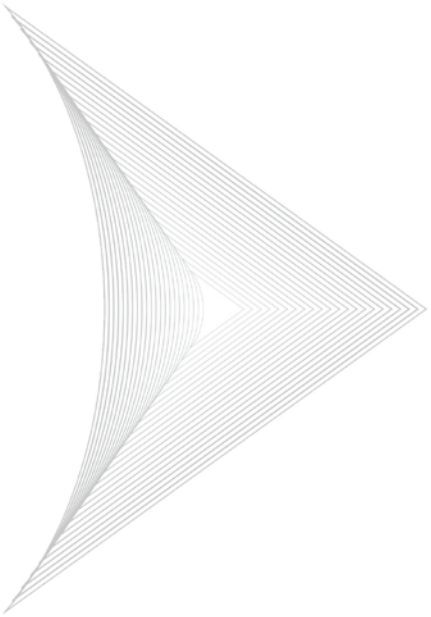
Huahuan

HX.PTP-GM02

Suction-window-mount
GNSS based
Indoor PTP Grandmaster

User's Manual



Beijing Huahuan Electronics Co.,Ltd.

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Version 1.0 (Sept. 2018)

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Model: HX.PTP-GM02

Product Name: GeckoSynco

Description: Suction-window-mount GNSS based Indoor PTP Grandmaster

Manual Version: 1.0

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1. Overview

HX.PTP-GM02, codenamed GeckoSynco, is a high precision timing source based on Global Navigation Satellite Systems (GNSS). What separates GeckoSynco from similar products in the market is its Peek2Sync design. With everything integrated into a small box, it is to be suction-mounted inside a building on to a window with only a partial view of the sky. This design eliminates the need for an outdoor satellite antenna, thus without associated lightning and other environment protection concerns, as well as much simplifies the site selection and installation process.

HX.PTP-GM02 supports IEEE-1588V2 precision timing protocol (PTP), to be used as a grandmaster (GM) in a PTP domain. Multiple PTP profile choices are built-in, useful for applications in telecommunications, electrical systems, and other scenarios where precision timing is needed.

Apart from being a PTP grandmaster, HX.PTP-GM02 also has a built-in NTP server, as well as an output port for 1 pulse-per-second and time-of-day (1PPS+ToD) signals used by different end equipment for timing reference.

1.1. Features

- ✧ Indoor device with creative Peek2Sync suction window mount design (Pat. No. ZL201520849428.3);
- ✧ GNSS[Note1] based synchronization, selectable among GPS, GLONASS or Beidou. Integrated antenna;
- ✧ Single-SV timing mode supported, only partial sky view required, ±100ns timing accuracy;
- ✧ PTP Grand-Master, NTP Server, 1PPS+ToD output with adjustable cable length delay compensation;
- ✧ SyncE function, the clock synchronization between devices in Ethernet is realized;

- ✧ 1PPS loopback distance measurement;
- ✧ High stability OCXO based, better than 1ppb holdover performance;
- ✧ Multiple PTP profile support, PnP operation within selected profile;
- ✧ 10/100/1000Base-T, PoE powered, low power consumption;
- ✧ 100/1000 Base-X Fiber optic Ethernet interface;
- ✧ Web server, SNMP, CLI configuration and management interfaces.

Note[1]: GPS is currently the most mature GNSS system. All the precision specifications given in this Manual are based on GPS. They may differ when other GNSS system is used.

1.2. Ordering Information

HX.PTP-GM02 ordering information is given in Table 1-1.

Table 1-1 HX.PTP-GM02 ordering information

Model	Description
HX.PTP-GM02/GP HX.PTP-GM02/GN HX.PTP-GM02/BD	● Main device×1 ● GP—GPS, GN—GLONASS, BD—Beidou ● Accessary: PoE Power adaptor×1 (specify power cord for your country), RJ45 plug×3, 6-pin RJ12 plug×1, suction cup×4 (screwed onto the main device)

2. 🕮 Typical Application

The HX.PTP-GM02 device receives satellite signals from various GNSS systems, acquires time synchronization to International Atomic Time (TAI)

within sub-μs accuracy, and provides timing reference to various application systems. Supported protocols include IEEE-1588V2, 1PPS+ToD, and Stratum-1 NTP server.

2.1. IEEE-1588V2 Grandmaster Clock

In the fields of telecommunications, electrical networks, measurement instruments, and industrial automation, time synchronization and/or frequency syntonization among individual nodes are key enablers for the normal functioning of the connected systems. In the past couple of decades, such system connections are quickly evolving from previous generations of diverse networking technologies into Ethernets. While a unified Ethernet networking technology improves a lot of aspects of the applications, one particular property of current Ethernet systems, namely timing opaqueness resulting from packet delay variations and asynchronous physical links, needs to be dealt with to achieve sub-μs synchronization. IEEE-1588 precision timing protocol was specifically designed for high precision synchronization over packet based networks, especially Ethernet networks.

In a PTP timing domain, one or several backup grandmaster clocks are needed to provide necessary timing reference. Since the requirements for timing differ in different industries, each industry specifies a separate profile based on the overall standard of the IEEE-1588V2. For example, in telecommunications, ITU-T G.8265.1 and G.8275.1 specify respectively network syntonization and synchronization profiles. Grandmaster clocks compliant to these profile standards are called telecom grandmasters, or T-GM.

Supported by hardware and software code sign, the HX.PTP-GM02 can operate under a set of pre-defined profiles, so that it can be readily used as a GM in a number of applications. Its usage is exemplified in the following pages, where a GeckoSynco provides timing reference for enterprise smallcells in 4G/5G mobile networks.

4G/5G base stations, including smallcells, require sub-μs timing synchronization. When Ethernet becomes the preferred technology for backhaul transmission, PTP is considered one of the main synchronization techniques. In principle, the complete backhaul network could constitute a single timing domain. In such a scheme, a T-GM is placed at the mobile core, and timing is distributed to every station through the vast expanse of complete set of core, aggregation, and access networks. This arrangement, however, has two problems.

