Configuring Frequency Synchronization

Frequency Synchronization is used to distribute precision frequency around a network. Frequency is synchronized accurately using Synchronized Ethernet (SyncE) in devices connected by Ethernet in a network. This module describes the concepts around this and details the various configurations involved. For information on SyncE commands, see System Management Command Reference for Cisco ASR 9000 Series Routers.

This module contains the following topics:

- Overview, on page 1
- Clocking Support for nV Cluster, on page 4
- Configuring Frequency Synchronization, on page 6

Overview

Frequency or timing synchronization is the ability to distribute precision frequency around a network. In this context, timing refers to precision frequency, not an accurate time of day. Precision frequency is required in next generation networks for applications such as circuit emulation.

To achieve compliance to ITU specifications for TDM, differential method circuit emulation must be used, which requires a known, common precision frequency reference at each end of the emulated circuit. The incumbent example of frequency synchronization is provided by SDH equipment. This is used in conjunction with an external timing technology to provide synchronization of precision timing across the network.

SDH equipments are widely replaced by Ethernet equipments and synchronized frequency is required over such Ethernet ports. Synchronous Ethernet (SyncE) is used to accurately synchronize frequency in devices connected by Ethernet in a network. SyncE provides level frequency distribution of known common precision frequency references to a physical layer Ethernet network.

To maintain SyncE links, a set of operational messages are required. These messages ensure that a node is always deriving timing information from the most reliable source and then transfers the timing source quality information to clock the SyncE link. In SDH networks, these are known as Synchronization Status Messages (SSMs). SyncE uses Ethernet Synchronization Message Channel (ESMC) to provide transport for SSMs.

Source and Selection Points

Frequency Synchronization implementation involves Sources and Selection Points.

A Source inputs frequency signals into a system or transmits them out of a system. There are four types of sources:
• Line interfaces. This includes SyncE interfaces and SONET interfaces.

• Clock interfaces. These are external connectors for connecting other timing signals, such as BITS, UTI and GPS.

• PTP clock. If IEEE 1588 version 2 is configured on the router, a PTP clock may be available to frequency synchronization as a source of the time-of-day and frequency.

• Internal oscillator. This is a free-running internal oscillator chip.

Each source has a Quality Level (QL) associated with it which gives the accuracy of the clock. This QL information is transmitted across the network using ESMC or SSMs contained in the SDH frames. This provides information about the best available source the devices in the system can synchronize to. To define a predefined network synchronization flow and prevent timing loops, you can assign priority values to the sources on each router. The combination of QL information and user-assigned priority levels allow each router to choose a source to synchronize its SyncE or SDH interfaces, as described in the ITU standard G.781.

A Selection Point is any point where a choice is made between several frequency signals and possibly one or many of them are selected. Selection points form a graph representing the flow of timing signals between different cards in a router running Cisco IOS XR software. For example, there can be one or many selection points between different Synchronous Ethernet inputs available on a single line card. This information is forwarded to a selection point on the RSP, to choose between the selected source from each card.

The input signals to the selection points can be:

• Received directly from a source.

• Received as the output from another selection point on the same card.

• Received as the output from a selection point on a different card.

The output of a selection point can be used in a number of ways, like:

• To drive the signals sent out of a set of interfaces.

• As input into another selection point on a card.

• As input into a selection point on another card.

Use `show frequency synchronization selection` command to see a detailed view of the different selection points within the system.

## SyncE Hardware Support Matrix

This table provides details on the hardware that supports SyncE:

<table>
<thead>
<tr>
<th>Hardware Variant</th>
<th>Cisco IOS XR</th>
<th>Cisco IOS XR 64 bit</th>
</tr>
</thead>
<tbody>
<tr>
<td>A9K-8X100GE-L-SE/TR (10GE and 100GE)</td>
<td>5.3.0</td>
<td>6.1.1</td>
</tr>
</tbody>
</table>

