

T-Series NTP Network Time Server

19-0221, 19-0218 & 19-0219
Configuration and User Guide

Models Covered: T100, T300, T550

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The latest version of this user guide can be obtained from www.TimeTools.co.uk.



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 www.timetools.co.uk.

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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 and is Galileo ready^{*1}.

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 (3×10^{-6} seconds) UTC (GPS Locked).

Synchronise in excess of 100,000 clients.

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.

^{*1} Hardware ready: a firmware update is required to enable the Galileo constellation.

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	-

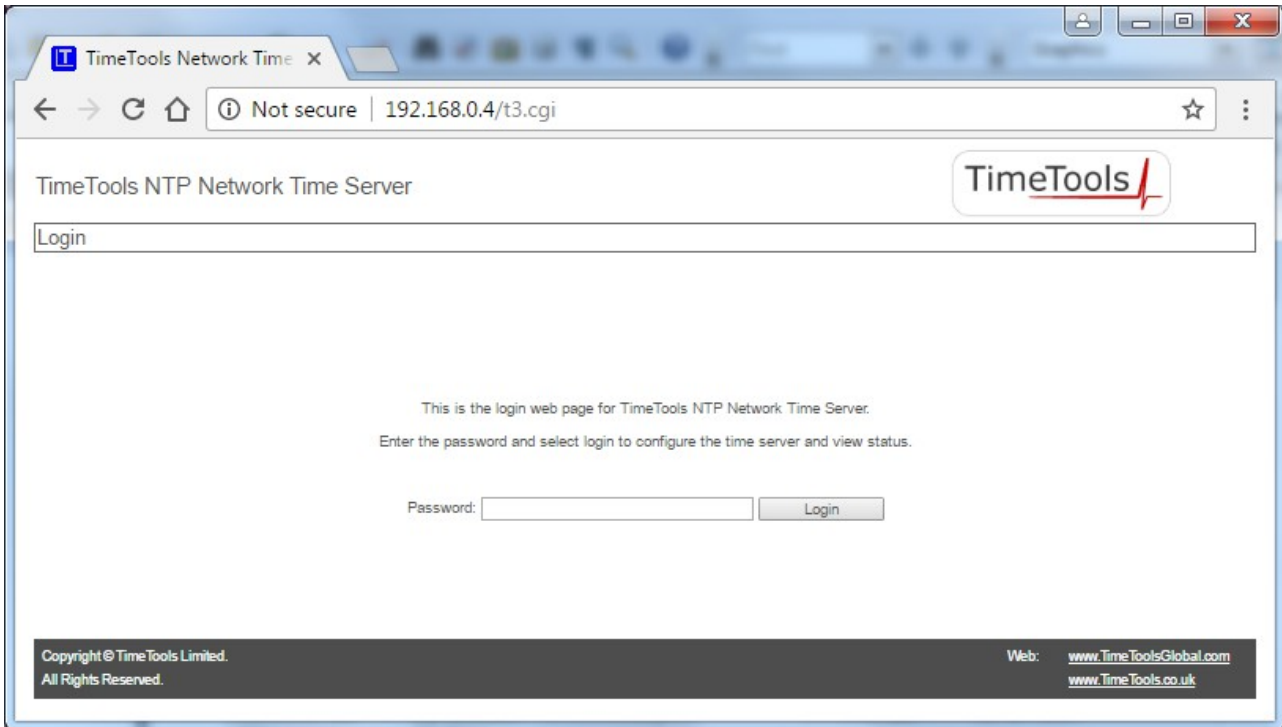
SNMP Configuration

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



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

Status Menu

The screenshot shows a web browser window displaying the 'TimeTools NTP Network Time Server' status page. The page is titled 'TimeTools NTP Network Time Server' and features a navigation menu at the bottom with buttons for Status, Information, Network, NTP, Notification, Security, System, and Logout. The main content area is divided into several sections:

- Status:** A search bar containing the word 'Status'.
- NTP Server Specification:**

