

# T-Series NTP Network Time Server

## Configuration and User Guide

Models Covered: T100, T300, T550  
Firmware Versions: 2.0.006 A/B  
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Date: 8 May 2024

The latest version of this user guide can be obtained from [TimeToolsLtd.com](http://TimeToolsLtd.com)



**CAUTION:**

Before installing and configuring any T-Series NTP server appliance, please read the manuals and retain for future reference. Please follow all instructions and heed all warnings.

Full product documentation can be found on the supplied CD or at [TimeToolsLtd.com](http://TimeToolsLtd.com)

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## 1. Introduction

Network Time Protocol (NTP) can be used to synchronize the time on network clients, across an IP network, to the correct time of an NTP time server. TimeTools T-Series NTP Servers provide a stratum 1 NTP Time Server for ensuring synchronization of time is correct across an entire network.

The T-Series Network Time Server acquires time from global positioning satellite constellations (GPS\GNSS) and distributes time across a network using the TCP/IP Network Time Protocol (NTP).

## 2. Key Features

Model T100 T300: 16-channel, high sensitivity GPS timing receiver.

Model T550: 32-channel, multi-constellation timing receiver providing reception of GPS, GLONASS, BeiDou, Galileo.

Timing receiver synchronises to less than 15 nanoseconds (GPS Locked).

Can operate with outdoor, indoor or window located antenna, saving on cabling costs.

T550: Integrated high-stability TCXO oscillator provides holdover during loss of signal lock.

NTP accurate to less than 3 microsecond ( $3 \times 10^{-6}$  seconds) UTC (GPS Locked).

Synchronise in excess of 2 million clients at default NTP polling rate.

Model T100 T300: Single 10/100 Mbit auto-sensing, auto-MDIX Ethernet ports.

Model T550: Dual 10/100 Mbit auto-sensing, auto-MDIX Ethernet ports.

IPv4 and IPv6 Internet Protocol.

## 3. Network Time Protocol (NTP)

### 3.1. Introduction

NTP is a computer network protocol which is used to synchronise time on computers across a network. NTP stands for Network Time Protocol. Dr David Mills of the University of Delaware invented it over 25 years ago. He saw a growing need to synchronise time on computers and networks. Now, many distributed computer processes and applications rely on precise system time. Transaction processing, event logging, CCTV and DVR applications all rely on accurate time stamping.

NTP has a hierarchical structure. At the highest level, or stratum, are precise hardware clocks, which can synchronise to highly accurate external time references, such as GPS or national radio time and frequency broadcasts. These hardware clock devices are known as stratum 0 devices. A stratum 1 time server obtains time directly from a hardware clock and is the most accurate reference in the NTP hierarchy. All lower stratum devices obtain time from the stratum above over a network. As the network introduces timing discrepancies, lower stratum devices are a factor less accurate.

A hierarchical structure allows the overhead of providing time to many clients to be shared among many time servers. Not all clients need to obtain time directly from a stratum 1 reference, but can utilise stratum 2 or 3 references. This has obvious advantages in large networks, such as the Internet, to spread load. However, in practice, on smaller networks, all clients can obtain time from a single stratum 1 time server.

NTP generally operates on a client-server basis. A network time client periodically requests time from a time server. The time server responds with a packet of information containing a time stamp. The time stamp is then used by the client to synchronise its system time. Complex algorithms are used to calculate the time a packet takes to get to the server and back-again, so as to eliminate or reduce any timing inaccuracies introduced by the network itself.

### 3.2. Time Zones and Daylight Saving Time

NTP uses UTC (Universal Time Coordinated) time, which is very similar to GMT time. It knows nothing of local time zones or daylight-saving time. It is a function of the time client to apply an offset to the supplied time to adjust for local time. In this manner, a time server located anywhere in the world can provide synchronisation to a client located anywhere else in the world. It allows clients to utilise different time zone and daylight-saving properties.

### 3.3. Fault Tolerance

NTP is fault tolerant, its internal algorithms can automatically select the best of a selection of external time sources to synchronise to. Also, multiple references can be peered to minimize any accumulated timing discrepancies. Depending on network traffic and the accuracy of the server, most clients can be synchronised to within a couple of milliseconds of the correct time.

### 3.4. NTP Support in Operating Systems

Most modern operating systems support either the Network Time Protocol (NTP) or Simple Network Time Protocol (SNTP) in some form or other. Originally developed for Linux, it has since been ported, in various forms, to UNIX, Netware and Microsoft Windows. SNTP is a simplified form of the protocol; it does not have some of the complex algorithms to maintain high precision time. However, the two protocols are entirely interchangeable – a SNTP client can synchronise to a NTP server.

### 3.5. Hardware Time References

A number of external time references are available that can be used as hardware reference clocks for NTP. The most common being GPS. The GPS system is a constellation of 24 orbiting satellites, primarily used for positioning and navigation. However, the GPS system also provides very precise timing information. GPS signals can be received anywhere, provided that an antenna can be located with a good view of the sky.

GLONASS is the Russian Global Navigation Satellite System (GNSS). It complements GPS by providing more satellites, allowing positions to be fixed more quickly and accurately, especially in built-up areas where the view to some satellites may be obscured by buildings. It also provides an alternate source of time for satellite integrity monitoring.

Galileo is the global navigation satellite system (GNSS) that is currently being created by the European Union (EU).



## 4. GPS\GNSS Operation

### 4.1. Start-Up

The first time the receiver module is powered-up, it searches for satellites from a cold start (no almanac, time, ephemeris, or stored position).

While the receiver will begin to compute position solutions in less than one minute, the receiver must continuously track satellites for approximately 15 minutes to download a complete almanac. A complete and current almanac is essential for correct UTC output. The initialization process with almanac download should not be interrupted.

During this period, the T-Series GNSS status will be shown as “No Lock”.



#### **INFORMATION:**

After power up, it can take as long as 15 minutes for the receiver to obtain a satellite lock, longer if the antenna has an obscured view of the sky.

### 4.2. Self-Survey

When the module has acquired and locked onto a set of satellites, and has obtained a valid ephemeris for each tracked satellite, it performs a self-survey. The self-survey is conducted by averaging 2000 valid position fixes, which will take approximately 30 minutes to complete.

On survey completion, the module automatically switches to a time-only mode (overdetermined clock mode).

The default mode during self-survey is 2D/3D Automatic, where the receiver must obtain a three-dimensional (3-D) position solution. If fewer than four conforming satellites are visible, the GNSS module suspends the self-survey. 3-D mode may not be achieved when the receiver is subjected to frequent obscuration or when the geometry is poor due to an incomplete constellation.

During this period, the T-Series GNSS status will be shown as “Survey”, it will also show the survey progress as a percentage.

### 4.3. Over-determined clock mode

Over-determined clock mode is used in stationary timing applications. This is the default mode for the GNSS module once a surveyed position is determined. After the receiver self-surveys its static reference position, it stores the surveyed reference position to non-volatile memory and automatically switches to over-determined clock mode and determines the clock solution.

The timing solution is qualified by T-RAIM algorithm, which automatically detects and rejects faulty satellites from the solution. Using the default anti-jamming setting, a minimum of two satellites is required for a fix in overdetermined clock mode. When you power-up the receiver, or after a long fix outages (longer than nine minutes), three satellites are required for the first fix. In this mode, the GNSS module does not navigate or update positions and velocities, but maintains the PPS output, solving only for the receiver clock error (bias) and error rate (bias rate). If the anti-jamming setting is disabled, only one satellite is required for a valid timing fix.

If a stored reference position from a previous self-survey is available at start-up, the GNSS module will use that stored reference position and will enter the over-determined clock mode immediately after power-on. Self-survey would only be re-started if the position integrity check detects a re-location of the antenna. The over-determined clock mode can only be entered when a reference position is available to the receiver from a self-survey.

When the receiver enters Over-determined clock mode, the T-Series GNSS status will be shown as “Ok”.

#### 4.4. Integrity Monitoring

Using a voting scheme based on pseudo-range residuals, the GPS\GNSS modules T-RAIM (Time Receiver Autonomous Integrity Monitoring) algorithm automatically removes the worst satellite with the highest residual from the solution set if that satellite's residual is above the current constellation average.

In addition to T-RAIM, the GNSS module implements position integrity checking on start up, in case the receiver has been moved to a new location. When the receiver is powered up with a surveyed position in memory, it will compare position fixes computed from the GNSS satellites to the surveyed position. If it finds that the surveyed position is off by more than 100 meters (approximately) horizontally or vertically in the first 60 consecutive GNSS fixes, it will delete the surveyed position from memory and restart the self-survey.



## 5. NTP Synchronisation

On power-up NTP generally starts in an unsynchronised state. Network time clients will be unable to obtain time from the device until it has synchronised its internal clock to a time reference. To synchronise its internal clock, the device needs to be provided with an accurate source of time. Generally accurate time is provided by a GPS\GNSS external time reference, however, you can also configure the NTP server to synchronise to other external NTP servers or use its internal real-time clock as a time reference.

