MANUAL

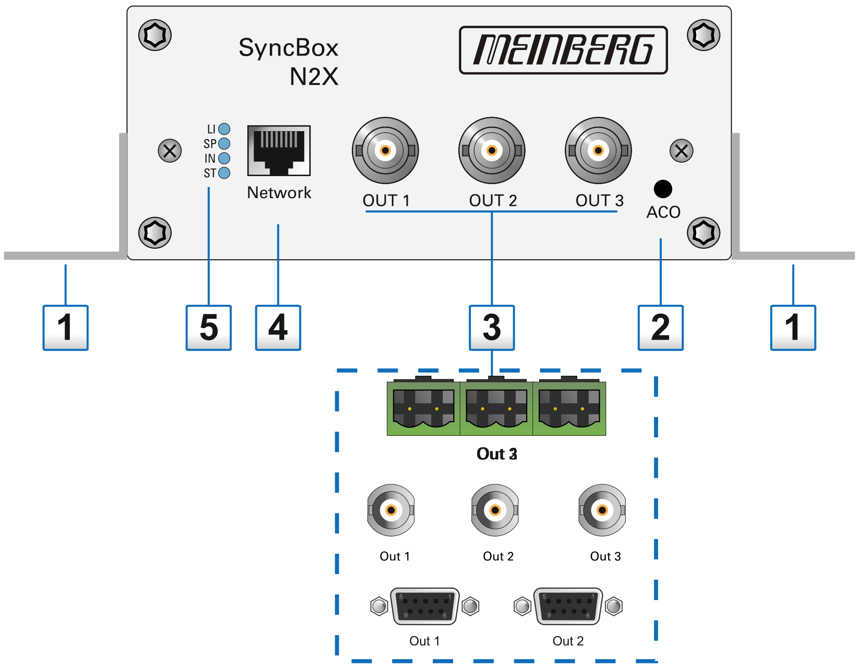
SyncBox N2X

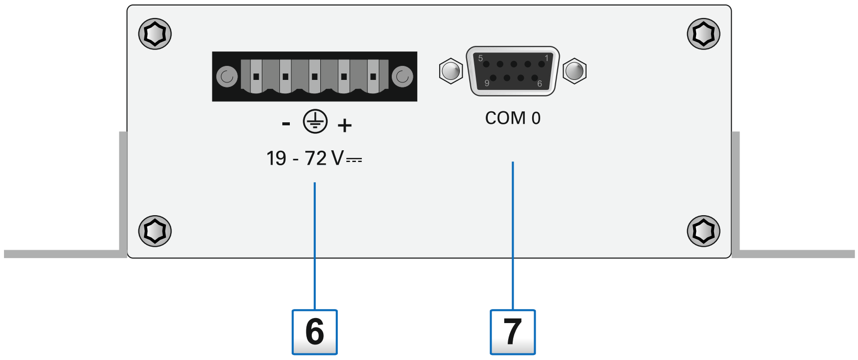
PTP Slave / NTP Client

29th September 2016

Meinberg Radio Clocks GmbH & Co. KG

Front view (Frontansicht) SyncBox N2X





ENGLISH

1. Wall Mount Brackets
2. ACO - Access Control Override - Access without Protection
3. Out 1 - Out 3:
   IRIG AM, Freq.Synth. sine, PPOs
   via BNC female, FO ST, 9pin D-SUB or 2pin DFK connector
4. Signal In / Remote / (Option: PoE) - RJ45 connector
5. LED Indicators
6. Power Supply: 19 - 72 VDC
7. COM 0 serial port

DEUTSCH

1. Winkel für Wandmontage
2. ACO - Access Control Override - Zugriff ohne Passworschutz
3. Out 1 - Out 3:
   IRIG AM, Freq.Synth. sine, PPOs über
   BNC, FO ST, 9pol. D-SUB oder 2-pol. DFK Buchsen
4. Signaleingang / Remote / (Option: PoE) Anschluss über RJ45
5. LED Statusanzeigen
6. Netzteil: 19 - 72 VDC
7. COM 0 serieller Anschluss

