

G.8275.2 Profile

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G.8275.2 profile

The G.8275.2 telecom profile is a Precision Time Protocol (PTP) profile that:

- Provides phase and time-of-day synchronization in telecommunication networks
- Operates with partial timing support from the network
- Supports an optional hybrid full timing support mode
- Uses PTP over IPv4 in unicast mode to achieve precise time synchronization

The G.8275.2 profile does not require every device in the network to participate in the PTP protocol. This profile is intended for use in carefully planned network environments where network behavior and performance, including static asymmetry, can be maintained within defined limits.

G.8275.2 clock types

The G.8275.2 profile supports partial timing, hybrid full timing, and three specific clock roles. It does not include assisted partial clock types.

G.8275.2 clock roles

The G.8275.2 profile supports these clock roles:

- **Telecom grandmaster (T-GM):** A T-GM is a clock type that provides timing information to other devices in the network. The T-GM typically connects to a primary reference time source, such as a Global

Navigation Satellite System (GNSS) receiver, and does not synchronize its local clock using other network elements.

- **Partial support telecom boundary clock (T-BC-P):** A T-BC-P is a boundary clock that can act as a grandmaster, synchronize from another PTP clock, or provide time to a secondary clock.
- **Partial support telecom time slave clock (T-TSC-P):** A T-TSC-P is a secondary clock that synchronizes its local clock to another PTP clock, such as a T-GM or T-BC-P. This clock does not provide synchronization to other devices.

PTP domain

Permitted PTP domain numbers for the G.8275.2 profile range from 44 to 63.

PTP messages and transport

The G.8275.2 profile requires PTP over IPv4 in unicast mode. The profile supports only one-step clock operation and unicast message negotiation.

The profile supports these modes:

- **Hybrid mode:** Provides holdover with assistance from Synchronous Ethernet (SyncE) for T-TSC, T-BC, or T-GM devices. Enable hybrid mode on a T-GM that uses a virtual port GNSS as input.
- **Non-hybrid mode:** Provides holdover without SyncE for T-TSC or T-BC devices. Enable non-hybrid mode on a T-GM that uses a virtual port (GNSS) as input.

The G.8275.2 profile uses these PTP messages.

- sync
- delay_req
- announce
- follow_up
- delay_resp
- signaling

Alternate best timetransmitter clock algorithm

This section explains the Alternate Best TimeTransmitter Clock Algorithm (BTCA) selection process and the role of its attributes in G.8275.2 PTP domains.

The G.8275.2 profile uses the BTCA, a modified version of the IEEE 1588 standard model. BTCA selects the primary time-transmitting clock, the Grandmaster, in a PTP domain. It enables each device to select its synchronization source and determine the operational state of its local ports.

Alternate BTCA attributes

The alternate BTCA evaluates these attributes in the order of selection priority:

clockClass: Indicates the traceability and accuracy of a PTP clock. A lower clockClass value indicates higher quality and traceability. For example, these values can mean the clock is traceable to a primary reference time source such as GNSS.

- 6: T-GM traceable to the primary reference clock provided by the GNSS.
- 7: T-GM previously traceable to the primary reference clock, currently in holdover within specification.
- 135: T-BC previously traceable to the primary reference clock, currently in holdover within specification.
- 160: T-GM previously traceable to the primary reference clock, currently in holdover out of specification and traceable to a Category 3 frequency source (OCXO in timing module).
- 165: T-BC currently in holdover out of specification.

clockAccuracy: Specifies the accuracy of the clock time relative to a reference time. The value is expressed as a range, for example within 25 nanoseconds or within 100 nanoseconds (ns).

offsetScaledLogVariance: Provides a statistical measure of the clock's stability. This attribute is a logarithmic representation of the variance of the clock offset, which indicates the stability of the time output.

priority2: Specifies a configurable numeric attribute used as a secondary tiebreaker if all other attribute values are equal. A lower value indicates higher priority.

