Technical Information

Operating Instructions

**SyncBox PTPv2
AHS/DHS**

Table of Contents

Quick Start Guide

One minute after power up you can connect via a null modem cable a serial terminal from your PC. While booting the system the green „RDY" LED is blinking and switch on permanently if system is ready. You can use e.g. the standard Hyperterminal program shipped with your Windows operating system. Configure your terminal program with 38400 Baud, 8 Data bits, no parity and 1 Stop bit. The terminal emulation have to set to VT100 (press RETURN for first connection):

The login name is always **„root"**. The password is **"timeserver"** by factory settings.

Type in the command „setup" to enter the configuration program. All further settings can be done with this program:

```
                   ┤ PTP-SyncBox CONFIGURATION UTILITY 1.00 ├

      Host: PTPv2_mbg_slave                   Uptime: 7 min
    Domain:                                     Date: Mon, 03.11.2008
      Ipv4: 172.16.3.228                        Time: 14:45:04

   PTP Configuration:

   Is Slave Only:                    1        PTP Seconds:    1225723536
   Network Protocol:                 1        Domain Number:  0
   Offset to Grandmaster (s):        0,000000000  Port State:     SLAVE
   Pathdelay to Grandmaster (s): 0,000000495  Port Link Up:   1
   Grandmaster MAC-Address:          00606E7C12A7  Timescale      PTP
   Time Source:                      GPS        UTC Offset:     0
   Leap Second:                      0



       ┌─────────┐  ┌─────┐                          ┌──────┐
       │Ethernet │  │ PTP │                          │ eXit │
       └─────────┘  └─────┘                          └──────┘
```

Choose the „Ethernet" button to set up the network configuration. To get the time of an external PTP IEEE1588 grandmaster you have to configure the SyncBox with an unique IP address and the default gateway. The „MST" and „SLV" LEDs reflect incoming and outgoing PTP packets: the „SLV" LED will flash green if a valid PTP packet will receive from an external PTP IEEE1588 grandmaster; the „MST" LED will flash if the SyncBox will send a PTP packet to the PTP network. While normal operation of the SyncBox the „SLV" LED should be flashing every 2 seconds.

After this all further settings can be done via network interface, either by using a WEB browser or a Telnet Session.

The outputs of the SyncBox (10MHz, PPS and IRIG) will be enabled if the system has been synchronized by an external PTP grandmaster once and the internal oscillator (OCXO HQ) has warmed up. When outputs will be enabled can be set up in the PTP configuration. The SyncBox will start with a non valid time until it it synchronized by an external PTP IEEE1588 grandmaster once.

PTPv2 Slave with high accuracy Oscillator

The SyncBox provides a high precision time base (OCXO HQ) with multiple outputs for 10MHz, PPS and IRIG via TCP/IP network, synchronized by a PTP IEEE1588 grandmaster reference clock. The SyncBox act as a PTP slave with high precision oscillator to produce different timing and frequency outputs. SyncBox is a set of equipment composed of a PTP IEEE1588 Time Stamp Unit (TSU) and a power supply, all installed in a metal DIN rail mounted chassis and ready to operate. Two user configurable outputs for 1 PPS, 10 MHz and unmodulated time code (IRIG) can be set up next to a modulated time code (IRIG) output. Also two capture inputs are integrated to get high precision time stamps of external events. A simplified LINUX operating system is installed on the single-board computers flash disk. After the network connection has been established the timeserver can also be configured and monitored remotely from a workstation via TELNET or SSH. An integrated HTTP server enables access to the SyncBox by using an ordinary WEB browser.

The Modular System SyncBox

The SyncBox is a set of equipment composed of a PTP IEEE1588 Time Stamp Unit (TSU) and a power supply unit, all installed in a metal rail mount case and ready to operate. The interfaces provided by the SyncBox are accessible via connectors in the front panel of the case. Details of the components are described below.

Front View SYNCBOX/AHS

SyncBox has one PTP IEEE1588 network interface. The outputs of the SyncBox (10MHz, PPS and IRIG) will be enabled if the System has been synchronized by an external PTP grandmaster once and the internal oscillator (OCXO HQ) has warmed up. The SyncBox will start with a non valid time until it it synchronized by an external PTP IEEE1588 gradmaster once. Next to PTP IEEE1588 a the Linux system supports a number of further network protocols: HTTP(S), SSH and Telnet. Because of this remote configuration or status requests can come from any WEB browser.

Changes in the receiver status, errors or other important events are logged on the local Linux system.

