



Configuring the Global Navigation Satellite System

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Information About GNSS

Industrial automation and control, utilities, and military networks require large numbers of devices in their networks to have an accurate and synchronized view of time. The IR8340 timing module has a built-in Global Navigation Satellite System (GNSS) receiver that enables the router to determine its own location and get an accurate time from a satellite constellation. GNSS capability simplifies network synchronization planning and provides flexibility and resilience in resolving network synchronization issues in a hierarchical network.

GNSS Hardware

The IR8340 timing module uses a GNSS receiver with precise frequency and phase outputs for the host system. When connected to an external GNSS antenna, the receiver contains all the circuitry necessary to automatically acquire GNSS satellite signals, track up to 32 GNSS satellites, and compute location, speed, heading, and time. It provides an accurate one pulse-per-second (PPS) and stable 10 MHz frequency output. For more information, see [GNSS Signaling, on page 2](#).



Note You are recommended to choose GPS LRM-400 cable for GNSS so that you can check all GNSS alarms. For a list of supported antennas and cables, see the *Cisco Catalyst IR8340 Rugged Series Router Hardware Installation Guide*.

The GNSS chip supports the following frequency bands:

- AUTO—GPS + QZSS + GLONASS (default)
- GPS
- GLONASS
- BeiDou

- Galileo

Software

The GNSS feature supports the following functions:

- Time Mode—A special receiver mode where the position of the receiver is known and fixed, and only the time is calculated using all available satellites.
- Survey-in—The procedure that is carried out prior to using Time Mode. It determines a stationary receiver's position by building a weighted mean of all valid 3D position solutions. The receiver computes the average position over an extended time period until a predefined standard deviation has been reached and the minimum observation time has passed by. Afterwards the receiver will be automatically set to fixed mode and the timing features will be activated.
- Survey-in and fixed-position navigation reduce timing jitter, even at low signal levels, and enable synchronization to be maintained with as few as one single satellite in view.
- Time pulse accuracy—Clear sky: 20 ns | Indoor: 500 ns.
- Configures the GNSS receiver.
- After the receiver has gained lock, software performs the following functions once per second:
 - Reads the new time/date.
 - Reads the corresponding PPS timestamp from the hardware.
 - Feeds time/date and PPS timestamp into the Time Services SW Virtual Clock/Servo for GNSS.

The GNSS SW Virtual Clock time can then be used to drive PTP output.

You can use the **constellation** CLI to choose between these constellations. When a constellation is changed, survey-in process is restarted to lock to a new constellation. For more information, see [Configuring the Satellite Constellation for GNSS, on page 4](#).

Default TOD format is **ubx** and out 1PPS can get when GNSS is locked (for example, PRTC mode).

Frequency 1hz: the following commands are required to enable to get locked:

```
Router(config)# network-clock synchronization automatic
Router(config)# network-clock synchronization mode QL-enabled
Router(config)# network-clock quality-level rx QL-PRC External R0 1hz
Router(config)# network-clock input-source 1 External R0 1hz
Router(config)# network-clock wait-to-restore 10 global
```

GNSS Signaling

There are two stages in the process for the GNSS receiver to acquire satellites and provide timing signals to the host system:

- Self-Survey Mode: On reset, the GNSS receiver comes up in self-survey mode and attempts to lock on to a minimum of four different satellites to obtain a 3-D fix on its current position. It computes nearly 2000 different positions for these satellites, which takes about 35 minutes. Also during this stage, the

GNSS receiver is able to generate accurate timing signals and achieve “Normal (Locked to GPS)” state. Note that the timing signal obtained during self-survey mode can be off by 20 seconds; therefore, Cisco IOS collects PPS only during OD mode.

After the self-survey is complete, the results are saved to the GNSS receiver flash, which speeds up the transition to OD mode the next time the self-survey runs. You can manually restart the self-survey process with the **gnss self-survey restart** Cisco IOS command. After self-survey mode completes again, the results in the GNSS receiver flash are overwritten with the updated results.