Table of Contents

1 Imprint

Meinberg Funkuhren GmbH & Co. KG
Lange Wand 9, 31812 Bad Pyrmont / Germany

Phone: + 49 (0) 52 81 / 93 09 - 0
Fax: + 49 (0) 52 81 / 93 09 - 30

Internet: http://www.meinberg.de
Mail: info@meinberg.de

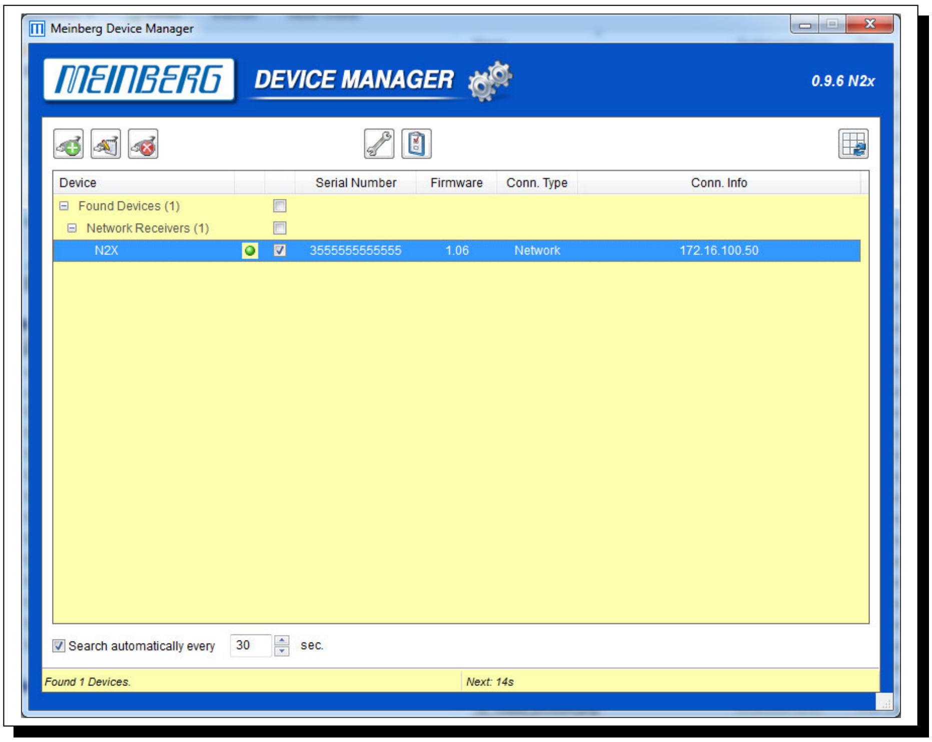
Date: 2016-06-22

2 Quick Start Guide for Initial Operation

After the SyncBox / N2X was connected to the power supply and the network, it can be configured and monitored by using Meinberg's Device Manager program.

The Meinberg Device Manager program can be downloaded here:

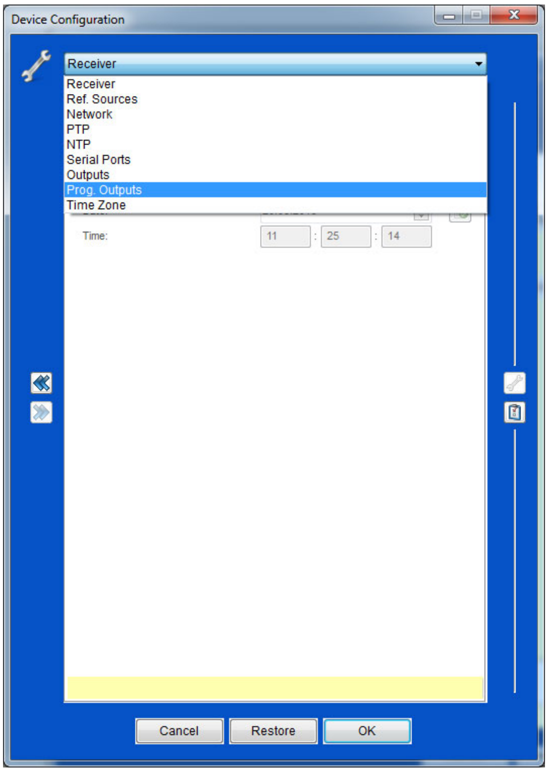
Windows: https://www.meinbergglobal.com/download/utils/windows/mbgdevman_setup.exe
Linux: https://www.meinbergglobal.com/download/utils/linux/mbgdevman.tar.gz



Configuration via the Network with the MEINBERG DEVICE MANAGER
After starting the "mbgdevman" all devices found in the network will be shown in the main window. By selecting the icon on the left side of the entry, all network addresses can be displayed. The LED icon indicates the status of the device. After selecting the checkbox, the edit / delete buttons are activated in the top left of the window. You can now use the edit button to adjust the connection type (network or serial connection). Here you can also set a new password (default: mbg).