### 5.1. Stratum 1 Operation

Stratum 1 operation of a NTP server is only guaranteed by synchronising the device with external hardware time references such as GPS\GNSS. An external hardware time reference can be considered to be stratum 0 – the highest stratum in the NTP hierarchy.

In order to maintain stratum 1 synchronisation, a NTP server must be supplied regular precise time-stamps by the external hardware reference clock.

### 5.2. Loss of Hardware Clock Synchronisation, TCXO Models (T550)

In the event that GPS\GNSS time references fail, models with a TCXO oscillator will maintain stratum 1 operation for a holdover period of 24 hours. When the holdover period expires, they will fall back to using any alternative external NTP time references that may be configured, changing stratum accordingly. If no alternative external NTP time references are configured, or if they fail, stratum 1 operation will cease and the device will enter an unsynchronised state. TCXO holdover is only enabled after 24 hours of continuous uninterrupted GPS\GNSS reception.

### 5.3. Loss of Hardware Clock Synchronisation, Non-TCXO Models (T100, T300)

In the event that GPS time references fail, models without a TCXO oscillator will fall back to using any alternative external NTP time references that may be configured, changing stratum accordingly. If no alternative external NTP time references are configured, or if they fail, stratum 1 operation will cease after a period of time.

### 5.4. NTP Peering

NTP can be configured to agree a common time between a number of NTP servers on a network. Peering allows a number of NTP servers to communicate together to provide a network with the same agreed time. Peering can be used to provide a high degree of redundancy.

Only servers with known good clocks should be peered together. The IP address or fully qualified domain name of peered NTP servers can be entered into the External Time Server field of the NTP Configuration Menu. See 'Web Interface' section.

### 5.5. External Backup NTP Servers

Most Internet based NTP servers will not allow peering. Therefore, to configure an external NTP server that does not allow peering as a backup time reference, to be used in the event of failure of the primary reference, you will need to use the NTP 'server' command in the NTP configuration file. You can append commands to the NTP configuration file using the 'Edit NTP Configuration' option in the 'NTP Configuration Menu'. The 'server' command has a single operand, the IP address or fully qualified domain name of the server to be used:

```
server time-b.nist.gov          # Domain name of external NTP time server
server 129.6.15.28             # IP address of external NTP time server
```

In the event of failure of the primary synchronisation reference, the backup server will be used for synchronisation. In this event the stratum of the NTP server will be one less than the stratum of the synchronisation server. i.e. If the synchronisation server is stratum 2, the appliance will become stratum 3. The NTP server will only revert to stratum 1 operation when the primary synchronisation reference (GPS\GNSS) comes back online.

## 5.6. Typical Synchronisation Hierarchy

Stratum 0	GPS, GLONASS, Galileo hardware clock references.
Stratum 1	NTP Server appliance synchronised to a hardware reference clock, such as GPS.
Lower Stratum (2 to 15)	NTP servers synchronised to other NTP servers.

## 6. Initial Configuration

Before configuring the NTP server, you will need to acquire the following basic configuration information:

IP address,  
Network mask,  
Gateway,  
Domain name servers

or confirm availability of a network DHCP server for dynamic networking configuration.

T-Series NTP servers are available with either a single or dual Ethernet ports. All models are configured with a default IP address on Eth0. For models with a second Ethernet port, Eth1 is configured as a DHCP client.



### IMPORTANT:

When first installing the T-Series on your network, ensure that no other device conflicts with the default IP address of the appliance.

Default IP Address (Eth0): 192.168.3.222  
Default IP Address (Eth1): DHCP Client

The T-Series can be initially configured in any of three ways:

- Over a network using a web browser on a PC connected to the same network segment.
- Using a web browser on a PC using a peer-to-peer (direct cable) network connection.
- Using a dumb terminal emulator on a PC using a RS232 serial connection.

### 6.1. Default Configuration

#### Security

Console, SSH, SCP, SFTP, FTP user name	admin
Console, SSH, SCP, SFTP, FTP default password	admin
HTTPS \ HTTP Web Password	admin

#### Network Configuration

Host Name	NTP001
Domain Name	-
Name Server 1	-
Name Server 2	-
Network Services	HTTPS: Enabled, HTTP: Enabled, FTP: Enabled SSH\SCP\SFTP: Enabled

#### Ethernet Port 0

DHCP	Disabled
IPv4 Address \ Mask	192.168.3.222/24
IPv4 Default Gateway	192.168.3.1
IPv6 Address/Mask A:	-
IPv6 Address/Mask B:	-
IPv6 Address/Mask C:	-
IPv6 Gateway:	-
DHCPv6:	Disabled

#### Ethernet Port 1 (T550 models)

DHCP	Enabled
IPv4 Address \ Mask	-
IPv6 Address/Mask A:	-



IPv6 Address/Mask B:	-
IPv6 Address/Mask C:	-
DHCPv6	Disabled

**NTP Configuration**

External NTP Server Address 1	-
Key	-
External NTP Server Address 2	-
Key	-
External NTP Server Address 3	-
Key	-
NTP Broadcast Address	-
Key	-
Trusted Keys	-
NTP Keys	-

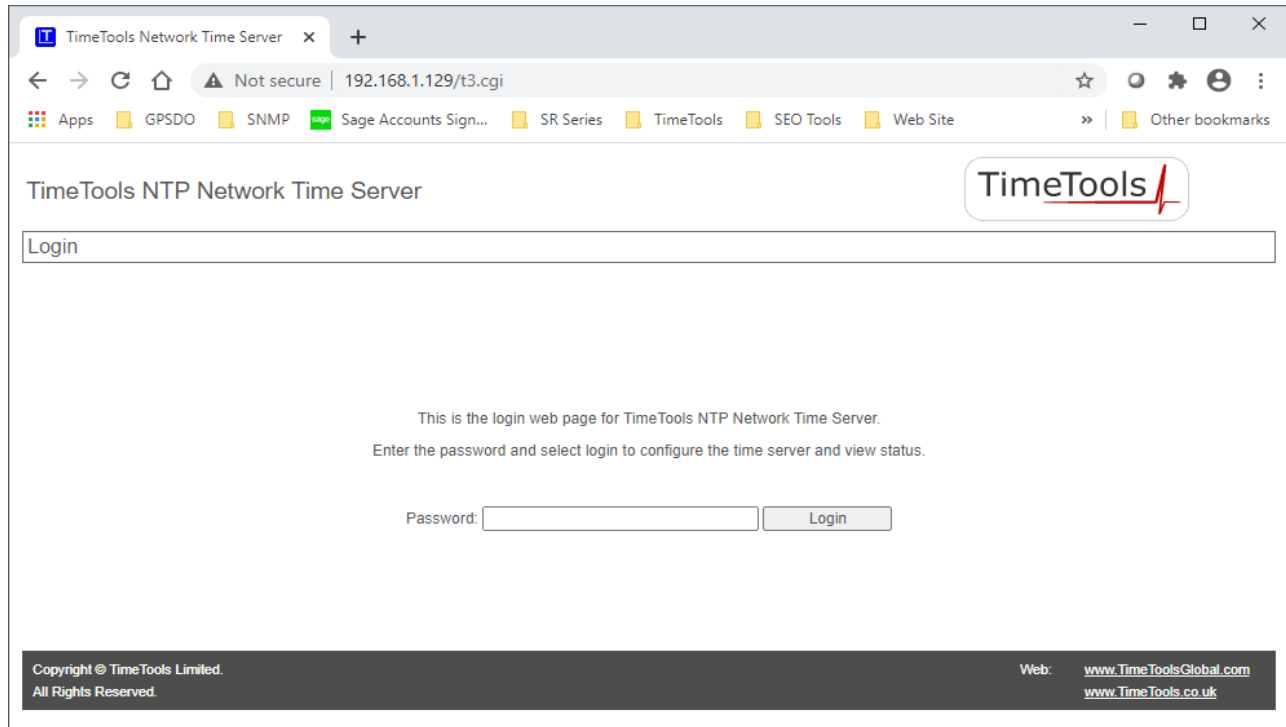
**SNMP Configuration**

SNMP Traps	Disabled
Community String	-
Trap Address 1:	-
Trap Address 2:	-
Trap Address 3:	-
Trap Address 4:	-

## 7. Web Interface

The web interface can be initiated by entering the IP address of the time server into a web browser, such as Internet Explorer, e.g. <http://192.168.3.222>. The user will then be greeted by the login screen. A HTTPS web connection can also be used.

### 7.1. Login



The screenshot shows a web browser window with the title "TimeTools Network Time Server". The address bar shows "192.168.1.129/t3.cgi". The page content includes the "TimeTools" logo, a "Login" button, and a password input field. The text on the page reads: "This is the login web page for TimeTools NTP Network Time Server. Enter the password and select login to configure the time server and view status." Below the password field is a "Login" button. At the bottom, there is a footer with copyright information and website URLs.