- Over-determined (OD) clock mode: The device transitions to OD mode when self-survey mode is completed and the position information is stored in non-volatile memory on the device. In this mode, the GNSS receiver outputs timing information based on satellite positions obtained in self-survey mode.

The GNSS receiver remains in OD mode until there is a reason to leave it, such as:

- Detection of a position relocation of the antenna of more than 100m, which triggers an automatic restart of the self-survey.
- Manual restart of the self-survey using the **gnss self-survey restart** command.

After the GNSS receiver locks on to a satellite system, it sends a 10ms wide PPS pulse and the current time/date according to the satellite system to the Cisco IOS time service.

GNSS LED

The GNSS LED (labeled "GPS" on the cable side and power supply side LEDs) indicates the GNSS status. The following table shows LED colors and their meaning.

Table 1: GNSS LED

Color	Status
Blinking Green	Attempting to acquire satellite fix.
Solid Green	GNSS has valid signal/fix.
Blinking Amber	Antenna fault.
Off	GNSS not configured.

Guidelines and Limitations

- GNSS is available as a timing source for PTP default and power profiles only.
- GNSS is available as a timing source for PTP only when PTP is in GMC-BC mode.
- Syslog messages are sent when the following GNSS events occur:
 - GNSS is in self-survey mode.
 - GNSS reaches OD mode.
 - GNSS firmware upgrade is in progress, complete, or failed.

- If the router is the PTP grandmaster clock and it loses the antenna signal, the clock quality will degrade, resulting in a grandmaster clock switchover.
- The GPS antenna alarm will not trigger an external relay alarm.
- To configure GNSS Auto, you must have a minimum of 8 tracking satellites for each enabled major GNSS (GPS and GLONASS).
- The Antenna Open alarm may be triggered without a hardware issue. In such a scenario, you may configure constellation AUTO to GPS or another constellation available in the location.

Configuring the Satellite Constellation for GNSS

Perform these steps to configure the satellite constellation for GNSS.

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: Router# <code>configure terminal</code>	Enter global configuration mode.
Step 2	gnss Example: Router(config)# <code>gnss</code>	Enable GNSS. When GNSS is enabled, the GNSS process will run to collect GNSS pulse-per-second (PPS) timestamp information. When GNSS is disabled, the chip operates normally, but there is no software process running to collect GNSS timestamp and PPS information.
Step 3	[no] constellation {auto galileo gps glonass beidou} Example: Router(config-gnss)# <code>constellation gps</code>	(Optional) Configure the GNSS constellation. The default is auto (GPS+GLONASS+QZSS). Only one constellation is active at any given time.
Step 4	exit Example: Router(config-gnss)# <code>exit</code>	Exit GNSS configuration mode.

Verifying Configuration

Command	Purpose
<code>show gnss status</code>	Display the GNSS status. See example output with field descriptions below.

Command	Purpose
show gnss satellite {all <i>satellite-number</i> }	Display status of satellites tracked by GNSS. The signal strength is displayed in the form <i>carrier-to-noise density (C/N0)</i> . The Signal Strength unit is dB-Hz and refers to the ratio of the carrier power and the noise power (dB) <i>per unit bandwidth</i> (Hz). Received satellite signal power varies with user antenna gain, satellite elevation angle, and satellite age. Typical C/N0 range is from 35–55 dB-Hz.
show gnss time	Display GNSS time.
show gnss location	Display GNSS location.
show gnss device	Display GNSS device information.
show network-clocks synchronization	Display network clock synchronization status.
show platform hardware network-clocks	Display network clocks for the hardware.

