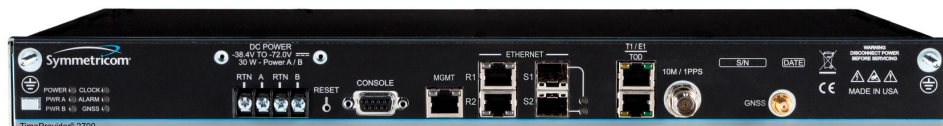


TimeProvider® 2700

Edge Grandmaster Clock



Key Features

- IEEE 1588-2008 Precision Time Protocol Grandmaster
- GNSS (GPS and GLONASS), Primary Reference Time Clock (PRTC)
- Mitigates impact of backhaul noise, packet delay variation and asymmetry
- Designed to support the future ITU-T G.8275.2 profile for phase synchronization
- Support for 8 to 64 PTP clients
- Gigabit Ethernet interfaces
- Synchronous Ethernet
- E1/T1, input or output
- 10 MHz, PPS and TOD output
- DC or AC power
- PTP input option
- TimePictra Synchronization Management System support

Key Benefits

- Sync solution for the mobile network edge: 4G/LTE and small cells
- No change out or upgrade of network hardware
- Mitigates impact of backhaul noise, packet delay variation and asymmetry
- Synchronization protection for high network availability
- Preserves current MPLS network engineering

Major Applications

- LTE-FDD, LTE-TDD, LTE-A networks
- Ethernet backhaul networks

The Symmetricom® TimeProvider® 2700 is an IEEE 1588 Precision Time Protocol (PTP) Grandmaster scaled and optimized to enable deployment of small cells and meet the stringent phase timing and synchronization requirements of 4G/LTE networks. It is designed for deployment in networks following the approach anticipated in the ITU-T G.8275.2 standard proposal.

With an integrated GNSS receiver (GPS or GLONASS) the TimeProvider 2700 meets

applicable performance requirements of the ITU-T G.8272 standard for a Primary Reference Time Clock (PRTC). It can operate in Synchronous Ethernet networks, and supports from 8 to 64 PTP clients. The TimeProvider 2700 offers the optional capability to accept PTP input and operate as an advanced boundary clock to complement and backup the GNSS signal. Additional output capabilities allow it to support legacy frequency timing applications.

Edge Master Clocks

The continuing evolution of mobile network technologies has driven the need for increased accuracy and greater availability of timing and synchronization signals. At the same time, backhaul networks with high packet delay variation present timing “jitter variation” and asymmetry challenges that are difficult to solve with current solutions. Furthermore, deploying a GNSS receiver at every location is impractical, particularly in many small cell environments. Together, these issues create the need for a new overall Synchronization Distribution Architecture for LTE networks.

Edge Master clocks are PTP synchronization solutions designed for deployment in current networks by locating a grandmaster at or near the edge or by overlaying the network with advanced boundary clocks at planned locations. They enable mobile network transitions to include small cells, and they support the stringent LTE-TDD and LTE-A phase and time requirements without overhauling the current backhaul network. In frequency synchronized networks (LTE-FDD, as well as 2G/3G), Edge Master equipment can be deployed to eliminate timing issues caused by diverse technologies in the backhaul network, high packet delay environments, and asymmetry inherent in Carrier Ethernet networks.

The TimeProvider 2700 is a PTP Grandmaster scaled for deployment at or near the edge of the backhaul network instead of closer to the network core. Also included in the Edge Master category, the TimeProvider 2300 is an advanced PTP boundary clock which can be deployed at select locations in the backhaul network to support precision time distribution to the mobile base stations. Together, Edge Master products enable synchronization distribution solutions that allow the mobile network to continue to evolve without retrofit of existing backhaul equipment and without changes to current network design and switching/routing policies.

