TimeTools

SR / SC Series
Network Time Protocol Server

USER GUIDE

Models Covered:

SR9850	
SR9750	SC9705
SR9210	SC9205
SR7110	SC7105

Firmware Revision 1.0.005.

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

Date: **March 2011**
Version: **1.0.006**

TimeTools Limited.
Unit 34, Wombourne Enterprise Park,
Bridgnorth Road, Wombourne,
South Staffordshire.
WV5 0AL
UK

Tel: **+44 (0) 1902 897400**
Fax: +44 (0) 870 123 1844
Email: **Info@TimeTools.co.uk**
Web: **www.TimeTools.co.uk**

1. Table of Contents

Note:

While reasonable efforts have been taken in the preparation of this document to ensure its accuracy, TimeTools Limited assumes no liability resulting from any errors or omissions in this manual, or from the use of the information contained herein.

All claims based on information publicly available at time of printing.

All product or service names mentioned in this document are trademarks of the companies with which they are associated.

Important Note:

For PLUGGABLE EQUIPMENT, the socket outlet shall be installed near the equipment and shall be easily accessible.

2. 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 SR Series NTP Servers provide a stratum 1 NTP Time Server for ensuring the time is correct across an entire network.

The SR Series Network Time Server acquires time from the MSF or DCF-77 Radio Signals or GPS satellite constellation and distributes time across a network using the TCP/IP Network Time Protocol (NTP).

Network managers appreciate the fact that the SR\SC Series is a complete time server housed in a self-contained rack-mountable unit (SR series) or compact enclosure (SC Series).

Cost savings are achieved by the simple configuration and installation compared to configuring a conventional workstation as a time-server. Savings continue with the elimination of software upgrade costs and network synchronization management.

2.1. Key Features

- Stand-alone dedicated Stratum 1 NTP Time Server.
- Robust 1U high, rack-mountable enclosure (SR) or compact enclosure (SC).
- Linux based, fully static design, **no unreliable hard disk drives.**
- Convenient front panel display, detailing time, and signal integrity (SR series).
- 10/100 Base-T Ethernet connectivity.
- Can accurately synchronise the time on any NTP or SNTP compatible client including: Windows 95,98, ME, NT, 2000, XP, Novell 5 & 6, UNIX and CISCO Routers and Hubs.
- Web, Telnet, FTP and RS232 remote configuration.
- Secure HTTPS and SSH remote configuration (SR9xxx\SC9xxx models).
- SNMP v1/v2c trap notifications of error conditions (SR9xxx\SC9xxx models).

2.2. Key Benefits

- Highly reliable and secure source of time for your Network.
- Easy to install, configure and maintain.
- Accurately synchronize mission critical network operations and applications across thousands of network clients.
- Secure source of time inside your firewall.

3. Network Time Protocol (NTP)

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. 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 the load. However, in practice, on small 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.

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.

The protocol 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.

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.

A number of external time references are available that can be used as a 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. There are also a number of national radio time and frequency broadcasts available: WWVB in the US, MSF in the UK and DCF-77 in Germany. These broadcasts provide an accurate source of time within, and local to, national boundaries.

4. NTP SR\SC Series Hardware

The SR\SC Series is complete NTP time server housed in a 1U high rack-mountable enclosure. It has a 40 character by 2 line backlit LCD display for status and configuration information. The rear of the unit has 5 connections: RJ45 LAN, GPS antenna, LF/aux port, console and IEC power inlet.

4.1. Power

Integrated Universal 100-240 VAC, 50-60 Hz CE/UL/CSA Approved PSU
Standard double fused, switched, IEC inlet.
Power consumption: approx 5W

4.2. Console

RS232 9-Way 'D' Type connection for status and configuration via dumb terminal emulator (Windows Hyper-terminal).
Terminal settings: 9600 Bits/Sec, No Parity, 8 Data Bits, 1 Stop Bit.

4.3. GPS and LF Antenna Connection

LF: MSF-60 \ DCF-77 Radio Antenna. RS232 9 Way 'D' type connection.
GPS: TNC connection for 5 Volt GPS antenna

4.4. Ethernet Network

10/100 BaseT RJ45 Auto sensing

Front Panel (SR Series)

SR Series Front Panel

Forty character by two line high-contrast blue backlit LCD display. Showing current UTC time and date, current offset to external reference clock, synchronisation status, GPS status and number of satellites used, LF radio signal quality and last successful decode.

4.5. Rear Panel

SR Series Rear Panel

SC Series Rear Panel

4.6. Rear Panel Connectors

IEC Switched Mains Inlet	Double Fused, Switched, IEC mains inlet, 100-240VAC, 50-60Hz 0.1A, Fuse: 2x T 0.315A LBC 250V
TNC GPS Antenna Connection	50 ohm TNC female connector to 5 volt GPS antenna. There should be 5V between the centre pin and outer barrel of the connector, which should be present all the way up to the GPS antenna. If 5 volts is not present at the antenna coax connector, it generally indicates a break in the cable. Any break in the cable is generally where the RF connectors are joined to the coax.
LF/AUX Input	9-way D-type female. Pin 3: RS232 level NMEA GPS output Pin 5: GND Also accepts MSF \ DCF-77 LF radio antenna. (SR-MXS-00, SR-DXS-00)
LAN	10/100 Mbit BaseT RJ45 Auto sensing
CONSOLE	9-way D-type female. RS232 Serial Console connection for device configuration using dumb terminal emulator (eg. Hyperterminal). Null modem cable supplied for connection to standard 9-way PC serial interface supplied.

4.7. Rear Panel Status LED's

LF LED (Yellow)	Pulses in-tune to the MSF or DCF-77 LF radio time code broadcast when a LF radio antenna is connected (SR-MXS-00, SR-DXS-00). When a good radio signal is being received, the LED should provide a steady, regular, one-pulse-per-second flash. If the LED flashes erratically or is completed on or off, it indicates that a weak signal is being received. In this instance the radio antenna may need to be repositioned or relocated. Pulse width: 100ms\200ms\300ms.
PWR LED (Red)	Mains power has been applied to the device.
GPS LED(Yellow)	Pulses one-pulse-per-second when a GPS lock has been achieved. This pulse is used as a highly accurate reference for synchronisation. Pulse width: 50msec.
GPS Antenna LED (Red)	The red LED next to the GPS antenna connection, when illuminated, indicates that there is a cable fault to the GPS antenna. The LED is illuminated when there is a short-circuit between in the inner-core and outer-sheath of the coax cable to the antenna. The coax cable should be examined for faults.

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 or LF radio external time reference, however, you can also configure the NTP server to synchronise to other 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 or LF radio. These external hardware time references can be considered to be stratum 0 references – 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 an external hardware reference clock, such as a GPS or radio time reference.

5.2. Loss of Hardware Clock Synchronisation, TCXO Models (SR9750, SR9850, SC9705)

In the event that GPS or LF radio 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 after a further 9 hours and the device will enter an unsynchronised state.

5.3. Loss of Hardware Clock Synchronisation, Non-TCXO Models (SR7110, SR9210, SC7105, SC9205)

In the event that GPS or LF radio 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 further 9 hours and the device will enter an unsynchronised state.

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

Many Internet based NTP servers will not allow peering. Therefore, if you want 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. ie. If the synchronisation server is stratum 2, the device will become stratum 3. The NTP server will only revert to stratum 1 operation when the primary synchronisation reference (GPS or LF radio) comes back on line.

5.6. Local Clock

The SR series has an internal battery-backed real-time clock (local clock) that NTP synchronises using the configured reference clocks. The local clock can also be used as an NTP reference clock itself, if other sources of time fail.

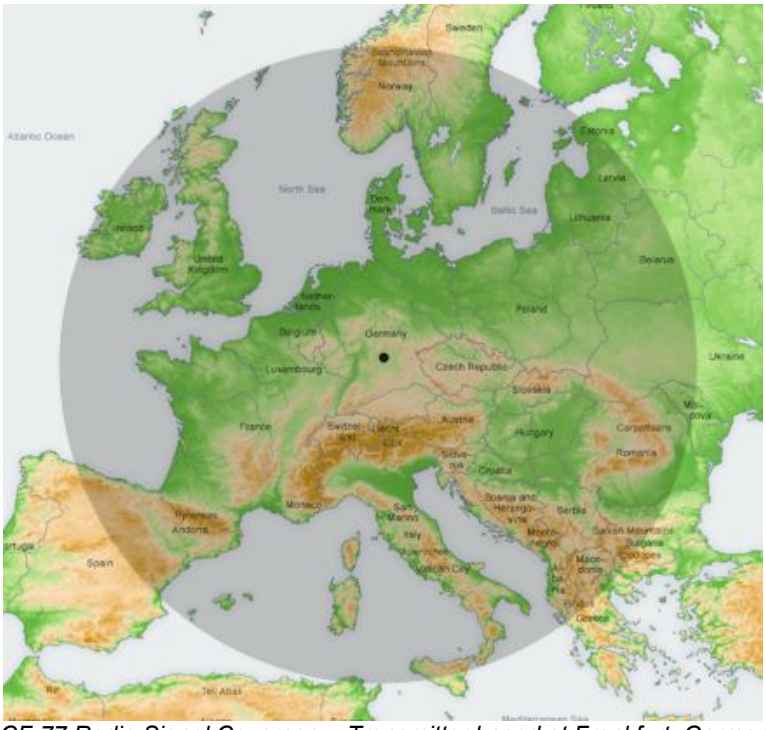
The local system clock stratum specifies the stratum level of the local system clock that is used as backup in the event of primary reference clock loss or failure. Setting the local system clock stratum to 16 (default) disables this feature.
Warning – the local system clock is unsynchronised and is prone to drift. It should, therefore, only be used if synchronisation of clients to the NTP server is required regardless of the accuracy of the NTP server's time.

5.7. Typical Synchronisation Hierarchy

Higher Stratum	GPS LF radio TCXO (SR9750, SR9850, SC9705 models only) Other Peered Stratum 1 NTP Servers
	Lower Stratum External NTP Servers
Lower Stratum	Local Clock

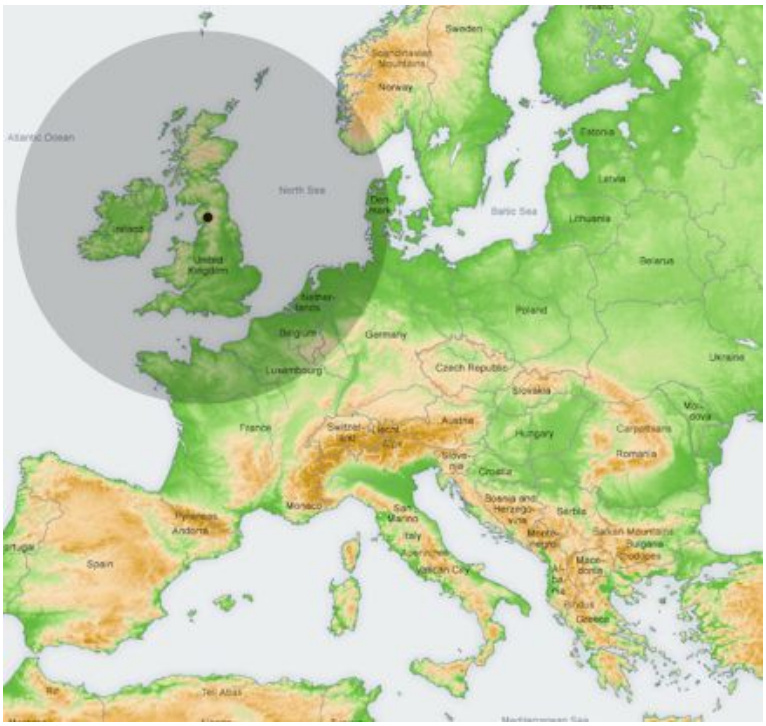
6. LF Radio Transmitter Coverage

The SR\SC Series NTP Server can be supplied with either DCF-77 or MSF radio antennas. The DCF-77 transmitter is located at Frankfurt, Germany. The coverage of the DCF-77 transmitter is Central and North-Western Europe.



DCF-77 Radio Signal Coverage – Transmitter based at Frankfurt, Germany

The MSF transmitter is located at Anthorn, Cumbria, UK. The coverage of the MSF transmitter is the whole of the British Isles and can often be received in much of North Western Europe.



MSF Radio Signal Coverage – Transmitter based at Anthorne, Cumbria, UK

7. MSF \ DCF-77 Radio Antenna Installation

The SR\SC Series NTP Server can be supplied with either MSF or DCF-77 radio antennas.

7.1. LF Radio Antennas

Four versions of LF radio antenna are available with the SR Series NTP Server.

MLS - TimeTools Standard MSF radio antenna.
DLS - TimeTools Standard DCF-77 radio antenna.
MXS - TimeTools High Gain MSF radio antenna for weak signal strength areas.
DXS - TimeTools High Gain DCF-77 radio antenna for weak signal strength areas.

The antenna needs to be mounted above ground away from any sources of electrical interference. Metal structures can act as a Faraday cage blocking signal penetration. Therefore, the antenna must be located externally of any metal structures.

The SR series NTP server display provides a real-time signal strength indicator. This should read a steady 100%, any less indicates loss of timing information. Also displayed is the last decoded time reception, which should increment each minute as time broadcasts are received.

7.2. MLS \ DLS Antenna Installation

The MLS\DLS LF antenna is a unidirectional active ferrite antenna. The antenna should be installed in a horizontal plane at right angles to the source of the radio transmission. The antenna incorporates a red\green LED which flashes in tune to the LF radio transmission. Ideally, the antenna needs to be located where a consistent red\green flash can be observed once per second. If the antenna LED flashes erratically or if the LED is completely red or green, the antenna may need to be relocated.

The antenna can be located up to 100m from the time server using CAT3 or better patch lead or structured cabling.