Note: The table also contains support details of upcoming releases. You can read this table in context of the current release and see relevant Release Notes for more information on supported features and hardware.
<table>
<thead>
<tr>
<th>Hardware Variant</th>
<th>Cisco IOS XR</th>
<th>Cisco IOS XR 64 bit</th>
</tr>
</thead>
<tbody>
<tr>
<td>A9K-RSP880-SE/TR</td>
<td>5.3.0</td>
<td>6.1.1</td>
</tr>
<tr>
<td>A9K-8X100GE-L-SE/TR (40-GE)</td>
<td>6.0.1</td>
<td>6.1.1</td>
</tr>
<tr>
<td>A9K-4X100GE-SE/TR</td>
<td>5.3.2 (100G LAN only)</td>
<td>6.1.1</td>
</tr>
<tr>
<td>A9K-8X100GE-SE/TR</td>
<td>6.0.1</td>
<td></td>
</tr>
<tr>
<td>A9K-MOD400-SE/TR</td>
<td>6.0.1</td>
<td>6.2.2</td>
</tr>
<tr>
<td>A9K-MOD200-SE/TR with MPA 20x10GE and Legacy MPAs</td>
<td>6.0.1</td>
<td>6.2.2</td>
</tr>
<tr>
<td>A9K-MOD400-SE/TR</td>
<td>6.1.3</td>
<td>6.2.2</td>
</tr>
<tr>
<td>A9K-MOD200-SE/TR with MPAs 2x100 and 1x100</td>
<td>6.1.3</td>
<td>6.2.2</td>
</tr>
<tr>
<td>A9K-400G-DWDM-TR</td>
<td>5.3.3</td>
<td></td>
</tr>
<tr>
<td>A9K-48X10GE-1G-SE/TR</td>
<td>6.0.1</td>
<td></td>
</tr>
<tr>
<td>A9K-24X10GE-1G-SE/TR</td>
<td>6.2.1</td>
<td>6.3.2</td>
</tr>
<tr>
<td>A99-RSP-SE/TR (Cisco ASR 9910 Series Routers)</td>
<td>6.1.4</td>
<td>6.3.2</td>
</tr>
<tr>
<td>A99-12X100GE</td>
<td>6.3.2</td>
<td>6.3.2</td>
</tr>
<tr>
<td>RSP880-LT-SE/TR</td>
<td>6.2.2</td>
<td>6.4.1</td>
</tr>
<tr>
<td>A9K-RSP440-TR/SE</td>
<td>4.3.4</td>
<td></td>
</tr>
<tr>
<td>Enhanced Ethernet Linecards</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A99-RP-SE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A99-RP2-TR/SE</td>
<td>5.3.0</td>
<td>6.3.2</td>
</tr>
<tr>
<td>Cisco ASR 9001 Series Routers</td>
<td>4.3.4</td>
<td></td>
</tr>
<tr>
<td>Cisco ASR 9901 Series Routers</td>
<td>NA</td>
<td>6.4.1</td>
</tr>
<tr>
<td>A99-RSP-SE/TR (Cisco ASR 9906 Series Routers)</td>
<td>6.3.1</td>
<td>6.3.2</td>
</tr>
<tr>
<td>A9K-RSP5-SE/TR</td>
<td>NA</td>
<td>6.5.15</td>
</tr>
<tr>
<td>A99-RP3-SE/TR</td>
<td>NA</td>
<td>6.5.15</td>
</tr>
<tr>
<td>A9K-8X100GE-X-TR</td>
<td>NA</td>
<td>6.5.15</td>
</tr>
<tr>
<td>A9K-16X100GE-TR</td>
<td>NA</td>
<td>6.5.15</td>
</tr>
</tbody>
</table>
SyncE Restrictions

This section lists a few restrictions in configuring frequency synchronization. They are:

- On SyncE line interfaces, only one interface from each PHY can be configured as SyncE input (there is no restriction on SyncE output) on the A9K-24X10GE-1G-SE/TR and A9K-48X10GE-1G-SE/TR line cards.

Clocking Support for nV Cluster

ASR9K cluster consists of two chassis connected together to provide redundancy and to meet higher bandwidth requirements. RSP440 provides two ICS (Inter-Chassis Synchronization) interfaces on the front plate. Clocking functionality support is added to the ICS interfaces. The ICS interfaces could be used for clocking, in the absence of other methods to synchronize frequency and Time-of-day information between the two cluster racks.

nV Cluster Limitations

The limitations for the frequency synchronization support for cluster are:

- This feature is supported only on RSP440.
- The two chassis of the cluster have to be co-located. The length of the cable used for the ICS link should be less than 10 meters. This is needed to ensure the phase delay added due the length of the cable is within limits.
- SSM and QL is not supported on ICS links. SSM messages are not exchanged over the ICS interface. Hence, QL value needs to be configured under ICS clock interface configuration.
- The selection of an input clock source is based on the configuration of priority, QL as well as the clock quality. For SyncE, the ICS interfaces are similar to the SyncE line interfaces as far as input clock selection is concerned.
- All Input clock sources to cluster setup has to be redundant.
- No support for 1588 BC on LAG interfaces with member links across racks.

Inter-Chassis Synchronization (ICS)

ICS-Frequency Synchronization

Frequency synchronization is provided using Inter-Chassis Synchronization links (ICS). These are dedicated interfaces on the RSP used to synchronize the time and frequency.
The ICS link between the Primary DSC and Backup DSC carries the clock. There is no transfer of QL information from Primary DSC to Backup DSC. The clock direction is always from Primary DSC to Backup DSC. The Primary DSC transmits the clock and Backup DSC receives the clock.

The ICS clock interface (sync 2 or sync 3) is a clock input on the Backup DSC. The clock selection algorithm for SyncE is independent on each RSP. So, output clock from the rack which has Primary DSC is the outcome of the clock selection on the Primary DSC. The output clock from the rack which has Backup DSC is the outcome of the clock selection on the Backup DSC. If the ICS clock interface configuration is such that it is the selected clock on the Backup DSC, then the output clocks from the Primary rack and Backup rack are synchronised.