TimeProvider® 2700

Meeting Stringent Synchronization Accuracy Requirements

Synchronization accuracy requirements have gone from relatively routine frequency specifications (16 ppb on the network side, 50 ppb for the air interface) to time and phase requirements as tight as $\pm 5 \mu\text{sec}$ or even $\pm 1.5 \mu\text{sec}$ in some of the proposals under discussion in the standards bodies. GNSS/GPS receivers co-deployed or integrated into the mobile base stations are not always a feasible solution for either technical or economic reasons (satellite visibility and antenna deployment costs for example). Primary Time Reference Clock performance, specified by ITU-T G.8272, meets the accuracy requirements using a GNSS signal (GPS or GLONASS) as a reference, and the IEEE 1588 Precision Time Protocol can deliver the needed accuracy under the right conditions. However backhaul networks with many hops and asymmetric paths between

the grandmaster and the PTP client, or networks with multiple transport technologies, or those with high packet delay variation due to loading or other issues, cannot be sure to consistently meet the required specifications.

One solution is to upgrade the backhaul network for Synchronous Ethernet and include a PTP Boundary Clock in every transport element. This is the approach proposed in ITU-T G.8275.1, currently a work in progress by the ITU-T. This solution requires that every network element between the grandmaster and the client support Synchronous Ethernet and include a boundary clock function—a solution that is not always feasible due to the high cost to upgrade a network or because the mobile carrier employs 3rd party networks for backhaul. Further, operating at Ethernet Layer 2, G.8275.1 may obsolete or conflict

with the current MPLS network design and provisioning policies of the backhaul network.

A better solution is to deploy an Edge Master class of product, using the approach proposed in G.8275.2 (also a work in progress at the ITU-T). Figure 1 depicts a TimeProvider 2700 at or near the eNodeB locations. This deployment mitigates or eliminates issues introduced by the performance of the backhaul, and therefore, makes unnecessary the need to upgrade the entire backhaul network to include boundary clocks in every network element. Operating over existing networks at Layer 3, this solution also preserves current MPLS and other network provisioning policies and engineering practices, and it is compatible with and leverages previous investment in using the G.8265.1 profile (and the pre-standard profile) for frequency synchronization.