Model:	T550	Firmware Build:	Rev. 1.0.001 25-JAN-17
NTP Version:	4.2.8		
- 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:	192.168.0.4
IPv6 Address:	fe80::214:2dff:fe4b:c2b6	IPv6 Address:	fe80::214:2dff:fe5b:c2b6
IPv6 Address A:		IPv6 Address A:	
IPv6 Address B:		IPv6 Address B:	
IPv6 Address C:		IPv6 Address C:	
- Network Time Protocol Status:**

NTP Clock Status:	Ok	NTP Estimated Error:	0.003 msec
Offset:	-0.001 msec	NTP Maximum Error:	3.500 msec
UTC Time:	10:40:30, 13-Apr-2017		
- GPS Synchronisation Status:**

GPS Status:	Ok	GPS Satellites:	13
GPS Position:	[Lat: 52.5276deg Long: -2.2130deg Alt: 155.51m]	GPS Last Sync:	10:39:30 13-04-2017

At the bottom of the page, there is a copyright notice: 'Copyright © Time Tools Limited. All Rights Reserved.' and a website link: 'Web: www.TimeToolsGlobal.com www.TimeTools.co.uk'.

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

IPv6 Address A	Assigned IPv6 Network address of appliance.
IPv6 Address B	Assigned IPv6 Network address of appliance.
IPv6 Address C	Assigned IPv6 Network address of appliance.
NTP Clock Status	The current NTP daemon status – OK / Not Synchronised.
Offset	The offset between the appliances system time and the currently utilised reference clock.
UTC Time	The appliances current system time (UTC).
NTP Estimated Error	Estimated kernel time error.
NTP Maximum Error	Maximum kernel time error.
GPS Status	OK: GPS satellite lock has been achieved and receiver operation is good. No Lock: GPS satellite lock not achieved or lost. This may be due to poor antenna location. Error: Indicates GPS\GNSS receiver error. Check the system log to find exact cause.
GPS Position	GPS positioning information, location and height
GPS Satellites	Satellites currently used in timing calculation.
GPS Last Sync	The last valid time-stamp provided to NTP from the GPS\GNSS reference clock.

7.2. Network Configuration Menu

TimeTools NTP Network Time Server

Network

Network Settings:

Host Name: Domain Name:

Name Server 1: Name Server 2:

Network Services:

HTTPS HTTP FTP SSH/SCP/SFTP

IPv4 Ethernet Configuration:

Ethernet Port 0

IPv4 Address/Mask:
 Default Gateway:
 DHCP:

Ethernet Port 1

IPv4 Address/Mask:
 DHCP:

IPv6 Ethernet Configuration:

Ethernet Port 0

IPv6 Address/Mask A:
 IPv6 Address/Mask B:
 IPv6 Address/Mask C:
 IPv6 Gateway:
 DHCPv6:

Ethernet Port 1

IPv6 Address/Mask A:
 IPv6 Address/Mask B:
 IPv6 Address/Mask C:
 DHCPv6:

Additional Ethernet Configuration:

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

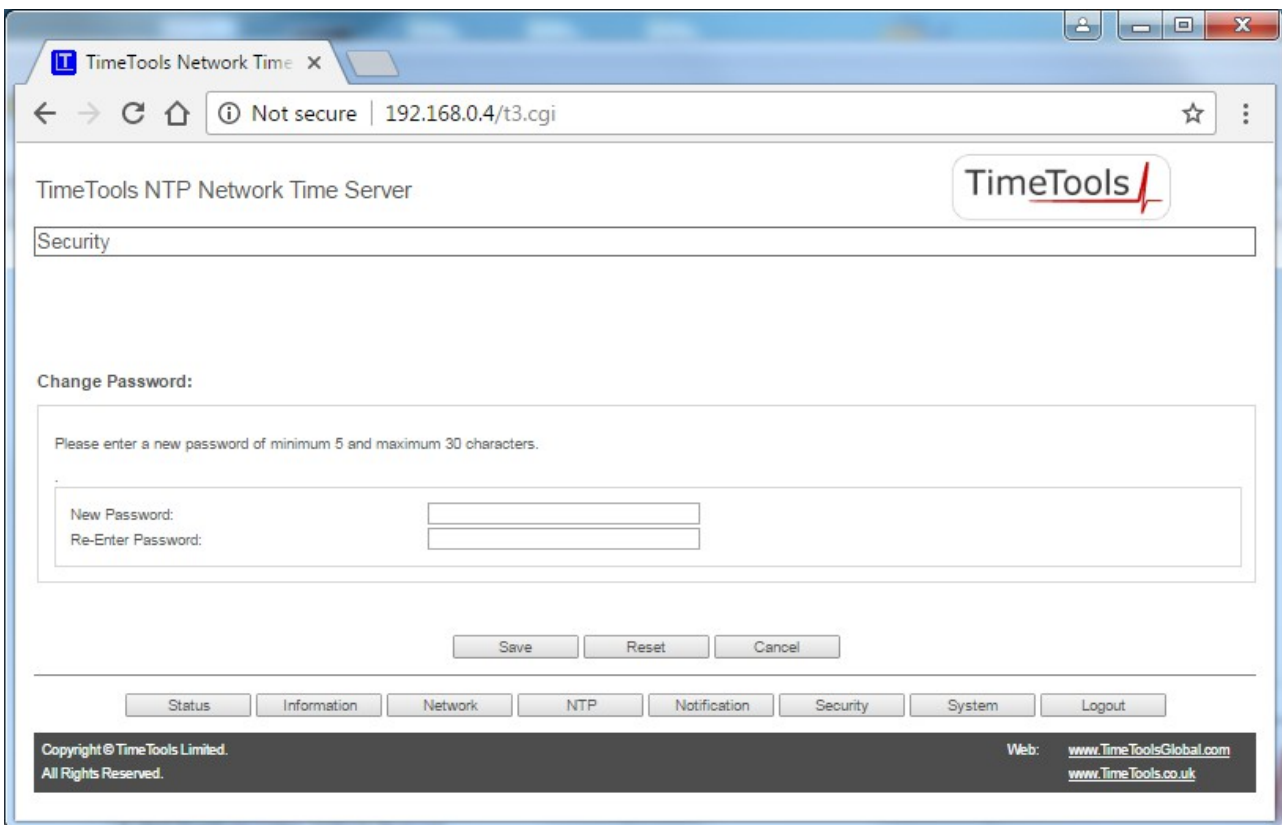
Save Reset Cancel

Status Information Network NTP Notification Security System Logout

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www.TimeTools.co.uk

Hostname	Hostname of time server.
Domain	Network domain name
Name Server 1	IP address of DNS name server 1.
Name Server 2	IP address of DNS name server 2.
Network Services	Shows which network services are currently enabled. HTTPS, HTTP, FTP, SSH/SCP/SFTP
IPv4 Address/Mask	IPv4 Network IP Address and subnet mask of the appliance.
Default Gateway	IPv4 Network default gateway
DHCP	Enable Dynamic Host Configuration Protocol
IPv6 Address/Mask	Additional IPv6 Network IP Addresses and subnet mask of the appliance.
IPv6 Gateway	IPv6 Network default gateway
DHCPv6	Enable DHCPv6 auto-configuration.
Additional Ethernet Configuration	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 title "TimeTools Network Time" and the URL "192.168.0.4/t3.cgi". The page content includes the "TimeTools" logo, a "Security" header, and a "Change Password:" section. The "Change Password:" section contains a message: "Please enter a new password of minimum 5 and maximum 30 characters." Below this message are two input fields: "New Password:" and "Re-Enter Password:". At the bottom of the form are three buttons: "Save", "Reset", and "Cancel". A navigation bar at the bottom of the page contains buttons for "Status", "Information", "Network", "NTP", "Notification", "Security", "System", and "Logout". The footer contains copyright information: "Copyright © TimeTools Limited. All Rights Reserved." and website links: "Web: www.TimeToolsGlobal.com" and "www.TimeTools.co.uk".

