Configuring Clocking and Timing

The terms *IR8340* and *router* are used throughout this document in text and CLI examples to refer to the Cisco Catalyst IR8340 Rugged Series Router, unless otherwise noted.

Clocking and Timing Overview

The Cisco IR8340 Routers have the capability of frequency and time synchronization. The router WAN ports (GigabitEthernet 0/0/0 and GigabitEthernet 0/0/1) are capable of distributing frequency and phase information. The LAN ports (GigabitEthernet 0/1/0 - GigabitEthernet 0/1/11) are capable of distributing phase information only. IR8340 can synchronize to a GPS source. The IR8340 router can also distribute phase via an external IRIG-B interface and external ToD RS-485 interface.

The IR8340 router supports a pluggable timing module (Cisco PID: IRM-TIMING-MOD) from Cisco IOS-XE Release 17.9.1, which has the following timing ports:

- ToD + 1 PPS Output—Provide or receive time of day (ToD) messages or one pulse-per-second (1 PPS) messages
- IRIG-B (analog and digital Input/Output) interfaces
- GNSS Receiver

Note You need license Network-Advantage on IR8340 to support all timing features (GNSS, IRIG-B and PTP profile like G.8265.1, G.8275.1, 1558v2, Power and Dot1as profiles). The **license boot level network-advantage** command enables license network-advantage.

Use the **show inventory** command to display the status of the timing module:

```
IR8340#show inventory
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
INFO: Please use "show license UDI" to get serial number for licensing.
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
NAME: "Chassis", DESCR: "Cisco IR8340-K9 Chassis Type"
```

```
PID: IR8340-K9          , VID: V00  , SN: FDO2523J1BL
NAME: "Power Supply Module 0", DESCR: "150W AC Power Supply Module for Cisco IR8340-K9"
PID: PWR-RGD-AC-DC-H    , VID: V01  , SN: DTH251705BY
NAME: "module 0", DESCR: "Cisco IR8340 Built-In NIM controller"
PID: IR8340-K9          , VID: V00  , SN: FDO252207UG
NAME: "Timing", DESCR: "Timing Module"
PID: IRM-TIMING-MOD     , VID: V00  , SN: FDO253409KG
NAME: "NIM subslot 0/0", DESCR: "Front Panel 2 ports Gigabitethernet Module"
PID: IR8340K9-2x1GC     , VID: V01  , SN:
```

Frequency Synchronization

IR8340 can recover the reference clock frequency from any of the following input sources:

- GNSS
- SyncE
- PTP Telecom Profile (G.8265.1/G.8275.1)
- Local Oscillator

When a reference clock is selected, it is propagated to downstream network elements via SyncE or PTP Telecom Profile (G.8265.1/G.8275.1).

Time or Phase Synchronization

It is important to precisely synchronize the time-of-day between different network devices. This is essential in calculating network delays.

The time/phase synchronization on IR8340 is by one of the following input sources:

- GNSS
- PTP
- IRIG-B

Time of Day (ToD) and 1PPS

You can use the time of day (ToD) and 1PPS port on the IR8340 router to exchange ToD clocking. By default, TOD is in UBX format when GNSS is source and in locked state.

Use the **show ptp wan tod** command to display ToD information:

```
IR8340#show ptp wan tod
PTPd ToD information:

Time: 01/05/22 11:35:21
```

Information about IRIG-B

The Inter-Range Instrumentation Group (IRIG) time codes are the result of the US military's need to standardize test ranges' timing codes towards the end of the 1950s. This standardization resulted in a common set of time codes that eliminated incompatibility challenges and allowed for the exchange of synchronized test data across ranges. Six IRIG codes variations were developed (A, B, D, E, G, H) of which IRIG time code B (IRIG-B) became widely accepted for time distribution with power, industrial automation, and control industries.

The IRIG standard was first published in 1960 with the latest version, IRIG standard 200-04, "IRIG Serial Time Code Formats," updated in September 2004. The IRIG-B time protocol is widely used by electric utilities and other verticals to establish and maintain time synchronization between system devices (e.g., power breakers, relays, meters, etc.) IRIG sends a complete time frame once per second, and each frame is composed of 100 bits. It contains time-of-year and year information in a BCD format, and (optionally) seconds-of-day in SBS. Though it is considered to be a reliable and predictable timing source distribution framework (dedicated timing signals) it traditionally relies on a precise timing source, e.g., GPS.

The IRIG protocol in the IR8340 has been implemented for format-B (IRIG-B) per IRIG standard 200-04 with capabilities to receive (INPUT) or transmit (OUTPUT) 4x Analog (AM) and 4x Digital (TTL) time code formats, see table below.