Localpriority: Specifies a configurable numeric attribute used to determine clock priority. A lower value indicates higher priority. This attribute is the primary tiebreaker in the BTCA, is locally significant, and is defined in the router PTP configuration.

Virtual port support in G.8275.2 profile

A virtual PTP port enables T-GM and T-BC devices to receive frequency and phase inputs from electrical sources. T-GM and T-BC devices receive frequency inputs such as SyncE, GNSS 1PPS, and Time of Day (ToD). These devices support virtual ports in both hybrid and non-hybrid modes.



Note SyncE is not supported in non-hybrid mode.

Virtual port operation

When configured to derive time and frequency from a GNSS source, T-GM and T-BC devices use the virtual port as the reference input.

Virtual ports participate in the alternate BTCA for T-BCs. In T-GM mode, specifically for primary only configurations, the device does not evaluate BTCA from G.8275.2 peers. Instead, the device uses local priority to select from multiple inputs, such as a virtual port or a G.8275.2 peer.

Virtual port selection

Virtual port selection uses these criteria:

- **T-GM:** The virtual port is available for selection when GNSS is locked and the external SyncE reference source is in the QL-PRC state.

- **T-BC:** The virtual port participates in the BTCA only when GNSS is locked and SyncE is in the QL-PRC state. If the system selects the virtual port as the primary clock, electrical inputs drive the PTP clock. The T-BC primary can be a virtual port or a WAN port, based on the alternate BTCA priority.

Virtual port attributes

Virtual ports locked to GNSS use these attributes:

- **clock class**: 6
- **clock accuracy**: 0x21, which is within 100 nanoseconds
- **offset scaled log variance**: 0x4E5D.

Guidelines and limitations

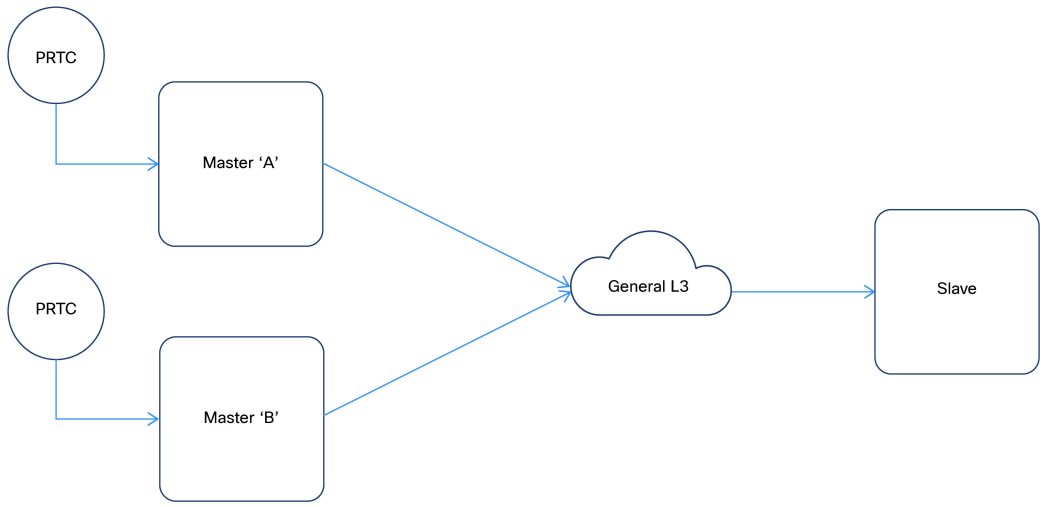
The G.8275.2 PTP profile has these requirements and constraints.

- Does not support Virtual Routing and Forwarding (VRF) or subinterfaces
- Supports only the loopback interface and the Gigabit interfaces GigabitEthernet0/0/0 and GigabitEthernet0/0/1 as transport interfaces on the IR8340 platform
- Excludes Pdelay_Req, Pdelay_Resp, Pdelay_Resp_Follow_Up and management messages.
- Does not support virtual port configuration for ordinary clocks
- Requires boundary clocks to implement configuration examples
- Can cause temporary frequency and phase inaccuracies in non-hybrid mode or partial timing support when switching between sources

G.8275.2 deployment scenario

The figure illustrates a typical G.8275.2 network configuration. This network contains two primary clocks, one boundary clock and one secondary clock. Server A operates as the ordinary clock and Server B acts as the backup server clock and includes a virtual port.