TimeTools NTP Network Time Server

TimeTools

Login

This is the login web page for TimeTools NTP Network Time Server.  
Enter the password and select login to configure the time server and view status.

Password:  Login

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[www.TimeTools.co.uk](http://www.TimeTools.co.uk)

Enter the configuration password in order to login to the device. Default: 'admin'.



## Status Menu

TimeTools NTP Network Time Server

Status

**NTP Server Specification**

Model:	T550	Firmware Build:	Rev. 2.0.001 21-JUL-20
NTP Version:	ntpd 4.2.8p15@1.3728		

**Network Configuration Settings**

Host Name:	NTP001	Domain:	
Ethernet Port 0 Status:	Up	Ethernet Port 1 Status:	Up
IPv4 Address:	192.168.3.222	IPv4 Address:	192.168.1.129
IPv6 Address:	fe80::214:2dff:fe4b:c2b6	IPv6 Address:	fe80::214:2dff:fe5b:c2b6
IPv6 Address A:	2a00:23c7:3f02:d00:214:2dff:fe4b:c2b6	IPv6 Address A:	2a00:23c7:3f02:d00:214:2dff:fe5b:c2b6
IPv6 Address B:	fdaa:bbcc:ddee:0:214:2dff:fe4b:c2b6	IPv6 Address B:	fdaa:bbcc:ddee:0:214:2dff:fe5b:c2b6
IPv6 Address C:		IPv6 Address C:	

**Network Time Protocol Status**

NTP Clock Status:	Ok.	NTP Synchronized To:	GNSS
NTP Offset:	0.001 msec	NTP Clock Stratum:	1
System Time:	07:52:45 04-Sep-2020 UTC		

**GNSS Synchronisation Status**

GNSS Status:	Ok	GNSS Satellites:	14
GNSS Position:	[Lat: 52.4749deg Long: -2.1337deg Alt: 182.97m]	GNSS Last Sync:	07:52:30 04-Sep-2020 UTC

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[www.TimeTools.co.uk](http://www.TimeTools.co.uk)


<b>Model</b>	NTP Server model.
<b>Firmware Build</b>	Describes the firmware build revision number and firmware build date.
<b>NTP Version</b>	Network Time Protocol version currently installed.
<b>Hostname</b>	Hostname of appliance.
<b>Domain</b>	Network domain name
<b>Ethernet Port Status</b>	The current state of the Ethernet port. Up – connected, Down – disconnected.
<b>IPv4 Address</b>	IPv4 Network address of appliance.
<b>IPv6 Address</b>	IPv6 Network address of appliance. Based on MAC address of Ethernet port.

<b>IPv6 Address A</b>	Assigned IPv6 Network address of appliance.
<b>IPv6 Address B</b>	Assigned IPv6 Network address of appliance.
<b>IPv6 Address C</b>	Assigned IPv6 Network address of appliance.
<b>NTP Clock Status</b>	The current NTP clock status – OK / Not Synchronised.
<b>NTP Offset</b>	The offset between the appliances system time and the currently utilised reference clock.
<b>NTP Synchronized To:</b>	The reference clock that the appliance is synchronized to. Typically GNSS, but may also be an external NTP server.
<b>NTP Clock Stratum:</b>	The current stratum level of the appliance. Typically stratum 1 when synchronized to GNSS.
<b>System Time</b>	The appliances current system time as UTC (not local time).
<b>GNSS Status</b>	OK: GNSS satellite lock has been achieved and receiver operation is good. No Lock:GNSS satellite lock not achieved or lost. This may be due to poor antenna location. Error: Indicates GNSS receiver error. Check the system log to find exact cause.
<b>GNSS Position</b>	GNSS positioning information, location and height
<b>GNSS Satellites</b>	Satellites currently used in timing calculation.
<b>GNSS Last Sync</b>	The last valid time-stamp provided to NTP from the GNSS reference clock.

## 7.2. Network Configuration Menu

TimeTools Network Time Server
Not secure | 192.168.1.129/t3.cgi

Apps | GPSDO | SNMP | Sage Accounts Sign... | SR Series | TimeTools | SEO Tools | Web Site | Suppliers | Other bookmarks



Network

**Network Settings:**

Host Name: <input type="text" value="NTP001"/>	Domain Name: <input type="text"/>
Name Server 1: <input type="text" value="8.8.8.8"/>	Name Server 2: <input type="text" value="8.8.4.4"/>

**Network Services:**

HTTPS   
  HTTP   
  FTP   
  SSH/SCP/SFTP

**IPv4 Ethernet Configuration:**

<b>Ethernet Port 0</b> IPv4 Address/Mask: <input type="text" value="192.168.3.222/24"/> Default Gateway: <input type="text" value="192.168.3.1"/> DHCP: <input type="checkbox"/>	<b>Ethernet Port 1</b> IPv4 Address/Mask: <input type="text"/> DHCP: <input checked="" type="checkbox"/>
---	--

**IPv6 Ethernet Configuration:**

<b>Ethernet Port 0</b> IPv6 Address/Mask A: <input type="text"/> IPv6 Address/Mask B: <input type="text"/> IPv6 Address/Mask C: <input type="text"/> IPv6 Gateway: <input type="text"/> DHCPv6: <input type="checkbox"/>	<b>Ethernet Port 1</b> IPv6 Address/Mask A: <input type="text"/> IPv6 Address/Mask B: <input type="text"/> IPv6 Address/Mask C: <input type="text"/> DHCPv6: <input type="checkbox"/>
---	---

**Additional Ethernet Configuration:**

```
# Network Additional Configuration File.
#
# Add any further network configuration commands here.
#
#
```

Status
Information
Network
NTP
Notification
Security
System
Logout

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[www.TimeTools.co.uk](http://www.TimeTools.co.uk)





<b>Hostname</b>	Hostname of time server.
<b>Domain</b>	Network domain name
<b>Name Server 1</b>	IP address of DNS name server 1.
<b>Name Server 2</b>	IP address of DNS name server 2.
<b>Network Services</b>	Shows which network services are currently enabled. HTTPS, HTTP, FTP, SSH/SCP/SFTP
<b>IPv4 Address/Mask</b>	IPv4 Network IP Address and subnet mask of the appliance.
<b>Default Gateway</b>	IPv4 Network default gateway
<b>DHCP</b>	Enable Dynamic Host Configuration Protocol
<b>IPv6 Address/Mask</b>	Additional IPv6 Network IP Addresses and subnet mask of the appliance.
<b>IPv6 Gateway</b>	IPv6 Network default gateway
<b>DHCPv6</b>	Enable DHCPv6 auto-configuration.
<b>Additional Ethernet Configuration</b>	Additional commands can be specified here that will be added to the boot sequence. Typically commands to add additional routes can be specified.

### 7.3. Security Configuration

The screenshot shows a web browser window with the URL `192.168.1.129/t3.cgi`. The page title is "TimeTools NTP Network Time Server" and the TimeTools logo is in the top right. The main heading is "Security".

**Change Password:**

Please enter a new password of minimum 5 and maximum 30 characters.

New Password:

Re-Enter Password:


Buttons: Save, Reset, Cancel

Navigation tabs: Status, Information, Network, NTP, Notification, Security, System, Logout

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The security configuration web page allows the default HTTP, HTTPS, FTP, SSH/SCP/SFTP and console password to be modified. (Default 'admin'). A password of at least 5 characters must be entered, with a maximum of 30 characters.

## 7.4. NTP Configuration Menu

TimeTools Network Time Server


---

NTP

**External NTP Servers:**

NTP Server Address 1:	<input type="text"/>	Authentication Key:	<input type="text"/>
NTP Server Address 2:	<input type="text"/>	Authentication Key:	<input type="text"/>
NTP Server Address 3:	<input type="text"/>	Authentication Key:	<input type="text"/>

**NTP Broadcasting:**

NTP Broadcast Address:	<input type="text"/>	Authentication Key:	<input type="text"/>
------------------------	----------------------	---------------------	----------------------

**NTP Keys:**

```
# NTP Authentication Keys File
#
# Add any required NTP authentication keys here.
#
#
```

Trusted Keys:

**Additional NTP Configuration:**

```
# NTP Additional Configuration File.
#
# Add any further NTP configuration paramaters here.
#
#
```

---

Status
Information
Network
NTP
Notification
Security
System
Logout

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<b>External NTP Servers</b>	<p>Up to three external NTP servers can be peered with the time server to provide backup in the event of primary time source loss or failure.</p> <p>In this mode the local clock can be synchronized to the remote peer or the remote peer can be synchronized to the local clock. This is useful in a network of servers where, depending on various failure scenarios, either the local or remote peer may be the better source of time.</p>
<b>NTP Broadcasting</b>	<p>In broadcast mode the local server sends periodic broadcast messages to a client population at the <i>address</i> specified, which is usually the broadcast address on (one of) the local network(s) or a multicast address assigned to NTP. The IANA has assigned the multicast group address IPv4 224.0.1.1 and IPv6 ff05::101 (site local) exclusively to NTP, but other non-conflicting addresses can be used to contain the messages within administrative boundaries. Ordinarily, this specification applies only to the local server operating as a sender; for operation as a broadcast client</p>
<b>Trusted Keys</b>	<p>Specifies the key identifiers, which are trusted for the purposes of authenticating peers with symmetric key cryptography, as well as keys used by the <code>ntpq</code> and <code>ntpd</code> programs. The authentication procedures require that both the local and remote servers share the same key and key identifier for this purpose, although different keys can be used with different servers. The <i>key</i> arguments are 32-bit unsigned integers with values from 1 to 65534 separated by a single space character.</p>
<b>NTP Keys</b>	<p>Contains key identifiers and keys controlling authentication of Network Time Protocol (NTP) transactions.</p>

## 7.5. System Information

System information and logs are split into four categories: NTP Log, NTP Status, System Log and GPS Status.