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 NTP Network Time Server

NTP

External NTP Servers:

NTP Server Address 1: Authentication Key:
 NTP Server Address 2: Authentication Key:
 NTP Server Address 3: Authentication Key:

NTP Broadcasting:

NTP Broadcast Address: Authentication Key:

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 parameters here.
#
#
```

Save Reset Cancel

Status Information Network NTP Notification Security System Logout

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www.TimeTools.co.uk

External NTP Servers	<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>
NTP Broadcasting	<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>
Trusted Keys	<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>
NTP Keys	<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 the TimeTools NTP Network Time Server web interface. The browser address bar shows the URL `192.168.0.4/t3.cgi`. The page title is "TimeTools NTP Network Time Server". The main content area is titled "Information" and displays a list of NTP log messages. Below the log messages, there are buttons for "NTP Log", "NTP Status", "System Log", "GPS Status", and "Cancel". At the bottom of the interface, there are buttons for "Status", "Information", "Network", "NTP", "Notification", "Security", "System", and "Logout". The footer contains copyright information for TimeTools Limited and website URLs.

```

Apr 13 09:52:25 NTP001 ntpd[256]: Listen normally on 2 lo 127.0.0.1:123
Apr 13 09:52:25 NTP001 ntpd[256]: Listen normally on 3 eth0 192.168.3.222:123
Apr 13 09:52:25 NTP001 ntpd[256]: Listen normally on 4 usb0 192.168.11.1:123
Apr 13 09:52:25 NTP001 ntpd[256]: Listen normally on 5 lo [::1]:123
Apr 13 09:52:25 NTP001 ntpd[256]: Listening on routing socket on fd #22 for interface updates
Apr 13 09:52:25 NTP001 ntpd[256]: SHM(0) 8011 81 mobilize assoc 5757
Apr 13 09:52:25 NTP001 ntpd[256]: 0.0.0.0 c01d 0d kern kernel time sync enabled
Apr 13 09:52:25 NTP001 ntpd[256]: 0.0.0.0 c012 02 freq_set kernel -105.379 PPM
Apr 13 09:52:25 NTP001 ntpd[256]: 0.0.0.0 c016 06 restart
Apr 13 09:52:25 NTP001 ntpd[256]: SHM(0) 802b 8b clock_event clk_no_reply