ICS-Time-of-Day
The ICS links also carry Time of Day (ToD) information when the ICS clock interfaces are configured for the same. Only the Backup DSC can synchronise with ToD from the Primary DSC and not vice versa. The 1588 clock information transmitted on all 1588 interfaces in the cluster (including interfaces on Backup rack) is of the clock selected at the Primary DSC. Thus, it is important that ICS clock interface on Backup DSC is configured such that it is the clock which is selected for ToD on the Backup DSC.

Recommended ICS Interface Connections

No inter-chassis frequency or time synchronization support:

Configuring Frequency Synchronization

SyncE is used from the ASR9K cluster to provide precision frequency to mobile cell sites. A BITS clock is connected to each chassis of the cluster, meaning that the frequencies of both chassis are synchronized and the cell sites will all be synchronized, regardless of which chassis they synchronize to. In most deployments redundant BITS connections would be made to each chassis, to prevent against failure of any single BITS link.

With inter-chassis synchronization support:
Figure 2: With inter-chassis synchronization support

SyncE is used to synchronize the frequency of an ASR9k cluster to an upstream device. To provide redundancy in the case of one of the external SyncE inputs going down, the frequencies of the different cluster chassis must somehow be synchronized; else cell sites which select links from different chassis to synchronize may be out of sync if one of the SyncE links goes down.

Configuring Frequency Synchronization

Enabling Frequency Synchronization on the Router

This task describes the router-level configuration required to enable frequency synchronization.

**SUMMARY STEPS**

1. configure
2. frequency synchronization
3. clock-interface timing-mode {independent | system
4. quality itu-t option {1 | 2} \\
5. log selection {changes | errors}
6. Use one of these commands:
   • end
   • commit

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
</tr>
<tr>
<td>configure</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router# configure</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td></td>
</tr>
<tr>
<td>frequency synchronization</td>
<td>Enables frequency synchronization on the router.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config)# frequency synchronization</td>
<td>(Optional) Configures the type of timing sources that can be used to drive the output from a clock interface. If this command is not used, the default quality mode is used. In the default mode, the clock interface output is driven only by input from line interfaces and the internal oscillator; it is never driven by input from another clock interface. In addition, some heuristic tests are run to detect if the signal being sent out of one clock interface can be looped back by some external box and sent back in via the same, or another clock interface.</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td></td>
</tr>
<tr>
<td>**clock-interface timing-mode {independent</td>
<td>system**</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config-freqsync)# clock-interface timing-mode system</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>(Optional) Specifies the quality level for the router. The default is <strong>option 1</strong>.</td>
</tr>
<tr>
<td>**quality itu-t option {1</td>
<td>2 generation {1</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config-freqsync)# quality itu-t option 2 generation 1</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>Enables logging to frequency synchronization.</td>
</tr>
<tr>
<td>**log selection {changes</td>
<td>errors}**</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config-freqsync)# log selection changes</td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>Saves configuration changes.</td>
</tr>
</tbody>
</table>
### Command or Action

- `end`
- `commit`

**Example:**

```bash
RP/0/RSP0/CPU0:router(config-freqsync)# end
```

or

```bash
RP/0/RSP0/CPU0:router(config-freqsync)# commit
```

### Purpose

- When you issue the `end` command, the system prompts you to commit changes:
  
  Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:

  - Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
  
  - Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
  
  - Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.

  - Use the **commit** command to save the configuration changes to the running configuration file, and remain within the configuration session.

---

**What to do next**

Configure frequency synchronization on any interfaces that should participate in frequency synchronization.

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### Configuring Frequency Synchronization on an Interface

By default, there is no frequency synchronization on line interfaces. Use this task to configure an interface to participate in frequency synchronization.

**Before you begin**

You must enable frequency synchronization globally on the router.