### 7.5.1. System Log and NTP Log

The system log is a log of all the messages generated by the Linux kernel and all applications since the device was last booted. The NTP log is a filtered version of the system log showing only NTP related log messages.

The screenshot shows a web browser window with the URL 192.168.1.129/t3.cgi. The page title is "TimeTools NTP Network Time Server". The main content area is titled "Information" and displays a log of system messages. The log entries include:

```

Sep 03 15:15:51 NTP001 kernel: Mountpoint-cache hash table entries: 1024 (order: 0, 4096 bytes)
Sep 03 15:16:04 NTP001 ntp-refclockd[240]: Starting ntp reference clock daemon.
Sep 03 15:16:04 NTP001 ntp-refclockd[240]: Static operation selected.
Sep 03 15:16:04 NTP001 ntp-refclockd[240]: Anti-jam mode enabled.
Sep 03 15:16:04 NTP001 ntp-refclockd[240]: Enabled Constellations: [3]: GPS GLONASS
Sep 03 15:16:04 NTP001 ntp-refclockd[240]: Holdover 86400 secs.
Sep 03 15:16:04 NTP001 ntp-refclockd[240]: Maximum GNSS Offset 1000 secs.
Sep 03 15:16:11 NTP001 ntpd[234]: ntpd 4.2.8p15@1.3728-o Tue Jul 14 10:37:08 UTC 2020 (2): Starting
Sep 03 15:16:11 NTP001 ntpd[234]: Command line: /usr/sbin/ntpd -p /run/ntpd.pid -c /etc/timetools/ntp.conf
Sep 03 15:16:11 NTP001 ntpd[234]: -----
Sep 03 15:16:11 NTP001 ntpd[234]: ntp-4 is maintained by Network Time Foundation,
Sep 03 15:16:11 NTP001 ntpd[234]: Inc. (NTF), a non-profit 501(c)(3) public-benefit
Sep 03 15:16:11 NTP001 ntpd[234]: corporation. Support and training for ntp-4 are
Sep 03 15:16:11 NTP001 ntpd[234]: available at https://www.nwtime.org/support
Sep 03 15:16:11 NTP001 ntpd[234]: -----
Sep 03 15:16:13 NTP001 ntpd[250]: proto: precision = 6.333 usec (-17)
Sep 03 15:16:13 NTP001 ntpd[250]: basedate set to 2020-07-02
Sep 03 15:16:13 NTP001 ntpd[250]: gps base set to 2020-07-05 (week 2113)
Sep 03 15:16:13 NTP001 ntpd[250]: Listen and drop on 0 v6wildcard [::]:123
Sep 03 15:16:13 NTP001 ntpd[250]: Listen and drop on 1 v4wildcard 0.0.0.0:123
Sep 03 15:16:13 NTP001 ntpd[250]: Listen normally on 2 lo 127.0.0.1:123
Sep 03 15:16:14 NTP001 ntpd[250]: Listen normally on 3 eth0 192.168.3.222:123
Sep 03 15:16:14 NTP001 ntpd[250]: Listen normally on 4 eth1 192.168.1.129:123
Sep 03 15:16:14 NTP001 ntpd[250]: Listen normally on 5 lo [::1]:123
Sep 03 15:16:14 NTP001 ntpd[250]: Listen normally on 6 eth0 [2a00:23c7:3f02:d00:214:2dff:fe4b:c2b6]:123
Sep 03 15:16:14 NTP001 ntpd[250]: Listen normally on 7 eth0 [fdaa:bbcc:ddee:0:214:2dff:fe4b:c2b6]:123
Sep 03 15:16:14 NTP001 ntpd[250]: Listen normally on 8 eth0 [fe80::214:2dff:fe4b:c2b6%2]:123
Sep 03 15:16:14 NTP001 ntpd[250]: Listen normally on 9 eth1 [2a00:23c7:3f02:d00:214:2dff:fe5b:c2b6]:123
Sep 03 15:16:14 NTP001 ntpd[250]: Listen normally on 10 eth1 [fdaa:bbcc:ddee:0:214:2dff:fe5b:c2b6]:123
Sep 03 15:16:14 NTP001 ntpd[250]: Listen normally on 11 eth1 [fe80::214:2dff:fe5b:c2b6%3]:123
Sep 03 15:16:14 NTP001 ntpd[250]: Listening on routing socket on fd #28 for interface updates
Sep 03 15:16:14 NTP001 ntpd[250]: SHM(0) 8011 81 mobilize assoc 35842
Sep 03 15:16:14 NTP001 ntpd[250]: kernel reports TIME_ERROR: 0x41: Clock Unsynchronized
Sep 03 15:16:14 NTP001 ntpd[250]: 0.0.0.0 c01d 0d kern kernel time sync enabled
Sep 03 15:16:14 NTP001 ntpd[250]: kernel reports TIME_ERROR: 0x41: Clock Unsynchronized
    
```

Below the log, there are buttons for "NTP Log", "NTP Status", "System Log", "GNSS Status", and "Cancel". At the bottom of the interface, there are navigation buttons for "Status", "Information", "Network", "NTP", "Notification", "Security", "System", and "Logout". The footer contains copyright information for TimeTools Limited and website URLs: www.TimeToolsGlobal.com and www.TimeTools.co.uk.



## 7.5.2. NTP Status

The screenshot shows the TimeTools NTP Network Time Server web interface. The main content area displays the NTP Status page, which includes a table of peers and their synchronization status. The table has columns for remote, refid, st, t, when, poll, reach, delay, offset, and jitter. The first row shows a peer with remote '\*SHM(0)', refid '.GNSS.', and st 0. Below the table, there is a detailed status report for the selected peer, including information about the ntpd version, processor, system, stratum, precision, rootdelay, rootdisp, refid, reftime, clock, mintc, offset, frequency, sys\_jitter, and clk\_wander. The status report also includes statistics for time since reset, receive buffers, free receive buffers, used receive buffers, low water refills, dropped packets, ignored packets, received packets, packets sent, packet send failures, input wakeups, and useful input wakeups.

remote	refid	st	t	when	poll	reach	delay	offset	jitter
*SHM(0)	.GNSS.	0	1	4	8	377	0.000	+0.000	0.008

associd=0 status=0418 leap\_none, sync\_uhf\_radio, 1 event, no\_sys\_peer, version="ntpd 4.2.8p15@1.3728-o Tue Jul 14 10:37:08 UTC 2020 (2)", processor="armv7l", system="Linux/4.4.177-2.8.6-dirty", leap=00, stratum=1, precision=-17, rootdelay=0.000, rootdisp=1.045, refid=GNSS, reftime=e2fc7071.c6dcef01 Fri, Sep 4 2020 7:51:13.776, clock=e2fc7075.0c2cbd2c Fri, Sep 4 2020 7:51:17.047, peer=35842, tc=3, mintc=3, offset=+0.000286, frequency=-103.824, sys\_jitter=0.007629, clk\_wander=0.000

time since reset: 59703  
 receive buffers: 64  
 free receive buffers: 63  
 used receive buffers: 0  
 low water refills: 1  
 dropped packets: 0  
 ignored packets: 0  
 received packets: 10938  
 packets sent: 10938  
 packet send failures: 0  
 input wakeups: 75870  
 useful input wakeups: 16219

Navigation buttons: NTP Log, NTP Status, System Log, GNSS Status, Cancel

Bottom navigation: Status, Information, Network, NTP, Notification, Security, System, Logout

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The NTP Status page provides current NTP synchronisation information. It provides a list of the peers known to the server as well as a summary of their state.

The symbol at the left margin displays the synchronisation status of each peer. The currently selected peer is marked '\*', while additional peers designated acceptable for synchronisation, but not currently selected, are marked '+'. Peers marked \* and + are included in the weighted average computation to set the local clock; the data produced by peers marked with other symbols are discarded.