PTP Status LEDs „MST" und „SLV"

To get the time from a PTP IEEE1588 grandmaster clock a valid IPv4 address and the gateway have to be set up on the ethernet port. The state of the PTP on the SyncBox will be reflect by the LEDs „MST" and „SLV". the „SLV" LED will flash green if a valid PTP paket will receive from an external PTP IEEE1588 grandmaster; the „MST" LED will flash if the SyncBox will send a PTP paket to the PTP network. While normal operation of the SyncBox the „SLV" LED should be flashing every 2 seconds.

User defined outputs OUT0, OUT1

Both outputs OUT0 and OUT1 can be set to 10 MHz, 1 PPS or unmodulated Time Code (IRIG) each. The default configuration is:

OUT0:   10 MHz

OUT1:   1 PPS

To change configuration of outputs open a Telnet or SSH session to the SyncBox and edit the file /mnt/flash/config/ptp/tsu_conf. The type of Time Code will be set for both outputs and also for the unmodulated output.

```
# Time Code Types for IRIG Mode:
# 0: B002_B122
# 1: B003_B123
# 2: A002_A132
# 3: A003_A133
# 4: AFNOR
# 5: IEEE1344
# 6: B220_1344
# 7: B222
# 8: B223

IRIG Mode: 4


# Output Modes:
#   0 : Idle
#   1 : 1PPS
#   2 : 10MHz
#   3 : IRIG

OUT0 Mode: 2
OUT1 Mode: 1

OUT0 inverted: 0
OUT1 inverted: 0
```

```
OUT0 active: 1
OUT1 active: 1
```

When outputs will be enabled can be set up in this file. By default all outputs will be enabled after booting the SyncBox (LED „ENB" will flash green). Be aware that the time of the SyncBox is not valid after reboot until the internal PTP has not synchronized by an external PTP grandmaster. To enable outputs when the internal PTP has synchronized and the OCXO HQ has been fine adjusted you have to set the parameter „OCXO HQ control:" to „1". It could take several hours to do the fine adjusting of the OCXO HQ.

Modulated Time Code (IRIG)

This output will provide a modulated Time Code (IRIG). The type of Time Code is the same as the outputs OUT0 and OUT1.

Capture Inputs CAP0, CAP1

Two time capture inputs called User Capture 0 and 1 are provided at the front panel (CAP0 and CAP1) to measure asynchronous time events. A falling TTL slope at one of these inputs lets the microprocessor save the current real time in its capture buffer. Before every capture the ports have to be enabled by software. This could be done by a command from Telnet or SSh session on the SyncBox. The command „show_ucap" will cyclic enable the capture ports and print the time in nano seconds and the channel number.

RS232 TERM

To connect a serial terminal use the left RS232 connector in the front panel. Via the serial terminal connection it possible to configure the SyncBox parameters with the command line interface. You have to use a NULL-MODEM cable connecting to your PC or Laptop computer. You can use e.g. the standard Hyperterminal program shipped with your Windows operating system. Configure your terminal program with 38400 Baud, 8 Databits, no parity and 1 Stopbit. The terminal emulation have to set to VT100. After connecting to the SYNCBOX there will be displayed the following message (press RETURN for first connection; default user: root password: timeserver).

DSR_IN- -DCD_IN
RTS_OUT- -RXD_IN
CTS_IN- -TXD_OUT
RI_IN- -DTR_OUT
  -GND
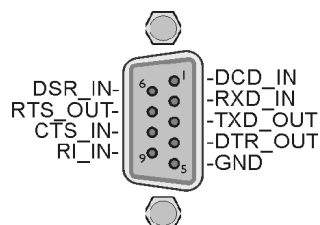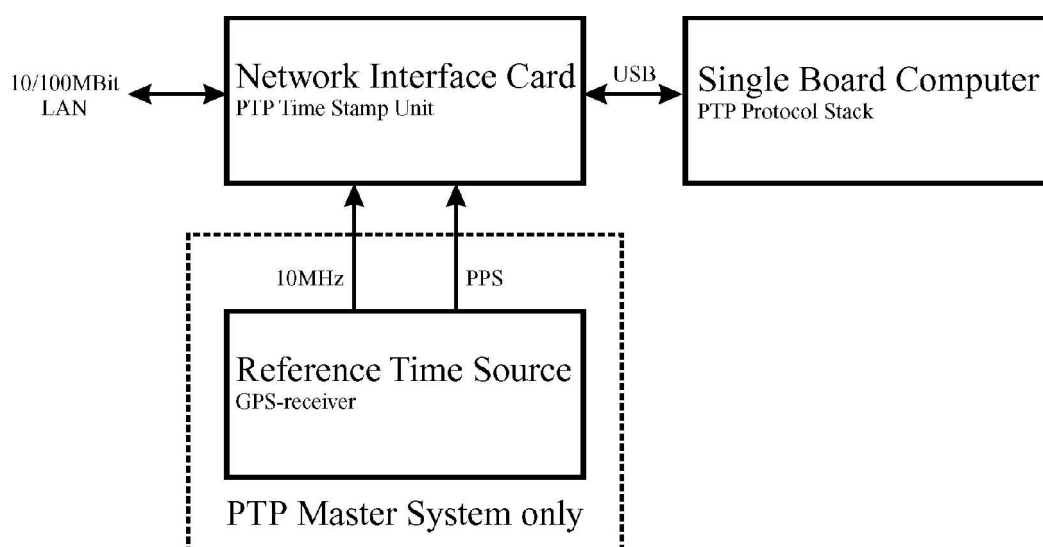
TERM