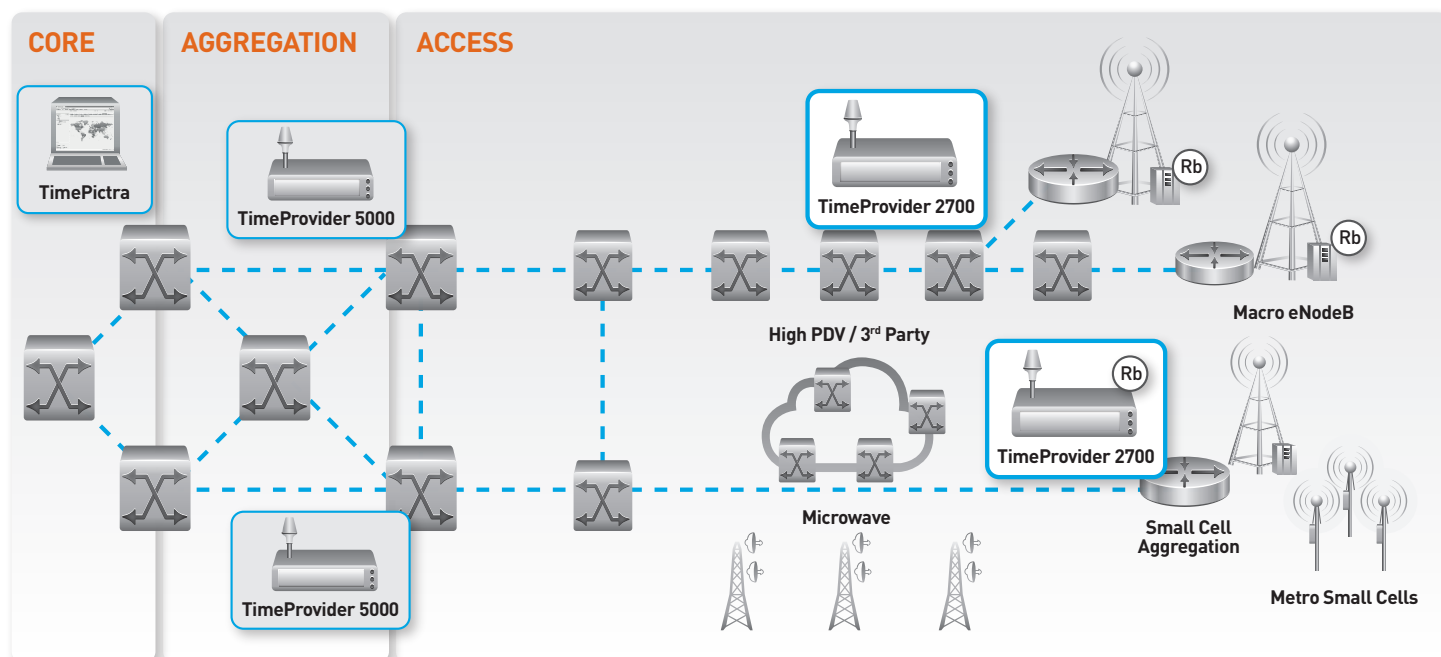


Figure 1: Grandmaster at or near the edge.

TimeProvider 2700 Grandmasters are deployed in locations that ensure timing and synchronization at the base stations are within specification—mitigating asymmetry and eliminating issues that may result from noisy or 3rd party backhaul.

The TimeProvider 5000 PTP Grandmaster provides an enhanced level of protection: enabling grandmasters at the edge of the network to hold synchronization for longer periods when GNSS signals are impaired. Rubidium oscillators, either in the base stations or the PTP grandmaster, also extend the holdover period. In the grandmaster, investment in the high grade oscillator is leveraged across multiple base stations.

The TimePictra Synchronization Management System provides remote management of the synchronization equipment and visibility of all PTP clients.

TimeProvider® 2700

GNSS (GPS and GLONASS) and Small Cells

Integrated GNSS receivers are a viable alternative for timing of macro eNodeB equipment, though operations would still be jeopardized by the well publicized vulnerabilities of GNSS systems, and so using network distributed synchronization at least for backup is considered best practice. Metro or public access small cells present new challenges for synchronization. They require stringent accuracy, but are often deployed in locations where adequate GNSS signal reception is not feasible: indoors, tunnels and urban canyons for example. The TimeProvider 2700 is designed for cost effective deployment at the small cell aggregation sites. From this location most small cell backhaul links can support distribution of PTP timing to small cell base stations. Should the small cell backhaul links themselves include many hops or high PDV, the problem can be solved by deploying an advanced boundary clock at selected small cell network nodes.

Protected Synchronization

As tighter synchronization becomes more essential to the normal operation of the network (Inter-Cell Interference Coordination, for example) the negative impact of losing synchronization becomes more significant. The overall Synchronization Distribution Architecture enabled by the TimeProvider 2700 offers cost effective ways to provide protection.

Referring again to Figure 1, it is likely that a centrally located, high capacity PTP grandmaster is already in place to provide frequency synchronization through existing networks. Common practice includes deployment at multiple locations allowing each grandmaster to provide backup for the others. The edge deployment of grandmasters can leverage this investment by incorporating a PTP client as an input to the TimeProvider 2700. Now operating with a boundary clock function, the edge grandmasters can use the backhaul distributed synchronization to complement

the GNSS input and extend the holdover period when satellite signals are impaired or lost due to natural, accidental or malicious causes (antennas knocked down in storms, cables damaged, jammers and spoofing).

Rubidium oscillators provide another way to protect synchronization by delivering best-in-class holdover performance (phase timing of $\pm 1.5 \mu\text{sec}$ for up to 24 hours). Often seen as expensive upgrades for individual macro base stations, rubidium oscillators in the grandmaster are now more affordable as their cost is amortized across an entire cluster of small cells and co-located macro base stations.