**SUMMARY STEPS**

1. `configure`
2. `interface type interface-path-id`
3. `frequency synchronization`
4. `selection input`
5. `priority priority-value`
6. `wait-to-restore minutes`
7. `ssm disable`
8. `time-of-day-priority priority`
9. `quality transmit {exact | highest | lowest} itu-t option ql-option`
10. `quality receive {exact | highest | lowest} itu-t option ql-option`
11. Use one of these commands:
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><code>configure</code></td>
<td><strong>Example:</strong>&lt;br&gt;RP/0/RSP0/CPU0:router# configure</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Enters interface configuration mode.</td>
</tr>
<tr>
<td><code>interface type interface-path-id</code></td>
<td><strong>Example:</strong>&lt;br&gt;RP/0/RSP0/CPU0:router(config)# interface GigabitEthernet0/1/1/0</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Enables frequency synchronization on the interface and enters interface frequency synchronization mode to configure the various options. By default, this causes the system selected frequency signal to be used for clocking transmission, but does not enable the use of the interface as an input.</td>
</tr>
<tr>
<td><code>frequency synchronization</code></td>
<td><strong>Example:</strong>&lt;br&gt;RP/0/RSP0/CPU0:router(config-if)# frequency synchronization</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>(Optional) Specifies the interface as a timing source to be passed to the selection algorithm.</td>
</tr>
<tr>
<td><code>selection input</code></td>
<td><strong>Example:</strong>&lt;br&gt;RP/0/RSP0/CPU0:router(config-if-freqsync)# selection input</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>(Optional) Configures the priority of the frequency source on a controller or an interface. Values can range from 1 (highest priority) to 254 (lowest priority). The default value is 100. This command is used to set the priority for an interface or clock interface. The priority is used in the clock-selection algorithm to choose between two sources that have the same quality level (QL). Lower priority values are preferred.</td>
</tr>
<tr>
<td><code>priority priority-value</code></td>
<td><strong>Example:</strong>&lt;br&gt;RP/0/RSP0/CPU0:router(config-if-freqsync)# priority 100</td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>(Optional) Configures the wait-to-restore time, in minutes, for frequency synchronization on an interface. This is the amount of time after the interface comes up before it is used for synchronization. Values can range from 0 to 12. The default value is 5.</td>
</tr>
<tr>
<td><code>wait-to-restore minutes</code></td>
<td><strong>Example:</strong>&lt;br&gt;RP/0/RSP0/CPU0:router(config-if-freqsync)# wait-to-restore 300</td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td>(Optional) Disables Synchronization Status Messages (SSMs) on the interface. For SyncE interfaces, this disables sending ESMC packets, and ignores any received ESMC packets.</td>
</tr>
<tr>
<td><code>ssm disable</code></td>
<td><strong>Example:</strong>&lt;br&gt;RP/0/RSP0/CPU0:router(config-if-freqsync)# ssm disable</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Step 8</strong> time-of-day-priority priority</td>
<td>• For SONET and clock interfaces, this causes DNU to be sent, and ignores any received QL value.</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-if-freqsync)# time-of-day-priority 50</td>
<td>(Optional) Specifies the priority of this time source as the time-of-day (ToD) source. The priority is used as the first criterion when selecting between sources for a time-of-day selection point. Values can range from 1 (highest priority) to 254 (lowest priority); the default value is 100.</td>
</tr>
<tr>
<td><strong>Step 9</strong> quality transmit {exact</td>
<td>highest</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-clk-freqsync)# quality transmit highest itu-t option 1 prc</td>
<td>• <strong>exact ql</strong>—Specifies the exact QL to send, unless DNU would otherwise be sent.</td>
</tr>
<tr>
<td></td>
<td>• <strong>highest ql</strong>—Specifies an upper limit on the QL to be sent. If the selected source has a higher QL than the QL specified here, this QL is sent instead.</td>
</tr>
<tr>
<td></td>
<td>• <strong>lowest ql</strong>— Specifies a lower limit on the QL to be sent. If the selected source has a lower QL than the QL specified here, DNU is sent instead.</td>
</tr>
<tr>
<td>The quality option specified in this command must match the globally-configured quality option in the <strong>quality itu-t option</strong> command.</td>
<td></td>
</tr>
<tr>
<td><strong>Note</strong> For clock interfaces that do not support SSM, only the exact QL can be specified. In this case, rather than sending DNU, the output is squelched, and no signal is sent.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 10</strong> quality receive {exact</td>
<td>highest</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-clk-freqsync)# quality receive highest itu-t option 1 prc</td>
<td>• <strong>exact ql</strong>— Specifies the exact QL regardless of the value received, unless the received value is DNU.</td>
</tr>
<tr>
<td></td>
<td>• <strong>highest ql</strong>— Specifies an upper limit on the received QL. If the received value is higher than this specified QL, this QL is used instead.</td>
</tr>
<tr>
<td></td>
<td>• <strong>lowest ql</strong>— Specifies a lower limit on the received QL. If the received value is lower than this specified QL, DNU is used instead.</td>
</tr>
<tr>
<td>The quality option specified in this command must match the globally-configured quality option in the <strong>quality itu-t option</strong> command.</td>
<td></td>
</tr>
<tr>
<td><strong>Note</strong> For clock interfaces that do not support SSM, only the exact QL can be specified.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 11</strong> Use one of these commands:</td>
<td>Saves configuration changes.</td>
</tr>
</tbody>
</table>
Configuring Frequency Synchronization on a Clock Interface

To enable a clock interface to be used as frequency input or output, you must configure the port parameters and frequency synchronization, as described in this task.

Note

The configuration on clock interfaces must be the same for corresponding clock interfaces across all RSPs to avoid changes in frequency synchronization behavior in the event of an RSP switchover.