Precision Time Protocol (PTP) / IEEE1588v2

PTP/IEEE1588 is a time synchronization protocol that offers sub-microsecond accuracy over a standard ethernet connection. This level of accuracy can be reached by adding a so-called hardware time stamping unit to the network ports that are used for PTP time synchronization. The time stamping unit captures the exact time when a PTP synchronization packet is sent or received. These time stamps are taken into account in order to compensate transfer delays introduced by the ethernet network.

In PTP networks there is only one active source of time, the so-called Grandmaster Clock. If two or more Grandmaster Clocks exist in one network, a algorithm defined in the standard is used to find out which one is the „best" source of time. This „Best Master Clock" algorithm has to be implemented on every PTP/IEEE1588 compliant system and therefore all clients („Slave Clocks") will select the same Grandmaster. The other, not selected Grandmaster Clocks will „step back" and enter passive mode, meaning that they do not send out synchronization packets as long as that is done by the selected master.

The installed network infrastructure components play a big role in a PTP network and directly influence the level of accuracy that can be reached on the clients. Asymmetric network connections degrade the accuracy, therefore classic layer 2 and 3 ethernet switches with their store and forward technology are not suitable for PTP/IEEE1588 networks and should be avoided. Simple ethernet hubs, at least the ones with fixed pass-through times, are no problem. In large networks special switches with built-in PTP/IEEE1588 functionality help to maintain a good level of accuracy even over several subnets and longer distances. These components act as so-called „Boundary Clocks", they compensate their internal packet processing times by using time stamping units on each port. They synchronize to the Grandmaster Clock and in turn act as a Grandmaster to the other subnets they are connected to.

General Information

The eurocard TSU-V2 acts as a standalone single board computer including network interface card (10/100MBit) with integrated Time Stamp Unit for obtaining time stamps in IEEE1588 (PTPv2) compatible networks. In conjunction with a single board computer and a reference time source (PTP master only) the module is capable of building a PTP Master or Slave system:

```
                      ┌──────────────────────────┐          ┌──────────────────────────┐
10/100MBit     ←────→ │ Network Interface Card   │ ←─USB──→ │ Single Board Computer    │
   LAN                │ PTP Time Stamp Unit      │          │ PTP Protocol Stack       │
                      └──────────────────────────┘          └──────────────────────────┘
                              ↑         ↑
                        ┌·····│·········│···········┐
                        ·   10MHz      PPS          ·
                        ·  ┌───────────────────────┐·
                        ·  │ Reference Time Source │·
                        ·  │ GPS-receiver          │·
                        ·  │                       │·
                        ·  └───────────────────────┘·
                        ·  PTP Master System only   ·
                        └···························┘
```

The Time Stamp Unit, integrated in a FPGA (**F**ield **P**rogrammable **G**ate **A**rray, programmable logic device), checks the data traffic on the MII-interface between the PHY receiver (physical connection to the network) and the Ethernet controller (MAC) of the module TSU-V2. If a valid PTP packet is detected, the Time Stamp Unit takes a time stamp that is read out by a micro controller and passed to the single board computer (SBC) running the PTP driver software.