TimeProvider 2700 Equipment

The TimeProvider 2700 PTP Grandmaster standard capabilities include either a GPS or GLONASS input, allowing it to fulfill the requirements as a Primary Reference Time Clock as defined by the ITU-T G.8272 standard for phase and time synchronization, as well as G.811 for frequency reference. The TimeProvider 2700 provides two gigabit Ethernet interfaces in a combo port configuration supporting use of either copper or optical connections. Synchronous Ethernet is supported on the input and output ports. Models are available to support 8, 16, 32 or 64 PTP clients; all operating at the full 128 messages per second rate. Client capacity can be increased in the field with software license options. The TimeProvider 2700 is available with either an OCXO or rubidium oscillator; each delivering a different level of phase and frequency holdover performance and allowing operators to better optimize their network SLAs. The TimeProvider 2700 includes a programmable 10 MHz or 1 PPS BNC port and a PPS+TOD RS422 on an RJ45 connection. Models with either dual DC or a single AC power input are available. Using passive cooling, TimeProvider 2700 has no fans.

TimeProvider 2700 Software License Options

Licensed software options for the TimeProvider 2700 include:

Greater client capacity: PTP client capacity in deployed units can be increased to 16, 32 or 64 clients, allowing network engineers to design for capacity they need today and be protected for increased requirements in the future.

Concurrent GPS and GLONASS: The base configuration allows the choice of either the GPS or the GLONASS GNSS system for the primary reference signal. A software license option enables support for both GPS and GLONASS concurrently; providing a greater level of sync network protection.

PTP Input: Employing PTP distributed over the backhaul network provides a backup to GNSS, allowing the oscillator to hold accurate timing longer than otherwise possible. The PTP client option, enabling a boundary clock function, includes advanced algorithms that compensate for network asymmetry—particularly important for LTE-TDD and LTE-A networks with tight phase synchronization requirements.

E1/T1 Input/Output: The E1/T1 software option activates this port for use as either an input or output. As an input the signal provides a frequency reference to the clock function. As an output it can be used for synchronization of equipment using this established timing reference.

Multicast and 2-step clock: Enable 2-step clock (on the output port) and multicast capabilities for operation in additional network scenarios.

Deployment of 4G/LTE networks and small cells present new technical and economic issues for network planners and engineers. A major challenge is to meet stringent timing requirements over backhaul paths that were not originally designed to deliver synchronization at the level of accuracy needed. Upgrading the backhaul network or deploying GNSS receivers at every base station and small cell is often not possible for technical or economic reasons. A new type of synchronization equipment is needed: the TimeProvider 2700 PTP Grandmaster and its companion product, the TimeProvider 2300 Boundary clock, enable synchronization architectures that are more feasible for many network scenarios.

TimeProvider® 2700

Specifications

GNSS Receiver

- 32 Channel GNSS L1 Receiver
- Choice of either GPS: 1575.42 MHz or GLONASS: 1601.5 MHz, software configurable
- Connector to Antenna: SMA (f)
- Impedance: 50 Ohms
- Voltage to Antenna: 5 VDC

Interfaces

- 1 AC power option, IEC 60320 C14 socket
- 1 DC power option, dual -48 VDC terminal block
- 1 Reset button
- 1 RS232 serial console port, (57,600 bps), DB9
- 1 Gigabit Ethernet – Management port
 - Shielded RJ45, 100/1000 BaseT Ethernet
- 2 Gigabit Ethernet – PTP/SyncE input and output combo ports
 - Shielded RJ45, 100/1000 BaseT Ethernet
 - SFP (optical), 1000 BaseX

Each port is configured as either as an input port (client) or an output port (master)
- 1 T1 or E1 input or output, software configurable, shielded RJ45 (optional)
 - G.703/9, G.823/G.824 sync interface compliance
- 1 Time of Day (TOD) output port, RS422 Data (9600 Baud) with pulse per second (PPS) signal, shielded RJ45
- 1 10MHz or 1 PPS output port, BNC (f)
- 1 L1 GNSS input port, SMA (f), 50 Ohm
- 2 Grounding lugs

IEEE 1588-2008 PTP OUTPUT

- PTP output client capacity: 8, 16, 32 or 64 clients
- Up to 128 messages per second per client
- 1-step
- 2-step clock (optional)
- PTP profiles
 - ITU-T G.8265.1 Frequency Profile (IPv4)
 - Telecom Profile (pre-standard ITU-T G.8265.1)
 - Default Profile (IEEE 1588-2008) (optional)
- VLAN (802.1Q, 802.1p)
- Best Master Clock Algorithm (BMCA), with Default Profile