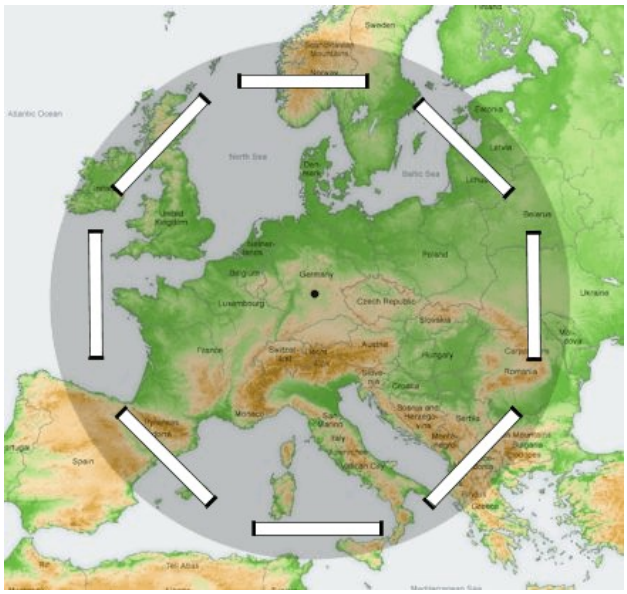
Fig: MLS \ DLS LF Radio Antenna

7.3. MXS \ DXS Antenna Installation

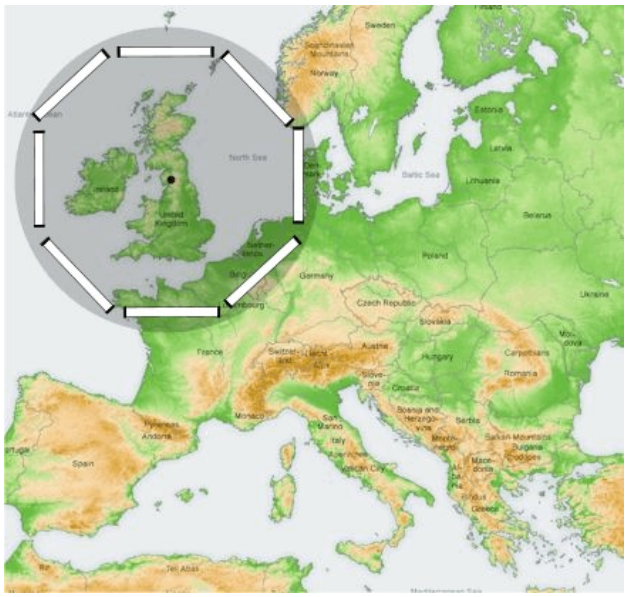
The MXS\DXS LF antenna is a unidirectional high-gain active ferrite antenna ideal for low signal strength areas. The antenna should be installed in a horizontal plane at right angles to the source of the radio transmission. The antenna incorporates a red\green LED which flashes in tune to the LF radio transmission. Ideally, the antenna needs to be located where a consistent red\green flash can be observed once per second. If the antenna LED flashes erratically or if the LED is completely red or green, the antenna may need to be relocated.

The antenna is provided with 5m of cable which can be extended up to 100m using RG58 coax.

Fig: MXS \ DXS High Gain LF Radio Antenna



The DCF-77 LF radio antenna should be installed in a horizontal plane at right-angles to the source of the radio transmitter located at Frankfurt, Germany.



The MSF LF radio antenna should be installed in a horizontal plane at right-angles to the source of the radio transmitter located at Anthorne, Cumbria, UK.

8. GPS Antenna Installation

The SR Series NTP Server has an integrated GPS receiver. An optional external antenna provides synchronisation with the global positioning system. GPS solutions can be utilised anywhere in the world.

The optional GPS antenna is a high-gain, jam-resistant, pole mounting GPS antenna,

For correct operation, the GPS antenna needs to have an un-obscured view of the sky. As a rule of thumb, the better the view of the sky, the more chance of a good consistent signal lock. Ideally, the antenna should be roof mounted with a 360-degree view of the sky. However, satisfactory operation can often be achieved by sitting the antenna on the side of a building or on a widow sill.

8.1. Typical Maximum GPS Cable Length (TWS3978 GPS Antenna)

Cable Type	Max Cable Distance	Max Cable Distance with Single GPS Amplifier
RG58	30m	-
LMR195	50m	100m
LMR200	60m	110m
LMR240	80m	140m
LMR400	150m	260m
LMR600	230m	400m

8.2. SRxxxx-10 and SCxxxx-10 High Sensitivity GPS Receiver

Later SR and SC series NTP servers with model postfix 10 and later are fitted with a high sensitivity GPS receiver with over-determined clock. The high sensitivity mode often allows the GPS antenna to be located indoors or in a window, considerably reducing installation costs and eliminating the need for surge suppression. The over-determined clock mode allows the receiver to operate from a single-satellite-in-view which allows the receiver to obtain a signal lock in highly challenging conditions.

In high sensitivity mode if the initial search for satellites fails to find a strong GPS signal, the receiver enters deep search mode and the time-to-first fix may take longer than normal. If during this period, the receiver is moved into bright signal conditions, the time-to-first fix may also take longer.

8.3. GPS Amplifier

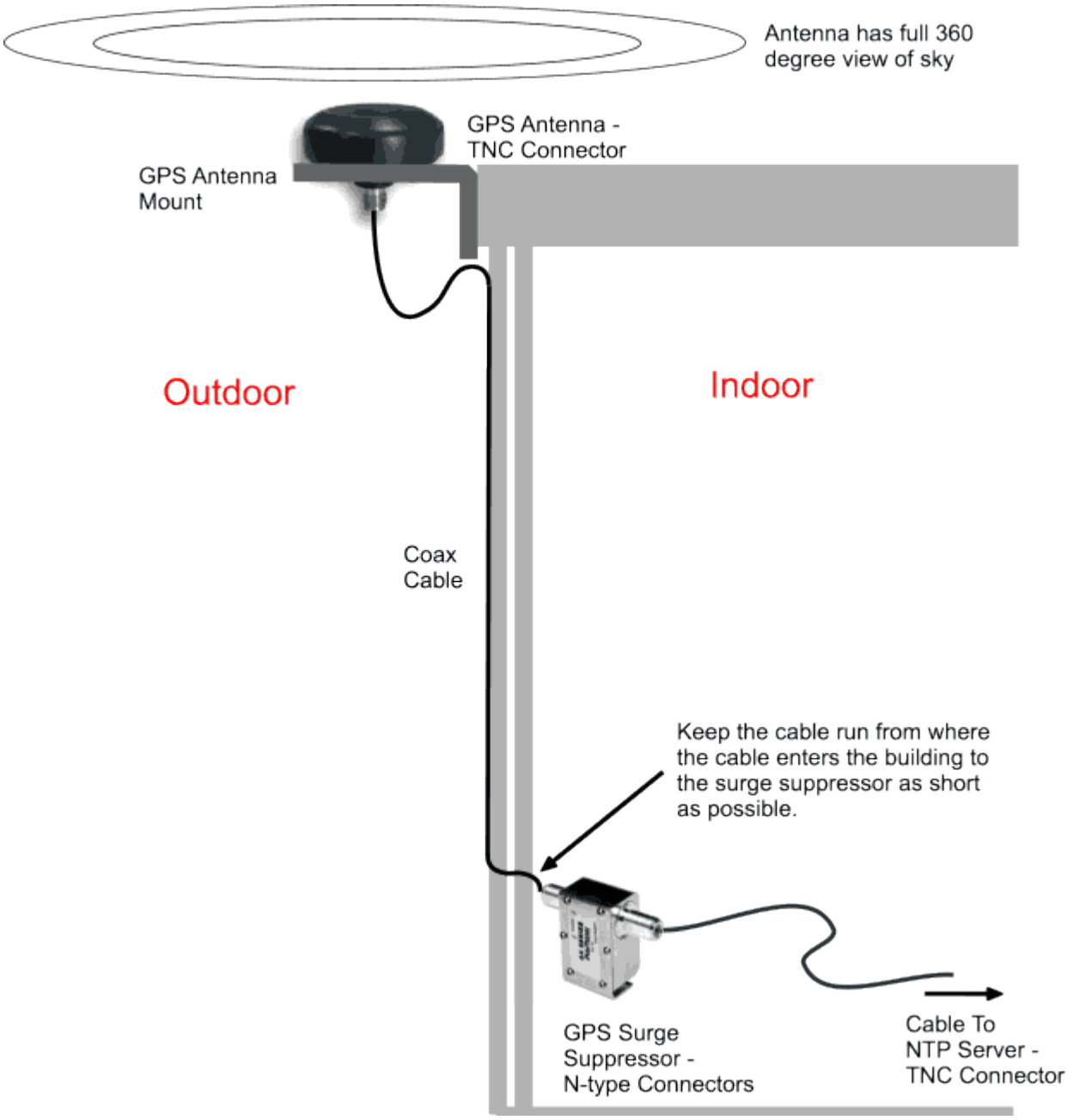
Single or multiple GPS in line amplifiers may be installed to significantly increase cable runs, if required (product code: T-AD200-8). GPS amplifiers should be placed in-line on the coax cable at the mid-point between the GPS antenna and receiver.

8.4. Surge Suppressors

Externally mounted GPS antennas can be prone to lightning strikes and other electrical surges. TimeTools recommends fitting surge suppressors (product code: SPP-GPS) to all externally mounted GPS antennas. The suppressor should be fitted where the GPS coax cable from the antenna enters the building. The surge suppressor requires a connection to a low-impedance ground. For more information about installing surge suppressors please visit the PolyPhaser web site at: www.polyphaser.com.

8.5. GPS Time Acquisition

On power-up the GPS receiver will “search the sky” in order to collect satellite orbital information. This process is fully automatic and, under normal circumstances, will take 3-4 minutes to achieve a signal lock. However, it can take much longer in challenging reception areas.



Typical GPS Antenna installation

9. SR Series Configuration

The SR Series can be configured in a number of ways:

- Web (HTTP) page via network.
- Via RS232 Console Port to host computer.
- Telnet session via network.
- Secure Web (HTTPS) page via network (SR9xxx\SC9xxx only).
- Secure SSH \ SCP (SR9xxx\SC9xxx only).

9.1. Default Configuration

Security

Console, Telnet, FTP username	admin
Console, Telnet, FTP password	admin
HTTP Web Password	admin

Network Configuration

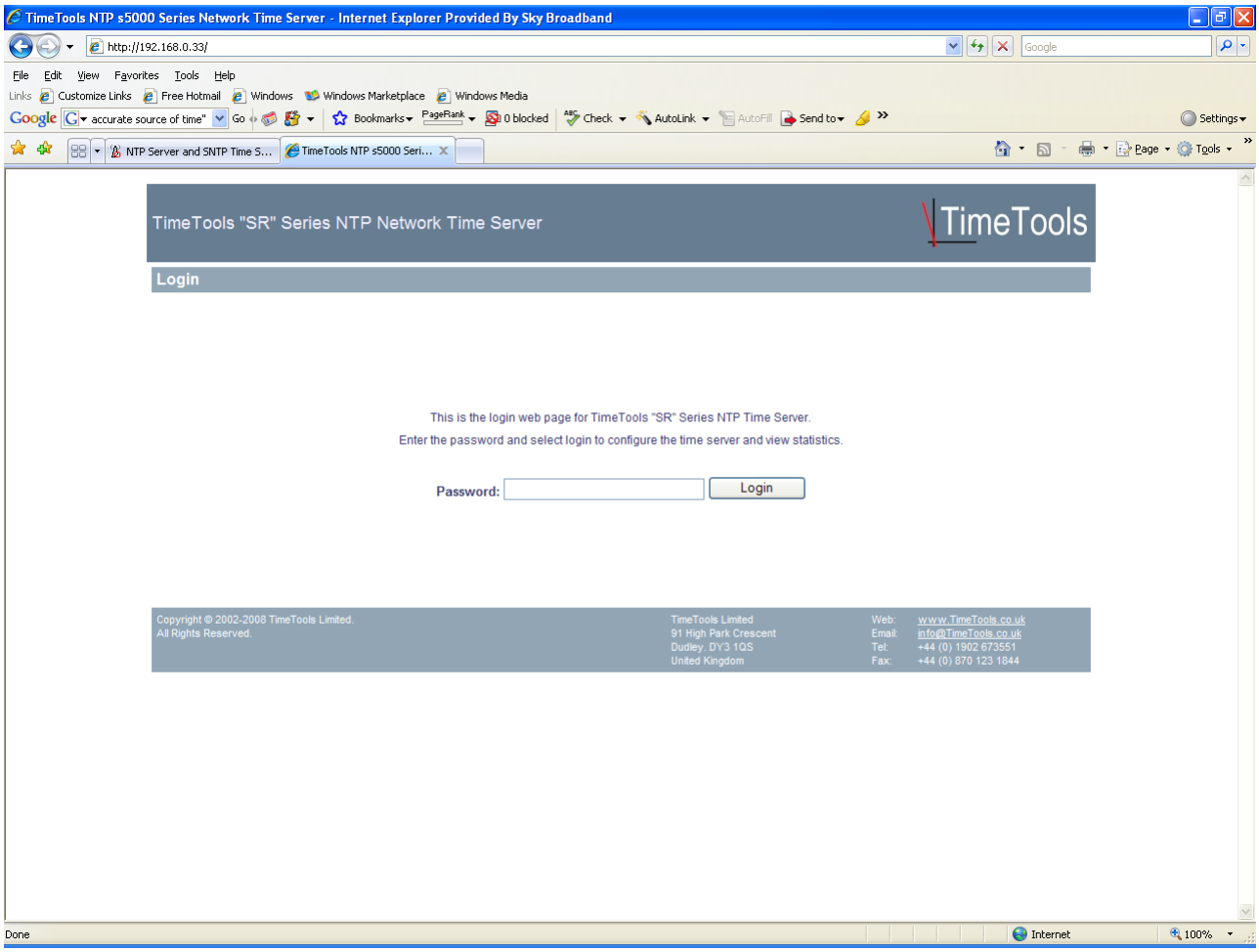
Host Name	NTP001
Domain Name	-
Name Server 1	-
Name Server 2	-
Syslog Server	-
Network Services	HTTP: Enabled, HTTPS: Disabled, Telnet: Enabled, SSH: Disabled, FTP: Enabled.
DHCP	Enabled
IP Address	-
Network Mask	-
Default Gateway	-