The upper part (center) of the window also contains the buttons "Edit Device" and "Status". The Edit button opens the "Device configuration" window. All important settings can be made for all of the listed devices, or for the selected system:

Receiver	Initialisation of the receiver
Reference Source	NTP or PTP
Network	Netzwork settings (IP, DHCP ...)
PTP	PTP Settings (PTP Mode, Profile, Protocol ...)
NTP	NTP Settings (Role, Server, Polling, Bond ...)
Serial Connectors	Baud Rate, Framing, Sring Type, COM0 Mode
Outputs	IRIG Codes, IRIG Timescale, Synth. Freq, Enable/Disable Outputs
Programm. Outputs	Mode, Invert, Enable Outputs (Always, If Sync)
Time Zone	Time Zone (UTC, CET/CEST, Custom with Offset), Daylight Saving



To adjust the network parameters of the N2X, press the tab with the assigned IP. By default, the DHCP service is enabled so that an IP address is assigned automatically. If the SyncBox got no correct address from the DCHP server, the default IP 169.254.120.123 will be set automatically. If the address should be assigned manually, the DHCP service must be disabled in this area.

By selecting the menu item PTP, the PTP mode can be changed. Via the tab "Role" you can select between multicast and unicast slave. Via the profiles tab you can select the PTP - Profile (Custom, Power and Telecom). In this area it is also possible to enter the Unicast Master and the intervals of the messages (Announce, Sync, DelayRequest).

3 The System SyncBox

The Meinberg SyncBox N2X is synchronized by a PTP Grandmaster or by a NTP Server and can be used as a time source for equipment that requires IRIG AM, Freq.Synth/sine, PPO (PPS, PPM, PPH, IRIG DCLS, Cyclic Pulses, Single Shot, Timer, DCF77 Mark, Time Sync, Freq. Synth./TTL, Time Slots) or serial time string for synchronization.

The SyncBox/N2X operates as a IEEE-1588 multicast slave clock or NTP client in a PTP / NTP network and with its interfaces this converter can synchronize many different systems. Our IEEE-1588 Grandmaster or LANTIME NTP Server, such the LANTIME M600, can be used as a reliable time source.

In order to support network management systems the SyncBox offers an extensive SNMP interface, which can be accessed by SNMP V1.

It allows the monitoring of all relevant system parameters - including operating system parameters, network interface statistics, detailed NTP status information as well as the complete system configuration.

The SyncBox N2X is equipped with a high precision oscillator "TCXO-LQ". The oscillator determines the long-term stability in holdover mode, ie when the synchronization with the time source is disturbed. Oscillator update to OCXO-HQ is possible.

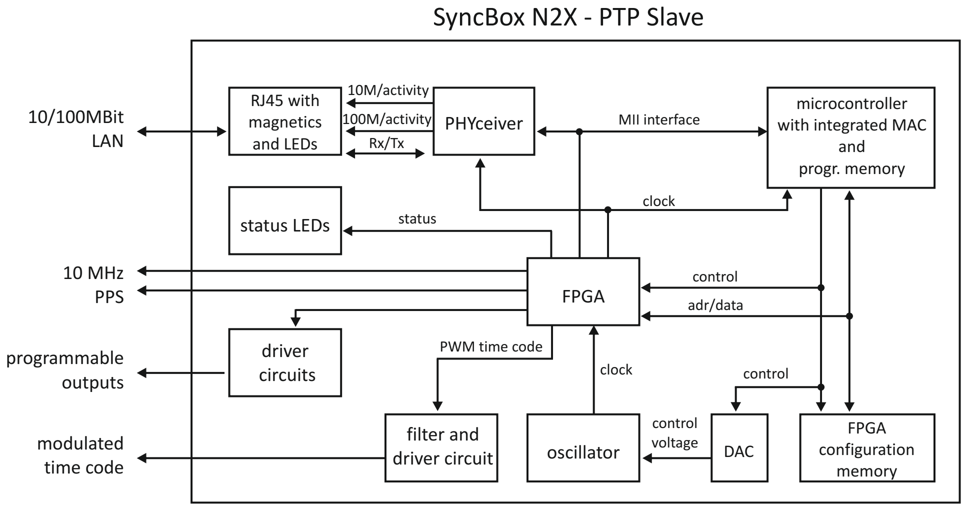
4 Precision Time Protocol (PTP) / IEEE1588