Functionality in Master Systems
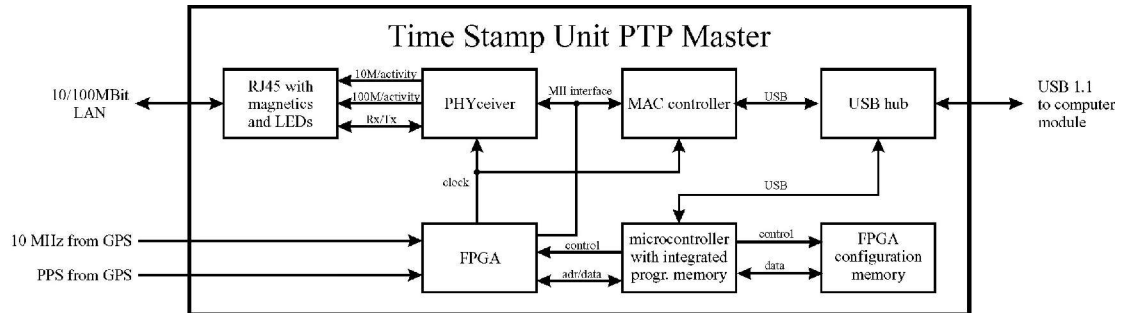
After power up, the module accepts the absolute time information (PTP seconds) of a reference time source (GPS controlled clock) once only and the PTP nanoseconds are set to zero. If the oscillator frequency of the reference time source has reached it's nominal value, resetting of the nanoseconds is repeated. This procedure leads to a maximum deviation of 20 nsec of the pulse per second (PPS) of the PTP Master compared to the PPS of the GPS controlled clock. The reference clock of TSU-V2 (50 MHz) is derived from the GPS disciplined oscillator of the reference time source by using a PLL (**P**hase **L**ocked **L**oop) of the FPGA. The direct coupling of the time stamp unit to the GPS system is achieved in this way.

Functionality in Slave Systems
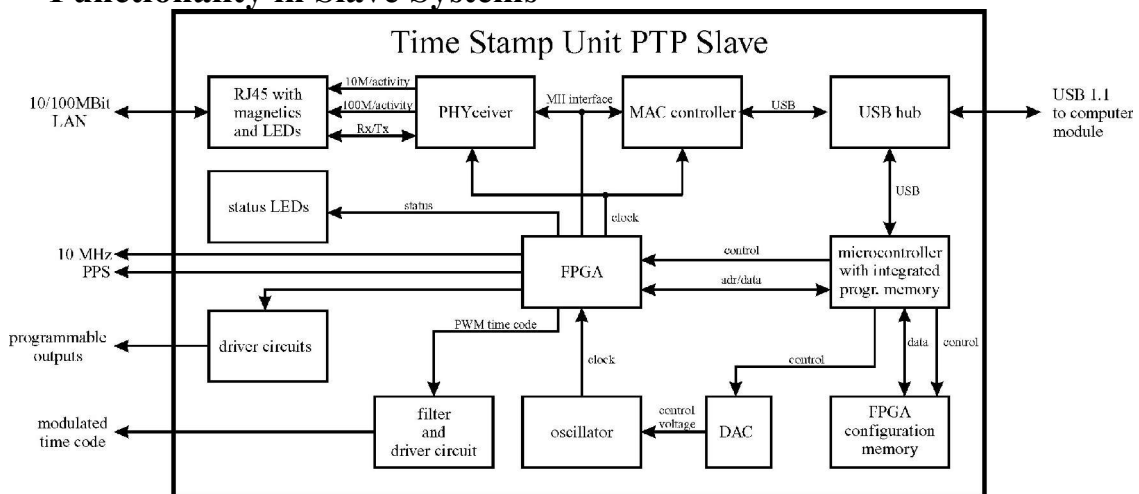
After decoding a valid time information from a PTP Master, the system sets it's own PTP seconds a nanoseconds accordingly. The PTP offset calculated by the PTP driver software of the single board computer is used for adjustment of the master oscillator of TSU-V2. High accuracy of the output signals (10 MHz/PPS/IRIG) generated by the PTP Slave is achieved this way.
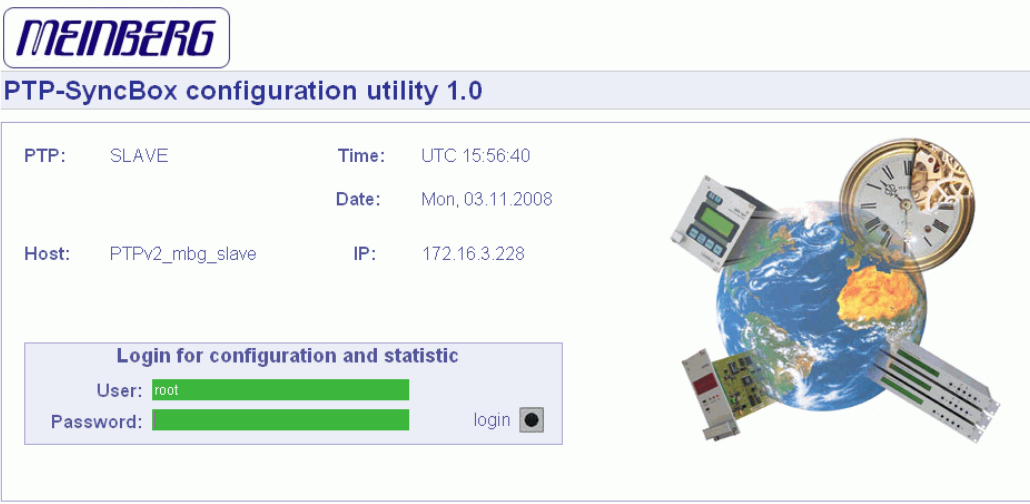
The WEB interface