Problem No.1, it is necessary that every node in the entire carrier's backbone packet transport network is PTP ready. The fact is that most of the legacy network equipment does not support PTP. It will need an enormous capital investment to replace all the equipment just for synchronization, while they are still quite capable for all the other functionalities needed for mobile backhaul operations. When smallcells are concerned, the backhaul may not entirely be owned by the carrier, part of the transport could be carried by the public internet. It is simply not practical to upgrade the entire internet to support PTP.

Problem No.2, even if all the nodes support PTP, the end results may not be adequate if too many intermediate nodes are crossed by the packets, between the end base station and the T-GM at the core network. This is because each node will contribute some phase error, causing degradation to the end-to-end clock quality, while 4G/5G mobile technology requirement for timing accuracy is too stringent to satisfy. Another drawback is that the added PTP packets to and from every node in the network dramatically increases the total load of the network bandwidth.

The more appropriate arrangement is to put a number of T-GM's at the edge of the network, closer to the base stations and smallcells. In this way, PTP timing domains are localized, the rest of the network just provides necessary bandwidth for data transmission, which most of existing backbone networks and even public internet are capable of. One of the key requirements for this arrangement is the availability of high quality, low cost, easy to install GM devices. The

GeckoSynco is particularly suited in this regard.

In the scenario shown in Figure 2-1, a HX.PTP-GM02 is running the ITU-T G.8275.1 profile. It is installed within an enterprise building as the local T-GM, constitutes a PTP domain with all the smallcells and the enterprise LAN devices. Smallcells get their timing synchronization from this PTP domain, and the public internet provides backhaul connection to the carrier network. PTP packets are local to the enterprise LAN, no PTP support is required in other parts of the backhaul.

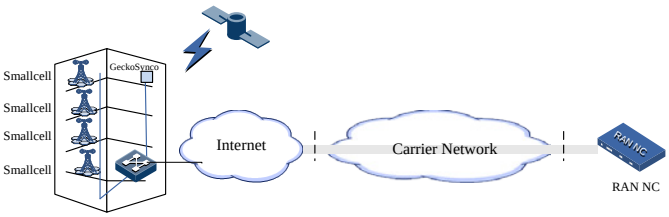

Figure 2-1 Enterprise smallcell synchronization scheme

Because GeckoSynco uses our Peek2Sync design, it can be easily sucked onto the inside of a window with resonable sky view. Unlike most GPS clocks, GeckoSynco do not require an outdore satellite antenna, thus avoids the need for site selection, mast installation and fixation, lightning protection, and other precautions associated with an outdoor antinna. The indoor condition is also a lot less harsh in terms of temperature, humidity, and other environmental factors, which is more faverable for longer operating life, stablilty and realibility.

The integrated design means that the connection between the GeckoSynco and the network equipment, which is typically in the equipment room at a fixed location far from the rooftop, is Ethernet. This meas the distance between the window site and the equipment room can be separated up to 100 meters. Much longer distance may be reached with optical Ethernet. This is in contrast with clocks using analog coax cable to connect to the rooftop antenna unit. Outdoor

antenna is needed because the attenuation introduced by the coax cable requires as good reception as possible. Still the very weak satellite signal limits the cable to just a few dozen meters, and thick coax cable and an intermediate active amplifier is usually required for longer reach, aggravating the installation task. This distance limitation also complicates the equipment room site selection.

2.2. 1PPS+ToD Scenario

In many applications, PTP is not used or supported. Many pre-PTP devices requiring time and frequency synchronization have 1PPS and ToD inputs for timing reference. Such devices include basestations, smallcells, telprotection equipment in power networks. Even in PTP networks, many IEEE-1588V2 compliant network nodes such as Ethernet switches, routers, PTN transmission equipnent, have their own 1PPS+ToD inputs for timing reference, and then act as GM in the domain. In such applications, the GeckoSynco does not run PTP protocol, but output 1PPS+ToD signal to those nodes.

Let's again take the example of the enterprise smallcell network depicted in Figure 2-1. The Ethernet LAN switch here is a PTP boundery clock that has a 1PPS+ToD input as its timing reference, and act as the T-GM in the domain. The role of the GeckoSynco in the diagram is no longer a PTP GM, but provides timing reference gained from GPS satellite through its 1PPS+ToD output. Though not much different from the previous example in terms of equipment used, installation simplicity, as well as performance, it does have an added benifit: a much longer distance buget between the GeckoSynco and the equipment room without resort to optical fibers. This is because the 1PPS+ToD cable can be 10 times longer than the 100 meters limit of Ethernet. When distance budgt exceeds 100 meters, this configuration may be considered. The 1PPS+ToD cable is usually also made with CAT5 cable just like the Ethernet cable, but the plug used

on the GeckoSynco side is a 6-pin RJ12 rather than usual RJ45. Connector on the othere end of the cable needs to match the specification of the matching input port on the Ethernet switch.

It should be noted here that the use of 1PPS+ToD signal as time reference has one precaution to be considered. Different from bidirectional PTP protocol exchanges between the T-GM and the switch, which automatically calculates the cable delay, the 1PPS+ToD is single directional, and thus the cable delay cannot be automatically adapted. When phase error needs to be within a few nonoseconds, installation engnieer needs to know the cable delay and compensate through the management interface provided by the GeckoSynco software. The 1PPS signal in a CAT5 cable is delayed about 5.02ns/meter. The web interface for entering cable delay is described in section 6.1.7. The GeckoSynco can actually measure the delay during installation by putting a loopback socket at the other end of the cable, without carefully measuring the cable length.

2.3. GeckoSynco as NTP Server

Most networked computers get their time from NTP servers. There are many NTP servers on the internet. For example, the IP address for one of the United States NIST (National Institute of Standards and Technology) NTP servers is 129.6.15.28.

However, not every computer network is connected to the internet. For example, many private LANs are physically separated from the outside world for security concerns. Computers in these isolated networks still need to keep correct time. A common solution is to setup a local NTP server within the network.

