Suggested Functional Specifications for a GPS-Synchronized Clock System using Network Time Protocol and Power over Ethernet

1.1 SCOPE

This document specifies a wired clock system that relies on the accuracy of the Global Positioning Satellite (GPS) system for synchronizing the time provided to clocks and network devices using the Network Time Protocol (NTP). Such a clock system relies on one or more NTP time servers with an integrated GPS receiver, to act as master clocks and virtually an unlimited number of network clock displays acting as client devices. In addition, other network client devices can benefit from the availability of the NTP timeservers. Data and low voltage DC power can be distributed over the same network cable using Power over Ethernet technology, resulting in significant cost savings. The limitations are primarily network configuration and implementation based, as the system can be added to an existing network or configured as an independent network to simply provide a synchronized clock display system.

Sample Wiring Diagram
1.2 GENERAL

NTP (Network Time Protocol) servers allow clients to synchronize clocks, bells, computer clocks, other computer timing devices and other kinds of network equipment using UTC (Universal Time Coordinated).

NTP servers with an integrated GPS receiver located on a LAN (Local Area Network) can provide the high accuracy of the GPS satellite system to provide the UTC reference time, eliminating the need for an internet connection to acquire time. Placing one or more NTP on your local network behind your facilities firewall enhances reliability, redundancy, accuracy, and security.

Using NTP is clearly an advantage since it permits automatic synchronization of all the equipment hooked up to the network, thus reducing the need and associated cost for personnel to travel to remote clock locations to set the time manually.

Many have observed that NTP clock installations have become easier, better synchronized, more reliable, and provide a traceable source of time for critical network functions, resulting in lower overall cost.

NTP provides a simplified protocol called SNTP (Simplified Network Time Protocol), which clients can utilize to set the time to trusted NTP timeservers. SNTP V4 is a subset of the full NTP V3 version and is widely accepted for client devices.

POE (Power over Ethernet) is a recognized and a growing method of significantly reducing installation costs and providing low voltage DC power to network devices by distributing power over the unused pair of standard network cables. The modest incremental cost of purchasing POE equipment that is compliant to the IEEE 802.3af standard, dramatically offsets the installation costs and safety issues associated with utilizing and distributing AC power.

A GPS Synchronized clock system using NTP and POE offer significant installation and maintenance cost benefits over traditional clock systems.
2.1 GENERAL SYSTEM REQUIREMENTS

The synchronized clock system shall meet or exceed the requirements of this specification in all aspects.

2.2 OPERATIONAL REQUIREMENTS AND ENVIRONMENTAL SPECIFICATIONS

The clock system shall be located and operated in an indoor environment, within the parameters of a standard network configuration, and utilizing standard industry provided network equipment and distribution methods, including standardized POE distribution technology. The clock system shall operate autonomously and provide software configuration options for time zone offsets, automatic daylight saving time corrections without scheduled operator intervention or maintenance. The clock system shall be configured via software control and shall allow for remote monitoring and configuration changes while providing password protection.

Environmental specifications
The system shall operate under the following environmental conditions:
- Operating Range: 32°F to 122°F (0°C to 50°C)
- Storage Range: -40°F to 70°F (-40°C to 70°C)
- Relative Humidity: 0-90%, non-condensing

Compliance specifications
All equipment shall be tested, labeled and certified by a nationally recognized and approved testing laboratory to meet the following low voltage safety and electromagnetic compliance requirements of the United States and European Union.
- FCC, part 15, Class B limits for radiated and line conducted emissions
- Low voltage directive 2006/95/EC
2.3 CLOCK ENGINEERING REQUIREMENTS AND PERFORMANCE

The network clocks shall meet the following engineering and performance requirements.

2.3.1 NETWORK CLOCK ENGINEERING GENERAL SPECIFICATION

The network clocks shall be designed to provide years of reliable and maintenance free service and shall be constructed of all metal enclosures with high impact, UV stable lenses to ensure structural integrity and maximum durability. A wall mounting bracket, or other means, shall be provided for mounting to the surface of a wall.