Apr 13 09:52:26 NTP001 ntpd[256]: Listen normally on 6 eth1 192.168.0.4:123
Apr 13 09:52:26 NTP001 ntpd[256]: bind(24) AF_INET6 fe80::214:2dff:fe4b:c2b6%2#123 flags 0x11 failed: Cannot assign requested address
Apr 13 09:52:26 NTP001 ntpd[256]: unable to create socket on eth0 (7) for fe80::214:2dff:fe4b:c2b6%2#123
Apr 13 09:52:26 NTP001 ntpd[256]: failed to init interface for address fe80::214:2dff:fe4b:c2b6%2
Apr 13 09:52:26 NTP001 ntpd[256]: bind(24) AF_INET6 fe80::214:2dff:fe5b:c2b6%3#123 flags 0x11 failed: Cannot assign requested address
Apr 13 09:52:26 NTP001 ntpd[256]: unable to create socket on eth1 (8) for fe80::214:2dff:fe5b:c2b6%3#123
Apr 13 09:52:26 NTP001 ntpd[256]: failed to init interface for address fe80::214:2dff:fe5b:c2b6%3
Apr 13 09:52:29 NTP001 ntpd[256]: Listen normally on 9 eth0 [fe80::214:2dff:fe4b:c2b6%2]:123
Apr 13 09:52:29 NTP001 ntpd[256]: Listen normally on 10 eth1 [fe80::214:2dff:fe5b:c2b6%3]:123
Apr 13 09:52:30 NTP001 ntp-refclockd[245]: GNSS: TFlags:[03] CrtAlm:[00] MnrAlm:[0208] DcdStat [08].
Apr 13 09:52:30 NTP001 ntp-refclockd[245]: GNSS state change: No signal lock.
Apr 13 09:52:32 NTP001 ntp-refclockd[245]: GNSS: TFlags:[03] CrtAlm:[00] MnrAlm:[0000] DcdStat [08].
Apr 13 09:52:34 NTP001 ntp-refclockd[245]: GNSS: TFlags:[03] CrtAlm:[00] MnrAlm:[0000] DcdStat [00].
Apr 13 09:52:39 NTP001 ntp-refclockd[245]: GNSS state change: Signal lock OK.
Apr 13 09:52:41 NTP001 ntpd[256]: SHM(0) 8034 84 reachable
Apr 13 09:52:41 NTP001 ntpd[256]: SHM(0) 904a 8a sys_peer
Apr 13 09:52:41 NTP001 ntpd[256]: 0.0.0.0 c41c 0c clock_step -0.814143 s
Apr 13 09:52:41 NTP001 ntpd[256]: 0.0.0.0 c415 05 clock_sync
Apr 13 09:52:49 NTP001 ntpd[256]: 0.0.0.0 c418 08 no_sys_peer
Apr 13 09:52:49 NTP001 ntpd[256]: SHM(0) 8054 84 reachable
Apr 13 09:52:49 NTP001 ntpd[256]: SHM(0) 906a 8a sys_peer
Apr 13 10:52:58 NTP001 ntp-refclockd[245]: Start TCXO calibration. [1492080779.893407]

```

7.5.2. NTP Status

TimeTools NTP Network Time Server

Information

remote	refid	st	t	when	poll	reach	delay	offset	jitter
*SHM(0)	.GNSS.	0	1	3	8	377	0.000	0.002	0.004