The GeckoSynco can be used as the local NTP server in such networks. GeckoSynco synchronizes to the TAI/UTC international standard time through GNSS satellites, with sub-microsecond accuracy. The built-in NTP service makes it an ideal stratum-1 NTP server. Without congestions and the resulting packet

delay variations, a computer can achieve higher time accuracy from a local NTP server than that from a faraway NTP server on the internet. This makes GeckoSynco also a good choice for networks requiring better timing even if it does have access to the internet.

3. Architecture and Instructions

3.1. Structure

HX.PTP-GM02 is depicted in the following diagram:

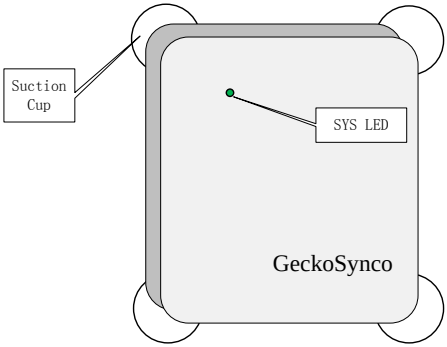

Figure 3-1 HX.PTP-GM02 diagram

On the front surface, a 3-color LED is used to indicate the operational status of the device, as described in Table 3-1.

Four suction cups are screwed into the corners on the back side. These suction cups can be easily pressed to mount the device onto a clean smooth window glass.

Three signal ports and a dip switch are placed on the front panel of the device, as shown in Figure 3-2. Two LEDs within the Ethernet port are used to indicate the status of the electrical Ethernet connection, while the LEDs along the optical port indicate the status of the optical Ethernet. Descriptions of these ports

and the dip switch are given in sections 3.1.2 through 3.1.5.

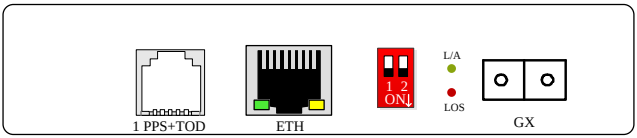

Figure 3-2 HX.PTP-GM02 bottom panel

Note: As a PoE powered device (PD), DC 48V power is provided to HX.PTP-GM02 through the Ethernet port. There is no separate power input.

3.1.1. System LED

The SYS LED on the front face is used to indicate the operational status of the GeckoSynco device, as described in the following table:

Table 3-1 Color code of the SYS LED

LED	Color Code	Descriptions
SYS	Red	Steady: Loss of satellite reception, unsynchronized
		Blinking: Loss of satellite reception, Holdover
	Green	Blinking: Normal, good for timing source
	Yellow	Steady: Booting
		Blinking: Synchronization acquisition
	Off	Unpowered or power failure

Table 3-2 Color code of the L/A and LOS LEDs

LED	Color Code	Descriptions
L/A	Green	On: Ethernet optical port Link up Blinking: Date transmitting in Ethernet optical port Off: Ethernet optical port Link down
LOS	Red	On: no optical signal received in Ethernet optical port Off: optical signal received in Ethernet optical port

3.1.2. Electrical ETH Port

The 8-pin RJ45 socket marked ETH on the bottom panel of the HX.PTP-GM02 is the 10/100/1000M Base-T Ethernet port. It is used for PTP protocol packets, management, as well as power input for the device.

1. 10/100/1000 Base-T Port

Being a standard IEEE 802.3 10/100/1000 Base-T Auto mode Ethernet port, the RJ45 connector diagram is shown in Figure 3-3 and pin definition for the RJ45 is given in Table 3-3. Note that it is compatible with PoE standard.

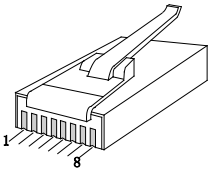

Figure 3-3 RJ45 connector diagram

Table 3-3 RJ-45 pin definition

Pin	1	2	3	4	5	6	7	8
Eth. Sig.	tip	ring	tip	tip	ring	ring	tip	ring

Twisted Pairing	pair	pair with pin6	pair	pair with pin3	pair
PoE 48V	+/-	-/+	+	-/+	-

Note:

- **For 10/100base-T Ethernet, pins 4, 5, 7, 8 are not used for signaling, while all pins are used for 1000Base-T.**
- **The port is auto-MDIX, which automatically adapts to straight-through or cross-over cables.**
- **The PoE voltage is applied between different pairs. While potentials on pair 4-5 and pair 7-8 are specified, they are not fixed but always in reverse polarity on pair1-2 and pair3-6 due to auto-cross.**

2. Power Over Ethernet

HX.PTP-GM02 is powered through its Ethernet port. As a PoE powered device (PD), it accepts DC 48V voltage from any set of pairs shown inTable 3-2. If the link partner, such as an Ethernet switch, is a PoE power sourcing equipment (PSE), power will be provided by that PSE through the Ethernet cable connecting them. If not, the optional accessary PoE adaptor should be inserted between them. Note that the device dissipates about 5W, and a class 2 PSE is sufficient for the PoE supply. Please refer to Section 3.2.

3. NM/CONSOLE

HX.PTP-GM02 can be managed through its Ethernet port. The built-in web server, SNMP agent, and CLI provide three different access methods for management operations. All three use Ethernet to connect to the device, either directly to the RJ45 port or through the connected LAN/WAN. Note that direct connection by a computer is only possible when PoE power is provided to the

device, most likely through the use of the PoE adaptor, as most computers do not have a PSE port.

Access to management is password protected. The initial user name and password are both ‘admin’ for a new device. As a security precaution, users are strongly advised to change both of them before the device is connected to a network.

 Note:

- The default IP address is 192.168.1.2, which needs to be changed to a valid local address.
- If IP address has being changed before but not remembered, flip the dip-2 on the dip switch to use the default IP temporally.