NTP Configuration

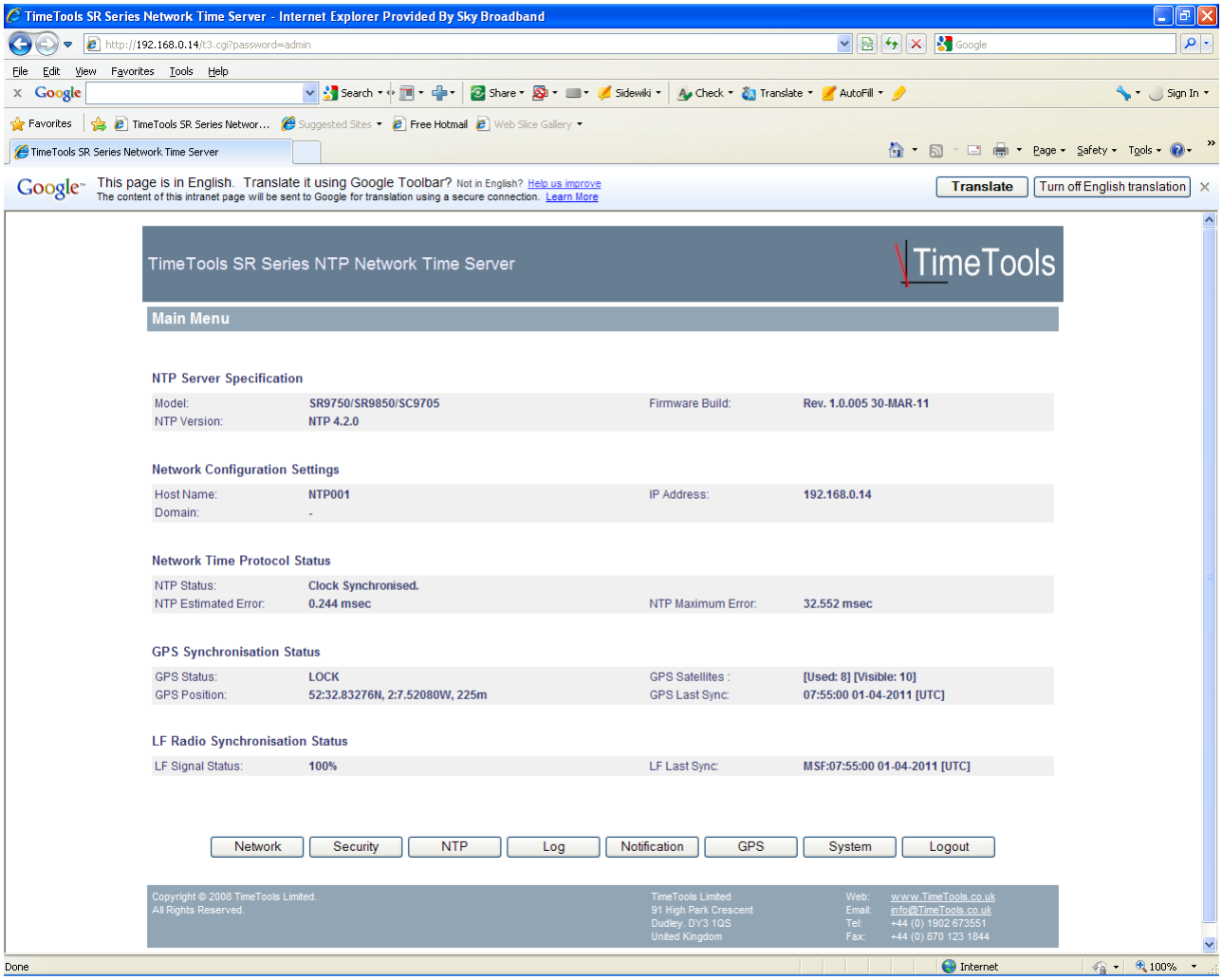
External NTP Server Address 1	-
Key	-
External NTP Server Address 2	-
Key	-
External NTP Server Address 3	-
Key	-
NTP Broadcast Address	-
Key	-
Local System Clock Stratum	16
Trusted Keys	-
NTP Keys	-

10. 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, eg http://192.168.0.4. The user will then be greeted by the login screen. A secure web connection (HTTPS) can also be used, if the HTTPS protocol is enabled (SR9xxx,SC9xxxx models only).



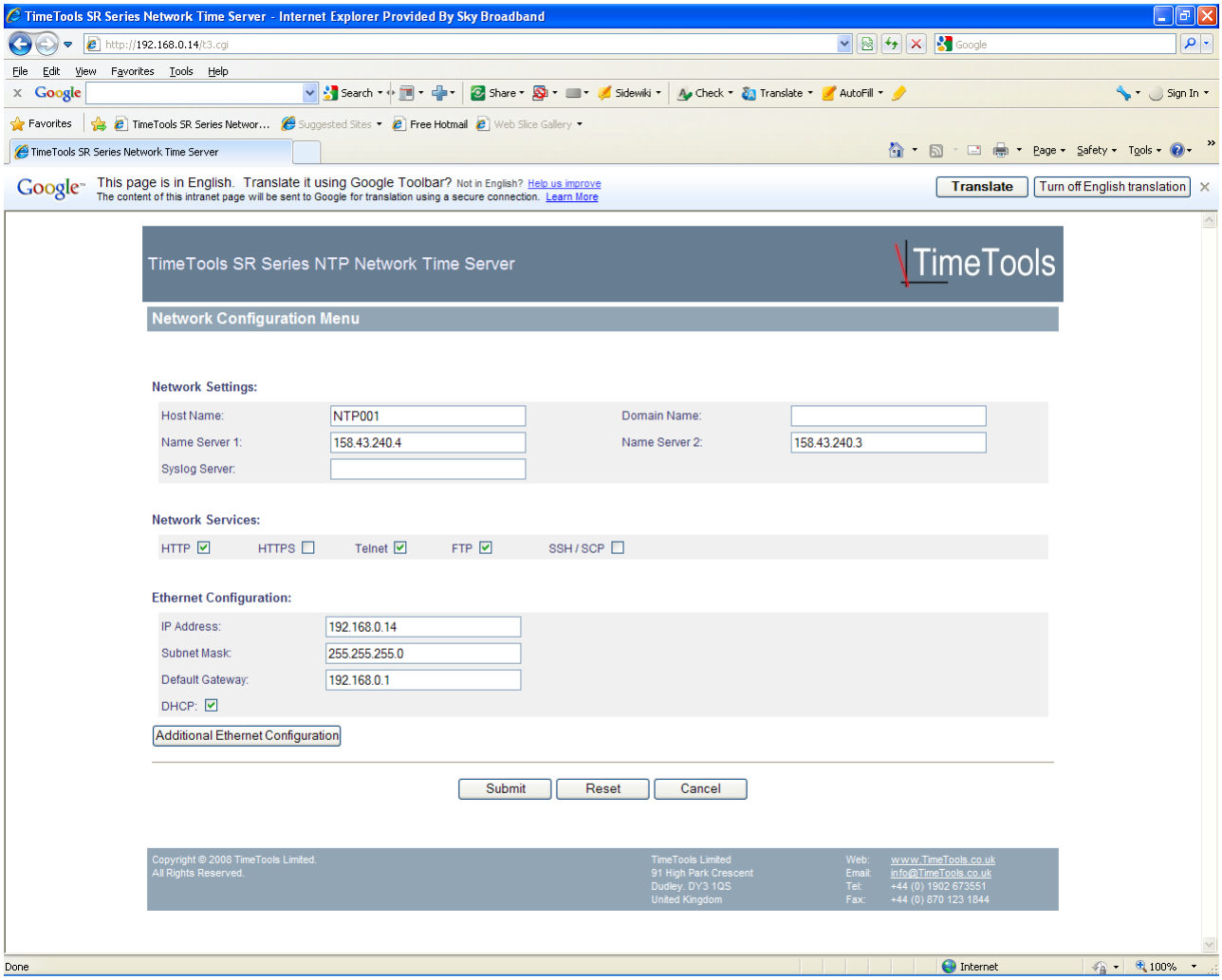
Configuration Menu



Model	NTP Server model.
Build	Describes the firmware build revision number and firmware build date.
NTP Version	Network Time Protocol version number currently installed.
Hostname	Hostname of time server.
Domain	Network domain name
IP Address	Network IP address of time server.
NTP Status	Clock Synchronised / Clock Not Synchronised
NTP Estimated Error	Estimated kernel time error
NTP Maximum Error	Maximum kernel time error
GPS Status	Lock: GPS satellite lock has been achieved and receiver operation OK. No Lock: GPS satellite lock not acheived or lost. This may be due to poor antenna location. No Comm: Indicates no communication with GPS receiver, probable receiver fault

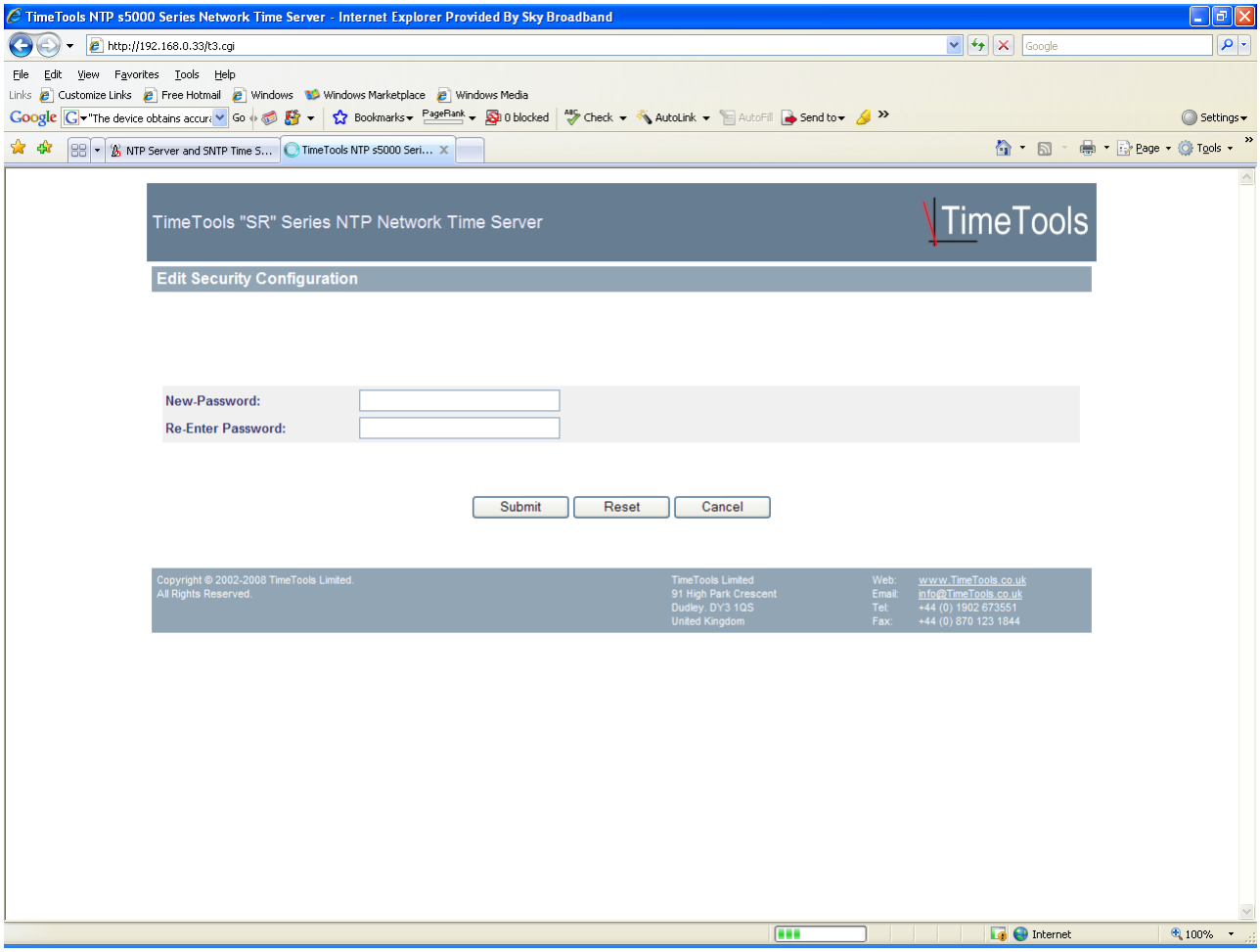
GPS Postion	GPS positioning information, location and height
GPS Satellites	Satellites used in last timing calculation and number of visible satellites
LF Signal Status	MSF \ DCF-77 radio antenna (if fitted) signal strength indicator (0%-100%). For good signal reception and decoding a consistant 100% signal strength is required of an extended period of time. NOSIG Indicates either no radio antenna detected, antenna fault or complete lack of signal reception
LF Last Sync	Last Sync Shows the last successfully decoded time from the MSF \ DCF-77 (if fitted) radio antenna. A radio time stamp is broadcast once every minute.