**remote** – The peer or server being synchronised to. SHM(0) is the GPS\GNSS reference clock.

The host names or addresses shown in the remote column correspond to the server and peer entries listed in the configuration file; however, the DNS names might not agree if the names listed are not the canonical DNS names.

**refid** – The refid column shows the peers current source of synchronization. 'GNSS' is specified for the local GPS\GNSS reference clock.

**st** – The st column reveals the stratum of the peer (0 to 16). Stratum 0, specifies a hardware reference clock such as GPS or GNSS.

t – Type (u: unicast or anycast client, b: broadcast or multicast client, l: local reference clock, s: symmetric peer, A: anycast server, B: broadcast server, M: multicast server);

when – The when column shows the time since the peer was last heard in seconds (default), hours (denoted by the “h” symbol) or days (specified by the “d” symbol).

poll – The polling interval in seconds for the peer.

reach – Status of reachability register in octal (See RFC-1305).

delay – Round trip communication delay to the remote peer or server (milliseconds);

offset – The mean offset in the times reported between the local host and the remote peer in milliseconds.

jitter – The mean deviation in the time reported from the peer in milliseconds.

Refer to the NTP Documentation Archive's ([doc.ntp.org](http://doc.ntp.org)) ntpq page for additional information.

### 7.5.3. GPS Status

The GPS Status page provides detailed information on the health and status of the T-Series GPS\GNSS receiver and the satellites tracking information.

TimeTools NTP Network Time Server

Information

```
Hardware: ResSMT 360 [3023] 1256119582 26/6/2015:[20] Firmware: 1.05.0 03/04/2018 [ResSMT 360]
Constellation: GPS,GLONASS. Mode: Static. Anti-Jam: Enabled. Holdover: 86400 secs.

Antenna Status: OK. GNSS Decoding Status: Doing fixes.
Fix: Over Determined Clock. Self-Survey Progress: Complete.
Critical Alarms: None.
Minor Alarms: None.

PPS Offset -7.35 nsec Clock Offset -17.79 ppb PPS Quantization Error 0.00 nsec
Position: [Lat: 52.4749deg Long: -2.1337deg Alt: 182.97m] Temperature: 40.3C
Dilution of Precision: [PDOP: 0.00, HDOP: 0.00, VDOP: 0.00, TDOP: 1.00]
```

PRN#	SNR(dBHz)	Fix-Type	SV-Type	Elevation	Azimuth	Em	ToM	Msec	BD	DC	Current
8	42	Time&Pos	GPS	44	286	1	460299	0	0	1	Y
26	32	Time&Pos	GPS	23	164	1	460299	0	0	1	Y
21	42	Time&Pos	GPS	67	224	1	460299	0	0	1	Y
20	37	Time&Pos	GPS	45	82	1	460299	0	0	1	Y
10	38	Time&Pos	GPS	42	130	1	460299	0	0	1	Y
18	37	Time&Pos	GPS	24	58	1	460299	0	0	1	Y
16	38	Time&Pos	GPS	58	184	1	460299	0	0	1	Y
27	39	Time&Pos	GPS	81	304	1	460299	0	0	1	Y
11	33	Time&Pos	GPS	17	256	1	460299	0	0	1	Y
7	32	Time&Pos	GPS	20	304	1	460299	0	0	1	Y
80	32	Time&Pos	GLONASS	32	210	1	460299	0	0	1	Y
82	30	Time&Pos	GLONASS	61	44	1	460299	0	0	1	Y
83	25	Time&Pos	GLONASS	57	282	1	460299	0	0	1	Y
67	25	Time&Pos	GLONASS	22	109	1	460299	0	0	1	Y
74	27	Time&Pos	GLONASS	20	334	1	460299	0	0	1	Y

NTP Log NTP Status System Log GNSS Status Cancel

Status Information Network NTP Notification Security System Logout

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The information provided can be very useful for system debugging and installation, to find the optimum location for a GPS\GNSS antenna and to confirm signal reception levels for existing installations.


#### Useful Receiver Information

Hardware	GPS\GNSS receiver hardware component version information.
Firmware	GPS\GNSS receiver firmware version information.
Antenna Status	Indicates current antenna status – OK/Open/Short. OK – Antenna operational. Open – Antenna input open circuit. Possible antenna or cable fault. Short – Antenna input short circuit. Possible antenna or cable fault.



GNSS Decoding Status	Indicates the decoding status of the GPS receiver: Doing fixes No Usable Satellites
Fix	GPS\GNSS fix mode.
Self-Survey Progress	When a self-survey procedure is in progress, this field shows the progress of the survey as a percentage of fixes collected so far. The self-survey will be complete when the self-survey progress reaches 100%. This field only has meaning while a self-survey is in progress.
Critical Alarms	This field provides status information of several critical alarm indicators.
Minor Alarms	This field provides status information of several minor alarm indicators. A minor alarm indicates a condition that the user should be alerted to, but does not indicate an immediate, or necessarily any, impairment of functionality.
Position	The current global position of the appliance, latitude and longitude, in degrees and the height in meters.
<b>Satellite Information</b>	
PRN:	A satellite PRN number uniquely identifies each particular satellite.
SNR:	The quality of received GNSS satellite-signals is reported as C/No value (Carrier-to-Noise power ratio). Low C/No values can result from low-elevation satellites, partially obscured signals (due to dense foliage for example), or reflected RF signals (multipath). Multipath can degrade the position and timing solution. Multipath is most commonly found in urban environments with many tall buildings and a preponderance of mirrored glass. Reflected signals tend to be weak (low C/No value), since each reflection diminishes the signal.
Elevation, Azimuth:	Satellite elevation and azimuth, in degrees. This shows the actual position of the satellite in the sky.
Fix Type	Indicates whether the satellite is used for position, timing or both.

## 7.6. Notification Configuration Menu

TimeTools Network Time Server


Notification

**SNMP:**

SNMP Service:

**SNMP System Parameters:**

sysLocation:  sysContact:

**SNMP v1/2c Configuration:**

Community String:

**SNMP v3 Configuration:**

User Name:

Authentication Protocol:  Authentication Password:

Privacy Protocol:  Privacy Password:

Text Engine ID:

**SNMP Traps:**

SNMP Trap Service:

Trap Address 1:

Trap Address 2:

Trap Address 3:

Trap Address 4:

[Download T-Series MIB File.](#)

---

Status
Information
Network
NTP
Notification
Security
System
Logout

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The Notification Configuration menu is used to enable and configure the appliances Simple Network Management Protocol (SNMP) service. SNMP can be used to monitor the status of the appliance. Notifications can be generated by the NTP server to warn a manager of error conditions that have occurred, such as loss of GPS signal or loss of synchronisation.

The T-Series supports SNMP v1, v2c and v3. When configured, the appliance can respond to requests for status information from a SNMP management system. It can also send SNMP traps or notifications to up to 4 separate SNMP management systems, each specified by their IP address. The Management Information Base (MIB) file is available for download from the Notification Configuration Menu page.

When the SNMP configuration is saved, the SNMP service restarts. If traps are enabled, the service will transmit a full set of traps that can be used for system monitoring test purposes.

<b>SNMP Service:</b>	Disabled: Disable the SNMP service. v1 Enabled: Enable SNMP v1 service. v2c Enabled: Enable SNMP v2c service. v3 Enabled: Enable SNMP v3 service.
<b>sysLocation:</b>	A display string representing the physical location of the appliance.
<b>sysContact:</b>	A display string identifying the appliance administrators contact details.
<b>SNMP v1/2c Configuration:</b>	The following configuration items are relevant to SNMP v1/2c only.
<b>Community String:</b>	SNMP v1/2c community string or password to read SNMP entities. The same community string is also used to send SNMP v1/2c traps.
<b>SNMP v3 Configuration:</b>	The following configuration items are relevant to SNMP v3 only.
<b>User Name:</b>	Specify SNMP v3 user or security name.
<b>Authentication Protocol:</b>	Specify protocol to authenticate SNMP v3 messages. None: Disable authentication. MD5: Enable MD5 authentication. SHA: Enable SHA authentication (recommended).
<b>Authentication Password:</b>	An authentication password or secret key to append to SNMP v3 messages.
<b>Privacy Protocol:</b>	Specify the privacy algorithm to use for SNMP v3 encryption. None: Disable privacy. DES: Enable DES encryption. AES: Enable AES encryption (recommended).
<b>Privacy Password:</b>	A privacy password or secret key for SNMP v3 privacy.
<b>Text Engine ID:</b>	An Engine ID uniquely identifies an SNMP v3 entity in a management domain. It is used for identification, not addressing, purposes. The text engine ID specifies up to 27 characters to be used to build the engine ID using the text format scheme (RFC 3411).
<b>SNMP Traps:</b>	The following configuration items relate to SNMP traps and notifications.
<b>SNMP Trap Service:</b>	Control the generation of SNMP traps and notifications. Disable SNMP TRAPs. Enable TRAPs. Enable INFORMs.
<b>Trap Address 1:</b>	Address of SNMP management system to send trap or inform messages.
<b>Trap Address 2:</b>	
<b>Trap Address 3:</b>	
<b>Trap Address 4:</b>	
<b>Download T-Series MIB File.</b>	Download the T-series MIB file for managing SNMP entities.