3.1.3. Optical Port

The socket marked GX on HX.PTP-GM02 is the 100/1000M Ethernet optical port, supporting auto-negotiation and forced 1000M full duplex mode. A hot swapable SFP optical module is required to use the optical Ethernet. When using single-fiber transceiver module, there is only one optical fiber port. The wavelength of a single-fiber transceiver module refers to its emission wavelength, which may be 1310nm or 1550nm. **Note: single-fiber devices with same emission wavelengths cannot interwork, matching wavelength modules are required for interconnection.**

When connector is inserted into optical transceiver module socket, the latching tab should be aligned to the corresponding notch. The bending radius of pigtail fiber should be no less than 50mm. When optical fiber connector is inserted or pulled, do not directly pull the optical fiber. Please reserve the protection plug on SFP optical module. When no optical fiber is connected, please ensure that the protection plug is inserted to prevent dust from entering.

3.1.4. 1PPS+TOD Port

The 6-pin RJ12 socket marked 1PPS+TOD on the bottom panel of the HX.PTP-GM02 is used for 1 pulse-per-second and time-of-day signal output. The pin numbering of the RJ12 connector is shown in Figure 3-4. Please note that ordinary RJ12 connectors widely used for telephones only have 4 pins, and therefore is not suitable for the 1PPS+ToD port. The signal definition for the port is given in Table 3-4. This table should be referenced when making the 1PPS+ToD cable. Both 1PPS and ToD are differential signals that should be carried by twisted pair cables with 0.4mm~0.5mm diameter conductors such as in a CAT5 cable. Pairing relationships given in the table must be honored.

Note that the link partner of the 1PPS+ToD may have its own connector type definitions, and the other end of the cable should be prepared accordingly.

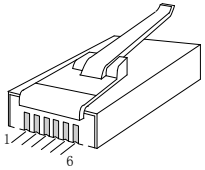

Figure 3-4 RJ-11 Pin numbering order

Table 3-4 1PPS+ToD port pin definition

Pin	Signal	Description
1	RS-422_1_N	1PPS, paired
2	RS-422_1_P	
3	-	-
4	GND	GND
5	RS-422_2_N	ToD, paired
6	RS-422_2_P	

3.1.5. The Dip Switches

The two-position dip switch at the right side on the bottom panel of HX.PTP-GM02 is described in Table 3-5.

Table 3-5 Dip switch functions

Dip No.	Function
1	Reserved
2	ON (down): use temporary IP address 192.168.1.2, start DHCP Server OFF (up): use permanent IP address set by the user
Note: If the IP address has being changed but not remembered, flip the dip-2 to use the default IP temporally, and check or change the permanent IP. Make sure to flip back the dip. **Setting the computer to a DHCP client is an easier way to make them in the same subnet, than to specify a matching IP and Mask.**	

3.2. Power Supply

As a PoE PD device, HX.PTP-GM02 gets its power from the connected Ethernet cable. Power dissipation is about 5 watts, and PoE voltage range is DC 36V~57V. An optional Class-2 PoE adaptor is available which converts wall voltage of AC 100V~240V to the PoE voltage. On one end of the adaptor is the AC power socket; on the other end are two RJ45 sockets for Ethernet cables, as depicted in Figure 3-5. The port labeled Data/IN is for the cable coming from the link partner such as a computer or a LAN switch, while the port labeled P+D/OUT is for the cable section connecting to GeckoSynco. Two LEDs indicate input and output power conditions.

Note that even if the GeckoSynco is not operating with its electrical Ethernet port, such as in the case of optical Ethernet or 1PPS+ToD, a strand of electrical Ethernet cable is still required from the PoE adaptor for power supply.

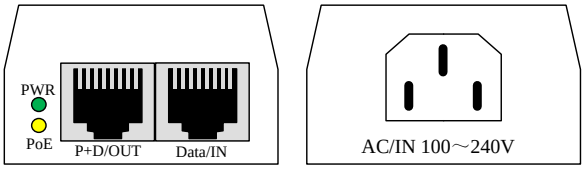

Figure 3-5 Front and rear panel of the PoE adaptor

3.3. Functional Descriptions

3.3.1. Time Synchronization

Anywhere on the surface of our globe, GeckoSynco can adjust its internal clock to the international standard time of TAI and UTC, by locking to satellite signals from GPS or other GNSS systems. The phase error is kept within 100ns from TAI/UTC, provided good reception conditions from the satellites. In principle, at least 4 satellites must be within its line of sight to resolve the four variables of the 3D position of latitude, longitude, and elevation from the sea level, as well as time. The more satellites in the line of sight, the more accurate these 4 variables can be calculated. That's why installation of the receiver antenna prefers as much sky view clearance as possible. Most systems require outdoor antenna on top of the buildings.

The GeckoSynco is designed with Peek2Sync technology. It only needs to be mounted indoors on a window with a reasonable sky view to achieve high precision time acquisition. Mostly used as a non-mobile device[Note2], best performance can be reached with 'Fixed' time mode (see Figure 6-4), provided that the precise 3D coordinates are known in advance, leaving only one variable of time to be calculated. With 'Fixed' mode, line of sight of down to 1 satellite can provide good synchronization. If precise 3D coordinates are not known, the GeckoSynco should be put in '3D Search' mode, and given enough time, from 24 hours to 72 hours, the device will

determine its 3D position by averaging algorithm. Once the position data is within preset accuracy, the device should be set to ‘Fixed’ mode for better timing performance.

Note: The time mode is stored in non-volatile memory not affected by power off. If the device is moved to a new location, 3D data must be updated either manually or through 3D search. Only a few meters difference will degrade the timing accuracy. If position is far off, the ‘Fixed’ mode may prevent the device from locking to the satellite.

When the SYS LED turns green, indicating accurate locking to the GNSS clock, the device is ready to serve as a PTP grandmaster, a 1PPS+ToD timing reference, or a NTP server. A new installation would take up to 15 minutes or longer to receive all the necessary information from the GNSS, while re-powering of a previously locked stationary device locks much faster since most of the necessary data are kept in the non-volatile memory during the previous operation.