10.1. Network Configuration Menu



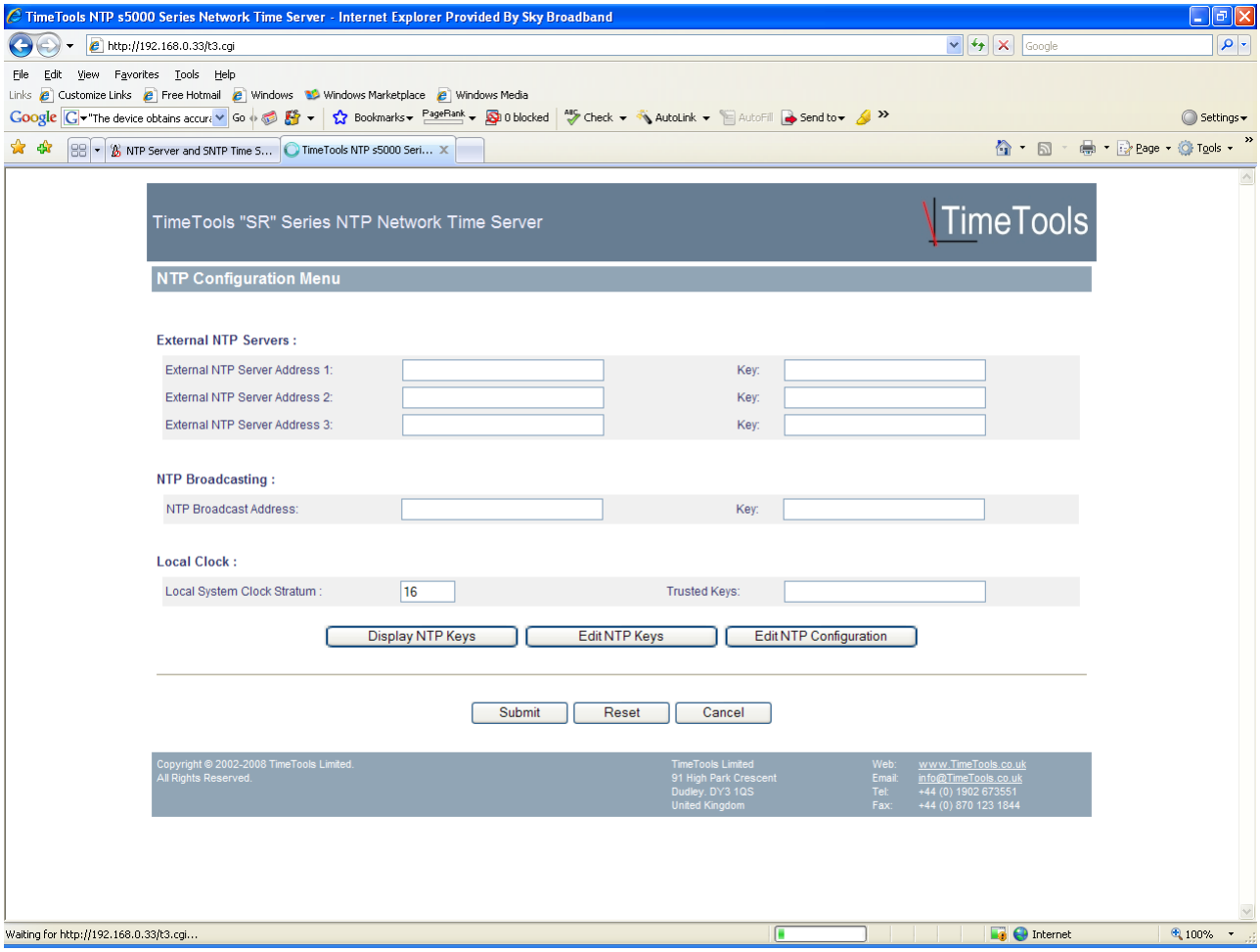
Hostname	Hostname of time server.
Domain	Network domain name
Name Server 1	IP address of DNS name server 1.
Name Server 2	IP address of DNS name server 2.
Syslog Server 1	Optional IP address for remote system log (syslog) messages
Network Services	Shows which network services are currently enabled. For added security any or all network services can be disabled. (HTTPS, SSH/SCP are not available on SR7110 and SC7105 models)
IP Address	Network IP Address of the time server
Subnet Mask	Network mask
Default Gateway	Network default gateway
DHCP	Enable Dynamic Host Configuration Protocol
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 here.

10.2. Security Configuration



The security configuration web page allows the default web, telnet and ftp passwords to be modified. (Default ‘admin’).

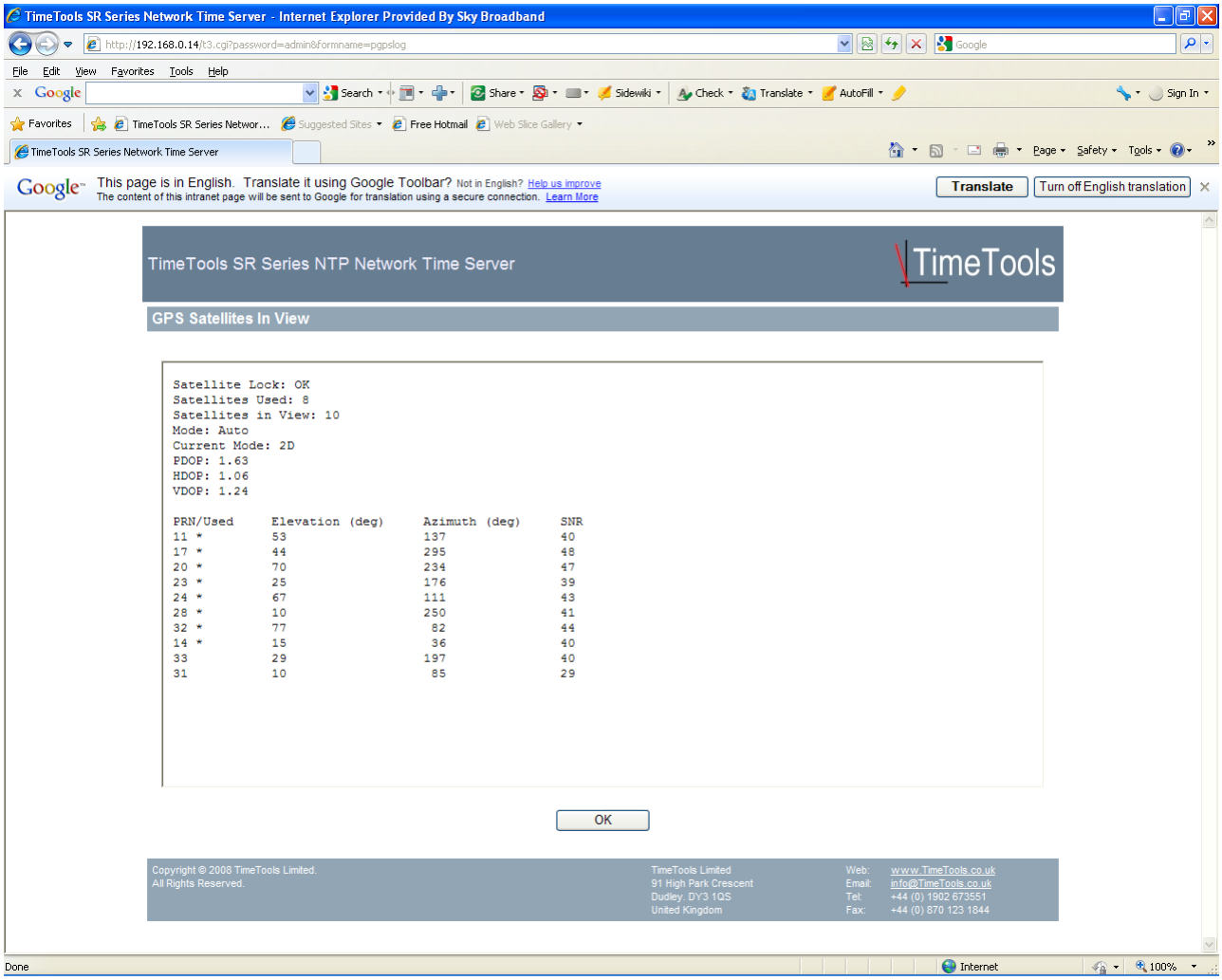
10.3. NTP Configuration Menu



External NTP Servers	Upto three external NTP servers can be peered with the time server to provide backup in the event of primary time source loss or failure. 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.
NTP Broadcasting	In broadcast mode the local server sends periodic broadcast messages to a client population at the *address* 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 nonconflicting 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
Local System Clock Stratum	The local system clock stratum specifies the stratum level of the local system clock that is used as backup in the event of primary reference clock loss or failure. Setting the local system clock stratum to 16 (default) disables this feature. Warning – the local system clock is unsynchronised and is prone to drift. It should, therefore, only be used if synchronisation of clients to the NTP server is required regardless of the accuracy of the NTP server's time.
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 `ntpdc`

	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.
NTP Keys	Contains key identifiers and keys controlling authentication of Network Time Protocol (NTP) transactions.

10.4. GPS Satellites in View



The GPS satellites in view page provides detailed information on the status of the GPS receiver and the satellites in view. This page is only applicable to systems that have a GPS antenna fitted. The information provided can be very useful to find the optimum location for a GPS antenna and also to provide signal reception levels for existing installations.

GPS Receiver Information

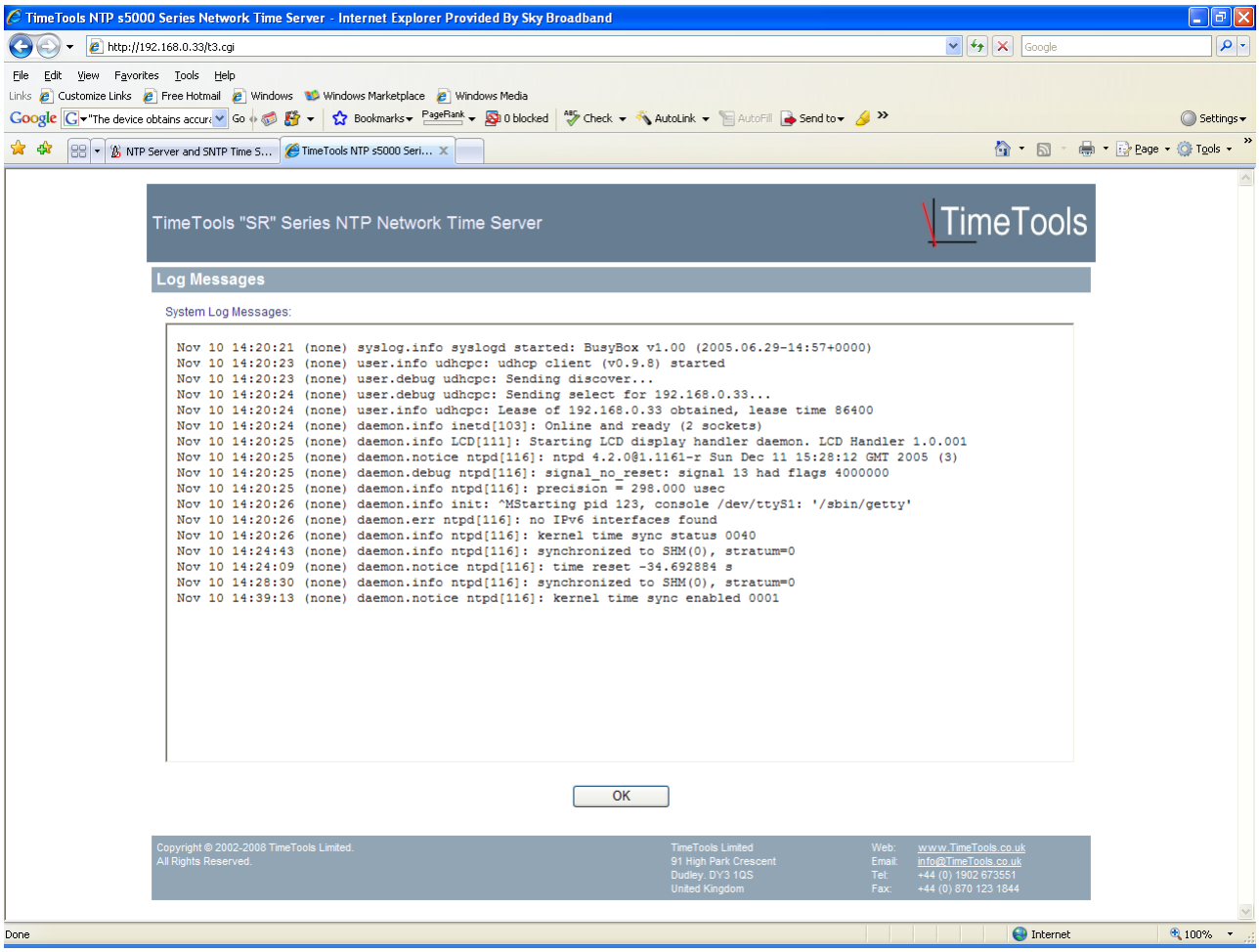
Satellite Lock:	Indicates whether a satellite lock has been achieved.
Satellites Used:	The number of GPS satellites used in the last time and position fix calculation. Range 0 to 12.
Satellites in View:	The total number of satellites in view. Range 0 to 12. 0 indicates no satellites currently in view.
Mode:	In manual mode, the receiver is forced to operate in either 2D or 3D mode. However, the NTP server operates the receiver in automatic mode, where the receiver is allowed to switch between 2D and 3D modes subject to the PDOP and satellite masks.
Current Mode:	Indicates receivers current fix mode: fix not available, 2D positioning or 3D positioning. 2D positioning is the minimum required for timing purposes.
PDOP, HDOP, VDOP:	Position, horizontal and vertical dilution of position. A low DOP value represents a better GPS positional precision due to the wider angular separation between the satellites used to calculate a GPS units position. Typically a value of 1 to 5 is good, 5 to 20 moderate, above 20 poor. These values only provide postioning dulution, they should not be used

to provide an indication of timing accuracy.

GPS Satellite Information

PRN:	A satellite PRN number uniquely identifies each particular GPS satellite. Values range from 1 to 32.
Used:	An asterisk next to the satellite PRN number indicates that the satellite is currently in use and is being tracked.
Elevation, Azimuth:	Satellite elevation and azimuth, in degrees. This shows the actual position of the satellite in the sky.
SNR:	Signal to noise ratio of the signal received from the satellite. This is a number between 0 and 99, where 99 indicates a perfect signal and 0 indicates the satellite is unavailable. Typically, a good SNR value for a satellite signal is around 40. Generally satellites with a SNR value of over 25 will be tracked.