Connect to the web interface by entering the following address into the address field of your web browser:

http://198.168.10.10

(You need to replace 198.168.10.10 with the IP address of your SyncBox). If you want to use an encrypted connection, replace the http:// with https:// in the above address. You may be prompted to accept the SSL certificate of your SyncBox the first time you are connecting to the system via HTTPS.

In both HTTP and HTTPS mode, you will see the following login screen:

On this start page you see a short status display. The upper line shows the operation mode of

This page will be reloaded every 30 seconds in order to reflect the current status of the unit. Please bear this in mind when you try to login and enter your password. If you do not press ENTER or the Login button within 30 seconds, the user and password field is cleared and you have to start over again.

Configuration: Main Menu

After entering the right password, the main menu page shows up. This page contains an overview of the most important configuration and status parameters for the system.

The start page gives a short overview of the most important configuration parameters and the runtime statistics of the unit. In the upper left corner you can read which SyncBox model and which version of the SyncBox software you are using. This LANTIME software version is a head version number describing the base system and important subsystems.

By using the buttons in the lower part of the screen, you can reach a number of configuration pages, which are described below.

Configuration: Ethernet

In the network configuration all parameters related to the network interfaces can be changed. In the first section you can change the hostname and domain name. You can also specify two nameserver. In the nameserver fields you have to enter an IPv4.

IPv4 addresses and DHCP

IPv4 addresses are built of 32 bits, which are grouped in four octets, each containing 8 bits. You can specify an IP address in this mask by entering four decimal numbers, separated by a point ".".

Example: 192.168.10.2

Additionally you can specify the IPv4 netmask and your default gateway address.

Please contact your network administrator, who can provide you with the settings suitable for your specific network.

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If there is a DHCP (Dynamic Host Configuration Protocol) server available in your network, the LANTIME system can obtain its IPv4 settings automatically from this server. If you want to use this feature (again, you should ask your network administrator whether this is applicable in your network), you can change the DHCP Client parameter to "ENABLED". Using DHCP is the default factory setting.

If the DHCP client has been activated, the automatically obtained parameters are shown in the appropriate fields (IPv4 address, netmask, gateway).

Configuration: Local

In the Local section you can activate an reboot of the SyncBox and set up a new password for the only user "root".
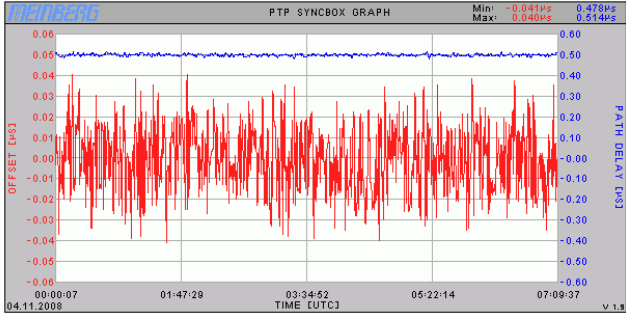
Configuration: Statistics

Statistical Information

In the first section a graphical diagram shows the running synchronization process. PTP is storing this statistical information in so-called "ptpstats" files, which are used here to draw the curves. The red line is describing the offset to the PTP grandmaster. The blue line shows the pathdelay to the PTP grandmaster. In the upper right corner of the diagram you will find the measurement range of the red and blue curve. The last 24 hours are shown initially, but you are able to select the last 10 days (or fewer days, depending on the system uptime) or download a specific ptpstat file. All time data is using UTC.

Configuration: Manual

This page gives you access to the documents stored on your SyncBox, especially the manuals and your own notes. The two lists include filename, language, file type, date and size of the documents/notes.

The SyncBox documents can be downloaded from here in order to read / print them on your workstation.

Configuration: PTP

In the PTP configuration all parameters related to the PTP protocol can be monitored and changed.