## 7.7. System Menu

The screenshot shows a web browser window with the URL `192.168.1.129/t3.cgi`. The page title is "TimeTools NTP Network Time Server". The main content area is titled "System" and contains three buttons: "Reboot", "Reset To Factory Defaults", and "Cancel". At the bottom of the page, there is a navigation bar with buttons for "Status", "Information", "Network", "NTP", "Notification", "Security", "System", and "Logout". The footer contains copyright information for TimeTools Limited and website URLs: [www.TimeToolsGlobal.com](http://www.TimeToolsGlobal.com) and [www.TimeTools.co.uk](http://www.TimeTools.co.uk).

- Reboot**            The reboot option restarts the time server. It is used to make any network configuration changes active.
- Factory Defaults**    The factory defaults menu option reverts all settings back to the factory defaults. All settings will revert to their factory defaults after the device has restarted. Please note, passwords will stay the same and will not revert back to default.



**IMPORTANT:**

When reverting to factory defaults, ensure that no other device on your network conflicts with the default IP address of the appliance.

Default IP Address (Eth0): 192.168.3.222  
 Default IP Address (Eth1): DHCP Client

## 8. Uploading User Generated SSL Certificates

All T-Series NTP servers can accept a user generated SSL certificate for authentication. The user generated certificate must be uploaded into the devices '/tmp/admin' directory using ftp or sftp. The uploaded certificate then needs to be saved into flash using the 'nts security savecert' command available from a console or SSH session to the time server.

**Command:**        nts security savecert  
                     nts security savecert [default]

Save uploaded user certificate files 'certificate.crt' and 'certificate.key' to flash.

Specifying default will restore original certificate files.

The device must be rebooted for any network configuration changes to take effect.

### 8.1. SSL Certificate File Format

The SSL certificate should be in the PEM file format.

The 'nts security savecert' command requires two certificate files: certificate.crt and certificate.key. Both files should be located in the /tmp/admin directory.

The 'certificate.crt' file should contain the server certificate. The certificate should be contained between ---- BEGIN CERTIFICATE---- and ----END CERTIFICATE---- statements.

The separate 'certificate.key' file should contain the private key. The private key should be contained between ---- BEGIN RSA PRIVATE KEY----- and -----END RSA PRIVATE KEY----- statements.

The default SSL certificate can be reinstated by using the 'nts security savecert default' commands

## 9. Console Configuration

### 9.1. RS232 Console Configuration

Use the console configuration cable provided to connect the 'console' port of the T-Series to a serial port of a computer.

A dumb terminal emulator, such as Hyper Terminal, can then be used on the computer to access the configuration menu of the NTP server.

### 9.2. Dumb Terminal Configuration Settings

Connect Using:	Direct to COMx	(where x is the com port number)
Bits per second:	115200	
Data bits:	8	
Parity:	None	
Stop bits:	1	
Flow control:	None	
Terminal Emulation:	ANSI	

Once the dumb terminal has been configured and the console cable connected to the correct COM port, the login prompt will appear by pressing 'ENTER'.

### 9.3. Secure Telnet Session (SSH) via Remote Host

The time server can be configured remotely using a secure telnet session (SSH), if enabled, configured for VT100 emulation. A number of SSH clients are freely available, the most common being Putty (<http://www.putty.org/>).

### 9.4. Logging On

The default username and password is 'admin'.

```
NTP001 login: admin
Password: xxxxx
```

See section 14, Command Line Interface for command information.



## 10. System Log Messages

System log messages are generated by both the NTP service and the reference clock service to warn of a system status change. Log messages can be viewed the system log tab of the information web page.

The following messages are generated by the GPS/TCXO reference clock service:

Type	Log Message	Model	Description
Warning	GNSS state change: No signal lock.	All Models	GNSS signal lock lost – possibly due to poor antenna location or faulty GPS antenna / cable.
Information	GNSS state change: Self survey.	All Models	GNSS self survey mode entered after change of location of antenna.
Information	GNSS state change: Signal lock OK.	All Models	GNSS signal lock regained after loss of signal.
Information	Start TCXO Calibration	T550	Restarting TCXO holdover oscillator calibration after reacquired GPS\GNSS signal.
Information	TCXO Enabled	T550	TCXO oscillator calibrated and ready for operation in the event of GPS\GNSS signal loss.
Warning	GNSS state change: No signal lock, entering holdover.	T550	GNSS signal lock lost - 24-hour TCXO holdover started.

The following are a selection of messages generated by the NTP service.

Type	Log Message	Description
Information	no_system_peer	No reference clock peer available.
Information	clock_sync	NTP local clock synchronised.
Information	SHM(0) reachable	NTP is receiving timestamps from GPS\GNSS receiver.
Information	SHM(0) sys_peer	NTP is using GPS\GNSS as reference clock peer.
Information	Clock step	Local clock step adjustment.

A full list of NTP service event messages is available at: <https://www.eecis.udel.edu/~mills/ntp/html/decode.html>



## 11. NTP Authentication

### 11.1. Symmetric Key Cryptography

The original RFC-1305 specification allows any one of possibly 65,534 keys, each distinguished by a 32-bit key identifier, to authenticate an association. The servers and clients involved must agree on the key and key identifier to authenticate NTP packets.

Keys and related information are specified in a key file. Besides the keys used for ordinary NTP associations, additional keys can be used as passwords for the `ntpq` and `ntpd` utility programs.

When `ntpd` is first started, it reads the key file and installs the keys in the key cache. However, individual keys must be activated with the `trusted keys` command before use. This allows, for instance, the installation of possibly several batches of keys and then activating or deactivating each batch remotely using `ntpd`. This also provides a revocation capability that can be used if a key becomes compromised.

### 11.2. NTP Keys

NTP Keys are entered in the following format:

KeyNumber M Key

where,

KeyNumber	A positive integer (1 to 65,534)
M	Specifies that Key is a 1-to-8 character ASCII string, using the MD5 authentication scheme.
Key	The key itself.

### 11.3. Trusted Keys

The trusted keys specifies the key identifiers which are trusted for the purposes of authenticating peers with symmetric key cryptography, as well as keys used by the `ntpq` and `ntpd` programs. The authentication procedures require that both the local and remote servers share the same key and key identifier for this purpose, although different keys can be used with different servers. The `key` arguments are 32-bit unsigned integers with values from 1 to 65,534 separated by a single space character.





## 12. LCD Display and Alarm LED Status

The T300 and T550 models have a two line by 40 character ultra-bright backlit LCD display for displaying current status and configuration information.

### 12.1. Initial Power-Up

On power-up the LCD display will remain blank for approximately 20 seconds, while the unit boots and performs a self-test. On completion of self tests, the display will show the model and firmware version.

```
TimeTools NTP Server T550
Build: Rev. 1.0.001 27-JAN-17
```

**Alarm LED Status: Alternate Red\Green, Rapid Flash**

### 12.2. LCD Display – Initial Operation

After the initial boot sequence, the device will then show its normal status display. The current UTC (Coordinated Universal Time) time and date, which is held internally by the devices real-time clock, will be shown. The current time offset compared to any available external time references will be shown.

Synchronisation 'Sync-Init' indicates that the device is waiting for external time references to come online. GPS status 'GNSS:NoLock' indicates that no GPS\GNSS satellite lock has yet been achieved.

```
UTC 09:40:27 04-Jan-2017 <1us offset
NTP:Init GNSS:NoLock Satellites:0
```

**Alarm LED Status: Red, Slow Flash**

If the device is powered up in a new location, or if the antenna has been moved, GPS\GNSS Self-Survey mode will be entered. A Self-Survey acquires very accurate positioning information and will take around 30 minutes to complete.

```
UTC 09:40:27 04-Jan-2017 <1us offset
NTP:Init GNSS:Svy-5% Satellites:14
```

**Alarm LED Status: Green Slow Flash**

When a GPS antenna is installed and a signal lock is achieved, time-stamps will be passed to NTP from the reference clock. NTP will then enter a calibration mode for a period of 10 to 15 minutes, while its internal clock is being skewed towards the correct time. During this period, the unit will still be in an unsynchronised state and will display '!!NO SYNC!!', as indicated below.

```
UTC 09:40:27 04-Jan-2017 <1us offset
NTP:No-Sync GNSS:Ok Satellites:14
```

**Alarm LED Status: Green Slow Flash**

### 12.3. LCD Display – Normal Operation

When the device is synchronised, the LCD display will typically appear as follows.

```
UTC 09:40:27 04-Jan-2017 2us offset
NTP:Ok GNSS:Ok Satellites:14
```

**Alarm LED Status: Green Constant**

UTC The current synchronised time maintained by the device. This is displayed as UTC time (Coordinated Universal Time).