10.5. Log Messages



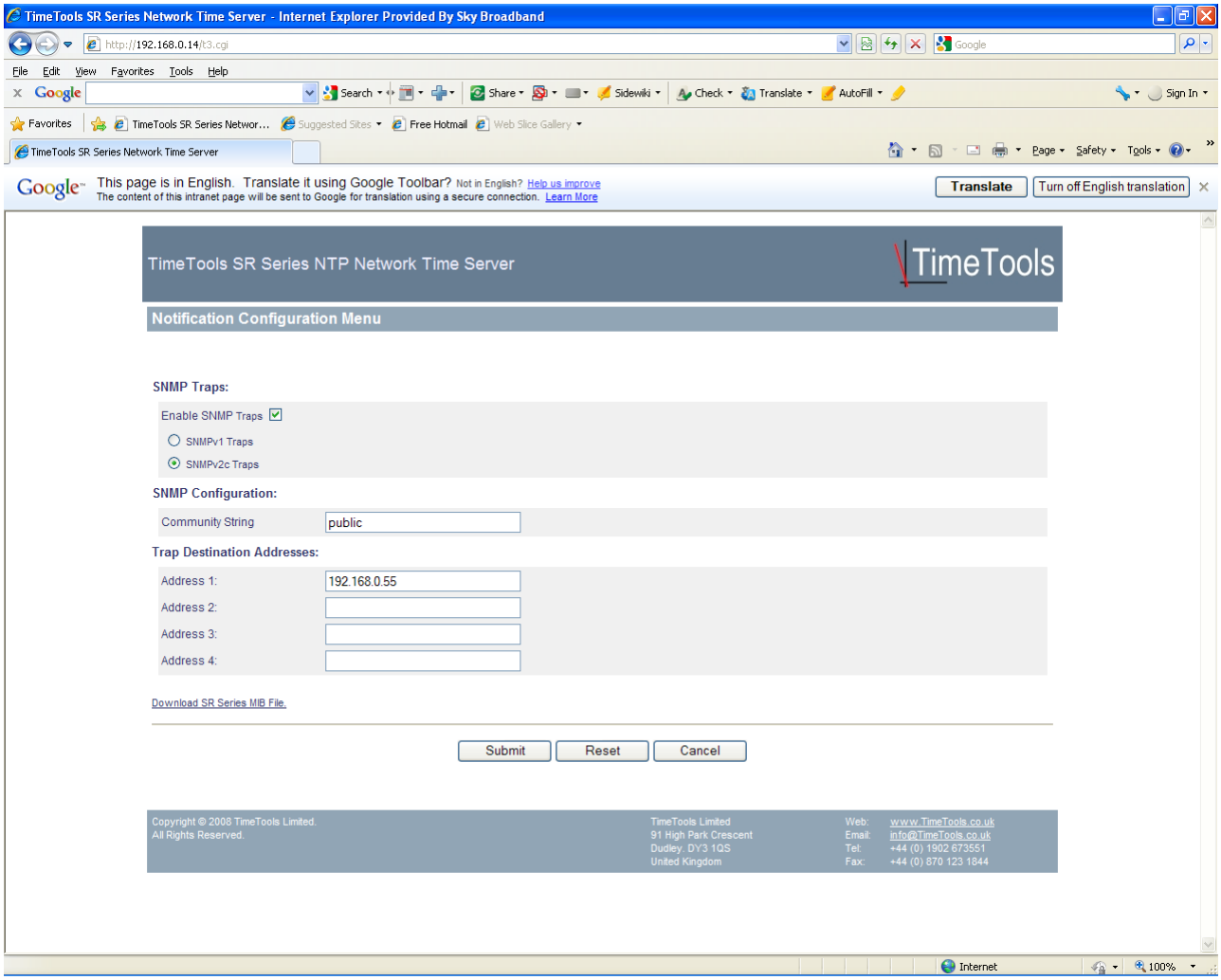
The log messages window displays the current contents of the system log. This includes all NTP information and error messages. The log display is periodically automatically refreshed.

See ‘System Log (SysLog) Messages’ section for a list of generated messages.

10.6. Notification Configuration Menu

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.

Note: The Notification Configuration Menu is not available on SR7110 and SC7105 models.



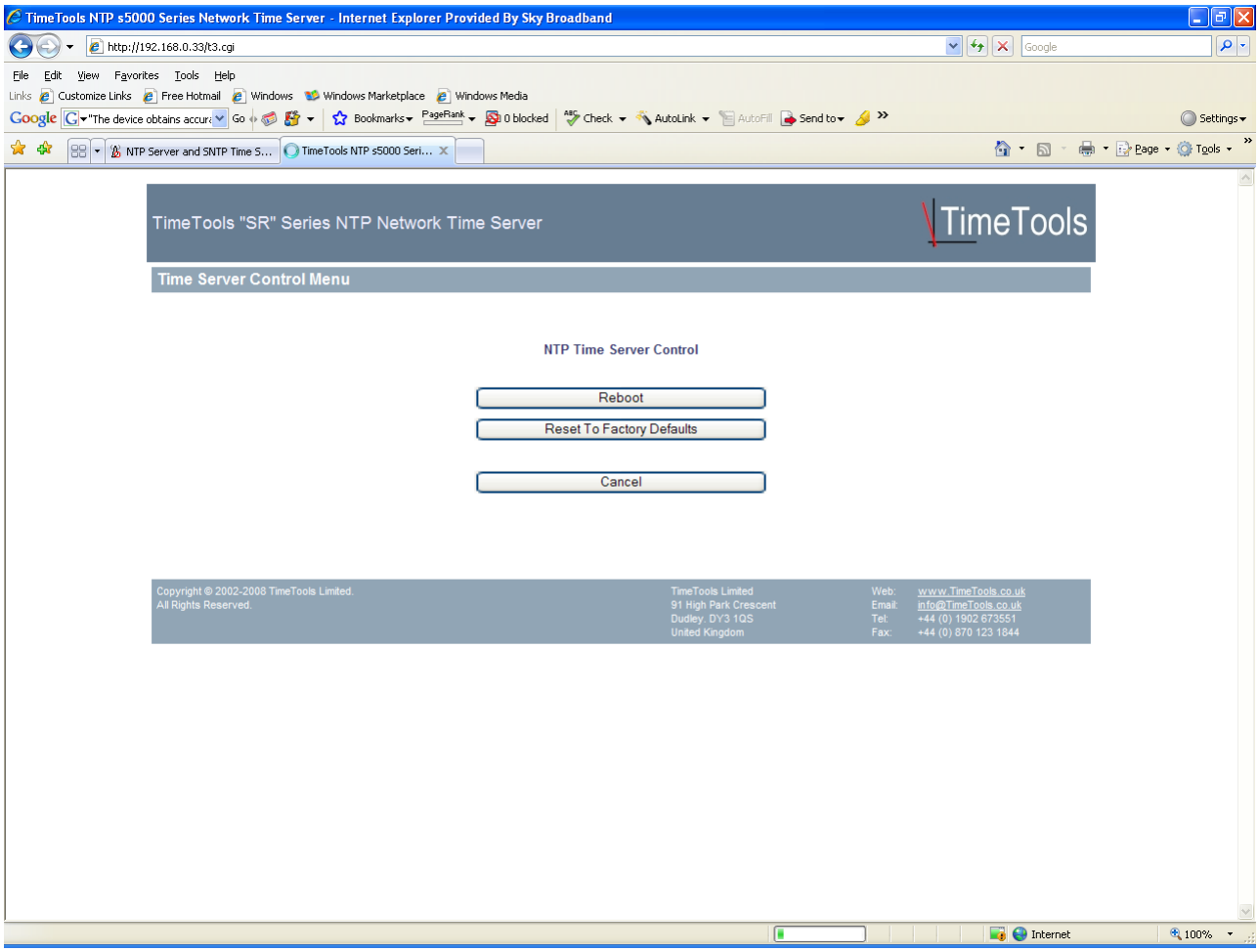
The SR\SC series supports SNMP v1 and v2c traps. When configured, the SR\SC series can send SNMP traps to up to 4 separate SNMP management systems, each specified by their IP address. The SR\SC series Management Information Base (MIB) file is available for download from the Notification Configuration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

The SR\SC series provides the following traps:

TmtSrTrapHeartbeat	*tmtSrTraps 10*	*"trap sent periodically to indicate that time server is functioning"*
TmtSrTrapSystemStart	*tmtSrTraps 11*	*"trap sent to indicate that time server has started "*
TmtSrTrapGpsNoComm	*tmtSrTraps 20*	*"trap sent to indicate GPS receiver communications error"*
TmtSrTrapGpsNoComm	*tmtSrTraps 20*	*"trap sent to indicate GPS receiver communications error"*
tmtSrTrapGpsBad	*tmtSrTraps 21*	*"trap sent when GPS receiver time is too far from time servers time in order to synchronise"*
TmtSrTrapGpsNoLock	*tmtSrTraps 22*	*"trap sent when GPS receiver has no signal lock"*
TmtSrTrapGpsLock	*tmtSrTraps 23*	*"trap sent when the GPS receiver has regained signal lock"*

TmtSrTrapLfTimeout	*tmtSrTraps 24*	*"trap sent when LF receiver is not synchronised"*
TmtSrTrapLfOk	*tmtSrTraps 25*	*"trap sent when LF receiver has re-synchronised"*
tmtSrTrapLfBad	*tmtSrTraps 26*	*"trap sent when LF receiver time is too far from time servers time in order to synchronise"*
TmtSrTrapNtpNoSync	*tmtSrTraps 41*	*"trap sent when NTP is not synchronised"*
TmtSrTrapNtpSyncOk	*tmtSrTraps 42*	*"trap sent when NTP is synchronised"*

10.7. Time Server Control 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 passwords will also revert back to their defaults.

11. Uploading User Generated SSL Certificates

The SR9xxx and SC9xxx models can accept a user generated SSL certificate for authentication. The user generated certificate must be uploaded into the SR series '/tmp/admin' directory using ftp. The uploaded certificate then needs to be saved into flash using the 'certsave' command available from a console 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.

12. Console Configuration

12.1. RS232 Console Configuration

Use the console configuration cable provided to connect the ‘console’ port of the SR 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.

12.2. Dumb Terminal Configuration Settings

Connect Using:	Direct to COMx	(where x is the com port number)
Bits per second:	9600	
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’.

12.3. Telnet Session via Remote Host

The time server can be configured remotely using a telnet session configured for VT100 emulation. From a host computer type:

```
telnet –t vt100 xxx.xxx.xxx.xxx
```

where xxx.xxx.xxx.xxx is the IP address of the time server. On successful connection, the login prompt will appear.

12.4. 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 (SR9xxx and SC9xxx models only).

12.5. Logging On

The default username and password is ‘admin’.

```
Linux 2.4.31 (NTP001) (0)

NTP001 login: admin
Password:
```

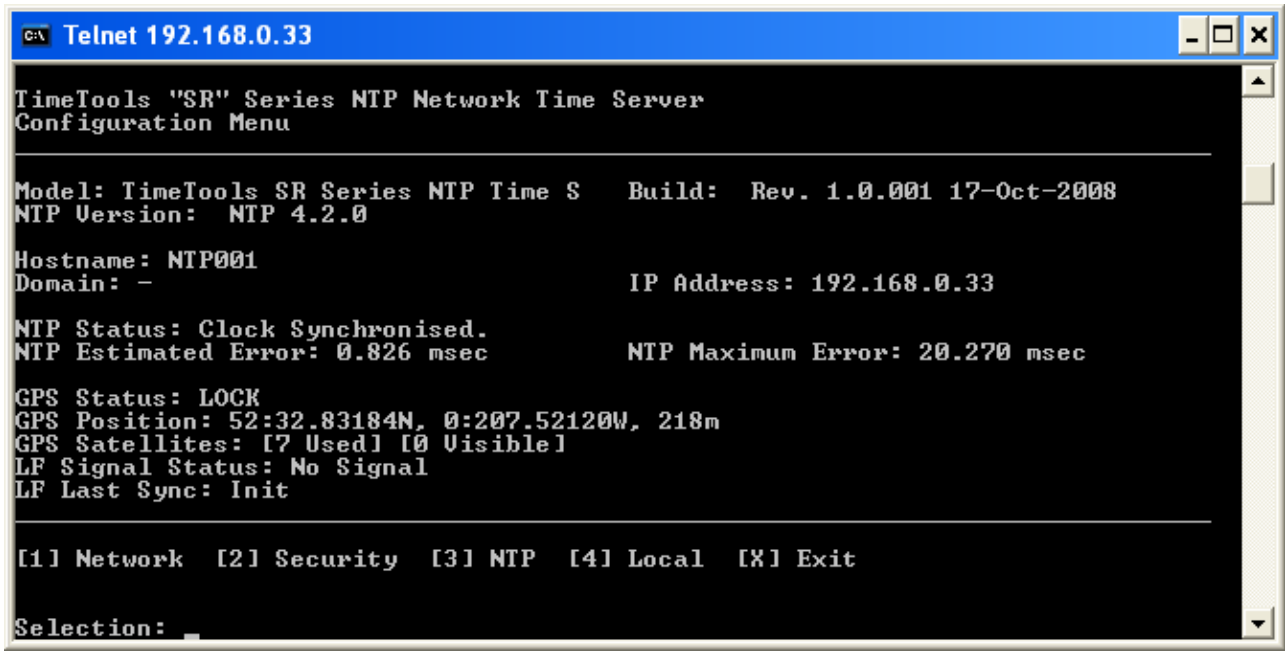
The console configuration menu can be entered by typing ‘console’ at the prompt:

```
/tmp/admin $console
```

The console application provides an easy to use configuration and status tool that is similar in format to the web interface menus.

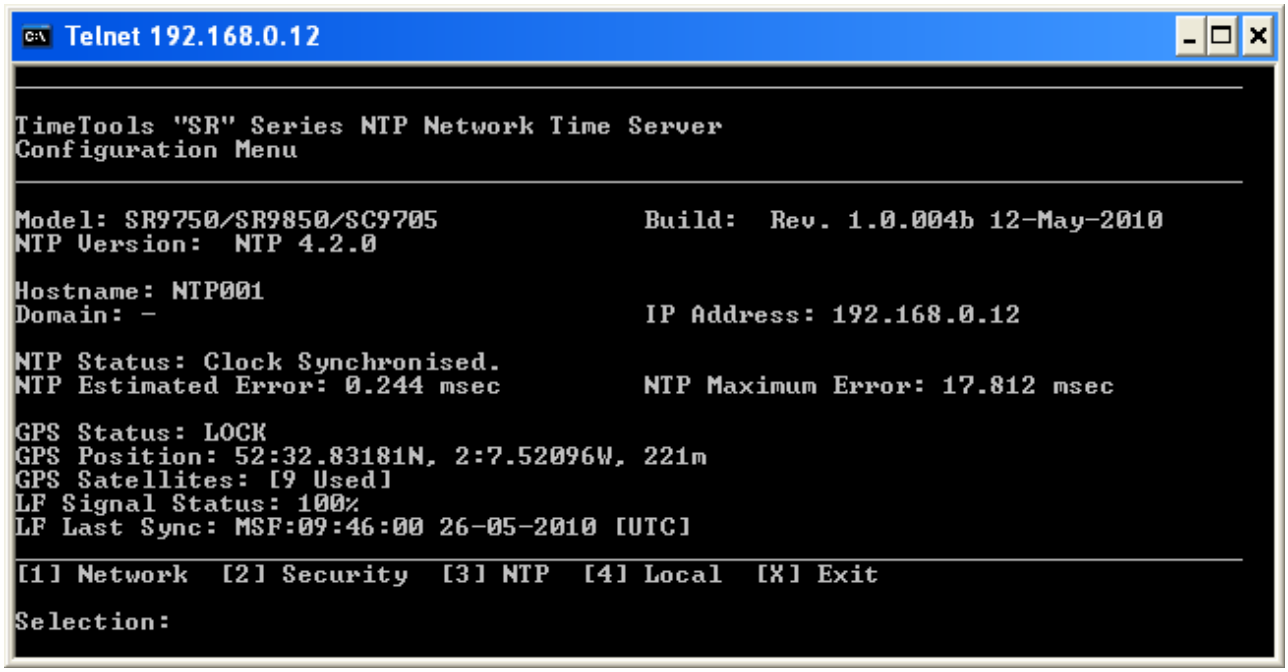
If the SR series detects no key-presses over a period of 5 minutes, then the console configuration menu will automatically exit.