The finish of the network clocks shall be of a high quality, durable, painted textured powder coat finish and available in black off the shelf. Other colors are available for large orders. Please contact Masterclock.

The network clocks enclosure shall be available in optional unpainted stainless steel material and finish for special applications.

The network clocks shall be available in double faced or dual mount options for applications in hallways or corridors.

The network clocks shall be designed for easy, cost effective, and reliable installation and use standard RJ45, 10MB Ethernet style connectors.

ACCURACY:
The networks clock displays shall be accurate to within 50 milliseconds of the UTC time reference provided by the NTP server(s) when synchronized.

PROTOCOL:
The Ethernet wired clocks shall support the following protocols:

SNTP, Simple Network Time Protocol
The network clocks shall operate with an internal reference time that is set to UTC (Universal Coordinated Time) via a built-in the SNTP client, from up to two NTP timeservers. Selection of the primary and secondary servers shall be automatic, but configurable by either static IP address or DHCP provided IP address configuration methods.
The network clocks shall be configurable to operate as an SNTP client in the following operational modes: unicast (or query), broadcast, or multicast.

**DHCP, Dynamic Host Configuration Protocol**
The network clocks shall utilize DHCP (Dynamic Host Configuration Protocol), by default, as a means of automating the configuration of all required network settings utilizing the optional settings area of a DHCP server. All DHCP network and optional NTP settings shall allow for enabling or disabling at each clock, in order to use static IP address mode network and NTP settings.

**SNMP, Simple Network Management Protocol**
The network clocks shall support SNMP (Simple Network Management Protocol) as a means of collecting and organizing information about managed clocks on the network and modifying that information to change device behavior. Masterclock offers a custom MIB (management information base) to work with an existing SNMP Manager (or Client or MIB browser).


**POWER:**
The network clocks shall utilize a standardized Power over Ethernet (POE) technology to power the clock in compliance with the IEEE 802.3af Power over Ethernet specification.

The network clocks shall be considered to be and to operate as Powered Devices (PD); and shall utilize a 48V DC nominal voltage supplied over the spare Ethernet network cable pairs, and/or the shared data/pairs, from an IEEE 802.3af compliant Power Sourcing Equipment (PSE) device, with a 10/100 MB rating, for a distance of up to 100m (328 ft). Power consumption shall be less than 12.95 Watts maximum for all PD equipment. Each network clock PD shall have a typical power rating of less than 7.5 W.

The network clocks shall be made available with an optional AC power. The power input shall be made as a universal type with an input power range of 90-264 VAC, 47-63 Hz and utilizing a standard IEC power jack.

**CONNECTORS:**
The network clock system shall utilize a Ethernet 10/100 Base-T (RJ45) and standard Cat 5 or Cat 6 cabling for the distribution of either data, or data and power using the same standard cable, and eliminating the need for an AC power source at the clock location.
CONFIGURATION SETTINGS:
The time displayed on the face of the network clocks may either be UTC time or local time and shall be configurable via software.

Clock displays shall be able to offset to any international time zone offset and provide automatic Daylight Saving Time (DST) adjustment. They shall provide maintenance-free, reliable operation. Configuration changes shall be retained in non-volatile flash.

All Masterclock network clocks shall utilize an internal maintenance-free, rechargeable, battery-backed real-time clock (RTC) to retain the internal time in the event of a power outage or for conditions in which the NTP server(s) is not available. The network clocks shall not display the time during a power outage, but shall recover from such power outage as a system without intervention.

During such “free-wheeling” periods and while in operation, the network clocks shall provide a visual indication that the device is relying on the internal oscillator and is not currently synchronized to the network timeserver.

2.3.2 ANALOG CLOCK ENGINEERING SPECIFICATION

The shape of the analog clock shall be round and 12” (30 cm) or 18” (46 cm) in size. The face of the clock shall be off-white; the time marks on face shall be black. The hour markings shall be in an English or Arabic numeral format and in an easily read font. Minute/second marking shall be provided. The analog clock shall have black hour and minute hands and a red second hand indicator.