Figure 1: Hybrid full timing support configuration topology



Configure G.8275.2 profile

The G.8275.2 Profile can be configured for partial timing support or for hybrid full timing support.

- Configure G.8275.2 profile for partial timing support
- Configure G.8275.2 profile for hybrid full timing support

Configure G.8275.2 profile for partial timing support

Configuring G.8275.2 profile for partial timing support includes these configurations:

- Configure T-GM
- Configure T-TSC-P

Configure T-GM

Perform this task to configure the T-GM for partial timing support and hybrid full timing support.

Procedure

Step 1 Configure global Sync-E, on page 7

Step 2 Configure Sync-E, on page 9 on the border interface that connects to T-TSC-P.

Step 3 Configure loopback interface.

Step 4 Configure GNSS.

Step 5 Configure G.8275.2 PTP as a hybrid boundary clock.

a) Use the **ptp clock boundary domain** *domain-number* **hybrid profile g8275.2** command to enable the hybrid PTP boundary clock.

Example:

```
Device(config)#ptp clock boundary domain 44 hybrid profile g8275.2
```

b) Use the **priority2** *priority-value* command to set the Priority2 field (default for holdover).

Example:

```
Device(config-ptp-clk)#priority2 25
```

c) Use the **virtual-port** *port-id* **profile g8275.2** command to create a virtual port for GNSS input.

Example:

```
Device(config-ptp-clk)#virtual-port vp1 profile g8275.2
```

d) Use the **input 1pps R0** command to configure the virtual port for 1PPS timing input.

Example:

```
Device(config-ptp-virtual-port)#input 1pps R0
```

e) Use the **input tod R0 ubx** command to configure the virtual port for ToD input.

Example:

```
Device(config-ptp-virtual-port)#input tod R0 ubx
```

f) Use the **priority2** *priority-value* command to define the priority for the virtual port.

Example:

```
Device(config-ptp-virtual-port)#priority2 25
```

g) Use the **clock-port** *port-name* **master profile g8275.2** command to define a primary port for connection to a T-TSC-P or a T-BC-P.

Example:

```
Device(config-ptp-clk)#clock-port primary1 master profile g8275.2
```

Note
The **master** keyword prevents any T-BC or T-TSC from becoming the primary clock. This T-GM can only function as the GMC.

h) Use the **transport ipv4 unicast interface** *loopback-interface***negotiation** command to configure the primary port to use the loopback interface for unicast transport.

Example:

```
Device(config-ptp-port)#transport ipv4 unicast interface Lo0 negotiation
```

i) (Optional) Use the **clock-port** *port-name* **profile g8275.2** command to define a regular primary port without master keyword, for alternate BTCA rules.

Example:

```
Device(config-ptp-clk)#clock-port primary1 profile g8275.2
```

j) Use the **transport ipv4 unicast interface** *loopback-interface* **negotiation** command to configure the regular primary port to use the loopback interface.

Example:

```
Device(config-ptp-port)#transport ipv4 unicast interface Lo0 negotiation
```

k) (Optional) Use the **clock source** *secondary-ip-address* command to configure primary port to accept connections from specified secondary clocks.

Example:

```
Device(config-ptp-port)#clock source 2.2.2.4
```

Replace *secondary-ip-address* with the actual IP address of the T-TSC-P loopback interface.

Configure global Sync-E

Perform this task to configure global Sync-E.

Procedure

Step 1 Use the **configure terminal** command to enter global configuration mode.

Example:

```
Device# configure terminal
```

Step 2 Use the **esmc process** command to enable the Ethernet Synchronization Messaging Channel (ESMC) process.