With the "Profile" parameter you can switch between the "Default" multicast profile and the "Unicast" PTP profile. Depending on the selected profile the corresponding TSU configuration file below will be used.

The delay mechanism is used to measure the propagation time between two nodes. You can choose the end-to-end or the peer-to-peer mechanism. When using peer-to-peer delay mechanism, every network node has to support peer-delay measurements.

Please keep in mind that peer-delay measurements are not supported when operating in Unicast mode.

A domain is a logical grouping of clocks that synchronize to each other using the protocol, but that are not necessarily synchronized to clocks in another domain. Be aware to use the same domain as configured on the grandmaster.

The PTP standard includes mappings to User Datagram Protocol (UDP), layer-2 Ethernet and other implementations. The SyncBoxV2 will support Layer 3 (IPv4/UDP) Layer-2 Ethernet (IEEE 802.3).

In the "Unicast Configuration" section the IP address of the PTP grandmaster can be configured. The UUID of the grandmaster should be left to default which is "FF:FF:FF:FF:FF:FF:FF:FF" if UDP/IPv4 is selected as network protocol. In case Layer 2 communication is used, the UUID of the grandmaster port should be entered here. Please make sure that the "Unicast" profile is selected if unicast negotiation shall be used.

Additional TSU (PTP time stamp unit) configuration parameters can be set directly in the text files that can be displayed in the „TSU Configuration files" section.

User Captures can be used to mark hardware events with high precision timestamps. SyncBox supports two User Capture inputs with TTL level. Time stamps will be taken with the rising edge of the input signal. With the Option „show user captures" the user capture inputs of the SyncBox will be activated and current captures will be shown in a scrollbox. These user captures can be shown in a Telnet/SSH session with the command „show_ucap" also.

The Command Line Interface

The command line interface (CLI) can be used within a TELNET, SSH or serial Terminal session. After login, just enter "setup" to start the CLI setup tool.
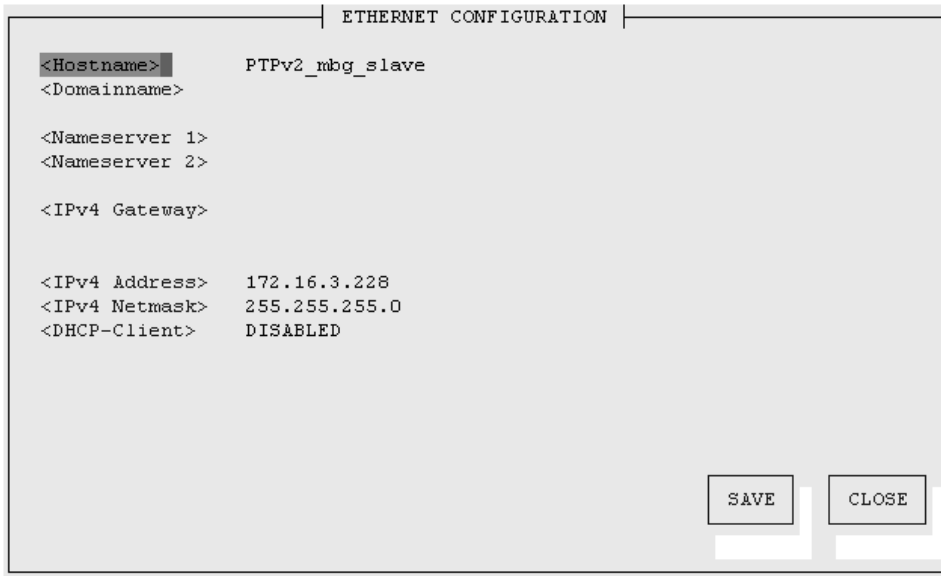
```
┌──────────────┤ PTP-SyncBox CONFIGURATION UTILITY 1.00 ├──────────────┐

    Host: PTPv2_mbg_slave                      Uptime: 7 min
  Domain:                                        Date: Mon, 03.11.2008
    Ipv4: 172.16.3.228                           Time: 14:45:04


PTP Configuration:

Is Slave Only:               1          PTP Seconds:    1225723536
Network Protocol:            1          Domain Number: 0
Offset to Grandmaster (s):   0,000000000 Port State:     SLAVE
Pathdelay to Grandmaster (s): 0,000000495 Port Link Up:  1
Grandmaster MAC-Address:     00606E7C12A7 Timescale      PTP
Time Source:                 GPS        UTC Offset:     0█
Leap Second:                 0




    ┌──────────┐  ┌──────┐                              ┌──────┐
    │ Ethernet │  │ PTP  │                              │ eXit │
    └──────────┘  └──────┘                              └──────┘
```

The start page gives a short overview of the most important configuration parameters and the runtime statistics of the unit. In the upper left corner you can read the network parameters like hostname, domainname and the IP address. The next section describe the PTP specific parameters.