The following example shows output for **show gnss status** after the GNSS receiver has completed self-survey mode and is providing timing information from the satellite system:

```
# show gnss status
GNSS status:
GNSS status: Enable
Clock Progress: Locked (GnssFixOK)
GNSS Fix Type: time only fix
Constellation: GLONASS
Satellite count: 9
PDOP: 99.989998 TDOP: 0.350000
HDOP: 99.989998 VDOP: 99.989998
Major Alarm: False
Minor Alarm: False
```

Status fields and possible values are:

- GNSS status
 - Enable
 - Disable
- Receiver Status
 - Auto—Auto mode for 2D/3D
 - 1SV—Single satellite
 - 2SV—Horizontal (2D)
 - 3SV—Full position (3D)
 - OD—Over-determined
- Survey progress—This field shows the progress of the survey as a percentage of fixes collected so far. The self-survey is complete when the self-survey progress reaches 100%.

- PDOP—Position dilution of precision
- HDOP—Horizontal dilution of precision
- VDOP—Vertical dilution of precision
- TDOP—Time dilution of precision
- Alarm
 - Antenna open
 - Antenna shorted
 - Not tracking satellites
 - Survey-in progress
 - No stored position
 - Leap second pending



Note If any GPS alarm conditions are present, the switch may not be providing timing information from the satellite system.

The alarm will clear automatically.

The following example shows output for **show gnss satellite**:

```
IR8340#show gnss satellite all
All Satellites Info:
SV ID Channel Eph Flag SV Used CNR Azimuth Elevation Health Quality
-----
19 6 1 - 24 260 1 1 4
18 6 1 - 31 219 2 1 7
15 6 1 Used 46 223 42 1 7
14 6 1 Used 44 340 73 1 7
13 6 1 Used 36 22 20 1 7
4 6 1 Used 48 349 27 1 7
3 6 1 Used 48 53 51 1 7
2 6 1 Used 45 114 24 1 7
```

The following examples show outputs for **show gnss time** and **show gnss location**:

```
IR8340# show gnss time
Current GNSS Time:
Time: 2021/12/09 07:11:59 UTC

IR8340# show gnss location
Current GNSS Location:
LOC: 12:56.187572 N 77:41.742096 E 832.44 m
```

The following example shows output for **show gnss device**:

```
IR8340#show gnss device
GNSS device:
```

```

Model: NEO-M8T-0
Software version: EXT CORE 3.01 (111141)
Hardware version: 00080000
Protocol version: 22.00
Firmware version: TIM 1.10
Unique Chip ID: 311652325097
Major GNSS Satellites supported: GPS;GLO;GAL;BDS

```

The following example shows output for **show network-clocks synchronization**:

```

IR8340#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
Equipment Clock : 2048 (EEC-Option1)
Clock Mode : QL-Enable
ESMC : Enabled
SSM Option : 1
T0 : External R0 1hz
Hold-off (global) : 300 ms
Wait-to-restore (global) : 10 sec
Tsm Delay : 180 ms
Revertive : No
Nominated Interfaces
  Interface          SigType      Mode/QL      Prio  QL_IN  ESMC Tx  ESMC Rx
  Internal           NA           NA/Dis       251   QL-SEC NA       NA
*External R0      1HZ       NA/Dis     1    QL-PRC NA     NA
IR8340#

```

The following example shows output for **show platform hardware network-clocks**:

```

IR8340#show platform hardware network-clocks
DPLL1 Status:
-----
Bandwidth: 0.001 Hz
Phase Slope Limit: 885 ns/s
Current PLL1 Mode: MANUAL NORMAL
Current Input Selected: REF4 (CLK_PPS_GPS_PLL)
Current PLL1 Holdover Status: OFF
Current PLL1 Lock Status: ON
DPLL2 Status:
-----
Bandwidth: 0.001 Hz
Phase Slope Limit: 885 ns/s
Current PLL2 Mode: MANUAL NORMAL
Current Input Selected: REF4 (CLK_PPS_GPS_PLL)
Current PLL2 Holdover Status: OFF
Current PLL2 Lock Status: ON

IR8340#show platform hardware network-clocks
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) : FAIL (SCM, CFM, GST, PFM failed)
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)
```

```
DCO Frequency:
```

```
Current_DCO_Freq_Offset: -0.033687
```

```
IR8340#
```