Offset	The current offset, or estimated error, between the maintained time and the external reference clock. This may vary according to the external reference clock that is currently being used.
NTP	OK - Denotes that the device is synchronised and can serve network time clients with the correct time. No-Sync – The NTP local clock is not currently synchronized.
GNSS	No-Lock – The GPS\GNSS receiver has not yet gained a satellite lock. Lock - Signifies that a GPS signal lock has been achieved. Error – A GPS\GNSS receiver error has been detected. View the system log to determine error type.
Satellites	The number of satellites currently in use by the GPS\GNSS receiver.

#### 12.4. LCD Display – Device Unsynchronised

If no external reference clock synchronisation has been possible for a period of time, eventually the display will show '!! NO-SYNC!!' indicating that the device has entered an unsynchronised mode and will no longer provide synchronisation to network time clients.

```
UTC 09:40:27 04-Jan-2017 <1us offset
NTP:No-Sync GNSS:NoLock Satellites:0
```

**Alarm LED Status: Red, Slow Flash**

#### 12.5. LCD Display – Ethernet Link Up\Down

When a new Ethernet link is established, the display will show the Ethernet port and Ipv4\IPv6 address for the newly established link.

```
ETH0: Up Ipv4:192.168.3.222 Ipv6:
fe80::214:2dff:fe4b:c2b7
```

**Alarm LED Status: Green, Rapid Flash**

Alternatively, when a link is removed, the display will indicate the Ethernet port associated with the removed link.

```
ETH0: Down.
```

**Alarm LED Status: Red, Rapid Flash**

#### 12.6. LCD Display – Internal Manual Time Adjustment Required

If the device has been powered off for an extended period, the internal time stored in the real-time clock may have drifted too far away from the correct time in order for the device to synchronise correctly. The GNSS status will show 'Error' indicating too great a difference between the received reference clock time-stamp and the devices system time.

```
UTC 09:40:27 04-Jan-2017 <1us offset
NTP:No-Sync GNSS:Error Satellites:14
```

**Alarm LED Status: Red, Rapid Flash**

In this event the real-time clock will need to be adjusted to within 10 minutes of the correct time from a console or SSH session, see section 'Correcting the System Time'.

Other GNSS receiver errors are possible. Check the NTP log for further information about the error.



## 13. Adjusting the System Time

In the unlikely event that the device has been powered off for an extended period of time, the units system time, stored in its battery-backed real-time clock may have drifted too far away from the correct time in order for synchronisation to occur. The LCD or web configuration fields GNSS status will show 'Error' when a GNSS signal lock is achieved.

In this event, the unit's system time will need to be adjusted manually to within 10 minutes of the correct UTC time. This can be done by opening a SSH session and logging into the device and using the 'ttsetclock' command.

```
admin@NTP001:~$ ttsetclock 0930 05012017          # set the devices system time
                                                    # (must be UTC time NOT local time !)
Thu Jan  5 09:30:00 UTC 2017
ttsetclock: System time updated.

/tmp/admin $ exit                                # exit the SSH session
Connection to host lost.
```

The ttsetclock command has the following syntax:

```
ttsetclock HHMM ddmmyyyy
```

where:

HH is the hour of the day	- 2 digits, range 0 - 23
MM is the minute of the hour	- 2 digits, range 0 - 60
dd is the day of the month	- 2 digits, range 1 - 31
mm is the month of the year	- 2 digits, range 1 - 12
yyyy is the current year	- 4 digits, range 1000 - 9999



**IMPORTANT:**

When adjusting an NTP servers system time, **UTC time MUST be used** NOT local time !

## 14. Command Line Interface

The command line interface is available from a console session via the serial console port or a SSH session. Login using the username 'admin' and the associated password (default: admin). A convenient command (nts) is provided to view and change the current device settings.

### 14.1. Help Information Commands

**Command:**        nts  
                  nts help

Display nts command help page.

### 14.2. System Status Commands

**Command:**        nts status

Show the current status of the device, including firmware versions, network configuration summary, NTP status and GNSS status.

**Command:**        nts status ntp

Show the current NTP synchronisation status. It provides a list of the peers known to the server as well as a summary of their state.

**Command:**        nts status gnss

Show detailed information on the health and status of the GNSS receiver and satellite tracking information.

**Command:**        nts status ntplog

Show a filtered version of the system log showing only NTP related log messages.

**Command:**        nts status syslog

Show the complete system log of all messages generated by the Linux kernel and all applications since the device was last booted.

### 14.3. NTP Configuration Commands

Please note, the NTP service must be restarted after any NTP configuration changes.

**Command:**        nts ntp

Show the currently saved NTP configuration.

**Command:**        nts ntp ext1 <address> [<key>]  
                  nts ntp ext2 <address> [<key>]  
                  nts ntp ext3 <address> [<key>]

Set external NTP address and optional authentication key. Up to three external NTP addresses can be specified: ext 1, ext2 and ext3.

Examples:        nts ntp ext1 192.168.1.262 15    # External NTP server IP address with authentication key 15.  
                   nts ntp ext2 0.uk.pool.ntp.org    # External Internet NTP server.

**Command:**        nts ntp broadcast <address> [<key>]

Set NTP broadcast address and optional authentication key. **Most NTP clients use unicast communication, generally broadcasting does not need to be configured.**

Example:        nts ntp broadcast 192.168.1.255    # Broadcast NTP to specified subnet.

**Command:**        nts ntp trust "<keys>"

Set NTP trusted authentication keys.

Example:        nts trust "3 5 12".                            # Set trusted keys 3 5 12.

**Command:**        nts ntp keys <keyfilename>

Save specified NTP key file to flash memory. The key file must be previously uploaded or created.

Example:        nts ntp keys mykeyfile                    # Save NTP keys file mykeyfile to flash.

**Command:**        nts ntp conf <conffilename>

Save specified NTP additional configuration file. The configuration file must be previously uploaded or created.

Example:        nts ntp conf myconffile                    # Save NTP configuration file myconffile to flash.

**Command:**        nts ntp panic <enable|disable>

Enable or disable NTP service and GNSS reference clock service time validation check at start up.  
 "nts ntp panic enable" turns on a 10 minute system time – reference clock time validation check at start up.  
 "nts ntp panic disable" turns off time validation at start up.

**Command:**        nts ntp restart

Restart the NTP service. **The NTP service must be restarted for any configuration changes to take effect.**

#### 14.4. SNMP Configuration Commands

**Command:**        nts snmp

Display currently saved SNMP configuration.

**Command:**        nts snmp version v1|v2c|v3

Set SNMP version: v1, v2c or v3.

v1:            Enable SNMP v1 service.  
 v2c:          Enable SNMP v2c service.  
 v3:            Enable SNMP v3 service.

***Command no longer implemented, use 'net snmp service' command instead.***

**Command:**     nts snmp system <location> <contact>

Set SNMP location and contact details. Location is a display string representing the physical location of the appliance. Contact is a display string identifying the appliance administrators contact details.

**Command:**     nts snmp community <comstring>

Set SNMP v1/2c community string or password to read SNMP entities. The same community string is also used to send SNMP v1/2c traps.

**Command:**     nts snmp user <username>

Specify SNMP v3 user or security name.

**Command:**     nts snmp auth <none|md5|sha> [password]

Specify protocol to authenticate SNMP v3 messages.

none:    Disable authentication.  
md5:    Enable MD5 authentication.  
sha:     Enable SHA authentication (recommended).

Authentication password or secret key to append to SNMP v3 messages.

**Command:**     nts snmp priv <none|des|aes> [password]

Specify the privacy algorithm to use for SNMP v3 encryption.

none:    Disable privacy.  
des:     Enable DES encryption.  
aes:     Enable AES encryption (recommended).

Privacy password or secret key for SNMP v3 privacy.

**Command:**     nts snmp engineid <engineid>

An Engine ID uniquely identifies an SNMP v3 entity in a management domain. It is used for identification, not addressing, purposes. The text engine ID specifies up to 27 characters to be used to build the engine ID using the text format scheme (RFC 3411).

**Command:**     nts snmp trapservice disable|trap|inform

Control the generation of SNMP traps and notifications.

disable: Disable SNMP TRAPs.  
trap:    Enable TRAPs.  
inform:  Enable INFORMs.

**Command:**     nts snmp trapaddress <addr1> [<addr2>] [<addr3>] [<addr4>]

Addresses of SNMP management system to send trap or inform messages.

**Command:**     nts snmp service disable|v1|v2c|v3

Disable or start \ restart specified SNMP service. The SNMP service must be restarted for any configuration changes to take effect. When the SNMP service restarts, if SNMP traps are enabled, the service will transmit a full set of traps that can be used for system monitoring test purposes.

disable  Disable SNMP service  
v1:     Start \ restart SNMP v1 service.  
v2c:    Start \ restart SNMP v2c service.  
v3:     Start \ restart SNMP v3 service.