IEEE 1588-2008 PTP INPUT

- (optional licensed feature)
- Boundary Clock function
 - Multi-sync function uses both PTP input or a frequency input (SyncE or E1/T1)
 - IPv4
 - 1-step or 2-step clock
 - PTP Profile: Telecom Profile (pre-standard ITU-T G.8265.1, frequency)

TIME AND FREQUENCY ACCURACY

When tracking and locked to GNSS:

- Time: within 100ns of UTC (conforms to ITU-T G.8272 sec. 6 for Primary Reference Time Clock)
- Frequency: G.811 frequency accuracy
- VLAN (802.1Q, 802.1p)

HOLDOVER PERFORMANCE

Oscillator	Phase $\pm 1.5 \mu\text{sec}$	Phase $5 \mu\text{sec}$	Phase $10 \mu\text{sec}$	Freq 16ppb
OCXO	30 minutes	4 hours	12 hours	1 month
Rubidium	24 hours	3 days	5 days	5 years

Holdover values are approximate and assume operation at constant temperature, no initial frequency or phase offset, and that the units has been powered on for 2 weeks and locked to GNSS for three consecutive days.

SYNCHRONOUS ETHERNET

- SyncE can be used as a frequency input and it can be generated as an output (as a master).
- Conforms to relevant sections ITU-T G.8261, G.8262, and G.8264 Ethernet Synchronization Message Channel (ESMC)

NETWORK SUPPORT

- IPv4
- HTTP/HTTPS/SSL
- ICMP (RFC 792)
- DHCP Client (RFC2131)
- IEEE 1588-2008 Precision Time Protocol
- IEEE 802.1Q, 802.1p VLAN filtering/tagging
- DSCP

MECHANICAL

- Size:

Height:	1.73 in. (44 mm); 1 RU
Width:	17.24 in. (438 mm)
Depth:	9.30 in. (237 mm)
Depth:	10.07 in (256mm) – including connectors on faceplate
- Rack Mounts: 19 in. and 23 in. rack mount options
- Weight: AC power model: 7.6 lbs (3.5 kg)
DC power model: 8.1 lbs (3.7 kg)

ENVIRONMENTAL

- Acoustic Noise Level: 0 dBA (negligible due to passive cooling)
- Operating temperature
 - OCXO model: -20°C to +60°C
 - Rubidium model: -5°C to +55°C
- Storage temperature: -40°C to +70°C
- Relative humidity: 5% to 95%

POWER

- DC power model: dual power feeds, -38.4 to -72 VDC
- AC power model: 100-240 VAC, 50/60 Hz
- Power consumption
 - OCXO model: 25 Watts (max)
 - Rubidium model: 30 Watts (max)

EMC COMPLIANCE

- FCC Part 15 (Class A)
- AS/NZS CISPR22 (Class A)
- EN55022 (Class A)
- KN55022 (Class A)
- ICES 003, Class A
- VCCI, Class A
- EU 2004/108/EC Electromagnetic Compatibility Directive
- EN 300 386 Telecommunications Network Equipment (EMC)

EMC IMMUNITY

- EN55024 (Class A)
- KN55024 (Class A)
 - EN-61000-4-2 ESD
 - EN-61000-4-3 Radiated Immunity
 - EN-61000-4-4 EFT
 - EN-61000-4-5 Surge
 - EN-61000-4-6 Low Frequency Common Immunity
 - EN-61000-3-2 Power Line Harmonics
 - EN-61000-3-3 Voltage Fluctuations / Flicker
 - EN-61000-4-11 Voltage Dips and Sags

TimeProvider® 2700

Specifications

SAFETY COMPLIANCE

- UL/CSA 60950-1 (2nd edition)
- CAN/CSA-C22.2 No. 60950-1 (2nd edition)
- IEC 60950-1 CB Scheme
- EN60950-1 (2nd edition)
- CE Mark