Example:

```
Device(config)#esmc process
```

Note
This step is not applicable for configuring backup source.

Step 3 Use the **network-clock revertive** command to enable revertive mode.

Example:

```
Device(config)#network-clock revertive
```

Note
This step is not required in T-TSC configuration.

Step 4 Use the **network-clock synchronization automatic** command to enable automatic synchronization.

Example:

```
Device(config)#network-clock synchronization automatic
```

Step 5 Use the **network-clock synchronization mode ql-enabled** command to enable QL mode.

Example:

```
Device(config)#network-clock synchronization mode ql-enabled
```

Step 6 Use the **network-clock quality-level rx** *quality-level* **external** *slot frequency* command to set the quality level for the external GNSS source.

Example:

Note
This step applies only to T-GM configuration.

```
Device(config)#network-clock quality-level rx QL-PRC External R0 1hz
```

Step 7 Set the input source. Choose the configuration according to your topology setup.

Configuration	Description
T-GM	Use the **network-clock input-source** *priority* **External R0** *slot-frequency* command to set the input source to GNSS. `Device(config)#network-clock input-source 2 External R0 1hz` **Note** QL-PRC is assigned to the input GNSS source.
T-BC/T-TSC	Use the **network-clock input-source** *priority* **interface** *interface-name* command to set the input source. `Device(config)# network-clock input-source 3 interface GigabitEthernet0/0/0` **Note** If you have multiple sources, repeat this command with the appropriate priority and interface.
GNSS as backup source	Use the **network-clock input-source** *priority* **interface** *interface-name* command to configure GNSS as an input source. `Device(config)#network-clock input-source 2 interface GigabitEthernet0/0/1` **Note** GNSS priority (2) is superior to WAN priority (3) in this example.
WAN as backup source	Use the **network-clock input-source** *priority* **interface** *interface-name* command to configure WAN as an input source. `Device(config)#network-clock input-source 3 interface GigabitEthernet0/0/0` **Note** Set priority values according to your network design.

Step 8 Use the **copy running-config startup-config** command in privileged EXEC mode to save the running configuration to the startup configuration.

Example:

Note
This step applies to T-GM, T-BC and T-TSC configurations.

```
Device(config)#end
            Device#copy running-config startup-config
```

Configure Sync-E

Perform this task to configure Sync-E on border interfaces that face hybrid T-GM, T-TSC, or T-TSC-P.

Procedure

Step 1 Use the **configure terminal** command to enter global configuration mode.

Example:

```
Device#configure terminal
```

Step 2 Use the **interface** *interface-name* command to enter configuration mode for the border interface.

Example:

```
Device(config)#interface GigabitEthernet0/0/0
```

Step 3 Use the **ip address***ip-address subnet-mask* command to assign the IP address and subnet mask to the interface.

Example:

```
Device(config-if)#ip address 1.1.1.1 255.255.255.252
```

Note
Assign the IP address and subnet mask that correspond to the interface.

interface	IP address	subnet-mask
T-GM	1.1.1.1	255.255.255.252
T-TSC-P	2.2.2.4	255.255.255.255
T-BC	1.1.1.2	255.255.255.252
T-TSC	1.1.1.6	255.255.255.252

Step 4 Use the **synchronous mode** command to enable synchronous operation on the interface.

Example:

```
Device(config-if)#synchronous mode
```

Step 5 Use the **exit** command to go back to global configuration mode.

Example:

```
Device(config-if)#exit
```

Configure loopback interface

Perform this task to configure the loopback interface to use the G.8275.2 profile.

Procedure

Step 1 Use the **configure terminal** command to enter global configuration mode.

Example:

```
Device#configure terminal
```

Step 2 Use the **interface Loopback** *interface number* command to enter the loopback interface configuration mode.

Example:

```
Device(config)#interface Loopback0
```

Step 3 Use the **ip address** *ip-address subnet-mask* command to assign the loopback IP address and subnet mask.