## 14.5. Network Configuration Commands

Please note, the NTP server must be rebooted after any network configuration changes.



**Command:** nts net

Show currently saved network configuration.

**Command:** nts net hostname <hostname>

Set host name. Please note, the NTP server must be rebooted after any network configuration changes.

Example: nts net hostname myhostname # Set hostname to myhostname

**Command:** nts net domainname <domainname>

Set domain name. Please note, the NTP server must be rebooted after any network configuration changes.

Example: nts net domainname mydomainname # Set domain name to mydomainname

**Command:** nts net nameserver <nameserver1> [<nameserver2>]

Set name servers – up to two name servers can be specified. Please note, the NTP server must be rebooted after any network configuration changes.

Example: nts net nameserver 8.8.8.8 8.8.4.4 # Set name servers

**Command:** nts net services [http] [https] [ftp] [ssh]

Set enabled network services. Please note, the NTP server must be rebooted after any network configuration changes.

Default: nts net service http https ftp ssh # Enable all network services

Example: nts net service https ssh # Enable HTTPS and SSH only. All other services disabled.  
nts net service # Disable all network services.

**Command:** nts net eth0ip dhcp  
nts net eth1ip dhcp

Set Eth0 or Eth1 IPv4 DHCP. Eth1 is only available on T550 models. Please note, the NTP server must be rebooted after any network configuration changes.

**Command:** nts net eth0ip <ipaddr/mask> [gw <gateway>]  
nts net eth1ip <ipaddr/mask> [gw <gateway>]

Set Eth0 or Eth1 IPv4 IP address /mask and gateway. Please note that the IP address and mask is specified using the CIDR notation. Eth1 is only available on T550 models. Please note, the NTP server must be rebooted after any network configuration changes.

Example: nts net eth0ip 192.168.0.1/24 gw 192.168.0.254

**Command:** nts net eth0ipv6 <ipv6addrA/mask> [<ipv6addrB/mask>] [<ipv6addrC/mask>] [gw <ipv6gateway>]  
nts net eth1ipv6 <ipv6addrA/mask> [<ipv6addrB/mask>] [<ipv6addrC/mask>] [gw <ipv6gateway>]

Set Eth0 or Eth1 IPv6 IP address/mask (up to three) and optional gateway. Eth1 is only available on T550 models. Please note, the NTP server must be rebooted after any network configuration changes.



## 14.6. GNSS Configuration Commands

**Command:**     nts gnss

Show current GNSS module configuration.

**Command:**     nts gnss <constellation>

Configure the GNSS module to receive specific constellations (T550 models only). Where <constellation> is one of: gps, gps-glonass, gps-galileo, gps-beidou, gps-glonass-qzss, gps-galileo-qzss, gps-beidou-qzss, gps-qzss.

GPS is the US GNSS system, available globally. GLONASS is the Russian GNSS system, available globally. Galileo is the European (EU) GNSS system, available globally. Beidou is the Chinese GNSS system, available globally. QZSS is the Japanese GNSS system, available only in the Asia-Oceania regions.

T100 and T300 models only receive the GPS GNSS system.

Default:           nts gnss gps-glonass     # GPS, GLONASS constellation

Examples:         nts gnss gps-glonass     # Change constellation to GPS and GLONASS.  
                  nts gnss gps               # Change constellation to GPS only.

**Command:**     nts gnss restart

Stop and restart the GNSS reference clock service.

## 14.7. Security Commands

**Command:**     nts security root <enable|disable>

Enable or disable the system root and timetools user accounts. The root and timetools user accounts can only be used from a serial console session. They are intended to be used to allow lost passwords to be recovered.

Warning: Disabling the root and timetools accounts will prevent lost passwords from being recovered. TimeTools does not recommend using this command.

Default:           nts security root enable

**Command:**     nts security savecert [default]

Save uploaded user certificate files 'certificate.crt' and 'certificate.key' to flash. Specifying default will restore original certificate files. The device must be rebooted for any network configuration changes to take effect. Same as ttsavecert command described below.

## 14.8. System Commands

**Command:**     nts system restart

Restart the NTP server. The device must be rebooted for any network configuration changes to take effect. Same as ttrstart command described below.

**Command:**     nts system default

Reset to factory defaults and restart. Same as ttdefault command described below.





**Command:** nts system shutdown

Safely shut down the device. The Linux operating system will safely shut down the device. Power can be removed once the alarm LED is extinguished.

**Command:** nts password "<newpassword>"

Set admin password. TimeTools recommends using only alphanumeric (A-Z, a-z, 0-9) password characters.

Example: nts system password "mynewpassword"

## 14.9. Legacy Commands

Help information on all commands is available using the -help option. eg. 'ttdefault -help'.

Command	Description
ttdefault	Reverted to factory default settings. The system must be restarted for the changes to take effect.
ttifconfig	Configure network settings.  usage: ttifconfig help - display help information..  ttifconfig eth ipv4ipaddress/mask [gateway] - update eth port configuration with ipv4 address, mask and optional default gateway. eg. ttifconfig eth0 192.168.0.3/24 - configure eth0 ipv4 address and mask..  ttifconfig eth1 192.168.0.3/24 192.168.0.1 - configure eth1 ipv4 address, mask and default gateway.
ttsavecert	Save uploaded SSL certificate files to flash.  usage: ttsavecert - save user certificate files 'certificate.crt' and 'certificate.key' to flash. ttsavecert default - revert to default user certificate.  The system must be restarted for the changes to take effect.
ttdefaultpwd	Reset 'admin' password to default (admin).
ttrestart	Reboot the appliance immediately.
ttsetclock	Manually adjust the system time. See section: '14. Adjusting the System Time'  usage: ttsetclock help - display help information. ttsetclock HHMM ddmmYYYY - update system time.  Eg: ttsetclock 1258 28062016 - Set system time to 12:58, 28 June 2016.

## 14.10. Typical Minimum Configuration Requirements

The T-Series is supplied with a default Eth0 IP address and network mask of 192.168.3.222/24. The dual-LAN T550 is supplied with Eth1 configured as a DHCP client.

The typical minimum configuration requirement is to set a new static IP address and network mask with an optional default gateway. The device must then be restarted for network configuration changes to take effect.

```
Example:..      nts net eth0ip 192.168.0.1/24 gw 192.168.0.254
                nts system restart
```

**Please note that IP addresses and network masks are specified using the CIDR notation. The notation is constructed from an IP address, a slash ('/') character, and a decimal number. The decimal number is the count of leading 1 bits in the subnet mask.**

Example: 192.168.0.1/24 specifies an IP address of 192.168.0.1 and a 24 bit network mask, i.e. 255.255.255.0

## 15. NTP Statistics

The NTP service records loop filter statistics and peer statistics in files named `loops.yyyymmdd` and `peers.yyyymmdd`, where `yyymmdd` is the date that the statistics refer to. The files are available in the devices `\tmp\admin\ntpstats` directory. Individual files are stored for 7 days before being discarded.

If required, the files can be downloaded from the device using FTP or SFTP.

File Location: `/tmp/admin/ntpstats`  
File Format: `loops.yyyymmdd`  
`peers.yyyymmdd`  
Days Kept: 7 days

Description:

The `loopstats` file records NTP loop filter statistics. Each update of the local clock outputs a line of the following form to the file generation set named `loopstats`:

```
50935 75440.031 0.000006019 13.778190 0.000351733 0.0133806
```

The first two fields show the date (Modified Julian Day) and time (seconds and fraction past UTC midnight). The next five fields show time offset (seconds), frequency offset (parts per million - PPM), RMS jitter (seconds), Allan deviation (PPM) and clock discipline time constant.

The `peerstats` file records NTP peer (reference clock) information. Each update from a peer outputs a line of the following format to the file generation set named `peerstats`:

day, second, address, status, offset, delay, dispersion, skew (variance)

## 16. Copyright and Permission Notices

### 16.1. Network Time Protocol (NTP) 4.2

```

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Version 3, 29 June 2007

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## 18. Document Amendments

### **T1300-01      21 Jun 2017**

Original document.

### **T1300-02      20 Feb 2019**

Amendments for 1.0.002 firmware.

Added Command Line Interface (CLI) commands.

Added position SNMP trap information for optional mobile operation.

### **T1300-03      03 Sep 2020**

Amendments for 2.0.001 firmware.

Added Command Line Interface (CLI) commands for SNMP v3.

Added Web Interface commands for SNMP v3.

### **T1300-04      03 Nov 2021**

Amendments for 2.0.003 firmware.

Added Command Line Interface (CLI) commands:  
nts system shutdown  
nts ntp panic <enable|disable>  
nts gnss restart

Added SSL Certificate File Format.