12.6. Configuration Menu



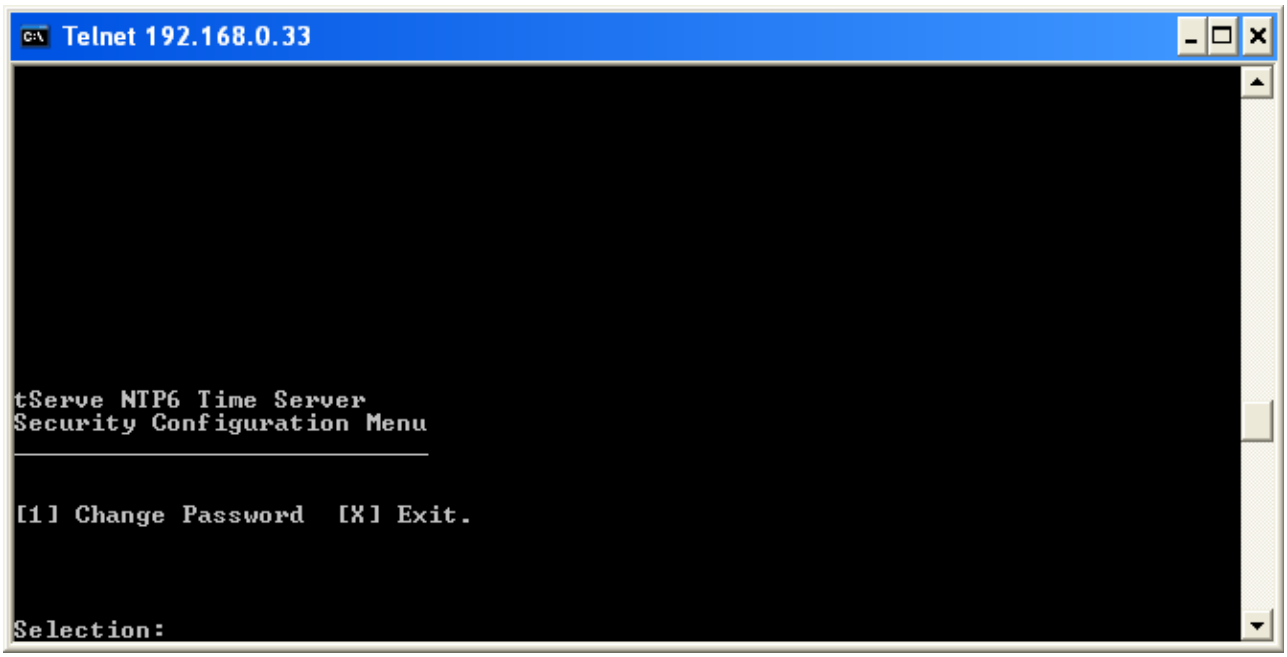
The configuration menu provides network, NTP and reference clock status information.

12.7. Network Configuration Menu



The network configuration menu displays the time server network configuration and allows settings to be modified. In order for any network changes to take effect, the time server should be rebooted.

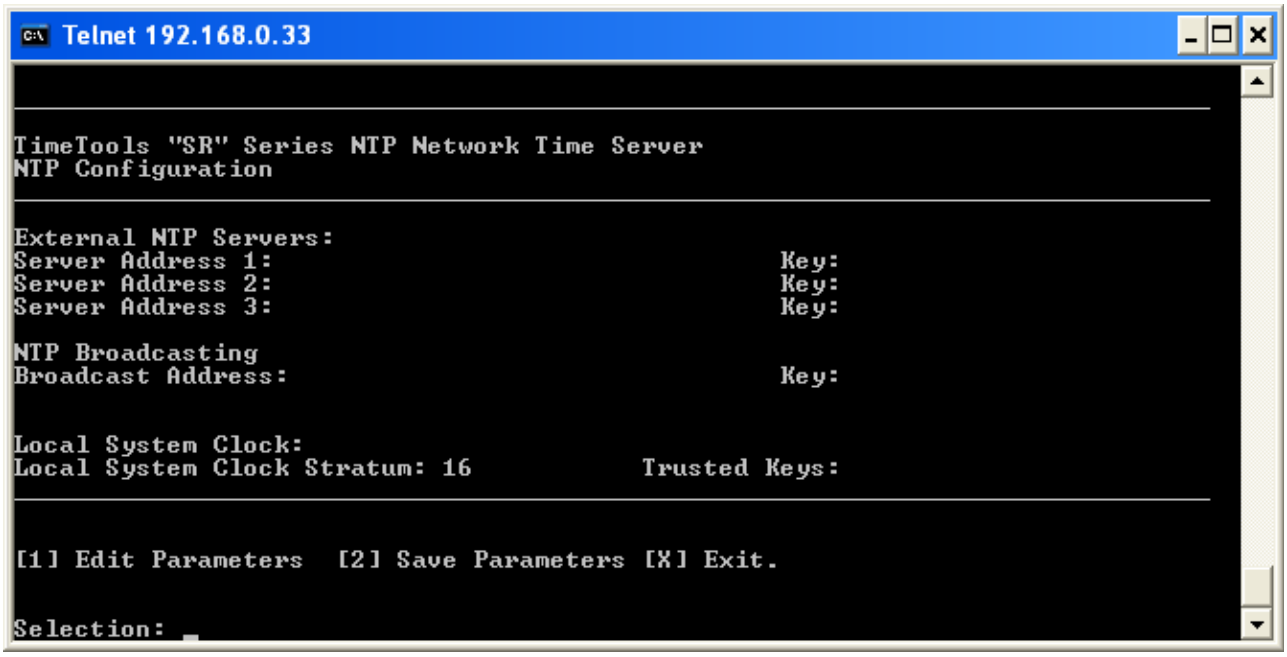
12.8. Security Configuration Menu



Change Password - Change 'admin' password for console and telnet connection.

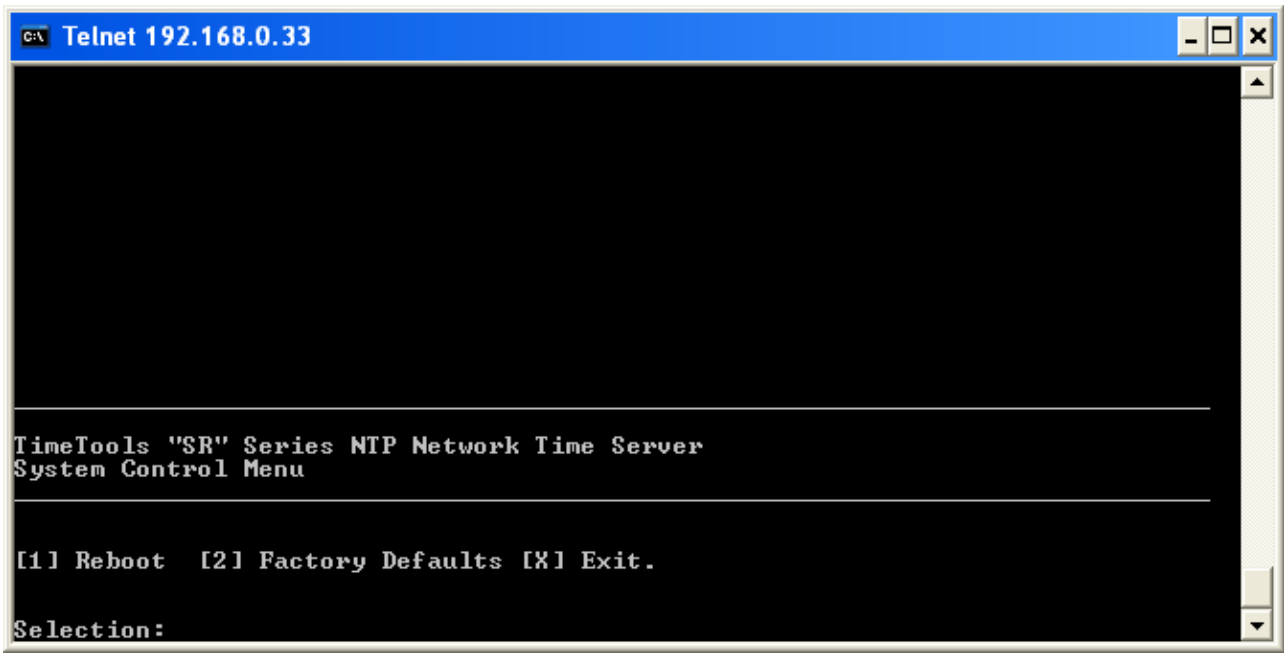
A separate password exists for http (web interface) sessions. The http (web interface) password can only be changed from the web interface.

12.9. NTP Configuration



Display and edit NTP configuration parameters.

12.10. System Control Menu



Allow time server to be rebooted and revert to factory settings.

In order for any network changes to take effect, the time-server should be rebooted.

Reverting to factory defaults does not affect the ‘console’ password. However the http web password reverts to ‘admin’.

13. System Log (SysLog) 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 from the /tmp/admin folder using ftp, the log tab of the system web page or by remote syslog messaging.

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

Type	Log Message	Model	Description
Error	ERROR: GPS communications timedout.	All Models (GPS)	Communications error with GPS receiver – possible hardware fault.
Warning	No GPS signal lock.	All Models (GPS)	GPS signal lock lost – possibly due to poor antenna location or faulty GPS antenna / cable.
Warning	LF radio reception timedout.	All Models (LF)	No valid radio timestamp received during last 3 minutes – possibly due to poor radio antenna location or faulty antenna / cable.
Warning (Debug)	Warning: TCXO oscillator calibration after %f secs outside expected range. (%f - %f) / %f = %f secs	SR9750/9850/SC9705	Invalid TCXO calibration to GPS/LF radio references – possible hardware fault.
Warning	Oscillator freerun period end	SR9750/9850/SC9705	The 24-hour TCXO oscillator stratum -1 holdover free-run period has come to an end.
Information	TimeTools Dual GPS\LF NTP Reference Clock Driver Started.	All Models	Reference clock driver startup message.
Information	GPS signal lock OK.	All Models (GPS)	GPS signal lock regained after loss of signal.
Information	LF radio reception OK.	All Models (LF)	LF radio reception resumed after loss of signal.
Information	Holdover oscillator calibrated.	SR9750/9850/SC9705	TCXO holdover oscillator calibrated to GPS / LF radio and is ready to run, if required.
Information	Oscillator freerun start.	SR9750/9850/SC9705	TCXO oscillator starting free-run stratum-1 holdover – due to loss of GPS / radio reference clock signal.

The following messages are generated by the NTP daemon – all models:

Type	Log Message	Description
Information	precision = 306.000 usec	Estimated system precision.
Information	kernel time sync status 0040	Clock unsynchronised
Notice	kernel time sync disabled 0001	NTP clock unsynchronised.
Notice	kernel time sync enabled 0001	NTP clock synchronised.
Information	synchronized to SHM(0), stratum=0	NTP currently synchronised to GPS reference clock.
Information	synchronized to SHM(1), stratum=0	NTP currently synchronised to LF radio reference clock.
Error	no servers reachable	All specified reference clocks are un-contactable.
Information	time reset ? s	On initial synchronisation, the system time has been adjusted to the correct time.

14. Updating SR Series Firmware

Updating the SR series NTP Server firmware is very straightforward.

1. Obtain Firmware Upgrade

Firmware upgrades can be obtained from http://www.timetools.co.uk/support/.

The firmware upgrade is stored as a compressed tarball that must be uploaded to the time server and unpacked. This is a very simple exercise.

IMPORTANT: Ensure firmware upgrade matches model type of installation unit.
Eg. SR71-x.x.xxx.tgz for TimeTools SR7110 and SC7105 series NTP server models.
SR92-x.x.xxx.tgz for TimeTools SR9210 and SC9205 series NTP server models.
SR97-x.x.xxx.tgz for TimeTools SR9750, SR9850 and SC9705 series NTP server models.

2. Uploading Firmware Using Ftp.

To upload the firmware upgrade to the unit requires the use of an FTP Client such as WS_FTP available from http://www.ipswitch.com/products/file-transfer.asp.

Typical FTP Settings:

Host: **192.168.0.200 (IP address of time server)**
Port: **21 (standard FTP port)**
Host Type: **UNIX (standard)**
User ID: **admin**
Password: **admin**

Change directory to '/tmp/admin'

Upload the firmware upgrade tarball file, **'SRmm-x.x.xxx.tgz'** to /tmp/admin directory.

3. Installing Firmware

From a telnet session, login as 'admin', password 'admin' (unless password modified).

```
>telnet 192.168.0.200
>NTP001 Login: admin
>Password: admin
```

Extract firmware as follows:

```
>extract SRmm-x.x.xxx.tgz          #Execute extract script, where SRmm-x.x.xxx.tgz is the update file.
WARNING: DO NOT TURN OFF OR RESET DEVICE UNTIL UPGRADE COMPLETE !
Update complete.
```

Finally, reboot the time server for the firmware upgrade to take effect.

```
>restart
```

4. Checking New Version Number.

When the unit has restarted, use a web-browser to check that the firmware version number has been updated. The unit has now been successfully updated.

15. NTP Authentication

15.1. 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 `ntpdc` 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 `ntpdc`. This also provides a revocation capability that can be used if a key becomes compromised.

15.2. 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.

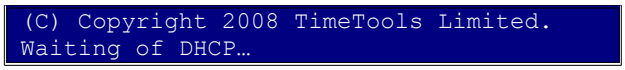
15.3. Trusted Keys

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 ntpdc 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.

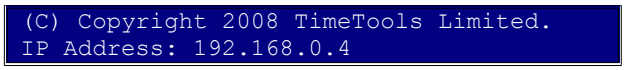
16. SR Series NTP Server Operation – LCD Display

16.1. LCD Display – Initial Power-Up

On power-up the SR Series LCD display will remain blank for approximately 20 seconds, while the unit performs a self-test. The device will then attempt to obtain network settings from a DHCP server.