ENVIRONMENTAL COMPLIANCE

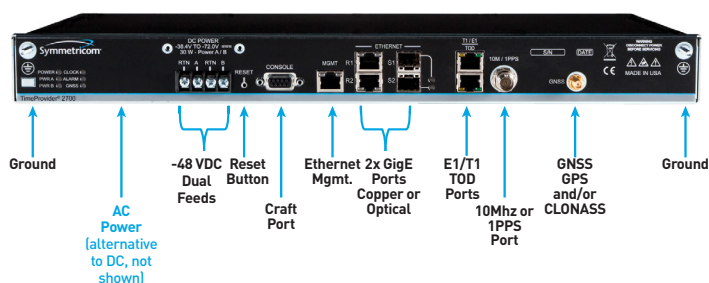
- EN300-019-2-3, Class T3.2
- ETSI EN 300 019-2-2 (1999) – Transportation, Class T2.3
- ETSI EN 300 019-2-1 (2000) – Storage, Class T1.2
- RoHS (6 of 6)

MANAGEMENT AND SECURITY

- TimePictra® Management System support
- SNMP v2c, v3 traps
- SYSLOG
- CLI, local (serial) and remote (telnet/SSH)
- Web interface (HTTP/HTTPS)
- Multi level user access
- Ability to disable management interfaces
- Remote software upgrade and rollback

MODELS and OPTIONS

- TimeProvider 2700 Grandmaster, rack mount ears and screws
- Client capacity models: 8, 16, 32 or 64
- Power supply models: AC or DC
- Oscillator models: OCXO or Rubidium
- SW license options
 - PTP client capacity expansion: 16, 32 or 64 clients
 - PTP Input license (required for boundary clock)
 - Enable E1/T1 port
 - Enable concurrent GPS and GLONASS
 - Enable multicast and 2-step clock
- HW accessories (not included)
 - AC power cords
 - Ethernet optical SFP
 - GNSS antenna and cable kits



Packet Delay Variation and Asymmetry

Timing and synchronization, fundamental in all mobile networks, is even more critical as small cells are added and networks evolve to LTE-TDD and LTE-A technologies. Backhaul network performance can dramatically impact PTP timing accuracy, and thereby the mobile network itself—affecting service quality and customer satisfaction.

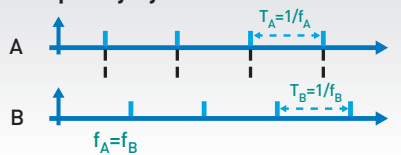
The problem is Packet Delay Variation (PDV) which represents the change in latency from packet to packet. Packet delay itself has no effect on the accuracy of the clock: constant delay would allow an accurate time offset calculation by the PTP client. Variable delay, however, induces noise in the PTP client's perception of the time at the master which can result in variation in time calculations based on the timestamps in the PTP packets.

Delay can vary as PTP packets are processed, buffered and queued along with the payload traffic through the network switches and routers, and it tends to be correlated to network load which can be highly asymmetric in nature. As the amount of traffic in the network increases, the delay variation is also likely to increase. Asymmetry is also introduced by the physical topology of the network as packets travel different and changing paths in the upstream and downstream directions.

Time accuracy is affected by both the magnitude of this variation and how effective the client is at removing this noise. The TimeProvider 2700 incorporates Symmetricom's advanced PTP client technology and a high quality reference oscillator. With a GNSS reference, advanced algorithms effectively filter this noise, allowing the timing signal at the base station to remain within specification.

Frequency, Phase and Time Synchronization

Frequency Synchronization



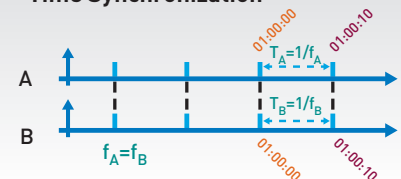
Leading edge of the pulses are at same pace, but not at the identical moment.

Phase Synchronization



Leading edge of the pulses are at identical moment.

Time Synchronization



Leading edge of the pulses are at the identical moment and identical time.

Note: This is a preliminary datasheet for product(s) under current development. Not all models and features will necessarily be available in the initial release, and all specifications are subject to change without notice.