When locked to the satellite system, if by any reason the satellite signals are blocked or interfered, the GeckoSynco will enter holdover mode, the SYS LED turns red and blinks. An internal high quality OCXO aided by the temperature compensation algorithm in the software keeps the holdover frequency stability within 1ppb for more than 72 hours. If the satellite signal fails before time synchronization is achieved, the SYS LED will be steadily red, and the device should not be used as a timing source.

Note[2]: If mounted on a mobile platform, the <100ns accuracy may be compromised.

3.3.2. Synchronous Ethernet (SyncE)

Synchronous Ethernet (SyncE) provides frequency reference at the physical level of the Ethernet signal.

Device supports two SyncE modes:

- ✧ SyncE slave

  Extract frequency signal from the optical Ethernet port.

- ✧ SyncE master

  Provide Ethernet frequency extracted from GNSS or internal holdover signal.

As the GM in a domain, the HX.PTP-GM02 is most likely to be a SyncE master, providing frequency as well as time reference to the rest of the network. But sometimes, a domain may wish to receive its frequency from a connected SyncE network while get accurate time from the local GM. Putting the HX.PTP-GM02 in SyncE slave mode may ease the frequency acquisition process from a GNSS.

3.3.3. PTP Grandmaster Clock

The primary role of the GeckoSynco is intended to be a grandmaster clock in a PTP domain described in IEEE-1588V2 standard. More than one GM may be used in a domain, and PTP best master protocol will select the best one among them to be the reference clock for the domain. Each GeckoSynco will announce its clock quality according to operational status. Multiple GMs provide redundancy for better reliability.

Different industries use different subsets of the configurable parameters specified in the original IEEE-1588V2 standard. The subsets are defined as specific profiles by respective industry standards. A user can select the appropriate profile among a set of built-in ones through the web browser. With a specific profile, some of the parameters are fixed, while others are given a settable range that may be reduced from what is allowed by IEEE 1588V2. Parameters adjustable within each profile are also set through the web page. See section 6.1.6 for details.

3.3.4. SNMP Agent

As a networked device, HX.PTP-GM02 can be managed remotely by a SNMP manager through its built-in SNMPv2 agent. The default community name is ‘public’ for retrieval of the read-only status information and ‘private’ for configurable parameters stored in the MIB of the managed device. Default community name for trap messages is also ‘public’.

Detailed information about HX.PTP-GM02 SNMP agent is out of scope of this Manual. If needed, end users may contact Huahuan for MIB.

4. 🕮 Installation and Operation

4.1. Location Selection

GeckoSynco is designed to be installed by suction onto a window inside a building. Find an appropriate location is the first step for successful operation. Following list should be observed.

- Good sky view for line of sight to the available satellite constellation. Usually higher floor windows have better sky views.
- Avoid possible interference sources, such as under high voltage power lines, near TV or radio broadcast antennas, near cellphone base station within its main lobe, within the path of microwave links, and other radiation sources.
- Easy cabling from the window to the intended equipment room. Distance should be within the reach of the signal cable.
- The window is not to be opened during the operation of the device.
- The window is not made of EM shielding material. Most metal plated windows are not suitable.

- The window is better away from direct sunlight during summer to maintain operational temperature.
- The surface of the window is smooth enough for suction.

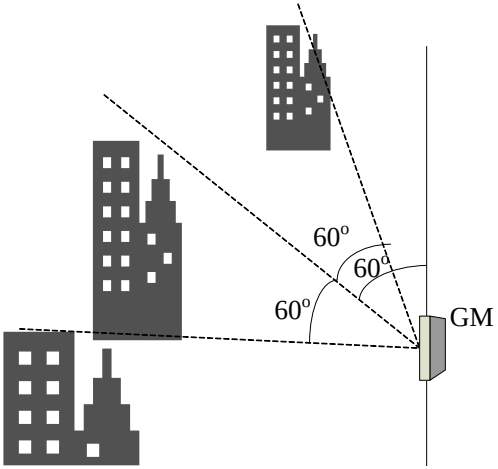

Figure 4-1 Sky view clearance

A better sky view clearance helps to achieve better performance. If the 3D position data is available in advance and the device can be put to 'Fixed' mode, a compromised sky view clearance may not be a serious limitation. But if the 3D coordinates need to be calculated by the GeckoSynco itself, the clearance should be the top priority in location selection. As a rule of thumb, there should be no obstruction to the sky within 60 degrees vertically and horizontally, as depicted in Figure 4-1. When installed, the satellite info web page can be consulted to verify that at least 4 satellites are in sight, given by the 'Num SV' parameter in Figure 6-6.

4.2. Installation

4.2.1. Mounting Procedure

Thoroughly clean the area on window surface to be used.

Gently but firmly press the device onto the cleaned window surface until it is securely fixed on the glass.

Plan in advance the routing of the cables and the location for the PoE adaptor and its AC power outlet. Note that long cables should not be allowed to dangle on their sockets; they should be secured as close as possible to the device to avoid reliability problems.

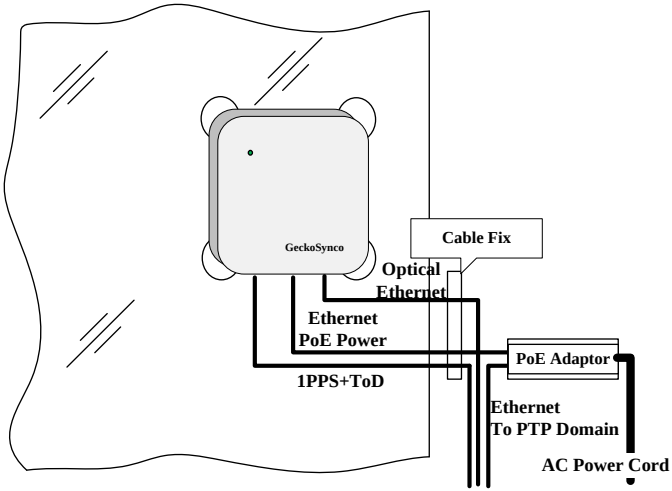

Figure 4-2 Installation schematic

Figure 4-2 depicts the installation schematic for the GeckoSynco. If the Ethernet link partner is a PSE that can supply the PoE power directly, the adaptor in the schematic is not needed. The use of the 1PPS+PoD and/or the optical cable is optional, depends on the use case, but the PoE Ethernet cable is always needed

for power even if the Ethernet is not in use otherwise.