Precision Time Protocol (PTP or IEEE 1588) is a time synchronization protocol that offers sub-microsecond accuracy over a standard Ethernet connection. This accuracy can be achieved by adding a hardware timestamping unit to the network ports that are used for PTP time synchronization. The timestamping unit captures the exact time when a PTP synchronization packet is sent or received. These timestamps are then taken into account to compensate for transfer delays introduced by the Ethernet network.

In PTP networks there is only one recognized active source of time, referred to as the Grandmaster Clock. If two or more Grandmaster Clocks exist in a single network, an algorithm defined in the PTP standard is used to determine which one is the „best“ source of time. This „Best Master Clock“ algorithm must be implemented on every PTP/IEEE1588 compliant system to insure that all clients („Slave Clocks“) will select the same Grandmaster. The remaining deselected Grandmaster Clocks will „step back“ and enter a passive mode, meaning that they do not send synchronization packets as long as that is being done by the designated Grandmaster.

The existing network infrastructure components play a big role in a PTP network and directly influence the level of accuracy that can be achieved by 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 networks and should be avoided. With activating the HQ-Filter (see chapter HQ-Filter) the Jitter can be eliminated. Simple Ethernet hubs with fixed pass-through times are not a problem. In large networks, special switches with built-in PTP functionality help to maintain high accuracy even over several subnets and longer distances. These components act as "Boundary Clocks" (BC) or "Transparent Clocks" (TC). They compensate their internal packet processing times by using timestamping units on each port. When acting as a Boundary Clock, they synchronize to the Grandmaster clock, and in turn act as a Master to the other subnets they are connected to. When acting as a Transparent Clock, then the "residence time" of the Masters' Sync-Packet is measured and added to the packet as a correction value. Internally the PTP timescale TAI (see chapter Timescale in Global Parameters).

4.1 Functionality in Slave Systems



After decoding valid time information from a PTP Master, the system sets its own PTP seconds and nanoseconds accordingly. The PTP offset calculated by the PTP driver software is used to adjust the master oscillator of the SyncBox N2X. This allows the PTP Slave to generate very high accuracy output signals (10 MHz/1PPS/IRIG).

4.2 PTPv2 IEEE 1588-2008 Configuration Guide

Setting up all devices in a PTP synchronization infrastructure is one of the most important parts in a network time synchronization project. The settings of the involved Grandmaster clocks as the source of time and the end devices ("Slaves") have to match in order to allow them to synchronize and avoid problems later, when the PTP infrastructure is deployed to production environments. In addition to that, the use of PTP aware network infrastructure components, namely network switches, introduces another set of parameters that have to be harmonized with the masters and slaves in a PTP setup.

It is therefore very important to start with making decisions how the to-be-installed PTP synchronization solution should operate, e.g. should the communication between the devices be based on multicast or unicast network traffic or how often should the masters send SYNC messages to the slaves.

This chapter lists the most important options and their implications on a synchronization environment in general. A detailed explanation of the configuration settings within the LANTIME configuration interfaces can be found later within this documentation.

4.2.1 General Options

The following general mode options have to be decided before deploying the infrastructure:

1) Layer 2 (Ethernet) or Layer 3 (UDP/IPv4) connections
2) Multicast or Unicast
3) Two-Step or One-Step Operation
4) End-to-End or Peer-to-Peer Delay Mechanism

The above options need to be defined for the whole setup, if devices do not stick to the same settings, they will not be able to establish a working synchronization link.