SUMMARY STEPS

1. configure
2. clock-interface sync port-no location node-id
3. port-parameters {bits-input mode | bits-output mode | dti}
4. ics
5. frequency synchronization
6. selection input
7. priority priority-value
8. wait-to-restore minutes
9. ssm disable
10. time-of-day-priority priority
11. quality transmit {exact | highest | lowest} itu-t option ql-option
12. quality receive {exact | highest | lowest} itu-t option ql-option
13. Use one of these commands:
   - `end`
   - `commit`

## DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td><code>configure</code></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router# configure</td>
<td></td>
</tr>
<tr>
<td>Step 2</td>
<td><code>clock-interface sync port-no location node-id</code></td>
<td>Enters clock interface configuration mode to configure the clock interface.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config)# clock-interface</td>
<td></td>
</tr>
<tr>
<td></td>
<td>sync 2 location 0/2/0</td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td>`port-parameters {bits-input mode</td>
<td>bits-output mode</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-clock-if)# port-parameters dti</td>
<td></td>
</tr>
<tr>
<td>Step 4</td>
<td><code>ics</code></td>
<td>Enables chassis synchronization.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config)# ics</td>
<td></td>
</tr>
<tr>
<td>Step 5</td>
<td><code>frequency synchronization</code></td>
<td>Enters clock interface frequency synchronization mode to configure frequency synchronization parameters. <strong>Note</strong> The remaining steps in this task are the same as those used to configure the interface frequency synchronization.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-clock-if)# frequency synchronization</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-clk-freqsync)#</td>
<td></td>
</tr>
<tr>
<td>Step 6</td>
<td><code>selection input</code></td>
<td>(Optional) Specifies the interface as a timing source to be passed to the selection algorithm.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-if-freqsync)# selection input</td>
<td></td>
</tr>
<tr>
<td>Step 7</td>
<td><code>priority priority-value</code></td>
<td>(Optional) Configures the priority of the frequency source on a controller or an interface. Values can range from 1 (highest priority) to 254 (lowest priority). The default value is 100. This command is used to set the priority for an interface or clock interface. The priority is used in the clock-selection algorithm to choose between two sources that have the same quality level (QL). Lower priority values are preferred.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-if-freqsync)# priority 100</td>
<td></td>
</tr>
</tbody>
</table>
### Configuring Frequency Synchronization on a Clock Interface

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 8</strong></td>
<td>(Optional) Configures the wait-to-restore time, in minutes, for frequency synchronization on an interface. This is the amount of time after the interface comes up before it is used for synchronization. Values can range from 0 to 12. The default value is 5.</td>
</tr>
<tr>
<td>wait-to-restore minutes</td>
<td>Example: RP/0/RSP0/CPU0:router(config-if-freqsync)# wait-to-restore 300</td>
</tr>
<tr>
<td><strong>Step 9</strong></td>
<td>(Optional) Disables Synchronization Status Messages (SSMs) on the interface.</td>
</tr>
<tr>
<td>ssm disable</td>
<td>Example: RP/0/RSP0/CPU0:router(config-if-freqsync)# ssm disable</td>
</tr>
<tr>
<td><strong>Step 10</strong></td>
<td>(Optional) Specifies the priority of this time source as the time-of-day (ToD) source. The priority is used as the first criterion when selecting between sources for a time-of-day selection point. Values can range from 1 (highest priority) to 254 (lowest priority); the default value is 100.</td>
</tr>
<tr>
<td>time-of-day-priority priority</td>
<td>Example: RP/0/RSP0/CPU0:router(config-if-freqsync)# time-of-day-priority 50</td>
</tr>
<tr>
<td><strong>Step 11</strong></td>
<td>(Optional) Adjusts the QL that is transmitted in SSMs.</td>
</tr>
<tr>
<td>quality transmit {exact</td>
<td>highest</td>
</tr>
<tr>
<td><strong>Step 12</strong></td>
<td>(Optional) Adjusts the QL value that is received in SSMs, before it is used in the selection algorithm.</td>
</tr>
<tr>
<td>quality receive {exact</td>
<td>highest</td>
</tr>
</tbody>
</table>

**Note** For clock interfaces that do not support SSM, only the lowest QL can be specified. In this case, rather than sending DNU, the output is squelched, and no signal is sent.
**Command or Action**

- `lowest ql`—Specifies a lower limit on the received QL. If the received value is lower than this specified QL, DNU is used instead.

The quality option specified in this command must match the globally-configured quality option in the `quality itu-t option` command.

**Purpose**

- For clock interfaces that do not support SSM, only the exact QL can be specified.

---

**Step 13**

- Use one of these commands:
  - `end`
  - `commit`

**Example:**

```
RP/0/RSP0/CPU0:router(config-if-freqsync)# end
```

**Saves configuration changes.**

- When you issue the `end` command, the system prompts you to commit changes:

  Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:

  - Entering `yes` saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
  - Entering `no` exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
  - Entering `cancel` leaves the router in the current configuration session without exiting or committing the configuration changes.

- Use the `commit` command to save the configuration changes to the running configuration file, and remain within the configuration session.

---

**Configuring Clock Interface with DTI input**

This procedure describes the steps involved to configure a Clock interface with DTI input.

1. To configure a clock interface, use `clock-interface sync value location node` command in the configuration mode.

   `RP/0/RSP0/CPU0:router(config)# clock-interface sync 1 location 0/RSP0/CPU0`

2. To configure port parameters for the given clock interface, use `port-parameters dti` command in the clock-interface configuration mode.