4.2.2. Connecting the Ethernet and PoE Adaptor

Step 1 Prepare two cables with appropriate lengths.

Step 2 Plug the RJ45 connector on one end of the first cable into the ETH socket on the GeckoSynco, the other end to the PoE adaptor port marked P+D/OUT.

Step 3 Plug the RJ45 connector on one end of the second cable to the PoE adaptor port marked Data/In, the other end to the link partner.

Step 4 Secure the cables at a nearby location.

Step 5 Connect AC power to the PoE adaptor, the SYS LED should glow.

4.2.3. Connecting the Optical Fiber

Step 1 Insert optical module to the device's Ethernet optical port.

Step 2 Respectively remove the dust caps on the optical module and the optical fiber, aim the head of the fiber at the optical module port and insert it into the port with moderate force.

Note:

- **When using dual-fiber SFP optical module, the directions of input and output should be consistent with the triangular logo of SFP optical module. Be careful not to reverse Tx and Rx.**
- **When optical fiber connector is inserted or pulled, do not directly pull the optical fiber. When no optical fiber is connected, please ensure that the protection plug is inserted to prevent dust from entering.**

4.2.4. Connecting the 1PPS+ToD Cable

Step 1 Prepare a CAT5 cable of appropriate length, crimping the supplied 6-pin RJ12 plug on one end according to Table 3-4. Take note of the cable length in meters for later delay calculation. Note that common 4-pin RJ12 plug is not suitable.

Step 2 Plug the RJ12 connector into the RJ12 socket on the GeckoSynco.

Step 3 Secure the cables at a nearby location.

Step 4 Connect the other end to the 1PPS+ToD input of the timing client. The connector and signal definition of the client equipment must be consulted. Make sure the polarity of the differential RS-422 signals must be matched

4.3. Setting Operating Parameters

See Section 6 🕮 Software Usage for details.

5. 🕮 Device Management

HX.PTP-GM02 can be managed through CLI commands, a web browser, or a SNMP manager. All three methods use the Ethernet port to communicate with the device.

To manage the device, a valid unique local IP must be allocated to it first. The factory default IP address is 192.168.1.2, which can be used to access the device to set its permanent IP address. Use a laptop with dynamic IP setting so that it is a DHCP client. Press down the dip-2 on the GeckoSynco and it becomes a DHCP server with the default IP. Connect the Ethernet cable from the laptop to the Data/IN socket on the PoE adaptor as the laptop is unlikely a PSE. Ping the default IP to verify correct connection. Use CLI or web browser through the default IP to set the allocated IP address to the device. Lift up the dip-2, and the device is ready to be managed through the new IP address.

Web server and CLI interface are described in the next chapter. Users who need to use SNMP management may request MIB from Huahuan.

6. Software Usage

6.1. Web Server Interface

This chapter describes web pages used to manage the HX.PTP-GM02.

6.1.1. Web Server Login

Type in the IP address in the address field of the web browser, for example:

http:// 192.168.1.2

to connect to the built-in web server of the GeckoSynco. Input correct username and password in the login page, click Login button to start management. The initial username and password are both ‘admin’, which should be changed by the end user as soon as possible using the following web page.

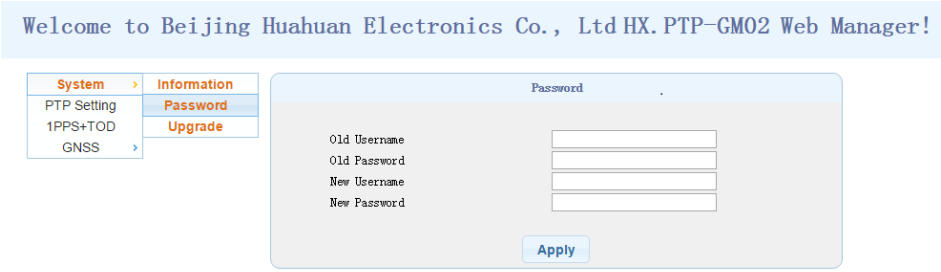

Figure 6-1 Change username & password

6.1.2. Version Enquiry and IP Setting

Click “System->Information” in the navigation tree on the left, enter System Information page. This page is used to check the software and firmware versions of the device, and check or modify IP related information. After modifying the IP info, click Apply to take effect.

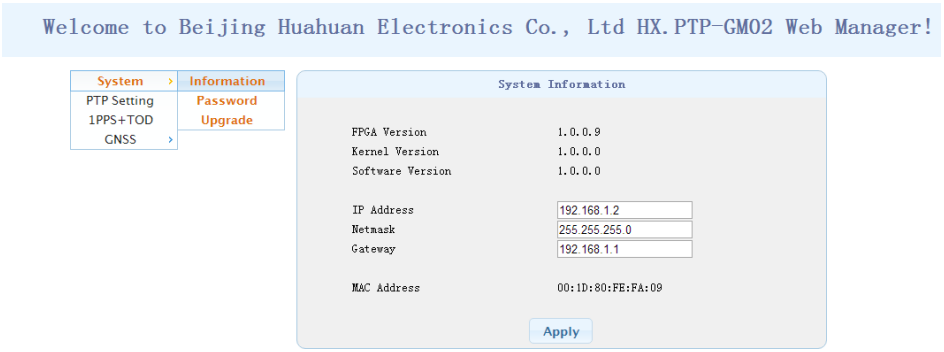

Figure 6-2 System info page

6.1.3. Online Upgrade

On the System Info page, current versions of FPGA, OS Kernel, and application software in the device are listed. Occasionally these firmware and/or software may require upgrade for bug-fixing or functional improvements. They can be online upgraded as described below.