By using the buttons in the lower part of the screen, you can reach a number of configuration pages, that are described below.

CLI Ethernet

```
                     ┤ ETHERNET CONFIGURATION ├
  <Hostname>      PTPv2_mbg_slave
  <Domainname>

  <Nameserver 1>
  <Nameserver 2>

  <IPv4 Gateway>


  <IPv4 Address>   172.16.3.228
  <IPv4 Netmask>   255.255.255.0
  <DHCP-Client>    DISABLED




                                        ┌────────┐  ┌────────┐
                                        │  SAVE  │  │ CLOSE  │
                                        └────────┘  └────────┘
```

In the network configuration all parameters related to the network interfaces can be changed. In the first section you can change the hostname and domain name. You can also specify two nameservers. In the nameserver fields you may enter an IPv4 address.

IPv4 addresses are built of 32 bits, which are grouped in four octets, each containing 8 bits. You can specify an IP address in this mask by entering four decimal numbers, separated by a point ".".

Example: 192.168.10.2

Additionally you can specify the IPv4 Netmask and your default gateway address.

Please contact your network administrator, who will provide you with the settings suitable for your specific network.

If you are running a DHCP (Dynamic Host Configuration Protocol) server in your network, the LANTIME system can obtain its IPv4 settings automatically from this server. If you want to use this feature (you should also ask your network administrator if this is applicable in your network), you can change the DHCP Client parameter to "ENABLED". This is the default setting.

If the DHCP client has been activated, the automatically obtained parameters are shown in the appropriate fields (IPv4 address, netmask, gateway).

CLI PTP parameters

```
├─────────────────────| PTP CONFIGURATION |─────────────────────┤

 <Profile>                      0
 <Delay Mechanism>              0
 <Clock Class Sync Cold>        6
 <Clock Class Sync Warm>        6
 <Clock Class Not Sync Cold>    248
 <Clock Class Not Sync Warm>    7
 <Simulation Clock Class>       0
 <Simulation Clock Accuracy>    0
 <Delay Request Interval>       3
 <Sync Interval>                1
 <Announce Interval>            1
 <Priority 1>                   0
 <Priority 2>                   0
 <Domain Number>                0
 <Network Protocol>             1
 <Timescale>                    1
 <Is Slave>                     1

                                      [ SAVE ]    [ CLOSE ]
```

In the PTP configuration all parameters related to the PTP protocol can be monitored and changed.

The "Profile" parameter is for future releases to change the specific behavior of the PTP protocol. The delay mechanism is designed to measure the propagation time between two nodes. You can choose the end-to-end (default: 0) or the peer-to-peer mechanism (= 1).

The parameters for Clock Class will define the value for the PTP clock class in the different states of the internal clock. In case of the SyncBox as a PTP slave these parameters will not take account.

The delay request interval, the sync interval, the priorities, the timescale and the announce interval will be specified by the PTP grandmaster only.

A domain is a logical grouping of clocks that synchronize to each other using the protocol, but that are not necessarily synchronized to clocks in another domain. Be aware to use the same domain like the grandmaster.

The PTP standard includes mappings to User Datagram Protocol (UDP), layer-2 Ethernet and other implementations. The SyncBoxV2 will support UDP (default:0 or 1) and the layer-2 Ethernet (= 2).

More configuration parameters to set up the outputs of the SyncBox can be edit manually via SSH or Terminal in the file "/config/tsu_config".

Attachment: Technical Information

Technical Specifications

HOUSING: Metal desktop case, DIN Mounting Rail
        125 mm x 115 mm x 189 mm (W x H x D)

PROTECTION
RATING: IP20

Front Panel connectors

Name	Type	Signal	Cable
Network	RJ-45	Ethernet	shielded data line
TERM	9pol. SUB-D	RS232	shielded data line
10Mhz output	BNC	Frequency	shielded data line
1 PPS output or IRIG DCLS	BNC	Frequency	shielded data line
IRIG modulated output	BNC	Frequency	shielded data line
2x Capture input	BNC	Frequency	shielded data line
Power supply	power cord receptacle		power supply cord

Safety instructions for building-in equipment

This building-in equipment has been designed and tested in accordance with the requirements of Standard IEC 950 "Safety of Information Technology Equipment, including Electrical Business Equipment".