   `RP/0/RSP0/CPU0:router(config-clock-if)# port-parameters dti`
3. To enable frequency synchronization, use `frequency synchronization` command in the clock-interface configuration mode.

   RP/0/RSP0/CPU0:router(config-clock-if)# frequency synchronization

4. To configure selection input for the given clock interface, use `selection input` command in the frequency-synchronization clock-configuration mode.

   RP/0/RSP0/CPU0:router(config-clk-freqsync)# selection input

5. To configure priority for the clock interface, use `priority number` command in the frequency-synchronization clock-configuration mode.

   RP/0/RSP0/CPU0:router(config-clk-freqsync)# priority 1

6. To configure wait-to-restore time for the clock interface, use `wait-to-restore number` command in the frequency-synchronization clock-configuration mode.

   RP/0/RSP0/CPU0:router(config-clk-freqsync)# wait-to-restore 0

7. To disable SSM packets for the clock interface, use `ssm disable` command in the frequency-synchronization clock-configuration mode.

   RP/0/RSP0/CPU0:router(config-clk-freqsync)# ssm disable

8. To configure quality settings for the clock interface, use `quality receive exact itu-t option number generation number PRS` command in the frequency-synchronization clock-configuration mode.

   RP/0/RSP0/CPU0:router(config-clk-freqsync)# quality receive exact itu-t option 2 generation 2 PRS

Verification

To display the current running configuration of an interface, use `show run clock-interface` command.

RP/0/RSP0/CPU0:router# show run clock-interface sync 1 location 0/RSP0/CPU0

clock-interface sync 1 location 0/RSP0/CPU0
port-parameters
dti
! frequency synchronization
  selection input
  priority 1
  wait-to-restore 0
  ssm disable
  quality receive exact itu-t option 2 generation 2 PRS
! !RP/0/RSP0/CPU0:router#

Configuring GPS Settings for a sync2 interface

This procedure describes the steps involved to configure GPS settings for a sync2 interface.
1. To configure a clock interface, use `clock-interface sync port-number location interface-location` command in the configuration mode.

   ```
   RP/0/RSP0/CPU0:router(config)# clock-interface sync 2 location 0/RSP0/CPU0
   ```

2. To configure port parameters for the given clock interface, use `port-parameters` command in the clock-interface configuration mode.

   ```
   RP/0/RSP0/CPU0:router(config-clock-if)# port-parameters
   ```

3. To configure GPS input parameters, use `gps-input tod-format gprmc pps-input ttl` command.

   ```
   RP/0/RSP0/CPU0:router(config-clk-parms)# gps-input tod-format gprmc pps-input ttl
   ```

4. To return to the clock-interface configuration mode, use `exit` command.

   ```
   RP/0/RSP0/CPU0:router(config-clk-parms)# exit
   ```

5. To enable frequency synchronization, use `frequency synchronization` command in the clock-interface configuration mode.

   ```
   RP/0/RSP0/CPU0:router(config-clock-if)# frequency synchronization
   ```

6. To configure selection input for the given clock interface, use `selection input` command in the frequency-synchronization clock-configuration mode.

   ```
   RP/0/RSP0/CPU0:router(config-clk-freqsync)# selection input
   ```

7. To configure priority for the clock interface, use `priority number` command in the frequency-synchronization clock-configuration mode.

   ```
   RP/0/RSP0/CPU0:router(config-clk-freqsync)# priority 10
   ```

8. To configure wait-to-restore time for the clock interface, use `wait-to-restore number` command in the frequency-synchronization clock-configuration mode.

   ```
   RP/0/RSP0/CPU0:router(config-clk-freqsync)# wait-to-restore 0
   ```

9. To disable SSM packets for the clock interface, use `ssm disable` command in the frequency-synchronization clock-configuration mode.

   ```
   RP/0/RSP0/CPU0:router(config-clk-freqsync)# ssm disable
   ```

10. To configure quality settings for the clock interface, use `quality receive exact itu-t option number generation number PRS` command in the frequency-synchronization clock-configuration mode.

    ```
    RP/0/RSP0/CPU0:router(config-clk-freqsync)# quality receive exact itu-t option 2 generation 2 PRS
    ```

**Verification**

To verify the configured GPS parameters, use `show run clock-interface` command.
**GPS ToD Support for NMEA**

National Marine Electronics Associations (NMEA) 0183 is a standard protocol used by GPS receivers to transmit data and is responsible for creating a standard uniform interface for digital data exchange between different marine electronic products. NMEA provides protocol strings to send out GPS updates. GPRMC is one such NMEA string that provides exact data and time (Greenwich time), latitude, longitude, heading, and speed. Router receives GPS ToD messages in serial ASCII stream through the RS422 interface in three formats - NTP Type 4, Cisco, and GPRMC. The timing data is extracted from this stream.

---

**Note**

Cisco ASR 9000 Series Routers can support ToD in NMEA or GPRMC format. Currently, this is supported only on RS422.

---

**Note**

You can refer to the below support information in context of the current release and see relevant Release Notes for more information on supported features and hardware.