Before upgrade, respective files, received from Huahuan, should be uploaded using FTP to the target device under the /home directory. Both username and password for FTP are defaulted to ‘root’.

The files for each package are:

FPGA package -- GM02_H.r *and* GM02_H.checksum
Kernel package -- GM02_K.r *and* GM02_K.checksum
Application package -- GM02_S.r *and* GM02_S.checksum

After correctly uploaded the necessary files into the /home directory, open the upgrade web page by click “System->Upgrade” in the navigation tree, as shown in Figure 6-3. Tick the boxes for items to be upgraded, click Apply to start upgrading.

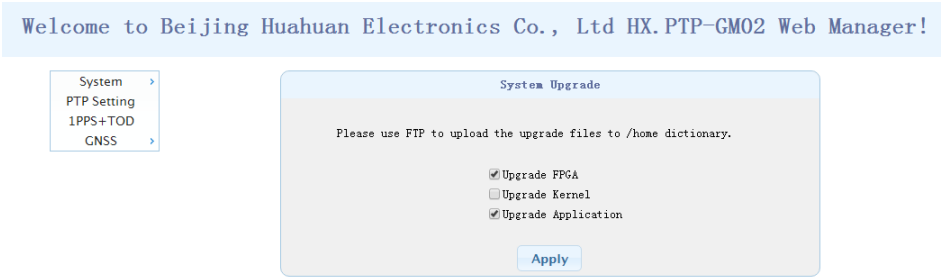

Figure 6-3 Upgrade interface

WARNING: the process will take quite some time to complete, DO NOT INTERUPT THE POWER SUPPLY DURING UPGRADE! The system will reboot after successful upgrade.

6.1.4. Configuring the Time Mode

HX.PTP-GM02 can operate under two different time modes, i.e. '3D Search' mode and 'Fixed' mode. Although the device is designed to provide time reference rather than navigation, the absolute position and the time are tightly coupled variables.

When GeckoSynco is set to 3D Search mode, it constantly solves the function set for four variables of 3D coordinates and time, according to received satellite signals. Due to variations in environmental conditions and thermosphere, and multi-path reflections that change with the relative positions to the moving satellites, uncertainty in both 3D coordinates and time will also vary temporally. This hampers the performance of the device in terms of time accuracy.

On the other hand, if the accurate 3D data are available, the GeckoSynco may operate in 'Fixed' mode, with only one variable of time needs to be resolved. This reduces calculation uncertainty, makes the device less vulnerable to variations and interferences, and timing accuracy is improved.

Unless the device is mounted on a mobile platform, the 3D position of the

GeckoSynco does not change in most installations, and the device should be put to ‘Fixed’ mode whenever possible to achieve higher time accuracy.

Click “GNSS->Settings” in the navigation tree at the left, to start the GNSS Setting page.

As stated above, best timing accuracy is achieved with ‘Fixed’ mode. If the user can obtain the precise[Note3] longitude, latitude, and elevation from sea level for the installation position of the GeckoSynco, then directly set Time Mode in Figure 6-4 to Fixed, and input the coordinates into the appropriate boxes, click Apply to take effect.

Figure 6-4 Fixed time mode

It is not always practical to know the 3D coordinates precisely in advance. The GeckoSynco can calculate its exact position by longtime averaging. Set the Time Mode to ‘3D Search’ and click Apply as in Figure 6-5.

Figure 6-5 3D search time mode

The GeckoSynco will start acquisition and averaging of the 3D coordinates. It may take some time to get usable values and the coordinates are all shown as 'invalid' during this period. When values are shown, they are color coded to indicate 3D precision, starting from red to yellow to green. When the color is in green, it means that the coordinates are accurate within 2 meters, and is ready to go into 'Fixed' mode. This process takes 1~3 days, and the longer period you wait, the more accurate they get.

When the coordinate values are green, click Use Mean to move the coordinates to the lower part of the page, the Time Mode changes to 'Fixed' at the same time. Click Apply to take effect.

Note[3] the coordinates should be accurate within a few meters to keep the time error within specification. Every meter-off results in a phase error of about 3ns.

6.1.5. GNSS Info Enquiry

Click "GNSS->Information" in the navigation tree, bring up the GNSS Info page as shown in Figure 6-6.

Figure 6-6 GNSS information

The GNSS Info includes current UTC date, time as well as the 3D coordinates. The middle section gives information on GNSS status. Satellite Type indicates which GNSS system is used by this GeckoSynco. Num SV gives number of satellites currently locked by this device. L.L.H. State is the current state of the GNSS receiver, possible values include:

Searching----no valid lock to the satellite system is achieved yet,

3D Fix----locked to the satellite system, in 3D search time mode,

Fixed----locked to the satellite system, in Fixed time mode.

SV stands for Space Vehicle, i.e. satellite. Num SV can be used to verify the installation quality. More SV means better reception, the more the better. 3D Search time mode requires at least 4 SVs.

Note: when move the device to new positions, new 3D coordinates must be entered, or change the time mode back to '3D Search' to re-initiate location acquisition.

6.1.6. PTP Parameter Setting

Click "PTP Setting" on the navigation tab into the PTP setting page.

Figure 6-7 PTP settings

Select an appropriate profile for the PTP operation. Default is the IEEE 1588-2008 default profile. If, for example, the device is used as a T-GM in a mobile backhaul network, the selected profile should be G.8275.

IEEE 1588-2008 specifies a range of parameters that can be set within a predefined value sets. Each profile defined by a specific industry standard will specify or restrict some of the parameters. When a particular profile is selected, parameters not allowed to be modified will become gray in the interface. Other parameters may still be changed, please check local policy for those values. Click Apply button to apply the changes.

6.1.7. 1PPS+ToD Setting

Click the “1PPS+ToD” on the navigation tab, enter 1PPS+ToD setting page. This page is used to set two parameters: 1PPS cable delay compensation, and ToD format selection.