NTP Log NTP Status System Log GPS Status Cancel

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);

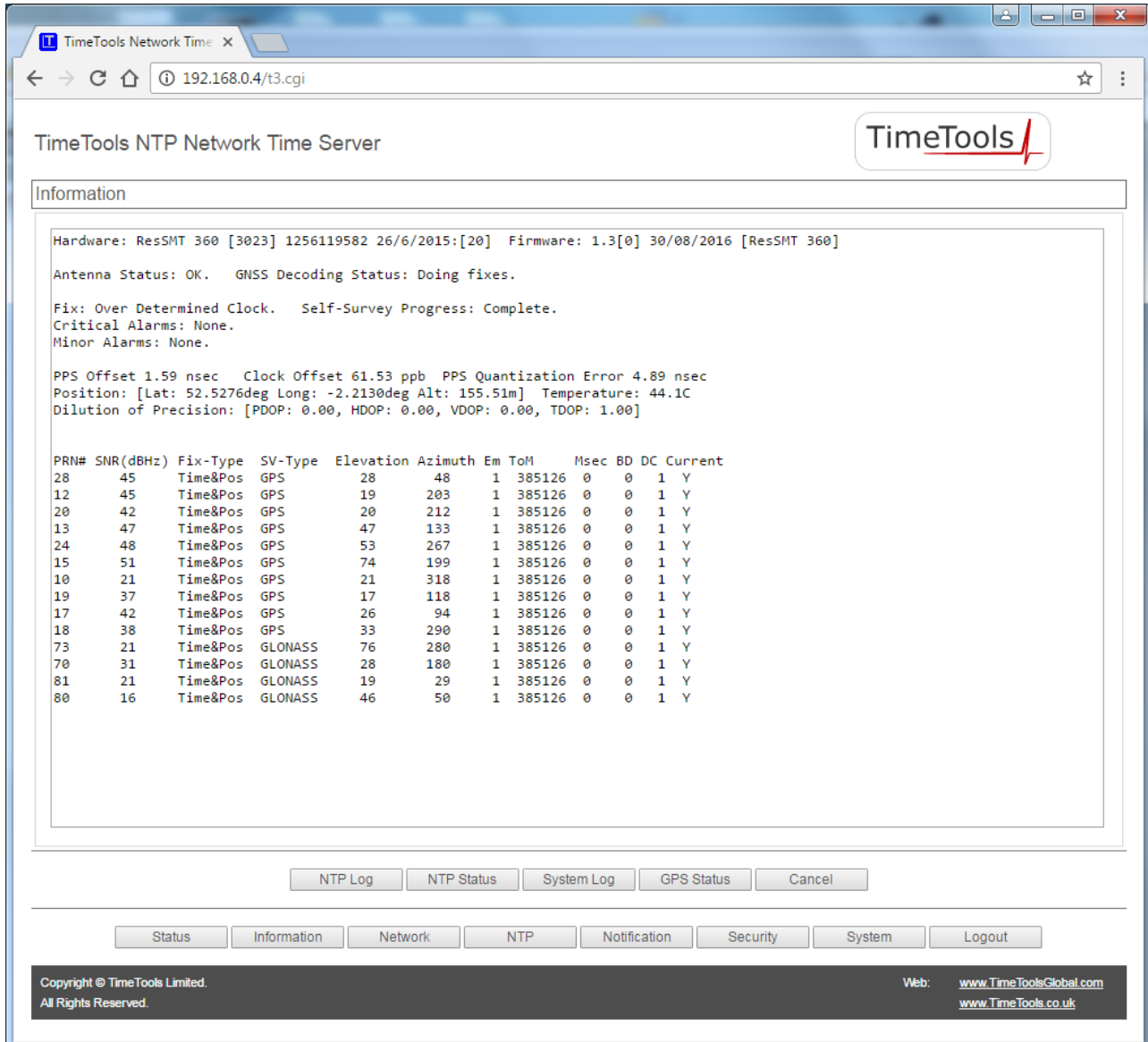
offset – The mean offset in the times reported between the local host and the remote peer in milliseconds.

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

Refer to the NTP Documentation Archive's (doc.ntp.org) 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: 1.3[0] 30/08/2016 [ResSMT 360]
Antenna Status: OK. GNSS Decoding Status: Doing fixes.
Fix: Over Determined Clock. Self-Survey Progress: Complete.
Critical Alarms: None.
Minor Alarms: None.
PPS Offset 1.59 nsec Clock Offset 61.53 ppb PPS Quantization Error 4.89 nsec
Position: [Lat: 52.5276deg Long: -2.2130deg Alt: 155.51m] Temperature: 44.1C
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
28	45	Time&Pos	GPS	28	48	1	385126	0	0	1	Y
12	45	Time&Pos	GPS	19	203	1	385126	0	0	1	Y
20	42	Time&Pos	GPS	20	212	1	385126	0	0	1	Y
13	47	Time&Pos	GPS	47	133	1	385126	0	0	1	Y
24	48	Time&Pos	GPS	53	267	1	385126	0	0	1	Y
15	51	Time&Pos	GPS	74	199	1	385126	0	0	1	Y
10	21	Time&Pos	GPS	21	318	1	385126	0	0	1	Y
19	37	Time&Pos	GPS	17	118	1	385126	0	0	1	Y
17	42	Time&Pos	GPS	26	94	1	385126	0	0	1	Y
18	38	Time&Pos	GPS	33	290	1	385126	0	0	1	Y
73	21	Time&Pos	GLONASS	76	280	1	385126	0	0	1	Y
70	31	Time&Pos	GLONASS	28	180	1	385126	0	0	1	Y
81	21	Time&Pos	GLONASS	19	29	1	385126	0	0	1	Y
80	16	Time&Pos	GLONASS	46	50	1	385126	0	0	1	Y

NTP Log NTP Status System Log GPS 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.
Satellite Information	
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 NTP Network Time Server

Notification

SNMP Traps:

- Disable SNMP Traps
- Enable SNMPv1 Traps
- Enable SNMPv2c Traps

SNMP Configuration:

Community String:

Trap Destination Addresses:

Trap Address 1:

Trap Address 2:

Trap Address 3:

Trap Address 4:

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

Save Reset Cancel

Status Information Network NTP Notification Security System Logout

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

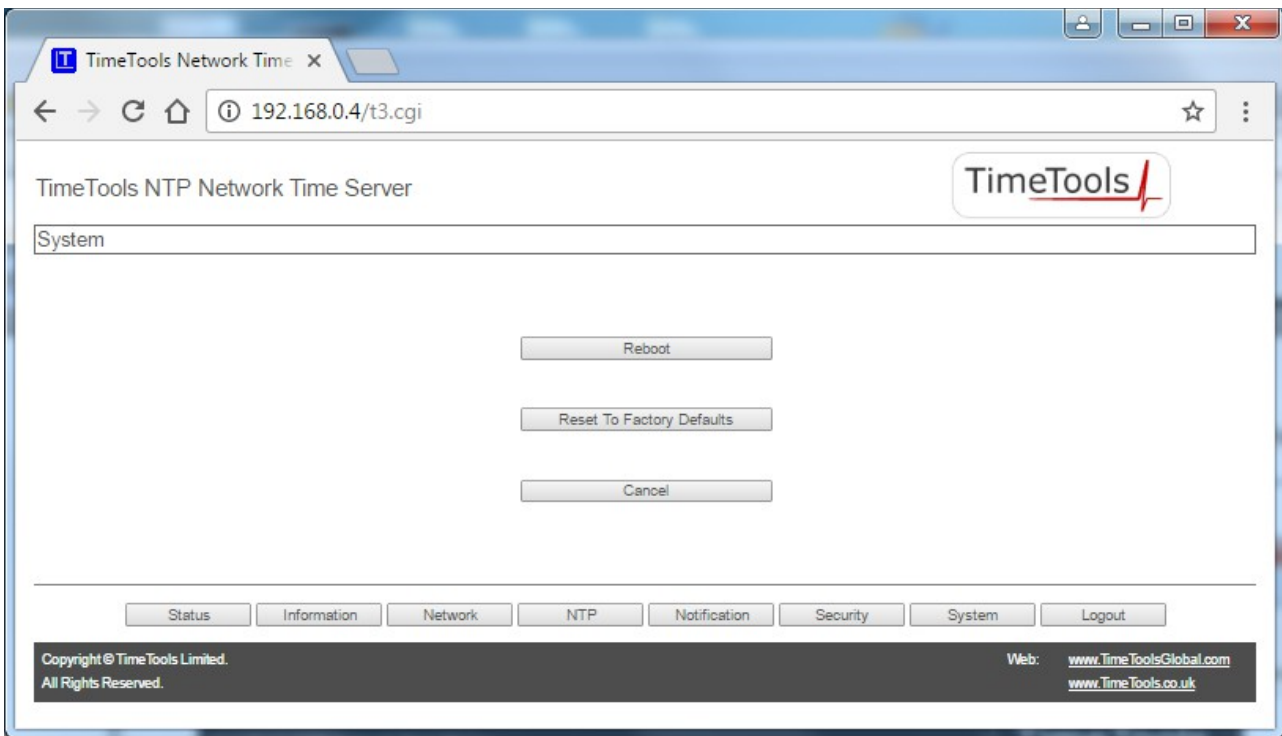