When network settings are obtained from the network DHCP server, the device will display the assigned DHCP IP address for 5 seconds. The IP address can then be used to configure the device over a network using telnet, SSH, HTTP or SSL (HTTPS) sessions.

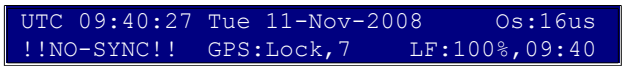


If no DHCP server is present on the network, the device will not be assigned an IP address. Configuration will therefore need to be carried out using the serial RS232 console connection to a PC serial port and dumb terminal emulator, see section ‘Console Configuration’.

16.2. LCD Display – Initial Operation

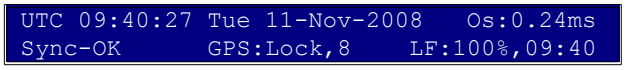
When network settings have been obtained, the device will then show its normal status display. The current UTC (Coordinated Universal Time) time and date, which is held internally by the devices real-time clock, will be shown. The current time offset compared to any available external time references will be shown, this defaults to 16usec on start-up. Synchronisation ‘Sync-Init’ indicates that the device is waiting for external time references to come online. GPS status ‘GPS:NoLock,0’ indicates that no GPS satellite lock has yet been achieved. LF radio status ‘LF:Nsig,Init’ indicates that no LF radio signal is currently being received.

When a GPS or radio 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.



16.3. LCD Display – Normal Operation

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



UTC	The current synchronised time maintained by the device. This is displayed as UTC time (Coordinated Universal Time).
Os	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 and also with the SR series model.
Sync-OK	Denotes that the device is synchronised and can serve network time clients with the correct time.
GPS:Lock,8	Signifies that a GPS signal lock has been achieved along with the number of satellites in currently in

use. If no GPS antenna is connected to the device and other external clock references are being utilised, this field will remain as 'GPS:NoLock,0'.

LF:100%,09:40 Signifies that a good (100%) radio signal is currently being received along with the time of the last correctly decoded LF time-stamp. If the indicator falls below 100% then broadcast time-stamp data is being lost, which will result in failure to decode transmitted time and date information. The time indicates the last correctly decoded broadcast LF radio time stamp. Most radio transmissions broadcast time data each minute, therefore, ideally this time should increment each minute as new timestamps are received.

16.4. 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.

16.5. 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 GPS status or the LF radio status will show 'BAD' indicating too great a difference between the received reference clock time-stamp and the devices system time.

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

17. Correcting the System Time

If 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 correctly occur. The LCD or web configuration fields GPS status or LF radio status will show 'Bad' when a GPS or radio 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 telnet session and logging into the device and using the 'setclock' command.

```
C:\>telnet 192.168.0.10                  # where 192.168.0.10 is the IP address of the NTP server.
Linux 2.4.31 (NTP001) (0)
NTP001 login: admin                      # username: admin
password:admin                           # default password: admin
BusyBox v1.00 (2005.06.29-14:57+0000)
Built-in shell (ash)
Enter 'help' for a list of built-in commands.

/tmp/admin $ setclock 081214222010       # set the devices system time (UTC)
Thu Aug 12 14:22:00 UTC 2010
/tmp/admin $ exit                        # exit the telnet session
Connection to host lost.
C:\>
```

The setclock command has the following syntax:

setclock mmddHHMMyyyy

where:

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

18. SR Series System Logs

System Log

File Location: /tmp/admin/messages
View using: 'cat /tmp/admin/messages' from console or use FTP or Web interface

```
Dec 28 11:12:13 (none) syslog.info syslogd started: BusyBox v1.00 (2005.06.29-14:57+0000)
Dec 28 11:12:13 (none) daemon.info inetd[76]: Online and ready (2 sockets)
Dec 28 11:12:14 (none) daemon.info LCD[84]: Starting LCD display handler daemon. LCD Handler 1.1.000
Dec 28 11:12:14 (none) daemon.notice ntpd[89]: ntpd 4.2.0@1.1161-r Sun Dec 11 15:28:12 GMT 2005 (3)
Dec 28 11:12:14 (none) daemon.debug ntpd[89]: signal_no_reset: signal 13 had flags 4000000
Dec 28 11:12:14 (none) daemon.info ntpd[89]: precision = 2.000 usec
Dec 28 11:12:14 (none) daemon.info ntpd[89]: kernel time sync status 0040
Dec 28 11:12:14 (none) daemon.info ntpd[89]: frequency initialized 8 PPM from /tmp/config/ntp.drift
Dec 28 11:16:33 (none) daemon.info ntpd[89]: synchronized to SHM(0), stratum=0
Dec 28 11:16:33 (none) daemon.notice ntpd[89]: kernel time sync disabled 0041
Dec 28 11:17:39 (none) daemon.notice ntpd[89]: kernel time sync enabled 0001
```

NTP LoopStats

File Location: /tmp/admin/loopstats
View using: 'cat /tmp/admin/loopstats' from console or use FTP or Web interface
Days Kept: 3 days, stored as /tmp/admin/loopstats.yyyymmdd
Description: Records loop filter statistics information. 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.

NTP ClockStats

File Location: /tmp/admin/clocklog-gps-yyyymmdd where yyyymmdd is the current date.
View using: 'cat /tmp/admin/clocklog-gps-yyyymmdd ' from console or use FTP
Days Kept: 1 day
Description: Records GPS reference clock statistics information. Each update of the local clock outputs a line of the following form to the file generation set named `clocklog-gps`:

```
29.12.2005-16:20:29) GPS Time Received: 16:20:30 29-12-2005 [UTC]
```

The first field records the time and date the reference clock time stamp was received followed by the received time stamp.

File Location: /tmp/admin/clocklog-lf-yyyymmdd where yyyymmdd is the current date.
View using: 'cat /tmp/admin/clocklog-lf-yyyymmdd ' from console or use FTP
Days Kept: 1 day
Description: Records LF (MSF\DCF-77) reference clock statistics information. Each update of the local clock outputs a line of the following form to the file generation set named `clocklog-lf`:

```
29.12.2005-16:20:29) MSF Time Received: 16:20:30 29-12-2005 [UTC]
```

The first field records the time and date the reference clock time stamp was received followed by the received time stamp.

19. Appendix A: Specifications

Firmware

Linux Version:	2.4.31
Supported Protocols	NTP 4.2.0, SNTP, TCP/IP, Telnet, FTP, HTTP, RS232 Console
Supported Secure Configuration Protocols	HTTPS, SSH (SR9xxx\SC9xxx models only)
Compatible Clients	NTP2, NTP3, NTP4, SNTP3, SNTP4

Hardware

Ethernet:	10/100 BaseT RJ45 Auto sensing
Enclosure:	1U High 19" Rack-mountable
Construction:	1.8mm Aluminium
Dimensions:	483 x 205 x 44 mm
Weight:	2.2Kg
Operating Temperature:	0C ~ +50C (SR Series) 0C ~ +70C (SC Series)
Power Supply	Universal 100-240 VAC 50-60 Hz CE/UL/CSA Approved PSU
Power Consumption (typical):	5W approx.
Heat Output (typical):	18 Btu/Hr

GPS Receiver Specification – SRxxxx-10 and SCxxxx-10 models

Accuracy (24 hr static)	
Horizontal	.<2.5 m 50%, <5 m 90%
SBAS	.<2.0 m 50%, <4 m 90%
Altitude	<5 m 50%, <8 m 90%
SBAS	<3 m 50%, <5 m 90%
Velocity	0.06 m/sec
Static PPs	.+/- 60ns RMS
PPS (Stationary Mode "indoor" @ -145dBm)	. +/-350ns
Acquisition (Autonomous, -130dBm, 50%)	
Reacquisition	2 s
Hot Start	3 s
Warm Start	35 s
Cold Start	38 s
Sensitivity (unaided)	
Tracking	.-160 dBm
Acquisition	.-148 dBm
Receiver Dynamics	2G
GPS Antenna Connector	TNC Female

20. Appendix B: Optional LF Radio Antenna

The SR Series NTP Server can be supplied with either MSF or DCF-77 radio antennas. The MSF transmitter is located at Anthorn, Cumbria, UK. The coverage of the MSF transmitter is the whole of the British Isles and can often be received in much of North Western Europe. The DCF-77 transmitter is located at Frankfurt, Germany. The coverage of the DCF-77 transmitter is Central and North-Western Europe.

Four versions of LF radio antenna are available with the SR Series NTP Server.

MLS - TimeTools Standard MSF radio antenna.
DLS - TimeTools Standard DCF-77 radio antenna.
MXS - TimeTools High Gain MSF radio antenna for weak signal strength areas.
DXS - TimeTools High Gain DCF-77 radio antenna for weak signal strength areas.

20.1. MLS \ DLS Antenna Installation

The MLS\DLS LF antenna is a unidirectional active ferrite antenna. The antenna should be installed in a horizontal plane at right angles to the source of the radio transmission. The antenna incorporates a red\green LED which flashes in tune to the LF radio transmission. Ideally, the antenna needs to be located where a consistent red\green flash can be observed once per second. If the antenna LED flashes erratically or if the LED is completely red or green, the antenna may need to be relocated.

The antenna can be located up to 100m from the time server using CAT3 or better patch lead or structured cabling.

Fig: MLS \ DLS LF Radio Antenna

Dimensions:	Length 76mm; Width: 35mm; Height: 20mm
Weight:	180g
Connector:	9 way ‘D’ female
Cable length:	2m
Maximum Cable Length:	100m (CAT3 or better, serial extension cable)

20.2. MXS \ DXS Antenna Installation

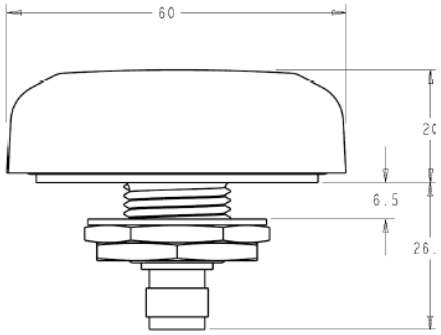
The MXS\DXS LF antenna is a unidirectional high-gain active ferrite antenna ideal for low signal strength areas. The antenna should be installed in a horizontal plane at right angles to the source of the radio transmission. The antenna incorporates a red\green LED which flashes in tune to the LF radio transmission. Ideally, the antenna needs to be located where a consistent red\green flash can be observed once per second. If the antenna LED flashes erratically or if the LED is completely red or green, the antenna may need to be relocated.

The antenna is provided with 5m of cable which can be extended up to 100m using RG58 coax.

Fig: MXS \ DXS High Gain LF Radio Antenna

Dimensions:	Length 210mm; Diameter: 20mm;
Weight:	200g
Connector:	BNC male
Cable length:	5m
Maximum Cable Length:	100m (RG58)

21. Appendix C: Optional High-Gain GPS Antenna



Environmental Specifications

Operating temp: -40c to +85c (-45c to +85c storage)
Weather Proof: IP67

Mechanical

Dimensions: 60 mm dia. x 21 mm H
Weight: 50g
Housing: GE Lexan EXL9330,
Mounting: ¾" thru-hole or bracket mount
Connector: TNC jack connector
Shock: Vertical axis 50G, Other axes 30G
Vibration: 3 axis, sweep = 15 min
10 –200 Hz log sweep: 3G

Antenna Response

Frequency: 1575.42 MHz
Gain: @ 90° 3 dBic
@ 20° -2.0 dBic
Polarization: Right Hand Circular
Axial ratio: @ 90° 4 dB
@ 20° 6 dB

Electrical

Voltage: 2.7 to 5.5 VDC
Current: 15mA
ESD circuit protection: 15KV

LNA Specifications

Frequency: 1572.5 – 1578 MHz
Output Impedance: 50 Ohm
VSWR: 1.5:1 max (at connector)
Gain: 40 dB (typical)
Noise figure: 0.5 dB (typical)

22. Appendix D: Optional GPS Surge Suppressor Specification

- Industries best RF performance
- Low throughput energy
- Multi-strike capability

Technical Specifications:

Current:	4Adc
Insertion Loss:	≤ 0.1dB
Freq. Range:	800-2500MHz
Mounting:	Bulkhead Flange
Operating Voltage:	+ / -6 Volts
Polarity:	+/-
Protected Side Connector:	N Female 50Ω
RF Power:	0.25 Watts
Surge Side Connector:	N Female 50Ω
Throughput Energy:	≤ 175µJ for 3kA @ 8/20µs Waveform
Turn-On Voltage:	7 Volts
Unit Impedance:	50Ω
Voltage Standing Wave Ratio:	1.1 : 1
Weatherised:	Bellcore #TA-NWT-000487 Procedure 4.11, Wind Driven (120 mph) Rain Intrusion.
UL Approved and Listed	UL497B

23. Appendix E: Copyright and Permission Notices

23.1. Network Time Protocol (NTP) 4.2

```
*********************************************************************
*                                                                   *
* Copyright (c) David L. Mills 1992-2005                            *
*                                                                   *
* Permission to use, copy, modify, and distribute this software and *
* its documentation for any purpose and without fee is hereby       *
* granted, provided that the above copyright notice appears in all  *
* copies and that both the copyright notice and this permission     *
* notice appear in supporting documentation, and that the name      *
* University of Delaware not be used in advertising or publicity    *
* pertaining to distribution of the software without specific,      *
* written prior permission. The University of Delaware makes no     *
* representations about the suitability this software for any       *
* purpose. It is provided "as is" without express or implied        *
* warranty.                                                         *
*                                                                   *
*********************************************************************
```

23.2. GNU Public Licence

```
GNU GENERAL PUBLIC LICENSE
                       Version 2, June 1991

 Copyright (C) 1989, 1991 Free Software Foundation, Inc.
                       51 Franklin St, Fifth Floor, Boston, MA  02110-1301  USA
 Everyone is permitted to copy and distribute verbatim copies
 of this license document, but changing it is not allowed.

                            Preamble

  The licenses for most software are designed to take away your
freedom to share and change it.  By contrast, the GNU General Public
License is intended to guarantee your freedom to share and change free
software--to make sure the software is free for all its users.  This
General Public License applies to most of the Free Software
Foundation's software and to any other program whose authors commit to
using it.  (Some other Free Software Foundation software is covered by
the GNU Library General Public License instead.)  You can apply it to
your programs, too.

  When we speak of free software, we are referring to freedom, not
price.  Our General Public Licenses are designed to make sure that you
have the freedom to distribute copies of free software (and charge for
this service if you wish), that you receive source code or can get it
if you want it, that you can change the software or use pieces of it
in new free programs; and that you know you can do these things.

  To protect your rights, we need to make restrictions that forbid
anyone to deny you these rights or to ask you to surrender the rights.
These restrictions translate to certain responsibilities for you if you
distribute copies of the software, or if you modify it.

  For example, if you distribute copies of such a program, whether
gratis or for a fee, you must give the recipients all the rights that
you have.  You must make sure that they, too, receive or can get the
```

source code. And you must show them these terms so they know their rights.