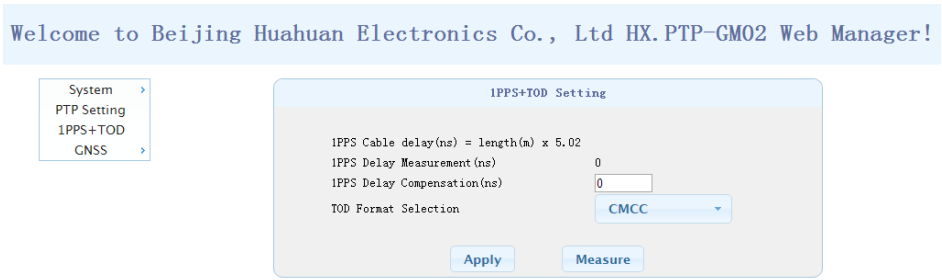

Figure 6-8 1PPS+ToD settings

1PPS cable delay compensation in nanosecond is used to enter the amount of delay due to the limited transmission speed of the signal in the twisted pair cable. The estimated delay for CAT5 cable is 5.02ns/s. When the cable length is 500 meters for example, it will introduce 2150ns, or 2.15μs delay. This delay is still very small for many applications, and compensation may not be necessary. But for some applications, for example 4G/5G mobile communication systems, this delay may not be tolerable and must be compensated for. Measure or estimate the cable delay, enter the number in the box to make the signal pulse edge come out of the port earlier by the specified amount. Note that the compensation is made in 5ns steps, the entered number will be automatically rounded accordingly.

ToD messages specify the exact time instant of each rising edge of the 1PPS pulse, as well as a number of other information useful for the client. This message is not sensitive to delays of millisecond range, so delay compensation does not affect ToD. But there are different flavors of ToD message format. The GeckoSynco has two built-in formats to choose from, namely the CMCC standard by China Mobile Communications Corporation, and G.8271 recommended by ITU-T.

Do not forget to click the Apply button for new settings to take effect.

6.2. CLI Description

CLI is a shell based command line interface for managing some of the operational parameters in the GeckoSynco device. It is provided for users who prefer a text interface, while the web server is adequate for most users. Those who prefer CLI are mostly experts, descriptions below will be brief.

6.2.1. CLI Login

Use telnet + IP to access the shell, login with correct username and password that are both defaulted to 'admin'. The prompt will change to:

CLI>

6.2.2. Version Check

CLI>**show ver**

FPGA Version: 1.0.0.3

Kernel Version: 1.0.0.0

SV Version: 1.0.0.3

6.2.3. IP Related Settings

CLI>**ipaddr 192.168.1.10**

to set the new permanent IP address, or

CLI>**ipaddr 192.168.1.10 netmask 255.255.255.0 gateway 192.168.1.1**

to set other info.

6.2.4. Check 1PPS Settings

CLI> **show out_1pps**

1PPS Output Duty : 10%

1PPS Output Delay(ns) : 0

6.2.5. Setting 1PPS Duty Cycle

CLI> **out_1pps duty 20**

sets 1PPS duty cycle to 20%. Allowed range: 10%~90%

6.2.6. Setting 1PPS Delay

CLI> **out_1pps delay + 10**

This command advance the 1PPS pulse output 10ns earlier. Allowable range is 0-10000ns. The '+' sign may be changed to '–' sign to delay the pulse output by the entered amount if so desired for whatever reason it may be.

6.2.7. Restore Factory Settings

CLI> **restore factory**

This command will cause the system to reboot after all values reset to the factory defaults.

7. 🕮 Trouble Shooting

Table 7-1 Common faults and solutions

Faults	Possible Cause	Solution
SYS LED Off	Ethernet cable loose or broken	Check the cable
	Power supply failure	Check AC, or replace PoE adaptor
	Device failure	Replace
SYS LED red	Satellite signal fail (newly appeared obstacles, interference sources, GNSS malfunction)	Remove obstacles, find new installation location, wait for GNSS recovery
LOS LED on	Fiber cut	Check the fiber
	Excessive line attenuation	Clean optical connector

	Overload optical power	An attenuator is needed if optical power is overloaded
	Local device fail or link partner device fail	Replace
Ethernet port LNK LED off	Link partner powered off or connection failure	Check the link partner
	Ethernet cable broken	Change cable

If failure persists, contact Huahuan for technical support.

8. 🕮 Specifications

8.1. Satellite

Item	Description
GNSS options	GPS, Beidou, Glonass
Antenna	Internal
Time mode	3D search, Fixed
Phase accuracy	<100ns (locked to GPS)
Frequency stability	<1ppb (GPS lost, holdover state, 72 hours)

8.2. Protocols

Item	Description
PTP Profile	IEEE 1588-2008 default IEEE 802.1AS ITU-T G.8265.1 ITU-T G.8275.1 V2 ITU-T G.8275.2 IEEE C37.238-2011 C37.238
NTP	RFC 5905, stratum-1
1PPS+ToD	ITU-T G.8271
SyncE	ITU-T G.8262 ITU-T G.8264

8.3. Ethernet Electrical Interface

Item	Description
Standards	IEEE 802.3
Speed	10/100/1000M
Mode	Auto, or forced 10/100/1000M full duplex, 10M/100M half-duplex
Connector	RJ45

8.4. Ethernet Optical Interface

Item	Description
Speed	100/1000M
Optical interface technical parameters	Determined by SFP optical module
Mode	Auto, or forced 100/1000M full duplex

Connector	LC

8.5. 1PPS+ToD Interface

Item	Description
Message format	CMCC, ITU-T G.8271
Electrical	RS422 , ITU-T G.703
Connector	6-pin RJ12

8.6. Management

Item	Description
Web	Most of web browsers
Command line	CLI
SNMP	V2/V3

8.7. Physical/Electrical/Environment

Item	Description
Size	120mm x 145mm x 38mm (W×H×D)
Weight	≤350g
Power supply	Class 2 PoE, AC 100 ～240V
Dissipation	≤5W
Operating temp	-10 ℃~ 50℃
Storage temp	-40 ℃~ 70℃
Humidity	5-90% RH (non-condensing)