Example:

```
Device(config-if)#ip address 2.2.2.2 255.255.255.255
```

- The example shows the IP address and subnet mask for T-GM configuration.
- Use 2.2.2.3 255.255.255.255 for T-BC configuration.

Configure GNSS

Perform this task to configure GNSS interface.

Procedure

Step 1 Use the **gnss** command to enter GNSS configuration mode.

Example:

```
Device(config)#gnss
```

Step 2 Use the **no shutdown** command to enable GNSS operation.

Example:

```
Device(config-gnss)#no shutdown
```

Configure T-TSC-P

Perform this task to configure T-TSC-P for partial timing support.

Procedure

Step 1 Configure the loopback interface to support PTP.

a) Use the **configure terminal** command to enter global configuration mode.

Example:

```
Device#configure terminal
```

b) Use the **interface Loopback***interface-number* command to create and enter the configuration mode for the loopback interface.

Example:

```
Device(config)#interface Loopback0
```

c) Use the **ip address** *ip-address subnet-mask* command to assign the loopback IP address and subnet mask.

Example:

```
Device(config)#ip address 2.2.2.4 255.255.255.255
```

Step 2 Configure G.8275.2 PTP profile.

a) Use the **ptp clock boundary domain** *domain-number* **profile g8275.2** command to enable the PTP boundary clock for the G.8275.2 profile.

Example:

```
Device(config)#ptp clock boundary domain 44 profile g8275.2
```

b) Use the **priority2** *priority-value* command to set the Priority2 field (default for holdover).

Example:

```
Device(config-ptp-clk)#priority2 25
```

c) Use the **clock-port** *port-name* **profile g8275.2** command to configure the secondary port for the G.8275.2 profile.

Example:

```
Device(config-ptp-clk)#clock-port secondary1 profile g8275.2
```

d) Use the **transport ipv4 unicast interface** *loopback-interface* **negotiation** command to set the interface for PTP unicast transport.

Example:

```
Device(config-ptp-port)#transport ipv4 unicast interface Lo0 negotiation
```

e) Use the **clock source** *gmc-ip-address* command to set the GMC source IP address.

Example:

```
Device(config-ptp-port)#clock source 2.2.2.2
```

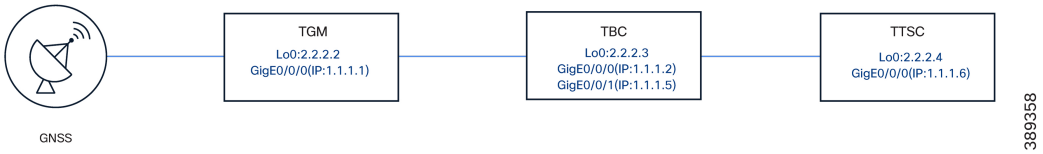
G.8275.2 profile for hybrid full timing support

Summary

This summary outlines the components and their roles in the G.8275.2 timing process.

Workflow

Figure 2: Topology: G.8275.2 profile for hybrid full timing support



Components

The key components involved in the G.8275.2 hybrid full timing supoprt process are:

- **T-GM:** Telecom grandmaster that acts as the GNSS source. It uses the GigabitEthernet0/0/0 interface with IP address 1.1.1.1/30
- **T-BC:** Telecom boundary clock that manages timing across multiple interfaces.

  Interfaces:

  - GigabitEthernet0/0/0 (connected to T-GM), IP 1.1.1.2/30
  - GigabitEthernet0/0/1 (connected to T-TSC), IP 1.1.1.5/30

- **T-TSC:** The telecom time slave clock that receives timing from the T-BC. It uses interface GigabitEthernet0/0/0, connected to TBC IP 1.1.1.6/30.
- **Loopback Interfaces:** Provides stable endpoints for G.8275.2 addressing and PTP communication.

Verify PTP status

To verify the status of PTP, Sync-E, and GNSS, you can run these commands. These commands are optional and can be executed as per the requirement.

Procedure

Step 1 Use the **show ptp clock running** command to display the current PTP clock configuration.