IR8340 IRIG-B Modes		Format ID	IRIG Signal
Analog (AM)	AM02	AM-B122	Amplitude Modulated, 1kHz / 1ms resolution, BCD_{TOY}
	AM03	AM-B123	Amplitude Modulated, 1kHz / 1ms resolution, BCD_{TOY}, SBS
	AM06	AM-B126	Amplitude Modulated, 1kHz / 1ms resolution, BCD_{TOY}, BCD_{YEAR}
	AM07	AM-B127	Amplitude Modulated, 1kHz / 1ms resolution, BCD_{TOY}, BCD_{YEAR}, SBS
Digital (TTL)	TTL02	TTL-B002	Unmodulated, DCLS, pulse-width-coded, BCD_{TOY}
	TTL03	TTL-B003	Unmodulated, DCLS, pulse-width-coded, BCD_{TOY}, SBS
	TTL06	TTL-B006	Unmodulated, DCLS, pulse-width-coded, BCD_{TOY}, BCD_{YEAR}
	TTL07	TTL-B007	Unmodulated, DCLS, pulse-width-code, BCD_{TOY}, BCD_{YEAR}, SBS

Note

- BCD: day of year, hours, minutes, and seconds.
- BCD_Year: BCD plus Year 00 – 99, which century is not coded.
- SBS: Straight Binary Seconds, 0 – 86339.

The IR8340 hardware has two physical interfaces, one for analog (AM) and one for digital (TTL), with INPUT or OUTPUT signal capabilities per interface.

This IRIG-B **INPUT** / **OUTPUT** signaling support allows the IR8340 to be a central timing device in multiple use-cases:

- **INPUT**: The IR8340 receives IRIG-B timing signaling (AM or TTL) from an IRIG-B time source if only available or so required. In this case IRIG-B can be used as the IR8340's clock source for PTP (only) - IR8340 configured as Grand Master Clock (GMC) for time distribution.

- **OUTPUT**: The IR8340 utilizes other precise timing sources, e.g., GNSS/GPS, PTP, NTP, as a clock source. The IRIG-B interface(s) can be used to transmit timing signal to IRIG-B dependent devices in location.

The IR8340 supports IRIG-B IN and IRIG-B OUT in addition to the GNSS interface. The following table shows the mapping of Time Source to time distribution protocol alignment (i.e. one will serve as time source to the other).

Time Source	Time Distribution
IRIG-B IN	PTP
GNSS, PTP, NTP	IRIG-B OUT

IRIG-B Configuration

Use the following command to configure IRIG mode (AM or TTL) and direction (IN or OUT) on the interface:

[**no**] **irig mode** {**TTL2**|**TTL3**|**TTL6**|**TTL7**|**AM2**|**AM3**|**AM6**|**AM7**} **dir** {**in | out**}

- TTL2 = IRIG-B002, TTL3 = IRIG-B003, TTL6 = IRIG-B006, TTL7 = IRIG-B007
- AM2 = IRIG-B122, AM3 = IRIG-B123, AM6 = IRIG-B126, AM7 = IRIG-B127

Use the **no** form of the command to disable the IRIG feature on the interface.

Note To switch input from digital to analog or vice versa, you must remove the input configuration on one port before reconfiguring the input on another port.

You can use the **show irig** command to display IRIG-B mode and direction configurations on the IR8340.

The following example shows output from IR8340 OUT direction.

```
IR8340#show irig
IRIG-B Digital mode disabled
IRIG-B Analog mode AM02 dir OUT
IRIG-B Clk Id 1 Source PTP  time: Year: 2021 Day: 343 Hour 8 Min 33 Sec 35.    //Source can
 be different based on what it's getting (can be GNSS/NTP/PTP/HANDSET/NONE).
                            ns 1639038815645806587 [0x16BF091E6BA52FFB]
IRIG-B Virtual Clock State: INACTIVE
*** IRIG-B input is disabled ***
```

The following example shows output from IR8340 IN direction.

```
IRIG-B Digital mode disabled
IRIG-B Analog mode AM02 dir IN
IRIG-B Clk Id 5 Source IRIG-B  time: Year: 2021 Day: 343 Hour 8 Min 36 Sec 25.  //Because
it's IN direction, the source is IRIG-B.
                            ns 1639038985184125000 [0x16BF0945E4EAA048]
IRIG-B Virtual Clock State: ACTIVE
*** IRIG-B AM input mode ***
B122 : Day 343 Hour 8 Min 36 Sec 24
NOTE: Input time shown is the last received frame time
```

PRTC Mode With GNSS

IR8340 can act in Primary Reference Time Clock (PRTC) mode, when GNSS is locked and no telecom profiles are configured. In PRTC mode, IR8340 provides TOD + 1pps output with TOD in UBX format.

Once IR8340 is in PRTC mode, ordinary clock and transparent clocks are not supported under LAN profiles. All boundary clocks under LAN profiles will be GMC-BC mode, which fetches timestamps and grandmaster clock details as per the GNSS input.

The following clock quality values will be provided by the GMC-BC master clock:

```
Clock Quality:
    Class: 6                        //----GNSS CLASS
    Accuracy: Within 250ns          //----GNSS Accuracy
    Offset (log variance): 20061    //----GNSS Variance
```

PRTC mode is supported on PTP Default and Power profile. The conversion will take place automatically when GNSS moves to locked state.

Note GNSS cannot be configured when the one of the following is configured:

- 802.1AS
- PTP TC mode
- GMC-BC options