The T-Series supports SNMP v1 and v2c traps. When configured, the T-Series can send SNMP traps to up to 4 separate SNMP management systems, each specified by their IP address. The Management Information Base (MIB) file is available for download from the Notification Configuration Menu page.

The T-Series provides the following traps:

<i>tmtTTrapHeartbeat</i>	<i>tmtTTraps 10</i>	<i>"trap sent periodically to indicate that time server is functioning"</i>
<i>tmtTTrapSystemStart</i>	<i>tmtTTraps 11</i>	<i>"trap sent to indicate that time server has started "</i>
<i>tmtTTrapGpsError</i>	<i>tmtTTraps 20</i>	<i>"trap sent to indicate GPS receiver error"</i>
<i>tmtTTrapGpsNoLock</i>	<i>tmtTTraps 22</i>	<i>"trap sent when GPS receiver has no signal lock"</i>

<i>tmtTTrapGpsLock</i>	<i>tmtTTraps 23</i>	<i>"trap sent when the GPS receiver has regained signal lock"</i>
<i>tmtTTrapNtpNoSync</i>	<i>tmtTTraps 41</i>	<i>"trap sent when NTP is not synchronised"</i>
<i>tmtTTrapNtpSyncOk</i>	<i>tmtTTraps 42</i>	<i>"trap sent when NTP is synchronised"</i>

7.7. System Menu



- 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 'certsave' command available from a console or SSH session to the time server.

Savecert syntax:

savecert - save SSL certificate to flash.

usage: savecert <filename> - save user certificate <filename> to flash.
 savecert -remove - remove user certificate from flash and use default certificate.

The device will need to be restarted for the changes to take effect.

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 daemon and the reference clock daemon 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 daemon:

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 daemon.

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 daemon 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).

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.

15. NTP Statistics

The NTP daemon 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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*
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```

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Version 2, June 1991

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