Example:

```
Device#show ptp clock running


PTP Boundary Clock [Domain 44] [Hybrid] [Profile: g8275.2]
State          Ports   Pkts sent   Pkts rcvd   Redundancy Mode
PHASE_ALIGNED  2       338098      1032563     Hot standby
PORT SUMMARY
Name   Tx Mode      Role      Transport    State   Sessions   Port Addr
slave1 unicast      negotiated Lo0          Slave   1          2.2.2.3
vp1    -            unknown    -            -       0          -
```

The output displays the number of packets sent and received. This information confirms that the secondary clock transmits packets and the primary clock responds. Ensure that these values increment. The **Role** and **State** fields provide the status of the clock as a secondary or primary.

Step 2 Use the **show ptp clock dataset default** command to view the default dataset.

Example:

```
Device#show ptp clock dataset default


CLOCK [Boundary Clock, domain 44]
  Profile: g8275.2
  Two Step Flag: No
  Clock Identity: 0x38:FD:F8:FF:FE:5B:DC:43
  Number Of Ports: 2
  Priority1: 128
  Priority2: 45
  Local Priority: 128
  Domain Number: 44
  Slave Only: No
  Signal Fail: No   Clock Quality:
    Class: 135
    Accuracy: Unknown
    Offset (log variance): 65535
```

This information includes default clock attributes and the default class based on the synchronization state.

Step 3 Use the **show ptp clock dataset parent** command to display parent clock information.

Example:

```
Device#show ptp clock dataset parent


CLOCK [Boundary Clock, domain 44]
  Profile: g8275.2

  Parent Clock Identity: 0x38:FD:F8:FF:FE:5B:D0:73
  Parent Port Number: 2
  Parent Stats: No
  Observed Parent Offset (log variance): 65535
  Observed Parent Clock Phase Change Rate: 2147483647

  Grandmaster Clock:
    Identity: 0x44:B6:BE:FF:FE:42:E7:C3
    Priority1: 128     Priority2: 25
    Clock Quality:
      Class: 6
      Accuracy: Within 100ns       Offset (log variance): 20061
```

This output shows the master (T-BC) and grandmaster (T-GM). The **class** attribute confirms if the time is traceable to the GNSS source (class 6).

Step 4 Use the **show ptp port dataset port** command to get detailed information of each PTP port.

Example:

```
Device#show ptp port dataset port


PORT [slave1]
  Clock Identity: 0x38:FD:F8:FF:FE:5B:DC:43
  Clock Profile: g8275.2
  Transport Interface: Loopback0
```

```
  Port Number: 1
  Port State: Slave
  Min Delay Req Interval (log base 2): -4
  Peer Mean Path Delay: 0
  Announce interval (log base 2): 1
  Announce Receipt Timeout: 3
  Sync Interval (log base 2): -5
  Delay Mechanism: End to End
  Peer Delay Request Interval (log base 2): -4
  PTP version: 2
  Local Priority: 128
  Master-only: False   Signal-fail: False
```

Step 5 Use the **show ptp wan stat stream 0** command to display PTP WAN statistics.

Example:

```
Device#show ptp wan stat stream 0


LOCK STATUS : PHASE LOCKED
SYNC Packet Stats
  Time elapsed since last packet: 0.0
  Configured Interval : -5, Acting Interval -5
  Tx packets : 0,  Rx Packets : 682718
  Last Seq Number : 64011,  Error Packets : 0
Delay Req Packet Stats
  ...
Current Data Set                            Units     Within tolerance?
  Offset from master :  +0.000000010        seconds          Yes
  Mean Path Delay    :  +0.000000598        seconds          Yes   ...
```

Note
Lock Status indicates the current synchronization state. The value can be:

- Acquiring
- Phase Locked (the Offset from master shows the sync accuracy) or
- Holdover

Step 6 Use the **show ptp wan tod** command to display the current PTP ToD information.

Example:

```
Device#show ptp wan tod


PTPd ToD information:
Time: 01/05/22 11:35:21
```

Step 7 Use the **show network-clocks synchronization** command to view network clock synchronization status.