  We protect your rights with two steps: (1) copyright the software, and (2) offer you this license which gives you legal permission to copy, distribute and/or modify the software.

  Also, for each author's protection and ours, we want to make certain that everyone understands that there is no warranty for this free software. If the software is modified by someone else and passed on, we want its recipients to know that what they have is not the original, so that any problems introduced by others will not reflect on the original authors' reputations.

  Finally, any free program is threatened constantly by software patents. We wish to avoid the danger that redistributors of a free program will individually obtain patent licenses, in effect making the program proprietary. To prevent this, we have made it clear that any patent must be licensed for everyone's free use or not licensed at all.

  The precise terms and conditions for copying, distribution and modification follow.

GNU GENERAL PUBLIC LICENSE
TERMS AND CONDITIONS FOR COPYING, DISTRIBUTION AND MODIFICATION

  0. This License applies to any program or other work which contains a notice placed by the copyright holder saying it may be distributed under the terms of this General Public License. The "Program", below, refers to any such program or work, and a "work based on the Program" means either the Program or any derivative work under copyright law: that is to say, a work containing the Program or a portion of it, either verbatim or with modifications and/or translated into another language. (Hereinafter, translation is included without limitation in the term "modification".) Each licensee is addressed as "you".

Activities other than copying, distribution and modification are not covered by this License; they are outside its scope. The act of running the Program is not restricted, and the output from the Program is covered only if its contents constitute a work based on the Program (independent of having been made by running the Program). Whether that is true depends on what the Program does.

  1. You may copy and distribute verbatim copies of the Program's source code as you receive it, in any medium, provided that you conspicuously and appropriately publish on each copy an appropriate copyright notice and disclaimer of warranty; keep intact all the notices that refer to this License and to the absence of any warranty; and give any other recipients of the Program a copy of this License along with the Program.

You may charge a fee for the physical act of transferring a copy, and you may at your option offer warranty protection in exchange for a fee.

  2. You may modify your copy or copies of the Program or any portion of it, thus forming a work based on the Program, and copy and distribute such modifications or work under the terms of Section 1 above, provided that you also meet all of these conditions:

    a) You must cause the modified files to carry prominent notices stating that you changed the files and the date of any change.

b) You must cause any work that you distribute or publish, that in whole or in part contains or is derived from the Program or any part thereof, to be licensed as a whole at no charge to all third parties under the terms of this License.

c) If the modified program normally reads commands interactively when run, you must cause it, when started running for such interactive use in the most ordinary way, to print or display an announcement including an appropriate copyright notice and a notice that there is no warranty (or else, saying that you provide a warranty) and that users may redistribute the program under these conditions, and telling the user how to view a copy of this License. (Exception: if the Program itself is interactive but does not normally print such an announcement, your work based on the Program is not required to print an announcement.)

These requirements apply to the modified work as a whole. If identifiable sections of that work are not derived from the Program, and can be reasonably considered independent and separate works in themselves, then this License, and its terms, do not apply to those sections when you distribute them as separate works. But when you distribute the same sections as part of a whole which is a work based on the Program, the distribution of the whole must be on the terms of this License, whose permissions for other licensees extend to the entire whole, and thus to each and every part regardless of who wrote it.

Thus, it is not the intent of this section to claim rights or contest your rights to work written entirely by you; rather, the intent is to exercise the right to control the distribution of derivative or collective works based on the Program.

In addition, mere aggregation of another work not based on the Program with the Program (or with a work based on the Program) on a volume of a storage or distribution medium does not bring the other work under the scope of this License.

3. You may copy and distribute the Program (or a work based on it, under Section 2) in object code or executable form under the terms of Sections 1 and 2 above provided that you also do one of the following:

a) Accompany it with the complete corresponding machine-readable source code, which must be distributed under the terms of Sections 1 and 2 above on a medium customarily used for software interchange; or,

b) Accompany it with a written offer, valid for at least three years, to give any third party, for a charge no more than your cost of physically performing source distribution, a complete machine-readable copy of the corresponding source code, to be distributed under the terms of Sections 1 and 2 above on a medium customarily used for software interchange; or,

c) Accompany it with the information you received as to the offer to distribute corresponding source code. (This alternative is allowed only for noncommercial distribution and only if you received the program in object code or executable form with such an offer, in accord with Subsection b above.)

The source code for a work means the preferred form of the work for making modifications to it. For an executable work, complete source code means all the source code for all modules it contains, plus any

associated interface definition files, plus the scripts used to control compilation and installation of the executable. However, as a special exception, the source code distributed need not include anything that is normally distributed (in either source or binary form) with the major components (compiler, kernel, and so on) of the operating system on which the executable runs, unless that component itself accompanies the executable.

If distribution of executable or object code is made by offering access to copy from a designated place, then offering equivalent access to copy the source code from the same place counts as distribution of the source code, even though third parties are not compelled to copy the source along with the object code.

4. You may not copy, modify, sublicense, or distribute the Program except as expressly provided under this License. Any attempt otherwise to copy, modify, sublicense or distribute the Program is void, and will automatically terminate your rights under this License. However, parties who have received copies, or rights, from you under this License will not have their licenses terminated so long as such parties remain in full compliance.

5. You are not required to accept this License, since you have not signed it. However, nothing else grants you permission to modify or distribute the Program or its derivative works. These actions are prohibited by law if you do not accept this License. Therefore, by modifying or distributing the Program (or any work based on the Program), you indicate your acceptance of this License to do so, and all its terms and conditions for copying, distributing or modifying the Program or works based on it.

6. Each time you redistribute the Program (or any work based on the Program), the recipient automatically receives a license from the original licensor to copy, distribute or modify the Program subject to these terms and conditions. You may not impose any further restrictions on the recipients' exercise of the rights granted herein. You are not responsible for enforcing compliance by third parties to this License.

7. If, as a consequence of a court judgment or allegation of patent infringement or for any other reason (not limited to patent issues), conditions are imposed on you (whether by court order, agreement or otherwise) that contradict the conditions of this License, they do not excuse you from the conditions of this License. If you cannot distribute so as to satisfy simultaneously your obligations under this License and any other pertinent obligations, then as a consequence you may not distribute the Program at all. For example, if a patent license would not permit royalty-free redistribution of the Program by all those who receive copies directly or indirectly through you, then the only way you could satisfy both it and this License would be to refrain entirely from distribution of the Program.

If any portion of this section is held invalid or unenforceable under any particular circumstance, the balance of the section is intended to apply and the section as a whole is intended to apply in other circumstances.

It is not the purpose of this section to induce you to infringe any patents or other property right claims or to contest validity of any such claims; this section has the sole purpose of protecting the integrity of the free software distribution system, which is

implemented by public license practices. Many people have made generous contributions to the wide range of software distributed through that system in reliance on consistent application of that system; it is up to the author/donor to decide if he or she is willing to distribute software through any other system and a licensee cannot impose that choice.

This section is intended to make thoroughly clear what is believed to be a consequence of the rest of this License.

8. If the distribution and/or use of the Program is restricted in certain countries either by patents or by copyrighted interfaces, the original copyright holder who places the Program under this License may add an explicit geographical distribution limitation excluding those countries, so that distribution is permitted only in or among countries not thus excluded. In such case, this License incorporates the limitation as if written in the body of this License.

9. The Free Software Foundation may publish revised and/or new versions of the General Public License from time to time. Such new versions will be similar in spirit to the present version, but may differ in detail to address new problems or concerns.

Each version is given a distinguishing version number. If the Program specifies a version number of this License which applies to it and "any later version", you have the option of following the terms and conditions either of that version or of any later version published by the Free Software Foundation. If the Program does not specify a version number of this License, you may choose any version ever published by the Free Software Foundation.

10. If you wish to incorporate parts of the Program into other free programs whose distribution conditions are different, write to the author to ask for permission. For software which is copyrighted by the Free Software Foundation, write to the Free Software Foundation; we sometimes make exceptions for this. Our decision will be guided by the two goals of preserving the free status of all derivatives of our free software and of promoting the sharing and reuse of software generally.

NO WARRANTY

11. BECAUSE THE PROGRAM IS LICENSED FREE OF CHARGE, THERE IS NO WARRANTY FOR THE PROGRAM, TO THE EXTENT PERMITTED BY APPLICABLE LAW. EXCEPT WHEN OTHERWISE STATED IN WRITING THE COPYRIGHT HOLDERS AND/OR OTHER PARTIES PROVIDE THE PROGRAM "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE ENTIRE RISK AS TO THE QUALITY AND PERFORMANCE OF THE PROGRAM IS WITH YOU. SHOULD THE PROGRAM PROVE DEFECTIVE, YOU ASSUME THE COST OF ALL NECESSARY SERVICING, REPAIR OR CORRECTION.

12. IN NO EVENT UNLESS REQUIRED BY APPLICABLE LAW OR AGREED TO IN WRITING WILL ANY COPYRIGHT HOLDER, OR ANY OTHER PARTY WHO MAY MODIFY AND/OR REDISTRIBUTE THE PROGRAM AS PERMITTED ABOVE, BE LIABLE TO YOU FOR DAMAGES, INCLUDING ANY GENERAL, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OR INABILITY TO USE THE PROGRAM (INCLUDING BUT NOT LIMITED TO LOSS OF DATA OR DATA BEING RENDERED INACCURATE OR LOSSES SUSTAINED BY YOU OR THIRD PARTIES OR A FAILURE OF THE PROGRAM TO OPERATE WITH ANY OTHER PROGRAMS), EVEN IF SUCH HOLDER OR OTHER PARTY HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

END OF TERMS AND CONDITIONS

How to Apply These Terms to Your New Programs

If you develop a new program, and you want it to be of the greatest possible use to the public, the best way to achieve this is to make it free software which everyone can redistribute and change under these terms.

To do so, attach the following notices to the program. It is safest to attach them to the start of each source file to most effectively convey the exclusion of warranty; and each file should have at least the "copyright" line and a pointer to where the full notice is found.

> <one line to give the program's name and a brief idea of what it does.>
> Copyright (C) <year> <name of author>
>
> This program is free software; you can redistribute it and/or modify it under the terms of the GNU General Public License as published by the Free Software Foundation; either version 2 of the License, or (at your option) any later version.
>
> This program is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU General Public License for more details.
>
> You should have received a copy of the GNU General Public License along with this program; if not, write to the Free Software Foundation, Inc., 51 Franklin St, Fifth Floor, Boston, MA 02110-1301 USA

Also add information on how to contact you by electronic and paper mail.

If the program is interactive, make it output a short notice like this when it starts in an interactive mode:

> Gnomovision version 69, Copyright (C) year name of author
> Gnomovision comes with ABSOLUTELY NO WARRANTY; for details type `show w'.
> This is free software, and you are welcome to redistribute it
> under certain conditions; type `show c' for details.

The hypothetical commands `show w' and `show c' should show the appropriate parts of the General Public License. Of course, the commands you use may be called something other than `show w' and `show c'; they could even be mouse-clicks or menu items--whatever suits your program.

You should also get your employer (if you work as a programmer) or your school, if any, to sign a "copyright disclaimer" for the program, if necessary. Here is a sample; alter the names:

> Yoyodyne, Inc., hereby disclaims all copyright interest in the program `Gnomovision' (which makes passes at compilers) written by James Hacker.
>
> <signature of Ty Coon>, 1 April 1989
> Ty Coon, President of Vice

This General Public License does not permit incorporating your program into proprietary programs. If your program is a subroutine library, you may consider it more useful to permit linking proprietary applications with the library. If this is what you want to do, use the GNU Library General Public License instead of this License.

24. Appendix F: Warranty

TimeTools Limited warrants the SR Series NTP Time Servers to be free from defects in material and workmanship during a three-year period. TimeTools Limited warrants GPS and LF antennas, GPS amplifiers, antenna cables and any integral batteries to be free from defects in material and workmanship during a one-year period. The Warranty begins on the date the unit is shipped from TimeTools.

TimeTools' liability under this Warranty is limited to repairing or replacing, at TimeTools' option, the defective equipment and providing upgrade version changes for firmware. In case of repair, the product must be returned to an authorized TimeTools Solutions Service Center.

This Warranty does not apply if repairs are required due to acts of nature beyond TimeTools' control such as, but not limited to, lightning strikes, power surges, misuse, damage, neglect, or if repairs/modifications have been made or attempted by anyone other than personnel authorized by TimeTools.

**IN NO EVENT WILL TIMETOOLS LIMITED BE LIABLE FOR ANY INDIRECT, SPECIAL,
INCIDENTAL, OR CONSEQUENTIAL DAMAGES FROM THE SALE OR USE OF THIS
PRODUCT.**

**THIS DISCLAIMER APPLIES BOTH DURING AND AFTER THE TERM OF THE WARRANTY.
TIMETOOLS LIMITED DISCLAIMS LIABILITY FOR ANY IMPLIED WARRANTIES, INCLUDING
IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A SPECIFIC PURPOSE.**

Repair and Returns

To obtain service under this Warranty, contact TimeTools at the address below during the Warranty period to receive a Return Material Authorization (RMA) number and shipping instructions. Then ship the product, transportation prepaid, for inspection.

Ship to:
TimeTools Limited
Attn: RMA XXXXXXX
Unit 34, Wombourne Enterprise Park,
Bridgnorth Road, Wombourne,
South Staffordshire.
WV5 0AL
UK

Typical equipment repair or replacement time is seven (7) business days, plus shipping
times. One-way shipping is the Customer's responsibility. TimeTools will return ship the equipment by the same means it was received.

TimeTools will not be responsible for dismounting and remounting of the NTP server, for unauthorized returns or for returns that do not list the RMA number and quantity returned on a packing list attached in plain view on the outside of the shipping container.