The analog clock shall contain a stepper motor drive and state-of-the-art microprocessor and electronics control to rapidly synchronize the hands on the face of the clock to an accurate NTP reference.

The stepper motor drive and gear system shall be of all metal construction for long, maintenance-free life and high product reliability. The gear and drive train system shall be smooth and quiet in operation to minimize motor noise.

An LED status indicator on the face of the clock shall illuminate when the clock is not synchronized.

The analog clock shall be available with the following options: LED illumination, double-face ceiling or wall mount, stainless steel enclosure.

A hand positioning sensor uses an infrared sensing mechanism that automatically detects and corrects the clocks hand positions, thus eliminating manual time adjustments.
2.3.3 DIGITAL CLOCK ENGINEERING SPECIFICATION

The displays shall utilize LED’s (Light Emitting Diodes) such that they
- are easy to read in various lighting conditions
- allow for large viewing angles
- maximum-viewing distances
- provide a long life expectancy and
- do not require back lighting

The LED’s shall be available in
- red, amber, green, blue, and white
- in character heights: 2.3” (5.8 cm), 4” (10 cm), and 7” (18 cm)
- variable brightness, adjustable via software
- automatic dimming via scheduling software for preset programming of a device to brighten or dim the units illumination automatically at specific times throughout the day

2.3.4 DIGITAL-ANALOG CLOCK SPECIFICATION

The shape of the clock shall square and 12” (30 cm) by 12” (30 cm) in size.

The 4-digit LED display of time or date shall be 2.3” (5.8 cm) in height and available in colors: red, green, blue, amber, or white. Time shall be displayed in 12- or 24-hour formats. Optional digital display of seconds shall be available in red, green, blue, or amber.

The analog display of seconds shall be available in colors red, green, blue, or amber.

Display shall be adjustable in brightness via configuration software.

3.0 CONFIGURATION SOFTWARE

The network clock system shall be fully configurable and managed remotely through IP via software to simplify the costs associated with administration.

GUI Interface – Windows configuration
The network clock system shall include a GUI (Graphical User Interface) based network software application, operating under the Windows OS, for configuration and maintenance of [the network time server and] all network clocks.
The GUI application shall include **password protection** of the clock configuration, **encrypted communication**, and the ability to enable or disable options that might reduce security. A status display to remotely monitor the time displayed on the clock, the internal UTC time, synchronization status, and any error condition regarding the clocks network status shall be provided by the network software.

**Console interface – Unix/Linux, non-Windows platform configuration**
A separate menu driven telnet console interface shall be provided for configuration of the network time server and network clocks on a non-Windows OS such as UNIX, Linux.

### 4.0 IPv6 AND SECURITY

**IPv6** - Next generation of Internet Protocol (IP) address standard that provides additional IP addresses for network devices, improved security, mobile communications, quality of service (QoS) for real time processing, and network management.

**SSL (Secure Sockets Layer)** - Allows sensitive information to be transmitted securely using a cryptographic system that uses two keys to encrypt data. SSL is used to secure HTTPS protocol to access configuration and status web pages.

**SSH (Secure Shell)** - Utilized SSL and data compression technologies to provide a secure and efficient means to control, communicate with, and transfer data to and from the master clock remotely.

### 5.0 REPAIR AND MAINTENANCE

Designed as solid-state devices, the clocks shall require no standard maintenance and shall have no user serviceable or replaceable parts inside in order to reduce the requirement for on-site maintenance and repair personnel.

Any necessary firmware updates shall be made available and able to be applied on location. Instructions and required update files shall be made available for download from Masterclock.com

A procedure for trouble-shooting typical installation, configuration, and operational issues shall be supplied as part of the documentation, as part of the user manual.

The manufacturer shall make warranty repair and service, as well as non-warranty repair service, available.

**QUESTIONS? CONTACT US:**
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