4.2.2 Network Layer 2 or Layer 3

PTP/IEEE 1588-2008 offers a number of so-called mappings on different network communication layers. For Meinberg products you can choose between running PTP over IEEE 802.3 Ethernet connections (network Layer 2) or UDP/IPv4 connections (Layer 3).

Layer 3 is the recommended mode, because it works in most environments. For Layer 2 mode the network needs to be able to provide Ethernet connections between master and slave devices, which is often not the case when your network is divided into different network segments and you have no layer 2 routing capabilities in your network infrastructure.

The only benefit of using Layer 2 mode would be a reduced traffic load, because the transmitted network frames do not need to include the IP and UDP header, saving 28 bytes per PTP packet/frame. Due to the fact that PTP is a low traffic protocol (when compared to other protocols), the reduced bandwidth consumption only plays a role when low-bandwidth network links (e.g. 2Mbit/s) have to be used or in pay-per-traffic scenarios, for example over leased-line connections.

4.2.3 End-To-End (E2E) or Peer-To-Peer (P2P) Delay Measurements

In addition to receiving the SYNC/FOLLOWUP messages a PTP slave device needs to be able to measure the network delay, i.e. the time it took the SYNC message to traverse the network path between the master and the slave. This delay is required to correct the received time information accordingly and it is measured by the slave in a configured interval (more about the message intervals later). A delay measurement is performed by sending a so-called DELAY_REQUEST to the master which timestamps it and returns the timestamp in a DELAY_RESPONSE message.

IEEE 1588-2008 offers two different mechanisms for performing the delay measurements. A slave can either measure the delay all the way to the master, this is called End-To-End (or E2E in short) or to its direct network neighbors (which would in almost all cases be a switch – or two in a redundant setup), using the Peer-To-Peer delay measurement mechanism (P2P). The delay measurements of all links between the master and the slave are then added and accumulated while a SYNC packet is traversing the network.

The advantage of this method is that it can dramatically reduce the degradation of accuracy after topology changes. For example: in a redundant network ring topology the network delay will be affected when the ring breaks open and network traffic needs to be redirected and flows into the other direction. A PTP slave in a sync infrastructure using E2E would in this case apply the wrong delay correction calculations until it performs the next delay measurement (and finds out that the network path delay has changed). The same scenario in a P2P setup would see much less time error, because the delay of all changed network links were already available.

The drawback: the P2P approach requires that all involved PTP devices and all switches support this mechanism. A switch/hub without P2P support would in the best case simply pass the so-called PDELAY messages through and as a result degrade the accuracy of the delay measurements. In the worst case it would block/drop the PDELAY messages completely, which effectively would result in no delay measurements at all.

So, E2E is the only available choice if you are running PTP traffic through non-PTP-aware switches. It is a reasonable choice if you are not using redundant network topologies or can accept that the delay measurements are wrong for a certain amount of time.

4.2.4 (P)DELAY_REQUEST Messages

As explained in the General Mode Options chapter (see the "End-To-End or Peer-to-Peer" section), the delay measurements are an important factor for achieving the required accuracy. Especially in E2E mode, the network path delay measurements play a crucial part in the synchronization process. Per default, the slaves will perform delay measurements every 8 seconds, resulting in sending and receiving one packet. This can be increased in case the network path delay variation in the network is relatively large (i.e. the time it takes for the SYNC message to reach the slave varies a lot) or the slave devices have to tightly follow the master and adjust their time base (oscillator) very often due to its instability.

Meinberg slave devices will limit the effect of an outdated path delay measurement by using filters and optimized PLL algorithms. This avoids that a clock "jumps around" and basically monitors the time difference to the master clock carefully for a certain amount of time before adjusting its own clock. With a low cost time base this is not possible, because the instability (i.e. temperature-dependent drift and overall short term stability/aging effects) and therefore these slaves would require to perform as many delay measurements and receive as many SYNC/FOLLOWUP messages as possible.

For P2P mode the delay request interval is not as critical, simply because the delay variation on a single-hop link (i.e. from your slave device to its switch) is very stable and does not change dramatically in typical environments.