Supported hardware are:

- A9K-RSP440-SE/TR
- A9K-RSP880-SE/TR
- A99-RP2-SE/TR
- A9K-RSP880-LT-SE/TR
- A99-RSP-SE/TR

---

**Configuring ICS**

This task enables inter-chassis synchronization for interfaces.

**SUMMARY STEPS**

1. configure
2. clock-interface sync port-no location node-id
3. port-parameters ics
4. frequency synchronization
5. selection input
6. priority priority-value
7. wait-to-restore minutes
### Detailed Steps

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> configure</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router# configure</td>
</tr>
<tr>
<td><strong>Step 2</strong> clock-interface sync <em>port-no</em> location <em>node-id</em></td>
<td>Enters clock interface configuration mode to configure the clock interface.</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config)# clock-interface sync 2 location 1/RSP0/CPU0</td>
</tr>
<tr>
<td><strong>Step 3</strong> port-parameters ics</td>
<td>Enables inter-chassis synchronization.</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-clock-if)# port-parameters ics</td>
</tr>
<tr>
<td><strong>Step 4</strong> frequency synchronization</td>
<td>Enters clock interface frequency synchronization mode to configure frequency synchronization parameters.</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-clock-if)# frequency synchronization</td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-clk-freqsync)#</td>
</tr>
<tr>
<td><strong>Step 5</strong> selection input</td>
<td>(Optional) Specifies the interface as a timing source to be passed to the selection algorithm.</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-if-freqsync)# selection input</td>
</tr>
<tr>
<td><strong>Step 6</strong> priority <em>priority-value</em></td>
<td>(Optional) Configures the priority of the frequency source on a controller or an interface. Values can range from 1 (highest priority) to 254 (lowest priority). The default value is 100.</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-if-freqsync)# priority 100</td>
</tr>
<tr>
<td><strong>Step 7</strong> wait-to-restore <em>minutes</em></td>
<td>(Optional) Configures the wait-to-restore time, in minutes, for frequency synchronization on an interface. This is the amount of time after the interface comes up before it is used for synchronization. Values can range from 0 to 12. The default value is 5.</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-if-freqsync)# wait-to-restore 300</td>
</tr>
</tbody>
</table>
Purpose
Command or Action | Purpose |
--- | --- |
Step 8 | time-of-day-priority priority |
Example: | (Optional) Specifies the priority of this time source as the time-of-day (ToD) source. The priority is used as the first criterion when selecting between sources for a time-of-day selection point. Values can range from 1 (highest priority) to 254 (lowest priority); the default value is 100. |
Step 9 | quality receive { exact | highest | lowest} itu option |
Example: | |
| | RP/0/RSP0/CPU0:router (config-clk-freqsync) # quality receive exact itu-t option 1 PRC |

**Verifying the Frequency Synchronization Configuration**

After performing the frequency synchronization configuration tasks, use this task to check for configuration errors and verify the configuration.

**SUMMARY STEPS**

1. show frequency synchronization configuration-errors
2. show frequency synchronization interfaces brief
3. show frequency synchronization interfaces node-id
4. show processes fsyncmgr location node-id

**DETAILED STEPS**

**Step 1**

show frequency synchronization configuration-errors

Example:

RP/0/RSP0/CPU0:router# show frequency synchronization configuration-errors

Node 0/2/CPU0:

Interface GigabitEthernet0/2/0/0 frequency synchronization
  * Frequency synchronization is enabled on this interface, but isn't enabled globally.

Interface GigabitEthernet0/2/0/0 frequency synchronization quality transmit exact itu-t option 2 generation 1 PRS
  * The QL that is configured is from a different QL option set than is configured globally.

Displays any errors that are caused by inconsistencies between shared-plane (global) and local-plane (interface) configurations. There are two possible errors that can be displayed:

- Frequency Synchronization is configured on an interface (line interface or clock-interface), but is not configured globally. Refer to Enabling Frequency Synchronization on the Router, on page 6
- The QL option configured on some interface does not match the global QL option. Under an interface (line interface or clock interface), the QL option is specified using the quality transmit and quality receive commands. The value
specified must match the value configured in the global **quality itu-t option** command, or match the default (option 1) if the global **quality itu-t option** command is not configured.

Once all the errors have been resolved, meaning there is no output from the command, continue to the next step.

