TAI*, *Time traceable* to *Yes*, *Frequency traceable* to *Yes* and *Time source* to *GPS*.

Configuring the PTP Pseudo-slave

Follow this procedure to enable the IEEE 1588-2008 performance analysis in test port B. It is assumed that most simple test port configuration is used (1000BASE-T interface, no VLANs) and hence no port specific configuration is required. The PTP profile is the same that in Port A, ITU-T G.8275.1.

1. From the *Home* panel, go to *Test*,
The test configuration panel is displayed.
2. Go to *PTP*.
3. Go to *Slave clock B* settings
4. Go to *Message timing*.
5. Configure *Announce TX interval* to *8 pkt/s*.
6. Leave the *Message timing* panel by clicking the *BACK* button.
7. Configure the *Domain* to the right value for your network.

If the previous settings are correct, the PTP indications (*PTP MS*) in the top of the screen will change from yellow to green

Configuring the Test Thresholds

Once the PTP is active the user still has to configure the tests to be run and set the thresholds for the results. In this setup these are the TE and MTIE / TDEV tests. No specific action is required to enable the TE test but the TE thresholds must be set by means the following procedure:

1. From the *Home* panel, go to *Test*,
The test configuration panel is displayed.
2. Go to *PTP two way TE objectives*.

3. Configure *Enable* to *On*.
4. Set *Total peak* to *30 ns*.
5. Set *Total average* to *10 ns*.
6. Set to zero all the remaining parameters in the PTP two way TE objectives panel.

To enable the MTIE and TDEV and configure and appropriate threshold for the G.8273.2 test follow these steps:

1. From the *Home* panel, go to *Test*,
The test configuration panel is displayed.
2. Go to *PTP wander test*.
3. Enable the MTIE / TDEV test by setting the *Enable* control to *On*.
4. Configure *Mask source* to *Standard*.
5. Configure *Device Type* to *PTP ITU Masks*.
6. Set *Standard* to *BC G.8273.2 dTE (CT)*.

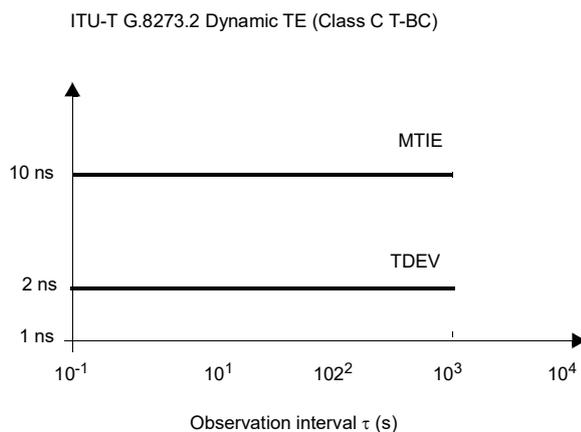


Figure 3 ITU-T G.8271.1 MTIE and TDEV masks to be verified at the output of the Class C T-BC

Running the Test

Te test is now ready to start. Press *RUN* in the test unit to do that. Now the TE and MTIE / TDEV are computed in real time. To check the TE results follow these steps:

1. From the *Home* panel, go to *Results*,
The test port results panel is displayed.
2. Select *Port B* to enter in the port specific results.

3. Enter in *PTP* to display results about the PTP protocol.
4. Go to *Time Error statistics* to get the 2-way TE results.
5. Check the maximum and minimum values of *Total*, *Low frequency* and *High frequency* TE and check that these are under the limits defined in ITU-T G.8273.2.

The MTIE / TDEV test is executed at the same time that the TE test. Real time results can be checked in the following way:

1. From the *Home* panel, go to *Results*,
The test port results panel is displayed.
1. Select *Port B* to enter in the port specific results.
2. Enter in *PTP* to display results about the PTP protocol.
3. Go to *PTP wander test*.
4. Choose between MTIE or TDEV
5. Check the *Time*, *TIE*, *MTIE* and *Mask* results (*MTIE* results panel) or *Time*, *TDEV* and *Mask* results (*TDEV* results panel).
Note: The TIE, MTIE and TDEV values must be understood as *pkfilteredTIE*, *pkfilteredMTIE*, and *pkfilteredTDEV* respectively.
Note: The amount of time to wait before the first results are displayed depends of the filter settings.

To stop the TE and MTIE / TDEV tests press *RUN* a second time at any moment.