Current firmware versions of Meinberg Grandmaster clocks (V5.32a and older) do not offer changing the Delay message rate in Multicast mode, it is fixed to one delay request every 8 seconds. Since this is actually a value that is transmitted in the DELAY_RESPONSE message as a maximum value, the slave devices are not allowed to perform delay measurements more often.

5 Attachment: Technical Information

5.1 Safety instructions for building-in equipment

This built-in type has been designed and tested in accordance with the requirements of of the IEC60950-1 standard „Safety of Information Technology Equipment, including Electrical Business Equipment".

- If the device is is assembled into another appliance (i.e. rack) additional requirements in accordance with IEC60950-1 standard have to be taken into account.
- The built-in type has been developed for use in office environment (pollution degree 2) and only be used in this environment. For use in rooms with a higher pollution degree more stringent requirements are applicable.
- The equipment/built-in type has been evaluated for use in a maximum ambient temperature of 50°C.
- The ventilation opening may not be covered.
- The built-in type is a class 1 equipment and must be connected to an grounded outlet (TN Power System) located close to the device and easily accessible.
- For safe operation the built-in type must be protected by max 16A fuse in the power installation system.
- Protection against fire must be assured in the end application.
- Disconnection of the equipment from mains is done by pulling all mains plugs.
- The built-in type may be opened only by qualified personell.

5.2 Technical Specifications SYNCBOX N2X

Housing:	Aluminium Case 45mm x 105mm x 160mm (H x W x D)
Power Supply:	19-72 VDC
Input Fuse:	Electronic
Protection Rating:	IP20
Power Consumption:	5 W
Humidity:	max. 85%
Ambient Temperature:	0 ... 50°C
Accuracy of pulse outputs:	PTP: +/- 100 ns (relative to the used IEEE 1588 Grandmaster Clock, after initial synchronization phase) NTP: +/- 1 ms (relativ to NTP when using a local time server) * after warm-up period
Precision Time Protocol (IEEE 1588)	UDP/IPv4 (L3) or IEEE802.3 (L2) Multicast E2E, E2E Hybrid or P2P Delay Mechanism PTP Subdomains (0-255) Power Profile compatible
Network Time Protocol (NTP)	Up to seven configurable external NTP Time Server Min. and max. polling interval (8s – 1024s) Standard NTP options (noselect, true, prefer, iburst)

5.3 SYNCBOX N2X Connectors

Name	Type	Signal	Cable
FRONT			
Network	RJ-45	10/100 BaseT	CAT 5 network cable
Out 1 – Out 3 optional	BNC connector ST connector 2pin DFK	TTL into 50 Ohm FO Photo-MOS	shielded data line Fiber Optic
REAR			
COM 0	9pin SUB-D	RS-232	shielded data line
Input Voltage optional	5pin DFK clamp PoE	19 - 72 V DC	Power supply cord

6 Declaration of Conformity

Konformitätserklärung

Doc ID: SyncBox N2X-2016-06-22

Hersteller *Manufacturer*	Meinberg Funkuhren GmbH & Co. KG Lange Wand 9, D-31812 Bad Pyrmont

erklärt in alleiniger Verantwortung, dass das Produkt,
declares under its sole responsibility, that the product

Produktbezeichnung *Product Designation*	**SyncBox N2X**

auf das sich diese Erklärung bezieht, mit den folgenden Normen übereinstimmt
to which this declaration relates is in conformity with the following standards

EN55022:2010	Limits and methods of measurement of radio interference characteristics of information technology equipment
EN55024:2010	Limits and methods of measurement of Immunity characteristics of information technology equipment
EN 50581:2012	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

gemäß den Richtlinien 2014/30/EU (Elektromagnetische Verträglichkeit), 2014/35/EU (Niederspannungsrichtlinie), 2011/65/EU (Beschränkung der Verwendung bestimmter gefährlicher Stoffe) und 93/68/EWG (CE Kennzeichnung) sowie deren Ergänzungen.
following the provisions of the directives 2014/30/EU (electromagnetic compatibility), 2014/35/EU (low voltage directive), 2011/65/EU (restriction of the use of certain hazardous substances) and 93/68/EEC (CE marking) and its amendments.

Bad Pyrmont, 2016-06-22

Günter Meinberg
Managing Director

SYNCBOX_N2X_22062016