Example:

```
Device#show network-clocks synchronization


Symbols:     En - Enable, Dis - Disable, Adis - Admin Disable
             NA - Not Applicable
             *  - Synchronization source selected
             #  - Synchronization source force selected
             &  - Synchronization source manually switched
Automatic selection process : Enable ...
*Gi0/0/0              NA          Sync/En      3     QL-PRC    -   -
```

```
External R0           1HZ         NA/Dis       4     QL-PRC    NA
NA
```

This output displays the Sync-E lock status and shows the available clocks (for example, **Internal**, **External R0**, and **Gi 0/0/0**), and which source is currently selected. For hybrid full timing support, QL-PRC should be present if PTP class is 6.

Step 8 Use the **show esmc detail** command to view ESMC details, including administrative configurations, port status, QL values, and packet counts.

Example:

```
Device#show esmc detail

Interface: GigabitEthernet0/0/0   Administrative configurations:
    Mode: Asynchronous
    ESMC TX: Disable
    ESMC RX: Disable     ...
  Operational status:
    Port status: UP     QL Receive: QL-DNU
    ...
    ESMC INFO pkts in: 777
    ESMC INFO pkts out: 1068
```

Step 9 Use the **show platform hardware network-clocks** command to view chassis-level network clock and PLL status.

Example:

```
Device#show platform hardware network-clocks

DPLL0 Status:
-------------
Bandwidth: 14 HZ
Phase Slope Limit: UNLIMITED

Current PLL0 Mode: MANUAL FREERUN

Current Input Selected: none

Current PLL0 Holdover Status: OFF

Current PLL0 Lock Status: OFF
System CPLD Holdover Status:

System CPLD Lock Status:

DPLL1 Status:
-------------
Bandwidth: 1.7 Hz

Phase Slope Limit: 7500 ns/s

Current PLL1 Mode: MANUAL NORMAL

Current Input Selected: REF6 (CLK_REC_25M_WAN1)

Current PLL1 Holdover Status: OFF

Current PLL1 Lock Status: ON

DPLL2 Status:
-------------
```

```
Bandwidth: 0.010 Hz

Phase Slope Limit: 885 ns/s

Current PLL2 Mode: TOP CLIENT (NCO)

Current Input Selected: none

Current PLL2 Holdover Status: OFF

Current PLL2 Lock Status: OFF

Current Input Status:
  REF0 (CLK_LOOPBACK1)   : OK
  REF1 (CLK_LOOPBACK2)   : OK
  REF2 ((TDM_SYNC_MB_PLL) : FAIL (SCM, CFM, GST, PFM failed)
  REF3 (RSV_2_M_PLL)      : FAIL (SCM, CFM, GST, PFM failed)
  REF4 (CLK_PPS_GPS_PLL)  : OK
  REF5 (CLK_PPS_MB_PLL)   : FAIL (SCM, CFM, GST, PFM failed)   REF6 (CLK_REC_25M_WAN1) : OK
  REF7 (CLK_REC_25M_WAN2) : FAIL (SCM, CFM, GST, PFM failed)   REF8 (CLK20M_OCXO)      : OK
  REF9 (RSV_1_MB_PLL)     : FAIL (SCM, CFM, GST, PFM failed)
  REF0 Freq Configured   : 25 Mhz
  REF1 Freq Configured   : 25 Mhz   REF2 Freq Configured   : 8 Khz
  REF3 Freq Configured   : 10 Mhz
  REF4 Freq Configured   : 1 Hz
  REF5 Freq Configured   : 1 Hz
  REF6 Freq Configured   : 25 Mhz
  REF7 Freq Configured   : 25 Mhz
  REF8 Freq Configured   : 20 Mhz
  REF9 Freq Configured   : 25 Mhz

DCO Frequency:
  Current_DCO_Freq_Offset: -0.044384
```

Sync-E uses PLL1 and PTP uses PLL2.