During installation of the building-in equipment in an end application (i.e. rack) additional requirements in accordance with Standard IEC 950 have to be taken into account.

- o The building-in equipment is a class 1 - equipment and must be connected to an earthed outlet (TN Power System).
- o The building-in equipment has been evaluated for use in office environment (pollution degree 2) and may be only used in this environment. For use in rooms with a higher pollution degree more stringent requirements are applicable.
- o The building-in equipment may not be opened.
- o Protection against fire must be assured in the end application.
- o The ventilation opening may not be covered.
- o The equipment/building-in equipment was evaluated for use in a maximum ambient temperature of 40 °C.
- o For safe operation the building-in equipment must be protected by max 16 A fuse in the power installation system.
- o Disconnection of the equipment from mains is done by pulling the mains plug.

CE-Label

CE

EN 60950

Safety of Information Technology Equipment,
including Electrical Business Equipment

Electromagnetic compatibility

EN50081-1

Electromagnetic compatibility (EMC). Generic emission
standard. Part 1: Residential, commercial and light industry

EN50082-2

Electromagnetic compatibility (EMC). Generic immunity
standard. Part 2: Industrial environment

Power supply

The variant DHS is designed for operation with a DC (18 V to 72 V, DC-insulation 1.5 kV). The voltage feed is done through 3 pol DFK connector in the front panel of the clock and should have low resistance to minimize spurious emission (EMI).

The type AHS with an AC (100 V to 240 V, 47 Hz to 63 Hz) and also DC (100 V to 240 V DC) power supply. The special model DAHS provides 3 pol DFK connector in the front panel instead of power cord receptacle. Both includes a fuse T500 mA which is available inside the housing.

To avoid potential differences between the signal ground of AHS/DHS and a post-connected unit installed on different DIN rails, the signal ground of the clock is insulated from the case.

The case must be grounded by using the rear contact!

Third party software

The SYNCBOX network timeserver is running a number of software products created and/or maintained by open source projects. A lot of people contributed to this and we explicitly want to thank everyone involved for her/his great work.

The used open source software comes with its own license which we want to mention below. If one of the licenses for a third party software product is violated, we will as soon as possible apply any changes needed in order to conform with the corresponding license after we acknowledged about that violation.

If a license for one of the software products states that we have to provide you with a copy of the source code or other material, we will gladly send it to you on data media via normal post or by e-mail upon request. Alternatively we can provide you with a link to a download location in the internet, allowing you to download the most actual version. Please note that we have to charge you for any incurred expenses if you choose to receive the source code on data media.

Operating System GNU/Linux

The distribution of the GNU/Linux operating system is covered by the GNU General Public License (GPL), which we included below.

More information about GNU/Linux can be found on the GNU website (www.gnu.org) and on the website of GNU/Linux (www.linux.org).

Our version of the Linux kernel has been optimized for the time server application by applying the so-called PPSkit-patch from Ulrich Windl.

Samba

The Samba software suite is a collection of programs, which implement the Server Message Block (SMB) protocol for UNIX systems. By using Samba your SYNCBOX is capable of sending Windows popup messages and serves request for network time by clients using the NET TIME command.

The distribution of Samba is covered – like GNU/Linux – by the GNU General Public License, see below.

The website of the Samba project (or a mirror) can be reached at www.samba.org!

Network Time Protocol Version 4 (NTP)

The NTP project, lead by David L. Mills, can be reached in the internet at www.ntp.org. There you will find a wealthy collection of documentation and information covering all aspects of the application of NTP for time synchronization purposes. The distribution and usage of the NTP software is allowed, as long as the following notice is included in our documentation:

```
**************************************************************************
*                                                                        *
* Copyright (c) David L. Mills 1992-2004                                  *
*                                                                        *
* Permission to use, copy, modify, and distribute this software          *
* and its documentation for any purpose and without fee is hereby        *
* granted, provided that the above copyright notice appears in all       *
* copies and that both the copyright notice and this permission          *
* notice appear in supporting documentation, and that the name           *
* University of Delaware not be used in advertising or publicity         *
* pertaining to distribution of the software without specific,           *
* written prior permission. The University of Delaware makes no          *
* representations about the suitability this software for any            *
* purpose. It is provided "as is" without express or implied             *
* warranty.                                                              *
*                                                                        *
**************************************************************************
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mini_httpd

For our web based configuration tool (HTTP and HTTPS) we use mini_httpd from ACME Labs. The distribution and usage of this program is free provided as long as the following notice appears in the documentation:

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Find out more regarding mini_httpd at the ACME Labs homepage (www.acme.com).

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