**Step 2**

**show frequency synchronization interfaces brief**

**Example:**

```bash
RP/0/RSP0/CPU0:router# show frequency synchronization interfaces brief
```

Flags: > - Up  D - Down  S - Assigned for selection
d - SSM Disabled  x - Peer timed out  i - Init state

<table>
<thead>
<tr>
<th>Fl</th>
<th>Interface</th>
<th>QLrcv</th>
<th>QLuse</th>
<th>Pri</th>
<th>QLsnd</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;S</td>
<td>GigabitEthernet0/2/0/0</td>
<td>Fail</td>
<td>Fail</td>
<td>100</td>
<td>DNU</td>
<td>None</td>
</tr>
<tr>
<td>D</td>
<td>GigabitEthernet0/2/0/1</td>
<td>n/a</td>
<td>Fail</td>
<td>100</td>
<td>n/a</td>
<td>None</td>
</tr>
</tbody>
</table>

**Example:**

```bash
RP/0/RSP0/CPU0:router# show frequency synchronization clock-interfaces brief
```

Flags: > - Up  D - Down  S - Assigned for selection
d - SSM Disabled  s - Output squelched  L - Looped back

Node 0/0/CPU0:

<table>
<thead>
<tr>
<th>Fl</th>
<th>Clock Interface</th>
<th>QLrcv</th>
<th>QLuse</th>
<th>Pri</th>
<th>QLsnd</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;S</td>
<td>Sync0</td>
<td>PRC</td>
<td>Fail</td>
<td>100</td>
<td>SSU-B</td>
<td>Internal0 [0/0/CPU0]</td>
</tr>
<tr>
<td>&gt;</td>
<td>Sync1</td>
<td>SSU-A</td>
<td>Fail</td>
<td>100</td>
<td>SSU-B</td>
<td>Internal0 [0/0/CPU0]</td>
</tr>
<tr>
<td>&gt;S</td>
<td>Internal0</td>
<td>n/a</td>
<td>SSU-B</td>
<td>255</td>
<td>n/a</td>
<td>None</td>
</tr>
</tbody>
</table>

Node 0/1/CPU0:

<table>
<thead>
<tr>
<th>Fl</th>
<th>Clock Interface</th>
<th>QLrcv</th>
<th>QLuse</th>
<th>Pri</th>
<th>QLsnd</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>Sync0</td>
<td>None</td>
<td>Fail</td>
<td>100</td>
<td>SSU-B</td>
<td>Internal0 [0/1/CPU0]</td>
</tr>
<tr>
<td>D</td>
<td>Sync1</td>
<td>None</td>
<td>Fail</td>
<td>100</td>
<td>SSU-B</td>
<td>Internal0 [0/1/CPU0]</td>
</tr>
<tr>
<td>&gt;S</td>
<td>Internal0</td>
<td>n/a</td>
<td>SSU-B</td>
<td>255</td>
<td>n/a</td>
<td>None</td>
</tr>
</tbody>
</table>

Verifies the configuration. Note the following points:

- All line interface that have frequency synchronization configured are displayed.
- All clock interfaces and internal oscillators are displayed.
- Sources that have been nominated as inputs (in other words, have **selection input** configured) have ‘S’ in the Flags column; sources that have not been nominated as inputs do not have ‘S’ displayed.

**Note** Internal oscillators are always eligible as inputs.

- ‘>’ or ‘D’ is displayed in the flags field as appropriate.

If any of these items are not true, continue to the next step.

**Step 3**

**show frequency synchronization interfaces node-id**

**Example:**

```bash
RP/0/RSP0/CPU0:router# show frequency synchronization interfaces GigabitEthernet0/2/0/2
```
Interface GigabitEthernet0/2/0/2 (shutdown)
  Assigned as input for selection
  SSM Enabled
  Input:
    Down
    Last received QL: Failed
    Effective QL: Failed, Priority: 100
  Output:
    Selected source: Sync0 [0/0/CPU0]
    Selected source QL: Opt-I/PRC
    Effective QL: Opt-I/PRC
    Next selection points: LC_INGRESS

RP/0/RSP0/CPU0:router# show frequency synchronization clock-interfaces location 0/1/CPU0

Node 0/1/CPU0:
---------------
Clock interface Sync0 (Down: mode not configured)
  SSM supported and enabled
  Input:
    Down
    Last received QL: Opt-I/PRC
    Effective QL: Failed, Priority: 100
  Output:
    Selected source: Internal0 [0/1/CPU0]
    Selected source QL: Opt-I/SSU-B
    Effective QL: Opt-I/SSU-B
    Next selection points: RP_SYSTEM

Clock interface Sync1 (Down: mode not configured)
  SSM supported and enabled
  Input:
    Down
    Last received QL: Opt-I/PRC
    Effective QL: Failed, Priority: 100
  Output:
    Selected source: Internal0 [0/1/CPU0]
    Selected source QL: Opt-I/SSU-B
    Effective QL: Opt-I/SSU-B
    Next selection points: RP_SYSTEM

Clock interface Internal0 (Up)
  Assigned as input for selection
  Input:
    Default QL: Opt-I/SSU-B
    Effective QL: Opt-I/SSU-B, Priority: 255
    Next selection points: RP_SYSTEM RP_CLOCK_INTF

Investigates issues within individual interfaces. If the clock interface is down, a reason is displayed. This may be because there is missing or conflicting platform configuration on the clock interface.

Step 4  show processes fsyncmgr location node-id

Example:

RP/0/RSP0/CPU0:router# show processes fsyncmgr location 0/0/CPU0

  Job Id: 134
  PID: 30202
  Executable path: /pkg/bin/fsyncmgr
  Instance #: 1
Verifies that the fsyncmgr process is running on the appropriate nodes.